# City of Meridian Wastewater Resource Recovery Facility Plan

Prepared for

City of Meridian

Meridian, Idaho

December 19, 2018

STATE OF IDAHO
DEPARTMENT OF
ENVIRONMENTAL QUALITY

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C.L. "Butch" Otter, Governor
John H. Tippets, Director

January 7, 2019

Mr. Clint Dolsby, P.E.
Assistant City Engineer
33 E. Broadway Ave. Suite 200
Meridian Idaho 83642

RE: City of Meridian (*Ada County*)
Wastewater Resource Recovery Facility - Facility Plan Update

Dear Mr. Dolsby:

The referenced project appears to meet State of Idaho standards and is approved based on the conditions listed below.

## I. **PROJECT SPECIFIC CONDITIONS:**

A. This approval is for the referenced Facility Plan (FP) only. DEQ understands that this update was submitted in compliance with Task No. 2 of Table 7 in Section I.C of National Pollutant Discharge Elimination System (NPDES) Permit Number ID0020192. When designing any facility upgrades associated with this FP, please submit a Preliminary Engineering Report (PER) for the improvements to the Idaho Department of Environmental Quality (DEQ) for review and approval prior to preparing and submitting detailed plans and specifications. Detailed plans and specifications cannot be reviewed until the PER is approved. Furthermore, no construction can begin until the detailed plans and specifications have been reviewed and approved by DEQ.

Please feel free to call me with any questions at (208) 373-0281, or contact me via e-mail at Dan.M.Smith@deq.idaho.gov.

Sincerely,

Dan Smith, P.E.
Staff Engineer

Enclosure: Approved and Stamped Facility Plan Cover Page

ec: Rick Kelly, P.E., Brown and Caldwell (w/ enclosure)
Todd Crutcher, P.E., Boise Regional Office
2019AGD38

# City of Meridian Wastewater Resource Recovery Facility Plan

Prepared for
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December 19, 2018

APPROVED
By: D. Smith
IDAHO DEQ
Boise Regional Office
Date: 1/7/19

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# List of Abbreviations

| | |
|---|---|
| °F | degree(s) Fahrenheit |
| A2O | anaerobic-anoxic-oxic |
| AGAD | acid-gas anaerobic digestion |
| BC | Brown and Caldwell |
| BNR | biological nutrient removal |
| BOD | biochemical oxygen demand |
| CIP | capital improvements plan |
| City | City of Meridian |
| CMAD | conventional mesophilic anaerobic digestion |
| CNG | compressed natural gas |
| COMPASS | Community Planning Association |
| d | day(s) |
| DAFT | dissolved air flotation thickener |
| DO | dissolved oxygen |
| EQ | equalization |
| EPA | United States Environmental Protection Agency |
| FPS | fermented primary sludge |
| $ft^2$ | square foot/feet |
| $ft^3$ | cubic foot/feet |
| gal | gallon(s) |
| gpcpd | gallons per capita per day |
| gpd | gallon(s) per day |
| gpm | gallon(s) per minute |
| GT | gravity thickening |
| $H_2S$ | hydrogen sulfide |
| HFO | hydrous ferric oxide |
| HLR | hydraulic loading rate |
| HRT | hydraulic retention time |
| hr | hour(s) |
| IDAPA | Idaho Administrative Procedures Act |
| IDEQ | Idaho Department of Environmental Quality |
| IPDES | Idaho Pollutant Discharge Elimination System |
| J-U-B | J-U-B Engineers, Inc. |
| kW | kilowatt |
| L | liter(s) |
| lb | pound(s) |
| MBR | membrane bioreactor |
| mg | milligram(s) |
| mgd | million gallon(s) per day |
| mg/L | milligrams per liter |
| mL | milliliters |
| MLR | mixed liquor recycle |
| N | nitrogen |
| $NH_4$-N | ammonia-nitrogen |
| $NO_2$-N | nitrite-nitrogen |
| $NO_3$-N | nitrate-nitrogen |
| $NO_x$-N | nitrate+nitrite-nitrogen |
| NPDES | National Pollutant Discharge Elimination System |
| NPW | non-potable water |
| NRCS | Natural Resource Conservation Service |
| NTU | Nephelometric Turbidity Units |
| O&M | operations and maintenance |
| OLR | organic loading rate |
| P | phosphorus |
| PFRP | process to further reduce pathogens |
| Plan | Meridian WRRF Facility Plan |
| $PO_4$-P | Phosphate-phosphorus |
| PRV | pressure relief valve |
| PS | primary sludge |
| RAS | return activated sludge |
| RDT | rotary-drum thickener |
| RIN | renewable identification number |
| scf | standard cubic foot/feet |
| scfm | standard cubic foot/feet per minute |
| SE | secondary effluent |
| SLR | solids loading rate |
| SMAD | staged mesophilic anaerobic digestion |
| SMP | Sewer Master Plan |
| SND | simultaneous nitrification and denitrification |
| SOR | surface overflow rate |
| SRT | solids retention time |

| | |
|---|---|
| TAD | thermophilic anaerobic digestion |
| TAZ | traffic analysis zones |
| TBEL | technology-based effluent limitations |
| THP | thermal hydrolysis process |
| TKN | total Kjeldahl nitrogen |
| TMDL | total maximum daily loads |
| TN | total nitrogen |
| TP | total phosphorus |
| TS | total solids |
| TSS | total suspended solids |
| TWAS | thickened waste activated sludge |
| UV | ultraviolet |
| VFA | volatile fatty acid |
| VS | volatile solids |
| VSR | volatile solids reduction |
| WAS | waste activated sludge |
| WGB | waste gas burner |
| WRRF | water resource recovery facility |

## Section 1

# Introduction/Purpose

The City of Meridian (City) is faced with the significant decision of how to best manage its wastewater in light of increasingly strict regulatory requirements and a fast-growing service population. Each of these factors will place increasing demands on the Meridian Wastewater Resource Recovery Facility (WRRF) and will require investments in the WRRF to maintain the City's desired level of service expectations. Acknowledging the importance and magnitude of this investment, the City retained Brown and Caldwell (BC) to develop a long-term framework for investments in the Meridian WRRF that cost-effectively enables the City's strategic priorities while limiting future risk. This framework is commonly referred to as a Facility Plan. The purpose of the Meridian WRRF Facility Plan (Plan) is to describe this long-term vision and bring increased clarity to nearer-term investments and to meet a required compliance activity as directed by the City's NPDES permit.

The Idaho Administrative Code establishes the requirements of the facility planning process (Idaho Administrative Procedures Act [IDAPA] 58.01.16) that all facility plans must address the hydraulic and treatment capacity of future wastewater treatment system upgrades. In addition, all plans must address project financing as well as maintenance and operation considerations for the proposed modifications to meet the requirements to treat flows and loads from the current and often potential future service areas covered by the treatment facility. This Plan must be submitted to the Idaho Department of Environmental Quality (IDEQ) for approval prior to any design documents for any specific project related to the Plan.

As the City of Meridian provides wastewater treatment services to the residents and businesses within the Meridian service area, this plan describes the existing and future treatment requirements to continue to meet the demands of their customers. As such, the primary purpose of this document is to prepare and evaluate treatment system expansion alternatives and recommended options and planning level costs to guide the City in future capital improvements planning. The secondary purpose of the document is to prepare the documentation necessary for the City to present for regulatory authority approval.

The City needs to complete this project to determine wastewater expansion requirements that respond to unprecedented growth in the planning area in a cost-effective manner while also complying with challenging current and future regulatory requirements for phosphorus and ammonia.

# Section 2

# Existing Conditions

## 2.1 City Planning Area

The City is located in southwest Idaho, approximately 32 miles east of Oregon and approximately 110 miles north of Nevada. The City is located in Ada County and is central to the Boise Metropolitan Area. The City covers an area of approximately 27 square miles. While the largest customer class is residential, City government encourages economic growth and is home to a variety of business types, including high-tech companies and local artisan shops. The current collections system planning boundary area is approximately 70 square miles as detailed in the 2015 Collection System Flow Monitoring Program for the City of Meridian (Murray, Smith, and Associates, Inc. 2016). The City operates a gravity collection system of approximately 410 miles in length with pipe diameter sizes ranging between 4- to 42-inches.

The City's area of impact is the future planning area that describes anticipated future annexation and development areas. The 2012 Wastewater Facility Plan (CH2M Hill and HDR, Inc., 2012) considered the future service area equivalent to the area of impact; this approach is still considered applicable for the WRRF Facility Plan Update. Historically, the City's area of impact was comprised of mostly agricultural land. In recent decades, residential and commercial uses have grown significantly and now represent the majority of the area of impact. The Meridian WRRF will continue to be a singular treatment approach serving the City through the planning period.

## 2.2 Description of Existing Treatment Facilities

The Meridian WRRF is a secondary treatment facility that uses conventional aerated activated sludge units for biological oxidation of the wastewater. The secondary treatment system was designed to be capable of biological nutrient removal (BNR) operation for removal of both nitrogen (N) and phosphorus (P). Per the City's current design documentation, the existing total rated hydraulic (peak hour) and process (peak month, 12-degree Celsius [°C] bioreactor temperature) capacity is 15.8 million gallons per day (mgd) and 10.2 mgd, respectively.

### 2.2.1 Liquid Stream Process

Figures 2-1 and 2-2 show the overall process flow schematic for the existing treatment facility, while design data for the major unit processes are given in Table 2-1. For Figure 2-2, solids streams are shown as green dashed lines while liquid streams are shown as solid blue lines. Raw wastewater enters the WRRF headworks by gravity and flows through the screens. The screens remove large objects and floating material that could damage downstream processes. The influent then is lifted by the existing headworks screw lift pumps to the vortex grit removal tanks. The screened and degritted wastewater flow is then split between the two primary sedimentation tanks for primary treatment. Collected screenings and grit are hauled to landfill. Primary effluent then is gravity fed to the secondary pump station, which lifts the flow into Aeration Basins 1 through 4. Primary clarifier sludge is pumped to the fermenter and scum is pumped to the digesters.

The secondary treatment system currently consists of four aeration basins designed to operate in an anaerobic-anoxic-oxic (A2O) process configuration. This configuration is capable of nitrification, denitrification, and biological phosphorus removal. The existing aeration basins are split into zones by concrete baffle walls to facilitate the A2O process for N and P removal. Mixing in anaerobic/anoxic/swing selector cells is provided by submerged medium-speed mixers, while aeration and mixing in the aerobic zones and swing zones is provided by centrifugal blowers and fine-pore disc diffusers. Return Activated Sludge (RAS) from Secondary Clarifiers 4 and 5 flows by gravity to the RAS denitrification basin, where it is pumped back to the head of the aeration basins. RAS from Secondary Clarifier 3 is pumped to the RAS denitrification basin. Mixed liquor exits the aeration tanks and flows via gravity to the secondary clarifier splitter box, which splits the flow into Secondary Clarifiers 3 through 5 for solids separation.

The secondary effluent from the plant is sent to tertiary filters for filtration of additional solids. Filtration is achieved via cloth disc filters (Filters 1, 2, 3, and 4). This is done for production of reclaimed water for use around the City. From tertiary filtration, the effluent then flows to post-aeration basins to increase the dissolved oxygen (DO) concentration prior to discharge. The aerated effluent is then directed to disinfection channels, where in-channel ultraviolet (UV) lamps are used for disinfection prior to discharge to Fivemile Creek or the reclaimed water pump station. The City is also authorized to discharge to the Boise River through a secondary outfall, though this outfall has not been used in recent years and would require significant upgrades before use.

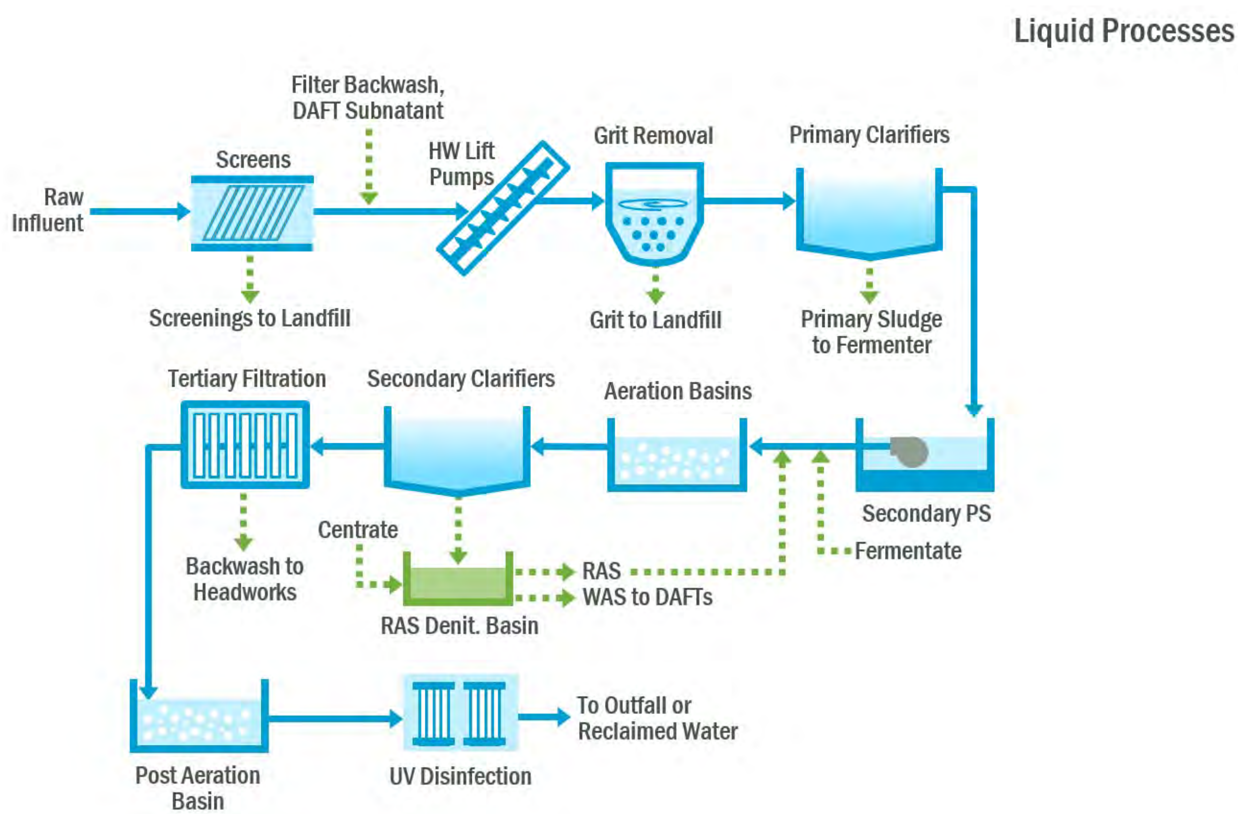


Figure 2-1. Meridian WRRF liquids process flow diagram

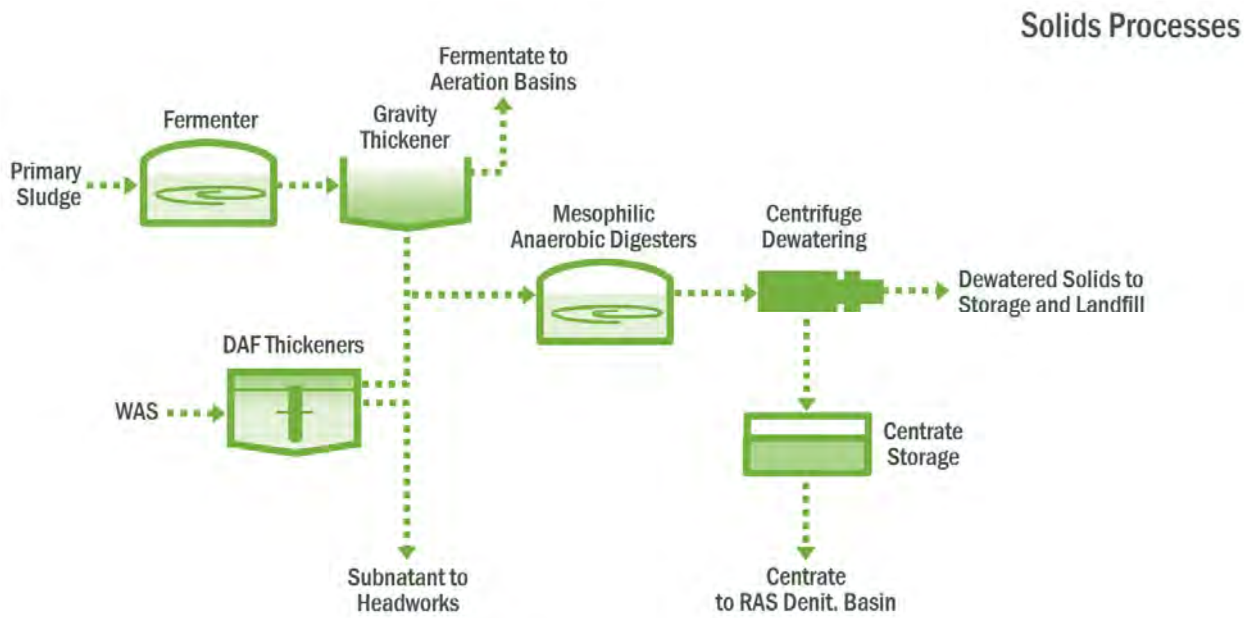


**Figure 2-2. Meridian WRRF solids process flow diagram**

### 2.2.2 Solids Handling

Primary sludge is pumped to a fermenter, where the solids are fermented to produce volatile fatty acids (VFAs) to facilitate the BNR processes. The fermented solids are then thickened, with the thickened primary sludge then pumped to anaerobic mesophilic digestion while carbon-rich fermentate is directed to the aeration basins. Waste activated sludge (WAS) is pumped to the dissolved air flotation thickeners (DAFTs) for thickening before digestion. The DAFT uses an air pressurization system to inject pressurized, aerated water into the bottom of a circular tank. The dissolved air promotes WAS solids to float to the surface of the tank and thicken in the float layer, which is then skimmed off into a collection pit. DAFT subnatant is returned to the influent screen channels through the plant drain pump station. The thickened waste activated sludge (TWAS) exits the DAFTs and is combined with thickened primary sludge and added to two mesophilic digesters operating in parallel. Stabilized biosolids from the two mesophilic digesters are stored in an unheated solids holding tank prior to dewatering. The stabilized biosolids are then dewatered by centrifuges, and the centrate is equalized in the centrate storage tanks prior to being returned to the RAS denitrification basin. The centrate stream can contain high concentrations of ammonia and phosphorus that will increase the nutrient load to the biological secondary treatment system. Dewatered biosolids from the centrifuges are stored onsite in asphalt drying beds prior to landfill disposal.

The Meridian WRRF uses chemicals to minimize formation of struvite in the dewatering centrifuges. The City achieves some struvite control through addition of ferric chloride upstream of the centrifuge, while ferric is also added upstream of digestion for hydrogen sulfide control. The struvite control facility includes a small chemical feed building and a 6,600-gallon chemical storage tank; a chemical feed line transports chemical to both the digester feed and centrifuge feed lines.

A summary of the major unit processes and equipment at the Meridian WRRF are listed in Table 2-1.

| Table 2-1. Major Processes and Equipment Design Data | | |
|---|---|---|
| Process Element | Number of Units | Design Data |
| Fine screen | 3 | |
| Size | 2 | 4 mm step screen |
| Capacity, each, mgd | | 11 |
| Size | 1 | 1 in. manual bar rack |
| Capacity, each, mgd | | 11 |
| Headworks lift pumps | 5 | Archimedes vertical screw |
| Capacity, each, mgd | | 4.5 |
| Grit removal | | |
| Grit removal chamber 1 | 1 | Vortex |
| Diameter, ft | | 7 |
| Capacity, mgd | | 6 |
| Grit removal chamber 2 | 1 | Vortex |
| Diameter, ft | | 12 |
| Capacity, mgd | | 12 |
| Grit classifier | 1 | |
| Capacity, mgd of influent flow | | 18 |
| Primary sedimentation | 2 | |
| Primary sedimentation tanks (hydraulic, peak hour) | | 15.1 mgd rated, each |
| Diameter, ft | | 80 |
| Sidewater depth, ft | | 12 |
| SOR @ 7.0 mgd (1 clarifier in service) | | 1,392 gpd/ft$^2$ |
| SOR @ 15.8 mgd (1 clarifier in service) | 2 | 3,143 gpd/ft$^2$ |
| Raw sludge pumps | | Recessed impeller |
| Capacity, each, gpm | | 250 |
| Secondary pump station | 4 | Submerged centrifugal |
| Capacity, each, mgd | | 8 |
| Aeration basins | | |
| Treatment trains | 4 | |
| Max month treatment capacity, each, mgd | | 2.52 (largest secondary clarifier offline) |
| Volume, total each, Mgal | | 0.63 |
| Sidewater depth, ft | | 14 |
| Aeration blowers | 2 | Variable-speed turbo air |
| Capacity, each, scfm | | 5,600 |
| Aeration blowers | 1 | Multistage centrifugal |
| Capacity, each, scfm | | 3,600 |

| Table 2-1. Major Processes and Equipment Design Data | | |
|---|---|---|
| Process Element | Number of Units | Design Data |
| Secondary clarifiers | | |
| Clarifiers 4 and 5 | 2 | |
| Diameter, ft | | 100 |
| Sidewater depth, ft | | 14.5 |
| Sludge removal mechanism type | | Spiral blade rake, gravity RAS |
| Peak hour SOR, gal/d/ft$^2$ | | 1,200 |
| Solids loading rate, lb/d/ft$^2$ | | 36.5 |
| Clarifier capacity, each (SOR), mgd | | 9.4 |
| Clarifier 3 | 1 | |
| Diameter, ft | | 80 |
| Sidewater depth, ft | | 12 |
| Sludge removal mechanism type | | Spiral blade rake, pumped RAS |
| Peak hour SOR, gal/d/ft$^2$ | | 1,200 |
| Solids loading rate, lb/d/ft$^2$ | | 36.5 |
| Clarifier capacity (based on SOR), mgd | | 6.0 |
| RAS pumps | | |
| Clarifier 3 capacity, each, gpm | 2 | 460 |
| RAS denitrification basin pumps | 3 | 2,000 |
| WAS pumps | | |
| Capacity, each, gpm | 2 | 250 |
| Tertiary filtration | 4 | |
| Type | | Cloth media |
| Filter 1, 2, and 4 capacity, peak, each, mgd | | 6.0 |
| Filter 3 capacity, peak, mgd | | 11 |
| UV disinfection | | |
| Channels | 4 | |
| Peak Hour Capacity, total, mgd | | 30 |
| Peak Hour Capacity, firm, mgd | | 22.5 |
| UV lamps | | |
| Lamps per bank, Channels 1 & 3/2 & 4 | 136/30 | |
| Banks per channel, Channels 1 & 3/2 & 4 | 3/2 | |
| Effluent flow measurement | | |
| 36-inch Parshall Flume | 1 | |
| Fivemile Creek outfall | | |
| 48-inch pipe | 1 | |
| Fermenter | | |
| Volume, Mgal | 1 | 0.129 |
| Gravity thickener | 1 | |
| Diameter, ft | | 40 |
| Sidewater depth, ft | | 10 |

| Table 2-1. Major Processes and Equipment Design Data | | |
|---|---|---|
| Process Element | Number of Units | Design Data |
| Dissolved air flotation thickener | 2 | |
| Diameter, ft | | 20 |
| Sidewater depth, ft | | 8 |
| Solids loading capacity, each, lb/d | | 15,700 (based on 50 lb/d/ft$^2$) |
| TWAS pumps | | Pump 1 = rotary lobe, pumps 2 and 3 = hose |
| Pump 1 capacity, gpm | 1 | 90 |
| Pumps 2 and 3 capacity, gpm | 2 | 75 |
| Mesophilic anaerobic digesters | 2 | Primary |
| Volume, each, Mgal | | 0.8 |
| Solids storage anaerobic digester | 1 | Secondary/storage |
| Volume, Mgal | | 0.507 |
| Centrifuges | 2 | |
| Flow capacity, each, gpm | | 120 |
| Solids capacity, each, lb/hr | | 1,750 |
| Centrate equalization tanks | 2 | |
| Normal operating volume, Mgal | | 0.107 |
| Mixer type | | Tank shark |
| Centrate pumps | 3 | Progressing cavity |
| Pump capacity, each, gpm | | 125 |

## 2.3 Current Facility Upgrades for Headworks and Liquid Stream Improvements

The Meridian WRRF Headworks Capacity Expansion project will provide new preliminary treatment processes, including raw influent pumping, headworks screening, and grit removal, prior to primary, secondary, and tertiary treatment that will be installed as part of the Liquid Stream Expansion project. These new wastewater facilities will be located to the west and north of the existing plant facilities, as shown in Figure 2-3. The existing headworks contains influent pumps (Archimedes screw-type) that cannot easily be modified or retrofit to reach the new treatment processes that will be constructed as part of the Liquid Stream Expansion project. Additionally, the existing influent pumps, screening equipment, and grit removal do not have adequate hydraulic capacity to handle future inflows. These combined limitations to the existing headworks facilities drove the need for headworks capacity expansion.

The Preliminary Engineering Report for the Headworks Capacity Expansion project was completed in July 2016, with final design documents completed in January 2017. Construction began on the project in June 2017, and it is scheduled for completion in January 2019.

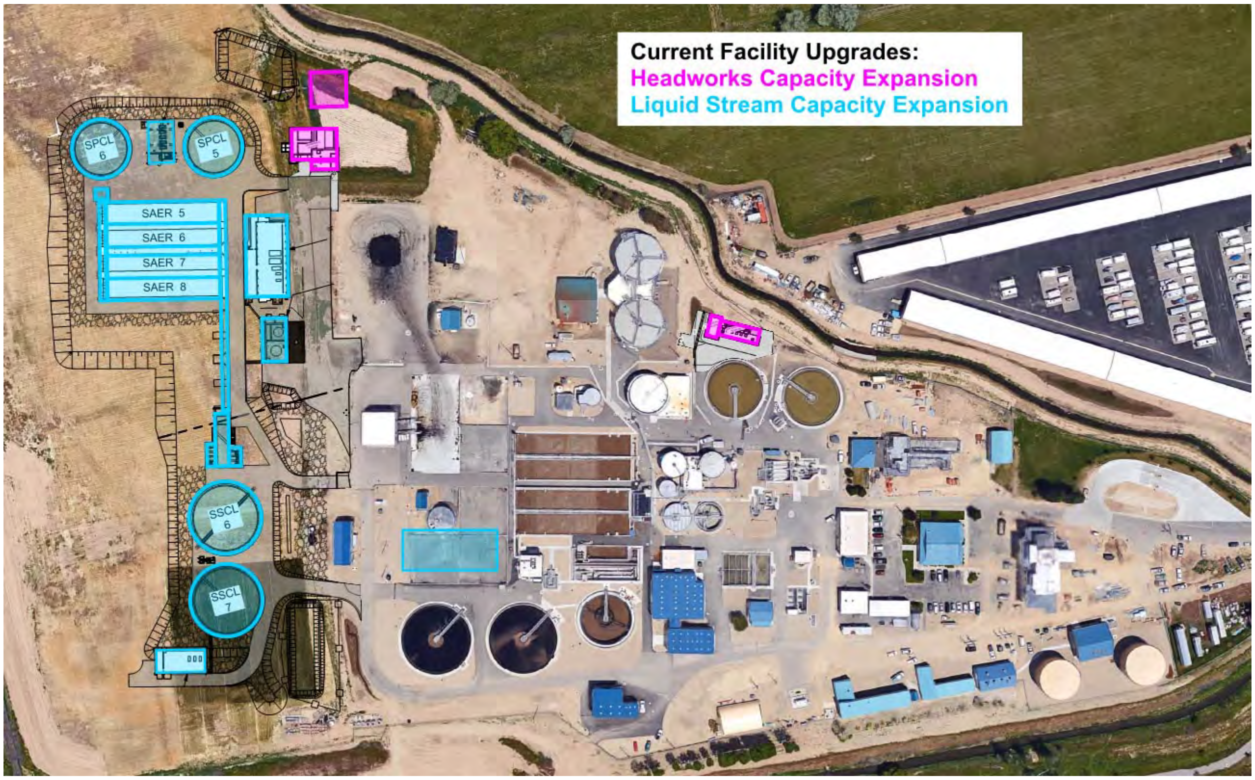


**Figure 2-3. Facilities currently under construction at the Meridian WRRF**

Driven by City population growth and new, stringent NPDES permit limitations on effluent ammonia and phosphorus, the Liquid Stream Capacity Expansion project will construct new primary and secondary treatment processes to integrate with the existing WRRF process. New tankage elements will include two primary clarifiers, four aeration basins, and two secondary clarifiers. New buildings include the Primary Sludge Pump Station, Aeration Blower Building 2, RAS Transfer Station, Chemical Feed Building 2, and RAS/WAS Station 2. The Preliminary Engineering Report for the project was completed in December 2015, with final design documents completed in August 2016. Project construction began in January 2017 and is scheduled for completion in July 2019.

The Liquid Stream Capacity Expansion is based on 15 mgd maximum month and 30.2 mgd peak hour flow rates, along with the interim NPDES permit requirements summarized in Section 2.4. The raw influent design criteria are summarized in Table 2-2.

**Table 2-2. Liquid Stream Capacity Raw Influent Flow and Load Design Criteria**

| Parameter | Units | Design Criteria |
|---|---|---|
| **Influent Flows** | | |
| Average annual | mgd | 13.0 |
| Maximum month | mgd | 15.0 |
| Peak hour | mgd | 30.2 |
| Buildout peak hour | mgd | 63.6 |
| **Influent BOD Loadings** | | |
| Average annual | lb/day | 28,600 |
| Maximum month | lb/day | 36,900 |

| Table 2-2. Liquid Stream Capacity Raw Influent Flow and Load Design Criteria | | |
|---|---|---|
| Parameter | Units | Design Criteria |
| Influent TSS Loadings | | |
| Average annual | lb/day | 28,200 |
| Maximum month | lb/day | 36,400 |
| Influent TKN Loadings | | |
| Average annual | lb/day | 5,180 |
| Maximum month | lb/day | 5,810 |
| Influent TP Loadings | | |
| Average annual | lb/day | 700 |
| Maximum month | lb/day | 900 |

The improvements associated with the Headworks and Liquid Stream Capacity Expansion projects are described in further detail below.

### 2.3.1 Headworks Capacity Expansion

The Headworks Capacity Expansion project will provide new influent pumping, screening, and grit removal capabilities needed to serve the new wastewater treatment facilities currently under construction and in the future. This new headworks facility will provide sufficient preliminary treatment of raw influent prior to primary, secondary, and tertiary treatment processes.

Influent flow design criteria are summarized in Table 2-3.

| Table 2-3. Influent Flow Design Criteria | |
|---|---|
| Parameter | Basis of Design |
| Startup minimum hour | 1.27 mgd |
| Minimum hour | 2.74 mgd |
| Average annual | 13.01 mgd |
| Maximum month | 15.0 mgd |
| Peak day | 20.16 mgd |
| Peak hour | 30.23 mgd |
| Buildout peak hour | 63.58 mgd |

The influent pump station will be located in the space north of existing Primary Clarifier 3. The headworks facility and biofilter will be located north and west of the existing WRRF. A summary of headworks upgrades design criteria is provided in Table 2-4.

| Table 2-4. New Influent Pump Station and Headworks Process Design Criteria | | |
|---|---|---|
| Facility/Unit Process | Capacity | Configuration |
| Influent Pump Station | Firm peak hour: 30.2 mgd<br>Buildout peak hour: 63.6 mgd | Small pumps<br>• 2, 4-mgd capacity screw centrifugal (immersible) pump<br>• 2, 51-hp variable speed motors<br>• 28.5-ft TDH<br>Large pumps<br>• 4, 8-mgd capacity screw centrifugal (immersible) pumps<br>• 41-ft TDH<br>• 4, 107-hp variable speed motors<br>Prerostal wet well configuration with Hidrostal submersible pumps<br>Headworks Building: 68 ft x 29 ft |

**Table 2-4. New Influent Pump Station and Headworks Process Design Criteria**

| Facility/Unit Process | Capacity | Configuration |
|---|---|---|
| Influent Forcemain | Design peak hour (1 forcemain line): 30.2 mgd<br>Buildout peak hour (2 foremains): 63.6 mgd | • 1, 36-inch forcemain (and portion of second forcemain) |
| Influent Screening | 2 +1 standby current phase[a]<br>3 +1 future at buildout peak hour<br>21.2 mgd capacity per perforated plate/raked bar screen | • 3, 21.2 mgd perforated plate screens<br>• 6-mm plate perforation size<br>• 3, variable speed 1.5-hp screen motors<br>• 3, constant speed 2-hp brush motors<br>• 2, 150 $ft^3$/hr screenings washer/compacter with grinder<br>• 1, manually raked bar screen<br>  ◦ 1.0-inch bar spacing<br>• Channel Dimensions (width x depth): 3.5 ft x 8 ft |
| Grit Removal | Firm peak hour: 32 mgd<br>Firm peak hour: 95 percent removal of 125-µm and larger grit<br>Total peak hour: 95 percent removal of 75 µm and larger grit | • 2, stacked tray settlers<br>• 12-ft diameter<br>• 3, 300-gpm recessed impeller grit pumps<br>• 2, 300-gpm vortex grit washers<br>• 2, 2.0 cubic yard/hour grit dewaterers |
| Primary Clarifier Splitter Box | | • Flow distribution control: 4 parallel cutthroat flumes (space for 8 total)<br>• Flume size (throat width x length): 2 ft x 6 ft<br>• Pipe size for Primary Clarifiers 3 and 4 (combined): 42-in<br>• Pipe size for Primary Clarifiers 5 and 6 (each): 36-in |
| Headworks Biofilter | Sized to treat all exhaust air from headworks building and covered equipment/channels | • 2 headworks biofilter blowers<br>  ◦ Blower 1 Capacity: 6,990 acfm<br>  ◦ Blower 2 Capacity: 6,770 acfm<br>• Motor size<br>  ◦ Blower 1: 20 hp<br>  ◦ Blower 2: 15 hp<br>• 2 headworks biofilters – engineered media<br>  ◦ Media Volume, each: 4,800 ft3<br>  ◦ Media Depth, each: 6 ft<br>• Residence Time<br>  ◦ Biofilter 1: 43 seconds<br>  ◦ Biofilter 2: 41 seconds |

[a] *Current phase refers to construction at present.*

*acfm = actual cubic feet per minute.*

### 2.3.2 Primary Treatment Expansion

The primary treatment system is designed to remove readily settleable solids from the influent liquid stream. Concentrated solids that have settled out in this process are removed by the primary sludge pumps and conveyed to either the fermenters or to the digesters. Primary clarifier effluent is conveyed to the aeration basins by the secondary pump station, currently. Existing Primary Clarifiers 3 and 4 are 80-ft diameter circular primary clarifiers and are normally in operation. Primary Clarifier 1 has been repurposed for use as a gravity thickener at the fermentation facilities. Primary Clarifier 2 has been mothballed, with plans to possibly convert it to a gravity thickener in the future.

The current liquid stream expansion project includes primary treatment process expansion with two new 80-ft diameter primary clarifiers and associated primary sludge and scum collection and pumping facilities. The two new primary treatment process units, Primary Clarifier 5 and 6, are being constructed in the northwest corner of the WRRF's expansion area and adjacent to the headworks expansion site. Space for future Primary Clarifiers 7 through 10 is planned to be adjacent to Primary Clarifiers 5 and 6. The clarified primary effluent will flow by gravity to the new mixed liquor distribution channel, where it will combine with RAS for even flow distribution to the new aeration basins.

The primary treatment process elements were reviewed through a series of workshops between the City and BC, during which appropriate equipment for each process element was selected. These components were designed according to requirements of IDAPA 58 Title 1 Section 16; IDAPA Wastewater Rules do not contain redundancy requirements for primary clarifiers. The number of units is instead based on average and peak hourly flow conditions with all units in service. The typical peak hour design surface overflow rate (SOR) of each primary clarifier is 3,000 gallons per day per square foot. Therefore, the peak capacity of each clarifier is 15.1 mgd, yielding a primary treatment capacity of 60.4 mgd with all four clarifiers in service.

The two new primary clarifiers will be supported by one primary sludge/scum pump station. The pump station will house three, 70-gpm primary sludge pumps and grinders for Primary Clarifiers 5 and 6, with space provided for two additional future primary sludge pumps associated with Primary Clarifiers 7 and 8, when needed. Positive displacement primary sludge pumps will function to convey primary sludge and, intermittently, primary scum to fermentation (primary sludge only) or digestion (primary scum and/or sludge).

### 2.3.3 Secondary Treatment Expansion

Existing secondary treatment facilities include a secondary pump station, four aeration basins, three secondary clarifiers, and associated RAS and scum pumping systems. The secondary treatment process removes total suspended solids (TSS), biochemical oxygen demand (BOD), ammonia, and nitrate/nitrite from the wastewater. When the system is operated in A2O (anaerobic/anoxic/oxic) configuration it can achieve enhanced biological phosphorus removal. Existing aeration basins are sized to 630,000 gallons each with maximum month capacity of 10.2 mgd.

Secondary treatment process expansion will consist of four new aeration basins, a secondary clarifier splitter box, two new secondary clarifiers, a new aeration blower building, a new RAS transfer station, and a new RAS/WAS return tank system. The new aeration basins were designed using the BioWin™ biological process simulator (EnviroSim Inc., Hamilton, Ontario) to establish tank volumes, oxygen demands, alkalinity and pH impacts, and chemical demands for supplemental carbon addition to meet future nutrient permit requirements. The BioWin model was calibrated per Water Environmental Research Foundation calibration protocols based on existing plant performance and an influent wastewater characterization study conducted in January 2015. Design flow and loadings from Table 2-2, Section 2.3, were used for modeling and sizing the new aeration basins. Future buildout of the aeration system is projected to include up to 16 basins in service.

To accommodate changing effluent regulations, the new aeration system configuration has some differences compared to the existing aeration system. First, the new aeration basin configuration will have a different number and type of aerated and unaerated zones compared to the current configuration. Each new aeration basin train will have three "swing zones" that can operate aerobically or anoxically, allowing for operation in an A/O, 5-Stage Bardenpho, or A2O configuration. This flexibility will allow the Meridian WRRF to adapt to changing and more stringent regulations that are anticipated to occur in the future. Secondly, the new aeration basin is deeper compared to the existing system (18 ft versus 14 ft) to provide the additional volume required to meet more stringent nutrient removal requirements and to facilitate improved oxygen transfer efficiency of the fine-pore aeration system. Third, the inclusion of an influent feed channel to the aeration basins will equally distribute primary effluent and RAS amongst them rather than a separate piped RAS feed to the existing units; this change also allows for simpler future expansion of the system.

Mixing of aerated and swing zones (when air is on) to maintain sufficient solids suspension will be achieved through fine pore aeration. At the downstream side of the aeration basin mixing of the mixed liquor collection channel will be accomplished through coarse bubble diffusers and a spiral-roll mixing pattern. Mixing of the unaerated zones, swing zones (when air is off), and the mixed liquor influent/mixed liquor distribution channel will be accomplished through mechanical mixing. Internal mixed liquor recycle (MLR) is performed using axial-flow type pumps that can convey nitrate-rich wastewater from the aerated zones to anoxic zones. This process promotes denitrification and can be flexibly operated in either A2O or 5-stage Bardenpho configurations.

The IDAPA Wastewater Rules governing aeration basin redundancy and design were fundamental to the development of new aeration basin design. As such, the combined aeration basin system, including both the new and old aeration basins, is designed to maintain treatment at maximum month flows and loads with one basin train out of service (from either the new or old side, but not both).

## 2.4 NPDES Permit Conditions

The City's current NPDES permit was finalized by the United States Environmental Protection Agency (EPA) Region 10 with an effective date of August 1, 2017 (NPDES Permit No. ID-0020192). The City's previous NPDES permit expired in November 2004, but an extension was granted until the new permit was issued. The Meridian WRRF is authorized to discharge to Fivemile Creek and the Boise River, Outfalls 001 and 002, respectively. The facility is currently rated for 10.2 mgd maximum monthly flow, and the solids produced by the WRRF are authorized for land application. The Meridian WRRF operates in a nutrient removal mode to facilitate N and P removal and achieve compliance with water quality standards and effluent toxicity requirements. The City also possesses a reuse water permit which mandates a seasonal average of 15.5 milligrams per liter (mg/L) total nitrogen (TN) for reclaimed water discharge.

The current NPDES permit includes a 10-year compliance schedule for total phosphorus (TP), ammonia (NH4), copper, cyanide, zinc, and mercury at the primary outfall (Fivemile Creek); in this window, the City must meet interim permit requirements for the identified parameters, with more stringent final limits achieved by June 30, 2027. All other effluent limitations and monitoring requirements began on the effective permit date. Under the schedule of compliance, the City must also meet a series of deadlines primarily focused on construction of facilities that will enable the WRRF to achieve the final permit limitations. The current NPDES permit interim and final limits are summarized in Tables 2-5 and 2-6, respectively.

**Table 2-5. Fivemile Creek Outfall NPDES Permit Interim Requirements (until June 30, 2027)**

| Parameter | Unit | Effluent Limitations | | |
|---|---|---|---|---|
| | | Average Monthly | Average Weekly | Maximum Daily |
| $BOD_5$ | mg/L | 20 | 30 | – |
| | lb/d | 1,701 | 2,552 | – |
| | % removal (min) | 85 | – | – |
| TSS | mg/L | 30 | 45 | – |
| | mg/L | 4-month rolling average: 17.5 | | |
| | lb/d[a] | 2,550 | 3,820 | – |
| | lb/d | 4-month rolling average: 1,489 | | |

| Table 2-5. Fivemile Creek Outfall NPDES Permit Interim Requirements (until June 30, 2027) | | | | |
|---|---|---|---|---|
| | | Effluent Limitations | | |
| Parameter | Unit | Average Monthly | Average Weekly | Maximum Daily |
| | % removal (min) | 85 | – | – |
| Dissolved oxygen[b] | mg/L | 6.0 | | |
| pH | s.u. | Between 6.5 and 9.0 | | |
| Total nitrogen[c] | mg/L | 15.5 seasonal average | | |
| E. coli bacteria | Number of colonies/100 mL | 126 (geometric mean) | – | 576 (instantaneous max) |
| Ammonia-nitrogen | mg/L | 12 | – | 20 |
| | lb/d | 1,021 | – | 1,701 |
| Total Phosphorus | mg/L | 2.5 annual average[d] | | |
| | lb/d | 213 annual average[d] | | |
| | mg/L | 1.0 annual average[e] | | |
| | lb/d | 85 annual average[e] | | |
| Copper[f] | µg/L | 13.3 | – | 18.5 |
| | lb/day | 1.13 | – | 1.57 |
| Mercury[f] | µg/L | 0.015 | – | 0.033 |
| | lb/day | 0.0013 | – | 0.0028 |
| Cyanide[g] | µg/L | Report year-round | | |
| Zinc[f] | µg/L | Report May–September | | |

a. *Combined loading effluent limitations for Outfalls 001 and 002 (Outfall 002 not anticipated to be used).*

b. *DO saturation and concentration must exceed 6.0 mg/L.*

c. *For reuse water permit.*

d. *Until July 31, 2022.*

e. *From August 1, 2022, until June 30, 2027.*

f. *Total recoverable.*

g. *Weak acid dissociable.*

| Table 2-6. Fivemile Creek Outfall NPDES Permit Final Requirements (Beginning June 30, 2027) | | | | |
|---|---|---|---|---|
| | | Effluent Limitations | | |
| Parameter | Unit | Average Monthly | Average Weekly | Maximum Daily |
| $BOD_5$ | mg/L | 20 | 30 | – |
| | lb/d | 1,701 | 2,552 | – |
| | % removal (min) | 85 | – | – |
| TSS | mg/L | 30 | 45 | – |
| | mg/L | 4-month rolling average: 17.5 | | |
| | lb/d[a] | 2,550 | 3,820 | – |
| | lb/d | 4-month rolling average: 1,489 | | |
| | % removal (min) | 85 | – | – |
| Dissolved oxygen[b] | mg/L | 6.0 | | |
| pH | s.u. | Between 6.5 and 9.0 | | |
| Total nitrogen[c] | mg/L | 15.5 seasonal average | | |

| Table 2-6. Fivemile Creek Outfall NPDES Permit Final Requirements (Beginning June 30, 2027) | | | | |
|---|---|---|---|---|
| | | Effluent Limitations | | |
| Parameter | Unit | Average Monthly | Average Weekly | Maximum Daily |
| E. coli bacteria | Number of colonies/100 mL | 126 (geometric mean) | – | 576 (instantaneous max) |
| Ammonia-nitrogen (October–April) | mg/L | 0.308 | – | 1.25 |
| | lb/d | 26.2 | – | 106 |
| Ammonia-nitrogen (May–September) | mg/L | 0.406 | – | 1.65 |
| | lb/d | 34.5 | – | 140 |
| Total Phosphorus (October–April) | µg/L | Report | Report | – |
| | lb/day[a] | 29.8 | Report | – |
| Total Phosphorus (May–September) | µg/L | Report | Report | – |
| | lb/day[a] | 8.5 | Report | – |
| Copper[d] (October–April) | µg/L | 11.9 | – | 18.5 |
| | lb/day | 1.01 | – | 1.57 |
| Copper[d] (May–September) | µg/L | 8.22 | – | 12.8 |
| | lb/day | 0.699 | – | 1.09 |
| Mercury[d] (October–April) | µg/L | 0.010 | – | 0.022 |
| | lb/day | 0.00085 | – | 0.00019 |
| Mercury[d] (May–September) | µg/L | Report | – | Report |
| Cyanide[e] (October–April) | µg/L | 3.23 | – | 9.62 |
| | lb/day | 0.275 | – | 0.818 |
| Cyanide[e] (May–September) | µg/L | 4.95 | – | 14.8 |
| | lb/day | 0.421 | – | 1.26 |
| Zinc[d] (October–April) | µg/L | Report | – | Report |
| Zinc[d] (May–September) | µg/L | 60.4 | – | 70.9 |
| | lb/day | 5.14 | – | 6.03 |

a. *Combined loading effluent limitations for Outfalls 001 and 002 (Outfall 002 not anticipated to be used).*

b. *DO saturation and concentration must exceed 6.0 mg/L.*

c. *For reuse water permit.*

d. *Total recoverable.*

e. *Weak acid dissociable.*

The Boise River outfall (NPDES permit Outfall 002) has not been used in years and would require significant upgrades before being put into service. A portion of the outfall pipe currently is used to convey reclaimed water to Heroes Park. The pipe and pumps to the outfall also lack the capacity to convey design flow rates that will be seen in the facility planning window, necessitating the replacement of the pumps and approximately 5 miles of pipe before use.

## 2.5 Existing WRRF Equipment Conditions and Maintenance Issues

At a workshop in January 2017, City of Meridian operations and maintenance staff identified existing equipment and facilities that may require replacement within the facility planning window. Staff based their assessment on condition (equipment age versus expected life and level of visual degradation) and performance (how well equipment functions and the amount of maintenance required). As a general rule, if repair costs are frequent and have reached 75 percent or more of the equipment cost, the item was considered likely to be replaced in the planning window. To assist with planning and budgeting, a list of the items flagged for potential replacement or repair is provided in Table 2-7.

**Table 2-7. Existing Facilities/Equipment Flagged for Potential Repair or Replacement**

| Facility/Equipment | Maintenance/Replacement Note |
|---|---|
| Primary Clarifiers 3 and 4 | |
| Mechanisms | May require replacement (end of expected life) |
| Penn Valley Primary Sludge Pumps | Replacement (high repair costs, confined space safety issue) |
| PC #3 concrete surface | Repair cracks |
| MCC 6 | Replacement (end of expected life, only MCC still outside) |
| Secondary Pump Station | |
| Secondary Pumps and VFDs | May require replacement (end of expected life) |
| Aeration Basins 1–4 | |
| Basins 1 and 2 surface/baffle walls | Repair cracks |
| IMLR pump VFDs | Replacement (end of expected life) |
| Blower Building No. 1 | Replace facility (space required, electrical old and maxed out, HVAC issues) |
| K-Turbo blowers | Likely replacement (reliability issues, availability of parts a concern) |
| Spencer blowers | May require replacement (end of useful life) |
| Secondary Clarifiers 3–5 | |
| SC #4 and 5 scum pumps | May require replacement (process/design limitations) |
| Mechanical Building | |
| Electrical system | Replacement (service, breakers, MCC) |
| UV Building | |
| Channels 1 and 3 UV banks | Likely replacement (end of expected life) |
| Digesters | |
| Digester #3 mixing pump | Likely replacement (end of expected life) |
| Digested sludge pumps | May require replacement (shafts wearing quickly) |
| Dewatering Building | |
| Centrifuge bowl overhaul | May be required in planning window (estimated $150,000 per bowl) |
| HVAC system | Likely replacement (functional issues) |
| Ferric Chloride System | Likely replacement (new building, piping, and electrical/PLC) |
| Fire alarms, power, and phase monitoring | May be upgraded to be on same system as new facilities |
| Lab | |
| HVAC system | Need to add redundant system |

Some equipment in need of repair or replacement was omitted from the list above because its associated facility is scheduled to be replaced in the near future (including the headworks and tertiary filtration facilities).

## 2.6 Existing Water Reuse Practices

The City treats a portion of its flow to meet municipal reuse water requirements for Class A discharge. Since 2009, the City has been providing Class A reuse water for beneficial reuse to a variety of projects, including application as turf irrigation for Heroes Park. As described in the City of Meridian Recycled Water Master Plan (HDR Engineering, Inc. 2012), additional water reuse projects were installed in 2011, including irrigation for landscaping at the Ten Mile Interchange and at a commercial gas station. A car wash also began using reuse water. Irrigation reuse represents the largest designated use in the near future.

The City's reuse permit (No. M-215-03) has been effective since November 21, 2017, and will expire on November 21, 2027. This permit replaced the previous reuse permit (No. LA-00215-02) that had been in place since April 19, 2010. The reuse permit is typically renewed for ten years.

Class A reuse water is authorized for many uses throughout the City, including dust suppression, toilet flushing, lined surface water features, sanitary sewer flushing, and fire suppression. Table 2-8 summarizes the main permit limits and conditions from the permit.

**Table 2-8. Summary of Reuse Permit No. M-215-03 Limits and Conditions**

| Category | Permit Limits and Conditions |
|---|---|
| Type of recycled water | Class A municipal |
| Reporting year for annual loading rates | January 1 through December 31 |
| Growing season | March 15 to October 31 |
| Non-growing season | November 1 to March 14 |
| Application season | • Irrigation only allowed during growing season<br>• Other uses allowed year-round |
| Maximum acres allowed for irrigation | 1,213 |
| Growing season hydraulic loading limits | None |
| Constituent loading limits | • Nitrogen (lb/acre): None<br>• Salt (non-volatile dissolved solids) (lb/acre): None |
| Allowable uses | • Uses allowed for Class A recycled water in Table 3 of the Recycled Water Rules, IDAPA 58.01.17.602.02, exclusive of ground water recharge<br>• Commercial carwash facilities, with warning signs adequate to notify the public the water is recycled water and is not safe for drinking<br>• Uses may be further limited by the facility's Plan of Operation |
| Total nitrogen limit | Shall not exceed 15.5 mg/L at point of compliance, based on the mean of the growing season samples |
| $BOD_5$ limit | Monthly average shall not exceed 10.0 mg/L at point of compliance, as determined from weekly composite sampling |
| pH range in recycled water | 6.0–9.0 |
| Turbidity limits in treated effluent prior to disinfection during periods of recycled water production | • Instantaneous maximum shall not exceed 5 Nephelometric Turbidity Units (NTU)<br>• 24-hour average shall not exceed 2 NTU<br>• When the continuous turbidity measurements are above the instantaneous limit of 5 NTU for more than five minutes, filtered effluent shall be automatically diverted until such time as the effluent is below the instantaneous limit |
| Disinfection limits in recycled water | • The median number of total coliform organisms shall not exceed 2.2 per 100 milliliters (mL), as determined from the results of the last 7 days for which analyses have been completed 24-hour average shall not exceed 2 NTU<br>• The number of total coliform shall not exceed 23 per 100 mL |
| Disinfection requirements | • A chlorine disinfection process that provides a concentration/contact time of 450 mg-min/L measured at the end of the contact time based on total chlorine residual and a modal contact time of not less than 90 minutes based on peak day dry weather flow<br>OR<br>• A disinfection process that, when combined with filtration, has been demonstrated to achieve 5-log inactivation of virus |
| Filter Loading Limit | Loading rate to the filter shall not exceed 6 gpm per square foot |

Flow is diverted to the reuse water system after disinfection via in-channel UV lamps. The City uses sodium hypochlorite to meet the disinfection requirements of the reuse permit. Two bolted-steel reuse storage tanks (each 500,000 gallons) provide the chlorine contact time required. Three reuse pumps, each with a capacity of 3.3 mgd, are installed in the tanks. The reuse pump station routes Class A effluent to the reuse distribution system via three variable speed vertical turbine pumps. Two of the pumps have a maximum capacity of 800 gpm, while the third has a maximum capacity of 50 gpm.

Currently, the City has no plans for expansion of the water reuse system for the period associated with this facility plan. Therefore, no planned expansion will be provided as part of this document.

## 2.7 Historical Influent Flow and Load, and Population Projections

The following sections describe the historical influent flow, load, and population projection data used for developing future projections for the Meridian WRRF.

### 2.7.1 Influent Flows

Historical influent flows for the period 2011 through 2016 are summarized in Table 2-9.

Table 2-9. Summary of Historical Influent Flows (2011–2016)

| Year | Annual Average (mgd) | Maximum Month (mgd) | Maximum Week (mgd) | Peak Day (mgd) |
|---|---|---|---|---|
| 2011 | 5.56 | 6.38 | 6.54 | 6.93 |
| 2012 | 5.53 | 6.18 | 6.36 | 6.57 |
| 2013 | 5.54 | 6.37 | 6.62 | 7.57 |
| 2014 | 6.20 | 7.32 | 7.95 | 8.35 |
| 2015 | 6.14 | 6.74 | 6.92 | 7.50 |
| 2016 | 6.70 | 7.41 | 7.62 | 9.34 |

Flow peaking factors were calculated using the 2011 through 2016 flow data. The flow peaking factors are provided in Table 2-10.

Table 2-10. Flow Peaking Factors (2011–2016)

| Year | Maximum Month: Average Annual | Peak Two-Week: Average Annual | Maximum Week: Average Annual | Peak Day: Average Annual |
|---|---|---|---|---|
| 2011 | 1.15 | 1.17 | 1.18 | 1.25 |
| 2012 | 1.12 | 1.14 | 1.15 | 1.19 |
| 2013 | 1.15 | 1.19 | 1.20 | 1.37 |
| 2014 | 1.18 | 1.23 | 1.28 | 1.35 |
| 2015 | 1.10 | 1.11 | 1.13 | 1.22 |
| 2016 | 1.11 | 1.14 | 1.14 | 1.39 |

### 2.7.2 Influent Loading

The City's historical loading data for the period 2011 through 2016 was used to calculate average annual influent loadings for BOD, TSS, and ammonia. These influent loadings are summarized in Table 2-11.

Table 2-11. Average Annual Historical Influent Loadings (2011–2016)

| Year | BOD (lb/day) | TSS (lb/day) | Ammonia (lb/day) |
|---|---|---|---|
| 2011 | 12,695 | 12,481 | 1,384 |
| 2012 | 13,498 | 13,422 | 1,489 |
| 2013 | 14,516 | 14,213 | 1,562 |
| 2014 | 15,830 | 14,601 | 1,715 |
| 2015 | 15,041 | 13,776 | 1,781 |
| 2016 | 16,423 | 14,919 | 1,942 |

### 2.7.3 Population and Projections

The projections for future population of the City were developed by the Community Planning Association (COMPASS). These projections were captured for 2016 and 2040. Traffic analysis zones (TAZ) representing the geographic areas of the City were used to divide population and employment statistics. These population and employment estimates from COMPASS for 2016 and 2040 are summarized in Table 2-12 (J-U-B Engineers, Inc. [J-U-B] 2017).

**Table 2-12. COMPASS Population and Employment Statistics**

| TAZ Demographic Areas | 2016 COMPASS | | 2040 COMPASS | |
|---|---|---|---|---|
| | Population | Employment | Population | Employment |
| North-Meridian | 31,220 | 4,410 | 51,130 | 9,420 |
| Central-Meridian | 46,500 | 29,080 | 67,720 | 48,550 |
| South-Meridian | 21,440 | 10,120 | 42,750 | 16,330 |
| **TOTAL** | **99,160** | **43,610** | **161,600** | **74,300** |

## 2.8 Planned Flow Reduction Measures

### 2.8.1 Inflow and Infiltration Reduction

The City has implemented an inflow and infiltration program, saving between 300,000 to 500,000 gpd through improvements at leaky manholes. The Collections System Flow Monitoring Program (Murray, Smith, and Associates 2015) describes the current system layout, capacity, management, operations, and maintenance. Flow monitoring studies have been performed annually from 2009 through 2017, with most of the collection system evaluated for infiltration and inflow. The City has continued to use information gathered from the studies to inform operations and maintenance procedures and to prioritize capital and repair projects. Basins are prioritized based on the magnitude of infiltration per foot of collection system and infiltration per manhole in the basin. Basin rankings are updated year-to-year due to new flow meter locations and modifications to the collection system because of new diversions, new trunk lines, and elimination of lift stations. MSA recommended that the City focus system repair efforts based on the infiltration and inflow rankings provided. Repairs may include pipe lining, joint repair, pipe replacement, manhole lining/repair, sewer service lining, and sewer service replacement.

The 2015 Flow Monitoring Program concluded that inflow is spread throughout the entire collection system, rather than one basin generating most of the inflow. Specific monitoring for combined inflow and infiltration was recommended, but specific studies for inflow separate from infiltration was not recommended by the Program.

### 2.8.2 Water Conservation

The Meridian Water Master Plan (Murray, Smith, and Associates, Inc. 2012) shows a decline in per capita water usage, which will have a significant impact on the future water supply needs of the system. The master plan detailed a per capita water consumption rate of 112 gallons per capita per day (gpcpd). The master plan indicated that it is reasonable to assume that the City could maintain an overall value of 112 gpcpd over the next 20 years as more customers come online with separate irrigation systems and additional conservation measures are employed.

The City proactively works to secure adequate water rights for providing necessary water supply and simultaneously implements conservation measures. The City has completed a formal water conservation plan which describes impacts of conservation on demand projections, the impact of the City's reclaimed water program, how to manage non-revenue water, cost estimate of specific conservation measures, and discussion of how the City will move forward on said measures (Murray, Smith, and Associates, Inc. 2012). The quantitative impact of the combined items is currently unknown.

The current conservation measures in place include the following:

- Meter water to customers and include a component of the bill for usage
- Reduce wasted water by tracking water used for flushing and hydrant flows
- Manage tight pressure zones to avoid high pressures and reduce leaks
- Enforce building codes for low flow toilets and shower heads
- Encourage the use of alternate water sources for irrigation, including both surface water and reclaimed water, to reduce potable water use for these activities.

These water conservation measures are expected to help reduce wastewater flows to the WRRF.

## 2.9 Existing Environmental Conditions

The following sections provide a high-level explanation of the existing environmental conditions for the Meridian WRRF planning area, referencing the 2007 Facility Plan Environmental Information Document (EID) (Carollo Engineers, 2007), provided in Appendix A. The 2007 Facility Plan EID listed three possible actions for each WRRF process alternative: Proposed Action, Alternative Actions, and No Action. The Proposed Action and Alternative Actions consisted of expansion and construction of new facilities to address future treatment requirements. The Proposed and Alternative Actions were developed for primary, secondary, tertiary, and biosolids treatment systems; biosolids reuse was also addressed. The potential environmental consequences associated with the three alternatives were documented (Section 3—Affected Environment/Environmental Consequences). The following sections are written based on the City's decision to pursue the Proposed Action to address future expansion and construction of new facilities. Any changes to these items since the 2007 Facility Plan EID are discussed herein.

### 2.9.1 Physiography, Topography, Geology, and Soils

The WRRF is located on the northwest side of the City on relatively flat, open land that has never been previously developed. The site is within the Ada County boundary and the City's area of impact. As described in the City's 2007 Facility Plan EID, the majority of topography is flat ground. A copy of the soil survey map, provided by the U.S. Department of Agriculture—Natural Resource Conservation Service (NRCS), within the immediate vicinity is provided in Appendix A. Soil units at the site are made up of Unit 1, Abo Silt Loam, Unit 5, Aeric Haplaquepts, and Unit 141, Purdam Silt Loam. To date, no faults or landslides have been identified at the site.

### 2.9.2 Surface and Ground Water Hydrology

The Meridian Water Master Plan details the water supply portfolio for the City. The potable water for the Meridian system is supplied with groundwater sources from 26 water wells situated throughout the City's service boundary. Well depths can range from 400 to 800 feet below ground surface. Total capacity of all wells in the Meridian water system is 35,900 gpm (51.7 mgd). For more information on the supply wells, refer to the City of Meridian Water Master Plan (Murray, Smith, & Associates, Inc. 2012).

The geotechnical report (Materials Testing & Inspection 2015) prepared for the Liquid Stream Expansion estimated groundwater depths ranging from 2 to 10 feet below ground surface. These groundwater levels are impacted by agricultural and commercial irrigation in the area, along with leakage from nearby canals and creeks. Groundwater is likely closest to the surface in the latter part of the irrigation season (late summer). The report estimated hydraulic conductivity at the site to be between 3 and 300 feet per day.

### 2.9.3 Fauna, Flora, and Natural Communities

The 2007 Facility Plan noted that expansion of the Meridian WRRF would eliminate majority of the cultivated ground, previously used for alfalfa hay production, that is located within facility boundaries. Construction would be confined to within the site boundary. In a report from the Idaho Conservation Data Center dated August 4, 2006, no plant species of conservation need were identified. The Idaho Conservation Data Center noted singular occurrences of Merriam's shrew (State S2), peregrine falcon (United States Forest Service Sensitive), and Woodhouse's toad (Bureau of Land Management Type 3). These are the only fauna that have been noted within the area. To reference these surveys, refer to Appendix A.

### 2.9.4 Housing, Industrial, and Commercial Development

The majority of the City's customer base is residential. Non-residential use supports mostly commercial, governmental, and institutional uses similar to residential users. There is little heavy industry within the City. The City experienced atypical, rapid growth between 1990 and 2007. Between 2000 and 2007 the yearly growth rate ranged between 6.5 percent and 21.8 percent, with an overall yearly average of 12.3 percent. This period was followed by a dramatic decrease in population growth associated with the economic downturn beginning in 2008. The City expects significant growth in the service area over a 20-year planning horizon but at a lesser rate than was observed between 2000 and 2007. The 2010 U.S. Census population estimate is 75,092 people, 26,674 housing units, and an average population density of 2,803 per square mile.

The area of impact has a comprehensive plan and land use plan developed by the City Planning Department. Future land use mapping and planning extends to the edge of the area of impact to the northwest. The far southwest sections of the City's planning area are designated as unplanned area. Current and future land uses include low, medium, and high density residential, commercial, and several mixed-use areas. Further information on these areas can be found in the City's Comprehensive Plan.

### 2.9.5 Cultural Resources

A cultural resource survey was conducted in August 2006 to support the 2007 Facility Plan development. The survey was performed by an archaeological and historical resource consultant, Archaeological Survey of Idaho. During this study no cultural resources were found or documented. No impact to cultural resources is projected for future expansion at the Meridian WRRF. In addition, the National Register of Historic Places was used to list and review potential historic sites within the area. From this list there were no historical sites located within the Meridian WRRF site and, therefore, no historical site impacts have been identified. For more information on the archaeological and historical studies performed at the site, refer to Appendix A.

### 2.9.6 Utility Use

The City's potable water is provided by the City of Meridian Water Department (Water Department). Potable water is conveyed by a 6-inch pipeline located on the east side of the Meridian WRRF and measured by a master meter that is maintained by the Water Department. The potable water distribution system within the Meridian WRRF connects to various buildings and fixtures via an 8-inch loop. The treatment processes that use potable water include polymer feed system for biosolids dewatering, WAS pump seal water, polymer feed system WAS thickening, digested sludge pump seal water, digester hot water boilers makeup water, and heat exchangers on gas boosters. The seal water pump station was relocated to the North Digester Control Building in 2017; this pump station serves a seal water demand of 20 gpm at 80 psi.

Non-potable water (NPW) service is used for process makeup water, wash-down, and foam suppression spray. The NPW system, which loops around the WRRF site, was constructed in 2002 and upgraded in 2017. The NPW service includes two vertical turbine pumps (each 100 HP and 2,300 gpm) and a submersible jockey pump (25 HP and 800 gpm), all located in the NPW/Reuse Pump Station downstream of the UV disinfection system. The upgraded system was designed to meet a NPW demand of 100 to 1,900 gpm at 70 psi. A recent analysis estimated the WRRF's maximum NPW usage to be 800 to 900 gpm, with an additional demand of 1,050 gpm to be added with the Liquid Stream Expansion (Mountain Waterworks, Inc. 2016).

The WRRF process drains system, built as part of the original WRRF in 1978, consists of an 8-inch diameter gravity sewer encompassing the plant site from headworks to the western edge of the sludge drying beds. Plant drainage flows have increased over time with the expansions of the dewatering building, the DAFT, and the centrate tank. In 2010, the installation of a plant drain pump station eliminated surcharging issues.

Natural gas is provided by Intermountain Gas Company via a 2-inch service line entering the north side of the Meridian WRRF.

Electrical supply and service is provided by Idaho Power Company via a 12.5-kilovolt distribution line. The City is currently in negotiations to purchase the distribution line within the WRRF fence line after the third power pole (Confirmed ownership transferred as of May 23, 2018). The electrical distribution system at the WRRF is served from an individual tap located on Ten Mile Road with primary metering. The facility is served by overhead radial taps. Idaho Power Company owns and operates a substation near the WRRF entrance on Ten Mile Road, just south of Fivemile Creek. The existing overhead distribution line is approximately 3.2 megawatts in capacity, for which the City has a current contract of 2.4 megawatts of demand from Idaho Power. The City has installed a backup power system with 3.2 megawatts/4.0 megavolt-amperes of capacity. Four parallel 800-kilowatt (kW) diesel engine generators, which are distributed via Idaho Power Company's distribution system back to the facility, operate at 480 V and step up to 12.5 kilovolts. There appears to be sufficient physical space for an additional engine generator located outside the building, if needed for redundancy.

### 2.9.7 Floodplains and/or Wetlands

The existing Meridian WRRF site is partially above and below the 100-year flood plain area that has been designated by the Federal Emergency Management Agency. As described in the 2007 Facility Plan, the facility expansion will occur entirely within an upland environment that is not subject to wetlands hydrology. No direct or indirect impacts to any existing wetlands are anticipated for current or future expansion at the site. For a map of the 100-year flood plain refer to Appendix A.

### 2.9.8 Wild, Scenic, and Recreational Rivers

The National Wild and Scenic Rivers System was enacted by the United States Congress in 1968 to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the continued use of present and future generations. Approximately 891 river miles in Idaho are designed as wild and scenic. River classifications include wild, scenic, or recreational. The Meridian WRRF discharges to Fivemile Creek and the Boise River, neither of which are classified as wild, scenic, or recreational.

### 2.9.9 Public Health and Water Quality Considerations

The intent of the Meridian WRRF expansion is to achieve water quality requirements contained in the NPDES permit at future flow and loading projections. NPDES permit limits are set in response to Environmental Protection Agency studies of total maximum daily loads (TMDLs) in a water body. Per the Clean Water Act, a TMDL is the maximum amount of pollutant a water body can receive and still meet water quality standards, which are set to protect the health of humans and aquatic life. Additional discussion of TMDLs impacting the Meridian WRRF follows in Section 2.10.4.

### 2.9.10 Important Farmlands Protection

The Meridian WRRF expansion will be contained within the facility boundary and will not involve conversion of prime farmland. Prime farmland, as defined by the NRCS, is "land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for those uses." As detailed in the 2007 Facility Plan EID, the conversion of farmland to other uses would be governed by land use policies that are independent of this project. The NRCS has identified 66 soil units within Ada County as prime farmland. None of the planning activities slated for the Meridian WRRF would alter any prime farmland to a different use.

### 2.9.11 Proximity to Sole Source Aquifer or Stream Flow Source Area

No impacts to sole source aquifers or stream flow source areas have been identified at this time.

### 2.9.12 Land Use and Development

As described in the 2007 Facility Plan EID, the site is bordered by agricultural land that will not be altered because of the site expansion. Access to these external areas will also remain unimpeded.

As the WRRF area grows, it will soon trigger a requirement for two site access points, per the local fire marshal. A second entrance could potentially be added from Ustick Road to the south side of the WRRF. This route will require further examination but could include a roadway through the reservoir site parcel owned by the City and on portions currently owned by private individuals and Nampa Meridian Irrigation District. This route would also require a bridge across Fivemile Creek.

### 2.9.13 Precipitation, Temperature, and Prevailing Winds

The climate which Meridian inhabits is typically characterized as moderate continental climate with hot, dry summers and cold, wet winters. Temperatures range between a normal mean low of approximately 22.6 degrees Fahrenheit in January and a normal mean high temperature of 90.6 degrees Fahrenheit in July. Average precipitation is 11.8 inches per year, with an average snowfall of 21.6 inches per year. For more information on this item refer to Appendix A.

### 2.9.14 Air Quality and Noise

Construction at the site will increase short-term vehicle and equipment emissions and noise. Dust control measures will be implemented during construction to limit dust formation. In addition, the Contractor will be required to meet specific emissions standards for all construction equipment.

The new Headworks facility will include a biofilter for odor control, which will likely reduce odors compared to the existing Headworks. The facility expansion will not introduce any new facilities that would contribute additional odor sources beyond existing facilities.

The facility also currently has an air permit for sulfide emissions from the anaerobic digester facilities. They currently treat these using ferric iron addition. New facilities are not anticipated to substantially increase the sulfide quantities beyond growth and the current iron addition system will be sufficient to maintain their permit compliance moving forward.

Noise levels will increase during the construction period. As discussed in the 2007 Facility Plan EID, the amount of construction noise may range between 68 and 96 decibels at a distance of 50 feet from certain construction equipment. Long-term background noise might slightly increase; however, this would involve installing noise-generating equipment similar to existing. If above-average noise-generating equipment is installed, the design and construction of said equipment would incorporate provisions for noise control.

### 2.9.15 Energy Production and Consumption

The facility expansion will involve the installation of energy-consumptive items such as pumps, process motors, blowers, and ultraviolet disinfection lamps. Energy efficiency standards were considered in the design phase and will be implemented during construction.

### 2.9.16 Socioeconomic Profile of Affected Community

The 2016 Idaho Department of Labor community profile for the City estimates a population of 93,225 with the labor force comprised of 45,943 people. Household median income in that year was $65,528 with 55 percent of the households earning more than the national average per year.

Impacts to the existing socio-economic make-up of the area should be minimal given that the proposed expansion is the least costly alternative for upgrading the wastewater treatment capacity for the City. The construction at the Meridian WRRF is going to follow a phased approach that will spread construction costs over many years to reduce impacts to ratepayers.

## 2.10 Water Quality Planning Information

The Meridian WRRF planning process is guided by a number of water quality regulations. These water quality regulations include federal and state criteria, which were used to develop treatment alternatives throughout the facility planning process. The water quality planning efforts described in the 2012 Facility Plan (CH2M Hill and HDR, Inc.) are still applicable. These regulatory drivers are discussed in more detail in the following sections.

### 2.10.1 State Water Quality Requirements

The federal Water Pollution Control Act, from which the Clean Water Act originates, establishes federal regulations for pollutant discharge to navigable waters of the United States (water bodies such as streams, rivers, lakes, and reservoirs). The NPDES permit program is intended to meet the statutory requirements of the Clean Water Act to reduce pollutant discharges. An NPDES permit is mandatory for any point source to discharge effluent to waters of the United States. These permits provide specific limitations for pollutants to help ensure the discharge meets its designated beneficial use and does not harm human health. The City’s current NPDES permit allows for the City to discharge treated effluent to Fivemile Creek (Outfall 001) and the Boise River (Outfall 002). Currently the EPA has primacy in administering the NPDES permit program in Idaho, but this is anticipated to change in the future. In 2014, the Idaho Legislature directed the IDEQ to seek EPA authorization to administer the NPDES permit program (i.e., transition primacy from EPA to IDEQ). This state program will be called the Idaho Pollutant Discharge Elimination System (IPDES) program and will regulate the discharge of pollutants into waters of the United States in Idaho. The IPDES program is still under approval by EPA, but primacy will revert to Idaho DEQ on July 1, 2018. It is currently estimated that EPA (or Idaho DEQ) approval will be given in 2018 and the IPDES permitting program will take approximately five years to be fully implemented in Idaho.

### 2.10.2 Water Quality and Technology-based Effluent Limitations

Water quality criteria and technology-based effluent limitations (TBELs) are considered for proposed surface water discharges. The Meridian WRRF treatment and performance by unit processes must achieve the water quality criteria and TBELs set by the EPA. Water quality standards include both narrative and numeric standards intended to achieve the water quality goals (i.e., designated uses) for a water body. Narrative standards are described in IDAPA 58.01.02.200 and apply to all Idaho surface water bodies. Numeric standards are set for Idaho water bodies and the subsequent NPDES permits for point sources are used to meet said standards.

TBELs are applied to secondary treatment processes and are enforced by the EPA. TBELs represent the minimum level of effluent quality achievable by a secondary treatment system. TBELs are typically expressed in terms of BOD and TSS removal. For these parameters, secondary treatment standards for publicly owned treatment works are usually 30 mg/L and 45 mg/L for 30-day average and 7-day averages, respectively, for both BOD and TSS. For both parameters, a 30-day average 85-percent removal requirement is enforced.

### 2.10.3 Designated Uses

As previously described in the City's 2012 Facility Plan, the State Water Quality Standards use a classification system for water bodies based on the expected beneficial uses of those water bodies. Fivemile Creek and the Boise River are the two permitted discharge locations for the Meridian WRRF. These water bodies are within the Lower Boise Sub-basin and are listed for specific beneficial use designations.

Fivemile Creek has cold water biota and secondary contact recreation as designated uses. The creek is listed as impaired for these uses, with the impairments believed to be caused by bacteria, sedimentation, and siltation.

The lower Boise River (Unit SW-5, river mile 50 to Indian Creek) has cold water biota, salmonid spawning, primary contact recreation, and agricultural water supply as designated uses.

### 2.10.4 Current TMDL Developments Impacting Future NPDES Permits

Fivemile Creek is a tributary to the lower Boise River because it discharges into Tenmile Creek, which ultimately discharges to the lower Boise River. There are TMDLs in effect for the lower Boise River for sediment, bacteria, and total phosphorus. The Meridian WRRF is therefore responsible for meeting the criteria of said TMDL regulations.

The *Lower Boise River TMDL: 2015 Sediment and Bacteria Addendum* (June 2015) established wasteload allocations for point sources, including the Meridian WRRF. *E. coli* wasteload allocations are based on a bacteria concentration of 126 colony-forming units per milliliter, collected as a 5-sample geometric mean over 30 days. Sediment wasteload allocations are expressed as 4-month averages and are based on 20 mg/L, less 2.5 mg/L for natural background. Fivemile Creek (assessment unit 010_03) has a wasteload allocation for these parameters that is enforced for the Meridian WRRF. The current wasteload allocations for sediment and bacteria at the Meridian WRRF are 1,489.4 lb/day (4-month average) and 49x(10^9) colony-forming units /day (30-day geometric mean), respectively, at the current design flow of 10.2 mgd. The City's NPDES permit currently reflects these requirements.

The *Lower Boise River TMDL 2015 Addendum* (IDEQ 2015) established the allowable loadings of TP to the lower Boise River. The City's average monthly wasteload allocation is 8.5 lb/day for May through September when discharging at a TP concentration of 0.1 mg/L. This wasteload allocation, in conjunction with the other imposed on other point sources in the watershed, is estimated to achieve the 0.07 mg/L TP target in the lower Boise River. The City's average monthly wasteload allocation is 29.8 lb/day for October through April when discharging at a TP concentration of 0.35 mg/L. The City's NPDES permit currently reflects these TMDL requirements.

Fivemile Creek currently is not listed by IDEQ as impaired for temperature and, subsequently, the City's NPDES permit does not contain temperature limits. The NPDES permit does require collection of temperature data for monitoring, which will allow IDEQ to evaluate current background temperature conditions. If the temperature of Fivemile Creek were regulated in the future by IDEQ, the agency would develop a TMDL establishing the amount of thermal loading the water body could receive and still achieve its beneficial use. Other local municipalities, such as City of Nampa and City of Boise, have temperature regulations enforced within their wastewater discharge permits. Because no formal TMDL study has been completed to date, the City will not formally plan or develop cost estimates for temperature treatment technologies until further information is available.

While there are no current TMDL studies looking at compounds of emerging concern (pharmaceuticals, endocrine disrupting compounds, etc.), there is future potential for limits associated with these compounds. Research has shown that many of these compounds, but not all, can be removed using longer sludge age biological nutrient removal systems, like the Meridian WRRF. Of those that cannot, many have been found to be oxidized using ozonation. As there are no current or anticipated future limits at this time, no formal sizing or costing of this equipment is completed as part of this study. While there are no formal plans to evaluate, design, or install control mechanisms for compounds of emerging concern, the City is interested in preparing for possible future limits and ensuring there is sufficient space on the treatment plant site associated with installation of an ozonation system that can be installed if such future limits are required. A preliminary sizing of an ozonation system indicates that it would be roughly equivalent in size to Secondary Clarifier 3. Therefore, as the secondary clarifiers are expanded on the west side of the facility and Clarifier 3 is abandoned and demolished in the future, an ozone contact system can be installed, if needed, to aid in compliance with any future regulations associated with compounds of emerging concern.

## Section 3

# Planning Criteria

The following report summarizes the City WRRF planning criteria development.

## 3.1 Introduction

The City's planning criteria were prepared by J-U-B, as part of the Sewer Master Plan update and documented in technical memorandum *Meridian Wastewater Treatment Facility Flow and Load Projections* (J-U-B 2017) included in Appendix B. The intent of this Facility Plan chapter is to summarize the key information from the flow and loadings projections analysis performed by J-U-B. This will include reference to the approaches used to develop:

- Existing population, employment, flows and loads
- Unit flows, unit loads and peaking factors used in future projections
- Population and employment projections for the committed and buildout scenarios
- Flow and load projections for the committed and buildout scenarios

The population and employment projections from the current Sewer Master Plan (SMP) update were evaluated alongside flow and load data.

## 3.2 Population and Employment Projections

The projections for future population of the City were developed by the COMPASS. These projections were captured for 2016 and 2040. TAZ representing the geographic areas of the City were used to divide population and employment statistics. Figure 3-1, from the J-U-B flow and loads analysis, illustrates the TAZ used.

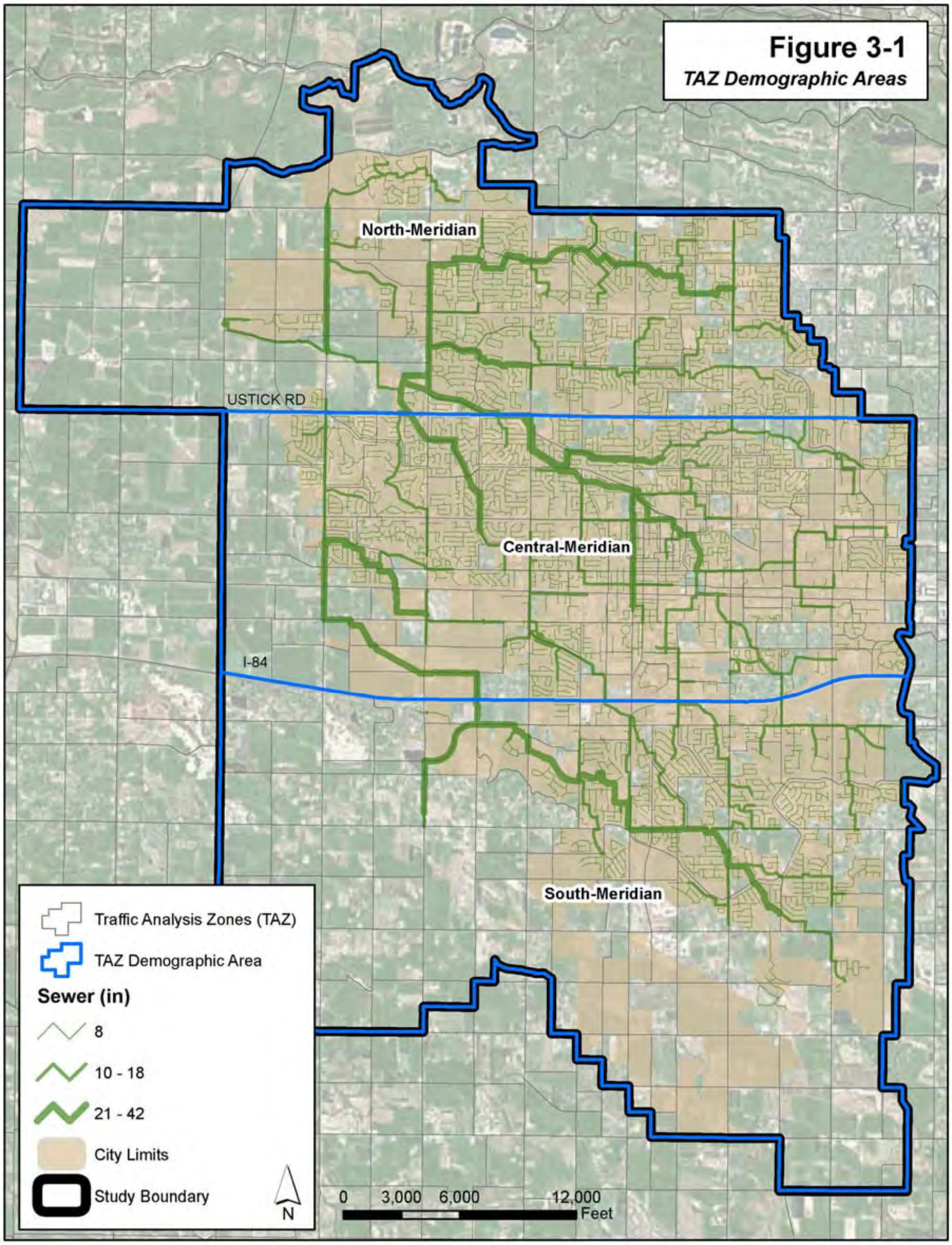


**Figure 3-1. TAZ demographic areas**

These population and employment estimates from COMPASS for 2016 and 2040 are summarized in Table 3-1.

**Table 3-1. COMPASS Population and Employment Statistics**

| TAZ Demographic Areas | 2016 COMPASS | | 2040 COMPASS | |
|---|---|---|---|---|
| | Population | Employment | Population | Employment |
| North-Meridian | 31,220 | 4,410 | 51,130 | 9,420 |
| Central-Meridian | 46,500 | 29,080 | 67,720 | 48,550 |
| South-Meridian | 21,440 | 10,120 | 42,750 | 16,330 |
| TOTAL | 99,160 | 43,610 | 161,600 | 74,300 |

The SMP update focuses on the collection system only and occurred simultaneously with the development of flow and loadings projections. Three modeling scenarios (existing, committed, and buildout) were evaluated to develop a summary of demographics. Table 3-2 is adapted from the SMP update and details the population and employment projections associated with each TAZ demographic area and modeling scenario.

**Table 3-2. Sewered Population and Employment Projections**

| TAZ Demographic Areas | Existing | | Committed (approximately 2040) | | Buildout | |
|---|---|---|---|---|---|---|
| | Population | Employment | Population | Employment | Population | Employment |
| North-Meridian | 31,700 | 3,980 | 46,230 | 8,520 | 96,770 | 17,830 |
| Central-Meridian | 49,670 | 28,230 | 65,530 | 46,980 | 85,900 | 61,580 |
| South-Meridian | 19,710 | 9,010 | 49,150 | 18,790 | 133,710 | 51,080 |
| TOTAL | 101,080 | 41,220 | 160,910 | 74,290 | 316,380 | 130,490 |

The City's committed service area is represented in the committed model scenario, including annexed areas. The committed model scenario represents allocated capacity for the Meridian WRRF. The SMP and the 2016 COMPASS estimates have slight differences most likely attributed to differing methodologies. While the projections for each demographic area do not match exactly with those for the 2040 COMPASS projections, the overall population for the City between the "committed" projections and the 2040 COMPASS estimates are within 0.5 percent of each other. Therefore, it can be assumed that the "committed" population scenario corresponds with a 2040 design year. These projections demonstrate a 2 percent average annual growth rate. The full buildout of the SMP study boundary is modeled by the buildout scenario. The buildout scenario population is estimated to be reached in 2074 using the continued 2 percent average annual growth rate.

## 3.3 Historical Flows and Loads

The City's historical average annual flow and load data, as provided in the J-U-B analysis, is summarized in Table 3-3. At the time of the analysis, data between November 2015 and October 2016 were used to represent 2016 annual average data, since November and December 2016 were not yet available.

| Table 3-3. Historical Flow and Loads (Average Annual) | | | | | | |
|---|---|---|---|---|---|---|
| Year | Flow[a] (mgd) | BOD (lb/day) | TSS (lb/day) | NH3 (lb/day) | TKN (lb/day) | TP (lb/day) |
| 2011 | 5.6 | 12,700 | 12,480 | 1,380 | 2,200 | 300 |
| 2012 | 5.5 | 13,500 | 13,420 | 1,490 | 2,290 | 300 |
| 2013 | 5.5 | 14,520 | 14,210 | 1,560 | 2,400 | 320 |
| 2014 | 6.2 | 15,830 | 14,600 | 1,720 | 2,560 | 330 |
| 2015 | 6.1 | 15,040 | 13,780 | 1,780 | 2,590 | 340 |
| 2016 | 6.6 | 16,340 | 14,790 | 1,930 | 2,910 | 350 |

*[a]Effluent flow data used. Influent flow data not available.*

### 3.3.1 Peaking Factors

The flow data was analyzed to determine peaking factors for average annual, peak month, peak week, and peak day for each year of data provided. J-U-B cited a decrease in peaking factor values attributed to the significant increase in population growth. The most representative peaking factors for current flow and load characteristics were those calculated from year 2016. The 2016 peaking factors were compared to the 6-year average peaking factors; if the 2016 peaking factors were lower than the 6-year average, the 6-year average was used. The resulting recommended peaking factors are summarized in Table 3-4.

| Table 3-4. Recommended Peaking Factors | | | | | | |
|---|---|---|---|---|---|---|
| Description | Flow | BOD | TSS | NH3 | TKN | TP |
| Average annual | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Peak month | 1.14 | 1.13 | 1.11 | 1.10 | 1.06 | 1.10 |
| Peak week | 1.18 | 1.27 | 1.23 | 1.23 | 1.17 | 1.25 |
| Peak day | 1.42 | 1.60 | 1.88 | 1.32 | 1.42 | 1.33 |
| Peak hour[a] | 1.78 | – | – | – | – | – |

*[a]Effluent peak hour flow data includes occasional recirculation flows that artificially increase the peak hour flow, resulting in a peak hour peaking factor greater than 2.6. This is not representative of typical influent peak hour flows. The peaking factor listed above was determined by using the maximum effluent peak hour flow averaged over each week, rather than maximum effluent peak hour flow from each day.*

### 3.3.2 Approach to Unit Flows and Loads

Existing water usage data was analyzed within the SMP update to establish unit flows to develop future flow projections. The average residential single family unit flow was calculated at 153 gpd.

The total wastewater loading was broken down into components, including sanitary loads (residential and non-residential), contracted loads from other utilities, and loads from permitted significant industrial users. The only loading component applicable to the City is sanitary loads. The unit loads for each constituent were developed through analyses of the existing sanitary loading data. The SMP update included development of sanitary flows for each land parcel connected to the sewer system based on winter water usage data between December 2015 and February 2016. Each land parcel was assigned a land use designation. Non-residential sanitary loads were estimated based on this SMP approach. The assumed non-residential sanitary unit loads are provided in Table 3-5. For additional information on the components of the loading data analyzed, refer to Appendix B.

| Table 3-5. Assumed Non-Residential Unit Loads | | | | | | |
|---|---|---|---|---|---|---|
| Land Use | BOD (mg/L) | TSS (mg/L) | NH3 (mg/L) | TKN (mg/L)[a] | TP (mg/L) | Source |
| Car wash | 315 | 62 | 3 | 5 | 6 | B&V[b] |
| Church, school | 222 | 106 | 72 | 109 | 11 | CT & Yelm[c,d] |
| Commercial | 442 | 157 | 51 | 77 | 7 | CT |
| Entertainment, parks/golf | 77 | 166 | 27 | 41 | 6 | Yelm |
| Hospital | 350 | 156 | 82 | 124 | 12 | Fairfax[e] |
| Hotel | 195 | 171 | 52 | 79 | 9 | CT |
| Office, industrial, public | 195 | 63 | 112 | 170 | 12 | CT |
| Restaurant | 781 | 193 | 36 | 55 | 11 | CT & Yelm |

[a]*Assumed TKN unit loads based on current ratio of TKN/$NH_3$ at WRRF.*

[b]*B&V Study (Water Effluent and Solid Waste Characteristics in the Professional Car Wash Industry, International Carwash Association).*

[c]*CT Study (State of Connecticut, 2006 Design Manual, Water Regulations and Discharges).*

[d]*Yelm Study (City of Yelm General Sewer Plan).*

[e]*Fairfax Study (Commonwealth of Virginia, State Board of Health and Disposal, Sewage Health and Disposal Regulations, 2000).*

The non-residential land use type and associated average daily flow and assumed unit loads were combined to estimate the average daily load for each load constituent. A mass balance approach was used to calculate the total residential sanitary loads. The total residential sanitary loads are summarized in Table 3-6. For information on infiltration and inflow analysis, refer to the SMP update.

| Table 3-6. Existing Flow and Loads (Winter Lows) | | | | | | |
|---|---|---|---|---|---|---|
| Description | Flow[a] (mgd) | BOD (lb/day) | TSS (lb/day) | NH3 (lb/day) | TKN (lb/day) | TP (lb/day) |
| Non-residential | 1.0 | 3,290 | 1,150 | 540 | 810 | 80 |
| Residential | 4.9 | 12,230 | 12,510 | 1,290 | 1,950 | 240 |
| **Total[b]** | **5.9** | **15,520** | **13,660** | **1,830** | **2,760** | **320** |

[a]*Does not include seasonal infiltration. The SMP estimates existing seasonal infiltration up to 1.42 mgd.*

[b]*Based on wintertime data (December 2015–February 2016), not annual averages.*

## 3.4 Flow and Load Projections

The following sections summarize the approach used by J-U-B to establish future flow and loading projections for the City's WRRF.

### 3.4.1 Flow Projections

As described in the *Meridian WWTF Flow and Load Projections*, the future land use assumptions from the SMP update were used to develop future average flows for the committed and buildout scenarios. These scenarios do not include allocations for industry or redevelopment and it is assumed new industrial dischargers will not be added to the City system. Flow projections are based on the future flows within the SMP and the peaking factors described in Table 3-4. Flow projections are summarized in Table 3-7.

| Table 3-7. Flow Projections | | | |
|---|---|---|---|
| Description (mgd) | Existing | Committed (2040) | Buildout (2074) |
| Average annual | 6.6 | 12.5 | 23.6 |
| Peak month | 7.5 | 14.2 | 26.8 |
| Peak week | 7.8 | 14.8 | 27.9 |
| Peak day | 9.3 | 17.7 | 33.4 |
| Peak hour | 11.7 | 22.3 | 42.0 |

### 3.4.2 Load Projections

Load projections were developed based on the unit loads and future land use information. The base committed and buildout scenarios from the SMP do not consider redevelopment. Future large-scale industries are also not considered in the load projections. Table 3-8 details the calculated existing, committed and buildout loads for each loading constituent.

| Table 3-8. Load Projections | | | | |
|---|---|---|---|---|
| Constituent | Load Description | Existing | Committed (2040) | Buildout (2074) |
| BOD (lb/day) | Average annual | 16,340 | 27,960 | 50,790 |
| | Peak month | 18,240 | 31,520 | 57,260 |
| | Peak week | 20,760 | 35,520 | 64,520 |
| | Peak Day | 26,080 | 44,630 | 81,060 |
| TSS (lb/day) | Average annual | 14,790 | 24,230 | 46,140 |
| | Peak month | 16,390 | 26,840 | 51,100 |
| | Peak week | 18,160 | 29,740 | 56,620 |
| | Peak day | 27,760 | 45,470 | 86,580 |
| NH3 (lb/day) | Average annual | 1,930 | 3,730 | 6,830 |
| | Peak month | 2,120 | 4,090 | 7,500 |
| | Peak week | 2,380 | 4,590 | 8,400 |
| | Peak day | 2,550 | 4,920 | 9,000 |
| TKN (lb/day) | Average annual | 2,910 | 5,620 | 10,300 |
| | Peak month | 3,090 | 5,960 | 10,920 |
| | Peak week | 3,410 | 6,590 | 12,060 |
| | Peak day | 4,130 | 7,970 | 14,580 |
| TP (lb/day) | Average annual | 350 | 630 | 1,150 |
| | Peak month | 390 | 690 | 1,260 |
| | Peak week | 440 | 780 | 1,430 |
| | Peak day | 470 | 840 | 1,530 |

## 3.5 Solids Projections

This section documents the solids flows and loads data used in sizing relevant equipment associated with Meridian WRRF improvements for a 20-year planning period, from 2020 to 2040.

Historical data from 2011 to 2016 were used to develop current solids flows and loads. Sludge production fluctuates throughout the year as the plant influent flow and characteristics change. The solids handling facilities and associated equipment must be sized properly to be able to handle solids production at peak events. Therefore, several peaking factors are needed, including maximum day, maximum week, maximum 2-week, and maximum month to design the solids system.

However, sometimes there is not enough data available to determine all peaking factors to this level of precision. In those cases, assumptions were made based on BC's engineering judgment and experience.

Future plant influent and solids production projections were developed in two previous projects, including the Wastewater Facility Plan (CH2M Hill and HDR, Inc. 2012), Headworks Capacity Expansion (CH2M Hill 2015), Side Stream Nitrogen Evaluation (BC 2015), Secondary Treatment Alternatives Evaluation (BC, 2016), and Flow and Load Projections (J-U-B 2017). BC developed future solids productions and peaking factors after reviewing previous solids projections, historical data, and proposed changes in the liquid treatment system.

The following key assumptions were used to develop current and future solids flow and load projections for this evaluation:

- Current primary sludge (PS) production rates under average conditions are based on data from 2014 and 2016. No data was reported for other years.
- Total solids (TS) and volatile solids (VS) concentrations for PS are based on the average value of historical data.
- Current PS flows are calculated based on existing PS production rates and TS concentrations.
- Peaking factors for current PS production are assumed to remain constant for future conditions.
- Current WAS flows and loads are based on historical data from 2011 to 2016.
- VS concentration of WAS at current conditions are assumed to be the same as those of projected future conditions.
- Peaking factors for current WAS flows and loads are calculated by averaging the peaking factors of historical data.
- Future PS production rate projections are based on plant influent data in the *Headworks Capacity Expansion TM* (CH2M Hill 2015) and the primary clarifier models developed for the *Side Stream Nitrogen Evaluation TM* (BC 2015).
- Current TS and VS concentrations for primary sludge are assumed to remain constant for future conditions.
- Future WAS production estimates were developed based on plant influent data and BioWin modeling in the *Secondary Treatment Alternatives Evaluations* (BC 2016).
- Future TS and VS concentration for WAS are based on BioWin modeling results from the *Secondary Treatment Alternatives Evaluations*, (BC 2016).
- Combined sludge production at maximum month and maximum 2-week conditions are calculated assuming peak sludge production for both PS and WAS occur simultaneously. This is a conservative assumption and provides a worst-case scenario for solids treatment system loadings.
- Combined sludge production for the maximum day condition is calculated assuming maximum day condition occurs concurrently with one sludge stream and maximum month condition with another sludge stream.

Solids flows and loads for current conditions are summarized in Table 3-9.

| Table 3-9. Summary of Solids Flows and Loads for 2020 | | | | | |
|---|---|---|---|---|---|
| Parameter | Unit | Average Annual | Maximum Month | Maximum 2-Week | Maximum Day |
| Primary Sludge [a,b,c,d] | | | | | |
| Sludge flow | gpd | 31,600 | 42,100 | 45,300 | 56,000 |
| Total solids | lb/d | 9,300 | 12,500 | 13,400 | 16,600 |
| Volatile solids | lb/d | 8,300 | 11,100 | 11,900 | 14,700 |
| Percent solids | Percent | 3.54 | 3.54 | 3.54 | 3.54 |
| Percent volatile solids | Percent of TS | 89 | 89 | 89 | 89 |
| WAS [e,f,g] | | | | | |
| Sludge flow | gpd | 124,200 | 147,300 | 156,500 | 174,800 |
| Total solids | lb/d | 7,200 | 8,500 | 9,100 | 10,500 |
| Volatile solids | lb/d | 5,300 | 6,000 | 6,600 | 7,800 |
| Percent solids | Percent | 0.70 | 0.86 | 0.80 | 0.71 |
| Percent volatile solids | Percent of TS | 72 | 70 | 72 | 74 |
| Sludge flow | gpd | | | | |
| Combined Primary Sludge and WAS [h,i] | | | | | |
| Sludge flow | gpd | 155,800 | 189,400 | 201,800 | 216,900 |
| Total solids | lb/d | 16,500 | 21,000 | 22,500 | 25,100 |
| Volatile solids | lb/d | 13,600 | 17,100 | 18,500 | 20,700 |
| Percent solids | Percent | 1.27 | 1.32 | 1.33 | 1.38 |
| Percent volatile solids | Percent of TS | 82 | 82 | 82 | 83 |

[a] *Average PS production on 2014 and 2016. No data was reported for other years.*

[b] *TS and VS concentrations for PS are based on average value of historical data.*

[c] *PS flow are calculated based on production and TS concentration.*

[d] *PS peaking factors are assumed to be the same as those of projected future conditions.*

[e] *WAS flows and loads are based on historical data from 2011 to 2016.*

[f] *VS of WAS are assumed to be the same as those of projected future conditions.*

[g] *Peaking factors for WAS flows and loads are calculated by averaging the peaking factors of historical data.*

[h] *Combined sludge production at maximum month and maximum 2-week conditions are calculated assuming peak sludge production for both PS and WAS occur simultaneously.*

[i] *Combined sludge production for the maximum day condition is calculated assuming maximum day condition occurs at the maximum day condition of one sludge stream and the maximum month condition of another sludge stream.*

Solids flow and load projections for future conditions are summarized in Table 3-10.

| Table 3-10. Summary of Solids Flows and Loads for 2040 | | | | | |
|---|---|---|---|---|---|
| Parameter | Unit | Average Annual | Maximum Month | Maximum 2-Week | Maximum Day |
| Primary Sludge [a,b] | | | | | |
| Sludge flow | gpd | 66,200 | 88,400 | 95,100 | 117,500 |
| Total solids | lb/d | 19,600 | 26,100 | 28,100 | 34,700 |
| Volatile solids | lb/d | 17,400 | 23,300 | 25,000 | 30,900 |
| Percent solids | Percent | 3.54 | 3.54 | 3.54 | 3.54 |
| Percent volatile solids | Percent of TS | 89 | 89 | 89 | 89 |
| WAS [c,d] | | | | | |
| Sludge flow | gpd | 204,600 | 183,900 | 225,500 | 263,900 |
| Total solids | lb/d | 13,000 | 13,300 | 15,100 | 15,700 |
| Volatile solids | lb/d | 9,400 | 9,400 | 10,900 | 11,600 |
| Percent solids | Percent | 0.76 | 0.86 | 0.80 | 0.71 |
| Percent volatile solids | Percent of TS | 72 | 70 | 72 | 74 |
| Sludge flow | gpd | | | | |
| Combined Primary Sludge and WAS [e,f] | | | | | |
| Sludge flow | gpd | 270,700 | 272,300 | 320,500 | 352,200 |
| Total solids | lb/d | 32,500 | 39,400 | 43,100 | 48,000 |
| Volatile solids | lb/d | 26,800 | 32,600 | 35,900 | 40,200 |
| Percent solids | Percent | 1.44 | 1.73 | 1.61 | 1.63 |
| Percent volatile solids | Percent of TS | 82 | 83 | 83 | 84 |

[a] *PS production based on plant influent data in the 2015 Basis of Design TM by CH2M Hill and the primary clarifier models developed for the Sidestream Nitrogen Removal TM.*

[b] *Total solids concentration and volatile solids concentration for primary sludge based on historical average data from 2011 to 2016.*

[c] *WAS productions were developed based on plant influent data and BioWin modeling in the 2015 Basis of Design TM by CH2M Hill.*

[d] *Total solids concentration and volatile solids concentration for WAS were based on BioWin modeling results.*

[e] *Combined sludge production at maximum month and maximum 2-week conditions are calculated assuming peak sludge production for both PS and WAS occur simultaneously.*

[f] *Combined sludge production for the maximum day condition is calculated assuming maximum day condition occurs at the maximum day condition of one sludge stream and the maximum month condition of another sludge stream.*

Combined sludge flows and loads were used to size process equipment that treats combined sludge, such as combined thickening, digestion, and dewatering. Separate PS and WAS flows and loads were used to size process equipment that treat the two sludge streams separately, such as separate thickening and associated pumps and piping.

In general, peak solids production for combined solids are lower than the sum of peak PS and WAS production because the peak events for separate sludge streams typically do not occur simultaneously. Peak day solids flow and load for combined solids were assumed to occur at the peak day condition of one sludge stream and the maximum month condition of another sludge stream for this evaluation. BC considers this approach to be conservative for process sizing and avoids over-sizing equipment.

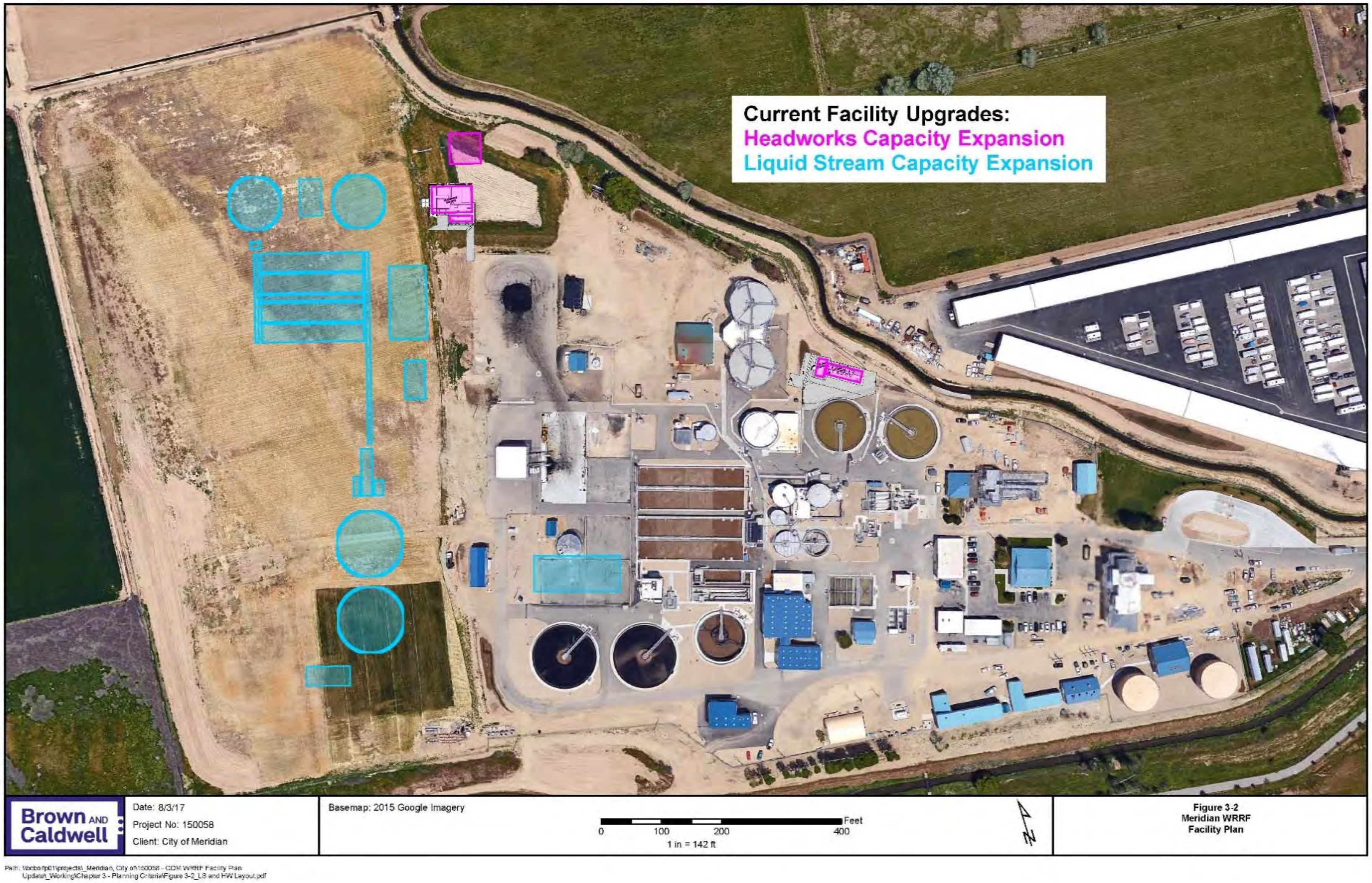


Figure 3-2. Meridian WRRF site layout and current upgrades

# Section 4

# Expansion Alternatives

This section of the report outlines the liquids and solids alternatives for expanding treatment capacity of the Meridian WRRF to meet future growth and permit conditions outlined in Section 3.

## 4.1 Liquid-Stream Treatment Analysis

To meet the anticipated stringent NPDES permit requirements for ammonia-nitrogen ($NH_4$-N), TP, and other constituents, a series of investigations were conducted in 2015 to evaluate alternatives for expanding the secondary treatment system and add-on processes to supplement the main stream processes. This section summarizes the alternatives evaluated and recommendations made in those investigations, and provides an assessment of tertiary filtration alternatives.

### 4.1.1 Design Flows and Loadings Used for Analysis

Unless otherwise noted, all alternatives discussed in the following sections were evaluated based on projected 2030 flows and loadings provided in the *Wastewater Facilities Plan* (CH2M Hill and HDR 2012). Projected 2040 flows and loadings are summarized in Section 3. Comparing the two sets of flows and loadings, the design flows are similar except for peak hour flow. The projected 2030 peak hour flow is 28 mgd based on the *Wastewater Facilities Plan*, while the recent projected 2040 peak hour flow is 22.3 mgd (CH2M Hill and HDR 2012). The design 2040 BOD, TSS, and phosphorus (P) loadings as described in Section 3 are lower than the previous 2030 projections, while the design ammonia and total Kjeldahl nitrogen (TKN) loadings are higher. However, when the 2040 ammonia and TKN loadings are extrapolated back to 2030 conditions, the corresponding 2030 loadings estimated for the *Sewer Master Plan* projections are comparable with the previous projected loadings. The previous analyses based on the projected 2030 values developed in the *Wastewater Facilities Plan* are thus considered conservative and acceptable for alternatives comparison. Updating the analyses to the current flow and loading projections is not expected to change the results.

### 4.1.2 Headworks Process Alternative Evaluation

The City is currently in the process of constructing a new headworks system consisting of a new influent wet well and pump station, 3 new screens, two new grit tanks, and flow measurement and splitting capabilities for the new and existing primary clarifiers, as well as space for future flow split to any new primary clarifiers. The upgrade is anticipated to be online in 2018 and has sufficient hydraulic and treatment capacity to meet the anticipated peak 2040 design year. The grit system was sized to meet buildout flows for the facility, there is space for a new screen to meet buildout flow and load conditions, and the influent pumps can be replaced with larger pumps as needed for increased flows beyond design year 2040. No expansion of this new headworks system is anticipated during the design period covered by this report.

### 4.1.3 Primary Process Alternative Evaluation

The City currently has two primary clarifiers with two additional primary clarifiers in construction as part of the liquid treatment expansion project. The capacity of these four primary clarifiers is sufficient to meet anticipated 2040 flows. Therefore, no new primary clarifiers are anticipated for the duration of the design period covered by this report. To meet buildout flows and loads, there is sufficient space to accommodate up to 4 additional primary clarifiers of the same size.

### 4.1.4 Secondary Treatment Process Alternative Evaluation

Alternatives for expanding the secondary treatment process were evaluated to meet the anticipated NDPES requirements while accommodating future flows and loadings. Detailed descriptions of the alternatives, process modeling setup and results, and cost estimates are provided in the BC report *Secondary Treatment Alternatives Evaluation* dated September 24, 2015, included in Appendix C (BC 2015b). Three alternatives were developed in conjunction with the City, as follows:

- Expansion of the existing system using a 5-stage Bardenpho process (convertible to A2O) to meet current and future NPDES requirements for discharge to Boise River/Five Mile Creek
- Expansion of the existing system by conversion to a 4-stage Bardenpho process for nitrogen (N) removal only, then discharging to groundwater to eliminate the need for biological or downstream chemical P removal
- Expansion of the existing system by conversion to a simultaneous nitrification and denitrification (SND) system with chemical P removal (as an alternative to the more conventional 5-stage Bardenpho process)

The following sections provide a summary of the analysis and the recommended alternative.

#### 4.1.4.1 Alternative 1: Expansion of Existing A2O/5-Stage Bardenpho System

This was considered as the base case alternative for expanding the existing system to provide both biological P and N removal, with tertiary chemical P removal as required for polishing to meet the permit requirements. The target effluent concentrations are summarized in Table 4-1.

**Table 4-1. Target Effluent Concentrations for Main Process Alternative 1 (mg/L)**

| Parameter | Monthly Average | Weekly Maximum | Daily Maximum |
|---|---|---|---|
| BOD | 20 | 30 | – |
| TSS | 20 | 30 | – |
| TP | 0.5 | – | – |
| $PO_4$-P | 0.1 | – | – |
| $NH_4$-N | 0.307 | – | 1.25 |
| NOx-N | 8 | – | – |
| TN | 10 | – | – |

Figure 4-1 presents a process flow schematic for the system that can operate in either 5-stage Bardenpho or A2O configuration.

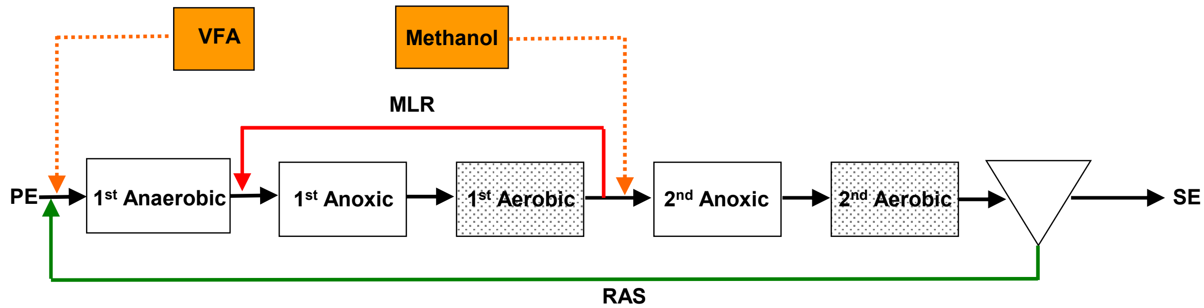


**Figure 4-1. Process flow schematic for Main Process Alternative 1: 5-stage Bardenpho process**

When operating in the 5-stage Bardenpho configuration, primary effluent enters the anaerobic zone, where supplementary carbon in the form of VFAs is added. Flow then moves to the first anoxic zone, where the initial stage of denitrification occurs. Flow then enters the first aerobic zone for nitrification. The MLR returns nitrate-rich mixed liquor from the end of the first aerobic zone to the first anoxic zone for denitrification. Flow passes to the second anoxic zone, where supplementary carbon is added in the form of methanol to ensure that additional denitrification occurs. Finally, flow enters the second aerobic zone to polish and strip any N gas in the solution before clarification.

The system can be converted to the simpler A2O process by operating the second anoxic cell as an aerated cell, and routing MLR from the end of the larger aeration cell to the anoxic cell, as illustrated in Figure 4-2.

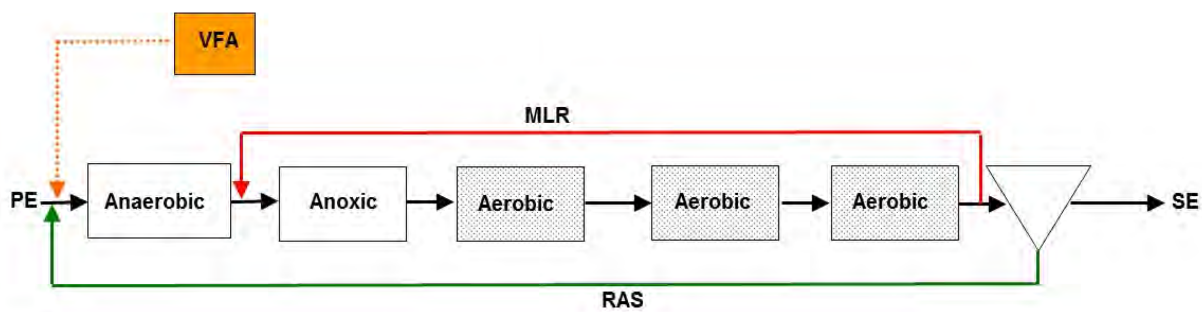


**Figure 4-2. Process flow schematic for Main Process Alternative 1: A2O process**

### 4.1.4.2 Alternative 2: Expansion for Nitrogen Removal Only (Groundwater Infiltration)

This is based on an alternative discharge to groundwater, which would require N removal only. The current outfall discharge points to both Five Mile Creek and Boise River would be eliminated. Because phosphorus is not a regulated constituent in groundwater per the Idaho Ground Water Quality Rule (IDAPA 58, Title 01, Chapter 11), biological P removal is not necessary for this alternative. Nitrate-nitrogen ($NO_3$-N) and nitrite-nitrogen ($NO_2$-N) are the primary constituents of concern for groundwater discharge. Target effluent concentrations for this alternative are given in Table 4-2.

**Table 4-2. Target Effluent Concentrations for Main Process Alternative 2 (mg/L)**

| Parameter | Daily Maximum |
|---|---|
| $NO_3$-N | 10 |
| $NO_2$-N | 1 |
| NOx-N | 10 |

Figure 4-3 presents the process flow schematic for the secondary system. The expanded system would consist of a 4-stage Bardenpho process that includes a first anoxic zone for initial denitrification, a first aerobic zone for nitrification, a second anoxic zone for further denitrification, and a final aerobic zone for air stripping N gas and polishing the mixed liquor prior to clarification. Methanol is added to the second anoxic zone while MLR returns nitrate-rich mixed liquor to the first anoxic zone for denitrification.

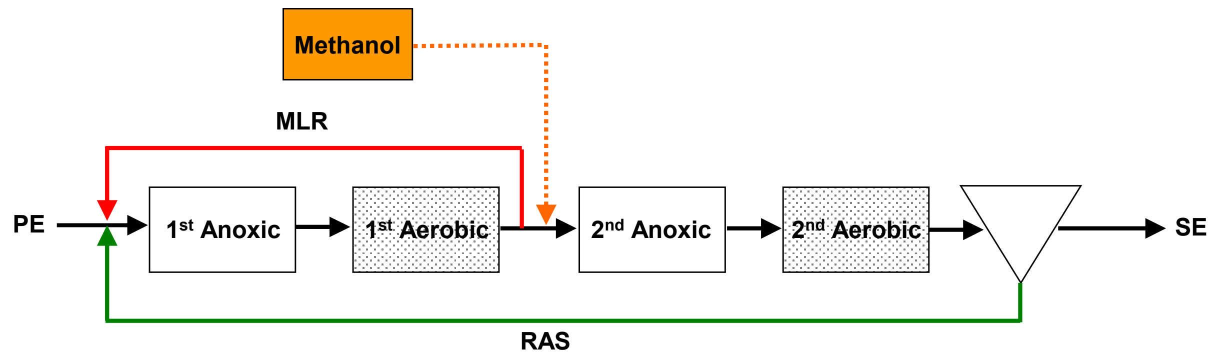


**Figure 4-3. Process flow schematic for Main Process Alternative 2: 4-stage Bardenpho process**

#### 4.1.4.3 Alternative 3: Simultaneous Nitrification/Denitrification with Chemical Phosphorus Removal

This alternative maintains plant discharge to Five Mile Creek. N removal is achieved in an activated sludge process with SND to reduce the size of the basins, as well as soluble carbon requirements to drive the denitrification processes. SND requires strict control of DO in the aeration basin to force nitrification and denitrification to occur simultaneously. The low DO concentration results in less aerobically oxidized influent carbon, which allows for better denitrification at low DO. Chemical P removal is used to remove excess phosphorus in the effluent. Target final effluent concentrations are the same as those for Alternative 1 (shown in Table 4-1).

#### 4.1.4.4 Sizing Requirements and Preliminary Capital and Operating Cost Estimates

The three main liquid process alternatives were simulated using the calibrated BioWin model from the Capacity Assessment project to determine basin sizing, sludge production rates, airflow requirements, and chemical requirements (for both chemicals added to the biological process and to any tertiary process for P removal, if required). The modeling results, based on 2030 design maximum month flow and loading conditions, are summarized in Table 4-3.

| Table 4-3. Summary of Sizing and Operating Requirements for Main Process Alternatives | | | | |
|---|---|---|---|---|
| Parameter | Unit | Alternative 1: 5-stage Bardenpho | Alternative 2: 4-stage Bardenpho (N removal only) | Alternative 3: SND and chemical P removal |
| Required SRT for year-round nitrification | d | 12 | 14 | 13 |
| Activated sludge basin volume, total | million gallons | 7.25 | 5.75 | 5.0 |
| MLR rate, percent of PE flow | Percent | 200 | 400 | 300 |
| WAS production | lb/d | 23,250 | 11,350 | 10,772 |
| Airflow requirement | scfm | 20,510 | 17,780 | 11,516 |
| Acetate use | lb/d | 9,230 | – | – |
| Methanol use | gpd | 615 | 310 | – |
| Chemical sludge from P removal to 0.07 mg/L | lb/d | 1,900 | – | 40,500 |
| Alum requirement for chemical P removal | gpd | 800 | – | 11,340 |
| Caustic soda requirement for pH control because of alum addition (50% solution) | lb/d<br>gpd | –<br>– | –<br>– | 8,500<br>1,340 |

Alternative 3 has the smallest basin volume requirement and lowest aeration requirements, but it has significant chemical requirements for tertiary P removal. Alternative 1 has the largest basin volume requirement, providing both N and P removal in the secondary system.

Planning-level capital costs for the three alternatives are summarized in Table 4-4. Note that all cost estimates presented here reflect preliminary estimates for evaluation purposes only. Final estimates of the recommended alternatives are presented in Section 6 of this report.

Alternative 2 has the highest capital cost, mainly because of a series of capital improvements to accommodate effluent discharge to groundwater through infiltration. Alternative 3 has the lowest capital cost, mainly because of it has the lowest aeration basin expansion requirements.

| Table 4-4. Planning-Level Comparative Capital Costs for Main Process Alternatives | | | |
|---|---|---|---|
| Process | Alternative 1: 5-stage Bardenpho | Alternative 2: 4-stage Bardenpho (N removal only) | Alternative 3: SND and Chemical P Removal |
| Greenfield aeration basin tank expansion | | | |
| Volume (million gallons) | 4.9 | 3.35 | 2.6 |
| Total cost (at $850,000/million gallons) | $4,170,000 | $2,850,000 | $2,210,000 |
| Existing basin retrofit | Common to all alternatives | | |
| New secondary clarifiers | Common to all alternatives | | |
| Chemical P removal facilities | $62,500 | – | $300,000 |
| Acetate addition facilities | $106,500 | – | – |
| Methanol addition facilities | $568,000 | $281,000 | $280,000 |
| Alkalinity addition facilities | – | – | $100,000 |
| Additional chlorine chemical disinfection | – | $1,736,000 | – |
| Effluent pump station | – | $4,206,000 | – |
| Effluent pipeline | – | $8,723,000 | – |
| Infiltration basins | – | $5,903,000 | – |

| Table 4-4. Planning-Level Comparative Capital Costs for Main Process Alternatives | | | |
|---|---|---|---|
| Process | Alternative 1: 5-stage Bardenpho | Alternative 2: 4-stage Bardenpho (N removal only) | Alternative 3: SND and Chemical P Removal |
| Land purchase [a] | – | $1,530,000 | – |
| **Total** | **$4,907,000** | **$25,228,000** | **$2,890,000** |

*a. Assumes 96 acres at $15,900 per acre.*

*Note: Planning-level costs provided in this table reflect construction costs only, and do not include contractor markups, contingency, inflation to midpoint of construction, bonds, insurance, etc.*

The modeling results in Table 4-3 were translated into operating costs associated with chemical addition, aeration demand, and biosolids hauling. Assumptions used to develop these costs are provided in the *Secondary Treatment Alternatives Evaluation* report included in Appendix C (BC 2015b). The operating costs for the three alternatives are summarized in Table 4-5. Alternative 2 has the lowest operating costs, mainly because it has the lowest overall chemical requirements, while Alternative 3 has the highest operating costs, mainly due to the significant chemical requirements to achieve chemical P removal.

| Table 4-5. Maximum Month Operating Costs for Main Process Alternatives | | | |
|---|---|---|---|
| Parameter | Alternative 1: 5-stage Bardenpho | Alternative 2: 4-stage Bardenpho (N removal only) | Alternative 3: SND and Chemical P Removal |
| Methanol | $42,000 | $21,000 | $2,800 |
| Acetate | $260,000 | – | – |
| Process aeration | $41,000 | $37,000 | $23,800 |
| Biosolids hauling | $11,000 | $5,000 | $27,300 |
| P removal chemical | $29,000 | – | $421,000 |
| Alkalinity addition | – | – | $76,000 |
| Effluent pump station electrical cost | – | $16,000 | – |
| Additional chlorine disinfection | – | $17,000 | – |
| Maintenance and replacement parts for groundwater discharge components | – | $11,000 | – |
| **Total per month** | **$383,000** | **$107,000** | **$551,000** |

While Alternative 3 provides the lowest capital cost, the operating costs are significant. Furthermore, this alternative presents the highest potential operational issues because of the need for stringent DO control and the potential for filamentous growth and associated bulking that may occur at the low DO operating conditions. For these reasons, Alternative 3 was not recommended for further evaluation.

Alternative 1 presents a lower capital cost compared with Alternative 2. As the City is still unsure if it will discharge to groundwater infiltration as the sole discharge for the plant or remain in Fivemile Creek, and because Alternative 1 can be configured to operate for N removal only to mimic Alternative 2, Alternative 1 (5-stage Bardenpho) was selected as the main liquid treatment process for further evaluation.

### 4.1.5 Add-On Process Evaluations

Several add-on processes were also evaluated, both separately and in conjunction with the 5-stage Bardenpho main process alternative selected for further study. The main purpose of these processes is to reduce the magnitude of the expansion and operational requirements of the secondary system by providing nutrient removal in a tertiary system, reducing nutrient loads in the recycle streams returned to the liquid treatment train, or converting or modifying the existing activated sludge processes to other processes that allow larger biomass inventory to accommodate biological nutrient removal. These processes include tertiary P removal, sidestream P removal, sidestream N removal, influent equalization (EQ) to reduce nutrient load peaks, centrate equalization, tertiary nitrification, and denitrification processes (to eliminate the need for N removal in the main process), conversion of the existing activated sludge process to an integrated fixed-film activated sludge process, conversion to a BioMag process, and conversion to a membrane bioreactor (MBR) process. Detailed descriptions and results of modeling and cost analyses of these add-on processes are included in the *Secondary Treatment Alternatives Evaluation* report (Appendix C) (BC 2015b).

Table 4-6 provides a capital and operating cost comparison of the add-on alternatives.

Based on a comparison of the results, the lowest capital cost options are MBR, base case (5-stage Bardenpho with no add-on alternatives), and centrate load equalization. The lowest-cost options from the maximum winter month operating cost standpoint are influent EQ with sidestream N and P removal, influent EQ alone, and sidestream P removal alone. Because of this analysis, the following options were selected for further evaluation:

- 5-stage Bardenpho with sidestream P removal (Ostara-type)
- 5-stage Bardenpho with sidestream P removal and centrate load equalization
- 5-stage Bardenpho with MBR

**Table 4-6. Cost Comparison of Add-On Alternatives**

| Cost | Base | Sidestream P | Influent EQ | Influent EQ + Sidestream N | Influent EQ + Sidestream N and P | Centrate Load EQ | Tertiary N + Denite | BioMag | MBR | IFAS |
|---|---|---|---|---|---|---|---|---|---|---|
| Capital [a] | $14,200,000 | $15,100,000 | $16,700,000 | $19,900,000 | $20,800,000 | $13,600,000 | $30,900,000 | $16,400,000 | $10,100,000 | $18,400,000 |
| Operating (maximum monthly cost) [a] | $420,000 | $268,000 | $304,000 | $306,000 | $248,000 | $411,000 | $449,000 | $457,000 | $552,000 | $442,000 |

*a. Capital and operating costs for all alternatives except for MBR include costs for the tertiary membrane system.*

*Notes:*

*Planning-level costs provided in this table reflect construction costs only, and do not include contractor markups, contingency, inflation to midpoint of construction, bonds, insurance, etc.*

*IFAS = integrated fixed-film activated sludge.*

### 4.1.6 Final Alternatives Evaluation

BioWin simulations were conducted for the three options selected in Section 1.3 for 2030 flows and loading conditions; and potential site layouts, preliminary capital cost estimates, and annual average operating costs were developed. Note that all cost estimates presented here reflect preliminary estimates for evaluation purposes only. Final estimates of the recommended alternatives are presented in Section 6 of this report.

Table 4-7 and Table 4-8 summarize the estimated capital construction costs and 2030 average monthly operating costs for the three alternatives, respectively.

**Table 4-7. Capital Construction Cost for Final Alternatives (all based on the 5-stage Bardenpho process, 2015 dollars) [a]**

| Area | With Sidestream P Removal | With Sidestream P Removal and Centrate Load EQ | With MBR |
|---|---|---|---|
| Headworks upgrade | Not estimated/separate project | Not estimated/separate project | Not estimated/separate project |
| Primary influent pump station (new) | $4,960,000 | $4,960,000 | $3,230,000 |
| Primary clarifiers | $5,650,000 | $5,650,000 | $5,650,000 |
| Aeration basins (new) | $18,070,000 | $18,070,000 | $5,930,000 |
| Aeration basins (retrofit of existing) | $5,190,000 | $5,190,000 | $5,580,000 |
| MBR treatment system | | | $22,660,000 |
| Secondary clarifiers | $6,460,000 | $6,460,000 | $0 |
| Tertiary treatment processes [b] | $12,280,000 | $12,330,000 | $230,000 |
| Supplemental carbon addition facilities | $680,000 | $680,000 | $680,000 |
| Sidestream P removal system | $4,670,000 | $4,660,000 | – |
| Centrate storage tank | – | $720,000 | – |
| **Total** | **$57,960,000** | **$58,700,000** | **$43,960,000** |

a. *Association for the Advancement of Cost Engineering Class 5 estimates, including contractor markups, labor markups, sales tax, and contingency.*

b. *Tertiary treatment consists of Actiflo ballasted flocculation system and alum addition facility, except for alternative with MBR, for which tertiary treatment consists of alum addition facility only.*

**Table 4-8. 2030 Average Monthly Operating Costs for Final Alternatives (all based on 5-stage Bardenpho process, 2015 dollars)**

| Parameter | With Sidestream P Removal | With Sidestream P Removal and Centrate Load EQ | With MBR |
|---|---|---|---|
| Methanol | $27,000 | $27,000 | $24,000 |
| Acetate (80% solution of acetic acid) | $50,300 | $50,300 | 325,000 |
| Process aeration | $30,100 | $30,100 | 46,000 |
| Sodium hypochlorite | – | – | $1,400 |
| Citric acid | – | – | $3,800 |
| Membrane replacement cost | – | – | $24,000 |
| Membrane auxiliary system | – | – | $5,800 |
| Actiflo monthly cost | $7,000 | $7,000 | – |
| Sidestream P removal | $15,000 | $15,000 | – |
| Biosolids hauling | $11,300 | $11,300 | $11,000 |
| P removal chemical | $29,000 | $29,000 | $29,000 |
| **Total** | **$170,000** | **$170,000** | **$470,000** |

Table 4-9 shows the estimated 20-year costs incorporating both the capital and average operating costs for a 20-year life cycle. The latter was estimated by assuming that the current annual operating cost would be approximately half of the 2030 costs.

| Table 4-9. 20-Year Costs for Final Alternatives (all based on 5-stage Bardenpho process, 2015 dollars) | | | |
|---|---|---|---|
| Parameter | With Sidestream P Removal | With Sidestream P Removal and Centrate Load EQ | With MBR |
| Total cost [a] | $93,000,000 | $94,000,000 | $141,000,000 |

a. *Total 20-year costs including capital cost of construction and operating costs during a 20-year period. The operating costs were calculated assuming that the 2030 costs are approximately double the current.*

Based on the results shown in Tables 4-7 to 4-9, the MBR option has the lowest capital cost. However, factoring in the estimates for annual operating cost differences between the options makes the MBR option far more expensive over a 20-year life cycle compared with the other two options. For the other two options with sidestream P removal, the estimated operating costs are the same, suggesting that the benefit of installing a centrate load EQ tank does not appear to translate to reduced operating costs.

Because the cost differences are relatively small, the City decided to proceed with the sidestream P removal and centrate load EQ option. This presents the most flexible option for operation of the facility, as it can be designed to operate as either a 5-stage Bardenpho or A2O process. It can also be designed to operate as a 4-stage Bardenpho or Modified Ludzack-Ettinger process, should the City decide to go to N removal only for groundwater recharge discharge.

This initial analysis looked only at expansion of the process to meet a rated capacity of 15 mgd maximum month flow and load. This required 4 new aeration basins of the 5-stage Bardenpho configuration and two additional 120 ft diameter secondary clarifiers. These are currently being constructed as part of the liquid process expansion project and are anticipated to be put into service by 2019.

To meet the 2040 design year flows and loads, two new aeration basins and one new secondary clarifier will be required. The layout for these new processes will be provided in Section 6.

### 4.1.7 Tertiary Filtration Alternative Assessment

Four cloth disk filters are providing tertiary treatment at the Meridian WRRF. Tertiary treatment is required to meet Class A reuse turbidity requirements. There is no coagulation system, so filter influent TSS must have solids particles greater than 10 microns for the filters to be effective. The peak firm capacity with one of the largest units out of service is 18 mgd, which less than the projected 2030 peak hour flow of 22.3 mgd. Future potential effluent N and P limits may require a higher level of tertiary filtration. This section presents an overview of the different types of tertiary filtration alternatives to address stringent P requirements and a comparison of the pros and cons of those alternatives.

The following tertiary filtration alternatives were evaluated:

- Cloth disk filters (base case)
- Granular media filters (including both downflow and upflow filters)
- Compressible media filters
- Iron-coated sand filters
- Membrane filters

#### 4.1.7.1 Cloth Disk Filters

The existing cloth disk filtration system can be replaced with new cloth disk filters or expanded by adding new units to meet future flow requirements. In a cloth media disk filter, high-density woven fabric is used as filter media. Each disk comprises multiple pie-shaped sections, which are mounted in a vertical plane. Each filter is made up of multiple disks. During filtration, the disks remain stationary and fully submerged. Secondary effluent passes by gravity through the media, and the filtered effluent is collected in the filtrate header, or flows into the collection tank. As solids accumulate on and within the media a mat is formed, providing additional filtration, and the influent liquid level increases. The filters are automatically backwashed based on water level differential or preset time intervals, with the disks cleaned in pairs in sequence. The remaining disks remain in filtration mode.

The most common manufacturers currently marketing disk filters include Aqua Aerobics for the AquaDisk® and AquaDiamond® filters, Veolia for the Hydrotech Discfilter, and WesTech for the SuperDisc™ filters. The AquaDisk filter can be constructed of one of several different types of fabric. It uses an outside-in flow configuration, with the solids retained outside the disk. Figure 4-4 shows a schematic of the AquaDisk filter as an example of relatively similar products. AquaDiamond filters combine traveling-bridge and cloth media filters and are typically installed in retrofit applications. The Hydrotech Discfilter, on the other hand, is constructed of micro-screen type filters and has the reverse flow path (i.e., inside-out), with the solids retained inside the disk. The WesTech SuperDisc filter is constructed of polyester filter media and has an inside-out flow path.

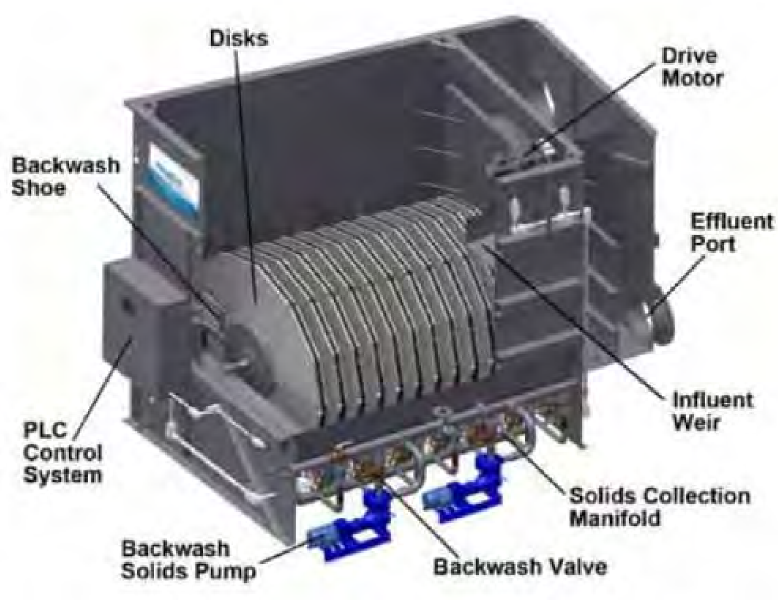


**Figure 4-4. Cloth disk filter schematic**

*Source: Aqua Aerobics 2017*

#### 4.1.7.2 Granular Media Filters

Granular media filters can be single-media (i.e., sand), dual-media (i.e., anthracite over sand), or multi-media (i.e., anthracite, sand, and garnet). The various configurations of granular media filters include shallow or deep bed, pressure or gravity, downflow or upflow, and continuous or intermittent backwash. Downflow filters are typically backwashed intermittently and often include air scouring.

Manufacturers of downflow filters include Evoqua (Hydro-Clear® pulsed bed filter) and WesTech (pressure filters).

The upflow, continuous-backwash filter uses deep-bed sand filtration. In an upflow filter, clarifier effluent is introduced at the bottom of the filter and then flows upward through the media, while at the same time, the sand bed moves downward. The filtered effluent exits at the top of the media bed, overflows a weir, and is discharged from the weir. When the sand and accumulated solids reach the bottom of the filter, they are withdrawn by an airlift pump, lifting the mixture through the airlift pipe. This creates a scouring action of the media particles as they travel to the top of the bed. Clean sand is recycled internally after passing through a washer/separator, while the lighter, filtered particles remain in suspension and flow to the waste drain. In this manner, the sand bed is continuously cleaned while both a continuous filtrate and reject are produced. No separate backwash pumps or backwash downtime is required.

Existing upflow filters include the DynaSand® filters by Parkson, Hydrasand® filters by Andritz, and SuperSand™ filters by WesTech.

The biggest disadvantage of the upflow, continuous-backwash filters is the high backwash volume generated (about 5 to 10 percent of the filter throughput). The backwash water is returned to the aeration basins for re-treatment. Therefore, a high backwash volume will increase the hydraulic load to the activated sludge system. Parkson offers a variation of the DynaSand filter that incorporates intermittent backwashing while allowing continuous filtration. This system, termed EcoWash, reduces reject water volume by automatically closing the reject line during the no-backwash periods. Backwashing is either controlled by differential pressure measurements or set by a timer. Figure 4-5 shows a schematic of the Parkson DynaSand filter, which is relatively representative of similar upflow filters.

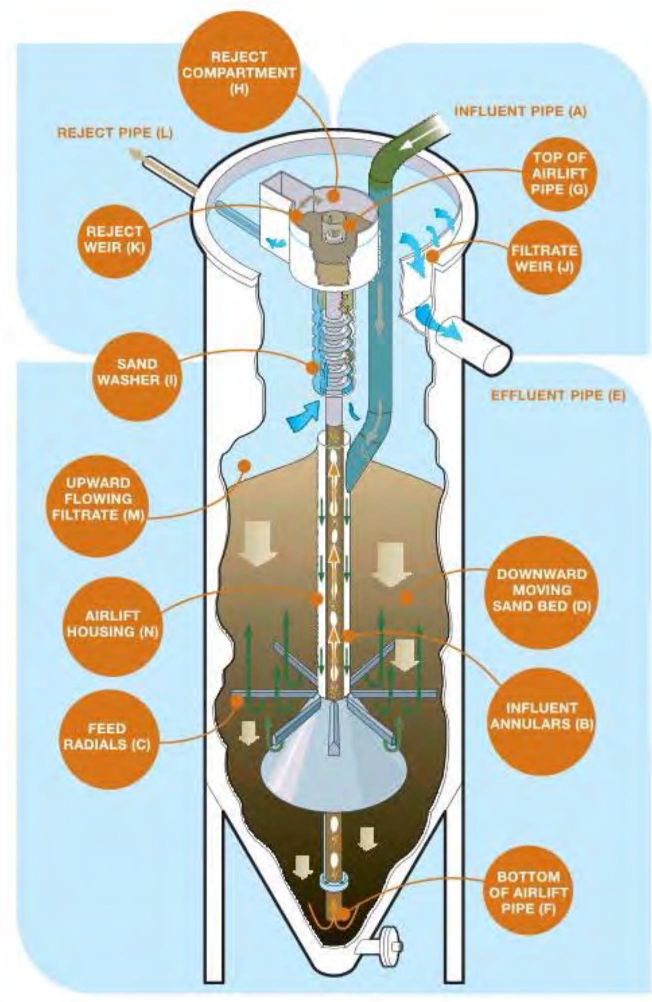


**Figure 4-5. Upflow Granular Media Filter schematic**

*Source: Parkson 2012*

### 4.1.7.3 Compressible Media Filters

Compressible media filters use a quasi-spherical, highly porous, and compressible medium: fuzzy balls. Operated in either upflow or downflow mode, the media are held, via upper and lower compression plates (or a compression bladder), at a specific media density. The compression can be varied, largely as a function of the type of solids being filtered and the desired solids removal rate. The filter represents a departure from conventional granular filters by allowing wastewater to flow through the media as opposed to around it. Therefore, significantly higher hydraulic loading rates (HLRs) (maximum of about 40 gallons per minute [gpm] per square foot [$ft^2$] compared to about 5 or 6 gpm/$ft^2$ for conventional filters) are permitted. The filter is backwashed using air and influent, with the plates opened to decompress the media. The medium is cleaned by shearing forces as the fluid moves past, and by abrasion as it rubs against itself.

Two compressible media filter products are currently on the market: Fuzzy Filter made by Schreiber and the WWETCO FlexFilter™ by WesTech.

Figure 4-6 shows a schematic of the Fuzzy Filter depicting the different operating cycles.


**Figure 4-6. Compressible media filter schematic**

*Source: Schreiber 2012*

#### 4.1.7.4 Iron-coated Sand Filters

Iron-coated sand filters are marketed as reactive filters by Nexom for its Blue PRO® filters. They are designed to achieve low P and metals effluent concentrations. The Blue PRO filter is a continuous-backwash sand filter, where the sand is coated with hydrous ferric oxide (HFO). The HFO-coated sand attracts and reacts with phosphorus and metals. Water is filtered as it flows upward and the sand moves downward by gravity to an airlift device. The airlift carries the media into a washbox where the discharged HFO coating and adsorbed contaminants are separated from the media. The regenerated media is then recoated with HFO. Waste solids, along with the excess phosphorus, are removed from the filter through the backwash or reject stream.

Figure 4-7 shows a schematic of the Blue PRO system.

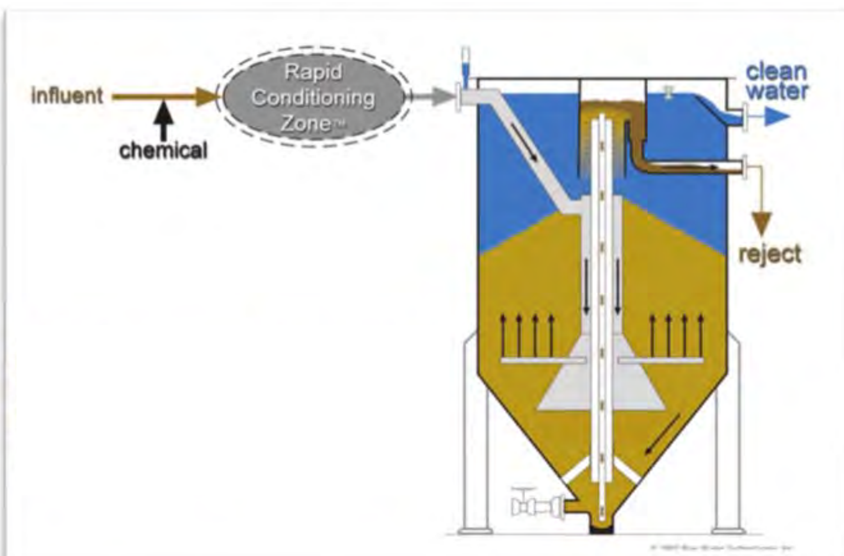


**Figure 4-7. Blue PRO filter schematic**

*Source: Blue Water Technologies, Inc. 2010*

#### 4.1.7.5 Membrane Filters

Tertiary membranes are typically ultrafiltration membranes with a nominal pore size of 0.04 micron. An ultrafiltration unit removes all particulate and some colloidal matter from the secondary effluent. The system consists of either pressurized or submerged (i.e., vacuum) membranes; the latter are installed in process tanks. Membrane filtration systems require ancillary equipment, including inlet strainers for pretreatment (250- to 500-micron opening size), feed or filtrate pumps, backwash tank and pumps, scour air blowers, clean-in-place tanks and pumps, a compressed-air system, and chemical feed systems for membrane cleaning and neutralization. Typically, sodium hypochlorite and citric acid are used for membrane cleaning, while sodium bisulfite, sodium hydroxide, and hydrochloric acid may be used for neutralization.

Ultrafiltration membrane system suppliers include GE (ZeeWeed 1000), Evoqua (Memcor), H2O Innovation, and Pall.

Figure 4-8 shows a photograph of pressurized membrane skids.

**Figure 4-8. Photograph of ultrafiltration membrane skids**

#### 4.1.7.6 Comparison of Filtration Alternatives

Table 4-10 shows a comparison of the various tertiary filtration alternatives. Capital and operations and maintenance (O&M) cost estimates were not developed as part of this investigation. In general, membrane filters are expected to have the highest capital and O&M costs because of the high cost of membranes relative to other types of media, and the high energy and chemical requirements for membrane cleaning and neutralization. For facility planning at the Meridian WRRF, it is assumed that the tertiary filtration system will be upgraded to include membrane filters mainly because of the higher effluent quality achievable, which will be required to meet a potential future lower P limit and any future limits on emerging contaminants.

| Table 4-10. Filtration Alternatives Comparison | | |
|---|---|---|
| **Alternatives** | **Pros** | **Cons** |
| Cloth disk filter | • Small footprint<br>• Low head loss<br>• Operator familiarity | • Low TSS capture efficiency<br>• More susceptible to fouling by oil and grease and water hardness scaling |
| Granular media filter | • Typically reliable (positive particle barrier)<br>• High HLRs (pressure filters)<br>• Can handle high TSS without blinding (upflow filters)<br>• No backwash pumping/storage (upflow filters) | • High head loss (downflow filters)<br>• High backwash water volume (for continuous backwash)<br>• Airlift pipe can become plugged (upflow filters) |
| Compressible media filter | • High HLRs<br>• No backwash pumping/storage | • Limited number of installations<br>• High head loss |
| Iron-coated sand filter | • Provide enhanced P removal<br>• No backwash pumping/storage | • Offered by 1 manufacturer<br>• Requires many units to treat design flows |
| Membrane filter | • Highest effluent quality (TSS, contaminants of emerging concern)<br>• Provides barrier against bacteria and virus (may reduce disinfection requirements)<br>• Small footprint | • High capital costs<br>• High O&M costs (chemicals, energy, membrane replacement) |

Table 4-11 summarizes the sizing data for the tertiary membrane system.

| Table 4-11. Tertiary Membrane System Design Data [a] | | |
|---|---|---|
| **Item** | **Unit** | **Value** |
| Pretreatment screens | | |
| Number of screens | – | 3 |
| Screen type | – | Punched holes or woven mesh |
| Opening size | Microns | 500 |
| Membrane tanks | | |
| Number of tanks | – | 5 |
| Number of cassettes per tank | – | 6 |
| Dimensions per tank (L x W x SWD) | ft | 16.33 x 13 x 12 |
| Total liquid volume | gal | 95,300 |
| Clean-in-place tank | | |
| Number of tanks | – | 1 |
| Tank liquid volume | gal | 17,000 |

a. *Source: GE 2017.*

### 4.1.8 Disinfection System Evaluation

The UV disinfection system was recently upgraded with additional units and enclosed in a building. The capacity of that system is 30 mgd total flow capacity and 22.5 mgd firm capacity. These capacities are sufficient to meet the anticipated 2040 peak hour flow of 22.3 mgd without requiring expansion of the system. The system will require additional lamps be added in the future to meet buildout flow conditions. In addition, existing UV system replacement will need to be completed due to life-cycle age within the next 10-15 years and is accounted for in the capital costs provided in Chapter 6 of this report. No expansion of the building or channels is anticipated during the planning period of this report.

### 4.1.9 Liquid Process Recommendations

This subsection of this report summarizes the findings of the liquids process expansion evaluation. Based on the results of the findings, the following recommendations are made for expansion of the liquid process train beyond the existing system upgrades during the 2030 planning window:

- Two new aeration basins configured as 5-Stage Bardenpho with swing cells to allow for alternate process configurations.
- One new 120 ft diameter secondary clarifier
- Tertiary treatment using membrane technology
- No anticipated expansion of headworks or primary treatment is needed to meet 2040 projected flows and loads
- No anticipated expansion of disinfection processes is needed to meet 2040 projected flows and loads

## 4.2 Solids Stream Treatment Analysis

While liquid expansion is required for growth and to meet stringent effluent permit limits, the solids treatment system; consisting of the biosolids thickening, stabilization, and dewatering processes; is also critical to meet City growth demands. This section of the report outlines the alternatives analysis completed for the solids treatment train.

### 4.2.1 Process Technology Screening Workshop

A process technology screening workshop attended by City staff and BC personnel was conducted on April 18, 2017, at the Meridian WRRF. The goal of the workshop was to discuss available solids treatment technologies and end-use alternatives, and screen those that were not viable or compatible with the long-term plan at the Meridian WRRF from further consideration.

Fermenting primary sludge will continue for the foreseeable future to produce VFAs for the liquid stream treatment process. Based on currently operation practice, the fermentation tank is reaching its capacity and an expansion is needed. Though an option of purchasing acetic acid in lieu of constructing a second fermentation tank is available, capital planning will account for the construction of a new tank and the chemical addition option will be re-evaluated as part of a separate feasibility study for fermenter system expansion at a later date. Therefore, PS fermentation was not discussed further during the workshop.

Solids treatment process technologies including thickening, stabilization, dewatering, post-dewatering, and end-use alternatives were discussed during the workshop. Details and conclusions drawn for each technology are discussed in the following sections.

#### 4.2.1.1 Thickening

The Meridian WRRF ferments primary sludge to provide VFAs used for the liquid treatment process, and will continue for the foreseeable future. The WRRF is also considering using the Ostara Waste Activated Sludge Stripping to Remove Internal Phosphorus (WASSTRIP®) process as an alternative for struvite control. Both PS fermentation and WASSTRIP® processes work the best with separated thickening of primary sludge and WAS. Therefore, combined thickening is not considered further in this evaluation.

Currently, the Meridian WRRF uses a gravity thickener (GT) for fermented primary sludge (FPS) thickening and DAFTs for WAS thickening. The throughputs of the DAFTs are limited by the pumps and piping to transfer WAS to the DAFTs. Other than that, the performance of the existing gravity thickener and DAFTs has been satisfactory. Both technologies demonstrate the ability to effectively thicken sludge to concentrations desired by the City. With recent operation adjustment, the DAFT has been consistently producing TWAS at a total solids (TS) concentration of 4 percent and higher. In addition, plant staff expressed confidence with their ability to operate these units continuously.

Gravity belt thickening was eliminated in the workshop because of its potential odor and relatively high maintenance requirements. Membrane thickening was also eliminated from future consideration because of its high capital and replacement costs.

Some mechanical thickening alternatives, such as rotary-drum thickener (RDT) and centrifuge, were carried forward because they have less odor potential and better performance than the existing thickening technologies.

Table 4-12 summarizes the thickening technologies discussed and the preliminary technology screening results of the workshop.

**Table 4-12. Summary of Thickening Technologies Evaluation During the Workshop**

| Technology | Eliminated | Retained | Reasons for Elimination/Retaining |
|---|---|---|---|
| Gravity belt thickening | ✓ | | Potential odor<br>High maintenance requirement |
| Membrane thickening | ✓ | | High costs |
| Combined thickening | ✓ | | FPS best achieved with separate thickening |
| GT | | ✓ | Process familiarity<br>Satisfactory performance |
| DAFT | | ✓ | Technology familiarity<br>Satisfactory performance |
| RDT | | ✓ | Potential for improved performance<br>Less odor potential |
| Centrifuge thickening | | ✓ | Potential for improved performance<br>Less odor potential |

Based on the above considerations, thickening alternatives carried forward to the conceptual-level evaluation are:

- Gravity thickener for PS thickening and DAFT for WAS thickening
- RDT for separated PS and WAS thickening
- Centrifuge for separated PS and WAS thickening

#### 4.2.1.2 Stabilization

The Meridian WRRF currently operates two conventional mesophilic digesters. The staff are comfortable with continued operation of conventional mesophilic anaerobic digestion (CMAD) for solids stabilization because of its low cost and their familiarity with its operation.

One of the challenges that the Meridian WRRF faces is struvite formation in the digesters and downstream processes. Struvite can cause many problems to solids treatment facilities and equipment, such as reducing active digester capacity, clogging sludge piping, and even damaging equipment. One of the key ingredients for struvite is phosphate, which is mainly released from WAS during anaerobic digestion. Therefore, treating WAS with an alternative stabilization technology will reduce struvite formation in the digesters.

CleanB™ is a proprietary sludge stabilization process that can be an alternative to anaerobic digestion. Thus, the CleanB process was carried forward for more detailed evaluation as an alternative stabilization technology to anaerobic digestion.

Table 4-13 summarizes stabilization technologies discussed, and the preliminary technology screening results of the workshop.

| Table 4-13. Summary of Stabilization Technologies Evaluation During the Workshop | | | |
|---|---|---|---|
| Technology | Eliminated | Retained | Reasons for Elimination/Retaining |
| TAD | ✓ | | Potential odor from dewatering process and end product<br>More vulnerable to operation changes |
| Temperature-phased anaerobic digestion | ✓ | | More facilities required and high cost |
| Anaerobic/aerobic | ✓ | | Complexity<br>More facilities required and high cost |
| THP, intermediate THP | ✓ | | High costs<br>Requires specially trained operator |
| Enzymatic hydrolysis | ✓ | | Lack of full-scale operation in North America |
| Aerobic digestion | ✓ | | High operation costs<br>No digester gas production |
| Lime stabilization | ✓ | | High potential for odor and dust |
| CMAD | | ✓ | Process familiarity<br>Satisfactory performance |
| SMAD | | ✓ | Can be easily modified from conventional mesophilic digestion<br>Better performance than conventional mesophilic digestion |
| Acid-/gas-phased anaerobic digestion | | ✓ | Can be easily modified from conventional mesophilic digestion<br>Better performance than conventional mesophilic digestion |
| CleanB chemical stabilization | | ✓ | Alternative WAS stabilization technology reducing struvite issues with anaerobic digestion |

Stabilization technologies carried forward to the conceptual-level evaluation are:

- CMAD
- SMAD
- Acid-/gas-phased anaerobic digestion
- CleanB chemical stabilization

#### 4.2.1.3 Dewatering

The Meridian WRRF currently operates two centrifuges for dewatering. The operators are comfortable with continued operation of dewatering centrifuges because of its reliable performance, and familiarity with their operation. The existing centrifuges are in good condition and should last for a relatively long time before they need replacing. A preliminary evaluation on the dewatering building indicates that there is space for adding a third centrifuge in the future, if needed.

Screw and belt filter presses offer a few advantages over centrifuges, such as lower power, polymer consumption, vibration, and noise potential. However, both screw and belt filter presses produce slightly wetter cake and have a larger footprint than the centrifuges with similar capacity.

The Meridian WRRF currently has one drying bed that is used for temporary cake storage. Because of its large footprint and low efficiency, the City has no interest in operating the drying bed in the future.

Table 4-14 summarizes dewatering technologies discussed, and the preliminary technology screening results of the workshop.

| Table 4-14. Summary of Dewatering Technologies Evaluation During the Workshop | | | |
|---|---|---|---|
| Technology | Eliminated | Retained | Reasons for Elimination/Retaining |
| Belt filter press | ✓ | | Potential odor<br>High maintenance requirement<br>Large footprint<br>Lower cake TS<br>Requires new equipment and potentially new building |
| Screw press | ✓ | | Lower cake TS<br>Requires new equipment and potentially new building |
| Drying bed | ✓ | | Large footprint<br>Potential odor |
| Centrifuge | | ✓ | Process familiarity<br>Satisfactory performance |

Based on the above considerations, centrifuges were selected as the dewatering technology in the workshop.

#### 4.2.1.4 Post-Dewatering Technologies and Biosolids End-Use Alternatives

The selection of solids stabilization and post-dewatering technologies is largely driven by the final use of biosolids and regulatory requirements for end use.

Dewatered solids at the Meridian WRRF are currently hauled to a local landfill for disposal. The landfill will continue to be a valid and inexpensive outlet for solids disposal in the near future.

Per the workshop, Meridian WRRF dewatered solids will continue be hauled to the landfill in the near future. Therefore, no post-dewatering technologies are considered further in this evaluation.

### 4.2.2 Development of Solids Process Technology Alternatives

The pre-screened technologies described in Section 1 were developed to a conceptual design level to define capital costs, feasibility to fit on the Meridian WRRF site, and process flow configuration information. This section summarizes the preliminary concept information for the selected technologies. Development of onsite technologies was based on the 2040 mass balance loading rate.

#### 4.2.2.1 Primary Sludge Fermentation

The Meridian WRRF currently uses the primary clarifiers to thicken the primary sludge to approximately 3.5 percent TS. The thickened primary sludge is then processed in a fermenter to produce VFAs for use in the liquid-stream treatment process. Elutriation water is added before the fermented sludge is fed to a gravity thickener. The supernatant from the gravity thickener containing VFAs is then pumped to the liquid stream treatment process. A portion of the thickened sludge is recycled back to the fermenter, while the rest is sent to the digesters. A simple schematic illustrating the fermentation-thickening process is shown in Figure 4-9.

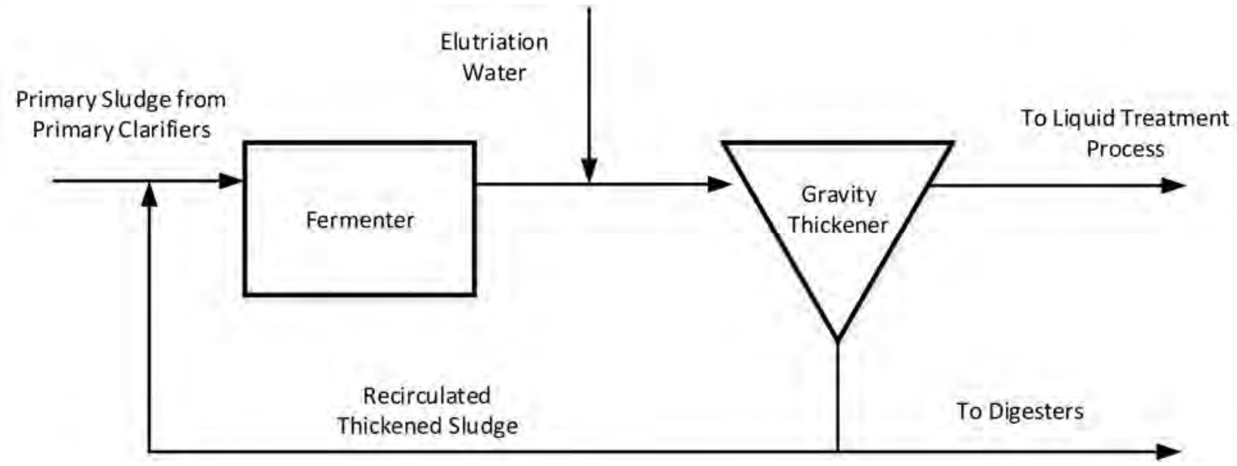


**Figure 4-9. Current FPS thickening process schematic**

A certain solids retention time (SRT) should be maintained for the fermenter to optimize VFA production. The SRT should be long enough to allow hydrolysis of complex compounds to VFAs, but not too long that the VFAs are converted to methane.

Historical data show that approximately 281,000 gpd of elutriation water is added to the fermented sludge, and approximately 100,000 gpd of gravity-thickened underflow is recirculated back to the fermenter. Recirculating a large amount of thickened sludge increases both the hydraulic and solids loading rates (SLRs) to the thickener, which can cause the thickener to overload, and adversely impact its performance. A potential benefit of recirculating thickened sludge is to increase the SRT in the fermenter to facilitate VFA production. However, because the TS concentration of the thicker underflow is approximately the same as the primary sludge fed to the fermenter, recirculating sludge has little impact.

The current primary solids loading rate to the fermenter indicates that it is reaching its design capacity, and that a second fermenter is required within the 2040 planning horizon. BC believes that the fermentation/thickening operation could be optimized to improve gravity thickener performance and produce more concentrated VFAs flows to the liquid treatment process. Therefore, BC recommends that the loading rates and performance for the fermentation/thickening process be re-evaluated after the operation is optimized.

For planning purposes, a conceptual-level design was developed assuming that a second fermenter is required. The old digester next to the existing fermenter can be retrofitted into a second fermenter.

Table 4-15 summarizes the major equipment associated with the new fermenter. The ancillary equipment associated with the new fermenter will be in the old digester control building.

**Table 4-15. Fermenter Major Equipment List [a]**

| Equipment Name | Total | Duty<br>Standby |
|---|---|---|
| Fermenter cover | 1 | 1+0 |
| Feed pump | 2 | 1+1 |
| FPS transfer pump | 2 | 1+1 |
| Odor control | 1 | 1+0 |

*a. New equipment and facility only.*

#### 4.2.2.2 Thickening Technologies

As discussed previously, thickening alternatives that passed the preliminary screen are:

- Gravity thickener for PS thickening and DAFT for WAS thickening
- RDT for separated PS and WAS thickening
- Centrifuge for separated PS and WAS thickening

Advantages and disadvantages, as well as conceptual-level design for each alternative, are discussed in the following sections.

As discussed previously, the FPS/thickening process could be optimized by improving the performance of the gravity thickener and reducing recycled flow to the fermenter. The results of the process optimization would affect the flows and loadings to the thickeners. For comparison, the thickening alternative evaluation assumes that the thickened sludge recirculation would be significantly decreased, and that the elutriation water flow would be also be reduced. This would improve the efficiency of the gravity thickener and increase the solids retention time of the fermenter, resulting in more concentrated VFA flows to the liquid treatment process We recommend re-evaluating the thickening alternative after the FPS/thickening operation is optimized.

##### 4.2.2.2.1 Gravity Thickeners

As mentioned above, GT is the current process used for FPS thickening at the Meridian WRRF. The operating principle is similar to that of a clarifier: using settling detention time to thicken solids. Gravity thickeners are easy to operate, but have limited performance potential in terms of percent TS and a significant odor control requirement. Figure 4-10 shows a typical covered gravity thickener.

**Figure 4-10. Covered gravity thickener**

The Meridian WRRF currently operates one 35-foot-diameter gravity thickener. Gravity thickeners can typically handle a peak SLR of up to 30 pounds per square foot per day (lb/ft$^2$/d) of surface area and an HLR up to 760 gallons per square foot per day (gal/ft$^2$/d) of surface area for PS thickening. Table

4-16 summarizes the results for preliminary sizing using gravity thickeners for PS flows and loadings in 2040.

| Table 4-16. Gravity Thickener Sizing Summary [a, b] | | | | |
|---|---|---|---|---|
| Parameter | Unit | Annual Average | Maximum 30-Day | Maximum Day |
| Design SLR | lb/ft²/d | | 30 | |
| Design HLR | gal/ft²/d | | 760 | |
| Feed sludge TS | lb/d | 17,600 | 23,500 | 31,200 |
| Feed sludge flow | gpd | 264,500 | 307,400 | 363,100 |
| Duty units | Number | 1 | 1 | 1 |
| SLR | lb/ft²/d | 18 | 24 | 32 |
| HLR | gal/ft²/d | 275 | 319 | 377 |

a. *Based on 2040 solids flows and loads.*

b. *Based on 24/7 operation.*

As shown in Table 4-16, one duty gravity thickener can handle PS flows and loads in 2040 except for the maximum day condition. Performance of the gravity thickener may be affected at the maximum day condition toward the end of the evaluation period (2040). because of the slightly higher SLR. Expected performance of the gravity thickener is summarized in Table 4-17.

| Table 4-17. Gravity Thickener Performance Summary | | |
|---|---|---|
| Parameter | Unit | Value |
| Solids capture rate | Percent | 90.0 |
| Thickened solids TS | Percent | 3.5 |

The results of the evaluation indicate that one duty 35-foot-diameter gravity thickener is capable of handling PS production through the design period. Performance of the gravity thickener may be slightly affected at the peak day condition in 2040 because of the slightly higher-than-recommended SLR.

The old primary clarifier adjacent to the existing gravity thickener can be retrofitted to function as a redundant gravity thickener, which will provide 100 percent redundancy. Having a redundant unit allows for non-interrupted process operation when on one unit is malfunction or taken off line for maintenance. Expected upgrades include a new gravity thickener mechanism, cover, feed pump, thickened sludge transfer pump, and expansion to the existing odor control system.

A conceptual design was developed for the new gravity thickener. Table 4-18 summarizes the major equipment associated with the new gravity thickener.

| Table 4-18. Gravity Thickener Major Equipment List [a] | | |
|---|---|---|
| Equipment Name | Total | Duty Standby |
| Collector mechanism | 1 | 1+0 |
| Gravity thickener cover | 1 | 1+0 |
| Thickened PS recirculation pump | 2 | 1+1 |
| Thickened PS transfer pump | 2 | 1+1 |
| Effluent transfer pump | 2 | 1+1 |
| Odor control | 1 | 1+0 |

a. *New equipment and facility only.*

#### 4.2.2.2.2 Dissolved Air Flotation Thickeners

DAFT is the current process used to thicken WAS at the Meridian WRRF. The DAFT process works by forming small air bubbles in a tank that attach to suspended solids to enhance their flotation and removal with the aid of a skimming device. Polymer is usually added as a coagulant aid. A typical DAFT installation is shown in Figure 4-11.


**Figure 4-11. DAFT installation**

The WAS is currently thickened in two 20-foot-diameter DAFTs. DAFTs can typically handle a peak SLR of up to 2 pounds per square foot per hour (lb/ft²/hr) of surface area, and an HLR up to 2 gpm/ft² of surface area. Table 4-19 summarizes the results for preliminary sizing using DAFT for future WAS flows and loadings.

**Table 4-19. DAFT Sizing Summary [a, b]**

| Parameter | Unit | Annual Average | Maximum 30-Day | Maximum Day |
|---|---|---|---|---|
| Design SLR | lb/ft²/hr | | 2.0 | |
| Design HLR | gpm/ft² | | 2.0 | |
| Feed sludge TS | lb/d | 13,000 | 13,300 | 15,700 |
| Feed sludge flow | gpd | 204,600 | 183,900 | 263,900 |
| Duty units | Number | 1 | 1 | 1 |
| SLR | lb/ft²/hr | 1.7 | 1.8 | 2.1 |
| HLR | gpm/ft² | 0.5 | 0.4 | 0.6 |

a. *Based on 2040 solids flows and loadings.*

b. *Based on 24/7 operation.*

One duty DAFT can handle WAS flows and loads in 2040 except for the maximum day condition, which may require that the second DAFT be in service. If only one DAFT is in operation during the maximum day condition, the performance of the DAFT may be affected because of the slightly higher SLR. Expected performance of the DAFT is summarized in Table 4-20.

| Table 4-20. DAFT Performance Summary | | |
|---|---|---|
| Parameter | Unit | Value |
| Polymer dose | lb/dry ton | 4–10 |
| Solids capture rate | Percent | 90 |
| Thickened solids TS | Percent | 4.0 |

The results of the evaluation indicate that one duty 20-foot-diameter DAFT is capable of handling WAS production through the design period. Performance of the DAFT may be slightly affected at the peak day condition in 2040 because of the slightly higher-than-recommended SLR.

The DAFTs are currently operated in semi-manual mode. After discussion with Meridian WRRF staff, a DAFT automation system is recommended to improve DAFT performance and reduce operation involvement. The throughputs of the DAFTs are also limited by the WAS pumps and piping. Therefore, retrofit of WAS pumps and piping is required. Table 4-21 summarizes the major equipment associated with the new DAFT.

| Table 4-21. DAFT Major Equipment List [a] | | |
|---|---|---|
| Equipment Name | Total | Duty Standby |
| DAFT automation | 1 | 1+0 |
| Retrofit DAFT feed pumps and piping | 2 | 1+1 |

*a. New equipment and facility only.*

#### 4.2.2.2.3 Rotary-Drum Thickeners

RDTs feed sludge into a rotating perforated drum to allow water to separate from solid material, and a screw conveyor internal to the drum to carry sludge solids to a discharge point. A polymer is typically added upstream of the RDT to encourage large solids flocs. Figure 4-12 shows a typical RDT system.

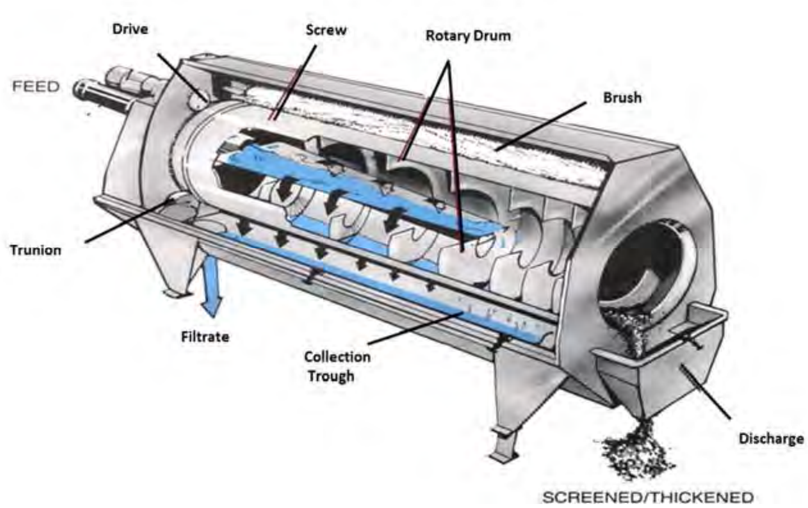


**Figure 4-12. RDT**

Because of the enclosed design, RDTs typically have lower odor control requirements than other alternatives, require smaller footprint, are simple to operate, and have low capital and O&M costs compared to DAFTs and thickening centrifuges. However, RDTs are also known to be sensitive to sludge feed concentrations and require a significant wash water demand.

Preliminary sizing and performance for separated PS and WAS thickening using RDTs are summarized in Table 4-22.

Table 4-22. RDT Sizing Summary [a, b]

| Parameter | Unit | Annual Average | Maximum 30-Day | Maximum Day |
|---|---|---|---|---|
| PS | | | | |
| Design HLR | gpm/machine | 200 | | |
| Feed sludge TS | lb/d | 17,600 | 23,500 | 31,200 |
| Feed sludge flow | gpd | 264,500 | 307,400 | 363,100 |
| Duty units | Number | 2 | 2 | 2 |
| SLR | lb/hr/machine | 366 | 489 | 650 |
| HLR | gpm/machine | 92 | 107 | 126 |
| WAS | | | | |
| Design HLR | gpm/machine | 200 | | |
| Feed sludge TS | lb/d | 13,000 | 13,300 | 15,700 |
| Feed sludge flow | lb/d | 204,600 | 183,900 | 263,900 |
| Duty units | Number | 1 | 1 | 1 |
| SLR | lb/hr/machine | 540 | 552 | 651 |
| HLR | gpm/machine | 142 | 128 | 183 |

*a. Based on 2040 solids flows and loadings.*

*b. Based on 24/7 operation.*

As shown in Table 4-22, four RDTs (200 gpm capacity each) are required for separated PS and WAS thickening. Two for primary sludge, one for WAS, and one swing standby unit. Expected performance of the RDTs is summarized in Table 4-23.

Table 4-23. RDT Performance Summary

| Parameter | Unit | Value |
|---|---|---|
| Polymer | lb/dry ton | 5–10 |
| Solids capture rate | Percent | 95 |
| Thickened solids TS | Percent | 5 |

Each RDT will have its dedicated feed pump, polymer system, and thickened sludge pump. We propose that the RDTs and auxiliary equipment be located in a new thickening building. A conceptual design was developed for a new RDT facility; Table 4-24 summarizes the major equipment associated with the potential new RDT facility.

| Table 4-24. RDT Major Equipment List [a] | | |
|---|---|---|
| Equipment Name | Total | Duty Standby |
| RDT, 200 gpm | 4 | 3+1 |
| RDT feed pump | 5 | 3+2 |
| Polymer feed system | 4 | 3+1 |
| Thickened PS transfer pump | 2 | 1+1 |
| TWAS transfer pump | 2 | 1+1 |
| Filtrate transfer pump | 2 | 1+1 |
| Thickening building | 1 | |

a. *New equipment and facility only.*

#### 4.2.2.2.4 Centrifuge Thickeners

Centrifuge thickening feeds solids into a fast-rotating centrifuge bowl that uses centrifugal force to push solids to the outside. A slower rotating screw conveyor inside the bowl collects the solids for discharge on one end of the unit. The bowl allows water (i.e., centrate) to separate and collect in the center for discharge on the opposite end of the unit. Polymer is usually added to increase solids separation. Figure 4-13 depicts typical centrifuge thickener equipment.


**Figure 4-13. Centrifuge equipment**

*Source: Flottweg 2017 (https://www.flottweg.com/fileadmin/user_upload/data/content-images/body-images/cms/upload/bildergalerie/Flieschema_/C5E.jpg)*

Centrifuges have the potential to produce the thickest solids concentrations of the alternatives listed and have the smallest footprint. Additionally, odor control requirements are low because of the enclosed equipment. However, centrifuge installations typically incur high capital and power costs.

Preliminary sizing and performance for separated PS and WAS thickening using centrifuges are summarized in Table 4-25.

| Table 4-25. Thickening Centrifuge Sizing Summary [a, b] | | | | |
|---|---|---|---|---|
| Parameter | Unit | Annual Average | Maximum 30-Day | Maximum Day |
| PS (based on centrifuge with 20-inch bowl) | | | | |
| Feed sludge TS | lb/d | 17,600 | 23,500 | 31,200 |
| Feed sludge flow | gpd | 264,500 | 307,400 | 363,100 |
| Duty units | Number | 2 | 2 | 2 |
| SLR | lb/hr/machine | 366 | 489 | 650 |
| HLR | gpm/machine | 92 | 107 | 126 |

| Table 4-25. Thickening Centrifuge Sizing Summary [a, b] | | | | |
|---|---|---|---|---|
| Parameter | Unit | Annual Average | Maximum 30-Day | Maximum Day |
| WAS (based on centrifuge with 20-inch bowl) | | | | |
| Feed sludge TS | lb/d | 13,000 | 13,300 | 15,700 |
| Feed sludge flow | lb/d | 204,600 | 183,900 | 263,900 |
| Duty units | Number | 1 | 1 | 1 |
| SLR | lb/hr/machine | 540 | 552 | 651 |
| HLR | gpm/machine | 142 | 128 | 183 |

a. *Based on 2040 solids flows and loadings.*

b. *Based on 24/7 operation.*

As shown in Table 4-25, four centrifuges (each with a 20-inch-diameter bowl) are required for separated PS and WAS thickening. Two for primary sludge, one for WAS, and one swing standby unit. Expected performance of the centrifuges is summarized in Table 4-26.

| Table 4-26. Thickening Centrifuge Performance Summary | | |
|---|---|---|
| Parameter | Unit | Value |
| Polymer | lb/dry ton | 0–5 |
| Solids capture rate | Percent | 95.0 |
| Thickened solids TS | Percent | 5.0 |

Each centrifuge will have its own dedicated feed pump, grinder, polymer system, and thickened sludge pump. We propose that the centrifuges and auxiliary equipment be located in a new thickening building. A conceptual design was developed for the new centrifuge facility. Table 4-27 summarizes the major equipment associated with the new centrifuge facility.

| Table 4-27. Centrifuge Major Equipment List [a] | | |
|---|---|---|
| Equipment Name | Total | Duty Standby |
| Centrifuge, 20-inch bowl | 4 | 3+1 |
| Centrifuge feed pump | 5 | 3+2 |
| Polymer feed system | 4 | 3+1 |
| Thickened PS transfer pump | 2 | 1+1 |
| TWAS transfer pump | 2 | 1+1 |
| Centrate transfer pump | 2 | 1+1 |
| Thickening building | 1 | |

a. *New equipment and facility only.*

#### 4.2.2.3 Stabilization Technologies

The solids stabilization technologies that passed the preliminary screening are discussed in this section, including:

- CMAD
- SMAD
- Acid-/gas-phased anaerobic digestion
- CleanB chemical stabilization

Digestion is a core stabilization technology for reducing pathogens, reducing vector attraction, and generally making a biosolids product capable of meeting regulatory requirements associated with beneficial use and disposal.

All digestion processes were evaluated under three loading conditions, including (1) the typical condition, (2) service condition, and (3) peak condition depending on sludge flows and loads and digester operation conditions:

- **Typical condition:** Annual average sludge flows and loadings to the digestion system, assuming all digesters in service.
- **Service condition:** 110 percent of annual average sludge flows and loadings to the digestion system, assuming the largest digester is out of service. This allows the largest unit to be offline at sludge flows and loadings slightly higher than the annual average condition.
- **Peak condition:** Peak 14-day sludge flows and loadings to the digestion system, assuming all digesters in service.

Although landfilling continues to be the outlet for biosolids disposition at Meridian WRRF, the City considers it important for the WRRF to be capable of producing Class B biosolids to meet potential future regulatory requirements and expand outlets for biosolids end use. Therefore, the digester evaluation is based on producing Class B product.

The simplest way to achieve Class B pathogen reduction under Code of Federal Regulations Title 40 Part 503 is to meet a minimum hydraulic retention time (HRT) of 15 days. While other pathogen reduction alternatives are permissible, they could require significant process and product monitoring. Thus, a minimum 15-day HRT was selected in designing the digestion alternatives for all loading conditions.

Annual average digester gas productions for the three digestion alternatives through the planning period were estimated. Digester gas production is affected by several factors, including:

- **VS loading to the digesters:** conversion of volatile solids generates digester gas
- **Volatile solids reduction (VSR):** indicates the percentage of volatile solids entering the digestion process that are destroyed by microorganisms producing gas during digestion
- **Specific digester gas production rate:** amount of digester gas that is produced for each pound of volatile solids destroyed during digestion

The historical average VSR is approximately 52 percent. It is expected that the VSR will remain the same in the future for CMAD operation. It is assumed that the VSR for the SMAD and acid-gas anaerobic digestion (AGAD) will be slightly higher at 54 percent. The assumptions used for digester gas production are summarized in Table 4-28.

**Table 4-28. Assumptions for Digestion Gas Calculations**

| Parameter | Unit | Value |
|---|---|---|
| VSR rate, CMAD | Percent | 52 |
| VSR rate, SMAD and AGAD | Percent | 54 |
| Specific biogas production rate | scf/lb VSR | 15 |

#### 4.2.2.3.1 Conventional Mesophilic Digestion

CMAD is a conventional sludge stabilization process currently in operation at the Meridian WRRF. CMAD employs operating temperatures between 95 and 102 degrees Fahrenheit (°F) and solids are digested under anaerobic conditions. Typically, CMAD systems are operated at a minimum HRT of 15 days, which, when requirements for VAR are met, guarantees Class B pathogen status for beneficial use. This stabilization process is known to have the longest operational history and supporting data when compared to other digestion technologies.

The benefits of using CMAD are that the plant staff currently have a significant amount of experience operating the system, producing a Class B product with a minimal amount of additional testing or processing. Digester performance and gas production rates can be easily predicted from CMAD systems. Figure 4-14 depicts a typical CMAD process.

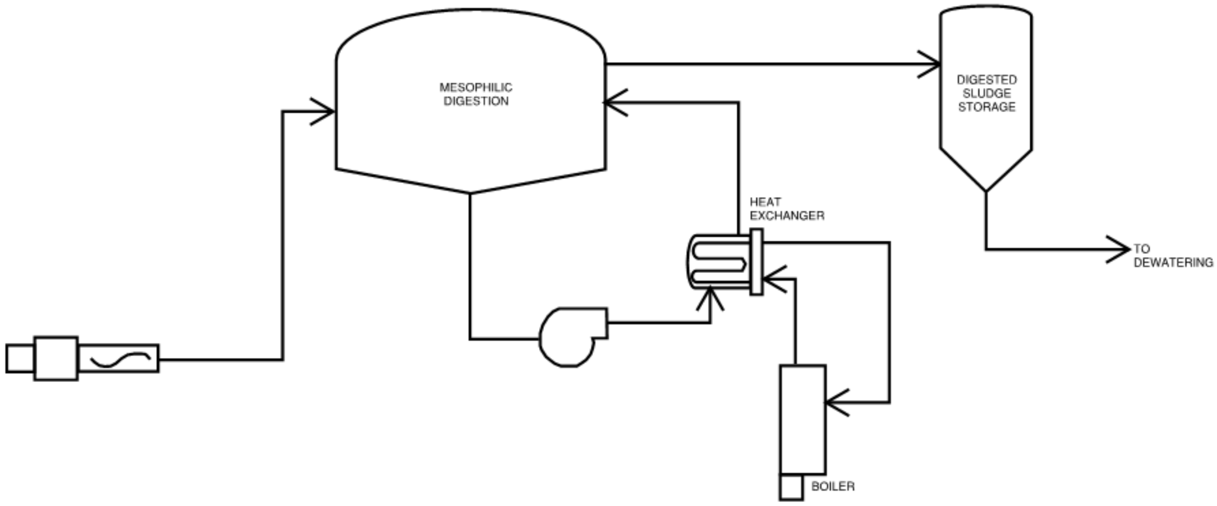


**Figure 4-14. Typical CMAD process flow diagram**

The design criteria for conventional anaerobic digestion are summarized in Table 4-29.

**Table 4-29. Conventional Mesophilic Digestion Design Criteria**

| Criterion | Unit | Typical Condition [a] | Service Condition [b] | Peak Condition [c] |
|---|---|---|---|---|
| HRT, minimum | d | 15 | 15 | 15 |
| OLR, maximum | lb-VS/ft$^3$/d | 0.15 | 0.18 | 0.18 |

a. *Annual average solids flows and loadings. All digesters in service.*

b. *110% of annual average solids flows and loadings. The largest digester out of service.*

c. *Peak 14-day solids flows and loadings. All digesters in service.*

The expected digester loading rates with three digesters at various loading conditions are summarized in Table 4-30.

**Table 4-30. Digester Sizing Summary for CMAD [a]**

| Parameter | Unit | Typical Condition [b] | Service Condition [c] | Peak Condition [d] |
|---|---|---|---|---|
| Digester feed TS | lb/d | 27,500 | 30,300 | 36,300 |
| Digester feed VS | lb/d | 22,600 | 24,800 | 30,100 |
| Digester feed flow | gpd | 89,700 | 98,600 | 119,200 |
| Duty digesters | number | 3 | 2 | 3 |
| Digester capacity, each | million gallons | 0.75 | 0.75 | 0.75 |
| OLR | lb-VS/ft$^3$/d | 0.07 | 0.12 | 0.10 |
| HRT | d | 25.1 | 15.2 | 18.9 |

a. *Based on 2040 solids flows and loadings.*

b. *Typical condition: annual average solids flows and loadings, assuming all digesters in service.*

c. *Service condition: 110% of annual average solids flows and loadings, assuming the largest digester out of service.*

d. *Peak condition: peak 14-day solids flows and loadings, assuming all digesters in service.*

The estimated digester gas flows are summarized in Table 4-31.

| Table 4-31. Summary of Projected Digester Gas Flows for CMAD (scfm) [a, b] | | |
|---|---|---|
| Annual Average | Maximum 30-Day | Maximum Day |
| 120 | 150 | 180 |

*a. Based on 2040 solids flows and loadings.*

*b. Assume 52% VSR and 15 $ft^3$/lb VSR gas production.*

Based on the design criteria in Table 4-29, three (two existing, one new) digesters are required for the CMAD alternative. The capacity of the new digester is assumed to be the same as the existing digesters. The new digester will be the same size as the existing digesters, 70 feet diameter and an active volume of 0.75 million gallons. Two digesters in service are required to meet future flows and loads, and a third digester will allow one unit out of service while maintaining stable operation and producing Class B biosolids.

We propose that the new digester be located at the open space to the west of the existing digester complex. This location will consolidate thickened sludge feeds to the digesters. Thickened sludge pumping is challenging because of high pressure requirements, non-Newtonian fluid behavior, ragging, and grease buildup. Providing short, consolidated thickened sludge piping routes will greatly reduce maintenance requirements related to this service. In addition, locating the digesters in a common location will greatly simplify connection of the digester gas piping and digested sludge transfer.

We propose constructing a new digester control building to house the mechanical equipment for the third digester. The new digester control building will be adjacent to the new digester.

The thickened PS pumps and TWAS pumps will transfer thickened sludge from the thickening facility to the digesters. Electrically operated valves located at each digester will be designed to sequentially feed PS and TWAS to each digester. Separate PS and TWAS feed lines and control valves will provide greater control of feed to the digestion process.

A conceptual design was developed for the CMAD alternative. Table 4-32 summarizes the major new equipment associated with the CMAD alternative.

| Table 4-32. CMAD Major Equipment List [a] | | |
|---|---|---|
| Equipment Name | Total | Duty Standby |
| Anaerobic digester | 1 at 0.75 million gallons | |
| Digester control building | 1 | |
| Digester feed valves [b] | 2 | 2+0 |
| Digester mixing pumps | 1 | 1+0 |
| Digester solids circulation pumps | 1 | 1+0 |
| Sludge heat exchangers | 1 | 1+0 |
| Hot water circulation pumps | 1 | 1+0 |
| Digested sludge transfer pumps | 2 | 1+1 |
| Sump pumps | 2 | 2+0 |
| Digester gas PRV assembly | 2 | 1+1 |

*a. New equipment and facility only.*

*b. 2 feed valves per digester will be installed. 1 will control TWAS addition and the other will control thickening PS addition.*

*PRV = pressure relief valve.*

#### 4.2.2.3.2 Staged Mesophilic Digestion

In a CMAD system, digesters are operated in parallel. In SMAD, the digesters are operated in series. Figure 4-15 shows the process schematic of this alternative including design criteria. The first stage consists of heating and mixing the feed sludge to sufficiently stabilize the influent sludge. In this first stage, a minimum HRT is required to prevent bacteria washout. A minimum HRT of 12 days is recommended for the first-stage reactors if the organic loading rate (OLR) remains below 0.15 pound volatile solids per cubic foot (lb-VS/ft$^3$) of digester volume. The second stage receives, heats, and mixes sludge from the first stage, but can operate at a lower HRT because the bulk of digestion takes place in the first stage. The total HRT must be 15 days or longer to meet the Class B requirement.

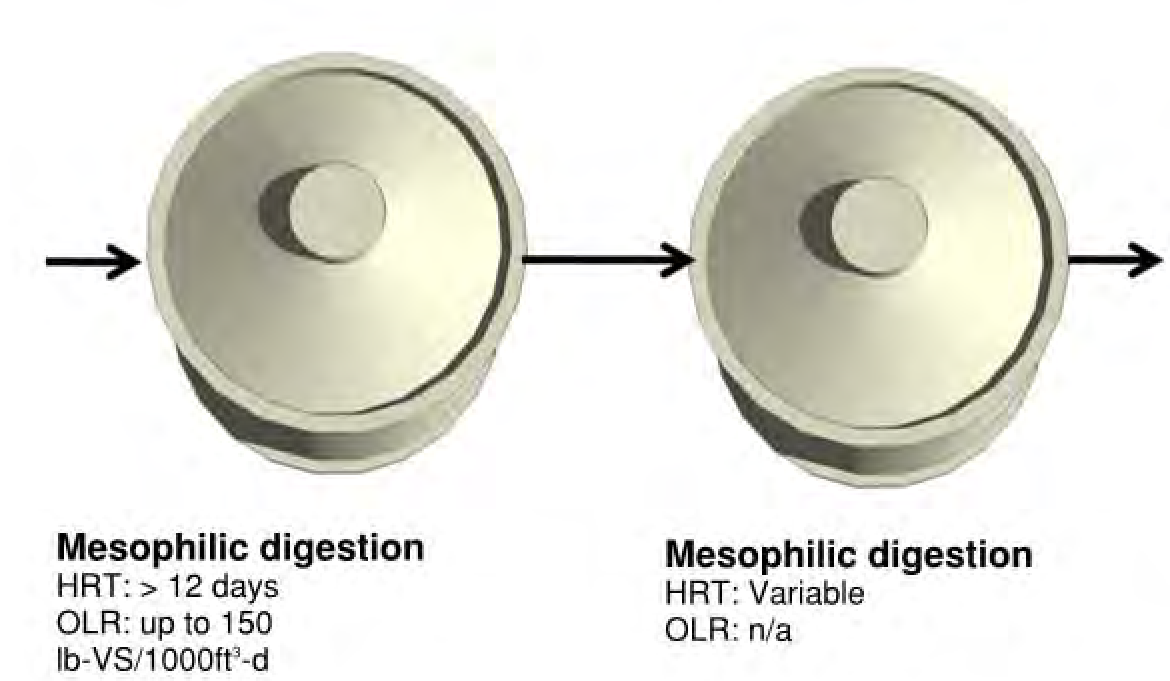


**Figure 4-15. Process schematic of SMAD**

The advantage of this process is that short circuiting of raw solids and pathogens is reduced because of the series configuration of the tanks. Thus, higher-quality biosolids are typical when compared against a single-staged mesophilic system operated at an equivalent detention time, although in both cases Class B biosolids are produced. A minor increase in gas production may be observed with this process. Despite these advantages, this alternative requires a large overall footprint and may require additional heating.

Digestion criteria for the staged digestion alternative evaluation are summarized in Table 4-33.

**Table 4-33. Staged Digestion Design Criteria**

| Parameter | Unit | Typical Condition [a] | Service Condition [b] | Peak Condition [c] |
|---|---|---|---|---|
| First-stage HRT, minimum | d | 12 | 12 | 12 |
| First-stage OLR, maximum | lb-VS/ft$^3$/d | 0.15 | 0.15 | 0.15 |
| Second-stage HRT, minimum [d] | d | 3 | 3 | 3 |

*a. Annual average solids flows and loadings. All digesters in service.*

*b. 110% of annual average solids flows and loadings. The largest digester out of service.*

*c. Peak 14-day solids flows and loadings. All digesters in service.*

*d. Criteria based on meeting 15 days total in first and second stages.*

The expected digester loading rates at various loading conditions are summarized in Table 4-34. This table assumes one smaller first-stage digester and an equally sized smaller second-stage digester with volume sized to meet the loading criteria. From a practical standpoint, if series digestion is selected, it may make more sense to build all digesters the same size at 0.75 million gallons and retain extra capacity for future loads and higher reliability.

**Table 4-34. Digester Sizing Summary for SMAD [a]**

| Parameter | Unit | Typical Condition [b] | Service Condition [c] | Peak Condition [d] |
|---|---|---|---|---|
| Digester feed TS | lb/d | 27,500 | 30,300 | 36,300 |
| Digester feed VS | lb/d | 22,600 | 24,800 | 30,100 |
| Digester feed flow | gpd | 89,700 | 98,600 | 119,200 |
| First-Stage Digesters | | | | |
| Duty digesters | number | 3 | 2 | 3 |
| Digester capacity, each | million gallons | 2 at 0.75, 1 at 0.5 [e] | 1 at 0.75, 1 at 0.5 [e] | 2 at 0.75, 1 at 0.5 [e] |
| OLR | lb-VS/ft$^3$/d | 0.08 | 0.15 | 0.11 |
| HRT | d | 22.3 | 12.7 | 16.8 |
| Second-Stage Digesters | | | | |
| Duty digesters | Number | 1 | 1 | 1 |
| Digester capacity, each [f] | MG | 0.5 | 0.5 | 0.5 |
| HRT | d | 5.6 | 5.1 | 4.2 |
| **Combined HRT** | d | 27.9 | 17.7 | 21.0 |

a. *Based on 2040 solids flows and loadings.*

b. *Annual average solids flows and loadings, assuming all digesters in service.*

c. *110% of annual average solids flows and loads, assuming the largest digester out of service.*

d. *Peak 14-day solids flows and loadings, assuming all digesters in service.*

e. *Minimum volume of new first-stage digester to meet loading criteria.*

f. *Sized same as smaller first-stage digester.*

The estimated digester gas flows are summarized in Table 4-35.

**Table 4-35. Summary of Projected Digester Gas Flows for SMAD (scfm) [a, b]**

| Annual Average | Maximum 30-Day | Maximum Day |
|---|---|---|
| 130 | 160 | 190 |

a. *Based on 2040 solids flows and loadings.*

b. *Assume 54% VSR and 15 ft$^3$/lb VSR gas production.*

Four digesters (2 existing, 2 new) are required for the series digestion alternative. There will be three digesters (two at 0.75 million gallons and one at 0.5 million gallons) for the first-stage digestion, and one digester (0.5 million gallons) for the second-stage digestion during normal operation. Pumping and piping configuration should allow one of the first-stage digesters to operate as a second-stage digester. This would allow the digestion system to continue operating in series mode when the second-stage digester is out of service.

In this alternative, two new digesters, each 50 feet diameter with an active volume of 0.5 million gallons, are required. One will function as a first-stage digester, the other as a second-stage digester.

A new digester control building is proposed to house the new digester mechanical equipment. We propose that the new digester and control building be located in the open space to the west of the existing digester complex.

A conceptual design was developed for the SMAD alternative. Table 4-36 summarizes the major new equipment associated with the SMAD alternative.

**Table 4-36. SMAD Major Equipment List [a]**

| Equipment Name | Total | Duty Standby |
|---|---|---|
| Anaerobic digester | 2 at 0.5 million gallons | |
| Digester control building | 1 | |
| Digester feed valves [b] | 4 | 4+0 |
| Digester mixing pumps | 2 | 2+0 |
| Digester solids circulation pumps | 2 | 2+0 |
| Sludge heat exchangers | 2 | 2+0 |
| Hot water circulation pumps | 2 | 2+0 |
| Digested sludge transfer pumps | 4 | 2+2 |
| Sump pumps | 2 | 2+0 |
| Digester gas PRV assembly | 4 | 2+2 |

a. *New equipment and facility only.*

b. *2 feed valves per digester will be installed. 1 will control TWAS addition and the other will control thickening PS addition.*

*PRV = pressure relief valve.*

#### 4.2.2.3.3 Acid-Gas Anaerobic Digestion

AGAD (also known as multi-phase or two-phase digestion) is a process in which two separate tanks are designed around different process goals, allowing the conditions in each tank to be optimized for the desired metabolic process. The first phase, the acid phase, is characterized by short HRT (typically 1 to 2 days), higher OLR, and low pH. Under these conditions, the acid-forming bacteria respire optimally, converting the particulate organics to volatile acids. The gas phase receives sludge from the acid phase, and has a longer HRT. The high level of volatile acids in the sludge support a strong methanogen population. Figure 4-16 depicts this process schematic.

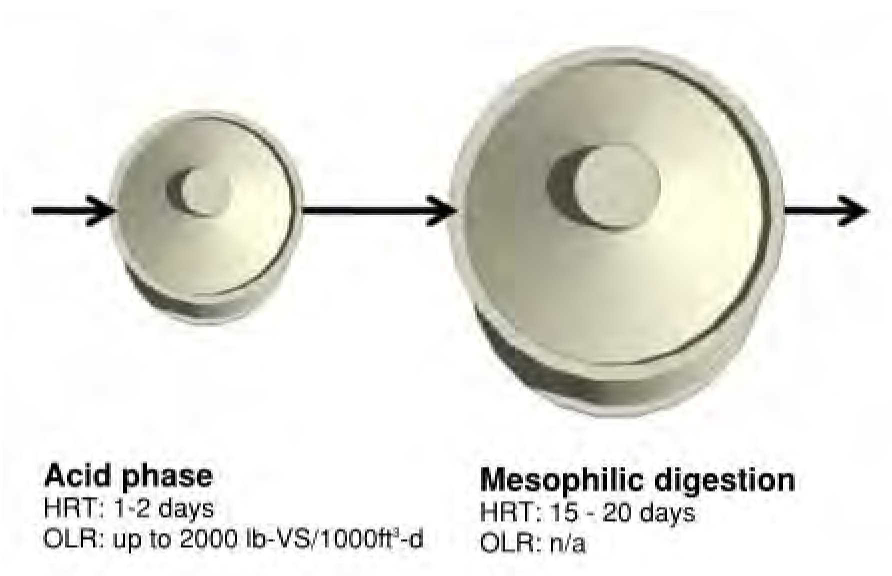


**Figure 4-16. Process schematic of acid-gas phase digestion**

As with CMAD, a total 15-day HRT is desirable in the AGAD process to meet the Class B biosolids criterion, and the sum of both the acid- and the gas-phase HRT is used to achieve this goal. However, most gas production occurs in the second phase rather than the first.

Note that the acid-phase sludges and gases are corrosive, and appropriate equipment and construction materials are required. Optimization of the acid phase is important for effective operation of AGAD. Note that unlike typical fermenters as used at the Meridian WRRF for supplying VFAs to the liquid stream, the acid reactor for AGAD is typically heated to mesophilic temperatures. Gas from the acid phase includes carbon dioxide, methane, and hydrogen sulfide ($H_2S$), and is commonly connected to the digester gas system. If the gas phase is not connected to the gas system, extensive odor control may be required. Excessive retention times in the acid phase may increase odorous compounds, including $H_2S$. These compounds may impact the operational life or performance of gas utilization equipment, and may generate odors at the flares. In addition, AGAD can be challenging to operate correctly, despite its apparent similarities to CMAD.

Digestion criteria used for the AGAD digestion evaluation are summarized in Table 4-37.

**Table 4-37. AGAD Digestion Design Criteria**

| Parameter | Unit | Typical Condition [a] | Service Condition [b] | Peak Condition [c] |
|---|---|---|---|---|
| Acid-phase HRT [d], minimum | d | 1 | 1 | 1 |
| Acid-phase OLR [d] | lb-VS/ft$^3$/d | 2 | 2 | 2 |
| Gas-phase HRT, minimum | d | 14 | 14 | 14 |
| Gas-phase OLR, maximum | lb-VS/ft$^3$/d | 0.15 | 0.18 | 0.18 |

a. *Annual average solids flows and loadings. All digesters in service.*
b. *110% of annual average solids flows and loadings. The largest digester out of service.*
c. *Peak 14-day solids flows and loadings. All digesters in service.*
d. *Peak day solids flows and loadings.*

The expected digester loading rates at various loading conditions are summarized in Table 4-38.

**Table 4-38. Digester Sizing Summary for AGAD [a]**

| Parameter | Unit | Typical Condition [b] | Service Condition [c] | Peak Condition [d] |
|---|---|---|---|---|
| Digester feed TS | lb/d | 27,500 | 30,300 | 36,300 |
| Digester feed VS | lb/d | 22,600 | 24,800 | 30,100 |
| Digester feed flow | gpd | 89,700 | 98,600 | 119,200 |
| Acid-Phase Digesters | | | | |
| Duty digesters | number | 1 | 1 | 1 |
| Digester capacity, each | million gallons | 0.15 | 0.15 | 0.15 |
| OLR | lb-VS/ft$^3$/d | 1.12 | 1.24 | 1.66 [e] |
| HRT | d | 1.7 | 1.5 | 1.1 [e] |
| Gas-Phase Digesters | | | | |
| Duty digesters | number | 3 | 2 | 3 |
| Digester capacity, each | million gallons | 0.75 | 0.75 | 0.75 |
| OLR | lb-VS/ft$^3$/d | 0.07 | 0.12 | 0.10 |
| HRT | d | 25.1 | 15.2 | 18.9 |
| **Combined HRT** | d | 26.8 | 16.7 | 20.2 |

a. *Based on 2040 solids flows and loadings.*
b. *Typical condition: annual average solids flows and loadings, assuming all digesters in service.*
c. *Service condition: 110% of annual average solids flows and loadings, assuming the largest digester out of service.*
d. *Peak condition: peak 14-day solids flows and loadings, assuming all digesters in service.*
e. *Acid-phase digester loading rates based on peak day solids flow and load.*

The estimated digester gas flows are summarized in Table 4-39.

| Table 4-39. Summary of Projected Digester Gas Flows for AGAD (scfm) [a, b] | | |
|---|---|---|
| Annual Average | Maximum 30-Day | Maximum Day |
| 130 | 160 | 190 |

a. *Based on 2040 solids flows and loadings.*

b. *Assume 54% VSR and 15 $ft^3$/lb VSR gas production.*

Three new digesters, including two new acid-phase digesters and one gas-phase digester, are required for the AGAD alternative to handle future solids flows and loadings. The new acid-phase digesters will have an active volume of 0.15 million gallons each. The new gas-phase digester will be the same size as the existing digesters: 70 feet diameter with an active volume of 0.75 million gallons.

Only one acid-phase digester is required during normal condition, the second acid-phase digester is a redundant unit. Two gas-phase digesters in service are required to meet future flows and loadings, and a third digester will allow one unit out of service while maintaining stable operation and producing Class B biosolids.

A new digester control building is proposed to house the mechanical equipment for the new digesters. We propose that the new digesters and control building be located in the open space to the west of the existing digester complex.

A conceptual design was developed for the AGAD alternative. Table 4-40 summarizes the major new equipment associated with the AGAD alternative.

| Table 4-40. AGAD Major Equipment List [a] | | |
|---|---|---|
| Equipment Name | Total | Duty Standby |
| Acid-phase digester | 2 at 0.15 million gallons each | |
| Gas-phase digester | 1 at 0.75 million gallons | |
| Digester control building | 1 | |
| Digester feed valves [b] | 4 | 4+0 |
| Digester mixing pumps | 2 | 2+0 |
| Digester solids circulation pumps | 2 | 2+0 |
| Sludge heat exchangers | 2 | 2+0 |
| Hot water circulation pumps | 2 | 2+0 |
| Digested sludge transfer pumps | 4 | 2+2 |
| Sump pumps | 2 | 2+0 |
| Digester gas PRV assembly | 4 | 2+2 |

a. *New equipment and facility only.*

b. *2 feed valves per digester will be installed. 1 will control TWAS addition and the other will control thickening PS addition.*

*PRV = pressure relief valve.*

#### 4.2.2.3.4 Chemical Stabilization: CleanB

The CleanB system is a plug-flow system designed to treat WAS to Class B standards through a patented chlorine dioxide injection system by BCR Environmental. It is a chemical oxidation process used to disinfect biosolids. It can be used as an alternative to anaerobic digestion processes to stabilize WAS only, or combined primary sludge and WAS.

The CleanB system uses two chemicals: (1) sulfuric acid (50 percent) and (2) sodium chlorite (15 percent). The chemicals are combined in BCR Environmental's patented generating system to generate chlorine dioxide. The chlorine dioxide is injected into the WAS stream for disinfection (i.e., stabilization) and deodorization.

The system comprises a bulk chemical storage and feed arrangement and four trains (three duty and one standby) of flow-through piping with generating systems and injection of the generated chlorine dioxide into each train.

The CleanB system is relatively new, with the earliest installation in 2010. There are a few municipal installations for WAS treatment, most of which are for smaller wastewater treatment plants with an influent flow less than 5 mgd. For larger plants that have anaerobic digestion in operation, the life-cycle cost for the CleanB system is typically higher than that of anaerobic digestion, as found in a previous study BC conducted for the City of Nampa (BC 2013) and a pilot study report prepared by CDM for the City of St. Petersburg (CDM 2011).

Beyond the cost analysis, there are non-cost criteria that led to CleanB not being recommended in the CDM Smith pilot study report. The most significant criterion is that the CleanB system did not provide sufficient treatment of the WAS on several occasions. CDM Smith found that the chemical demand is likely to change because of the condition of the sludge to be treated, which makes optimizing the chemical dosage challenging (CDM Smith 2011).

Based on the above considerations, the CleanB system is eliminated from further evaluation.

#### 4.2.2.4 Dewatering Technologies

The only dewatering technology carried through to the conceptual design was centrifuge.

A centrifuge comprises a bowl and internal screw conveyor rotating at slightly different speeds. Centrifugal force propels the heavier digested solids to the wall of the bowl at accelerations of approximately 3,000 gravitational units. Centrate (i.e., the remaining residual liquid) accumulates along the axis of rotation and is discharged over a concentric weir. An inner cylinder has a screw or scroll encircling its outer surface. Because the scroll conveyor rotates at a slightly slower rotational speed than the outer bowl (i.e., the differential), the scroll moves sludge along the inner surface of the bowl, conveying the dewatered solids to a dewatering beach, and then to its discharge. The liquid centrate is conveyed via an overflow weir to a liquid drain. A picture of a dewatering centrifuge is presented in Figure 4-17.


**Figure 4-17. Dewatering centrifuge**

*Source: Alfa Laval 2017 (https://www.tpomag.com/uploads/imager/uploads/images/57685/alfa_laval_aldec_g3_180122_121252_2c7f46364ea575bd87d99098ec06c024.jpg)*

The Meridian WRRF currently operates two dewatering centrifuges, each with a hydraulic capacity of approximately 120 gpm and a solids capacity of approximately 1,750 lb/hr. Table 4-41 summarizes the results for preliminary sizing using centrifuge dewatering digested solids flows and loadings.

| Table 4-41. Centrifuge Dewatering Sizing and Performance Summary [a, b] | | | | |
|---|---|---|---|---|
| Parameter | Unit | Average Annual | Maximum 30-Day | Maximum Day |
| Centrifuge feed TS | lb/d | 15,800 | 19,000 | 22,700 |
| Centrifuge feed flow | gpd | 89,700 | 108,800 | 132,800 |
| Duty equipment | Number | 2 | 2 | 2 |
| Operation | hr/d | 10 | 12 | 16 |
| Operation | d/week | 5 | 5 | 5 |
| HLR | gpm/machine | 105 | 106 | 97 |
| SLR | lb/hr/machine | 1,104 | 1,103 | 991 |

a. *Based on 2040 flows and loadings.*

b. *Based on existing centrifuges.*

Based on the results of this evaluation, two duty units are capable of processing future solids flows and loads if the operation schedule is kept for no more than 16 hours per day, 5 days per week. One new centrifuge with similar specifications is recommended to provide redundancy. The expected performance of the dewatering centrifuge is summarized in Table 4-42.

| Table 4-42. Summary of Centrifuge Dewatering Performance | | |
|---|---|---|
| Dewatering Technology | Dewatered Cake TS Concentration | Solids Capture Rate |
| Centrifuge | 18%–22% | 98% |

The number of duty centrifuges required depends on the dewatering operation schedule. Only one duty dewatering centrifuge is needed if the dewatering system is operated on a 24-hour per day, 7-day per week schedule. The second unit will provide 100 percent redundancy and thus eliminates the need for a new redundant unit.

One new dewatering centrifuge is required to keep the dewatering operation schedule under 16 hours per day, 5 days per week. The new centrifuge and associated ancillary equipment will be installed in the existing dewatering building.

Plumbing in the existing centrifuges allows only one centrifuge in operation at a time; we recommend updating the plumbing and adding a new centrifuge feed pump to allow both centrifuges to work in parallel.

Table 4-43 summarizes the major equipment associated with the solids handling building.

| Table 4-43. Dewatering Major Equipment List [a] | | |
|---|---|---|
| Equipment Name | Total | Duty Standby |
| Centrifuge | 1 | 1+0 |
| Polymer feed system | 1 | 1+0 |
| Centrifuge feed pump | 1 | 1+0 |
| Grinder | 1 | 1+0 |
| Dewatered cake conveyer | 1 | 1+0 |

a. *New equipment and facility only.*

### 4.2.3 Capital Costs

Planning-level capital cost estimates for the solids treatment alternatives that were evaluated were developed based on new equipment and facilities and required upgrades to the existing facilities. The results are summarized in the following sub-sections. These estimates are preliminary and for evaluation purposes only. All final estimates for the recommended alternatives are updated and presented in Section 6 of this report.

#### 4.2.3.1.1 Primary Sludge Fermentation

Capital cost estimates for the FPS process described in Section 4.2.2.1 were developed and are shown in Table 4-44. The capital costs for retrofitting the old digester to a new fermenter and associated equipment are estimated to be $1.1 million. As discussed previously, we recommend re-evaluating the need for fermenter expansion for future conditions after the FPS/thickening operation is optimized.

Table 4-44. Fermenter Capital Project Cost Estimates

| New Facility and Existing Equipment Upgrade | Capital Cost |
|---|---|
| Fermenter | $1.14 M |

#### 4.2.3.1.2 Thickening

Capital cost estimates for the thickening alternatives described in Section 4.2.2.2 were developed. Table 4-45 summarizes the capital cost for each alternative.

Table 4-45. Solids Thickening Alternatives Capital Project Cost Estimates

| New Facility and Existing Equipment Upgrade | Capital Cost ($1,000) |
|---|---|
| New gravity thickener and DAFT | $1.22 M |
| RDTs | $5.72 M |
| Centrifuges | $7.45M |

Converting the existing abandoned facilities into a gravity thickener and using the existing DAFTs has the lowest capital cost among the three alternatives. Both the RDT and centrifuge alternatives will require all new equipment and buildings, which increase the capital costs significantly. The centrifuge alternative has the highest capital cost, mostly due to the higher cost associated with centrifuges.

One benefit for the RDT and centrifuge thickening alternative is the potential improved thickening performance. Improved thickening will reduce the hydraulic loads to the digesters. Although the increased thickening performance from RDTs and centrifuges will not eliminate the need for an additional digester for the evaluated planning period (i.e., 2040), they can be more favorable in the future when existing thickening reaches useful life and the solids production has increased to demand more digesters.

As discussed previously, we recommend re-evaluating the need for sludge thickener expansion after the FPS/thickening operation is optimized.

#### 4.2.3.1.3 Digestion

Capital cost estimates for the digestion alternatives described in Section 4.2.2.3 were developed. Table 4-46 summarizes the estimated capital cost for each facility.

Table 4-46. Digestion Alternatives Capital Project Cost Estimates

| New Facility and Existing Equipment Upgrade | Capital Cost ($1,000) |
|---|---|
| CMAD | $5.19 M |
| SMAD | $7.75 M |
| AGAD | $10.89M |

The CMAD alternative has the lowest capital costs among the three alternatives, followed by SMAD. The AGAD alternative has the highest capital costs because of more required digesters and associated equipment.

One of the benefits of SMAD and AGAD is the slightly higher gas production and slightly less digested solids to dispose of compared to CMAD. Because digester gas is currently used only for heating, and dewatered solids are hauled to a landfill, the benefits of SMAD and AGAD are unlikely to offset the higher capital costs.

##### 4.2.3.1.4 Dewatering

Capital costs for the dewatering process expansion described in Section 4.2.2.4 were developed and are shown in Table 4-47. The capital costs for adding one new dewatering centrifuge and associated equipment are estimated to be $1.1 million.

Table 4-47. Solids Dewatering Alternatives Capital Project Cost Estimates

| New Facility and Existing Equipment Upgrade | Capital Cost ($1,000) |
|---|---|
| Centrifuge | $1.10 M |

### 4.2.4 Solids Process Recommendations

This subsection presents the evaluation of historical Meridian WRRF operational data and the existing solids treatment system, and presents a cost evaluation of alternatives to determine the most appropriate solids handling process technologies for implementation for the future 20-year planning period. This evaluation included the following efforts:

- Review and validation of historical data
- Projection of solids flows and loadings for the future design condition at 2040
- Condition assessment for the existing equipment and facilities, and identification of current and future changes needed for the solids management system
- Assessment of suitable alternatives at the alternatives workshop on April 18, 2017
- Development of conceptual alternatives for the solids treatment processes for a 20-year planning period
- Development of capital cost estimates for all the alternatives identified

Based on the results of this evaluation, the following changes/upgrades to the solids treatment processes are recommended:

- The fermenter is reaching its capacity under current operation. Expansion of the fermentation process is needed. The old digester next to the existing fermenter can be retrofitted into a second fermenter as needed.
- The FPS/thickening operation should be evaluated for process operation and optimization, as it is likely that there are additional changes that can be made to this system to improve overall performance with respect to VFA generation. The capacity and performance of the PS fermenters and thickeners should be re-evaluated after the process optimization is completed.
- Continuation of GT for PS thickening and DAFT for WAS thickening is recommended. The old primary clarifier adjacent to the existing gravity thickener can be retrofitted to a new gravity thickener to provide redundancy. The two existing DAFT units have sufficient capacity and redundancy to handle future WAS flows and loadings. The DAFT feed pumping and piping should be retrofitted to allow more WAS flow to the DAFTs. More instrumentations and controls should be added to automate operation of the DAFTs.

- Continuation of CMAD is recommended for solids stabilization. A third digester is recommended if the City desires to consistently produce Class B biosolids.
- Continuation of centrifuge dewatering is recommended. The existing feed piping should be reconfigured to allow the centrifuges to operate in parallel. A third centrifuge is recommended to provide redundancy in case on unit is out of service.

The CMAD system can be retrofitted to produce Class A biosolids if needed to meet future regulatory or economic changes. This can be achieved in different ways, such as conversion to thermophilic anaerobic digestion (TAD) with Class A batch tanks, adding a pretreatment process such as thermal hydrolysis process, or by adding a thermal drying process after digestion and dewatering. TAD with Class A batch tanks will have lower costs and will be easier to implement than other alternatives. Converting the CMAD system to TAD with batch tanks will require addition of batch tanks and associated pumping and mixing equipment, and increasing the capacity of sludge heating system to heat sludge to thermophilic temperature.

## 4.3 Sidestream Treatment Technology Alternatives

Sidestream treatment is important for reducing nutrients in the recycle streams from solids thickening and dewatering processes, so that these nutrients do not need to be re-treated or removed in the liquid treatment processes. There are two types of sidestream treatment alternatives: (1) N sidestream removal and (2) P sidestream removal/recovery. Each process was looked at for viability for the City, and results are summarized here.

### 4.3.1 Nitrogen Sidestream Treatment Evaluation

As mentioned above, sidestream N removal was evaluated in a 2015 study, which is documented in the technical memorandum *Meridian Wastewater Treatment Plant Sidestream Nitrogen Evaluation* (January 9, 2015), attached in Appendix D (BC 2015a). In that study, a previously calibrated BioWin model was used to determine the impact of removing a portion of the sidestream N load on the capacity of the existing secondary activated sludge process and the upgrades necessary to meet the proposed effluent limits. An Anammox-based sidestream treatment system was assumed. In addition, the impact of yearly digester maintenance on the secondary treatment process was investigated. During digester cleaning, the centrate ammonia load greatly increases, which can stress the secondary process. The results of the study show that the high diurnal fluctuation in the raw influent N loading minimizes the impact of N removal from the centrate. Load-pacing the centrate was found to be a more cost-effective way to improve nitrification efficiency and reduce the scope of secondary process expansion. As the wastewater and centrate characteristics have not, and are not, anticipated to significantly change from those evaluated in that study, the recommendation from that study is carried forward for this facility plan: no sidestream N removal processes are recommended at this time. The City has already installed additional centrate equalization recommended from that study, and the recommended centrate load-pacing will not require additional capital installations, only control system modifications.

### 4.3.2 Phosphorus Sidestream Treatment Evaluation

Sidestream phosphorus treatment was evaluated in the 2015 *Secondary Treatment Alternatives Evaluation* study (September 24), attached in Appendix C (BC 2015b). The study used a calibrated BioWin model to determine which mainstream process would most efficiently meet future permit limitations. The study included an analysis of sidestream phosphorus removal benefits to the selected mainstream process (i.e., reducing mainstream phosphorus loads). The study demonstrated that sidestream phosphorus removal would reduce the aeration basin expansion by 26 percent and reduce annual supplemental carbon demand by 63 percent. Based on the findings installation of sidestream phosphorus removal was recommended. The 2016 *Side Stream Phosphorus Removal Technology*

*Evaluation* (BC 2016) study compared three different sidestream phosphorus removal technologies using a business case evaluation to combine capital costs and 20 years of operational costs into a single comparable figure, called the net present value. The study was updated with a new technology and new struvite related operation and maintenance costs in 2018 as part of the facility plan, the updated evaluation is included in Appendix E.

The updated sidestream phosphorus treatment evaluation compared technologies based on capital cost, operating expenses, and process benefits (mitigation of struvite operation and maintenance expense, increasing dewatered solids content, reducing polymer demand, and the potential sale of recovered struvite). The study recommends AirPrex with phosphorus sequestration as the best alternative based the highest net present value. The Airprex process places a reactor directly after digestion and forms struvite in the sludge. In the sequestration mode, the struvite remains in the sludge for final disposal. The process can easily be updated to capture and wash struvite if the plant decides to sell struvite on the fertilizer market.

## Section 5

# Resource Recovery

While the City of Meridian is not required by permit to recover resources from their wastewater, there are some potential advantages to some resource recovery in the treatment process. These can range from using effluent or biogas as heat and power sources to recovery of water for reuse options and nutrients or biosolids for fertilizer production. The City of Meridian WRRF generates digester gas and biosolids from its anaerobic digesters. Digester gas contains up to 60 percent methane, making it a useful energy source. The biosolids generated by the facility contain carbon, nutrients, and minerals that are valuable for soil conditioning or potentially as a solid fuel.

Digester effluent contains high concentrations of ammonia and phosphorous. These nutrients may be extracted from the effluent and marketed separately as a fertilizer. The facility's effluent may also be re-used for irrigation and other non-potable water uses.

These and other potential resource recovery opportunities as well as technologies employed for recovery and the feasibility of production for the City are discussed in this section of the report.

## 5.1 Potential Digester Gas Beneficial Uses

Digester gas consists of roughly 60 percent methane and 40 percent carbon dioxide, with up to a few percent of trace gasses consisting of nitrogen, oxygen, water vapor, hydrogen sulfide, and siloxanes. The methane content of the digester gas makes digester gas a potential gaseous fuel to generate heat in boilers, electricity or mechanical power in an engine, or as a raw material for generating renewable natural gas. However, the hydrogen sulfide, moisture, and siloxanes that are prevalent in digester gas may need to be removed to avoid damage to equipment that use the digester gas. Figure 5-1 illustrates the most common beneficial end uses of digester gas.

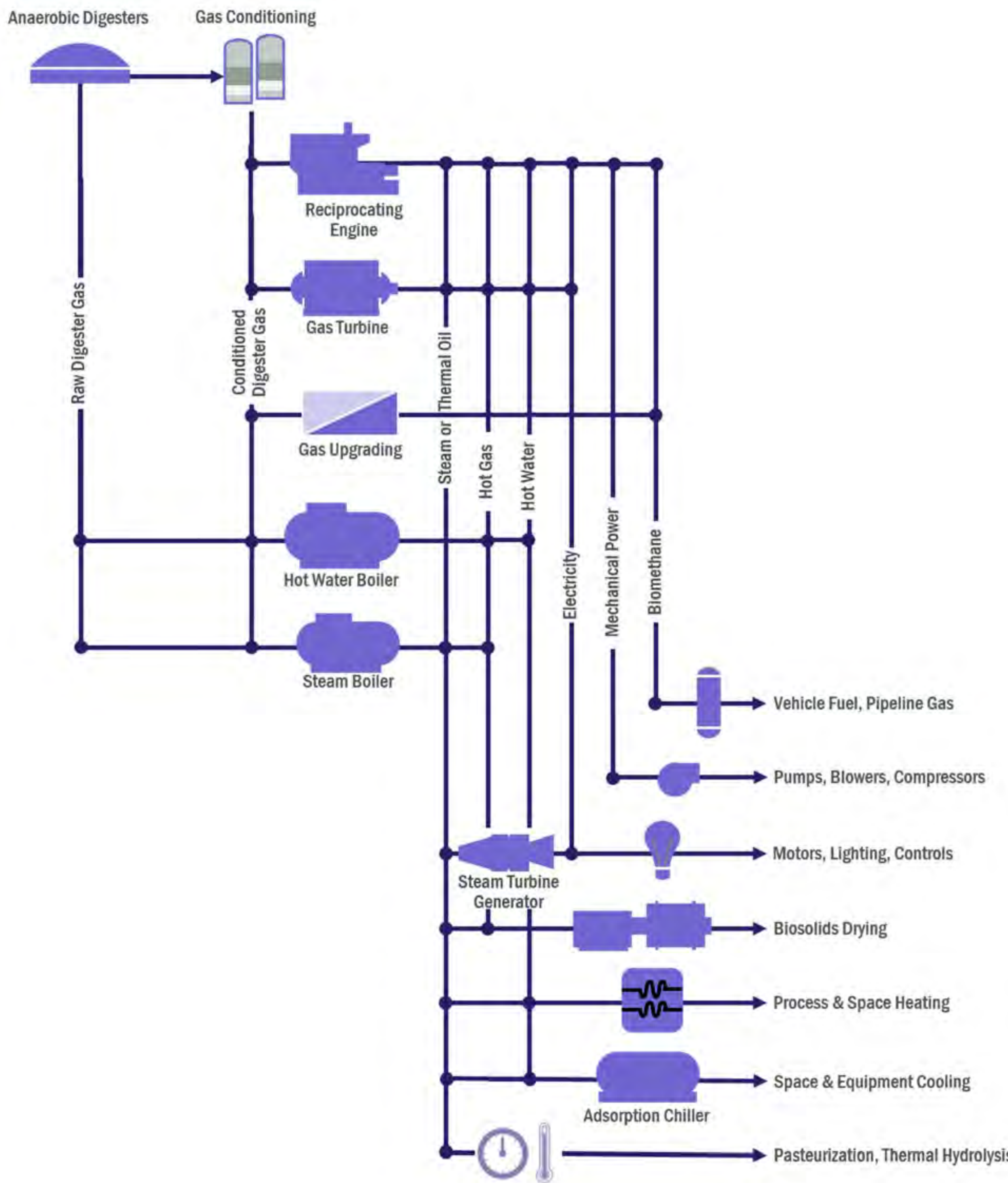


**Figure 5-1. Common digester gas end uses**

The following sections describe the common digester gas end uses that could be implemented at the City of Meridian's WRRF. Approximate equipment capacities are given for each use. Equipment was sized based on the projected 2040 gas production rates assuming a VSR of 52 percent and a digester gas yield of 15 standard cubic feet per pound of VSR. The resulting projected digester gas production rate resembles a standard distribution with an average value of 122 standard cubic feet per minute (scfm) and a standard deviation of 24 scfm (Figure 5-2). The distribution of the digester gas production rate was based on the historical solids production distribution.

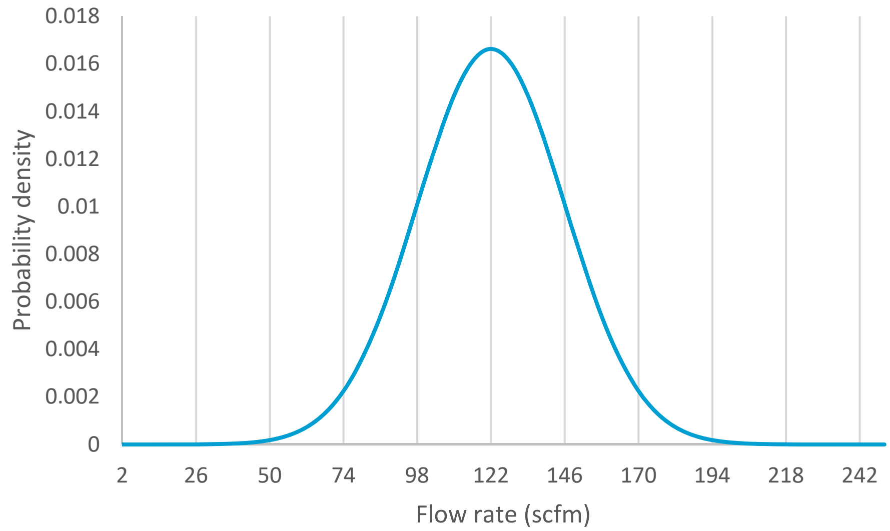


**Figure 5-2. Projected 2040 total digester gas production rate distribution**

### 5.1.1 Heating

Plant heating is the most common digester gas end use at wastewater plants, and is currently the only end use employed at the City of Meridian WRRF. Digester gas is combusted in one or both of the plant's two boilers to generate hot water. The hot water is used to heat the anaerobic digesters and the facility's buildings. Each boiler has a capacity of 60 boiler horsepower (~2 MMBtuh of hot water). Based on current digester gas use in the boilers and projected sludge production rates, one additional boiler would be necessary. The exact size of the new boiler should be determined from a thorough analysis of the plant's heating data, which was not available for this study. However, for the purposes of this facilities plan, the new boiler's capacity is estimated to be the same as existing, 60 boiler horsepower.

Figure 5-3 illustrates the boiler heat output based on digester consumption data from July 2016 to July 2017. The peak 2-week digester gas consumption was 97,000 scfd—97 percent of the boilers' peak capacities. The plant's peak 2-week sludge production (flow) is estimated add roughly 0.8 MMBtuh of peak 2-week heat demand by 2040, in addition to other future heat demands associated with a new digester (shell losses) and new buildings. Consequently, a new boiler would be necessary to meet heat demands while also retaining a standby boiler.

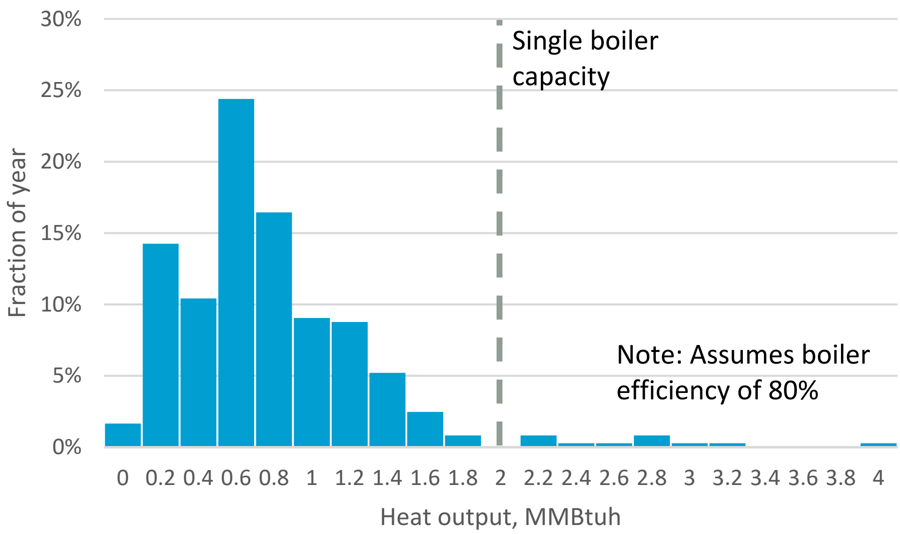


**Figure 5-3. 2016–2017 boiler heat output distribution (using digester gas only)**

During much of the year, the plant generates more digester gas than what is needed for plant heating. On an annual average, the plant currently uses only one-third of the digester gas it produces for plant heating. The excess digester gas is disposed of in a waste gas burner (WGB). The plant's current WGB is approximately 30 years old and has a capacity of 370 scfm of digester gas. BC recommends that WGBs have a capacity equal to or more than twice the plant's peak day production rate of digester gas. Based on this design parameter, the current WGB is adequately sized for a peak day production rate of 185 scfm. As a result, the existing WGB will have a capacity comparable to the 2040 peak day flow rate of 190 scfm. However, given the age of the WGB, and a typical design life of 30-40 years for a WGB, we recommend replacing the WGB within the next 15 years to assure adequate reliability and capacity. The City currently has a spare WGB on site for installation and is only waiting until the existing unit reaches the end of its useful life to install the new unit, which is approximately the same capacity as the existing unit.

During periods of high heat demand, usually in the winter, the quantity of digester gas produced is not sufficient to meet all of the plant's heating needs. During these times, one of both of the boilers are supplemented with natural gas. Dual-fuel burners that can combust either digester gas or natural gas are used in the boilers.

The digester gas is fed to boilers with only moisture removal conditioning, though ferric chloride is added directly to the digester liquid for sulfide control. However, depending on the future composition of the digester gas and boiler emissions requirements, the digester gas may require conditioning such as compression and reduction of hydrogen sulfide and siloxanes. Hydrogen sulfide in the digester gas creates sulfur oxide ($SO_x$) in the boiler exhaust and can cause corrosion in boilers and other combustion equipment. When siloxanes are combusted, they form silicon oxide (sand) that can foul burners and boiler internals. Gas compression may be necessary if siloxane removal is implemented or ultra-low NOx burners become necessary to meet emissions requirements.

Hydrogen sulfide can be removed from the digester gas in vessels containing iron-bearing wood chips, zeolite, or dried clay. Moisture must be removed from the digester gas prior to siloxane removal and is accomplished by cooling the digester gas to about 40 degrees Fahrenheit (°F). Siloxanes can be removed after hydrogen sulfide and moisture removal in vessels containing specialized activated carbon. The iron media and activated carbon would need to be replaced periodically as they become saturated with contaminants.

While the plant currently uses hot water boilers, steam or thermal oil boilers could be used instead to accommodate a wider range of heating applications. Hot water can only be heated to about 210°F, but steam and thermal oil can be heated up to 300 and 550°F, respectively, and could be used for a wider variety of heating applications including biosolids drying (see Section 4.3) and absorption chilling, in addition to digester and space heating. Absorption chilling uses the heat from steam or thermal oil to drive a refrigeration cycle that generates chilled water that can be used for equipment and/or space cooling.

At present, digester gas can be used in boilers for plant heating without gas conditioning. The boiler air permit limits the $H_2S$ concentration in the digester gas to less than 3,600 ppm. Ferric chloride is added to the sludge prior to digestion, which keeps $H_2S$ in the digester gas at concentrations low enough that gas conditioning is not necessary. As a result, continuing to use digester gas for plant heating is recommended. The plant currently uses a hot water loop for plant heating; at this point, converting to steam or thermal oil would not be beneficial since there are not substantial needs for high-quality heat at the plant (e.g., large cooling loads or thermal drying).

### 5.1.2 Electricity Generation

Digester gas is sometimes used at wastewater treatment plants in gas-fueled engines to drive electrical generators. The electricity generated is used to reduce the plant's reliance on grid electricity. Unless co-digestion using outside additional digester feedstocks is employed, the electricity generated would not be sufficient to power the entire plant. In addition to electricity, jacket water and hot exhaust gas is generated by the combustion engines. The heat from these sources are commonly used for any of the plant heating applications described in the previous section. The generation of heat and electricity is referred to as cogeneration or combined heat and power.

The most common engines are reciprocating internal combustion engines and gas turbines. Reciprocating engine-generators fueled on digester gas are similar to automobile engines and are available in a wide range of electrical generation capacities from 50 kW up to 2,500 kW. Reciprocating engine-generators have high fuel-to-electricity conversion efficiencies, generally 36 to 40 percent. About 40 percent of the energy not converted to electricity heats water in the engine and can be transferred to the plant's hot water circulation loop for plant heating. Another 40 percent of the heat may be recovered from the engine exhaust. The engine exhaust is typically 900 to 1,000°F and can be used to generate steam or heat thermal oil, or used to dry biosolids. The remaining 20 percent of the energy becomes heat in the engine lubrication oil or radiates to the engine's enclosure and is generally not recoverable.

There are numerous reciprocating engine-generator manufacturers that offer packages for digester gas: GE Jenbacher, Caterpillar/MWM, Cummins, MTU/Rolls Royce, MAN, Mitsubishi, and Dresser Rand/Gauscor.

Gas turbine engines are and are available in electrical generation capacities of 1,000 kW and higher. As a result, these engines are employed at large wastewater treatment plants. Their fuel-to-electricity conversion efficiencies are lower, about 25 percent, but virtually all of the remaining energy creates high-temperature (1,000°F) exhaust that can be used for biosolids drying, to make steam, or to heat thermal oil. Gas turbine engines have cleaner emissions than reciprocating engines, and are therefore easier to permit in strict air quality districts. Gas turbine manufacturers include Solar and Kawasaki.

Fuel cell systems designed to operate on methane gas have been tried at the pilot scale at a few wastewater treatment plants. Methane fuel cells create hydrogen gas from the methane and combine it with oxygen in a fuel cell to generate electricity without combustion. None of the installations have been successful, largely because even trace quantities of hydrogen sulfide and other micro-constituents will damage fuel cells.

Digester gas conditioning is required to remove hydrogen sulfide and siloxanes. The sulfur oxides and silicon oxide otherwise generated during combustion create corrosive and abrasive compounds that will quickly erode, corrode, and foul engine internals and emissions control devices.

Based on the projected 2040 digester gas production rates, a reciprocating engine with an electrical output capacity of 600 kW would maximize the use of the plant's digester gas. However, the heat produced by cogeneration would not be adequate to heat the plant digesters and buildings in the winter. Some plants with cogeneration provide additional heat with natural gas or propane in a supplemental boiler. Other plants use oversized cogeneration units and supplement the digester gas with natural gas (or landfill gas where available) to generate adequate heat for the plant, as well as additional electricity.

As examples, the City of Pocatello wastewater treatment plant and the Central Valley WRF in Salt Lake City employ reciprocating engine cogeneration facilities. Central Valley WRF fuels their engines with roughly 50 percent digester gas and 50 percent natural gas, by energy content, to generate most of the plant's electricity needs and uses both jacket water and engine exhaust heat to generate hot water. The hot water is used to heat the plant's facilities and anaerobic digesters and also to make chilled water via an absorption chiller in the summer.

Cogeneration requires a significant capital and maintenance investment. Given the relatively low cost of electricity to the plant at present, there is not likely a strong economic advantage to making such an investment. A typical 20 year payback for cogeneration requires a power cost of greater than $0.08-0.10/kWh, which is higher than that currently paid by the City. If future utility prices make cogeneration an attractive digester gas end use, one or more engine-generators and associated equipment could be located in a new building with a footprint of approximately 3,000 square feet.

### 5.1.3 Biomethane

Biomethane, also known as renewable natural gas, is methane that has been extracted from digester gas and compressed for injection into the utility natural gas pipeline or for use in compressed natural gas (CNG) vehicles. The methane is separated from the carbon dioxide via a series of physical and/or chemical processes collectively referred to as gas upgrading.

There are four common gas upgrading processes: membrane separation, pressure swing absorption, water solvent, and amine solvent. Each of these technologies are described briefly below:

- **Membrane separation.** Membrane separation gas upgrading compresses the digester gas into special membranes that allow carbon dioxide (tail gas) to pass across the membrane while the methane (product gas) is retained within the membrane. The product gas is further compressed for vehicle use or pipeline injection. Two manufacturers offer gas separation membranes: Air Liquide and DMT Carborex. BioCNG packages Air Liquide's membranes with compressors and gas conditioning equipment into systems with capacities from 50 to 400 scfm of digester gas.
- **Pressure swings absorption.** The pressure swing absorption process compresses digester gas into vessels that contain a media that absorbs carbon dioxide at high pressures. When the media becomes saturated with carbon dioxide, the vessel is switched offline and a $CO_2$-free gas is used to remove the $CO_2$ from the media. When the media is recharged, the vessel is then switched online to resume gas upgrading. Guild Associates and Xebec currently offer pressure swing absorption systems for digester gas.
- **Water solvent extraction.** Water-solvent gas upgrading compresses the digester gas and bubbles it through a pressurized column of water. At high pressure, the water absorbs $CO_2$ and hydrogen

sulfide while the methane remains in a gaseous form and exits the top of the column. The water is then depressurized in a separate vessel and aerated to release the $CO_2$ and hydrogen sulfide. Greenlane is currently the only company to offer a water solvent system in the United States.

- **Amine solvent extraction.** Amine solvent gas upgrading works similarly to water solvent extraction, except that it is done under near-atmospheric pressure and heat is used to drive the $CO_2$ out of the amine solvent. Amine solvent extraction is common in the natural gas refining industry, but is uncommon at U.S. wastewater treatment plants. Läckeby Water offers an amine solvent system sized for wastewater treatment plants.

In all cases, the tail gas contains carbon dioxide and some residual methane, hydrogen sulfide, and other constituents that must be flared in a specialized low-Btu WGB or thermal oxidizer.

Biomethane has commanded high market values in recent years thanks to the federally-mandated Renewable Fuels Standards. This program requires that a certain volume of the vehicle fuels sold in the United States be from renewable resources, such as ethanol, biodiesel, and biomethane. Renewable identification numbers (RINs) can be obtained for biomethane that is produced and used to fuel CNG vehicles. RINs for biomethane generated by municipal sewage sludge have had market values ranging from $2.60 per therm to 3.90 per therm in the past 12 months. As a result of the high revenues associated with biomethane, gas upgrading processes have become popular at wastewater treatment plants in recent years. The federal renewable fuel volume requirements are only defined through 2022, however they are currently anticipated to continue at present levels beyond 2022.

The quantity of biomethane that could be generated by a typical wastewater treatment plant is usually far more than can be consumed on-site by city vehicles. Consequently, gas upgrading installations either only upgrade a small fraction of the plant’s available digester gas, or upgrade a large portion of the digester gas and inject it into the plant’s natural gas utility. The biomethane can then be “wheeled” through the natural gas pipeline to public CNG fueling stations. The biomethane quality requirements for pipeline injection are more restrictive than the fuel quality requirements for on-site CNG vehicle use, and real-time gas quality monitoring is generally required. These requirements increase the cost and complexity of the gas upgrading process.

As an example, King County’s South Treatment Plant in Renton, Washington currently produces about 500 million Btu per day (MMBtu/d) of pipeline-quality biomethane using a water solvent system. The system is approaching 30 years of age and a detailed design is in progress for an Air Liquide gas membrane separation system to replace it by 2021. Accounting for the sale of RINs, the project is expected to pay back in about 11 years.

The Persigo wastewater treatment plant in Grand Junction, CO produces approximately 40 scfm of biomethane (60 MMBtu/d or 500 gasoline gallon equivalents) and pipes it directly over a distance of about 6 miles to the City’s transit bus fueling station. The gas upgrading system is a packaged gas membrane separation system provided by BioCNG.

The appropriate capacity for a digester gas upgrading system depends on the process. Assuming a gas membrane separation system with a high methane recovery rate (86 percent), the City of Meridian’s WRRF could produce up to 140 MMBtu/d of biomethane. This is equivalent to about 1,200 equivalent gallons of gasoline per day.

While gas upgrading can be an economical end use for digester gas, at present the City of Meridian has not evaluated opportunities associated with purchase of a large CNG vehicle fleet or sale of biomethane to a large natural gas pipeline nearby (which currently does not exist within several miles of the WRRF). Meridian should continue to investigate the challenges and opportunities of a biomethane program and if opportunities become available to the City of Meridian that make gas upgrading attractive, the equipment could be located at the facility within a footprint of approximately 3,000 square feet.

## 5.2 Potential Biosolids Beneficial Uses

Biosolids produced by the City of Meridian's WRRF are currently transported to the local landfill. Biosolids contain organic carbon, nitrogen, phosphorous, and other micronutrients and minerals which makes them useful for fertilizing crops and improving soils when used as a soil amendment. If the biosolids are dried, their carbon content also makes them a potential solid fuel and used in place of coal or wood. This section describes potential beneficial products that are made from biosolids and the processes that would be necessary to create these products.

Beneficial use of biosolids on land is regulated under federal law by US EPA Part 503 regulations (Code of Federal Regulations Title 40 Part 503). This regulation defines principally two levels of treatment: Class A designation requires a process to further reduce pathogens (PFRP) in which biosolids are treated with high temperatures or chemicals to reduce pathogens to very low levels (comparable to pasteurization) and are deemed suitable for unrestricted use by the public as a soil amendment. Class B biosolids are treated to reduce volatile solids to below a prescribed, reducing vector attraction, and at elevated temperatures to significantly reduce pathogens, a process to significantly reduce pathogens. Class B biosolids are permitted to be used on private agricultural lands, but with limited application rates, set backs from public access, and monitoring.

Figure 5-4 summarizes these products and processes.

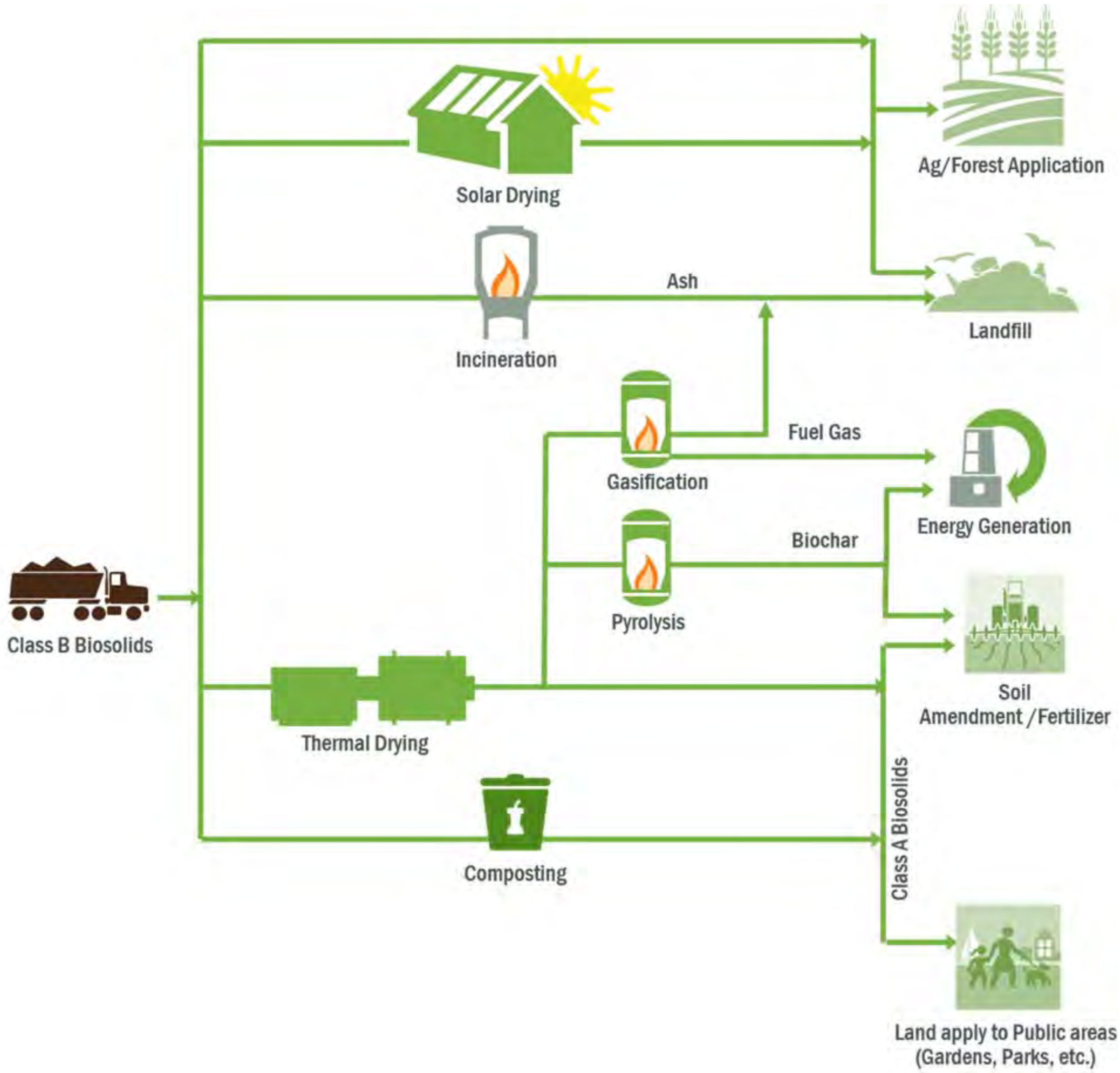


**Figure 5-4. Summary of potential biosolids products and processes**

The WRRF is expected to generate an average of 15,775 dry lb/day of biosolids in 2040, with a peak day production rate of 23,760 dry lb/day (see Chapter 3). Based on these values, the capacities for each biosolids end use are estimated assuming all of the biosolids are applied toward the end use.

### 5.2.1 Class B Land Application

Class B biosolids can be applied directly to agricultural lands, forests, or marginal lands (e.g., mine reclamation land) where public access is restricted. Since the organic carbon, nitrogen, and phosphorous in the biosolids are beneficial to the soil, the product can offset commercial fertilizers. Typically, the biosolids is provided to farmers free of charge. For the City of Meridian, the distance over which the biosolids must be transported to an accepting farmer may be significantly greater than the distance to the local landfill. Since the WRRF already produces Class B biosolids, the City could elect to land apply their biosolids with no modification to the plant.

As an example, the City of Boise and King County currently land apply biosolids to agricultural and forest lands. The City of Boise land-applies its biosolids from its two wastewater treatment plants at its Twenty Mile South Farm.

Currently the City disposes of biosolids at the landfill. Dewatered cake is stored on the treatment plant site on an old drying bed and trucked to the landfill on a periodic basis. To make agricultural use economically attractive to the City, the hauling and application costs would have to be lower than current costs. One option the City could consider is continuing landfill disposal as their primary disposal option, while at the same time allowing local farmers to pick up dewatered biosolids from the plant at their own cost and be responsible on their own for complying with Part 503 limitations and reporting requirements and acquiring any necessary permits from the state. Alternatively, the City could truck biosolids to local farmers willing to apply and monitor their application as required, as long as the hauling distance and related cost to the City is less than landfilling costs. A modest educational and advertisement campaign by the City could help encourage farmers to participate.

### 5.2.2 Class A Compost

Biosolids composting would involve blending of dewatered biosolids with bulking material (e.g., yard, agricultural, or forestry waste) and aerating/holding the blend according to US EPA Class A prescriptions to produce compost, a humus-like product suitable for unrestricted beneficial use. Blending is necessary to achieve the water retention, density, and handling properties that are desirable for composting. Compost blends generally consist of one part biosolids to 1.5 to 3 parts of bulking material.

As the organic material in the compost mass degrades, the compost itself heats to temperatures within the pasteurization range, destroying pathogenic organisms. Composting is a mostly aerobic process, as the introduction of oxygen accelerates microbial reactions necessary to achieve pasteurization temperatures. Composting is considered a PFRP in achieving Class A pathogen reduction under the Part 503 regulations, but temperature and processing time must be carefully monitored. While the compost feedstocks reduce in mass during the degradation inherent in the composting process, the addition of a bulking agent translates to having a similar or somewhat greater volume of product to manage. Unlike Class B biosolids that can only be applied to limited-access areas, Class A biosolids may be applied to gardens, lawns, parks, and other public or residential areas.

Biosolids composting has been successfully practiced in the United States for several decades. Common composting technologies include in-vessel, aerated static pile, and windrow composting. These are distinguished by the manner in which feedstocks are introduced and mixed, and how the active piles are aerated. In-vessel systems allow composting to occur in an enclosed vessel and are typically selected because of the ability to control odors and a somewhat higher process throughput. In aerated static-pile systems, aeration is provided below the pile through aeration piping. In a windrow system, tall rows of compost are “built” and periodically turned with specialized equipment to aerate the compost. Windrow composting is typically the least expensive composting option, but concerns over odors and emissions can make it difficult to site these installations.

Composting in general has a large footprint, as separate process areas are required for preprocessing (blending of biosolids with other feedstocks/bulking agents), active composting,

screening/post-processing, and curing/storage. For example, to process all of the plant’s biosolids through 2040 with a 2:3 biosolids:bulking agent ratio would require a 4- to 5-acre aerated static pile facility. In addition to considering available land for a composting facility, the capacity of the local compost market would also need to be considered.

As an example, Central Valley WRF in South Salt Lake, Utah composts their biosolids with shredded landscape wood waste to a Class A product using in-vessel aerated static piles. The compost is sold to the public under the name of Oquirrh Mountain Compost.

The City of Meridian could truck their biosolids to a composting facility as an alternative to landfilling it, with no modifications to the facility.

Costs for composting can be high and are typically only partially offset by revenue from the sale of the compost product. As an example, the Inland Empire Utilities Agency in southern California pays a tipping fee of about $50 per wet ton of biosolids to a private composter who generates the compost and markets and retains revenues from sales. With current City of Meridian landfill tipping fees at less than $30 per wet ton, a composting operation is not likely be economically viable.

### 5.2.3 Class A Soil Amendment

Soil amendments consist of biosolids mixed with other carbonaceous materials (i.e., agricultural or forestry waste) to augment the texture, moisture retention, and nutrient content of the soil amendment product.

Producing a soil amendment is advantageous over composting in that it does not require the acreage and monitoring of compost piles. If Class A biosolids are produced by the plant, they can be processed directly into a soil amendment. If the plant produces Class B biosolids, they must be thermally processed to Class A biosolids (see below for more information on thermal treatment), then used to produce a soil amendment. Because the soil amendment contains Class A biosolids, it has a wider range of potential uses.

The City of Tacoma in Washington produces and sells a soil amendment it calls TAGRO to local residents and businesses. TAGRO is a mixture of approximately 50 percent Class A biosolids from their temperature-phased anaerobic digestion process, 25 percent sawdust, and 25 percent sand. Since the City of Meridian's WRRF only produces Class B biosolids and Class A biosolids production was not recommended for expansion of the solids facilities as discussed in Chapter 4, this end use is not considered further in this facilities plan.

### 5.2.4 Thermal Treatment

After digestion, the biosolids may be heated for the purpose of reducing/eliminating pathogens to create Class A biosolids, and/or removing moisture to reduce the volume and weight of the biosolids. This section discusses three thermal treatment processes that may be applied to municipal biosolids: solar drying, and two types of mechanical dryers.

Solar drying is a low-energy means of reducing the weight and volume of biosolids through evaporation of the water bound up in the solids. Historically, this took the form of open-air drying beds, but because of both aesthetic (e.g., odors, vectors) concerns and the desire to increase drying bed throughput, covered solar drying beds and greenhouse-type installations are becoming more common. The product resulting from solar drying typically has a total solids content around 75 percent. In addition, while the process does reduce pathogens, it is not considered a PFRP for achieving Class A pathogen reduction under federal law (Part 503). Instead, utilities wishing to market or distribute their product as Class A biosolids must test for bacteria and viruses per federal regulations. Consequently, solar drying is generally only used as a means to reduce transportation costs for landfilling or land applying the biosolids.

Thermal drying of biosolids involves using heat generated at the plant to dry the biosolids to a low moisture content, usually less than 10 percent moisture. The resulting biosolids are Class A and the weight and volume are significantly reduced. The biosolids may be landfilled, land applied, used to make soil amendments and fertilizers, or used as a solid fuel.

Biosolids dryers are manufactured by several established companies including Kruger, Komline-Sanderson, Huber, and Andritz. Biosolids dryers are available in different configurations that are categorized by their heating method: direct drying or indirect drying. These dryer technologies are briefly discussed in the following sections.

#### 5.2.4.1 Direct Dryers

In direct dryers, moisture removal is achieved predominantly by convective heat transfer. As an example, convective heat transfer is similar to using a hair dryer. Air is blown over a hot surface, transferring the heat with the flow of the air. For a direct dryer, hot air is produced through the combustion of fuel in a furnace, boiler, or combustion engine, or the use of an air-to-air or liquid-to-air heat exchanger with a high-grade heat source. The resulting hot air is exhausted directly into the drying vessel. The hot gases come into direct contact with the dewatered cake, causing the water within the cake to evaporate. Direct dryers are capable of making a high-quality biosolids product consisting of uniform, hard, spherical pellets similar in appearance (with the exception of color and odor) to commercial inorganic fertilizer products. Most of the largest thermal drying operations in the United States use direct dryers to create their biosolids products. Two types of commonly used direct dryers are drum dryers and belt dryers.

An advantage of the belt drying system is that it operates at lower temperatures than a drum dryer, and typically creates an air stream with fewer odors. The typical operating temperature for the hot air in a belt dryer is 280°F–350°F, whereas the typical operating temperature for a drum dryer is 800°F–1100°F. This permits a belt dryer to use a wider variety of heat sources than a drum dryer, although their physical size is larger to facilitate the necessary heat transfer at lower temperatures.

#### 5.2.4.2 Indirect Dryers

Indirect dryers achieve moisture removal predominantly by conductive heat transfer, and the biosolids are kept separate from the primary heated drying medium. An example of conductive heat transfer is frying an egg in a skillet. The skillet is heated by the stove and transfers heat into the egg through the surfaces in physical contact with the egg. This is referred to as indirect heating because the egg is not in direct contact with the heating medium (i.e., the stove).

In an indirect biosolids dryer, the biosolids are heated through physical contact with the heated surfaces of the dryer. The indirect dryer consists of a stationary vessel with an internal agitator and stirring assembly that is heated with a heat conveyance medium (steam or thermal oil) that is either heated in a boiler or comes from another high-grade heat source. The dewatered cake enters the stationary vessel of the indirect dryer and is continuously agitated as it passes from one end of the vessel to the other. The heat is transferred from the drying medium to the cake by circulating the medium through the internals of the stirring mechanisms, augers, shafts, disks, dryer casing, or other equipment that comes into contact with the cake. A small flow of air is passed through the vessel to carry away water vapor. Indirect dryers are typically identified by the internal mechanism used to agitate and convey the material in the dryer. Thus, these dryers are commonly known as screw dryers or paddle dryers. Indirect dryers may be operated on a continuous basis or batch-operated and can use heat at a temperature of 350°F–400°F.

Regardless of the dryer technology, thermal drying is energy-intensive. Energy requirements vary somewhat among dryer manufacturers, but as a conservative estimate, 1,600 Btu's of heat is required to evaporate one pound of water from biosolids. Assuming the solids can be thickened to 20 percent, drying all of the plant's biosolids to 90 percent dry weight would require an average of about 100 MMBtu per day. The plant's average digester gas production would just be adequate to provide the required heat for drying the biosolids. Consequently, natural gas would be expected to be needed to supplement the plant's digester gas supply since the boilers impose an additional fuel demand of up to 120 MMBtu per day.

The dried product can be landfilled, land-applied, sold as fertilizer to businesses or to the general public, or sold as a solid fuel to coal power plants or cement factories. The Milwaukee Metropolitan Sewerage District uses a drum dryer to dry their biosolids. The biosolids are sold nationwide as Milorganite. At present, there is not a strong economic or regulatory driver for drying biosolids since the City of Meridian can cheaply landfill their biosolids. However, space will be reserved at the plant's location for a biosolids drying facility in case changes to the market and/or regulations make dried biosolids economically advantageous.

Dried biosolids may be further processed to generate additional fuels or soil conditioning products, as will be discussed in the next section.

### 5.2.5 Thermal decomposition

In contrast to thermal treatment, thermal decomposition processes, including incineration, gasification and pyrolysis, modify the chemical makeup of the biosolids to generate various products.

Biosolids may be incinerated to reduce the biosolids to its ash content – about 10 percent of its dry weight. The ash generally has no value and would be landfilled. Incineration is more common in the Eastern United States where space and disposal options are limited. Janicki Bioenergy has recently introduced an incineration process that recovers some of the water and energy content from the biosolids to generate a small amount of electricity and reclaimed water.

Gasification and pyrolysis heat the biosolids to high temperatures in the absence of oxygen to produce syngas, a combination of hydrogen, carbon monoxide, and carbon dioxide. The syngas could be used on-site for heat or power generation. In the gasification process, only syngas and ash are produced. In the pyrolysis process, less syngas is produced while the process also generates biochar. Biochar is similar to charcoal and can be sold as a solid fuel or as a soil conditioner. While the gasification and pyrolysis processes are successful in the fossil fuel and charcoal industries, they have not been reliably applied to municipal biosolids beyond the pilot scale.

Of the thermal decomposition technologies, only incineration is considered technically viable for municipal biosolids. Incineration is attractive when there is limited space at the wastewater treatment plant and landfilling or land applying biosolids is not a viable option. Further, air permits for incinerator technologies can be difficult to acquire and are often more stringent that typical air permits for waste gas burner systems, as they typically require monitoring of fugitive metal emissions like mercury. As a result, incinerators are uncommon in sparsely populated western states like Idaho. Typically, incineration is accomplished on raw, undigested biosolids. The City of Meridian already has significant investment and familiarity with their digestion system. For these reasons, these technologies were not considered further.

## 5.3 Sidestream Nitrogen Recovery

Sidestream nitrogen removal can be carried out using a biological or non-biological (physical-chemical) process. This section summarizes the findings of a previous biological nitrogen removal study and discusses non-biological sidestream removal technologies.

### 5.3.1 Nitrogen Sidestream Treatment Evaluation

Sidestream N removal was evaluated in a 2015 study, which is documented in the technical memorandum *Meridian Wastewater Treatment Plant Sidestream Nitrogen Evaluation* (January 9, 2015), attached in Appendix D (BC 2015a). In that study, a previously calibrated BioWin model was used to determine the impact of removing a portion of the sidestream N load on the capacity of the existing secondary activated sludge process and the upgrades necessary to meet the proposed effluent limits. An Anammox-based sidestream treatment system was assumed. In addition, the impact of yearly digester maintenance on the secondary treatment process was investigated. During digester cleaning, the centrate ammonia load greatly increases, which can stress the secondary process. The results of the study show that the high diurnal fluctuation in the raw influent N loading minimizes the impact of N removal from the centrate. Load-pacing the centrate was found to be a more cost-effective way to improve nitrification efficiency and reduce the scope of secondary process expansion. As the wastewater and centrate characteristics have not, and are not, anticipated to significantly change from those evaluated in that study, the recommendation from that study is carried forward for this facility plan: no sidestream N removal processes are recommended at this time. The City has already installed additional centrate equalization recommended from that study, and the recommended centrate load-pacing will not require additional capital installations, only control system modifications.

### 5.3.2 Non-Biological Nitrogen Removal Sidestream Processes

Ammonia may be removed from side streams by physical-chemical means. Processes that have been used in the past are ammonia stripping and selective ion exchange. Neither of these processes are used today because of significant operational constraints and their high costs relative to biological treatment.

In ammonia stripping, ammonia nitrogen can be converted from the ammonium ($NH_4^+$) ion to ammonia gas ($NH_3$) by raising the wastewater pH to approximately 11. Passing the high pH wastewater flow counter-current against an upflowing stream of air in a tall column filled with plastic media will transfer the ammonia into the air stream. The ammonia-rich air stream is directed to a second column counter-current to a downward flow of sulfuric acid. Ammonium sulfate is produced that may be used as a fertilizer. The efficiency of the stripping reaction declines at low temperatures. The cost of elevating pH is high and the marketability of the fertilizer product is limited. Fouling of the media with scale also occurs, causing poor liquid distribution in the column. This technology has been marketed as AmRhex by a Canadian company, 3XR, Inc. over the past decade but it is no longer in business. Ammonia strippers may be purchased from chemical industry contractors.

In ion exchange, zeolite materials such as clinoptilolite, selectively remove ammonia from solution by adsorption. The process is very efficient but the clinoptilolite becomes saturated with ammonia and needs to be regenerated, typically achieved by passing sodium chloride solution through the column of ion exchange media. The ion exchange media is expensive and disposal of the ammonia-rich regenerant has proven to be difficult. This technology (in concert with ammonia stripping) was marketed as ASR by Thermo-Energy Corp. over the past decade. It, too, is no longer in business.

Costs were compared of ammonia stripping versus Anammox treatment of ammonia-rich sidestreams for the Central Valley Water Reclamation Facility in Salt Lake City in 2017. For a flow rate of 467,000 gal/day and an ammonia concentration of 829 mg/L, capital costs for the Anammox system were $5.7 million versus $3.7 million for air stripping. However, operating costs were $4.70/gal for the Anammox system but $87/gal for the stripping system because of the high chemical costs.

## 5.4 Sidestream Phosphorous Recovery

Sidestream Phosphorous removal was initially considered in the City of Meridian WRRF's 2012 Facility Plan to help reduce the amount of internally recycled phosphorus to improve secondary treatment performance with respect to biological phosphorus removal. The specific recommendation was for a struvite recovery system, which removes the phosphorus by precipitating it as the mineral struvite, where struvite is a solid composed of equimolar amounts of magnesium (Mg), ammonium, and phosphate ($PO_4$) (chemical formula: $MgNH_4PO_4 \cdot 6H_2O$). Results of the add-on process evaluation discussed above confirmed that adding a side stream phosphorus removal facility would significantly reduce the amount of supplemental carbon required to drive the Bio-P process in the main stream, with potentially significant savings in operating costs. Phosphorus removed from the side stream also has the potential for reducing high O&M costs associated with controlling and mitigating struvite precipitation within the solids handling processes at the Facility, which has been an issue with the City because of the nature of struvite precipitating out on solids handling pipelines and equipment. A review of available phosphorus removal technologies was thus conducted, with development of life cycle costs. These are provided in the updated technical memorandum *WRRF Side Stream Phosphorus Removal Technologies Evaluation* dated December 1, 2017, included in Appendix E.

## 5.5 Water Reuse

Due to the high-quality effluent and tertiary treatment process at the WRRF, virtually all of effluent produced during the reuse season (typically May through October) is of reuse quality. However, due to limits in the reuse water system (storage and disinfection), only up to 1 mgd is used for reuse as described in Chapter 2. At this time, the City intends to continue maintaining this system at its current size, with no plans to expand or modify it as there are currently no anticipated increases in demand for this water.

## 5.6 Sludge Fermentation

Volatile fatty acids are generated from the plant's primary sludge and used as a carbon source for liquid stream biological phosphorous removal. This process is considered part of the liquid stream process and is discussed in greater detail in Chapter 4.

## 5.7 Selected Resource Recovery Approach

The facilities plan will include space for a biosolids thermal drying facility and sidestream phosphorous recovery. The plant will continue to use its digester gas to fuel its boilers for process and space heating and the facilities plan will include a new 60-hp boiler to meet future heat demands. If future conditions are such that cogeneration or gas upgrading becomes an attractive digester gas end use for the City of Meridian, space for a 3,000 square foot area has been identified to house either end use equipment.

While landfilling the biosolids is currently economical for the plant, dried biosolids would provide the plant with more disposal or end use options if landfilling becomes less economical in the future. Natural gas would be used to supplement the plant's digester gas supply in the future if a biosolids drying process is introduced. The City of Meridian could also consider land applying, offering existing produced biosolids for farmer pickup and use, or providing its biosolids to an off-site compost facility with no modifications to the plant.

For the facilities plan layout, a belt dryer is assumed for the biosolids dryer because it would require the most space of the biosolids drying technologies. If drying is selected in the future, the type of biosolids dryer should be evaluated in detail and ultimately selected based on staff preference, product requirements, air permitting, lifecycle costs, and heat source. The belt dryer assumed in the facilities plan is sized to dry all of the plant's biosolids to 90 percent solids content.

The dryer would be housed in a facility with dimensions of approximately 40 ft by 50 ft, located near the existing dewatering facility to minimize sludge transport distances. The dried biosolids are assumed to be loaded directly into a truck, with no on-site storage.

The plant's existing WGB may have enough capacity through 2040. However, given the age of the existing WGB (commissioned in the late 1980s), it is assumed in this facilities plan that it will be replaced within the next 15 years to ensure the WGB has adequate capacity and reliability.

Section 6

# Capital Improvements Plan

## 6.1 Objective

The purpose of this chapter is to present a capital improvements plan (CIP) for the projects recommended in Sections 4 and 5. The CIP provides a clear outline of the required projects between 2019 and 2039, including estimated costs and approximate year of initiation for each project. Costs presented are planning-level estimates (Association for the Advancement of Cost Engineering Class 5). The CIP was developed with consideration for project grouping and potential delivery methods to meet regulatory, financial, and organizational constraints of the City.

## 6.2 Schedule and Sequence

The CIP schedule and project sequencing are driven by regulatory constraints, future capacity needs, and infrastructure replacement requirements. The 10-year compliance schedule in the City's NPDES permit includes several planning and construction deadlines, as summarized in Table 6-1, that set the construction schedule for many of the projects. The City's growth projections, as described in Chapter 3, are the basis for scheduling capacity upgrades.

Table 6-1. NPDES Permit Schedule of Compliance Deadlines

| Task | Deadline |
|---|---|
| Provide amended facility plan to the IDEQ | July 31, 2019 |
| Provide schedule of design upgrades required to meet final effluent limits to the IDEQ and EPA | July 31, 2022 |
| Achieve TP interim limit not to exceed 1.0 mg/L (annual average) | July 31, 2022 |
| Complete final design report on BNR upgrades | July 31, 2023 |
| Complete construction for BNR upgrades to meet the final ammonia and TP limitations | July 31, 2025 |
| Complete tertiary filtration construction and begin process optimization | July 31, 2026 |
| Achieve compliance with final effluent limitations in NPDES permit | July 31, 2027 |

## 6.3 Site Layout and CIP Outline

The projects recommended in this Facility Plan are shown on the site layout in Figure 6-1. The figure includes projects currently in construction (blue outline), projects projected for this facility planning window (red outline), and potential future facilities (green outline). The potential future facilities are shown to reserve space onsite. Construction of these facilities is not anticipated before 2040, however, so they are not included as part of the CIP.

The CIP is outlined in Table 6-2, covering all the planned future facilities from Figure 6-1 (those in red). Projects were assembled into two primary groups based on the NPDES permit compliance schedule: construction starting in 2020 and in 2024. Start dates for individual projects can be moved up as needed to meet the City's funding schedule. Two projects are planned for later dates: construction starting in 2030 and 2037.

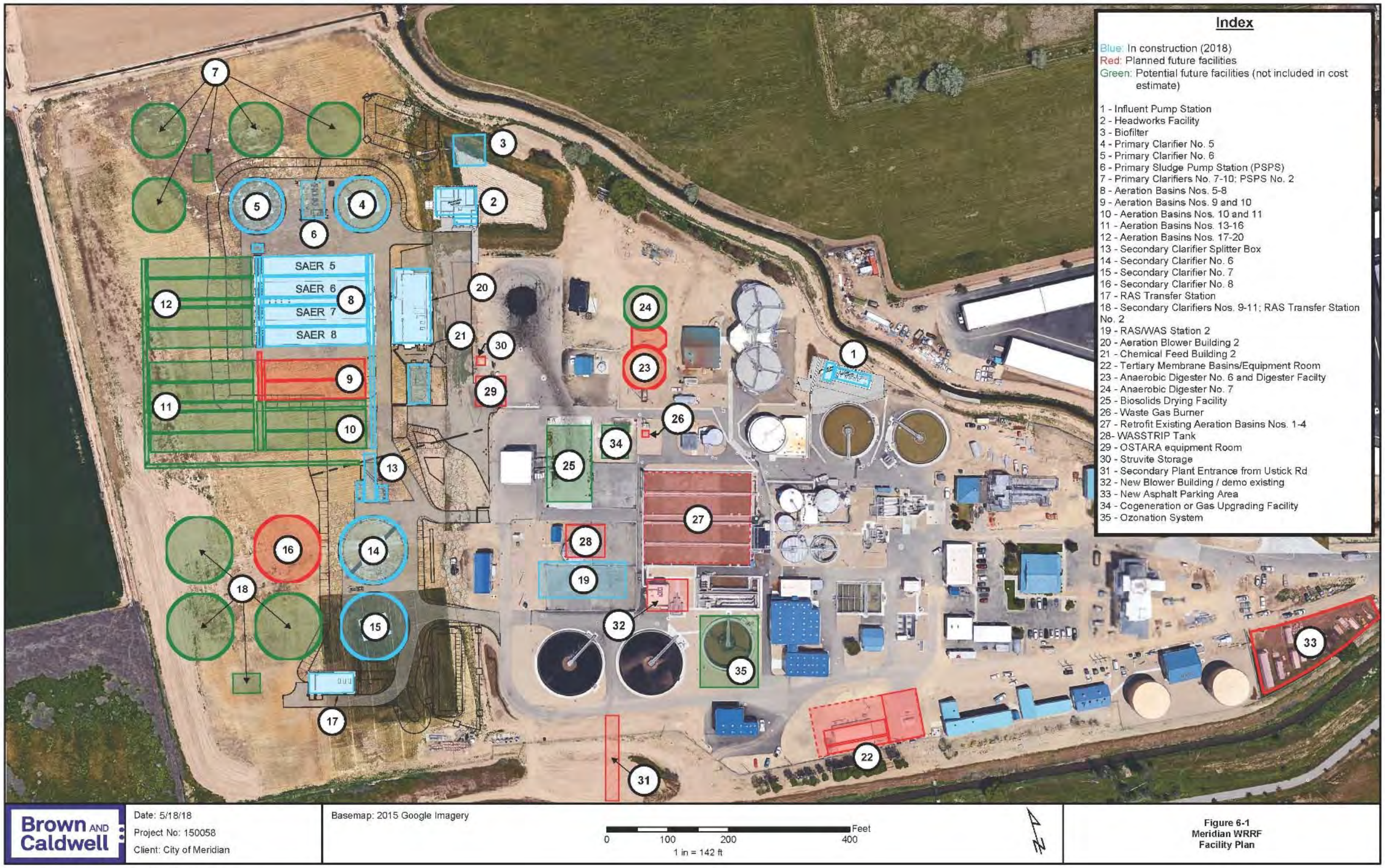


Figure 6-1 Meridian facility plan layout

**Table 6-2. Meridian WRRF Capital Improvement Plan**

| Construction Start, Fiscal Year | Facility Plan Project | Meridian Comprehensive Financial Plan Project | Subtotal Project Cost, including contingency and escalation[a] | Total Project Cost, including soft costs[b] | Project Description | Project Justification |
|---|---|---|---|---|---|---|
| 2020 | Side Stream Phosphorus Removal System | Sidestream Phosphorus Recovery | $6,040,000 | $7,550,000 | The estimate for this project was based on an Ostara Pearl system, as it was the higher cost/more conservative option. Other technologies, including CNP's AirPrex system, are also under consideration. The Ostara system consists of a Pearl reactor, sodium hydroxide for pH control, and magnesium chloride, as well as associated equipment for chemical pumping and feeding of centrate and DAFT subnatant to the reactor. Harvesting struvite crystals from the reactor requires grit dewatering, washing, and drying systems, as well as equipment for bagging and moving the crystals. The system is housed within a building and requires a struvite storage area. | This system would reduce the amount of internally recycled phosphorus at the WRRF, improving secondary treatment performance with respect to biological phosphorus removal (Bio-P). The process would reduce the amount of supplemental carbon required to drive Bio-P and reduce O&M costs associated with controlling and mitigating struvite precipitation within pipelines and solids handling processes at the WRRF. If the Pearl system is selected, the City could also make a small profit from selling the struvite product to Ostara for use as a fertilizer supplement. |
| 2020 | WASSTRIP tank | Sidestream Phosphorus Recovery | $1,750,000 | $2,190,000 | Construct a concrete WASSTRIP tank with a capacity of approximately 550,000 gallons to hold WAS for approximately 10 hours in an anaerobic environment. The project also requires two 650-gpm solids-handling pumps for conveying WASSTRIP effluent to the DAFTs. | The WASSTRIP process is designed to release phosphate from WAS that was taken up during the Bio-P process. Once the WASSTRIP effluent is thickened, the phosphate-rich subnatant is combined with centrate from the dewatering centrifuges and passed to the Pearl reactor. The thickened WAS is sent to digestion, and since it now has a much lower phosphorus concentration, the potential to precipitate struvite in the digesters and downstream piping and equipment is greatly reduced. The WASSTRIP process directs phosphorus to where it is desired (Pearl reactor), while reducing O&M costs associated with controlling unwanted struvite formation. |
| 2020 | DAFT automation | DAFT Retrofit | $190,000 | $240,000 | Configure the existing WAS flow meter and WAS TSS meter to calculate solids loading to the DAFT. Add additional | The current DAFT configuration limits polymer dose control to manual adjustment and is often set at a single flow rate. Automation of |

| Table 6-2. Meridian WRRF Capital Improvement Plan | | | | | | |
|---|---|---|---|---|---|---|
| Construction Start, Fiscal Year | Facility Plan Project | Meridian Comprehensive Financial Plan Project | Subtotal Project Cost, including contingency and escalation[a] | Total Project Cost, including soft costs[b] | Project Description | Project Justification |
| | | | | | controls equipment to automate polymer dosing. Address pipe bottlenecks into DAFTs by upsizing influent pipe to 6-inch glass-lined ductile iron pipe. | polymer dosing to the WAS load to the DAFTs would improve system control and reduce overall polymer use. |
| 2020 | Anaerobic Digester with Control Building | Digester 6 and New Digester Control Building | $11,090,000 | $13,860,000 | Construct Digester No. 6 to match existing Digesters Nos. 4 and 5 (0.75 Mgal, 70-ft diameter, 26-ft side water depth). Also construct a control building of approximately 5,000 sq-ft (half below grade, half above grade) adjacent to the new digester. Major equipment includes a mixing pump, a heat exchanger, two feed pumps, and two solids circulation pumps. | The City places an importance on achieving Class B pathogen reduction in biosolids to meet potential future regulatory requirements and to expand outlets for biosolids end use. Class B pathogen reduction can be achieved by meeting a minimum HRT of 15 days. Two digesters in service are required to meet this minimum HRT at future flows and loads. A third digester is necessary to maintain the required HRT if one unit is out of service. |
| 2020 | Centrifuge feed piping | DAFT Retrofit | $190,000 | $240,000 | Install additional piping and add a centrifuge feed pump to allow both existing dewatering centrifuges to operate in parallel. | Setting up the centrifuges to operate in parallel would push off the need for adding a third centrifuge for several years. It would also add operational flexibility, allowing for shorter dewatering operation periods. |
| 2020 | New Secondary WRRF Entrance | WRRF Second Access | $980,000 | $1,230,000 | Build a second WRRF entrance. For this Facility Plan, the assumed route was from Ustick Road to the south of the plant, through the reservoir site parcel owned by the City and portions owned by private individuals and Nampa Meridian Irrigation District. The 20-ft wide, paved road crosses Fivemile Creek over a new bridge (18-ft wide and 50-ft long) before entering the plant near Secondary Clarifiers Nos. 4 and 5. Cost includes $100,000 for easement acquisition. | As the WRRF area grows, it will soon trigger a requirement for two access points, per the local fire marshal. A second entrance would ensure that an access road to/from the WRRF remains open in case the primary entrance is blocked due to construction, accident, etc. Large trucks could also be directed to enter through the second entrance to avoid congestion near the Administration Building. |

**Table 6-2. Meridian WRRF Capital Improvement Plan**

| Construction Start, Fiscal Year | Facility Plan Project | Meridian Comprehensive Financial Plan Project | Subtotal Project Cost, including contingency and escalation[a] | Total Project Cost, including soft costs[b] | Project Description | Project Justification |
|---|---|---|---|---|---|---|
| 2022 | Aeration Basins 1–4 retrofit | Wastewater Treatment Plant Capacity Upgrades | $6,240,000 | $7,800,000 | Demolish select concrete and piping in existing basins, install new concrete baffle walls, reconfigure the aeration grid with new diffusers, add new basin mixers, install new IMLR pumps, replace pumps in the existing RAS basin, add new chemical feed points, and repair concrete. | Retrofitting Aeration Basins 1–4 will allow the basins to operate in a 5-Stage Bardenpho configuration, matching the configuration of new Aeration Basins 5–8 and providing the most efficient process for biological nutrient removal. By upgrading existing infrastructure, the City will be able to delay construction of future Aeration Basins 11 and 12, saving capital expense. Operators will benefit from having a consistent plant process configuration for treatment. |
| 2022 | Aeration Basins 9 and 10 | Wastewater Treatment Plant Capacity Upgrades | $4,900,000 | $6,130,000 | Install two rectangular concrete aeration basins south of Aeration Basins 5–8, including aeration diffusers. Extend the Mixed Liquor Distribution Channel to the new basins. Add another 700-hp blower to the Blower Building to meet additional air demands. | Additional treatment volume is required to achieve compliance with final effluent limitations in the City's NPDES permit. The stringent ammonia-nitrogen limits are the primary driver for expansion, which would create enough nitrification volume for the remainder of the facility planning window. |

| Table 6-2. Meridian WRRF Capital Improvement Plan | | | | | | |
|---|---|---|---|---|---|---|
| Construction Start, Fiscal Year | Facility Plan Project | Meridian Comprehensive Financial Plan Project | Subtotal Project Cost, including contingency and escalation[a] | Total Project Cost, including soft costs[b] | Project Description | Project Justification |
| 2022 | Blower Building No. 1 (demolish/ replace) | Wastewater Treatment Plant Capacity Upgrades | $4,230,000 | $5,290,000 | Demolish existing Blower Building No. 1 and existing secondary splitter box. Construct a new facility, approximately 55-ft by 70-ft, in the same area. The facility includes two new 700-hp blowers and one new 350-hp blower. | In the workshop described in Section 2.5 of this document, Blower Building No. 1 was flagged for replacement by WRRF staff. The facility has old and outdated electrical systems that have reached maximum capacity. The HVAC system also needs to be replaced. The facility has no space for expansion, though new VFDs and harmonic filters may be needed. Plant staff is concerned about the reliability of the K-Turbo blowers, along with the availability of parts to maintain them. The Spencer blowers may reach the end of their useful life in this planning window. Fully functional and reliable blowers in this facility are important for maintaining treatment in Aeration Basins 1–4.<br>Since the existing secondary splitter box is being replaced in the Liquid Stream Expansion project, a new larger facility could be placed in the location of existing Blower Building No. 1 and the adjacent splitter box. |
| 2024 | Fermenter No. 2 (digester retrofit) | Biological Nutrient Removal Carbon Distribution (Fermentation) | $2,410,000 | $3,010,000 | Retrofit existing 35-ft diameter Digester No. 2 into a second fermenter. This will require the demolition of portions of the digester along with the addition of electrical equipment, instrumentation, pumps, and piping. | Fermenters produce readily available carbon in the form of VFAs, which drives Bio-P in the secondary treatment process. VFAs produced in the fermenters reduce the amount of supplemental carbon that needs to be purchased for the process. Based on the current primary solids loading rate to Fermenter No. 1, it will soon reach its design capacity, necessitating additional fermenter capacity. |

| Table 6-2. Meridian WRRF Capital Improvement Plan | | | | | | |
|---|---|---|---|---|---|---|
| Construction Start, Fiscal Year | Facility Plan Project | Meridian Comprehensive Financial Plan Project | Subtotal Project Cost, including contingency and escalation[a] | Total Project Cost, including soft costs[b] | Project Description | Project Justification |
| 2024 | Gravity Thickener No. 2 (primary clarifier retrofit) | Biological Nutrient Removal Carbon Distribution (Fermentation) | $2,660,000 | $3,320,000 | Retrofit existing 40-ft diameter Primary Clarifier No. 2 into a second gravity thickener to be used in conjunction with the fermentation system. Upgrades include a new mechanism, a cover, a feed pump, a thickened sludge transfer pump, and expansion of the existing odor control system. | A second gravity thickener would provide full redundancy of thickening capabilities for the fermentation system, allowing for the continued production of VFAs even if one thickener is not operational. |
| 2024 | Tertiary Membrane Facility | Tertiary Filter Expansion | $18,070,000 | $22,590,000 | Construct five 21,000-gal rectangular membrane basins, a common feed channel, and a 17,000-gal clean-in-place tank. Install five membranes with associated pumps, compressed air system, backwash tank and pumps, and scour air blowers, along with three inlet strainers (500-micron opening) and chemical day tanks/totes for cleaning. Construct a 7,000-sq ft building for equipment, and install covers on the membrane basins and feed channel. | Tertiary membrane filters would allow the WRRF to meet stringent NPDES effluent P limits, along with any potential future limits on emerging contaminants. While the capital and O&M costs are high for membrane filters, they produce the highest effluent quality of any tertiary filter on the market. Membrane filters also provide a barrier against bacteria and viruses and may thus reduce disinfection requirements. Compared to other filter options, membrane filters have a relatively small footprint. |
| 2024 | New Parking Area | Tertiary Filter Expansion | $100,000 | $130,000 | Construct an additional 16,000-sq ft asphalt parking area to the east of the reclaimed water tanks near the WRRF entrance. | In the workshop described in Section 2.5 of this document, parking was identified as an area of need for the City. More parking spaces are needed for staff and fleet vehicles. |
| 2024 | Centrifuge No. 3 | Centrifuge No. 3 | $1,570,000 | $1,960,000 | Install a third centrifuge, along with ancillary piping and electrical/controls equipment, within the existing dewatering facility. | Two duty centrifuges are capable of processing future solids flows and loads if the dewatering schedule is limited to no more than 16 hours per day, 5 days per week. One new centrifuge is recommended to provide redundancy, especially since drying beds at the WRRF are being demolished for construction of other facilities. If a centrifuge bowl requires repairs, it can be offline for an |

| Table 6-2. Meridian WRRF Capital Improvement Plan | | | | | | |
|---|---|---|---|---|---|---|
| Construction Start, Fiscal Year | Facility Plan Project | Meridian Comprehensive Financial Plan Project | Subtotal Project Cost, including contingency and escalation[a] | Total Project Cost, including soft costs[b] | Project Description | Project Justification |
| | | | | | | extended period, making a redundant centrifuge important. |
| 2024 | Boiler | Boiler | $370,000 | $460,000 | Install a third 60-hp boiler in the existing digester control building, along with ancillary piping and electrical/controls equipment. | Digester gas is combusted in the boilers to generate hot water, which is used to heat the digesters and the facility's buildings. Based on current digester gas use in the boilers and projected sludge production rates, one additional boiler will be necessary. |
| 2025 | Upgrade UV Equipment in UV Channels 1 and 3 | WRRF UV Channel Bulbs (replace two banks of original bulbs) | $1,490,000 | $1,860,000 | Upgrade the older UV equipment in UV Channels 1 and 3 to match the Trojan 3000Plus units installed in the newer UV Channels 2 and 4. Project includes minor demolition and concrete work in UV Channels 1 and 3 and new electrical equipment. | The existing UV equipment will reach obsolescence around this time. The new UV units will more efficiently disinfect the effluent stream, providing greater treatment capacity through the UV channels at lower operating costs. The new UV units require much fewer lamps per channel, which will reduce staff time spent maintaining lamps. |
| 2030 | Waste Gas Burner installation | – | $120,000 | $150,000 | Replace the existing waste gas burner with the new waste gas burner that has already been purchased by the City. Project includes piping and electrical components. | The existing waste gas burner is approximately 30 years old and will reach the end of its useful life within approximately 15 years. It should be replaced to ensure adequate reliability and gas disposal capacity. |
| 2037 | Secondary Clarifier No. 8 | – | $3,170,000 | $3,960,000 | Construct an additional 100-ft diameter secondary clarifier adjacent to Secondary Clarifier No. 6, including excavation, piping, and electrical equipment. | Another secondary clarifier is required to maintain solids loading rates below design maximum levels at 2040 flows and loads. |

*[a]Subtotal project cost includes 30% contingency and escalation to midpoint of construction.*

*[b]Total project cost is subtotal project cost plus soft costs. Soft costs are assumed to be 25% of subtotal project cost and include engineering design services, services during construction, and legal and administrative services.*

Table 6-3 shows the cost estimates for the projects in the CIP outline, grouped and summed by fiscal year of construction start. Detailed cost estimate reports are provided in Appendix F.

**Table 6-3. CIP Estimates of Total Cost**

| Projects by Construction Start Fiscal Year | Subtotal Project Cost, including contingency and escalation[a] | Total Project Cost, including soft costs[b] |
|---|---|---|
| 2020 Projects | $20,240,000 | $25,310,000 |
| 2022 Projects | $15,370,000 | $19,220,000 |
| 2024 Projects | $25,180,000 | $31,470,000 |
| 2025 Project | $1,490,000 | $1,860,000 |
| 2030 Project | $120,000 | $150,000 |
| 2037 Project | $3,170,000 | $3,960,000 |

*[a]Subtotal project cost includes 30% contingency and escalation to midpoint of construction.*

*[b]Total project cost is subtotal project cost plus soft costs. Soft costs are assumed to be 25% of subtotal project cost and include engineering design services, services during construction, and legal and administrative services.*

## Section 7

# Financial Information

## 7.1 Introduction

One of the most critical elements in the development of a Wastewater Resource Recovery Facility Plan is ensuring that the identified capital plan can be funded and implemented on the proposed schedule. This section provides a review of the City's ability to implement the projects identified in Section 6 – Capital Improvements Plan and any effects that the proposed projects will have on staffing and organizational requirements. The City's Capital Improvements Plan is derived from the City's Comprehensive Financial Plan (CFP).

As part of the Facility Plan, the City has identified a CIP that includes over $66 million (2019 dollars) worth of projects for implementation between FY2019 and FY23 funding. The costs included in the Facility Plan are "planning level" and are considered somewhat conservative. The City regularly conducts an analysis to ensure adequate funding is available to satisfy the CIP projects. This analysis includes modeling efforts conducted by the Public Works and Finance departments.

## 7.2 Funding Analysis

The City maintains the Enterprise Fund under the premise of "pay as you go." This approach means the City accumulates the money before it spends it. The City of Meridian has been fortunate enough to historically self-fund all WRRF projects. The City's funds are managed using financial management best practices. The City's model accounts for forecasted revenue, operations expense, capital expense, and required reserves and budgets to maintain solvency through a minimum of a 5-year forecast window. Assumptions used in that effort change as information becomes available. Ending fund balance is calculated at the close of the fiscal year and at the conclusion of a full financial audit that the City is required to undertake to reconcile the books annually. At the conclusion of FY17, the Enterprise Fund ending balance was approximately $50M. Projections from models express the Ending Fund Balance (EFB) in terms of "Undesignated" fund balance. This represents any remaining fund balance after all revenue and liabilities are calculated. Model projections for the next 5 years (FY19–23) show the undesignated EFB in the $10M - $30M range given the current CIP. This would suggest that the fund is capable of supporting the current plan. As with any projection, any number of variables could affect that analysis positively or negatively. The City takes a conservative approach in its forecasting efforts.

The current 5-year forecast does not contemplate rate increases at this time. Any revenue increases that are approved would further strengthen the fund assuming the same expense profile.

The fund balance could be significantly impacted by the following factors:

- Actual construction costs
- Rate adjustments
- Actual CIP implementation rates
- Variable growth rates
- Unanticipated capital projects
- Unanticipated reduction in revenue due to reductions in consumption and development.

## 7.3 Staffing Analysis

The Wastewater Resource Recovery Facility staffing requirements have been analyzed with respect to current growth rates and compliance with the new NPDES discharge permit. Additionally, the decision was recently made to move towards a 24-hour/7-days-a-week operation of the facility by Fiscal Year 2020, eliminating the five hours of unstaffed time during the night. Four new positions (three operators and one mechanic), anticipated to be added in FY19 and FY20, will be needed to facilitate this transition. The Facility's new permit includes interim limits and requirements which are much more stringent and complex than those in the previous permit. Coupled with growth, the new permit regulations will necessitate an advanced level of oversight at the treatment facility. In total there will be approximately 13 additional staff positions added to the WRRF over the course of the next 10 years. Of these positions, six are planned to be wastewater operators, four are planned to be wastewater mechanics, two are planned to be lab staff, and one additional instrument technician is planned to be added. The WRRF is doubling its assets with the current capacity expansion project, which includes new, advanced equipment, and the WRRF will be further expanded with the projects identified in the facility plan. This development increases the complexity of the operation and necessitates staff with advanced knowledge of treatment processes and biological nutrient removal. The addition of these positions will provide necessary resources to accommodate growth and additional treatment requirements as the wastewater utility continues to grow each year.

## 7.4 Summary

Overall the City has been proactive in maintaining their WRRF and consistently provides a high level of service to their customers. The City evaluates their financial status and staffing levels regularly to ensure there is adequate funding and staff to implement the CIP. Rate and fee adjustments are evaluated on an annual basis and recommendations are made to City leadership as a part of that process.

## Section 8

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# Appendix A: EID from 2007 Facility Plan – Carollo Engineers (2007)

USDA Soil Survey Map

Archaeological and Historical Studies

Average Precipitation and Temperature

Engineers...Working Wonders With Water™

September 27, 2007
7425A.00

Idaho Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706

Attention: Ms. Nancy Bowser, NEPA Coordinator

Subject: City of Meridian - Facility Plan Update EID

Dear Nancy:

As a follow-up to our telephone conversation yesterday, we are sending you three copies of the Environmental Information Document (EID) and one Final Facility Plan, complete with EID, for your review.

Based on the September 14, 2007 letter we received from Peter Bair at DEQ and on our conversation yesterday, we understand that DEQ has a large backlog of EIDs for review and a priority system. The priority system includes higher priority for projects that have received DEQ funding for their preparation, or are on the DEQ fundable projects list. As such, the Meridian Facility Plan Update EID has a lower priority than fundable projects and this will likely result in delaying the review of the document for an extended period of time, or until the City's projects are listed on the fundable list.

Please review the document when your priorities allow, and please feel free to call us at the number below at any time during your review, if you have questions or need further clarification on the contents of the Facility Plan Update or EID.

Sincerely,

CARROLLO ENGINEERS, P.C.

Timothy R. Tekippe, P.E.

TRT:sf

Enclosures: Facility Plan Update, EID

cc: Len Grady, P.E., City of Meridian



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carollo.com

**City of Meridian**

**WWTP Facility Plan**

**ENVIRONMENTAL INFORMATION DOCUMENT**

September 2007

carollo engineers

12592 WEST EXPLORER DRIVE, SUITE 200 • BOISE, IDAHO 83713 • (208) 376-2288 • FAX (208) 376-2251

**CITY OF MERIDIAN**

**WWTP Facility Plan**

**ENVIRONMENTAL INFORMATION DOCUMENT**

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**Page No.**



## LIST OF TABLES



## LIST OF FIGURES

**City of Meridian**
# WASTEWATER TREATMENT PLANT FACILITY PLAN ENVIRONMENTAL INFORMATION DOCUMENT

## COVER SHEET

### PROJECT IDENTIFICATION

City of Meridian Wastewater Treatment Plant Facility Plan

City of Meridian
660 E. Watertower, Ste. 200
Meridian, Idaho 83642

### CONTACT PERSONS

Mr. Clint Dolsby, P.E.
City Engineer
660 E Watertower, Ste. 200
Meridian, Idaho 83642
Phone (208) 898-5500
Fax (208) 887-1297

### PROJECT COST ESTIMATE/FUNDING SOURCES

The estimated capital costs for the Proposed Actions are as follows:

TOTAL CAPITAL COST*: $ 108,500,000

* Conceptual level estimate in 2006 dollars. Actual cost is spread out over several years. See the Executive Summary for details.

The City will consider funding the recommended upgrades through an SRF loan. The estimated capital cost, including engineering services, for the first phase of the project (2008-2010) is approximately $34,529,000.

## ESTIMATED USER FEES

The existing wastewater system user charge is approximately $21.28 per month, and the debt service charge is $0 per month. The project will increase the user charge by approximately $5.53 per month, all of which will go to new debt service. The total monthly cost per household after the project is in operation will therefore be $26.81 per month.

The current wastewater collection system assessment fee (connection fee) is $1,730 per Equivalent Residential Unit (ERU). The project will increase wastewater assessment fees by approximately $3,400.

## ABSTRACT

The City of Meridian is undertaking an overall wastewater treatment plant facilities evaluation that identifies present and future improvements necessary to maintain acceptable operation and treatment capacity of the plant. A Facility Plan Report was prepared to identify the necessary improvements (Reference 1). As part of the overall wastewater treatment plant evaluation, an environmental report has been prepared to assess the potential impacts that the actions could have on the existing environment within the planning area. The environmental report is comprehensive and includes a description of the existing environment, a description of the alternative actions, an assessment of potential impacts that the actions could have on the environment, and a listing of mitigation measures that would be followed during implementation of the Proposed Action. Public hearings were held during the preparation of the final report to solicit input on the alternative evaluations.

# 1.0 PURPOSE AND NEED FOR ACTION

The City of Meridian owns and operates the wastewater treatment plant (WWTP), which treats municipal wastewater from the City. The City is conducting a facility plan update project for their WWTP to meet future growth and potential future National Pollutant Discharge Elimination System (NPDES) discharge permit requirements. The WWTP currently discharges all treated wastewater to either Five Mile Creek or the Boise River. The existing WWTP is adequate treatment capacity to meet current capacity demands and discharge permit requirements. However, continued growth will require additional treatment capacity to ensure discharge permit requirements are met in the future. The WWTP Facility Plan Update (Reference 1) recommends additional facilities necessary to meet projected treatment requirements over the next 24 years. The Proposed Action addresses this need through construction and expansion of various plant processes, as discussed below. The purpose of the Proposed Action is to construct improvements necessary to allow the WWTP to achieve capacity and treatment requirements over the next 24 years.

**Table 1 Flow and Loading Projections
WWTP Facility Plan Update
City of Meridian**

| Parameter | Existing Plant Criteria(1) | 2030 Projections | 2030 Treatment Plant Expansion Criteria (2) |
|---|---|---|---|
| Population | 96,000 | 192,593 | |
| Avg. Day Flow (mgd) | 7.0 | 16.2 | 9.2 |
| Avg. Max Month Flow (mgd) | 9.1 | 19.1 | 10 |
| Peak Hour Flow (mgd) | 15.9 | 36.7 | 27.6(3) |

Notes:
1. Capacity and criteria after current expansion project is completed.
2. Capacity assumes exiting plant in service.
3. Assumes only 9.1 mgd going to existing treatment plant.

Given the existing treatment capacity and limited space available with the existing facility footprint to expand treatment capacity, a new parallel treatment plant built on vacant land within the plant boundary is recommended.

# 2.0 PROPOSED ACTION AND ALTERNATIVES

The WWTP Facility Plan Update project has evaluated and recommended various upgrades and expansion options for the WWTP. As part of this process, alternative evaluations have been provided, and a No Action Alternative was investigated. The Proposed Action and Alternative Actions consist of expansion and construction of new facilities to meet future treatment requirements. A site-plan identifying the locations of the Proposed Action improvements is provided in Figure 1. The following discussion is broken down into each process area, detailing the Proposed Action and alternative comparisons.

## 2.1 Headworks

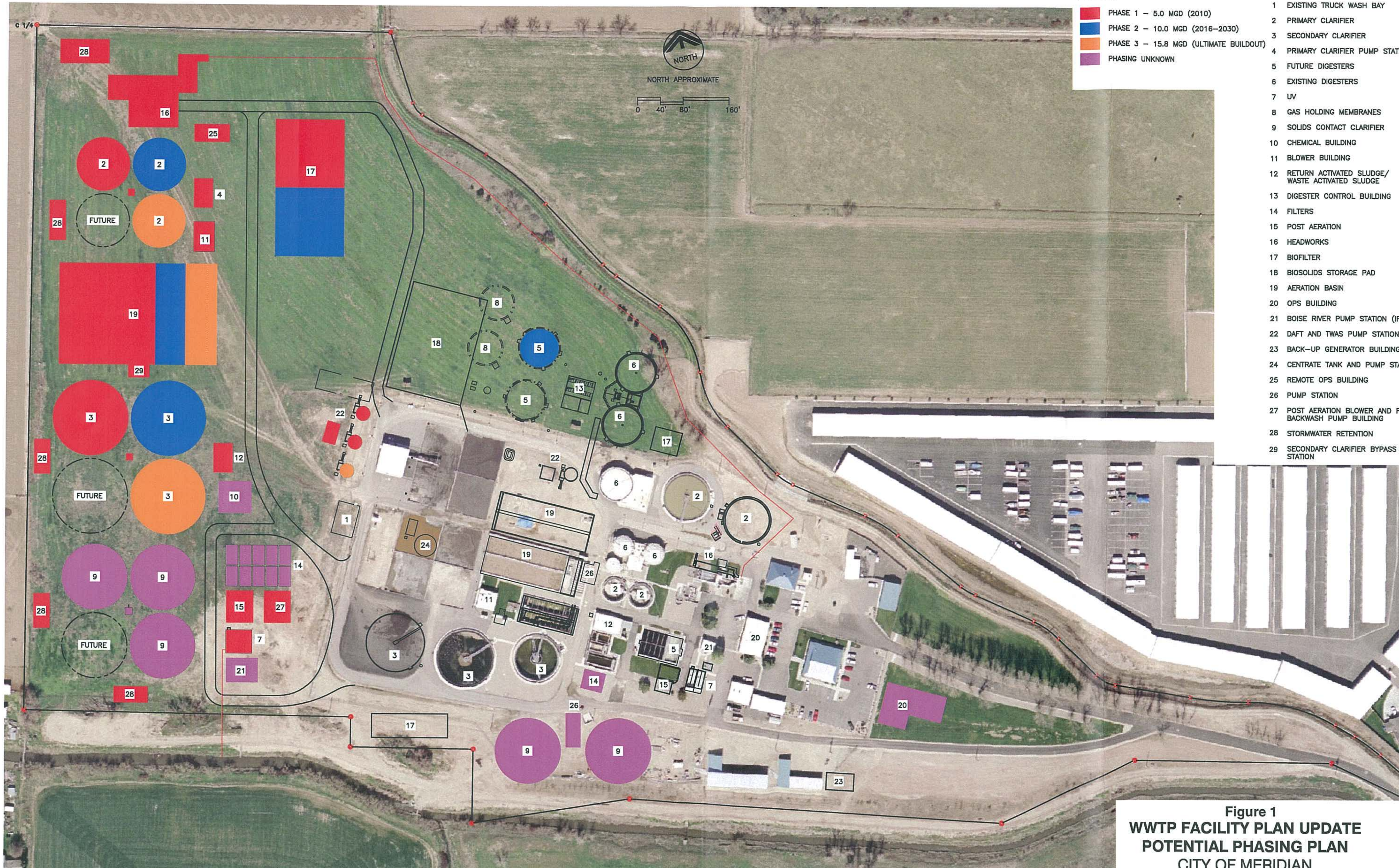
The plant headworks removes screenings and grit from the influent, measures influent flow, and lifts flow to the primary clarifiers. The existing headworks consists of two mechanical screens, five screw pumps, two grit chambers, and a flow measurement/flow splitting structure. The existing headworks does not have adequate capacity to serve future plant expansion requirements.

### *2.1.1 Proposed Action*

The Proposed Action involves constructing a new separate headworks, with a gravity line connecting the existing headworks to the new headworks. Additional details are provided below.

The existing headworks screening capacity is limited to a peak hour flow, firm process capacity (capacity with largest unit out of service) of 18 million gallons per day (mgd). The 2005 peak hour flow was recorded at 13.0 mgd (Technical Memorandum No. 1 of the Facility Plan Update). The Idaho Department of Environmental Quality (DEQ) requires wastewater treatment plants to have a firm screening process capacity to meet or exceed peak hour flow. The 2030 projected peak hour flow is 36.7 mgd.

The Proposed Action for expanding the headworks includes construction of a new gravity line from the existing headworks influent collection box to a new remote headworks, that will include flow measurement, screening, pumping, and grit removal. It is recommended that a new 72-in pipe gravity pipe be constructed from the existing headworks to the new headworks. The new headworks would be similar to the existing headworks configuration with the exception that the screens will be located after pumping as opposed to before pumping at the existing headworks. In order to minimize process upsets, it is recommended that the existing plant be operated at a relatively constant flow of 9.1 mgd. Therefore the conveyance, pumping, screening, and grit removal facilities are sized for a firm peak hour flow capacity of 27.6 mgd (2030 peak hour of 36.7 mgd minus existing plant capacity of 9.1 mgd) with room to expand for community buildout flows.




**LEGEND**

- PHASE 1 – 5.0 MGD (2010)
- PHASE 2 – 10.0 MGD (2016–2030)
- PHASE 3 – 15.8 MGD (ULTIMATE BUILDOUT)
- PHASING UNKNOWN

**FACILITIES**

1 EXISTING TRUCK WASH BAY
2 PRIMARY CLARIFIER
3 SECONDARY CLARIFIER
4 PRIMARY CLARIFIER PUMP STATION
5 FUTURE DIGESTERS
6 EXISTING DIGESTERS
7 UV
8 GAS HOLDING MEMBRANES
9 SOLIDS CONTACT CLARIFIER
10 CHEMICAL BUILDING
11 BLOWER BUILDING
12 RETURN ACTIVATED SLUDGE/ WASTE ACTIVATED SLUDGE
13 DIGESTER CONTROL BUILDING
14 FILTERS
15 POST AERATION
16 HEADWORKS
17 BIOFILTER
18 BIOSOLIDS STORAGE PAD
19 AERATION BASIN
20 OPS BUILDING
21 BOISE RIVER PUMP STATION (IF NEEDED)
22 DAFT AND TWAS PUMP STATION
23 BACK–UP GENERATOR BUILDING
24 CENTRATE TANK AND PUMP STATION
25 REMOTE OPS BUILDING
26 PUMP STATION
27 POST AERATION BLOWER AND FILTER BACKWASH PUMP BUILDING
28 STORMWATER RETENTION
29 SECONDARY CLARIFIER BYPASS PUMP STATION

**Figure 1**
**WWTP FACILITY PLAN UPDATE**
**POTENTIAL PHASING PLAN**
CITY OF MERIDIAN

carollo engineers

### *2.1.2 Alternative Actions*

Alternative actions for the above Proposed Action are explained further in Technical Memorandum No. 2. One alternative option involves pumping at the existing headworks with dual forcemain to the new headworks. This option was not elected due to difficulties in construction, high costs, and limitations it would cause on existing required plant access. The second alternative option is similar to the recommended option, however, screening and grit removal would occur below grade and prior to pumping. This option was not selected because it would require the screening and grit removal facilities to be placed approximately 20 feet below grade. This would lead to problems due to high groundwater levels and cost associated with constructing facilities below grade.

### *2.1.3 No Action*

Under the No Action alternative, the existing headworks capacity will not meet the projected flows to the plant or the necessary DEQ requirements. If the incoming flow exceeds the headworks capacity, wastewater will backup onto streets and into homes.

## 2.2 Primary Treatment

Primary treatment facilities at the WWTP remove a portion of the influent suspended solids that can be separated from the flow by gravity, as well as those solids that float and can be skimmed off. The existing WWTP currently has four primary clarifiers available for primary treatment with associated sludge and scum pumps. A comprehensive description of the primary treatment process is contained in Technical Memorandum No. 2 of the Facility Plan Update.

### *2.2.1 Proposed Action*

The current firm peak hour process capacity (with the largest tank out-of-service) is 15.9 mgd, and firm average day capacity is 7.0 mgd. Therefore, the firm process capacity must be expanded to meet the projected 2030 average day flow of 16.2 mgd and projected peak hour flow of 36.7 mgd.

The Proposed Action includes constructing additional primary clarifiers to meet future firm capacity requirements. Initially, two (2) 80-foot diameter primary clarifiers will provide redundant average day capacity of approximately 5.0 mgd. To meet 2030 demands, one additional 80-foot diameter clarifier is needed for redundancy.

### *2.2.2 Alternative Actions*

No Alternative Actions are developed for the primary treatment process.

### 2.2.3 No Action

The No Action alternative would not allow the WWTP to effectively treat future flows. Implementation of a No Action alternative is not a viable option.

## 2.3 Secondary and Tertiary Treatment

Secondary treatment at the WWTP removes total suspended solids, biochemical oxygen demand, ammonia, and nitrate/nitrite from the flow stream. Tertiary treatment provides additional solids removal, dissolved oxygen addition, and disinfection. Secondary treatment at the existing WWTP consists of four aeration basins, and three secondary clarifiers. Existing tertiary treatment includes three tertiary filters, a post-aeration basin, and two ultraviolet (UV) disinfection basins. Technical Memorandum No. 2 of the Facility Plan Update contains a detailed description of the secondary and tertiary treatment processes and upgrade alternatives.

### 2.3.1 Proposed Action

The Proposed Action involves constructing new secondary and tertiary treatment processes, as discussed below.

#### 2.3.1.1 Secondary Treatment

At present, there are four aeration basins at the plant, each with an approximate treatment capacity of 3.2 mgd. To provide adequate treatment capacity for future flow (year 2030) conditions, installing five new aeration basins is recommended.

Secondary clarification is accomplished at the existing plant using two 100-foot diameter clarifiers and one 80-foot diameter clarifier. In order to meet the 2030 flow requirements, three 120-foot diameter secondary clarifiers are recommended with two to be run at any given time and the third in reserve.

#### 2.3.1.2 Tertiary Treatment

The existing three filters have an average day treatment total capacity of approximately 5.0 mgd. The new plant will likely meet existing permit requirements without tertiary filtration. However, to consistently meet the $BOD_5$ limit of 10 mg/L, it is recommended that tertiary filtration be included with the initial construction of the new plant and new filters be constructed at the existing plant. Recommended alternatives include conventional granular media or cloth-disc media.

The existing UV disinfection system has capacity to treat peak flow conditions by installing additional banks of UV lamps into the existing basins. However, to treat the projected 2030 flows, three additional UV basins are recommended to be added as part of the new treatment train.

### 2.3.2 *Alternative Actions*

Expansion Alternative Actions developed for the secondary treatment process included treatment trains with oxidation ditches, extended aeration basins, membrane bioreactors, the "Cannibal" process, and sequencing batch reactors. With the exception of the membrane bioreactors, each of these alternatives were either expensive, did not make use of existing equipment and tankage, or were in some other way incompatible with the existing facilities when compared to the Proposed Action.

Alternative Actions included in the tertiary treatment expansion involved adding various types of filtration equipment including membranes, upflow sand media, conventional granular media, and cloth-disc media. Based on the evaluation completed, it is recommended to evaluate granular media and cloth-disc media filters further. Further evaluation is necessary during pre-design of the tertiary treatment expansion to develop firm design criteria and provide the most effective filtration system for the WWTP.

### 2.3.3 *No Action*

The No Action alternative would compromise the ability of the WWTP to effectively treat future flows, and will result in the plant violating its NPDES discharge permit requirements.

## 2.4 Biosolids Treatment and Reuse

Biosolids at the WWTP include solids removed during primary sedimentation (primary sludge) and excess solids generated and removed from the secondary treatment process (waste activated sludge). The existing biosolids stabilization facilities include two dissolved air flotation thickeners (DAFTs), two thermophilic anaerobic digesters, and a mesophilic anaerobic digester. A centrifuge and eight sludge drying beds are available for biosolids dewatering. A current expansion project will provide two new mesophilic digesters and one new centrifuge. Primary sludge is sent directly to the digesters. Waste activated sludge (WAS) is thickened in the DAFTs to produce thickened waste activated sludge (TWAS) prior to digestion. After digestion, sludge is dewatered with a centrifuge and land-applied to local agricultural fields.

### 2.4.1 *Proposed Action*

As discussed in Technical Memorandum No. 3 of the Facility Plan, the existing biosolids treatment process has adequate capacity to treat current solids loading. However, future redundancy is limited. To continue land applying the biosolids, the plant must meet Environmental Protection Agency (EPA) Class B biosolids treatment requirements, which includes a 15-day detention time at temperatures between 35 to 50 degrees Celsius for pathogen reduction. Under 2030 projections, if one mesophilic digester must be taken out of service for any length of time, the plant is not able to provide the 15-day detention time. In order to meet the upcoming needs of the plant, by 2030 two additional DAFTs will need to be constructed. In addition to the two 70-foot diameter mesophilic digester units currently planned, one additional digester is needed in the future. As for disposal, the City will continue to land apply their current solids. In the event that this option is no longer available, another viable alternative is to dispose of the solids at the Ada County landfill.

### *2.4.2 Alternative Actions*

One alternative to land application or landfill disposal options is to produce a Class A biosolids. Presently, a sludge dryer appears to be the most cost effective way for the plant to produce Class A biosolids, with the lowest potential for odor generation (if the dryer is contained and air scrubbed for odors).

### *2.4.3 No Action*

The No Action alternative would not allow the WWTP to treat the biosolids to a level acceptable for land application, and would result in the need to find alternative biosolids disposal options which may not be available, or at the very least would increase disposal cost considerably.

# 3.0 AFFECTED ENVIRONMENT/ENVIRONMENTAL CONSEQUENSES

This section provides a description of the existing environment for the Proposed Action, Alternative Actions, and No Action Alternative and discusses potential environmental consequences associated with each of these alternatives.

## 3.1 Planning Area

The planning area includes the incorporated areas of the City of Meridian. The Proposed Action and Alternative Actions are all located within the existing wastewater treatment plant property boundaries. The existing wastewater treatment plant is the sole wastewater treatment plant in the City of Meridian's planning area. No inter-regional issues would result from construction within the plant boundaries.

There are no active plans to regionalize wastewater treatment in the Boise River watershed. The economies of scale from a larger centralized treatment facility may offer a marginal cost savings with regionalized wastewater treatment. However, the total costs for regional collection are expected to exceed any savings in treatment, so regionalization has not been developed beyond a conceptual feasibility study in the mid-1990s. Currently, there are no inter-agency agreements to support regionalization.

The following paragraphs provide a general description of the existing wastewater treatment plant site and describes the features and conditions of the site.

### 3.1.1 General Description of the Site

The wastewater treatment plant is located to the north/northwest of the City of Meridian. The site is situated on existing land that is open space owned by the City, and is not currently used for any designated purpose. The site is located within Ada County and within the City's area of impact.

### 3.1.2 Topography and Soils

The topography around the site consists of relatively flat ground.

A copy of the soil survey map for the immediate area (per U.S. Department of Agriculture - Natural Resource Conservation Service (NRCS)) is included in Appendix B. Soil units at the site consist of Unit 1, Abo Silt Loam, Unit 5, Aeric Haplaquepts, and Unit 141, Purdam Silt Loam.

No slides or faults were identified at the site, and groundwater ranges from approximately 6 feet below the surface in non-irrigation seasons to 4 feet below the surface during irrigation season.

### 3.1.3 Land Use

The Proposed and Alternative Actions all lie within the existing wastewater treatment plant's boundaries (see Figure 1). The Proposed Action and Alternative Actions are compatible with current and future land uses at the site.

### 3.1.4 Farm Land

The NRCS has designated 66 soil units within Ada County as prime farmland (see Appendix B). Prime farmland is defined as "land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for those uses." Neither the Proposed Action nor the Alternative Actions would directly convert any prime farmland to a different use. The conversion of farmland to other uses would be governed by land use policies that are independent of this project.

### 3.1.5 Formally Classified Lands

The site is not located on any formally classified lands.

### 3.1.6 Climate

The climate of the Meridian area can be characterized as a moderate continental climate characterized by hot, dry summers with cold and wet winters. The temperature varies from a normal mean low temperature of approximately 22.6 degrees Fahrenheit in January to a normal mean high temperature of 90.6 degrees Fahrenheit in July (Reference 2). Snowfall averages 21.6 inches per year, total yearly precipitation averages about 11.7 inches, while free water surface evaporation reaches about 40 inches a year (Reference 3).

### 3.1.7 *Population*

The population of Meridian grew as follows from 1970 to 2000:

| Year | Population[1] |
|---|---|
| 1970 | 2,616 |
| 1980 | 6,658 |
| 1990 | 9,596 |
| 2000 | 34,919 |
| 2005[2] | 62,997 |

[1] Per US Census Data (Reference 2)
[2] COMPASS, April 2006

Overall, the rate of growth averaged about 9.0 percent per year for the 30-year period, while growth during the period from 1990 to 2000 was slightly higher at about 13.8 percent per year. The City's population is projected to grow to about 192,593 by 2030. This growth in the City is a major factor necessitating upgrades to the wastewater treatment plant.

### 3.1.8 *Wastewater Flow Projections*

Wastewater flows are projected to increase over the next several years as the City population grows. In 2005, the City experienced an average day flow of 4.3 mgd and peak hour flow of 13.0 mgd. By the year 2030, these flows are projected to increase to approximately 16.2 mgd for an average day flow and approximately 36.7 mgd for peak hour flow (see Technical Memorandum No. 1).

The upgraded wastewater treatment facilities must be capable of providing adequate treatment for the plant to meet its discharge permit requirements and flow projections. The Proposed Action will provide adequate treatment capacity for the plant to meet current and projected future needs.

## 3.2 Proposed Action

The following paragraphs describe environmental baseline conditions associated with the Proposed Action and any potential impacts that construction of the Proposed Action could have on these conditions.

### 3.2.1 *Floodplains*

As discussed previously, the Proposed Action involves expansion of the current wastewater treatment plant site, part of which is located above and part is below the 100-year flood plain that has been designated by the Federal Emergency Management Agency. A map of the 100-year flood plain is included in Appendix B. Construction of facilities within this area of impact will be done with the walls of the facilities above the 100-year floodplain.

### *3.2.2 Wetlands*

Construction of the Proposed Action would occur entirely within an upland environment that is void of any hydric soils and hydrophytic vegetation, and it is not subject to wetlands hydrology. As such, the site does not qualify as wetlands.

Given the existing site conditions and designation of mitigation measures, no direct or indirect impacts to any existing wetlands would occur as a result of constructing the Proposed Action.

### *3.2.3 Cultural Resources*

Laurie Mauser, an archaeological and historical resource consultant, completed a cultural resource survey in August 2006. No cultural resources were found or recorded for the Proposed Action site. As such, the Proposed Action is not projected to have any impact on cultural resources. A copy of the complete Cultural Resource Report is included in Appendix A.

A copy of historic sites listed in the National Register of Historic Places was viewed to determine if the Proposed Action was located near any registered site (Reference 4). A total of four sites were listed, and all are within the City limits of Meridian, but away from the Proposed Action site. No impact to these sites is anticipated.

### *3.2.4 Visual Aesthetics*

The new facilities to be constructed as part of the Proposed Action would be constructed within the existing plant boundaries. Care will be taken during and after construction to restore disturbed vegetation. The Proposed Action would not result in a visual impact to the area.

### *3.2.5 Biological Resources*

Most of the existing site contains large process equipment buildings and concrete tanks, asphalt and gravel roadways, decorative shrubs and turf. A portion of the site has been cultivated with alfalfa hay. The Proposed Action would result in construction of additional buildings and concrete tanks and roadways and eliminate the vast majority of the cultivated ground, which is within the plant boundaries. Construction of the Proposed Action would be confined to areas within the existing site.

The Idaho Conservation Data Center indicated that no species listed as threatened or endangered are present in the planning area based on current information (*see attached letter in Appendix B*).

### 3.2.6 *Water Quality*

Construction of the Proposed Action is expected to have no direct impacts on the existing water quality of Five Mile Creek, located approximately 500 feet from the site. Best Management Practices (BMPs) would be employed during construction to control erosion and contain sediment run-off from the site.

### 3.2.7 *Socio-Economic/Environmental Justice*

In 2003, the per capita income for the City of Meridian was $32,571. This is about 125 percent of the State of Idaho's per capita income of $26,137 for the same year (*Reference 2*).

The Proposed Action is the least expensive alternative for upgrading the wastewater treatment capacity for the City. This provides an opportunity to minimize cost impacts to the residents, some of whom are lower-income citizens. In this way, the impacts to the existing socio-economic make-up of the area should be minimized.

The Proposed Action would be undertaken in phases constructed over a several years. This phased construction approach will spread construction costs over a number of years to minimize cost impacts to citizens.

### 3.2.8 *Air Quality and Noise*

The Proposed Action would result in short-term increases of vehicle and equipment emissions during periods of construction. Dust control measures would be implemented during construction to limit the formation of dust. The Contractor would be required to meet any applicable emission standards for construction equipment.

The Proposed Action would not incorporate any new facilities that would cause additional odor sources beyond current treatment processes.

Noise levels during construction would increase. The amount of construction noise could range from 68 to 96 decibels at a distance of 50 feet depending upon the type of construction equipment used. Long-term background noise may increase slightly, however, noise-generating equipment similar to existing equipment would be installed. If above-average noise-generating equipment would be installed, provisions for noise control would be included in the design and construction of such equipment.

### 3.2.9 *Transportation*

Short-term traffic to the site would increase as workers, equipment, and material deliveries access the construction. In the long-term, the Proposed Action would have no significant impact on the existing traffic flow of nearby streets and roads.

#### *3.2.10 Energy Consumption*

A number of energy-consuming devises would be installed as part of the Proposed Action. The Proposed Action requires the addition of pumps, process motors, blowers, and ultraviolet disinfection lamps. The amount of increase would be determined during design of the new facilities. New equipment incorporated into the design would achieve current industry standards regarding energy efficiency.

#### *3.2.11 Recreation and Open Space*

The site is bordered by agricultural land, and access to this land would not be altered with construction of the Proposed Action.

### 3.3 Alternative Actions

The environmental baseline conditions associated with the Alternative Actions are identical to the Proposed Action. As such, there are no deviations from Section 3.2.

### 3.4 No Action Alternative

The following paragraphs describe impacts that could be expected with implementation of the No Action Alternative.

#### *3.4.1 Flood Plain*

No impact.

#### *3.4.2 Wetlands*

No impact.

#### *3.4.3 Cultural Resources*

No impact.

#### *3.4.4 Visual Aesthetics*

No impact.

#### *3.4.5 Biological Resources*

No impact.

#### *3.4.6 Water Quality*

The existing plant could not meet the water quality requirements outlined in the discharge permit at future flow and loading conditions. Since the plant discharges to either Five Mile Creek or the Boise River, the water quality of those receiving waters would be impacted.

### *3.4.7 Socio-Economic/Environmental Justice*

The No Action Alternative would result in the City's wastewater treatment plant being deficient with respect to effectively treating the wastewater prior to discharge. This would impact public safety, the environment, and could result in large monetary fines.

### *3.4.8 Air Quality and Noise*

No impact.

### *3.4.9 Transportation*

No impact.

### *3.4.10 Energy Consumption*

Energy consumption would remain at current use levels.

### *3.4.11 Recreation and Open Space*

No impact.

## 4.0 MITIGATION SUMMARY

Mitigation measures would be undertaken with the Proposed Action to minimize the potential for impacting the surrounding environment as a result of implementing the action. At a minimum, the following mitigation measures would be undertaken as necessary:

- The Contract Documents would require the Contractor for the project to employ erosion prevention and sediment control measures to limit the opportunity for sediment to migrate off-site during construction. Methods employed would include installing silt fencing around the entire work area, placing straw bales and intermediate fencing as necessary, collecting and routing run-off to a sedimentation area prior to discharge to off-site, constructing rock construction entrances, and other methods as required. The goal would be to minimize the opportunity for sediment to leave the site and enter area receiving waters.
- Equipment fueling and washing would occur in designated areas away from any run-off features.
- The Contract Documents would require the Contractor to employ dust control at the site as necessary to limit the formation of dust.
- Following construction, the site landscaping (grass cover and some trees) would be restored.
- Portable sanitary facilities would be used throughout construction.

- Recommendations provided in the cultural resource evaluation would be incorporated into the Contract Documents as applicable. Any construction activities that unearth cultural resources would result in a halt to construction in the affected area and lead to a detailed archeological investigation.
- The wastewater treatment plant would remain in operation throughout construction to ensure continual use for the City's customers.

## 5.0 PUBLIC PARTICIPATION AND INPUT

Public participation in the planning process was solicited at the following meeting:

- An open house Public Meeting was held on October 30, 2006 at Meridian City Hall. The intent of the open house was to provide an opportunity for local citizens to view the planned project and to answer any questions.
- Although the public meeting was advertised in the local paper and at previous City Council Meetings, no citizens attended the meeting or sent written comments on the draft Facility Plan.

Reference 1 City of Meridian WWTP Facility Plan Update, City of Meridian. 2006. Carollo Engineers.

Reference 2 Idaho Department of Commerce website at http://www.idoc.state.id.us.

Reference 3 Idaho State Climate Services website at http://baegis.ag.uidaho.edu.

Reference 4 National Register Information System, database of the National Register of Historic Places website at http://www.nr.nps.gov

The following agencies were consulted during the preparation of this Environmental Report:

U.S. Department of the Interior – Fish and Wildlife Service (USFWS)

U.S. Department of Agriculture – Natural Resource Conservation Service (NRCS)

U.S. National Park Service – National Register of Historic Places

Idaho Department of Commerce

Idaho Department of Fish and Game (IDFG)

Idaho Division of Environmental Quality (IDEQ)

ARCHAEOLOGICAL AND HISTORICAL RESOURCE CONSULTING

August 22, 2006

RECEIVED

AUG 24 2006

CAROLLO ENGINEERS
BOISE OFFICE

Carollo Engineers
Stuart Hurley
12592 W. Explorer Drive
Boise, ID 83713

Dear Mr. Hurley,

Enclosed are four sets of the Cultural Resource Survey Report for the Meridian project. Two sets go to ISHPO to the attention of Suzi Neitzel, Deputy SHPO. Two sets are for your records.

Thank you for the opportunity to do this project. Please contact me if you have any questions.

Sincerely,

Laurie Mauser

Laurie Mauser
Archaeologist

Enc.

17474 E. Cape Horn Road
Bayview, Idaho 83803

Bayview: 208-683-1751
Boise: 208-331-8464

# ARCHAEOLOGICAL AND HISTORICAL SURVEY REPORT
## *ARCHAEOLOGICAL SURVEY OF IDAHO*

### A. KEY INFORMATION

**Project Name:** **City of Meridian Wastewater Treatment Expansion Project**

**Author/principal investigator:** Laurie Mauser

**Report Date:** August 21, 2006

**County:** Ada

**Legal Description:** T. 4 N., R. 1 W., Section 34

**Acres Surveyed/level of survey:** 35 acres intensive-complete

### B. PROJECT DESCRIPTION

The City of Meridian is proposing to expand existing wastewater treatment facilities on city-owned property west of the existing wastewater treatment plant. The APE is bounded by the Creason Lateral on the northeast boundary, a lined irrigation ditch and agricultural field on the north, an irrigation ditch and agricultural field on the west boundary and Fivemile Creek along the south boundary. The project will consist of construction of basins, ponds, structures and equipment within an approximate 35 acre area and within a 50 foot setback from city property boundaries on the north, west and south sides. See Figure 3 which illustrates the expansion project.

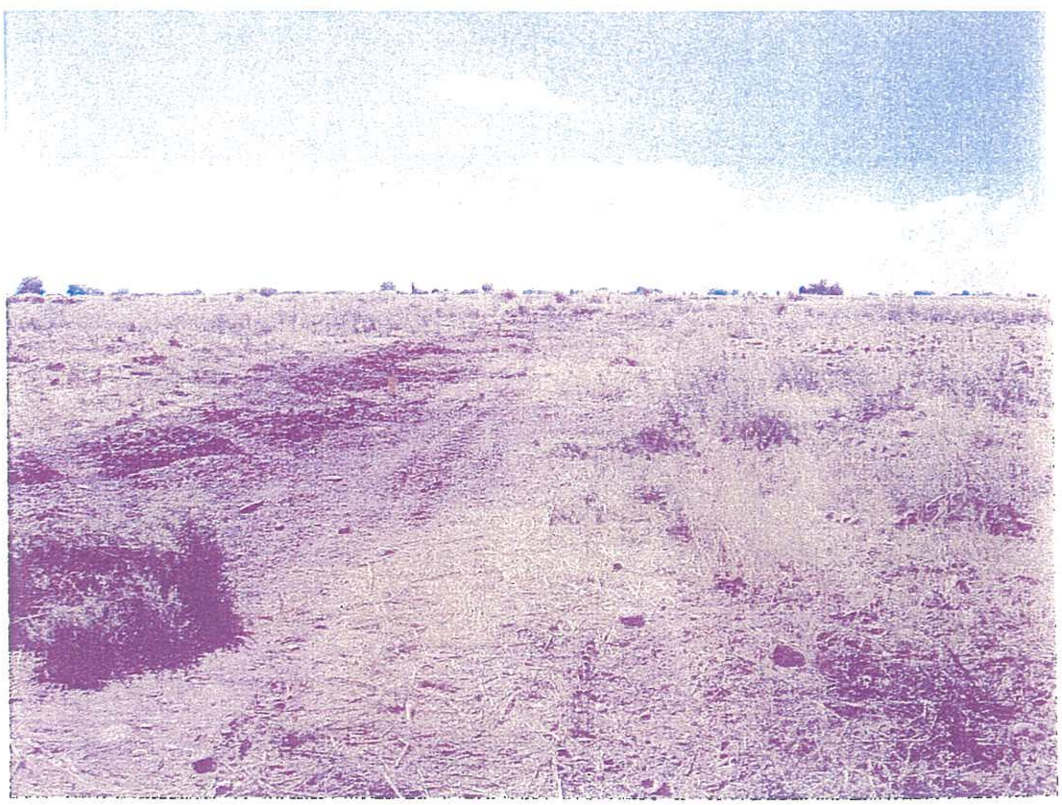
**Potential direct and indirect impacts to known or suspected cultural properties:** Cultural resources within the APE may be destroyed by excavation.

**Area of Potential Effect (APE):** The APE consists of approximately 35 acres of city-owned land. (See Figures 2 and 3 for location of the APE.)

**Acres in project APE:** 30 acres

**Landowner:** City

**View from near southwest corner of APE looking northeast.**



**View looking west from center/east boundary of the APE.**

## C. STATEMENT OF OBJECTIVES FOR SURVEY

The objectives of the survey were to document prehistoric and historic cultural material through review of archival sources and intensive surface examination of the APE in accordance with 36 CFR 800.

## D. LOCATION AND GENERAL ENVIRONMENTAL SETTING

The project is located three miles south of the Boise River on a low river terrace developed for agriculture. The project vicinity is located within the lower Boise River basin on the Western Snake River Plain, a Basin and Range valley (Alt and Hyndman 1989). The floodplain of the Boise River consists of unconsolidated alluvium and well-sorted gravel containing gravel and cobbles from the Idaho batholith and Snake River Group. Shrub-steppe desert vegetation predominated before irrigation transformed the region. Vegetation in the project area is plowed grain crop with weeds. Elevation is 2555 feet amsl.

**USGS topographic map source:** Star, ID 7.5' series (Figure 2)

## E. PRE-FIELD RESEARCH

**Sources of information checked:** a records check was conducted at the Idaho State Preservation Office which included a check of archaeological and architectural inventories, maps, and survey reports.

**Summary of previous studies:**

Several studies have been conducted within a mile of the project APE:

**Table 1. Summary of previous cultural resource studies conducted within a mile of the APE.**

| Report No. | Date | Author | Title | Results |
|---|---|---|---|---|
| 2000/1033 | 2000 | Ogden Environmental and Energy Services | Nampa-Meridian Irrigation District Proposed Fee Title and Rights-of-Way Transfer; Ada and Canyon Counties, Idaho. | Fivemile Creek |
| 2004/12 | 2003 | Mauser, L. | City of Meridian Wastewater Treatment Plant Upgrade Project, Ada County. | No sites |
| Survey 260 | 1999 | Arrowrock Group | Ada County Reconnaissance | 01-19743<br>01-19747<br>01-19764<br>01-19766<br>01-19768 |
| Survey 159 | 1990 | Davis, B. | Ada County Irrigation Study | 01-5983-5 |

Ogden Environmental recorded canals and drains for transfer of title from the Bureau of Reclamation to Nampa-Meridian Irrigation District, one of which was Fivemile Creek located adjacent to the south boundary of the project APE.

Mauser surveyed the area adjacent and east of the APE for expansion of the plant facilities in 2003. No sites were recorded in the mostly developed area.

The Arrowrock Group recorded farmsteads in Ada County, four of which are located in the vicinity of the project. Davis's survey of Ada County irrigation features resulted in recording three canal structures near the project.

## F. EXPECTED HISTORIC AND PREHISTORIC LAND USE AND SITE SENSITIVITY

The project area is located at the northern edge of the Great Basin culture area. A chronology for the region is offered by Meatte (1990) which contends use of the region from 11,500 BP extending to 4,200 BP by small mobile groups using a small range of tools to utilize food resources. From 4,200-250 BP groups were semi-sedentary foragers, occupying riverine villages during winter months, relying on stored foods with more diverse tool assemblages and occupying subterranean dwellings in riverine locations where salmon runs were relied on for subsistence. Ethnographically, the Northern Paiute occupied the Western Snake River Plain wintering along the Snake and Boise Rivers and moving seasonally to higher elevations in search of subsistence. Expected sites would contain artifacts associated with hunting, fishing and gathering and fire-affected rocks and groundstone implements used in food processing.

Euroamerican settlement began as emigrants on the Oregon Trail were attracted to the region in the mid-1800s and in response to the mining boom on the Boise Front and south of the project area in Silver City. Small farms to supply the miners grew along the rivers. The Oregon Short Line Railway mainline and other branch lines were constructed across southern Idaho 1880-1920s providing early settlers access to other regions and aided southern Idaho in its development and growth. The U.S. Bureau of Reclamation Boise Project through the Reclamation Act of 1902 included completion of construction of the New York Canal and smaller ditches, Arrowrock Dam and three storage facilities including Deer Flat Reservoir (Lake Lowell) in 1909 and ditches in the project vicinity. An historic barn located near the project was constructed in 1917 (ISHS site inventory form for 01-19764), indicating the project area has been farmed since the early 1900s.

Expected historic sites include features and material associated with early settlement, transportation, and agriculture themes such as watercourse features, roads or trails, fences, and structures.

**Table 2. Previously recorded sites located within a mile of the project APE.**

| Site No. | Date/Recorder | Description | NRHP eligibility | Proximity to APE |
|---|---|---|---|---|
| 01-5983-4 | Davis/1990 | Lemp Canal Structures | Not eligible | Outside/0.5 mile N |
| 01-5985 | Davis/1990 | Lemp Canal Drop Structure | Not eligible | Outside/0.75 mile NE |
| 01-19743 | Arrowrock/1999 | "Hoot" Gibson barn/2789 W. McMillan | Eligible | Outside/0.9 mi NE |
| 01-19747 | Arrowrock/1999 | Ustick Farmstead/2875 Ustick Road | Not eligible | Outside/0.75 mile SE |
| 01-19764 | Arrowrock/1999 | King Barn/4065 Ten Mile | Eligible | Outside/0.25 mile E |
| 01-19766 | Arrowrock/1999 | Quenzer Farmstead | Eligible | Outside/0.5 mile NW |
| 01-19768 | Arrowrock/1999 | Dean Quenzer Barn/3680 Black Cat Road | Not eligible | Outside/0.4 mile SW |
| (no # found) | Ogden Environmental/2000 | Fivemile Creek | Eligible | Outside/adjacent |
| 01-19880 | Oz bun and Hylton/2000 | Rutledge Lateral | Eligible | Outside/0.5 mile W |
| 01-19881 | Ozbun and Hylton/2000 | Ninemile Creek | Eligible | Outside/0.1 mile S |

## G. FIELD METHODS

**Areas examined and type of coverage:** An intensive-complete pedestrian survey was conducted within the APE in east-west transects spaced 30 meters apart.

**Ground surface conditions:** Surface visibility was approximately 75 percent.

**Areas not examined and reasons:** The entire APE was examined.

**Field personnel:** Laurie Mauser

**Survey date:** August 15, 2006

**Problems encountered:** none

**Area surveyed:** 35 acres

## H. RESULTS

The project APE consists of an agricultural field which has been plowed and formerly planted in grain. The field area is disturbed further by vehicle movement and some use for staging for current plant expansion activities. No cultural resources were noted or recorded within the project APE.

The Creason Lateral (M-1) was recorded, located outside the APE but adjacent to the city-owned property boundary and outside of the 50 foot setback from the property boundary.

**Table 3. Properties located within or adjacent to the APE.**

| Site No. | Site Type | Description | Relationship to APE | National Register eligibility |
|---|---|---|---|---|
| (no # available) | Historic | Fivemile Creek | Outside | Eligible |
| M-1 | Historic | Creason Lateral | Outside 50 ft. setback | Eligible |
| 01-19764 | Historic | King Barn/4065 Ten Mile | Outside | Eligible |

Creason Lateral (M-1) is an historic canal associated with the Boise Project (U.S. Dept. of the Interior 1920). It is located on the city property line outside the APE and outside of the 50 foot setback. The site is eligible for the National Register under Criteria A for its association with the Boise Project and the development of agriculture in the region.

**Creason Lateral (M-1), canal maintenance road and undeveloped area (right of road) on northeast boundary of city-owned property looking southeast.**

***Previously recorded cultural resources:***

Fivemile Creek is located adjacent to the south boundary of the city-owned property and outside of the APE and 50-foot setback.

**Fivemile Creek looking west.**

King Barn (01-19764) is not visible from the project APE nor Ten Mile Road. It may no longer exist, however, newly constructed storage buildings and other structures may block the view of the barn.

***Noted but not recorded:***

A wooden aqueduct structure crossing Fivemile is located outside of the project area approximately 100 feet from the APE southwest corner boundary. A farmstead is located southwest of the APE corner boundary on the south side of Fivemile Creek. Several structures appear to be historic but vegetation along Fivemile Creek blocked a clear view and there was no access to this property.

**Table 4. Properties noted but not recorded.**

| Site No. | Site Type | Description | Relationship to APE | Reason Not Recorded |
|---|---|---|---|---|
| M-2 | Historic | Irrigation aqueduct | Outside and outside 50 ft. setback | Outside APE |
| M-3 | Historic | Farmstead | Outside and outside 50 ft. setback, | Outside APE, no access |

View of wooden aqueduct (M-2) looking southwest across Fivemile Creek and toward farmstead (M-3).

## I. CONCLUSIONS AND RECOMMENDATIONS

The project consists of construction of wastewater treatment ponds and facilities on a 35 acre parcel of city-owned land adjacent to existing wastewater treatment facilities.

Cultural resources eligible for the National Register of Historic Places were identified near but outside the project APE, the Creason Lateral (M-1) and Fivemile Creek. A National Register-eligible barn (01-19764) is located near the project but was not visible from the APE. These properties and project effects are summarized in Table 5.

**Table 5. All properties in/abutting the APE newly or previously recorded and summary of eligibility and project effects.**

| Site No. | Site Type | Description | NRHP eligibility | Project Impacts |
|---|---|---|---|---|
| (no # available) | Historic | Fivemile Creek | Eligible | No effect/outside APE |
| M-1 | Historic | Creason Lateral | Eligible | No effect/outside APE |
| 01-19764 | Historic | King Barn/4065 Ten Mile | Eligible | No effect/outside APE |

The project will have ***no effect*** on properties eligible for the National Register because they are outside of the APE. It is recommended that the project proceed.

## J. ATTACHMENTS

Figure 1. Vicinity Map
Figure 2. Location of Project, Previously Recorded Sites and Area Surveyed.
Figure 3. Aerial plan map
ISHS Site Inventory Form

## K. REPOSITORY

Original survey records and attendant data will be maintained at 17474 E. Cape Horn Drive, Bayview, ID 83803.

## L. CERTIFICATION OF RESULTS

I certify that the investigation was conducted and documented according to Secretary of Interior's Standards and Guidelines and that the report is complete and accurate to the best of my knowledge.

Laurie Mauser — **Reporter**

Aug. 21, 2006 — **Date**

**References:**


Alt, David D and Donald W. Hyndman

1989 Roadside Geology of Idaho. Mountain Press Publishing Company, Missoula.

Meatte, Daniel S.

1990 *Prehistory of the Western Snake River Basin: An Overview.* Occasional Paper of the Museum of Natural History No. 35. Pocatello, Idaho.

U. S. Department of the Interior

1920 United States Reclamation Service Boise Project Idaho map.

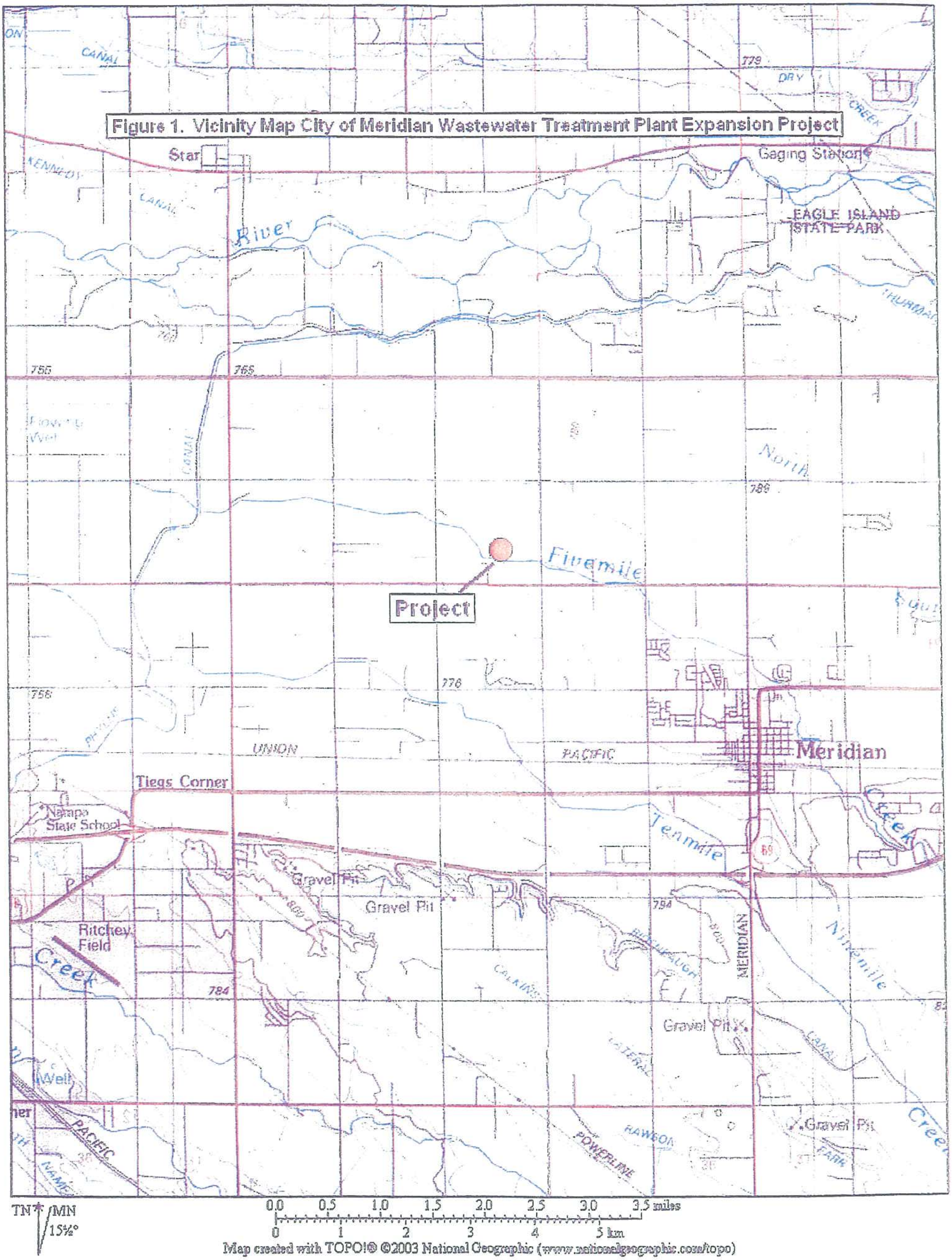
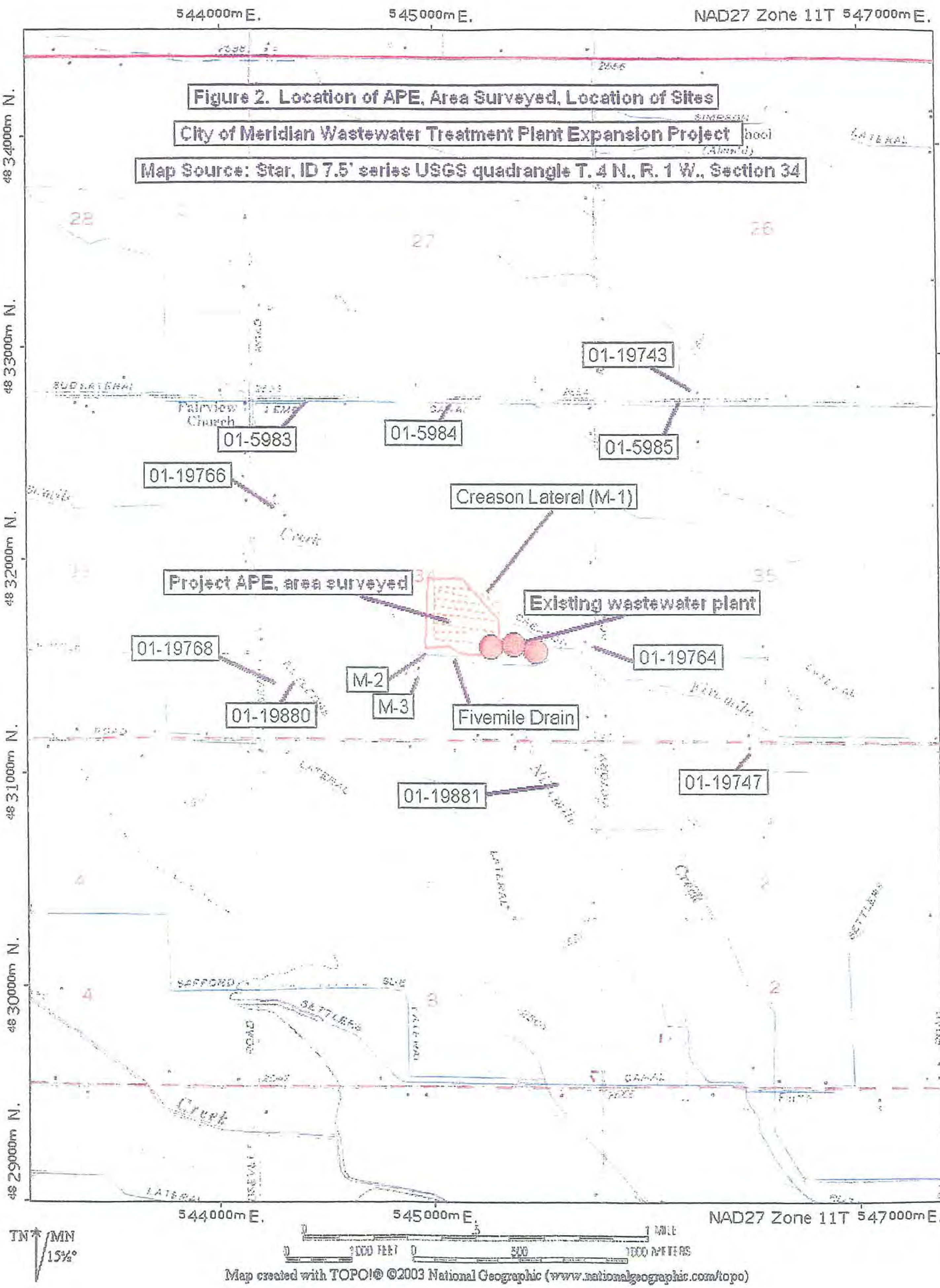
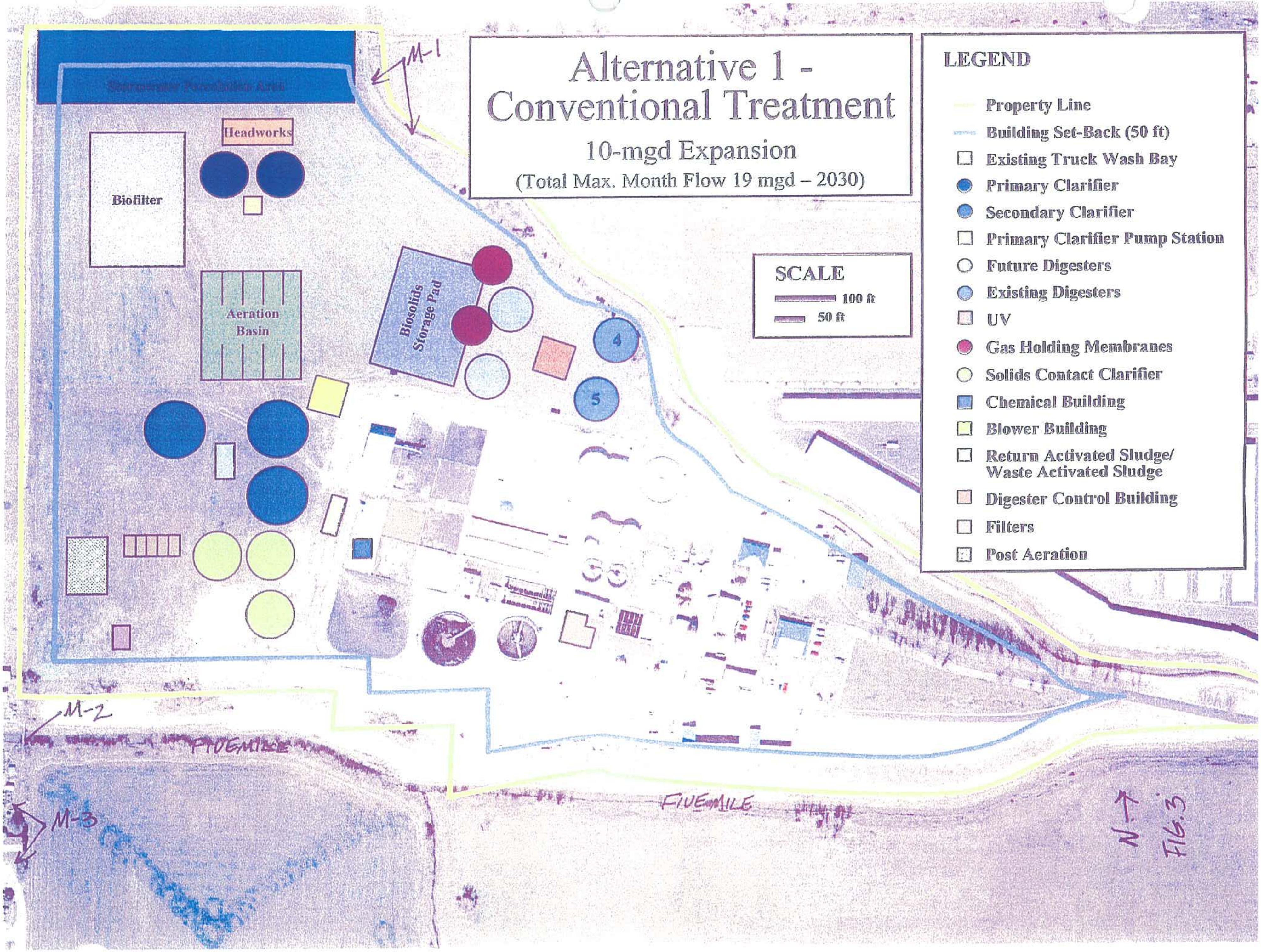



Figure 1. Vicinity Map City of Meridian Wastewater Treatment Plant Expansion Project

Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)



Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)


Alternative 1 -
Conventional Treatment
10-mgd Expansion
(Total Max. Month Flow 19 mgd – 2030)
LEGEND
Property Line
Building Set-Back (50 ft)
Existing Truck Wash Bay
Primary Clarifier
Secondary Clarifier
Primary Clarifier Pump Station
Future Digesters
Existing Digesters
UV
Gas Holding Membranes
Solids Contact Clarifier
Chemical Building
Blower Building
Return Activated Sludge/
Waste Activated Sludge
Digester Control Building
Filters
Post Aeration
SCALE
100 ft
50 ft
Headworks
Biofilter
Aeration
Basin
Biosolids
Storage Pad
4
5
M-1
M-2
M-3
FIVEMILE
FIVEMILE
N
FIG. 3

# IDAHO HISTORIC SITES INVENTORY FORM

PROPERTY NAME: Creason Lateral | FIELD#: M-1
STREET: | RESTRICT: ☐
CITY: Meridian | VICINITY: ☑ | COUNTY CD: 1 | COUNTY NAME: Ada
SUBNAME: | BLOCK: | SUBLOT: | ACRES: | LESS THAN: ☑
TAX PARCEL: | UTMZ: 11 | EASTING: 545765 | NORTHING: 4831534
TOWNSHIP: 4 | N_S: N | RANGE: 1 | E_W: W | SECTION: 34 | NE 1/4 | SE 1/4
QUADRANGLE: Star | OTHERMAP: US Reclamation Service Boise Project 1920
SANBORN MAP: | SANBORN MAP#: | PHOTO#:

PROPERTY TYPE: Structure | CONST/ACT1: Original Construction | ACTDATE1: 1908 | CIRCA1: ☑
CONST/ACT2: | ACTDATE2: | CIRCA2: ☐
ASSOCIATED FEATURES: | TOTAL # FEATURES:

ORIGINAL USE: Agriculture/Subsistence | WALL MATERIAL: EARTH
ORIGSUBUSE: | FOUND. MATERIAL:
CURRENT USE: Agriculture/Subsistence | ROOF MATERIAL:
CURSUBUSE: | OTHER MATERIAL:
ARCHSTYLE: | PLAN: | CONDITION: Excellent

NR REF #: | NPS CERT: | ACTIONDATE: | FUTURE ELIG DATE:
DIST/MPLNAME1: | DIST/MPLNAME2:

Individually Eligible ☑ | Contributing in a potential district ☐ | Noncontributing ☐ | Future eligibility ☐
Not Eligible ☐ | Multiple Property Study ☐ | Not evaluated ☐

CRITERIA: A ☑ B ☐ C ☑ D ☐ | CRITERIA CONSIDERATION: A ☑ B ☐ C ☑ D ☐ E ☐ F ☐ G ☐
AREA OF SIGNIF: Agriculture | AREA OF SIGNIF: Engineering

COMMENTS: The canal is indicated on the 1920 Usf Reclamation Service map of the Boise Project. The canal originates at the South Slough, flows northwesterly to the Lemp Canal (USArmy Corps of Engineers Juridictional Determination 2004). Additional legals: NW 1/4 T3N, R1E Section 1,;S 1/2 T4 N, R1W Section 35; NW 1/4 and SW 1/4 of NE 1/4 T4N, R1W Section 34.

PROJ/RPT TITLE: City of Meridian Wastewater Treatment Expansion | SVY DATE: 8/15/06 | SVY LEVEL: Intensive
RECORDED BY: L. Mauser | PH: 208-683-1751 | ADDRESS: 17474 E. Cape Horn Road, Bayview, ID 83803
SUBMITTED PHOTOS ☑ | NEGS ☐ | SLIDES ☐ | SKETCH MAP ☐

SVY RPT #: | ******** FOR ISHPO USE ONLY ******** | IHSI#: 01-11111
MS RPT #: | SITS#:
IHPR #: | HABS NO. ID-: | HAER NO. ID-: | REV#:

# IDAHO HISTORIC SITES INVENTORY FORM

CS # | IHSI# REF | NR REF# 2 | REV# REF

SVY RPT# 1 | SVY RPT# 2 | SVY RPT# 3 | MS RPT# 1 | MS RPT# 2

ADD'L NOTES

MORE DATA ☐

ATTACH ☐

# OF PHOTOS | NEGBOX# | # OF SLIDES | SHPO DETER | DETER DATE

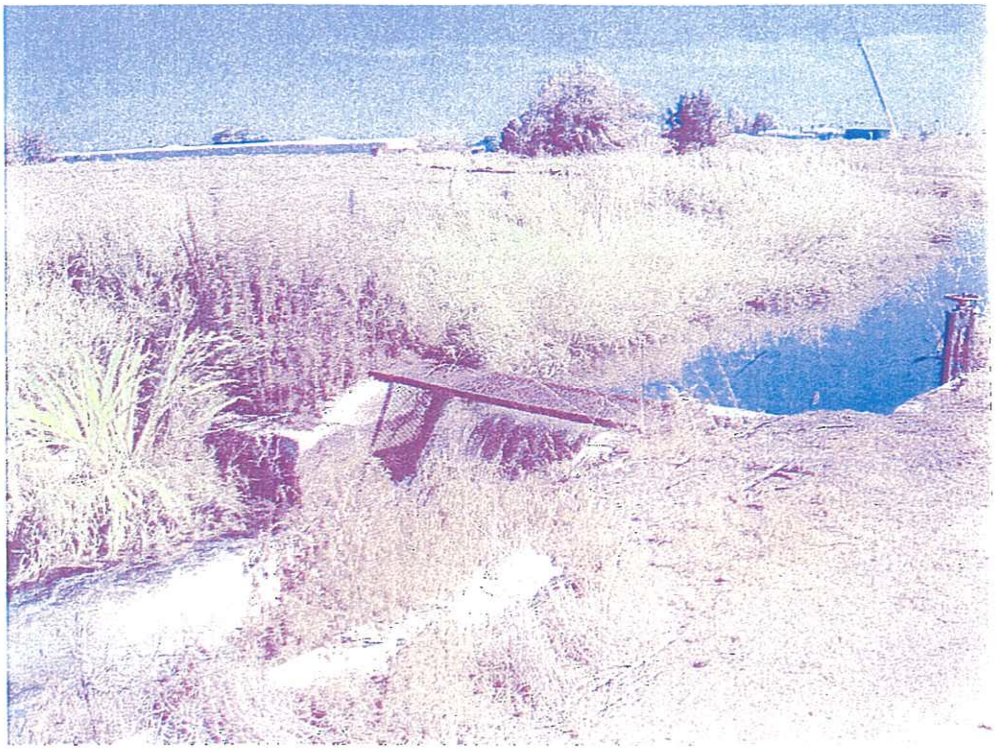
INITIALED | ENTRY DATE | REVISE1 | REVISE2 | REVISE3

IHSI# ______

SITS# ______

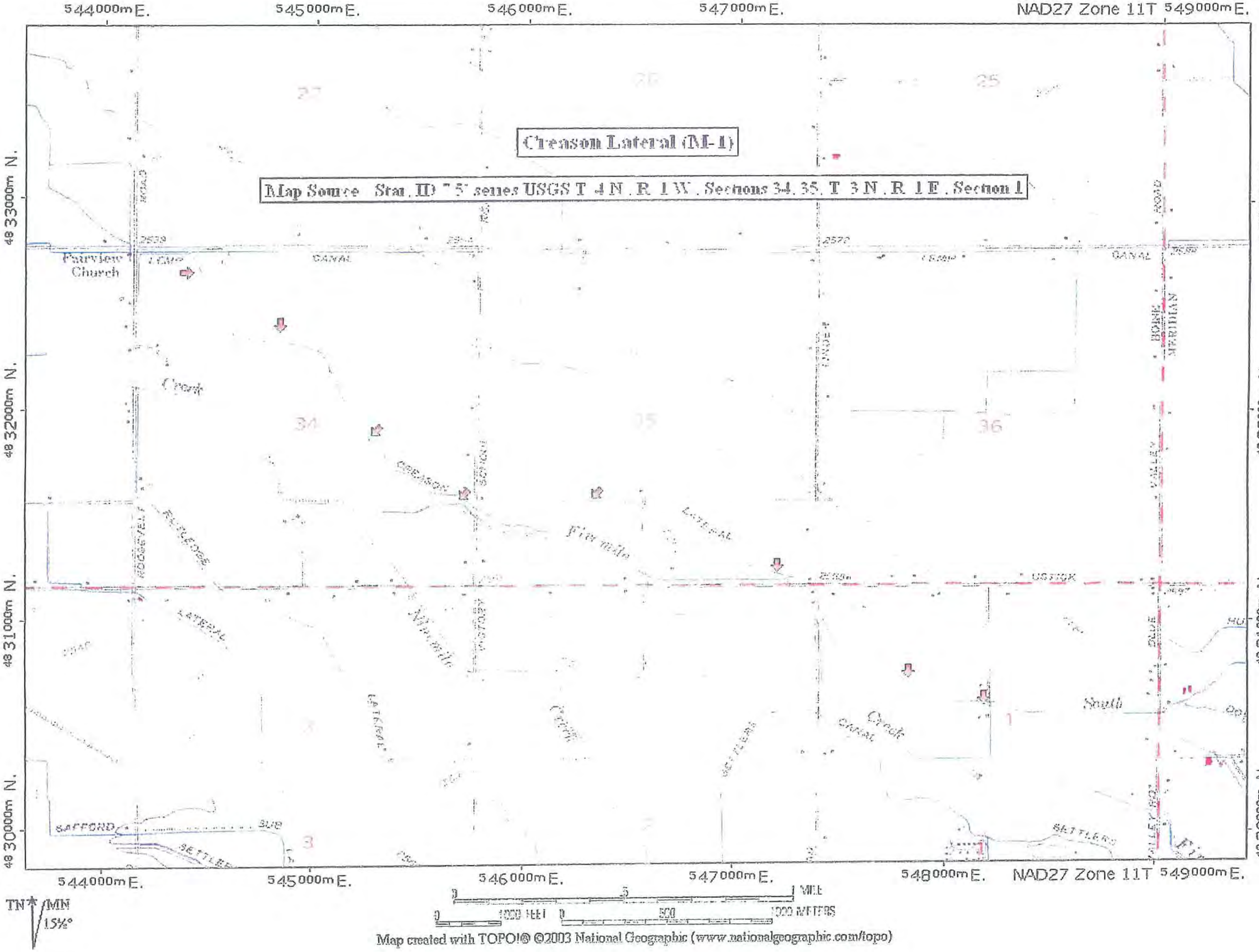
REV# ______

## Creason Lateral (M-1)



View of Creason Lateral looking southeast in NW ¼ of SE ¼ of Section 34.

View looking southeast from southeast of above photo.



Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)

IDAHO CONSERVATION DATA CENTER

*The Idaho Conservation Data Center collects, analyzes, maintains, and disseminates scientific information necessary for the management and conservation of Idaho's biological diversity.*

NatureServe
NatureServe member

August 4, 2006

Stuart-Hurley, P.E.
Carollo Engineers
12592 W. Explorer Drive, Suite 200
Boise, ID 83713

Dear Mr. Hurley:

I am responding to your request for a list and database records of plant and animal species of greatest conservation need for the Meridian Wastewater Treatment Plant located in T4N R1W Section 34.

The Idaho Conservation Data Center database contains the following known occurrences either within or within the vicinity of the area indicated (see database records for details):

<u>Animals</u>

**Merriam's shrew** (State S2): one occurrence.
**Peregrine falcon** (USFS Sensitive): one occurrence.
**Woodhouse's toad** (BLM Type 3): one occurrence.

<u>Plants</u>

**None**

<u>Other species to be considered:</u>

**Gray wolf** (USFWS Experimental Nonessential Population Zone): needs to be considered.
**Pygmy rabbit** (USFS Sensitive): needs to be considered if big sagebrush habitat is present.

StreamNet provides the fish species of special concern data and their response is included as a separate letter.

For animal status definitions please go to http://fishandgame.idaho.gov/cdc/cwcs_table_of_contents.cfm and click on Appendix B: Idaho Species of Greatest Conservation Need. For plant status definitions please go to http://fishandgame.idaho.gov/cdc/plants/ and follow the links for the species you are searching for. On the pages with species and status information you can click on the heading (BLM, USFS, etc.) at the top of the status columns and you will automatically go to the page with the status definitions for that heading.

If there are questions pertaining to this request please contact me at 208-287-2730 or smitchell@idfg.idaho.gov.

Sincerely,

Stephanie Mitchell

Stephanie Mitchell
Ecology Information Manager
Office Manager

**Index by State and City**
National Register Information System

08/12/2003 17:06:32

**No filter**

Include filter in navigation

| Row | STATE | COUNTY | RESOURCE NAME | ADDRESS | CITY | LISTED | MULTIPLE |
|---|---|---|---|---|---|---|---|
| 1 | ID | Ada | **Hunt, E. F., House** | 49 E. State | Meridian | 1982-11-17 | Tourtellotte and Hummel Architecture TR |
| 2 | ID | Ada | **Meridian Exchange Bank** | 109 E. 2nd St. | Meridian | 1982-11-17 | Tourtellotte and Hummel Architecture TR |
| 3 | ID | Ada | **Neal, Halbert F. and Grace, House** | 101 W. Pine St. | Meridian | 1982-10-19 | |
| 4 | ID | Ada | **Tolleth House** | 134 E. State Ave. | Meridian | 1996-12-20 | |

Page 1

First Page Next Page Refresh Export


PROJECT LOCATION
(Joins sheet 18)
1 Mile
5000 Feet
3000
2000
1000
0
Scale 1:20000
N
LATERAL
SUBLATERAL
Roosevelt School

Ada County Area, Idaho Pri
Table Y.--Prime Farmland

(Only the soils considered prime farmland are listed. Urban or built-up areas of the not considered prime farmland. If a soil is prime farmland only under certain c conditions are specified in parentheses after the soil name.)

| Map symbol | Soil name |
|---|---|
| 1 | ABO SILT LOAM (Prime farmland if irrigated) |
| 6 | BALDOCK LOAM (Prime farmland if drained) |
| 7 | BEETVILLE FINE SANDY LOAM (Prime farmland if irrigated) |
| 8 | BISSELL LOAM, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigated) |
| 9 | BISSELL LOAM, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigated) |
| 13 | BRENT LOAM, LOW RAINFALL, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigated |
| 14 | BRENT LOAM, LOW RAINFALL, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigated |
| 22 | CASHMERE COARSE SANDY LOAM, 0 TO 4 PERCENT SLOPES (Prime farmland if irrigat |
| 26 | CHARDOTON STONY SILTY CLAY LOAM, 0 TO 2 PERCENT SLOPES (Prime farmland if ir |
| 27 | CHARDOTON STONY SILTY CLAY LOAM, 2 TO 4 PERCENT SLOPES (Prime farmland if ir |
| 28 | CHARDOTON-KIESEL VARIANT SILTY CLAY LOAMS, 0 TO 2 PERCE NT SLOPES (Prime far |
| 29 | CHARDOTON-TINDAHAY COMPLEX, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigat |
| 30 | CHILCOTT SILT LOAM, BEDROCK SUBSTRATUM, 0 TO 2 PERCENT SLOPES (Prime farmlan |
| 31 | CHILCOTT SILT LOAM, BEDROCK SUBSTRATUM, 2 TO 4 PERCENT SLOPES (Prime farmlan |
| 32 | CHILCOTT-BRENT SILT LOAMS, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigate |
| 34 | CHILCOTT-SEBREE COMPLEX, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigated) |
| 35 | CHILCOTT-SEBREE COMPLEX, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigated) |
| 37 | CHILCOTT-SEBREE COMPLEX, BEDROCK SUBSTRATUM, 0 TO 2 PER CENT SLOPES (Prime f irrigated) |
| 38 | CHILCOTT-SEBREE COMPLEX, BEDROCK SUBSTRATUM, 2 TO 4 PER CENT SLOPES (Prime f irrigated) |
| 46 | DRAX LOAM (Prime farmland if irrigated) |
| 47 | DRAX-GOOSE CREEK-URBAN LAND COMPLEX (Prime farmland if irrigated) |
| 48 | ELIJAH SILT LOAM, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigated) |
| 49 | ELIJAH SILT LOAM, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigated) |
| 51 | ELIJAH SILT LOAM, BEDROCK SUBSTRATUM, 0 TO 2 PERCENT SL OPES (Prime farmland |
| 52 | ELIJAH SILT LOAM, BEDROCK SUBSTRATUM, 2 TO 4 PERCENT SL OPES (Prime farmland |
| 54 | ELIJAH-URBAN LAND COMPLEX, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigate |
| 55 | FALK FINE SANDY LOAM (Prime farmland if irrigated) |
| 56 | FALK-MOULTON-URBAN LAND COMPLEX (Prime farmland if irrigated) |
| 60 | GARBUTT SILT LOAM, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigated) |
| 61 | GARBUTT SILT LOAM, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigated) |
| 65 | GOOSE CREEK LOAM (Prime farmland if irrigated) |
| 66 | HARPT LOAM, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigated) |
| 67 | HARPT LOAM, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigated) |
| 71 | JENNESS FINE SANDY LOAM, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigated) |
| 72 | JENNESS FINE SANDY LOAM, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigated) |
| 92 | LANKBUSH-CHARDOTON COMPLEX, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigat |
| 99 | LANKBUSH-TINDAHAY SANDY LOAMS, 0 TO 2 PERCENT SLOPES (Prime farmland if irri |
| 100 | LANKBUSH-TINDAHAY SANDY LOAMS, 2 TO 4 PERCENT SLOPES (Prime farmland if irri |
| 110 | MINIDOKA SILT LOAM, BEDROCK SUBSTRATUM, 2 TO 4 PERCENT SLOPES (Prime farmlan |
| 115 | OLIAGA VARIANT LOAM (Prime farmland if irrigated) |
| 124 | POTRATZ SILT LOAM, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigated) |
| 125 | POTRATZ SILT LOAM, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigated) |

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|---|---|
| 129 | POWER SILT LOAM, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigated) |
| 130 | POWER SILT LOAM, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigated) |
| 133 | POWER-MCCAIN SILT LOAMS, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigated) |
| 134 | POWER-MCCAIN SILT LOAMS, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigated) |
| 137 | POWER-MCCAIN COMPLEX, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigated) |
| 138 | POWER-MCCAIN COMPLEX, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigated) |
| 140 | POWER-POTRATZ SILT LOAMS, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigated |
| 141 | PURDAM SILT LOAM, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigated) |
| 142 | PURDAM SILT LOAM, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigated) |
| 144 | PURDAM-POWER SILT LOAMS, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigated) |
| 145 | PURDAM-POWER SILT LOAMS, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigated) |
| 147 | PURDAM-POWER-URBAN LAND COMPLEX, 0 TO 2 PERCENT SLOPES (Prime farmland if ir |
| 160 | SCISM SILT LOAM, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigated) |
| 161 | SCISM SILT LOAM, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigated) |
| 163 | SCISM SILT LOAM, BEDROCK SUBSTRATUM, 0 TO 2 PERCENT SLO PES (Prime farmland |
| 164 | SCISM SILT LOAM, BEDROCK SUBSTRATUM, 2 TO 4 PERCENT SLO PES (Prime farmland |

Table Y.--Prime Farmland--Continued

| Map symbol | Soil name |
|---|---|
| 174 | TENMILE VERY GRAVELLY LOAM, 0 TO 4 PERCENT SLOPES (Prime farmland if irrigat |
| 178 | TINDAHAY FINE SANDY LOAM, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigated |
| 179 | TINDAHAY FINE SANDY LOAM, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigated |
| 186 | TRUESDALE FINE SANDY LOAM, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigate |
| 187 | TRUESDALE FINE SANDY LOAM, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigate |
| 191 | TRUESDALE FINE SANDY LOAM, BEDROCK SUBSTRATUM, 2 TO 4 P ERCENT SLOPES (Prime irrigated) |
| 192 | TURBYFILL FINE SANDY LOAM, 0 TO 2 PERCENT SLOPES (Prime farmland if irrigate |
| 193 | TURBYFILL FINE SANDY LOAM, 2 TO 4 PERCENT SLOPES (Prime farmland if irrigate |

Ada County Area, Idaho
Soil Map Legend

Print

| Map symbol | Soil name |
|---|---|
| 1 | ABO SILT LOAM |
| 2 | ADA GRAVELLY SANDY LOAM, 4 TO 15 PERCENT SLOPES |
| 3 | ADA GRAVELLY SANDY LOAM, 15 TO 30 PERCENT SLOPES |
| 4 | ADA GRAVELLY SANDY LOAM, 30 TO 60 PERCENT SLOPES |
| 5 | AERIC HAPLAQUEPTS, NEARLY LEVEL |
| 6 | BALDOCK LOAM |
| 7 | BEETVILLE FINE SANDY LOAM |
| 8 | BISSELL LOAM, 0 TO 2 PERCENT SLOPES |
| 9 | BISSELL LOAM, 2 TO 4 PERCENT SLOPES |
| 10 | BOWNS STONY LOAM, 0 TO 8 PERCENT SLOPES |
| 11 | BOWNS-ROCK OUTCROP COMPLEX, 0 TO 15 PERCENT SLOPES |
| 12 | BRAM SILT LOAM |
| 13 | BRENT LOAM, LOW RAINFALL, 0 TO 2 PERCENT SLOPES |
| 14 | BRENT LOAM, LOW RAINFALL, 2 TO 4 PERCENT SLOPES |
| 15 | BRENT LOAM, LOW RAINFALL, 4 TO 8 PERCENT SLOPES |
| 16 | BRENT LOAM, 8 TO 12 PERCENT SLOPES |
| 17 | BRENT LOAM, 12 TO 30 PERCENT SLOPES |
| 18 | BRENT-HAW LOAMS, 8 TO 25 PERCENT SLOPES |
| 19 | BRENT-LADD LOAMS, 4 TO 15 PERCENT SLOPES |
| 20 | BRENT-LADD LOAMS, 15 TO 30 PERCENT SLOPES |
| 21 | BRENT-SEARLES COMPLEX, 15 TO 30 PERCENT SLOPES |
| 22 | CASHMERE COARSE SANDY LOAM, 0 TO 4 PERCENT SLOPES |
| 23 | CASHMERE COARSE SANDY LOAM, 4 TO 12 PERCENT SLOPES |
| 24 | CASHMERE COARSE SANDY LOAM, 12 TO 30 PERCENT SLOPES |
| 25 | CHANCE FINE SANDY LOAM |
| 26 | CHARDOTON STONY SILTY CLAY LOAM, 0 TO 2 PERCENT SLOPES |
| 27 | CHARDOTON STONY SILTY CLAY LOAM, 2 TO 4 PERCENT SLOPES |
| 28 | CHARDOTON-KIESEL VARIANT SILTY CLAY LOAMS, 0 TO 2 PERCE NT SLOPES |
| 29 | CHARDOTON-TINDAHAY COMPLEX, 0 TO 2 PERCENT SLOPES |
| 30 | CHILCOTT SILT LOAM, BEDROCK SUBSTRATUM, 0 TO 2 PERCENT SLOPES |
| 31 | CHILCOTT SILT LOAM, BEDROCK SUBSTRATUM, 2 TO 4 PERCENT SLOPES |
| 32 | CHILCOTT-BRENT SILT LOAMS, 0 TO 2 PERCENT SLOPES |
| 33 | CHILCOTT-BRENT COMPLEX, 2 TO 8 PERCENT SLOPES |
| 34 | CHILCOTT-SEBREE COMPLEX, 0 TO 2 PERCENT SLOPES |
| 35 | CHILCOTT-SEBREE COMPLEX, 2 TO 4 PERCENT SLOPES |
| 36 | CHILCOTT-SEBREE COMPLEX, 4 TO 8 PERCENT SLOPES |
| 37 | CHILCOTT-SEBREE COMPLEX, BEDROCK SUBSTRATUM, 0 TO 2 PER CENT SLOPES |
| 38 | CHILCOTT-SEBREE COMPLEX, BEDROCK SUBSTRATUM, 2 TO 4 PER CENT SLOPES |
| 39 | CHILCOTT-SEBREE COMPLEX, BEDROCK SUBSTRATUM, 4 TO 8 PER CENT SLOPES |
| 40 | COLTHORP SILT LOAM, 0 TO 2 PERCENT SLOPES |
| 41 | COLTHORP SILT LOAM, 2 TO 4 PERCENT SLOPES |
| 42 | COLTHORP COBBLY LOAM, 0 TO 2 PERCENT SLOPES |
| 43 | COLTHORP COBBLY CLAY LOAM, 2 TO 4 PERCENT SLOPES |
| 44 | DAY CLAY, 5 TO 15 PERCENT SLOPES |
| 45 | DAY CLAY, 15 TO 30 PERCENT SLOPES |
| 46 | DRAX LOAM |
| 47 | DRAX-GOOSE CREEK-URBAN LAND COMPLEX |
| 48 | ELIJAH SILT LOAM, 0 TO 2 PERCENT SLOPES |
| 49 | ELIJAH SILT LOAM, 2 TO 4 PERCENT SLOPES |
| 50 | ELIJAH SILT LOAM, 4 TO 8 PERCENT SLOPES |

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| 51 | ELIJAH SILT LOAM, BEDROCK SUBSTRATUM, 0 TO 2 PERCENT SL OPES |
| 52 | ELIJAH SILT LOAM, BEDROCK SUBSTRATUM, 2 TO 4 PERCENT SL OPES |
| 53 | ELIJAH SILT LOAM, BEDROCK SUBSTRATUM, 4 TO 8 PERCENT SL OPES |
| 54 | ELIJAH-URBAN LAND COMPLEX, 0 TO 2 PERCENT SLOPES |
| 55 | FALK FINE SANDY LOAM |
| 56 | FALK-MOULTON-URBAN LAND COMPLEX |
| 57 | FELTHAM LOAMY SAND, 0 TO 3 PERCENT SLOPES |
| 58 | FELTHAM LOAMY SAND, 3 TO 12 PERCENT SLOPES |
| 59 | FELTHAM-RUBBLE LAND COMPLEX, 0 TO 10 PERCENT SLOPES |
| 60 | GARBUTT SILT LOAM, 0 TO 2 PERCENT SLOPES |
| 61 | GARBUTT SILT LOAM, 2 TO 4 PERCENT SLOPES |
| 62 | GARBUTT SILT LOAM, 4 TO 8 PERCENT SLOPES |
| 63 | GEM SILTY CLAY LOAM, 2 TO 15 PERCENT SLOPES |
| 64 | GEM-ROCK OUTCROP COMPLEX, 5 TO 40 PERCENT SLOPES |
| 65 | GOOSE CREEK LOAM |
| 66 | HARPT LOAM, 0 TO 2 PERCENT SLOPES |

Soil Map Legend--Continued

| Map symbol | Soil name |
|---|---|
| 67 | HARPT LOAM, 2 TO 4 PERCENT SLOPES |
| 68 | HAW-LANKBUSH COMPLEX, 4 TO 15 PERCENT SLOPES |
| 69 | HAW-LANKBUSH COMPLEX, 15 TO 25 PERCENT SLOPES |
| 70 | HAW-LANKBUSH COMPLEX, 25 TO 40 PERCENT SLOPES |
| 71 | JENNESS FINE SANDY LOAM, 0 TO 2 PERCENT SLOPES |
| 72 | JENNESS FINE SANDY LOAM, 2 TO 4 PERCENT SLOPES |
| 73 | KUNATON SILTY CLAY LOAM, 0 TO 2 PERCENT SLOPES |
| 74 | KUNATON SILTY CLAY LOAM, 2 TO 4 PERCENT SLOPES |
| 75 | KUNATON-RUBBLE LAND COMPLEX, 2 TO 8 PERCENT SLOPES |
| 76 | KUNATON-SEBREE SILTY CLAY LOAMS, 0 TO 2 PERCENT SLOPES |
| 77 | KUNATON-SEBREE SILTY CLAY LOAMS, 2 TO 4 PERCENT SLOPES |
| 78 | KUNATON-SEBREE SILTY CLAY LOAMS, 4 TO 8 PERCENT SLOPES |
| 79 | LADD LOAM, 4 TO 15 PERCENT SLOPES |
| 80 | LADD LOAM, 15 TO 30 PERCENT SLOPES |
| 81 | LADD LOAM, 30 TO 65 PERCENT SLOPES |
| 82 | LADD-ADA COMPLEX, 15 TO 30 PERCENT SLOPES |
| 83 | LADD-ADA COMPLEX, 30 TO 60 PERCENT SLOPES |
| 84 | LADD-HAW LOAMS, 30 TO 60 PERCENT SLOPES |
| 85 | LADD-SEARLES COMPLEX, 4 TO 15 PERCENT SLOPES |
| 86 | LADD-SEARLES COMPLEX, 15 TO 30 PERCENT SLOPES |
| 87 | LADD-SEARLES COMPLEX, 30 TO 65 PERCENT SLOPES |
| 88 | LADD-VAN DUSEN LOAMS, 30 TO 60 PERCENT SLOPES |
| 89 | LANKBUSH-BRENT SANDY LOAMS, 4 TO 12 PERCENT SLOPES |
| 90 | LANKBUSH-BRENT SANDY LOAMS, 12 TO 30 PERCENT SLOPES |
| 91 | LANKBUSH-BRENT SANDY LOAMS, 30 TO 65 PERCENT SLOPES |
| 92 | LANKBUSH-CHARDOTON COMPLEX, 0 TO 2 PERCENT SLOPES |
| 93 | LANKBUSH-LADD COMPLEX, 15 TO 30 PERCENT SLOPES |
| 94 | LANKBUSH-LADD COMPLEX, 30 TO 60 PERCENT SLOPES |
| 95 | LANKBUSH-TENMILE COMPLEX, 0 TO 4 PERCENT SLOPES |
| 96 | LANKBUSH-TENMILE COMPLEX, 4 TO 12 PERCENT SLOPES |
| 97 | LANKBUSH-TENMILE COMPLEX, 12 TO 20 PERCENT SLOPES |
| 98 | LANKBUSH-TENMILE COMPLEX, 35 TO 65 PERCENT SLOPES |
| 99 | LANKBUSH-TINDAHAY SANDY LOAMS, 0 TO 2 PERCENT SLOPES |
| 100 | LANKBUSH-TINDAHAY SANDY LOAMS, 2 TO 4 PERCENT SLOPES |
| 101 | MCCAIN SILT LOAM, 0 TO 2 PERCENT SLOPES |
| 102 | MCCAIN SILT LOAM, 2 TO 4 PERCENT SLOPES |
| 103 | MCCAIN SILT LOAM, 4 TO 8 PERCENT SLOPES |
| 104 | MCCAIN SILT LOAM, 8 TO 12 PERCENT SLOPES |
| 105 | MCCAIN EXTREMELY STONY SILT LOAM, 0 TO 2 PERCENT SLOPES |

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|---|---|
| 106 | MCCAIN EXTREMELY STONY SILT LOAM, 2 TO 4 PERCENT SLOPES |
| 107 | MCCAIN EXTREMELY STONY SILT LOAM, 4 TO 8 PERCENT SLOPES |
| 108 | MCCAIN EXTREMELY STONY SILT LOAM, 8 TO 12 PERCENT SLOPE S |
| 109 | MCCAIN-ROCK OUTCROP COMPLEX, 0 TO 15 PERCENT SLOPES |
| 110 | MINIDOKA SILT LOAM, BEDROCK SUBSTRATUM, 2 TO 4 PERCENT SLOPES |
| 111 | MOULTON FINE SANDY LOAM |
| 112 | NOTUS SOILS |
| 113 | OLA-SEARLES COMPLEX, 15 TO 30 PERCENT SLOPES |
| 114 | OLA-SEARLES COMPLEX, 30 TO 80 PERCENT SLOPES |
| 115 | OLIAGA VARIANT LOAM |
| 116 | PAYETTE-QUINCY COMPLEX, 15 TO 30 PERCENT SLOPES |
| 117 | PAYETTE-QUINCY COMPLEX, 30 TO 65 PERCENT SLOPES |
| 118 | PEASLEY SILTY CLAY LOAM, 2 TO 6 PERCENT SLOPES |
| 119 | PIPELINE SILT LOAM, 0 TO 2 PERCENT SLOPES |
| 120 | PIPELINE SILT LOAM, 2 TO 4 PERCENT SLOPES |
| 121 | PIPELINE SILT LOAM, 4 TO 8 PERCENT SLOPES |
| 122 | PIPELINE SILT LOAM, 8 TO 12 PERCENT SLOPES |
| 123 | PITS, GRAVEL |
| 124 | POTRATZ SILT LOAM, 0 TO 2 PERCENT SLOPES |
| 125 | POTRATZ SILT LOAM, 2 TO 4 PERCENT SLOPES |
| 126 | POTRATZ SILT LOAM, 4 TO 8 PERCENT SLOPES |
| 127 | POTRATZ-POWER SILT LOAMS, 4 TO 8 PERCENT SLOPES |
| 128 | POTRATZ-TREVINO COMPLEX, 4 TO 12 PERCENT SLOPES |
| 129 | POWER SILT LOAM, 0 TO 2 PERCENT SLOPES |
| 130 | POWER SILT LOAM, 2 TO 4 PERCENT SLOPES |
| 131 | POWER SILT LOAM, 4 TO 8 PERCENT SLOPES |
| 132 | POWER SILT LOAM, 8 TO 12 PERCENT SLOPES |
| 133 | POWER-MCCAIN SILT LOAMS, 0 TO 2 PERCENT SLOPES |

Soil Map Legend--Continued

| Map symbol | Soil name |
|---|---|
| 134 | POWER-MCCAIN SILT LOAMS, 2 TO 4 PERCENT SLOPES |
| 135 | POWER-MCCAIN SILT LOAMS, 4 TO 8 PERCENT SLOPES |
| 136 | POWER-MCCAIN SILT LOAMS, 8 TO 12 PERCENT SLOPES |
| 137 | POWER-MCCAIN COMPLEX, 0 TO 2 PERCENT SLOPES |
| 138 | POWER-MCCAIN COMPLEX, 2 TO 4 PERCENT SLOPES |
| 139 | POWER-MCCAIN COMPLEX, 4 TO 8 PERCENT SLOPES |
| 140 | POWER-POTRATZ SILT LOAMS, 2 TO 4 PERCENT SLOPES |
| 141 | PURDAM SILT LOAM, 0 TO 2 PERCENT SLOPES |
| 142 | PURDAM SILT LOAM, 2 TO 4 PERCENT SLOPES |
| 143 | PURDAM SILT LOAM, 4 TO 8 PERCENT SLOPES |
| 144 | PURDAM-POWER SILT LOAMS, 0 TO 2 PERCENT SLOPES |
| 145 | PURDAM-POWER SILT LOAMS, 2 TO 4 PERCENT SLOPES |
| 146 | PURDAM-POWER SILT LOAMS, 4 TO 8 PERCENT SLOPES |
| 147 | PURDAM-POWER-URBAN LAND COMPLEX, 0 TO 2 PERCENT SLOPES |
| 148 | QUINCY SAND, 2 TO 8 PERCENT SLOPES |
| 150 | QUINCY-LANKBUSH COMPLEX, 4 TO 12 PERCENT SLOPES |
| 151 | QUINCY-LANKBUSH COMPLEX, 12 TO 30 PERCENT SLOPES |
| 152 | QUINCY-LANKBUSH COMPLEX, 30 TO 80 PERCENT SLOPES |
| 153 | RAINEY-OLA COARSE SANDY LOAMS, 15 TO 30 PERCENT SLOPES |
| 154 | RAINEY-OLA COARSE SANDY LOAMS, 30 TO 65 PERCENT SLOPES |
| 155 | RIDENBAUGH-SEBREE SILTY CLAY LOAMS, 0 TO 2 PERCENT SLOP ES |
| 156 | RIDENBAUGH-SEBREE SILTY CLAY LOAMS, 2 TO 4 PERCENT SLOP ES |
| 157 | RIVERWASH |
| 158 | ROCK OUTCROP-TREVINO COMPLEX, 5 TO 20 PERCENT SLOPES |
| 159 | RUBBLE LAND |
| 160 | SCISM SILT LOAM, 0 TO 2 PERCENT SLOPES |
| 161 | SCISM SILT LOAM, 2 TO 4 PERCENT SLOPES |

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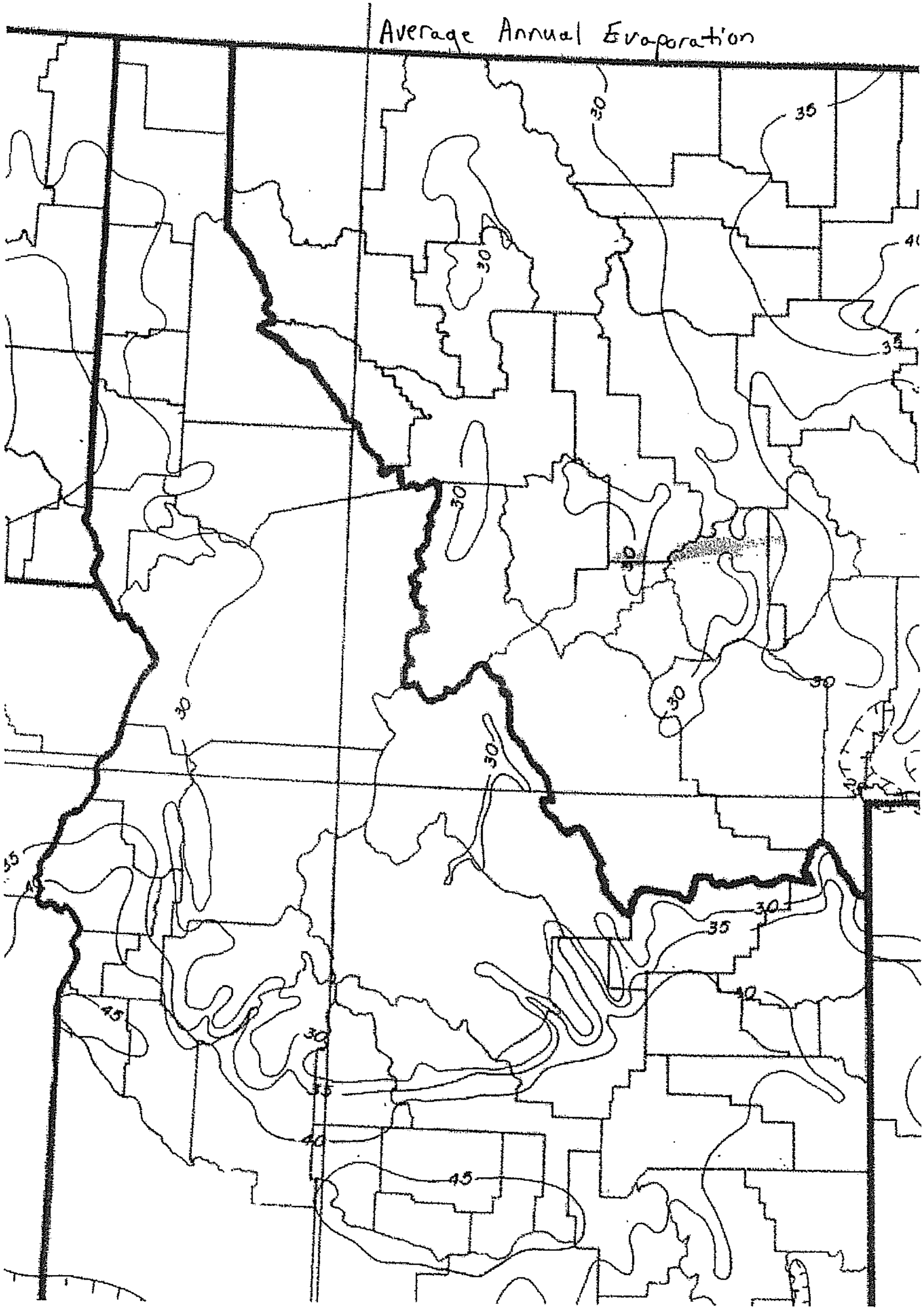
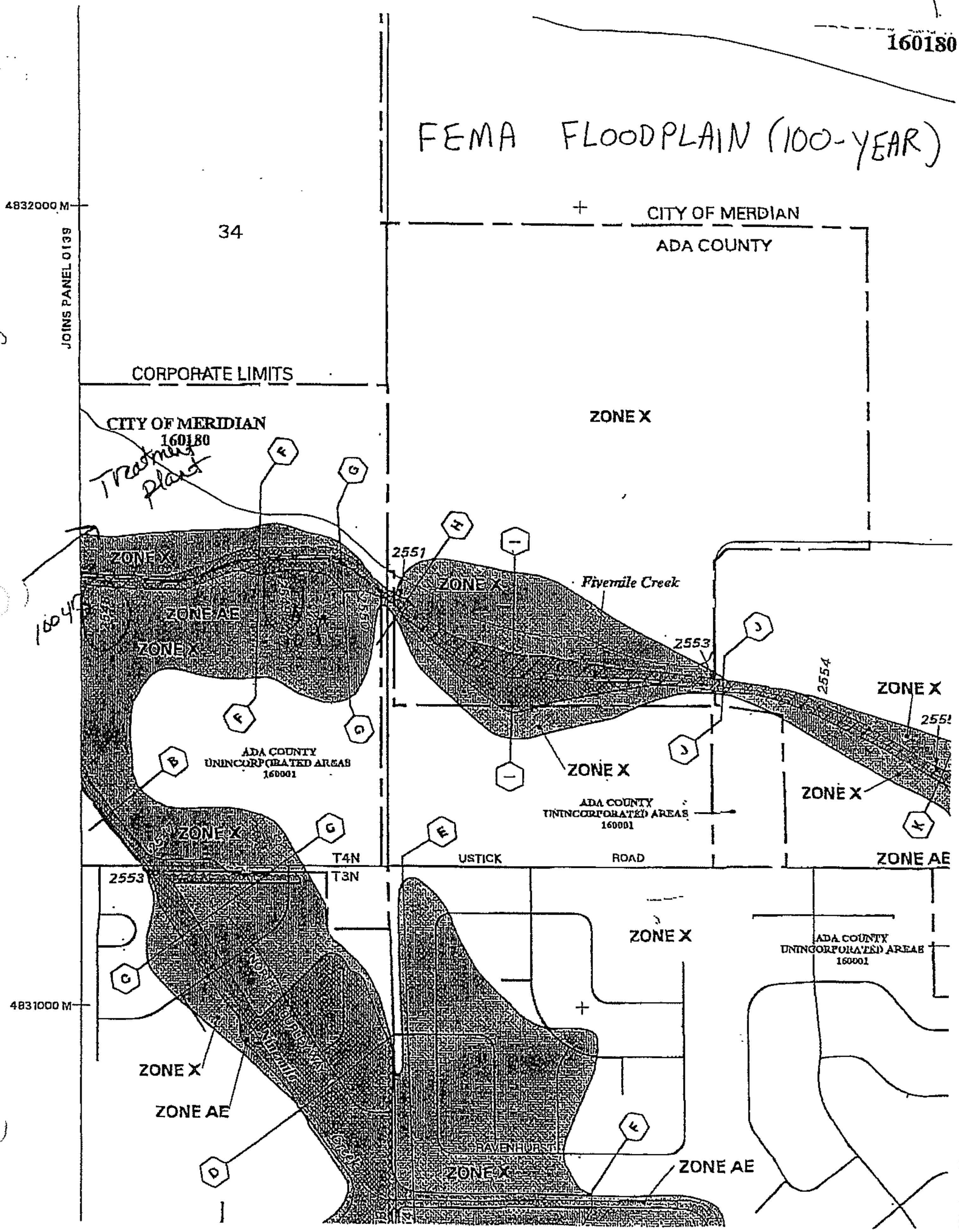
|---|---|
| 162 | SCISM SILT LOAM, 4 TO 8 PERCENT SLOPES |
| 163 | SCISM SILT LOAM, BEDROCK SUBSTRATUM, 0 TO 2 PERCENT SLO PES |
| 164 | SCISM SILT LOAM, BEDROCK SUBSTRATUM, 2 TO 4 PERCENT SLO PES |
| 165 | SCISM SILT LOAM, BEDROCK SUBSTRATUM, 4 TO 8 PERCENT SLO PES |
| 166 | SCISM SILT LOAM, BEDROCK SUBSTRATUM, 8 TO 12 PERCENT SL OPES |
| 167 | SEARLES-LADD COMPLEX, 4 TO 15 PERCENT SLOPES |
| 168 | SEARLES-LADD COMPLEX, 15 TO 30 PERCENT SLOPES |
| 169 | SEARLES-LADD COMPLEX, 30 TO 65 PERCENT SLOPES |
| 171 | SEARLES-ROCK OUTCROP COMPLEX, 30 TO 80 PERCENT SLOPES |
| 172 | SHABLISS VERY FINE SANDY LOAM, 0 TO 2 PERCENT SLOPES |
| 173 | SHABLISS VERY FINE SANDY LOAM, 2 TO 4 PERCENT SLOPES |
| 174 | TENMILE VERY GRAVELLY LOAM, 0 TO 4 PERCENT SLOPES |
| 175 | TENMILE VERY GRAVELLY LOAM, 4 TO 12 PERCENT SLOPES |
| 176 | TENMILE VERY GRAVELLY LOAM, 12 TO 30 PERCENT SLOPES |
| 177 | TENMILE VERY GRAVELLY LOAM, 30 TO 65 PERCENT SLOPES |
| 178 | TINDAHAY FINE SANDY LOAM, 0 TO 2 PERCENT SLOPES |
| 179 | TINDAHAY FINE SANDY LOAM, 2 TO 4 PERCENT SLOPES |
| 180 | TINDAHAY FINE SANDY LOAM, 4 TO 8 PERCENT SLOPES |
| 181 | TINDAHAY GRAVELLY LOAM, 8 TO 12 PERCENT SLOPES |
| 182 | TREVINO-POTRATZ COMPLEX, 0 TO 4 PERCENT SLOPES |
| 183 | TRIO VERY FINE SANDY LOAM, 0 TO 2 PERCENT SLOPES |
| 184 | TRIO VERY FINE SANDY LOAM, 2 TO 4 PERCENT SLOPES |
| 185 | TRIO VERY FINE SANDY LOAM, 4 TO 8 PERCENT SLOPES |
| 186 | TRUESDALE FINE SANDY LOAM, 0 TO 2 PERCENT SLOPES |
| 187 | TRUESDALE FINE SANDY LOAM, 2 TO 4 PERCENT SLOPES |
| 188 | TRUESDALE FINE SANDY LOAM, 4 TO 8 PERCENT SLOPES |
| 189 | TRUESDALE FINE SANDY LOAM, 8 TO 12 PERCENT SLOPES |
| 190 | TRUESDALE FINE SANDY LOAM, BEDROCK SUBSTRATUM, 0 TO 2 P ERCENT SLOPES |
| 191 | TRUESDALE FINE SANDY LOAM, BEDROCK SUBSTRATUM, 2 TO 4 P ERCENT SLOPES |
| 192 | TURBYFILL FINE SANDY LOAM, 0 TO 2 PERCENT SLOPES |
| 193 | TURBYFILL FINE SANDY LOAM, 2 TO 4 PERCENT SLOPES |
| 194 | TURBYFILL FINE SANDY LOAM, 20 TO 35 PERCENT SLOPES |
| 195 | URBAN LAND |
| 196 | VANDERHOFF SOILS, 30 TO 60 PERCENT SLOPES |
| 197 | VAN DUSEN-PAYETTE COMPLEX, 30 TO 65 PERCENT SLOPES |
| 198 | XEROLLIC HAPLARGIDS, VERY STEEP |
| 199 | DAM |
| 200 | PLAYAS |
| 201 | WATER |


Average Annual Evaporation
30
35
40
45


160180
FEMA FLOODPLAIN (100-YEAR)
4832000 M
JOINS PANEL 0139
34
CITY OF MERDIAN
ADA COUNTY
CORPORATE LIMITS
CITY OF MERIDIAN
160180
Treatment plant
ZONE X
ZONE X
ZONE AE
ZONE X
2551
Fivemile Creek
2553
2554
ZONE X
ADA COUNTY
UNINCORPORATED AREAS
160001
ZONE X
ZONE X
ADA COUNTY
UNINCORPORATED AREAS
160001
ZONE X
T4N
USTICK
ROAD
ZONE AE
T3N
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ZONE X
ADA COUNTY
UNINCORPORATED AREAS
160001
4831000 M
ZONE X
ZONE AE
RAVENHURST
ZONE X
ZONE AE

# Appendix B: Meridian WRRF Flow and Load Projections TM

JUB developed flow and load projections TM

J·U·B ENGINEERS, INC.

J-U-B COMPANIES | THE LANGDON GROUP | GATEWAY MAPPING INC.

# Technical Memorandum

**DATE:** April 6, 2017

**TO:** Clint Dolsby, P.E.

**FROM:** Chris Webb, P.E.

**REVIEW BY:** Dan Ayers, P.E.

**SUBJECT:** **Meridian WWTF Flow & Load Projections - DRAFT**

## I. Introduction

The City requested that J-U-B prepare flow and loading projections for the current Wastewater Treatment Facility Plan. This included analyzing flow and load data for the Wastewater Treatment Facility (WWTF), as well as summarizing population and employment projections from the current Sewer Master Plan (SMP) update.

This memorandum includes a summary of the following:

- Existing population, employment, flows and loads
- Unit flows, unit loads and peaking factors used in future projections
- Population and employment projections for the committed and buildout scenarios
- Flow and load projections for the committed and buildout scenarios

**Table 1** lists and defines several flow and load terms used in this memorandum.

**TABLE 1 – DEFINITION OF TERMS**

| Term | Definition |
|---|---|
| Average Day | Average flow/load in a 24-hour period |
| Average Annual | Average flow/load for an entire calendar year (12 months) |
| Peak Month | Highest 30-day average flow/load for an entire calendar year (12 months) |
| Peak Week | Highest 7-day average flow/load for an entire calendar year (12 months) |
| Peak Day | Highest 24-hour average flow/load for an entire calendar year (12 months) |
| Peak Hour | Highest 1-hour average flow for an entire calendar year (12 months) |
| MGD | Million gallons per day |
| BOD | Biochemical oxygen demand |
| TSS | Total suspended solids |
| NH3 | Ammonia as nitrogen |
| TKN | Total Kjeldahl nitrogen |
| TP | Total phosphorus |

## II. Population & Employment Projections

Existing and future estimates for Treasure Valley population and employment are developed by the Community Planning Association (COMPASS) each year. Their current estimates are for 2016 and 2040. These population and employment estimates are broken down and summarized by geographic areas called Traffic Analysis Zones (TAZ). Meridian is divided into three TAZ demographic areas as shown in **Figure 1**. The population and employment estimates from COMPASS for 2016 and 2040 are summarized in **Table 2** for each demographic area.

**TABLE 2 – COMPASS POPULATION AND EMPLOYMENT ESTIMATES**

| TAZ Demographic Areas | 2016 COMPASS | | 2040 COMPASS | |
|---|---|---|---|---|
| | Population | Employment | Population | Employment |
| North-Meridian | 31,220 | 4,410 | 51,130 | 9,420 |
| Central-Meridian | 46,500 | 29,080 | 67,720 | 48,550 |
| South-Meridian | 21,440 | 10,120 | 42,750 | 16,330 |
| **Total** | **99,160** | **43,610** | **161,600** | **74,300** |

The current SMP update focuses solely on the collection system and is being updated separately. It includes a demographics summary related to the three main modeling scenarios (existing, committed and buildout). **Table 3** provides a population and employment projection for each TAZ demographic area and each modeling scenario.

**TABLE 3 – SEWERED POPULATION AND EMPLOYMENT PROJECTIONS**

| TAZ Demographic Areas | Existing | | Committed | | Buildout | |
|---|---|---|---|---|---|---|
| | Population | Employment | Population | Employment | Population | Employment |
| North-Meridian | 31,700 | 3,980 | 46,230 | 8,520 | 96,770 | 17,830 |
| Central-Meridian | 49,670 | 28,230 | 65,530 | 46,980 | 85,900 | 61,580 |
| South-Meridian | 19,710 | 9,010 | 49,150 | 18,790 | 133,710 | 51,080 |
| **Total** | **101,080** | **41,220** | **160,910** | **74,290** | **316,380** | **130,490** |

The existing model scenario represents the areas currently sewered by the City. There are slight differences between the existing model estimates from the SMP and the 2016 COMPASS estimates, likely due to differences in methodology.

The committed model scenario represents everything the City has committed to serve. In most cases this corresponds to everything that has been annexed into the City. These projections closely match those from COMPASS for the year 2040 and represent an average annual growth rate of 2%.

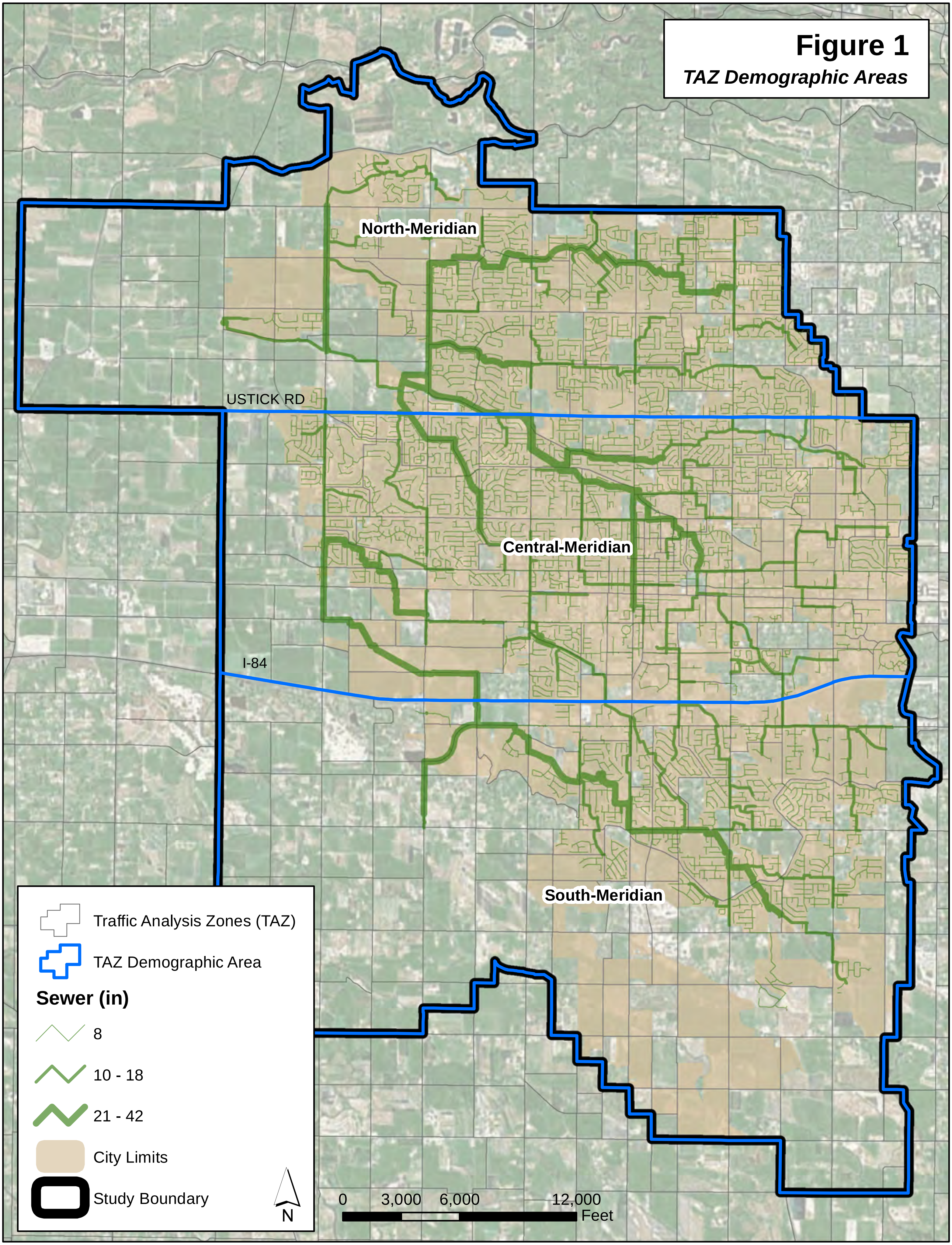
Figure 1
TAZ Demographic Areas
North-Meridian
Central-Meridian
South-Meridian
USTICK RD
I-84
Traffic Analysis Zones (TAZ)
TAZ Demographic Area
Sewer (in)
8
10 - 18
21 - 42
City Limits
Study Boundary
N
0
3,000
6,000
12,000
Feet

The buildout scenario represents full buildout of the SMP study boundary. A continued 2% average annual growth rate reaches the buildout scenario population in approximately 2074. This study boundary is shown in **Figure 1** and closely matches the impact area for the City.

## III. Historical Flows & Loads

The City provided historical WWTF data for most of the past 6 years. **Table 4** shows the average annual flow and the average annual load for each wastewater constituent. Annual average data for 2016 was determined using data from November 2015 through October 2016, since November and December 2016 data were not available. **Figure 2** shows the 2016 daily data for flow and each load constituent.

**TABLE 4 – HISTORICAL FLOWS & LOADS (AVERAGE ANNUAL)**

| Year | Flow [1] (MGD) | BOD (lb/day) | TSS (lb/day) | NH3 (lb/day) | TKN (lb/day) | TP (lb/day) |
|---|---|---|---|---|---|---|
| 2011 | 5.6 | 12,700 | 12,480 | 1,380 | 2,200 | 300 |
| 2012 | 5.5 | 13,500 | 13,420 | 1,490 | 2,290 | 300 |
| 2013 | 5.5 | 14,520 | 14,210 | 1,560 | 2,400 | 320 |
| 2014 | 6.2 | 15,830 | 14,600 | 1,720 | 2,560 | 330 |
| 2015 | 6.1 | 15,040 | 13,780 | 1,780 | 2,590 | 340 |
| 2016 | 6.6 | 16,340 | 14,790 | 1,930 | 2,910 | 350 |

*(1) – Effluent flow data used. Influent flow data not available.*

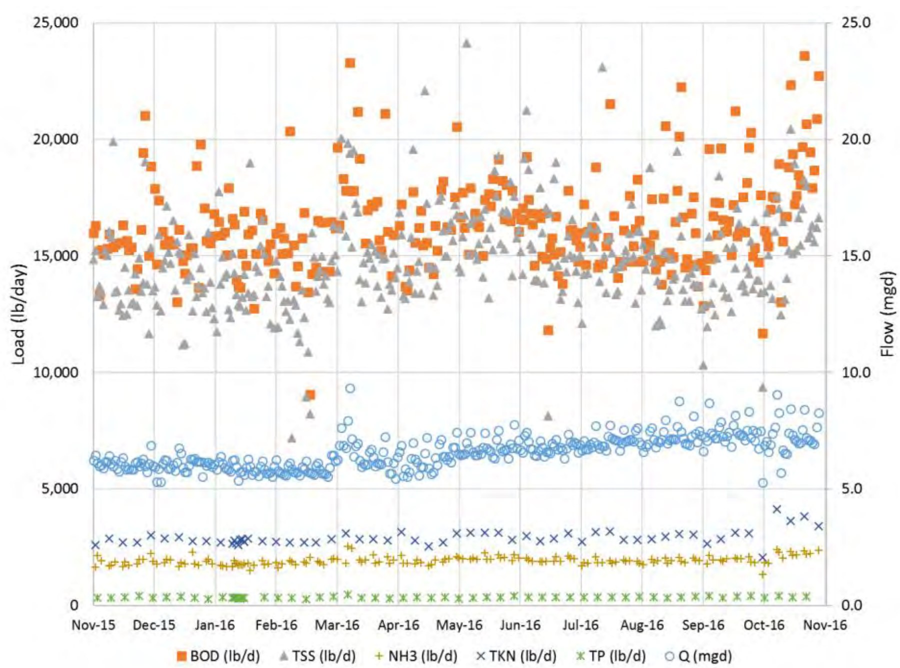


**FIGURE 2 – 2016 DAILY FLOWS & LOADS**

The data was analyzed to determine peaking factors for the average annual, peak month, peak week and peak day for each year of data provided. **Appendix A** contains a summary of the calculated peaking factors for each year. The City has experienced significant growth, especially in the last couple years. There are many factors that affect peaking factors, but generally peaking factors decrease as the service area, population, and/or flow increase. Due to the significant recent growth, peaking factors from 2016 are most representative of the current flow and load characteristics.

However, in order to provide conservative flow and load projections, 2016 peaking factors for each constituent were compared the average peaking factor over the past 6 years. In situations where the 2016 peaking factor was lower than the 6-year average, the 6-year average was used. The resulting recommended peaking factors are summarized in **Table 5.**

**TABLE 5 – RECOMMENDED PEAKING FACTORS**

| Description | Flow | BOD | TSS | NH3 | TKN | TP |
|---|---|---|---|---|---|---|
| Average Annual | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Peak Month | 1.14 | 1.13 | 1.11 | 1.10 | 1.06 | 1.10 |
| Peak Week | 1.18 | 1.27 | 1.23 | 1.23 | 1.17 | 1.25 |
| Peak Day | 1.42 | 1.60 | 1.88 | 1.32 | 1.42 | 1.33 |
| Peak Hour [1] | 1.78 | - | - | - | - | - |

*(1) – Effluent peak hour flow data includes occasional recirculation flows that artificially increase the peak hour flow resulting in a peak hour peaking factor greater than 2.6. This is not representative of typical influent peak hour flows. The peaking factor listed above was determined by using the maximum effluent peak hour flow averaged over each week, rather than maximum effluent peak hour flow from each day.*

## IV. Unit Flows & Loads

An analysis of existing water usage data was completed as a part of the SMP to establish unit flows for use in projecting future flows. The average residential single family unit flow was determined to be 153 gallons per day (gpd). A summary of all the unit flows can be found in **Appendix A**.

Current wastewater loads can be summarized by various components that make up the total. These components can include sanitary loads (residential and non-residential), contracted loads from other utilities and loads from permitted significant industrial users (SIUs). Sanitary loads (residential and non-residential) are currently the only component for the City. An analysis of the existing sanitary loading data was completed to determine unit loads for each constituent for use in future load projections.

In the SMP sanitary flows were developed for each parcel connected to the sewer system based on winter water usage data (Dec 2015 – Feb 2016). Land use designations were also assigned to each parcel. Non-residential sanitary loads were estimated using this SMP information and the assumed non-residential sanitary unit loads listed in **Table 6**.

Unit loads for mixed use land use types were determined in a similar manner to mixed use unit flows (see **Appendix A**).

**TABLE 6 – ASSUMED UNIT LOADS – NON-RESIDENTIAL**

| Land Use | BOD (mg/L) | TSS (mg/L) | NH3 (mg/L) | TKN [1] (mg/L) | TP (mg/L) | Source |
|---|---|---|---|---|---|---|
| Car Wash | 315 | 62 | 3 | 5 | 6 | B&V [2] |
| Church, School | 222 | 106 | 72 | 109 | 11 | CT & Yelm [3, 4] |
| Commercial | 442 | 157 | 51 | 77 | 7 | CT |
| Entertainment, Parks/Golf | 77 | 166 | 27 | 41 | 6 | Yelm |
| Hospital | 350 | 156 | 82 | 124 | 12 | Fairfax [5] |
| Hotel | 195 | 171 | 52 | 79 | 9 | CT |
| Office, Industrial, Public | 195 | 63 | 112 | 170 | 12 | CT |
| Restaurant | 781 | 193 | 36 | 55 | 11 | CT & Yelm |

*(1) – Assumed TKN unit loads based on current ratio of TKN/NH3 at WWTF*

*(2) – B&V Study (Water Effluent and Solid Waste Characteristics in the Professtional Car Wash Industry, International Carwash Association)*

*(3) – CT Study (State of Connecticut, 2006 Design Manual, Water Regulations and Discharges)*

*(4) – Yelm Study (City of Yelm General Sewer Plan)*

*(5) – Fairfax Study (Commonwealth of Virginia, State Board of Health and Disposal, Sewage Health and Disposal Regulations, 2000)*

The average daily flow for each non-residential land use type from the SMP and the assumed unit loads were used to estimate an average daily load for each load constituent. A mass balance was used to then calculate the total residential sanitary loads as shown in **Table 7**. Residential unit loads, shown in **Table 8**, were then estimated for each constituent using the existing population from **Table 3**.

**TABLE 7 – EXISTING FLOW & LOADS (WINTER LOWS)**

| Description | Flow [1] (MGD) | BOD (lb/day) | TSS (lb/day) | NH3 (lb/day) | TKN (lb/day) | TP (lb/day) |
|---|---|---|---|---|---|---|
| Non-Residential | 1.0 | 3,290 | 1,150 | 540 | 810 | 80 |
| Residential | 4.9 | 12,230 | 12,510 | 1,290 | 1,950 | 240 |
| **Total [2]** | **5.9** | **15,520** | **13,660** | **1,830** | **2,760** | **320** |

*(1) – Does not include seasonal infiltration. The SMP estimates existing seasonal infiltration up to 1.42 MGD.*

*(2) – Based on wintertime data (Dec 2015 – Feb 2016), not annual averages.*

**TABLE 8 – RECOMMENDED UNIT LOADS - RESIDENTIAL**

| Land Use | BOD (mg/L) | TSS (mg/L) | NH3 (mg/L) | TKN (mg/L) | TP (mg/L) |
|---|---|---|---|---|---|
| Residential | 300 | 307 | 32 | 48 | 6 |

## V. Flow & Load Projections

Future average flows for the committed and buildout scenarios were developed based on the future land use assumptions in the SMP. Neither redevelopment nor reserve industrial flows were included in the base committed and buildout scenarios in the SMP. **Table 9** shows the projected peak month, peak week, peak day and peak hour flows at the WWTF based on the future flows from the SMP and the WWTF peaking factors listed in **Table 5**.

**TABLE 9 – FLOW PROJECTIONS**

| Description | Existing | Committed | Buildout |
|---|---|---|---|
| Average Annual Flow (MGD) | 6.6 | 12.5 | 23.6 |
| Peak Month Flow (MGD) | 7.5 | 14.2 | 26.8 |
| Peak Week Flow (MGD) | 7.8 | 14.8 | 27.9 |
| Peak Day Flow (MGD) | 9.3 | 17.7 | 33.4 |
| Peak Hour Flow (MGD) | 11.7 | 22.3 | 42.0 |

Future loads were developed using the future land use assumptions in the SMP, population projections and unit loads presented in **Table 6** and **Table 8**. Redevelopment was not included in the base committed and buildout scenarios in the SMP. These projections also do not include any reserve loads for future large scale industries. **Table 10** summarizes the resulting existing, committed and buildout loads for each loading constituent. **Appendix B** includes a summary of the flow and load projections broken down by TAZ demographic area.

**TABLE 10 – LOAD PROJECTIONS**

| Constituent | Load Description | Existing | Committed | Buildout |
|---|---|---|---|---|
| BOD (lb/day) | Average Annual | 16,340 | 27,960 | 50,790 |
| | Peak Month | 18,420 | 31,520 | 57,260 |
| | Peak Week | 20,760 | 35,520 | 64,520 |
| | Peak Day | 26,080 | 44,630 | 81,060 |
| TSS (lb/day) | Average Annual | 14,790 | 24,230 | 46,140 |
| | Peak Month | 16,390 | 26,840 | 51,100 |
| | Peak Week | 18,160 | 29,740 | 56,620 |
| | Peak Day | 27,760 | 45,470 | 86,580 |
| NH3 (lb/day) | Average Annual | 1,930 | 3,730 | 6,830 |
| | Peak Month | 2,120 | 4,090 | 7,500 |
| | Peak Week | 2,380 | 4,590 | 8,400 |
| | Peak Day | 2,550 | 4,920 | 9,000 |
| TKN (lb/day) | Average Annual | 2,910 | 5,620 | 10,300 |
| | Peak Month | 3,090 | 5,960 | 10,920 |
| | Peak Week | 3,410 | 6,590 | 12,060 |
| | Peak Day | 4,130 | 7,970 | 14,580 |
| TP (lb/day) | Average Annual | 350 | 630 | 1,150 |
| | Peak Month | 390 | 690 | 1,260 |
| | Peak Week | 440 | 780 | 1,430 |
| | Peak Day | 470 | 840 | 1,530 |

# Appendix A: Peaking Factors & Unit Flows

## Peaking Factors

Peaking factors for each wastewater constituent was calculated for each year from 2011 to 2016. A summary is included in **Table A-1.**

**TABLE A-1 - HISTORICAL PEAKING FACTORS**

| | | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Min | Avg | Max |
|---|---|---|---|---|---|---|---|---|---|---|
| Flow | Peak Month | 1.15 | 1.12 | 1.15 | 1.18 | 1.10 | 1.12 | 1.10 | 1.14 | 1.18 |
| | Peak Week | 1.18 | 1.15 | 1.20 | 1.28 | 1.13 | 1.16 | 1.13 | 1.18 | 1.28 |
| | Peak Day | 1.25 | 1.19 | 1.37 | 1.35 | 1.22 | 1.42 | 1.19 | 1.30 | 1.42 |
| BOD | Peak Month | 1.17 | 1.12 | 1.13 | 1.18 | 1.06 | 1.10 | 1.06 | 1.13 | 1.18 |
| | Peak Week | 1.32 | 1.19 | 1.18 | 1.42 | 1.15 | 1.27 | 1.15 | 1.26 | 1.42 |
| | Peak Day | 1.59 | 1.71 | 1.50 | 1.66 | 1.67 | 1.44 | 1.44 | 1.60 | 1.71 |
| TSS | Peak Month | 1.17 | 1.09 | 1.10 | 1.14 | 1.03 | 1.11 | 1.03 | 1.10 | 1.17 |
| | Peak Week | 1.29 | 1.27 | 1.24 | 1.21 | 1.13 | 1.22 | 1.13 | 1.23 | 1.29 |
| | Peak Day | 2.28 | 2.10 | 2.25 | 1.50 | 1.50 | 1.63 | 1.50 | 1.88 | 2.28 |
| NH3 | Peak Month | 1.06 | 1.10 | 1.11 | 1.11 | 1.05 | 1.10 | 1.05 | 1.09 | 1.11 |
| | Peak Week | 1.12 | 1.17 | 1.19 | 1.18 | 1.11 | 1.23 | 1.11 | 1.17 | 1.23 |
| | Peak Day | 1.18 | 1.30 | 1.24 | 1.23 | 1.28 | 1.32 | 1.18 | 1.26 | 1.32 |
| TKN | Peak Month | 1.05 | 1.04 | 1.09 | 1.03 | 1.04 | 1.06 | 1.03 | 1.05 | 1.09 |
| | Peak Week | 1.17 | 1.13 | 1.15 | 1.06 | 1.07 | 1.17 | 1.06 | 1.13 | 1.17 |
| | Peak Day | 1.11 | 1.19 | 1.16 | 1.11 | 1.17 | 1.42 | 1.11 | 1.19 | 1.42 |
| TP | Peak Month | 1.11 | 1.10 | 1.08 | 1.03 | 1.07 | 1.10 | 1.03 | 1.08 | 1.11 |
| | Peak Week | 1.36 | 1.15 | 1.16 | 1.19 | 1.23 | 1.25 | 1.15 | 1.22 | 1.36 |
| | Peak Day | 1.43 | 1.16 | 1.19 | 1.27 | 1.27 | 1.33 | 1.16 | 1.28 | 1.43 |

## Unit Flows

As part of the Collection System Sewer Master Plan existing water usage data was analyzed to determine unit flows for a variety of specific land use types. **Table A-2** summarizes the unit flows developed for non-residential land use types. All unit flows are based on the net area which excludes right-of-way, open space, roads etc. that get included when development occurs.

**TABLE A-2 - UNIT FLOWS**

| Land Use Designation | Net Unit Flow (GPAD) [2] |
|---|---|
| Assisted Living | 850 |
| Car Wash | 10,520 |
| Church | 60 |
| Commercial [(1)] | 520 |
| Entertainment | 310 |
| Employment – Low Density | 540 |
| Employment – Mixed | 1,040 |
| Employment – High Density | 2,540 |
| Hospital | 850 |
| Hotel | 3,050 |
| Industrial | 190 |
| Lifestyle Center | 2,980 |
| Mixed Use - Commercial | 1,820 |
| Mixed Use - Community | 1,080 |
| Mixed Use - Interchange | 940 |
| Mixed Use - Neighborhood | 1,250 |
| Mixed Use - Non-Residential | 600 |
| Mixed Use - Regional | 820 |
| Mixed Use - Residential | 1,300 |
| Office | 270 |
| Old Town | 920 |
| Open Space | 0 |
| Parks/Golf Courses | 10 |
| Public | 130 |
| Restaurant | 1,880 |
| School | 120 |

(1) *Commercial unit flow is a composite unit flow of Car Wash, Commercial-Retail, Entertainment, Hotel, Office, and Restaurant.*

(2) *Gallons per acre per day*

The City's future land use map (from the current comprehensive plan) has several different mixed use categories. Unit flows for these mixed use designations were developed using a mix of the following base uses: residential, office, commercial, public and industrial. **Table A-3** summarizes the percentages of each base use included in the mix use designation. A mixed use multiplier was applied to the resulting unit flow due to the increased density associated with mixed use.

**TABLE A-3 - MIXED USE PERCENTAGES**

| Land Use | Residential % | Office % | Commercial % | Public % | Industrial % |
|---|---|---|---|---|---|
| Employment – High Density | 0 | 80 | 20 | 0 | 0 |
| Employment – Mixed | 0 | 50 | 10 | 0 | 40 |
| Employment – Low Density | 0 | 100 | 0 | 0 | 0 |
| Mixed Use - Commercial | 20 | 25 | 50 | 5 | 0 |
| Mixed Use - Community | 35 | 25 | 30 | 10 | 0 |
| Mixed Use - Interchange | 30 | 30 | 20 | 20 | 0 |
| Mixed Use - Neighborhood | 50 | 30 | 10 | 10 | 0 |
| Mixed Use - Non-Residential | 0 | 40 | 55 | 5 | 0 |
| Mixed Use - Regional | 15 | 25 | 50 | 10 | 0 |
| Mixed Use - Residential | 50 | 25 | 20 | 5 | 0 |
| Lifestyle Center | 32 | 16 | 40 | 12 | 0 |
| Old Town | 25 | 25 | 35 | 15 | 0 |

**Table A-4** summarizes the unit flows developed for residential land use types. Assumed residential densities are also listed. These densities were determined through an analysis of recent developments and discussion with the City.

**TABLE A-4 - RESIDENTIAL UNIT FLOWS AND DENSITIES**

| Land Use Designation | Unit Flows (GPDU) [1] | Gross Densities (DU/AC) [2] |
|---|---|---|
| Residential – Single Family Low | 153 | 3.0 |
| Residential – Single Family Medium | 153 | 4.5 |
| Residential – Multi-Family Medium-High | 115 | 10.0 |
| Residential – Multi-Family High | 115 | 20.0 |

(1) *Gallons per dwelling unit*

(2) *Dwelling units per acre*

# Appendix B: Flow & Load Projections by TAZ Demographic Areas

**Figure 1** shows the TAZ demographic areas developed by COMPASS. **Table B-1** shows the annual average flow projections for each of the TAZ demographic areas.

**TABLE B-1 – FLOW PROJECTIONS BY AREA (AVERAGE ANNUAL)**

| TAZ Demographic Areas | Existing Flow (MGD) | Committed Flow (MGD) | Buildout Flow (MGD) |
|---|---|---|---|
| North-Meridian | 1.7 | 3.0 | 6.4 |
| Central-Meridian | 3.7 | 5.8 | 7.6 |
| South-Meridian | 1.2 | 3.7 | 9.5 |
| **Total** | 6.6 | 12.5 | 23.6 |

**Table B-2** shows the annual average load projections for each constituent by TAZ demographic areas.

**TABLE B-2 – LOAD PROJECTIONS BY AREA (AVERAGE ANNUAL)**

| Constituent | TAZ Demographic Areas | Existing | Committed | Buildout |
|---|---|---|---|---|
| BOD (lb/day) | North-Meridian | 3,920 | 6,320 | 13,580 |
| | Central-Meridian | 9,400 | 13,600 | 17,250 |
| | South-Meridian | 3,020 | 7,940 | 19,740 |
| TSS (lb/day) | North-Meridian | 3,890 | 6,010 | 13,060 |
| | Central-Meridian | 8,060 | 10,940 | 14,040 |
| | South-Meridian | 2,840 | 7,170 | 18,810 |
| NH3 (lb/day) | North-Meridian | 480 | 800 | 1,710 |
| | Central-Meridian | 1,090 | 1,840 | 2,520 |
| | South-Meridian | 360 | 1,080 | 2,570 |
| TKN (lb/day) | North-Meridian | 720 | 1,200 | 2,580 |
| | Central-Meridian | 1,640 | 2,780 | 3,800 |
| | South-Meridian | 550 | 1,630 | 3,880 |
| TP (lb/day) | North-Meridian | 90 | 140 | 300 |
| | Central-Meridian | 200 | 310 | 400 |
| | South-Meridian | 60 | 180 | 440 |

# Appendix C: Secondary Treatment Alternatives Evaluation Report

# Secondary Treatment Alternatives Evaluation

Prepared for

City of Meridian, Idaho

September 24, 2015

# Secondary Treatment Alternatives Evaluation

Prepared for

City of Meridian, Idaho

September 24, 2015

Brown AND Caldwell

950 West Bannock Street, Suite 350

Boise, ID 83702

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Brown AND Caldwell

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# List of Tables

# List of Abbreviations

| | |
|---|---|
| AACE | Association for the Advancement of Cost Engineering |
| AOB | ammonia-oxidizing bacteria |
| A/O | anoxic/oxic |
| BAF | biological aerated filtration |
| BioP | biological phosphorus removal |
| BOD | biochemical oxygen demand (5-day) |
| °C | degree(s) Celsius |
| $CaCO_3$ | calcium carbonate |
| CIP | clean-in-place |
| City | City of Meridian |
| COD | chemical oxygen demand |
| d | day(s) |
| DO | dissolved oxygen |
| EPA | Environmental Protection Agency |
| EQ | equalization |
| ft | foot/feet |
| $ft^2$ | square foot/feet |
| FTE | full-time equivalent |
| gal | gallon(s) |
| GE | General Electric |
| gpd | gallon(s) per day |
| gpm | gallon(s) per minute |
| IDAPA | Idaho Administrative Procedures Act |
| IFAS | integrated fixed-film activated sludge |
| IMLR | internal mixed liquor recycle |
| ISS | inert suspended solids |
| kWh | kilowatt-hour(s) |
| L | liter(s) |
| lb | pound(s) |
| MBR | membrane bioreactor |
| mg | milligram(s) |
| Mgal | million gallon(s) |
| mgd | million gallon(s) per day |
| mg/L | milligram(s) per liter |
| MLR | mixed liquor recycle |
| MLSS | mixed liquor suspended solids |
| mmol | millimole(s) |
| N | nitrogen |
| $NH_3$ | ammonia |
| $NH_4$-N | ammonia-nitrogen |
| NOB | nitrite-oxidizing bacteria |
| NOx-N | nitrate-nitrogen + nitrite-nitrogen |
| $NO_2$-N | nitrite-nitrogen |
| $NO_3$-N | nitrate-nitrogen |
| NPDES | National Pollutant Discharge Elimination System |
| OHO | ordinary heterotrophic organism |
| O&M | operations and maintenance |
| OUR | oxygen uptake rate |
| P | phosphorus |
| PE | primary effluent |
| $PO_4$-P | orthophosphate |
| RAS | return activated sludge |
| RI | raw influent |
| scfm | standard cubic foot/feet per minute |
| SE | secondary effluent |
| SND | simultaneous nitrification and denitrification |
| SRT | solids retention time |
| TKN | total Kjeldahl nitrogen |
| TM | technical memorandum |
| TN | total nitrogen |
| TP | total phosphorus |
| TSS | total suspended solids |
| VFA | volatile fatty acid |
| VSS | volatile suspended solids |
| WAS | waste activated sludge |
| WRRF | wastewater resource recovery facility |
| WWTP | wastewater treatment plant |

# Executive Summary

The City of Meridian (City) is in the process of receiving a new National Pollutant Discharge Elimination System (NPDES) permit. This new permit will contain very stringent limitations on effluent ammonia ($NH_4$) and phosphorus (P). The draft permit that the City has received from the Environmental Protection Agency (EPA) is presented in Table ES-1.

| Table ES-1. October 2014 Draft NPDES Permit (all values in mg/L) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Discharge Location: Fivemile Creek | | | | | Discharge Location: Boise River | | | |
| | Period | Season | Month | Week | Day | Period | Month | Week | Day |
| **Summer** | | | | | | | | | |
| BOD | May–Sept | – | 20 | 30 | – | May–Sept | 30 | 45 | – |
| TSS | May–Sept | – | 20 | 30 | – | May–Sept | 30 | 45 | – |
| TP | May–Sept | 0.12 | – | – | | May–Sept | 0.07 | 0.165 | – |
| $NH_4$-N | May–Sept | – | 0.405 | – | 1.65 | July–Oct | 0.242 | – | 1.06 |
| **Winter** | | | | | | | | | |
| BOD | Oct–April | – | 20 | 30 | – | Oct–April | 30 | 45 | – |
| TSS | Oct–April | – | 20 | 30 | – | Oct–April | 30 | 45 | – |
| TP | Oct–April | – | – | – | – | Oct–April | – | – | – |
| $NH_4$-N | Oct–April | – | 0.307 | – | 1.25 | Nov–Jun | 0.255 | – | 1.04 |

While the City had completed a Facilities Plan in 2012 to evaluate upgrade needs to meet growth, the new permit requirements were not known at that time and the proposed permit limits received in 2014 were far more restrictive with respect to ammonia than were anticipated in the 2012 Facilities Plan. Based on this new potential permit, the City was interested in determining the upgrades required for the treatment plant to meet these very restrictive limits. This project was initiated to meet this objective. In order to accomplish this objective, this project was laid out in three main stages:

1. Evaluate up to three main process alternatives for expansion and select the most appropriate based on capital and operating costs as well as ease of operation for further study.
2. Evaluate up to eight add-on processes to supplement the main process determined in stage 1 to reduce footprint and/or chemical use of the processes. Select three options for final evaluation.
3. Complete final review of options and complete an Association for the Advancement of Cost Engineering (AACE) Class 5 capital cost estimate for each of the three options. Recommend the most appropriate option for plant expansion.

## Main Process Alternatives

The main process alternative evaluation used the calibrated BioWin model from the Capacity Assessment project to determine the sizing of three alternatives for biological phosphorus removal (BioP) and nitrogen removal. The alternatives evaluated were:

- expansion of the existing system using a 5-stage Bardenpho process (convertible to A2O per City request)

- expansion of the existing system by conversion to a 4-stage Bardenpho process for nitrogen (N) removal only, then discharge to groundwater to eliminate the need for biological P removal
- expansion of the existing system by conversion to a simultaneous nitrification and denitrification (SND) system with chemical P removal

The results of the sizing were then used to develop rough cost of construction and operating costs for non-common unit processes. Based on the results presented in Section 2 of this report, the 5-stage Bardenpho option was selected as the main process alternative to provide the basis of further evaluations. This option was selected because it presented a moderate capital cost and operating cost while also presenting the lowest risk and allowing for the greatest flexibility for future modifications to the process, should this be desired by the City.

## Add-On Process Alternatives

Add-on processes were evaluated to determine if they were effective at reducing the footprint or chemical use of the selected 5-stage Bardenpho process. Several add-on alternatives were evaluated using the BioWin model developed for the 5-stage Bardenpho process. These alternatives included:

- adding sidestream P removal (e.g., Ostara™) to reduce phosphorus in the recycle streams
- adding influent equalization (EQ) to reduce nutrient load peaks:
  - without any sidestream treatment
  - with sidestream Anammox treatment for N removal
  - with sidestream Anammox treatment and sidestream P removal
- adding centrate N load equalization
- eliminating denitrification and some nitrification in the main process (convert to anoxic/oxic [A/O] process) and use tertiary nitrification and denitrification technologies
- adding fixed-film media to aerated zone for conversion to integrated fixed-film activated sludge (IFAS) process to increase biomass without increasing mixed liquor suspended solids (MLSS) concentration
- adding BioMag ballasted secondary sludge process to improve sludge separation
- converting sludge separation to membrane bioreactor (MBR) process

Once these alternatives were evaluated for sizing, rough capital and operational costs were again developed to compare options. Based on these comparisons, the options with the lowest capital cost were determined to be the MBR option and the option of adding sidestream P removal to the main process. These two processes were carried forward for further evaluation and detailed cost estimation. In addition, a third alternative not evaluated here that combined adding sidestream P and centrate load equalization was added for further evaluation.

## Final Alternatives Evaluation and Recommendation

The final alternatives evaluation confirmed the previous process sizing from the main process and add-on process evaluations for summer maximum month conditions. This evaluation also developed detailed AACE Class 5 cost estimates for comparison of the options, and determined the 20-year approximate operating costs for each option (differential operating costs only).

Based on the results of this evaluation, the MBR option remained the lowest capital cost option at $44 million compared with $57 million and $58 million for the other two options. However, factoring in the estimates for annual operating cost differences between the options makes the MBR option far more expensive over a 20-year life cycle compared with the other two options ($141 million versus less than $95 million, including capital and operating costs for 20 years).

Therefore, the recommendation is to upgrade the facility using the 5-stage Bardenpho process with sidestream P removal, according to the lowest capital and operating cost option presented above. This option also presents the most flexible option for operation of the facility, as it can be designed to operate as either a 5-stage Bardenpho process or an A2O process. It can also be designed to operate as a 4-stage Bardenpho or Modified Ludzack-Ettinger process, should the City decide to go to N removal only for groundwater recharge discharge.

If the City would like to replace or add redundancy for its currently aging centrate storage tank, we would recommend building a new centrate storage tank and sizing the centrate pumps for centrate load equalization, which adds approximately $720,000 to the overall construction cost and provides the benefit of reducing peak month chemical use.

## Section 1

# Introduction

The City of Meridian (City) has received a preliminary draft of its new National Pollutant Discharge Elimination System (NPDES) permit, which calls for decreased wastewater resource recovery facility (WRRF) effluent limitations for ammonia-nitrogen ($NH_4$-N), total phosphorus (TP), and other constituents. These proposed permit limits are more stringent than were anticipated in the 2012 Facilities Plan prepared for the City. Therefore, to prepare for the new permit, the City requested help in determining the most appropriate alternatives for expanding the secondary treatment system to meet the new stringent permit.

This work was completed in three steps:

1. Evaluate alternatives for expanding the main secondary treatment process and make a recommendation for the appropriate process expansion based on planning-level capital and operations and maintenance (O&M) cost estimates
2. Once the main treatment alternative has been selected, evaluate processes that can be added to this process to reduce footprint or increase efficiency of the system, narrowing down the potential for add-on processes to the top three selections based on preliminary capital and O&M cost estimates
3. Evaluate the top three alternatives in detail for appropriate sizing to meet all seasonal flow and load conditions and develop more detailed planning-level costs to determine the most cost-effective approach to expanding the facility

This section describes the background information required to complete each of the steps above, including the target effluent concentrations from the draft NPDES permit and the summary influent and centrate parameters used for biological modeling.

## 1.1 Target Effluent Concentrations

The goal of each modeling scenario was to generate effluent characteristics that conform to a set of target conditions. The target conditions were based on draft NPDES permit documents, as well as operational targets discussed with City staff prior to the modeling effort. Target conditions were developed for total ammonia nitrogen ($NH_4$-N), oxidized nitrogen (NOx-N), and orthophosphate ($PO_4$-P).

The draft NPDES permit includes limits for TP, biochemical oxygen demand (BOD), total suspended solids (TSS), ammonia, and a variety of other parameters, including metals and complex organic compounds. Table 1-2 summarizes the permit limits that relate directly to this evaluation.

Table 1-1. October 2014 Draft NPDES Permit (all values in mg/L)

| | Discharge Location: Fivemile Creek | | | | | Discharge Location: Boise River | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Period | Season | Month | Week | Day | Period | Month | Week | Day |
| Summer | | | | | | | | | |
| BOD | May–Sept | – | 20 | 30 | – | May–Sept | 30 | 45 | – |
| TSS | May–Sept | – | 20 | 30 | – | May–Sept | 30 | 45 | – |
| TP | May–Sept | 0.12 | – | – | | May–Sept | 0.07 | 0.165 | – |

Brown AND Caldwell

| Table 1-1. October 2014 Draft NPDES Permit (all values in mg/L) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Discharge Location: Fivemile Creek | | | | | Discharge Location: Boise River | | | |
| | Period | Season | Month | Week | Day | Period | Month | Week | Day |
| $NH_4$-N | May–Sept | – | 0.405 | – | 1.65 | July–Oct | 0.242 | – | 1.06 |
| Winter | | | | | | | | | |
| BOD | Oct–April | – | 20 | 30 | – | Oct–April | 30 | 45 | – |
| TSS | Oct–April | – | 20 | 30 | – | Oct–April | 30 | 45 | – |
| TP | Oct–April | – | – | – | – | Oct–April | – | – | – |
| $NH_4$-N | Oct–April | – | 0.307 | – | 1.25 | Nov–Jun | 0.255 | – | 1.04 |

### 1.1.1 Ammonia

Draft NPDES permit documents specify maximum day ammonia limits for the summer and winter conditions. The limits for discharge location 001 (Fivemile Creek) have been used as the basis of this evaluation, as that is the primary discharge location and presents the most challenging limits to meet. Both maximum month and peak day ammonia limits were considered for this evaluation.

### 1.1.2 Oxidized Nitrogen

Oxidized nitrogen can denitrify within the secondary clarifier, resulting in bubbling of nitrogen gas, which can impair mixed liquor settleability. Further oxidized nitrogen comprises a portion of total nitrogen, which is regulated for production of reclaimed water. The City produces reclaimed water and has a seasonal total nitrogen (TN) limit for this permit of 15.5 milligrams per liter nitrogen (mg/L-N). Therefore, in order to comply with the reclaimed water nitrogen requirements and to reduce the risk of clarifier denitrification, the target effluent NOx-N concentration was set at 8.0 mg/L (monthly average).

### 1.1.3 Phosphorus

Draft NPDES permit documents specify restrictions on phosphorus in the effluent. This will likely require the plant to commence chemical addition to remove phosphorus. To reduce chemical demands, biological P removal should be maximized. The modeling effort aimed to minimize effluent orthophosphate, as much as reasonably possible, giving priority to meeting the above targets for ammonia and oxidized nitrogen. A $PO_4$-P concentration of less than 0.1 mg/L was used as a goal.

When evaluating chemical demands for the final permit limit, the more restrictive limit of 0.07 mg/L TP for the Boise River discharge was used for conservatism in sizing of equipment and storage tanks.

## 1.2 Input Characteristics for Modeling

For this evaluation, two model inputs were used for determining system sizing. One input was used to simulate the primary effluent (PE) and the other was used to simulate the centrate for the predicted design year 2030 conditions. Development of these inputs was completed as part of the Sidestream Nitrogen Evaluation study completed in January 2015. The inputs determined from that study for both summer and winter maximum month conditions and average annual conditions are summarized below.

### 1.2.1 Primary Effluent Characteristics

PE is defined as raw influent (RI) treated in the plant's primary clarifiers. The PE input files do not include contributions from the dewatering centrate, which is presented and discussed later in this section.

The present-day scenarios were developed based upon an assessment of historical RI flows and loadings. Data from 2009–14 were reviewed to determine current average loadings, along with peak month and peak day peaking factors, and day-to-day variability. These data are summarized in Table 1-2.

**Table 1-2. Historical Raw Influent Data Analysis[a]**

| Parameter | RI Flow, mgd | RI BOD, lb/d | RI TSS, lb/d | RI $NH_4$-N, lb/d | RI TP, lb/d |
|---|---|---|---|---|---|
| Summer[b] | | | | | |
| Average | 5.8 | 14,000 | 14,000 | 1,400 | 300 |
| Max month | 6.6 | 16,250 | 17,300 | 1,700 | 350 |
| Max day | 7.5 | 22,000 | 24,000 | 2,000 | 420 |
| Standard error[c] | 0.05 | 0.1 | 0.13 | 0.065 | 0.09 |
| Winter[b] | | | | | |
| Average | 5.1 | 14,500 | 13,750 | 1,570 | 310 |
| Max month | 5.7 | 16,500 | 16,250 | 1,800 | 345 |
| Max day | 6.4 | 21,000 | 28,000 | 1,950 | 375 |
| Standard error[c] | 0.05 | 0.1 | 0.13 | 0.065 | 0.08 |

a. *The values in this table reflect averages over the period from 2009–14.*

b. *Summer data include May–September; winter data include November–March.*

c. *The standard error is calculated by dividing the standard deviation by the mean value. The values in the table represent the average variability in that data over a 30-day period.*

The 2030 scenarios were taken from the 2012 Facilities Plan (July 2012, CH2M Hill and HDR), and are summarized in Table 1-3.

**Table 1-3. 2012 Facilities Plan 2030 Residential/Commercial Flows and Loads[a]**

| Parameter | Unit | Average | Maximum Month | Maximum Week | Maximum Day |
|---|---|---|---|---|---|
| Flow | mgd | 12.2 | 14.2 | 15.5 | 17.2 |
| BOD | lb/d | 27,100 | 34,900 | 42,900 | 46,500 |
| TSS | lb/d | 26,700 | 34,500 | 41,700 | 45,900 |
| $NH_4$-N | lb/d | 3,200 | 3,900 | 4,200 | 4,900 |
| TKN | lb/d | 4,900 | 5,500 | 5,800 | 6,400 |
| TP | lb/d | 660 | 850 | 1070 | 1100 |
| $PO_4$-P | lb/d | 330 | 430 | 500 | 580 |

a. *Table 3-4 of the 2012 Facilities Plan developed by CH2M Hill and HDR.*

Influent loadings (Table 1-2) were used to develop the present-day scenarios, the 2012 Facilities Plan projections (Table 1-3) were used to develop 2030 scenarios, and other projections were based on linear extrapolation between those two data sets. Primary clarifier removal of TSS and BOD were estimated using a pair of empirical models, based on historical performance. These empirical models are described elsewhere (see Sidestream Nitrogen Evaluation, January 2015).

The primary clarifier performance models were used to translate RI BOD and TSS projections from Table 1-3 into PE loadings. RI total Kjeldahl nitrogen (TKN) and TP loadings were assumed to pass through the primary clarifiers unchanged. $NH_4$-N loadings based on Table 1-2 were translated into TKN loadings using the following ratio:

RI $NH_4$-N/TKN = 0.65

which is based on historical averages over the period 2009–14.

Other assumptions include the following:

- PE pH was 7.8 in the summer and 7.9 in the winter, based on historical RI data from 2009–14.
- PE alkalinity was 304 mg/L calcium carbonate ($CaCO_3$), based on data from the May 2011 wastewater characterization.
- PE volatile suspended solids (VSS):TSS ratio was 0.86, based on the May 2011 wastewater characterization.
- PE chemical oxygen demand (COD):BOD ratio was 2.10, based on the May 2011 wastewater characterization.

The PE inputs for each of the model scenarios are summarized in Table 1-4.

**Table 1-4. Primary Effluent Characteristics for each Model Scenario**

| Year | 2030 | 2030 | Current | Current | Midpoint | Midpoint |
|---|---|---|---|---|---|---|
| Season | Summer | Winter | Summer | Winter | Summer | Winter |
| Flow condition | Max month | Max month | Max month | Max month | Average day | Average day |
| Load condition | Max month | Max month | Max month | Max month | Average day | Average day |
| Raw Influent Loadings (from Tables 3 and 4) | | | | | | |
| BOD lb/d | 34,900 | 34,900 | 16,250 | 16,500 | 20,550 | 20,800 |
| TSS lb/d | 34,500 | 34,500 | 17,300 | 16,250 | 20,350 | 20,225 |
| TKN lb/d | 5,500 | 5,500 | 2,615 | 2,769 | 3,527 | 3,658 |
| TP lb/d | 850 | 850 | 350 | 345 | 480 | 485 |
| Primary Clarifier Performance (from empirical models) | | | | | | |
| Primary TSS rem % | 71.7% | 74.6% | 73.2% | 74.8% | 69.4% | 72.0% |
| Primary BOD rem % | 34.9% | 37.8% | 34.4% | 38.2% | 32.6% | 35.7% |
| Primary Effluent Characteristics (BioWin inputs) | | | | | | |
| Flow, mgd | 14.2 | 12.3 | 6.6 | 5.7 | 9.3 | 8.2 |
| COD, mg/L | 403 | 446 | 407 | 451 | 374 | 410 |
| TKN, mg/L | 46.4 | 53.7 | 47.5 | 58.2 | 45.3 | 53.4 |
| TP, mg/L | 7.2 | 8.3 | 6.4 | 7.3 | 6.2 | 7.1 |
| NOx, mg/L | 0 | 0 | 0 | 0 | 0 | 0 |
| pH | 7.8 | 7.9 | 7.8 | 7.9 | 7.8 | 7.9 |
| Alkalinity, mg/L CaCO3 | 304 | 304 | 304 | 304 | 304 | 304 |
| ISS, mg/L | 11.3 | 11.8 | 11.5 | 11.8 | 11.0 | 11.4 |

The PE characteristics were translated into 30-day, hourly model input files according to the following procedure.

Day-to-day variability in loadings was based on the standard errors presented in Table 1-2. It was assumed that the PE variability in flow, COD, TKN, TP, and inert suspended solids (ISS) would match the RI variability in flow, BOD, $NH_4$-N, TP, and TSS, respectively.

Maximum day loadings were incorporated into maximum month scenarios using peaking factors developed from the historical data (Table 1-2), or as presented in the 2012 Facilities Plan.

Diurnal variability was based on a diurnal normalization of key parameters developed during the May 2011 wastewater characterization. The values from the 2011 characterization are plotted on Figure 1-1. A repeat of the wastewater characterization was completed in January 2015, but was found to not significantly differ from that measured in 2011. Therefore, the 2011 wastewater characterization was used.

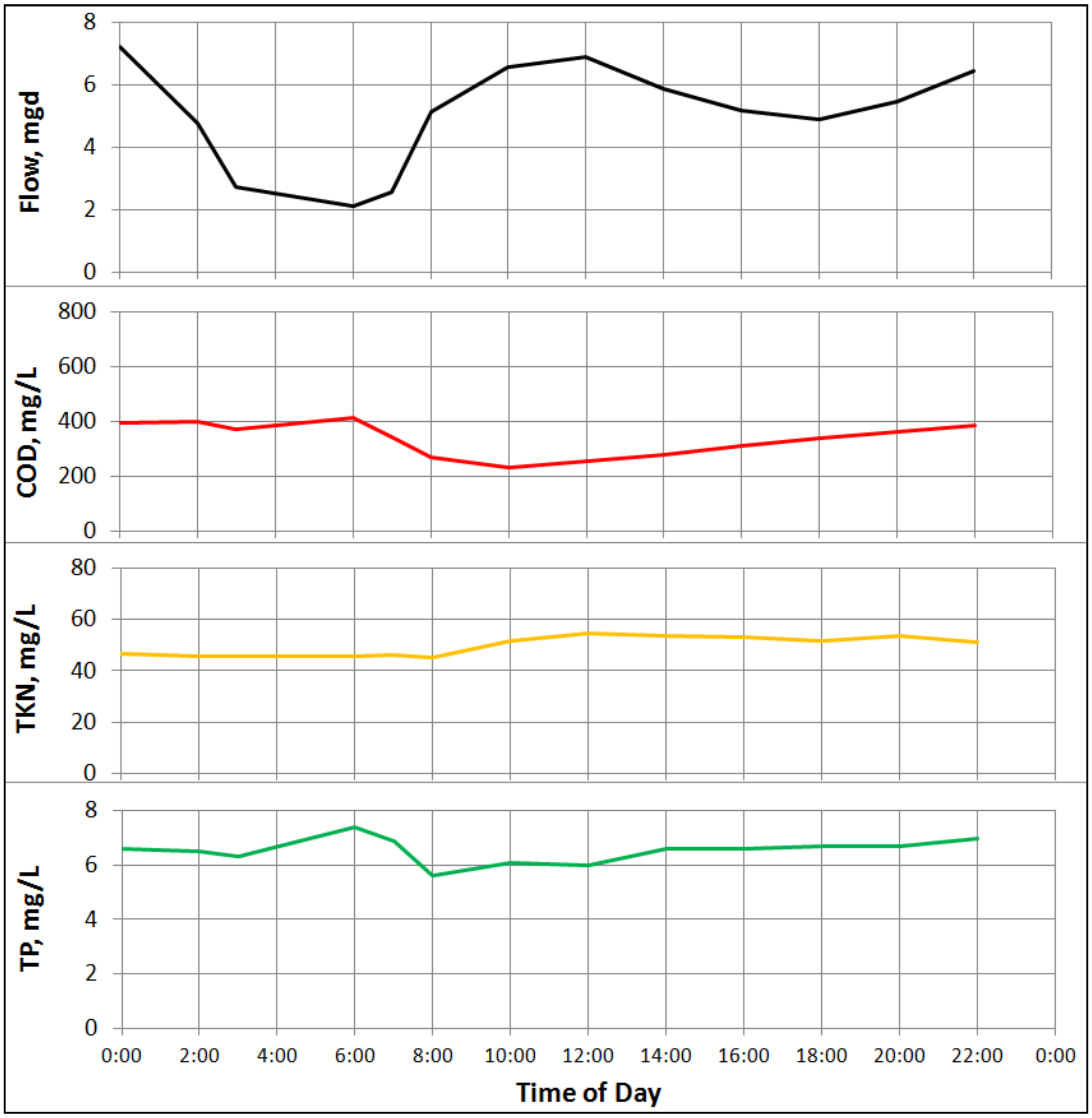


**Figure 1-1. Diurnal variability of raw influent parameters**

*(from May 2011 wastewater characterization)*

Figure 1-2 presents the randomized 30-day model input file for the 2030 summer maximum month condition. This input file includes a peak day flow of 16.9 mgd, which occurs on day 3 of the scenario, a peak day TKN load of 6,320 pounds (lb), which occurs on day 17 of the scenario, and a peak day TP load of 1,080 lb, which occurs on day 23 of the model. These values are all within 12 percent of Facilities Plan peak day projections (Table 1-2); the small deviation reflects the inherent randomization of the model file development.

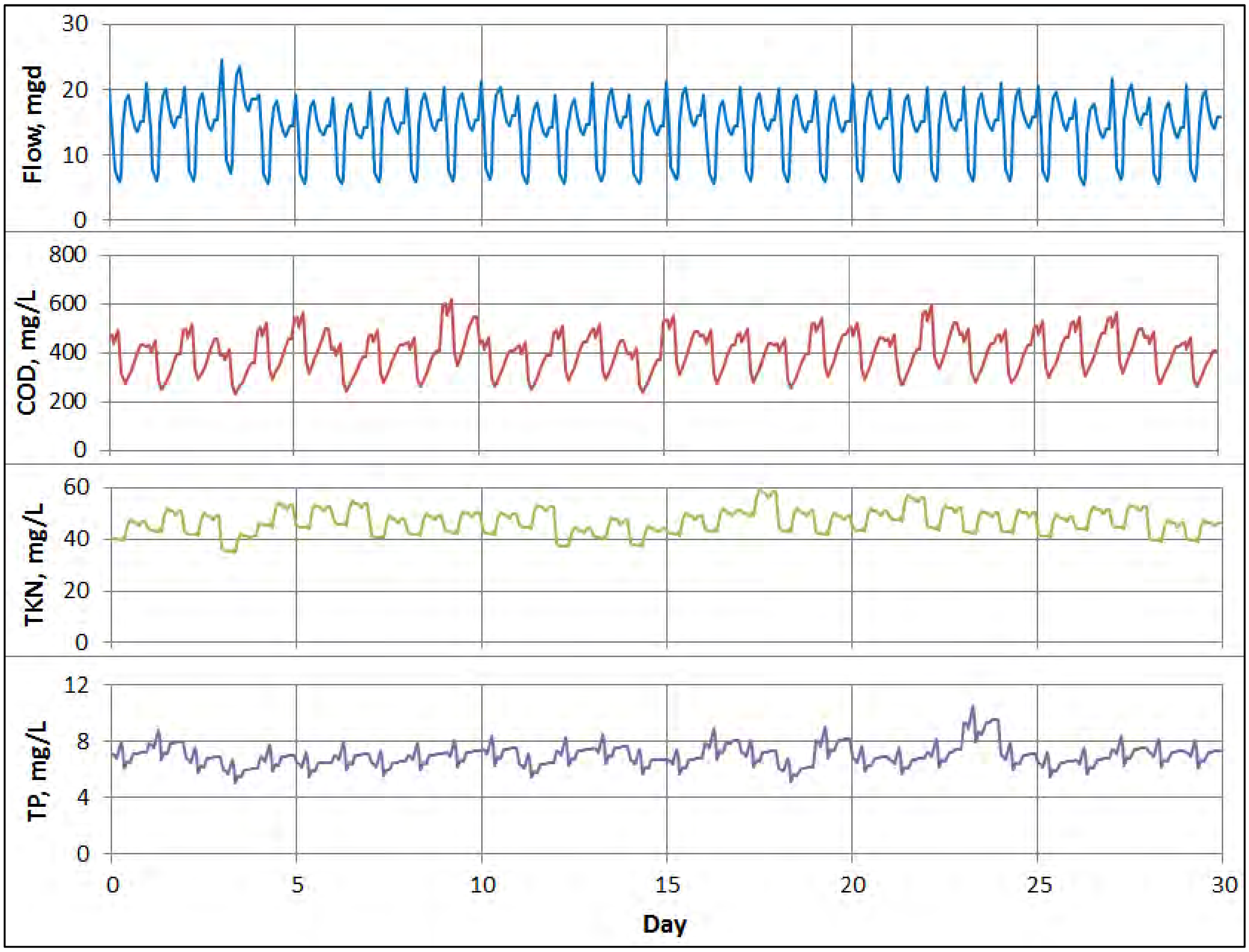


**Figure 1-2. 2030 summer maximum month model input parameters**

### 1.2.2 Centrate Characteristics

Centrate parameters were developed based on the following sources of information:

- Facilities Plan: Table 5-1 in the 2012 Facilities Plan summarizes projected centrate characteristics for the 2030 maximum month condition. The basis of these projections is not known. This table is reproduced below as Table 1-5.

**Table 1-5. Facilities Plan Centrate Projections[a]**

| Parameter | Unit | 2010 | 2030 |
|---|---|---|---|
| Flow | mgd | 0.045 | 0.103 |
| TKN | mg/L | 1,108 | 960 |
| $NH_4$-N | mg/L | 1,057 | 910 |

| Table 1-5. Facilities Plan Centrate Projections[a] | | | |
|---|---|---|---|
| Parameter | Unit | 2010 | 2030 |
| TP | mg/L | 501 | 530 |
| $PO_4$-P | mg/L | 489 | 520 |
| TSS | mg/L | 711 | 640 |
| VSS | mg/L | 522 | 455 |
| BOD | mg/L | 173 | 315 |
| COD | mg/L | 1,756 | 1,805 |
| Alkalinity | mg/L $CaCO_3$ | 3,625 | 4,100 |

*a. Table 5-1 of the 2012 Facilities Plan.*

- Historical plant data: The plant collects weekly data on centrate $NH_4$-N and TSS, and monthly data on centrate TP. These data were used to project the typical variability in centrate characteristics. As centrate flow is not actively metered, centrate flow was assumed to be equal to the "gallons dewatered," which is recorded in the plant's data historian. The historical data are summarized in Table 1-6.

| Table 1-6. Historical Centrate Data Analysis[a] | | | | |
|---|---|---|---|---|
| Parameter | $NH_4$-N | TSS | TP | Gallons Dewatered |
| Unit | mg/L | mg/L | mg/L | gpd |
| Summer[b] | | | | |
| Average | 865 | 185 | 165 | 54,000 |
| Max month | 945 | 270 | – | 68,000 |
| Standard errorc | 0.050 | 0.36 | – | 0.185 |
| Winter[b] | | | | |
| Average | 850 | 145 | 170 | 59,000 |
| Max month | 930 | 230 | – | 70,000 |
| Standard errorc | 0.045 | 0.28 | – | 0.15 |

*a. The values in this table reflect averages over the period from 2009–14.*

*b. Summer data include May–September; winter data include November–March.*

*c. The standard error is calculated by dividing the standard deviation by the mean value. The values in the table represent the average variability in that data over a 30-day period.*

- Data from other plants: Detailed centrate characterization data from the Chambers Creek Regional Wastewater Treatment Plant (WWTP) in Pierce County, Washington, were used to define the input fractions when information on the Meridian centrate stream was not available. Table 1-7 summarizes the centrate input parameters.

| Table 1-7. Centrate Parameters | | |
|---|---|---|
| Parameter | Value | Source |
| Total COD, mgCOD/L | 1,802 | 2012 Facilities Plan |
| Total Kjeldahl nitrogen, mgN/L | 960 | 2012 Facilities Plan |
| Total P, mgP/L | 530 | 2012 Facilities Plan |

**Table 1-7. Centrate Parameters**

| Parameter | Value | Source |
|---|---|---|
| Nitrate N, mgN/L | 0 | Chambers Creek |
| pH | 7.9 | Chambers Creek |
| Alkalinity, mmol/L | 82 | 2012 Facilities Plan |
| Inorganic S.S., mgISS/L | 185 | 2012 Facilities Plan |
| Calcium, mg/L | 24.8 | Chambers Creek |
| Magnesium, mg/L | 2.72 | Chambers Creek |
| Dissolved oxygen, mg/L | 0 | Chambers Creek |
| Fractions | | |
| Fbs: readily biodegradable | 0.595 | Calculated[a] |
| Fac: acetate | 0.039 | Calculated[a] |
| Fxsp: non-colloidal slowly biodegradable | 0.993 | Calculated[a] |
| Fus: unbiodegradable soluble | 0.0039 | Calculated[a] |
| Fup: unbiodegradable particulate | 0.320 | Calculated[a] |
| Fna: ammonia | 0.900 | Calculated[a] |
| Fnox: particulate organic nitrogen | 0.509 | Calculated[a] |
| Fnus: soluble unbiodegradable TKN | 0.015 | Calculated[a] |
| FupN: N:COD ratio for unbiodegradable part. COD | 0.051 | Calculated[a] |
| Fpo4: phosphate | 0.850 | Calculated[a] |
| FupP: P:COD ratio for unbiodegradable part. COD | 0.064 | Calculated[a] |

*a. Fractions were calculated based on a combination of data from the Facilities Plan and Chambers Creek.*

A 30-day randomized centrate itinerary was developed. Day-to-day variability (Figure 1-3) was based on historical data for flow, $NH_4$-N (used as surrogate for TKN), and TSS (used as surrogate for ISS). Other parameters were held constant over the 30 days. The centrate was assumed to be returned continuously over each 24-hour period. No diurnal variability in centrate flow was modeled.

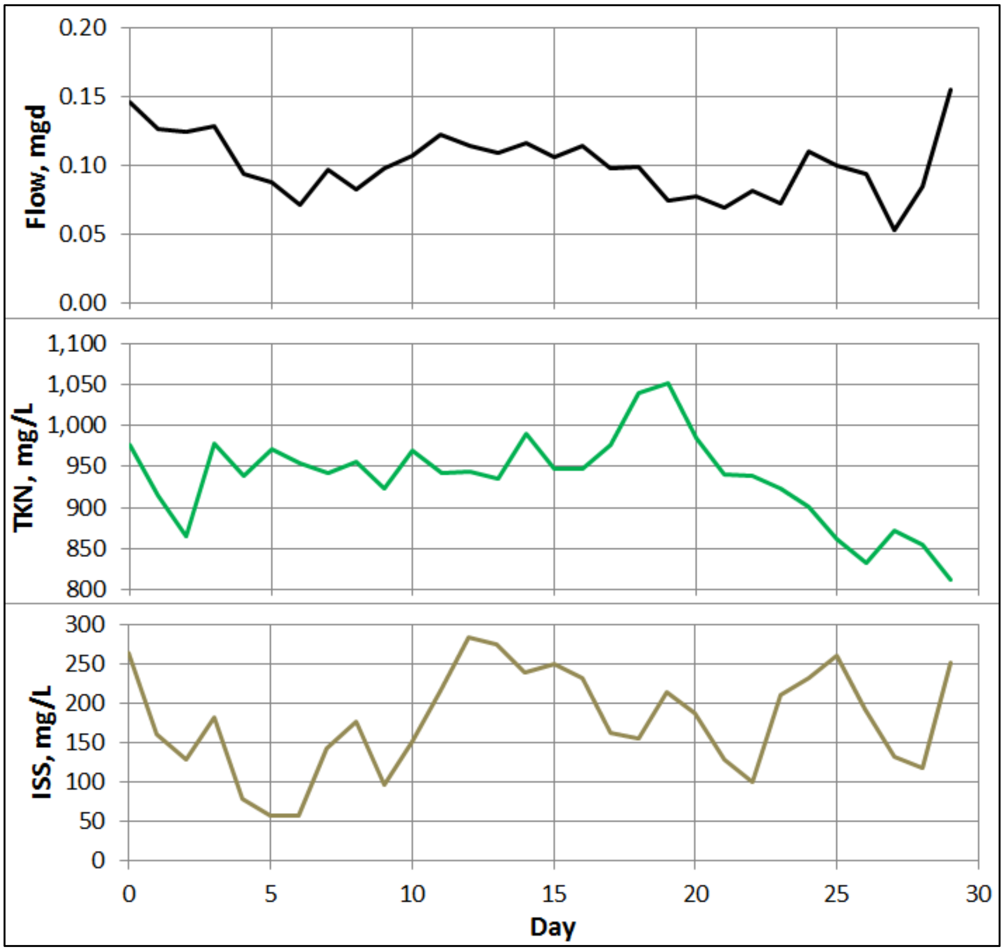


**Figure 1-3. Centrate input variability**

It is important to note that the centrate concentration for TP used for these analyses is very high compared with historical data and typical centrate from BioP facilities. The value used for this analysis was taken from the 2012 Facilities Plan. While this concentration is significantly higher than the highest ever recorded value for centrate TP as reported by plant staff (approximately 275 mg/L, as reported by Tracy Crane), it is unknown why the Facilities Plan predicts such a high concentration. Though this concentration is very high, it was used for this analysis because the reasoning behind development of this value is unknown and cannot be disputed and this high value will present a conservative result for both sizing of the system for full biological P removal and chemical addition systems (for supplemental carbon and chemical removal of phosphorus).

## 1.3 Summary

The required effluent characteristics presented in Table 1-1 were used to define the requirements for system performance for all subsequent evaluations presented in later sections. In addition, the PE and centrate 30-day flow and loading patterns presented in Section 1.2 made up the basis for influent loadings used for all subsequent modeling, with exceptions and changes as noted in later sections of this report.

# Section 2

# Main Process Alternative Screening

This section provides a summary of the preliminary evaluation for main stream processes, which included the following tasks:

- Using the calibrated BioWin model from the Capacity Assessment project to determine the necessary secondary treatment sizing and operating parameters for main stream process alternatives. The following three alternatives are to be evaluated:
  - expansion of the existing system using a 5-stage Bardenpho process (convertible to A2O per City request)
  - expansion of the existing system by conversion to a 4-stage Bardenpho process for N removal only, then discharging to groundwater to eliminate the need for biological P removal
  - expansion of the existing system by conversion to a simultaneous nitrification and denitrification (SND) system with chemical P removal
- Developing high-level cost estimates for each of the three alternatives evaluated for both capital expansion of non-common treatment processes and chemical usage rates.
- Recommending the most cost-effective of the three alternatives for further evaluation.

Following this introduction, this section is organized into four main parts. Sections 2.1 through 2.3 discuss the results of evaluations of each of the three alternatives discussed above. Section 2.4 includes the recommendations for follow-on evaluations.

## 2.1 Alternative 1: Expansion of Existing System Using 5-Stage Bardenpho

This section provides a description of the modeling, sizing, and cost estimate results for the A2O/5-stage Bardenpho expansion alternative. This alternative was considered for expansion as a “base case” expansion of the existing system to provide both biological P and N removal, with tertiary chemical P removal needed for polishing to the final permit limit requirements. Addition of soluble carbon sources to drive the biological nutrient removal processes is also part of this alternative, as required to meet permitted effluent discharge limits. For evaluation of this alternative, as well as all other alternatives, the fermenter is not accounted for in the modeling to determine worst-case carbon addition needs.

### 2.1.1 BioWin Model Setup

The base model used for all BioWin simulations was developed and calibrated to plant operating conditions for the Capacity Assessment project that is currently ongoing with the City. This calibrated model was then modified to reflect the configuration changes necessary to operate in either A2O mode (current operating mode for the plant) or 5-stage Bardenpho mode (to achieve lower TP and TN concentrations with less chemical use).

Figure 2-1 presents the process flow schematic for the system that can operate in the 5-stage Bardenpho configuration, but can be easily reconfigured to operate as an A2O process. This figure also shows the process schematic for the configuration as constructed in BioWin. For the 5-stage Bardenpho process flow schematic, PE enters the first anaerobic zone, where it mixes with additional volatile fatty acids (VFAs) to promote biological P removal. Flow then moves to the first anoxic zone, where the initial stage of denitrification occurs. Flow then enters the first aerobic zone for nitrification, followed by the second anoxic zone, where additional denitrification occurs, with the help of methanol addition for a carbon source. Finally, flow enters the second aerobic stage for polishing and stripping of any N gas in solution before clarification. The mixed liquor recycle (MLR) in the 5-stage Bardenpho configuration returns nitrate-rich mixed liquor from the end of the first aerobic zone to the first anoxic zone for denitrification.

For the BioWin schematic, shown are the secondary pump station, the anaerobic zone (Ana 1), two first-stage anoxic zones (Anox 1a and 1b), the first swing zone (Swing 1), two aerated zones (Aer 1 and 2), the two second swing zones (Swing 2a and 2b), the final aerated zone (Aer 3), and the secondary clarifiers. Also shown are two internal mixed liquor recycle (IMLR) streams, depending on the mode of operation (A2O versus Bardenpho), the clarifier return activated sludge (RAS) and waste activated sludge (WAS) streams, the RAS denitrification basin (RAS Denit Basin), and the secondary effluent (SE). Feed to the system was the PE, as measured during the wastewater characterization period, and the dewatering centrate (Centrate). Chemical addition for enhancing biological P and N removal was achieved through addition of acetate, for phosphorus, and methanol, for TN removal. While the existing plant does have primary sludge fermentation to supplement carbon addition for improved biological N and P removal, because of a lack of information on the fermentate, it was left out of these simulations in lieu of direct chemical carbon supplementation. It is assumed that once additional data are gathered on the fermenter operation, the quantities of acetate and methanol can be refined and lowered at predesign during subsequent sizing and analyses of the selected expansion alternatives.

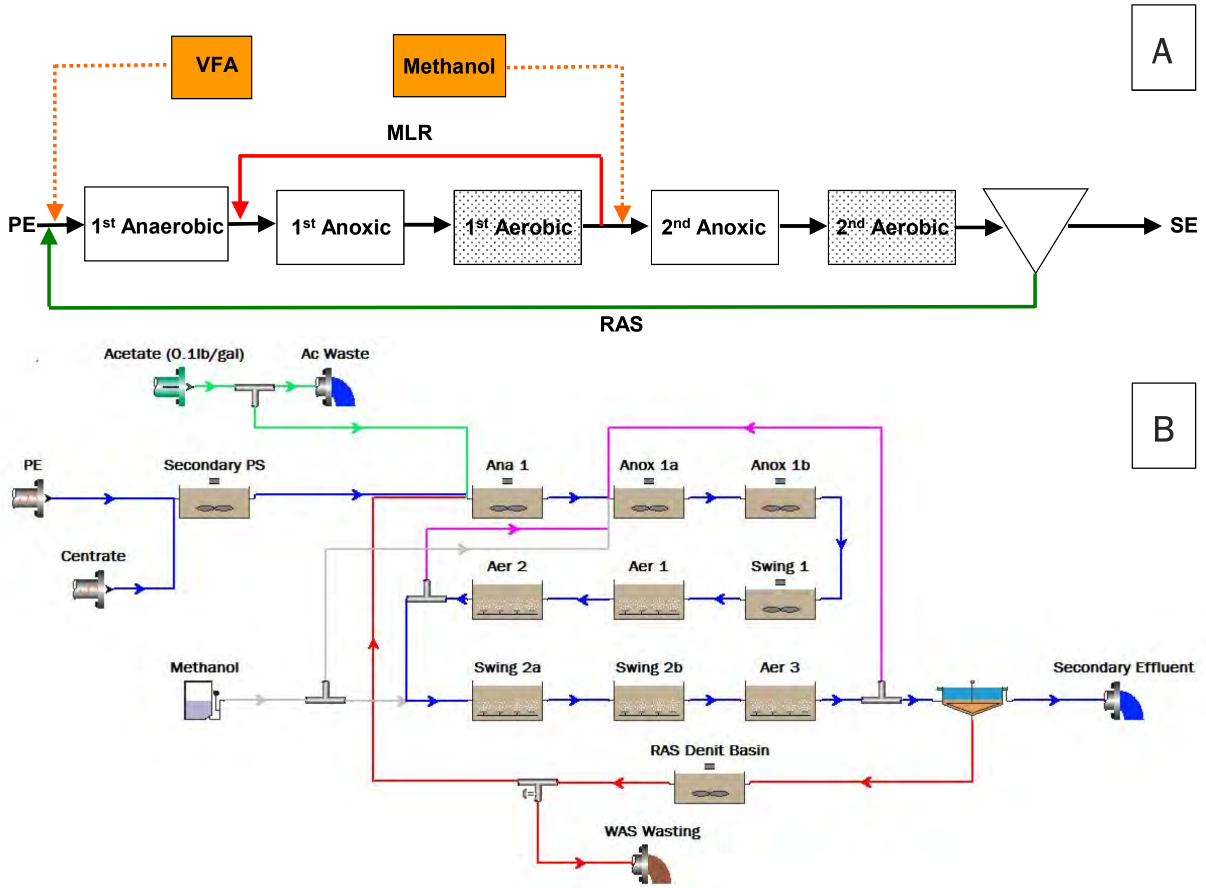


**Figure 2-1. Process flow schematic (A) and BioWin simulator schematic (B) for 5-stage Bardenpho processes**

Once this configuration was developed, it was used to optimally size the treatment system volume and determine operating parameters and chemical usage rates based on the process selected (A2O versus Bardenpho) at winter maximum month flows and loads. Winter conditions were chosen for this first screening-level evaluation because it presents the most restrictive seasonal condition. Summer and average annual conditions were modeled for the final selected alternatives presented later in this report.

The operating limitations for the plant included a maximum operating mixed liquor suspended solids (MLSS) concentration of 4,000 mg/L, assuming that at least one additional secondary clarifier is constructed (common to all alternatives), and operating dissolved oxygen (DO) concentrations of 2.0 mg/L for all aerated zones, with the exception of 1.0 mg/L for Aer 3.

Based on the mode of operation, the system was configured differently. For A2O mode operation, Swing 1 was left unaerated while Swing 2a and 2b were aerated to maintain a DO concentration of 2.0 mg/L. The first MLR was not used, but the MLR immediately after Aer 3 was turned on to recycle nitrate and nitrite for denitrification. Methanol was flow-paced to the PE flow and entered the process at Anox 1a only, as Swing 2a was aerated. Acetate was also flow-paced to the PE flow and entered the system at Ana 1. RAS recycle was set at 50 percent of the PE flow.

For the 5-stage Bardenpho configuration, Swing 1 was aerated to maintain a DO of 2.0 mg/L while Swing zones 2a and 2b were unaerated to set up the second-stage anoxic zone configuration common to the Bardenpho process. The second MLR was turned off and only the first MLR (located after Aer 2) was used. Methanol was flow-paced to PE flow and entered the process at Swing 2a, while acetate was flow-paced to PE flow and entered the process at Ana 1. RAS recycle was set at 50 percent of the PE flow.

For both simulations, the secondary clarifiers were initially set to remove a constant value of 99.9 percent of incoming solids; this value was adjusted very slightly during the simulations to achieve effluent TSS concentrations between 5 and 10 mg/L. Further, it was assumed that a fourth secondary clarifier of equal diameter and volume to existing clarifiers 4 and 5 would be installed to allow for higher operating MLSS concentrations. The clarifier sludge blanket was assumed to be 7 percent of the settler height, and the clarifier solids underflow rate was paced at 50 percent of the PE. The WAS flow rate was adjusted automatically during modeling to regulate the solids retention time (SRT) of the process to maintain nitrification and meet the target effluent concentrations presented in Section 1.

Using these process and effluent constraints and the PE and Centrate influent concentrations discussed in Section 1, optimal system and chemical use sizing was completed for each alternative. The final results of basin sizing, optimum IMLR flow pacing, chemical use, air demand, and WAS production rates are presented in Section 2.1.2.

### 2.1.2 Model Results for Winter Conditions

The results of modeling showed that the 5-stage Bardenpho processes required approximately the same overall tank volume and operating SRT to achieve the effluent target concentrations presented in Table 2-1 as the A2O process. While the tank volumes were similar, the chemical usage rate for methanol was three times higher for the A2O process than for the 5-stage Bardenpho process. Conversely, the acetate requirements for the Bardenpho process were 1.3 times higher than for the A2O process. The airflow requirements and WAS production rates were higher for the A2O process because of greater overall supplemental carbon added and more aerated volume. The overall process sizing and monthly average air demands, WAS production, and chemical usage rates for the Bardenpho process configuration is presented in Table 2-1. Detailed model outputs from the BioWin modeling for each approach are presented in Appendix A of this report.

It is important to note that airflow requirements are estimated using BioWin modeling software and do not necessarily reflect the true airflow amounts that would be anticipated. However, they do allow for comparison of relative airflow needs among alternatives and can be used to estimate annual O&M costs on a relative order-of-magnitude basis.

WAS production estimates provided are for information only and for comparison among alternatives as expansion of solids handling facilities to meet increased solids needs are outside the scope of this study. The same holds for additional chemical sludge generated from tertiary chemical P removal and filtration necessary to achieve final effluent concentrations of 0.07 mg/L TP. It is assumed that the chemical removal of phosphorus is to remove the difference between the secondary effluent TP (as high as 0.5 mg/L) and the final effluent permit requirement of 0.07 mg/L TP, plus the amount of alum added to meet this requirement on a monthly average basis. These values are also provided in Table 2-1.

| Table 2-1. 5-Stage Bardenpho Modeling Results | | |
|---|---|---|
| Unit Process | Parameter/Unit | Value |
| Required SRT for nitrification | -, days | 12 |
| Activated sludge basin total | Volume, Mgal | 7.25 |
| Anaerobic cell 1 (Ana 1) | Volume, Mgal | 0.5 |
| Anoxic cell 1a (Anox 1a) | Volume, Mgal | 0.375 |
| Anoxic cell 1b (Anox 1b) | Volume, Mgal | 0.375 |
| Swing cell 1 | Volume, Mgal | 0.5 |
| Aerobic cell 1 (Aer 1) | Volume, Mgal | 1.5 |
| Aerobic cell 2 (Aer 2) | Volume, Mgal | 2.0 |
| Swing cell 2a (Swing 2a) | Volume, Mgal | 0.75 |
| Swing cell 2b (Swing 2b) | Volume, Mgal | 0.75 |
| Aerobic cell 3 (Aer 3) | Volume, Mgal | 0.5 |
| MLR rate | Flow rate, percent of PE | 200 |
| WAS production | Mass rate, lb/d | 23,250 |
| Additional chemical sludge from P removal to 0.07 mg/L | Mass rate, lb/d | 1,900 |
| Alum requirement for chemical P removal | Flow rate, gal/d | 800 |
| Airflow requirement | Flow rate, scfm | 20,510 |
| Acetate use | Flow rate, lb/d | 9,230 |
| Methanol use | Flow rate, gal/d | 615 |

It is important to note that while the high chemical demand for acetate and methanol is driven by the effluent P and TN effluent requirements because of insufficient soluble carbon in the influent, the large increase in tank volume was mainly due to the high SRT required to maintain sufficient nitrification to meet very stringent effluent ammonia limits. This stringent limit is more difficult to meet because of the high variability in influent TKN and ammonia-nitrogen in the centrate recycle stream, as was also determined in the Sidestream Nitrogen Removal Evaluation. Alternative means of reducing this variability, and potentially SRT and basin volume, will be evaluated in more detail in the subsequent add-on processes evaluation.

These parameters are used in developing the preliminary capital and operating cost estimates presented in Section 2.1.3.

### 2.1.3 Preliminary Capital and Operating Cost Estimates

In order to meet the 2030 maximum month conditions, the main secondary treatment process will need to be expanded. The critical factor is maintaining a high enough SRT to ensure that the maximum monthly and daily ammonia concentrations are not exceeded. This results in a high MLSS concentration, which imposes a high solids loading to the secondary clarifiers. For the winter condition, with a maximum month flow of 12.3 million gallons per day (mgd) and a maximum day flow of 13.8 mgd, the maximum allowable MLSS concentration will be approximately 4,000 mg/L assuming that at least one new secondary clarifier matching dimensions of existing clarifiers 4 and 5 is constructed.

Using these criteria, the sizes of the aeration basins required to meet the effluent targets for the 2030 maximum month condition were 7.25 million gallons (Mgal). Given 2.4 Mgal of existing volume, the scope of the basin expansion would be 4.9 Mgal. The existing basins would also need to be retrofitted to accommodate the updated configuration, though these retrofits would be similar in cost and scope among all alternatives (move baffle walls, reconfigure aeration grids, add/move IMLR) and therefore are not considered in the cost comparison of alternatives provided in Section 5.

#### 2.1.3.1 Capital Costs

The City of Nampa, Idaho, is currently expanding its aeration basins by 3.3 Mgal. Given the proximity to Meridian, and the similarity among projects, the costs from the Nampa expansion have been used to project relative costs of aeration basin expansion at Meridian. The Nampa aeration basin expansion is projected to have a direct cost of $2.55 million, which computes to $771,900/Mgal. Because of minor inflation and other factors that have occurred since the Nampa cost estimate was completed, this value should be inflated by about 10 percent, which brings the estimate to $850,000/Mgal. Extrapolating to the scope of expansion for this alternative, the capital cost (without contractor markups) to expand just the aeration tanks is expected to be approximately $4.17 million.

Additional facilities will need to be constructed as part of this alternative that are not common to the other alternatives and mainly consist of the acetate and methanol chemical handling and metering facilities. The estimated costs for these facilities, as well as the cost for expansion of the activated sludge basins, are summarized in Table 2-2. It is important to note that the costs provided on this table are preliminary planning-level costs that do not include contractor markups and special conditions like contingency, markups, engineering, tax, bonds, or insurance. In addition, these costs do not reflect costs for common expansion requirements among all alternatives, such as additional secondary clarifiers, solids system expansions, or construction of already planned facilities like the headworks or primary clarifiers. This means that these costs do not reflect the true cost for construction, but provide comparative costs for evaluating differences among the expansion alternatives only. Final Association for the Advancement of Cost Engineering (AACE) Class 5 construction cost estimates will be provided for the final recommended expansion alternatives associated with additional tasks for this work.

**Table 2-2. Planning-Level Comparative Capital Costs for 5-Stage Bardenpho Expansion**

| Process | Quantity | Unit Cost | Total |
|---|---|---|---|
| Greenfield aeration basin tank expansion | 4.9 Mgal | $850,000/Mgal | $4,170,000 |
| Existing basin retrofit | Common to all alternatives | | |
| New secondary clarifiers | Common to all alternatives | | |
| Tertiary filtration (membranes) | Common to all alternatives | | |
| Chemical P removal facilities | – | – | $62,500 |
| Acetate addition facilities | – | – | $106,500 |
| Methanol addition facilities | – | – | $568,000 |
| Total | – | – | $4,907,000 |

*Note: costs provided in this table reflect construction cost only and do not include contractor markups, contingency, inflation to midpoint of construction, bonds, insurance, etc. A more complete construction cost estimate will be provided as part of the final report.*

#### 2.1.3.2 Operating Costs

The modeling results in Table 2-2 translate into operating costs associated with acetate and methanol dosing, aeration demand, biosolids hauling, and chemical addition for P removal. The following assumptions were used to develop these costs:

- electricity: $0.069 per kilowatt-hour (kWh)
- biosolids hauling and application: $5.933 per wet ton (assuming 20 percent cake solids)
- methanol: $2.25 per gallon (gal)
- acetate: $0.74/lb
- aeration energy demand: 30 kWh per standard cubic foot per minute (scfm) per month
- chemical addition for P removal: $1.22/gal of alum

The electric and biosolids costs come from the plant. The methanol cost is a long-term average value from Olympia, Washington. The price of methanol is unstable, and has varied from close to $1.00 per gallon to over $4.50 per gallon during the past 10 years. The cost for acetate is a single value obtained from a local chemical supplier to the Boise area. The aeration energy demand is based on data from other plants with similar process demands. The chemical addition cost for P removal is a cost for alum addition determined for the City of Nampa in 2013.

The annual operating costs are summarized in Table 2-3.

Table 2-3. Maximum Month Operating Costs for 5-Stage Bardenpho Alternative

| Parameter | Quantity | Unit Cost | Total per Month |
|---|---|---|---|
| Methanol | 18,450 gal | $2.25/gal | $42,000 |
| Acetate | 173 tons | $0.74/lb | $260,000 |
| Process aeration | 20,510 scfm | $0.069/kWh | $41,000 |
| Biosolids hauling | 1,900 wet tons | $5.933/wet ton | $11,000 |
| P removal chemical | 24,000 gal | $1.22/gal | $29,000 |
| **Total** | | | **$383,000** |

The maximum month operating cost for carbon addition, aeration, biosolids disposal, and chemical P removal for the 5-stage Bardenpho system is approximately $380,000. This cost represents the maximum monthly operating cost for this alternative. Other winter monthly operating costs will be less than this amount as they will be of lower flow and load.

## 2.2 Alternative 2: Expansion for Nitrogen Removal Only (Groundwater Infiltration)

This subsection provides a description of the modeling, sizing, and cost estimate results for the 4-stage Bardenpho expansion alternative, with discharge to groundwater. This alternative looks at a process that removes nitrogen only, with the intent of eliminating the current outfall discharge points to both Fivemile Creek and the Boise River, with an alternate discharge to groundwater. This alternative builds on the groundwater infiltration alternatives that the City is currently investigating in another project. Because phosphorus is not a regulated constituent in groundwater per the Idaho Ground Water Quality Rule (Idaho Administrative Procedures Act [IDAPA] 58, Title 01, Chapter 11), biological P removal is not necessary for this alternative. Nitrate-nitrogen and nitrite-nitrogen are the primary constituents of concern for groundwater discharge.

### 2.2.1 BioWin Model Setup

The calibrated base model used for all BioWin simulations was modified to reflect the configuration changes necessary to operate in 4-stage Bardenpho mode. Figure 2-2 presents the process flow schematic for the system as well as the BioWin process flow schematic. For the process flow schematic, the four stages that compose the 4-stage Bardenpho process include a first anoxic cell for initial denitrification, a first aerobic cell for nitrification, a second-stage anoxic cell for further denitrification, and a final aerobic cell for air stripping of nitrogen gas and last-minute polishing of the wastewater prior to clarification. The methanol addition for carbon is to the second anoxic cell, while the MLR returns nitrate-rich mixed liquor to the first anoxic cell for denitrification.

For the BioWin process flow schematic, shown are the secondary pump station, a first-stage anoxic zone (Anox 1), two swing zones (Swing 1 and Aer 1/Swing 2), two aerated zones (Aer 2 and 3), two second-stage anoxic zones (Anox 2a and 2b), the final aerated zone (Post Aer), and the secondary clarifiers. An IMLR stream (from Aer 3 effluent to Anox 1 influent) is also shown, along with the RAS and WAS streams, the RAS denitrification basin (RAS Denit Basin), and the secondary effluent. Feed to the system was the PE, as measured during the wastewater characterization period, and the dewatering centrate (Centrate). Methanol addition was used to enhance biological N removal (denitrification). The existing plant has primary sludge fermentation to supplement carbon addition for improved biological N removal. However, because of a lack of information on the fermentate, it was left out of these simulations in lieu of direct chemical carbon supplementation. It is assumed that the quantities of methanol can be refined at predesign once additional data are gathered on the fermenter operation.

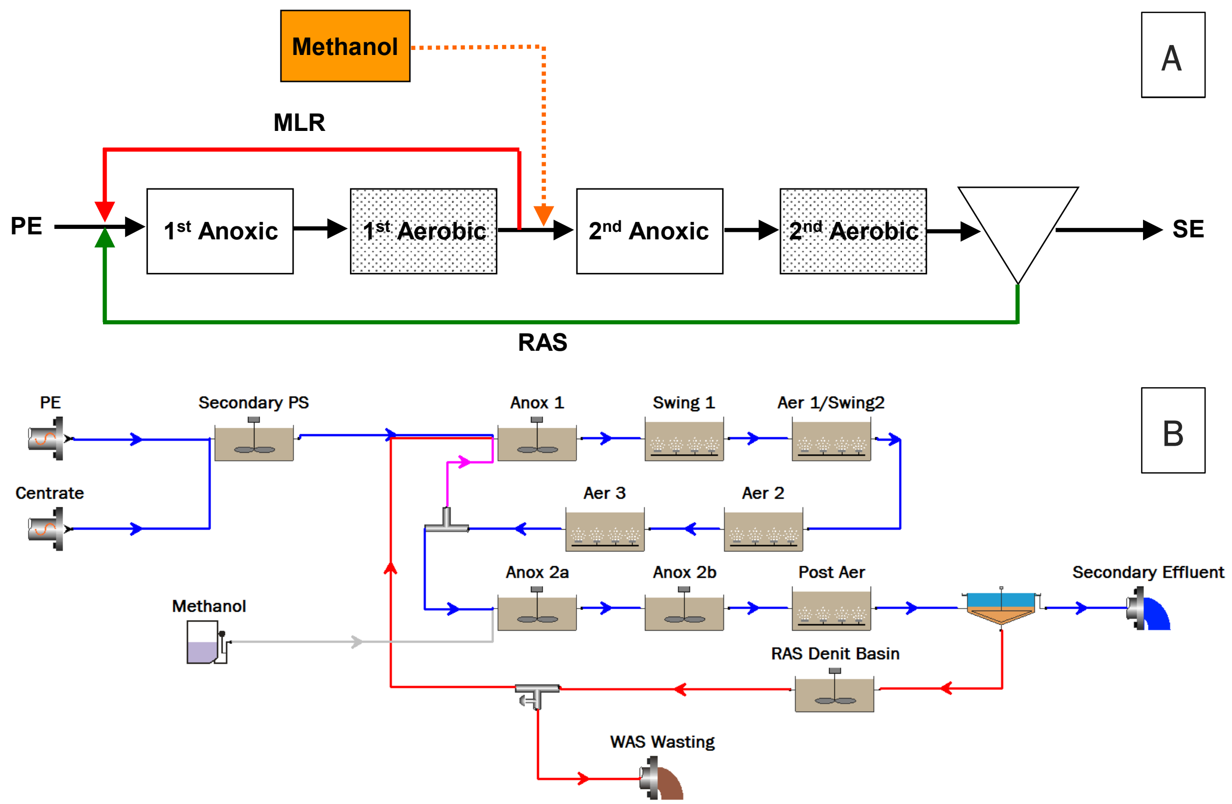


**Figure 2-2. Process flow schematic (A) and BioWin simulator schematic (B) for 4-stage Bardenpho processes**

This configuration was used to optimally size the treatment system volume and determine operating parameters and chemical usage rates at winter maximum month flows and loads. The operating limitations for the plant included a maximum operating MLSS concentration of 4,000 mg/L, assuming that a fourth secondary clarifier is constructed (common to all alternatives), and an operating DO concentration of 2.0 mg/L is used for all aerated zones (with the exception of 3.6 mg/L for Aer 1/Swing 2). Effluent limitations for BOD and TSS are the same as listed in Section 1.

However, as this option does not discharge to either Fivemile Creek or the Boise River, the surface water discharge requirements for nitrogen and phosphorus species no longer apply. Instead, nitrogen species effluent limits, listed in Table 2-4, were set by IDAPA 58.01.11 primary constituent standards. There are currently no limits for phosphorus for discharge to groundwater.

**Table 2-4. Target Effluent Concentrations (all values in mg/L)**

| Parameter | Daily Maximum |
|---|---|
| $NO_3$-N | 10 |
| $NO_2$-N | 1 |
| NOx-N | 10 |

The PE and centrate used for all simulations were discussed in Section 1 of this report. For preliminary evaluations discussed here, only winter conditions were evaluated. Summer conditions will be evaluated for final comparisons.

For the Alternative 2 simulations, the secondary clarifiers were set to remove a constant value of 99.9 percent of incoming solids. It was assumed that a fourth secondary clarifier of equal diameter and volume to existing clarifiers 4 and 5 would be installed to allow for higher operating MLSS concentrations. The clarifier sludge blanket was assumed to be 7 percent of the settler height, and the clarifier solids underflow rate was paced at 70 percent of the PE. The WAS flow rate was adjusted automatically during modeling to regulate the SRT of the process to maintain nitrification and meet the target effluent N concentrations presented in Table 2-4.

Using these process and effluent constraints and the PE and Centrate influent concentrations discussed here, optimal system and chemical use sizing was completed. The final results of basin sizing, optimum MLR flow pacing, chemical use, air demand, and WAS production rates are presented in Section 2.2.2.

### 2.2.2 Model Results for Winter Conditions

Table 2-5 shows the Alternative 2 process sizing and operating parameters required to achieve the effluent target concentrations listed in Table 2-4. With fewer effluent restrictions, overall tank volume was reduced by 1.5 MGal compared to Alternative 1. The Alternative 2 process also required less methanol addition (six times less than the A2O/5-stage Bardenpho process) and no acetate addition. The airflow requirements and WAS production rates were also lower for Alternative 2 because of less aerated volume and less supplemental carbon added. Detailed model outputs from the BioWin modeling are presented in Appendix A of this report.

Airflow requirements were estimated using BioWin modeling software and do not necessarily reflect the true airflow amounts that would be anticipated. However, they do allow for comparison of relative airflow needs among alternatives and can be used to estimate annual O&M costs on a relative order-of-magnitude basis. Similarly, WAS production estimates are for information only and for comparison among alternatives as expansion of solids handling facilities to meet increased solids needs are outside the scope of this study.

| Table 2-5. 4-Stage Bardenpho (N Removal Only) Modeling Results | | |
|---|---|---|
| Unit Process | Parameter/Unit | Value |
| Required SRT for nitrification | -, days | 14 |
| Activated sludge basin total | Volume, Mgal | 5.75 |
| Anoxic cell 1 (Anox 1) | Volume, Mgal | 1.25 |
| Swing cell 1 (Swing 1) | Volume, Mgal | 0.5 |
| Swing cell 2 (Aer 1/Swing 2) | Volume, Mgal | 0.5 |
| Aerobic cell 2 (Aer 2) | Volume, Mgal | 1.0 |
| Aerobic cell 3 (Aer 3) | Volume, Mgal | 1.0 |
| Anoxic cell 2a (Anox 2a) | Volume, Mgal | 0.5 |
| Anoxic cell 2b (Anox 2b) | Volume, Mgal | 0.5 |
| Post-aerobic cell (Post Aer) | Volume, Mgal | 0.5 |
| IMLR rate | Flow rate, percent of PE | 400 |
| WAS production | Mass rate, lb/d | 11,350 |
| Airflow requirement | Flow rate, scfm | 17,780 |
| Acetate use | Flow rate, gal/d | 0 |
| Methanol use | Flow rate, gal/d | 310 |
| MLSS | Average conc., mg/L | 3,270 |

The effluent nitrite target (1.0 mg nitrite-nitrogen per liter [$NO_2$-N/L]) proved to be the limiting parameter while modeling Alternative 2. To achieve this target concentration (while limiting chemical addition), additional volume was provided in the first anoxic zone (to reach 1.25 MGal) and the IMLR rate was increased to 400 percent of the PE flow. The SRT was increased to 14 days to allow for more complete nitrification from ammonia-nitrogen to nitrate-nitrogen. Because of high variability in influent TKN and ammonia-nitrogen, methanol feed was flow-paced to the PE stream, with an average daily use of 310 gallons per day (gpd). Means for reducing the influent variability, and potentially SRT and basin volume, will be evaluated in more detail in the subsequent add-on processes evaluation. It is important to point out that the overall methanol usage rate dropped from the previous option. This is because the soluble BOD from the influent for Alternative 2 goes to offset the methanol demand as it can be used for denitrification, while for Alternative 1, all soluble BOD goes to the BioP process.

The modeling results were used to develop the preliminary capital and operating cost estimates presented in Section 2.2.3.

### 2.2.3 Preliminary Capital and Operating Cost Estimates

To treat the 2030 maximum month flow and loading conditions, the main secondary treatment process will need to be expanded. As discussed in Section 2.2.2, a high SRT is required to achieve low effluent nitrite concentrations. This results in a high MLSS concentration, which imposes a high solids loading to the secondary clarifiers. For the winter condition, with a maximum month flow of 12.3 mgd and a maximum day flow of 13.8 mgd, the maximum allowable MLSS concentration will be approximately 4,000 mg/L. This assumes that one new secondary clarifier matching the dimensions of clarifiers 4 and 5 is constructed (this assumption is common to all alternatives evaluated).

As shown in Table 2-5, 5.75 Mgal of activated sludge volume is required to meet effluent targets for the 2030 maximum month condition. Given 2.4 Mgal of existing volume, the scope of basin expansion would be 3.35 Mgal. The existing basins would also need to be retrofitted to accommodate the updated configuration, though these retrofits would be similar in cost and scope among all alternatives (e.g., move baffle walls, reconfigure aeration grids, and add/move MLR).

#### 2.2.3.1 Capital Costs

Table 2-6 summarizes the capital costs expected for Alternative 2. The cost for the Nampa aeration basin expansion was used as a basis for greenfield basin expansion at Meridian. With a unit cost of $850,000/Mgal, the capital cost to expand just the aeration tanks is expected to be approximately $2.85 million. The retrofit of the existing activated sludge tanks (2.4 Mgal) is common to all alternatives.

This alternative requires a series of capital improvements to accommodate effluent discharge to groundwater through infiltration basins. These improvements include:

- purchase of land for the infiltration site (approximately 96 acres at $16,000/acre)
- construction of earthen infiltration basins (five total at 15 acres each, plus buffer)
- construction of a large effluent pump station at the WRRF (1,320 horsepower)
- installation of 4.5 miles of 36-inch-diameter ductile iron pipe to reach the infiltration site
- construction of additional chlorine disinfection facilities to treat the effluent to Class A reuse standards

Brown and Caldwell previously developed technical memorandum (TM) T-01 (“Draft Business Case Evaluation,” 2013) to investigate infiltration as a wastewater effluent management alternative for the City. The TM examined the capital and operating costs for Meridian to discharge to infiltration basins (Attachment C of that document). These planning-level costs were used as a basis for the infiltration-related costs in Table 2-6, with adjustments made for inflation (3 percent per year to reach 2015 dollars) and to account for new potential infiltration sites.

**Table 2-6. Planning-Level Comparative Capital Costs for 4-Stage Bardenpho (N Removal Only) Expansion**

| Process | Quantity | Unit Cost | Total |
|---|---|---|---|
| Greenfield aeration basin tank expansion | 3.35 Mgal | $850,000/Mgal | $2,850,000 |
| Existing basin retrofit | Common to all alternatives | | |
| Additional secondary clarifiers | Common to all alternatives | | |
| Methanol addition facilities | – | – | $281,000 |
| Additional chlorine chemical disinfection | – | – | $1,736,000 |
| Effluent pump station | – | – | $4,206,000 |
| Effluent pipeline | – | – | $8,723,000 |
| Infiltration basins | – | – | $5,903,000 |
| Land purchase[a] | – | – | $1,530,000 |
| **Total** | | | **$25,228,000** |

*a. Assumes 96 acres at $15,900 per acre.*

*Note: costs provided in this table reflect construction cost only and do not include contractor markups, contingency, inflation to midpoint of construction, bonds, insurance, etc. A more complete construction cost estimate will be provided as part of the final report.*

It is important to note that the costs provided in Table 2-6 are preliminary planning-level costs that do not include contractor markups and special conditions. In addition, these costs do not reflect costs for common expansion requirements among all alternatives, such as additional secondary clarifiers, solids system expansions, or construction of already-planned facilities like the headworks or primary clarifiers. This means that these costs do not reflect the true cost for construction, but provide comparative costs for evaluating differences among the expansion alternatives only. Final AACE Class 5 construction cost estimates will be provided for the final recommended expansion alternatives associated with additional tasks for this work.

#### 2.2.3.2 Operating Costs

The modeling results in Table 2-5 translate into operating costs associated with methanol dosing, aeration demand, and biosolids hauling. Additional costs associated with discharge to infiltration basins must also be considered, including electrical costs for the effluent pump station and additional labor costs.

The following assumptions were used to develop these costs:

- electricity: $0.069/kWh
- biosolids hauling and application: $5.933/wet ton (assuming 20 percent cake solids)
- methanol (99 percent solution): $2.25/gal
- aeration energy demand: 30 kWh per standard cubic foot per minute (scfm) per month
- sodium hypochlorite: $1.33/gal
- labor full-time equivalent (FTE): $60,000

The electric and biosolids costs were provided by Meridian WRRF staff. The methanol cost is a long-term average value from Olympia, Washington. The price of methanol is unstable, and has varied from close to $1.00 per gallon to over $4.50 per gallon during the past 10 years. The aeration energy demand is based on data from other plants with similar process demands. The sodium hypochlorite cost is from TM T-01, inflated to 2015 dollars. It was assumed that $40,000 per year would be required for maintenance and replacement parts for the infiltration components (pump station, pipeline, basins, etc.), per TM T-01.

The maximum monthly operating costs are summarized in Table 2-7. Based on the results of this table, the maximum monthly operating costs for the 4-stage Bardenpho alternative would be approximately $107,000. This is the maximum month winter operating cost for this alternative. Other winter months with lower than maximum monthly loads will have lower operating costs for this option.

**Table 2-7. Maximum Monthly Operating Costs for 4-Stage Bardenpho (N Removal Only) Alternative**

| Parameter | Quantity | Unit Cost | Total |
|---|---|---|---|
| Methanol | 9,500 gal | $2.25/gal | $21,000 |
| Process aeration | 533,400 kWh | $0.069/kWh | $37,000 |
| Biosolids hauling[a] | 860 wet tons | $5.933/wet ton | $5,000 |
| Effluent pump station electrical cost | 232,000 kWh | $0.069/kWh | $16,000 |
| Additional chlorine disinfection[b] | 13,000 gal | $1.33/gal | $17,000 |
| Maintenance and replacement parts for groundwater discharge components[a] | – | – | $11,000 |
| **Total** | | | **$107,000** |

a. *Estimated in TM T-01 “Draft Business Case Evaluation,” October 21, 2013; includes labor (1.5 FTE at $60,000 per FTE) and $40,000 in yearly allowances for replacement parts.*

b. *Estimated in TM T-01 “Draft Business Case Evaluation,” October 21, 2013; cost inflated to 2015 dollars.*

## 2.3 Alternative 3: Simultaneous Nitrification/Denitrification with Chemical Phosphorus Removal

This section provides a description of the modeling, sizing, and cost estimate results for SND in a 4-stage Bardenpho configuration expansion alternative for intended discharge to Fivemile Creek. This alternative requires chemical P removal for all phosphorus in the effluent. SND requires strict control of DO in the aerated zones of the basin in order to force nitrification and denitrification to occur together in the aerated zones. This is done in order to shrink the size of the basins while also reducing soluble carbon needed to drive the denitrification processes.

### 2.3.1 BioWin Model Setup

The base model was developed and calibrated to plant operating conditions and modified to simulate the operation of a 4-stage Bardenpho configuration in a low DO SND mode. The flow schematic for the 4-stage Bardenpho process is presented and described in detail previously in Figure 2-3. The configuration as constructed in the BioWin simulator is presented in Figure 4-1. Shown are the first-stage anoxic zone (Anx 1), two aerated zones (Aer 1 and 2), the second anoxic zone (Anx 2), the final aerated zone (Aer 3), and the secondary clarifier. Also shown is the IMLR stream, the clarifier RAS and WAS streams, the RAS denitrification basin (RAS Denit Basin), and the secondary effluent. Feed to the system was the PE, as measured during the wastewater characterization period, and the dewatering centrate (Centrate). Methanol can be added to the second anoxic zone to enhance denitrification if necessary to meet the effluent TN limit. However, the successful operation in SND mode avoided the need of supplemental carbon addition as seen below.

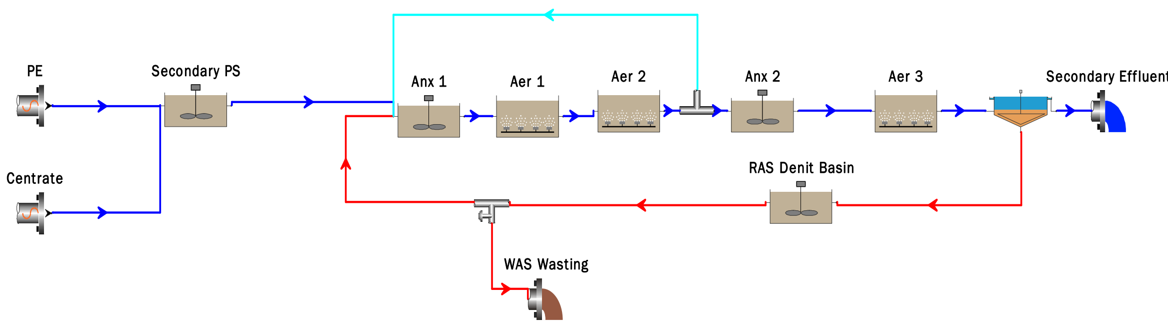


**Figure 2-3. Process flow schematic in BioWin simulator for SND alternative**

Once this configuration was developed, it was used to optimally size the treatment system volume and determine operating parameters at winter maximum month flows and loads. The operating limitations for the plant included a maximum operating MLSS concentration of 4,000 mg/L, assuming that a fourth secondary clarifier is constructed (common to all alternatives). The low DO SND was achieved by operating DO concentrations of 0.5 mg/L and 0.3 mg/L for the first aerated zone (Aer 1) and second aerated zone (Aer 2), respectively, with the exception of 2.0 mg/L for the third aerated zone (Aer 3), and effluent limitations according to Section 1. The monthly average values used to generate diurnal input for the model were also discussed in Section 1. For preliminary evaluations discussed here, only winter conditions were evaluated. Summer conditions will be evaluated for final comparisons.

The clarifier sludge blanket was assumed to be 7 percent of the settler height, and the clarifier solids underflow rate was paced at 50 percent of the PE. The WAS flow rate was adjusted automatically during modeling to regulate the SRT of the process to maintain nitrification and meet the target effluent ammonia concentrations presented in Section 1.

Using these process and effluent constraints and the PE and Centrate influent concentrations, an optimal system was completed for the SND alternative. The final results of basin sizing, optimum IMLR flow pacing, air demand, and WAS production rates are presented in Section 2.3.2.

### 2.3.2 Model Results for Winter Conditions

The low DO operation results in the adaptation of microbial population, especially ammonia-oxidizing bacteria (AOB) and nitrite-oxidizing bacteria (NOB) and ordinary heterotrophic organisms (OHO) to new redox conditions. In order to simulate these adaptions and resulting SND, key BioWin default kinetic parameters are changed to SND calibrated values as seen in the Table 2-8.

Table 2-8. SND Modeling Changes to Switching Function

| Parameter | BioWin Default | Manipulated |
|---|---|---|
| Anoxic/aerobic DO half saturation (mg $O_2$/L) | 0.05 | 0.3 |
| AOB DO half saturation (mg $O_2$/L) | 0.25 | 0.15 |
| NOB DO half saturation (mg $O_2$/L) | 0.5 | 0.15 |
| Anoxic $NO_2$-N half saturation (mg N/L) | 0.01 | 0.02 |

The model was optimized to meet effluent criteria as seen by the effluent nitrogen in Table 2-9.

Table 2-9. Effluent Nitrogen

| Parameter | Average | Peak Day |
|---|---|---|
| Effluent $NH_4$-N (mg/L) | 0.26 | 0.74 |
| Effluent $NO_3$-N (mg/L) | 2.48 | 7.25 |
| Effluent $NO_2$-N (mg/L) | 0.11 | 0.44 |
| Effluent $NO_x$-N (mg/L) | 2.60 | 7.63 |
| Effluent TN (mg/L) | 5.42 | 10.85 |

The low DO SND applied in the 4-stage Bardenpho configuration proved highly efficient in terms of volumetric and carbon requirement for N removal. The low DO operation resulted in less influent carbon being oxidized aerobically, which allowed better denitrification at low DO. Further, biological P removal was not a requirement for this alternative as it was assumed to be completed through tertiary chemical removal; therefore, acetate was not required. The added benefit of not requiring acetate addition was a smaller volumetric requirement to meet effluent N limits because of lower carbon and biomass concentrations. In fact, this configuration required the smallest volume among all alternatives. Supplemental carbon usage, aeration demand, and WAS production were also lowest among all alternatives. However, as this alternative requires chemical P removal, the chemical usage rates are highest for this alternative because of the large quantity of alum required, and the amount of caustic soda needed to maintain pH because of alum addition, which reduces alkalinity. These findings are summarized in Table 2-10. Detailed model outputs from the BioWin modeling for this approach are presented in Appendix A of this report.

| Table 2-10. SND Modeling Results | | |
|---|---|---|
| **Unit Process** | **Parameter/Unit** | **Value** |
| Required SRT for nitrification | -, days | 13 |
| Activated sludge basin total | Volume, Mgal | 5 |
| Anoxic cell 1 (Anx 1) | Volume, Mgal | 0.5 |
| Anoxic cell 2 (Anx 2) | Volume, Mgal | 1.0 |
| Aerobic cell 1 (Aer 1) | Volume, Mgal | 1.5 |
| Aerobic cell 2 (Aer 2) | Volume, Mgal | 1.5 |
| Aerobic cell 3 (Aer 3) | Volume, Mgal | 0.5 |
| MLR rate | Flow rate, percent of PE | 300 |
| WAS production | Mass rate, lb/d | 10,772 |
| Airflow requirement | Flow rate, scfm | 11,516 |
| MLSS | Average conc., mg/L | 3,395 |
| Alum requirement for chemical P removal | Flow rate, gal/d | 11,340 |
| Additional chemical sludge from chemical P removal | Mass rate, lb/d | 40,500 |
| Caustic soda requirement for pH control because of alum addition (50% solution) | Mass rate, lb/d<br>Flow rate, gal/d | 8,500<br>1,340 |

The increase in tank volume relative to current volume was mainly due to the high SRT required to maintain sufficient nitrification to meet very stringent effluent ammonia limits. This stringent limit is more difficult to meet because of the high variability in influent TKN and ammonia-nitrogen in the centrate recycle stream and the variability in the plant influent diurnal flows and loads, as was also determined in the Sidestream Nitrogen Removal Evaluation. Alternative means of reducing this variability, and potentially SRT and basin volume, will be evaluated in more detail in the subsequent add-on processes evaluation.

The modeling results were used to develop the preliminary capital and operating cost estimates presented in Section 2.3.3.

### 2.3.3 Preliminary Capital and Operating Cost Estimates

This section presents preliminary capital and operating cost estimates for Alternative 3.

#### 2.3.3.1 Capital Costs

In order to meet the 2030 maximum month conditions, the main secondary treatment process will need to be expanded. The sizes of the aeration basins required to meet the effluent targets for the 2030 maximum month condition were 5 Mgal. Given 2.4 Mgal of existing volume, the scope of the basin expansion would be 2.6 Mgal. The existing basins would also need to be retrofitted to accommodate the updated configuration, though these retrofits would be similar in cost and scope among all alternatives (move baffle walls, reconfigure aeration grids, add/move MLR) and therefore are not considered in the cost comparison of alternatives provided in Section 5. The capital cost (without contractor markups) of the tankage expansion for this alternative is expected to be approximately $2.2 million (based on nearby Nampa aeration basin expansion).

Additional facilities will need to be constructed as part of this alternative that mainly consists of chemical handling and metering facilities for chemical P removal. In addition, cost for a methanol addition facility is provided, as there may be methanol requirements if DO control is not maintained to the precise levels required for SND. Further, because of the large quantities of alum required for chemical P removal, alkalinity addition to maintain effluent pH within permit limits will be required prior to the outfall. This can consist of a caustic soda storage tank and metering pump, which will minimize cost. The estimated costs for these facilities as well as the cost for expansion of the activated sludge basins are summarized in Table 2-11.

**Table 2-11. Planning-Level Comparative Capital Costs for SND Expansion**

| Facility | Quantity | Unit Cost | Total |
|---|---|---|---|
| Greenfield aeration basin tank expansion | 2.6 Mgal | $850,000/Mgal | $2,210,000 |
| Existing basin retrofit | Common to all alternatives | | |
| Additional secondary clarifiers | Common to all alternatives | | |
| Chemical P removal facilities | – | – | $300,000 |
| Methanol addition facilities | – | – | $280,000 |
| Alkalinity addition facilities | – | – | $100,000 |
| **Total** | | | **$2,890,000** |

### 2.3.3.2 Operating Costs

The modeling results in Table 2-12 translate into operating costs associated with aeration demand, biosolids hauling, and chemical addition for P removal. The following assumptions were used to develop these costs:

- electricity: $0.069/kWh
- biosolids hauling and application: $5.933/wet ton
- aeration energy demand: 30 kWh/scfm/month
- methanol addition: $2.25/gal
- alum addition for chemical P removal: $1.22/gal
- caustic soda addition for pH control: $1.89/gal

The annual operating costs are summarized in Table 4-5.

**Table 2-12. Maximum Month Operating Costs for SND Alternative**

| Parameter | Quantity | Unit Cost | Total |
|---|---|---|---|
| Process aeration | 345,500 kWh | $0.069/kWh | $23,800 |
| Biosolids hauling[a] | 4,600 wet tons | $5.933/wet ton | $27,300 |
| Methanol addition[b] | 1,250 gal | $2.25/gal | $2,800 |
| Alum addition | 345,000 gal | $1.22/gal | $421,000 |
| Alkalinity addition | 40,200 gal | $1.89/gal | $76,000 |
| **Total** | | | **$551,000** |

a. *Includes solids from chemical P removal.*

b. *Estimated at 1,250 gal/month as conservative estimate for methanol; modeling showed no methanol required.*

*Note: costs provided in this table reflect construction cost only and do not include contractor markups, contingency, inflation to midpoint of construction, bonds, insurance, etc. A more complete construction cost estimate will be provided as part of the final report.*

Based on the results, the costs associated with operation of Alternative 3 are $551,000 for the winter maximum month load. Other months with lower loadings will have lower operating costs for this option.

## 2.4 Conclusions and Recommendations from Main Process Alternatives Screening

The results of this evaluation offer the following conclusions and recommendations.

### 2.4.1 Conclusions

Table 2-13 provides a capital and operating cost comparison of the three alternatives.

Table 2-13. Cost Comparison of Alternatives

| Cost | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|
| Capital | $4,907,000 | $25,228,000 | $2,890,000 |
| Operating (maximum monthly cost) | $383,000 | $107,000 | $551,000 |

*Note: costs provided in this table reflect construction cost only and do not include contractor markups, contingency, inflation to midpoint of construction, bonds, insurance, etc. A more complete construction cost estimate will be provided as part of the final report.*

1. The approximate cost of Alternative 1 (5-stage Bardenpho) is $4.9 million capital and $0.38 million/month operating costs (maximum month load). This is the median operating and capital cost alternative.
2. The approximate cost of Alternative 2 (4-stage Bardenpho) is $25.3 million capital and $0.11 million/month operating costs (maximum month load). This is the highest capital cost alternative, but the lowest operating cost alternative.
3. The approximate cost of Alternative 3 (SND) is $2.9 million capital and $0.55 million/month operating costs (maximum month load). This is the highest operating cost alternative, but the lowest capital cost alternative.
4. Alternatives 1 and 2 can be configured such that the system can operate in either a 4-stage or 5-stage Bardenpho mode, so selecting one alternative does not preclude use of the other alternative at a future time.

### 2.4.2 Recommendations

While Alternative 3 provides the lowest capital cost, the operating costs are significant. Further, this alternative presents the highest potential operational issues because of the need for tight DO control and the potential for filamentous growth and associated bulking because of low DO conditions that may occur. For these reasons, Alternative 3 is not recommended for further evaluation.

Alternative 1 presents a lower capital cost compared with Alternative 2. As the City is still unsure if it is willing to go to groundwater infiltration as the sole discharge for the plant, and because Alternative 1 can be configured to operate for N removal only (like alternative 2), we recommend carrying Alternative 1 (5-stage Bardenpho) forward for further evaluation for add-on technologies. Therefore, for subsequent evaluations in Sections 3 and 4 of this report, the main process alternative is the 5-stage Bardenpho configuration.

## Section 3

# Add-On Process Evaluations

This section provides a summary of the evaluation for add-on processes, which included the following tasks:

1. Evaluate tertiary treatment technologies for chemical P removal down to 0.07 mg/L TP.
2. Use the BioWin model developed for the 5-stage Bardenpho process, which was the main process alternative selected for further study, to determine the necessary secondary treatment sizing and operating parameters for the various add-on process alternatives. The following add-on alternatives were evaluated:
   - adding sidestream P removal (e.g., Ostara™) to reduce phosphorus in the recycle streams
   - adding influent equalization (EQ) to reduce nutrient load peaks:
     - without any sidestream treatment
     - with sidestream Anammox treatment for N removal
     - with sidestream Anammox treatment and sidestream P removal
   - adding centrate N load equalization
   - eliminating denitrification and some nitrification in the main process (convert to anoxic/oxic [A/O] process) and use tertiary nitrification and denitrification technologies
   - adding fixed-film media to aerated zone for conversion to integrated fixed-film activated sludge (IFAS) process to increase biomass without increasing MLSS concentration
   - adding BioMag ballasted secondary sludge process to improve sludge separation
   - converting sludge separation to membrane bioreactor (MBR) process
3. Develop high-level cost estimates for each of the add-on alternatives evaluated for both capital expansion of non-common treatment processes and chemical usage rates.
4. Recommend the three most cost-effective alternatives for further evaluation.

The remainder of this section discusses the tertiary P removal alternatives, the results of evaluations of each of the add-on alternatives listed above, and the summary and recommendations for the three options to be carried through for further evaluation.

## 3.1 Tertiary Phosphorus Removal Options

This section provides sizes and cost estimates for two P removal and tertiary filtration systems. Tertiary chemical P removal and filtration is required to meet the ultralow effluent TP limit of 0.07 mg/L. When investigating options for meeting these limits, it was determined that the existing tertiary Discfilters were not capable of meeting the 0.07 mg/L TP limit set forward in this project. Therefore, alternative filtration technologies were investigated to meet these limits. Two options were evaluated: the first is a proprietary ballasted flocculation system called Actiflo followed by Kruger Discfilters. The second option is a standard flocculation system followed by General Electric (GE) tertiary filtration membranes.

### 3.1.1 Kruger Actiflo and Discfilter System

The Kruger Actiflo system is a proprietary coagulation, flocculation, and ballasted sedimentation process that is capable of achieving very low effluent reactive phosphorus and effluent with very low TSS. The process is diagrammed in Figure 3-1; the first stage of the system is a coagulation tank for rapid mixing of secondary effluent water and coagulation chemicals. This is followed by a flocculation tank, which introduces Microsand ballast and supplemental polymer if required. Large floc is expected to form around the ballast material to create a dense floc particle that settles quickly. The final phase is sedimentation in a lamellar plate clarifier. Effluent would continue to existing Kruger Discfilters while sludge is passed to a hydrocyclone for ballast recovery. Kruger guarantees effluent phosphorus less than 0.07 mg/L of TP with this system and all effluent passed through the Discfilters can meet Title 22 reclaimed water standards.

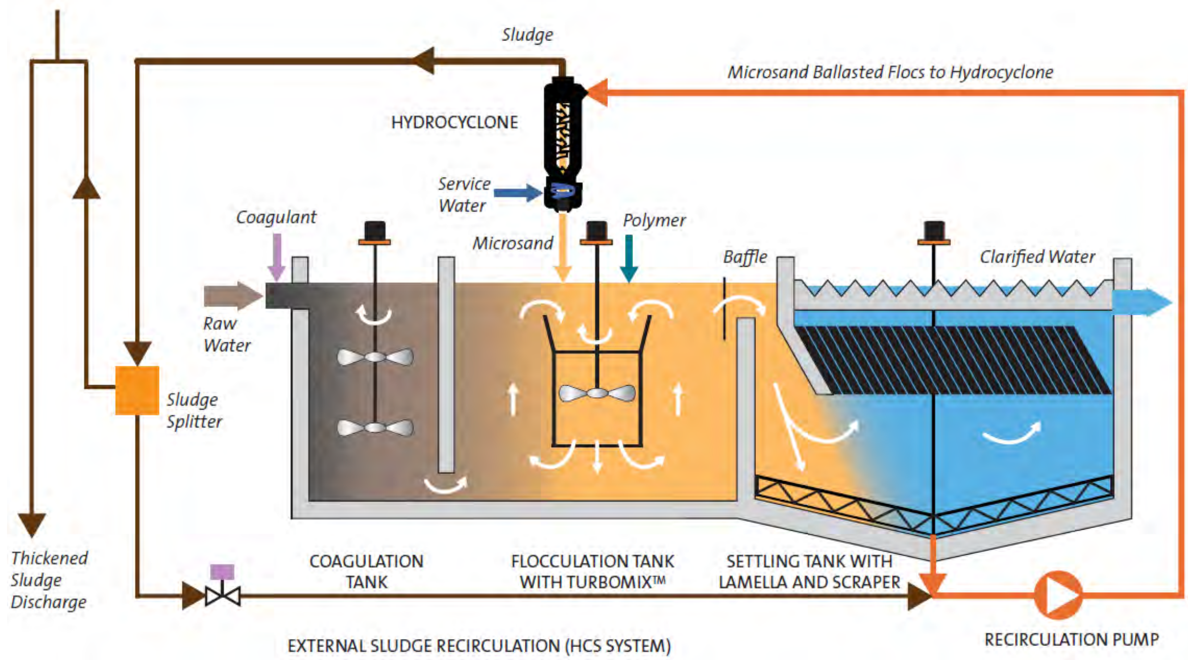


**Figure 3-1. Diagram of Actiflo system**

*Source: Actiflo brochure, 2015*

#### 3.1.1.1 Preliminary Capital and Operating Costs

The Actiflo/Discfilter system is designed to meet the 2030 peak hour flow of 28.0 mgd; it uses two Actiflo systems, each capable of treating 14.0 mgd. This configuration allows treatment of maximum month flows with full redundancy of systems. The filter design uses existing Kruger Discfilters and assumes the Aqua-diamond filter will be out of service by 2030, requiring additional Discfilter units. The system was sized to treat the 2030 peak flow of 28.0 mgd operating at a maximum flux rate (6.0 gallons per minute per square foot [gpm/ft$^2$]) and 14.0 mgd operating at a typical flux rate (4.0 gpm/ft$^2$).

##### 3.1.1.1.1 Capital Cost

Kruger provided capital costs for both the Actiflo and supplemental Discfilter systems. These costs include only the equipment and do not include support structures (i.e., tankage), influent pumping, or chemical supply pumping. Table 3-1 provides the Kruger cost estimates and costs for additional equipment and support structures.

| Table 3-1. Planning-Level Comparative Capital Costs for Actiflo and Discfilter Tertiary Treatment | | | |
|---|---|---|---|
| **Process** | **Quantity** | **Unit Cost** | **Total** |
| Actiflo Kruger cost estimate | 2 | $1,150,000/unit | $2,300,000 |
| Actiflo tankage | 0.3 Mgal | $850,000/Mgal | $255,000 |
| Coagulation chemical storage | 1 | $21,000/tank | $21,000 |
| Coagulation chemical pumping | 2 | $11,000/pump | $22,000 |
| Discfilter Kruger cost estimate | 2 | $257,500/filter | $515,000 |
| Discfilter support structures (building, tanks, etc.) | – | – | $1,000,000 |
| **Total** | | | **$4,113,000** |

#### 3.1.1.1.2 Operating Costs

The maximum monthly operation cost estimates are provided in Table 3-2. Kruger provided operating cost estimates for the systems listed above. The coagulation chemical was assumed to be alum and the dose required was approximated based on an empirical data set (S. Hermanowicz, 2006). Based on the data, a metal ion to phosphorus molar ratio of 10 to 1 is required. The high ratio is necessary because of a competing metal hydroxide reaction and the low influent P concentration. Influent TP was assumed to be 0.5 mg/L and effluent concentration of 0.07 mg/L TP. This approximation is acceptable for a comparative analysis; however, jar testing should be performed to verify dosages prior to completing design of upgrades. Chemical sludge production estimates are based on an ideal model that assumes only metal hydroxides or metal phosphates will form. The electric and biosolids costs were provided by Meridian WRRF staff; it was assumed that chemical sludge hauling costs will be the same as for biosolids.

The following assumptions were used to develop these costs:

- electricity: $0.069/kWh
- alum addition for chemical P removal: $1.22/gal
- solids hauling and application: $5.933/wet ton (assuming 20 percent cake solids)

| Table 3-2. Maximum Monthly Operating Costs for Tertiary Chemical Phosphorus Removal | | | |
|---|---|---|---|
| **Parameter** | **Quantity** | **Unit Cost** | **Total** |
| Coagulant (alum) | 28,500 gal | $1.22/gal | $34,800 |
| Polymer | 0.89 ton | $4,500/ton | $4,000 |
| Solids hauling | 162 ton | $5.933/wet ton | $960 |
| Sand loss | 3.6 ton | $200/ton | $720 |
| Power consumption | 19,000 kWh | $0.069/kWh | $1,300 |
| **Total** | – | – | **$41,800** |

### 3.1.2 GE Tertiary Membrane System

The second tertiary P removal system is an ultrafiltration membrane filtration unit. Ultrafiltration systems consist of membrane cartridges with ultrafine pore sizes (<0.04 microns). An ultrafiltration unit removes all particulate and some colloidal matter from the treatment stream. Soluble phosphorus will pass through the membrane. Therefore, to achieve effluent less than 0.07 mg/L, chemical P removal will also be required. The tertiary membranes will take the place of the existing Discfilter system. An additional benefit provided by this system is compliance with Title 22 reclaimed water requirements for all of the flow.

#### 3.1.2.1 Preliminary Capital and Operating Costs

GE supplied a cost estimate based on the ZeeWeed 1000 system designed to treat 2030 peak hour flow of 28 mgd with all units operational and the 2030 max month flow of 14.2 mgd with one unit out of service. This system will include chemical P removal equipment similar to the system described above as well as equipment unique to membrane systems. The ZeeWeed 1000 will require additional membrane tanks, clean-in-place (CIP) tankage equipment, and a 500-micron prescreen system.

##### 3.1.2.1.1 Capital Costs

GE provided preliminary capital costs for the ZeeWeed system. Additional equipment including tanks and the pre-screen were estimated based on previous work.

**Table 3-3. Planning-Level Comparative Costs for Tertiary Membrane System**

| Process | Quantity | Unit Cost | Total |
|---|---|---|---|
| Coagulation chemical storage | 1 | $21,000/tank | $21,000 |
| Coagulation chemical pumping | 2 | $11,000/pump | $22,000 |
| Inlet strainers (500-micron screens) | – | – | $288,000 |
| Membrane system | – | – | $5,919,000 |
| Membrane tanks | 0.112 Mgal | $850,000/Mgal | $95,000 |
| CIP tank | 0.019 Mgal | $850,000/Mgal | $16,000 |
| **Total** | **–** | **–** | **$6,318,000** |

*Note: Costs provided in this table reflect construction cost only and do not include contractor markups, contingency, inflation to midpoint of construction, bonds, insurance, etc. A more complete construction cost estimate will be provided as part of the final report.*

##### 3.1.2.1.2 Operating Costs

The estimates for max month flow operating cost are provided in Table 3-4. Chemical requirements shown on this table are based on maintenance schedules provided by GE. Auxiliary power requirements are based on the listed horsepower of the manufacturer-supplied pumps and blower units.

**Table 3-4. Maximum Month Operating Costs for Tertiary Membrane Alternative**

| Parameter | Quantity | Unit Cost | Total per Month |
|---|---|---|---|
| Coagulant (alum) | 28,500 gal | $1.22/gal | $34,800 |
| Sodium hypochlorite | 2,692 gal | $1.33/gal | $3,500 |
| Citric acid | 317 gal | $5.49/gal | $1,700 |
| Hydrochloric acid | 158 gal | $1.20/gal | $200 |
| Sodium bisulfite | 650 gal | $2.92/gal | $1,900 |
| Solids hauling | 162 ton | $5.933/wet ton | $960 |
| Sodium hydroxide | 333 gal | $2.67/gal | $900 |
| Membrane replacement cost[a] | 2835 modules | $1,040/module | $25,000 |
| Membrane auxiliary system[b] | 51,667 kWh | $0.069/kWh | $3,600 |
| **Total** | | | **$72,560** |

a. *Membrane life assumed to be 10 years. Monthly replacement cost is averaged over the 10-year period.*

b. *Power requirements for scour air blowers, permeate pumps, backwash pumps, and air compressor.*

### 3.1.3 Tertiary P Removal Conclusions

Because the tertiary membrane system presents the highest potential capital and operating cost option when compared with the Actiflo/Discfilter option, tertiary membranes were carried through as the tertiary treatment system for all subsequent add-on processes requiring tertiary treatment to present the most conservative approach.

For all subsequent add-on option evaluations, costs for coagulant chemical storage and monthly usage requirements, as well as biosolids generation due to coagulant chemical, are estimated separate from the tertiary membrane P removal systems.

## 3.2 Sidestream Phosphorus Removal Add-On Process

This section provides a description of the modeling, sizing, and cost estimate results for the 5-stage Bardenpho expansion alternative, with the addition of an Ostara™-like struvite recovery system for sidestream P removal. This add-on alternative was evaluated to determine if removal of phosphorus from the centrate prior to discharge to the main stream treatment process would result in savings in ultimate tank size and/or chemical use within the main treatment process. As described in TM 1, the assumptions from the 2012 Facilities Plan showed that the TP in the centrate makes up more than 35 percent of the TP load to the aeration basins (sidestream TP + raw influent TP). Because centrate struvite recovery systems, like Ostara™, can remove between 80 and 90 percent of the sidestream P load, it was assumed that this would help to reduce overall chemical carbon requirements and potentially lead to footprint savings for the main treatment process (5-stage Bardenpho).

### 3.2.1 Sidestream P Removal Add-On BioWin Model Setup

The base model used for all BioWin simulations conducted as part of TM 2 was the final model developed for the 5-stage Bardenpho alternative described in detail in Section 2 of TM 1. The only modification made to this model was to alter the input for the centrate to reduce the P load in the recycle by 80 percent and the TKN was reduced by 15 percent, assuming that this much phosphate and ammonia was removed through a sidestream struvite recovery process. The general process flow schematic for this process is shown in Figure 3-2.

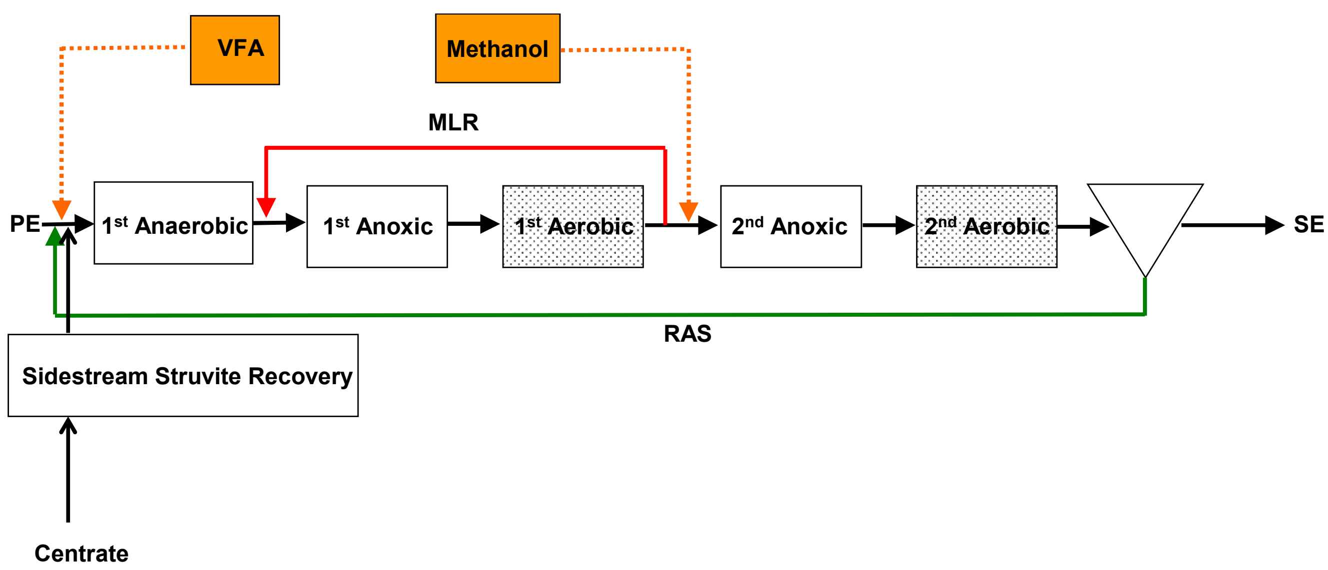


**Figure 3-2. Process flow schematic for 5-stage Bardenpho processes with sidestream struvite recovery**

This configuration was used to optimally size the treatment system volume and determine operating parameters and chemical usage rates at winter maximum month flows and loads. The operating limitations for the plant included a maximum operating MLSS concentration of 4,000 mg/L, assuming that a fourth secondary clarifier is constructed, and an operating DO concentration of 2.0 mg/L is used for all aerated zones. The effluent limitations for this process did not change from those presented in Section 1.

The PE concentrations used for all simulations, which were developed during the Sidestream Nitrogen Removal Evaluation project from the 2012 Facilities Plan, reflect a 30-day hourly diurnal model. The monthly average values used to generate this diurnal input model were summarized in Section 1. For preliminary evaluations discussed here, only winter conditions were evaluated. Summer conditions will be evaluated for final comparisons. Centrate data, also developed during the Sidestream Nitrogen Removal Evaluation project from the 2012 Facilities Plan reported values, are summarized in Table 1-7, with the exception of TP, which was reduced by 80 percent, and TKN, which was reduced by 15 percent to account for the sidestream struvite recovery process.

For the Sidestream P Add-On simulations, the secondary clarifiers were set to remove a constant value of 99.9 percent of incoming solids. It was assumed that a fourth secondary clarifier of equal diameter and volume to existing clarifiers 4 and 5 would be installed to allow for higher operating MLSS concentrations. The clarifier sludge blanket was assumed to be 7 percent of the settler height, and the clarifier solids underflow rate was paced at 50 percent of the PE. The WAS flow rate was adjusted automatically during modeling to regulate the SRT of the process to maintain nitrification and meet the target effluent N concentrations presented in Section 1.

Using these process and effluent constraints and the PE and modified centrate influent concentrations discussed here, optimal system and chemical use sizing was completed. The final results of basin sizing, optimum MLR flow pacing, chemical use, air demand, and WAS production rates are presented in Section 3.2.2.

### 3.2.2 Model Results for Winter Conditions

Table 3-5 shows the process sizing and operating parameters required to achieve the effluent target concentrations for the 5-stage Bardenpho process with sidestream struvite recovery. With reduced phosphate in the centrate recycle stream, the biggest change from the 5-stage Bardenpho process was the significant reduction in supplemental carbon (acetate) addition. This also allowed for a reduction in the overall tank volume, WAS production, and air demand of the system. Detailed model outputs from the BioWin modeling are presented in Appendix B of this report.

Airflow requirements were estimated using BioWin modeling software and do not necessarily reflect the true airflow amounts that would be anticipated. However, they do allow for comparison of relative airflow needs among alternatives and can be used to estimate annual O&M costs on a relative order-of-magnitude basis. Similarly, WAS production estimates are for information only and for comparison among alternatives as expansion of solids handling facilities to meet increased solids needs are outside the scope of this study.

**Table 3-5. 5-Stage Bardenpho with Sidestream P Removal Modeling Results**

| Unit Process | Parameter/Unit | Value |
|---|---|---|
| Required SRT for nitrification | –, days | 12 |
| Activated sludge basin total | Volume, Mgal | 6.0 |
| Anaerobic cell 1 | Volume, Mgal | 0.4 |

| Table 3-5. 5-Stage Bardenpho with Sidestream P Removal Modeling Results | | |
|---|---|---|
| Unit Process | Parameter/Unit | Value |
| Anoxic cell 1a | Volume, Mgal | 0.3 |
| Anoxic cell 1b | Volume, Mgal | 0.3 |
| Swing cell 1 | Volume, Mgal | 0.4 |
| Aerobic cell 1a | Volume, Mgal | 1.4 |
| Aerobic cell 1b | Volume, Mgal | 1.5 |
| Swing/anoxic cell 2a | Volume, Mgal | 0.6 |
| Swing/anoxic cell 2b | Volume, Mgal | 0.6 |
| Post-aerobic cell | Volume, Mgal | 0.5 |
| MLR rate | Flow rate, percent of PE | 200 |
| WAS production | Mass rate, lb/d | 20,800 |
| Additional chemical sludge from tertiary P removal | Mass rate, lb/d | 1,900 |
| Airflow requirement | Flow rate, scfm | 16,725 |
| Acetate use | Mass rate, lb/d | 3,420 |
| Methanol use | Flow rate, gpd | 615 |

As previously found, the effluent ammonia target (0.307 mg ammonia-nitrogen per liter [mg-$NH_4$-N/L]) proved to be the limiting parameter while modeling this option. However, with reduced phosphorus and TKN entering the main stream process, the acetate use was reduced significantly as less acetate was needed to support the phosphate release in the anaerobic zones (3,400 lb/d versus over 9,000 lb/d for 5-stage Bardenpho without sidestream P removal).

The modeling results were used to develop the preliminary capital and operating cost estimates presented in Section 3.3.

### 3.2.3 Preliminary Capital and Operating Cost Estimates

To treat the 2030 maximum month flow and loading conditions, the main secondary treatment process will need to be expanded. As discussed above, a high SRT is required to achieve low effluent ammonia concentrations. This results in a high MLSS concentration, which imposes a high solids loading to the secondary clarifiers. For the winter condition, with a maximum month flow of 12.3 mgd and a maximum day flow of 13.8 mgd, the maximum allowable MLSS concentration will be approximately 4,000 mg/L. This assumes that one new secondary clarifier matching the dimensions of clarifiers 4 and 5 is constructed. While previous analyses for main stream process alternatives assumed that this clarifier would be common to all alternatives evaluated, this is not the case for the add-on alternatives evaluation. The same holds for tertiary P removal filtration processes. Therefore, these costs are now included in all options, including the sidestream struvite recovery add-on process presented in Table 3-6 below.

As shown in Table 3-6, 6.0 Mgal of activated sludge volume is required to meet effluent targets for the 2030 maximum month condition. Given 2.4 Mgal of existing volume, the scope of basin expansion would be 3.6 Mgal. The existing basins would also need to be retrofitted to accommodate the updated configuration, with these costs also developed for each option.

#### 3.2.3.1 Capital Costs

Table 3-6 summarizes the capital costs expected for the 5-stage Bardenpho process with sidestream P removal/recovery. The assumptions made for costs developed for this estimate include the following:

- greenfield basin expansion and existing basin retrofit costs per Mgal were developed using estimates for the City of Nampa's current plant expansion
- costs for additional secondary clarifiers were taken from estimates completed for similar-sized clarifiers at the Pierce County Chambers Creek WASTEWATER TREATMENT PLANT expansion currently in construction
- tertiary membrane costs were taken from a vendor quote obtained from GE Zenon
- costs for chemical facilities were developed using costs for tanks and pump equipment obtained from equipment vendors
- P recovery facilities (sidestream P removal) were obtained from the 2012 Facilities Plan, and reduced by 50 percent to eliminate contractor markups and estimators' contingencies

**Table 3-6. Planning-Level Comparative Capital Costs for 5-Stage Bardenpho with Sidestream P Removal**

| Process | Quantity | Unit Cost | Total |
|---|---|---|---|
| Greenfield aeration basin tank expansion | 3.6 Mgal | $850,000/Mgal | $3,060,000 |
| Existing basin retrofit | 2.4 Mgal | $400,000/Mgal | $960,000 |
| Additional secondary clarifiers | 1 | $2,000,000 | $2,000,000 |
| Tertiary filtration for P removal (membranes) | – | – | $6,320,000 |
| P recovery facilities | – | – | $2,000,000 |
| Chemical P removal facilities | – | – | $62,500 |
| Acetate addition facilities | – | – | $106,500 |
| Methanol addition facilities | – | – | $568,000 |
| **Total** | **–** | **–** | **$15,080,000** |

*Note: Costs provided in this table reflect construction cost only and do not include contractor markups, contingency, inflation to midpoint of construction, bonds, insurance, etc. A more complete construction cost estimate will be provided as part of the final report.*

It is important to note that the costs provided in Table 3-2 are preliminary planning-level costs that do not include contractor markups and special conditions. In addition, these costs do not reflect costs for common expansion requirements among all alternatives, such as additional secondary clarifiers, solids system expansions, or construction of already-planned facilities like the headworks or primary clarifiers. This means that these costs do not reflect the true cost for construction, but provide comparative costs for evaluating differences among the expansion alternatives only. Final AACE Class 5 construction cost estimates will be provided for the final recommended expansion alternatives associated with additional tasks for this work.

#### 3.2.3.2 Operating Costs

The modeling results in Table 3-5 translate into operating costs associated with alum, acetate, and methanol dosing; aeration demand; and biosolids hauling. Additional costs associated with operation of the tertiary membrane system and sidestream struvite recovery system must also be considered.

The following assumptions were used to develop these costs:

- electricity: $0.069/kWh
- biosolids hauling and application: $5.933/wet ton (assuming 20 percent cake solids)

- methanol (99 percent solution): $2.25/gal
- aeration energy demand: 30 kWh/scfm/month
- alum (P removal chemical): $1.22/gal
- tertiary filtration operating costs: $36,800/maximum month
- operation of struvite recovery facility: $20,000/maximum month

The electric and biosolids costs were provided by Meridian WRRF staff. The methanol cost is a long-term average value from Olympia, Washington. The price of methanol is unstable, and has varied from close to $1.00 per gallon to over $4.50 per gallon during the past 10 years. The aeration energy demand is based on data from other plants with similar process demands. The tertiary filtration operating cost is from GE Zenon as shown in Table 3-4, but with the cost for alum taken out of the system, since this cost is accounted for separately in the table below. The operating costs for the struvite recovery facility are a conservative estimate from other facilities operating struvite recovery systems.

The maximum monthly operating costs are summarized in Table 3-7. Based on the results of this table, the maximum monthly operating costs for the 5-stage Bardenpho with sidestream P removal would be approximately $268,000. This is the highest anticipated winter monthly operating cost for the parameters provided in Table 3-7 below. Operating the system during other winter months will cost less than this amount.

**Table 3-7. Maximum Monthly Winter Operating Costs for 5-Stage Bardenpho with Sidestream P Recovery**

| Parameter | Quantity | Unit Cost | Total |
|---|---|---|---|
| Methanol | 18,450 gal | $2.25/gal | $41,500 |
| Acetate (80% solution of acetic acid) | 64 ton | $0.74/lb | $95,000 |
| Tertiary filtration chemical/operating cost | – | – | $36,800 |
| Struvite recovery facility chemical/operating cost | – | – | $20,000 |
| Process aeration | 501,800 kWh | $0.069/kWh | $35,000 |
| Biosolids hauling | 1,700 wet ton | $5.933/wet ton | $10,000 |
| P removal chemical | 24,000 gal | $1.22/gal | $29,000 |
| **Total** | – | – | **$268,000** |

## 3.3 Influent Flow Equalization Options

This section provides a description of the modeling, sizing, and cost estimate results for the 5-stage Bardenpho expansion alternative, with the addition of influent EQ and sidestream treatment options with influent EQ. This add-on alternative was evaluated to determine if equalizing influent flow to reduce minimum and maximum daily loadings would result in savings in ultimate tank size and/or chemical use within the main treatment process. Sidestream N and P treatment options were also evaluated in conjunction with the influent flow EQ to determine if there was benefit to be gained from reducing nutrient loads in the recycle streams. Each of the three options (influent EQ, influent EQ with sidestream N removal, influent EQ with sidestream N and P removal) are discussed in detail in the subsections below.

### 3.3.1 Influent Flow Equalization

This section presents the add-on BioWin model setup, model results for winter conditions, and preliminary capital and operating costs for the influent flow EQ option.

#### 3.3.1.1 Add-On BioWin Model Setup

The base model used for all BioWin simulations conducted as part of this evaluation was the final model developed for the 5-stage Bardenpho alternative described in detail in Section 2. The only modification made to this model was to include a flow EQ tank of 2.4 Mgal capacity (equal to the existing aeration tank capacity) to equalize flows throughout the day. The general process flow schematic for this process is shown in Figure 3-3.

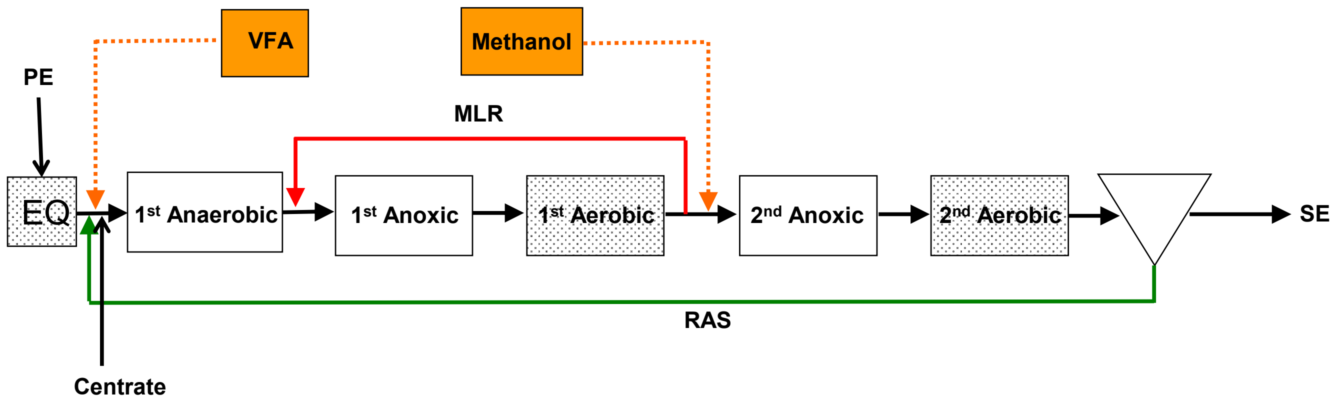


**Figure 3-3. Process flow schematic for 5-stage Bardenpho processes with influent flow equalization**

This configuration was used to optimally size the treatment system volume and determine operating parameters and chemical usage rates at winter maximum month flows and loads. The operating limitations for the plant included a maximum operating MLSS concentration of 4,000 mg/L, assuming that a fourth secondary clarifier is constructed, and an operating DO concentration of 2.0 mg/L is used for all aerated zones. The effluent limitations for this process did not change from those presented in Section 1.

The PE concentrations used for all simulations, which were developed during the Sidestream Nitrogen Removal Evaluation project from the 2012 Facilities Plan, reflect a 30-day hourly diurnal model. The monthly average values used to generate this diurnal input model were summarized in Section 1. For preliminary evaluations discussed here, only winter conditions were evaluated. Summer conditions will be evaluated for final comparisons. Centrate data, also developed during the Sidestream Nitrogen Removal Evaluation project from the 2012 Facilities Plan reported values, are summarized in Section 1.

As with the Sidestream P Add-On simulations, the secondary clarifiers were set to remove a constant value of 99.9 percent of incoming solids. It was assumed that a fourth secondary clarifier of equal diameter and volume to existing clarifiers 4 and 5 would be installed to allow for higher operating MLSS concentrations. The clarifier sludge blanket was assumed to be 7 percent of the settler height, and the clarifier solids underflow rate was paced at 50 percent of the PE. The WAS flow rate was adjusted automatically during modeling to regulate the SRT of the process to maintain nitrification and meet the target effluent N concentrations presented above.

The EQ basin was modeled as a variable volume tank without biological activity. The volume of the EQ basin was set at 2.3 Mgal (volume of existing tanks), and the base outflow from the EQ basin was set at 12.2 mgd, which was the average maximum monthly flow for the winter simulation period. The tank was set up so that if influent flow exceeded 12.2 mgd, the tank would fill if partially empty while the outflow remained at 12.2 mgd. If the tank was full and flow exceeded 12.2 mgd, then the outflow would equal the inflow. If the inflow was less than 12.2 mgd, then the outflow would remain at 12.2

mgd until the tank was completely drained, at which point the outflow equaled the reduced inflow rate.

Using these process and effluent constraints and the PE and modified centrate influent concentrations discussed here, optimal system and chemical use sizing was completed. The final results of basin sizing, optimum MLR flow pacing, chemical use, air demand, and WAS production rates are presented in Section 3.3.1.2.

#### 3.3.1.2 Model Results for Winter Conditions

Table 3-8 shows the process sizing and operating parameters required to achieve the effluent target concentrations for the 5-stage Bardenpho process with influent flow EQ. With reduced peak N and P loads to the plant, a reduction in the operating SRT was required for nitrification under winter conditions, as the peak loads were reduced to the facility. This also allowed for a reduction in the amount of acetate and methanol required to meet the target effluent conditions. Together, these allowed for a small reduction in the activated sludge basin volume (to 7.0 Mgal from 7.25 Mgal). This modest decrease in size is due to the fact that the influent flow equalization, while good at dampening flows, does not affect the diurnal loading of nitrogen and phosphorus enough to provide significant load equalization to the system. Influent and centrate load equalization would likely result in a greater overall reduction in tank volume than influent flow equalization alone. However, influent load equalization would likely require a greater volume of equalization than is available using existing tankage alone and would require a very complex flow regime to implement. Centrate load equalization was also analyzed as a separate option reported below.

As existing tankage would be needed for equalization for this option, this resulted in more greenfield aeration basin construction than for the option of 5-stage Bardenpho without any equalization. Also, as the SRT was reduced, the WAS production rate increased, though the air demands did decrease because of lowered MLSS concentrations. Detailed model outputs from the BioWin modeling are presented in Appendix B of this report.

Airflow requirements were estimated using BioWin modeling software and do not necessarily reflect the true airflow amounts that would be anticipated. However, they do allow for comparison of relative airflow needs among alternatives and can be used to estimate annual O&M costs on a relative order-of-magnitude basis. Similarly, WAS production estimates are for information only and for comparison among alternatives as expansion of solids handling facilities to meet increased solids needs are outside the scope of this study.

**Table 3-8. 5-Stage Bardenpho with Influent EQ Modeling Results**

| Unit Process | Parameter/Unit | Value |
|---|---|---|
| Required SRT for nitrification | –, days | 11 |
| Influent EQ basin total | Volume, Mgal | 2.4 |
| Activated sludge basin total | Volume, Mgal | 7.0 |
| Anaerobic cell 1 | Volume, Mgal | 0.5 |
| Anoxic cell 1a | Volume, Mgal | 0.375 |
| Anoxic cell 1b | Volume, Mgal | 0.375 |
| Swing cell 1 | Volume, Mgal | 0.5 |
| Aerobic cell 1a | Volume, Mgal | 1.5 |
| Aerobic cell 1b | Volume, Mgal | 1.75 |
| Swing/anoxic cell 2a | Volume, Mgal | 0.75 |

| Table 3-8. 5-Stage Bardenpho with Influent EQ Modeling Results | | |
|---|---|---|
| Unit Process | Parameter/Unit | Value |
| Swing/anoxic cell 2b | Volume, Mgal | 0.75 |
| Post-aerobic cell | Volume, Mgal | 0.5 |
| MLR rate | Flow rate, percent of PE | 200 |
| WAS production | Mass rate, lb/d | 23,050 |
| Additional chemical sludge from tertiary P removal | Mass rate, lb/d | 1,900 |
| Airflow requirement | Flow rate, scfm | 16,630 |
| Acetate use | Flow rate, gpd | 5,600 |
| Methanol use | Flow rate, gpd | 550 |

As previously found and described in Section 2, the effluent ammonia target (0.307 mg $NH_4$-N/L) proved to be the limiting parameter while modeling this option. However, with more equalized P and TKN loads entering the main stream process, the acetate and methanol use was reduced.

The modeling results were used to develop the preliminary capital and operating cost estimates presented below.

#### 3.3.1.3 Preliminary Capital and Operating Cost Estimates

To treat the 2030 maximum month flow and loading conditions, the main secondary treatment process will need to be expanded. As discussed previously, a high SRT is required to achieve low effluent ammonia concentrations. This results in a high MLSS concentration, which imposes a high solids loading to the secondary clarifiers. For the winter condition, with a maximum month flow of 12.3 mgd and a maximum day flow of 13.8 mgd, the maximum allowable MLSS concentration will be approximately 4,000 mg/L. This assumes that one new secondary clarifier matching the dimensions of clarifiers 4 and 5 is constructed. While previous analyses for main stream process alternatives assumed that this clarifier would be common to all alternatives evaluated, this is not the case for the add-on alternatives evaluation. The same holds for tertiary P removal filtration processes. Therefore, these costs are now included in all options, including the influent EQ add-on process presented in Table 3-10 below.

As shown in Table 3-8, 7.0 Mgal of activated sludge volume is required to meet effluent targets for the 2030 maximum month condition. Given that 2.4 Mgal of existing volume would be used for influent EQ, the scope of basin expansion would be 7.0 Mgal. The existing basins would also need to be retrofitted to accommodate the updated EQ configuration, with these costs also developed below.

##### 3.3.1.3.1 Capital Costs

Table 3-9 summarizes the capital costs expected for the 5-stage Bardenpho process with sidestream P removal/recovery. The assumptions made for costs developed for this estimate include the following:

- greenfield basin expansion and existing basin retrofit costs per Mgal were developed using estimates for the City of Nampa’s current plant expansion
- costs for additional secondary clarifiers were taken from estimates completed for similar-sized clarifiers at the Pierce County Chambers Creek WWTP expansion currently in construction
- tertiary membrane costs were taken from a vendor quote obtained from GE Zenon

- costs for chemical facilities were developed using costs for tanks and pump equipment obtained from equipment vendors
- cost for retrofit of existing basin to EQ tanks was estimated from planning work completed for Pierce County, Washington

**Table 3-9. Planning-Level Comparative Capital Costs for 5-Stage Bardenpho with Influent EQ**

| Process | Quantity | Unit Cost | Total |
|---|---|---|---|
| Greenfield aeration basin tank expansion | 7.0 Mgal | $850,000/Mgal | $5,950,000 |
| Existing basin retrofit to EQ tank | 2.4 Mgal | $700,000/Mgal | $1,680,000 |
| New secondary clarifiers (100 ft dia.) | 1 | $ 2,000,000 | $2,000,000 |
| Tertiary filtration (membranes) | – | – | $6,320,000 |
| Chemical P removal facilities | – | – | $62,500 |
| Acetate addition facilities | – | – | $106,500 |
| Methanol addition facilities | – | – | $568,000 |
| **Total** | – | – | **$16,690,000** |

*Note: Costs provided in this table reflect construction cost only and do not include contractor markups, contingency, inflation to midpoint of construction, bonds, insurance, etc. A more complete construction cost estimate will be provided as part of the final report.*

It is important to note that the costs provided in Table 3-10 are preliminary planning-level costs that do not include contractor markups and special conditions. In addition, these costs do not reflect costs for common expansion requirements among all alternatives, such as additional secondary clarifiers, solids system expansions, or construction of already-planned facilities like the headworks or primary clarifiers. This means that these costs do not reflect the true cost for construction, but provide comparative costs for evaluating differences among the expansion alternatives only. Final AACE Class 5 construction cost estimates will be provided for the final recommended expansion alternatives associated with additional tasks for this work.

#### 3.3.1.3.2 Operating Costs

The modeling results in Table 3-8 translate into operating costs associated with alum, acetate, and methanol dosing; aeration demand; and biosolids hauling. Additional costs associated with operation of the tertiary membrane system must also be considered.

The following assumptions were used to develop these costs:

- electricity: $0.069/kWh
- biosolids hauling and application: $5.933/wet ton (assuming 20 percent cake solids)
- methanol (99 percent solution): $2.25/gal
- aeration energy demand: 30 kWh/scfm/month
- alum (P removal chemical): $1.22/gal
- tertiary filtration operating costs: $36,800/maximum month

The electric and biosolids costs were provided by Meridian WRRF staff. The methanol cost is a long-term average value from Olympia, Washington. The price of methanol is unstable, and has varied from close to $1.00 per gallon to over $4.50 per gallon during the past 10 years. The aeration energy demand is based on data from other plants with similar process demands. The tertiary filtration operating cost is from GE Zenon.

The maximum monthly operating costs are summarized in Table 3-9. Based on the results of this table, the maximum monthly operating costs for the 5-stage Bardenpho with influent EQ removal would be approximately $304,000. This is the highest anticipated winter monthly operating cost for the parameters provided in Table 3-10 below. Operating the system during other winter months will cost less than this amount.

**Table 3-10. Maximum Monthly Winter Operating Costs for 5-Stage Bardenpho with Influent EQ**

| Parameter | Quantity | Unit Cost | Total |
|---|---|---|---|
| Methanol | 16,500 gal | $2.25/gal | $37,100 |
| Acetate (80% solution of acetic acid) | 105 ton | $0.74/lb | $155,000 |
| Tertiary filtration chemical/operating cost | – | – | $36,800 |
| Process aeration | 498,900 kWh | $0.069/kWh | $34,500 |
| Biosolids hauling | 1,900 wet ton | $5.933/wet ton | $11,300 |
| P removal chemical | 24,000 gal | $1.22/gal | $29,000 |
| Total | – | – | $304,000 |

## 3.3.2 Influent Flow Equalization with Sidestream N Removal

This section presents the add-on BioWin model setup, model results for winter conditions, and preliminary capital and operating costs for the influent flow EQ with sidestream N removal option.

### 3.3.2.1 Add-On BioWin Model Setup

The base model used for all BioWin simulations conducted as part of this evaluation was the final model developed for the 5-stage Bardenpho alternative described in detail in Section 2. The only modification made to this model was to include a flow EQ tank of 2.4 Mgal capacity (equal to the existing aeration tank capacity) to equalize flows throughout the day and a reduction in the centrate concentrations for TKN, as described previously in the Sidestream Nitrogen Removal Evaluation project. The general process flow schematic for this process is shown in Figure 3-4.

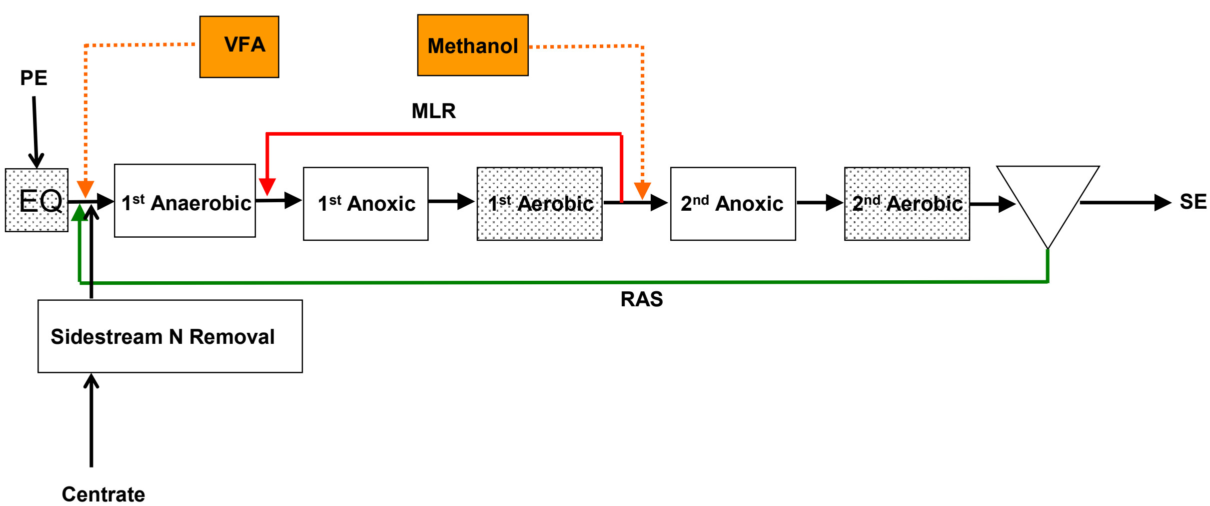


**Figure 3-4. Process flow schematic for 5-stage Bardenpho processes with influent flow equalization and sidestream N removal**

This configuration was used to optimally size the treatment system volume and determine operating parameters and chemical usage rates at winter maximum month flows and loads. The operating limitations for the plant included a maximum operating MLSS concentration of 4,000 mg/L, assuming that a fourth secondary clarifier is constructed, and an operating DO concentration of 2.0

mg/L is used for all aerated zones. The effluent limitations for this process did not change from those presented in Section 1.

The PE concentrations used for all simulations, which were developed during the Sidestream Nitrogen Removal Evaluation project from the 2012 Facilities Plan, reflect a 30-day hourly diurnal model. The monthly average values used to generate this diurnal input model were summarized in Section 1. For preliminary evaluations discussed here, only winter conditions were evaluated. Summer conditions will be evaluated for final comparisons. Centrate data after undergoing sidestream treatment for N removal with an Anammox-type process was developed during the Sidestream Nitrogen Removal Evaluation project from the 2012 Facilities Plan reported values and is reported elsewhere.

The secondary clarifiers were set to remove a constant value of 99.9 percent of incoming solids. It was assumed that a fourth secondary clarifier of equal diameter and volume to existing clarifiers 4 and 5 would be installed to allow for higher operating MLSS concentrations. The clarifier sludge blanket was assumed to be 7 percent of the settler height, and the clarifier solids underflow rate was paced at 50 percent of the PE. The WAS flow rate was adjusted automatically during modeling to regulate the SRT of the process to maintain nitrification and meet the target effluent N concentrations presented in Section 1.

Using these process and effluent constraints and the PE and modified centrate influent concentrations discussed here, optimal system and chemical use sizing was completed. The final results of basin sizing, optimum MLR flow pacing, chemical use, air demand, and WAS production rates are presented below.

#### 3.3.2.2 Model Results for Winter Conditions

Table 3-11 shows the process sizing and operating parameters required to achieve the effluent target concentrations for the 5-stage Bardenpho process with influent flow EQ and sidestream N removal. Influent EQ reduced peak N and P loads to the plant and sidestream N removal using an Anammox-type process reduced the centrate N loads recycled to the main process by 80 percent. Together, the influent EQ and centrate N removal allowed for a reduction in the amount of acetate and methanol required to meet the target effluent conditions, though acetate use was slightly higher than with influent EQ alone. This, along with the equalized loads, allowed for a small reduction in the activated sludge basin volume in the aerated cells (to 6.5 Mgal from 7.0 Mgal with influent EQ alone). However, as existing tankage would be needed for equalization for this option, this resulted in more greenfield aeration basin construction than for the option of 5-stage Bardenpho without any equalization or sidestream treatment. Detailed model outputs from the BioWin modeling are presented in Appendix B of this report.

Airflow requirements were estimated using BioWin modeling software and do not necessarily reflect the true airflow amounts that would be anticipated. However, they do allow for comparison of relative airflow needs among alternatives and can be used to estimate annual O&M costs on a relative order-of-magnitude basis. Similarly, WAS production estimates are for information only and for comparison among alternatives as expansion of solids handling facilities to meet increased solids needs are outside the scope of this study.

| Table 3-11. 5-Stage Bardenpho with Influent EQ and Sidestream N Removal Modeling Results | | |
|---|---|---|
| **Unit Process** | **Parameter/Unit** | **Value** |
| Required SRT for nitrification | –, days | 12 |
| Influent EQ basin total | Volume, Mgal | 2.4 |
| Activated sludge basin total | Volume, Mgal | 6.5 |
| Anaerobic cell 1 | Volume, Mgal | 0.5 |
| Anoxic cell 1a | Volume, Mgal | 0.375 |
| Anoxic cell 1b | Volume, Mgal | 0.375 |
| Swing cell 1 | Volume, Mgal | 0.5 |
| Aerobic cell 1a | Volume, Mgal | 1.5 |
| Aerobic cell 1b | Volume, Mgal | 1.25 |
| Swing/anoxic cell 2a | Volume, Mgal | 0.75 |
| Swing/anoxic cell 2b | Volume, Mgal | 0.75 |
| Post-aerobic cell | Volume, Mgal | 0.5 |
| MLR rate | Flow rate, percent of PE | 200 |
| WAS production | Mass rate, lb/d | 21,400 |
| Additional chemical sludge from tertiary P removal | Mass rate, lb/d | 1,900 |
| Airflow requirement | Flow rate, scfm | 15,770 |
| Acetate use | Flow rate, gpd | 6,040 |
| Methanol use | Flow rate, gpd | 310 |

As previously found, the effluent ammonia target (0.307 mg $NH_4$-N/L) proved to be the limiting parameter while modeling this option. However, with more equalized P and TKN loads entering the main stream process, the acetate and methanol use was reduced.

The modeling results were used to develop the preliminary capital and operating cost estimates presented in Section 3.3.2.3.

#### 3.3.2.3 Preliminary Capital and Operating Cost Estimates

To treat the 2030 maximum month flow and loading conditions, the main secondary treatment process will need to be expanded. As discussed previously, a high SRT is required to achieve low effluent ammonia concentrations. This results in a high MLSS concentration, which imposes a high solids loading to the secondary clarifiers. For the winter condition, with a maximum month flow of 12.3 mgd and a maximum day flow of 13.8 mgd, the maximum allowable MLSS concentration will be approximately 4,000 mg/L. This assumes that one new secondary clarifier matching the dimensions of clarifiers 4 and 5 is constructed. While previous analyses for main stream process alternatives assumed that this clarifier would be common to all alternatives evaluated, this is not the case for the add-on alternatives evaluation. The same holds for tertiary P removal filtration processes. Therefore, these costs are now included in all options, including the influent EQ tanks and sidestream Anammox-type N removal add-on processes presented in Table 3-12 below.

As shown in Table 3-11, 7.0 Mgal of activated sludge volume is required to meet effluent targets for the 2030 maximum month condition. Given that 2.4 Mgal of existing volume would be used for influent EQ, the scope of basin expansion would be 7.0 Mgal. The existing basins would also need to be retrofitted to accommodate the updated EQ configuration, with these costs also developed below.

#### 3.3.2.3.1 Capital Costs

Table 3-12 summarizes the capital costs expected for the 5-stage Bardenpho process with sidestream Anammox. The assumptions made for costs developed for this estimate include the following:

- greenfield basin expansion and existing basin retrofit costs per Mgal were developed using estimates for the City of Nampa's current plant expansion
- costs for additional secondary clarifiers were taken from estimates completed for similar-sized clarifiers at the Pierce County Chambers Creek WWTP expansion currently in construction
- tertiary membrane costs were taken from a vendor quote obtained from GE Zenon
- costs for chemical facilities were developed using costs for tanks and pump equipment obtained from equipment vendors
- cost for retrofit of existing basin to EQ tanks was estimated from planning work completed for Pierce County, Washington
- cost for DEMON™ Anammox process for sidestream treatment was obtained from the vendor during the Sidestream Nitrogen Removal Evaluation project

**Table 3-12. Planning-Level Comparative Capital Costs for 5-Stage Bardenpho with Influent EQ and Sidestream N Removal**

| Process | Quantity | Unit Cost | Total |
|---|---|---|---|
| Greenfield aeration basin tank expansion | 6.5 Mgal | $850,000/Mgal | $5,525,000 |
| Existing basin conversion to EQ tank | 2.4 Mgal | $700,000/Mgal | $1,680,000 |
| New secondary clarifiers | 1 | $ 2,000,000 | $2,000,000 |
| Tertiary filtration (membranes) | – | – | $6,320,000 |
| DEMON™ Anammox facilities | – | – | $3,600,000 |
| Chemical P removal facilities | – | – | $62,500 |
| Acetate addition facilities | – | – | $106,500 |
| Methanol addition facilities | – | – | $568,000 |
| **Total** | – | – | **$19,870,000** |

*Note: Costs provided in this table reflect construction cost only and do not include contractor markups, contingency, inflation to midpoint of construction, bonds, insurance, etc. A more complete construction cost estimate will be provided as part of the final report.*

It is important to note that the costs provided in Table 3-12 are preliminary planning-level costs that do not include contractor markups and special conditions. In addition, these costs do not reflect costs for common expansion requirements among all alternatives, such as additional secondary clarifiers, solids system expansions, or construction of already-planned facilities like the headworks or primary clarifiers. This means that these costs do not reflect the true cost for construction, but provide comparative costs for evaluating differences among the expansion alternatives only. Final AACE Class 5 construction cost estimates will be provided for the final recommended expansion alternatives associated with additional tasks for this work.

#### 3.3.2.3.2 Operating Costs

The modeling results in Table 3-11 translate into operating costs associated with alum, acetate, and methanol dosing; aeration demand; and biosolids hauling. Additional costs associated with operation of the tertiary membrane system must also be considered.

The following assumptions were used to develop these costs:

- electricity: $0.069/kWh
- biosolids hauling and application: $5.933/wet ton (assuming 20 percent cake solids)
- methanol (99 percent solution): $2.25/gal
- aeration energy demand: 30 kWh/scfm/month
- alum (P removal chemical): $1.22/gal
- tertiary filtration operating costs: $36,800/maximum month
- sidestream N removal operating costs: $8,500/maximum month (from Sidestream Evaluation TM annual cost/12 with a 1.3 peaking factor for maximum month operation)

The electric and biosolids costs were provided by Meridian WRRF staff. The methanol cost is a long-term average value from Olympia, Washington. The price of methanol is unstable, and has varied from close to $1.00 per gallon to over $4.50 per gallon during the past 10 years. The aeration energy demand is based on data from other plants with similar process demands. The tertiary filtration operating cost is from GE Zenon.

The maximum monthly operating costs are summarized in Table 3-13. Based on the results of this table, the maximum monthly operating costs for the 5-stage Bardenpho with influent EQ and sidestream N removal would be approximately $306,000. This is the highest anticipated winter monthly operating cost for the parameters provided in Table 3-13 below. Operating the system during other winter months will cost less than this amount.

**Table 3-13. Maximum Monthly Winter Operating Costs for 5-Stage Bardenpho with Influent EQ and Sidestream Anammox N Removal**

| Parameter | Quantity | Unit Cost | Total |
|---|---|---|---|
| Methanol | 9,300 gal | $2.25/gal | $21,000 |
| Acetate (80% solution of acetic acid) | 113 ton | $0.74/lb | $167,000 |
| Tertiary filtration chemical/operating cost | – | – | $36,800 |
| Process aeration | 473,100 kWh | $0.069/kWh | $33,000 |
| Biosolids hauling | 1,750 wet ton | $5.933/wet ton | $10,400 |
| P removal chemical | 24,000 gal | $1.22/gal | $29,000 |
| DEMON monthly operating cost | – | – | $8,500 |
| **Total** | | | **$306,000** |

### 3.3.3 Influent Flow Equalization with Sidestream N and P Removal

This section presents the add-on BioWin model setup, model results for winter conditions, and preliminary capital and operating costs for the influent flow EQ with sidestream N and P removal option.

#### 3.3.3.1 Add-On BioWin Model Setup

The base model used for all BioWin simulations conducted as part of this subsection was the final model developed for the 5-stage Bardenpho alternative described in detail in Section 2. The only modification made to this model was to include a flow EQ tank of 2.4 Mgal capacity (equal to the existing aeration tank capacity) to equalize flows throughout the day and modifications to the centrate to account for addition of sidestream N and P removal processes. The general process flow schematic for this process is shown in Figure 3-5.

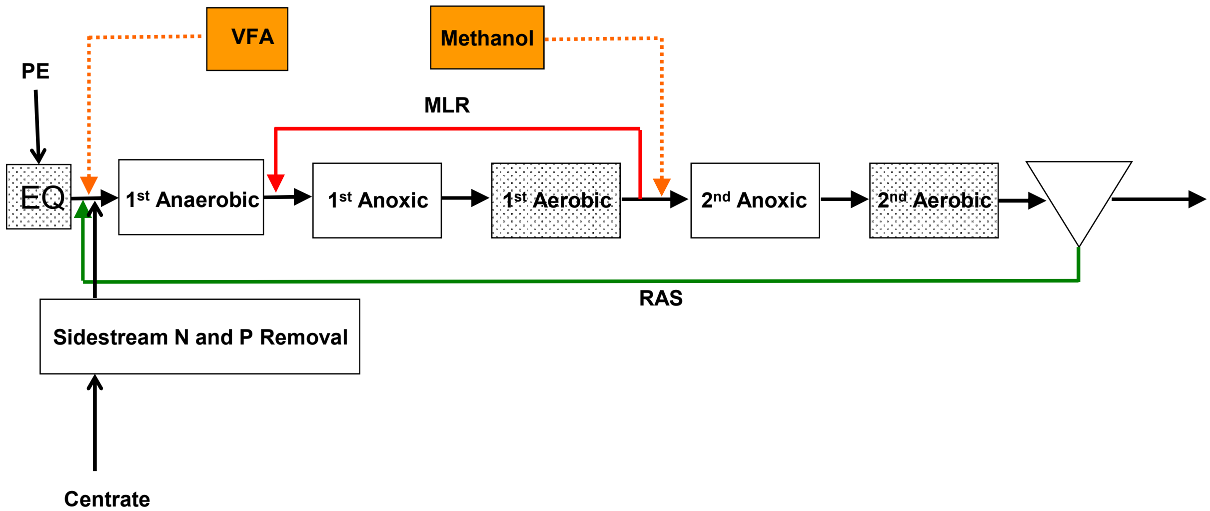


**Figure 3-5. Process flow schematic for 5-stage Bardenpho processes with influent flow equalization and sidestream N and P removal processes**

This configuration was used to optimally size the treatment system volume and determine operating parameters and chemical usage rates at winter maximum month flows and loads. The operating limitations for the plant included a maximum operating MLSS concentration of 4,000 mg/L, assuming that a fourth secondary clarifier is constructed, and an operating DO concentration of 2.0 mg/L is used for all aerated zones. The effluent limitations for this process did not change from those presented in Section 1.

The PE concentrations used for all simulations, which were developed during the Sidestream Nitrogen Removal Evaluation project from the 2012 Facilities Plan, reflect a 30-day hourly diurnal model. The monthly average values used to generate this diurnal input model were summarized in Section 1. For preliminary evaluations discussed here, only winter conditions were evaluated. Summer conditions will be evaluated for final comparisons. Centrate data were also developed during the Sidestream Nitrogen Removal Evaluation project from the 2012 Facilities Plan reported values, but were modified to reduce TN and TP concentrations in the centrate according to the typical reductions observed from sidestream Anammox-type N removal and struvite recovery P removal processes (85 percent N removal and 80 percent P removal).

The secondary clarifiers were set to remove a constant value of 99.9 percent of incoming solids. It was assumed that a fourth secondary clarifier of equal diameter and volume to existing clarifiers 4 and 5 would be installed to allow for higher operating MLSS concentrations. The clarifier sludge blanket was assumed to be 7 percent of the settler height, and the clarifier solids underflow rate was paced at 50 percent of the PE. The WAS flow rate was adjusted automatically during modeling to regulate the SRT of the process to maintain nitrification and meet the target effluent N concentrations presented in TM 1.

Using these process and effluent constraints and the PE and modified centrate influent concentrations discussed here, optimal system and chemical use sizing was completed. The final results of basin sizing, optimum MLR flow pacing, chemical use, air demand, and WAS production rates are presented in Section 3.3.3.2.

#### 3.3.3.2 Model Results for Winter Conditions

Table 3-14 shows the process sizing and operating parameters required to achieve the effluent target concentrations for the 5-stage Bardenpho process with influent flow EQ and sidestream N and

P removal. With reduced peak N and P loads to the plant, and reduction in the N and P loads from the centrate, there was a significant reduction in the amount of acetate and methanol required to meet the target effluent conditions for P and N, respectively. The reduction of these supplemental carbon additions allowed for a significant reduction in the activated sludge basin volume (to 5.3 Mgal from 6.5 Mgal for influent EQ with sidestream N alone). However, as existing tankage would be needed for equalization for this option, this resulted in more greenfield aeration basin construction than for the option of 5-stage Bardenpho without any equalization or sidestream treatment. Detailed model outputs from the BioWin modeling are presented in Appendix B of this report.

Airflow requirements were estimated using BioWin modeling software and do not necessarily reflect the true airflow amounts that would be anticipated. However, they do allow for comparison of relative airflow needs among alternatives and can be used to estimate annual O&M costs on a relative order-of-magnitude basis. Similarly, WAS production estimates are for information only and for comparison among alternatives as expansion of solids handling facilities to meet increased solids needs are outside the scope of this study.

**Table 3-14. 5-Stage Bardenpho with Influent EQ Modeling and Sidestream N and P Removal Results**

| Unit Process | Parameter/Unit | Value |
|---|---|---|
| Required SRT for nitrification | –, days | 11 |
| Influent EQ basin total | Volume, Mgal | 2.4 |
| Activated sludge basin total | Volume, Mgal | 5.3 |
| Anaerobic cell 1 | Volume, Mgal | 0.5 |
| Anoxic cell 1a | Volume, Mgal | 0.35 |
| Anoxic cell 1b | Volume, Mgal | 0.35 |
| Swing cell 1 | Volume, Mgal | 0.5 |
| Aerobic cell 1a | Volume, Mgal | 1.0 |
| Aerobic cell 1b | Volume, Mgal | 1.0 |
| Swing/anoxic cell 2a | Volume, Mgal | 0.6 |
| Swing/anoxic cell 2b | Volume, Mgal | 0.5 |
| Post-aerobic cell | Volume, Mgal | 0.5 |
| MLR rate | Flow rate, percent of PE | 200 |
| WAS production | Mass rate, lb/d | 23,050 |
| Additional chemical sludge from tertiary P removal | Mass rate, lb/d | 1,900 |
| Airflow requirement | Flow rate, scfm | 16,630 |
| Acetate use | Flow rate, gpd | 3,420 |
| Methanol use | Flow rate, gpd | 280 |

As previously found, the effluent ammonia target (0.307 mg $NH_4$-N/L) proved to be the limiting parameter while modeling this option. However, with more equalized P and TKN loads entering the main stream process, the acetate and methanol use was reduced, which allowed for shrinking of the aerobic volume while still maintaining an MLSS concentration below 4,000 mg/L.

The modeling results were used to develop the preliminary capital and operating cost estimates presented in Section 3.3.3.3.

#### 3.3.3.3 Preliminary Capital and Operating Cost Estimates

To treat the 2030 maximum month flow and loading conditions, the main secondary treatment process will need to be expanded. As discussed previously, a high SRT is required to achieve low effluent ammonia concentrations. This results in a high MLSS concentration, which imposes a high solids loading to the secondary clarifiers. For the winter condition, with a maximum month flow of 12.3 mgd and a maximum day flow of 13.8 mgd, the maximum allowable MLSS concentration will be approximately 4,000 mg/L. This assumes that one new secondary clarifier matching the dimensions of clarifiers 4 and 5 is constructed. While previous analyses for main stream process alternatives assumed that this clarifier would be common to all alternatives evaluated, this is not the case for the add-on alternatives evaluation. The same holds for tertiary P removal filtration processes. Therefore, these costs are now included in all options, including the influent EQ, sidestream Anammox, and struvite recovery add-on processes presented in Table 3-16 below.

As shown in Table 3-14, 5.3 Mgal of activated sludge volume is required to meet effluent targets for the 2030 maximum month condition. Given that 2.4 Mgal of existing volume would be used for influent EQ, the scope of basin expansion would be 5.3 Mgal. The existing basins would also need to be retrofitted to accommodate the updated EQ configuration, with these costs also developed below.

##### 3.3.3.3.1 Capital Costs

Table 3-15 summarizes the capital costs expected for the 5-stage Bardenpho process with sidestream P removal/recovery. The assumptions made for costs developed for this estimate include the following:

- greenfield basin expansion and existing basin retrofit costs per Mgal were developed using estimates for the City of Nampa’s current plant expansion
- costs for additional secondary clarifiers were taken from estimates completed for similar-sized clarifiers at the Pierce County Chambers Creek WWTP expansion currently in construction
- tertiary membrane costs were taken from a vendor quote obtained from GE Zenon
- costs for chemical facilities were developed using costs for tanks and pump equipment obtained from equipment vendors
- cost for DEMON™ Anammox process for sidestream treatment was obtained from the vendor during the Sidestream Nitrogen Removal Evaluation project
- P recovery facilities (sidestream P removal) were obtained from the 2012 Facilities Plan, and reduced by 50 percent to eliminate contractor markups and estimators’ contingencies
- cost for retrofit of existing basin to EQ tanks was estimated from planning work completed for Pierce County, Washington

**Table 3-15. Planning-Level Comparative Capital Costs for 5-Stage Bardenpho with Influent EQ and Sidestream N and P Removal**

| Process | Quantity | Unit Cost | Total |
|---|---|---|---|
| Greenfield aeration basin tank expansion | 5.3 Mgal | $850,000/Mgal | $4,505,000 |
| Existing basin retrofit to EQ tank | 2.4 Mgal | $700,000/Mgal | $1,680,000 |
| DEMON Anammox facilities | – | – | $3,600,000 |
| Struvite recovery facilities | – | – | $2,000,000 |
| New secondary clarifiers | 1 | $ 2,000,000 | $2,000,000 |
| Tertiary filtration (membranes) | – | – | $6,320,000 |

| Table 3-15. Planning-Level Comparative Capital Costs for 5-Stage Bardenpho with Influent EQ and Sidestream N and P Removal | | | |
|---|---|---|---|
| Process | Quantity | Unit Cost | Total |
| Chemical P removal facilities | – | – | $62,500 |
| Acetate addition facilities | – | – | $106,500 |
| Methanol addition facilities | – | – | $568,000 |
| **Total** | **–** | **–** | **$20,840,000** |

*Note: Costs provided in this table reflect construction cost only and do not include contractor markups, contingency, inflation to midpoint of construction, bonds, insurance, etc. A more complete construction cost estimate will be provided as part of the final report.*

It is important to note that the costs provided in Table 3-15 are preliminary planning-level costs that do not include contractor markups and special conditions. In addition, these costs do not reflect costs for common expansion requirements among all alternatives, such as additional secondary clarifiers, solids system expansions, or construction of already-planned facilities like the headworks or primary clarifiers. This means that these costs do not reflect the true cost for construction, but provide comparative costs for evaluating differences among the expansion alternatives only. Final AACE Class 5 construction cost estimates will be provided for the final recommended expansion alternatives associated with additional tasks for this work.

#### 3.3.3.3.2 Operating Costs

The modeling results in Table 3-14 translate into operating costs associated with alum, acetate, and methanol dosing; aeration demand; and biosolids hauling. Additional costs associated with operation of the tertiary membrane system must also be considered.

The following assumptions were used to develop these costs:

- electricity: $0.069/kWh
- biosolids hauling and application: $5.933/wet ton (assuming 20 percent cake solids)
- methanol (99 percent solution): $2.25/gal
- aeration energy demand: 30 kWh/scfm/month
- alum (P removal chemical): $1.22/gal
- tertiary filtration operating costs: $36,800/maximum month
- sidestream N removal operating costs: $8,500/maximum month (from Sidestream Evaluation TM annual cost/12 with a 1.3 peaking factor for maximum month operation)
- operation of struvite recovery facility: $20,000/maximum month

The electric and biosolids costs were provided by Meridian WRRF staff. The methanol cost is a long-term average value from Olympia, Washington. The price of methanol is unstable, and has varied from close to $1.00 per gallon to over $4.50 per gallon during the past 10 years. The aeration energy demand is based on data from other plants with similar process demands. The tertiary filtration operating cost is from GE Zenon. The operating costs for the struvite recovery facility are a conservative estimate from other facilities operating struvite recovery systems.

The maximum monthly operating costs are summarized in Table 3-16. Based on the results of this table, the maximum monthly operating costs for the 5-stage Bardenpho with influent EQ and sidestream N and P removal would be approximately $248,000. This is the highest anticipated winter monthly operating cost for the parameters provided in Table 3-16 below. Operating the system during other winter months will cost less than this amount.

| Table 3-16. Maximum Monthly Winter Operating Costs for 5-Stage Bardenpho with Influent EQ and Sidestream N and P Removal | | | |
|---|---|---|---|
| Parameter | Quantity | Unit Cost | Total |
| Methanol | 8,400 gal | $2.25/gal | $19,000 |
| Acetate (80% solution of acetic acid) | 64 ton | $0.74/lb | $95,000 |
| Tertiary filtration chemical/operating cost | – | – | $36,800 |
| Process aeration | 440,700 kWh | $0.069/kWh | $30,400 |
| Biosolids hauling | 1,575 wet ton | $5.933/wet ton | $9,300 |
| P removal chemical | 24,000 gal | $1.22/gal | $29,000 |
| DEMON monthly operating cost | – | – | $8,500 |
| Struvite recovery facility monthly operating cost | – | – | $20,000 |
| **Total** | | | **$248,000** |

## 3.4 Centrate Nitrogen Load Equalization

This section provides a description of the modeling, sizing, and cost estimate results for the 5-stage Bardenpho expansion alternative with equalized centrate N load. The current plant operation is to equalize the flow of the centrate stream on a daily basis, which means the centrate flow to the main stream process is consistently the same each hour of the day. This alternative looked at distributing the centrate equally over certain hours of the day when the PE ammonia loads were low and the COD:TKN ratios were highest. The objective is to provide a more equalized ammonia load to the biological process during the day to reduce ammonia loading “peaks and valleys,” which typically improves performance of nitrification and reduces breakthrough of ammonia during peak loading periods. With this type of N loading EQ operation it is possible to optimize the main stream treatment process and potentially reduce the sizing of the 5-stage Bardenpho process.

### 3.4.1 BioWin Model Setup

For this alternative, a new diurnal centrate itinerary was prepared based on the winter PE diurnal schedule and daily centrate data (Section 1). The daily average centrate ammonia load was distributed equally from 12 a.m. to 7 a.m. to fill in the low PE ammonia loading and high COD:TKN ratio time periods. The calibrated base model of the 5-stage Bardenpho process was used for the simulation, as represented by the process flow diagram shown in Figure 3-6.

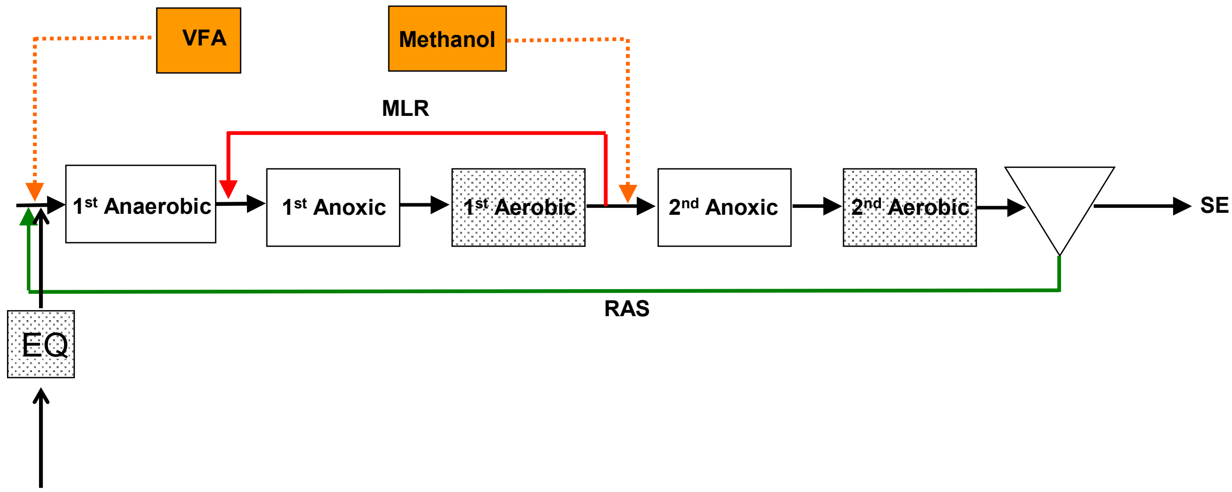


**Figure 3-6. Process flow schematic for 5-stage Bardenpho processes with centrate load equalization**

As discussed previously, the centrate load was returned during the minimum PE ammonia load period of each day. Figure 3-7 from the BioWin simulation shows how the centrate ammonia load was distributed throughout the 30-day simulation period.

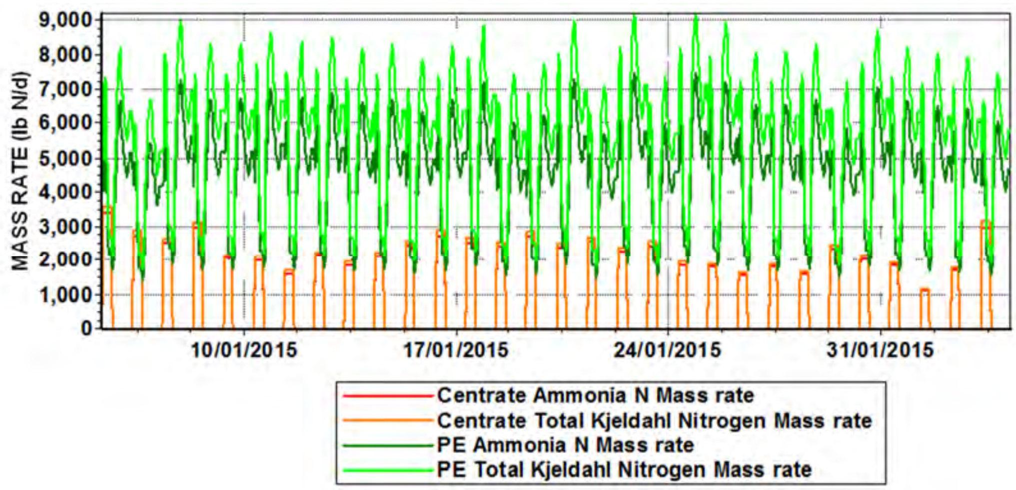


**Figure 3-7. PE and centrate nitrogen mass rates**

Once the centrate itinerary was developed, the model was simulated to optimally size the treatment system volume and determine operating parameters under winter maximum month flows and loads. The centrate equalizing schedule described above and a 12-day SRT were the basis for the following optimization runs. The BioWin simulation outputs were evaluated in terms of the effluent permit values provided in Section 1. Outputs that met the permitted values were selected and are described below:

- Reduce aeration basin volume: The aerated zone volumes were reduced. The optimum sizing was reducing the aerated zone volume by 0.75 Mgal.
- Reduce chemical use: Methanol feed can be reduced from 615 to 560 gpd.

### 3.4.2 Model Results for Winter Conditions

Table 3-17 shows the alternative process sizing and operating parameters required to achieve the effluent target concentrations listed in Section 1. The simulation shows an approximate 16 percent reduction in airflow from the 5-stage Bardenpho process without centrate N loading equalization.

**Table 3-17. 5-Stage Bardenpho with Centrate Load EQ Modeling Results**

| Unit Process | Parameter/Unit | Value |
|---|---|---|
| Required SRT for nitrification | –, days | 12 |
| Activated sludge basin total | Volume, Mgal | 6.5 |
| Anaerobic cell 1 (Ana 1) | Volume, Mgal | 0.5 |
| Anoxic cell 1a (Anox 1a) | Volume, Mgal | 0.375 |
| Anoxic cell 1b (Anox 1b) | Volume, Mgal | 0.375 |
| Swing cell 1 | Volume, Mgal | 0.5 |
| Aerobic cell 1 (Aer 1) | Volume, Mgal | 1.5 |
| Aerobic cell 2 (Aer 2) | Volume, Mgal | 1.25 |
| Swing cell 2a (Swing 2a) | Volume, Mgal | 0.75 |
| Swing cell 2b (Swing 2b) | Volume, Mgal | 0.75 |
| Aerobic cell 3 (Aer 3) | Volume, Mgal | 0.5 |
| IMLR rate | Flow rate, percent of PE | 200 |
| WAS production | Mass rate, lb/d | 23,310 |
| Additional chemical sludge from P removal to 0.07 mg/L | Mass rate, lb/d | 1,900 |
| Airflow requirement | Flow rate, scfm | 17,250 |
| Acetate use | Flow rate, lb/d | 9,110 |
| Methanol use | Flow rate, gpd | 560 |

An important item to note is that the current centrate EQ tank is 105,000 gallons. Based on the information available, it appears that this volume would be sufficient for the centrate ammonia load EQ scenario proposed, but further evaluation would be recommended to determine if the tank volume and pump capacities are adequate if this option is selected for design.

### 3.4.3 Preliminary Capital and Operating Cost Estimates

The total size of the aeration basins to meet the maximum month condition is 6.5 Mgal. Given 2.4 Mgal of existing volume, the basin expansion would be only 4.15 Mgal. As discussed in Section 2, the existing basins would need to be retrofitted to accommodate the updated configuration.

#### 3.4.3.1 Capital Costs

Table 3-18 presents the capital cost for the centrate N load EQ alternative. For this alternative, the aeration basin quantity and total cost was modified to reflect the savings in aeration basin volume (0.75 MGal) with centrate N loading equalization. The chemical facilities sizes estimated for the 5-stage Bardenpho process were not adjusted for this alternative because the chemical quantities are the same or similar.

**Table 3-18. Planning-Level Comparative Capital Costs for 5-Stage Bardenpho Expansion with Centrate Load Equalization**

| Process | Quantity | Unit Cost | Total |
|---|---|---|---|
| Greenfield aeration basin tank expansion | 4.15 Mgal | $850,000/Mgal | $3,530,000 |
| Existing basin retrofit | 2.4 Mgal | $400,000/Mgal | $960,000 |
| Centrate EQ tank modifications | – | – | $50,000 |
| New secondary clarifiers (100 ft dia.) | 1 | $ 2,000,000 | $ 2,000,000 |
| Tertiary filtration (membranes) | – | – | $6,320,000 |
| Chemical P removal facilities | – | – | $62,500 |
| Acetate addition facilities | – | – | $106,500 |
| Methanol addition facilities | – | – | $568,000 |
| **Total** | **–** | **–** | **$13,595,000** |

*Note: Costs provided in this table reflect construction cost only and do not include contractor markups, contingency, inflation to midpoint of construction, bonds, insurance, etc. A more complete construction cost estimate will be provided as part of the final report.*

### 3.4.3.2 Operating Costs

The modeling results in Table 3-17 translate into operating costs associated with acetate and methanol dosing, aeration demand, biosolids hauling, and chemical addition for P removal. The following assumptions were used to develop these costs:

- electricity: $0.069/kWh
- biosolids hauling and application: $5.933/wet ton (assuming 20 percent cake solids)
- methanol: $2.25/gal
- acetate: $0.74/lb
- aeration energy demand: 30 kWh/scfm/month
- chemical addition for P removal: $1.22/gal of alum

The electric and biosolids costs come from the plant. The methanol cost is a long-term average value from Olympia, Washington. The price of methanol is unstable, and has varied from close to $1.00 per gallon to over $4.50 per gallon during the past 10 years. The cost for acetate is a single value obtained from a local chemical supplier to the Boise area. The aeration energy demand is based on data from other plants with similar process demands. The chemical addition cost for P removal is a cost for alum addition determined for the City of Nampa in 2013.

The annual operating costs are summarized in Table 3-19.

**Table 3-19. Maximum Month Operating Costs for 5-Stage Bardenpho with Centrate Load Equalization**

| Parameter | Quantity | Unit Cost | Total per Month |
|---|---|---|---|
| Methanol | 16,820 gal | $2.25/gal | $38,000 |
| Acetate | 173 tons | $0.74/lb | $260,000 |
| Tertiary filtration chemical/operating cost | – | – | $36,800 |
| Process aeration | 517,500 kWh | $0.069/kWh | $35,700 |
| Biosolids hauling | 1,890 wet tons | $5.933/wet ton | $11,200 |
| P removal chemical | 24,000 gal | $1.22/gal | $29,000 |
| **Total** | | | **$411,000** |

The maximum month operating cost for carbon addition, aeration, biosolids disposal, and chemical P removal for the 5-stage Bardenpho system with centrate load equalization is approximately $411,000. This is the highest anticipated monthly cost for winter operating conditions. Operating the system during other winter months will cost less than this amount.

# 3.5 Tertiary Nitrification and Denitrification Process

This section provides a description of the modeling, sizing, and cost estimate results for tertiary nitrification and denitrification. Tertiary nitrification and denitrification filtration systems would be provided after the secondary clarifiers. The objective of this alternative is to focus on denitrification in a tertiary process and provide only partial nitrification and complete biological P removal in the main stream process. As complete nitrification in the main stream process has been the size-limiting factor for upgrades with this system, it was thought that completing nitrification and denitrification in tertiary processes may present some main stream basin size and cost advantages to completing these processes all in the main aeration tankage.

## 3.5.1 BioWin Model Setup

For this scenario, the main stream 5-stage Bardenpho configuration was simplified to an A/O process configuration with one anaerobic zone followed by two aerobic zones, as shown in the process flow diagram in Figure 3-8. Methanol addition and IMLR were eliminated from the treatment process but acetate was fed to support P removal in the biological reactors. The BioWin influent and centrate flow and load itinerary for the 5-stage Bardenpho process (refer to TM 1) was used for the simulation. Although they were not modeled in BioWin, the tertiary processes include a BIOFOR®N (Infilco Degremont) biological aerated filtration (BAF) system to provide post-nitrification followed by Denite® filters (Severn Trent) for post-denitrification.

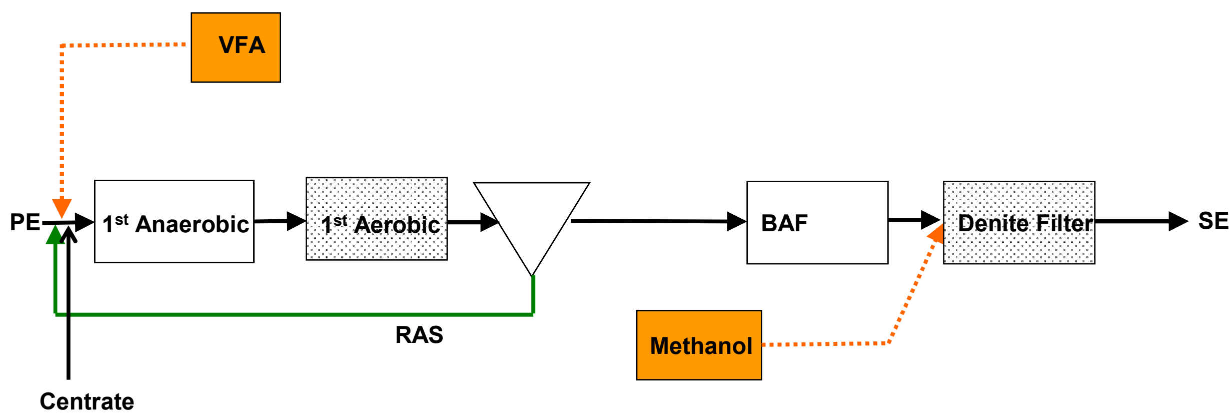


**Figure 3-8. Process flow schematic for A/O process use with tertiary nitrification and denitrification**

## 3.5.2 Model Results for Winter Conditions

Two modeling scenarios were identified for this alternative to understand and compare the sizing and cost implications if only some or all nitrification would take place in the tertiary process. Option 1 assumes that most of the influent ammonia is treated in the tertiary process (approximately 40 mg/L) and little to no nitrification takes place in the main stream process. Option 2 assumes that some nitrification does take place in the main stream process but about 25 percent (10 mg/L) of the remaining influent ammonia is nitrified in the tertiary process. The treatment goal for each of these options was to maintain less than 0.5 mg/L as TP in the secondary effluent and meet the N permit limits following tertiary treatment for denitrification. When completing the evaluations of these two options, it was determined that there was minimal difference in sizing of the main A/O process tanks for meeting either 40 mg $NH_4$-N/L effluent ammonia or 10 mg $NH_4$-N/L effluent ammonia, but there was a very large difference in costs of the tertiary treatment processes (40 mg $NH_4$-N/L ammonia BAFs were much larger and more expensive). Therefore, as the 10 mg $NH_4$-N/L option (Option 2) presented the lowest overall capital and operating cost, only this option is presented in this section. Based on the analysis for meeting a main stream effluent ammonia concentration of 10 mg $NH_4$-N/L, Table 3-20 presents the process assumptions and sizing for the winter flow and loading conditions.

**Table 3-20. Option 2 Modeling Results**

| Unit Process | Parameter/Unit | Value |
|---|---|---|
| Required SRT for nitrification | –, days | 4 |
| Activated sludge basin total | Volume, Mgal | 3.75 |
| Anaerobic cell 1 (Ana 1) | Volume, Mgal | 0.5 |
| Anoxic cell 1a (Anox 1a) | Volume, Mgal | 0 |
| Anoxic cell 1b (Anox 1b) | Volume, Mgal | 0 |
| Swing cell 1 | Volume, Mgal | 0 |
| Aerobic cell 1 (Aer 1) | Volume, Mgal | 1.25 |
| Aerobic cell 2 (Aer 2) | Volume, Mgal | 2.0 |
| Swing cell 2a (Swing 2a) | Volume, Mgal | 0 |
| Swing cell 2b (Swing 2b) | Volume, Mgal | 0 |
| Aerobic cell 3 (Aer 3) | Volume, Mgal | 0 |
| IMLR rate | Flow rate, percent of PE | 0 |
| WAS production | Mass rate, lb/d | 26,420 |
| Additional chemical sludge from P removal to 0.07 mg/L | Mass rate, lb/d | 1,900 |
| Airflow requirement[a] | Flow rate, scfm | 16,000 |
| Acetate use | Flow rate, lb/d | 9,110 |
| Methanol use | Flow rate, gpd | 1,500 |

a. *BioWin air required = 12,990 scfm, BIOFOR®N air required = 3,010 scfm.*

From these data, it can be observed that there is a significant reduction in the SRT relative to the 5-stage Bardenpho process presented in TM 1, which is a result of not having to complete nitrification in the main treatment process. Along with that is a reduction in the tank sizes and airflow requirements. However, the WAS production rates increase because of the lower SRT. Further, because all denitrification is now completed in the tertiary denitrification process, no soluble BOD from the influent waste stream is available for denitrification. Therefore, additional methanol is required to complete denitrification compared to when denitrification is completed as part of the main stream treatment process.

### 3.5.3 Preliminary Capital and Operating Cost Estimates

The total size of the aeration basins to meet the maximum month condition is 3.75 Mgal. Given 2.4 Mgal of existing volume, the basin expansion would be only 1.35 Mgal. As discussed in TM 1, the existing basins would need to be retrofitted to accommodate the updated configuration. Capital costs to accommodate these changes are listed below.

#### 3.5.3.1 Capital Costs

Vendor proposals were requested for the BAF and denitrifying filter equipment presented here. The costs for the tertiary filter processes include the following:

1. vendor-provided equipment budgetary prices (Infilco Degremont and Severn Trent)
   a. Eight 11' 8" x 100' Severn Trent Denite® filters: $5.4 million
   b. Six 27' x 31.5' IDI BIOFOR®N filters @ 10 mg/L-N influent $NH_4$-N: $3.9 million
2. mechanical allowance of 15 percent
3. equipment installation allowance of 10 percent
4. estimated construction costs for tanks, influent and effluent channels, gallery, and electrical support buildings based on Brown and Caldwell's Littleton/Englewood WWTP Denite® facility footprint and construction costs:
   a. building = $250/ft²
   b. building foundation = $350/ft²
   c. similar-sized Denite® filter facility for both options

Methanol addition facility costs were increased proportionately based on comparing the methanol flow rates to the 5-stage Bardenpho main stream option in TM1.

The overall capital cost is presented in Table 3-21.

**Table 3-21. Planning-Level Comparative Capital Costs for Tertiary Nitrification/Denitrification**

| Process | Quantity | Unit Cost | Total |
|---|---|---|---|
| Greenfield aeration basin tank expansion | 1.4 Mgal | $850,000/Mgal | $1,190,000 |
| Existing basin retrofit | 2.4 Mgal | $400,000/Mgal | $960,000 |
| New secondary clarifiers (100 ft dia.) | 1 | $ 2,000,000 | $ 2,000,000 |
| Tertiary nitrification (BAF) | – | – | $7,700,000 |
| Tertiary denitrification (Denite filter) | – | – | $11,500,000 |
| Tertiary filtration (membranes) | – | – | $6,320,000 |
| Chemical P removal facilities | – | – | $62,500 |
| Acetate addition facilities | – | – | $106,500 |
| Methanol addition facilities | – | – | $1,034,000 |
| **Total** | – | – | **$30,870,000** |

*Note: Costs provided in this table reflect construction cost only and do not include contractor markups, contingency, inflation to midpoint of construction, bonds, insurance, etc. A more complete construction cost estimate will be provided as part of the final report.*

#### 3.5.3.2 Operating Costs

The modeling results in Table 3-22 translate into operating costs associated with acetate and methanol dosing, aeration demand, and biosolids hauling. The following assumptions were used to develop these costs:

- electricity: $0.069/kWh
- biosolids hauling and application: $5.933/wet ton (assuming 20 percent cake solids)
- methanol: $2.25/gal
- acetate: $0.74/lb

- aeration energy demand: 30 kWh/scfm/month

The electric and biosolids costs come from the plant. The methanol cost is a long-term average value from Olympia, Washington. The price of methanol is unstable, and has varied from close to $1.00 per gallon to over $4.50 per gallon during the past 10 years. The cost for acetate is a single value obtained from a local chemical supplier to the Boise area. The aeration energy demand is based on data from other plants with similar process demands.

| Table 3-22. Maximum Month Operating Costs for Tertiary Nitrification/Denitrification | | | |
|---|---|---|---|
| Parameter | Quantity | Unit Cost | Total per Month |
| Methanol | 33,600 gal | $2.25/gal | $75,600 |
| Acetate | 173 tons | $0.74/lb | $260,000 |
| Tertiary filtration chemical/operating cost | – | – | $36,800 |
| Process aeration [a] | 480,000 kWh | $0.069/kWh | $33,100 |
| Biosolids hauling | 2,470 wet tons | $5.933/wet ton | $14,700 |
| P removal chemical | 24,000 gal | $1.22/gal | $29,000 |
| **Total** | | | **$449,000** |

*a. Includes A/O and tertiary nitrification filter aeration requirements.*

The maximum winter monthly operating cost is $449,000. This is the highest anticipated monthly cost for winter operating conditions. Operating the system during other winter months will cost less than this amount.

# 3.6 BioMag Ballasted Activated Sludge System

This section provides a description of the modeling, sizing, and cost estimate results for the BioMag ballasted activated sludge system. The BioMag system uses magnetite addition to the mixed liquor to increase its specific gravity and allow for improved settleability in conventional secondary clarifiers. Magnetite is recovered from the WAS via shearing of the flocs in a shear mill, followed by magnetic drum separation of the magnetite from the biological floc. This system is considered an alternative to MBRs because of its ability to operate at very high mixed liquor concentrations, but while still using conventional secondary clarifiers. BioMag was evaluated to determine if the savings in tank size, because of its ability to operate at high MLSS concentrations, would result in overall cost savings in addition to footprint savings.

## 3.6.1 BioMag Add-On BioWin Model Setup

The base model used for all BioWin simulations conducted as part of this section was the final model developed for the 5-stage Bardenpho alternative described in detail in Section 2. The only modification made to this model was to modify the activated sludge system by increasing the mixed liquor concentration to reflect the use of magnetite as a ballast to assist mixed liquor settling in secondary clarifiers. The general process flow schematic for this process is shown in Figure 3-9.

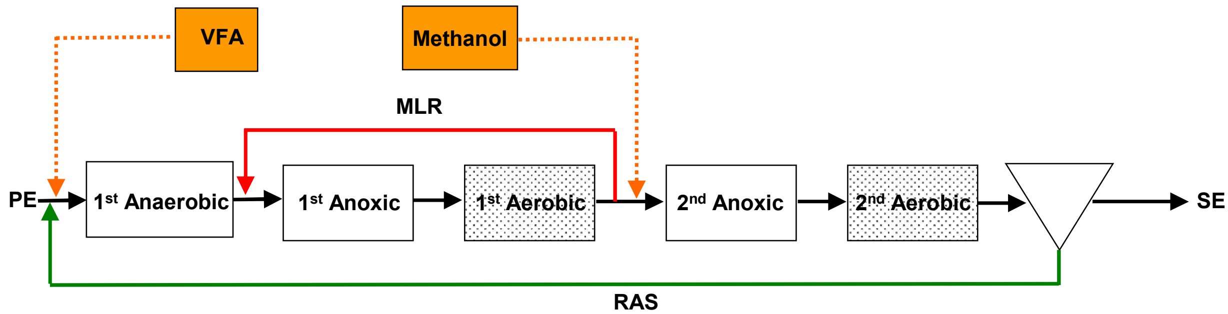


**Figure 3-9. Process flow schematic for BioMag ballasted 5-stage Bardenpho process**

This configuration was used to optimally size the treatment system volume and determine operating parameters and chemical usage rates at winter maximum month flows and loads. In this case, the operating MLSS concentration was not restricted because of the use of the magnetite ballasting agent. It was assumed that a fourth secondary clarifier is constructed, and an operating DO concentration of 2.0 mg/L is used for all aerated zones. The effluent limitations for this process did not change from those presented in Section 1.

The PE concentrations used for all simulations, which were developed during the Sidestream Nitrogen Removal Evaluation project from the 2012 Facilities Plan, reflect a 30-day hourly diurnal model. The monthly average values used to generate this diurnal input model were summarized in Section 1. For preliminary evaluations discussed here, only winter conditions were evaluated. Summer conditions will be evaluated for final comparisons. Centrate data were also developed during the Sidestream Nitrogen Removal Evaluation project from the 2012 Facilities Plan reported values.

The secondary clarifiers were set to remove a constant value of 99.9 percent of incoming solids. It was assumed that a fourth secondary clarifier of equal diameter and volume to existing clarifiers 4 and 5 would be installed to allow for higher operating MLSS concentrations. The clarifier sludge blanket was assumed to be 7 percent of the settler height, and the clarifier solids underflow rate was paced at 50 percent of the PE. The WAS flow rate was adjusted automatically during modeling to regulate the SRT of the process to maintain nitrification and meet the target effluent N concentrations presented in Section 1.

Using these process and effluent constraints and the PE and modified centrate influent concentrations discussed here, optimal system and chemical use sizing was completed. The final results of basin sizing, optimum MLR flow pacing, chemical use, air demand, and WAS production rates are presented in Section 3.6.2.

### 3.6.2 Model Results for Winter Conditions

Table 3-23 shows the process sizing and operating parameters required to achieve the effluent target concentrations for the BioMag ballasted 5-stage Bardenpho process. With no change to the peak N and P loads to the plant, there was no change to the amount of acetate and methanol required to meet the target effluent conditions for P and N, respectively. The ballast used with the BioMag process allows for higher MLSS concentrations to be carried in the system. While there was no change to the anaerobic volume required to achieve the desired effluent P concentration, the use of the ballast allowed for a significant reduction in the non-aerobic volume such that the overall activated sludge basin volume was reduced to 4.19 Mgal. Detailed model outputs from the BioWin modeling are presented in Appendix B of this report.

Airflow requirements were estimated using BioWin modeling software and do not necessarily reflect the true airflow amounts that would be anticipated. However, they do allow for comparison of relative airflow needs among alternatives and can be used to estimate annual O&M costs on a relative order-of-magnitude basis. Similarly, WAS production estimates are for information only and for comparison among alternatives as expansion of solids handling facilities to meet increased solids needs are outside the scope of this study.

**Table 3-23. BioMag Ballasted 5-Stage Bardenpho Process Results**

| Unit Process | Parameter/Unit | Value |
|---|---|---|
| Required SRT for nitrification | –, days | 17.3 |
| Activated sludge basin total | Volume, Mgal | 4.19 |
| Anaerobic cell 1 | Volume, Mgal | 0.50 |
| Anoxic cell 1a | Volume, Mgal | 0.19 |
| Anoxic cell 1b | Volume, Mgal | 0.19 |
| Swing cell 1 | Volume, Mgal | 0.27 |
| Aerobic cell 1a | Volume, Mgal | 0.82 |
| Aerobic cell 1b | Volume, Mgal | 1.1 |
| Swing/anoxic cell 2a | Volume, Mgal | 0.42 |
| Swing/anoxic cell 2b | Volume, Mgal | 0.42 |
| Post-aerobic cell | Volume, Mgal | 0.28 |
| MLR rate | Flow rate, percent of PE | 200 |
| WAS production | Mass rate, lb/d | 15,350 |
| Airflow requirement | Flow rate, scfm | 25,750 |
| Acetate use | Flow rate, gpd | 9,110 |
| Methanol use | Flow rate, gpd | 615 |

As previously found, the effluent ammonia target (0.307 mg $NH_4$-N/L) proved to be the limiting parameter while modeling this option. This resulted in the SRT being increased to 17.3 days and the MLSS concentration to 7,610 mg/L. The higher MLSS concentration was manageable because of the use of the magnetite ballast. However, the higher sludge inventory increased the maintenance aeration requirement such that the overall airflow requirement increased to 25,750 scfm. The demand for acetate and methanol were the same as for the base 5-stage Bardenpho case.

The modeling results were used to develop the preliminary capital and operating cost estimates presented in Section 3.6.3.

### 3.6.3 Preliminary Capital and Operating Cost Estimates

To treat the 2030 maximum month flow and loading conditions, the main secondary treatment process will need to be expanded. As discussed previously, a high SRT is required to achieve low effluent ammonia concentrations. This results in a high MLSS concentration, which imposes a high solids loading to the secondary clarifiers. With the use of the ballast, a higher clarifier solids loading can be tolerated than with conventional activated sludge systems. However, at the estimated MLSS concentration of 7,610 mg/L, one new secondary clarifier matching the dimensions of clarifiers 4 and 5 is constructed for the winter condition modeled. While previous analyses for main stream process alternatives assumed that this clarifier would be common to all alternatives evaluated, this is not the case for the add-on alternatives evaluation. The same holds for tertiary P removal filtration processes. Therefore, these costs are now included in Table 3-23.

As shown in Table 3-24, 4.19 Mgal of activated sludge volume is required to meet effluent targets for the 2030 maximum month condition. This represents a significant savings over the 7.25 Mgal required for the base 5-stage Bardenpho case defined in Section 2.

#### 3.6.3.1 Capital Costs

Table 3-24 summarizes the capital costs expected for the BioMag ballasted 5-stage Bardenpho process. The assumptions made for costs developed for this estimate include the following:

- greenfield basin expansion and existing basin retrofit costs per Mgal were developed using estimates for the City of Nampa's current plant expansion
- costs for additional secondary clarifiers were taken from estimates completed for similar-sized clarifiers at the Pierce County Chambers Creek WWTP expansion currently in construction
- tertiary membrane costs were taken from a vendor quote obtained from GE Zenon
- costs for chemical facilities were developed using costs for tanks and pump equipment obtained from equipment vendors
- cost for BioMag process requirements was obtained from the vendor

**Table 3-24. Planning-Level Comparative Capital Costs for BioMag Ballasted 5-Stage Bardenpho Process**

| Process | Quantity | Unit Cost | Total |
|---|---|---|---|
| Greenfield aeration basin tank expansion | 1.8 Mgal | $850,000/Mgal | $1,530,000 |
| Existing basin retrofit | 2.4 Mgal | $400,000/Mgal | $960,000 |
| BioMag process facilities | – | – | $2,850,000 |
| New secondary clarifiers | 2 | $ 2,000,000 | $4,000,000 |
| Tertiary filtration (membranes) | – | – | $6,320,000 |
| Chemical P removal facilities | – | – | $62,500 |
| Acetate addition facilities | – | – | $106,500 |
| Methanol addition facilities | – | – | $568,000 |
| **Total** | | | **$16,400,000** |

*Note: Costs provided in this table reflect construction cost only and do not include contractor markups, contingency, inflation to midpoint of construction, bonds, insurance, etc. A more complete construction cost estimate will be provided as part of the final report.*

It is important to note that the costs provided in Table 3-24 are preliminary planning-level costs that do not include contractor markups and special conditions. In addition, these costs do not reflect costs for common expansion requirements among all alternatives, such as additional secondary clarifiers, solids system expansions, or construction of already-planned facilities like the headworks or primary clarifiers. This means that these costs do not reflect the true cost for construction, but provide comparative costs for evaluating differences among the expansion alternatives only. Final AACE Class 5 construction cost estimates will be provided for the final recommended expansion alternatives associated with additional tasks for this work.

#### 3.6.3.2 Operating Costs

The modeling results in Table 3-23 translate into operating costs associated with alum, acetate, and methanol dosing; aeration demand; biosolids hauling; ballast makeup; and supplementary power requirements for the BioMag equipment. Additional costs associated with operation of the tertiary membrane system must also be considered.

The following assumptions were used to develop these costs:

- electricity: $0.069/kWh
- biosolids hauling and application: $5.933/wet ton (assuming 20 percent cake solids)
- methanol (99 percent solution): $2.25/gal
- aeration energy demand: 30 kWh/scfm/month
- alum (P removal chemical): $1.22/gal
- tertiary filtration operating costs: $36,800/maximum month

The electric and biosolids costs were provided by Meridian WWTP staff. The methanol cost is a long-term average value from Olympia, Washington. The price of methanol is unstable, and has varied from close to $1.00 per gallon to over $4.50 per gallon during the past 10 years. The aeration energy demand is based on data from other plants with similar process demands. The tertiary filtration operating cost is from GE Zenon.

The maximum monthly operating costs are summarized in Table 3-25. Based on the results of this table, the maximum monthly operating costs for the BioMag ballasted 5-stage Bardenpho process would be approximately $457,000. This is the highest anticipated winter monthly operating cost for the parameters provided in Table 7-3. Operating the system during other winter months will cost less than this amount.

Table 3-25. Maximum Monthly Winter Operating Costs for BioMag Ballasted 5-Stage Bardenpho Process

| Parameter | Quantity | Unit Cost | Total |
|---|---|---|---|
| Methanol | 18,450 gal | $2.25/gal | $42,000 |
| Acetate (80% solution of acetic acid) | 173 ton | $0.74/lb | $260,000 |
| Tertiary filtration chemical/operating cost | – | – | $36,800 |
| Process aeration | 772,500 kWh | $0.069/kWh | $53,300 |
| Biosolids hauling | 1,290 wet ton | $5.933/wet ton | $7,700 |
| P removal chemical | 24,000 gal | $1.22/gal | $29,000 |
| Magnetite | 66,000 lb | $0.35/lb | $23,100 |
| BioMag power consumption | 78,000 kWh | $0.069/kWh | $5,400 |
| **Total** | | | **$457,000** |

## 3.7 Membrane Bioreactor System

This section provides a description of the modeling, sizing, and cost estimate results for the MBR alternative. This alternative is a variation of Alternative 1 of the main stream alternatives. The existing conventional activated sludge system would be converted to an MBR system to provide both biological P and N removal, with tertiary chemical P removal needed for polishing to the final permit limit requirements. Addition of soluble carbon sources to drive the biological nutrient removal processes is also part of this alternative, as required to meet permitted effluent discharge limits. For evaluation of this alternative, as well as all other alternatives, the fermenter is not accounted for in the modeling to determine worst-case carbon addition needs.

### 3.7.1 BioWin Model Setup

The BioWin model used for the 5-stage Bardenpho conventional activated sludge system was modified to reflect the configuration for an MBR system. The secondary clarifiers are replaced by membrane tanks for solids separation. Sizing of the membrane tanks and membrane cassette displacement volume in the tanks are based on a budgetary proposal from an MBR manufacturer using hollow-fiber ultrafiltration membranes. The MBR system can also be designed using flat plate-type membranes.

Figure 3-10 presents a process flow schematic for the MBR system. Similar to the conventional activated sludge system alternative, the MBR system can be configured to operate as either a 5-stage Bardenpho or A2O process, depending on whether a second anoxic stage is included and where the MLR stream is routed from. In an MBR system, mixed liquor from the aeration basins either flows by gravity or is pumped to the membrane tanks. Membrane cassettes are submerged in the mixed liquor. Permeate is drawn through the membrane and out of the tanks via permeate pumps. Mixed liquor is returned from the membrane tanks to the aeration basins as RAS. Typically, a RAS flow ratio of about 300 to 400 percent is used to prevent accumulation of solids in the membrane tanks and minimize the difference in mixed liquor solids concentrations between the aeration basins and the membrane tanks. Other ancillary equipment for an MBR system includes coarse-bubble diffusers and blowers to provide scouring air for the membranes, chemical cleaning systems, backpulse/CIP tank, air compressors for the instrument air, and a control panel.

Similar to the flow sheet for the conventional activated sludge system, supplemental carbon is added for biological nutrient removal, including acetate for P removal and methanol for TN removal. Fermentate from the existing primary sludge fermenter is not included in the MBR simulations. Addition of fermentate will be included at predesign when finalizing the sizing of the selected expansion alternative and will reduce the dosing rates for acetate and methanol as determined in this analysis. With the ultrafiltration membranes in an MBR system, a separate tertiary filtration process will not be needed. To meet the stringent effluent P requirement, alum will be added as a coagulant just upstream of the membrane tanks.

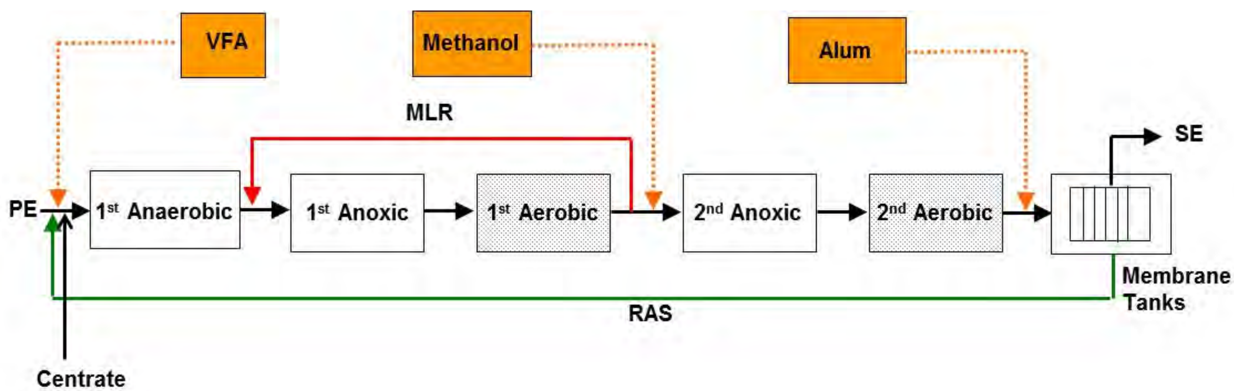


**Figure 3-10. Process flow schematic for 5-stage Bardenpho process with MBR**

Once this configuration was developed, it was used to optimally size the treatment system volume and determine operating parameters at winter maximum month flows and loads. The operating limitations for this alternative included a maximum operating MLSS concentration of 10,000 mg/L in the membrane tanks, on a monthly average basis. Because of the high MLSS concentration in an MBR system, the alpha ($\alpha$) factor, which is a parameter used to describe oxygen transfer rate in process water in relation to that in clean water, is reduced by 20 percent as it has been found that oxygen transfer efficiency drops at higher MLSS concentrations. The operating DO concentration is set at 2.0 mg/L in all aerated zones, and is assumed to be 6 mg/L in the membrane tanks because of the scouring air supplied to those tanks. The target effluent concentrations, as shown in Table 3-26, are similar to those used for the 5-stage Bardenpho conventional activated sludge process alternative, except that an effluent $PO_4$-P limit of 0.1 mg/L was first used to run an initial simulation without alum addition, and then a lower limit of 0.07 mg/L was used in a subsequent simulation with alum addition.

| Table 3-26. Target Effluent Concentrations for MBR Simulations (all values in mg/L) | | | |
|---|---|---|---|
| Parameter | Monthly Average | Weekly Maximum | Daily Maximum |
| BOD | 2 | – | – |
| TSS | 1 | – | – |
| $PO_4$-P | 0.1/0.07[a] | – | – |
| $NH_4$-N | 0.307 | – | 1.25 |
| NOx-N | 8 | – | – |
| TN | 10 | – | – |

*a. A target effluent concentration of 0.1 mg/L was first used in a simulation without alum addition; then a target effluent concentration of 0.07 mg/L was subsequently used in a simulation with alum addition.*

Using these process and effluent constraints and the PE and centrate influent concentrations, an optimal system was completed for the SND alternative. The final results of basin sizing, optimum MLR flow pacing, air demand, and WAS production rates are presented in Section 3.7.2.

### 3.7.2 Model Results for Winter Conditions

The results of modeling showed that with the ability to accommodate high MLSS concentrations (more than twice of that for the conventional process), the MBR process would require half of the aeration basin volume that is required by the conventional process to achieve the effluent target concentrations presented in Table 8-1. While the tank volumes were smaller, the chemical usage rate for acetate was 50 percent higher than that for the conventional activated sludge process. A high acetate dosing rate was found to be required to meet the target effluent $PO_4$-P concentrations at the higher MLSS concentrations in an MBR system. It is suspected that the more concentrated biomass allows more organisms, including the ordinary heterotrophs that do not accumulate polyphosphate, to use the added acetate, thus resulting in a higher acetate requirement to achieve the same effluent P level. The airflow requirements and WAS production rates were also higher for the MBR process because of the lower alpha factor and greater amount of acetate added. The overall process sizing and monthly average air demands, WAS production, and chemical usage rates for the MBR process configuration are presented in Table 3-27. Detailed model outputs from the BioWin modeling for each approach are presented in Appendix B of this report.

The biosolids production estimate given in Table 3-27 was derived from the sludge production rate predicted in the BioWin simulation without alum addition for P removal, plus the calculated chemical sludge generated by alum addition to remove the difference between a secondary effluent TP concentration of 0.5 mg/L and the final effluent permit requirement of 0.07 mg/L TP. This method provides a consistent basis for comparing total sludge production rates among alternatives.

| Table 3-27. 5-Stage Bardenpho with MBR Modeling Results | | |
|---|---|---|
| Unit Process | Parameter/Unit | Value |
| Required SRT for nitrification | –, days | 12 |
| Activated sludge basin total | Volume, Mgal | 3.63 |
| Anaerobic cell 1 (Ana 1) | Volume, Mgal | 0.25 |

| Table 3-27. 5-Stage Bardenpho with MBR Modeling Results | | |
|---|---|---|
| Unit Process | Parameter/Unit | Value |
| Anoxic cell 1a (Anox 1a) | Volume, Mgal | 0.187 |
| Anoxic cell 1b (Anox 1b) | Volume, Mgal | 0.187 |
| Swing cell 1 | Volume, Mgal | 0.25 |
| Aerobic cell 1 (Aer 1) | Volume, Mgal | 0.75 |
| Aerobic cell 2 (Aer 2) | Volume, Mgal | 1.0 |
| Swing cell 2a (Swing 2a) | Volume, Mgal | 0.375 |
| Swing cell 2b (Swing 2b) | Volume, Mgal | 0.375 |
| Aerobic cell 3 (Aer 3) | Volume, Mgal | 0.25 |
| Membrane basins, total | Volume, Mgal | 0.285 |
| IMLR rate | Flow rate, percent of PE | 200 |
| WAS production (including alum sludge for P removal to 0.07 mg/L) | Mass rate, lb/d | 27,700 |
| Alum requirement for chemical P removal | Flow rate, gpd | 800 |
| Airflow requirement | Flow rate, scfm | 24,520 |
| Acetate use | Flow rate, lb/d | 13,790 |
| Methanol use | Flow rate, gpd | 615 |

It should be noted that while the maximum MLSS concentration of 10,000 mg/L in the membrane tanks is more than twice the maximum MLSS concentration of 4,000 mg/L in the aeration basins assumed in this alternatives evaluation for a conventional activated sludge system, the total basin volume is not reduced by the same ratio for a number of reasons:

- the aeration basin MLSS concentration is lower than the membrane tank MLSS concentration (20 percent lower when the RAS flow is 400 percent of the PE flow)
- the MBR system requires more acetate for P removal, which generates more biomass and thus higher MLSS concentrations
- the aeration basin volume, and thus the MLSS concentration, is limited by the diffuser air supply capacity in the basins

It was found that the oxygen uptake rates (OURs), especially in swing cell 1, were very high under the 2030 winter maximum month condition. If one basin is out of service in the summer, the corresponding OURs would be even higher. In order to meet the high oxygen demands, full floor coverage of panel-type high-efficiency diffusers would be required.

Results from the BioWin simulations are used in developing the preliminary capital and operating cost estimates presented below.

### 3.7.3 Preliminary Capital and Operating Cost Estimates

This section presents preliminary capital and operating cost estimates for the MBR system option.

#### 3.7.3.1 Capital Costs

In order to meet the 2030 maximum month conditions, the main secondary treatment process will need to be expanded. For the MBR alternative, the total volume of the aeration basins required to meet the effluent targets for the 2030 maximum month condition is 3.6 Mgal. Given 2.4 Mgal of existing volume, the scope of the basin expansion would be 1.2 Mgal. The capital cost (without contractor markups) of the tankage expansion for this alternative is expected to be approximately $1 million (based on nearby Nampa aeration basin expansion).

Additional facilities will need to be constructed as part of this alternative that are not common to the other alternatives. These consist of the membrane tanks; membrane filtration system (vendor package); PE fine screens; and chemical handling and metering facilities for methanol, acetate, and alum. The estimated costs for these facilities as well as the cost for expansion of the activated sludge basins are summarized in Table 3-28.

**Table 3-28. Planning-Level Comparative Capital Costs for 5-Stage Bardenpho with MBR**

| Process | Quantity | Unit Cost | Total |
|---|---|---|---|
| Greenfield aeration basin tank expansion | 1.2 Mgal | $850,000/Mgal | $1,040,000 |
| Existing basin retrofit | 2.4 Mgal | $400,000/Mgal | $960,000 |
| PE fine screens | – | – | $980,000 |
| Membrane system | – | – | $6,200,000 |
| Membrane tanks | 0.285 Mgal | $850,000/Mgal | $242,000 |
| Chemical P removal facilities | – | – | $62,500 |
| Acetate addition facilities | – | – | $106,500 |
| Methanol addition facilities | – | – | $568,000 |
| **Total** | | | **$10,120,000** |

*Note: Costs provided in this table reflect construction cost only and do not include contractor markups, contingency, inflation to midpoint of construction, bonds, insurance, etc. A more complete construction cost estimate will be provided as part of the final report.*

### 3.7.3.2 Operating Costs

The modeling results in Table 3-27 translate into operating costs associated with acetate and methanol dosing, aeration demand, biosolids hauling, and chemical addition for P removal. Furthermore, operation of the membrane system is associated with additional energy and chemical costs, as well as membrane replacement costs. The following assumptions were used to develop these costs:

- electricity: $0.069/kWh
- biosolids hauling and application: $5.933/wet ton (assuming 20 percent cake solids)
- methanol: $2.25/gal
- acetate: $0.74/lb
- aeration energy demand: 30 kWh/scfm/month
- chemical addition for P removal: $1.22/gal of alum
- sodium hypochlorite for membrane cleaning: $1.54/gal (10.3 percent by weight solution)
- citric acid for membrane cleaning: $5.49/gal (50 percent by weight solution)
- membrane replacement: $1,050 per module

The electric and biosolids costs come from the plant. The methanol cost is a long-term average value from Olympia, Washington. The price of methanol is unstable, and has varied from close to $1.00 per gallon to over $4.50 per gallon during the past 10 years. The costs for acetate, sodium hypochlorite, and citric acid are obtained from a local chemical supplier to the Boise area. The aeration energy demand is based on data from other plants with similar process demands. The chemical addition cost for P removal is a cost for alum addition determined for the City of Nampa in

2013. The cost for the replacement membrane module was provided by the same MBR manufacturer that provided the budgetary cost for the system.

The annual operating costs are summarized in Table 3-29.

**Table 3-29. Maximum Month Operating Costs for 5-Stage Bardenpho with MBR**

| Parameter | Quantity | Unit Cost | Total per Month |
|---|---|---|---|
| Methanol | 18,450 gal | $2.25/gal | $42,000 |
| Acetate | 258 tons | $0.74/lb | $383,000 |
| Sodium hypochlorite | 886 gal | $1.54/gal | $1,400 |
| Citric acid | 693 gal | $5.49/gal | $3,800 |
| Membrane replacement cost [a] | 2,688 modules | $1,050/module | $24,000 |
| Membrane auxiliary system [b] | 83,417 kWh | $0.069/kWh | $5,800 |
| Process aeration | 735,600 kWh | $0.069/kWh | $51,000 |
| Biosolids hauling | 2,080 wet tons | $5.933/wet ton | $12,000 |
| P removal chemical | 24,000 gal | $1.22/gal | $29,000 |
| **Total** | | | **$552,000** |

a. *Membrane life assumed to be 10 years. Monthly replacement cost is averaged over the 10-year period.*

b. *Power requirements for scour air blowers, permeate pumps, backwash pumps, and air compressor.*

The winter maximum month operating cost for the MBR alternative is approximately $552,000. This is the highest anticipated monthly cost for winter operating conditions. Operating the system during other winter months will cost less than this amount.

## 3.8 IFAS 5-Stage Bardenpho Process

This section provides a description of the modeling, sizing, and cost estimate results for IFAS within the 5-stage Bardenpho expansion alternative. Specifically designed media is added to the aeration process to increase the surface area for biological activity. The IFAS process is considered for upgrading existing systems to expand capacity within existing tankage to meet new nitrifying requirements.

The Kruger AnoxKaldnes IFAS system is a proprietary system and the proposed design consists of four process trains, each comprising the following reactors:

- two anaerobic selectors
- one pre-anoxic reactor for denitrification
- two aerobic IFAS reactors for nitrification
- one deoxygenation reactor (to reduce high oxygen from aerobic zones prior to anoxic zones)
- one post-anoxic reactor
- one post-aeration reactor

Figure 3-11 is a process flow diagram for the Kruger AnoxKaldnes IFAS system.

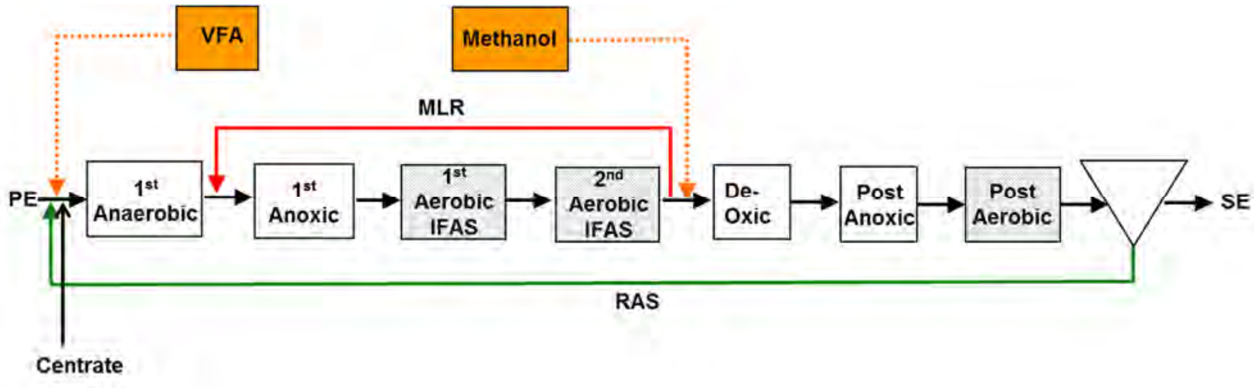


**Figure 3-11. Process flow schematic for IFAS 5-stage Bardenpho process**

### 3.8.1 Model Results for Winter Conditions

For modeling of the IFAS system, a BioWin model was developed using a fixed-film media add-in to simulate the effect of the media on the process. This was then compared with the sizing quote provided by the manufacturer of the IFAS system, in this case a Kruger AnoxKaldnes system. When the results of the BioWin model were compared with those provided by the manufacturer, the BioWin sizing proved to be significantly larger than the quote provided by Kruger, though Kruger did not provide estimates for chemical needs. Therefore, to stay within the sizing provided by the manufacturer, the tank sizing, MLR rates, and estimated WAS production rates were taken from the Kruger quote while all chemical needs were not changed from the 5-stage Bardenpho system (acetate, methanol, alum). In addition, airflow requirements were estimated by using the original 5-stage Bardenpho airflow quantities and increasing this by 50 percent to account for the need to aerate the system to a DO of between 4 and 6 mg/L using a coarse-bubble diffuser system. These chemical quantities and airflow quantities, while high, are lower than those estimated using the BioWin model for the system.

Table 3-30 shows the process sizing and operating parameters required to achieve the effluent target concentrations for the Kruger AnoxKaldnes IFAS system. The sizing is based on the maximum month load during winter conditions. With the addition of the IFAS media, the biggest change from the 5-stage Bardenpho process was the reduction in the total activated sludge volume required. Airflow requirements are expected to be higher to suspend the IFAS media in the aerobic reactors. Detailed information on the sizing by Kruger is provided in Appendix B. Alum, acetate, and methanol requirements were assumed to be the same as the 5-stage Bardenpho process.

**Table 3-30. 5-Stage Bardenpho with IFAS Modeling Results**

| Unit Process | Parameter/Unit | Value |
|---|---|---|
| Activated sludge basin total | Volume, Mgal | 5.67 |
| MLR rate | Flow rate, percent of PE | 300 |
| WAS production | Mass rate, lb/d | 23,250 |
| Additional chemical sludge from tertiary P removal | Mass rate, lb/d | 1,900 |
| Airflow requirement | Flow rate, scfm | 30,800 |
| Acetate use | Flow rate, gpd | 9,230 |
| Methanol use | Flow rate, gpd | 615 |

### 3.8.2 Preliminary Capital and Operating Cost Estimates

To treat the 2030 maximum month flow and loading conditions, the main secondary treatment process will need to be expanded. A high SRT is required to achieve low effluent ammonia concentrations. This results in a high MLSS concentration, which imposes a high solids loading to the secondary clarifiers. For the winter condition, with a maximum month flow of 12.3 mgd and a maximum day flow of 13.8 mgd, the maximum allowable MLSS concentration will be approximately 4,000 mg/L. One new secondary clarifier matching the dimensions of clarifiers 4 and 5 (100-foot diameter) is assumed to be needed.

As shown in Table 3-30, 5.7 Mgal of activated sludge volume is required to meet effluent targets for the 2030 maximum month condition. Given 2.4 Mgal of existing volume, the scope of basin expansion would be 3.3 Mgal. The existing basins would also need to be retrofitted to accommodate the updated configuration and these costs are reflected in the capital cost estimates.

#### 3.8.2.1 Capital Costs

Table 3-31 summarizes the capital costs expected for the IFAS 5-stage Bardenpho process. The assumptions made for costs developed for this estimate include the following:

- Greenfield basin expansion and existing basin retrofit costs per Mgal were developed using estimates for the City of Nampa's current plant expansion. However, as manufacturer quotes included new equipment for the basins, the values generated for the City of Nampa were reduced by 20 percent to account for this equipment.
- Costs for additional secondary clarifiers were taken from estimates completed for similar-sized clarifiers at the Pierce County Chambers Creek WWTP expansion currently in construction.
- Kruger AnoxKaldnes IFAS system costs are based on the vendor quote and includes the AnoxKaldnes K5 media, cylindrical screen assemblies, air sparge system, medium-bubble aeration system, submersible mixers, MLR wall pumps, and modulating airflow control valves.
- Costs for chemical facilities were developed using costs for tanks and pump equipment obtained from equipment vendors.

**Table 3-31. Planning-Level Comparative Capital Costs for IFAS 5-Stage Bardenpho**

| Process | Quantity | Unit Cost | Total |
|---|---|---|---|
| Greenfield aeration basin tank expansion | 3.3 Mgal | $680,000/Mgal | $2,240,000 |
| Existing basin retrofit | 2.4 Mgal | $320,000/Mgal | $770,000 |
| IFAS equipment and appurtenances | – | – | $6,370,000 |
| Additional secondary clarifiers | 1 | $2,000,000 | $2,000,000 |
| Tertiary filtration for P removal | – | – | $6,320,000 |
| Chemical P removal facilities | – | – | $62,500 |
| Acetate addition facilities | – | – | $106,500 |
| Methanol addition facilities | – | – | $568,000 |
| **Total** | | | **$18,440,000** |

*Note: Costs provided in this table reflect construction cost only and do not include contractor markups, contingency, inflation to midpoint of construction, bonds, insurance, etc. A more complete construction cost estimate will be provided as part of the final report.*

It is important to note that the costs provided in Table 3-31 are preliminary planning-level costs that do not include contractor markups and special conditions. This means that these costs do not reflect the true cost for construction, but provide comparative costs for evaluating differences among the add-on alternatives only. Final AACE Class 5 construction cost estimates will be provided for the final recommended expansion alternatives associated with additional tasks for this work.

#### 3.8.2.2 Operating Costs

Table 3-32 presents the operating costs associated with alum, acetate, and methanol dosing; aeration demand; and biosolids hauling. Additional costs associated with operation of the tertiary membrane system must also be considered. The following assumptions were used to develop these costs:

- electricity: $0.069/kWh
- biosolids hauling and application: $5.933/wet ton (assuming 20 percent cake solids)
- methanol (99 percent solution): $2.25/gal
- aeration energy demand: 30 kWh/scfm/month
- alum (P removal chemical): $1.22/gal
- tertiary filtration operating costs: $36,800/maximum month

The maximum monthly operating costs for the IFAS 5-stage Bardenpho process would be approximately $442,000.

**Table 3-32. Maximum Monthly Winter Operating Costs for IFAS 5-Stage Bardenpho**

| Parameter | Quantity | Unit Cost | Total |
|---|---|---|---|
| Methanol | 18,450 gal | $2.25/gal | $41,500 |
| Acetate (80% solution of acetic acid) | 173 ton | $0.74/lb | $260,000 |
| Process aeration | 924,000 kWh | $0.069/kWh | $63,800 |
| Tertiary filtration chemical/operating cost | – | – | $36,800 |
| Biosolids hauling | 1,900 wet ton | $5.933/wet ton | $11,300 |
| P removal chemical | 24,000 gal | $1.22/gal | $29,000 |
| Total | | | $442,000 |

## 3.9 Conclusions and Recommendations

The results of this evaluation offer the following conclusions and recommendations.

### 3.9.1 Conclusions

Table 3-33 provides a capital and operating cost comparison of the add-on alternatives.

**Table 3-33. Cost Comparison of Alternatives**

| Cost | Base | Sidestream P | Inf. EQ | Inf. EQ + Sidestream N | Inf EQ + Sidestream N and P | Cent. Load EQ | Tert. Nit + Denite | BioMag | MBR | IFAS |
|---|---|---|---|---|---|---|---|---|---|---|
| Capital | $14.2M | $15.1M | $16.7M | $19.9M | $20.8M | $13.6M | $30.9M | $16.4M | $10.1M | $18.4M |
| Operating (maximum monthly cost) | $420k | $268k | $304k | $306k | $248k | $411k | $449k | $457k | $552k | $442k |

*Note: Costs provided in this table reflect construction cost only and do not include contractor markups, contingency, inflation to midpoint of construction, bonds, insurance, etc. A more complete construction cost estimate will be provided as part of the final report.*

Based on a comparison of the results, the cheapest capital cost options are the MBR, the base case (5-stage Bardenpho with no add-on alternatives), and the centrate load equalization. The cheapest options from the maximum winter month operating cost standpoint are influent EQ with sidestream N and P removal, influent EQ alone, and sidestream P removal alone.

### 3.9.2 Recommendations

These costs were presented to the City during a workshop held on May 5, 2015. At this workshop, each option, including capital and O&M costs, were discussed. During this meeting, it was decided that, because the City was already interested in sidestream P removal, this option should be carried forward for detailed evaluation as one of the final three alternatives. The second option to carry forward for further evaluation is the lowest apparent capital cost option, which is the MBR option. In addition, the City is interested in replacing its current centrate EQ tank. While this option has a higher operating cost, the City was interested in carrying this option forward as the third option for detailed evaluation, but that it should be coupled with sidestream P removal. Therefore, the following are the three options to carry forward from this study for detailed final evaluation:

1. 5-stage Bardenpho with sidestream P removal (Ostara-type)
2. 5-stage Bardenpho with sidestream P removal and centrate load equalization
3. 5-stage Bardenpho with MBR

Each of these alternatives is evaluated for 2030 summer maximum month flows and loads as well as 2030 average annual flows and loads in the following Section. In addition, a detailed AACE Class 5 cost estimate has been prepared for each of these options for final comparison.

## Section 4

# Final Alternatives Evaluation

This section presents the results of the final evaluation of the pared-down list of alternatives determined from Section 3. As part of this evaluation, the following were completed:

1. Use the BioWin models developed for the following three 5-stage Bardenpho configurations to determine if summer maximum month operating conditions can be accommodated with the sizing of options previously determined for winter conditions. If summer conditions prove more stringent, optimize treatment system sizing to accommodate summer flows and loads:
   a. 5-stage Bardenpho configuration with sidestream P removal (e.g., Ostara™)
   b. 5-stage Bardenpho configuration with centrate N load equalization and sidestream P removal
   c. 5-stage Bardenpho converting sludge separation to MBR process
2. Use the BioWin models developed for the above three options to determine the steady-state operating conditions for average annual flows and loads for 2030 to determine the average annual operating costs for further evaluations.
3. Develop potential site layouts for each of the three options.
4. Develop AACE Class 5 capital cost estimates for each of the three alternatives evaluated.
5. Recommend the most cost-effective alternative for future expansion.

Each of these options and the costs associated with each are described below.

## 4.1 5-Stage Bardenpho with Sidestream P Removal

The first of the final options evaluated in detail was the 5-stage Bardenpho process with sidestream P removal. This option was evaluated for operation under summer maximum month conditions to determine if sizing for winter conditions was adequate for summer operation. The summer simulations were conducted in the same manner as winter simulations, with the average PE concentrations used for the summer simulations shown in Table 1-4. The temperature used for conducting any biological modeling for the summer conditions was 18 degrees Celsius (°C), which is the minimum monthly temperature for the summer and presents the most restrictive summer temperature for achieving nitrification.

Based on the BioWin simulation results, it was determined that for summer conditions, the average SRT could be reduced significantly from winter conditions (from 12 days to 6 days) and still maintain adequate nitrification. Further, the reduced SRT resulted in reduced MLSS concentration in the basins, which allowed for at least one basin (of the same 0.6 Mgal size as current) to be taken out of service for summer maximum month conditions. This allows for necessary redundancy and routine maintenance. Based on these results, the size of basins was determined during winter simulations presented in Section 3. Results of summer BioWin simulations are presented in Appendix C.

### 4.1.1 Layout

Based on summer maximum month and winter maximum month simulation results, a layout of plant expansion to meet the 2030 projected conditions discussed in Section 1 was completed. This layout is shown in Figure 4-1.

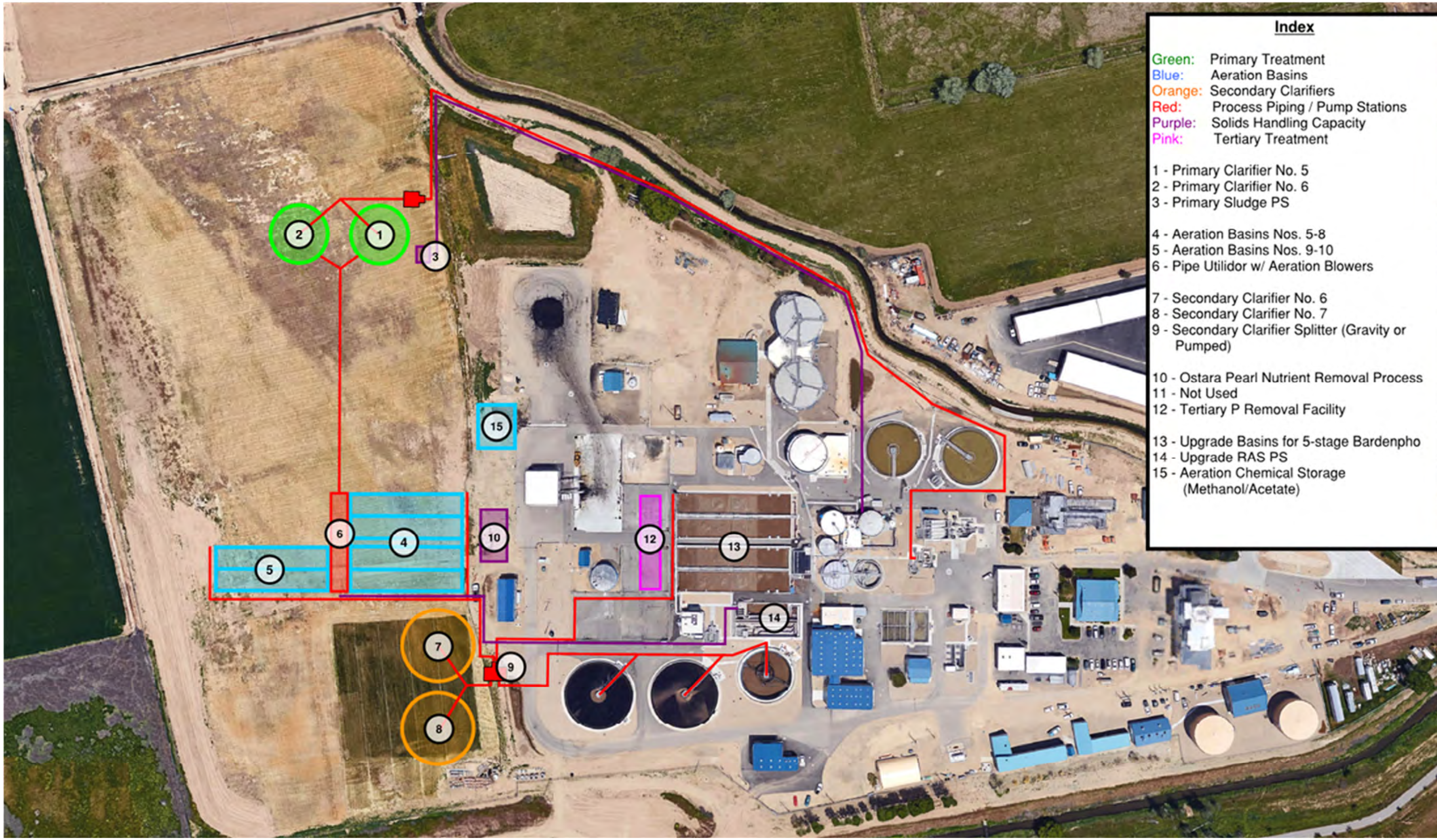


Figure 4-1. Plant layout for 5-stage Bardenpho with sidestream P removal

As can be seen on this figure, expansion of the aeration tankage will occur mostly to the west of the existing plant on undeveloped property owned by the City. Aeration tanks are currently shown to be expanded with individual tanks of the same size as the current tanks. In addition to the aeration tank expansion, this plant layout shows expansion of two additional primary clarifiers on the same west property, two new secondary clarifiers, a tertiary P removal facility (modeled after Actiflo), chemical addition facilities, and other flow-splitting devices and conveyance pipelines. Each of these items is included in the cost estimate presented later in this section.

### 4.1.2 2030 Average Annual Operating Costs

In addition to conducting BioWin simulations at the winter and summer maximum month flow and load conditions, simulations were conducted for the 2030 average annual conditions in order to determine the average yearly operating cost for each option evaluated in detail in this section. These simulations were conducted under steady-state conditions, as this provided the highest associated oxygen demand and chemical usage rates. While average annual conditions were not provided in Section 1, the average summer and average winter conditions were described on Table 1-4. The average annual flow and load condition was developed by taking the average of the summer and winter average conditions described on Table 1-4. Simulations were conducted at a temperature of 18°C. Table 4-1 presents the results of the average annual operating costs based on these simulations. Detailed results of these simulations are presented in Appendix C. The following assumptions were used to develop these costs:

- electricity: $0.069/kWh
- biosolids hauling and application: $5.933/wet ton (assuming 20 percent cake solids)
- methanol (99 percent solution): $2.25/gal
- aeration energy demand: 30 kWh/scfm/month
- alum (P removal chemical): $1.22/gal
- Actiflo operating costs: $7,000/month
- operation of struvite recovery facility: $15,000/average month

**Table 4-1. 2030 Average Monthly Operating Costs for 5-Stage Bardenpho with Sidestream P Removal**

| Parameter | Quantity | Unit Cost | Total (2015 dollars) |
|---|---|---|---|
| Methanol | 12,000 gal | $2.25/gal | $27,000 |
| Acetate (80% solution of acetic acid) | 34 tons | $0.74/lb | $50,300 |
| Process aeration | 436,000 kWh (14,520 scfm) | $0.069/kWh | $30,100 |
| Actiflo monthly cost | – | – | $7,000 |
| Sidestream P removal monthly cost | – | – | $15,000 |
| Biosolids hauling | 1,020 wet tons | $5.933/wet ton | $11,300 |
| P removal chemical | 24,000 gal | $1.22/gal | $29,000 |
| Total | | | $170,000 |

As can be seen from this table, the 2030 average monthly cost for operating the 5-stage Bardenpho system with sidestream P removal is approximately $170,000, or $2,040,000 per year. This is significantly lower than the maximum winter operating cost for this same option of $268,000 per month.

### 4.1.3 Capital Cost

An AACE Class 5 capital cost estimate was prepared for the 5-stage Bardenpho with sidestream P removal alternative. The breakdown of the costs is presented in Table 4-2. The detailed cost estimate for all options is presented in Appendix D.

**Table 4-2. Capital Construction Cost for 5-Stage Bardenpho with Sidestream P Removal**

| Area | Cost (2015 dollars) |
|---|---|
| Headworks upgrade | Not estimated/separate project |
| Primary influent pump station (new) | $4,960,000 |
| Primary clarifiers | $5,650,000 |
| Aeration basins (new) | $18,070,000 |
| Aeration basins (retrofit of existing) | $5,190,000 |
| Secondary clarifiers | $6,460,000 |
| Tertiary treatment processes | $12,280,000 |
| Supplemental carbon addition facilities | $680,000 |
| Sidestream P removal system | $4,670,000 |
| *Total* | ***$57,960,000*** |

### 4.1.4 Estimated 20-Year Cost

To provide an estimate of the 20-year cost of this option, several assumptions must be made regarding the annual operating cost shown in Table 4-1.

First, the 2030 average annual flows and loads are approximately double the current average annual flows and loads. Therefore, the current annual operating cost would be approximately $1,020,000 for this plant configuration. By knowing the average operating cost today and in 2030, we can approximate the average operating cost for a 20-year life cycle. This cost is estimated to be about $1,760,000 per year, or $35,200,000 over the 20-year period (in 2015 dollars).

Adding this value to the capital cost of construction of $58 million gives an approximate 20-year cost for this option of $93 million.

## 4.2 5-Stage Bardenpho with Sidestream P Removal and Centrate Load Equalization

The second of the final options evaluated in detail was the 5-stage Bardenpho process with sidestream P removal and centrate load equalization. As with the previous option, this option was evaluated for operation under summer maximum month conditions to determine if sizing for winter conditions was adequate for summer operation.

Based on the BioWin simulation results, it was determined that for summer conditions, the average SRT could be reduced significantly from winter conditions (from 12 days down to 6 days) and still maintain adequate nitrification. Further, the reduced SRT resulted in reduced MLSS concentration in the basins, which allowed for at least one basin (of the same 0.6 Mgal size as current) to be taken out of service for summer maximum month conditions. This allows for necessary redundancy and routine maintenance. Based on these results, the size of basins was determined during winter simulations presented in Section 3. Results of summer BioWin simulations for the 5-stage Bardenpho option with sidestream P removal and centrate load equalization are presented in Appendix C.

### 4.2.1 Layout

Based on summer maximum month and winter maximum month simulation results, a layout of plant expansion to meet the 2030 projected conditions discussed in Section 1 was completed. This layout is shown in Figure 4-2.

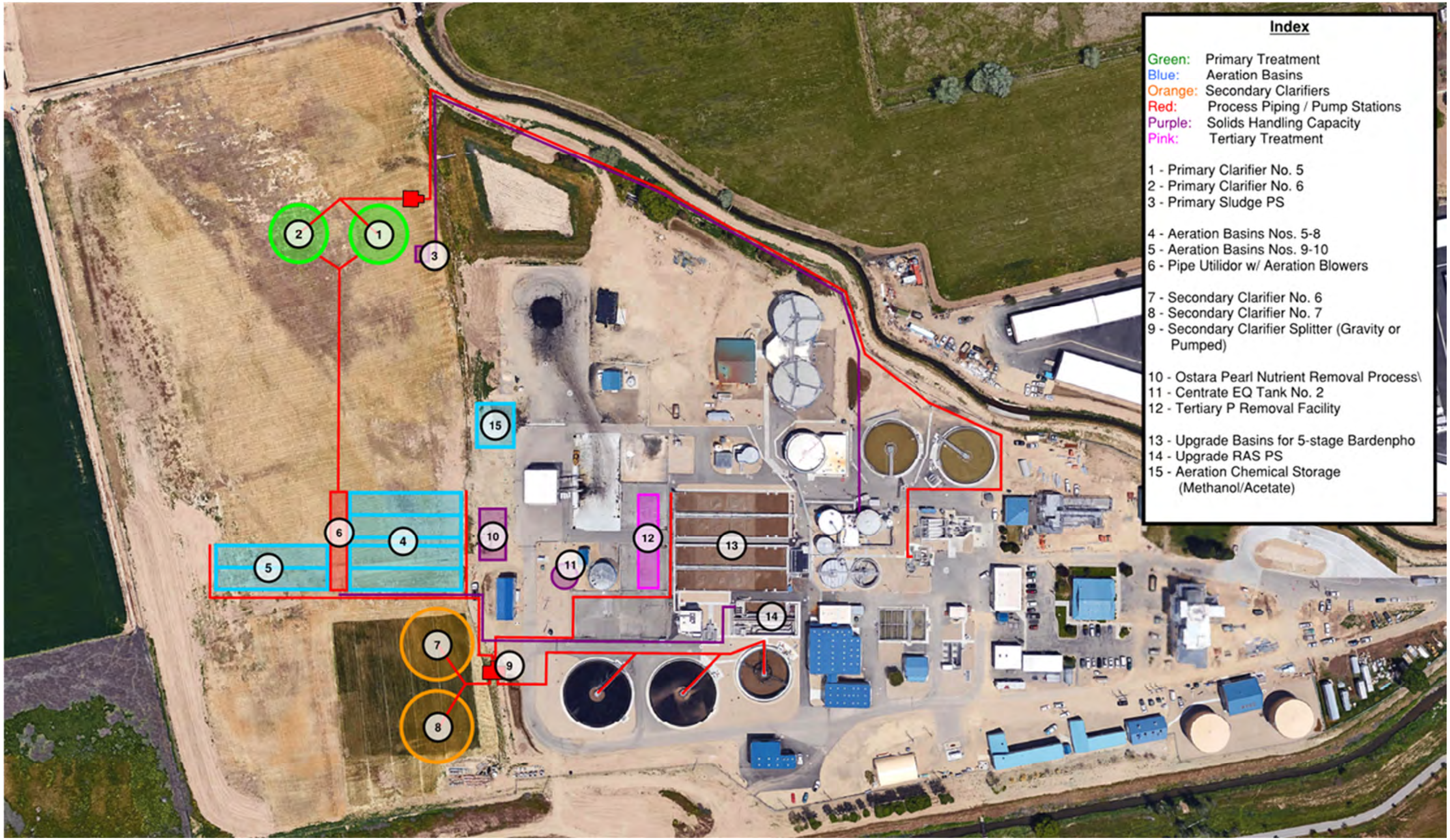


**Figure 4-2. Plant layout for 5-stage Bardenpho with sidestream P removal and centrate load equalization**

As can be seen on this figure, the layout is exactly the same as that shown in Figure 4-1 for the previous option, with one exception. This option shows an additional centrate storage tank constructed immediately to the east of the existing centrate storage/EQ tank. This additional tank is necessary to provide redundancy for the existing tank should centrate load equalization be used. All additional unit processes shown on the figure are included in the cost estimate.

### 4.2.2 2030 Average Annual Operating Costs

In addition to conducting BioWin simulations at the winter and summer maximum month flow and load conditions, simulations were conducted for the 2030 average annual conditions in order to determine the average yearly operating cost for each option evaluated in detail in this section. These simulations were conducted under steady-state conditions, as discussed in Section 4.1.2. Table 4-3 presents the results of the average annual operating costs based on these simulations. Detailed results of these simulations are presented in Appendix C. The following assumptions were used to develop these costs:

- electricity: $0.069/kWh
- biosolids hauling and application: $5.933/wet ton (assuming 20 percent cake solids)
- methanol (99 percent solution): $2.25/gal
- aeration energy demand: 30 kWh/scfm/month
- alum (P removal chemical): $1.22/gal
- Actiflo operating costs: $7,000/month
- operation of struvite recovery facility: $15,000/average month

**Table 4-3. 2030 Average Monthly Operating Costs for 5-Stage Bardenpho with Sidestream P Removal and Centrate Load Equalization**

| Parameter | Quantity | Unit Cost | Total (2015 dollars) |
|---|---|---|---|
| Methanol | 12,000 gal | $2.25/gal | $27,000 |
| Acetate (80% solution of acetic acid) | 34 ton | $0.74/lb | $50,300 |
| Process aeration | 436,000 kWh (14,520 scfm) | $0.069/kWh | $30,100 |
| Actiflo monthly cost | – | – | $7,000 |
| Sidestream P removal monthly cost | – | – | $15,000 |
| Biosolids hauling | 1,020 wet ton | $5.933/wet ton | $11,300 |
| P removal chemical | 24,000 gal | $1.22/gal | $29,000 |
| **Total** | | | **$170,000** |

As can be seen from this table, the 2030 average monthly cost for operating the 5-stage Bardenpho system with sidestream P removal and centrate load equalization is approximately $170,000, or $2,040,000 per year. This operating cost is approximately the same as determined for the summer operating conditions for the 5-stage Bardenpho option without the centrate storage tank. Therefore, while some benefit was observed in installing a centrate load EQ tank in Section 3, this did not translate to reduced operating cost under average annual conditions.

### 4.2.3 Capital Cost

An AACE Class 5 capital cost estimate was prepared for the 5-stage Bardenpho with sidestream P removal and centrate load equalization alternative. The breakdown of the costs is presented in Table 4-4. The detailed cost estimate for all options is presented in Appendix D.

| Table 4-4. Capital Construction Cost for 5-Stage Bardenpho with Sidestream P Removal and Centrate Load Equalization | |
|---|---|
| **Area** | **Cost (2015 dollars)** |
| Headworks upgrade | Not estimated/separate project |
| Primary influent pump station (new) | $4,960,000 |
| Primary clarifiers | $5,650,000 |
| Aeration basins (new) | $18,070,000 |
| Aeration basins (retrofit of existing) | $5,190,000 |
| Secondary clarifiers | $6,460,000 |
| Tertiary treatment processes | $12,330,000 |
| Supplemental carbon addition facilities | $680,000 |
| Sidestream P removal system | $4,660,000 |
| Centrate storage tank | $720,000 |
| *Total* | *$58,700,000* |

### 4.2.4 Estimated 20-Year Cost

To provide an estimate of the 20-year cost of this option, several assumptions must be made regarding the annual operating cost shown in Table 4-3.

First, the 2030 average annual flows and loads are approximately double the current average annual flows and loads. Therefore, the current annual operating cost would be approximately $1,020,000 for this plant configuration. By knowing the average operating cost today and in 2030, we can approximate the average operating cost for a 20-year life cycle. This cost is estimated to be about $1,760,000 per year, or $35,200,000 over the 20-year period (in 2015 dollars).

Adding this value to the capital cost of construction of $59 million gives an approximate 20-year cost for this option of $94 million.

## 4.3 5-Stage Bardenpho with MBR Solids Separation

The final option evaluated in detail was the 5-stage Bardenpho process modified for MBR as the solids separation. As with the previous options, this option was evaluated for operation under summer maximum month conditions to determine if sizing for winter conditions was adequate for summer operation.

Again, for summer conditions the average SRT could be reduced significantly from winter conditions (from 12 days down to 6 days) and still maintain adequate nitrification. Further, the reduced SRT resulted in reduced MLSS concentration in the basins, which allowed for at least one basin (of the same 0.6 Mgal size as current) to be taken out of service for summer maximum month conditions. This allows for necessary redundancy and routine maintenance. Based on these results, the size of basins was determined during winter simulations presented in Section 3. Results of summer BioWin simulations for the 5-stage Bardenpho option with MBR are presented in Appendix C.

### 4.3.1 Layout

Based on summer maximum month and winter maximum month simulation results, a layout of plant expansion to meet the 2030 projected conditions discussed in Section 1 was completed. This layout is shown in Figure 4-3.


Figure 4-3. Plant layout for 5-stage Bardenpho with MBR

As can be seen on this figure, the layout shows a significant departure from the other options evaluated. First, only one additional aeration tank is constructed. This is because the MBR can have significant footprint savings due to its ability to operate at a much higher MLSS concentration. Second, it easy to notice that there are no secondary clarifiers, but only an MBR building. This is because the MBR is taking the place of the clarifiers for solids/liquids separation. Lastly, no tertiary treatment systems are shown on these drawings. This is because the MBR takes the place of tertiary treatment technologies and the P removal chemical can be added directly to the flow into the MBR. All additional unit processes shown on the figure are included in the cost estimate.

### 4.3.2 2030 Average Annual Operating Costs

In addition to conducting BioWin simulations at the winter and summer maximum month flow and load conditions, simulations were conducted for the 2030 average annual conditions in order to determine the average yearly operating cost for each option evaluated in detail in this section. These simulations were conducted under steady-state conditions, as discussed in Section 4.1.2. Table 4-5 presents the results of the average annual operating costs based on these simulations. Detailed results of these simulations are presented in Appendix C. The following assumptions were used to develop these costs:

- electricity: $0.069/kWh
- biosolids hauling and application: $5.933/wet ton (assuming 20 percent cake solids)
- methanol (99 percent solution): $2.25/gal
- aeration energy demand: 30 kWh/scfm/month
- alum (P removal chemical): $1.22/gal
- Actiflo operating costs: $7,000/month
- operation of struvite recovery facility: $15,000/average month

**Table 4-5. 2030 Average Annual Operating Costs for 5-Stage Bardenpho with MBR**

| Parameter | Quantity | Unit Cost | Total (2015 dollars) |
|---|---|---|---|
| Methanol | 10,650 gal | $2.25/gal | $24,000 |
| Acetate | 219 tons | $0.74/lb | $325,000 |
| Sodium hypochlorite | 886 gal | $1.54/gal | $1,400 |
| Citric acid | 693 gal | $5.49/gal | $3,800 |
| Membrane replacement cost | 2,688 modules | $1,050/module | $24,000 |
| Membrane auxiliary system | 83,417 kWh | $0.069/kWh | $5,800 |
| Process aeration | 667,000 kWh (22,220 scfm) | $0.069/kWh | $46,000 |
| Biosolids hauling | 1,900 wet tons | $5.933/wet ton | $11,000 |
| P removal chemical | 24,000 gal | $1.22/gal | $29,000 |
| **Total** | | | **$470,000** |

As can be seen from this table, the 2030 average monthly cost for operating the 5-stage Bardenpho system with MBR is approximately $470,000, or $5,640,000 per year. This operating cost is significantly higher than the other two options. This increase in operating cost is due to the higher demands for chemicals, especially acetate, to drive nutrient removal processes. Further, additional maintenance costs are associated with the membrane system that are not required for the other options. Though the costs for tertiary treatment are not required in this option, the cost for maintaining the membranes themselves appears to be higher than the cost for maintaining the tertiary treatment systems described in the other options.

### 4.3.3 Capital Cost

An AACE Class 5 capital cost estimate was prepared for the 5-stage Bardenpho with MBR alternative. The breakdown of the costs is presented in Table 4-6. The detailed cost estimate for all options is presented in Appendix D. The capital costs for this option are significantly lower than the other options, mainly due to the smaller footprint and requirement for less aeration basin volume and no secondary clarifiers.

**Table 4-6. Capital Construction Cost for 5-Stage Bardenpho with MBR**

| Area | Cost (2015 dollars) |
|---|---|
| Headworks upgrade | Not estimated/separate project |
| Primary influent pump station (new) | $3,230,000 |
| Primary clarifiers | $5,650,000 |
| Aeration basins (new) | $5,930,00 |
| Aeration basins (retrofit of existing) | $5,580,000 |
| MBR treatment system | $22,660,000 |
| Secondary clarifiers | $0 |
| Tertiary treatment processes | $230,000 |
| Supplemental carbon addition facilities | $680,000 |
| *Total* | *$43,960,000* |

### 4.3.4 Estimated 20-Year Cost

To provide an estimate of the 20-year cost of this option, several assumptions must be made regarding the annual operating cost shown in Table 4-3.

First, the 2030 average annual flows and loads are approximately double the current average annual flows and loads. Therefore, the current operating cost would be approximately $2,820,000 annually for this plant configuration. By knowing the average operating cost today and in 2030, we can approximate the average operating cost for a 20-year life cycle. This cost is estimated to be about $4,860,000 per year, or $97,200,000 over the 20-year period (in 2015 dollars).

Adding this value to the capital cost of construction of $44 million gives an approximate 20-year cost for this option of $141 million.

## 4.4 Final Recommendation

Based on the results of this evaluation, the MBR option remained the lowest capital cost option at $44 million compared with $57 million and $58 million for the other two options. However, factoring in the estimates for annual operating cost differences between the options makes the MBR option far more expensive over a 20-year life cycle compared with the other two options ($141 million versus less than $95 million).

Therefore, the recommendation is to upgrade the facility using the 5-stage Bardenpho process with sidestream P removal, according to the lowest capital and operating cost option presented above. This option also presents the most flexible option for operation of the facility, as it can be designed to operate as either a 5-stage Bardenpho process or an A2O process. It can also be designed to operate as a 4-stage Bardenpho or Modified Ludzack-Ettinger process, should the City decide to go to N removal only for groundwater recharge discharge.

If the City would like to replace or add redundancy for its currently aging centrate storage tank, we would recommend building a new centrate storage tank and sizing the centrate pumps for centrate load equalization, which adds approximately $720,000 to the overall construction cost and provides the benefit of reducing peak month chemical use.

## Section 5

# Limitations

This document was prepared solely for City of Meridian in accordance with professional standards at the time the services were performed and in accordance with the contract between City of Meridian and Brown and Caldwell dated October 1, 2014. This document is governed by the specific scope of work authorized by City of Meridian; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by City of Meridian and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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Section 6

# References

Tebbutt, T. H. Y and D. G. Christoulas (1975). “Performance relationships for primary sedimentation,” Water Research, 9, 347–356.

Wahlberg, E. J., and Keinath, T. M. (1988). Development of settling flux curves using SVI. Journal of the Water Pollution Control Federation 60(12): 2095–2100.

Wahlberg, E. J., J. L. Morris, W. H. Kido, R. S. Swanson, D. Finger, D. A. Philips (1997). “Primary Sedimentation: It’s Performing Better Than You Think,” Proceedings of the Water Environment Federation 70th Annual Conference & Exposition.

# Appendix A: BioWin Modeling Results from Main Process Alternatives Evaluation

# BioWin user and configuration data

## Project details

Project name: COM Capacity Assessment

Project ref.: 147104.070.****

Plant name: Meridian WWTP

User name: Zach Dobroth

Created: 6/29/2011

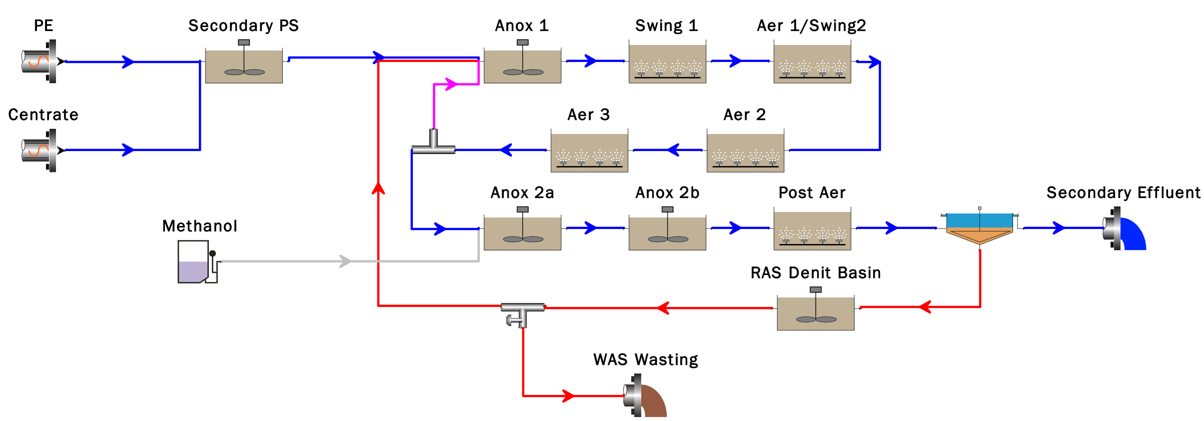
Saved: 7/6/2015

Target SRT: 14.00 days

SRT: **** days

Temperature: 14.0°C

## Flowsheet



# Configuration information for all Bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Anox 1 | 1.2500 | 1.194E+4 | 14.000 | Un-aerated |
| Anox 2b | 0.5000 | 4774.3058 | 14.000 | Un-aerated |
| Swing 1 | 0.5000 | 4774.3058 | 14.000 | 1623 |
| Aer 1/Swing2 | 0.5000 | 4774.3058 | 14.000 | 1623 |
| Aer 2 | 1.0000 | 9548.6117 | 14.000 | 3245 |
| Aer 3 | 1.0000 | 9548.6117 | 14.000 | 3245 |
| Anox 2a | 0.5000 | 4774.3058 | 14.000 | Un-aerated |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |
| Post Aer | 0.5000 | 4527.2475 | 14.764 | 1026 |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Anox 1 | 0 |
| Anox 2b | 0 |
| Swing 1 | 2.0 |
| Aer 1/Swing2 | 3.6 |
| Aer 2 | 2.0 |
| Aer 3 | 2.0 |
| Anox 2a | 0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |

| | |
|---|---|
| Post Aer | 2.0 |

### Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Anox 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Anox 2b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 1/Swing2 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 2 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 3 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Anox 2a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Post Aer | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

## Configuration information for all Methanol addition units

### Operating data Average (flow/time weighted as required)

| Element name | Methanol |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |

| | |
|---|---|
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 1188000.00 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |

| | |
|---|---|
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 0.000600000739681704 |

# Configuration information for all Effluent units

# Configuration information for all Ideal clarifier units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] |
|---|---|---|---|
| Clarifier | 2.9670 | 2.880E+4 | 13.770 |

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| Clarifier | Flow paced | 70.00 % |

| Element name | Average Temperature | Reactive | Percent removal | Blanket fraction |
|---|---|---|---|---|
| Clarifier | Uses global setting | Yes | 99.90 | 0.07 |

# Configuration information for all COD Influent units

## Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 30.00 | 30.00 |
| Flow | 12.4611703212226 | 0.100114816828393 |
| Total COD mgCOD/L | 416.48 | 1801.80 |
| Total Kjeldahl Nitrogen mgN/L | 54.01 | 934.39 |
| Total P mgP/L | 8.12 | 529.81 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.95 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.43 | 185.22 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.5950 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 0.0392 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9931 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.0039 |
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.3197 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.9400 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5086 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0146 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0512 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9300 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.0642 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-4 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 | 0 |

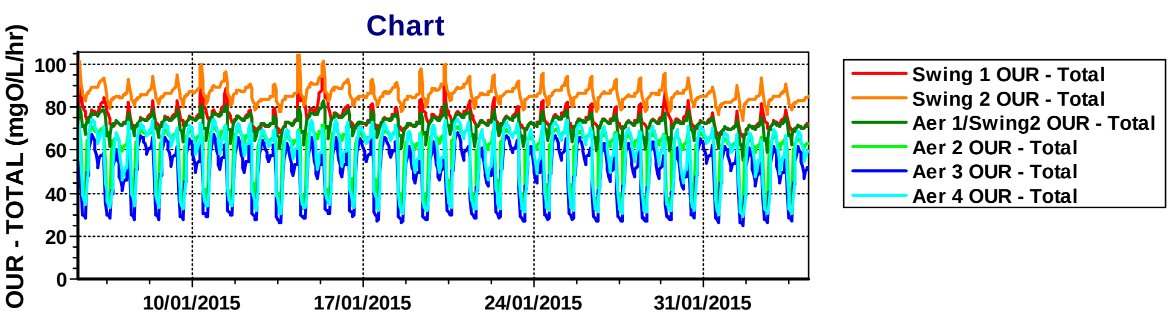
# Configuration information for all Sludge units

# Configuration information for all Splitter units

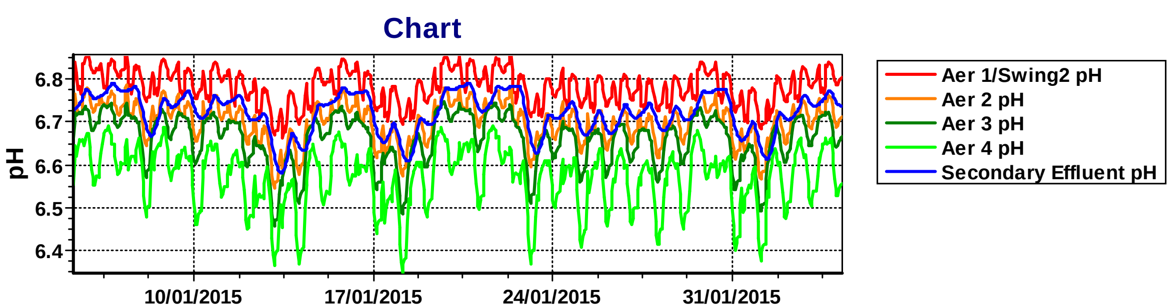
## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
| --- | --- | --- |
| IMLR | Flow paced | 400.00 % |
| RAS / WAS | Flowrate [Side] | 0.17081228917571 |

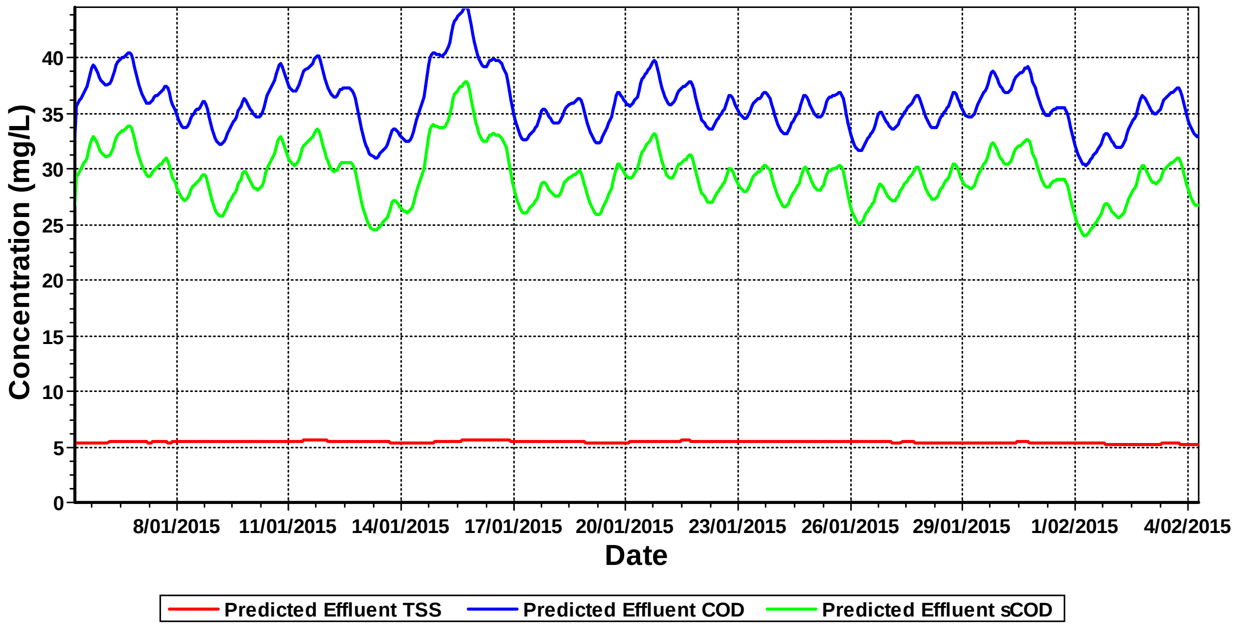
## Album page - OURs



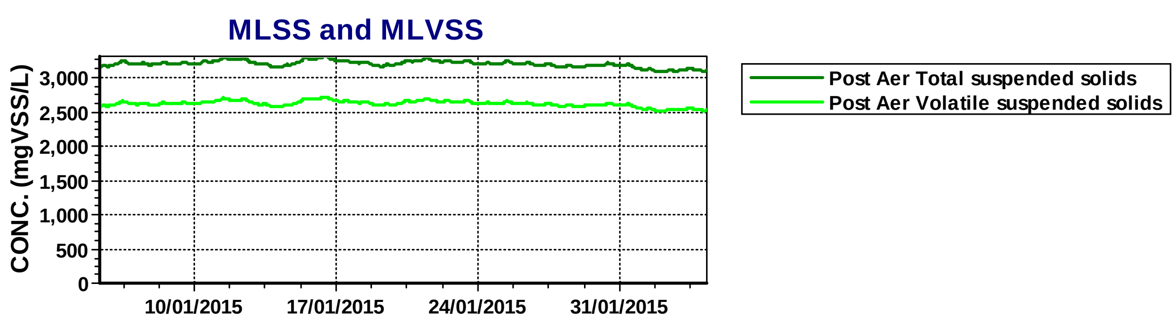

## Album page - OURs



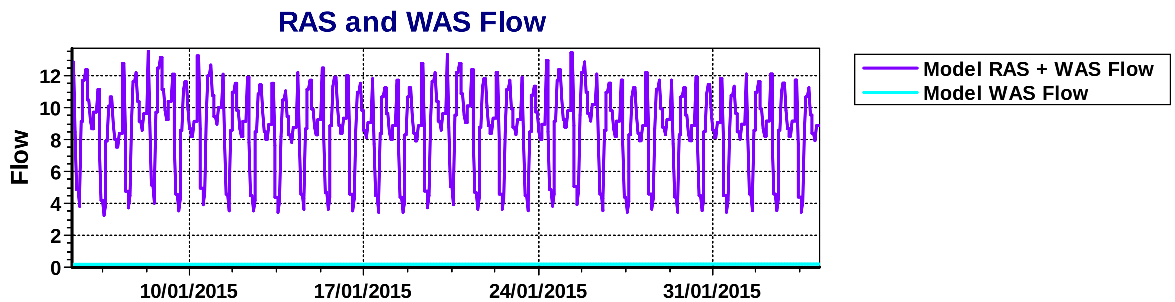
Album page - TSS, COD, BOD



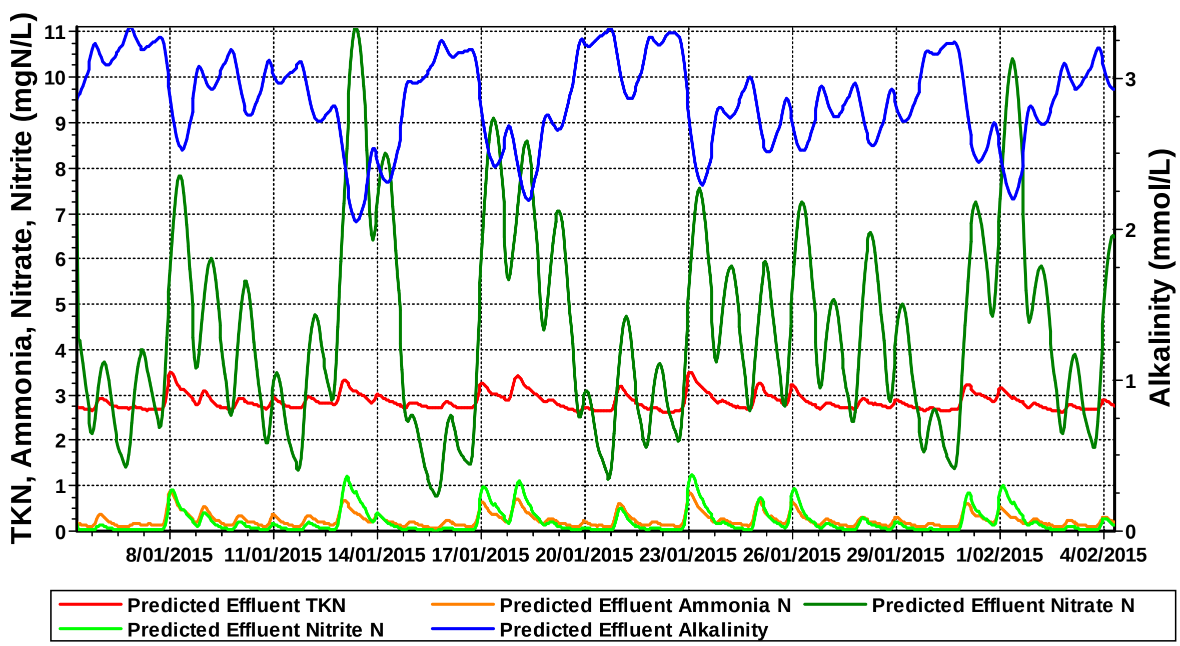

Album page - Mixed Liquor, RAS Flow



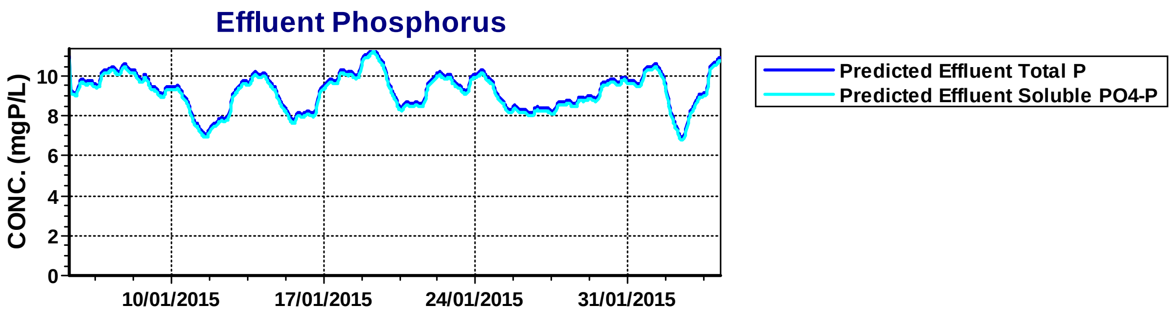
Album page - Mixed Liquor, RAS Flow



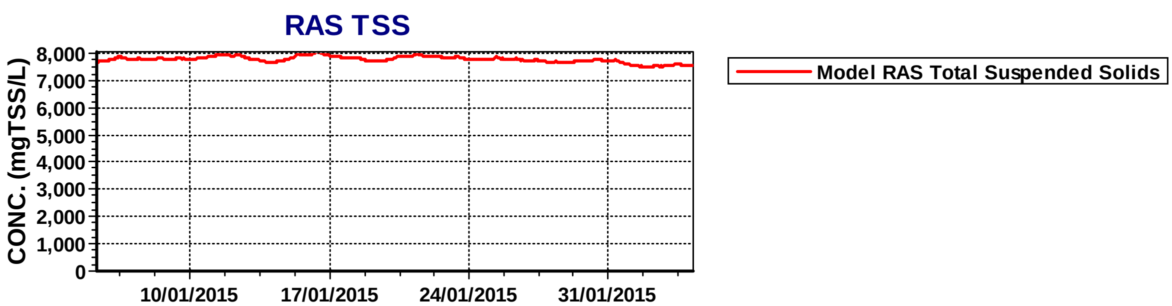

Album page - Nitrogen Sp., Alkalinity



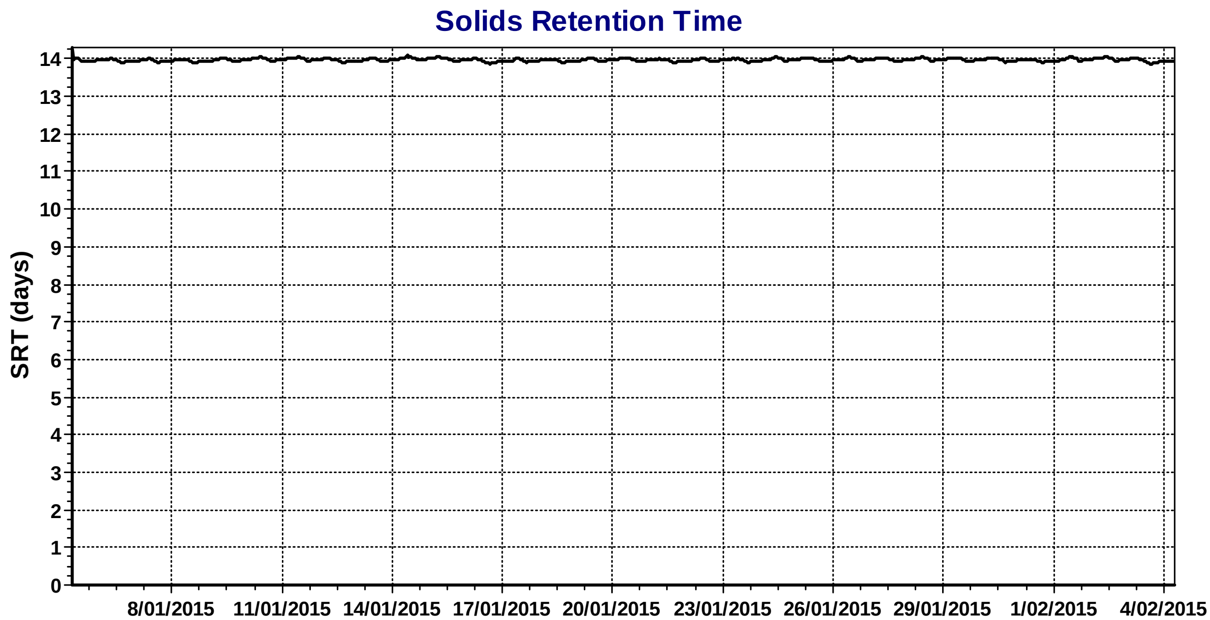
Album page - TP, RAS TSS



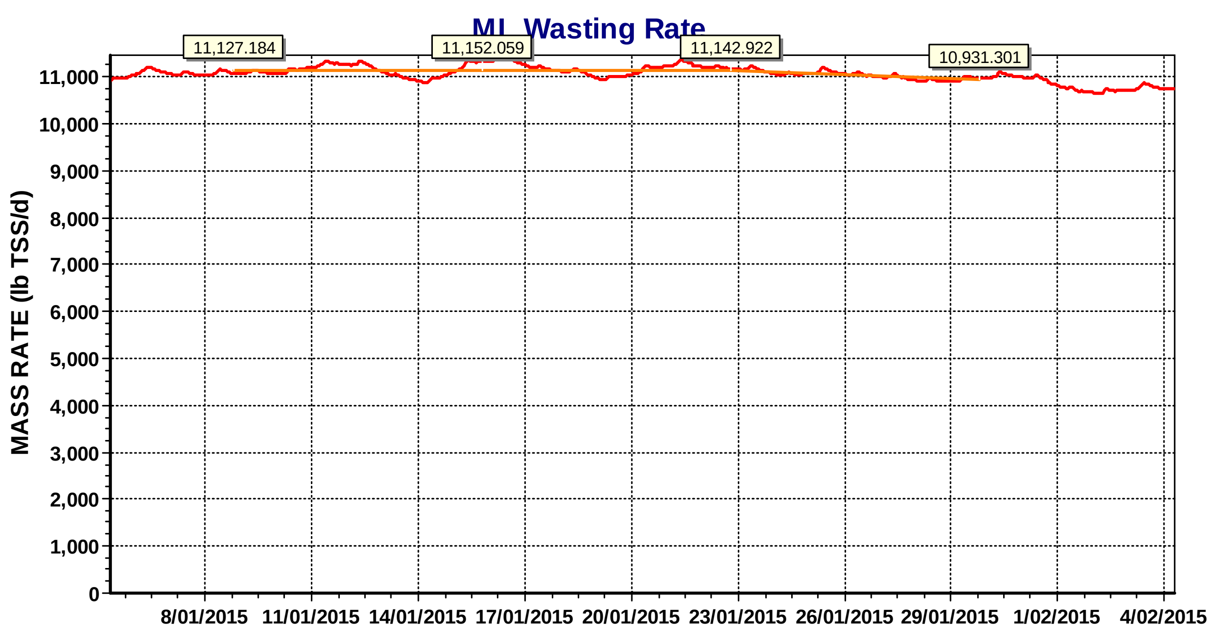

Album page - TP, RAS TSS



Album page - SRT




Album page - WAS Mass



# BioWin user and configuration data

## Project details

Project name: Alternatives Analysis    Project ref.: 147571

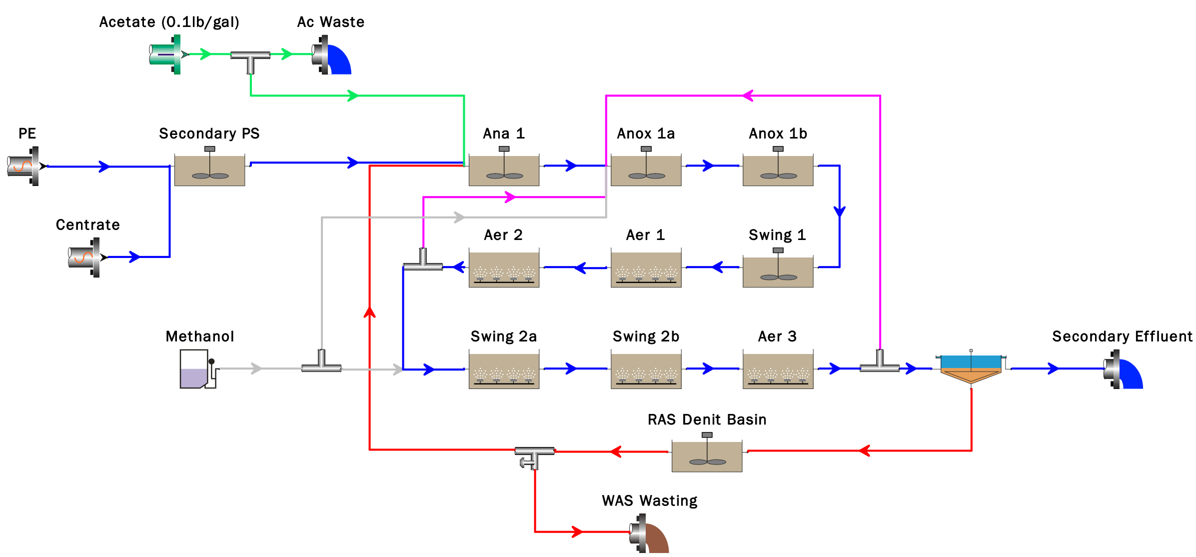
Plant name: Meridian WWTP    User name: Rick Kelly

Created: 6/29/2011    Saved: 3/31/2015

Target SRT: 12.00 days    SRT: **** days

Temperature: 14.0°C

## Flowsheet




# Configuration information for all Bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Ana 1 | 0.5000 | 4774.3058 | 14.000 | Un-aerated |
| Aer 1 | 1.5000 | 1.432E+4 | 14.000 | 4868 |
| Aer 2 | 2.0000 | 1.910E+4 | 14.000 | 6491 |
| Swing 2a | 0.7500 | 7161.4587 | 14.000 | 2434 |
| Aer 3 | 0.5000 | 4774.3058 | 14.000 | 1623 |
| Anox 1a | 0.3750 | 3580.7294 | 14.000 | Un-aerated |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |
| Anox 1b | 0.3750 | 3580.7294 | 14.000 | Un-aerated |
| Swing 1 | 0.5000 | 4774.3058 | 14.000 | Un-aerated |
| Swing 2b | 0.7500 | 7161.4587 | 14.000 | 1623 |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Ana 1 | 0 |
| Aer 1 | 2.5 |
| Aer 2 | 2.0 |
| Swing 2a | 2.0 |
| Aer 3 | 2.0 |
| Anox 1a | 0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |
| Anox 1b | 0 |
| Swing 1 | 0 |

| | |
|---|---|
| Swing 2b | 2.0 |

### Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Ana 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 2 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Swing 2a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 3 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Anox 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Anox 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 2b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

## Configuration information for all Methanol addition units

### Operating data Average (flow/time weighted as required)

| Element name | Methanol |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |

| | |
|---|---|
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 11880.00 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |

| | |
|---|---|
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

## Configuration information for all Effluent units

## Configuration information for all Ideal clarifier units

### Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] |
|---|---|---|---|
| Clarifier | 2.8000 | 2.718E+4 | 13.770 |

### Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| Clarifier | Flow paced | 50.00 % |

| Element name | Average Temperature | Reactive | Percent removal | Blanket fraction |
|---|---|---|---|---|
| Clarifier | Uses global setting | Yes | 99.90 | 0.07 |

# Configuration information for all COD Influent units

## Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 30.00 | 30.00 |
| Flow | 12.461167588271 | 0.100114816828393 |
| Total COD mgCOD/L | 416.48 | 1801.80 |
| Total Kjeldahl Nitrogen mgN/L | 54.01 | 934.39 |
| Total P mgP/L | 8.12 | 529.81 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.95 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.43 | 185.22 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.5950 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 0.0392 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9931 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.0039 |
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.3197 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.9500 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5086 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0050 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0512 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9300 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.0642 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-4 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 | 0 |

# Configuration information for all Sludge units

# Configuration information for all Splitter units

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| BDF IMLR | Flow paced | 0.00 % |
| RAS / WAS | Flowrate [Side] | 0.200282928951046 |
| Acetate Splitter | Flow paced | 0.60 % |
| Splitter21 | Fraction | 1.00 |
| A2O IMLR | Flow paced | 400.00 % |

# Configuration information for all Stream (SV) Influent units

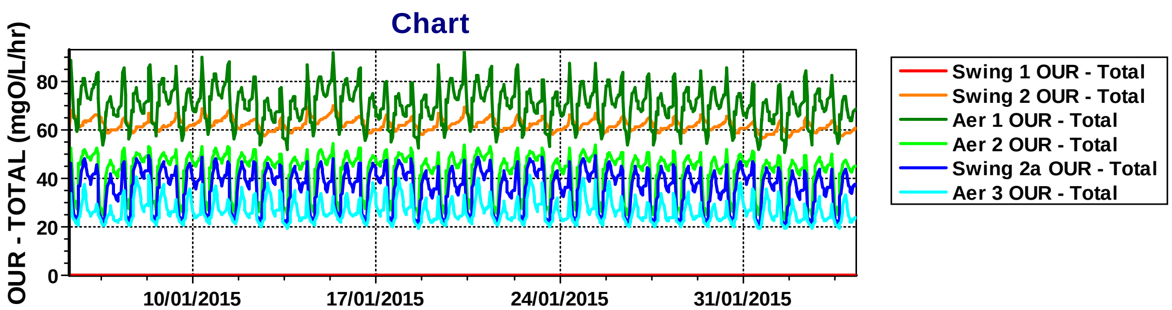
## Operating data Average (flow/time weighted as required)

| Element name | Acetate (0.1lb/gal) |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |

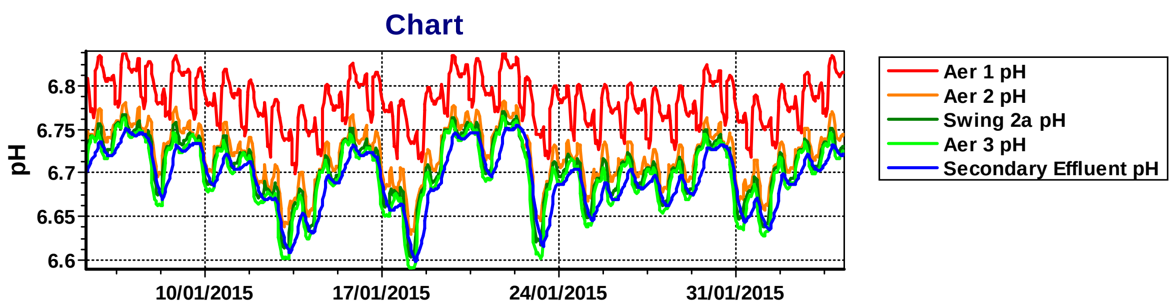
| | |
|---|---|
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 11980.00 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |

| | |
|---|---|
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

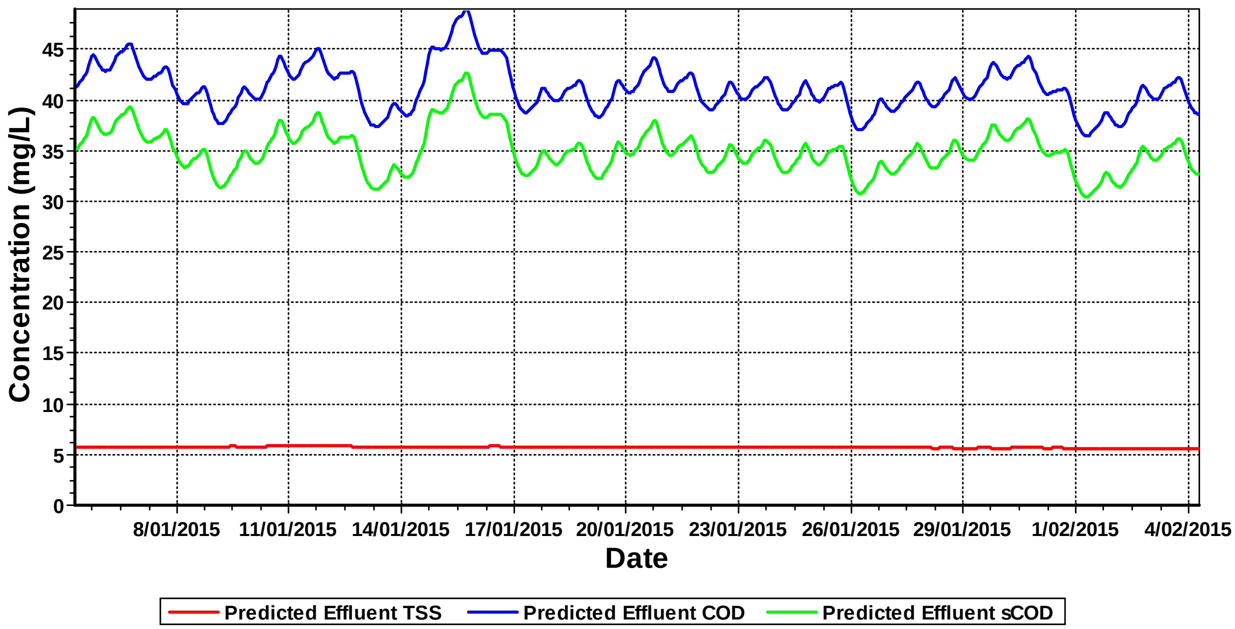
Album page - OURs



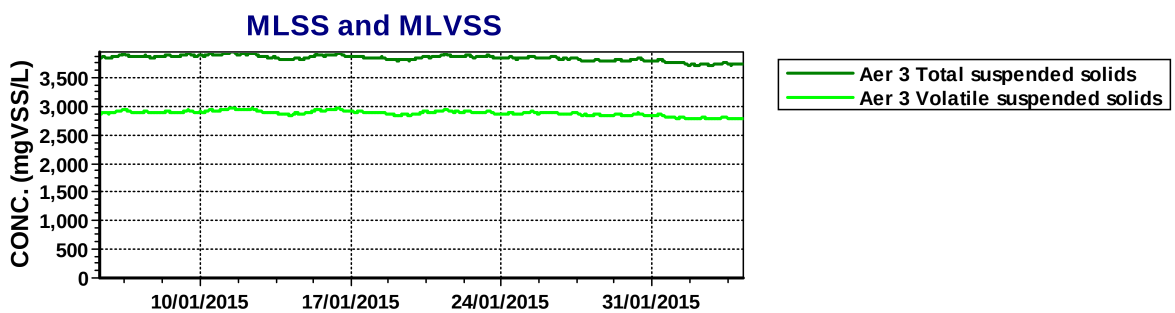

Album page - OURs



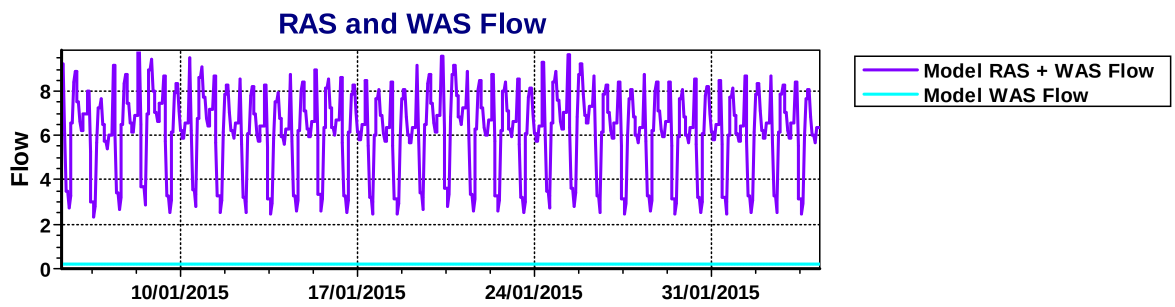

Album page - TSS, COD, BOD



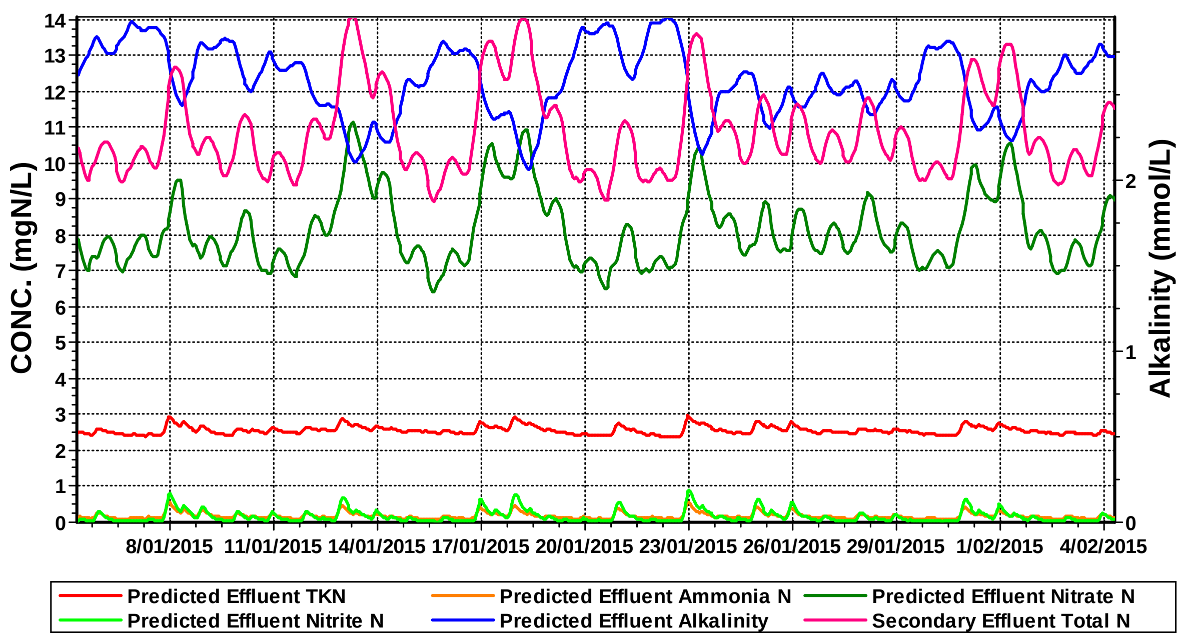

Album page - Mixed Liquor, RAS Flow



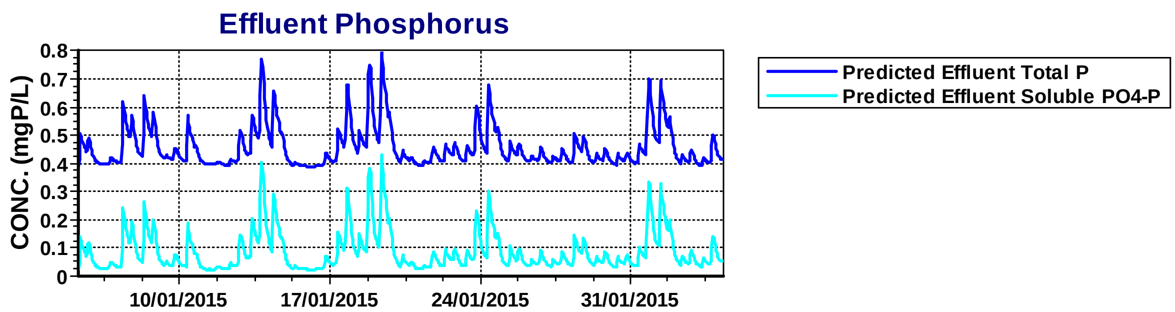

Album page - Mixed Liquor, RAS Flow



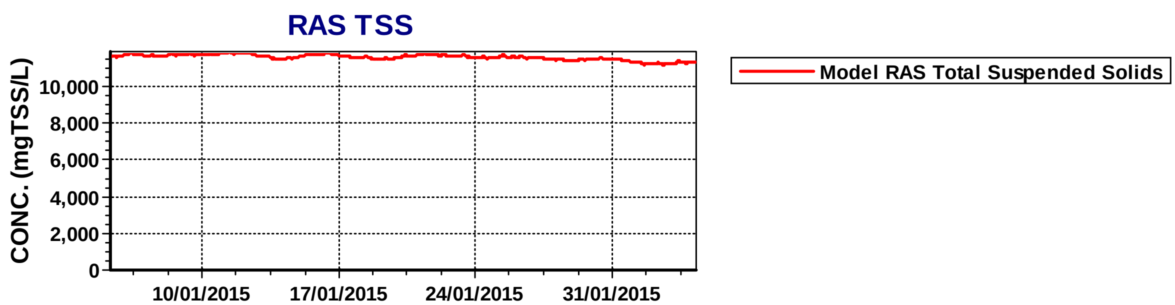

Album page - Nitrogen Sp., Alkalinity



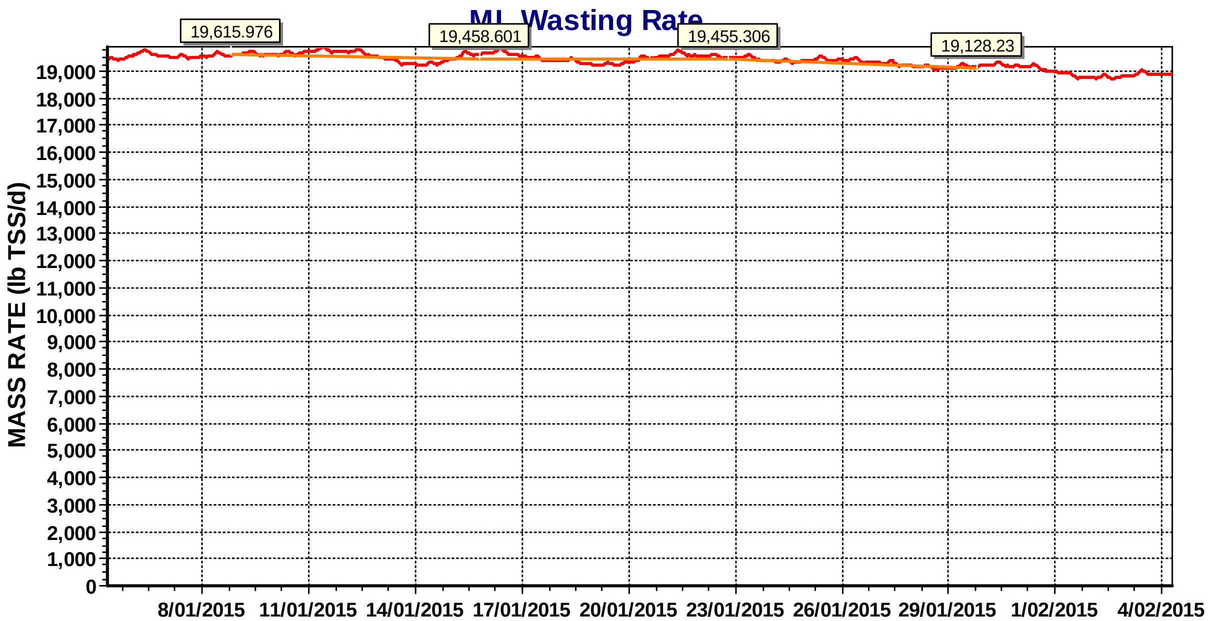

Album page - TP, RAS TSS



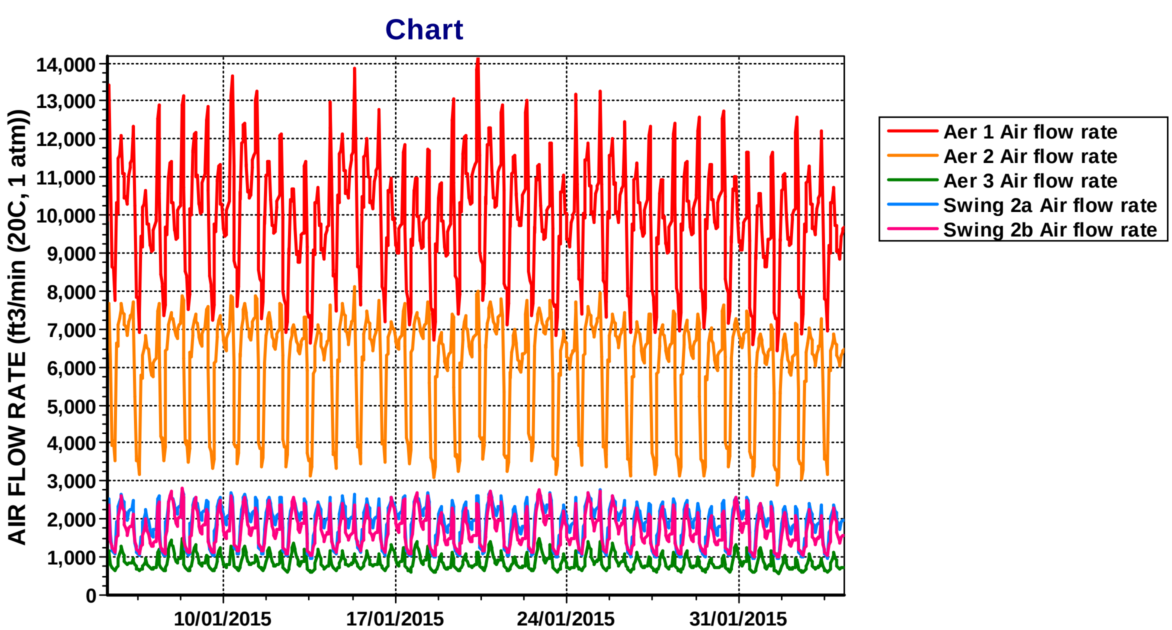

Album page - TP, RAS TSS



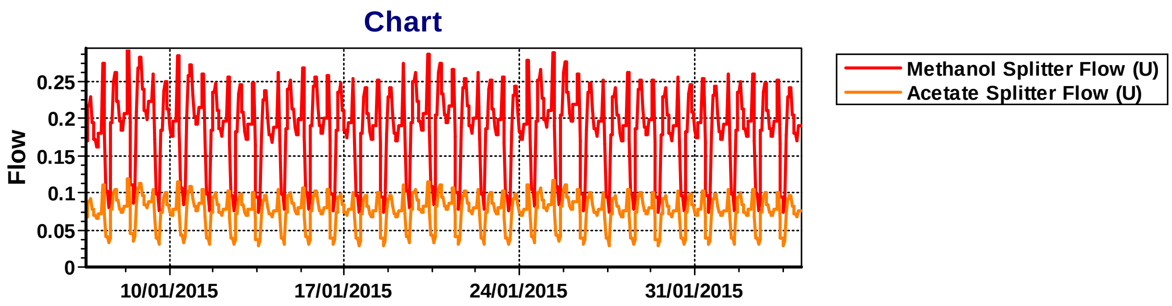

Album page - WAS Mass




Album page - Air Flow Rate




Album page - Page 16




Meridian Alternative's Analysis version 1

Expansion using selectable 5 stage modified Bardenpho/A2O process

Tank sizes optimized based on individual simulations from A2O and 5 stage modified Bardenpho processes

To achieve target effluent concentrations, for Bardenpho process:
Set BDF IMLR at 200% influent, Set A2O IMLR at 0%
Set Swing 1 Aerated, Swing 2a and 2b unaerated.
SRT = 12 days
Acetate flow pace at 0.8% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 0.5% of PE flow rate, 1% methanol solution.  All methanol to swing 2a

To achieve target effluent concentrations, for A2O process:
Set BDF IMLR at 0% influent, Set A2O IMLR at 400%
Set Swing 1 unaerated, Swing 2a and 2b aerated.
SRT = 12 days
Acetate flow pace at 0.6% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 1.5% of PE flow rate, 1% methanol solution.  all methanol to Anoxic 1a

# BioWin user and configuration data

## Project details

Project name: Alternatives Analysis

Project ref.: 147571

Plant name: Meridian WWTP

User name: Pusker Regmi

Created: 6/29/2011

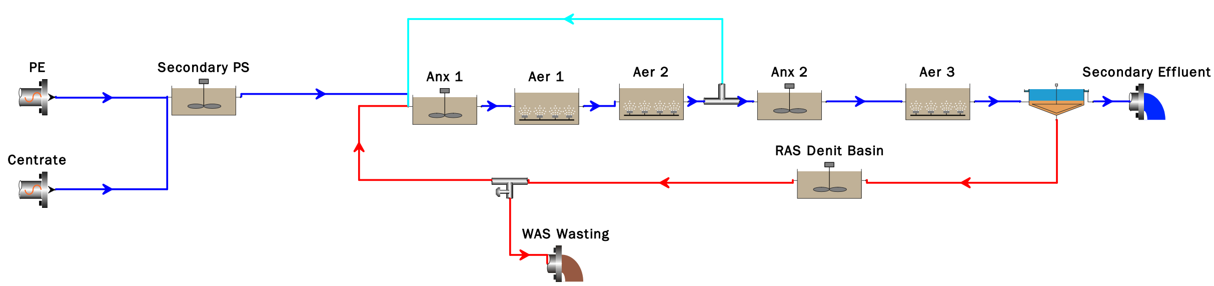
Saved: 4/3/2015

Target SRT: 13.00 days

SRT: **** days

Temperature: 15.0°C

## Flowsheet




# Configuration information for all Bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Anx 1 | 0.5000 | 4774.3058 | 14.000 | Un-aerated |
| Aer 1 | 1.5000 | 1.432E+4 | 14.000 | 4868 |
| Anx 2 | 1.0000 | 9548.6117 | 14.000 | Un-aerated |
| Aer 3 | 0.5000 | 4774.3058 | 14.000 | 1623 |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |
| Aer 2 | 1.5000 | 1.358E+4 | 14.764 | 3078 |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Anx 1 | 0 |
| Aer 1 | 0.5 |
| Anx 2 | 0 |
| Aer 3 | 2.0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |
| Aer 2 | 0.3 |

## Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Anx 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

| | | | | | |
|---|---|---|---|---|---|
| Aer 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Anx 2 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 3 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 2 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

## Configuration information for all Effluent units

## Configuration information for all Ideal clarifier units

### Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] |
|---|---|---|---|
| Clarifier | 2.1300 | 2.068E+4 | 13.770 |

### Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| Clarifier | Flow paced | 50.00 % |

| Element name | Average Temperature | Reactive | Percent removal | Blanket fraction |
|---|---|---|---|---|
| Clarifier | Uses global setting | Yes | 99.90 | 0.07 |

# Configuration information for all COD Influent units

## Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 30.00 | 30.00 |
| Flow | 12.461167588271 | 0.100114816828393 |
| Total COD mgCOD/L | 416.48 | 1801.80 |
| Total Kjeldahl Nitrogen mgN/L | 54.01 | 934.39 |
| Total P mgP/L | 8.12 | 529.81 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.95 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.43 | 185.22 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.5940 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 0.0391 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9930 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.0039 |
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.3196 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.9500 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5080 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0140 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0350 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9300 |

| | | |
|---|---|---|
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.0642 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-4 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 | 0 |

## Configuration information for all Sludge units

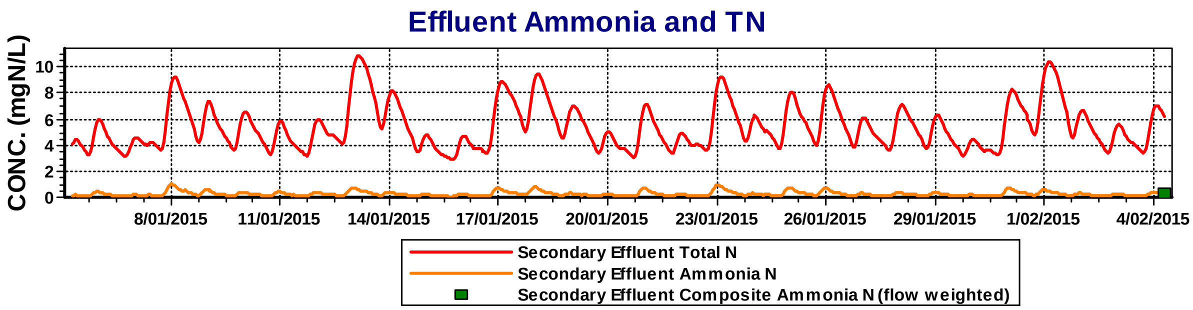
## Configuration information for all Splitter units

### Operating data Average (flow/time weighted as required)

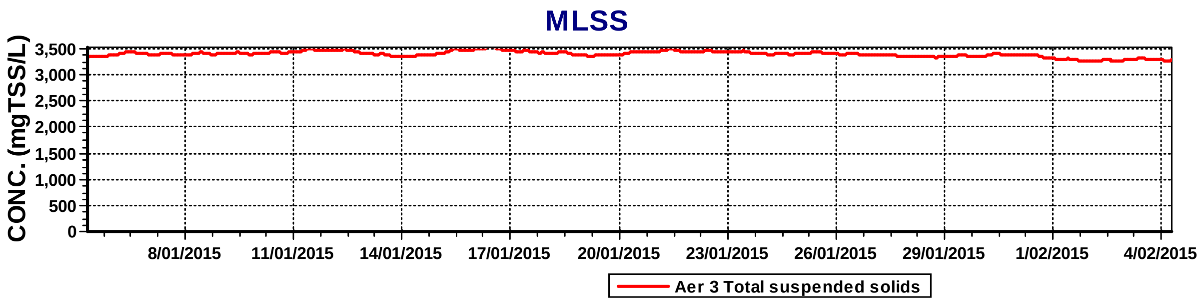
| Element name | Split method | Average Split specification |
|---|---|---|
| IMLR | Flow paced | 300.00 % |
| RAS / WAS | Flowrate [Side] | 0.129545329729831 |

### BioWin Album

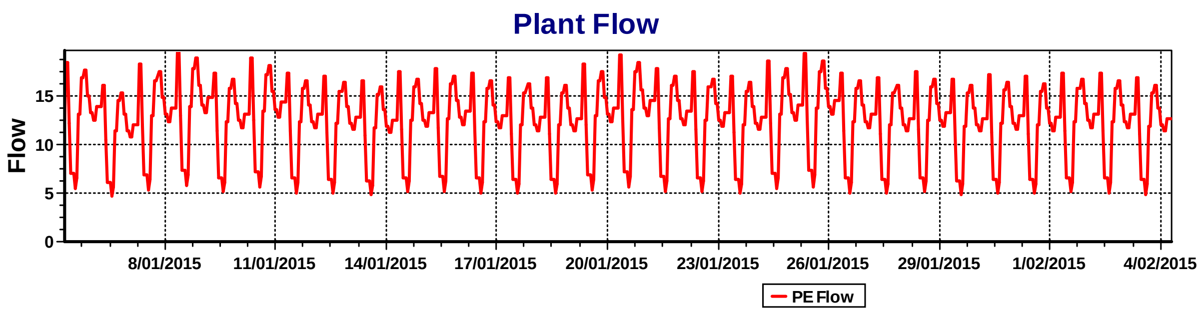
### Album page - Main Parameters



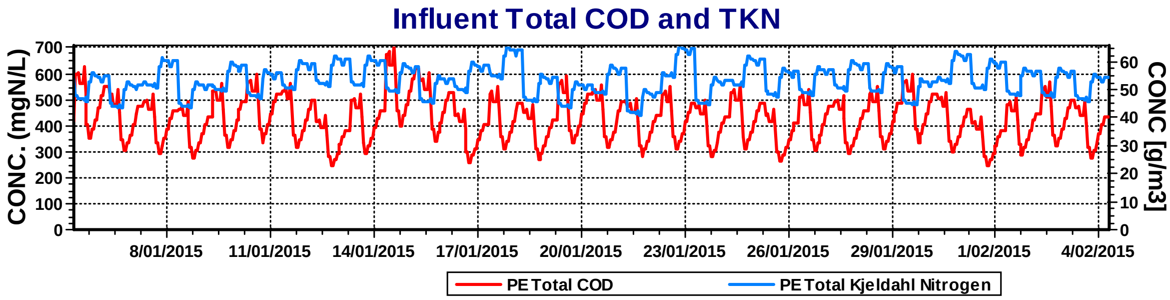

Album page - Main Parameters



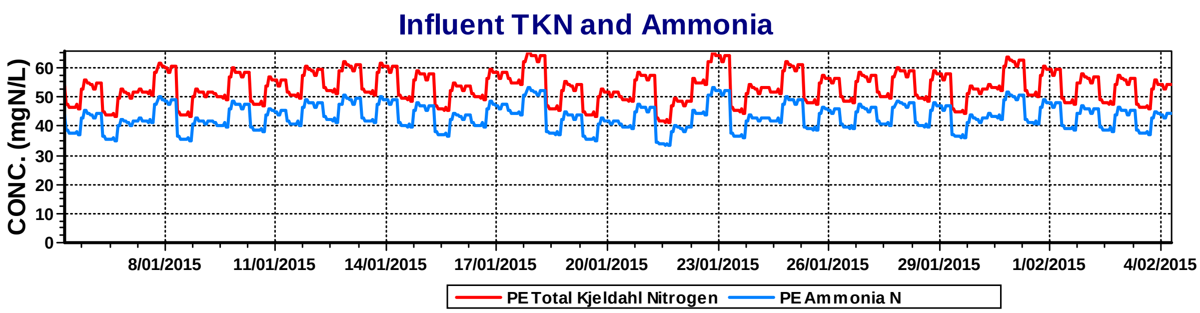

Album page - Inf Flow/COD/TKN



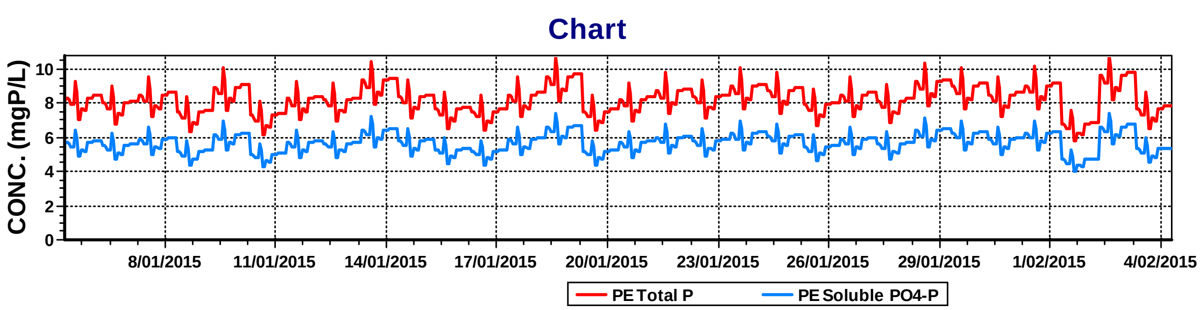

Album page - Inf Flow/COD/TKN



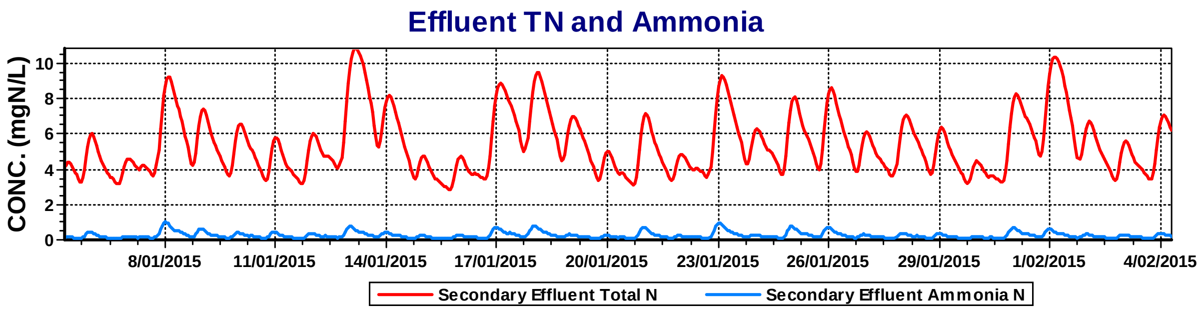

Album page - Influent N/P



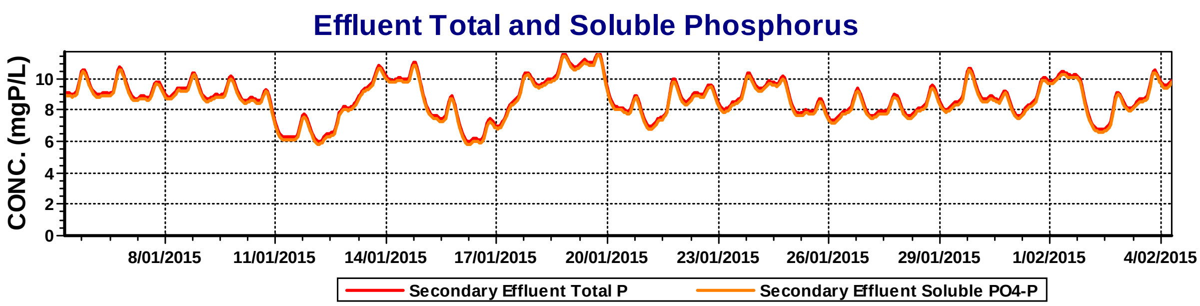

Album page - Influent N/P



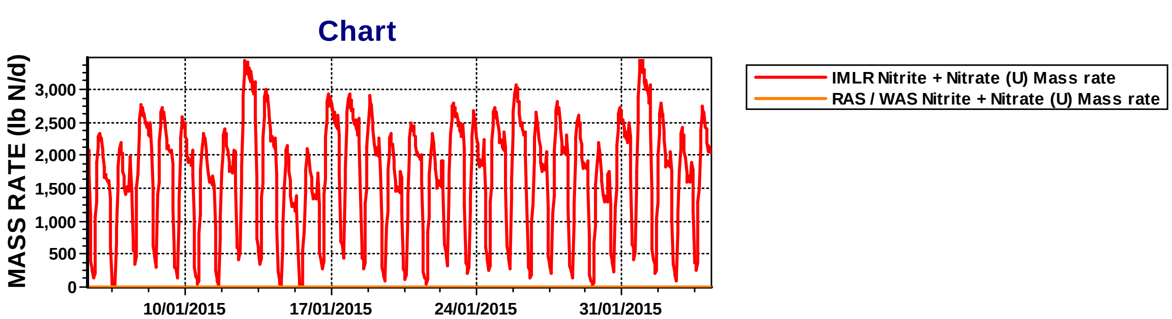

Album page - Effluent N/P




Album page - Effluent N/P

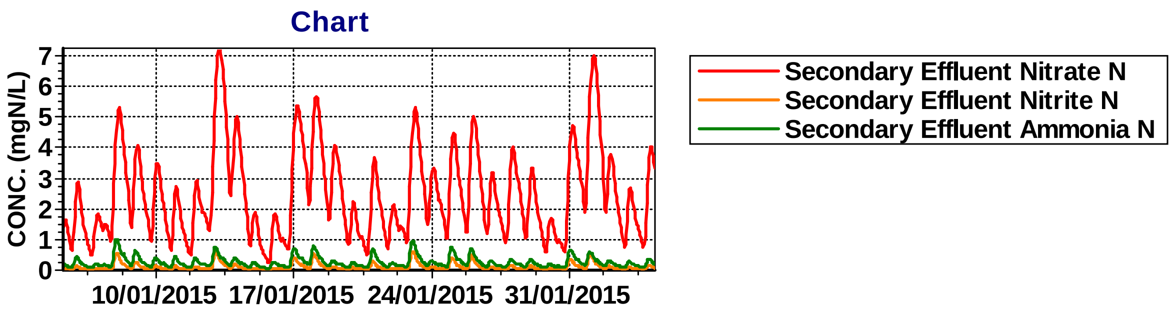



Album page - Page 6

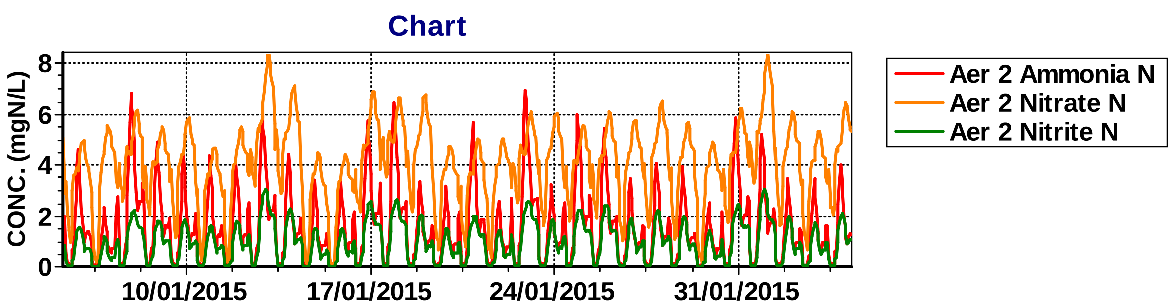



Album page - Page 6

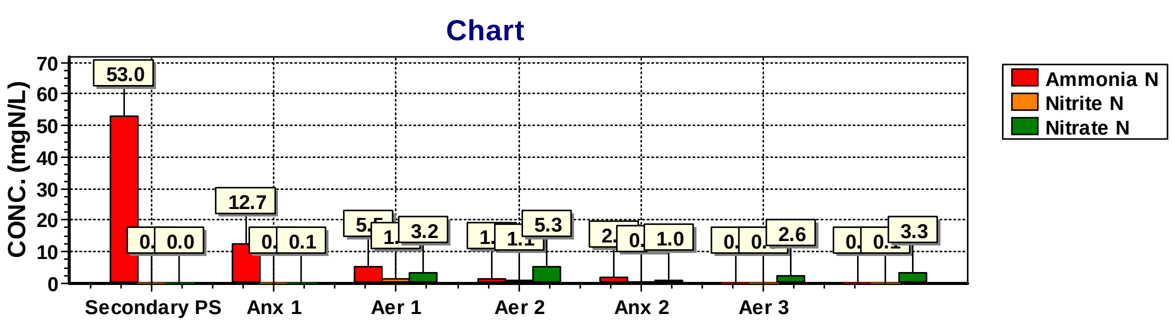
Album page - Page 7




Album page - Page 7




Album page - Page 8




Album page - Page 8

## Switches

| Name | Default | Value |
|---|---|---|
| Aerobic/anoxic DO half sat. [mgO2/L] | 0.0500 | 0.3000 |
| Anoxic/anaerobic NOx half sat. [mgN/L] | 0.1500 | 0.1500 |
| AOB DO half sat. [mgO2/L] | 0.2500 | 0.1500 |
| NOB DO half sat. [mgO2/L] | 0.5000 | 0.1500 |
| AAO DO half sat. [mgO2/L] | 0.0100 | 0.0100 |
| Anoxic NO3(->NO2) half sat. [mgN/L] | 0.1000 | 0.1000 |
| Anoxic NO3(->N2) half sat. [mgN/L] | 0.0500 | 0.0500 |
| Anoxic NO2(->N2) half sat. (mgN/L) | 0.0100 | 0.0200 |
| NH3 nutrient half sat. [mgN/L] | 0.0050 | 0.0050 |
| PolyP half sat. [mgP/mgCOD] | 0.0100 | 0.0100 |
| VFA sequestration half sat. [mgCOD/L] | 5.0000 | 5.0000 |
| P uptake half sat. [mgP/L] | 0.1500 | 0.1500 |
| P nutrient half sat. [mgP/L] | 0.0010 | 0.0010 |
| Autotroph CO2 half sat. [mmol/L] | 0.1000 | 0.1000 |
| H2 low/high half sat. [mgCOD/L] | 1.0000 | 1.0000 |
| Propionic acetogens H2 inhibition [mgCOD/L] | 5.0000 | 5.0000 |
| Synthesis anion/cation half sat. [meq/L] | 0.0100 | 0.0100 |

# Appendix B: BioWin Modeling Results from Add-On Process Alternatives Evaluation

# BioWin user and configuration data

## Project details

Project name: Alternatives Analysis - Biomag    Project ref.: 147571

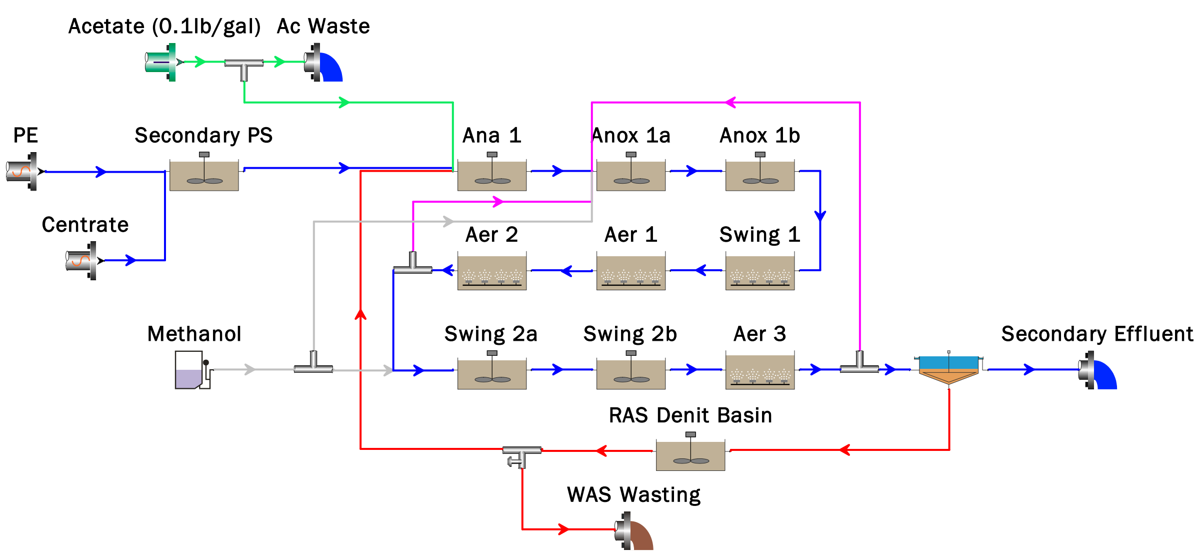
Plant name: Meridian WWTP    User name: H Melcer

Created: 6/29/2011    Saved: 7/17/2015

Target SRT: 12.00 days    SRT: **** days

Temperature: 14.0°C

## Flowsheet



# Configuration information for all Bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Ana 1 | 0.5000 | 4774.3058 | 14.000 | Un-aerated |
| Aer 1 | 0.8200 | 7829.8616 | 14.000 | 2661 |
| Aer 2 | 1.1000 | 1.050E+4 | 14.000 | 3570 |
| Swing 2a | 0.4200 | 4010.4169 | 14.000 | Un-aerated |
| Aer 3 | 0.2800 | 2673.6113 | 14.000 | 909 |
| Anox 1a | 0.1900 | 1814.2362 | 14.000 | Un-aerated |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |
| Anox 1b | 0.1900 | 1814.2362 | 14.000 | Un-aerated |
| Swing 1 | 0.2700 | 2578.1251 | 14.000 | 584 |
| Swing 2b | 0.4200 | 4010.4169 | 14.000 | Un-aerated |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Ana 1 | 0 |
| Aer 1 | 2.5 |
| Aer 2 | 2.0 |
| Swing 2a | 0 |
| Aer 3 | 2.0 |
| Anox 1a | 0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |
| Anox 1b | 0 |
| Swing 1 | 2.0 |
| Swing 2b | 0 |

## Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Ana 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 2 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Swing 2a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 3 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Anox 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Anox 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 2b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

# Configuration information for all Methanol addition units

## Operating data Average (flow/time weighted as required)

| Element name | Methanol |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |

| | |
|---|---|
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 11880.00 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |

| | |
|---|---|
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

# Configuration information for all Effluent units

# Configuration information for all Ideal clarifier units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] |
|---|---|---|---|
| Clarifier | 2.8000 | 2.718E+4 | 13.770 |

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| Clarifier | Flow paced | 50.00 % |

| Element name | Average Temperature | Reactive | Percent removal | Blanket fraction |
|---|---|---|---|---|
| Clarifier | Uses global setting | Yes | 99.90 | 0.07 |

# Configuration information for all COD Influent units

## Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 30.00 | 30.00 |
| Flow | 12.461167588271 | 0.100114816828393 |
| Total COD mgCOD/L | 416.48 | 1801.80 |
| Total Kjeldahl Nitrogen mgN/L | 54.01 | 934.39 |
| Total P mgP/L | 8.12 | 529.81 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.95 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.43 | 185.22 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.5950 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 0.0392 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9931 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.0039 |
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.3197 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.9500 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5086 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0050 |

| | | |
|---|---|---|
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0512 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9300 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.0642 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-4 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 | 0 |

# Configuration information for all Sludge units

# Configuration information for all Splitter units

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| BDF IMLR | Flow paced | 200.00 % |
| RAS / WAS | Flowrate [Side] | 0.08 |
| Acetate Splitter | Flow paced | 0.80 % |
| Splitter21 | Flowrate [Side] | 0 |
| A2O IMLR | Flow paced | 0.00 % |

# Configuration information for all Stream (SV) Influent units

## Operating data Average (flow/time weighted as required)

| Element name | Acetate (0.1lb/gal) |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 11980.00 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |

| | |
|---|---|
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

## BioWin Album

## Album page - Table

| BDF IMLR | Aer 3 | Swing 2a | Aer 2 | Aer 1 | Anox 1a | Ana 1 | Secondary | PE | Elements |
|---|---|---|---|---|---|---|---|---|---|
| 8131.92 | 8081.78 | 8110.86 | 8131.92 | 8158.70 | 8206.81 | 8316.07 | 449.80 | 595.58 | Total COD |
| 551.75 | 549.39 | 549.91 | 551.75 | 557.10 | 565.98 | 584.81 | 63.69 | 47.74 | Total |
| 7.58 | 19.24 | 19.24 | 44.51 | 44.51 | 44.51 | 19.18 | 12.82 | 18.47 | Flow [mgd] |
| 2.00 | 2.00 | 0 | 2.00 | 2.50 | 0 | 0 | 0 | 0 | Dissolved |
| 7838.26 | 7810.33 | 7819.22 | 7838.26 | 7807.71 | 7763.89 | 7666.19 | 112.41 | 138.42 | Total |
| 5550.99 | 5524.93 | 5536.40 | 5550.99 | 5559.09 | 5567.94 | 5589.48 | 97.14 | 129.64 | Volatile |
| 1.12 | 1.03 | 4.03 | 1.12 | 1.31 | 1.38 | 9.41 | 146.94 | 191.70 | Filtered |
| 0.97 | 0.09 | 0.54 | 0.97 | 6.81 | 16.90 | 37.78 | 52.96 | 38.67 | Ammonia N |
| 2.75 | 0.02 | 0.40 | 2.75 | 3.60 | 1.41 | 0.00 | 0 | 0 | Nitrite N |
| 23.88 | 11.10 | 14.41 | 23.88 | 17.82 | 12.35 | 0.00 | 0 | 0 | Nitrate N |
| 579.81 | 577.55 | 577.77 | 579.81 | 579.95 | 580.10 | 580.55 | 14.10 | 8.30 | Total P |
| 2.20 | 0.03 | 1.02 | 2.20 | 14.75 | 31.84 | 70.61 | 11.26 | 5.73 | Soluble PO4- |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 6.75 | 22.12 | 30.07 | Volatile fatty |
| 124.87 | 123.96 | 124.28 | 124.87 | 124.39 | 123.69 | 122.16 | 0 | 0 | Fixed stored |
| 118.77 | 117.81 | 118.17 | 118.77 | 118.40 | 117.54 | 116.00 | 0.04 | 0.06 | Ammonia |
| 1.27 | 1.26 | 1.26 | 1.27 | 1.27 | 1.27 | 1.27 | 0.04 | 0.06 | Anaerobic |
| 2336.53 | 2335.24 | 2330.97 | 2336.53 | 2332.70 | 2328.46 | 2316.82 | 0.00 | 0 | Endogenous |
| 0.21 | 0.20 | 0.20 | 0.21 | 0.21 | 0.21 | 0.22 | 0.04 | 0.06 | Methanogen |
| 0.06 | 0.05 | 0.05 | 0.06 | 0.06 | 0.06 | 0.08 | 0.04 | 0.06 | Methanogen |
| 695.52 | 707.43 | 706.61 | 695.52 | 696.14 | 696.83 | 698.75 | 0.04 | 0.06 | Methylotroph |
| 64.75 | 64.23 | 64.42 | 64.75 | 64.42 | 64.08 | 63.26 | 0.04 | 0.06 | Nitrite |
| 2508.96 | 2495.52 | 2498.33 | 2508.96 | 2502.14 | 2489.68 | 2461.76 | 0.05 | 0.06 | Ordinary |
| 1767.04 | 1759.38 | 1760.15 | 1767.04 | 1761.66 | 1753.71 | 1735.65 | 0.04 | 0.06 | Polyphospha |
| 0.24 | 0.23 | 0.24 | 0.24 | 0.24 | 0.25 | 0.26 | 0.04 | 0.06 | Propionic |
| ----- | 18250.50 | 27406.91 | 71954.80 | 53429.96 | 12310.64 | 31988.72 | 37.81 | ----- | Total solids |
| 0.00 | 0.00 | 4.51 | 0.00 | 0.00 | 0.00 | 0.00 | 0 | 0 | Methanol |

| RAS / WAS | RAS / WAS | Clarifier (U) | Clarifier | Secondary | BDF IMLR (U) |
|---|---|---|---|---|---|
| 24402.75 | 24402.75 | 24409.74 | 47.18 | 47.18 | 8131.92 |
| 1662.92 | 1662.92 | 1663.04 | 2.67 | 2.67 | 551.75 |
| 0.08 | 6.25 | 6.33 | 12.91 | 12.91 | 36.93 |
| 0 | 0 | 0.00 | 1.69 | 1.69 | 2.00 |
| 23660.81 | 23660.81 | 23673.34 | 11.60 | 11.60 | 7838.26 |
| 16734.26 | 16734.26 | 16740.82 | 8.19 | 8.19 | 5550.99 |
| 0.16 | 0.16 | 0.41 | 0.89 | 0.89 | 1.12 |
| 1.83 | 1.83 | 1.40 | 0.12 | 0.12 | 0.97 |
| 0.00 | 0.00 | 0.04 | 0.05 | 0.05 | 2.75 |
| 0.03 | 0.03 | 0.89 | 11.21 | 11.21 | 23.88 |
| 1751.82 | 1751.82 | 1752.04 | 0.92 | 0.92 | 579.81 |
| 1.91 | 1.91 | 0.33 | 0.05 | 0.05 | 2.20 |
| 0.08 | 0.08 | 0.03 | 0.00 | 0.00 | 0.00 |
| 375.09 | 375.09 | 375.31 | 0.18 | 0.18 | 124.87 |
| 356.34 | 356.34 | 356.67 | 0.17 | 0.17 | 118.77 |
| 3.82 | 3.82 | 3.82 | 0.00 | 0.00 | 1.27 |
| 7098.54 | 7098.54 | 7095.80 | 3.53 | 3.53 | 2336.53 |
| 0.60 | 0.60 | 0.60 | 0.00 | 0.00 | 0.21 |
| 0.14 | 0.14 | 0.14 | 0.00 | 0.00 | 0.06 |
| 2144.15 | 2144.15 | 2144.87 | 1.05 | 1.05 | 695.52 |
| 194.28 | 194.28 | 194.45 | 0.10 | 0.10 | 64.75 |
| 7545.79 | 7545.79 | 7555.56 | 3.71 | 3.71 | 2508.96 |
| 5328.22 | 5328.22 | 5330.59 | 2.60 | 2.60 | 1767.04 |
| 0.70 | 0.70 | 0.70 | 0.00 | 0.00 | 0.24 |
| ----- | ----- | ----- | 38974.54 | ----- | ----- |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

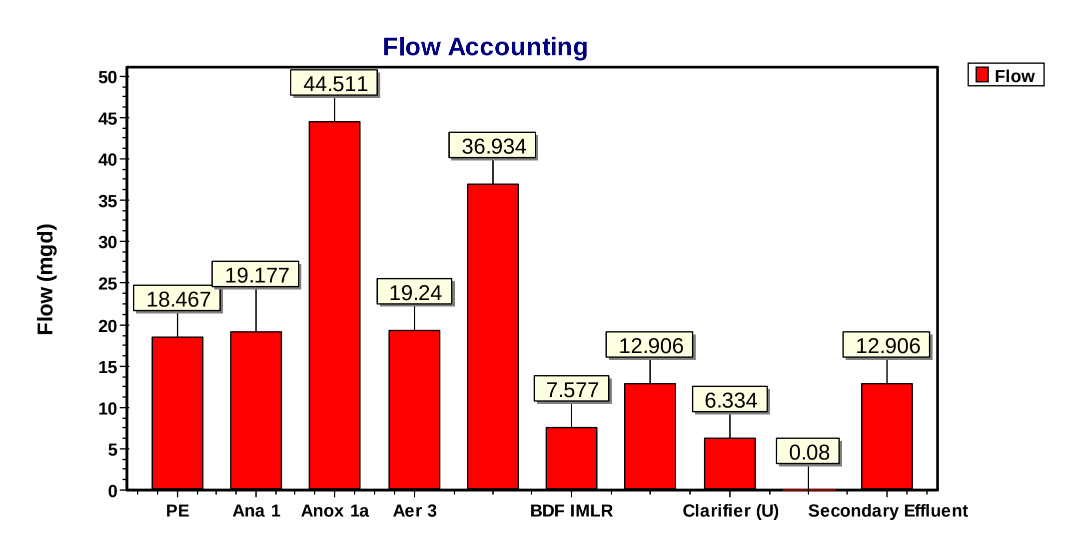
## Album page - Output Table 1

| Elements | PE | Secondary |
|---|---|---|
| Flow [mgd] | 18.47 | 12.82 |
| Liquid | 0 | 0.04 |
| Temperature | 14.00 | 14.00 |
| pH [] | 7.95 | 7.95 |
| Total | 138.42 | 112.41 |
| Volatile | 129.64 | 97.14 |
| Total COD | 595.58 | 449.80 |
| Filtered COD | 310.67 | 236.31 |
| Volatile fatty | 30.07 | 22.12 |
| Total | 339.16 | 253.85 |
| Readily bio. | 152.18 | 121.80 |
| Slowly bio. | 87.92 | 63.20 |
| Slowly bio. | 278.42 | 201.85 |
| Sol. inert | 40.50 | 29.19 |
| Total | 47.74 | 63.69 |
| Ammonia N | 38.67 | 52.96 |
| Nitrite N | 0 | 0 |
| Nitrate N | 0 | 0 |
| Total | 38.67 | 52.96 |
| Total N | 47.74 | 63.69 |
| Total P | 8.30 | 14.10 |
| Soluble PO4- | 5.73 | 11.26 |
| Air flow rate | ----- | 0 |
| Polyphospha | 0.06 | 0.04 |
| Ammonia | 0.06 | 0.04 |
| Nitrite | 0.06 | 0.04 |
| Ordinary | 0.06 | 0.05 |
| Methanol | 0 | 0 |

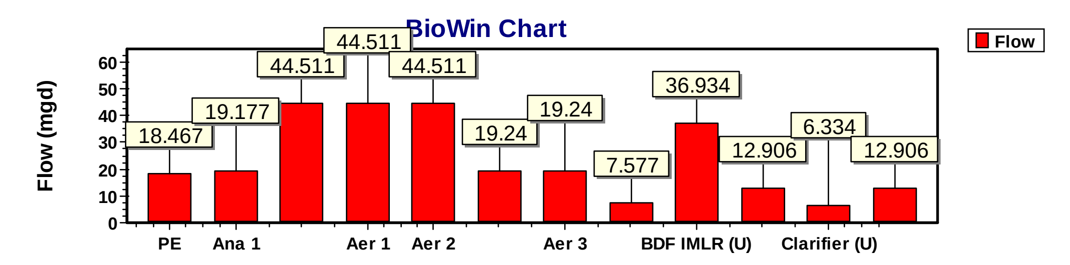
| BDF IMLR (U) | BDF IMLR | Secondary | Clarifier (U) | Clarifier | Aer 3 | Swing 2a | Aer 2 | Aer 1 | Anox 1a | Ana 1 |
|---|---|---|---|---|---|---|---|---|---|---|
| 36.93 | 7.58 | 12.91 | 6.33 | 12.91 | 19.24 | 19.24 | 44.51 | 44.51 | 44.51 | 19.18 |
| 0 | 0 | 0 | 2.80 | 2.80 | 0.28 | 0.42 | 1.10 | 0.82 | 0.19 | 0.50 |
| 14.00 | 14.00 | 14.00 | 14.00 | 14.00 | 14.00 | 14.00 | 14.00 | 14.00 | 14.00 | 14.00 |
| 6.46 | 6.46 | 6.68 | 6.74 | 6.68 | 6.68 | 6.62 | 6.46 | 6.62 | 6.85 | 7.01 |
| 7838.26 | 7838.26 | 11.60 | 23673.34 | 11.60 | 7810.33 | 7819.22 | 7838.26 | 7807.71 | 7763.89 | 7666.19 |
| 5550.99 | 5550.99 | 8.19 | 16740.82 | 8.19 | 5524.93 | 5536.40 | 5550.99 | 5559.09 | 5567.94 | 5589.48 |
| 8131.92 | 8131.92 | 47.18 | 24409.74 | 47.18 | 8081.78 | 8110.86 | 8131.92 | 8158.70 | 8206.81 | 8316.07 |
| 35.79 | 35.79 | 35.30 | 39.73 | 35.30 | 36.40 | 39.73 | 35.79 | 35.92 | 50.75 | 80.74 |
| 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 6.75 |
| 2985.52 | 2985.52 | 5.22 | 8950.43 | 5.22 | 2959.90 | 2978.71 | 2985.52 | 3001.34 | 3020.49 | 3074.87 |
| 1.59 | 1.59 | 1.26 | 0.54 | 1.26 | 1.46 | 0.72 | 1.59 | 1.85 | 1.24 | 3.14 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.45 | 3.20 |
| 132.50 | 132.50 | 0.11 | 326.91 | 0.11 | 111.67 | 127.79 | 132.50 | 159.32 | 196.37 | 282.62 |
| 34.16 | 34.16 | 33.98 | 36.78 | 33.98 | 34.89 | 34.39 | 34.16 | 33.75 | 33.22 | 31.79 |
| 551.75 | 551.75 | 2.67 | 1663.04 | 2.67 | 549.39 | 549.91 | 551.75 | 557.10 | 565.98 | 584.81 |
| 0.97 | 0.97 | 0.12 | 1.40 | 0.12 | 0.09 | 0.54 | 0.97 | 6.81 | 16.90 | 37.78 |
| 2.75 | 2.75 | 0.05 | 0.04 | 0.05 | 0.02 | 0.40 | 2.75 | 3.60 | 1.41 | 0.00 |
| 23.88 | 23.88 | 11.21 | 0.89 | 11.21 | 11.10 | 14.41 | 23.88 | 17.82 | 12.35 | 0.00 |
| 27.60 | 27.60 | 11.39 | 2.33 | 11.39 | 11.21 | 15.35 | 27.60 | 28.23 | 30.66 | 37.78 |
| 578.38 | 578.38 | 13.94 | 1663.97 | 13.94 | 560.51 | 564.72 | 578.38 | 578.52 | 579.74 | 584.81 |
| 579.81 | 579.81 | 0.92 | 1752.04 | 0.92 | 577.55 | 577.77 | 579.81 | 579.95 | 580.10 | 580.55 |
| 2.20 | 2.20 | 0.05 | 0.33 | 0.05 | 0.03 | 1.02 | 2.20 | 14.75 | 31.84 | 70.61 |
| ----- | ----- | ----- | ----- | ----- | 979.84 | 0 | 7461.05 | 8636.26 | 0 | 0 |
| 1767.04 | 1767.04 | 2.60 | 5330.59 | 2.60 | 1759.38 | 1760.15 | 1767.04 | 1761.66 | 1753.71 | 1735.65 |
| 118.77 | 118.77 | 0.17 | 356.67 | 0.17 | 117.81 | 118.17 | 118.77 | 118.40 | 117.54 | 116.00 |
| 64.75 | 64.75 | 0.10 | 194.45 | 0.10 | 64.23 | 64.42 | 64.75 | 64.42 | 64.08 | 63.26 |
| 2508.96 | 2508.96 | 3.71 | 7555.56 | 3.71 | 2495.52 | 2498.33 | 2508.96 | 2502.14 | 2489.68 | 2461.76 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.51 | 0.00 | 0.00 | 0.00 | 0.00 |

| WAS Wasting | RAS / WAS | RAS / WAS | RAS Denit |
|---|---|---|---|
| 0.08 | 0.08 | 6.25 | 6.33 |
| 0 | 0 | 0 | 0.07 |
| 14.00 | 14.00 | 14.00 | 14.00 |
| 6.76 | 6.76 | 6.76 | 6.76 |
| 23660.81 | 23660.81 | 23660.81 | 23660.81 |
| 16734.26 | 16734.26 | 16734.26 | 16734.26 |
| 24402.75 | 24402.75 | 24402.75 | 24402.75 |
| 41.33 | 41.33 | 41.33 | 41.33 |
| 0.08 | 0.08 | 0.08 | 0.08 |
| 8943.93 | 8943.93 | 8943.93 | 8943.93 |
| 0.14 | 0.14 | 0.14 | 0.14 |
| 0.00 | 0.00 | 0.00 | 0.00 |
| 329.30 | 329.30 | 329.30 | 329.30 |
| 37.11 | 37.11 | 37.11 | 37.11 |
| 1662.92 | 1662.92 | 1662.92 | 1662.92 |
| 1.83 | 1.83 | 1.83 | 1.83 |
| 0.00 | 0.00 | 0.00 | 0.00 |
| 0.03 | 0.03 | 0.03 | 0.03 |
| 1.87 | 1.87 | 1.87 | 1.87 |
| 1662.96 | 1662.96 | 1662.96 | 1662.96 |
| 1751.82 | 1751.82 | 1751.82 | 1751.82 |
| 1.91 | 1.91 | 1.91 | 1.91 |
| ---- | ---- | ---- | 0 |
| 5328.22 | 5328.22 | 5328.22 | 5328.22 |
| 356.34 | 356.34 | 356.34 | 356.34 |
| 194.28 | 194.28 | 194.28 | 194.28 |
| 7545.79 | 7545.79 | 7545.79 | 7545.79 |
| 0.00 | 0.00 | 0.00 | 0.00 |

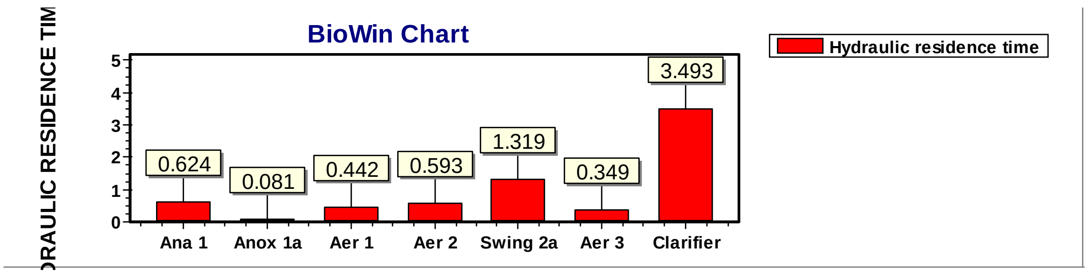
## Album page - SS Flow Accounting



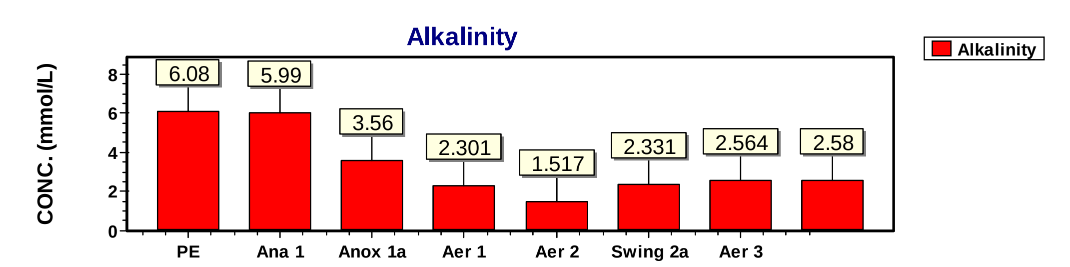

## Album page - SS Flow and HRT



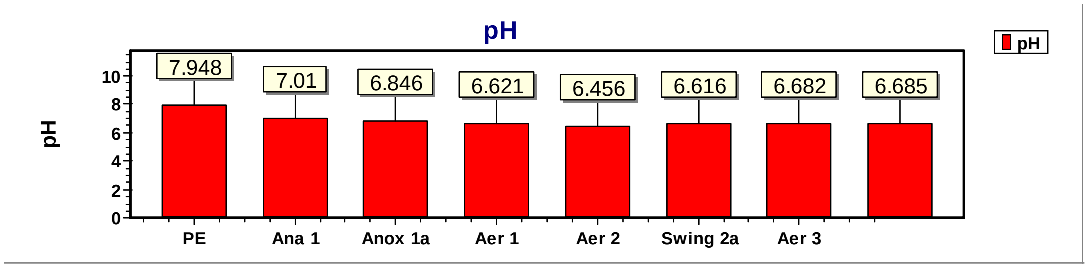

Album page - SS Flow and HRT



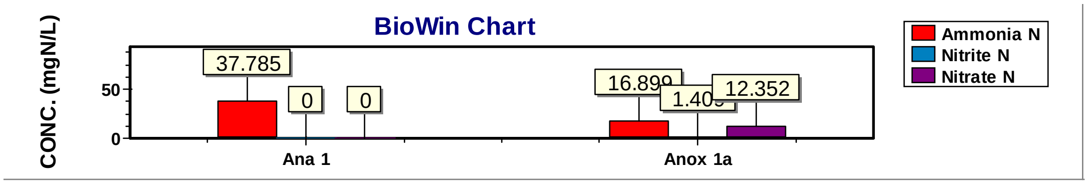

Album page - SS pH-Alkalinity




Album page - SS pH-Alkalinity




Album page - SS NH3-NO2-NO3

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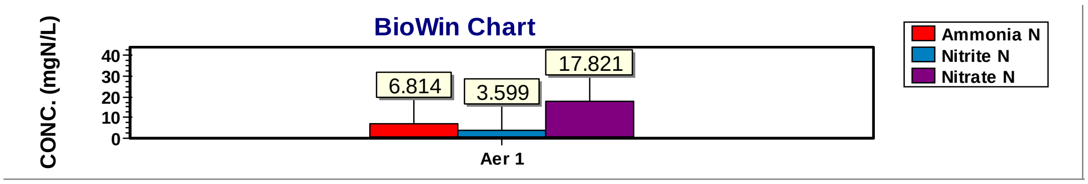
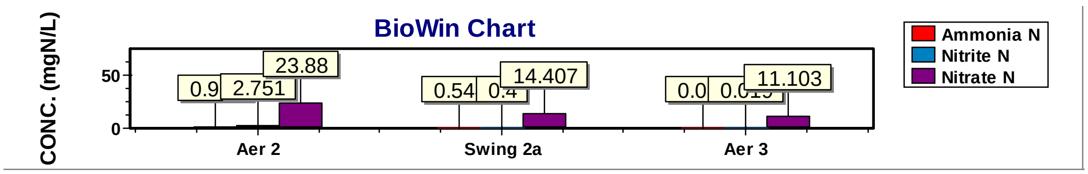
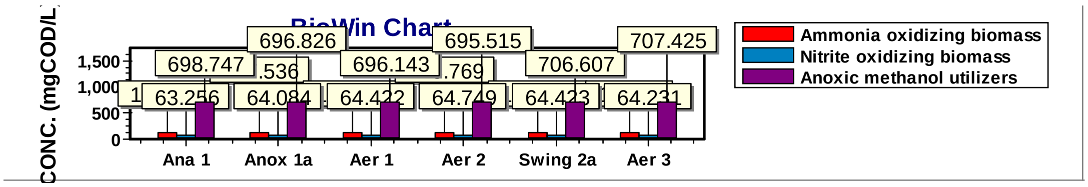


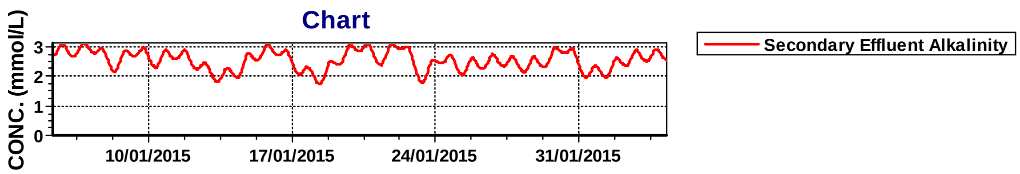

Album page - SS NH3-NO2-NO3




Album page - SS AOB-NOB

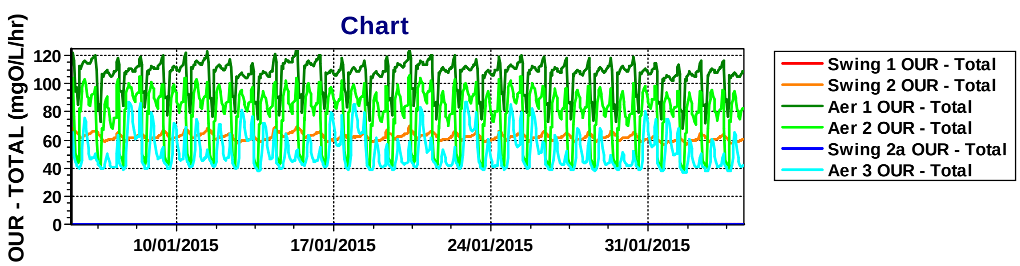



Album page - SS AOB-NOB

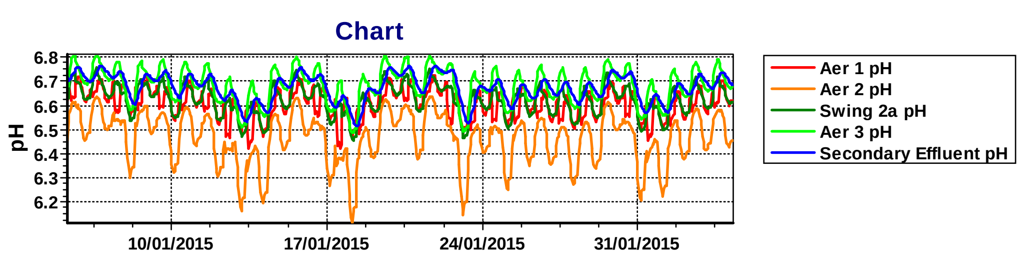



Album page - SS AOB-NOB

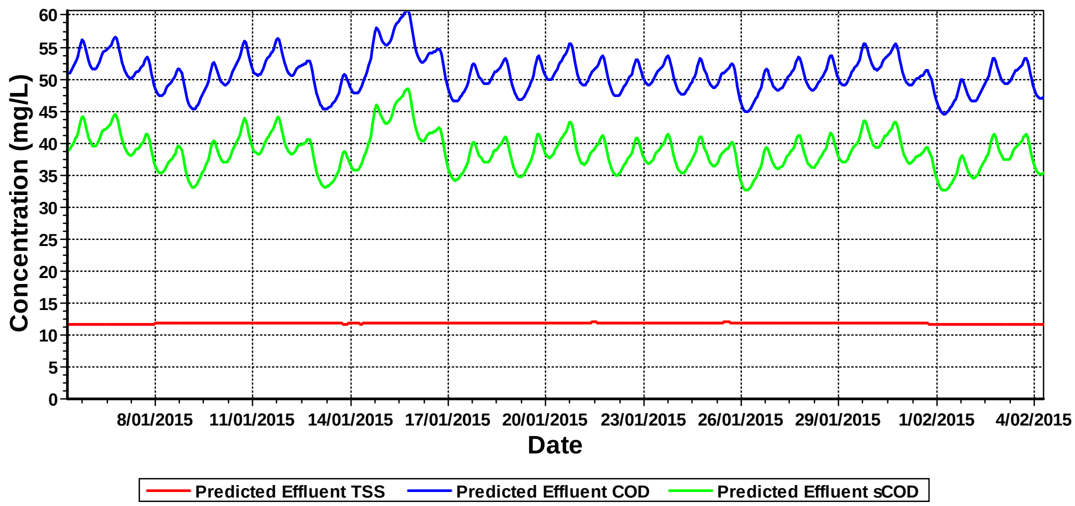
Album page - OURs



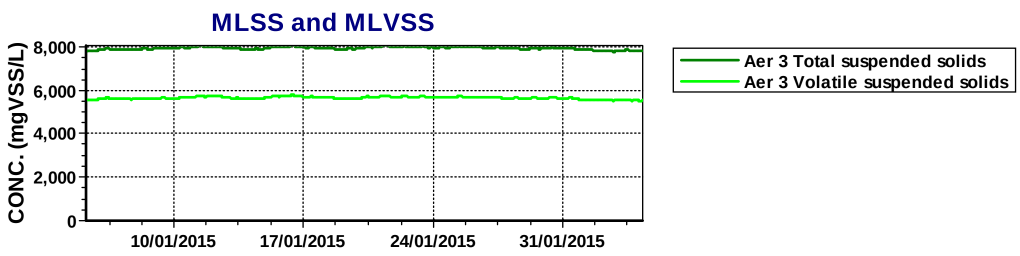

Album page - OURs



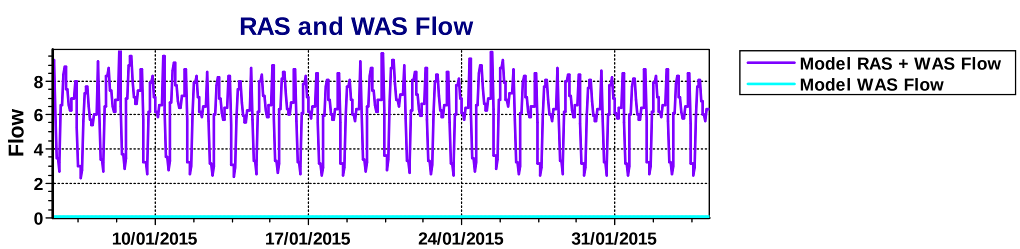
Album page - TSS, COD, BOD



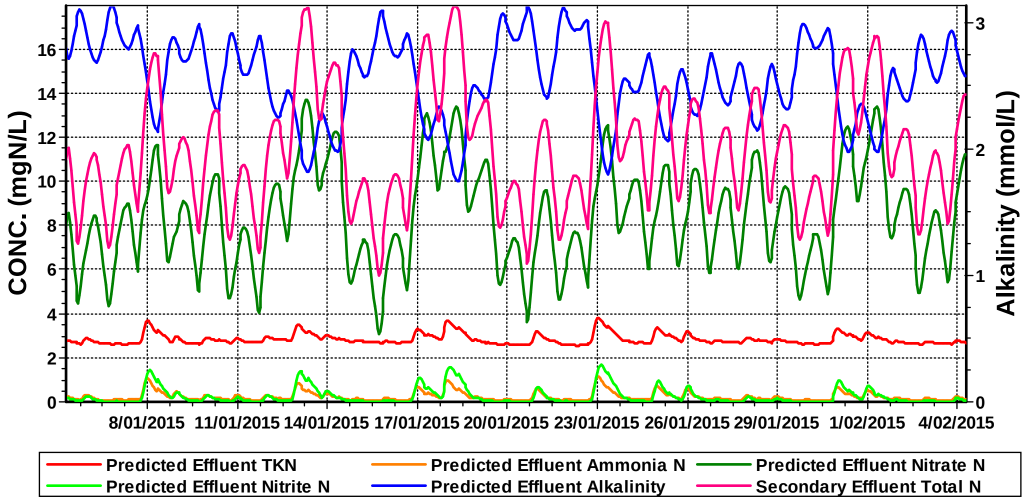

Album page - Mixed Liquor, RAS Flow



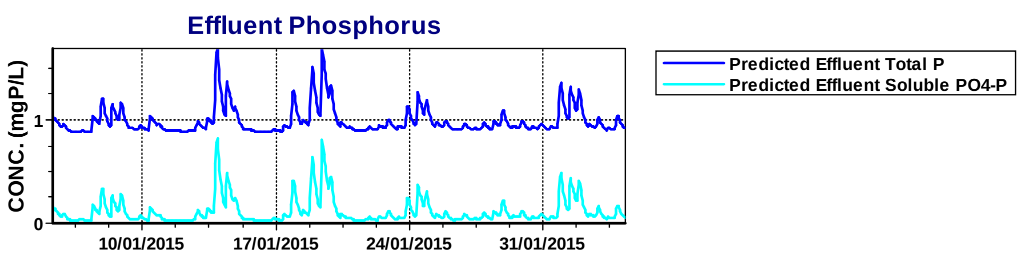

Album page - Mixed Liquor, RAS Flow



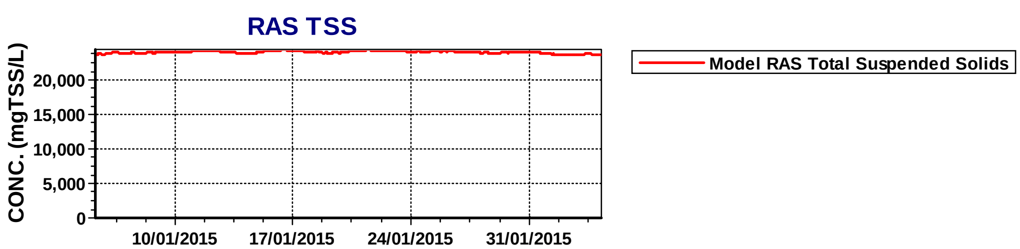
Album page - Nitrogen Sp., Alkalinity



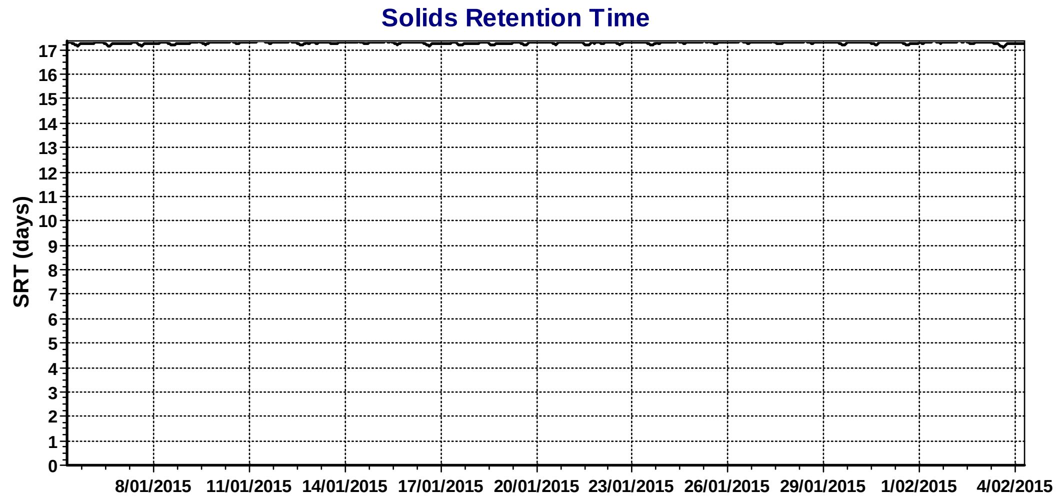

Album page - TP, RAS TSS



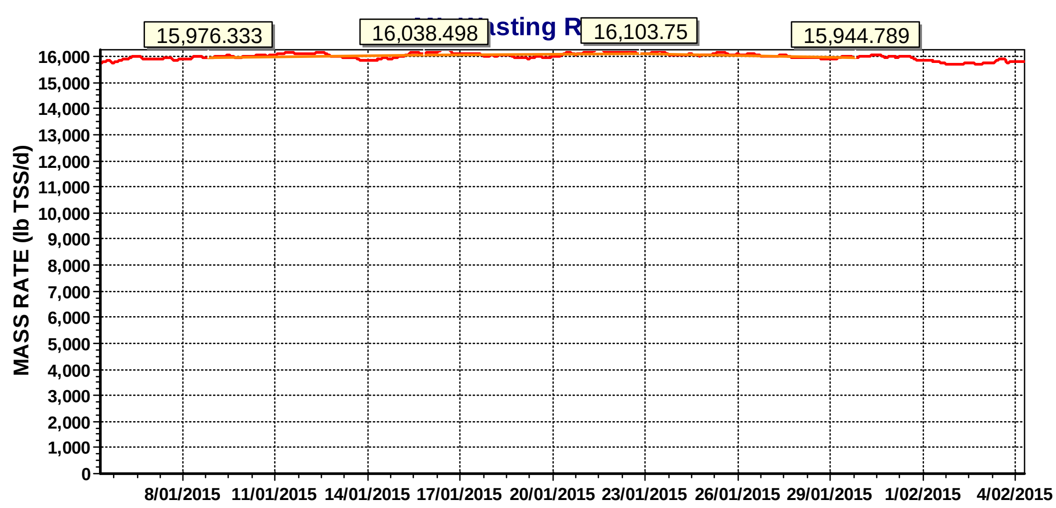

Album page - TP, RAS TSS



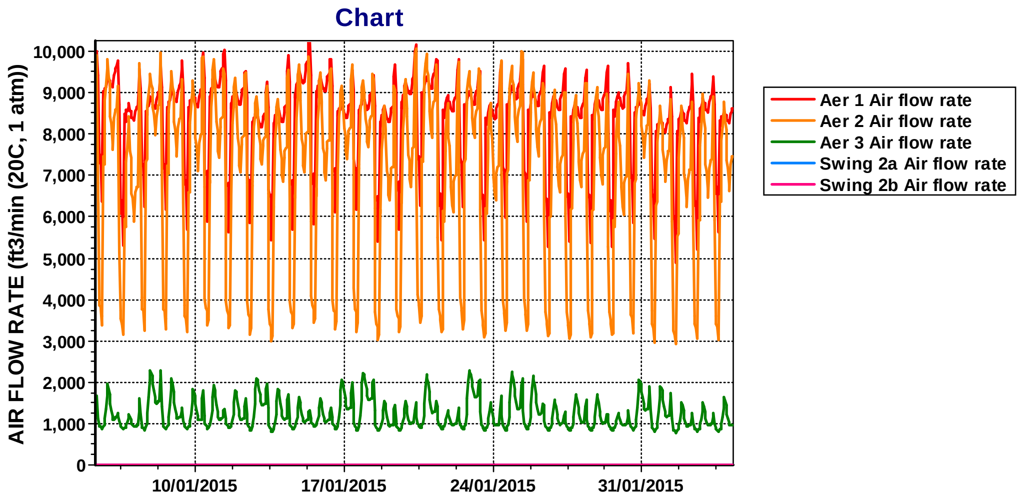
Album page - SRT




Album page - WAS Mass



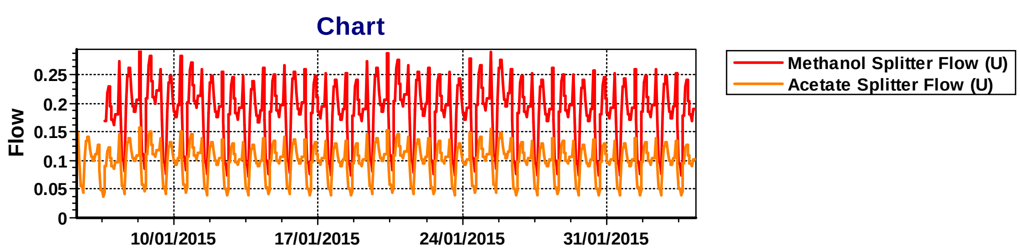

Album page - Air Flow Rate




## Album page - Page 16

| Elements | Air flow rate [ft3/min (20C, 1 atm)] | Flow [mgd] |
|---|---|---|
| Acetate Splitter (U) | ----- | 0.15 |
| Aer 1 | 8636.26 | 44.51 |
| Aer 2 | 7461.05 | 44.51 |
| Aer 3 | 979.84 | 19.24 |
| Swing 2a | 0 | 19.24 |
| Swing 2b | 0 | 19.24 |

## Album page - Page 16



## Global Parameters

### Common

| Name | Default | Value | |
|---|---|---|---|
| Hydrolysis rate [1/d] | 2.1000 | 2.1000 | 1.0290 |
| Hydrolysis half sat. [-] | 0.0600 | 0.0600 | 1.0000 |
| Anoxic hydrolysis factor [-] | 0.2800 | 0.2800 | 1.0000 |
| Anaerobic hydrolysis factor (AS) [-] | 0.0400 | 0.0400 | 1.0000 |
| Anaerobic hydrolysis factor (AD) [-] | 0.5000 | 0.5000 | 1.0000 |
| Adsorption rate of colloids [L/(mgCOD d)] | 0.1500 | 0.1500 | 1.0290 |
| Ammonification rate [L/(mgN d)] | 0.0400 | 0.0400 | 1.0290 |
| Assimilative nitrate/nitrite reduction rate [1/d] | 0.5000 | 0.5000 | 1.0000 |
| Endogenous products decay rate [1/d] | 0 | 0 | 1.0000 |

### AOB

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.9000 | 0.9000 | 1.0720 |
| Substrate (NH4) half sat. [mgN/L] | 0.7000 | 0.7000 | 1.0000 |
| Byproduct NH4 logistic slope [-] | 50.0000 | 50.0000 | 1.0000 |
| Byproduct NH4 inflection point [mgN/L] | 1.4000 | 1.4000 | 1.0000 |
| AOB denite DO half sat. [mg/L] | 0.1000 | 0.1000 | 1.0000 |
| AOB denite HNO2 half sat. [mgN/L] | 5.000E-6 | 5.000E-6 | 1.0000 |
| Aerobic decay rate [1/d] | 0.1700 | 0.1700 | 1.0290 |
| Anoxic/anaerobic decay rate [1/d] | 0.0800 | 0.0800 | 1.0290 |
| KiHNO2 [mmol/L] | 0.0050 | 0.0050 | 1.0000 |

## NOB

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.7000 | 0.7000 | 1.0600 |
| Substrate (NO2) half sat. [mgN/L] | 0.1000 | 0.1000 | 1.0000 |
| Aerobic decay rate [1/d] | 0.1700 | 0.1700 | 1.0290 |
| Anoxic/anaerobic decay rate [1/d] | 0.0800 | 0.0800 | 1.0290 |
| KiNH3 [mmol/L] | 0.0750 | 0.0750 | 1.0000 |

## AAO

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.2000 | 0.2000 | 1.1000 |
| Substrate (NH4) half sat. [mgN/L] | 2.0000 | 2.0000 | 1.0000 |
| Substrate (NO2) half sat. [mgN/L] | 1.0000 | 1.0000 | 1.0000 |
| Aerobic decay rate [1/d] | 0.0190 | 0.0190 | 1.0290 |
| Anoxic/anaerobic decay rate [1/d] | 0.0095 | 0.0095 | 1.0290 |
| Ki Nitrite [mgN/L] | 1000.0000 | 1000.0000 | 1.0000 |
| Nitrite sensitivity constant [L / (d mgN) ] | 0.0160 | 0.0160 | 1.0000 |

## OHO

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 3.2000 | 3.2000 | 1.0290 |
| Substrate half sat. [mgCOD/L] | 5.0000 | 5.0000 | 1.0000 |
| Anoxic growth factor [-] | 0.5000 | 0.5000 | 1.0000 |

| | | | |
|---|---|---|---|
| Denite N2 producers (NO3 or NO2) [-] | 0.5000 | 0.5000 | 1.0000 |
| Aerobic decay rate [1/d] | 0.6200 | 0.6200 | 1.0290 |
| Anoxic decay rate [1/d] | 0.2330 | 0.2330 | 1.0290 |
| Anaerobic decay rate [1/d] | 0.1310 | 0.1310 | 1.0290 |
| Fermentation rate [1/d] | 1.6000 | 1.6000 | 1.0290 |
| Fermentation half sat. [mgCOD/L] | 5.0000 | 5.0000 | 1.0000 |
| Fermentation growth factor (AS) [-] | 0.2500 | 0.2500 | 1.0000 |
| Free nitrous acid inhibition [mmol/L] | 1.000E-7 | 1.000E-7 | 1.0000 |

## Methylotrophs

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 1.3000 | 1.3000 | 1.0720 |
| Methanol half sat. [mgCOD/L] | 0.5000 | 0.5000 | 1.0000 |
| Denite N2 producers (NO3 or NO2) [-] | 0.5000 | 0.5000 | 1.0000 |
| Aerobic decay rate [1/d] | 0.0400 | 0.0400 | 1.0290 |
| Anoxic/anaerobic decay rate [1/d] | 0.0300 | 0.0300 | 1.0290 |
| Free nitrous acid inhibition [mmol/L] | 1.000E-7 | 1.000E-7 | 1.0000 |

## PAO

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.9500 | 0.9500 | 1.0000 |
| Max. spec. growth rate, P-limited [1/d] | 0.4200 | 0.4200 | 1.0000 |
| Substrate half sat. [mgCOD(PHB)/mgCOD(Zbp)] | 0.1000 | 0.1000 | 1.0000 |
| Substrate half sat., P-limited [mgCOD(PHB)/mgCOD(Zbp)] | 0.0500 | 0.0500 | 1.0000 |
| Magnesium half sat. [mgMg/L] | 0.1000 | 0.1000 | 1.0000 |

| | | | |
|---|---|---|---|
| Cation half sat. [mmol/L] | 0.1000 | 0.1000 | 1.0000 |
| Calcium half sat. [mgCa/L] | 0.1000 | 0.1000 | 1.0000 |
| Aerobic/anoxic decay rate [1/d] | 0.1000 | 0.1000 | 1.0000 |
| Aerobic/anoxic maintenance rate [1/d] | 0 | 0 | 1.0000 |
| Anaerobic decay rate [1/d] | 0.0400 | 0.0400 | 1.0000 |
| Anaerobic maintenance rate [1/d] | 0 | 0 | 1.0000 |
| Sequestration rate [1/d] | 4.5000 | 4.5000 | 1.0000 |
| Anoxic growth factor [-] | 0.3300 | 0.3300 | 1.0000 |

## Acetogens

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.2500 | 0.2500 | 1.0290 |
| Substrate half sat. [mgCOD/L] | 10.0000 | 10.0000 | 1.0000 |
| Acetate inhibition [mgCOD/L] | 10000.0000 | 10000.0000 | 1.0000 |
| Anaerobic decay rate [1/d] | 0.0500 | 0.0500 | 1.0290 |
| Aerobic/anoxic decay rate [1/d] | 0.5200 | 0.5200 | 1.0290 |

## Methanogens

| Name | Default | Value | |
|---|---|---|---|
| Acetoclastic max. spec. growth rate [1/d] | 0.3000 | 0.3000 | 1.0290 |
| H2-utilizing max. spec. growth rate [1/d] | 1.4000 | 1.4000 | 1.0290 |
| Acetoclastic substrate half sat. [mgCOD/L] | 100.0000 | 100.0000 | 1.0000 |
| Acetoclastic methanol half sat. [mgCOD/L] | 0.5000 | 0.5000 | 1.0000 |
| H2-utilizing CO2 half sat. [mmol/L] | 0.1000 | 0.1000 | 1.0000 |
| H2-utilizing substrate half sat. [mgCOD/L] | 0.1000 | 0.1000 | 1.0000 |

| | | | |
|---|---|---|---|
| H2-utilizing methanol half sat. [mgCOD/L] | 0.5000 | 0.5000 | 1.0000 |
| Acetoclastic propionic inhibition [mgCOD/L] | 10000.0000 | 10000.0000 | 1.0000 |
| Acetoclastic anaerobic decay rate [1/d] | 0.1300 | 0.1300 | 1.0290 |
| Acetoclastic aerobic/anoxic decay rate [1/d] | 0.6000 | 0.6000 | 1.0290 |
| H2-utilizing anaerobic decay rate [1/d] | 0.1300 | 0.1300 | 1.0290 |
| H2-utilizing aerobic/anoxic decay rate [1/d] | 2.8000 | 2.8000 | 1.0290 |

## pH

| Name | Default | Value |
|---|---|---|
| OHO low pH limit [-] | 4.0000 | 4.0000 |
| OHO high pH limit [-] | 10.0000 | 10.0000 |
| Methylotrophs low pH limit [-] | 4.0000 | 4.0000 |
| Methylotrophs high pH limit [-] | 10.0000 | 10.0000 |
| Autotrophs low pH limit [-] | 5.5000 | 5.5000 |
| Autotrophs high pH limit [-] | 9.5000 | 9.5000 |
| PAO low pH limit [-] | 4.0000 | 4.0000 |
| PAO high pH limit [-] | 10.0000 | 10.0000 |
| OHO low pH limit (anaerobic) [-] | 5.5000 | 5.5000 |
| OHO high pH limit (anaerobic) [-] | 8.5000 | 8.5000 |
| Propionic acetogens low pH limit [-] | 4.0000 | 4.0000 |
| Propionic acetogens high pH limit [-] | 10.0000 | 10.0000 |
| Acetoclastic methanogens low pH limit [-] | 5.0000 | 5.0000 |
| Acetoclastic methanogens high pH limit [-] | 9.0000 | 9.0000 |
| H2-utilizing methanogens low pH limit [-] | 5.0000 | 5.0000 |
| H2-utilizing methanogens high pH limit [-] | 9.0000 | 9.0000 |

## Switches

| Name | Default | Value |
| --- | --- | --- |
| Aerobic/anoxic DO half sat. [mgO2/L] | 0.0500 | 0.0500 |
| Anoxic/anaerobic NOx half sat. [mgN/L] | 0.1500 | 0.1500 |
| AOB DO half sat. [mgO2/L] | 0.2500 | 0.2500 |
| NOB DO half sat. [mgO2/L] | 0.5000 | 0.5000 |
| AAO DO half sat. [mgO2/L] | 0.0100 | 0.0100 |
| Anoxic NO3(->NO2) half sat. [mgN/L] | 0.1000 | 0.1000 |
| Anoxic NO3(->N2) half sat. [mgN/L] | 0.0500 | 0.0500 |
| Anoxic NO2(->N2) half sat. (mgN/L) | 0.0100 | 0.0100 |
| NH3 nutrient half sat. [mgN/L] | 0.0050 | 0.0050 |
| PolyP half sat. [mgP/mgCOD] | 0.0100 | 0.0100 |
| VFA sequestration half sat. [mgCOD/L] | 5.0000 | 5.0000 |
| P uptake half sat. [mgP/L] | 0.1500 | 0.1500 |
| P nutrient half sat. [mgP/L] | 0.0010 | 0.0010 |
| Autotroph CO2 half sat. [mmol/L] | 0.1000 | 0.1000 |
| H2 low/high half sat. [mgCOD/L] | 1.0000 | 1.0000 |
| Propionic acetogens H2 inhibition [mgCOD/L] | 5.0000 | 5.0000 |
| Synthesis anion/cation half sat. [meq/L] | 0.0100 | 0.0100 |

## Common

| Name | Default | Value |
| --- | --- | --- |
| Biomass volatile fraction (VSS/TSS) | 0.9200 | 0.9200 |
| Endogenous residue volatile fraction (VSS/TSS) | 0.9200 | 0.9200 |
| N in endogenous residue [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in endogenous residue [mgP/mgCOD] | 0.0220 | 0.0220 |
| Endogenous residue COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| Particulate substrate COD:VSS ratio [mgCOD/mgVSS] | 1.6000 | 2.2000 |

| | | |
|---|---|---|
| Particulate inert COD:VSS ratio [mgCOD/mgVSS] | 1.6000 | 2.2000 |

## AOB

| Name | Default | Value |
|---|---|---|
| Yield [mgCOD/mgN] | 0.1500 | 0.1500 |
| AOB denite NO2 fraction as TEA [-] | 0.5000 | 0.5000 |
| Byproduct NH4 fraction to N2O [-] | 0.0025 | 0.0025 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## NOB

| Name | Default | Value |
|---|---|---|
| Yield [mgCOD/mgN] | 0.0900 | 0.0900 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## AAO

| Name | Default | Value |
|---|---|---|

| | | |
|---|---|---|
| Yield [mgCOD/mgN] | 0.1140 | 0.1140 |
| Nitrate production [mgN/mgBiomassCOD] | 2.2800 | 2.2800 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## OHO

| Name | Default | Value |
|---|---|---|
| Yield (aerobic) [-] | 0.6660 | 0.6660 |
| Yield (fermentation, low H2) [-] | 0.1000 | 0.1000 |
| Yield (fermentation, high H2) [-] | 0.1000 | 0.1000 |
| H2 yield (fermentation low H2) [-] | 0.3500 | 0.3500 |
| H2 yield (fermentation high H2) [-] | 0 | 0 |
| Propionate yield (fermentation, low H2) [-] | 0 | 0 |
| Propionate yield (fermentation, high H2) [-] | 0.7000 | 0.7000 |
| CO2 yield (fermentation, low H2) [-] | 0.7000 | 0.7000 |
| CO2 yield (fermentation, high H2) [-] | 0 | 0 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Endogenous fraction - aerobic [-] | 0.0800 | 0.0800 |
| Endogenous fraction - anoxic [-] | 0.1030 | 0.1030 |
| Endogenous fraction - anaerobic [-] | 0.1840 | 0.1840 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| Yield (anoxic) [-] | 0.5400 | 0.5400 |
| Yield propionic (aerobic) [-] | 0.6400 | 0.6400 |
| Yield propionic (anoxic) [-] | 0.4600 | 0.4600 |
| Yield acetic (aerobic) [-] | 0.6000 | 0.6000 |

| | | |
|---|---|---|
| Yield acetic (anoxic) [-] | 0.4300 | 0.4300 |
| Yield methanol (aerobic) [-] | 0.5000 | 0.5000 |
| Adsorp. max. [-] | 1.0000 | 1.0000 |
| Max fraction to N2O at high FNA over nitrate [-] | 0.0500 | 0.0500 |
| Max fraction to N2O at high FNA over nitrite [-] | 0.1000 | 0.1000 |

## Methylotrophs

| Name | Default | Value |
|---|---|---|
| Yield (anoxic) [-] | 0.4000 | 0.4000 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| Max fraction to N2O at high FNA over nitrate [-] | 0.1000 | 0.1000 |
| Max fraction to N2O at high FNA over nitrite [-] | 0.1500 | 0.1500 |

## PAO

| Name | Default | Value |
|---|---|---|
| Yield (aerobic) [-] | 0.6390 | 0.6390 |
| Yield (anoxic) [-] | 0.5200 | 0.5200 |
| Aerobic P/PHA uptake [mgP/mgCOD] | 0.9300 | 0.9300 |
| Anoxic P/PHA uptake [mgP/mgCOD] | 0.3500 | 0.3500 |
| Yield of PHA on sequestration [-] | 0.8890 | 0.8890 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| N in sol. inert [mgN/mgCOD] | 0.0700 | 0.0700 |

| | | |
|---|---|---|
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous part. [-] | 0.2500 | 0.2500 |
| Inert fraction of endogenous sol. [-] | 0.2000 | 0.2000 |
| P/Ac release ratio [mgP/mgCOD] | 0.5100 | 0.5100 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| Yield of low PP [-] | 0.9400 | 0.9400 |

## Acetogens

| Name | Default | Value |
|---|---|---|
| Yield [-] | 0.1000 | 0.1000 |
| H2 yield [-] | 0.4000 | 0.4000 |
| CO2 yield [-] | 1.0000 | 1.0000 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## Methanogens

| Name | Default | Value |
|---|---|---|
| Acetoclastic yield [-] | 0.1000 | 0.1000 |
| Methanol acetoclastic yield [-] | 0.1000 | 0.1000 |
| H2-utilizing yield [-] | 0.1000 | 0.1000 |
| Methanol H2-utilizing yield [-] | 0.1000 | 0.1000 |
| N in acetoclastic biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| N in H2-utilizing biomass [mgN/mgCOD] | 0.0700 | 0.0700 |

| | | |
|---|---|---|
| P in acetoclastic biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| P in H2-utilizing biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Acetoclastic fraction to endog. residue [-] | 0.0800 | 0.0800 |
| H2-utilizing fraction to endog. residue [-] | 0.0800 | 0.0800 |
| Acetoclastic COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| H2-utilizing COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## General

| Name | Default | Value |
|---|---|---|
| Molecular weight of other anions [mg/mmol] | 35.5000 | 35.5000 |
| Molecular weight of other cations [mg/mmol] | 39.1000 | 39.1000 |
| Mg to P mole ratio in polyphosphate [mmolMg/mmolP] | 0.3000 | 0.3000 |
| Cation to P mole ratio in polyphosphate [meq/mmolP] | 0.1500 | 0.3000 |
| Ca to P mole ratio in polyphosphate [mmolCa/mmolP] | 0.0500 | 0.0500 |
| Cation to P mole ratio in organic phosphate [meq/mmolP] | 0.0100 | 0.0100 |
| Bubble rise velocity (anaerobic digester) [cm/s] | 23.9000 | 23.9000 |
| Bubble Sauter mean diameter (anaerobic digester) [cm] | 0.3500 | 0.3500 |
| Anaerobic digester gas hold-up factor [] | 1.0000 | 1.0000 |
| Tank head loss per metre of length (from flow) [m/m] | 0.0025 | 0.0025 |

## Mass transfer

| Name | Default | Value | |
|---|---|---|---|
| Kl for H2 [m/d] | 17.0000 | 17.0000 | 1.0240 |
| Kl for CO2 [m/d] | 10.0000 | 10.0000 | 1.0240 |
| Kl for NH3 [m/d] | 1.0000 | 1.0000 | 1.0240 |

| | | | |
|---|---|---|---|
| Kl for CH4 [m/d] | 8.0000 | 8.0000 | 1.0240 |
| Kl for N2 [m/d] | 15.0000 | 15.0000 | 1.0240 |
| Kl for N2O [m/d] | 8.0000 | 8.0000 | 1.0240 |
| Kl for O2 [m/d] | 13.0000 | 13.0000 | 1.0240 |

## Henry's law constants

| Name | Default | Value | |
|---|---|---|---|
| CO2 [M/atm] | 3.4000E-2 | 3.4000E-2 | 2400.0000 |
| O2 [M/atm] | 1.3000E-3 | 1.3000E-3 | 1500.0000 |
| N2 [M/atm] | 6.5000E-4 | 6.5000E-4 | 1300.0000 |
| N2O [M/atm] | 2.5000E-2 | 2.5000E-2 | 2600.0000 |
| NH3 [M/atm] | 5.8000E+1 | 5.8000E+1 | 4100.0000 |
| CH4 [M/atm] | 1.4000E-3 | 1.4000E-3 | 1600.0000 |
| H2 [M/atm] | 7.8000E-4 | 7.8000E-4 | 500.0000 |

## Physico-chemical rates

| Name | Default | Value | |
|---|---|---|---|
| Struvite precipitation rate [1/d] | 3.000E+10 | 3.000E+10 | 1.0240 |
| Struvite redissolution rate [1/d] | 3.000E+11 | 3.000E+11 | 1.0240 |
| Struvite half sat. [mgTSS/L] | 1.0000 | 1.0000 | 1.0000 |
| HDP precipitation rate [L/(molP d)] | 1.000E+8 | 1.000E+8 | 1.0000 |
| HDP redissolution rate [L/(mol P d)] | 1.000E+8 | 1.000E+8 | 1.0000 |
| HAP precipitation rate [molHDP/(L d)] | 5.000E-4 | 5.000E-4 | 1.0000 |

## Physico-chemical constants

| Name | Default | Value |
|---|---|---|
| Struvite solubility constant [mol/L] | 6.918E-14 | 6.918E-14 |
| HDP solubility product [mol/L] | 2.750E-22 | 2.750E-22 |
| HDP half sat. [mgTSS/L] | 1.0000 | 1.0000 |
| Equilibrium soluble PO4 with Al dosing at pH 7 [mgP/L] | 0.0100 | 0.0100 |
| Al to P ratio [molAl/molP] | 0.8000 | 0.8000 |
| Al(OH)3 solubility product [mol/L] | 1.259E+9 | 1.259E+9 |
| AlHPO4+ dissociation constant [mol/L] | 7.943E-13 | 7.943E-13 |
| Equilibrium soluble PO4 with Fe dosing at pH 7 [mgP/L] | 0.0100 | 0.0100 |
| Fe to P ratio [molFe/molP] | 1.6000 | 1.6000 |
| Fe(OH)3 solubility product [mol/L] | 0.0500 | 0.0500 |
| FeH2PO4++ dissociation constant [mol/L] | 5.012E-22 | 5.012E-22 |

## Aeration

| Name | Default | Value |
|---|---|---|
| Alpha (surf) OR Alpha F (diff) [-] | 0.5000 | 0.5000 |
| Beta [-] | 0.9500 | 0.9500 |
| Surface pressure [kPa] | 101.3250 | 101.3250 |
| Fractional effective saturation depth (Fed) [-] | 0.3250 | 0.3250 |
| Supply gas CO2 content [vol. %] | 0.0350 | 0.0350 |
| Supply gas O2 [vol. %] | 20.9500 | 20.9500 |
| Off-gas CO2 [vol. %] | 2.0000 | 2.0000 |
| Off-gas O2 [vol. %] | 18.8000 | 18.8000 |
| Off-gas H2 [vol. %] | 0 | 0 |
| Off-gas NH3 [vol. %] | 0 | 0 |
| Off-gas CH4 [vol. %] | 0 | 0 |

| | | |
|---|---|---|
| Surface turbulence factor [-] | 2.0000 | 2.0000 |
| Set point controller gain [] | 1.0000 | 1.0000 |

## Modified Vesilind

| Name | Default | Value |
|---|---|---|
| Maximum Vesilind settling velocity (Vo) [ft/min] | 0.387 | 0.387 |
| Vesilind hindered zone settling parameter (K) [L/g] | 0.370 | 0.370 |
| Clarification switching function [mg/L] | 100.000 | 100.000 |
| Specified TSS conc.for height calc. [mg/L] | 2500.000 | 2500.000 |
| Maximum compactability constant [mg/L] | 15000.000 | 15000.000 |

## Double exponential

| Name | Default | Value |
|---|---|---|
| Maximum Vesilind settling velocity (Vo) [ft/min] | 0.934 | 0.934 |
| Maximum (practical) settling velocity (Vo') [ft/min] | 0.615 | 0.615 |
| Hindered zone settling parameter (Kh) [L/g] | 0.400 | 0.400 |
| Flocculent zone settling parameter (Kf) [L/g] | 2.500 | 2.500 |
| Maximum non-settleable TSS [mg/L] | 20.0000 | 20.0000 |
| Non-settleable fraction [-] | 0.0010 | 0.0010 |
| Specified TSS conc. for height calc. [mg/L] | 2500.0000 | 2500.0000 |

## Emission factors

| Name | Default | Value |
|---|---|---|
| Carbon dioxide equivalence of nitrous oxide | 296.0000 | 296.0000 |
| Carbon dioxide equivalence of methane | 23.0000 | 23.0000 |

## Biofilm general

| Name | Default | Value | |
|---|---|---|---|
| Attachment rate [ g / (m2 d) ] | 80.0000 | 80.0000 | 1.0000 |
| Attachment TSS half sat. [mg/L] | 100.0000 | 100.0000 | 1.0000 |
| Detachment rate [g/(m3 d)] | 8.000E+4 | 8.000E+4 | 1.0000 |
| Solids movement factor [] | 10.0000 | 10.0000 | 1.0000 |
| Diffusion neta [] | 0.8000 | 0.8000 | 1.0000 |
| Thin film limit [mm] | 0.5000 | 0.5000 | 1.0000 |
| Thick film limit [mm] | 3.0000 | 3.0000 | 1.0000 |
| Assumed Film thickness for tank volume correction (temp independent) [mm] | 0.7500 | 0.7500 | 1.0000 |
| Film surface area to media area ratio - Max.[ ] | 1.0000 | 1.0000 | 1.0000 |
| Minimum biofilm conc. for streamer formation [gTSS/m2] | 4.0000 | 4.0000 | 1.0000 |

## Maximum biofilm concentrations [mg/L]

| Name | Default | Value | |
|---|---|---|---|
| Ordinary heterotrophic organisms (OHO) | 5.000E+4 | 5.000E+4 | 1.0000 |
| Methylotrophs | 5.000E+4 | 5.000E+4 | 1.0000 |
| Ammonia oxidizing biomass (AOB) | 1.000E+5 | 1.000E+5 | 1.0000 |
| Nitrite oxidizing biomass (NOB) | 1.000E+5 | 1.000E+5 | 1.0000 |
| Anaerobic ammonia oxidizers (AAO) | 5.000E+4 | 5.000E+4 | 1.0000 |
| Polyphosphate accumulating organisms (PAO) | 5.000E+4 | 5.000E+4 | 1.0000 |

| | | | |
|---|---|---|---|
| Propionic acetogens | 5.000E+4 | 5.000E+4 | 1.0000 |
| Methanogens - acetoclastic | 5.000E+4 | 5.000E+4 | 1.0000 |
| Methanogens - hydrogenotrophic | 5.000E+4 | 5.000E+4 | 1.0000 |
| Endogenous products | 3.000E+4 | 3.000E+4 | 1.0000 |
| Slowly bio. COD (part.) | 5000.0000 | 5000.0000 | 1.0000 |
| Slowly bio. COD (colloid.) | 4000.0000 | 4000.0000 | 1.0000 |
| Part. inert. COD | 5000.0000 | 5000.0000 | 1.0000 |
| Part. bio. org. N | 0 | 0 | 1.0000 |
| Part. bio. org. P | 0 | 0 | 1.0000 |
| Part. inert N | 0 | 0 | 1.0000 |
| Part. inert P | 0 | 0 | 1.0000 |
| Stored PHA | 5000.0000 | 5000.0000 | 1.0000 |
| Releasable stored polyP | 1.150E+6 | 1.150E+6 | 1.0000 |
| Fixed stored polyP | 1.150E+6 | 1.150E+6 | 1.0000 |
| Readily bio. COD (complex) | 0 | 0 | 1.0000 |
| Acetate | 0 | 0 | 1.0000 |
| Propionate | 0 | 0 | 1.0000 |
| Methanol | 0 | 0 | 1.0000 |
| Dissolved H2 | 0 | 0 | 1.0000 |
| Dissolved methane | 0 | 0 | 1.0000 |
| Ammonia N | 0 | 0 | 1.0000 |
| Sol. bio. org. N | 0 | 0 | 1.0000 |
| Nitrous Oxide N | 0 | 0 | 1.0000 |
| Nitrite N | 0 | 0 | 1.0000 |
| Nitrate N | 0 | 0 | 1.0000 |
| Dissolved nitrogen gas | 0 | 0 | 1.0000 |
| PO4-P (Sol. & Me Complexed) | 1.000E+10 | 1.000E+10 | 1.0000 |
| Sol. inert COD | 0 | 0 | 1.0000 |
| Sol. inert TKN | 0 | 0 | 1.0000 |
| ISS Influent | 1.300E+6 | 1.300E+6 | 1.0000 |
| Struvite | 8.500E+5 | 8.500E+5 | 1.0000 |

| | | | |
|---|---|---|---|
| Hydroxy-dicalcium-phosphate | 1.150E+6 | 1.150E+6 | 1.0000 |
| Hydroxy-apatite | 1.600E+6 | 1.600E+6 | 1.0000 |
| Magnesium | 0 | 0 | 1.0000 |
| Calcium | 0 | 0 | 1.0000 |
| Metal | 1.000E+10 | 1.000E+10 | 1.0000 |
| Other Cations (strong bases) | 0 | 0 | 1.0000 |
| Other Anions (strong acids) | 0 | 0 | 1.0000 |
| Total CO2 | 0 | 0 | 1.0000 |
| User defined 1 | 0 | 0 | 1.0000 |
| User defined 2 | 0 | 0 | 1.0000 |
| User defined 3 | 5.000E+4 | 5.000E+4 | 1.0000 |
| User defined 4 | 5.000E+4 | 5.000E+4 | 1.0000 |
| Dissolved oxygen | 0 | 0 | 1.0000 |

## Effective diffusivities [m2/s]

| Name | Default | Value | |
|---|---|---|---|
| Ordinary heterotrophic organisms (OHO) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Methylotrophs | 5.000E-14 | 5.000E-14 | 1.0290 |
| Ammonia oxidizing biomass (AOB) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Nitrite oxidizing biomass (NOB) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Anaerobic ammonia oxidizers (AAO) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Polyphosphate accumulating organisms (PAO) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Propionic acetogens | 5.000E-14 | 5.000E-14 | 1.0290 |
| Methanogens - acetoclastic | 5.000E-14 | 5.000E-14 | 1.0290 |
| Methanogens - hydrogenotrophic | 5.000E-14 | 5.000E-14 | 1.0290 |
| Endogenous products | 5.000E-14 | 5.000E-14 | 1.0290 |
| Slowly bio. COD (part.) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Slowly bio. COD (colloid.) | 5.000E-12 | 5.000E-12 | 1.0290 |

| | | | |
|---|---|---|---|
| Part. inert. COD | 5.000E-14 | 5.000E-14 | 1.0290 |
| Part. bio. org. N | 5.000E-14 | 5.000E-14 | 1.0290 |
| Part. bio. org. P | 5.000E-14 | 5.000E-14 | 1.0290 |
| Part. inert N | 5.000E-14 | 5.000E-14 | 1.0290 |
| Part. inert P | 5.000E-14 | 5.000E-14 | 1.0290 |
| Stored PHA | 5.000E-14 | 5.000E-14 | 1.0290 |
| Releasable stored polyP | 5.000E-14 | 5.000E-14 | 1.0290 |
| Fixed stored polyP | 5.000E-14 | 5.000E-14 | 1.0290 |
| Readily bio. COD (complex) | 6.900E-10 | 6.900E-10 | 1.0290 |
| Acetate | 1.240E-9 | 1.240E-9 | 1.0290 |
| Propionate | 8.300E-10 | 8.300E-10 | 1.0290 |
| Methanol | 1.600E-9 | 1.600E-9 | 1.0290 |
| Dissolved H2 | 5.850E-9 | 5.850E-9 | 1.0290 |
| Dissolved methane | 1.963E-9 | 1.963E-9 | 1.0290 |
| Ammonia N | 2.000E-9 | 2.000E-9 | 1.0290 |
| Sol. bio. org. N | 1.370E-9 | 1.370E-9 | 1.0290 |
| Nitrous Oxide N | 1.607E-9 | 1.607E-9 | 1.0290 |
| Nitrite N | 2.980E-9 | 2.980E-9 | 1.0290 |
| Nitrate N | 2.980E-9 | 2.980E-9 | 1.0290 |
| Dissolved nitrogen gas | 1.900E-9 | 1.900E-9 | 1.0290 |
| PO4-P (Sol. & Me Complexed) | 2.000E-9 | 2.000E-9 | 1.0290 |
| Sol. inert COD | 6.900E-10 | 6.900E-10 | 1.0290 |
| Sol. inert TKN | 6.850E-10 | 6.850E-10 | 1.0290 |
| ISS Influent | 5.000E-14 | 5.000E-14 | 1.0290 |
| Struvite | 5.000E-14 | 5.000E-14 | 1.0290 |
| Hydroxy-dicalcium-phosphate | 5.000E-14 | 5.000E-14 | 1.0290 |
| Hydroxy-apatite | 5.000E-14 | 5.000E-14 | 1.0290 |
| Magnesium | 7.200E-10 | 7.200E-10 | 1.0290 |
| Calcium | 7.200E-10 | 7.200E-10 | 1.0290 |
| Metal | 4.800E-10 | 4.800E-10 | 1.0290 |
| Other Cations (strong bases) | 1.440E-9 | 1.440E-9 | 1.0290 |

| | | | |
|---|---|---|---|
| Other Anions (strong acids) | 1.440E-9 | 1.440E-9 | 1.0290 |
| Total CO2 | 1.960E-9 | 1.960E-9 | 1.0290 |
| User defined 1 | 6.900E-10 | 6.900E-10 | 1.0290 |
| User defined 2 | 6.900E-10 | 6.900E-10 | 1.0290 |
| User defined 3 | 5.000E-14 | 5.000E-14 | 1.0290 |
| User defined 4 | 5.000E-14 | 5.000E-14 | 1.0290 |
| Dissolved oxygen | 2.500E-9 | 2.500E-9 | 1.0290 |

## EPS Strength coefficients [ ]

| Name | Default | Value | |
|---|---|---|---|
| Ordinary heterotrophic organisms (OHO) | 1.0000 | 1.0000 | 1.0000 |
| Methylotrophs | 1.0000 | 1.0000 | 1.0000 |
| Ammonia oxidizing biomass (AOB) | 5.0000 | 1.0000 | 1.0000 |
| Nitrite oxidizing biomass (NOB) | 25.0000 | 1.0000 | 1.0000 |
| Anaerobic ammonia oxidizers (AAO) | 10.0000 | 1.0000 | 1.0000 |
| Polyphosphate accumulating organisms (PAO) | 1.0000 | 1.0000 | 1.0000 |
| Propionic acetogens | 1.0000 | 1.0000 | 1.0000 |
| Methanogens - acetoclastic | 1.0000 | 1.0000 | 1.0000 |
| Methanogens - hydrogenotrophic | 1.0000 | 1.0000 | 1.0000 |
| Endogenous products | 1.0000 | 1.0000 | 1.0000 |
| Slowly bio. COD (part.) | 1.0000 | 1.0000 | 1.0000 |
| Slowly bio. COD (colloid.) | 1.0000 | 1.0000 | 1.0000 |
| Part. inert. COD | 1.0000 | 1.0000 | 1.0000 |
| Part. bio. org. N | 1.0000 | 1.0000 | 1.0000 |
| Part. bio. org. P | 1.0000 | 1.0000 | 1.0000 |
| Part. inert N | 1.0000 | 1.0000 | 1.0000 |
| Part. inert P | 1.0000 | 1.0000 | 1.0000 |
| Stored PHA | 1.0000 | 1.0000 | 1.0000 |

| | | | |
|---|---|---|---|
| Releasable stored polyP | 1.0000 | 1.0000 | 1.0000 |
| Fixed stored polyP | 1.0000 | 1.0000 | 1.0000 |
| Readily bio. COD (complex) | 0 | 0 | 1.0000 |
| Acetate | 0 | 0 | 1.0000 |
| Propionate | 0 | 0 | 1.0000 |
| Methanol | 0 | 0 | 1.0000 |
| Dissolved H2 | 0 | 0 | 1.0000 |
| Dissolved methane | 0 | 0 | 1.0000 |
| Ammonia N | 0 | 0 | 1.0000 |
| Sol. bio. org. N | 0 | 0 | 1.0000 |
| Nitrous Oxide N | 0 | 0 | 1.0000 |
| Nitrite N | 0 | 0 | 1.0000 |
| Nitrate N | 0 | 0 | 1.0000 |
| Dissolved nitrogen gas | 0 | 0 | 1.0000 |
| PO4-P (Sol. & Me Complexed) | 1.0000 | 1.0000 | 1.0000 |
| Sol. inert COD | 0 | 0 | 1.0000 |
| Sol. inert TKN | 0 | 0 | 1.0000 |
| ISS Influent | 0.3300 | 0.3300 | 1.0000 |
| Struvite | 1.0000 | 1.0000 | 1.0000 |
| Hydroxy-dicalcium-phosphate | 1.0000 | 1.0000 | 1.0000 |
| Hydroxy-apatite | 1.0000 | 1.0000 | 1.0000 |
| Magnesium | 0 | 0 | 1.0000 |
| Calcium | 0 | 0 | 1.0000 |
| Metal | 1.0000 | 1.0000 | 1.0000 |
| Other Cations (strong bases) | 0 | 0 | 1.0000 |
| Other Anions (strong acids) | 0 | 0 | 1.0000 |
| Total CO2 | 0 | 0 | 1.0000 |
| User defined 1 | 0 | 0 | 1.0000 |
| User defined 2 | 0 | 0 | 1.0000 |
| User defined 3 | 1.0000 | 1.0000 | 1.0000 |
| User defined 4 | 1.0000 | 1.0000 | 1.0000 |

| | | | |
|---|---|---|---|
| Dissolved oxygen | 0 | 0 | 1.0000 |

Meridian Alternative's Analysis version 1

Expansion using selectable 5 stage modified Bardenpho/A2O process

Tank sizes optimized based on individual simulations from A2O and 5 stage modified Bardenpho processes

To achieve target effluent concentrations, for Bardenpho process:
Set BDF IMLR at 200% influent, Set A2O IMLR at 0%
Set Swing 1 Aerated, Swing 2a and 2b unaerated.
SRT = 12 days
Acetate flow pace at 0.8% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 0.5% of PE flow rate, 1% methanol solution. All methanol to swing 2a

To achieve target effluent concentrations, for A2O process:
Set BDF IMLR at 0% influent, Set A2O IMLR at 400%
Set Swing 1 unaerated, Swing 2a and 2b aerated.
SRT = 12 days
Acetate flow pace at 0.6% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 1.5% of PE flow rate, 1% methanol solution. all methanol to Anoxic 1a

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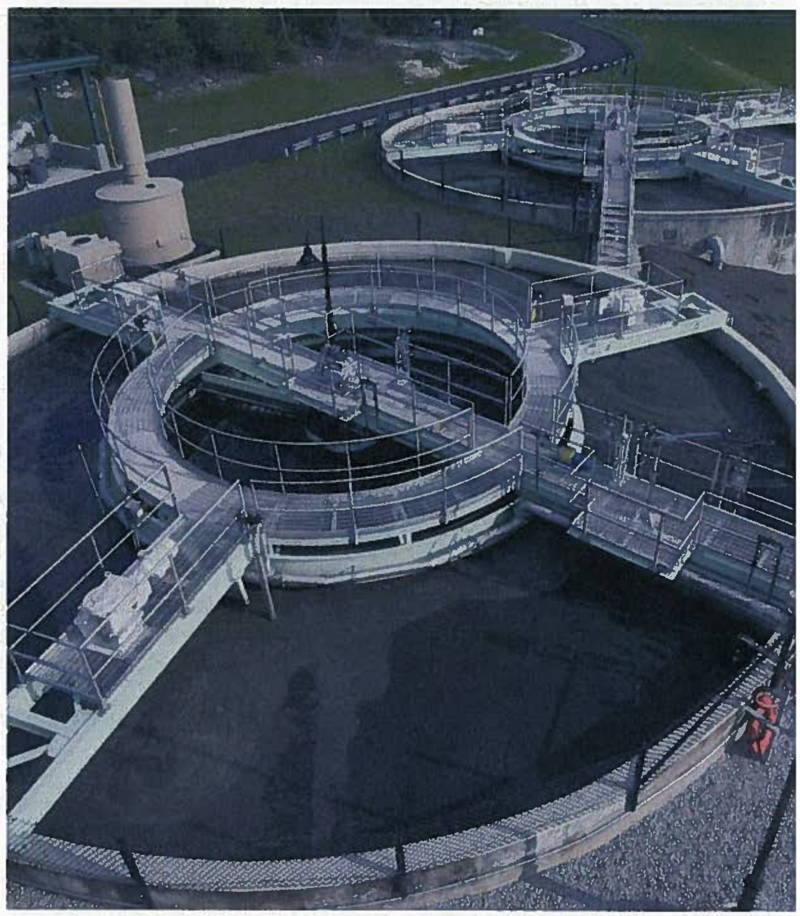
# MERIDIAN, ID

# BIOMAG™ CONCEPTUAL PROPOSAL, REV1



*April 2015*

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Evoqua Water Technologies is pleased to present a preliminary BioMag system proposal. The BioMag system is a proven, reliable, treatment process using magnetite to ballast the biological floc in an activated sludge process. This high density ballast (specific gravity of 5.2) allows the plant to operate at elevated mixed liquor concentrations while achieving enhanced settling rates.

# 1 DESIGN SUMMARY

Table 1 summarizes the design flows used as the basis for the proposed BioMag system. Any max month, peak day or peak hourly flows will need to be evaluated for a final design.

**Table 1: Design flows.**

| Parameter | Units | Summer | Winter |
|---|---|---|---|
| Design Average Daily Flow | MGD | 14 | 12.3 |
| Design Max Month Flow | MGD | TBD | TBD |
| Design Peak Daily Flow | MGD | TBD | TBD |
| Design Peak Hourly Flow | MGD | TBD | TBD |

Table 2 summarizes the design influent water quality (after primary clarifiers) used as the basis for the proposed BioMag system.

**Table 2: Design influent water quality after primary clarifier.**

| Parameter | Units | Summer | Winter |
|---|---|---|---|
| Biochemical Oxygen Demand ($BOD_5$) | mg/L | 202 | 223 |
| Chemical Oxygen Demand (COD) | mg/L | 403 | 446 |
| Total Suspended Solids (TSS) | mg/L | 85 | 85 |
| Ammonia Nitrogen ($NH_3$-N ) | mg/L | 34 | 40 |
| Total Kjeldahl Nitrogen (TKN) | mg/L | 46 | 54 |
| Total Phosphorus (TP) | mg/L | 7.2 | 8.3 |
| Alkalinity | mg/L as $CaCO_3$ | 350 | 350 |
| Max Influent Temperature | °C | 25 | 25 |
| Min Influent Temperature | °C | 12 | 12 |

Table 3 summarizes the secondary effluent performance requirements used as the basis for the proposed BioMag system.

**Table 3: Secondary effluent performance requirements.**

| Parameter[1] | Units | Summer | Winter |
|---|---|---|---|
| Biochemical Oxygen Demand ($BOD_5$) | mg/L | 20 | 20 |
| Total Suspended Solids (TSS) | mg/L | 20 | 20 |
| Nitrate/Nitrite (NOx-N) | mg/L | 8 | 8 |
| Ammonia ($NH_3$-N) | mg/L | 0.405 | 0.307 |
| Total Phosphorus (TP)[2] | mg/L | 0.5 | 0.5 |

Table 4 summarizes the preliminary process parameters for the proposed BioMag system.

**Table 4: Design and process parameters.**

| Parameter[3] | Units | Value |
|---|---|---|
| Number of biological treatment trains | - | TBD |
| Biological Treatment Volume | MG | TBD |
| Aerobic SRT | d | TBD |
| Max Recommended Design MLSS in Biological System (excluding magnetite) | mg/l | 8,000 |
| Aeration/Mixing System | - | TBD |
| Design WAS rate (excluding magnetite) | lb/d | 20,000 |
| Design RAS/WAS MLSS (excluding magnetite) | g/L | 14-20 |
| Thickened RAS to Recovery Equipment (excl magnetite) | g/L | 20 |
| Max Clarifier Loading Rates | | |
| @ Average | lb/sf/d | 50 |
| @ Peak | lb/sf/d | 100 |

[1] Effluent BOD, and nitrogen removals are contingent upon biological system design and equipment.

[2] Listed effluent TP is secondary effluent. Tertiary CoMag or filters will be required to reach a final effluent TP of 0.1 mg/L.

[3] WAS Rate and WAS MLSS are estimated at this stage. These parameters are critical for sizing of the BioMag recovery equipment and will need to be confirmed for final design. WAS thickening is assumed if underflow cannot achieve value shown.

# 2 BIOMAG OPERATING COSTS

As a guidance and reference, table 5 lists the main consumables associated with the BioMag system recommended for this project.

**Table 5: Estimated BioMag consumables[4]**

| Item | Guidance |
|---|---|
| Magnetite usage | ~2200 lb/day at ADF / 93% recovery (~$0.35/lb.) |
| Power usage of magnetite feed / recovery equipment | ~2600 kWh/d |
| Polymer | 0.5 to 1.5 mg/l – active |

# 3 ADDITIONAL DESIGN CONSIDERATIONS

The following design considerations will need to be evaluated and discussed in more detail before a final design is established:

- Continued use of existing primary clarifiers
- Biological system design
- Secondary clarifier sizing and design
- Supplemental mixing requirements
- Existing return sludge and waste sludge pumping capacity
- Biosolids wasting strategy (ie surface wasting)
- Chemical feed systems; chemical preference
- BioMag building layout

[4] The values show are estimated values for this design based on existing plant data performance from other BioMag™ installations; they are not intended to reflect guaranteed values. A reasonable safety factor would be applied to values for any performance guarantee.

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# 4 SCOPE OF SUPPLY

Evoqua will supply the following equipment and services with the BioMag system. All equipment or services not specified in table 6 are to be supplied by others.

**Table 6: Evoqua Scope of Supply**

| Item | Quantity | Description |
|---|---|---|
| **Ballast Storage and Feed System** | | |
| Ballast mix tank mixer | 1 | 3 HP – vertical shaft |
| Magnetite storage silo | 1 | 25 ton outdoor silo |
| Magnetite dry feeder system | 1 | Hopper, 10 foot stinger and drop pipe |
| Compressed Air System | 1 | Lead/Lag 10 HP air compressors, air receiver and heatless desiccant dryer |
| **Ballast Recovery System** | | |
| Magnetic drum separator | 4 | 7.5 HP each |
| Shear mill | 4 | 40 HP each |
| Pump – ballast mix tank discharge | 2 | Dry Pit Submersible (~300 gpm) |
| Pump – shear mill feed | 2 | Rotary Lobe (~150 gpm) |
| Flow control valves | Multiple | Motor operated modulating plug valve (ballast mix tank feed, mag drum feed) |
| Flow meters | Multiple | Ballast mix tank feed, Mag drum, ballast return |
| Level sensors/switches | Multiple | Mag drum, ballast mix tank |
| **Control System Hardware** | | |
| Control panel | 1 | NEMA 12 control panel with PLC and door mounted HMI |
| **Services** | | |
| Engineering support | | Site visits/design kickoff; basis of design engineer support |
| Installation oversight, commissioning and training | | Up to 8 days |
| Start-up and performance testing | | Up to 15 days |

# 5 PROCESS DESIGN SUPPORT/RECOMMENDATIONS

In the event that the aeration system for the existing plant will require upgrading due to the equipment age or replacement due to a significant plant capacity increase, Evoqua will make recommendations for the new aeration system that will be compatible with the BioMag system. Consideration is given to the basin configuration, new aeration equipment energy efficiency, treatment goals, power turndown requirements, capital costs, supplemental mixing requirements and ease of installation. For many plants, Evoqua has recommended the use of simultaneous nitrification denitrification for the upgraded aeration basin, due to the energy savings potential with this process, even when strict denitrification is not required. Simultaneous nitrification denitrification can save 20 – 30% in energy over a conventional MLE process.

Evoqua recommends the use of jet aeration when the aeration system requires upgrading with the addition of BioMag. Jet aeration offers several advantages for any activated sludge process, but has additional benefits when a BioMag system is used. The benefits of jet aeration are:

- Supplemental mixing in the aeration basins, that may be required with a BioMag system, can be eliminated;
- a high oxygen transfer efficiency which does not diminish over time;
- there are no moving parts, which minimizes maintenance;
- there are no parts to be replaced;
- exceptional power turndown with independent mixing and aeration;
- fits any basin configuration; and
- low installation costs.

As this project progresses with the BioMag system, Evoqua will make a more specific recommendation for the equipment and the process configuration for the existing aeration basin and any other basins, anoxic or anaerobic, that may be included in the flowsheet.

## 6 BUDGETARY PRICING

The budgetary price for the proposed Evoqua BioMag system is provided under separate cover.

The initial magnetite charge for the proposed system will require approximately **125** tons of virgin magnetite at design conditions. Evoqua can provide magnetite at a cost of **$525** per ton plus freight.

The scope of supply and pricing are based on Evoqua standard equipment selection, standard terms of sale and warranty terms as described herein. Any variations from these standards may affect this budgetary quotation. Additionally, please note this budgetary quotation is for review and informational purposes only and does not constitute an offer for acceptance.

This price makes no provision for bonds, taxes, tariffs, duties, permitting fees and other fees and charges that are not made explicit above.

All pricing is quoted at FOB, Factory (full freight allowed). No taxes, regulatory fees or other costs related to the procurement and installation of the system are included.

# 6 BUDGETARY PRICING

The budgetary price for the proposed Evoqua BioMag system is $2,854,000.0.0

The initial magnetite charge for the proposed system will require approximately 125 tons of virgin magnetite at design conditions. Evoqua can provide magnetite at a cost of $525 per ton plus freight.

The scope of supply and pricing are based on Evoqua standard equipment selection, standard terms of sale and warranty terms as described herein. Any variations from these standards may affect this budgetary quotation. Additionally, please note this budgetary quotation is for review and informational purposes only and does not constitute an offer for acceptance.

This price makes no provision for bonds, taxes, tariffs, duties, permitting fees and other fees and charges that are not made explicit above.

All pricing is quoted at FOB, Factory (full freight allowed). No taxes, regulatory fees or other costs related to the procurement and installation of the system are included.

# BioWin user and configuration data

## Project details

Project name: Alternatives Analysis  Project ref.: 147571

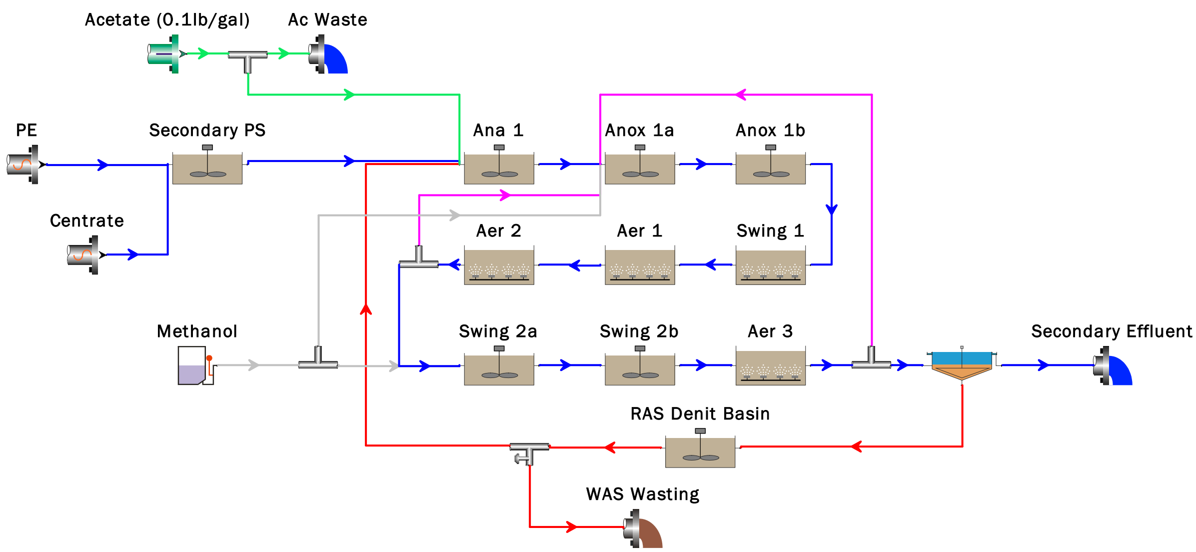
Plant name: Meridian WWTP  User name: Rick Kelly

Created: 6/29/2011  Saved: 4/30/2015

Target SRT: 12.00 days  SRT: **** days

Temperature: 14.0°C

## Flowsheet




# Configuration information for all Bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Ana 1 | 0.5000 | 4774.3058 | 14.000 | Un-aerated |
| Aer 1 | 1.5000 | 1.432E+4 | 14.000 | 4868 |
| Aer 2 | 1.2500 | 1.194E+4 | 14.000 | 4057 |
| Swing 2a | 0.7500 | 7161.4587 | 14.000 | Un-aerated |
| Aer 3 | 0.5000 | 4774.3058 | 14.000 | 1623 |
| Anox 1a | 0.3750 | 3580.7294 | 14.000 | Un-aerated |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |
| Anox 1b | 0.3750 | 3580.7294 | 14.000 | Un-aerated |
| Swing 1 | 0.5000 | 4774.3058 | 14.000 | 1082 |
| Swing 2b | 0.7500 | 7161.4587 | 14.000 | Un-aerated |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Ana 1 | 0 |
| Aer 1 | 2.5 |
| Aer 2 | 2.0 |
| Swing 2a | 0 |
| Aer 3 | 2.0 |
| Anox 1a | 0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |
| Anox 1b | 0 |
| Swing 1 | 2.0 |

| | |
|---|---|
| Swing 2b | 0 |

### Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Ana 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 2 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Swing 2a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 3 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Anox 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Anox 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 2b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

## Configuration information for all Methanol addition units

### Operating data Average (flow/time weighted as required)

| Element name | Methanol |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |

| | |
|---|---|
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 1188000.00 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |

| | |
|---|---|
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 5.00 |
| Other Anions (strong acids) meq/L | 5.00 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 2.64172037284185E-5 |

# Configuration information for all Effluent units

# Configuration information for all Ideal clarifier units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] |
|---|---|---|---|
| Clarifier | 2.8000 | 2.718E+4 | 13.770 |

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| Clarifier | Flow paced | 50.00 % |

| Element name | Average Temperature | Reactive | Percent removal | Blanket fraction |
|---|---|---|---|---|
| Clarifier | Uses global setting | Yes | 99.90 | 0.07 |

# Configuration information for all COD Influent units

## Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 30.00 | 30.00 |
| Flow | 12.461167588271 | 0.100014702011564 |
| Total COD mgCOD/L | 416.48 | 1801.80 |
| Total Kjeldahl Nitrogen mgN/L | 54.01 | 934.40 |
| Total P mgP/L | 8.12 | 529.81 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.95 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.43 | 185.22 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
| --- | --- | --- |
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.5950 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 0.0392 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9931 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.0039 |
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.3197 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.9500 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5086 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0050 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0512 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9300 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.0642 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-4 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 | 0 |

# Configuration information for all Sludge units

# Configuration information for all Splitter units

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
| --- | --- | --- |
| BDF IMLR | Flow paced | 200.00 % |
| RAS / WAS | Flowrate [Side] | 0.179947546016876 |
| Acetate Splitter | Flow paced | 0.80 % |
| Splitter21 | Flowrate [Side] | 0 |
| A2O IMLR | Flow paced | 0.00 % |

# Configuration information for all Stream (SV) Influent units

## Operating data Average (flow/time weighted as required)

| Element name | Acetate (0.1lb/gal) |
| --- | --- |
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |

| | |
|---|---|
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 11980.00 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |

| | |
|---|---|
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

## BioWin Album

## Album page - Table

| Elements | Total COD [mg/L] | Total Kjeldahl Nitrogen [mgN/L] | Flow [mgd] | Dissolved oxygen [mg/L] | Total suspended solids [mgTSS/L] | Volatile suspended solids [mgVSS/L] | Filtered Carbonaceous BOD [mg/L] | Ammonia N [mgN/L] | Nitrite N [mgN/L] | Nitrate N [mgN/L] | Total P [mgP/L] | Soluble PO4-P [mgP/L] | Volatile fatty acids [mg/L] | Fixed stored polyP [mgP/L] | Ammonia oxidizing biomass (AOB) [mgCOD/L] | Anaerobic ammonia oxidizers (AAO) [mgCOD/L] | Endogenous products [mgCOD/L] | Methanogens - acetoclastic [mgCOD/L] | Methanogens - hydrogenotrophic [mgCOD/L] | Methylotrophs [mgCOD/L] | Nitrite oxidizing biomass (NOB) [mgCOD/L] | Ordinary heterotrophic organisms (OHO) [mgCOD/L] | Polyphosphate accumulating organisms (PAO) [mgCOD | Propionic acetogens [mgCOD/L] | Total solids mass [lb] | Methanol [mgCOD/L] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | | | / L] | | | |
| PE | 416.48 | 54.01 | 12.46 | 0 | 102.12 | 90.65 | 134.05 | 43.75 | 0 | 0 | 8.12 | 5.60 | 21.03 | 0 | 0.04 | 0.04 | 0 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | ----- | 0 |
| SecondaryPS | 433.29 | 54.56 | 12.67 | 0 | 106.69 | 94.31 | 139.46 | 44.19 | 0 | 0 | 7.81 | 5.39 | 21.88 | 0 | 0.04 | 0.04 | 0.00 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 35.88 | 0 |
| Ana1 | 4306.23 | 306.48 | 18.92 | 0 | 3728.28 | 2833.10 | 26.73 | 31.49 | 0 | 0.00 | 268.89 | 54.08 | 25.22 | 60.09 | 64.50 | 0.63 | 914.80 | 0.15 | 0.06 | 328.75 | 32.68 | 1470.20 | 870.98 | 0.17 | 15557.01 | 0.00 |
| Anox1a | 4195.92 | 291.15 | 44.26 | 0 | 3809.71 | 2820.94 | 2.41 | 13.77 | 1.06 | 6.77 | 269.76 | 25.07 | 0.96 | 61.50 | 65.90 | 0.63 | 925.12 | 0.14 | 0.04 | 327.20 | 33.41 | 1504.78 | 889.28 | 0.16 | 11922.58 | 0.00 |
| Aer1 | 4145.31 | 282.45 | 44.26 | 2.50 | 3858.95 | 2811.78 | 1.33 | 3.60 | 3.31 | 11.88 | 270.12 | 6.70 | 0.00 | 62.33 | 66.80 | 0.63 | 929.54 | 0.13 | 0.04 | 326.55 | 33.77 | 1520.55 | 898.71 | 0.15 | 48306.75 | 0.00 |
| Aer2 | 4126.76 | 279.72 | 44.26 | 2.00 | 3873.64 | 2806.10 | 1.13 | 0.57 | 2.32 | 15.67 | 270.30 | 0.39 | 0.00 | 62.56 | 66.98 | 0.63 | 931.99 | 0.13 | 0.03 | 326.18 | 33.98 | 1525.02 | 902.18 | 0.15 | 40408.82 | 0.00 |
| Swing2a | 4119.79 | 278.87 | 18.98 | 0 | 3865.84 | 2799.86 | 4.94 | 0.43 | 0.34 | 7.58 | 269.75 | 0.10 | 0.01 | 62.19 | 66.64 | 0.62 | 931.34 | 0.13 | 0.03 | 336.75 | 33.80 | 1517.21 | 897.43 | 0.15 | 24196.48 | 5.70 |
| Aer | 40 | 27 | 18. | 2.0 | 38 | 27 | 0.9 | 0.0 | 0.0 | 4.7 | 27 | 0.0 | 0.0 | 61. | 66. | 0.6 | 93 | 0.1 | 0.0 | 33 | 33. | 15 | 89 | 0.1 | 16 | 0.0 |

| | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 91.33 | 8.42 | 98 | 0 | 57.38 | 89.15 | 5 | 9 | 2 | 6 | 0.25 | 2 | 0 | 90 | 42 | 2 | 5.98 | 2 | 3 | 8.20 | 66 | 12.37 | 6.61 | 4 | 095.69 | 0 |
| BDFIMLR | 4126.76 | 279.72 | 19.33 | 2.00 | 3873.64 | 2806.10 | 1.13 | 0.57 | 2.32 | 15.67 | 270.30 | 0.39 | 0.00 | 62.56 | 66.98 | 0.63 | 931.99 | 0.13 | 0.03 | 326.18 | 33.98 | 1525.02 | 902.18 | 0.15 | ----- | 0.00 |
| BDFIMLR (U) | 4126.76 | 279.72 | 24.92 | 2.00 | 3873.64 | 2806.10 | 1.13 | 0.57 | 2.32 | 15.67 | 270.30 | 0.39 | 0.00 | 62.56 | 66.98 | 0.63 | 931.99 | 0.13 | 0.03 | 326.18 | 33.98 | 1525.02 | 902.18 | 0.15 | ----- | 0.00 |
| Secondary Effluent | 39.80 | 2.32 | 12.65 | 1.79 | 5.77 | 4.17 | 0.85 | 0.18 | 0.18 | 6.03 | 0.44 | 0.03 | 0.00 | 0.09 | 0.10 | 0.00 | 1.43 | 0.00 | 0.00 | 0.50 | 0.05 | 2.26 | 1.34 | 0.00 | ----- | 0.00 |
| Clarifier | 39.80 | 2.32 | 12.65 | 1.79 | 5.77 | 4.17 | 0.85 | 0.18 | 0.18 | 6.03 | 0.44 | 0.03 | 0.00 | 0.09 | 0.10 | 0.00 | 1.43 | 0.00 | 0.00 | 0.50 | 0.05 | 2.26 | 1.34 | 0.00 | 18997.44 | 0.00 |
| Clarifier (U) | 12163.06 | 829.85 | 6.33 | 0.00 | 11537.57 | 8338.18 | 0.33 | 1.03 | 0.02 | 0.31 | 809.76 | 0.34 | 0.06 | 185.01 | 198.58 | 1.86 | 2807.42 | 0.36 | 0.08 | 1011.67 | 100.61 | 4515.71 | 2681.41 | 0.42 | ----- | 0.00 |
| RAS/WAS | 12161.16 | 829.92 | 6.15 | 0 | 11533.37 | 8335.86 | 0.14 | 1.34 | 0.00 | 0.02 | 810.07 | 1.21 | 0.08 | 184.93 | 198.48 | 1.86 | 2809.17 | 0.36 | 0.08 | 1011.40 | 100.54 | 4510.56 | 2680.50 | 0.42 | ----- | 0.00 |

| | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RAS/WAS (U) | 12161.16 | 829.92 | 0.18 | 0 | 11533.37 | 8335.86 | 0.14 | 1.34 | 0.00 | 0.02 | 810.07 | 1.21 | 0.08 | 184.93 | 198.48 | 1.86 | 2809.17 | 0.36 | 0.08 | 1011.40 | 100.54 | 4510.56 | 2680.50 | 0.42 | ----- | 0.00 |

## Album page - Output Table 1

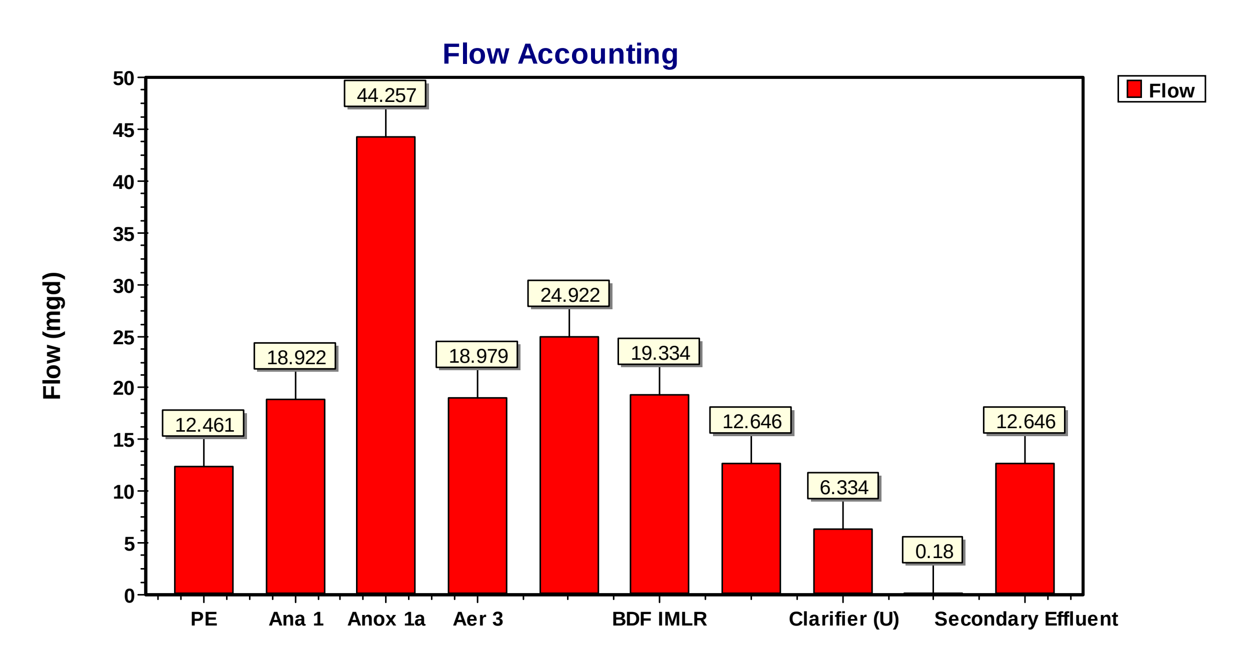
| Elements | Flow [mgd] | Liquid volume [Mil. Gal] | Temperature [deg. C] | pH [] | Total suspended solids [mg TSS/L] | Volatile suspended solids [mg VSS/L] | Total COD [mg/L] | Filtered COD [mg/L] | Volatile fatty acids [mg/L] | Total Carbonaceous BOD [mg/L] | Readily bio. COD (complex) [mg COD/L] | Slowly bio. COD (colloid.) [mg COD/L] | Slowly bio. COD (part.) [mg COD/L] | Sol. inert COD [mg COD/L] | Total Kjeldahl Nitrogen [mg N/L] | Ammonia N [mg N/L] | Nitrite N [mg N/L] | Nitrate N [mg N/L] | Total inorganic N [mg N/L] | Total N [mg N/L] | Total P [mg P/L] | Soluble PO4-P [mg P/L] | Air flow rate [ft3/min (20 C, 1 atm)] | Polyphosphate accumulating organisms (PAO) [mg COD/L] | Ammonia oxidizing biomass (AOB) [mg COD/L] | Nitrite oxidizing biomass (NOB) [mg COD/L] | Ordinary heterotrophic organisms (OHO) [mg COD/L] | Methanol [mg COD/L] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P | 12. | 0 | 14. | 7.9 | 10 | 90. | 41 | 21 | 21. | 23 | 10 | 61. | 19 | 28. | 54. | 43. | 0 | 0 | 43. | 54. | 8.1 | 5.6 | --- | 0.0 | 0.0 | 0.0 | 0.0 | 0 |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | 46 | | 00 | 5 | 2.12 | 65 | 6.48 | 7.24 | 03 | 7.17 | 6.41 | 48 | 4.69 | 32 | 01 | 75 | | | 75 | 01 | 2 | 0 | -- | 4 | 4 | 4 | 4 | |
| SecondaryPS | 12.67 | 0.04 | 14.00 | 7.95 | 106.69 | 94.31 | 433.29 | 226.01 | 21.88 | 246.75 | 110.71 | 63.96 | 202.55 | 29.46 | 54.56 | 44.19 | 0 | 0 | 44.19 | 54.56 | 7.81 | 5.39 | 0 | 0.04 | 0.04 | 0.04 | 0.04 | 0 |
| Ana1 | 18.92 | 0.50 | 14.00 | 6.94 | 3728.28 | 2833.10 | 4306.23 | 96.42 | 25.22 | 1753.67 | 6.02 | 5.69 | 231.43 | 30.67 | 306.48 | 31.49 | 0 | 0.00 | 31.49 | 306.48 | 268.89 | 54.08 | 0 | 870.98 | 64.50 | 32.68 | 1470.20 | 0.00 |
| Anox1a | 44.26 | 0.38 | 14.00 | 6.87 | 3809.71 | 2820.94 | 4195.92 | 47.86 | 0.96 | 1692.43 | 1.67 | 0.74 | 144.62 | 31.52 | 291.15 | 13.77 | 1.06 | 6.77 | 21.59 | 298.98 | 269.76 | 25.07 | 0 | 889.28 | 65.90 | 33.41 | 1504.78 | 0.00 |
| Aer1 | 44.26 | 1.50 | 14.00 | 6.65 | 3858.95 | 2811.78 | 4145.31 | 34.02 | 0.00 | 1670.18 | 1.88 | 0.01 | 100.24 | 31.89 | 282.45 | 3.60 | 3.31 | 11.88 | 18.80 | 297.65 | 270.12 | 6.70 | 7784.87 | 898.71 | 66.80 | 33.77 | 1520.55 | 0.00 |
| Aer2 | 44.26 | 1.25 | 14.00 | 6.57 | 3873.64 | 2806.10 | 4126.76 | 33.68 | 0.00 | 1659.20 | 1.59 | 0.00 | 81.26 | 32.05 | 279.72 | 0.57 | 2.32 | 15.67 | 18.56 | 297.71 | 270.30 | 0.39 | 3892.17 | 902.18 | 66.98 | 33.98 | 1525.02 | 0.00 |
| Swing2a | 18.98 | 0.75 | 14.00 | 6.71 | 3865.84 | 2799.86 | 4119.79 | 38.69 | 0.01 | 1657.12 | 0.69 | 0.00 | 76.06 | 32.12 | 278.87 | 0.43 | 0.34 | 7.58 | 8.35 | 286.79 | 269.75 | 0.10 | 0 | 897.43 | 66.64 | 33.80 | 1517.21 | 5.70 |
| Aer3 | 18.98 | 0.50 | 14.00 | 6.76 | 3857.38 | 2789.15 | 4091.33 | 33.82 | 0.00 | 1637.81 | 1.34 | 0.00 | 60.62 | 32.40 | 278.42 | 0.09 | 0.02 | 4.76 | 4.87 | 283.20 | 270.25 | 0.02 | 857.62 | 896.61 | 66.42 | 33.66 | 1512.37 | 0.00 |
| Clarifier | 12.65 | 2.80 | 14.00 | 6.76 | 5.77 | 4.17 | 39.80 | 33.75 | 0.00 | 3.26 | 1.19 | 0.00 | 0.06 | 32.48 | 2.32 | 0.18 | 0.18 | 6.03 | 6.39 | 8.53 | 0.44 | 0.03 | ----- | 1.34 | 0.10 | 0.05 | 2.26 | 0.00 |

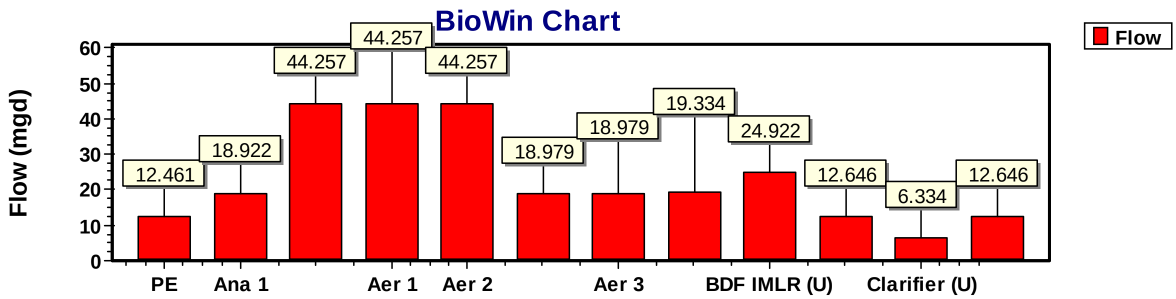
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Clarifier (U) | 6.33 | 2.80 | 14.00 | 6.78 | 11537.57 | 8338.18 | 12163.06 | 36.05 | 0.06 | 4886.35 | 0.41 | 0.00 | 177.11 | 33.21 | 829.85 | 1.03 | 0.02 | 0.31 | 1.36 | 830.18 | 809.76 | 0.34 | ----- | 2681.41 | 198.58 | 100.61 | 4515.71 | 0.00 |
| Secondary Effluent | 12.65 | 0 | 14.00 | 6.76 | 5.77 | 4.17 | 39.80 | 33.75 | 0.00 | 3.26 | 1.19 | 0.00 | 0.06 | 32.48 | 2.32 | 0.18 | 0.18 | 6.03 | 6.39 | 8.53 | 0.44 | 0.03 | ----- | 1.34 | 0.10 | 0.05 | 2.26 | 0.00 |
| BDFIMLR | 19.33 | 0 | 14.00 | 6.57 | 3873.64 | 2806.10 | 4126.76 | 33.68 | 0.00 | 1659.20 | 1.59 | 0.00 | 81.26 | 32.05 | 279.72 | 0.57 | 2.32 | 15.67 | 18.56 | 297.71 | 270.30 | 0.39 | ----- | 902.18 | 66.98 | 33.98 | 1525.02 | 0.00 |
| BDFIMLR (U) | 24.92 | 0 | 14.00 | 6.57 | 3873.64 | 2806.10 | 4126.76 | 33.68 | 0.00 | 1659.20 | 1.59 | 0.00 | 81.26 | 32.05 | 279.72 | 0.57 | 2.32 | 15.67 | 18.56 | 297.71 | 270.30 | 0.39 | ----- | 902.18 | 66.98 | 33.98 | 1525.02 | 0.00 |
| RAS Denit Basin | 6.33 | 0.07 | 14.00 | 6.80 | 11533.37 | 8335.86 | 12161.16 | 36.66 | 0.08 | 4883.56 | 0.11 | 0.00 | 179.03 | 33.36 | 829.92 | 1.34 | 0.00 | 0.02 | 1.36 | 829.93 | 810.07 | 1.21 | 0 | 2680.50 | 198.48 | 100.54 | 4510.56 | 0.00 |
| RAS/WAS | 6.15 | 0 | 14.00 | 6.80 | 11533.37 | 8335.86 | 12161.16 | 36.66 | 0.08 | 4883.56 | 0.11 | 0.00 | 179.03 | 33.36 | 829.92 | 1.34 | 0.00 | 0.02 | 1.36 | 829.93 | 810.07 | 1.21 | ----- | 2680.50 | 198.48 | 100.54 | 4510.56 | 0.00 |
| RA | 0.1 | 0 | 14. | 6.8 | 11 | 83 | 12 | 36. | 0.0 | 48 | 0.1 | 0.0 | 17 | 33. | 82 | 1.3 | 0.0 | 0.0 | 1.3 | 82 | 81 | 1.2 | --- | 26 | 19 | 10 | 45 | 0.0 |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S/WAS(U) | 8 | | 00 | 0 | 533.37 | 35.86 | 161.16 | 66 | 8 | 83.56 | 1 | 0 | 9.03 | 36 | 9.92 | 4 | 0 | 2 | 6 | 9.93 | 0.07 | 1 | -- | 80.50 | 8.48 | 0.54 | 10.56 | 0 |
| WASWasting | 0.18 | 0 | 14.00 | 6.80 | 11533.37 | 8335.86 | 12161.16 | 36.66 | 0.08 | 4883.56 | 0.11 | 0.00 | 179.03 | 33.36 | 829.92 | 1.34 | 0.00 | 0.02 | 1.36 | 829.93 | 810.07 | 1.21 | ----- | 2680.50 | 198.48 | 100.54 | 4510.56 | 0.00 |

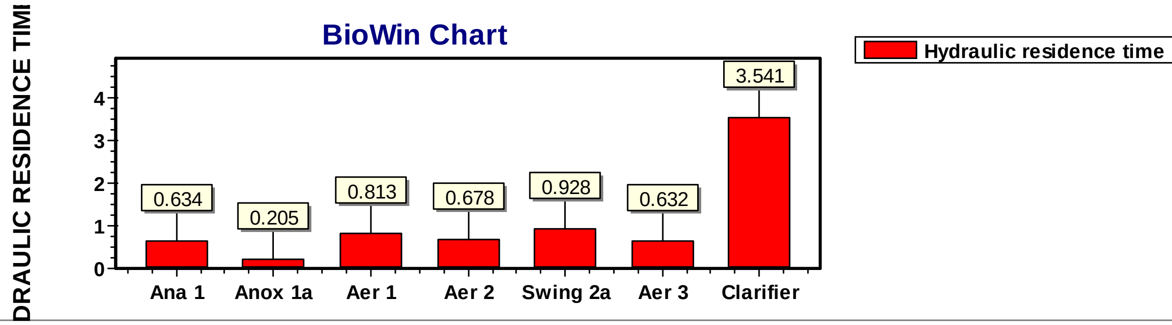
## Album page - SS Flow Accounting



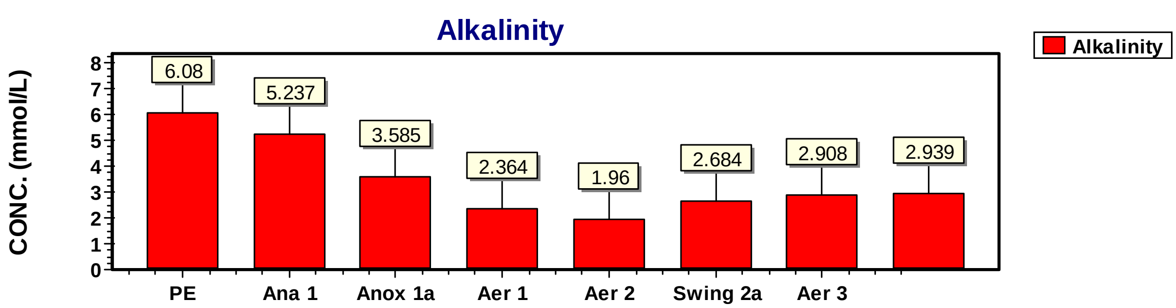

## Album page - SS Flow and HRT



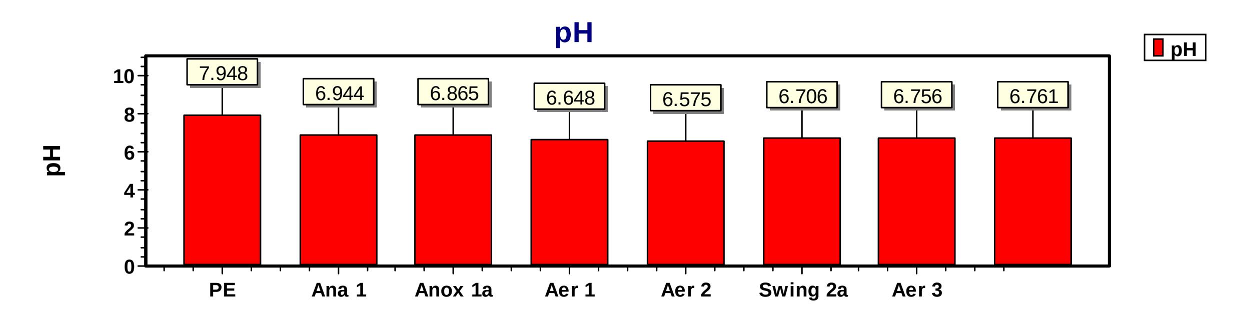

Album page - SS Flow and HRT



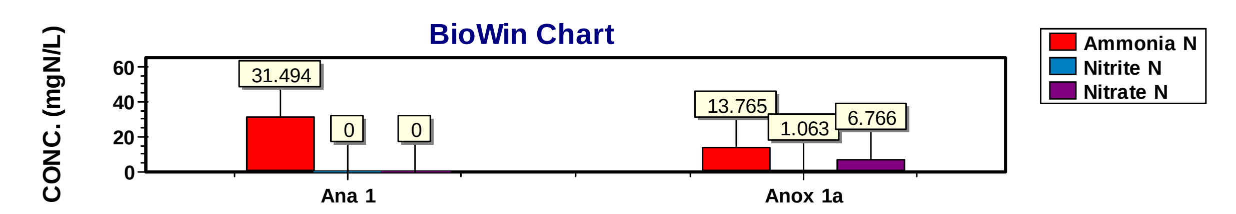

Album page - SS pH-Alkalinity



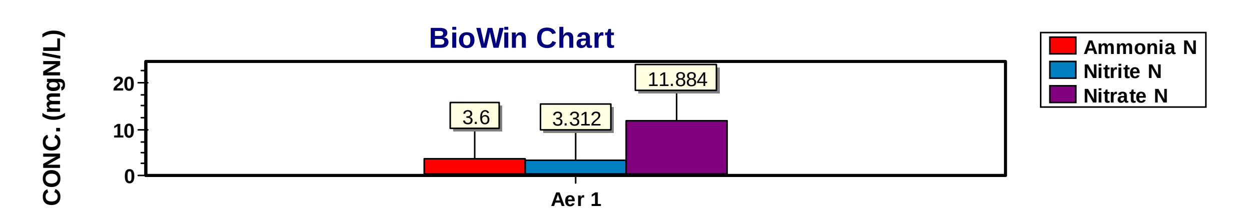

Album page - SS pH-Alkalinity



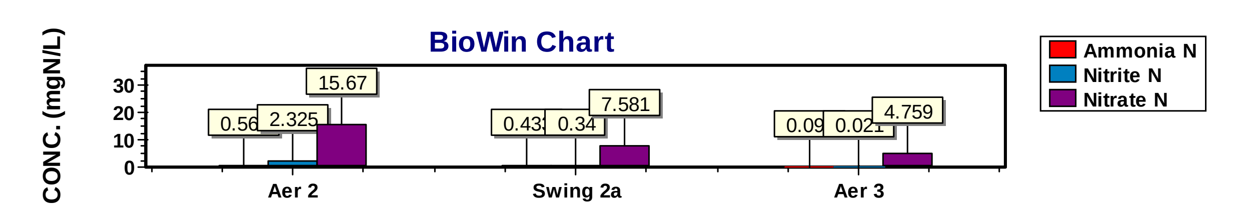

Album page - SS NH3-NO2-NO3



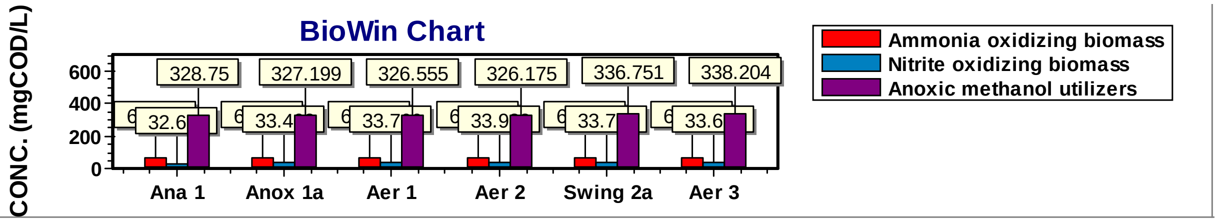

Album page - SS NH3-NO2-NO3



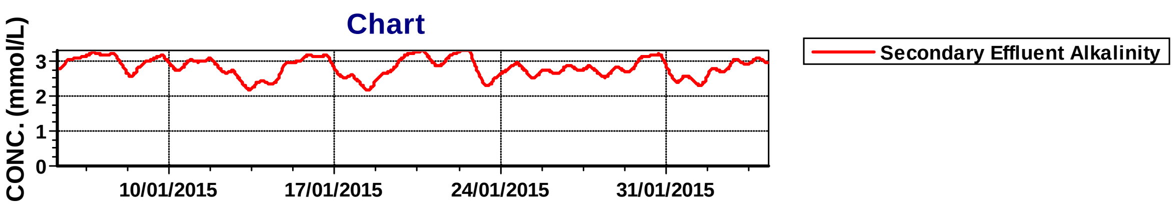

Album page - SS NH3-NO2-NO3



Album page - SS AOB-NOB

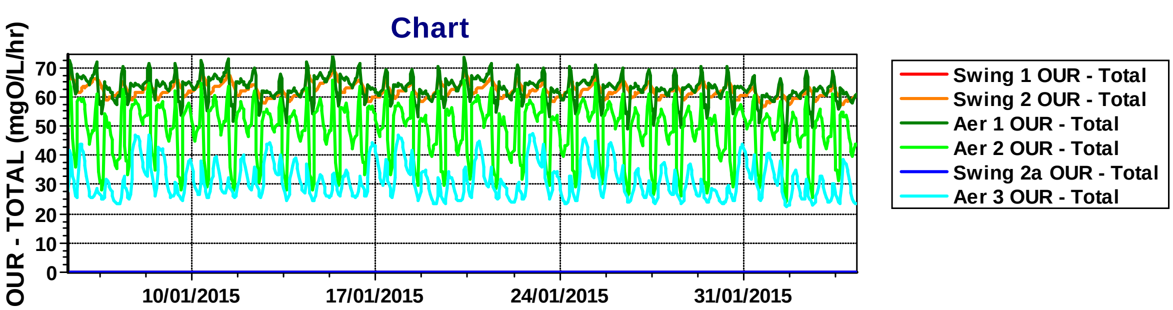



Album page - SS AOB-NOB

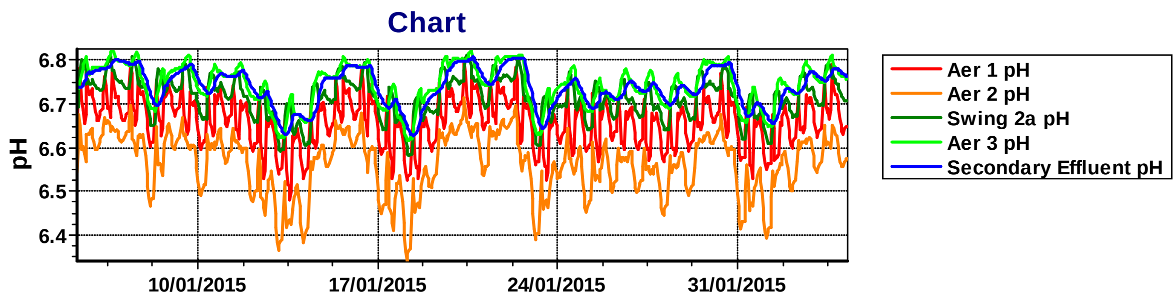



Album page - SS AOB-NOB

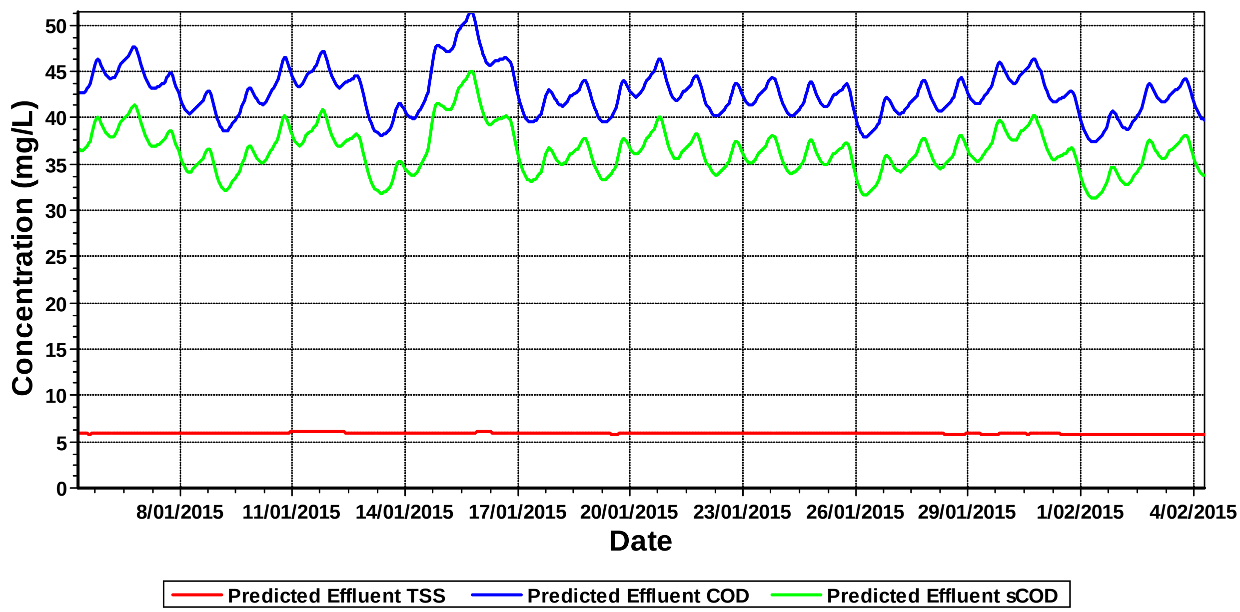
Album page - OURs



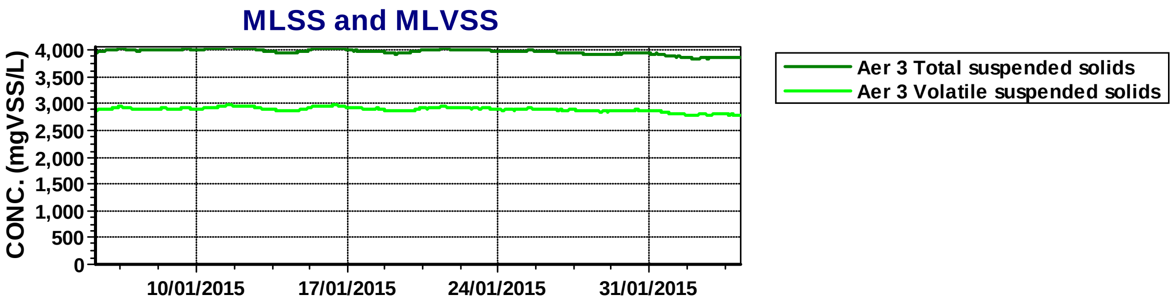

Album page - OURs



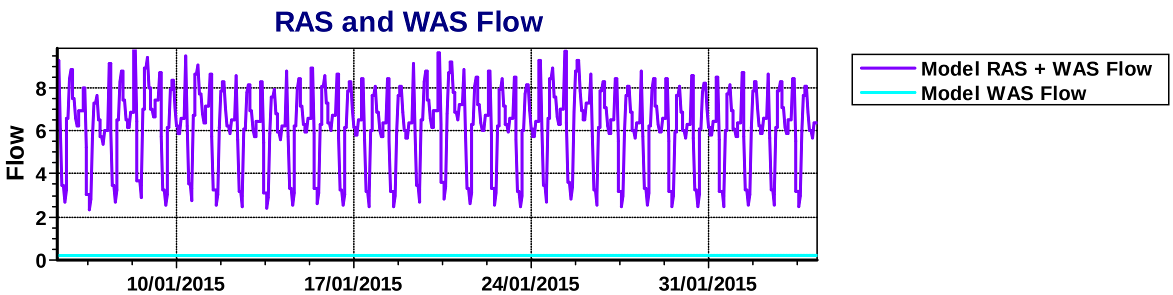

Album page - TSS, COD, BOD



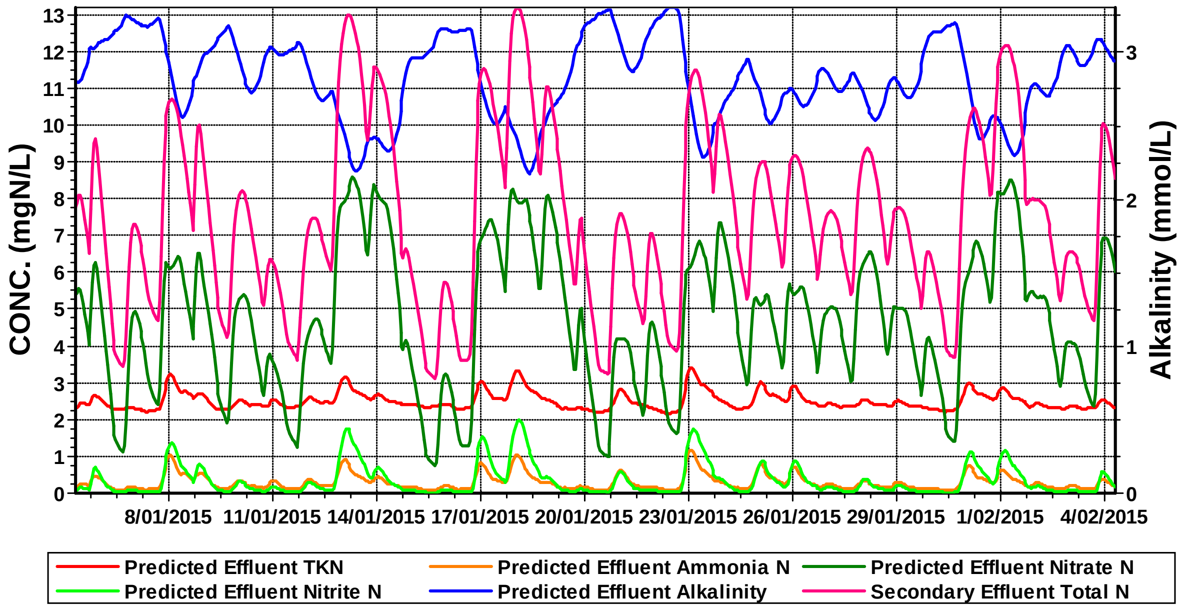

Album page - Mixed Liquor, RAS Flow



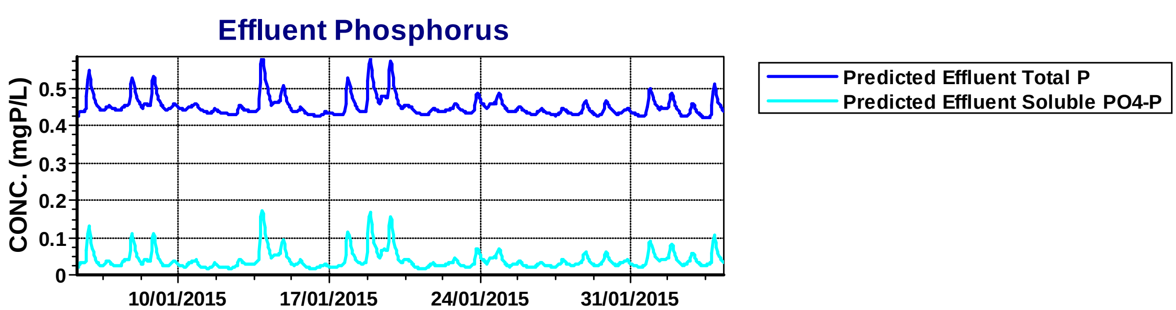

Album page - Mixed Liquor, RAS Flow



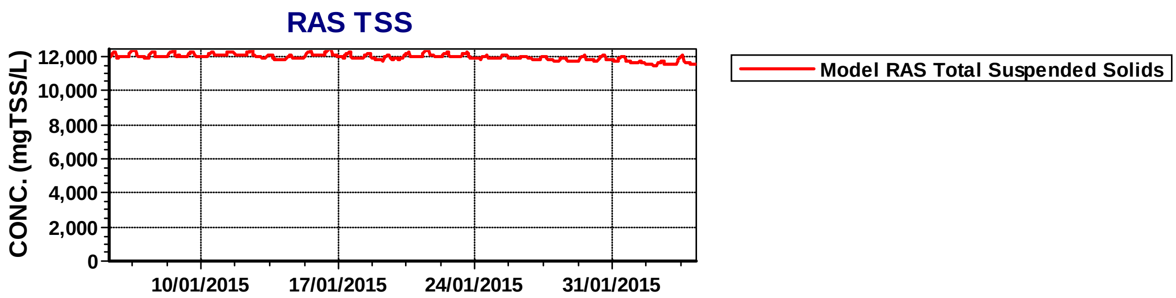

Album page - Nitrogen Sp., Alkalinity



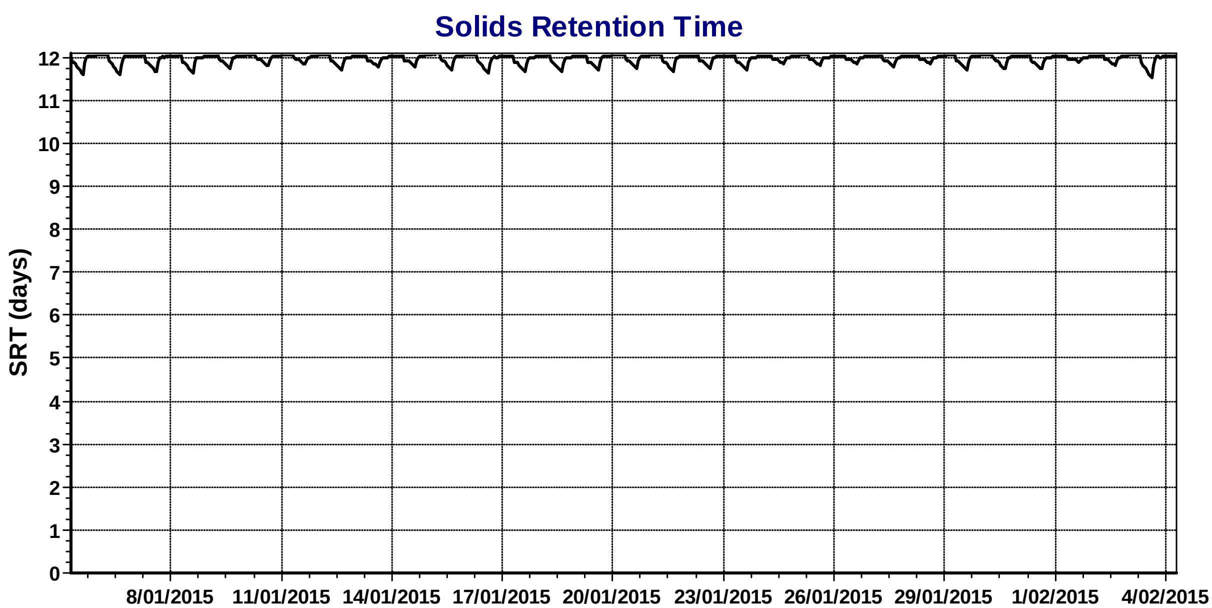

Album page - TP, RAS TSS



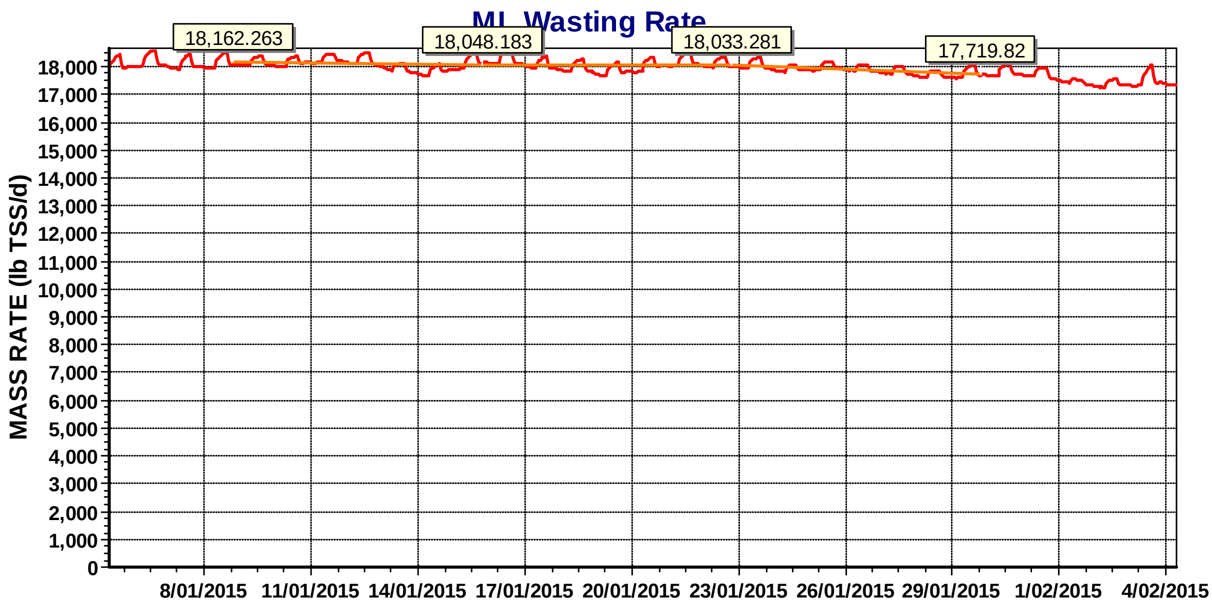

Album page - TP, RAS TSS



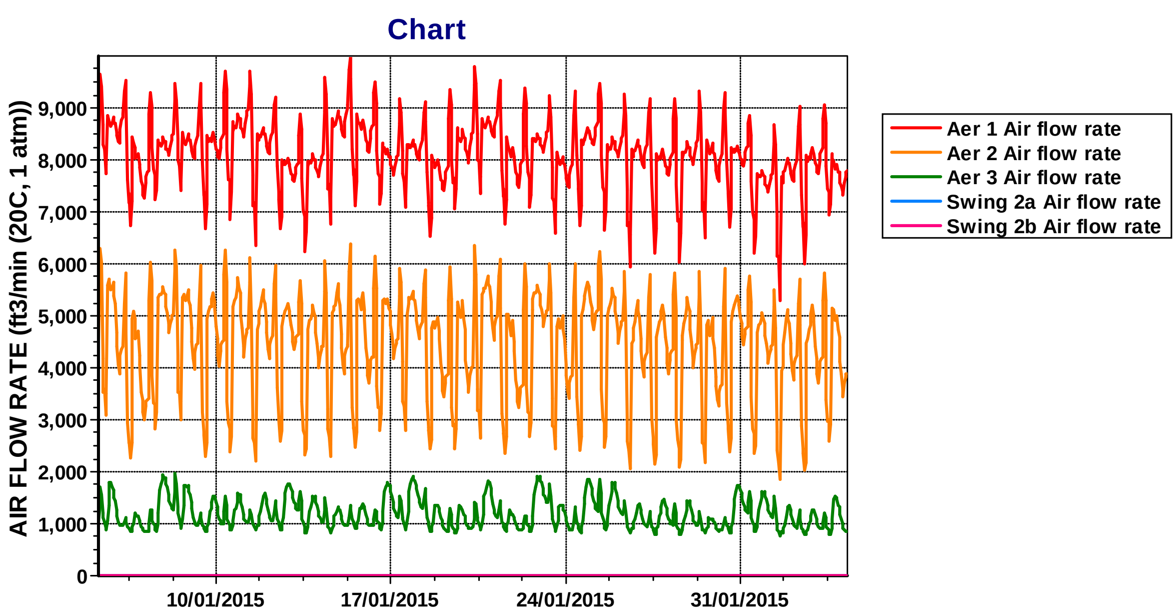

Album page - SRT




Album page - WAS Mass



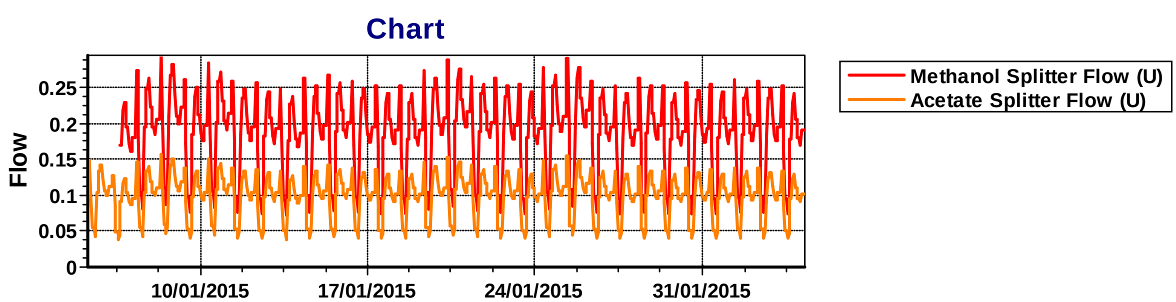

Album page - Air Flow Rate



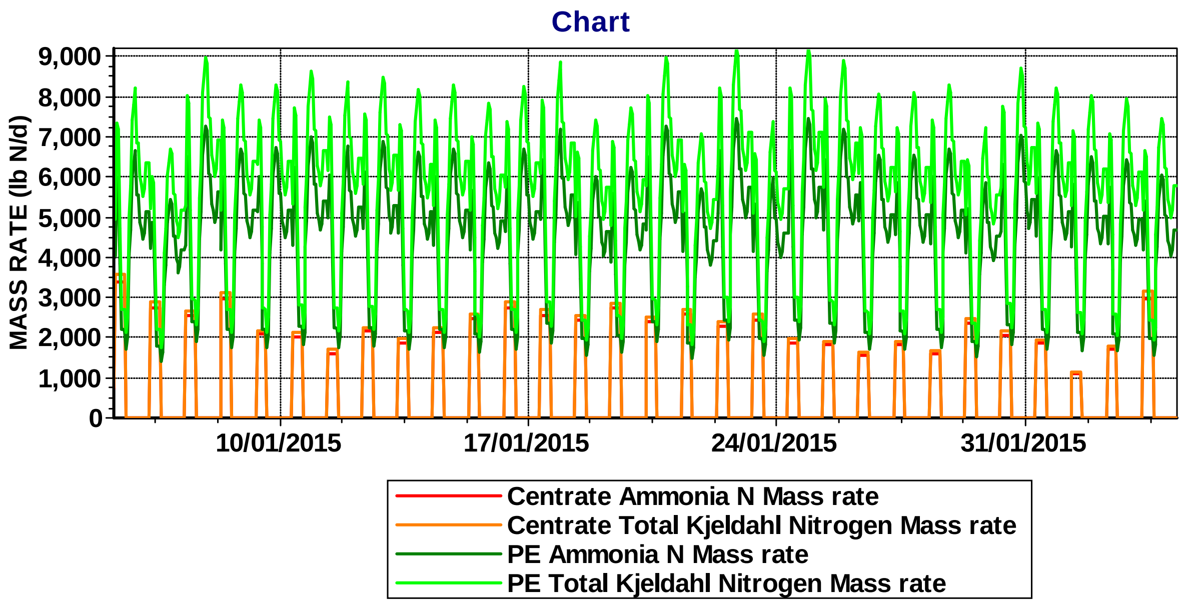

Album page - Page 16

| Elements | Air flow rate [ft3/min (20C, 1 atm)] | Flow [mgd] |
|---|---|---|
| Acetate Splitter (U) | ---- | 0.10 |
| Aer 1 | 7784.87 | 44.26 |
| Aer 2 | 3892.17 | 44.26 |
| Aer 3 | 857.62 | 18.98 |
| Swing 2a | 0 | 18.98 |
| Swing 2b | 0 | 18.98 |

## Album page - Page 16




## Album page - Centrate Addition




## Global Parameters

### Common

| Name | Default | Value | |
|---|---|---|---|
| Hydrolysis rate [1/d] | 2.1000 | 2.1000 | 1.0290 |
| Hydrolysis half sat. [-] | 0.0600 | 0.0600 | 1.0000 |
| Anoxic hydrolysis factor [-] | 0.2800 | 0.2800 | 1.0000 |
| Anaerobic hydrolysis factor (AS) [-] | 0.0400 | 0.0400 | 1.0000 |
| Anaerobic hydrolysis factor (AD) [-] | 0.5000 | 0.5000 | 1.0000 |
| Adsorption rate of colloids [L/(mgCOD d)] | 0.1500 | 0.1500 | 1.0290 |
| Ammonification rate [L/(mgN d)] | 0.0400 | 0.0400 | 1.0290 |
| Assimilative nitrate/nitrite reduction rate [1/d] | 0.5000 | 0.5000 | 1.0000 |
| Endogenous products decay rate [1/d] | 0 | 0 | 1.0000 |

### AOB

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.9000 | 0.9000 | 1.0720 |
| Substrate (NH4) half sat. [mgN/L] | 0.7000 | 0.7000 | 1.0000 |
| Byproduct NH4 logistic slope [-] | 50.0000 | 50.0000 | 1.0000 |
| Byproduct NH4 inflection point [mgN/L] | 1.4000 | 1.4000 | 1.0000 |
| AOB denite DO half sat. [mg/L] | 0.1000 | 0.1000 | 1.0000 |
| AOB denite HNO2 half sat. [mgN/L] | 5.000E-6 | 5.000E-6 | 1.0000 |
| Aerobic decay rate [1/d] | 0.1700 | 0.1700 | 1.0290 |
| Anoxic/anaerobic decay rate [1/d] | 0.0800 | 0.0800 | 1.0290 |
| KiHNO2 [mmol/L] | 0.0050 | 0.0050 | 1.0000 |

## NOB

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.7000 | 0.7000 | 1.0600 |
| Substrate (NO2) half sat. [mgN/L] | 0.1000 | 0.1000 | 1.0000 |
| Aerobic decay rate [1/d] | 0.1700 | 0.1700 | 1.0290 |
| Anoxic/anaerobic decay rate [1/d] | 0.0800 | 0.0800 | 1.0290 |
| KiNH3 [mmol/L] | 0.0750 | 0.0750 | 1.0000 |

## AAO

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.2000 | 0.2000 | 1.1000 |
| Substrate (NH4) half sat. [mgN/L] | 2.0000 | 2.0000 | 1.0000 |
| Substrate (NO2) half sat. [mgN/L] | 1.0000 | 1.0000 | 1.0000 |

| | | | |
|---|---|---|---|
| Aerobic decay rate [1/d] | 0.0190 | 0.0190 | 1.0290 |
| Anoxic/anaerobic decay rate [1/d] | 0.0095 | 0.0095 | 1.0290 |
| Ki Nitrite [mgN/L] | 1000.0000 | 1000.0000 | 1.0000 |
| Nitrite sensitivity constant [L / (d mgN) ] | 0.0160 | 0.0160 | 1.0000 |

## OHO

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 3.2000 | 3.2000 | 1.0290 |
| Substrate half sat. [mgCOD/L] | 5.0000 | 5.0000 | 1.0000 |
| Anoxic growth factor [-] | 0.5000 | 0.5000 | 1.0000 |
| Denite N2 producers (NO3 or NO2) [-] | 0.5000 | 0.5000 | 1.0000 |
| Aerobic decay rate [1/d] | 0.6200 | 0.6200 | 1.0290 |
| Anoxic decay rate [1/d] | 0.2330 | 0.2330 | 1.0290 |
| Anaerobic decay rate [1/d] | 0.1310 | 0.1310 | 1.0290 |
| Fermentation rate [1/d] | 1.6000 | 1.6000 | 1.0290 |
| Fermentation half sat. [mgCOD/L] | 5.0000 | 5.0000 | 1.0000 |
| Fermentation growth factor (AS) [-] | 0.2500 | 0.2500 | 1.0000 |
| Free nitrous acid inhibition [mmol/L] | 1.000E-7 | 1.000E-7 | 1.0000 |

## Methylotrophs

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 1.3000 | 1.3000 | 1.0720 |
| Methanol half sat. [mgCOD/L] | 0.5000 | 0.5000 | 1.0000 |
| Denite N2 producers (NO3 or NO2) [-] | 0.5000 | 0.5000 | 1.0000 |
| Aerobic decay rate [1/d] | 0.0400 | 0.0400 | 1.0290 |

| | | | |
|---|---|---|---|
| Anoxic/anaerobic decay rate [1/d] | 0.0300 | 0.0300 | 1.0290 |
| Free nitrous acid inhibition [mmol/L] | 1.000E-7 | 1.000E-7 | 1.0000 |

## PAO

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.9500 | 0.9500 | 1.0000 |
| Max. spec. growth rate, P-limited [1/d] | 0.4200 | 0.4200 | 1.0000 |
| Substrate half sat. [mgCOD(PHB)/mgCOD(Zbp)] | 0.1000 | 0.1000 | 1.0000 |
| Substrate half sat., P-limited [mgCOD(PHB)/mgCOD(Zbp)] | 0.0500 | 0.0500 | 1.0000 |
| Magnesium half sat. [mgMg/L] | 0.1000 | 0.1000 | 1.0000 |
| Cation half sat. [mmol/L] | 0.1000 | 0.1000 | 1.0000 |
| Calcium half sat. [mgCa/L] | 0.1000 | 0.1000 | 1.0000 |
| Aerobic/anoxic decay rate [1/d] | 0.1000 | 0.1000 | 1.0000 |
| Aerobic/anoxic maintenance rate [1/d] | 0 | 0 | 1.0000 |
| Anaerobic decay rate [1/d] | 0.0400 | 0.0400 | 1.0000 |
| Anaerobic maintenance rate [1/d] | 0 | 0 | 1.0000 |
| Sequestration rate [1/d] | 4.5000 | 4.5000 | 1.0000 |
| Anoxic growth factor [-] | 0.3300 | 0.3300 | 1.0000 |

## Acetogens

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.2500 | 0.2500 | 1.0290 |
| Substrate half sat. [mgCOD/L] | 10.0000 | 10.0000 | 1.0000 |
| Acetate inhibition [mgCOD/L] | 10000.0000 | 10000.0000 | 1.0000 |
| Anaerobic decay rate [1/d] | 0.0500 | 0.0500 | 1.0290 |

| | | | |
|---|---|---|---|
| Aerobic/anoxic decay rate [1/d] | 0.5200 | 0.5200 | 1.0290 |

## Methanogens

| Name | Default | Value | |
|---|---|---|---|
| Acetoclastic max. spec. growth rate [1/d] | 0.3000 | 0.3000 | 1.0290 |
| H2-utilizing max. spec. growth rate [1/d] | 1.4000 | 1.4000 | 1.0290 |
| Acetoclastic substrate half sat. [mgCOD/L] | 100.0000 | 100.0000 | 1.0000 |
| Acetoclastic methanol half sat. [mgCOD/L] | 0.5000 | 0.5000 | 1.0000 |
| H2-utilizing CO2 half sat. [mmol/L] | 0.1000 | 0.1000 | 1.0000 |
| H2-utilizing substrate half sat. [mgCOD/L] | 0.1000 | 0.1000 | 1.0000 |
| H2-utilizing methanol half sat. [mgCOD/L] | 0.5000 | 0.5000 | 1.0000 |
| Acetoclastic propionic inhibition [mgCOD/L] | 10000.0000 | 10000.0000 | 1.0000 |
| Acetoclastic anaerobic decay rate [1/d] | 0.1300 | 0.1300 | 1.0290 |
| Acetoclastic aerobic/anoxic decay rate [1/d] | 0.6000 | 0.6000 | 1.0290 |
| H2-utilizing anaerobic decay rate [1/d] | 0.1300 | 0.1300 | 1.0290 |
| H2-utilizing aerobic/anoxic decay rate [1/d] | 2.8000 | 2.8000 | 1.0290 |

## pH

| Name | Default | Value |
|---|---|---|
| OHO low pH limit [-] | 4.0000 | 4.0000 |
| OHO high pH limit [-] | 10.0000 | 10.0000 |
| Methylotrophs low pH limit [-] | 4.0000 | 4.0000 |
| Methylotrophs high pH limit [-] | 10.0000 | 10.0000 |
| Autotrophs low pH limit [-] | 5.5000 | 5.5000 |
| Autotrophs high pH limit [-] | 9.5000 | 9.5000 |

| | | |
|---|---|---|
| PAO low pH limit [-] | 4.0000 | 4.0000 |
| PAO high pH limit [-] | 10.0000 | 10.0000 |
| OHO low pH limit (anaerobic) [-] | 5.5000 | 5.5000 |
| OHO high pH limit (anaerobic) [-] | 8.5000 | 8.5000 |
| Propionic acetogens low pH limit [-] | 4.0000 | 4.0000 |
| Propionic acetogens high pH limit [-] | 10.0000 | 10.0000 |
| Acetoclastic methanogens low pH limit [-] | 5.0000 | 5.0000 |
| Acetoclastic methanogens high pH limit [-] | 9.0000 | 9.0000 |
| H2-utilizing methanogens low pH limit [-] | 5.0000 | 5.0000 |
| H2-utilizing methanogens high pH limit [-] | 9.0000 | 9.0000 |

## Switches

| Name | Default | Value |
|---|---|---|
| Aerobic/anoxic DO half sat. [mgO2/L] | 0.0500 | 0.0500 |
| Anoxic/anaerobic NOx half sat. [mgN/L] | 0.1500 | 0.1500 |
| AOB DO half sat. [mgO2/L] | 0.2500 | 0.2500 |
| NOB DO half sat. [mgO2/L] | 0.5000 | 0.5000 |
| AAO DO half sat. [mgO2/L] | 0.0100 | 0.0100 |
| Anoxic NO3(->NO2) half sat. [mgN/L] | 0.1000 | 0.1000 |
| Anoxic NO3(->N2) half sat. [mgN/L] | 0.0500 | 0.0500 |
| Anoxic NO2(->N2) half sat. (mgN/L) | 0.0100 | 0.0100 |
| NH3 nutrient half sat. [mgN/L] | 0.0050 | 0.0050 |
| PolyP half sat. [mgP/mgCOD] | 0.0100 | 0.0100 |
| VFA sequestration half sat. [mgCOD/L] | 5.0000 | 5.0000 |
| P uptake half sat. [mgP/L] | 0.1500 | 0.1500 |
| P nutrient half sat. [mgP/L] | 0.0010 | 0.0010 |
| Autotroph CO2 half sat. [mmol/L] | 0.1000 | 0.1000 |
| H2 low/high half sat. [mgCOD/L] | 1.0000 | 1.0000 |

| | | |
|---|---|---|
| Propionic acetogens H2 inhibition [mgCOD/L] | 5.0000 | 5.0000 |
| Synthesis anion/cation half sat. [meq/L] | 0.0100 | 0.0100 |

## Common

| Name | Default | Value |
|---|---|---|
| Biomass volatile fraction (VSS/TSS) | 0.9200 | 0.9200 |
| Endogenous residue volatile fraction (VSS/TSS) | 0.9200 | 0.9200 |
| N in endogenous residue [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in endogenous residue [mgP/mgCOD] | 0.0220 | 0.0220 |
| Endogenous residue COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| Particulate substrate COD:VSS ratio [mgCOD/mgVSS] | 1.6000 | 2.2000 |
| Particulate inert COD:VSS ratio [mgCOD/mgVSS] | 1.6000 | 2.2000 |

## AOB

| Name | Default | Value |
|---|---|---|
| Yield [mgCOD/mgN] | 0.1500 | 0.1500 |
| AOB denite NO2 fraction as TEA [-] | 0.5000 | 0.5000 |
| Byproduct NH4 fraction to N2O [-] | 0.0025 | 0.0025 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## NOB

| Name | Default | Value |
|---|---|---|
| Yield [mgCOD/mgN] | 0.0900 | 0.0900 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## AAO

| Name | Default | Value |
|---|---|---|
| Yield [mgCOD/mgN] | 0.1140 | 0.1140 |
| Nitrate production [mgN/mgBiomassCOD] | 2.2800 | 2.2800 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## OHO

| Name | Default | Value |
|---|---|---|
| Yield (aerobic) [-] | 0.6660 | 0.6660 |
| Yield (fermentation, low H2) [-] | 0.1000 | 0.1000 |
| Yield (fermentation, high H2) [-] | 0.1000 | 0.1000 |
| H2 yield (fermentation low H2) [-] | 0.3500 | 0.3500 |
| H2 yield (fermentation high H2) [-] | 0 | 0 |
| Propionate yield (fermentation, low H2) [-] | 0 | 0 |

| | | |
|---|---|---|
| Propionate yield (fermentation, high H2) [-] | 0.7000 | 0.7000 |
| CO2 yield (fermentation, low H2) [-] | 0.7000 | 0.7000 |
| CO2 yield (fermentation, high H2) [-] | 0 | 0 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Endogenous fraction - aerobic [-] | 0.0800 | 0.0800 |
| Endogenous fraction - anoxic [-] | 0.1030 | 0.1030 |
| Endogenous fraction - anaerobic [-] | 0.1840 | 0.1840 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| Yield (anoxic) [-] | 0.5400 | 0.5400 |
| Yield propionic (aerobic) [-] | 0.6400 | 0.6400 |
| Yield propionic (anoxic) [-] | 0.4600 | 0.4600 |
| Yield acetic (aerobic) [-] | 0.6000 | 0.6000 |
| Yield acetic (anoxic) [-] | 0.4300 | 0.4300 |
| Yield methanol (aerobic) [-] | 0.5000 | 0.5000 |
| Adsorp. max. [-] | 1.0000 | 1.0000 |
| Max fraction to N2O at high FNA over nitrate [-] | 0.0500 | 0.0500 |
| Max fraction to N2O at high FNA over nitrite [-] | 0.1000 | 0.1000 |

## Methylotrophs

| Name | Default | Value |
|---|---|---|
| Yield (anoxic) [-] | 0.4000 | 0.4000 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| Max fraction to N2O at high FNA over nitrate [-] | 0.1000 | 0.1000 |
| Max fraction to N2O at high FNA over nitrite [-] | 0.1500 | 0.1500 |

## PAO

| Name | Default | Value |
|---|---|---|
| Yield (aerobic) [-] | 0.6390 | 0.6390 |
| Yield (anoxic) [-] | 0.5200 | 0.5200 |
| Aerobic P/PHA uptake [mgP/mgCOD] | 0.9300 | 0.9300 |
| Anoxic P/PHA uptake [mgP/mgCOD] | 0.3500 | 0.3500 |
| Yield of PHA on sequestration [-] | 0.8890 | 0.8890 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| N in sol. inert [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous part. [-] | 0.2500 | 0.2500 |
| Inert fraction of endogenous sol. [-] | 0.2000 | 0.2000 |
| P/Ac release ratio [mgP/mgCOD] | 0.5100 | 0.5100 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| Yield of low PP [-] | 0.9400 | 0.9400 |

## Acetogens

| Name | Default | Value |
|---|---|---|
| Yield [-] | 0.1000 | 0.1000 |
| H2 yield [-] | 0.4000 | 0.4000 |
| CO2 yield [-] | 1.0000 | 1.0000 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## Methanogens

| Name | Default | Value |
|---|---|---|
| Acetoclastic yield [-] | 0.1000 | 0.1000 |
| Methanol acetoclastic yield [-] | 0.1000 | 0.1000 |
| H2-utilizing yield [-] | 0.1000 | 0.1000 |
| Methanol H2-utilizing yield [-] | 0.1000 | 0.1000 |
| N in acetoclastic biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| N in H2-utilizing biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in acetoclastic biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| P in H2-utilizing biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Acetoclastic fraction to endog. residue [-] | 0.0800 | 0.0800 |
| H2-utilizing fraction to endog. residue [-] | 0.0800 | 0.0800 |
| Acetoclastic COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| H2-utilizing COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## General

| Name | Default | Value |
|---|---|---|
| Molecular weight of other anions [mg/mmol] | 35.5000 | 35.5000 |
| Molecular weight of other cations [mg/mmol] | 39.1000 | 39.1000 |
| Mg to P mole ratio in polyphosphate [mmolMg/mmolP] | 0.3000 | 0.3000 |
| Cation to P mole ratio in polyphosphate [meq/mmolP] | 0.1500 | 0.3000 |
| Ca to P mole ratio in polyphosphate [mmolCa/mmolP] | 0.0500 | 0.0500 |
| Cation to P mole ratio in organic phosphate [meq/mmolP] | 0.0100 | 0.0100 |
| Bubble rise velocity (anaerobic digester) [cm/s] | 23.9000 | 23.9000 |
| Bubble Sauter mean diameter (anaerobic digester) [cm] | 0.3500 | 0.3500 |
| Anaerobic digester gas hold-up factor [] | 1.0000 | 1.0000 |

| | | |
|---|---|---|
| Tank head loss per metre of length (from flow) [m/m] | 0.0025 | 0.0025 |

## Mass transfer

| Name | Default | Value | |
|---|---|---|---|
| Kl for H2 [m/d] | 17.0000 | 17.0000 | 1.0240 |
| Kl for CO2 [m/d] | 10.0000 | 10.0000 | 1.0240 |
| Kl for NH3 [m/d] | 1.0000 | 1.0000 | 1.0240 |
| Kl for CH4 [m/d] | 8.0000 | 8.0000 | 1.0240 |
| Kl for N2 [m/d] | 15.0000 | 15.0000 | 1.0240 |
| Kl for N2O [m/d] | 8.0000 | 8.0000 | 1.0240 |
| Kl for O2 [m/d] | 13.0000 | 13.0000 | 1.0240 |

## Henry's law constants

| Name | Default | Value | |
|---|---|---|---|
| CO2 [M/atm] | 3.4000E-2 | 3.4000E-2 | 2400.0000 |
| O2 [M/atm] | 1.3000E-3 | 1.3000E-3 | 1500.0000 |
| N2 [M/atm] | 6.5000E-4 | 6.5000E-4 | 1300.0000 |
| N2O [M/atm] | 2.5000E-2 | 2.5000E-2 | 2600.0000 |
| NH3 [M/atm] | 5.8000E+1 | 5.8000E+1 | 4100.0000 |
| CH4 [M/atm] | 1.4000E-3 | 1.4000E-3 | 1600.0000 |
| H2 [M/atm] | 7.8000E-4 | 7.8000E-4 | 500.0000 |

## Physico-chemical rates

| Name | Default | Value | |
|---|---|---|---|
| Struvite precipitation rate [1/d] | 3.000E+10 | 3.000E+10 | 1.0240 |
| Struvite redissolution rate [1/d] | 3.000E+11 | 3.000E+11 | 1.0240 |
| Struvite half sat. [mgTSS/L] | 1.0000 | 1.0000 | 1.0000 |
| HDP precipitation rate [L/(molP d)] | 1.000E+8 | 1.000E+8 | 1.0000 |
| HDP redissolution rate [L/(mol P d)] | 1.000E+8 | 1.000E+8 | 1.0000 |
| HAP precipitation rate [molHDP/(L d)] | 5.000E-4 | 5.000E-4 | 1.0000 |

## Physico-chemical constants

| Name | Default | Value |
|---|---|---|
| Struvite solubility constant [mol/L] | 6.918E-14 | 6.918E-14 |
| HDP solubility product [mol/L] | 2.750E-22 | 2.750E-22 |
| HDP half sat. [mgTSS/L] | 1.0000 | 1.0000 |
| Equilibrium soluble PO4 with Al dosing at pH 7 [mgP/L] | 0.0100 | 0.0100 |
| Al to P ratio [molAl/molP] | 0.8000 | 0.8000 |
| Al(OH)3 solubility product [mol/L] | 1.259E+9 | 1.259E+9 |
| AlHPO4+ dissociation constant [mol/L] | 7.943E-13 | 7.943E-13 |
| Equilibrium soluble PO4 with Fe dosing at pH 7 [mgP/L] | 0.0100 | 0.0100 |
| Fe to P ratio [molFe/molP] | 1.6000 | 1.6000 |
| Fe(OH)3 solubility product [mol/L] | 0.0500 | 0.0500 |
| FeH2PO4++ dissociation constant [mol/L] | 5.012E-22 | 5.012E-22 |

## Aeration

| Name | Default | Value |
|---|---|---|
| Alpha (surf) OR Alpha F (diff) [-] | 0.5000 | 0.5000 |

| | | |
|---|---|---|
| Beta [-] | 0.9500 | 0.9500 |
| Surface pressure [kPa] | 101.3250 | 101.3250 |
| Fractional effective saturation depth (Fed) [-] | 0.3250 | 0.3250 |
| Supply gas CO2 content [vol. %] | 0.0350 | 0.0350 |
| Supply gas O2 [vol. %] | 20.9500 | 20.9500 |
| Off-gas CO2 [vol. %] | 2.0000 | 2.0000 |
| Off-gas O2 [vol. %] | 18.8000 | 18.8000 |
| Off-gas H2 [vol. %] | 0 | 0 |
| Off-gas NH3 [vol. %] | 0 | 0 |
| Off-gas CH4 [vol. %] | 0 | 0 |
| Surface turbulence factor [-] | 2.0000 | 2.0000 |
| Set point controller gain [] | 1.0000 | 1.0000 |

## Modified Vesilind

| Name | Default | Value |
|---|---|---|
| Maximum Vesilind settling velocity (Vo) [ft/min] | 0.387 | 0.387 |
| Vesilind hindered zone settling parameter (K) [L/g] | 0.370 | 0.370 |
| Clarification switching function [mg/L] | 100.000 | 100.000 |
| Specified TSS conc.for height calc. [mg/L] | 2500.000 | 2500.000 |
| Maximum compactability constant [mg/L] | 15000.000 | 15000.000 |

## Double exponential

| Name | Default | Value |
|---|---|---|
| Maximum Vesilind settling velocity (Vo) [ft/min] | 0.934 | 0.934 |
| Maximum (practical) settling velocity (Vo') [ft/min] | 0.615 | 0.615 |

| | | |
|---|---|---|
| Hindered zone settling parameter (Kh) [L/g] | 0.400 | 0.400 |
| Flocculent zone settling parameter (Kf) [L/g] | 2.500 | 2.500 |
| Maximum non-settleable TSS [mg/L] | 20.0000 | 20.0000 |
| Non-settleable fraction [-] | 0.0010 | 0.0010 |
| Specified TSS conc. for height calc. [mg/L] | 2500.0000 | 2500.0000 |

## Emission factors

| Name | Default | Value |
|---|---|---|
| Carbon dioxide equivalence of nitrous oxide | 296.0000 | 296.0000 |
| Carbon dioxide equivalence of methane | 23.0000 | 23.0000 |

## Biofilm general

| Name | Default | Value | |
|---|---|---|---|
| Attachment rate [ g / (m2 d)  ] | 80.0000 | 80.0000 | 1.0000 |
| Attachment TSS half sat.  [mg/L] | 100.0000 | 100.0000 | 1.0000 |
| Detachment rate [g/(m3 d)] | 8.000E+4 | 8.000E+4 | 1.0000 |
| Solids movement factor [] | 10.0000 | 10.0000 | 1.0000 |
| Diffusion neta [] | 0.8000 | 0.8000 | 1.0000 |
| Thin film limit  [mm] | 0.5000 | 0.5000 | 1.0000 |
| Thick film limit [mm] | 3.0000 | 3.0000 | 1.0000 |
| Assumed Film thickness for tank volume correction (temp independent) [mm] | 0.7500 | 0.7500 | 1.0000 |
| Film surface area to media area ratio - Max.[ ] | 1.0000 | 1.0000 | 1.0000 |
| Minimum biofilm conc. for streamer formation [gTSS/m2] | 4.0000 | 4.0000 | 1.0000 |

## Maximum biofilm concentrations [mg/L]

| Name | Default | Value | |
|---|---|---|---|
| Ordinary heterotrophic organisms (OHO) | 5.000E+4 | 5.000E+4 | 1.0000 |
| Methylotrophs | 5.000E+4 | 5.000E+4 | 1.0000 |
| Ammonia oxidizing biomass (AOB) | 1.000E+5 | 1.000E+5 | 1.0000 |
| Nitrite oxidizing biomass (NOB) | 1.000E+5 | 1.000E+5 | 1.0000 |
| Anaerobic ammonia oxidizers (AAO) | 5.000E+4 | 5.000E+4 | 1.0000 |
| Polyphosphate accumulating organisms (PAO) | 5.000E+4 | 5.000E+4 | 1.0000 |
| Propionic acetogens | 5.000E+4 | 5.000E+4 | 1.0000 |
| Methanogens - acetoclastic | 5.000E+4 | 5.000E+4 | 1.0000 |
| Methanogens - hydrogenotrophic | 5.000E+4 | 5.000E+4 | 1.0000 |
| Endogenous products | 3.000E+4 | 3.000E+4 | 1.0000 |
| Slowly bio. COD (part.) | 5000.0000 | 5000.0000 | 1.0000 |
| Slowly bio. COD (colloid.) | 4000.0000 | 4000.0000 | 1.0000 |
| Part. inert. COD | 5000.0000 | 5000.0000 | 1.0000 |
| Part. bio. org. N | 0 | 0 | 1.0000 |
| Part. bio. org. P | 0 | 0 | 1.0000 |
| Part. inert N | 0 | 0 | 1.0000 |
| Part. inert P | 0 | 0 | 1.0000 |
| Stored PHA | 5000.0000 | 5000.0000 | 1.0000 |
| Releasable stored polyP | 1.150E+6 | 1.150E+6 | 1.0000 |
| Fixed stored polyP | 1.150E+6 | 1.150E+6 | 1.0000 |
| Readily bio. COD (complex) | 0 | 0 | 1.0000 |
| Acetate | 0 | 0 | 1.0000 |
| Propionate | 0 | 0 | 1.0000 |
| Methanol | 0 | 0 | 1.0000 |
| Dissolved H2 | 0 | 0 | 1.0000 |
| Dissolved methane | 0 | 0 | 1.0000 |
| Ammonia N | 0 | 0 | 1.0000 |
| Sol. bio. org. N | 0 | 0 | 1.0000 |

| | | | |
|---|---|---|---|
| Nitrous Oxide N | 0 | 0 | 1.0000 |
| Nitrite N | 0 | 0 | 1.0000 |
| Nitrate N | 0 | 0 | 1.0000 |
| Dissolved nitrogen gas | 0 | 0 | 1.0000 |
| PO4-P (Sol. & Me Complexed) | 1.000E+10 | 1.000E+10 | 1.0000 |
| Sol. inert COD | 0 | 0 | 1.0000 |
| Sol. inert TKN | 0 | 0 | 1.0000 |
| ISS Influent | 1.300E+6 | 1.300E+6 | 1.0000 |
| Struvite | 8.500E+5 | 8.500E+5 | 1.0000 |
| Hydroxy-dicalcium-phosphate | 1.150E+6 | 1.150E+6 | 1.0000 |
| Hydroxy-apatite | 1.600E+6 | 1.600E+6 | 1.0000 |
| Magnesium | 0 | 0 | 1.0000 |
| Calcium | 0 | 0 | 1.0000 |
| Metal | 1.000E+10 | 1.000E+10 | 1.0000 |
| Other Cations (strong bases) | 0 | 0 | 1.0000 |
| Other Anions (strong acids) | 0 | 0 | 1.0000 |
| Total CO2 | 0 | 0 | 1.0000 |
| User defined 1 | 0 | 0 | 1.0000 |
| User defined 2 | 0 | 0 | 1.0000 |
| User defined 3 | 5.000E+4 | 5.000E+4 | 1.0000 |
| User defined 4 | 5.000E+4 | 5.000E+4 | 1.0000 |
| Dissolved oxygen | 0 | 0 | 1.0000 |

## Effective diffusivities [m2/s]

| Name | Default | Value | |
|---|---|---|---|
| Ordinary heterotrophic organisms (OHO) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Methylotrophs | 5.000E-14 | 5.000E-14 | 1.0290 |
| Ammonia oxidizing biomass (AOB) | 5.000E-14 | 5.000E-14 | 1.0290 |

| | | | |
|---|---|---|---|
| Nitrite oxidizing biomass (NOB) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Anaerobic ammonia oxidizers (AAO) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Polyphosphate accumulating organisms (PAO) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Propionic acetogens | 5.000E-14 | 5.000E-14 | 1.0290 |
| Methanogens - acetoclastic | 5.000E-14 | 5.000E-14 | 1.0290 |
| Methanogens - hydrogenotrophic | 5.000E-14 | 5.000E-14 | 1.0290 |
| Endogenous products | 5.000E-14 | 5.000E-14 | 1.0290 |
| Slowly bio. COD (part.) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Slowly bio. COD (colloid.) | 5.000E-12 | 5.000E-12 | 1.0290 |
| Part. inert. COD | 5.000E-14 | 5.000E-14 | 1.0290 |
| Part. bio. org. N | 5.000E-14 | 5.000E-14 | 1.0290 |
| Part. bio. org. P | 5.000E-14 | 5.000E-14 | 1.0290 |
| Part. inert N | 5.000E-14 | 5.000E-14 | 1.0290 |
| Part. inert P | 5.000E-14 | 5.000E-14 | 1.0290 |
| Stored PHA | 5.000E-14 | 5.000E-14 | 1.0290 |
| Releasable stored polyP | 5.000E-14 | 5.000E-14 | 1.0290 |
| Fixed stored polyP | 5.000E-14 | 5.000E-14 | 1.0290 |
| Readily bio. COD (complex) | 6.900E-10 | 6.900E-10 | 1.0290 |
| Acetate | 1.240E-9 | 1.240E-9 | 1.0290 |
| Propionate | 8.300E-10 | 8.300E-10 | 1.0290 |
| Methanol | 1.600E-9 | 1.600E-9 | 1.0290 |
| Dissolved H2 | 5.850E-9 | 5.850E-9 | 1.0290 |
| Dissolved methane | 1.963E-9 | 1.963E-9 | 1.0290 |
| Ammonia N | 2.000E-9 | 2.000E-9 | 1.0290 |
| Sol. bio. org. N | 1.370E-9 | 1.370E-9 | 1.0290 |
| Nitrous Oxide N | 1.607E-9 | 1.607E-9 | 1.0290 |
| Nitrite N | 2.980E-9 | 2.980E-9 | 1.0290 |
| Nitrate N | 2.980E-9 | 2.980E-9 | 1.0290 |
| Dissolved nitrogen gas | 1.900E-9 | 1.900E-9 | 1.0290 |
| PO4-P (Sol. & Me Complexed) | 2.000E-9 | 2.000E-9 | 1.0290 |
| Sol. inert COD | 6.900E-10 | 6.900E-10 | 1.0290 |

| | | | |
|---|---|---|---|
| Sol. inert TKN | 6.850E-10 | 6.850E-10 | 1.0290 |
| ISS Influent | 5.000E-14 | 5.000E-14 | 1.0290 |
| Struvite | 5.000E-14 | 5.000E-14 | 1.0290 |
| Hydroxy-dicalcium-phosphate | 5.000E-14 | 5.000E-14 | 1.0290 |
| Hydroxy-apatite | 5.000E-14 | 5.000E-14 | 1.0290 |
| Magnesium | 7.200E-10 | 7.200E-10 | 1.0290 |
| Calcium | 7.200E-10 | 7.200E-10 | 1.0290 |
| Metal | 4.800E-10 | 4.800E-10 | 1.0290 |
| Other Cations (strong bases) | 1.440E-9 | 1.440E-9 | 1.0290 |
| Other Anions (strong acids) | 1.440E-9 | 1.440E-9 | 1.0290 |
| Total CO2 | 1.960E-9 | 1.960E-9 | 1.0290 |
| User defined 1 | 6.900E-10 | 6.900E-10 | 1.0290 |
| User defined 2 | 6.900E-10 | 6.900E-10 | 1.0290 |
| User defined 3 | 5.000E-14 | 5.000E-14 | 1.0290 |
| User defined 4 | 5.000E-14 | 5.000E-14 | 1.0290 |
| Dissolved oxygen | 2.500E-9 | 2.500E-9 | 1.0290 |

## EPS Strength coefficients [ ]

| Name | Default | Value | |
|---|---|---|---|
| Ordinary heterotrophic organisms (OHO) | 1.0000 | 1.0000 | 1.0000 |
| Methylotrophs | 1.0000 | 1.0000 | 1.0000 |
| Ammonia oxidizing biomass (AOB) | 5.0000 | 1.0000 | 1.0000 |
| Nitrite oxidizing biomass (NOB) | 25.0000 | 1.0000 | 1.0000 |
| Anaerobic ammonia oxidizers (AAO) | 10.0000 | 1.0000 | 1.0000 |
| Polyphosphate accumulating organisms (PAO) | 1.0000 | 1.0000 | 1.0000 |
| Propionic acetogens | 1.0000 | 1.0000 | 1.0000 |
| Methanogens - acetoclastic | 1.0000 | 1.0000 | 1.0000 |
| Methanogens - hydrogenotrophic | 1.0000 | 1.0000 | 1.0000 |

| | | | |
|---|---|---|---|
| Endogenous products | 1.0000 | 1.0000 | 1.0000 |
| Slowly bio. COD (part.) | 1.0000 | 1.0000 | 1.0000 |
| Slowly bio. COD (colloid.) | 1.0000 | 1.0000 | 1.0000 |
| Part. inert. COD | 1.0000 | 1.0000 | 1.0000 |
| Part. bio. org. N | 1.0000 | 1.0000 | 1.0000 |
| Part. bio. org. P | 1.0000 | 1.0000 | 1.0000 |
| Part. inert N | 1.0000 | 1.0000 | 1.0000 |
| Part. inert P | 1.0000 | 1.0000 | 1.0000 |
| Stored PHA | 1.0000 | 1.0000 | 1.0000 |
| Releasable stored polyP | 1.0000 | 1.0000 | 1.0000 |
| Fixed stored polyP | 1.0000 | 1.0000 | 1.0000 |
| Readily bio. COD (complex) | 0 | 0 | 1.0000 |
| Acetate | 0 | 0 | 1.0000 |
| Propionate | 0 | 0 | 1.0000 |
| Methanol | 0 | 0 | 1.0000 |
| Dissolved H2 | 0 | 0 | 1.0000 |
| Dissolved methane | 0 | 0 | 1.0000 |
| Ammonia N | 0 | 0 | 1.0000 |
| Sol. bio. org. N | 0 | 0 | 1.0000 |
| Nitrous Oxide N | 0 | 0 | 1.0000 |
| Nitrite N | 0 | 0 | 1.0000 |
| Nitrate N | 0 | 0 | 1.0000 |
| Dissolved nitrogen gas | 0 | 0 | 1.0000 |
| PO4-P (Sol. & Me Complexed) | 1.0000 | 1.0000 | 1.0000 |
| Sol. inert COD | 0 | 0 | 1.0000 |
| Sol. inert TKN | 0 | 0 | 1.0000 |
| ISS Influent | 0.3300 | 0.3300 | 1.0000 |
| Struvite | 1.0000 | 1.0000 | 1.0000 |
| Hydroxy-dicalcium-phosphate | 1.0000 | 1.0000 | 1.0000 |
| Hydroxy-apatite | 1.0000 | 1.0000 | 1.0000 |
| Magnesium | 0 | 0 | 1.0000 |

| | | | |
|---|---|---|---|
| Calcium | 0 | 0 | 1.0000 |
| Metal | 1.0000 | 1.0000 | 1.0000 |
| Other Cations (strong bases) | 0 | 0 | 1.0000 |
| Other Anions (strong acids) | 0 | 0 | 1.0000 |
| Total CO2 | 0 | 0 | 1.0000 |
| User defined 1 | 0 | 0 | 1.0000 |
| User defined 2 | 0 | 0 | 1.0000 |
| User defined 3 | 1.0000 | 1.0000 | 1.0000 |
| User defined 4 | 1.0000 | 1.0000 | 1.0000 |
| Dissolved oxygen | 0 | 0 | 1.0000 |

Meridian Alternative's Analysis version 1

Expansion using selectable 5 stage modified Bardenpho/A2O process

Tank sizes optimized based on individual simulations from A2O and 5 stage modified Bardenpho processes

To achieve target effluent concentrations, for Bardenpho process:
Set BDF IMLR at 200% influent, Set A2O IMLR at 0%
Set Swing 1 Aerated, Swing 2a and 2b unaerated.
SRT = 12 days
Acetate flow pace at 0.8% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 0.5% of PE flow rate, 1% methanol solution.  All methanol to swing 2a

To achieve target effluent concentrations, for A2O process:
Set BDF IMLR at 0% influent, Set A2O IMLR at 400%
Set Swing 1 unaerated, Swing 2a and 2b aerated.
SRT = 12 days
Acetate flow pace at 0.6% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 1.5% of PE flow rate, 1% methanol solution.  all methanol to Anoxic 1a

**CENTRATE LOAD EQUALIZATION AND OPTIMIZATION**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Permit Limits | | | | | 0.307 | 1.25 | 8 | 10 | 0.5 | |
| | | | | | 30-D Ave | Max Day | 30-D Ave | 30-D Ave | 30-D Ave | |
| | Cen EQ | SRT | Basin Vol | Chem | NH3 | NH3 | NOx | TN | TP | |
| Run | hrs | days | Reduced? | Reduced? | mg/L | mg/L | mg/L | mg/L | mg/L | Notes |
| Bardenpho | -- | 12 | N | N | 0.27 | 0.63 | 5.34 | 7.95 | 0.41 | |
| CEN EQ_24hr | 24 | 12 | N | N | 0.27 | 0.63 | 5.34 | 7.95 | 0.41 | check ok! |
| CEN EQ_7hr | 7 | 12 | N | N | 0.18 | 0.34 | 5.75 | 8.15 | 0.42 | |
| CEN EQ_7hr | 7 | 11 | N | N | 0.24 | 0.5 | 5.02 | 7.54 | 0.38 | |
| CEN EQ_7hr | 7 | 10 | N | N | 0.36 | 0.79 | 3.91 | 6.78 | 0.38 | |
| CEN EQ_7hr | 7 | 10.5 | N | N | 0.29 | 0.62 | 4.52 | 7.17 | 0.36 | |
| CEN EQ_7hr_AB1 | 7 | 12 | Y | N | 0.24 | 0.49 | 4.65 | 7.25 | 0.44 | |
| CEN EQ_7hr_AB2 | 7 | 12 | Y | N | 0.82 | 1.85 | 1.35 | 5.9 | 0.51 | |
| CEN EQ_7hr_AB3 | 7 | 12 | Y | N | 0.39 | 0.89 | 2.69 | 5.9 | 0.47 | |
| CEN EQ_7hr_AB4 | 7 | 12 | Y | N | 0.29 | 0.62 | 3.86 | 6.67 | 0.45 | |
| CEN EQ_7hr_AB1 | 7 | 11 | Y | N | 0.34 | 0.74 | 3.74 | 6.65 | 0.4 | |
| CEN EQ_7hr_M1 | 7 | 12 | N | Y | 0.21 | 0.38 | 7.54 | 9.98 | 0.44 | |
| CEN EQ_7hr_AB4_M1 | 7 | 12 | Y | Y | 0.31 | 0.64 | 5.66 | 8.54 | 0.46 | |
| CEN EQ_7hr_AB4_M2 | 7 | 12 | Y | Y | 0.3 | 0.63 | 4.75 | 7.59 | 0.45 | Selected |

Centrate EQ options

Equalize centrate ammonia load from 12AM to 7AM

1. Can reduce SRT from 12 days to 10.5 days
2. Can reduce zone Aer2 from 2 MG to 1.25 MG
3. Can reduce MeOH from 0.6 MGD to 0.5MGD
4. Can reduce zone Aer 2 from 2MG to 1.25 MG and reduce MeOH from 0.06 MGD to 0.057 MGD

**Option 4 was best option selected**

**Adjust Basin Volumes**

modified

| | Volume MG | | | | |
|---|---|---|---|---|---|
| RUN | Bardenpho CEN_EQ | AB1 | AB2 | AB3 | AB4 |
| **Ana1** | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| **Anox1a** | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 |
| **Anox1b** | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 |
| **Swing1** | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| **Aer1** | 1.5 | 1.5 | 1 | 1.25 | 1.5 |
| **Aer2** | 2 | 1.5 | 1 | 1.25 | 1.25 |
| **Swing2a** | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 |
| **Swing2b** | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 |
| **Aer3** | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

**Adjust Methanol Dosing**

| | Flow Pacing to PE | MeOH Flow |
|---|---|---|
| **RUN** | **%** | **mgd** |
| **Bardenpho_CEN_EQ** | 0.5 | 0.06 |
| **M1** | 0.4 | 0.05 |
| **M2** | 0.45 | 0.057 |

| Time (days) | Flow | Total COD mgCOD/L | Total Kjeldahl Nitrogen mgN/L | Total P mgP/L | Nitrate N mgN/L | pH | Alkalinity mmol/L | Inorganic S.S. mgISS/L | Calcium mg/L | Magnesium mg/L | Dissolved oxygen mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 0.43789652 | 1801.802 | 976.3 | 529.80576 | 0 | 7.9 | 82 | 264.317882 | 24.8 | 2.72 | 0 |
| 0.083 | 0.43789652 | 1801.802 | 976.3 | 529.80576 | 0 | 7.9 | 82 | 264.317882 | 24.8 | 2.72 | 0 |
| 0.125 | 0.43789652 | 1801.802 | 976.3 | 529.80576 | 0 | 7.9 | 82 | 264.317882 | 24.8 | 2.72 | 0 |
| 0.250 | 0.43789652 | 1801.802 | 976.3 | 529.80576 | 0 | 7.9 | 82 | 264.317882 | 24.8 | 2.72 | 0 |
| 0.292 | 0.43789652 | 1801.802 | 976.3 | 529.80576 | 0 | 7.9 | 82 | 264.317882 | 24.8 | 2.72 | 0 |
| 0.333 | 0 | | | | | | | | | | |
| 0.417 | 0 | | | | | | | | | | |
| 0.500 | 0 | | | | | | | | | | |
| 0.583 | 0 | | | | | | | | | | |
| 0.667 | 0 | | | | | | | | | | |
| 0.750 | 0 | | | | | | | | | | |
| 0.833 | 0 | | | | | | | | | | |
| 0.917 | 0 | | | | | | | | | | |
| 1.000 | 0.37719135 | 1801.802 | 915.5 | 529.80576 | 0 | 7.9 | 82 | 160.192772 | 24.8 | 2.72 | 0 |
| 1.083 | 0.37719135 | 1801.802 | 915.5 | 529.80576 | 0 | 7.9 | 82 | 160.192772 | 24.8 | 2.72 | 0 |
| 1.125 | 0.37719135 | 1801.802 | 915.5 | 529.80576 | 0 | 7.9 | 82 | 160.192772 | 24.8 | 2.72 | 0 |
| 1.250 | 0.37719135 | 1801.802 | 915.5 | 529.80576 | 0 | 7.9 | 82 | 160.192772 | 24.8 | 2.72 | 0 |
| 1.292 | 0.37719135 | 1801.802 | 915.5 | 529.80576 | 0 | 7.9 | 82 | 160.192772 | 24.8 | 2.72 | 0 |
| 1.333 | 0 | | | | | | | | | | |
| 1.417 | 0 | | | | | | | | | | |
| 1.500 | 0 | | | | | | | | | | |
| 1.583 | 0 | | | | | | | | | | |
| 1.667 | 0 | | | | | | | | | | |
| 1.750 | 0 | | | | | | | | | | |
| 1.833 | 0 | | | | | | | | | | |
| 1.917 | 0 | | | | | | | | | | |
| 2.000 | 0.37109169 | 1801.802 | 865.7 | 529.80576 | 0 | 7.9 | 82 | 127.518246 | 24.8 | 2.72 | 0 |
| 2.083 | 0.37109169 | 1801.802 | 865.7 | 529.80576 | 0 | 7.9 | 82 | 127.518246 | 24.8 | 2.72 | 0 |
| 2.125 | 0.37109169 | 1801.802 | 865.7 | 529.80576 | 0 | 7.9 | 82 | 127.518246 | 24.8 | 2.72 | 0 |
| 2.250 | 0.37109169 | 1801.802 | 865.7 | 529.80576 | 0 | 7.9 | 82 | 127.518246 | 24.8 | 2.72 | 0 |
| 2.292 | 0.37109169 | 1801.802 | 865.7 | 529.80576 | 0 | 7.9 | 82 | 127.518246 | 24.8 | 2.72 | 0 |
| 2.333 | 0 | | | | | | | | | | |
| 2.417 | 0 | | | | | | | | | | |
| 2.500 | 0 | | | | | | | | | | |
| 2.583 | 0 | | | | | | | | | | |
| 2.667 | 0 | | | | | | | | | | |
| 2.750 | 0 | | | | | | | | | | |
| 2.833 | 0 | | | | | | | | | | |
| 2.917 | 0 | | | | | | | | | | |
| 3.000 | 0.38308793 | 1801.802 | 977.3 | 529.80576 | 0 | 7.9 | 82 | 181.642089 | 24.8 | 2.72 | 0 |
| 3.083 | 0.38308793 | 1801.802 | 977.3 | 529.80576 | 0 | 7.9 | 82 | 181.642089 | 24.8 | 2.72 | 0 |
| 3.125 | 0.38308793 | 1801.802 | 977.3 | 529.80576 | 0 | 7.9 | 82 | 181.642089 | 24.8 | 2.72 | 0 |
| 3.250 | 0.38308793 | 1801.802 | 977.3 | 529.80576 | 0 | 7.9 | 82 | 181.642089 | 24.8 | 2.72 | 0 |
| 3.292 | 0.38308793 | 1801.802 | 977.3 | 529.80576 | 0 | 7.9 | 82 | 181.642089 | 24.8 | 2.72 | 0 |
| 3.333 | 0 | | | | | | | | | | |
| 3.417 | 0 | | | | | | | | | | |
| 3.500 | 0 | | | | | | | | | | |
| 3.583 | 0 | | | | | | | | | | |
| 3.667 | 0 | | | | | | | | | | |
| 3.750 | 0 | | | | | | | | | | |
| 3.833 | 0 | | | | | | | | | | |
| 3.917 | 0 | | | | | | | | | | |
| 4.000 | 0.2789805 | 1801.802 | 939.1 | 529.80576 | 0 | 7.9 | 82 | 79.1349048 | 24.8 | 2.72 | 0 |
| 4.083 | 0.2789805 | 1801.802 | 939.1 | 529.80576 | 0 | 7.9 | 82 | 79.1349048 | 24.8 | 2.72 | 0 |
| 4.125 | 0.2789805 | 1801.802 | 939.1 | 529.80576 | 0 | 7.9 | 82 | 79.1349048 | 24.8 | 2.72 | 0 |
| 4.250 | 0.2789805 | 1801.802 | 939.1 | 529.80576 | 0 | 7.9 | 82 | 79.1349048 | 24.8 | 2.72 | 0 |
| 4.292 | 0.2789805 | 1801.802 | 939.1 | 529.80576 | 0 | 7.9 | 82 | 79.1349048 | 24.8 | 2.72 | 0 |
| 4.333 | 0 | | | | | | | | | | |
| 4.417 | 0 | | | | | | | | | | |
| 4.500 | 0 | | | | | | | | | | |
| 4.583 | 0 | | | | | | | | | | |
| 4.667 | 0 | | | | | | | | | | |
| 4.750 | 0 | | | | | | | | | | |
| 4.833 | 0 | | | | | | | | | | |
| 4.917 | 0 | | | | | | | | | | |

| Time (days) | Flow | Total COD mgCOD/L | Total Kjeldahl Nitrogen mgN/L | Total P mgP/L | Nitrate N mgN/L | pH | Alkalinity mmol/L | Inorganic S.S. mgISS/L | Calcium mg/L | Magnesium mg/L | Dissolved oxygen mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.000 | 0.26183965 | 1801.802 | 971.7 | 529.80576 | 0 | 7.9 | 82 | 56.9103224 | 24.8 | 2.72 | 0 |
| 5.083 | 0.26183965 | 1801.802 | 971.7 | 529.80576 | 0 | 7.9 | 82 | 56.9103224 | 24.8 | 2.72 | 0 |
| 5.125 | 0.26183965 | 1801.802 | 971.7 | 529.80576 | 0 | 7.9 | 82 | 56.9103224 | 24.8 | 2.72 | 0 |
| 5.250 | 0.26183965 | 1801.802 | 971.7 | 529.80576 | 0 | 7.9 | 82 | 56.9103224 | 24.8 | 2.72 | 0 |
| 5.292 | 0.26183965 | 1801.802 | 971.7 | 529.80576 | 0 | 7.9 | 82 | 56.9103224 | 24.8 | 2.72 | 0 |
| 5.333 | 0 | | | | | | | | | | |
| 5.417 | 0 | | | | | | | | | | |
| 5.500 | 0 | | | | | | | | | | |
| 5.583 | 0 | | | | | | | | | | |
| 5.667 | 0 | | | | | | | | | | |
| 5.750 | 0 | | | | | | | | | | |
| 5.833 | 0 | | | | | | | | | | |
| 5.917 | 0 | | | | | | | | | | |
| 6.000 | 0.21329618 | 1801.802 | 954.4 | 529.80576 | 0 | 7.9 | 82 | 56.495922 | 24.8 | 2.72 | 0 |
| 6.083 | 0.21329618 | 1801.802 | 954.4 | 529.80576 | 0 | 7.9 | 82 | 56.495922 | 24.8 | 2.72 | 0 |
| 6.125 | 0.21329618 | 1801.802 | 954.4 | 529.80576 | 0 | 7.9 | 82 | 56.495922 | 24.8 | 2.72 | 0 |
| 6.250 | 0.21329618 | 1801.802 | 954.4 | 529.80576 | 0 | 7.9 | 82 | 56.495922 | 24.8 | 2.72 | 0 |
| 6.292 | 0.21329618 | 1801.802 | 954.4 | 529.80576 | 0 | 7.9 | 82 | 56.495922 | 24.8 | 2.72 | 0 |
| 6.333 | 0 | | | | | | | | | | |
| 6.417 | 0 | | | | | | | | | | |
| 6.500 | 0 | | | | | | | | | | |
| 6.583 | 0 | | | | | | | | | | |
| 6.667 | 0 | | | | | | | | | | |
| 6.750 | 0 | | | | | | | | | | |
| 6.833 | 0 | | | | | | | | | | |
| 6.917 | 0 | | | | | | | | | | |
| 7.000 | 0.2881506 | 1801.802 | 941.3 | 529.80576 | 0 | 7.9 | 82 | 141.792798 | 24.8 | 2.72 | 0 |
| 7.083 | 0.2881506 | 1801.802 | 941.3 | 529.80576 | 0 | 7.9 | 82 | 141.792798 | 24.8 | 2.72 | 0 |
| 7.125 | 0.2881506 | 1801.802 | 941.3 | 529.80576 | 0 | 7.9 | 82 | 141.792798 | 24.8 | 2.72 | 0 |
| 7.250 | 0.2881506 | 1801.802 | 941.3 | 529.80576 | 0 | 7.9 | 82 | 141.792798 | 24.8 | 2.72 | 0 |
| 7.292 | 0.2881506 | 1801.802 | 941.3 | 529.80576 | 0 | 7.9 | 82 | 141.792798 | 24.8 | 2.72 | 0 |
| 7.333 | 0 | | | | | | | | | | |
| 7.417 | 0 | | | | | | | | | | |
| 7.500 | 0 | | | | | | | | | | |
| 7.583 | 0 | | | | | | | | | | |
| 7.667 | 0 | | | | | | | | | | |
| 7.750 | 0 | | | | | | | | | | |
| 7.833 | 0 | | | | | | | | | | |
| 7.917 | 0 | | | | | | | | | | |
| 8.000 | 0.2465276 | 1801.802 | 956.4 | 529.80576 | 0 | 7.9 | 82 | 176.958633 | 24.8 | 2.72 | 0 |
| 8.083 | 0.2465276 | 1801.802 | 956.4 | 529.80576 | 0 | 7.9 | 82 | 176.958633 | 24.8 | 2.72 | 0 |
| 8.125 | 0.2465276 | 1801.802 | 956.4 | 529.80576 | 0 | 7.9 | 82 | 176.958633 | 24.8 | 2.72 | 0 |
| 8.250 | 0.2465276 | 1801.802 | 956.4 | 529.80576 | 0 | 7.9 | 82 | 176.958633 | 24.8 | 2.72 | 0 |
| 8.292 | 0.2465276 | 1801.802 | 956.4 | 529.80576 | 0 | 7.9 | 82 | 176.958633 | 24.8 | 2.72 | 0 |
| 8.333 | 0 | | | | | | | | | | |
| 8.417 | 0 | | | | | | | | | | |
| 8.500 | 0 | | | | | | | | | | |
| 8.583 | 0 | | | | | | | | | | |
| 8.667 | 0 | | | | | | | | | | |
| 8.750 | 0 | | | | | | | | | | |
| 8.833 | 0 | | | | | | | | | | |
| 8.917 | 0 | | | | | | | | | | |
| 9.000 | 0.29225996 | 1801.802 | 922.4 | 529.80576 | 0 | 7.9 | 82 | 95.5565461 | 24.8 | 2.72 | 0 |
| 9.083 | 0.29225996 | 1801.802 | 922.4 | 529.80576 | 0 | 7.9 | 82 | 95.5565461 | 24.8 | 2.72 | 0 |
| 9.125 | 0.29225996 | 1801.802 | 922.4 | 529.80576 | 0 | 7.9 | 82 | 95.5565461 | 24.8 | 2.72 | 0 |
| 9.250 | 0.29225996 | 1801.802 | 922.4 | 529.80576 | 0 | 7.9 | 82 | 95.5565461 | 24.8 | 2.72 | 0 |
| 9.292 | 0.29225996 | 1801.802 | 922.4 | 529.80576 | 0 | 7.9 | 82 | 95.5565461 | 24.8 | 2.72 | 0 |
| 9.333 | 0 | | | | | | | | | | |
| 9.417 | 0 | | | | | | | | | | |
| 9.500 | 0 | | | | | | | | | | |
| 9.583 | 0 | | | | | | | | | | |
| 9.667 | 0 | | | | | | | | | | |
| 9.750 | 0 | | | | | | | | | | |
| 9.833 | 0 | | | | | | | | | | |
| 9.917 | 0 | | | | | | | | | | |

| Time (days) | Flow | Total COD mgCOD/L | Total Kjeldahl Nitrogen mgN/L | Total P mgP/L | Nitrate N mgN/L | pH | Alkalinity mmol/L | Inorganic S.S. mgISS/L | Calcium mg/L | Magnesium mg/L | Dissolved oxygen mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.000 | 0.31955219 | 1801.802 | 970.2 | 529.80576 | 0 | 7.9 | 82 | 151.727613 | 24.8 | 2.72 | 0 |
| 10.083 | 0.31955219 | 1801.802 | 970.2 | 529.80576 | 0 | 7.9 | 82 | 151.727613 | 24.8 | 2.72 | 0 |
| 10.125 | 0.31955219 | 1801.802 | 970.2 | 529.80576 | 0 | 7.9 | 82 | 151.727613 | 24.8 | 2.72 | 0 |
| 10.250 | 0.31955219 | 1801.802 | 970.2 | 529.80576 | 0 | 7.9 | 82 | 151.727613 | 24.8 | 2.72 | 0 |
| 10.292 | 0.31955219 | 1801.802 | 970.2 | 529.80576 | 0 | 7.9 | 82 | 151.727613 | 24.8 | 2.72 | 0 |
| 10.333 | 0 | | | | | | | | | | |
| 10.417 | 0 | | | | | | | | | | |
| 10.500 | 0 | | | | | | | | | | |
| 10.583 | 0 | | | | | | | | | | |
| 10.667 | 0 | | | | | | | | | | |
| 10.750 | 0 | | | | | | | | | | |
| 10.833 | 0 | | | | | | | | | | |
| 10.917 | 0 | | | | | | | | | | |
| 11.000 | 0.36608102 | 1801.802 | 942.1 | 529.80576 | 0 | 7.9 | 82 | 215.811924 | 24.8 | 2.72 | 0 |
| 11.083 | 0.36608102 | 1801.802 | 942.1 | 529.80576 | 0 | 7.9 | 82 | 215.811924 | 24.8 | 2.72 | 0 |
| 11.125 | 0.36608102 | 1801.802 | 942.1 | 529.80576 | 0 | 7.9 | 82 | 215.811924 | 24.8 | 2.72 | 0 |
| 11.250 | 0.36608102 | 1801.802 | 942.1 | 529.80576 | 0 | 7.9 | 82 | 215.811924 | 24.8 | 2.72 | 0 |
| 11.292 | 0.36608102 | 1801.802 | 942.1 | 529.80576 | 0 | 7.9 | 82 | 215.811924 | 24.8 | 2.72 | 0 |
| 11.333 | 0 | | | | | | | | | | |
| 11.417 | 0 | | | | | | | | | | |
| 11.500 | 0 | | | | | | | | | | |
| 11.583 | 0 | | | | | | | | | | |
| 11.667 | 0 | | | | | | | | | | |
| 11.750 | 0 | | | | | | | | | | |
| 11.833 | 0 | | | | | | | | | | |
| 11.917 | 0 | | | | | | | | | | |
| 12.000 | 0.3415931 | 1801.802 | 944.2 | 529.80576 | 0 | 7.9 | 82 | 283.844444 | 24.8 | 2.72 | 0 |
| 12.083 | 0.3415931 | 1801.802 | 944.2 | 529.80576 | 0 | 7.9 | 82 | 283.844444 | 24.8 | 2.72 | 0 |
| 12.125 | 0.3415931 | 1801.802 | 944.2 | 529.80576 | 0 | 7.9 | 82 | 283.844444 | 24.8 | 2.72 | 0 |
| 12.250 | 0.3415931 | 1801.802 | 944.2 | 529.80576 | 0 | 7.9 | 82 | 283.844444 | 24.8 | 2.72 | 0 |
| 12.292 | 0.3415931 | 1801.802 | 944.2 | 529.80576 | 0 | 7.9 | 82 | 283.844444 | 24.8 | 2.72 | 0 |
| 12.333 | 0 | | | | | | | | | | |
| 12.417 | 0 | | | | | | | | | | |
| 12.500 | 0 | | | | | | | | | | |
| 12.583 | 0 | | | | | | | | | | |
| 12.667 | 0 | | | | | | | | | | |
| 12.750 | 0 | | | | | | | | | | |
| 12.833 | 0 | | | | | | | | | | |
| 12.917 | 0 | | | | | | | | | | |
| 13.000 | 0.32749548 | 1801.802 | 935.0 | 529.80576 | 0 | 7.9 | 82 | 274.253405 | 24.8 | 2.72 | 0 |
| 13.083 | 0.32749548 | 1801.802 | 935.0 | 529.80576 | 0 | 7.9 | 82 | 274.253405 | 24.8 | 2.72 | 0 |
| 13.125 | 0.32749548 | 1801.802 | 935.0 | 529.80576 | 0 | 7.9 | 82 | 274.253405 | 24.8 | 2.72 | 0 |
| 13.250 | 0.32749548 | 1801.802 | 935.0 | 529.80576 | 0 | 7.9 | 82 | 274.253405 | 24.8 | 2.72 | 0 |
| 13.292 | 0.32749548 | 1801.802 | 935.0 | 529.80576 | 0 | 7.9 | 82 | 274.253405 | 24.8 | 2.72 | 0 |
| 13.333 | 0 | | | | | | | | | | |
| 13.417 | 0 | | | | | | | | | | |
| 13.500 | 0 | | | | | | | | | | |
| 13.583 | 0 | | | | | | | | | | |
| 13.667 | 0 | | | | | | | | | | |
| 13.750 | 0 | | | | | | | | | | |
| 13.833 | 0 | | | | | | | | | | |
| 13.917 | 0 | | | | | | | | | | |
| 14.000 | 0.34717684 | 1801.802 | 989.8 | 529.80576 | 0 | 7.9 | 82 | 239.772423 | 24.8 | 2.72 | 0 |
| 14.083 | 0.34717684 | 1801.802 | 989.8 | 529.80576 | 0 | 7.9 | 82 | 239.772423 | 24.8 | 2.72 | 0 |
| 14.125 | 0.34717684 | 1801.802 | 989.8 | 529.80576 | 0 | 7.9 | 82 | 239.772423 | 24.8 | 2.72 | 0 |
| 14.250 | 0.34717684 | 1801.802 | 989.8 | 529.80576 | 0 | 7.9 | 82 | 239.772423 | 24.8 | 2.72 | 0 |
| 14.292 | 0.34717684 | 1801.802 | 989.8 | 529.80576 | 0 | 7.9 | 82 | 239.772423 | 24.8 | 2.72 | 0 |
| 14.333 | 0 | | | | | | | | | | |
| 14.417 | 0 | | | | | | | | | | |
| 14.500 | 0 | | | | | | | | | | |
| 14.583 | 0 | | | | | | | | | | |
| 14.667 | 0 | | | | | | | | | | |
| 14.750 | 0 | | | | | | | | | | |
| 14.833 | 0 | | | | | | | | | | |
| 14.917 | 0 | | | | | | | | | | |

| Time (days) | Flow | Total COD mgCOD/L | Total Kjeldahl Nitrogen mgN/L | Total P mgP/L | Nitrate N mgN/L | pH | Alkalinity mmol/L | Inorganic S.S. mgISS/L | Calcium mg/L | Magnesium mg/L | Dissolved oxygen mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15.000 | 0.31767991 | 1801.802 | 946.6 | 529.80576 | 0 | 7.9 | 82 | 249.915461 | 24.8 | 2.72 | 0 |
| 15.083 | 0.31767991 | 1801.802 | 946.6 | 529.80576 | 0 | 7.9 | 82 | 249.915461 | 24.8 | 2.72 | 0 |
| 15.125 | 0.31767991 | 1801.802 | 946.6 | 529.80576 | 0 | 7.9 | 82 | 249.915461 | 24.8 | 2.72 | 0 |
| 15.250 | 0.31767991 | 1801.802 | 946.6 | 529.80576 | 0 | 7.9 | 82 | 249.915461 | 24.8 | 2.72 | 0 |
| 15.292 | 0.31767991 | 1801.802 | 946.6 | 529.80576 | 0 | 7.9 | 82 | 249.915461 | 24.8 | 2.72 | 0 |
| 15.333 | 0 | | | | | | | | | | |
| 15.417 | 0 | | | | | | | | | | |
| 15.500 | 0 | | | | | | | | | | |
| 15.583 | 0 | | | | | | | | | | |
| 15.667 | 0 | | | | | | | | | | |
| 15.750 | 0 | | | | | | | | | | |
| 15.833 | 0 | | | | | | | | | | |
| 15.917 | 0 | | | | | | | | | | |
| 16.000 | 0.34305758 | 1801.802 | 947.2 | 529.80576 | 0 | 7.9 | 82 | 231.893132 | 24.8 | 2.72 | 0 |
| 16.083 | 0.34305758 | 1801.802 | 947.2 | 529.80576 | 0 | 7.9 | 82 | 231.893132 | 24.8 | 2.72 | 0 |
| 16.125 | 0.34305758 | 1801.802 | 947.2 | 529.80576 | 0 | 7.9 | 82 | 231.893132 | 24.8 | 2.72 | 0 |
| 16.250 | 0.34305758 | 1801.802 | 947.2 | 529.80576 | 0 | 7.9 | 82 | 231.893132 | 24.8 | 2.72 | 0 |
| 16.292 | 0.34305758 | 1801.802 | 947.2 | 529.80576 | 0 | 7.9 | 82 | 231.893132 | 24.8 | 2.72 | 0 |
| 16.333 | 0 | | | | | | | | | | |
| 16.417 | 0 | | | | | | | | | | |
| 16.500 | 0 | | | | | | | | | | |
| 16.583 | 0 | | | | | | | | | | |
| 16.667 | 0 | | | | | | | | | | |
| 16.750 | 0 | | | | | | | | | | |
| 16.833 | 0 | | | | | | | | | | |
| 16.917 | 0 | | | | | | | | | | |
| 17.000 | 0.29311305 | 1801.802 | 975.8 | 529.80576 | 0 | 7.9 | 82 | 161.824108 | 24.8 | 2.72 | 0 |
| 17.083 | 0.29311305 | 1801.802 | 975.8 | 529.80576 | 0 | 7.9 | 82 | 161.824108 | 24.8 | 2.72 | 0 |
| 17.125 | 0.29311305 | 1801.802 | 975.8 | 529.80576 | 0 | 7.9 | 82 | 161.824108 | 24.8 | 2.72 | 0 |
| 17.250 | 0.29311305 | 1801.802 | 975.8 | 529.80576 | 0 | 7.9 | 82 | 161.824108 | 24.8 | 2.72 | 0 |
| 17.292 | 0.29311305 | 1801.802 | 975.8 | 529.80576 | 0 | 7.9 | 82 | 161.824108 | 24.8 | 2.72 | 0 |
| 17.333 | 0 | | | | | | | | | | |
| 17.417 | 0 | | | | | | | | | | |
| 17.500 | 0 | | | | | | | | | | |
| 17.583 | 0 | | | | | | | | | | |
| 17.667 | 0 | | | | | | | | | | |
| 17.750 | 0 | | | | | | | | | | |
| 17.833 | 0 | | | | | | | | | | |
| 17.917 | 0 | | | | | | | | | | |
| 18.000 | 0.2962044 | 1801.802 | 1039.4 | 529.80576 | 0 | 7.9 | 82 | 155.664391 | 24.8 | 2.72 | 0 |
| 18.083 | 0.2962044 | 1801.802 | 1039.4 | 529.80576 | 0 | 7.9 | 82 | 155.664391 | 24.8 | 2.72 | 0 |
| 18.125 | 0.2962044 | 1801.802 | 1039.4 | 529.80576 | 0 | 7.9 | 82 | 155.664391 | 24.8 | 2.72 | 0 |
| 18.250 | 0.2962044 | 1801.802 | 1039.4 | 529.80576 | 0 | 7.9 | 82 | 155.664391 | 24.8 | 2.72 | 0 |
| 18.292 | 0.2962044 | 1801.802 | 1039.4 | 529.80576 | 0 | 7.9 | 82 | 155.664391 | 24.8 | 2.72 | 0 |
| 18.333 | 0 | | | | | | | | | | |
| 18.417 | 0 | | | | | | | | | | |
| 18.500 | 0 | | | | | | | | | | |
| 18.583 | 0 | | | | | | | | | | |
| 18.667 | 0 | | | | | | | | | | |
| 18.750 | 0 | | | | | | | | | | |
| 18.833 | 0 | | | | | | | | | | |
| 18.917 | 0 | | | | | | | | | | |
| 19.000 | 0.22328356 | 1801.802 | 1052.2 | 529.80576 | 0 | 7.9 | 82 | 214.728131 | 24.8 | 2.72 | 0 |
| 19.083 | 0.22328356 | 1801.802 | 1052.2 | 529.80576 | 0 | 7.9 | 82 | 214.728131 | 24.8 | 2.72 | 0 |
| 19.125 | 0.22328356 | 1801.802 | 1052.2 | 529.80576 | 0 | 7.9 | 82 | 214.728131 | 24.8 | 2.72 | 0 |
| 19.250 | 0.22328356 | 1801.802 | 1052.2 | 529.80576 | 0 | 7.9 | 82 | 214.728131 | 24.8 | 2.72 | 0 |
| 19.292 | 0.22328356 | 1801.802 | 1052.2 | 529.80576 | 0 | 7.9 | 82 | 214.728131 | 24.8 | 2.72 | 0 |
| 19.333 | 0 | | | | | | | | | | |
| 19.417 | 0 | | | | | | | | | | |
| 19.500 | 0 | | | | | | | | | | |
| 19.583 | 0 | | | | | | | | | | |
| 19.667 | 0 | | | | | | | | | | |
| 19.750 | 0 | | | | | | | | | | |
| 19.833 | 0 | | | | | | | | | | |
| 19.917 | 0 | | | | | | | | | | |

| Time (days) | Flow | Total COD mgCOD/L | Total Kjeldahl Nitrogen mgN/L | Total P mgP/L | Nitrate N mgN/L | pH | Alkalinity mmol/L | Inorganic S.S. mgISS/L | Calcium mg/L | Magnesium mg/L | Dissolved oxygen mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.000 | 0.2329057 | 1801.802 | 985.0 | 529.80576 | 0 | 7.9 | 82 | 187.935926 | 24.8 | 2.72 | 0 |
| 20.083 | 0.2329057 | 1801.802 | 985.0 | 529.80576 | 0 | 7.9 | 82 | 187.935926 | 24.8 | 2.72 | 0 |
| 20.125 | 0.2329057 | 1801.802 | 985.0 | 529.80576 | 0 | 7.9 | 82 | 187.935926 | 24.8 | 2.72 | 0 |
| 20.250 | 0.2329057 | 1801.802 | 985.0 | 529.80576 | 0 | 7.9 | 82 | 187.935926 | 24.8 | 2.72 | 0 |
| 20.292 | 0.2329057 | 1801.802 | 985.0 | 529.80576 | 0 | 7.9 | 82 | 187.935926 | 24.8 | 2.72 | 0 |
| 20.333 | 0 | | | | | | | | | | |
| 20.417 | 0 | | | | | | | | | | |
| 20.500 | 0 | | | | | | | | | | |
| 20.583 | 0 | | | | | | | | | | |
| 20.667 | 0 | | | | | | | | | | |
| 20.750 | 0 | | | | | | | | | | |
| 20.833 | 0 | | | | | | | | | | |
| 20.917 | 0 | | | | | | | | | | |
| 21.000 | 0.20704903 | 1801.802 | 939.6 | 529.80576 | 0 | 7.9 | 82 | 128.137123 | 24.8 | 2.72 | 0 |
| 21.083 | 0.20704903 | 1801.802 | 939.6 | 529.80576 | 0 | 7.9 | 82 | 128.137123 | 24.8 | 2.72 | 0 |
| 21.125 | 0.20704903 | 1801.802 | 939.6 | 529.80576 | 0 | 7.9 | 82 | 128.137123 | 24.8 | 2.72 | 0 |
| 21.250 | 0.20704903 | 1801.802 | 939.6 | 529.80576 | 0 | 7.9 | 82 | 128.137123 | 24.8 | 2.72 | 0 |
| 21.292 | 0.20704903 | 1801.802 | 939.6 | 529.80576 | 0 | 7.9 | 82 | 128.137123 | 24.8 | 2.72 | 0 |
| 21.333 | 0 | | | | | | | | | | |
| 21.417 | 0 | | | | | | | | | | |
| 21.500 | 0 | | | | | | | | | | |
| 21.583 | 0 | | | | | | | | | | |
| 21.667 | 0 | | | | | | | | | | |
| 21.750 | 0 | | | | | | | | | | |
| 21.833 | 0 | | | | | | | | | | |
| 21.917 | 0 | | | | | | | | | | |
| 22.000 | 0.24389604 | 1801.802 | 938.9 | 529.80576 | 0 | 7.9 | 82 | 99.0254652 | 24.8 | 2.72 | 0 |
| 22.083 | 0.24389604 | 1801.802 | 938.9 | 529.80576 | 0 | 7.9 | 82 | 99.0254652 | 24.8 | 2.72 | 0 |
| 22.125 | 0.24389604 | 1801.802 | 938.9 | 529.80576 | 0 | 7.9 | 82 | 99.0254652 | 24.8 | 2.72 | 0 |
| 22.250 | 0.24389604 | 1801.802 | 938.9 | 529.80576 | 0 | 7.9 | 82 | 99.0254652 | 24.8 | 2.72 | 0 |
| 22.292 | 0.24389604 | 1801.802 | 938.9 | 529.80576 | 0 | 7.9 | 82 | 99.0254652 | 24.8 | 2.72 | 0 |
| 22.333 | 0 | | | | | | | | | | |
| 22.417 | 0 | | | | | | | | | | |
| 22.500 | 0 | | | | | | | | | | |
| 22.583 | 0 | | | | | | | | | | |
| 22.667 | 0 | | | | | | | | | | |
| 22.750 | 0 | | | | | | | | | | |
| 22.833 | 0 | | | | | | | | | | |
| 22.917 | 0 | | | | | | | | | | |
| 23.000 | 0.21606118 | 1801.802 | 923.5 | 529.80576 | 0 | 7.9 | 82 | 210.617904 | 24.8 | 2.72 | 0 |
| 23.083 | 0.21606118 | 1801.802 | 923.5 | 529.80576 | 0 | 7.9 | 82 | 210.617904 | 24.8 | 2.72 | 0 |
| 23.125 | 0.21606118 | 1801.802 | 923.5 | 529.80576 | 0 | 7.9 | 82 | 210.617904 | 24.8 | 2.72 | 0 |
| 23.250 | 0.21606118 | 1801.802 | 923.5 | 529.80576 | 0 | 7.9 | 82 | 210.617904 | 24.8 | 2.72 | 0 |
| 23.292 | 0.21606118 | 1801.802 | 923.5 | 529.80576 | 0 | 7.9 | 82 | 210.617904 | 24.8 | 2.72 | 0 |
| 23.333 | 0 | | | | | | | | | | |
| 23.417 | 0 | | | | | | | | | | |
| 23.500 | 0 | | | | | | | | | | |
| 23.583 | 0 | | | | | | | | | | |
| 23.667 | 0 | | | | | | | | | | |
| 23.750 | 0 | | | | | | | | | | |
| 23.833 | 0 | | | | | | | | | | |
| 23.917 | 0 | | | | | | | | | | |
| 24.000 | 0.33069352 | 1801.802 | 900.4 | 529.80576 | 0 | 7.9 | 82 | 232.161155 | 24.8 | 2.72 | 0 |
| 24.083 | 0.33069352 | 1801.802 | 900.4 | 529.80576 | 0 | 7.9 | 82 | 232.161155 | 24.8 | 2.72 | 0 |
| 24.125 | 0.33069352 | 1801.802 | 900.4 | 529.80576 | 0 | 7.9 | 82 | 232.161155 | 24.8 | 2.72 | 0 |
| 24.250 | 0.33069352 | 1801.802 | 900.4 | 529.80576 | 0 | 7.9 | 82 | 232.161155 | 24.8 | 2.72 | 0 |
| 24.292 | 0.33069352 | 1801.802 | 900.4 | 529.80576 | 0 | 7.9 | 82 | 232.161155 | 24.8 | 2.72 | 0 |
| 24.333 | 0 | | | | | | | | | | |
| 24.417 | 0 | | | | | | | | | | |
| 24.500 | 0 | | | | | | | | | | |
| 24.583 | 0 | | | | | | | | | | |
| 24.667 | 0 | | | | | | | | | | |
| 24.750 | 0 | | | | | | | | | | |
| 24.833 | 0 | | | | | | | | | | |
| 24.917 | 0 | | | | | | | | | | |

| Time (days) | Flow | Total COD mgCOD/L | Total Kjeldahl Nitrogen mgN/L | Total P mgP/L | Nitrate N mgN/L | pH | Alkalinity mmol/L | Inorganic S.S. mgISS/L | Calcium mg/L | Magnesium mg/L | Dissolved oxygen mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 25.000 | 0.29928528 | 1801.802 | 862.1 | 529.80576 | 0 | 7.9 | 82 | 260.189688 | 24.8 | 2.72 | 0 |
| 25.083 | 0.29928528 | 1801.802 | 862.1 | 529.80576 | 0 | 7.9 | 82 | 260.189688 | 24.8 | 2.72 | 0 |
| 25.125 | 0.29928528 | 1801.802 | 862.1 | 529.80576 | 0 | 7.9 | 82 | 260.189688 | 24.8 | 2.72 | 0 |
| 25.250 | 0.29928528 | 1801.802 | 862.1 | 529.80576 | 0 | 7.9 | 82 | 260.189688 | 24.8 | 2.72 | 0 |
| 25.292 | 0.29928528 | 1801.802 | 862.1 | 529.80576 | 0 | 7.9 | 82 | 260.189688 | 24.8 | 2.72 | 0 |
| 25.333 | 0 | | | | | | | | | | |
| 25.417 | 0 | | | | | | | | | | |
| 25.500 | 0 | | | | | | | | | | |
| 25.583 | 0 | | | | | | | | | | |
| 25.667 | 0 | | | | | | | | | | |
| 25.750 | 0 | | | | | | | | | | |
| 25.833 | 0 | | | | | | | | | | |
| 25.917 | 0 | | | | | | | | | | |
| 26.000 | 0.2804956 | 1801.802 | 833.5 | 529.80576 | 0 | 7.9 | 82 | 193.228479 | 24.8 | 2.72 | 0 |
| 26.083 | 0.2804956 | 1801.802 | 833.5 | 529.80576 | 0 | 7.9 | 82 | 193.228479 | 24.8 | 2.72 | 0 |
| 26.125 | 0.2804956 | 1801.802 | 833.5 | 529.80576 | 0 | 7.9 | 82 | 193.228479 | 24.8 | 2.72 | 0 |
| 26.250 | 0.2804956 | 1801.802 | 833.5 | 529.80576 | 0 | 7.9 | 82 | 193.228479 | 24.8 | 2.72 | 0 |
| 26.292 | 0.2804956 | 1801.802 | 833.5 | 529.80576 | 0 | 7.9 | 82 | 193.228479 | 24.8 | 2.72 | 0 |
| 26.333 | 0 | | | | | | | | | | |
| 26.417 | 0 | | | | | | | | | | |
| 26.500 | 0 | | | | | | | | | | |
| 26.583 | 0 | | | | | | | | | | |
| 26.667 | 0 | | | | | | | | | | |
| 26.750 | 0 | | | | | | | | | | |
| 26.833 | 0 | | | | | | | | | | |
| 26.917 | 0 | | | | | | | | | | |
| 27.000 | 0.15872815 | 1801.802 | 872.1 | 529.80576 | 0 | 7.9 | 82 | 132.301189 | 24.8 | 2.72 | 0 |
| 27.083 | 0.15872815 | 1801.802 | 872.1 | 529.80576 | 0 | 7.9 | 82 | 132.301189 | 24.8 | 2.72 | 0 |
| 27.125 | 0.15872815 | 1801.802 | 872.1 | 529.80576 | 0 | 7.9 | 82 | 132.301189 | 24.8 | 2.72 | 0 |
| 27.250 | 0.15872815 | 1801.802 | 872.1 | 529.80576 | 0 | 7.9 | 82 | 132.301189 | 24.8 | 2.72 | 0 |
| 27.292 | 0.15872815 | 1801.802 | 872.1 | 529.80576 | 0 | 7.9 | 82 | 132.301189 | 24.8 | 2.72 | 0 |
| 27.333 | 0 | | | | | | | | | | |
| 27.417 | 0 | | | | | | | | | | |
| 27.500 | 0 | | | | | | | | | | |
| 27.583 | 0 | | | | | | | | | | |
| 27.667 | 0 | | | | | | | | | | |
| 27.750 | 0 | | | | | | | | | | |
| 27.833 | 0 | | | | | | | | | | |
| 27.917 | 0 | | | | | | | | | | |
| 28.000 | 0.25176037 | 1801.802 | 855.5 | 529.80576 | 0 | 7.9 | 82 | 118.35595 | 24.8 | 2.72 | 0 |
| 28.083 | 0.25176037 | 1801.802 | 855.5 | 529.80576 | 0 | 7.9 | 82 | 118.35595 | 24.8 | 2.72 | 0 |
| 28.125 | 0.25176037 | 1801.802 | 855.5 | 529.80576 | 0 | 7.9 | 82 | 118.35595 | 24.8 | 2.72 | 0 |
| 28.250 | 0.25176037 | 1801.802 | 855.5 | 529.80576 | 0 | 7.9 | 82 | 118.35595 | 24.8 | 2.72 | 0 |
| 28.292 | 0.25176037 | 1801.802 | 855.5 | 529.80576 | 0 | 7.9 | 82 | 118.35595 | 24.8 | 2.72 | 0 |
| 28.333 | 0 | | | | | | | | | | |
| 28.417 | 0 | | | | | | | | | | |
| 28.500 | 0 | | | | | | | | | | |
| 28.583 | 0 | | | | | | | | | | |
| 28.667 | 0 | | | | | | | | | | |
| 28.750 | 0 | | | | | | | | | | |
| 28.833 | 0 | | | | | | | | | | |
| 28.917 | 0 | | | | | | | | | | |
| 29.000 | 0.46389956 | 1801.802 | 811.7 | 529.80576 | 0 | 7.9 | 82 | 251.949803 | 24.8 | 2.72 | 0 |
| 29.083 | 0.46389956 | 1801.802 | 811.7 | 529.80576 | 0 | 7.9 | 82 | 251.949803 | 24.8 | 2.72 | 0 |
| 29.125 | 0.46389956 | 1801.802 | 811.7 | 529.80576 | 0 | 7.9 | 82 | 251.949803 | 24.8 | 2.72 | 0 |
| 29.250 | 0.46389956 | 1801.802 | 811.7 | 529.80576 | 0 | 7.9 | 82 | 251.949803 | 24.8 | 2.72 | 0 |
| 29.292 | 0.46389956 | 1801.802 | 811.7 | 529.80576 | 0 | 7.9 | 82 | 251.949803 | 24.8 | 2.72 | 0 |
| 29.333 | 0 | | | | | | | | | | |
| 29.417 | 0 | | | | | | | | | | |
| 29.500 | 0 | | | | | | | | | | |
| 29.583 | 0 | | | | | | | | | | |
| 29.667 | 0 | | | | | | | | | | |
| 29.750 | 0 | | | | | | | | | | |
| 29.833 | 0 | | | | | | | | | | |
| 29.917 | 0 | | | | | | | | | | |

**Winter (Dynamic)**
**Equalize TKN Load and/or COD:TKN Ratio**

Centrate Pumping: 12:00:00 AM | 8 | 7:30:00 AM

Manual Entries

| | | | | | Influent (PE) | | | | | | EQ Centrate | | | | Influent + EQ Centrate | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Flow | COD | TKN | TKN Load | COD Load | COD:TKN | TKN Load | Flow | TKN | COD Load | TKN Load | COD Load | COD:TKN |
| Time (days) | Day | Hours | Time Check | Time Value | mgd | mg/L | mg/L | lb/d | lb/d | | lb/d | mgd | mg/L | lb/d | lb/d | lb/d | |
| 0.0 | 0 | 0.0 | 12:00:00 AM | 12:00:00 AM | 18.5 | 595.6 | 47.7 | 7,353 | 91,728 | 12.5 | 3565.4 | 0.438 | 976.3 | 6580.3 | 10,919 | 98,308 | 9.0 |
| 0.1 | 0 | 2.0 | 2:00:00 AM | 2:00:00 AM | 12.1 | 606.2 | 46.6 | 4,724 | 61,422 | 13.0 | 3565.4 | 0.438 | 976.3 | 6580.3 | 8,289 | 68,003 | 8.2 |
| 0.1 | 0 | 3.0 | 3:00:00 AM | 3:00:00 AM | 6.9 | 562.2 | 46.6 | 2,702 | 32,587 | 12.1 | 3565.4 | 0.438 | 976.3 | 6580.3 | 6,268 | 39,168 | 6.2 |
| 0.3 | 0 | 6.0 | 6:00:00 AM | 6:00:00 AM | 5.4 | 628.9 | 46.4 | 2,091 | 28,343 | 13.6 | 3565.4 | 0.438 | 976.3 | 6580.3 | 5,656 | 34,923 | 6.2 |
| 0.3 | 0 | 7.0 | 7:00:00 AM | 7:00:00 AM | 6.5 | 522.8 | 47.3 | 2,566 | 28,369 | 11.1 | 3565.4 | 0.438 | 976.3 | 6580.3 | 6,132 | 34,950 | 5.7 |
| 0.3 | 0 | 8.0 | 8:00:00 AM | 8:00:00 AM | 13.1 | 404.6 | 45.9 | 5,023 | 44,233 | 8.8 | 0.0 | 0.000 | | 0.0 | 5,023 | 44,233 | 8.8 |
| 0.4 | 0 | 10.0 | 10:00:00 AM | 10:00:00 AM | 16.8 | 353.1 | 52.9 | 7,401 | 49,402 | 6.7 | 0.0 | 0.000 | | 0.0 | 7,401 | 49,402 | 6.7 |
| 0.5 | 0 | 12.0 | 12:00:00 PM | 12:00:00 PM | 17.7 | 388.0 | 55.8 | 8,232 | 57,216 | 7.0 | 0.0 | 0.000 | | 0.0 | 8,232 | 57,216 | 7.0 |
| 0.6 | 0 | 14.0 | 2:00:00 PM | 2:00:00 PM | 15.0 | 424.3 | 54.7 | 6,862 | 53,239 | 7.8 | 0.0 | 0.000 | | 0.0 | 6,862 | 53,239 | 7.8 |
| 0.7 | 0 | 16.0 | 4:00:00 PM | 4:00:00 PM | 13.2 | 471.3 | 54.5 | 6,002 | 51,929 | 8.7 | 0.0 | 0.000 | | 0.0 | 6,002 | 51,929 | 8.7 |
| 0.8 | 0 | 18.0 | 6:00:00 PM | 6:00:00 PM | 12.5 | 516.8 | 52.9 | 5,502 | 53,745 | 9.8 | 0.0 | 0.000 | | 0.0 | 5,502 | 53,745 | 9.8 |
| 0.8 | 0 | 20.0 | 8:00:00 PM | 8:00:00 PM | 13.9 | 551.6 | 54.7 | 6,354 | 64,082 | 10.1 | 0.0 | 0.000 | | 0.0 | 6,354 | 64,082 | 10.1 |
| 0.9 | 0 | 22.0 | 10:00:00 PM | 10:00:00 PM | 13.9 | 551.6 | 54.7 | 6,354 | 64,082 | 10.1 | 0.0 | 0.000 | | 0.0 | 6,354 | 64,082 | 10.1 |
| 1.0 | 1 | 24.0 | 12:00:00 AM | 12:00:00 AM | 16.0 | 511.3 | 44.9 | 5,993 | 68,193 | 11.4 | 2879.8 | 0.377 | 915.5 | 5668.1 | 8,873 | 73,861 | 8.3 |
| 1.1 | 1 | 26.0 | 2:00:00 AM | 2:00:00 AM | 10.5 | 520.4 | 43.9 | 3,850 | 45,663 | 11.9 | 2879.8 | 0.377 | 915.5 | 5668.1 | 6,730 | 51,331 | 7.6 |
| 1.1 | 1 | 27.0 | 3:00:00 AM | 3:00:00 AM | 6.0 | 482.7 | 43.9 | 2,202 | 24,226 | 11.0 | 2879.8 | 0.377 | 915.5 | 5668.1 | 5,082 | 29,894 | 5.9 |
| 1.3 | 1 | 30.0 | 6:00:00 AM | 6:00:00 AM | 4.7 | 539.9 | 43.7 | 1,704 | 21,071 | 12.4 | 2879.8 | 0.377 | 915.5 | 5668.1 | 4,584 | 26,739 | 5.8 |
| 1.3 | 1 | 31.0 | 7:00:00 AM | 7:00:00 AM | 5.6 | 448.8 | 44.5 | 2,091 | 21,091 | 10.1 | 2879.8 | 0.377 | 915.5 | 5668.1 | 4,971 | 26,759 | 5.4 |
| 1.3 | 1 | 32.0 | 8:00:00 AM | 8:00:00 AM | 11.4 | 347.4 | 43.2 | 4,094 | 32,884 | 8.0 | 0.0 | 0.000 | | 0.0 | 4,094 | 32,884 | 8.0 |
| 1.4 | 1 | 34.0 | 10:00:00 AM | 10:00:00 AM | 14.5 | 303.1 | 49.8 | 6,032 | 36,727 | 6.1 | 0.0 | 0.000 | | 0.0 | 6,032 | 36,727 | 6.1 |
| 1.5 | 1 | 36.0 | 12:00:00 PM | 12:00:00 PM | 15.3 | 333.1 | 52.5 | 6,709 | 42,536 | 6.3 | 0.0 | 0.000 | | 0.0 | 6,709 | 42,536 | 6.3 |
| 1.6 | 1 | 38.0 | 2:00:00 PM | 2:00:00 PM | 13.0 | 364.3 | 51.5 | 5,593 | 39,579 | 7.1 | 0.0 | 0.000 | | 0.0 | 5,593 | 39,579 | 7.1 |
| 1.7 | 1 | 40.0 | 4:00:00 PM | 4:00:00 PM | 11.4 | 404.6 | 51.3 | 4,891 | 38,605 | 7.9 | 0.0 | 0.000 | | 0.0 | 4,891 | 38,605 | 7.9 |
| 1.8 | 1 | 42.0 | 6:00:00 PM | 6:00:00 PM | 10.8 | 443.6 | 49.8 | 4,484 | 39,956 | 8.9 | 0.0 | 0.000 | | 0.0 | 4,484 | 39,956 | 8.9 |
| 1.8 | 1 | 44.0 | 8:00:00 PM | 8:00:00 PM | 12.1 | 473.6 | 51.5 | 5,178 | 47,641 | 9.2 | 0.0 | 0.000 | | 0.0 | 5,178 | 47,641 | 9.2 |
| 1.9 | 1 | 46.0 | 10:00:00 PM | 10:00:00 PM | 12.1 | 473.6 | 51.5 | 5,178 | 47,641 | 9.2 | 0.0 | 0.000 | | 0.0 | 5,178 | 47,641 | 9.2 |
| 2.0 | 2 | 48.0 | 12:00:00 AM | 12:00:00 AM | 18.3 | 491.1 | 52.7 | 8,031 | 74,837 | 9.3 | 2679.2 | 0.371 | 865.7 | 5576.4 | 10,710 | 80,413 | 7.5 |
| 2.1 | 2 | 50.0 | 2:00:00 AM | 2:00:00 AM | 12.0 | 499.8 | 51.5 | 5,159 | 50,112 | 9.7 | 2679.2 | 0.371 | 865.7 | 5576.4 | 7,839 | 55,688 | 7.1 |
| 2.1 | 2 | 51.0 | 3:00:00 AM | 3:00:00 AM | 6.9 | 463.6 | 51.5 | 2,951 | 26,586 | 9.0 | 2679.2 | 0.371 | 865.7 | 5576.4 | 5,630 | 32,163 | 5.7 |
| 2.3 | 2 | 54.0 | 6:00:00 AM | 6:00:00 AM | 5.3 | 518.6 | 51.2 | 2,284 | 23,123 | 10.1 | 2679.2 | 0.371 | 865.7 | 5576.4 | 4,963 | 28,700 | 5.8 |
| 2.3 | 2 | 55.0 | 7:00:00 AM | 7:00:00 AM | 6.4 | 431.1 | 52.2 | 2,803 | 23,145 | 8.3 | 2679.2 | 0.371 | 865.7 | 5576.4 | 5,482 | 28,722 | 5.2 |
| 2.3 | 2 | 56.0 | 8:00:00 AM | 8:00:00 AM | 13.0 | 333.6 | 50.7 | 5,486 | 36,088 | 6.6 | 0.0 | 0.000 | | 0.0 | 5,486 | 36,088 | 6.6 |
| 2.4 | 2 | 58.0 | 10:00:00 AM | 10:00:00 AM | 16.6 | 291.1 | 58.4 | 8,083 | 40,304 | 5.0 | 0.0 | 0.000 | | 0.0 | 8,083 | 40,304 | 5.0 |
| 2.5 | 2 | 60.0 | 12:00:00 PM | 12:00:00 PM | 17.5 | 319.9 | 61.6 | 8,991 | 46,680 | 5.2 | 0.0 | 0.000 | | 0.0 | 8,991 | 46,680 | 5.2 |
| 2.6 | 2 | 62.0 | 2:00:00 PM | 2:00:00 PM | 14.9 | 349.9 | 60.4 | 7,495 | 43,435 | 5.8 | 0.0 | 0.000 | | 0.0 | 7,495 | 43,435 | 5.8 |
| 2.7 | 2 | 64.0 | 4:00:00 PM | 4:00:00 PM | 13.1 | 388.6 | 60.1 | 6,555 | 42,366 | 6.5 | 0.0 | 0.000 | | 0.0 | 6,555 | 42,366 | 6.5 |
| 2.8 | 2 | 66.0 | 6:00:00 PM | 6:00:00 PM | 12.3 | 426.1 | 58.4 | 6,009 | 43,848 | 7.3 | 0.0 | 0.000 | | 0.0 | 6,009 | 43,848 | 7.3 |
| 2.8 | 2 | 68.0 | 8:00:00 PM | 8:00:00 PM | 13.8 | 454.8 | 60.4 | 6,940 | 52,282 | 7.5 | 0.0 | 0.000 | | 0.0 | 6,940 | 52,282 | 7.5 |
| 2.9 | 2 | 70.0 | 10:00:00 PM | 10:00:00 PM | 13.8 | 454.8 | 60.4 | 6,940 | 52,282 | 7.5 | 0.0 | 0.000 | | 0.0 | 6,940 | 52,282 | 7.5 |
| 3.0 | 3 | 72.0 | 12:00:00 AM | 12:00:00 AM | 19.7 | 464.9 | 45.1 | 7,398 | 76,219 | 10.3 | 3122.5 | 0.383 | 977.3 | 5756.7 | 10,520 | 81,976 | 7.8 |
| 3.1 | 3 | 74.0 | 2:00:00 AM | 2:00:00 AM | 12.9 | 473.2 | 44.1 | 4,752 | 51,037 | 10.7 | 3122.5 | 0.383 | 977.3 | 5756.7 | 7,875 | 56,794 | 7.2 |
| 3.1 | 3 | 75.0 | 3:00:00 AM | 3:00:00 AM | 7.4 | 438.9 | 44.1 | 2,718 | 27,078 | 10.0 | 3122.5 | 0.383 | 977.3 | 5756.7 | 5,841 | 32,834 | 5.6 |
| 3.3 | 3 | 78.0 | 6:00:00 AM | 6:00:00 AM | 5.8 | 491.0 | 43.9 | 2,103 | 23,551 | 11.2 | 3122.5 | 0.383 | 977.3 | 5756.7 | 5,226 | 29,307 | 5.6 |
| 3.3 | 3 | 79.0 | 7:00:00 AM | 7:00:00 AM | 6.9 | 408.1 | 44.7 | 2,582 | 23,573 | 9.1 | 3122.5 | 0.383 | 977.3 | 5756.7 | 5,704 | 29,330 | 5.1 |
| 3.3 | 3 | 80.0 | 8:00:00 AM | 8:00:00 AM | 14.0 | 315.9 | 43.4 | 5,053 | 36,754 | 7.3 | 0.0 | 0.000 | | 0.0 | 5,053 | 36,754 | 7.3 |
| 3.4 | 3 | 82.0 | 10:00:00 AM | 10:00:00 AM | 17.9 | 275.6 | 50.0 | 7,445 | 41,049 | 5.5 | 0.0 | 0.000 | | 0.0 | 7,445 | 41,049 | 5.5 |
| 3.5 | 3 | 84.0 | 12:00:00 PM | 12:00:00 PM | 18.8 | 302.9 | 52.8 | 8,281 | 47,542 | 5.7 | 0.0 | 0.000 | | 0.0 | 8,281 | 47,542 | 5.7 |
| 3.6 | 3 | 86.0 | 2:00:00 PM | 2:00:00 PM | 16.0 | 331.2 | 51.7 | 6,904 | 44,237 | 6.4 | 0.0 | 0.000 | | 0.0 | 6,904 | 44,237 | 6.4 |
| 3.7 | 3 | 88.0 | 4:00:00 PM | 4:00:00 PM | 14.1 | 367.9 | 51.5 | 6,038 | 43,149 | 7.1 | 0.0 | 0.000 | | 0.0 | 6,038 | 43,149 | 7.1 |
| 3.8 | 3 | 90.0 | 6:00:00 PM | 6:00:00 PM | 13.3 | 403.4 | 50.0 | 5,535 | 44,658 | 8.1 | 0.0 | 0.000 | | 0.0 | 5,535 | 44,658 | 8.1 |
| 3.8 | 3 | 92.0 | 8:00:00 PM | 8:00:00 PM | 14.8 | 430.6 | 51.7 | 6,392 | 53,248 | 8.3 | 0.0 | 0.000 | | 0.0 | 6,392 | 53,248 | 8.3 |
| 3.9 | 3 | 94.0 | 10:00:00 PM | 10:00:00 PM | 14.8 | 430.6 | 51.7 | 6,392 | 53,248 | 8.3 | 0.0 | 0.000 | | 0.0 | 6,392 | 53,248 | 8.3 |
| 4.0 | 4 | 96.0 | 12:00:00 AM | 12:00:00 AM | 17.4 | 530.3 | 51.2 | 7,410 | 76,804 | 10.4 | 2185.0 | 0.279 | 939.1 | 4192.2 | 9,595 | 80,996 | 8.4 |
| 4.1 | 4 | 98.0 | 2:00:00 AM | 2:00:00 AM | 11.4 | 539.8 | 50.0 | 4,760 | 51,429 | 10.8 | 2185.0 | 0.279 | 939.1 | 4192.2 | 6,945 | 55,621 | 8.0 |
| 4.1 | 4 | 99.0 | 3:00:00 AM | 3:00:00 AM | 6.5 | 500.6 | 50.0 | 2,723 | 27,285 | 10.0 | 2185.0 | 0.279 | 939.1 | 4192.2 | 4,908 | 31,478 | 6.4 |
| 4.3 | 4 | 102.0 | 6:00:00 AM | 6:00:00 AM | 5.1 | 560.0 | 49.7 | 2,107 | 23,731 | 11.3 | 2185.0 | 0.279 | 939.1 | 4192.2 | 4,292 | 27,924 | 6.5 |
| 4.3 | 4 | 103.0 | 7:00:00 AM | 7:00:00 AM | 6.1 | 465.5 | 50.7 | 2,586 | 23,754 | 9.2 | 2185.0 | 0.279 | 939.1 | 4192.2 | 4,771 | 27,946 | 5.9 |
| 4.3 | 4 | 104.0 | 8:00:00 AM | 8:00:00 AM | 12.3 | 360.3 | 49.2 | 5,061 | 37,037 | 7.3 | 0.0 | 0.000 | | 0.0 | 5,061 | 37,037 | 7.3 |
| 4.4 | 4 | 106.0 | 10:00:00 AM | 10:00:00 AM | 15.8 | 314.4 | 56.7 | 7,458 | 41,364 | 5.5 | 0.0 | 0.000 | | 0.0 | 7,458 | 41,364 | 5.5 |
| 4.5 | 4 | 108.0 | 12:00:00 PM | 12:00:00 PM | 16.6 | 345.4 | 59.8 | 8,295 | 47,907 | 5.8 | 0.0 | 0.000 | | 0.0 | 8,295 | 47,907 | 5.8 |
| 4.6 | 4 | 110.0 | 2:00:00 PM | 2:00:00 PM | 14.1 | 377.8 | 58.6 | 6,915 | 44,577 | 6.4 | 0.0 | 0.000 | | 0.0 | 6,915 | 44,577 | 6.4 |
| 4.7 | 4 | 112.0 | 4:00:00 PM | 4:00:00 PM | 12.4 | 419.7 | 58.4 | 6,047 | 43,480 | 7.2 | 0.0 | 0.000 | | 0.0 | 6,047 | 43,480 | 7.2 |
| 4.8 | 4 | 114.0 | 6:00:00 PM | 6:00:00 PM | 11.7 | 460.1 | 56.7 | 5,544 | 45,001 | 8.1 | 0.0 | 0.000 | | 0.0 | 5,544 | 45,001 | 8.1 |
| 4.8 | 4 | 116.0 | 8:00:00 PM | 8:00:00 PM | 13.1 | 491.2 | 58.6 | 6,402 | 53,656 | 8.4 | 0.0 | 0.000 | | 0.0 | 6,402 | 53,656 | 8.4 |

| Centrate | | | | | | |
|---|---|---|---|---|---|---|
| | Flow | TKN | TKN Load | COD | COD Load | COD:TKN |
| Time (days) | mgd | mg/L | lb/d | mg/L | lb/d | |
| 0 | 0.15 | 976.3 | 1188.5 | 1801.802 | 2193.4 | 1.8 |
| 1 | 0.13 | 915.5 | 959.9 | 1801.802 | 1889.4 | 2.0 |
| 2 | 0.12 | 865.7 | 893.1 | 1801.802 | 1858.8 | 2.1 |
| 3 | 0.13 | 977.3 | 1040.8 | 1801.802 | 1918.9 | 1.8 |
| 4 | 0.09 | 939.1 | 728.3 | 1801.802 | 1397.4 | 1.9 |
| 5 | 0.09 | 971.7 | 707.3 | 1801.802 | 1311.6 | 1.9 |
| 6 | 0.07 | 954.4 | 565.9 | 1801.802 | 1068.4 | 1.9 |
| 7 | 0.10 | 941.3 | 754.0 | 1801.802 | 1443.3 | 1.9 |
| 8 | 0.08 | 956.4 | 655.4 | 1801.802 | 1234.9 | 1.9 |
| 9 | 0.10 | 922.4 | 749.4 | 1801.802 | 1463.9 | 2.0 |
| 10 | 0.11 | 970.2 | 861.9 | 1801.802 | 1600.6 | 1.9 |
| 11 | 0.12 | 942.1 | 958.8 | 1801.802 | 1833.7 | 1.9 |
| 12 | 0.11 | 944.2 | 896.7 | 1801.802 | 1711.0 | 1.9 |
| 13 | 0.11 | 935.0 | 851.3 | 1801.802 | 1640.4 | 1.9 |
| 14 | 0.12 | 989.8 | 955.3 | 1801.802 | 1739.0 | 1.8 |
| 15 | 0.11 | 946.6 | 836.0 | 1801.802 | 1591.3 | 1.9 |
| 16 | 0.11 | 947.2 | 903.4 | 1801.802 | 1718.4 | 1.9 |
| 17 | 0.10 | 975.8 | 795.1 | 1801.802 | 1468.2 | 1.8 |
| 18 | 0.10 | 1039.4 | 855.9 | 1801.802 | 1483.7 | 1.7 |
| 19 | 0.07 | 1052.2 | 653.2 | 1801.802 | 1118.4 | 1.7 |
| 20 | 0.08 | 985.0 | 637.7 | 1801.802 | 1166.6 | 1.8 |
| 21 | 0.07 | 939.6 | 540.8 | 1801.802 | 1037.1 | 1.9 |
| 22 | 0.08 | 938.9 | 636.6 | 1801.802 | 1221.7 | 1.9 |
| 23 | 0.07 | 923.5 | 554.7 | 1801.802 | 1082.3 | 2.0 |
| 24 | 0.11 | 900.4 | 827.8 | 1801.802 | 1656.4 | 2.0 |
| 25 | 0.10 | 862.1 | 717.2 | 1801.802 | 1499.1 | 2.1 |
| 26 | 0.09 | 833.5 | 649.9 | 1801.802 | 1405.0 | 2.2 |
| 27 | 0.05 | 872.1 | 384.8 | 1801.802 | 795.1 | 2.1 |
| 28 | 0.08 | 855.5 | 598.7 | 1801.802 | 1261.1 | 2.1 |
| 29 | 0.15 | 811.7 | 1046.8 | 1801.802 | 2323.7 | 2.2 |

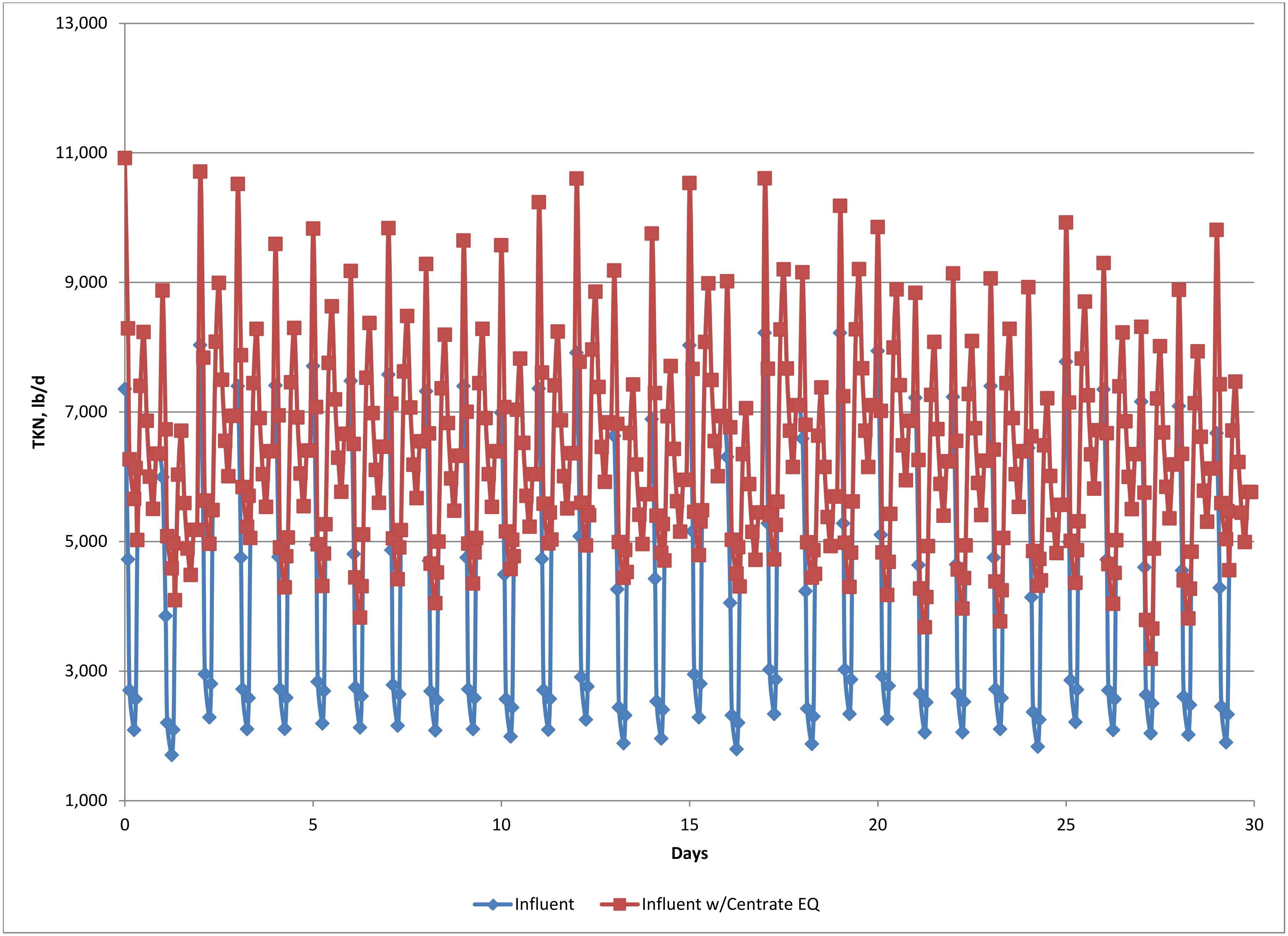
| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.9 | 4 | 118.0 | 10:00:00 PM | 10:00:00 PM | 13.1 | 491.2 | 58.6 | 6,402 | 53,656 | 8.4 | 0.0 | 0.000 | | 0.0 | 6,402 | 53,656 | 8.4 |
| 5.0 | 5 | 120.0 | 12:00:00 AM | 12:00:00 AM | 18.9 | 565.8 | 48.8 | 7,708 | 89,411 | 11.6 | 2121.9 | 0.262 | 971.7 | 3934.7 | 9,830 | 93,345 | 9.5 |
| 5.1 | 5 | 122.0 | 2:00:00 AM | 2:00:00 AM | 12.5 | 575.9 | 47.6 | 4,952 | 59,871 | 12.1 | 2121.9 | 0.262 | 971.7 | 3934.7 | 7,074 | 63,805 | 9.0 |
| 5.1 | 5 | 123.0 | 3:00:00 AM | 3:00:00 AM | 7.1 | 534.1 | 47.6 | 2,833 | 31,764 | 11.2 | 2121.9 | 0.262 | 971.7 | 3934.7 | 4,955 | 35,699 | 7.2 |
| 5.3 | 5 | 126.0 | 6:00:00 AM | 6:00:00 AM | 5.5 | 597.5 | 47.4 | 2,192 | 27,627 | 12.6 | 2121.9 | 0.262 | 971.7 | 3934.7 | 4,314 | 31,561 | 7.3 |
| 5.3 | 5 | 127.0 | 7:00:00 AM | 7:00:00 AM | 6.7 | 496.7 | 48.3 | 2,690 | 27,653 | 10.3 | 2121.9 | 0.262 | 971.7 | 3934.7 | 4,812 | 31,587 | 6.6 |
| 5.3 | 5 | 128.0 | 8:00:00 AM | 8:00:00 AM | 13.4 | 384.4 | 46.9 | 5,265 | 43,116 | 8.2 | 0.0 | 0.000 | | 0.0 | 5,265 | 43,116 | 8.2 |
| 5.4 | 5 | 130.0 | 10:00:00 AM | 10:00:00 AM | 17.2 | 335.4 | 54.0 | 7,758 | 48,154 | 6.2 | 0.0 | 0.000 | | 0.0 | 7,758 | 48,154 | 6.2 |
| 5.5 | 5 | 132.0 | 12:00:00 PM | 12:00:00 PM | 18.1 | 368.6 | 57.0 | 8,629 | 55,770 | 6.5 | 0.0 | 0.000 | | 0.0 | 8,629 | 55,770 | 6.5 |
| 5.6 | 5 | 134.0 | 2:00:00 PM | 2:00:00 PM | 15.4 | 403.1 | 55.9 | 7,194 | 51,894 | 7.2 | 0.0 | 0.000 | | 0.0 | 7,194 | 51,894 | 7.2 |
| 5.7 | 5 | 136.0 | 4:00:00 PM | 4:00:00 PM | 13.6 | 447.7 | 55.6 | 6,291 | 50,617 | 8.0 | 0.0 | 0.000 | | 0.0 | 6,291 | 50,617 | 8.0 |
| 5.8 | 5 | 138.0 | 6:00:00 PM | 6:00:00 PM | 12.8 | 490.9 | 54.0 | 5,767 | 52,387 | 9.1 | 0.0 | 0.000 | | 0.0 | 5,767 | 52,387 | 9.1 |
| 5.8 | 5 | 140.0 | 8:00:00 PM | 8:00:00 PM | 14.3 | 524.0 | 55.9 | 6,661 | 62,464 | 9.4 | 0.0 | 0.000 | | 0.0 | 6,661 | 62,464 | 9.4 |
| 5.9 | 5 | 142.0 | 10:00:00 PM | 10:00:00 PM | 14.3 | 524.0 | 55.9 | 6,661 | 62,464 | 9.4 | 0.0 | 0.000 | | 0.0 | 6,661 | 62,464 | 9.4 |
| 6.0 | 6 | 144.0 | 12:00:00 AM | 12:00:00 AM | 17.3 | 534.8 | 51.8 | 7,480 | 77,230 | 10.3 | 1697.8 | 0.213 | 954.4 | 3205.2 | 9,177 | 80,435 | 8.8 |
| 6.1 | 6 | 146.0 | 2:00:00 AM | 2:00:00 AM | 11.4 | 544.3 | 50.6 | 4,805 | 51,714 | 10.8 | 1697.8 | 0.213 | 954.4 | 3205.2 | 6,503 | 54,920 | 8.4 |
| 6.1 | 6 | 147.0 | 3:00:00 AM | 3:00:00 AM | 6.5 | 504.8 | 50.6 | 2,749 | 27,437 | 10.0 | 1697.8 | 0.213 | 954.4 | 3205.2 | 4,446 | 30,642 | 6.9 |
| 6.3 | 6 | 150.0 | 6:00:00 AM | 6:00:00 AM | 5.1 | 564.7 | 50.3 | 2,127 | 23,863 | 11.2 | 1697.8 | 0.213 | 954.4 | 3205.2 | 3,825 | 27,068 | 7.1 |
| 6.3 | 6 | 151.0 | 7:00:00 AM | 7:00:00 AM | 6.1 | 469.4 | 51.3 | 2,610 | 23,886 | 9.2 | 1697.8 | 0.213 | 954.4 | 3205.2 | 4,308 | 27,091 | 6.3 |
| 6.3 | 6 | 152.0 | 8:00:00 AM | 8:00:00 AM | 12.3 | 363.3 | 49.8 | 5,109 | 37,242 | 7.3 | 0.0 | 0.000 | | 0.0 | 5,109 | 37,242 | 7.3 |
| 6.4 | 6 | 154.0 | 10:00:00 AM | 10:00:00 AM | 15.7 | 317.0 | 57.4 | 7,528 | 41,594 | 5.5 | 0.0 | 0.000 | | 0.0 | 7,528 | 41,594 | 5.5 |
| 6.5 | 6 | 156.0 | 12:00:00 PM | 12:00:00 PM | 16.6 | 348.3 | 60.5 | 8,373 | 48,173 | 5.8 | 0.0 | 0.000 | | 0.0 | 8,373 | 48,173 | 5.8 |
| 6.6 | 6 | 158.0 | 2:00:00 PM | 2:00:00 PM | 14.1 | 381.0 | 59.3 | 6,980 | 44,824 | 6.4 | 0.0 | 0.000 | | 0.0 | 6,980 | 44,824 | 6.4 |
| 6.7 | 6 | 160.0 | 4:00:00 PM | 4:00:00 PM | 12.4 | 423.2 | 59.1 | 6,105 | 43,721 | 7.2 | 0.0 | 0.000 | | 0.0 | 6,105 | 43,721 | 7.2 |
| 6.8 | 6 | 162.0 | 6:00:00 PM | 6:00:00 PM | 11.7 | 464.0 | 57.4 | 5,596 | 45,251 | 8.1 | 0.0 | 0.000 | | 0.0 | 5,596 | 45,251 | 8.1 |
| 6.8 | 6 | 164.0 | 8:00:00 PM | 8:00:00 PM | 13.1 | 495.3 | 59.3 | 6,463 | 53,954 | 8.3 | 0.0 | 0.000 | | 0.0 | 6,463 | 53,954 | 8.3 |
| 6.9 | 6 | 166.0 | 10:00:00 PM | 10:00:00 PM | 13.1 | 495.3 | 59.3 | 6,463 | 53,954 | 8.3 | 0.0 | 0.000 | | 0.0 | 6,463 | 53,954 | 8.3 |
| 7.0 | 7 | 168.0 | 12:00:00 AM | 12:00:00 AM | 17.1 | 413.3 | 53.3 | 7,576 | 58,794 | 7.8 | 2262.0 | 0.288 | 941.3 | 4330.0 | 9,838 | 63,124 | 6.4 |
| 7.1 | 7 | 170.0 | 2:00:00 AM | 2:00:00 AM | 11.2 | 420.7 | 52.0 | 4,867 | 39,369 | 8.1 | 2262.0 | 0.288 | 941.3 | 4330.0 | 7,129 | 43,699 | 6.1 |
| 7.1 | 7 | 171.0 | 3:00:00 AM | 3:00:00 AM | 6.4 | 390.2 | 52.0 | 2,784 | 20,887 | 7.5 | 2262.0 | 0.288 | 941.3 | 4330.0 | 5,046 | 25,217 | 5.0 |
| 7.3 | 7 | 174.0 | 6:00:00 AM | 6:00:00 AM | 5.0 | 436.4 | 51.8 | 2,154 | 18,166 | 8.4 | 2262.0 | 0.288 | 941.3 | 4330.0 | 4,416 | 22,496 | 5.1 |
| 7.3 | 7 | 175.0 | 7:00:00 AM | 7:00:00 AM | 6.0 | 362.8 | 52.8 | 2,644 | 18,184 | 6.9 | 2262.0 | 0.288 | 941.3 | 4330.0 | 4,906 | 22,514 | 4.6 |
| 7.3 | 7 | 176.0 | 8:00:00 AM | 8:00:00 AM | 12.1 | 280.8 | 51.3 | 5,175 | 28,351 | 5.5 | 0.0 | 0.000 | | 0.0 | 5,175 | 28,351 | 5.5 |
| 7.4 | 7 | 178.0 | 10:00:00 AM | 10:00:00 AM | 15.5 | 245.0 | 59.0 | 7,625 | 31,664 | 4.2 | 0.0 | 0.000 | | 0.0 | 7,625 | 31,664 | 4.2 |
| 7.5 | 7 | 180.0 | 12:00:00 PM | 12:00:00 PM | 16.3 | 269.2 | 62.3 | 8,481 | 36,673 | 4.3 | 0.0 | 0.000 | | 0.0 | 8,481 | 36,673 | 4.3 |
| 7.6 | 7 | 182.0 | 2:00:00 PM | 2:00:00 PM | 13.9 | 294.5 | 61.0 | 7,070 | 34,124 | 4.8 | 0.0 | 0.000 | | 0.0 | 7,070 | 34,124 | 4.8 |
| 7.7 | 7 | 184.0 | 4:00:00 PM | 4:00:00 PM | 12.2 | 327.1 | 60.8 | 6,183 | 33,284 | 5.4 | 0.0 | 0.000 | | 0.0 | 6,183 | 33,284 | 5.4 |
| 7.8 | 7 | 186.0 | 6:00:00 PM | 6:00:00 PM | 11.5 | 358.6 | 59.0 | 5,668 | 34,448 | 6.1 | 0.0 | 0.000 | | 0.0 | 5,668 | 34,448 | 6.1 |
| 7.8 | 7 | 188.0 | 8:00:00 PM | 8:00:00 PM | 12.9 | 382.8 | 61.0 | 6,546 | 41,074 | 6.3 | 0.0 | 0.000 | | 0.0 | 6,546 | 41,074 | 6.3 |
| 7.9 | 7 | 190.0 | 10:00:00 PM | 10:00:00 PM | 12.9 | 382.8 | 61.0 | 6,546 | 41,074 | 6.3 | 0.0 | 0.000 | | 0.0 | 6,546 | 41,074 | 6.3 |
| 8.0 | 8 | 192.0 | 12:00:00 AM | 12:00:00 AM | 16.6 | 495.1 | 52.9 | 7,318 | 68,470 | 9.4 | 1966.3 | 0.247 | 956.4 | 3704.6 | 9,284 | 72,175 | 7.8 |
| 8.1 | 8 | 194.0 | 2:00:00 AM | 2:00:00 AM | 10.9 | 503.9 | 51.7 | 4,701 | 45,849 | 9.8 | 1966.3 | 0.247 | 956.4 | 3704.6 | 6,667 | 49,553 | 7.4 |
| 8.1 | 8 | 195.0 | 3:00:00 AM | 3:00:00 AM | 6.2 | 467.3 | 51.7 | 2,689 | 24,325 | 9.0 | 1966.3 | 0.247 | 956.4 | 3704.6 | 4,655 | 28,029 | 6.0 |
| 8.3 | 8 | 198.0 | 6:00:00 AM | 6:00:00 AM | 4.9 | 522.8 | 51.4 | 2,081 | 21,156 | 10.2 | 1966.3 | 0.247 | 956.4 | 3704.6 | 4,047 | 24,861 | 6.1 |
| 8.3 | 8 | 199.0 | 7:00:00 AM | 7:00:00 AM | 5.8 | 434.6 | 52.4 | 2,554 | 21,176 | 8.3 | 1966.3 | 0.247 | 956.4 | 3704.6 | 4,520 | 24,881 | 5.5 |
| 8.3 | 8 | 200.0 | 8:00:00 AM | 8:00:00 AM | 11.8 | 336.3 | 50.9 | 4,998 | 33,018 | 6.6 | 0.0 | 0.000 | | 0.0 | 4,998 | 33,018 | 6.6 |
| 8.4 | 8 | 202.0 | 10:00:00 AM | 10:00:00 AM | 15.1 | 293.5 | 58.6 | 7,365 | 36,876 | 5.0 | 0.0 | 0.000 | | 0.0 | 7,365 | 36,876 | 5.0 |
| 8.5 | 8 | 204.0 | 12:00:00 PM | 12:00:00 PM | 15.9 | 322.5 | 61.9 | 8,192 | 42,709 | 5.2 | 0.0 | 0.000 | | 0.0 | 8,192 | 42,709 | 5.2 |
| 8.6 | 8 | 206.0 | 2:00:00 PM | 2:00:00 PM | 13.5 | 352.7 | 60.6 | 6,829 | 39,740 | 5.8 | 0.0 | 0.000 | | 0.0 | 6,829 | 39,740 | 5.8 |
| 8.7 | 8 | 208.0 | 4:00:00 PM | 4:00:00 PM | 11.9 | 391.8 | 60.4 | 5,972 | 38,762 | 6.5 | 0.0 | 0.000 | | 0.0 | 5,972 | 38,762 | 6.5 |
| 8.8 | 8 | 210.0 | 6:00:00 PM | 6:00:00 PM | 11.2 | 429.6 | 58.6 | 5,475 | 40,118 | 7.3 | 0.0 | 0.000 | | 0.0 | 5,475 | 40,118 | 7.3 |
| 8.8 | 8 | 212.0 | 8:00:00 PM | 8:00:00 PM | 12.5 | 458.5 | 60.6 | 6,323 | 47,834 | 7.6 | 0.0 | 0.000 | | 0.0 | 6,323 | 47,834 | 7.6 |
| 8.9 | 8 | 214.0 | 10:00:00 PM | 10:00:00 PM | 12.5 | 458.5 | 60.6 | 6,323 | 47,834 | 7.6 | 0.0 | 0.000 | | 0.0 | 6,323 | 47,834 | 7.6 |
| 9.0 | 9 | 216.0 | 12:00:00 AM | 12:00:00 AM | 17.5 | 671.2 | 50.7 | 7,398 | 97,996 | 13.2 | 2248.2 | 0.292 | 922.4 | 4391.8 | 9,646 | 102,388 | 10.6 |
| 9.1 | 9 | 218.0 | 2:00:00 AM | 2:00:00 AM | 11.5 | 683.1 | 49.5 | 4,752 | 65,619 | 13.8 | 2248.2 | 0.292 | 922.4 | 4391.8 | 7,001 | 70,011 | 10.0 |
| 9.1 | 9 | 219.0 | 3:00:00 AM | 3:00:00 AM | 6.6 | 633.6 | 49.5 | 2,718 | 34,814 | 12.8 | 2248.2 | 0.292 | 922.4 | 4391.8 | 4,967 | 39,206 | 7.9 |
| 9.3 | 9 | 222.0 | 6:00:00 AM | 6:00:00 AM | 5.1 | 708.7 | 49.2 | 2,103 | 30,279 | 14.4 | 2248.2 | 0.292 | 922.4 | 4391.8 | 4,352 | 34,671 | 8.0 |
| 9.3 | 9 | 223.0 | 7:00:00 AM | 7:00:00 AM | 6.2 | 589.2 | 50.2 | 2,582 | 30,308 | 11.7 | 2248.2 | 0.292 | 922.4 | 4391.8 | 4,830 | 34,700 | 7.2 |
| 9.3 | 9 | 224.0 | 8:00:00 AM | 8:00:00 AM | 12.4 | 456.0 | 48.8 | 5,053 | 47,256 | 9.4 | 0.0 | 0.000 | | 0.0 | 5,053 | 47,256 | 9.4 |
| 9.4 | 9 | 226.0 | 10:00:00 AM | 10:00:00 AM | 15.9 | 397.9 | 56.1 | 7,445 | 52,777 | 7.1 | 0.0 | 0.000 | | 0.0 | 7,445 | 52,777 | 7.1 |
| 9.5 | 9 | 228.0 | 12:00:00 PM | 12:00:00 PM | 16.8 | 437.2 | 59.2 | 8,281 | 61,125 | 7.4 | 0.0 | 0.000 | | 0.0 | 8,281 | 61,125 | 7.4 |
| 9.6 | 9 | 230.0 | 2:00:00 PM | 2:00:00 PM | 14.3 | 478.2 | 58.0 | 6,904 | 56,877 | 8.2 | 0.0 | 0.000 | | 0.0 | 6,904 | 56,877 | 8.2 |
| 9.7 | 9 | 232.0 | 4:00:00 PM | 4:00:00 PM | 12.5 | 531.1 | 57.8 | 6,038 | 55,477 | 9.2 | 0.0 | 0.000 | | 0.0 | 6,038 | 55,477 | 9.2 |
| 9.8 | 9 | 234.0 | 6:00:00 PM | 6:00:00 PM | 11.8 | 582.4 | 56.1 | 5,535 | 57,418 | 10.4 | 0.0 | 0.000 | | 0.0 | 5,535 | 57,418 | 10.4 |
| 9.8 | 9 | 236.0 | 8:00:00 PM | 8:00:00 PM | 13.2 | 621.6 | 58.0 | 6,392 | 68,461 | 10.7 | 0.0 | 0.000 | | 0.0 | 6,392 | 68,461 | 10.7 |
| 9.9 | 9 | 238.0 | 10:00:00 PM | 10:00:00 PM | 13.2 | 621.6 | 58.0 | 6,392 | 68,461 | 10.7 | 0.0 | 0.000 | | 0.0 | 6,392 | 68,461 | 10.7 |
| 10.0 | 10 | 240.0 | 12:00:00 AM | 12:00:00 AM | 17.8 | 572.3 | 47.0 | 6,987 | 85,075 | 12.2 | 2585.6 | 0.320 | 970.2 | 4801.9 | 9,573 | 89,877 | 9.4 |
| 10.1 | 10 | 242.0 | 2:00:00 AM | 2:00:00 AM | 11.7 | 582.5 | 45.9 | 4,489 | 56,968 | 12.7 | 2585.6 | 0.320 | 970.2 | 4801.9 | 7,074 | 61,769 | 8.7 |
| 10.1 | 10 | 243.0 | 3:00:00 AM | 3:00:00 AM | 6.7 | 540.3 | 45.9 | 2,568 | 30,224 | 11.8 | 2585.6 | 0.320 | 970.2 | 4801.9 | 5,153 | 35,026 | 6.8 |
| 10.3 | 10 | 246.0 | 6:00:00 AM | 6:00:00 AM | 5.2 | 604.4 | 45.7 | 1,987 | 26,287 | 13.2 | 2585.6 | 0.320 | 970.2 | 4801.9 | 4,572 | 31,089 | 6.8 |
| 10.3 | 10 | 247.0 | 7:00:00 AM | 7:00:00 AM | 6.3 | 502.4 | 46.6 | 2,439 | 26,312 | 10.8 | 2585.6 | 0.320 | 970.2 | 4801.9 | 5,024 | 31,114 | 6.2 |
| 10.3 | 10 | 248.0 | 8:00:00 AM | 8:00:00 AM | 12.7 | 388.8 | 45.2 | 4,773 | 41,025 | 8.6 | 0.0 | 0.000 | | 0.0 | 4,773 | 41,025 | 8.6 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.4 | 10 | 250.0 | 10:00:00 AM | 10:00:00 AM | 16.2 | 339.3 | 52.1 | 7,032 | 45,819 | 6.5 | 0.0 | 0.000 | | 0.0 | 7,032 | 45,819 | 6.5 |
| 10.5 | 10 | 252.0 | 12:00:00 PM | 12:00:00 PM | 17.1 | 372.8 | 55.0 | 7,822 | 53,066 | 6.8 | 0.0 | 0.000 | | 0.0 | 7,822 | 53,066 | 6.8 |
| 10.6 | 10 | 254.0 | 2:00:00 PM | 2:00:00 PM | 14.5 | 407.8 | 53.8 | 6,521 | 49,378 | 7.6 | 0.0 | 0.000 | | 0.0 | 6,521 | 49,378 | 7.6 |
| 10.7 | 10 | 256.0 | 4:00:00 PM | 4:00:00 PM | 12.8 | 452.9 | 53.6 | 5,703 | 48,162 | 8.4 | 0.0 | 0.000 | | 0.0 | 5,703 | 48,162 | 8.4 |
| 10.8 | 10 | 258.0 | 6:00:00 PM | 6:00:00 PM | 12.0 | 496.6 | 52.1 | 5,228 | 49,847 | 9.5 | 0.0 | 0.000 | | 0.0 | 5,228 | 49,847 | 9.5 |
| 10.8 | 10 | 260.0 | 8:00:00 PM | 8:00:00 PM | 13.4 | 530.1 | 53.8 | 6,038 | 59,435 | 9.8 | 0.0 | 0.000 | | 0.0 | 6,038 | 59,435 | 9.8 |
| 10.9 | 10 | 262.0 | 10:00:00 PM | 10:00:00 PM | 13.4 | 530.1 | 53.8 | 6,038 | 59,435 | 9.8 | 0.0 | 0.000 | | 0.0 | 6,038 | 59,435 | 9.8 |
| 11.0 | 11 | 264.0 | 12:00:00 AM | 12:00:00 AM | 17.3 | 438.8 | 51.1 | 7,362 | 63,171 | 8.6 | 2876.3 | 0.366 | 942.1 | 5501.1 | 10,238 | 68,672 | 6.7 |
| 11.1 | 11 | 266.0 | 2:00:00 AM | 2:00:00 AM | 11.4 | 446.6 | 49.9 | 4,729 | 42,300 | 8.9 | 2876.3 | 0.366 | 942.1 | 5501.1 | 7,606 | 47,801 | 6.3 |
| 11.1 | 11 | 267.0 | 3:00:00 AM | 3:00:00 AM | 6.5 | 414.2 | 49.9 | 2,705 | 22,442 | 8.3 | 2876.3 | 0.366 | 942.1 | 5501.1 | 5,582 | 27,943 | 5.0 |
| 11.3 | 11 | 270.0 | 6:00:00 AM | 6:00:00 AM | 5.1 | 463.4 | 49.7 | 2,093 | 19,519 | 9.3 | 2876.3 | 0.366 | 942.1 | 5501.1 | 4,970 | 25,020 | 5.0 |
| 11.3 | 11 | 271.0 | 7:00:00 AM | 7:00:00 AM | 6.1 | 385.2 | 50.7 | 2,569 | 19,537 | 7.6 | 2876.3 | 0.366 | 942.1 | 5501.1 | 5,446 | 25,038 | 4.6 |
| 11.3 | 11 | 272.0 | 8:00:00 AM | 8:00:00 AM | 12.3 | 298.1 | 49.2 | 5,029 | 30,462 | 6.1 | 0.0 | 0.000 | | 0.0 | 5,029 | 30,462 | 6.1 |
| 11.4 | 11 | 274.0 | 10:00:00 AM | 10:00:00 AM | 15.7 | 260.2 | 56.7 | 7,409 | 34,022 | 4.6 | 0.0 | 0.000 | | 0.0 | 7,409 | 34,022 | 4.6 |
| 11.5 | 11 | 276.0 | 12:00:00 PM | 12:00:00 PM | 16.5 | 285.8 | 59.8 | 8,241 | 39,403 | 4.8 | 0.0 | 0.000 | | 0.0 | 8,241 | 39,403 | 4.8 |
| 11.6 | 11 | 278.0 | 2:00:00 PM | 2:00:00 PM | 14.1 | 312.6 | 58.6 | 6,870 | 36,664 | 5.3 | 0.0 | 0.000 | | 0.0 | 6,870 | 36,664 | 5.3 |
| 11.7 | 11 | 280.0 | 4:00:00 PM | 4:00:00 PM | 12.3 | 347.3 | 58.3 | 6,008 | 35,762 | 6.0 | 0.0 | 0.000 | | 0.0 | 6,008 | 35,762 | 6.0 |
| 11.8 | 11 | 282.0 | 6:00:00 PM | 6:00:00 PM | 11.7 | 380.7 | 56.7 | 5,508 | 37,013 | 6.7 | 0.0 | 0.000 | | 0.0 | 5,508 | 37,013 | 6.7 |
| 11.8 | 11 | 284.0 | 8:00:00 PM | 8:00:00 PM | 13.0 | 406.4 | 58.6 | 6,361 | 44,132 | 6.9 | 0.0 | 0.000 | | 0.0 | 6,361 | 44,132 | 6.9 |
| 11.9 | 11 | 286.0 | 10:00:00 PM | 10:00:00 PM | 13.0 | 406.4 | 58.6 | 6,361 | 44,132 | 6.9 | 0.0 | 0.000 | | 0.0 | 6,361 | 44,132 | 6.9 |
| 12.0 | 12 | 288.0 | 12:00:00 AM | 12:00:00 AM | 16.9 | 523.6 | 56.2 | 7,912 | 73,746 | 9.3 | 2690.0 | 0.342 | 944.2 | 5133.1 | 10,602 | 78,879 | 7.4 |
| 12.1 | 12 | 290.0 | 2:00:00 AM | 2:00:00 AM | 11.1 | 532.9 | 54.9 | 5,083 | 49,382 | 9.7 | 2690.0 | 0.342 | 944.2 | 5133.1 | 7,773 | 54,515 | 7.0 |
| 12.1 | 12 | 291.0 | 3:00:00 AM | 3:00:00 AM | 6.4 | 494.3 | 54.9 | 2,908 | 26,199 | 9.0 | 2690.0 | 0.342 | 944.2 | 5133.1 | 5,598 | 31,332 | 5.6 |
| 12.3 | 12 | 294.0 | 6:00:00 AM | 6:00:00 AM | 4.9 | 552.9 | 54.6 | 2,250 | 22,787 | 10.1 | 2690.0 | 0.342 | 944.2 | 5133.1 | 4,940 | 27,920 | 5.7 |
| 12.3 | 12 | 295.0 | 7:00:00 AM | 7:00:00 AM | 5.9 | 459.7 | 55.7 | 2,761 | 22,808 | 8.3 | 2690.0 | 0.342 | 944.2 | 5133.1 | 5,451 | 27,941 | 5.1 |
| 12.3 | 12 | 296.0 | 8:00:00 AM | 8:00:00 AM | 12.0 | 355.7 | 54.1 | 5,405 | 35,562 | 6.6 | 0.0 | 0.000 | | 0.0 | 5,405 | 35,562 | 6.6 |
| 12.4 | 12 | 298.0 | 10:00:00 AM | 10:00:00 AM | 15.3 | 310.4 | 62.2 | 7,963 | 39,717 | 5.0 | 0.0 | 0.000 | | 0.0 | 7,963 | 39,717 | 5.0 |
| 12.5 | 12 | 300.0 | 12:00:00 PM | 12:00:00 PM | 16.2 | 341.1 | 65.7 | 8,857 | 45,999 | 5.2 | 0.0 | 0.000 | | 0.0 | 8,857 | 45,999 | 5.2 |
| 12.6 | 12 | 302.0 | 2:00:00 PM | 2:00:00 PM | 13.8 | 373.1 | 64.4 | 7,384 | 42,802 | 5.8 | 0.0 | 0.000 | | 0.0 | 7,384 | 42,802 | 5.8 |
| 12.7 | 12 | 304.0 | 4:00:00 PM | 4:00:00 PM | 12.1 | 414.4 | 64.1 | 6,458 | 41,749 | 6.5 | 0.0 | 0.000 | | 0.0 | 6,458 | 41,749 | 6.5 |
| 12.8 | 12 | 306.0 | 6:00:00 PM | 6:00:00 PM | 11.4 | 454.3 | 62.2 | 5,920 | 43,209 | 7.3 | 0.0 | 0.000 | | 0.0 | 5,920 | 43,209 | 7.3 |
| 12.8 | 12 | 308.0 | 8:00:00 PM | 8:00:00 PM | 12.7 | 485.0 | 64.4 | 6,837 | 51,520 | 7.5 | 0.0 | 0.000 | | 0.0 | 6,837 | 51,520 | 7.5 |
| 12.9 | 12 | 310.0 | 10:00:00 PM | 10:00:00 PM | 12.7 | 485.0 | 64.4 | 6,837 | 51,520 | 7.5 | 0.0 | 0.000 | | 0.0 | 6,837 | 51,520 | 7.5 |
| 13.0 | 13 | 312.0 | 12:00:00 AM | 12:00:00 AM | 16.8 | 452.7 | 47.3 | 6,630 | 63,518 | 9.6 | 2553.9 | 0.327 | 935.0 | 4921.3 | 9,184 | 68,440 | 7.5 |
| 13.1 | 13 | 314.0 | 2:00:00 AM | 2:00:00 AM | 11.1 | 460.8 | 46.1 | 4,260 | 42,533 | 10.0 | 2553.9 | 0.327 | 935.0 | 4921.3 | 6,813 | 47,454 | 7.0 |
| 13.1 | 13 | 315.0 | 3:00:00 AM | 3:00:00 AM | 6.3 | 427.4 | 46.1 | 2,437 | 22,566 | 9.3 | 2553.9 | 0.327 | 935.0 | 4921.3 | 4,990 | 27,487 | 5.5 |
| 13.3 | 13 | 318.0 | 6:00:00 AM | 6:00:00 AM | 4.9 | 478.1 | 45.9 | 1,885 | 19,626 | 10.4 | 2553.9 | 0.327 | 935.0 | 4921.3 | 4,439 | 24,548 | 5.5 |
| 13.3 | 13 | 319.0 | 7:00:00 AM | 7:00:00 AM | 5.9 | 397.4 | 46.8 | 2,314 | 19,645 | 8.5 | 2553.9 | 0.327 | 935.0 | 4921.3 | 4,868 | 24,566 | 5.0 |
| 13.3 | 13 | 320.0 | 8:00:00 AM | 8:00:00 AM | 11.9 | 307.6 | 45.5 | 4,529 | 30,630 | 6.8 | 0.0 | 0.000 | | 0.0 | 4,529 | 30,630 | 6.8 |
| 13.4 | 13 | 322.0 | 10:00:00 AM | 10:00:00 AM | 15.3 | 268.4 | 52.4 | 6,673 | 34,209 | 5.1 | 0.0 | 0.000 | | 0.0 | 6,673 | 34,209 | 5.1 |
| 13.5 | 13 | 324.0 | 12:00:00 PM | 12:00:00 PM | 16.1 | 294.9 | 55.2 | 7,423 | 39,620 | 5.3 | 0.0 | 0.000 | | 0.0 | 7,423 | 39,620 | 5.3 |
| 13.6 | 13 | 326.0 | 2:00:00 PM | 2:00:00 PM | 13.7 | 322.6 | 54.1 | 6,188 | 36,866 | 6.0 | 0.0 | 0.000 | | 0.0 | 6,188 | 36,866 | 6.0 |
| 13.7 | 13 | 328.0 | 4:00:00 PM | 4:00:00 PM | 12.0 | 358.3 | 53.9 | 5,411 | 35,959 | 6.6 | 0.0 | 0.000 | | 0.0 | 5,411 | 35,959 | 6.6 |
| 13.8 | 13 | 330.0 | 6:00:00 PM | 6:00:00 PM | 11.4 | 392.8 | 52.4 | 4,961 | 37,217 | 7.5 | 0.0 | 0.000 | | 0.0 | 4,961 | 37,217 | 7.5 |
| 13.8 | 13 | 332.0 | 8:00:00 PM | 8:00:00 PM | 12.7 | 419.3 | 54.1 | 5,729 | 44,375 | 7.7 | 0.0 | 0.000 | | 0.0 | 5,729 | 44,375 | 7.7 |
| 13.9 | 13 | 334.0 | 10:00:00 PM | 10:00:00 PM | 12.7 | 419.3 | 54.1 | 5,729 | 44,375 | 7.7 | 0.0 | 0.000 | | 0.0 | 5,729 | 44,375 | 7.7 |
| 14.0 | 14 | 336.0 | 12:00:00 AM | 12:00:00 AM | 18.3 | 561.5 | 45.2 | 6,887 | 85,630 | 12.4 | 2865.8 | 0.347 | 989.8 | 5217.0 | 9,753 | 90,847 | 9.3 |
| 14.1 | 14 | 338.0 | 2:00:00 AM | 2:00:00 AM | 12.0 | 571.5 | 44.1 | 4,424 | 57,339 | 13.0 | 2865.8 | 0.347 | 989.8 | 5217.0 | 7,290 | 62,556 | 8.6 |
| 14.1 | 14 | 339.0 | 3:00:00 AM | 3:00:00 AM | 6.9 | 530.1 | 44.1 | 2,531 | 30,421 | 12.0 | 2865.8 | 0.347 | 989.8 | 5217.0 | 5,397 | 35,638 | 6.6 |
| 14.3 | 14 | 342.0 | 6:00:00 AM | 6:00:00 AM | 5.4 | 592.9 | 43.9 | 1,958 | 26,458 | 13.5 | 2865.8 | 0.347 | 989.8 | 5217.0 | 4,824 | 31,675 | 6.6 |
| 14.3 | 14 | 343.0 | 7:00:00 AM | 7:00:00 AM | 6.4 | 492.9 | 44.7 | 2,404 | 26,483 | 11.0 | 2865.8 | 0.347 | 989.8 | 5217.0 | 5,269 | 31,700 | 6.0 |
| 14.3 | 14 | 344.0 | 8:00:00 AM | 8:00:00 AM | 13.0 | 381.5 | 43.5 | 4,704 | 41,293 | 8.8 | 0.0 | 0.000 | | 0.0 | 4,704 | 41,293 | 8.8 |
| 14.4 | 14 | 346.0 | 10:00:00 AM | 10:00:00 AM | 16.6 | 332.9 | 50.0 | 6,932 | 46,117 | 6.7 | 0.0 | 0.000 | | 0.0 | 6,932 | 46,117 | 6.7 |
| 14.5 | 14 | 348.0 | 12:00:00 PM | 12:00:00 PM | 17.5 | 365.8 | 52.8 | 7,710 | 53,412 | 6.9 | 0.0 | 0.000 | | 0.0 | 7,710 | 53,412 | 6.9 |
| 14.6 | 14 | 350.0 | 2:00:00 PM | 2:00:00 PM | 14.9 | 400.1 | 51.7 | 6,427 | 49,700 | 7.7 | 0.0 | 0.000 | | 0.0 | 6,427 | 49,700 | 7.7 |
| 14.7 | 14 | 352.0 | 4:00:00 PM | 4:00:00 PM | 13.1 | 444.4 | 51.5 | 5,621 | 48,477 | 8.6 | 0.0 | 0.000 | | 0.0 | 5,621 | 48,477 | 8.6 |
| 14.8 | 14 | 354.0 | 6:00:00 PM | 6:00:00 PM | 12.3 | 487.2 | 50.0 | 5,153 | 50,172 | 9.7 | 0.0 | 0.000 | | 0.0 | 5,153 | 50,172 | 9.7 |
| 14.8 | 14 | 356.0 | 8:00:00 PM | 8:00:00 PM | 13.8 | 520.1 | 51.7 | 5,951 | 59,822 | 10.1 | 0.0 | 0.000 | | 0.0 | 5,951 | 59,822 | 10.1 |
| 14.9 | 14 | 358.0 | 10:00:00 PM | 10:00:00 PM | 13.8 | 520.1 | 51.7 | 5,951 | 59,822 | 10.1 | 0.0 | 0.000 | | 0.0 | 5,951 | 59,822 | 10.1 |
| 15.0 | 15 | 360.0 | 12:00:00 AM | 12:00:00 AM | 19.2 | 528.8 | 50.2 | 8,027 | 84,539 | 10.5 | 2507.9 | 0.318 | 946.6 | 4773.8 | 10,535 | 89,312 | 8.5 |
| 15.1 | 15 | 362.0 | 2:00:00 AM | 2:00:00 AM | 12.6 | 538.2 | 49.0 | 5,157 | 56,608 | 11.0 | 2507.9 | 0.318 | 946.6 | 4773.8 | 7,665 | 61,382 | 8.0 |
| 15.1 | 15 | 363.0 | 3:00:00 AM | 3:00:00 AM | 7.2 | 499.2 | 49.0 | 2,950 | 30,033 | 10.2 | 2507.9 | 0.318 | 946.6 | 4773.8 | 5,458 | 34,807 | 6.4 |
| 15.3 | 15 | 366.0 | 6:00:00 AM | 6:00:00 AM | 5.6 | 558.4 | 48.8 | 2,282 | 26,121 | 11.4 | 2507.9 | 0.318 | 946.6 | 4773.8 | 4,790 | 30,895 | 6.4 |
| 15.3 | 15 | 367.0 | 7:00:00 AM | 7:00:00 AM | 6.8 | 464.2 | 49.7 | 2,801 | 26,146 | 9.3 | 2507.9 | 0.318 | 946.6 | 4773.8 | 5,309 | 30,920 | 5.8 |
| 15.3 | 15 | 368.0 | 8:00:00 AM | 8:00:00 AM | 13.6 | 359.3 | 48.3 | 5,483 | 40,766 | 7.4 | 0.0 | 0.000 | | 0.0 | 5,483 | 40,766 | 7.4 |
| 15.4 | 15 | 370.0 | 10:00:00 AM | 10:00:00 AM | 17.4 | 313.5 | 55.6 | 8,079 | 45,530 | 5.6 | 0.0 | 0.000 | | 0.0 | 8,079 | 45,530 | 5.6 |
| 15.5 | 15 | 372.0 | 12:00:00 PM | 12:00:00 PM | 18.4 | 344.5 | 58.7 | 8,986 | 52,731 | 5.9 | 0.0 | 0.000 | | 0.0 | 8,986 | 52,731 | 5.9 |
| 15.6 | 15 | 374.0 | 2:00:00 PM | 2:00:00 PM | 15.6 | 376.8 | 57.5 | 7,491 | 49,066 | 6.5 | 0.0 | 0.000 | | 0.0 | 7,491 | 49,066 | 6.5 |
| 15.7 | 15 | 376.0 | 4:00:00 PM | 4:00:00 PM | 13.7 | 418.5 | 57.3 | 6,551 | 47,859 | 7.3 | 0.0 | 0.000 | | 0.0 | 6,551 | 47,859 | 7.3 |
| 15.8 | 15 | 378.0 | 6:00:00 PM | 6:00:00 PM | 12.9 | 458.8 | 55.6 | 6,006 | 49,533 | 8.2 | 0.0 | 0.000 | | 0.0 | 6,006 | 49,533 | 8.2 |
| 15.8 | 15 | 380.0 | 8:00:00 PM | 8:00:00 PM | 14.5 | 489.8 | 57.5 | 6,936 | 59,060 | 8.5 | 0.0 | 0.000 | | 0.0 | 6,936 | 59,060 | 8.5 |
| 15.9 | 15 | 382.0 | 10:00:00 PM | 10:00:00 PM | 14.5 | 489.8 | 57.5 | 6,936 | 59,060 | 8.5 | 0.0 | 0.000 | | 0.0 | 6,936 | 59,060 | 8.5 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16.0 | 16 | 384.0 | 12:00:00 AM | 12:00:00 AM | 17.7 | 476.1 | 42.6 | 6,306 | 70,444 | 11.2 | 2710.1 | 0.343 | 947.2 | 5155.1 | 9,016 | 75,599 | 8.4 |
| 16.1 | 16 | 386.0 | 2:00:00 AM | 2:00:00 AM | 11.7 | 484.6 | 41.6 | 4,051 | 47,170 | 11.6 | 2710.1 | 0.343 | 947.2 | 5155.1 | 6,761 | 52,326 | 7.7 |
| 16.1 | 16 | 387.0 | 3:00:00 AM | 3:00:00 AM | 6.7 | 449.4 | 41.6 | 2,317 | 25,026 | 10.8 | 2710.1 | 0.343 | 947.2 | 5155.1 | 5,027 | 30,181 | 6.0 |
| 16.3 | 16 | 390.0 | 6:00:00 AM | 6:00:00 AM | 5.2 | 502.7 | 41.4 | 1,793 | 21,766 | 12.1 | 2710.1 | 0.343 | 947.2 | 5155.1 | 4,503 | 26,921 | 6.0 |
| 16.3 | 16 | 391.0 | 7:00:00 AM | 7:00:00 AM | 6.3 | 417.9 | 42.2 | 2,201 | 21,787 | 9.9 | 2710.1 | 0.343 | 947.2 | 5155.1 | 4,911 | 26,942 | 5.5 |
| 16.3 | 16 | 392.0 | 8:00:00 AM | 8:00:00 AM | 12.6 | 323.5 | 41.0 | 4,307 | 33,970 | 7.9 | 0.0 | 0.000 | | 0.0 | 4,307 | 33,970 | 7.9 |
| 16.4 | 16 | 394.0 | 10:00:00 AM | 10:00:00 AM | 16.1 | 282.3 | 47.2 | 6,346 | 37,939 | 6.0 | 0.0 | 0.000 | | 0.0 | 6,346 | 37,939 | 6.0 |
| 16.5 | 16 | 396.0 | 12:00:00 PM | 12:00:00 PM | 17.0 | 310.1 | 49.8 | 7,059 | 43,940 | 6.2 | 0.0 | 0.000 | | 0.0 | 7,059 | 43,940 | 6.2 |
| 16.6 | 16 | 398.0 | 2:00:00 PM | 2:00:00 PM | 14.5 | 339.2 | 48.8 | 5,884 | 40,886 | 6.9 | 0.0 | 0.000 | | 0.0 | 5,884 | 40,886 | 6.9 |
| 16.7 | 16 | 400.0 | 4:00:00 PM | 4:00:00 PM | 12.7 | 376.8 | 48.6 | 5,146 | 39,880 | 7.7 | 0.0 | 0.000 | | 0.0 | 5,146 | 39,880 | 7.7 |
| 16.8 | 16 | 402.0 | 6:00:00 PM | 6:00:00 PM | 12.0 | 413.1 | 47.2 | 4,718 | 41,274 | 8.7 | 0.0 | 0.000 | | 0.0 | 4,718 | 41,274 | 8.7 |
| 16.8 | 16 | 404.0 | 8:00:00 PM | 8:00:00 PM | 13.4 | 441.0 | 48.8 | 5,448 | 49,213 | 9.0 | 0.0 | 0.000 | | 0.0 | 5,448 | 49,213 | 9.0 |
| 16.9 | 16 | 406.0 | 10:00:00 PM | 10:00:00 PM | 13.4 | 441.0 | 48.8 | 5,448 | 49,213 | 9.0 | 0.0 | 0.000 | | 0.0 | 5,448 | 49,213 | 9.0 |
| 17.0 | 17 | 408.0 | 12:00:00 AM | 12:00:00 AM | 17.5 | 522.0 | 56.3 | 8,220 | 76,219 | 9.3 | 2385.3 | 0.293 | 975.8 | 4404.6 | 10,605 | 80,624 | 7.6 |
| 17.1 | 17 | 410.0 | 2:00:00 AM | 2:00:00 AM | 11.5 | 531.3 | 55.0 | 5,280 | 51,037 | 9.7 | 2385.3 | 0.293 | 975.8 | 4404.6 | 7,666 | 55,442 | 7.2 |
| 17.1 | 17 | 411.0 | 3:00:00 AM | 3:00:00 AM | 6.6 | 492.8 | 55.0 | 3,020 | 27,078 | 9.0 | 2385.3 | 0.293 | 975.8 | 4404.6 | 5,406 | 31,482 | 5.8 |
| 17.3 | 17 | 414.0 | 6:00:00 AM | 6:00:00 AM | 5.1 | 551.2 | 54.7 | 2,337 | 23,551 | 10.1 | 2385.3 | 0.293 | 975.8 | 4404.6 | 4,723 | 27,955 | 5.9 |
| 17.3 | 17 | 415.0 | 7:00:00 AM | 7:00:00 AM | 6.2 | 458.3 | 55.8 | 2,869 | 23,573 | 8.2 | 2385.3 | 0.293 | 975.8 | 4404.6 | 5,254 | 27,977 | 5.3 |
| 17.3 | 17 | 416.0 | 8:00:00 AM | 8:00:00 AM | 12.4 | 354.7 | 54.2 | 5,615 | 36,754 | 6.5 | 0.0 | 0.000 | | 0.0 | 5,615 | 36,754 | 6.5 |
| 17.4 | 17 | 418.0 | 10:00:00 AM | 10:00:00 AM | 15.9 | 309.5 | 62.4 | 8,273 | 41,049 | 5.0 | 0.0 | 0.000 | | 0.0 | 8,273 | 41,049 | 5.0 |
| 17.5 | 17 | 420.0 | 12:00:00 PM | 12:00:00 PM | 16.8 | 340.0 | 65.8 | 9,202 | 47,542 | 5.2 | 0.0 | 0.000 | | 0.0 | 9,202 | 47,542 | 5.2 |
| 17.6 | 17 | 422.0 | 2:00:00 PM | 2:00:00 PM | 14.3 | 371.9 | 64.5 | 7,671 | 44,237 | 5.8 | 0.0 | 0.000 | | 0.0 | 7,671 | 44,237 | 5.8 |
| 17.7 | 17 | 424.0 | 4:00:00 PM | 4:00:00 PM | 12.5 | 413.1 | 64.2 | 6,708 | 43,149 | 6.4 | 0.0 | 0.000 | | 0.0 | 6,708 | 43,149 | 6.4 |
| 17.8 | 17 | 426.0 | 6:00:00 PM | 6:00:00 PM | 11.8 | 453.0 | 62.4 | 6,150 | 44,658 | 7.3 | 0.0 | 0.000 | | 0.0 | 6,150 | 44,658 | 7.3 |
| 17.8 | 17 | 428.0 | 8:00:00 PM | 8:00:00 PM | 13.2 | 483.5 | 64.5 | 7,102 | 53,248 | 7.5 | 0.0 | 0.000 | | 0.0 | 7,102 | 53,248 | 7.5 |
| 17.9 | 17 | 430.0 | 10:00:00 PM | 10:00:00 PM | 13.2 | 483.5 | 64.5 | 7,102 | 53,248 | 7.5 | 0.0 | 0.000 | | 0.0 | 7,102 | 53,248 | 7.5 |
| 18.0 | 18 | 432.0 | 12:00:00 AM | 12:00:00 AM | 17.0 | 470.9 | 46.4 | 6,589 | 66,877 | 10.1 | 2567.6 | 0.296 | 1039.4 | 4451.1 | 9,157 | 71,328 | 7.8 |
| 18.1 | 18 | 434.0 | 2:00:00 AM | 2:00:00 AM | 11.2 | 479.3 | 45.3 | 4,233 | 44,782 | 10.6 | 2567.6 | 0.296 | 1039.4 | 4451.1 | 6,801 | 49,233 | 7.2 |
| 18.1 | 18 | 435.0 | 3:00:00 AM | 3:00:00 AM | 6.4 | 444.5 | 45.3 | 2,421 | 23,759 | 9.8 | 2567.6 | 0.296 | 1039.4 | 4451.1 | 4,989 | 28,210 | 5.7 |
| 18.3 | 18 | 438.0 | 6:00:00 AM | 6:00:00 AM | 5.0 | 497.2 | 45.1 | 1,874 | 20,664 | 11.0 | 2567.6 | 0.296 | 1039.4 | 4451.1 | 4,441 | 25,115 | 5.7 |
| 18.3 | 18 | 439.0 | 7:00:00 AM | 7:00:00 AM | 6.0 | 413.4 | 46.0 | 2,300 | 20,683 | 9.0 | 2567.6 | 0.296 | 1039.4 | 4451.1 | 4,867 | 25,135 | 5.2 |
| 18.3 | 18 | 440.0 | 8:00:00 AM | 8:00:00 AM | 12.1 | 319.9 | 44.7 | 4,501 | 32,249 | 7.2 | 0.0 | 0.000 | | 0.0 | 4,501 | 32,249 | 7.2 |
| 18.4 | 18 | 442.0 | 10:00:00 AM | 10:00:00 AM | 15.5 | 279.2 | 51.4 | 6,632 | 36,018 | 5.4 | 0.0 | 0.000 | | 0.0 | 6,632 | 36,018 | 5.4 |
| 18.5 | 18 | 444.0 | 12:00:00 PM | 12:00:00 PM | 16.3 | 306.7 | 54.2 | 7,377 | 41,715 | 5.7 | 0.0 | 0.000 | | 0.0 | 7,377 | 41,715 | 5.7 |
| 18.6 | 18 | 446.0 | 2:00:00 PM | 2:00:00 PM | 13.9 | 335.5 | 53.2 | 6,149 | 38,815 | 6.3 | 0.0 | 0.000 | | 0.0 | 6,149 | 38,815 | 6.3 |
| 18.7 | 18 | 448.0 | 4:00:00 PM | 4:00:00 PM | 12.2 | 372.6 | 52.9 | 5,378 | 37,860 | 7.0 | 0.0 | 0.000 | | 0.0 | 5,378 | 37,860 | 7.0 |
| 18.8 | 18 | 450.0 | 6:00:00 PM | 6:00:00 PM | 11.5 | 408.6 | 51.4 | 4,930 | 39,184 | 7.9 | 0.0 | 0.000 | | 0.0 | 4,930 | 39,184 | 7.9 |
| 18.8 | 18 | 452.0 | 8:00:00 PM | 8:00:00 PM | 12.8 | 436.1 | 53.2 | 5,694 | 46,721 | 8.2 | 0.0 | 0.000 | | 0.0 | 5,694 | 46,721 | 8.2 |
| 18.9 | 18 | 454.0 | 10:00:00 PM | 10:00:00 PM | 12.8 | 436.1 | 53.2 | 5,694 | 46,721 | 8.2 | 0.0 | 0.000 | | 0.0 | 5,694 | 46,721 | 8.2 |
| 19.0 | 19 | 456.0 | 12:00:00 AM | 12:00:00 AM | 18.6 | 526.6 | 53.1 | 8,221 | 81,478 | 9.9 | 1959.5 | 0.223 | 1052.2 | 3355.3 | 10,180 | 84,833 | 8.3 |
| 19.1 | 19 | 458.0 | 2:00:00 AM | 2:00:00 AM | 12.2 | 536.0 | 51.9 | 5,281 | 54,559 | 10.3 | 1959.5 | 0.223 | 1052.2 | 3355.3 | 7,241 | 57,914 | 8.0 |
| 19.1 | 19 | 459.0 | 3:00:00 AM | 3:00:00 AM | 7.0 | 497.1 | 51.9 | 3,021 | 28,946 | 9.6 | 1959.5 | 0.223 | 1052.2 | 3355.3 | 4,980 | 32,301 | 6.5 |
| 19.3 | 19 | 462.0 | 6:00:00 AM | 6:00:00 AM | 5.4 | 556.1 | 51.6 | 2,338 | 25,175 | 10.8 | 1959.5 | 0.223 | 1052.2 | 3355.3 | 4,297 | 28,531 | 6.6 |
| 19.3 | 19 | 463.0 | 7:00:00 AM | 7:00:00 AM | 6.5 | 462.3 | 52.6 | 2,869 | 25,199 | 8.8 | 1959.5 | 0.223 | 1052.2 | 3355.3 | 4,828 | 28,555 | 5.9 |
| 19.3 | 19 | 464.0 | 8:00:00 AM | 8:00:00 AM | 13.2 | 357.8 | 51.1 | 5,616 | 39,290 | 7.0 | 0.0 | 0.000 | | 0.0 | 5,616 | 39,290 | 7.0 |
| 19.4 | 19 | 466.0 | 10:00:00 AM | 10:00:00 AM | 16.9 | 312.2 | 58.9 | 8,274 | 43,881 | 5.3 | 0.0 | 0.000 | | 0.0 | 8,274 | 43,881 | 5.3 |
| 19.5 | 19 | 468.0 | 12:00:00 PM | 12:00:00 PM | 17.8 | 343.0 | 62.1 | 9,203 | 50,822 | 5.5 | 0.0 | 0.000 | | 0.0 | 9,203 | 50,822 | 5.5 |
| 19.6 | 19 | 470.0 | 2:00:00 PM | 2:00:00 PM | 15.1 | 375.2 | 60.9 | 7,672 | 47,290 | 6.2 | 0.0 | 0.000 | | 0.0 | 7,672 | 47,290 | 6.2 |
| 19.7 | 19 | 472.0 | 4:00:00 PM | 4:00:00 PM | 13.3 | 416.7 | 60.6 | 6,710 | 46,126 | 6.9 | 0.0 | 0.000 | | 0.0 | 6,710 | 46,126 | 6.9 |
| 19.8 | 19 | 474.0 | 6:00:00 PM | 6:00:00 PM | 12.5 | 456.9 | 58.9 | 6,151 | 47,739 | 7.8 | 0.0 | 0.000 | | 0.0 | 6,151 | 47,739 | 7.8 |
| 19.8 | 19 | 476.0 | 8:00:00 PM | 8:00:00 PM | 14.0 | 487.7 | 60.9 | 7,103 | 56,921 | 8.0 | 0.0 | 0.000 | | 0.0 | 7,103 | 56,921 | 8.0 |
| 19.9 | 19 | 478.0 | 10:00:00 PM | 10:00:00 PM | 14.0 | 487.7 | 60.9 | 7,103 | 56,921 | 8.0 | 0.0 | 0.000 | | 0.0 | 7,103 | 56,921 | 8.0 |
| 20.0 | 20 | 480.0 | 12:00:00 AM | 12:00:00 AM | 19.3 | 440.2 | 49.3 | 7,943 | 70,887 | 8.9 | 1913.2 | 0.233 | 985.0 | 3499.9 | 9,856 | 74,386 | 7.5 |
| 20.1 | 20 | 482.0 | 2:00:00 AM | 2:00:00 AM | 12.7 | 448.1 | 48.2 | 5,103 | 47,467 | 9.3 | 1913.2 | 0.233 | 985.0 | 3499.9 | 7,016 | 50,967 | 7.3 |
| 20.1 | 20 | 483.0 | 3:00:00 AM | 3:00:00 AM | 7.3 | 415.6 | 48.2 | 2,919 | 25,183 | 8.6 | 1913.2 | 0.233 | 985.0 | 3499.9 | 4,832 | 28,683 | 5.9 |
| 20.3 | 20 | 486.0 | 6:00:00 AM | 6:00:00 AM | 5.6 | 464.9 | 47.9 | 2,259 | 21,903 | 9.7 | 1913.2 | 0.233 | 985.0 | 3499.9 | 4,172 | 25,403 | 6.1 |
| 20.3 | 20 | 487.0 | 7:00:00 AM | 7:00:00 AM | 6.8 | 386.5 | 48.9 | 2,772 | 21,924 | 7.9 | 1913.2 | 0.233 | 985.0 | 3499.9 | 4,685 | 25,424 | 5.4 |
| 20.3 | 20 | 488.0 | 8:00:00 AM | 8:00:00 AM | 13.7 | 299.1 | 47.5 | 5,426 | 34,183 | 6.3 | 0.0 | 0.000 | | 0.0 | 5,426 | 34,183 | 6.3 |
| 20.4 | 20 | 490.0 | 10:00:00 AM | 10:00:00 AM | 17.5 | 261.0 | 54.7 | 7,994 | 38,177 | 4.8 | 0.0 | 0.000 | | 0.0 | 7,994 | 38,177 | 4.8 |
| 20.5 | 20 | 492.0 | 12:00:00 PM | 12:00:00 PM | 18.5 | 286.8 | 57.7 | 8,892 | 44,216 | 5.0 | 0.0 | 0.000 | | 0.0 | 8,892 | 44,216 | 5.0 |
| 20.6 | 20 | 494.0 | 2:00:00 PM | 2:00:00 PM | 15.7 | 313.6 | 56.5 | 7,413 | 41,143 | 5.6 | 0.0 | 0.000 | | 0.0 | 7,413 | 41,143 | 5.6 |
| 20.7 | 20 | 496.0 | 4:00:00 PM | 4:00:00 PM | 13.8 | 348.4 | 56.3 | 6,483 | 40,130 | 6.2 | 0.0 | 0.000 | | 0.0 | 6,483 | 40,130 | 6.2 |
| 20.8 | 20 | 498.0 | 6:00:00 PM | 6:00:00 PM | 13.0 | 382.0 | 54.7 | 5,943 | 41,534 | 7.0 | 0.0 | 0.000 | | 0.0 | 5,943 | 41,534 | 7.0 |
| 20.8 | 20 | 500.0 | 8:00:00 PM | 8:00:00 PM | 14.6 | 407.7 | 56.5 | 6,863 | 49,522 | 7.2 | 0.0 | 0.000 | | 0.0 | 6,863 | 49,522 | 7.2 |
| 20.9 | 20 | 502.0 | 10:00:00 PM | 10:00:00 PM | 14.6 | 407.7 | 56.5 | 6,863 | 49,522 | 7.2 | 0.0 | 0.000 | | 0.0 | 6,863 | 49,522 | 7.2 |
| 21.0 | 21 | 504.0 | 12:00:00 AM | 12:00:00 AM | 17.3 | 511.1 | 50.0 | 7,217 | 73,790 | 10.2 | 1622.5 | 0.207 | 939.6 | 3111.3 | 8,840 | 76,902 | 8.7 |
| 21.1 | 21 | 506.0 | 2:00:00 AM | 2:00:00 AM | 11.4 | 520.2 | 48.8 | 4,636 | 49,411 | 10.7 | 1622.5 | 0.207 | 939.6 | 3111.3 | 6,259 | 52,522 | 8.4 |
| 21.1 | 21 | 507.0 | 3:00:00 AM | 3:00:00 AM | 6.5 | 482.5 | 48.8 | 2,652 | 26,215 | 9.9 | 1622.5 | 0.207 | 939.6 | 3111.3 | 4,275 | 29,326 | 6.9 |
| 21.3 | 21 | 510.0 | 6:00:00 AM | 6:00:00 AM | 5.1 | 539.7 | 48.6 | 2,052 | 22,800 | 11.1 | 1622.5 | 0.207 | 939.6 | 3111.3 | 3,675 | 25,911 | 7.1 |
| 21.3 | 21 | 511.0 | 7:00:00 AM | 7:00:00 AM | 6.1 | 448.7 | 49.5 | 2,519 | 22,822 | 9.1 | 1622.5 | 0.207 | 939.6 | 3111.3 | 4,141 | 25,933 | 6.3 |
| 21.3 | 21 | 512.0 | 8:00:00 AM | 8:00:00 AM | 12.3 | 347.2 | 48.1 | 4,930 | 35,583 | 7.2 | 0.0 | 0.000 | | 0.0 | 4,930 | 35,583 | 7.2 |
| 21.4 | 21 | 514.0 | 10:00:00 AM | 10:00:00 AM | 15.7 | 303.0 | 55.4 | 7,264 | 39,741 | 5.5 | 0.0 | 0.000 | | 0.0 | 7,264 | 39,741 | 5.5 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21.5 | 21 | 516.0 | 12:00:00 PM | 12:00:00 PM | 16.6 | 332.9 | 58.4 | 8,079 | 46,027 | 5.7 | 0.0 | 0.000 | | 0.0 | 8,079 | 46,027 | 5.7 |
| 21.6 | 21 | 518.0 | 2:00:00 PM | 2:00:00 PM | 14.1 | 364.2 | 57.3 | 6,735 | 42,828 | 6.4 | 0.0 | 0.000 | | 0.0 | 6,735 | 42,828 | 6.4 |
| 21.7 | 21 | 520.0 | 4:00:00 PM | 4:00:00 PM | 12.4 | 404.5 | 57.0 | 5,890 | 41,774 | 7.1 | 0.0 | 0.000 | | 0.0 | 5,890 | 41,774 | 7.1 |
| 21.8 | 21 | 522.0 | 6:00:00 PM | 6:00:00 PM | 11.7 | 443.5 | 55.4 | 5,400 | 43,235 | 8.0 | 0.0 | 0.000 | | 0.0 | 5,400 | 43,235 | 8.0 |
| 21.8 | 21 | 524.0 | 8:00:00 PM | 8:00:00 PM | 13.1 | 473.4 | 57.3 | 6,236 | 51,551 | 8.3 | 0.0 | 0.000 | | 0.0 | 6,236 | 51,551 | 8.3 |
| 21.9 | 21 | 526.0 | 10:00:00 PM | 10:00:00 PM | 13.1 | 473.4 | 57.3 | 6,236 | 51,551 | 8.3 | 0.0 | 0.000 | | 0.0 | 6,236 | 51,551 | 8.3 |
| 22.0 | 22 | 528.0 | 12:00:00 AM | 12:00:00 AM | 16.8 | 490.2 | 51.5 | 7,230 | 68,775 | 9.5 | 1909.8 | 0.244 | 938.9 | 3665.0 | 9,140 | 72,440 | 7.9 |
| 22.1 | 22 | 530.0 | 2:00:00 AM | 2:00:00 AM | 11.1 | 499.0 | 50.3 | 4,645 | 46,053 | 9.9 | 1909.8 | 0.244 | 938.9 | 3665.0 | 6,554 | 49,718 | 7.6 |
| 22.1 | 22 | 531.0 | 3:00:00 AM | 3:00:00 AM | 6.3 | 462.8 | 50.3 | 2,657 | 24,433 | 9.2 | 1909.8 | 0.244 | 938.9 | 3665.0 | 4,567 | 28,098 | 6.2 |
| 22.3 | 22 | 534.0 | 6:00:00 AM | 6:00:00 AM | 4.9 | 517.7 | 50.1 | 2,056 | 21,251 | 10.3 | 1909.8 | 0.244 | 938.9 | 3665.0 | 3,966 | 24,916 | 6.3 |
| 22.3 | 22 | 535.0 | 7:00:00 AM | 7:00:00 AM | 5.9 | 430.3 | 51.0 | 2,523 | 21,271 | 8.4 | 1909.8 | 0.244 | 938.9 | 3665.0 | 4,433 | 24,936 | 5.6 |
| 22.3 | 22 | 536.0 | 8:00:00 AM | 8:00:00 AM | 11.9 | 333.1 | 49.6 | 4,939 | 33,165 | 6.7 | 0.0 | 0.000 | | 0.0 | 4,939 | 33,165 | 6.7 |
| 22.4 | 22 | 538.0 | 10:00:00 AM | 10:00:00 AM | 15.3 | 290.6 | 57.1 | 7,277 | 37,040 | 5.1 | 0.0 | 0.000 | | 0.0 | 7,277 | 37,040 | 5.1 |
| 22.5 | 22 | 540.0 | 12:00:00 PM | 12:00:00 PM | 16.1 | 319.3 | 60.2 | 8,094 | 42,899 | 5.3 | 0.0 | 0.000 | | 0.0 | 8,094 | 42,899 | 5.3 |
| 22.6 | 22 | 542.0 | 2:00:00 PM | 2:00:00 PM | 13.7 | 349.3 | 59.0 | 6,747 | 39,917 | 5.9 | 0.0 | 0.000 | | 0.0 | 6,747 | 39,917 | 5.9 |
| 22.7 | 22 | 544.0 | 4:00:00 PM | 4:00:00 PM | 12.0 | 387.9 | 58.8 | 5,901 | 38,935 | 6.6 | 0.0 | 0.000 | | 0.0 | 5,901 | 38,935 | 6.6 |
| 22.8 | 22 | 546.0 | 6:00:00 PM | 6:00:00 PM | 11.4 | 425.4 | 57.1 | 5,409 | 40,297 | 7.4 | 0.0 | 0.000 | | 0.0 | 5,409 | 40,297 | 7.4 |
| 22.8 | 22 | 548.0 | 8:00:00 PM | 8:00:00 PM | 12.7 | 454.0 | 59.0 | 6,247 | 48,047 | 7.7 | 0.0 | 0.000 | | 0.0 | 6,247 | 48,047 | 7.7 |
| 22.9 | 22 | 550.0 | 10:00:00 PM | 10:00:00 PM | 12.7 | 454.0 | 59.0 | 6,247 | 48,047 | 7.7 | 0.0 | 0.000 | | 0.0 | 6,247 | 48,047 | 7.7 |
| 23.0 | 23 | 552.0 | 12:00:00 AM | 12:00:00 AM | 17.5 | 522.0 | 50.7 | 7,398 | 76,219 | 10.3 | 1664.2 | 0.216 | 923.5 | 3246.8 | 9,062 | 79,466 | 8.8 |
| 23.1 | 23 | 554.0 | 2:00:00 AM | 2:00:00 AM | 11.5 | 531.3 | 49.5 | 4,752 | 51,037 | 10.7 | 1664.2 | 0.216 | 923.5 | 3246.8 | 6,417 | 54,284 | 8.5 |
| 23.1 | 23 | 555.0 | 3:00:00 AM | 3:00:00 AM | 6.6 | 492.8 | 49.5 | 2,718 | 27,078 | 10.0 | 1664.2 | 0.216 | 923.5 | 3246.8 | 4,383 | 30,324 | 6.9 |
| 23.3 | 23 | 558.0 | 6:00:00 AM | 6:00:00 AM | 5.1 | 551.2 | 49.2 | 2,103 | 23,551 | 11.2 | 1664.2 | 0.216 | 923.5 | 3246.8 | 3,768 | 26,797 | 7.1 |
| 23.3 | 23 | 559.0 | 7:00:00 AM | 7:00:00 AM | 6.2 | 458.3 | 50.2 | 2,582 | 23,573 | 9.1 | 1664.2 | 0.216 | 923.5 | 3246.8 | 4,246 | 26,820 | 6.3 |
| 23.3 | 23 | 560.0 | 8:00:00 AM | 8:00:00 AM | 12.4 | 354.7 | 48.8 | 5,053 | 36,754 | 7.3 | 0.0 | 0.000 | | 0.0 | 5,053 | 36,754 | 7.3 |
| 23.4 | 23 | 562.0 | 10:00:00 AM | 10:00:00 AM | 15.9 | 309.5 | 56.1 | 7,445 | 41,049 | 5.5 | 0.0 | 0.000 | | 0.0 | 7,445 | 41,049 | 5.5 |
| 23.5 | 23 | 564.0 | 12:00:00 PM | 12:00:00 PM | 16.8 | 340.0 | 59.2 | 8,281 | 47,542 | 5.7 | 0.0 | 0.000 | | 0.0 | 8,281 | 47,542 | 5.7 |
| 23.6 | 23 | 566.0 | 2:00:00 PM | 2:00:00 PM | 14.3 | 371.9 | 58.0 | 6,904 | 44,237 | 6.4 | 0.0 | 0.000 | | 0.0 | 6,904 | 44,237 | 6.4 |
| 23.7 | 23 | 568.0 | 4:00:00 PM | 4:00:00 PM | 12.5 | 413.1 | 57.8 | 6,038 | 43,149 | 7.1 | 0.0 | 0.000 | | 0.0 | 6,038 | 43,149 | 7.1 |
| 23.8 | 23 | 570.0 | 6:00:00 PM | 6:00:00 PM | 11.8 | 453.0 | 56.1 | 5,535 | 44,658 | 8.1 | 0.0 | 0.000 | | 0.0 | 5,535 | 44,658 | 8.1 |
| 23.8 | 23 | 572.0 | 8:00:00 PM | 8:00:00 PM | 13.2 | 483.5 | 58.0 | 6,392 | 53,248 | 8.3 | 0.0 | 0.000 | | 0.0 | 6,392 | 53,248 | 8.3 |
| 23.9 | 23 | 574.0 | 10:00:00 PM | 10:00:00 PM | 13.2 | 483.5 | 58.0 | 6,392 | 53,248 | 8.3 | 0.0 | 0.000 | | 0.0 | 6,392 | 53,248 | 8.3 |
| 24.0 | 24 | 576.0 | 12:00:00 AM | 12:00:00 AM | 16.8 | 565.3 | 46.1 | 6,441 | 79,054 | 12.3 | 2483.3 | 0.331 | 900.4 | 4969.3 | 8,925 | 84,023 | 9.4 |
| 24.1 | 24 | 578.0 | 2:00:00 AM | 2:00:00 AM | 11.0 | 575.4 | 45.0 | 4,138 | 52,936 | 12.8 | 2483.3 | 0.331 | 900.4 | 4969.3 | 6,621 | 57,905 | 8.7 |
| 24.1 | 24 | 579.0 | 3:00:00 AM | 3:00:00 AM | 6.3 | 533.7 | 45.0 | 2,367 | 28,085 | 11.9 | 2483.3 | 0.331 | 900.4 | 4969.3 | 4,850 | 33,054 | 6.8 |
| 24.3 | 24 | 582.0 | 6:00:00 AM | 6:00:00 AM | 4.9 | 597.0 | 44.8 | 1,832 | 24,426 | 13.3 | 2483.3 | 0.331 | 900.4 | 4969.3 | 4,315 | 29,396 | 6.8 |
| 24.3 | 24 | 583.0 | 7:00:00 AM | 7:00:00 AM | 5.9 | 496.3 | 45.6 | 2,248 | 24,450 | 10.9 | 2483.3 | 0.331 | 900.4 | 4969.3 | 4,731 | 29,419 | 6.2 |
| 24.3 | 24 | 584.0 | 8:00:00 AM | 8:00:00 AM | 11.9 | 384.1 | 44.3 | 4,400 | 38,121 | 8.7 | 0.0 | 0.000 | | 0.0 | 4,400 | 38,121 | 8.7 |
| 24.4 | 24 | 586.0 | 10:00:00 AM | 10:00:00 AM | 15.2 | 335.2 | 51.0 | 6,483 | 42,576 | 6.6 | 0.0 | 0.000 | | 0.0 | 6,483 | 42,576 | 6.6 |
| 24.5 | 24 | 588.0 | 12:00:00 PM | 12:00:00 PM | 16.1 | 368.3 | 53.9 | 7,211 | 49,310 | 6.8 | 0.0 | 0.000 | | 0.0 | 7,211 | 49,310 | 6.8 |
| 24.6 | 24 | 590.0 | 2:00:00 PM | 2:00:00 PM | 13.7 | 402.8 | 52.8 | 6,011 | 45,883 | 7.6 | 0.0 | 0.000 | | 0.0 | 6,011 | 45,883 | 7.6 |
| 24.7 | 24 | 592.0 | 4:00:00 PM | 4:00:00 PM | 12.0 | 447.4 | 52.6 | 5,257 | 44,754 | 8.5 | 0.0 | 0.000 | | 0.0 | 5,257 | 44,754 | 8.5 |
| 24.8 | 24 | 594.0 | 6:00:00 PM | 6:00:00 PM | 11.3 | 490.5 | 51.0 | 4,819 | 46,319 | 9.6 | 0.0 | 0.000 | | 0.0 | 4,819 | 46,319 | 9.6 |
| 24.8 | 24 | 596.0 | 8:00:00 PM | 8:00:00 PM | 12.6 | 523.6 | 52.8 | 5,566 | 55,228 | 9.9 | 0.0 | 0.000 | | 0.0 | 5,566 | 55,228 | 9.9 |
| 24.9 | 24 | 598.0 | 10:00:00 PM | 10:00:00 PM | 12.6 | 523.6 | 52.8 | 5,566 | 55,228 | 9.9 | 0.0 | 0.000 | | 0.0 | 5,566 | 55,228 | 9.9 |
| 25.0 | 25 | 600.0 | 12:00:00 AM | 12:00:00 AM | 17.1 | 501.4 | 54.5 | 7,774 | 71,518 | 9.2 | 2151.7 | 0.299 | 862.1 | 4497.4 | 9,926 | 76,015 | 7.7 |
| 25.1 | 25 | 602.0 | 2:00:00 AM | 2:00:00 AM | 11.3 | 510.3 | 53.2 | 4,994 | 47,889 | 9.6 | 2151.7 | 0.299 | 862.1 | 4497.4 | 7,146 | 52,387 | 7.3 |
| 25.1 | 25 | 603.0 | 3:00:00 AM | 3:00:00 AM | 6.4 | 473.3 | 53.2 | 2,857 | 25,407 | 8.9 | 2151.7 | 0.299 | 862.1 | 4497.4 | 5,009 | 29,905 | 6.0 |
| 25.3 | 25 | 606.0 | 6:00:00 AM | 6:00:00 AM | 5.0 | 529.4 | 53.0 | 2,211 | 22,098 | 10.0 | 2151.7 | 0.299 | 862.1 | 4497.4 | 4,362 | 26,595 | 6.1 |
| 25.3 | 25 | 607.0 | 7:00:00 AM | 7:00:00 AM | 6.0 | 440.1 | 54.0 | 2,713 | 22,119 | 8.2 | 2151.7 | 0.299 | 862.1 | 4497.4 | 4,865 | 26,616 | 5.5 |
| 25.3 | 25 | 608.0 | 8:00:00 AM | 8:00:00 AM | 12.1 | 340.6 | 52.4 | 5,311 | 34,487 | 6.5 | 0.0 | 0.000 | | 0.0 | 5,311 | 34,487 | 6.5 |
| 25.4 | 25 | 610.0 | 10:00:00 AM | 10:00:00 AM | 15.5 | 297.2 | 60.4 | 7,825 | 38,517 | 4.9 | 0.0 | 0.000 | | 0.0 | 7,825 | 38,517 | 4.9 |
| 25.5 | 25 | 612.0 | 12:00:00 PM | 12:00:00 PM | 16.4 | 326.6 | 63.7 | 8,703 | 44,609 | 5.1 | 0.0 | 0.000 | | 0.0 | 8,703 | 44,609 | 5.1 |
| 25.6 | 25 | 614.0 | 2:00:00 PM | 2:00:00 PM | 13.9 | 357.2 | 62.4 | 7,255 | 41,509 | 5.7 | 0.0 | 0.000 | | 0.0 | 7,255 | 41,509 | 5.7 |
| 25.7 | 25 | 616.0 | 4:00:00 PM | 4:00:00 PM | 12.2 | 396.7 | 62.2 | 6,345 | 40,487 | 6.4 | 0.0 | 0.000 | | 0.0 | 6,345 | 40,487 | 6.4 |
| 25.8 | 25 | 618.0 | 6:00:00 PM | 6:00:00 PM | 11.5 | 435.0 | 60.4 | 5,816 | 41,904 | 7.2 | 0.0 | 0.000 | | 0.0 | 5,816 | 41,904 | 7.2 |
| 25.8 | 25 | 620.0 | 8:00:00 PM | 8:00:00 PM | 12.9 | 464.4 | 62.4 | 6,718 | 49,963 | 7.4 | 0.0 | 0.000 | | 0.0 | 6,718 | 49,963 | 7.4 |
| 25.9 | 25 | 622.0 | 10:00:00 PM | 10:00:00 PM | 12.9 | 464.4 | 62.4 | 6,718 | 49,963 | 7.4 | 0.0 | 0.000 | | 0.0 | 6,718 | 49,963 | 7.4 |
| 26.0 | 26 | 624.0 | 12:00:00 AM | 12:00:00 AM | 16.9 | 410.2 | 52.0 | 7,348 | 57,942 | 7.9 | 1949.8 | 0.280 | 833.5 | 4215.0 | 9,298 | 62,157 | 6.7 |
| 26.1 | 26 | 626.0 | 2:00:00 AM | 2:00:00 AM | 11.1 | 417.5 | 50.8 | 4,720 | 38,799 | 8.2 | 1949.8 | 0.280 | 833.5 | 4215.0 | 6,670 | 43,014 | 6.4 |
| 26.1 | 26 | 627.0 | 3:00:00 AM | 3:00:00 AM | 6.4 | 387.3 | 50.8 | 2,700 | 20,584 | 7.6 | 1949.8 | 0.280 | 833.5 | 4215.0 | 4,650 | 24,799 | 5.3 |
| 26.3 | 26 | 630.0 | 6:00:00 AM | 6:00:00 AM | 5.0 | 433.2 | 50.6 | 2,089 | 17,903 | 8.6 | 1949.8 | 0.280 | 833.5 | 4215.0 | 4,039 | 22,118 | 5.5 |
| 26.3 | 26 | 631.0 | 7:00:00 AM | 7:00:00 AM | 6.0 | 360.1 | 51.5 | 2,564 | 17,920 | 7.0 | 1949.8 | 0.280 | 833.5 | 4215.0 | 4,514 | 22,135 | 4.9 |
| 26.3 | 26 | 632.0 | 8:00:00 AM | 8:00:00 AM | 12.0 | 278.7 | 50.1 | 5,019 | 27,941 | 5.6 | 0.0 | 0.000 | | 0.0 | 5,019 | 27,941 | 5.6 |
| 26.4 | 26 | 634.0 | 10:00:00 AM | 10:00:00 AM | 15.4 | 243.2 | 57.6 | 7,395 | 31,206 | 4.2 | 0.0 | 0.000 | | 0.0 | 7,395 | 31,206 | 4.2 |
| 26.5 | 26 | 636.0 | 12:00:00 PM | 12:00:00 PM | 16.2 | 267.2 | 60.8 | 8,226 | 36,141 | 4.4 | 0.0 | 0.000 | | 0.0 | 8,226 | 36,141 | 4.4 |
| 26.6 | 26 | 638.0 | 2:00:00 PM | 2:00:00 PM | 13.8 | 292.3 | 59.6 | 6,857 | 33,629 | 4.9 | 0.0 | 0.000 | | 0.0 | 6,857 | 33,629 | 4.9 |
| 26.7 | 26 | 640.0 | 4:00:00 PM | 4:00:00 PM | 12.1 | 324.6 | 59.3 | 5,997 | 32,802 | 5.5 | 0.0 | 0.000 | | 0.0 | 5,997 | 32,802 | 5.5 |
| 26.8 | 26 | 642.0 | 6:00:00 PM | 6:00:00 PM | 11.4 | 355.9 | 57.6 | 5,497 | 33,949 | 6.2 | 0.0 | 0.000 | | 0.0 | 5,497 | 33,949 | 6.2 |
| 26.8 | 26 | 644.0 | 8:00:00 PM | 8:00:00 PM | 12.8 | 379.9 | 59.6 | 6,349 | 40,479 | 6.4 | 0.0 | 0.000 | | 0.0 | 6,349 | 40,479 | 6.4 |
| 26.9 | 26 | 646.0 | 10:00:00 PM | 10:00:00 PM | 12.8 | 379.9 | 59.6 | 6,349 | 40,479 | 6.4 | 0.0 | 0.000 | | 0.0 | 6,349 | 40,479 | 6.4 |
| 27.0 | 27 | 648.0 | 12:00:00 AM | 12:00:00 AM | 17.4 | 482.9 | 49.5 | 7,160 | 69,889 | 9.8 | 1154.5 | 0.159 | 872.1 | 2385.2 | 8,315 | 72,274 | 8.7 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27.1 | 27 | 650.0 | 2:00:00 AM | 2:00:00 AM | 11.4 | 491.6 | 48.3 | 4,600 | 46,798 | 10.2 | 1154.5 | 0.159 | 872.1 | 2385.2 | 5,754 | 49,184 | 8.5 |
| 27.1 | 27 | 651.0 | 3:00:00 AM | 3:00:00 AM | 6.5 | 455.9 | 48.3 | 2,631 | 24,829 | 9.4 | 1154.5 | 0.159 | 872.1 | 2385.2 | 3,786 | 27,214 | 7.2 |
| 27.3 | 27 | 654.0 | 6:00:00 AM | 6:00:00 AM | 5.1 | 510.0 | 48.1 | 2,036 | 21,595 | 10.6 | 1154.5 | 0.159 | 872.1 | 2385.2 | 3,190 | 23,980 | 7.5 |
| 27.3 | 27 | 655.0 | 7:00:00 AM | 7:00:00 AM | 6.1 | 424.0 | 49.0 | 2,499 | 21,615 | 8.7 | 1154.5 | 0.159 | 872.1 | 2385.2 | 3,653 | 24,000 | 6.6 |
| 27.3 | 27 | 656.0 | 8:00:00 AM | 8:00:00 AM | 12.3 | 328.1 | 47.6 | 4,891 | 33,702 | 6.9 | 0.0 | 0.000 | | 0.0 | 4,891 | 33,702 | 6.9 |
| 27.4 | 27 | 658.0 | 10:00:00 AM | 10:00:00 AM | 15.8 | 286.3 | 54.8 | 7,206 | 37,640 | 5.2 | 0.0 | 0.000 | | 0.0 | 7,206 | 37,640 | 5.2 |
| 27.5 | 27 | 660.0 | 12:00:00 PM | 12:00:00 PM | 16.6 | 314.6 | 57.8 | 8,016 | 43,593 | 5.4 | 0.0 | 0.000 | | 0.0 | 8,016 | 43,593 | 5.4 |
| 27.6 | 27 | 662.0 | 2:00:00 PM | 2:00:00 PM | 14.1 | 344.1 | 56.7 | 6,682 | 40,563 | 6.1 | 0.0 | 0.000 | | 0.0 | 6,682 | 40,563 | 6.1 |
| 27.7 | 27 | 664.0 | 4:00:00 PM | 4:00:00 PM | 12.4 | 382.2 | 56.4 | 5,844 | 39,565 | 6.8 | 0.0 | 0.000 | | 0.0 | 5,844 | 39,565 | 6.8 |
| 27.8 | 27 | 666.0 | 6:00:00 PM | 6:00:00 PM | 11.7 | 419.0 | 54.8 | 5,357 | 40,949 | 7.6 | 0.0 | 0.000 | | 0.0 | 5,357 | 40,949 | 7.6 |
| 27.8 | 27 | 668.0 | 8:00:00 PM | 8:00:00 PM | 13.1 | 447.3 | 56.7 | 6,187 | 48,825 | 7.9 | 0.0 | 0.000 | | 0.0 | 6,187 | 48,825 | 7.9 |
| 27.9 | 27 | 670.0 | 10:00:00 PM | 10:00:00 PM | 13.1 | 447.3 | 56.7 | 6,187 | 48,825 | 7.9 | 0.0 | 0.000 | | 0.0 | 6,187 | 48,825 | 7.9 |
| 28.0 | 28 | 672.0 | 12:00:00 AM | 12:00:00 AM | 17.3 | 538.8 | 49.2 | 7,088 | 77,679 | 11.0 | 1796.2 | 0.252 | 855.5 | 3783.2 | 8,885 | 81,462 | 9.2 |
| 28.1 | 28 | 674.0 | 2:00:00 AM | 2:00:00 AM | 11.4 | 548.4 | 48.0 | 4,554 | 52,015 | 11.4 | 1796.2 | 0.252 | 855.5 | 3783.2 | 6,350 | 55,798 | 8.8 |
| 28.1 | 28 | 675.0 | 3:00:00 AM | 3:00:00 AM | 6.5 | 508.7 | 48.0 | 2,605 | 27,596 | 10.6 | 1796.2 | 0.252 | 855.5 | 3783.2 | 4,401 | 31,379 | 7.1 |
| 28.3 | 28 | 678.0 | 6:00:00 AM | 6:00:00 AM | 5.1 | 569.0 | 47.8 | 2,016 | 24,002 | 11.9 | 1796.2 | 0.252 | 855.5 | 3783.2 | 3,812 | 27,785 | 7.3 |
| 28.3 | 28 | 679.0 | 7:00:00 AM | 7:00:00 AM | 6.1 | 473.0 | 48.7 | 2,474 | 24,024 | 9.7 | 1796.2 | 0.252 | 855.5 | 3783.2 | 4,270 | 27,808 | 6.5 |
| 28.3 | 28 | 680.0 | 8:00:00 AM | 8:00:00 AM | 12.3 | 366.1 | 47.3 | 4,842 | 37,458 | 7.7 | 0.0 | 0.000 | | 0.0 | 4,842 | 37,458 | 7.7 |
| 28.4 | 28 | 682.0 | 10:00:00 AM | 10:00:00 AM | 15.7 | 319.5 | 54.5 | 7,134 | 41,835 | 5.9 | 0.0 | 0.000 | | 0.0 | 7,134 | 41,835 | 5.9 |
| 28.5 | 28 | 684.0 | 12:00:00 PM | 12:00:00 PM | 16.6 | 351.0 | 57.5 | 7,935 | 48,452 | 6.1 | 0.0 | 0.000 | | 0.0 | 7,935 | 48,452 | 6.1 |
| 28.6 | 28 | 686.0 | 2:00:00 PM | 2:00:00 PM | 14.1 | 383.9 | 56.3 | 6,615 | 45,085 | 6.8 | 0.0 | 0.000 | | 0.0 | 6,615 | 45,085 | 6.8 |
| 28.7 | 28 | 688.0 | 4:00:00 PM | 4:00:00 PM | 12.4 | 426.4 | 56.1 | 5,785 | 43,975 | 7.6 | 0.0 | 0.000 | | 0.0 | 5,785 | 43,975 | 7.6 |
| 28.8 | 28 | 690.0 | 6:00:00 PM | 6:00:00 PM | 11.7 | 467.6 | 54.5 | 5,303 | 45,513 | 8.6 | 0.0 | 0.000 | | 0.0 | 5,303 | 45,513 | 8.6 |
| 28.8 | 28 | 692.0 | 8:00:00 PM | 8:00:00 PM | 13.0 | 499.1 | 56.3 | 6,125 | 54,268 | 8.9 | 0.0 | 0.000 | | 0.0 | 6,125 | 54,268 | 8.9 |
| 28.9 | 28 | 694.0 | 10:00:00 PM | 10:00:00 PM | 13.0 | 499.1 | 56.3 | 6,125 | 54,268 | 8.9 | 0.0 | 0.000 | | 0.0 | 6,125 | 54,268 | 8.9 |
| 29.0 | 29 | 696.0 | 12:00:00 AM | 12:00:00 AM | 16.8 | 467.8 | 47.6 | 6,671 | 65,522 | 9.8 | 3140.3 | 0.464 | 811.7 | 6971.0 | 9,811 | 72,493 | 7.4 |
| 29.1 | 29 | 698.0 | 2:00:00 AM | 2:00:00 AM | 11.0 | 476.1 | 46.5 | 4,285 | 43,875 | 10.2 | 3140.3 | 0.464 | 811.7 | 6971.0 | 7,426 | 50,846 | 6.8 |
| 29.1 | 29 | 699.0 | 3:00:00 AM | 3:00:00 AM | 6.3 | 441.6 | 46.5 | 2,451 | 23,277 | 9.5 | 3140.3 | 0.464 | 811.7 | 6971.0 | 5,592 | 30,248 | 5.4 |
| 29.3 | 29 | 702.0 | 6:00:00 AM | 6:00:00 AM | 4.9 | 494.0 | 46.3 | 1,897 | 20,245 | 10.7 | 3140.3 | 0.464 | 811.7 | 6971.0 | 5,037 | 27,216 | 5.4 |
| 29.3 | 29 | 703.0 | 7:00:00 AM | 7:00:00 AM | 5.9 | 410.7 | 47.2 | 2,328 | 20,265 | 8.7 | 3140.3 | 0.464 | 811.7 | 6971.0 | 5,468 | 27,236 | 5.0 |
| 29.3 | 29 | 704.0 | 8:00:00 AM | 8:00:00 AM | 11.9 | 317.8 | 45.8 | 4,557 | 31,596 | 6.9 | 0.0 | 0.000 | | 0.0 | 4,557 | 31,596 | 6.9 |
| 29.4 | 29 | 706.0 | 10:00:00 AM | 10:00:00 AM | 15.3 | 277.4 | 52.8 | 6,714 | 35,288 | 5.3 | 0.0 | 0.000 | | 0.0 | 6,714 | 35,288 | 5.3 |
| 29.5 | 29 | 708.0 | 12:00:00 PM | 12:00:00 PM | 16.1 | 304.7 | 55.7 | 7,468 | 40,870 | 5.5 | 0.0 | 0.000 | | 0.0 | 7,468 | 40,870 | 5.5 |
| 29.6 | 29 | 710.0 | 2:00:00 PM | 2:00:00 PM | 13.7 | 333.3 | 54.6 | 6,225 | 38,029 | 6.1 | 0.0 | 0.000 | | 0.0 | 6,225 | 38,029 | 6.1 |
| 29.7 | 29 | 712.0 | 4:00:00 PM | 4:00:00 PM | 12.0 | 370.2 | 54.3 | 5,444 | 37,093 | 6.8 | 0.0 | 0.000 | | 0.0 | 5,444 | 37,093 | 6.8 |
| 29.8 | 29 | 714.0 | 6:00:00 PM | 6:00:00 PM | 11.3 | 405.9 | 52.8 | 4,991 | 38,391 | 7.7 | 0.0 | 0.000 | | 0.0 | 4,991 | 38,391 | 7.7 |
| 29.8 | 29 | 716.0 | 8:00:00 PM | 8:00:00 PM | 12.7 | 433.3 | 54.6 | 5,764 | 45,775 | 7.9 | 0.0 | 0.000 | | 0.0 | 5,764 | 45,775 | 7.9 |
| 29.9 | 29 | 718.0 | 10:00:00 PM | 10:00:00 PM | 12.7 | 433.3 | 54.6 | 5,764 | 45,775 | 7.9 | 0.0 | 0.000 | | 0.0 | 5,764 | 45,775 | 7.9 |


13,000
11,000
9,000
7,000
5,000
3,000
1,000
TKN, lb/d
0
5
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15
20
25
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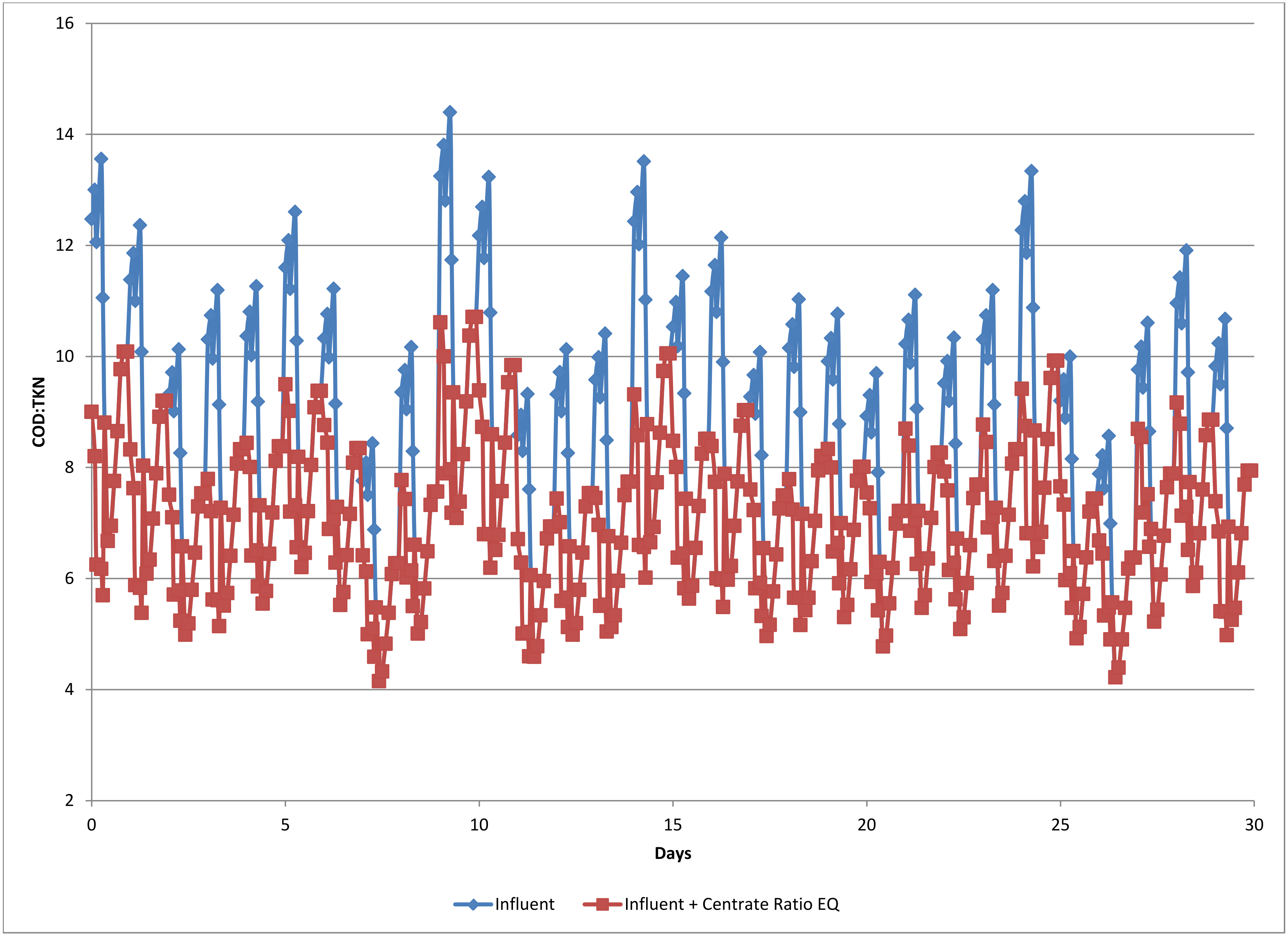
Days
Influent
Influent w/Centrate EQ

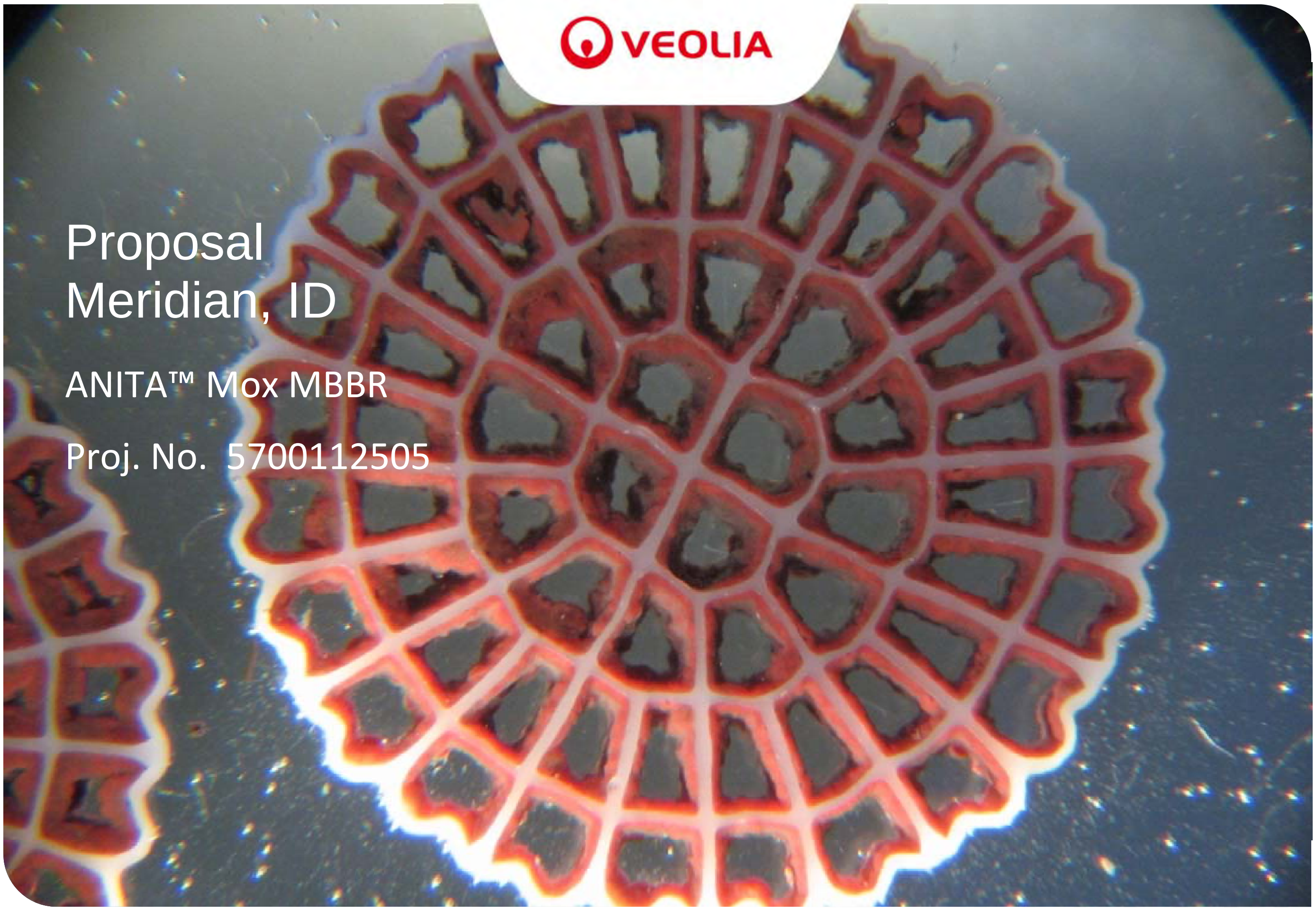


16
14
12
10
8
6
4
2
COD:TKN
0
5
10
15
20
25
30
Days
Influent
Influent + Centrate Ratio EQ

| Date | Eff NH3 mg/L | Eff NO3 mg/L | Eff TN mg/L | Eff TP mg/L | Aer 1 Air flow rate scfm | Aer 2 Air flow rate scfm | Aer 3 Air flow rate scfm | Swing 1 Air flow rate scfm | WAS Mas Rate lb/d | MeOH Flow mgd | MeOH Flow gpd | Purchased MeOH Flow gpd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/5/2015 | 0.29 | 5.27 | 8.01 | 0.47 | 8652.01 | 4977.53 | 1355.48 | 3713.04 | 18095.87 | 0.06 | 58109 | 581 |
| 1/6/2015 | 0.17 | 2.89 | 5.37 | 0.45 | 8237.55 | 4173.17 | 1028.75 | 3614.99 | 18181.18 | 0.05 | 53699 | 537 |
| 1/7/2015 | 0.24 | 4.05 | 6.63 | 0.46 | 8033.86 | 4298.14 | 1184.26 | 3510.65 | 18078.59 | 0.06 | 55802 | 558 |
| 1/8/2015 | 0.59 | 5.76 | 9.36 | 0.47 | 8350.98 | 4916.60 | 1463.24 | 3590.52 | 18140.62 | 0.06 | 61191 | 612 |
| 1/9/2015 | 0.23 | 3.64 | 6.20 | 0.46 | 8225.04 | 4440.55 | 1129.32 | 3601.28 | 18141.64 | 0.06 | 57879 | 579 |
| 1/10/2015 | 0.22 | 4.22 | 6.80 | 0.45 | 8410.60 | 4604.57 | 1197.19 | 3678.43 | 18145.65 | 0.06 | 58716 | 587 |
| 1/11/2015 | 0.19 | 2.47 | 4.95 | 0.44 | 8382.82 | 4504.20 | 1157.77 | 3682.74 | 18247.50 | 0.06 | 57006 | 570 |
| 1/12/2015 | 0.32 | 4.91 | 7.77 | 0.44 | 8060.20 | 4533.37 | 1272.12 | 3489.96 | 18211.69 | 0.05 | 54686 | 547 |
| 1/13/2015 | 0.52 | 7.92 | 11.77 | 0.47 | 7763.46 | 4408.08 | 1295.90 | 3407.91 | 17924.84 | 0.05 | 53409 | 534 |
| 1/14/2015 | 0.25 | 6.10 | 8.90 | 0.48 | 8257.37 | 4474.20 | 1131.51 | 3639.33 | 17849.04 | 0.05 | 54835 | 548 |
| 1/15/2015 | 0.12 | 1.92 | 4.33 | 0.45 | 8628.01 | 4492.57 | 1114.86 | 3759.00 | 18138.21 | 0.06 | 56505 | 565 |
| 1/16/2015 | 0.23 | 2.82 | 5.48 | 0.43 | 8276.25 | 4485.76 | 1214.32 | 3573.59 | 18261.05 | 0.06 | 55667 | 557 |
| 1/17/2015 | 0.52 | 7.01 | 10.64 | 0.45 | 8088.04 | 4663.38 | 1370.96 | 3493.18 | 18061.55 | 0.05 | 54270 | 543 |
| 1/18/2015 | 0.54 | 7.31 | 11.22 | 0.47 | 7968.31 | 4496.19 | 1295.57 | 3474.83 | 17954.58 | 0.05 | 53726 | 537 |
| 1/19/2015 | 0.17 | 5.42 | 7.89 | 0.50 | 8070.92 | 4237.58 | 1041.86 | 3554.06 | 17848.28 | 0.06 | 56731 | 567 |
| 1/20/2015 | 0.17 | 2.37 | 4.78 | 0.46 | 8495.70 | 4543.45 | 1200.96 | 3693.80 | 18023.04 | 0.06 | 60178 | 602 |
| 1/21/2015 | 0.29 | 3.53 | 6.24 | 0.44 | 8294.10 | 4499.23 | 1171.58 | 3619.12 | 18188.69 | 0.06 | 58139 | 581 |
| 1/22/2015 | 0.23 | 3.22 | 5.75 | 0.45 | 8113.02 | 4326.62 | 1171.44 | 3544.12 | 18093.16 | 0.06 | 56094 | 561 |
| 1/23/2015 | 0.63 | 6.32 | 10.25 | 0.45 | 8064.87 | 4592.58 | 1350.70 | 3506.59 | 18052.33 | 0.05 | 54835 | 548 |
| 1/24/2015 | 0.22 | 4.87 | 7.43 | 0.46 | 8061.73 | 4353.42 | 1159.40 | 3539.76 | 17910.25 | 0.06 | 57517 | 575 |
| 1/25/2015 | 0.47 | 4.82 | 8.02 | 0.45 | 8277.57 | 4785.27 | 1400.19 | 3590.78 | 17979.75 | 0.06 | 60761 | 608 |
| 1/26/2015 | 0.35 | 4.76 | 7.67 | 0.44 | 8007.44 | 4417.26 | 1190.70 | 3545.94 | 17911.22 | 0.06 | 57384 | 574 |
| 1/27/2015 | 0.18 | 4.53 | 7.02 | 0.44 | 7940.55 | 4247.00 | 1083.71 | 3499.13 | 17825.99 | 0.05 | 54186 | 542 |
| 1/28/2015 | 0.22 | 5.46 | 8.09 | 0.44 | 7893.90 | 4273.48 | 1111.29 | 3495.18 | 17691.50 | 0.06 | 55094 | 551 |
| 1/29/2015 | 0.18 | 4.12 | 6.60 | 0.44 | 8051.68 | 4231.22 | 1035.94 | 3549.54 | 17759.70 | 0.05 | 54283 | 543 |
| 1/30/2015 | 0.17 | 2.91 | 5.35 | 0.44 | 8008.14 | 4192.24 | 1099.34 | 3507.68 | 17807.95 | 0.05 | 54188 | 542 |
| 1/31/2015 | 0.47 | 6.50 | 9.90 | 0.44 | 7764.12 | 4451.91 | 1305.20 | 3376.01 | 17724.62 | 0.05 | 54201 | 542 |
| 2/1/2015 | 0.36 | 7.10 | 10.28 | 0.46 | 7443.49 | 4099.56 | 1137.26 | 3341.20 | 17438.63 | 0.05 | 54892 | 549 |
| 2/2/2015 | 0.18 | 4.39 | 6.83 | 0.44 | 7788.23 | 4145.55 | 1025.83 | 3453.95 | 17364.46 | 0.06 | 55204 | 552 |
| 2/3/2015 | 0.19 | 3.92 | 6.43 | 0.44 | 7935.02 | 4304.54 | 1090.07 | 3432.84 | 17543.88 | 0.05 | 54099 | 541 |
| 2/4/2015 | 0.26 | 6.61 | 9.38 | 0.45 | 7570.16 | 3796.03 | 958.26 | 3339.49 | 17336.45 | 0.05 | 54775 | 548 |
| **Average** | **0.30** | **4.75** | **7.59** | **0.45** | **8,100** | **4,418** | **1,185** | **3,543** | **17,933** | **0.06** | **56,066** | **561** |
| **Max** | **0.63** | **7.92** | **11.77** | **0.50** | **8,652** | **4,978** | **1,463** | **3,759** | **18,261** | **0.06** | **61,191** | **612** |

| | | |
|---|---|---|
| **Total Ave Air** | **17,247** | **scfm** |
| **Total Max Air** | **18,852** | **scfm** |
| **Total MeOH** | **16,820** | **gallons** |
| **Ave WAS calc** | **23,313** | **lb/d** |

| | | | |
|---|---|---|---|
| **Info from :** | 30-DaySimulationWithQAir | | |
| power/scfm/yr | | 350 | |
| $/kwhr | | 0.069 | |
| WAS Rate increase | | 1.3 | |
| | mg COD/L | | |
| Methanol Solution | | 11880 | |
| Purchased Methanol | | 1188000 | |
| Methanol Price $/gal | $ | 2.25 | corrected per TM1 - SMF |
| **Monthly** | | | |
| **Ave Air Cost** | **$** | **35,000.00** | |
| **Ave MeOH Cost** | **$** | **38,000.00** | |



# Proposal
# Meridian, ID

## ANITA™ Mox MBBR

Proj. No. 5700112505

Submitted to: Lynn Williams, P.E.
Brown and Caldwell

Submitted by: Daniel Hurt
Application Engineer

Date: 5/11/2015



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Cary, NC 27513
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**www.krugerusa.com**

***Water Technologies***

# Introduction

I. Kruger Inc. (a subsidiary of Veolia Water Technologies) is pleased to present this preliminary budgetary proposal for our ANITA™ Mox MBBR process for deammonification of Conventional Anaerobic Digester rejection water at Meridian, ID WWTP. This design is based upon influent flows and loads, design temperatures and other information we have received from you.

In order to achieve the expected removals as summarized in Table 2, we recommend constructing one (1) ANITA Mox MBBR process train with one (1) ANITA Mox MBBR reactor for deammonification of $NH_3$-N. The tank dimensions along with other important process parameters are summarized in Table 3. A preliminary Layout Sketch is included in Process Configuration Section in Page 5.

Please note that a partial nitritation processes with ammonia oxidizing bacteria (AOB) in aerobic conditions consume a significant amount of alkalinity. To ensure that the best performance of the process is achieved, we have included the minimum alkalinity needed in Table 3. If the dewatering schedule does not allow for continuous flow to the process, equalization upstream of the ANITA Mox reactor is recommended.

We appreciate the opportunity to provide this proposal to you. If you have any questions or need further information, please don't hesitate to contact our local representative, Steve Reilly of W.H. Reilly & Co., or our regional sales manager, Brad Mrdjenovich at (brad.mrdjenovich@veolia.com) or (919)-931-5978.

Cc: CT, BM, GAT, LGW, JH, project file (Kruger)
Steve Reilly (W.H. Reilly & Co.)

| Revision | Date | Process Eng. | Comments |
|---|---|---|---|
| 0 | 05/04/2015 | JH_GAT | Initial, budgetary proposal. |

## We Know Water

**Kruger Inc. (Kruger)** is a water and wastewater solutions provider specializing in advanced and differentiating technologies. Kruger provides complete processes and systems ranging from biological nutrient removal to mobile surface water treatment. The ACTIFLO® Microsand Ballasted Clarifier, BioCon® Dryer, BIOSTYR® Biological Aerated Filter (BAF) and NEOSEP™ **MBR are just a few of the innovative technologies offered by Kruger.**

**Kruger Inc. is a Veolia Water Solutions & Technologies' (VWS) company** providing innovative water and wastewater treatment solutions for the U.S. municipal market. As a global company with 135 Business Units in 57 countries, **Veolia Water** with nearly 10,000 employees worldwide and with over 250 proprietary technologies is the world leader in water and wastewater treatment.

Kruger delivers unequalled **S**ervice to our customers delivering and creating **V**alue while being environmentally **R**esponsible with a focus on safety. Since 1986, Kruger has been providing leading edge technologies for biological wastewater treatment, High Rate Clarification for phosphorus removal and water treatment, filtration for TSS removal, water reuse and drinking water and Biosolids processing. Based in Cary, North Carolina, Kruger's 120 plus professionals are dedicated to providing the most technically sound solution to meet our customers' needs while following our principles of **SVR.**

## Energy Focus

Kruger, along with Veolia Water Solutions & Technologies (VWS) is dedicated to delivering sustainable and innovative technologies and solutions. We offer our customers integrated solutions which include resource-efficient technology to improve operations, reduce costs, achieve sustainability goals, decrease dependency on limited resources, and comply with current and anticipated regulations.

Veolia's investments in R&D outpace that of our competition. Our focus is on delivering

- neutral or positive energy solutions
- migration towards green chemicals or zero chemical consumption
- water-footprint-efficient technologies with high recovery rates

Our carbon footprint reduction program drives innovation, accelerates adoption and development of clean technologies, and offers our customers sustainable solutions.
Kruger is benchmarking its technologies and solutions by working with our customers and performing total carbon cost analysis over the lifetime of the installation.
By committing to the innovative development of clean and sustainable technologies and solutions worldwide, Kruger and VWS will continue to maximize the financial benefits for every customer.

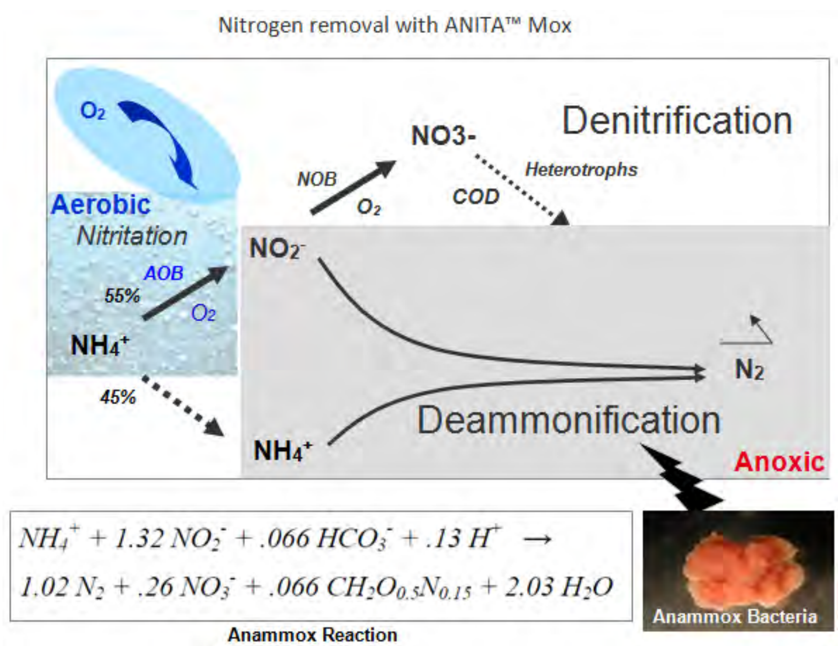
# Process Description

## <u>AnoxKaldnes MBBR</u>

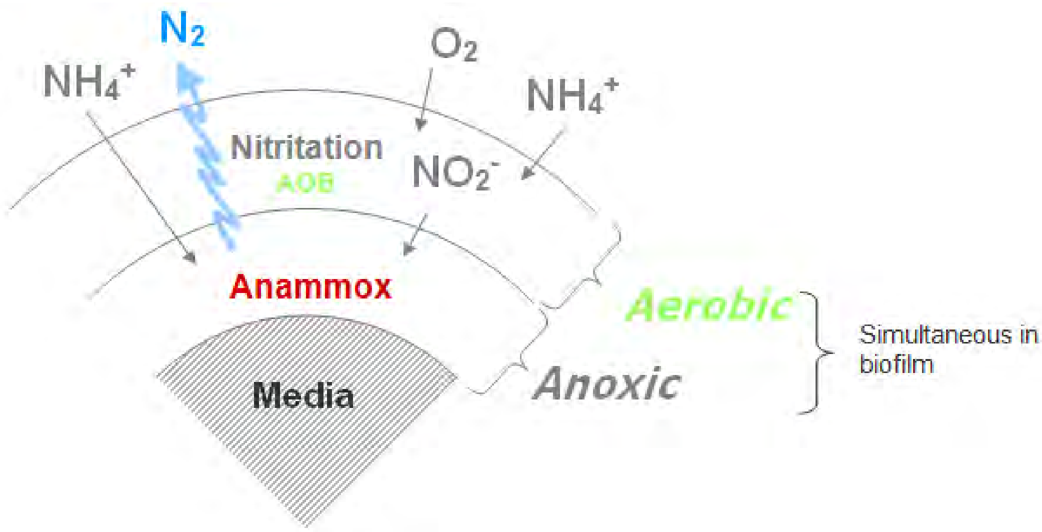
The MBBR process is a continuous-flow, non-clogging biofilm reactor containing moving “carrier elements” or media. The media flows with the water currents in the reactor and does not require backwashing or cleaning.

The biomass that treats the wastewater is attached to the surfaces of the media. The media is designed to provide a large protected surface area for the biofilm and optimal conditions for biological activity when suspended in water. AnoxKaldnes media is made from polyethylene and has a density slightly less then water.

The ANITA™ Mox process is a single-stage nitrogen removal process based on the MBBR platform. The process is specifically designed for treatment of waste streams with high ammonia concentrations. The system can achieve ammonia removals of 80-90% and total nitrogen removals of 75-85%. The treatment method uses only 40% of the oxygen demand of conventional nitrification, and it requires no external carbon source.



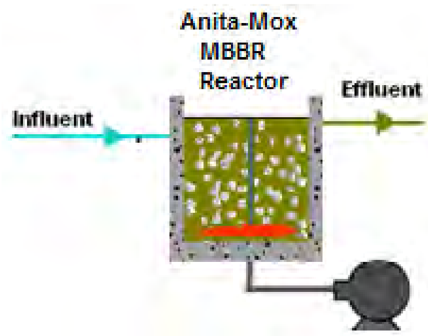

The ANITA Mox process consists of an aerobic nitritation reaction and an anoxic ammonia oxidation (anammox) reaction. The two steps take place simultaneously in different layers of the biofilm. Nitritation occurs in the outer layer of the biofilm. Approximately 55% of the influent ammonia is oxidized to nitrite ($NO_2^-$). Anammox activity occurs in the inner layer. In this step, the nitrite produced and the remaining ammonia are utilized by the anammox bacteria and converted to nitrogen gas ($N_2$) and a small amount of nitrate ($NO_3^-$).



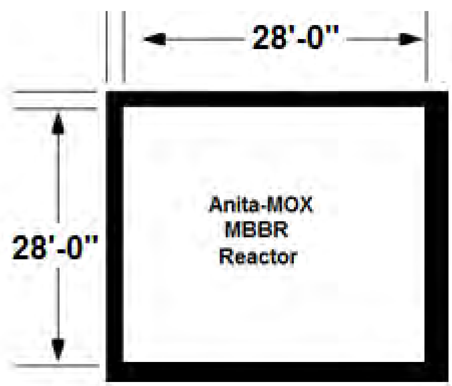

The aerobic and anoxic reactions occur in a single MBBR reactor. The combined biomass grows attached to the AnoxKaldnes media and is retained in the reactor by media screens. This biomass retention is an important characteristic of the system, since the anammox bacteria growth rate is very slow when compared to conventional wastewater bacteria growth rates.

## AnoxKaldnes ANITA™ Mox System Configuration

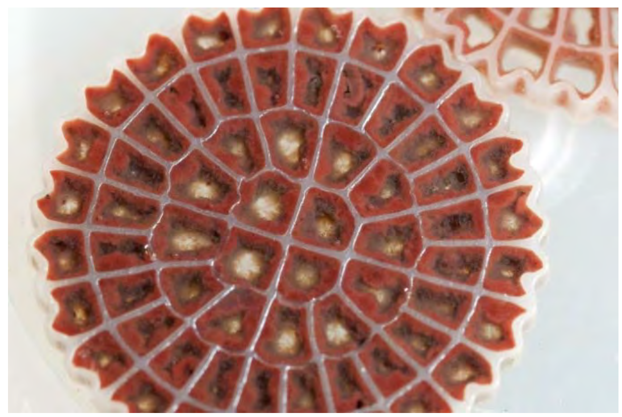
Kruger proposes the ANITA™ Mox process for deammonification of centrate at Meridian, ID. We recommend constructing one (1) ANITA Mox process train with one (1) ANITA Mox MBBR reactor for deammonification.




**Proposed ANITA Mox MBBR Process Configuration**




**Preliminary Layout Sketch - NOT FOR CONSTRUCTION**



## Design Summary

The design assumes that the side stream entering into the proposed ANITA Mox system contains no toxic compounds and has sufficient alkalinity and that none of the equipment provided would be used in a classified area (e.g. Class 1, Division 1 or Class 1, Division 2).

The ANITA Mox influent design basis is summarized in Table 1. The target effluent criteria for the ANITA Mox system are listed in Table 2. The process design is summarized in Table 3.

**Table 1: Influent Design Basis**

| Parameter | Units | Value |
|---|---|---|
| Flow, Design | MGD | 0.103 |
| COD, Design Flow | mg/L | 1,802 |
| TSS, Design Flow[1] | mg/L | 1,000 |
| TKN, Design Flow | mg/L | 960 |
| $NH_4$-N, Design Flow[1] | mg/L | 884 |
| Elevation[2] | ft | 2,600 |
| Design Temperature | °C | 30 |

**[1]Assumed values**
**[2]Assumed valves based on the best available information**

**Table 2: Expected Removals**

| Parameter | Units | % Removal |
|---|---|---|
| $NH_4$-N (mg/L) | % | 80-85 |
| Total Inorganic Nitrogen (mg/L) | % | 70-75 |

**Table 3: Process Design Summary**

| Parameter | Units | Values |
|---|---|---|
| Number of Process Trains | - | 1 |
| Number of ANITA Mox Reactor per Train | - | 1 |
| **ANITA Mox MBBR Reactor** | | |
| Dimensions (Each) | ft | 28 L × 28 W × 20 SWD |
| Volume (Each) | $ft^3$ | 15,680 |
| Total Volume (All Reactors, All Trains) | $ft^3$ | 15,680 |
| Recommended Freeboard | ft | 2 - 3 |
| Media Type: | - | K5 |
| Fill of Biofilm Carriers, All Reactors | % | 41 |
| Media Volume (All Reactors, All Trains) | $ft^3$ | 6,710 |
| Aeration System Type | - | Medium Bubble |
| Residual DO, Max. Month | mg/L | 1.5 |
| Total Process Air Requirement (All Reactors, All Trains) | SCFM | ~600 |
| Discharge Pressure (From Top of Drop Pipe) | psi | 9.0 |
| Minimum Alkalinity Required in influent | mg/L | 4,000 |
| Estimated Effluent TSS Concentration at Design Condition | mg/L | 1,200 |
| Sludge Production at Design Conditions | lb/day | 1,030 |

## Scope of Supply

Kruger is pleased to present our scope of supply which includes process engineering design, equipment procurement, and field services required for the proposed treatment system, as related to the equipment specified. The work will be performed to Kruger's high standards under the direction of a Project Manager. All matters related to the design, installation, or performance of the system shall be communicated through the Kruger representative giving the Engineer and Owner ready access to Kruger's extensive capabilities.

### Process and Design Engineering

Kruger will provide process engineering and design support for the system as follows:

- Process Engineering consisting of aeration system sizing and configuration, sieve and outlet design.
- Review and approval of P&I Diagram for the AnoxKaldnes ANITA Mox portion of the process. Preliminary General Arrangement Drawings and review and approval of final General Arrangement Drawings for the process. Review of reactor drawings with respect to penetrations and dimensions, excluding structural design.
- Equipment installation instructions for all equipment supplied by Kruger.

### Field Services

Kruger will furnish a Service Engineer to perform the following tasks:

- Inspect installation of key pieces of equipment during construction.
- Inspect the completed system prior to startup.
- Assist the Contractor with initial startup of the system.
- Train the Owner’s staff in the proper operation and maintenance of the AnoxKaldnes ANITA Mox system.
- Test and start any Kruger-supplied control equipment, including PLC programming and SCADA systems.

## AnoxKaldnes ANITA™ Mox System Equipment

| Mechanical Equipment Items | Qty | Description |
|---|---|---|
| AnoxKaldnes K5 Media, ($ft^3$) | 6,710 | Carrier elements are made of high density polyethylene. The total media quantity will include a volume of ~5% seeded media. |
| Cylindrical Screen Assemblies | 2 | Two (2) per reactor. 304L SS. 23"ø perforated plate pipes terminated in ANSI flanges for mounting directly to the tank wall. |
| Medium Bubble Aeration System | 1 lot | 304L SS including header, lateral piping, and hardware (excluding concrete anchor bolts). |
| Specially Designed Mechanical Mixers | 1 | One (1) top entry mixer per ANITA Mox Reactor |
| Airlift Pumps | 2 | Two airlift pumps per ANITA Mox reactor for foam suppression. |
| Positive Displacement Blowers | 1 + 1 | One (1) duty plus one (1) standby. Each blower will be rated for 599 SCFM and 40 HP with a VFD. |
| **Instrumentation and Controls Equipment Items** | **Qty** | **Description** |
| PLC Control Panel | 1 | NEMA 12 Freestanding or Wall Mount Control Panel (For Indoor Use). ControlLogix PLC; Panelview HMI; 120V Feed |
| High Level Float Switch | 1 | One (1) for each media zone. |
| DO Probe (LDO) | 1 | One (1) for each Aerobic zone. Aerobic Zone DO Monitoring |
| pH/Temp. meter | 1 | One (1) pH meter for each ANITA Mox reactor. |
| Thermal Mass Flowmeter | 1 | One (1) for each ANITA Mox reactor for air flow control |
| **Instrumentation and Controls (NOT INCLUDED)*** | **Qty** | **Description** |
| Influent Ammonia Nitrogen Probe | 1 | One (1) ammonia nitrogen probe for all process trains. For nutrient monitoring |
| Combination Ammonia / Nitrate Nitrogen Analyzer | 1 | One (1) combination ammonia / nitrate nitrogen probe for each ANITA Mox reactor. For nutrient monitoring. |

*** Kruger can supply these items if required, but are not part of our standard offering. Please contact Kruger if you would like this included in Kruger's Scope of supply.**

**Notes Regarding System Design and Installation**

- For any MBBR or IFAS system, regardless of manufacturer, the quality and finish of reactor surfaces is important for the long-term longevity of the system. AnoxKaldnes has years of experience in the design and manufacture of MBBR and IFAS systems, with the quality and texture of the finished reactor walls is important. It is particularly important to prevent chipping, holidays, or rough areas that would leave open any annular spaces around media retention screens.

**Scope of Supply BY INSTALLER/PURCHASER**

The scope of supply by others for the AnoxKaldnes ANITA™ Mox system should include, but is not limited to, the following items:

- All civil/site and electrical work.
- A concrete foundation for the tanks.
- Reactors to house the MBBR treatment equipment.
- All provisions for interconnecting piping.
- Unloading, storage and installation of equipment.
- Centrate equalization tanks
- Cover for reactor tanks
- Temporary provisions for screened primary or secondary effluent during startup.
- Temporary reactor heating during startup.
- Mixer bridges and other structural modifications for the reactors.

## Design Options

In addition to the proposed system as detailed herein, Kruger is able to further incorporate our process and controls expertise into wastewater treatment plants, allowing municipalities to meet stringent effluent requirements and future plant upgrades. Kruger is also able to offer our instrumentation and controls expertise to build upon the proposed system by providing a **customized plant-wide SCADA system** or designing a **Motor Control Center (MCC)**, providing clients a single source responsibility for plant controls. Please contact Kruger if the options above are of interest or to be included in the current proposed system or future upgrades. ***Please note that the design options listed above are not included in the pricing noted herein.*

## Schedule

- Shop drawings will be submitted within 6-8 weeks of receipt of an executed contract by all parties.
- All equipment will be delivered within 18-20 weeks after receipt of written approval of the shop drawings.
- Installation manuals will be furnished upon delivery of equipment.
- Operation and Maintenance Manuals will be submitted within 90 days after receipt of approved shop drawings.

# Pricing

The price for the AnoxKaldnes ANITA™ Mox MBBR system, as defined herein, including process and design engineering, field services, and equipment supply is: **$710,300**

Pricing is FOB shipping point, with freight allowed to the job site. This pricing does not include any sales or use taxes. In addition, pricing is valid for ninety (90) days from the date of issue and is subject to negotiation of a mutually acceptable contract.

***Please note that the above pricing is expressly contingent upon the items in this proposal and are subject to I. Kruger Inc. Standard Terms of Sale detailed herein.***

**Kruger Standard Terms of Payment**

The terms of payment are as follows:

- 10% on receipt of fully executed contract
- 15% on submittal of shop drawings
- 75% on the delivery of equipment to the site

Payment shall not be contingent upon receipt of funds by the Contractor from the Owner. There shall be no retention in payments due to I. Kruger Inc. All other terms per our Standard Terms of Sale are attached.

All payment terms are net 30 days from the date of invoice. Final payment not to exceed 120 days from delivery of equipment.

# I. Kruger Inc. Standard Terms of Sale

1. Applicable Terms. These terms govern the purchase and sale of the equipment and related services, if any (collectively, "Equipment"), referred to in Seller's purchase order, quotation, proposal or acknowledgment, as the case may be ("Seller's Documentation"). Whether these terms are included in an offer or an acceptance by Seller, such offer or acceptance is conditioned on Buyer's assent to these terms. Seller rejects all additional or different terms in any of Buyer's forms or documents.

2. Payment. Buyer shall pay Seller the full purchase price as set forth in Seller's Documentation. Unless Seller's Documentation provides otherwise, freight, storage, insurance and all taxes, duties or other governmental charges relating to the Equipment shall be paid by Buyer. If Seller is required to pay any such charges, Buyer shall immediately reimburse Seller. All payments are due within 30 days after receipt of invoice. Buyer shall be charged the lower of 1 ½% interest per month or the maximum legal rate on all amounts not received by the due date and shall pay all of Seller's reasonable costs (including attorneys' fees) of collecting amounts due but unpaid. All orders are subject to credit approval.

3. Delivery. Delivery of the Equipment shall be in material compliance with the schedule in Seller's Documentation. Unless Seller's Documentation provides otherwise, Delivery terms are F.O.B. Seller's facility.

4. Ownership of Materials. All devices, designs (including drawings, plans and specifications), estimates, prices, notes, electronic data and other documents or information disclosed by Seller or prepared solely by Seller or Buyer or jointly by Seller and Buyer in connection with this Agreement, and all intellectual property rights therein, shall be and remain the confidential and proprietary property of Seller, whether or not patented by Seller ("Work Product"). Buyer hereby irrevocably assigns all rights in any Work Product to Seller. Seller grants Buyer a non-exclusive, non-transferable (except to a successor-in interest to the ownership of the Equipment), paid-up license to use the Work Product solely in connection with Buyer's use, operation, repair and maintenance of the Equipment at the Jobsite defined in this Agreement. Buyer may not disclose, share, transfer, or sell any such Work Product to third parties without Seller's prior written consent and such consent may be arbitrarily withheld. Buyer agrees not to resell, transfer or give any of the biologically colonized media or bacteria from the system to any party other than Seller or any of Seller's affiliates without the prior written consent of Seller for a period of fifteen (15) years from the effective date of this Agreement. Buyer shall not cultivate bacteria or use biomass carriers retrieved from the ANITA Mox system for any research or non-research purposes without prior written consent of the Seller. Any new developments, discoveries or inventions resulting from the operation of the ANITA Mox system in which the ANITA Mox process is a component or is in any way incorporated in whole or in part shall be owned solely by the Seller.

5. Changes. Seller shall not implement any changes in the scope of work described in Seller's Documentation unless Buyer and Seller agree in writing to the details of the change and any resulting price, schedule or other contractual modifications. This includes any changes necessitated by a change in applicable law occurring after the effective date of any contract including these terms.

6. Warranty. Subject to the following sentence, Seller warrants to Buyer that the Equipment shall materially conform to the description in Seller's Documentation and shall be free from defects in material and workmanship. The foregoing warranty shall not apply to any Equipment that is specified or otherwise demanded by Buyer and is not manufactured or selected by Seller, as to which (i) Seller hereby assigns to Buyer, to the extent assignable, any warranties made to Seller and (ii) Seller shall have no other liability to Buyer under warranty, tort or any other legal theory. If Buyer gives Seller prompt written notice of breach of this warranty within 18 months from delivery or 1 year from beneficial use, whichever occurs first (the "Warranty Period"), Seller shall, at its sole option and as Buyer's sole remedy, repair or replace the subject parts or refund the purchase price therefore. If Seller determines that any claimed breach is not, in fact, covered by this warranty, Buyer shall pay Seller its then customary charges for any repair or replacement made by Seller. Seller's warranty is conditioned on Buyer's (a) operating and maintaining the Equipment in accordance with Seller's instructions, (b) not making any unauthorized repairs or alterations, and (c) not being in default of any payment obligation to Seller. Seller's warranty does not cover damage caused by chemical action or abrasive material, misuse or improper installation (unless installed by Seller). THE WARRANTIES SET FORTH IN THIS SECTION ARE SELLER'S SOLE AND EXCLUSIVE WARRANTIES AND ARE SUBJECT TO SECTION 10 BELOW. SELLER MAKES NO OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE.

7. Indemnity. Seller shall indemnify, defend and hold Buyer harmless from any claim, cause of action or liability incurred by Buyer as a result of third party claims for personal injury, death or damage to tangible property, to the extent caused by Seller's negligence. Seller shall have the sole authority to direct the defense of and settle any indemnified claim. Seller's indemnification is conditioned on Buyer (a) promptly, within the Warranty Period, notifying Seller of any claim, and (b) providing reasonable cooperation in the defense of any claim.

8. Force Majeure. Neither Seller nor Buyer shall have any liability for any breach (except for breach of payment obligations) caused by extreme weather or other act of God, strike or other labor shortage or disturbance, fire, accident, war or civil disturbance, delay of carriers, failure of normal sources of supply, act of government or any other cause beyond such party's reasonable control.

9. Cancellation. If Buyer cancels or suspends its order for any reason other than Seller's breach, Buyer shall promptly pay Seller for work performed prior to cancellation or suspension and any other direct costs incurred by Seller as a result of such cancellation or suspension.

10. LIMITATION OF LIABILITY. NOTWITHSTANDING ANYTHING ELSE TO THE CONTRARY, SELLER SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER INDIRECT DAMAGES, AND SELLER'S TOTAL LIABILITY ARISING AT ANY TIME FROM THE SALE OR USE OF THE EQUIPMENT SHALL NOT EXCEED THE PURCHASE PRICE PAID FOR THE EQUIPMENT. THESE LIMITATIONS APPLY WHETHER THE LIABILITY IS BASED ON CONTRACT, TORT, STRICT LIABILITY OR ANY OTHER THEORY.

Miscellaneous. If these terms are issued in connection with a government contract, they shall be deemed to include those federal acquisition regulations that are required by law to be included. These terms, together with any quotation, purchase order or acknowledgement issued or signed by the Seller, comprise the complete and exclusive statement of the agreement between the parties (the "Agreement") and supersede any terms contained in Buyer's documents, unless separately signed by Seller. No part of the Agreement may be changed or cancelled except by a written document signed by Seller and Buyer. No course of dealing or performance, usage of trade or failure to enforce any term shall be used to modify the Agreement. If any of these terms is unenforceable, such term shall be limited only to the extent necessary to make it enforceable, and all other terms shall remain in full force and effect. Buyer may not assign or permit any other transfer of the Agreement without Seller's prior written consent. The Agreement shall be governed by the laws of the State of North Carolina without regard to its conflict of laws provisions.

# BioWin user and configuration data

## Project details

Project name: Alternatives Analysis    Project ref.: 147571

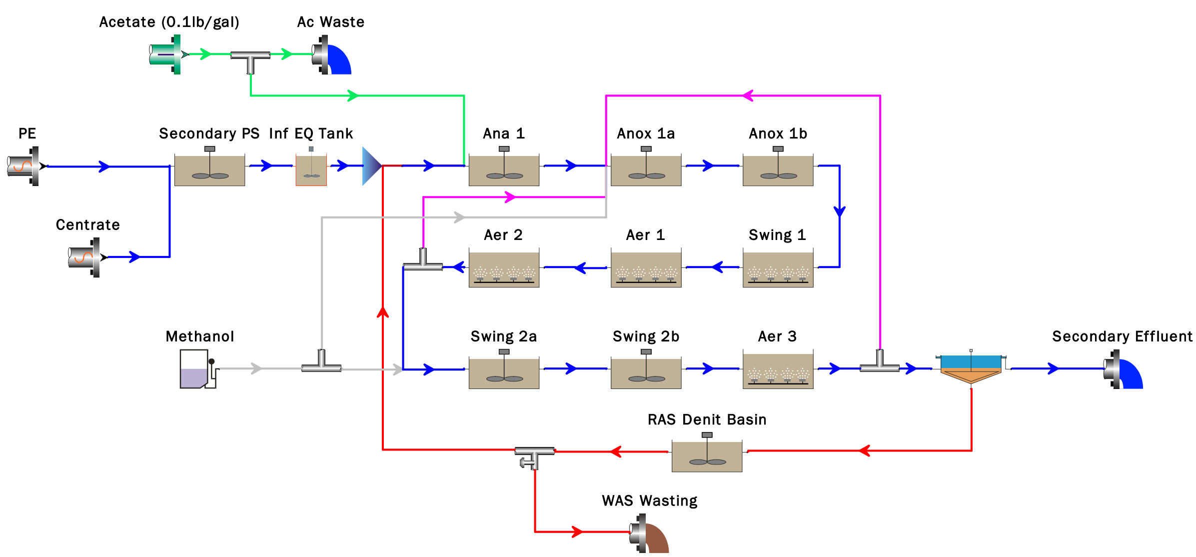
Plant name: Meridian WWTP    User name: Rick Kelly

Created: 6/29/2011    Saved: 4/29/2015

Target SRT: 12.00 days    SRT: **** days

Temperature: 14.0°C

## Flowsheet




## Configuration information for all Variable volume bioreactor units

### Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Inf EQ Tank | 2.4000 | 2.292E+4 | 14.000 | Un-aerated |

### Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Inf EQ Tank | 0 |

### Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Inf EQ Tank | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

## Configuration information for all Bioreactor units

### Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Ana 1 | 0.5000 | 4774.3058 | 14.000 | Un-aerated |
| Aer 1 | 1.5000 | 1.432E+4 | 14.000 | 4868 |

| | | | | |
|---|---|---|---|---|
| Aer 2 | 1.2500 | 1.194E+4 | 14.000 | 4057 |
| Swing 2a | 0.7500 | 7161.4587 | 14.000 | Un-aerated |
| Aer 3 | 0.5000 | 4774.3058 | 14.000 | 1623 |
| Anox 1a | 0.3750 | 3580.7294 | 14.000 | Un-aerated |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |
| Anox 1b | 0.3750 | 3580.7294 | 14.000 | Un-aerated |
| Swing 1 | 0.5000 | 4774.3058 | 14.000 | 1082 |
| Swing 2b | 0.7500 | 7161.4587 | 14.000 | Un-aerated |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Ana 1 | 0 |
| Aer 1 | 2.5 |
| Aer 2 | 2.0 |
| Swing 2a | 0 |
| Aer 3 | 2.0 |
| Anox 1a | 0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |
| Anox 1b | 0 |
| Swing 1 | 2.0 |
| Swing 2b | 0 |

## Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Ana 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 2 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Swing 2a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 3 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Anox 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Anox 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 2b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

# Configuration information for all Methanol addition units

## Operating data Average (flow/time weighted as required)

| Element name | Methanol |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |

| | |
|---|---|
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 11880.00 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |

| | |
|---|---|
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 0.055 |

# Configuration information for all Effluent units

# Configuration information for all Ideal clarifier units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] |
|---|---|---|---|
| Clarifier | 2.8000 | 2.718E+4 | 13.770 |

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| Clarifier | Flow paced | 50.00 % |

| Element name | Average Temperature | Reactive | Percent removal | Blanket fraction |
|---|---|---|---|---|
| Clarifier | Uses global setting | Yes | 99.90 | 0.07 |

# Configuration information for all COD Influent units

## Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 30.00 | 30.00 |
| Flow | 12.4611703212226 | 0.100114816828393 |
| Total COD mgCOD/L | 416.48 | 1096.91 |
| Total Kjeldahl Nitrogen mgN/L | 54.01 | 196.49 |
| Total P mgP/L | 8.12 | 477.82 |
| Nitrate N mgN/L | 0 | 36.84 |
| pH | 7.95 | 6.75 |
| Alkalinity mmol/L | 6.08 | 13.34 |
| ISS Influent mgISS/L | 11.43 | 67.65 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0.10 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.0014 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 4.312E-4 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9976 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.5976 |

| | | |
|---|---|---|
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.0870 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.8845 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5000 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0102 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0319 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9400 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.1277 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 0.0636 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 3.510E-5 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 0.0245 |
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.640E-5 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 0.0514 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 2.950E-5 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 9.450E-6 |
| FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 7.780E-6 |
| FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 7.780E-6 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 | 0 |

## Configuration information for all Sludge units

## Configuration information for all Splitter units

### Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| BDF IMLR | Flow paced | 200.00 % |
| RAS / WAS | Flowrate [Side] | 0.180762328827811 |
| Acetate Splitter | Flow paced | 0.53 % |

| | | |
|---|---|---|
| Splitter21 | Flowrate [Side] | 0 |
| A2O IMLR | Flowrate [Side] | 0 |

# Configuration information for all Stream (SV) Influent units

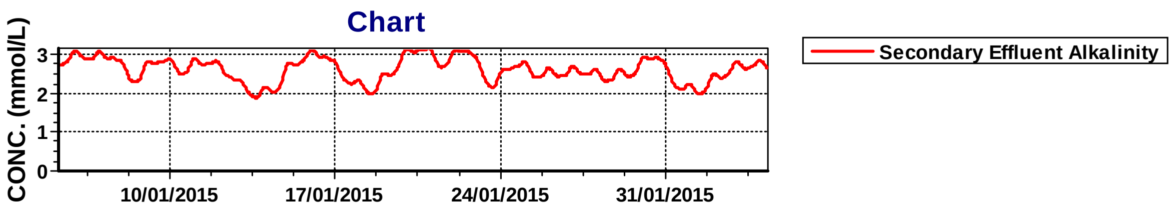
## Operating data Average (flow/time weighted as required)

| Element name | Acetate (0.1lb/gal) |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |

| | |
|---|---|
| Acetate mgCOD/L | 11980.00 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

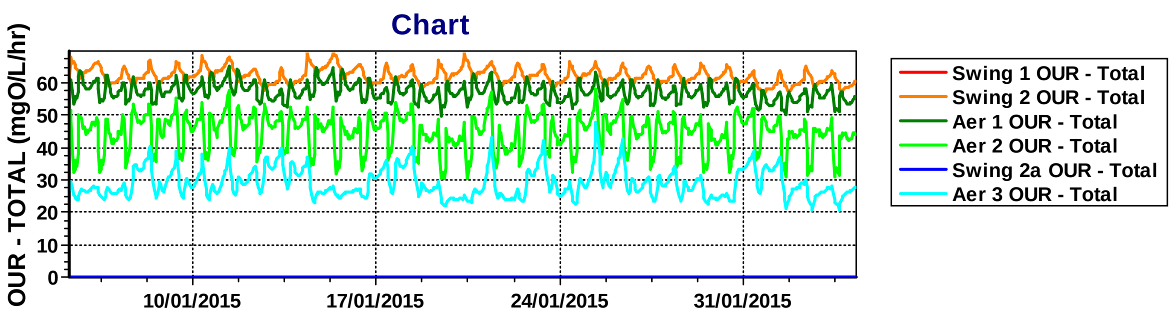
BioWin Album

Album page - SS AOB-NOB

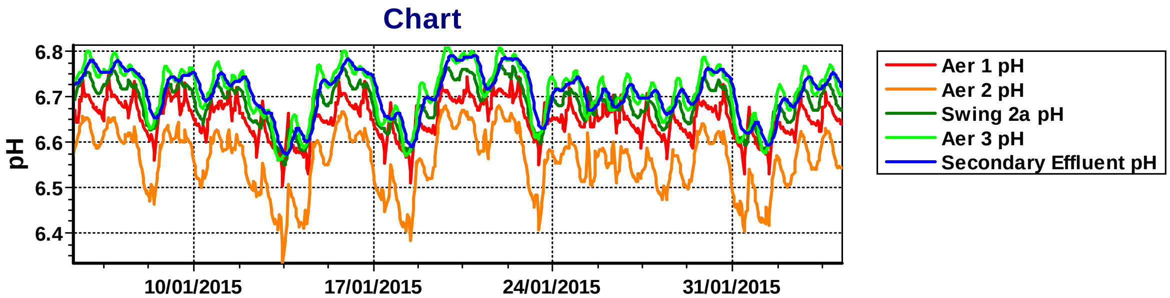



Album page - SS AOB-NOB

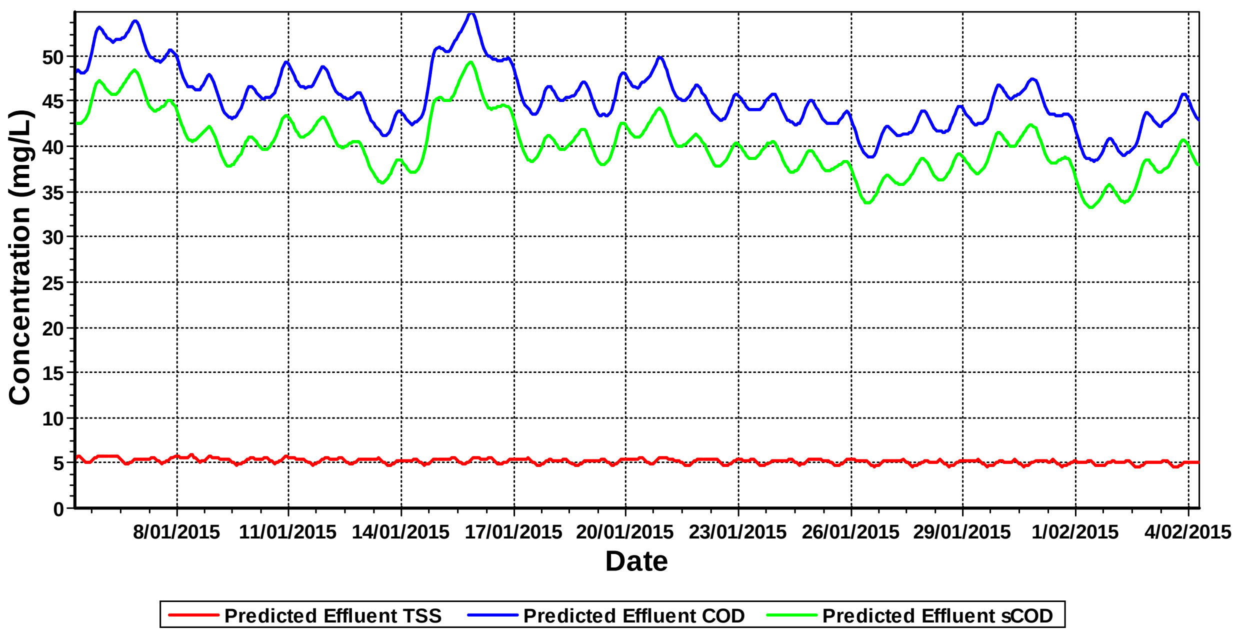
Album page - OURs



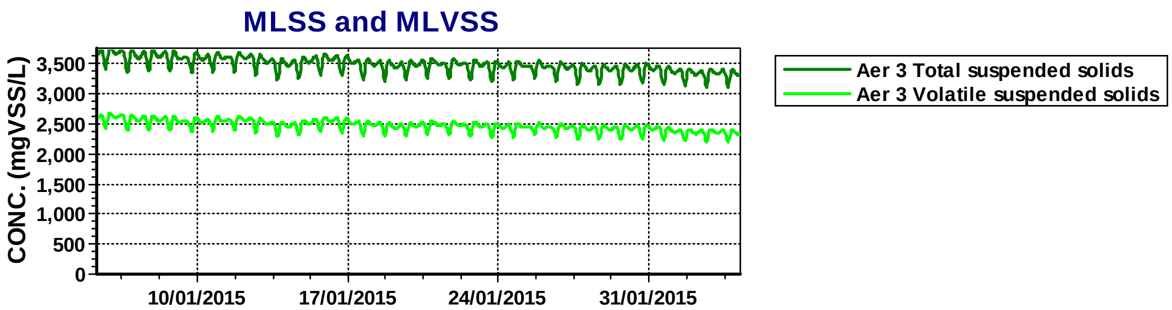

Album page - OURs



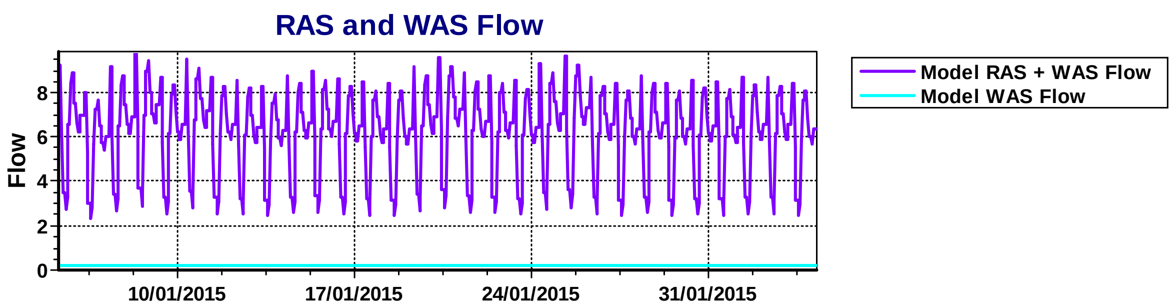

Album page - TSS, COD, BOD



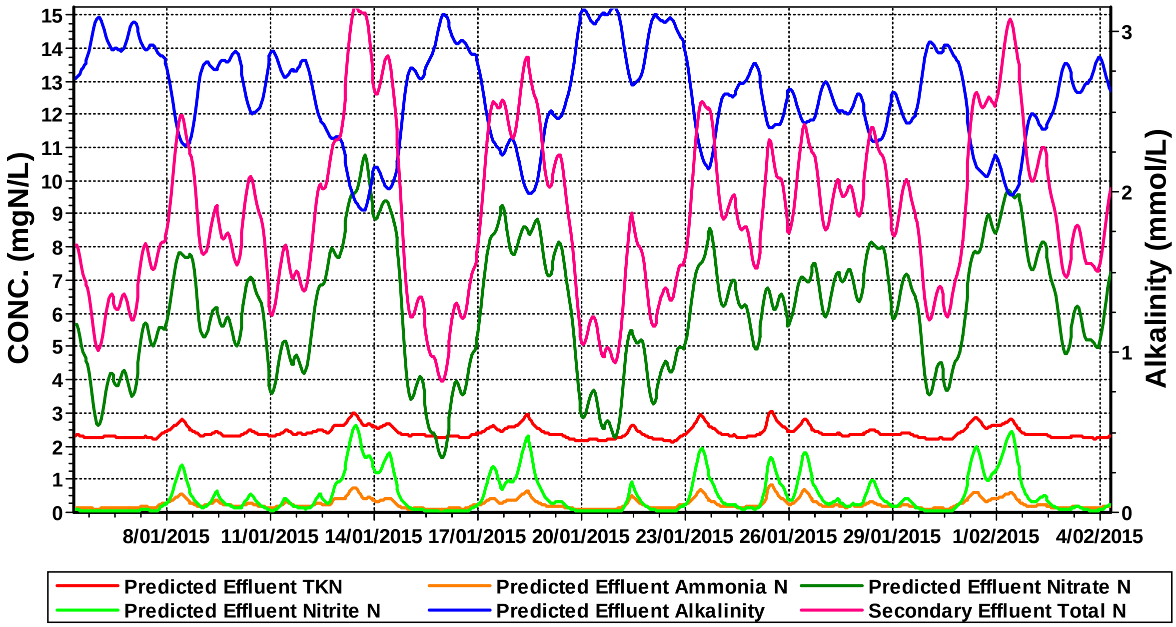

Album page - Mixed Liquor, RAS Flow



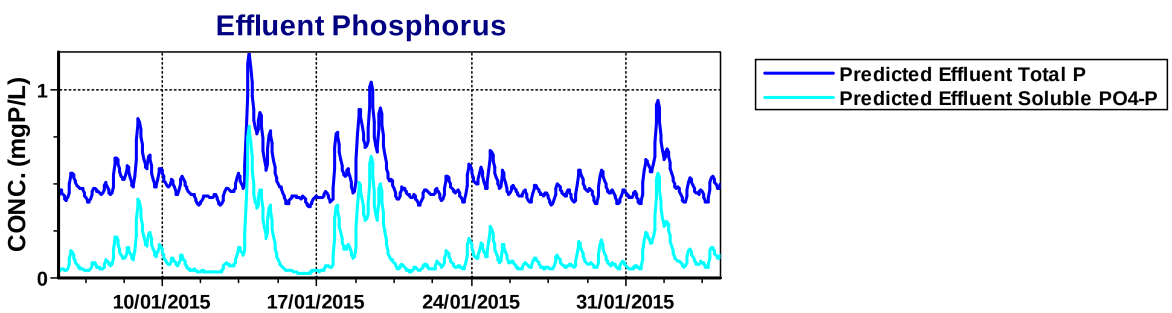

Album page - Mixed Liquor, RAS Flow



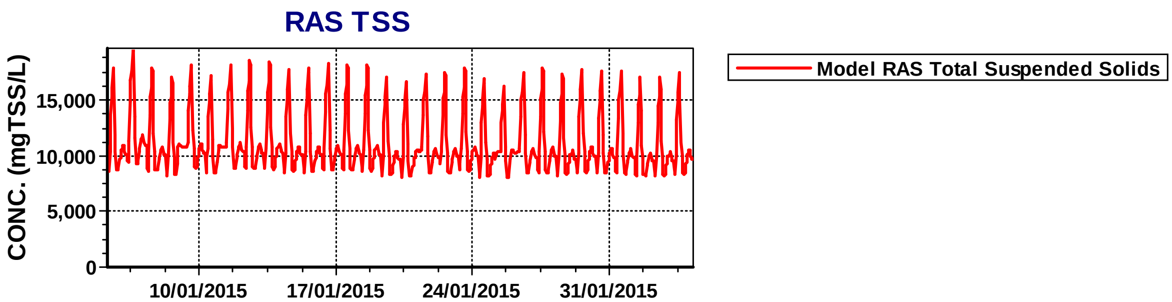

Album page - Nitrogen Sp., Alkalinity



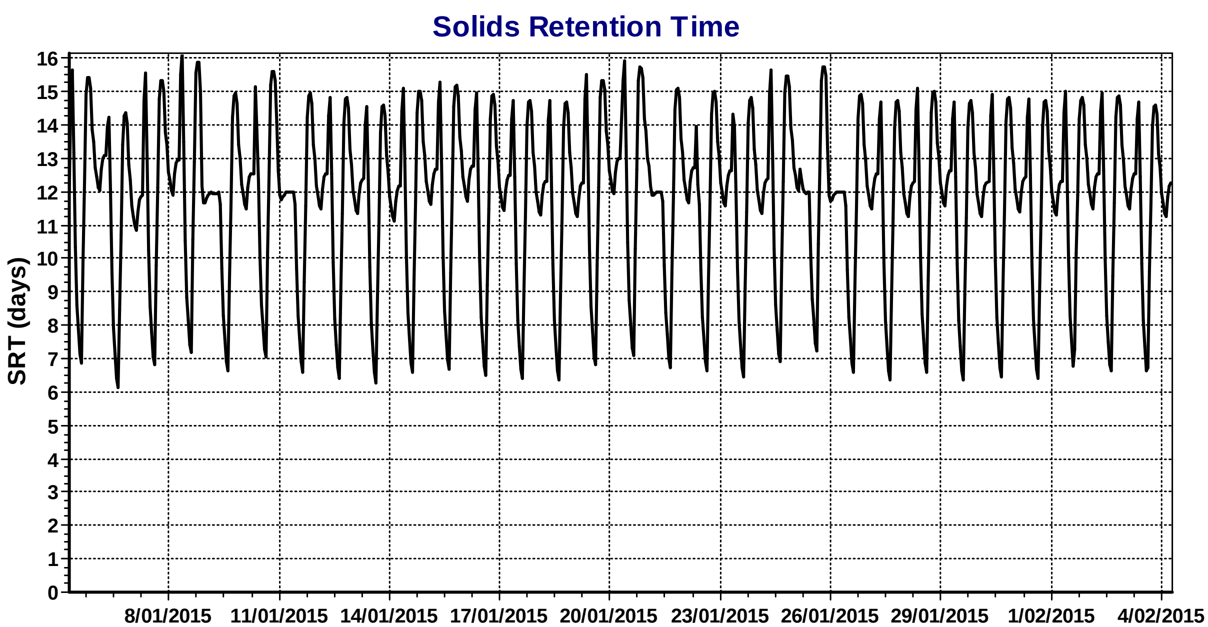

Album page - TP, RAS TSS



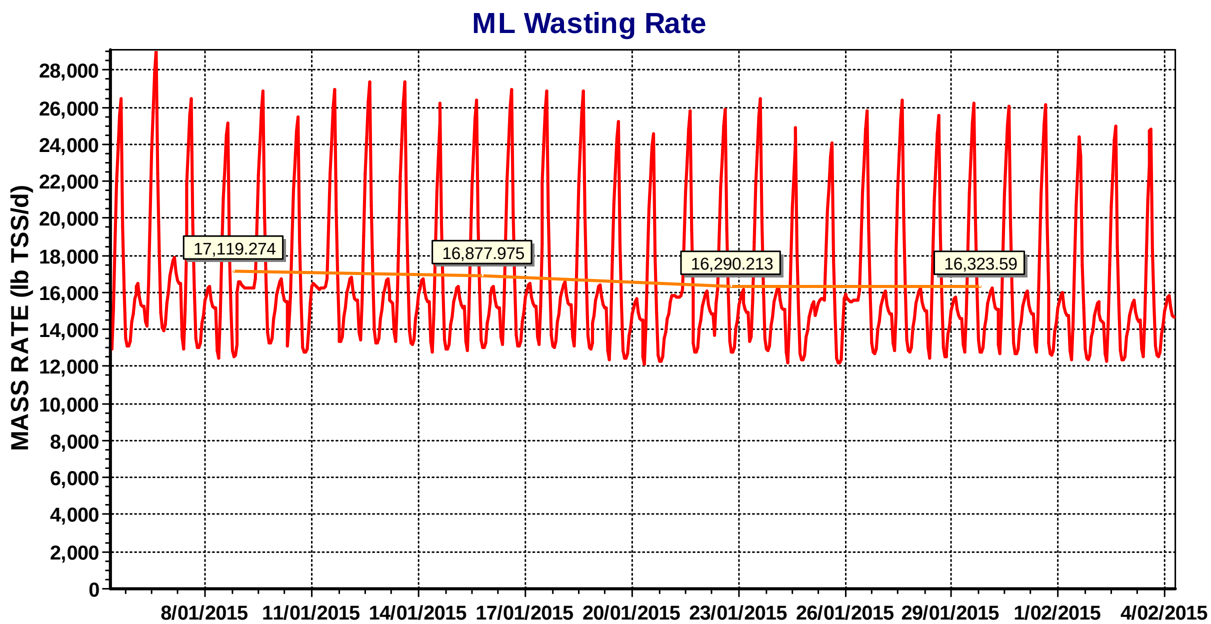

Album page - TP, RAS TSS



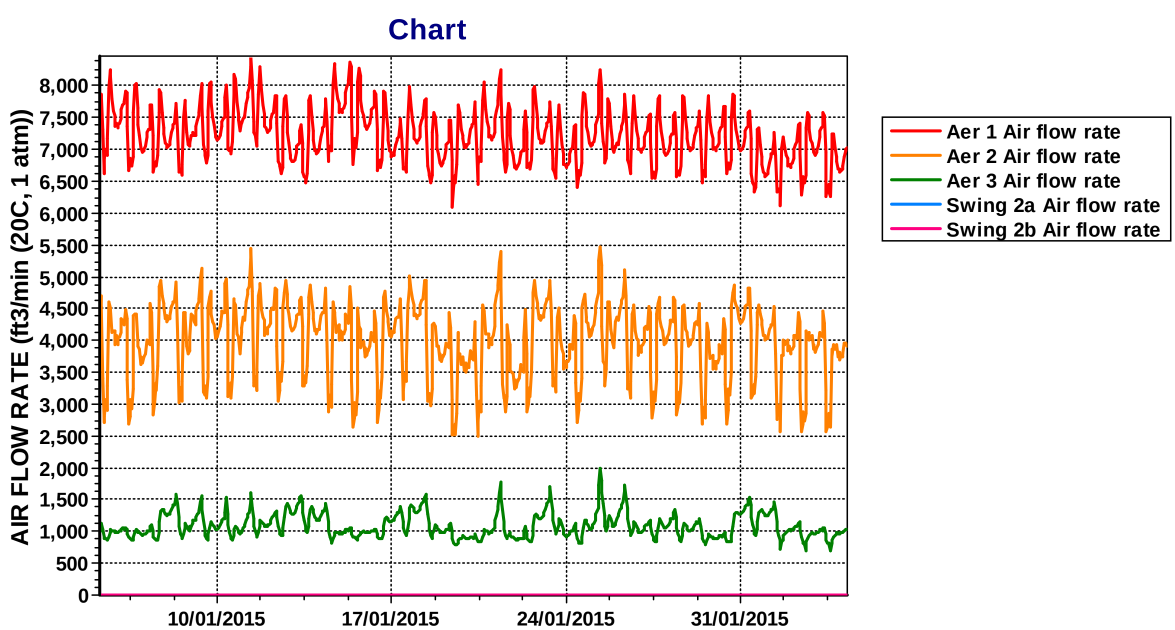

Album page - SRT



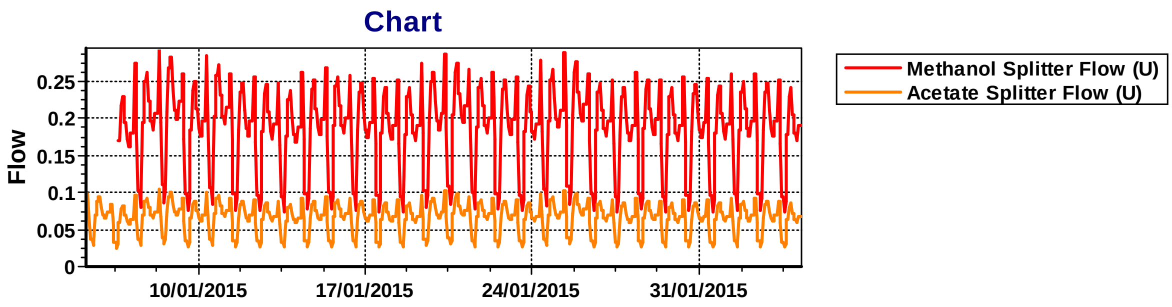

Album page - WAS Mass



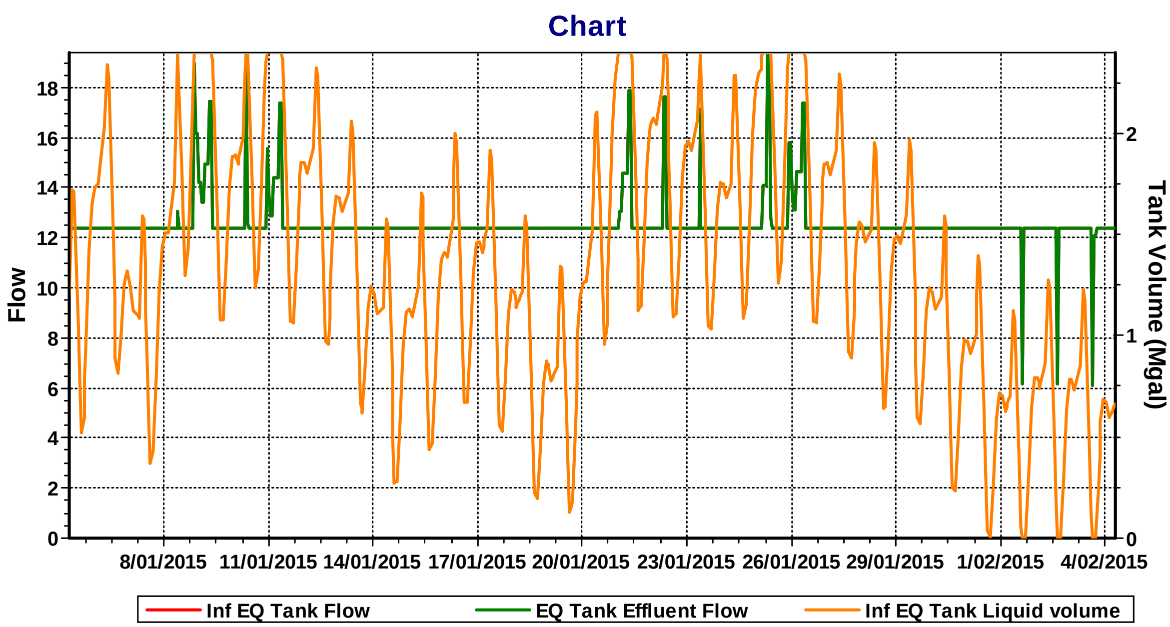

Album page - Air Flow Rate




Album page - Methanol/Acetate Flow




Album page - Inf EQ Tank




Meridian Alternative's Analysis version 1

Expansion using selectable 5 stage modified Bardenpho/A2O process

Tank sizes optimized based on individual simulations from A2O and 5 stage modified Bardenpho processes

<u>To achieve target effluent concentrations, for Bardenpho process:</u>
Set BDF IMLR at 200% influent, Set A2O IMLR at 0%
Set Swing 1 Aerated, Swing 2a and 2b unaerated.
SRT = 12 days
Acetate flow pace at 0.8% of PE flow rate, 0.1lb acetate COD per gallon used.

Methanol flow pace at 0.5% of PE flow rate, 1% methanol solution.  All methanol to swing 2a

**Modification for Influent Equalization**

For this model, Use Bardenpho process setup as described above (will modify volumes and chemical flow setpoints based on results.  Set influent equalization tank volume to volume of existing ABs (2.4 Mgal).  Operate influent EQ basin as starting 50% full with constant outflow equal to monthly average flow (12.3 MGD for winter conditions).

# BioWin user and configuration data

## Project details

Project name: Alternatives Analysis    Project ref.: 147571

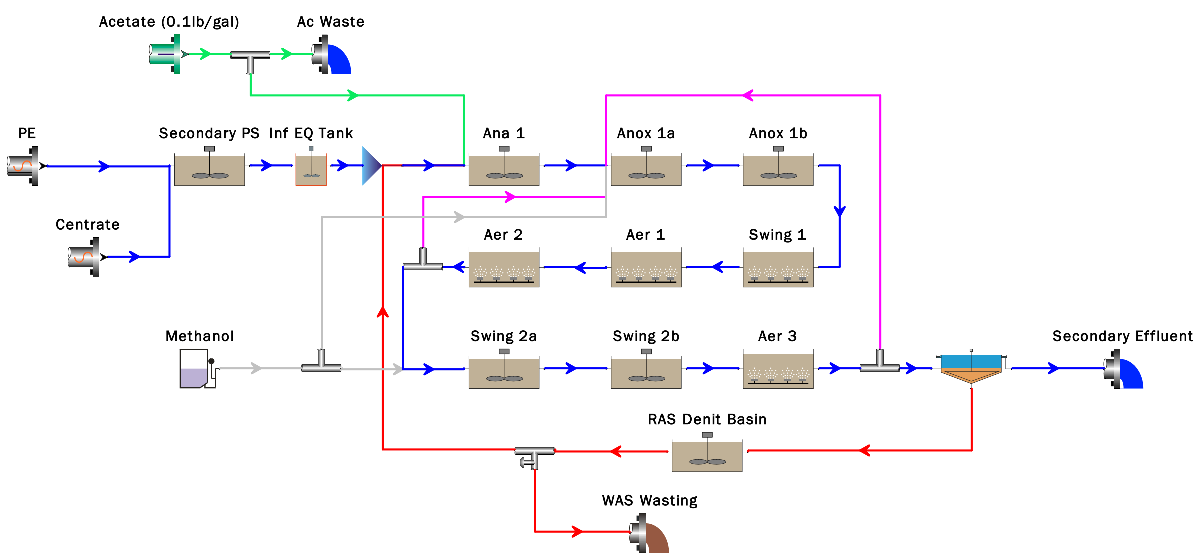
Plant name: Meridian WWTP    User name: Rick Kelly

Created: 6/29/2011    Saved: 4/30/2015

Target SRT: 12.00 days    SRT: **** days

Temperature: 14.0°C

## Flowsheet




## Configuration information for all Variable volume bioreactor units

### Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Inf EQ Tank | 2.4000 | 2.292E+4 | 14.000 | Un-aerated |

### Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Inf EQ Tank | 0 |

### Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Inf EQ Tank | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

## Configuration information for all Bioreactor units

### Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Ana 1 | 0.5000 | 4774.3058 | 14.000 | Un-aerated |
| Aer 1 | 1.0000 | 9548.6117 | 14.000 | 3245 |

| | | | | |
|---|---|---|---|---|
| Aer 2 | 1.0000 | 9548.6117 | 14.000 | 3245 |
| Swing 2a | 0.6000 | 5729.1670 | 14.000 | Un-aerated |
| Aer 3 | 0.5000 | 4774.3058 | 14.000 | 1623 |
| Anox 1a | 0.3500 | 3342.0141 | 14.000 | Un-aerated |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |
| Anox 1b | 0.3500 | 3342.0141 | 14.000 | Un-aerated |
| Swing 1 | 0.5000 | 4774.3058 | 14.000 | 1082 |
| Swing 2b | 0.5000 | 4774.3058 | 14.000 | Un-aerated |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Ana 1 | 0 |
| Aer 1 | 2.5 |
| Aer 2 | 2.0 |
| Swing 2a | 0 |
| Aer 3 | 2.0 |
| Anox 1a | 0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |
| Anox 1b | 0 |
| Swing 1 | 2.0 |
| Swing 2b | 0 |

## Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Ana 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 2 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Swing 2a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 3 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Anox 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Anox 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 2b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

# Configuration information for all Methanol addition units

## Operating data Average (flow/time weighted as required)

| Element name | Methanol |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |

| | |
|---|---|
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 11880.00 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |

| | |
|---|---|
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 0.055 |

# Configuration information for all Effluent units

# Configuration information for all Ideal clarifier units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] |
|---|---|---|---|
| Clarifier | 2.8000 | 2.718E+4 | 13.770 |

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| Clarifier | Flow paced | 50.00 % |

| Element name | Average Temperature | Reactive | Percent removal | Blanket fraction |
|---|---|---|---|---|
| Clarifier | Uses global setting | Yes | 99.90 | 0.07 |

# Configuration information for all COD Influent units

## Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 30.00 | 30.00 |
| Flow | 12.4611703212226 | 0.100114816828393 |
| Total COD mgCOD/L | 416.48 | 1096.91 |
| Total Kjeldahl Nitrogen mgN/L | 54.01 | 140.16 |
| Total P mgP/L | 8.12 | 52.98 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.95 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.43 | 185.22 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.0014 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 4.312E-4 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9976 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.5976 |

| | | |
|---|---|---|
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.0870 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.7000 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5000 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0102 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0319 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.6000 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.1280 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 0.0636 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 3.510E-5 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 0.0245 |
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.640E-5 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 0.0514 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 2.950E-5 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 9.450E-6 |
| FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 7.780E-6 |
| FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 7.780E-6 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 | 0 |

## Configuration information for all Sludge units

## Configuration information for all Splitter units

### Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| BDF IMLR | Flow paced | 200.00 % |
| RAS / WAS | Flowrate [Side] | 0.147478886797187 |
| Acetate Splitter | Flow paced | 0.30 % |

| | | |
|---|---|---|
| Splitter21 | Flowrate [Side] | 0 |
| A2O IMLR | Flowrate [Side] | 0 |

# Configuration information for all Stream (SV) Influent units

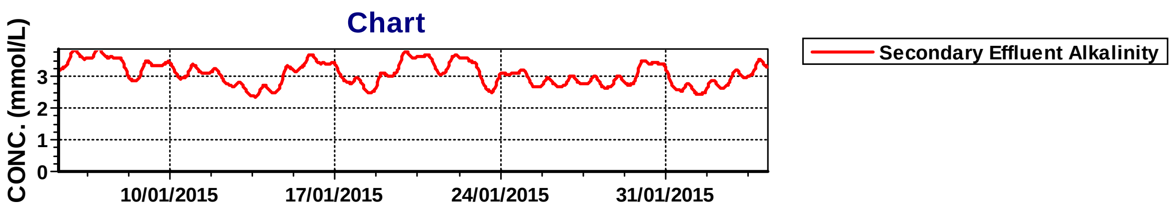
## Operating data Average (flow/time weighted as required)

| Element name | Acetate (0.1lb/gal) |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |

| | |
|---|---|
| Acetate mgCOD/L | 11980.00 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

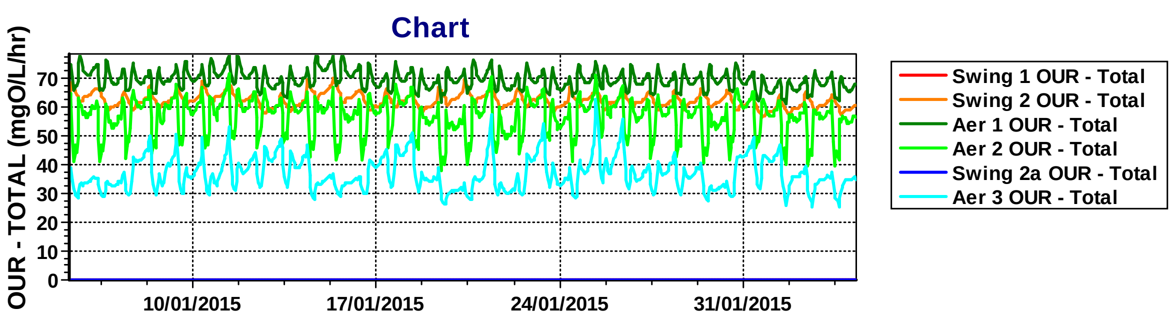
BioWin Album

Album page - SS AOB-NOB

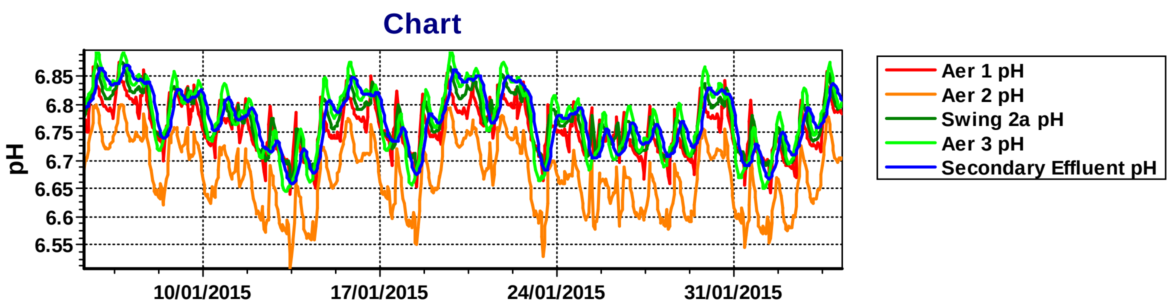



Album page - SS AOB-NOB

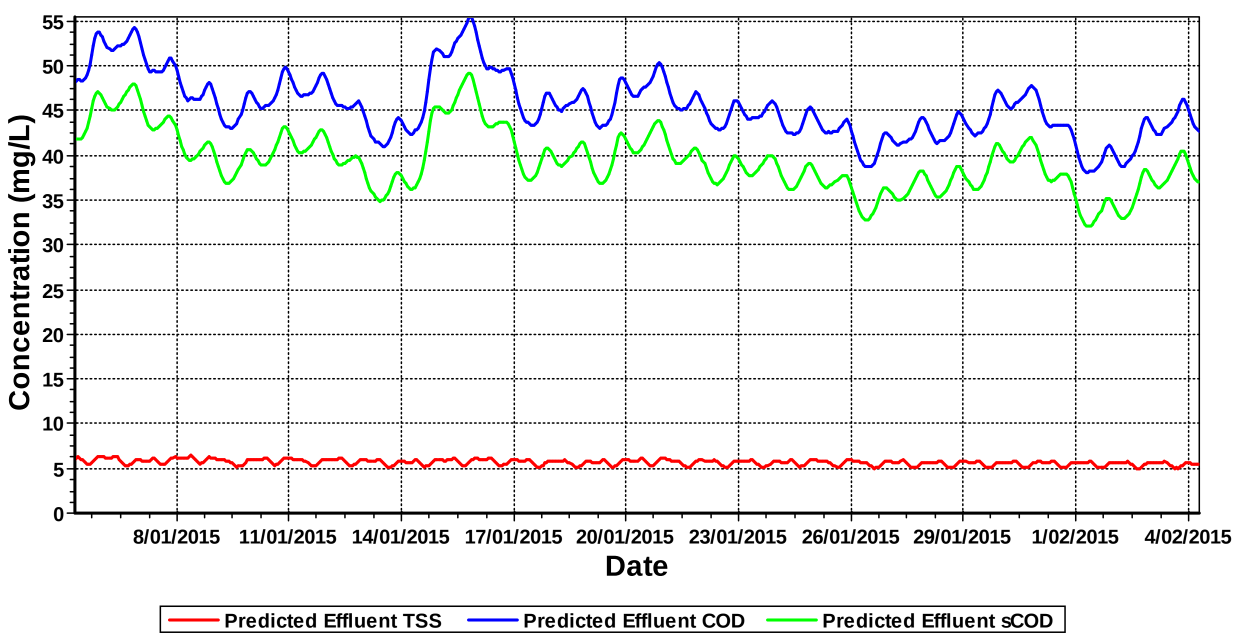
Album page - OURs



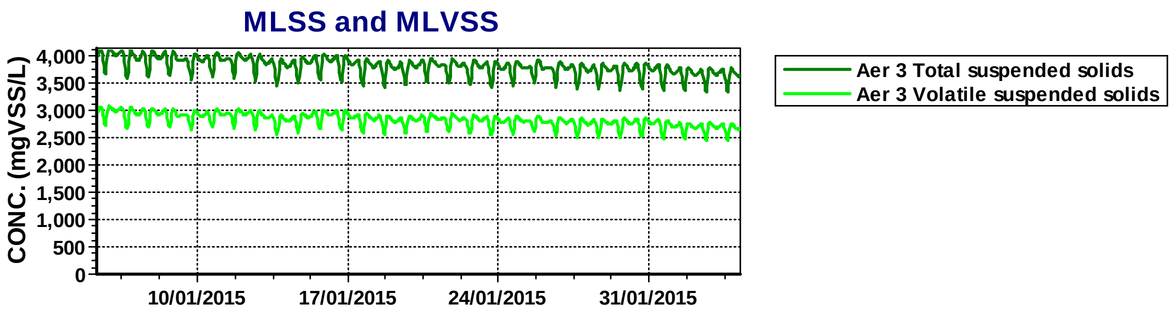

Album page - OURs



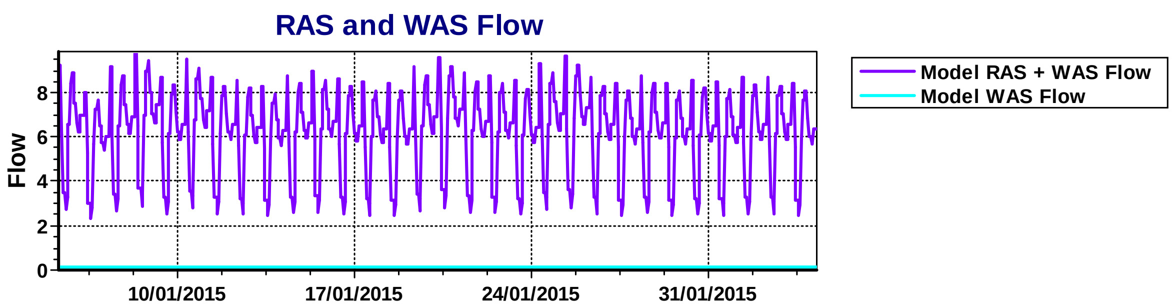

Album page - TSS, COD, BOD



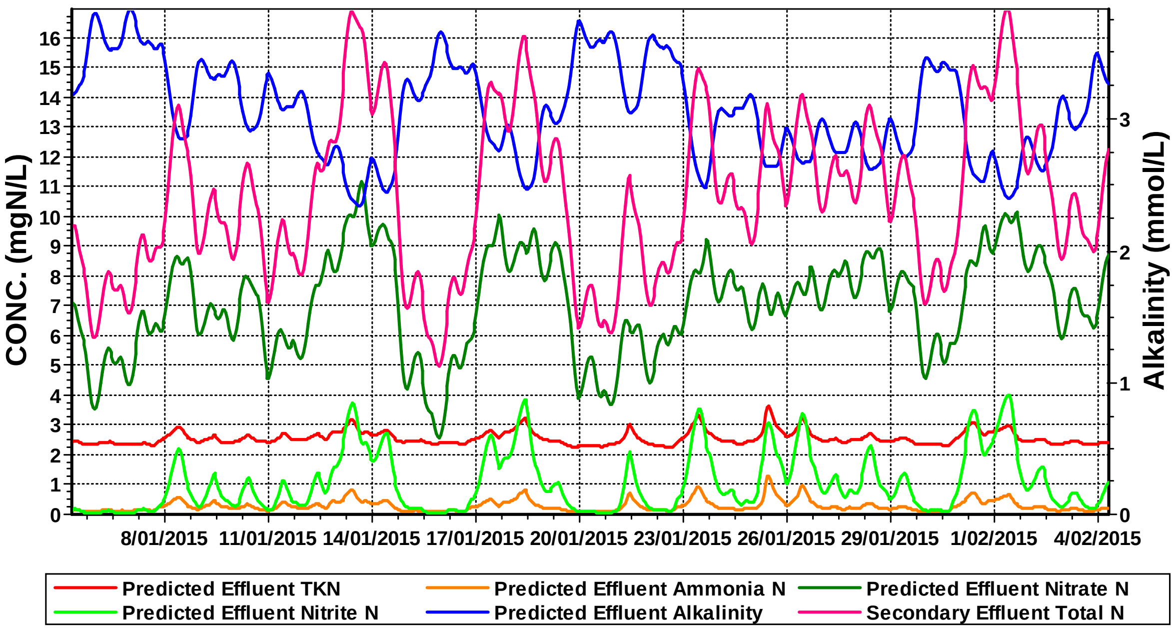

Album page - Mixed Liquor, RAS Flow



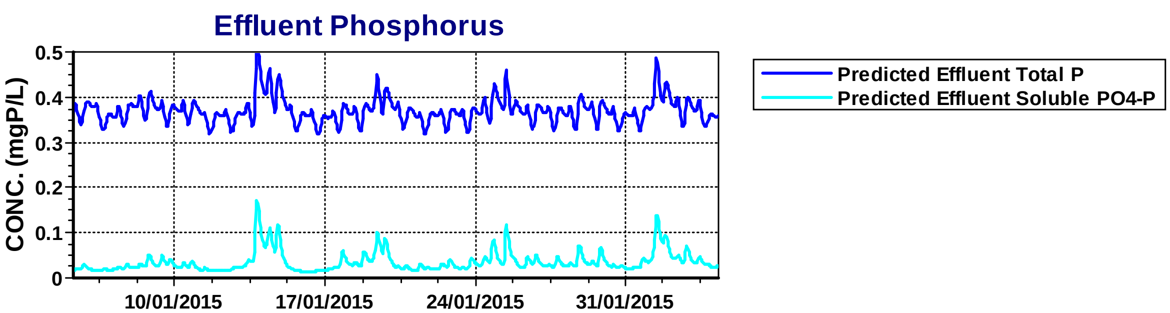

Album page - Mixed Liquor, RAS Flow



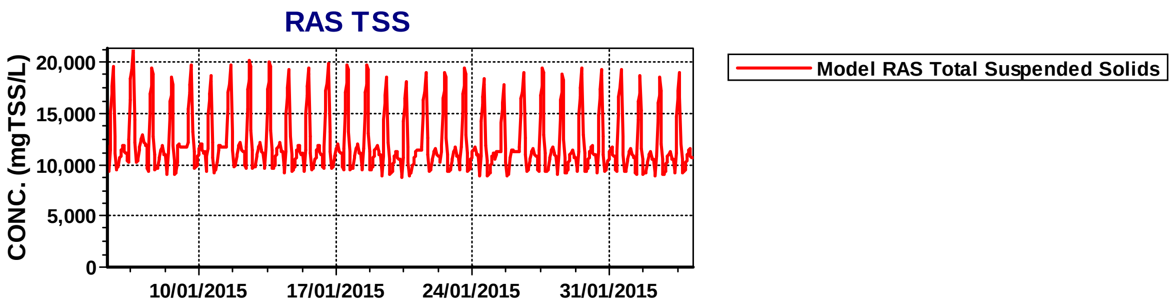

Album page - Nitrogen Sp., Alkalinity



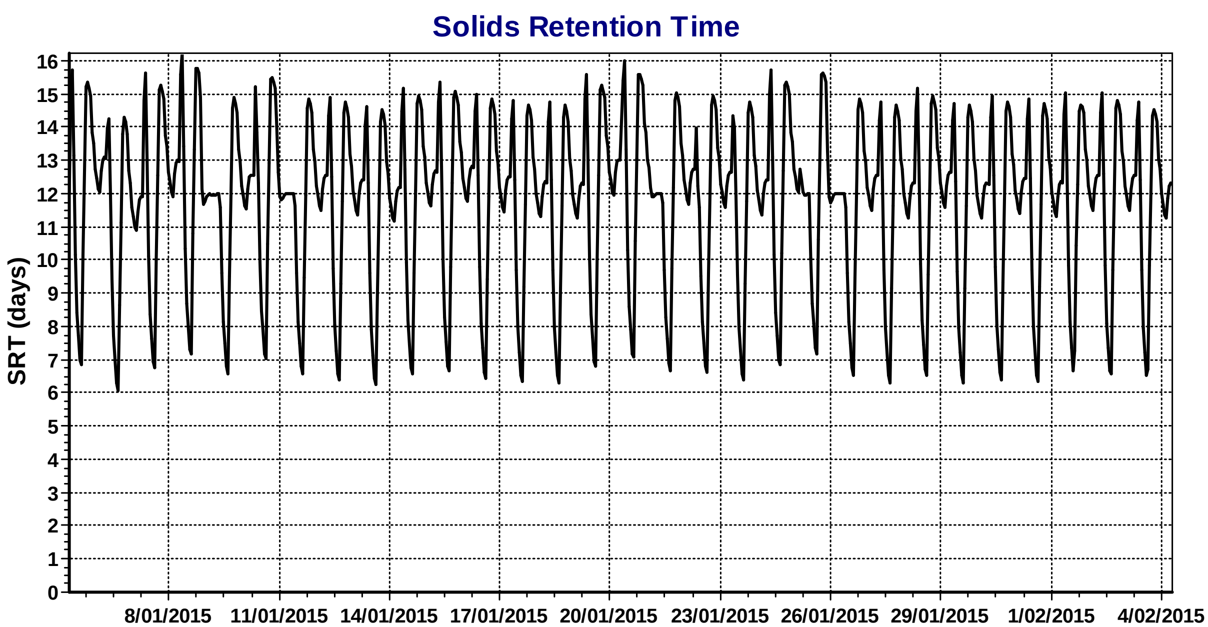

Album page - TP, RAS TSS



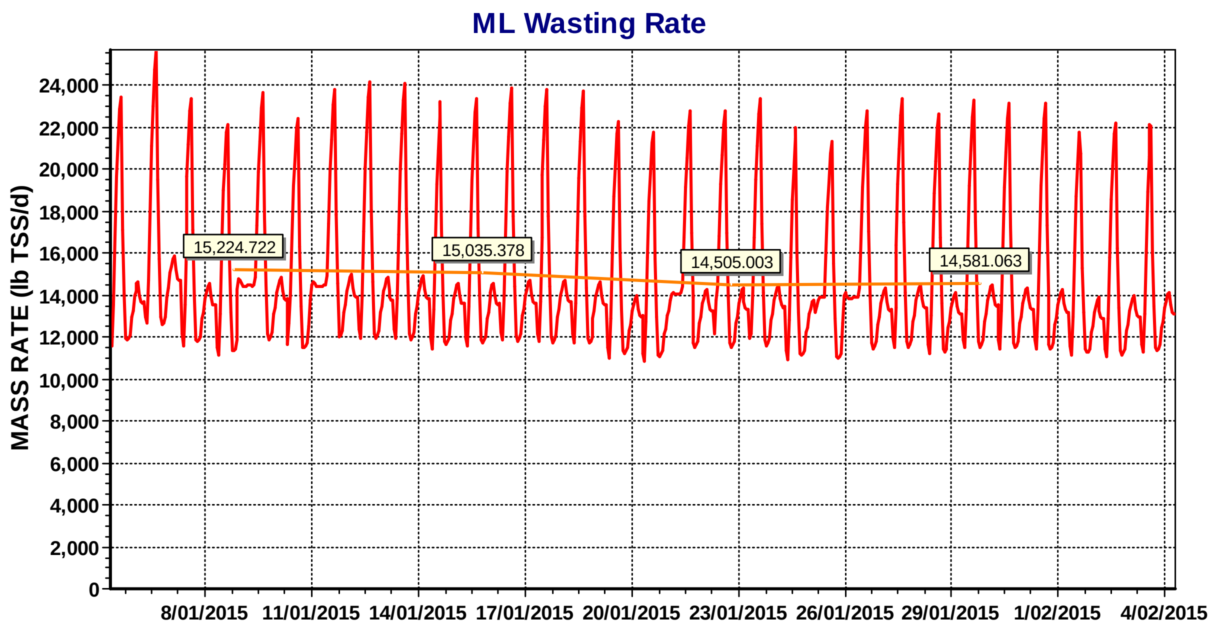

Album page - TP, RAS TSS



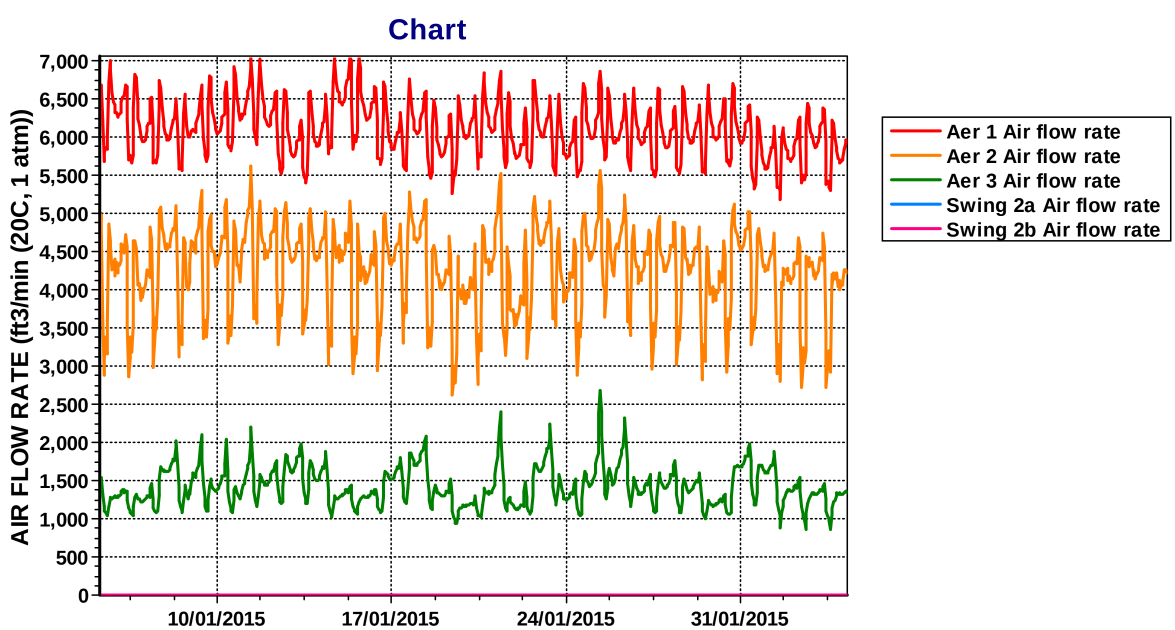

Album page - SRT



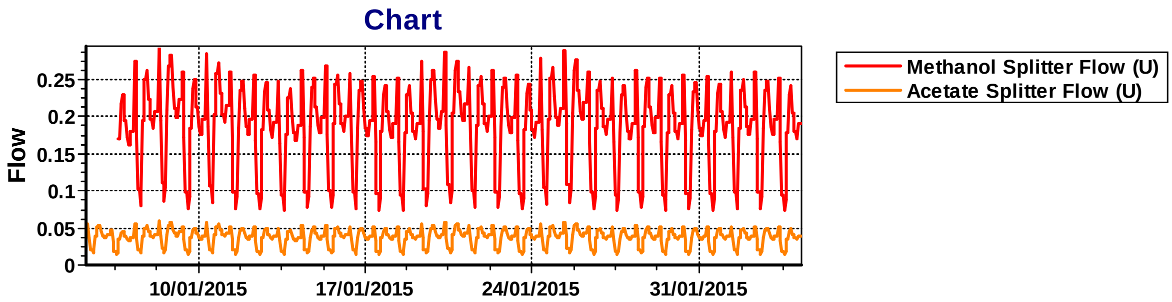

Album page - WAS Mass



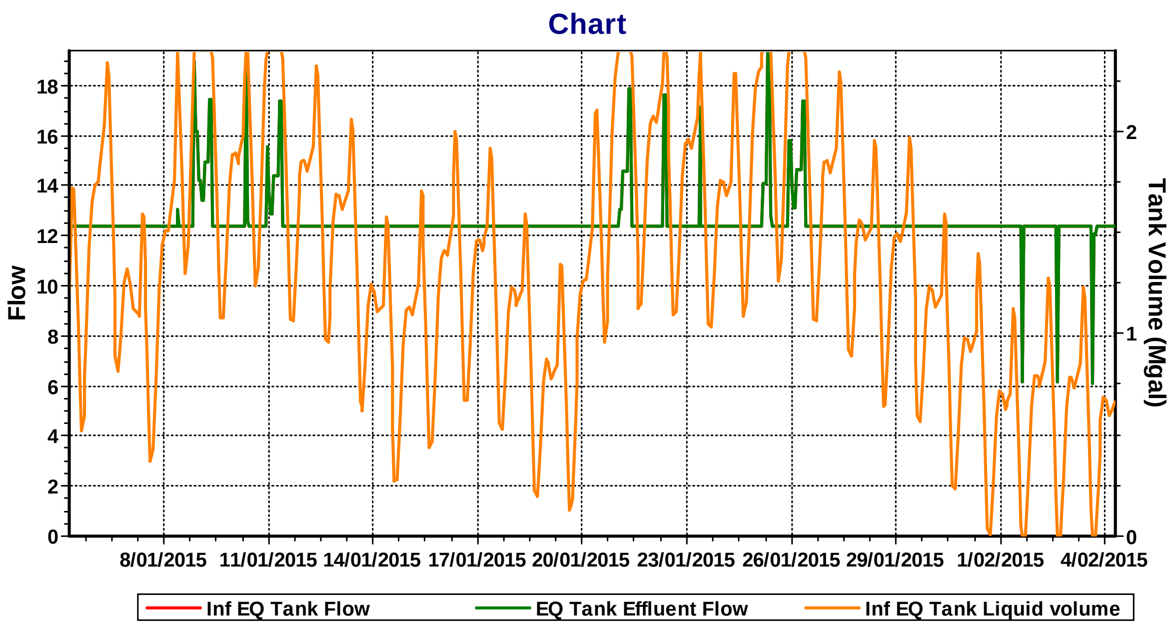

Album page - Air Flow Rate




Album page - Methanol/Acetate Flow




## Album page - Inf EQ Tank




## Global Parameters

Meridian Alternative's Analysis version 1

Expansion using selectable 5 stage modified Bardenpho/A2O process

Tank sizes optimized based on individual simulations from A2O and 5 stage modified Bardenpho processes

<u>To achieve target effluent concentrations, for Bardenpho process:</u>
Set BDF IMLR at 200% influent, Set A2O IMLR at 0%

Set Swing 1 Aerated, Swing 2a and 2b unaerated.
SRT = 12 days
Acetate flow pace at 0.8% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 0.5% of PE flow rate, 1% methanol solution. All methanol to swing 2a

**<u>Modification for Influent Equalization</u>**
For this model, Use Bardenpho process setup as described above (will modify volumes and chemical flow setpoints based on results. Set influent equalization tank volume to volume of existing ABs (2.4 Mgal). Operate influent EQ basin as starting 50% full with constant outflow equal to monthly average flow (12.3 MGD for winter conditions).

# BioWin user and configuration data

## Project details

Project name: Alternatives Analysis Project ref.: 147571

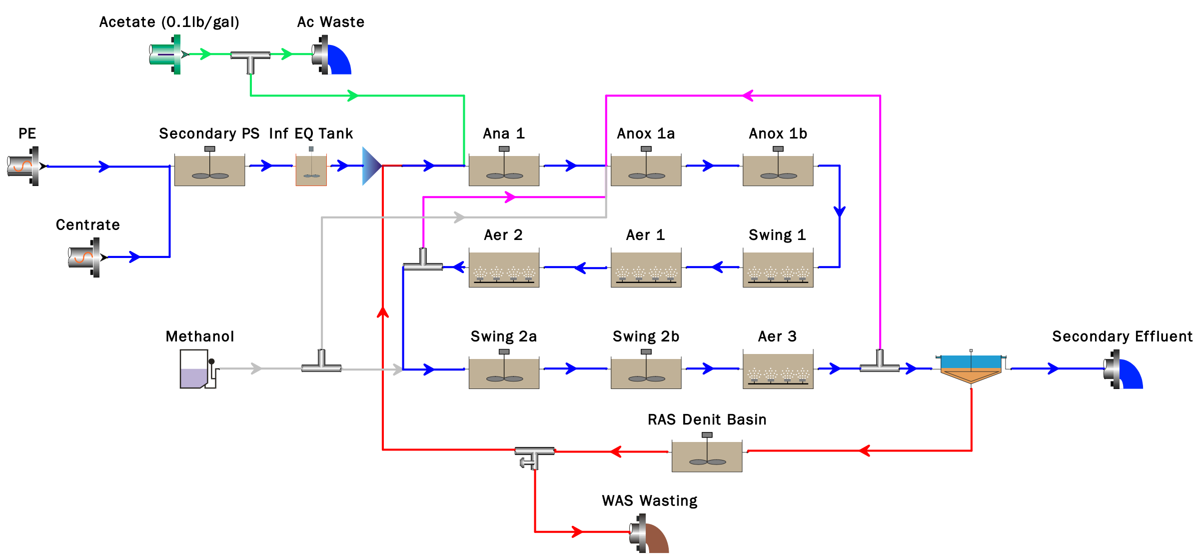
Plant name: Meridian WWTP User name: Rick Kelly

Created: 6/29/2011 Saved: 4/29/2015

Target SRT: 11.00 days SRT: **** days

Temperature: 14.0°C

## Flowsheet




# Configuration information for all Variable volume bioreactor units

### Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Inf EQ Tank | 2.4000 | 2.292E+4 | 14.000 | Un-aerated |

### Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Inf EQ Tank | 0 |

### Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Inf EQ Tank | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

## Configuration information for all Bioreactor units

### Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Ana 1 | 0.5000 | 4774.3058 | 14.000 | Un-aerated |
| Aer 1 | 1.5000 | 1.432E+4 | 14.000 | 4868 |

| | | | | |
|---|---|---|---|---|
| Aer 2 | 1.7500 | 1.671E+4 | 14.000 | 5680 |
| Swing 2a | 0.7500 | 7161.4587 | 14.000 | Un-aerated |
| Aer 3 | 0.5000 | 4774.3058 | 14.000 | 1623 |
| Anox 1a | 0.3750 | 3580.7294 | 14.000 | Un-aerated |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |
| Anox 1b | 0.3750 | 3580.7294 | 14.000 | Un-aerated |
| Swing 1 | 0.5000 | 4774.3058 | 14.000 | 1082 |
| Swing 2b | 0.7500 | 7161.4587 | 14.000 | Un-aerated |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Ana 1 | 0 |
| Aer 1 | 2.5 |
| Aer 2 | 2.0 |
| Swing 2a | 0 |
| Aer 3 | 2.0 |
| Anox 1a | 0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |
| Anox 1b | 0 |
| Swing 1 | 2.0 |
| Swing 2b | 0 |

## Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Ana 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 2 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Swing 2a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 3 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Anox 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Anox 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 2b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

# Configuration information for all Methanol addition units

## Operating data Average (flow/time weighted as required)

| Element name | Methanol |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |

| | |
|---|---|
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 11880.00 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |

| | |
|---|---|
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 0.055 |

# Configuration information for all Effluent units

# Configuration information for all Ideal clarifier units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] |
|---|---|---|---|
| Clarifier | 2.8000 | 2.718E+4 | 13.770 |

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| Clarifier | Flow paced | 50.00 % |

| Element name | Average Temperature | Reactive | Percent removal | Blanket fraction |
|---|---|---|---|---|
| Clarifier | Uses global setting | Yes | 99.90 | 0.07 |

# Configuration information for all COD Influent units

## Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 30.00 | 30.00 |
| Flow | 12.4611703212226 | 0.100114816828393 |
| Total COD mgCOD/L | 416.48 | 1801.80 |
| Total Kjeldahl Nitrogen mgN/L | 54.01 | 934.39 |
| Total P mgP/L | 8.12 | 529.81 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.95 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.43 | 185.22 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.5950 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 0.0392 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9931 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.0039 |

| | | |
|---|---|---|
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.3197 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.9500 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5086 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0050 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0512 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9300 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.0642 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-4 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 | 0 |

## Configuration information for all Sludge units

## Configuration information for all Splitter units

### Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| BDF IMLR | Flow paced | 200.00 % |
| RAS / WAS | Flowrate [Side] | 0.212440569459111 |
| Acetate Splitter | Flow paced | 0.49 % |

| | | |
|---|---|---|
| Splitter21 | Flowrate [Side] | 0 |
| A2O IMLR | Flowrate [Side] | 0 |

# Configuration information for all Stream (SV) Influent units

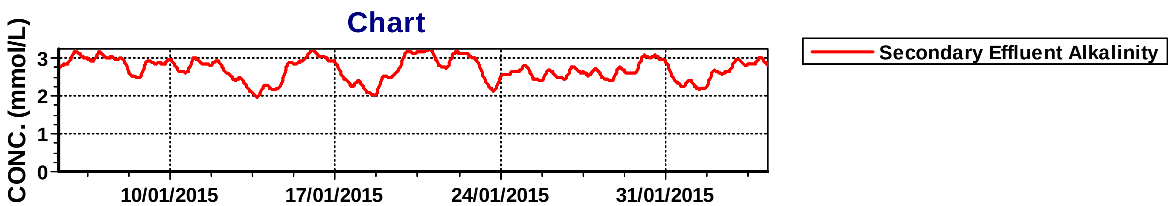
## Operating data Average (flow/time weighted as required)

| Element name | Acetate (0.1lb/gal) |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |

| | |
|---|---|
| Acetate mgCOD/L | 11980.00 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

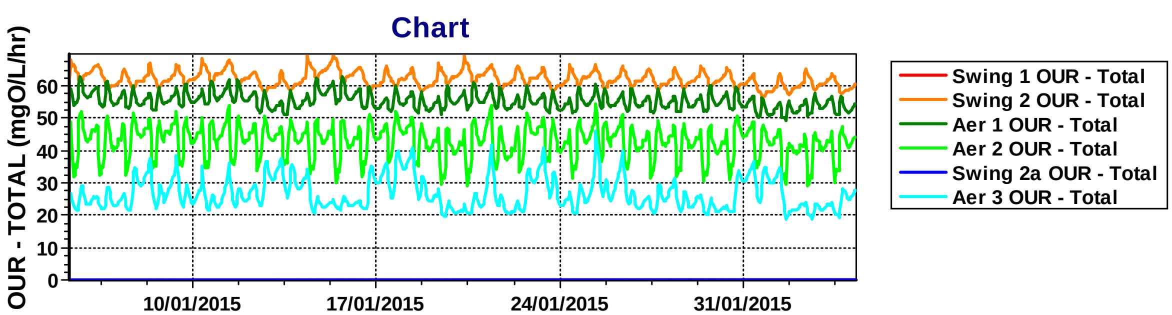
BioWin Album

Album page - SS AOB-NOB

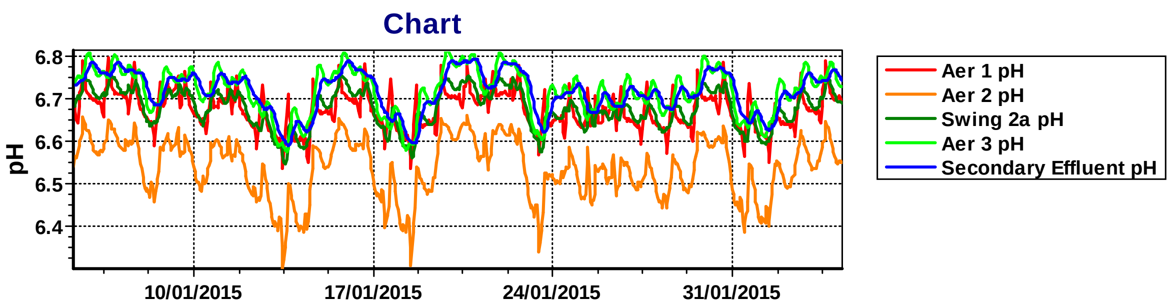



Album page - SS AOB-NOB

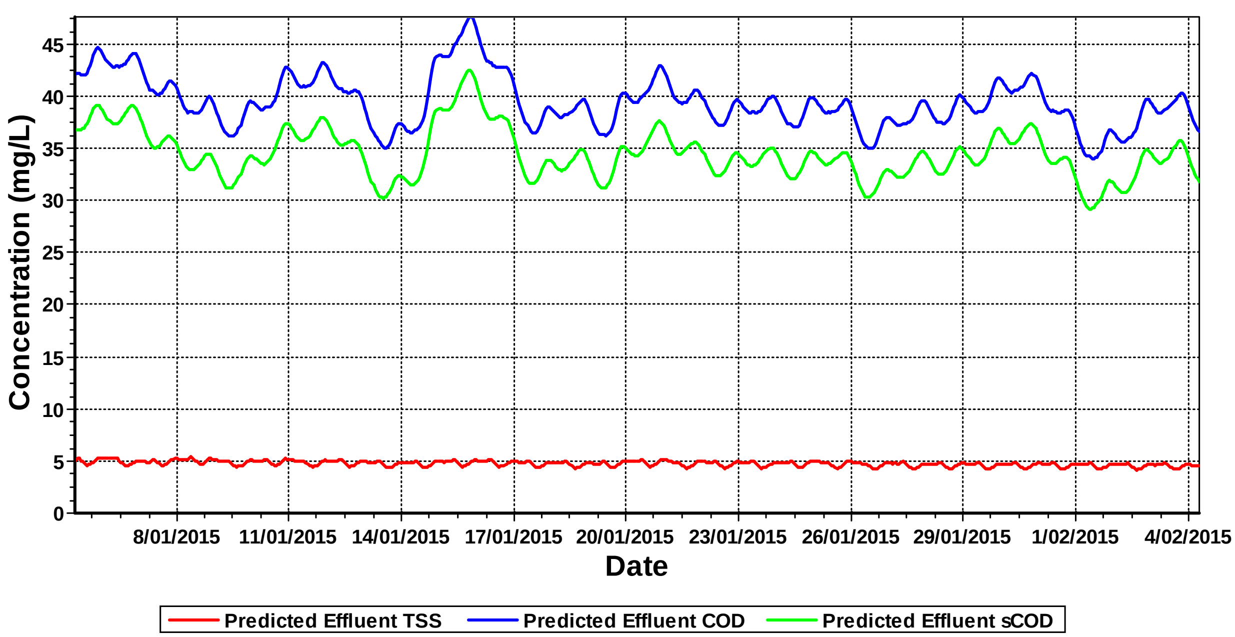
Album page - OURs



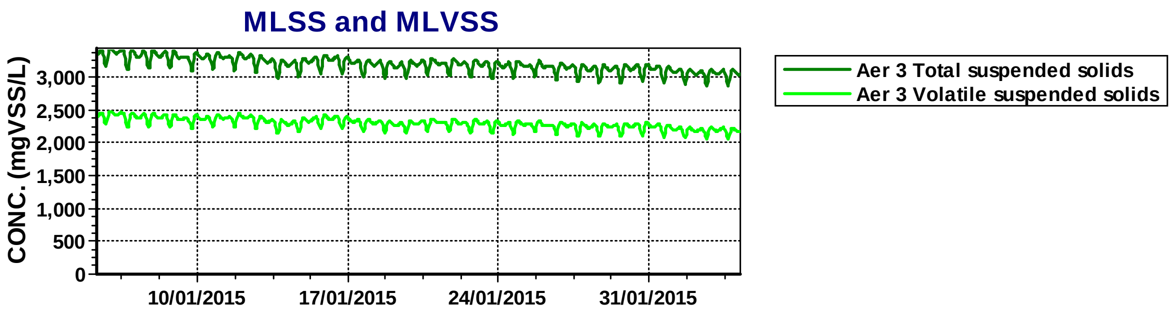

Album page - OURs



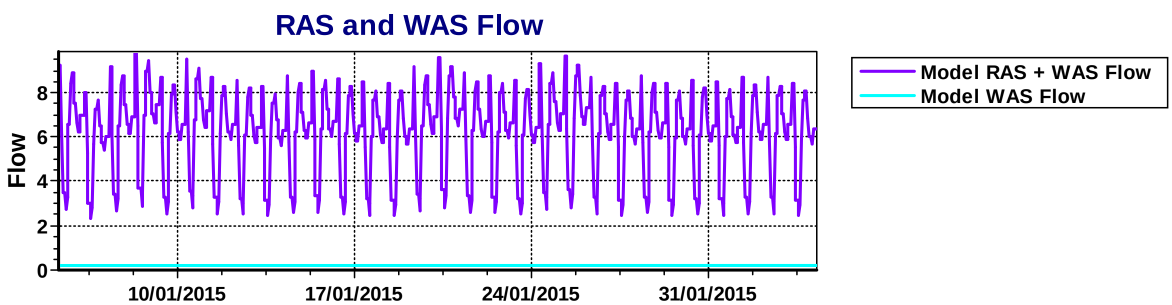

Album page - TSS, COD, BOD



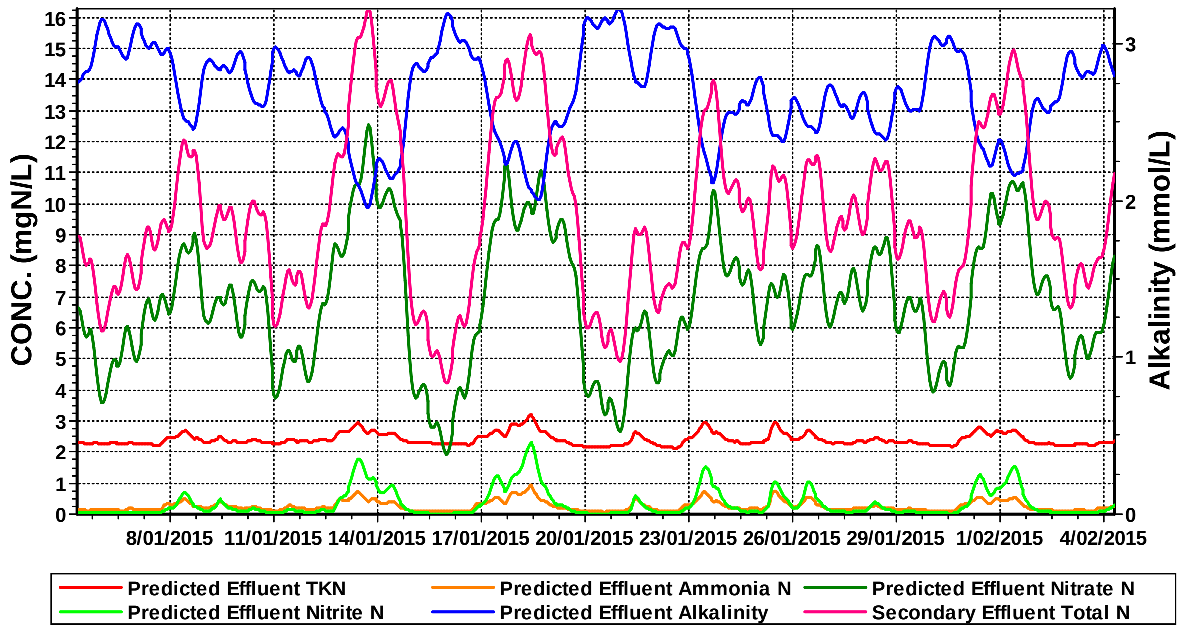

Album page - Mixed Liquor, RAS Flow



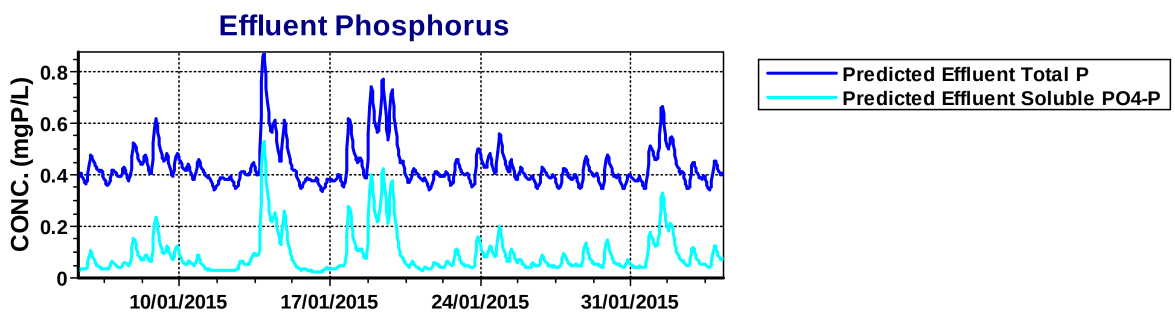

Album page - Mixed Liquor, RAS Flow



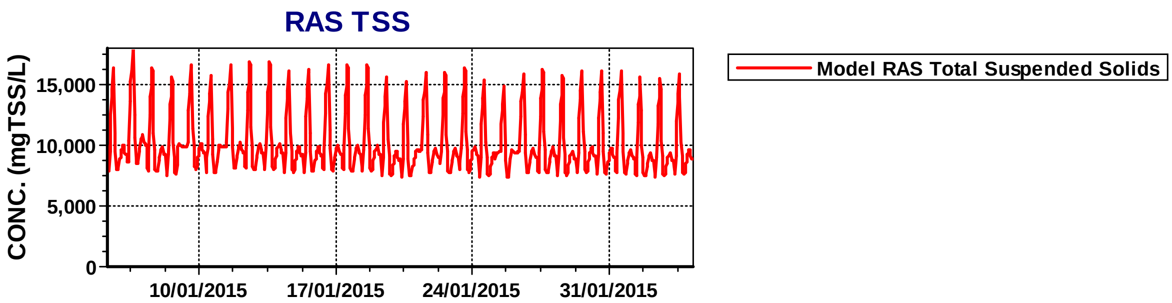

Album page - Nitrogen Sp., Alkalinity



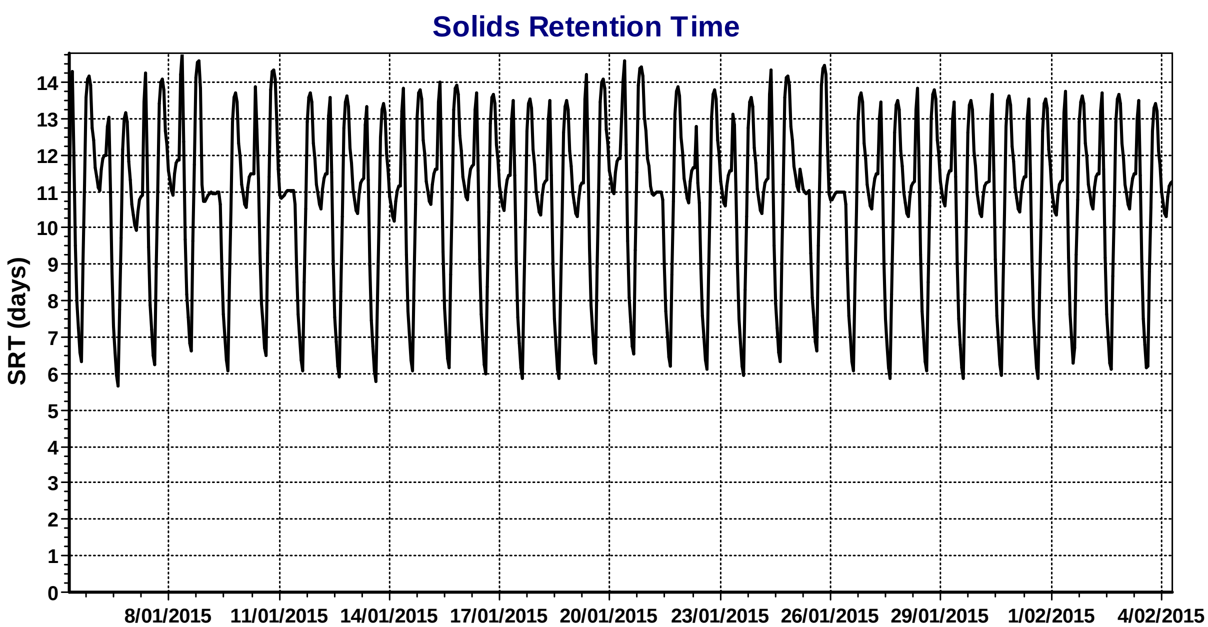

Album page - TP, RAS TSS



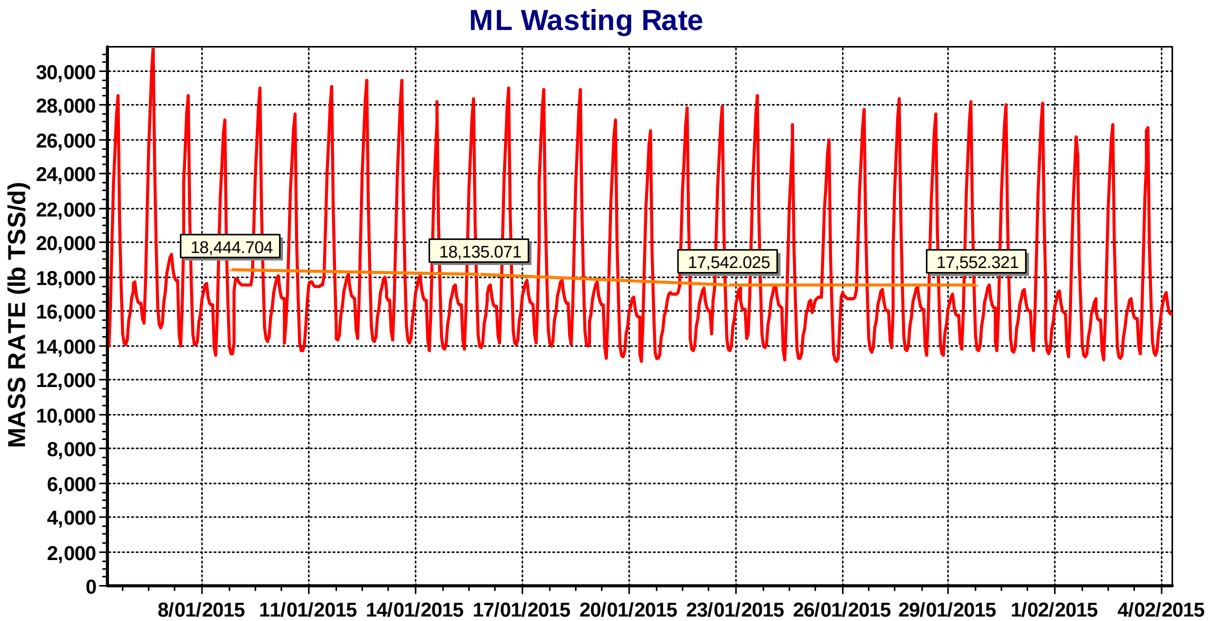

Album page - TP, RAS TSS



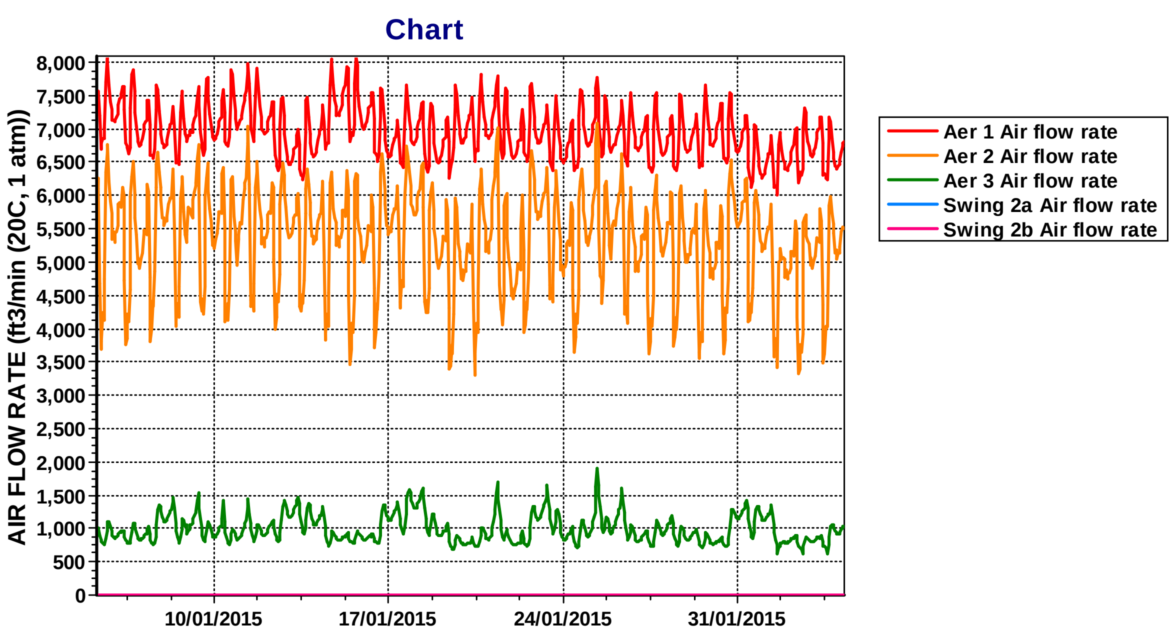

Album page - SRT



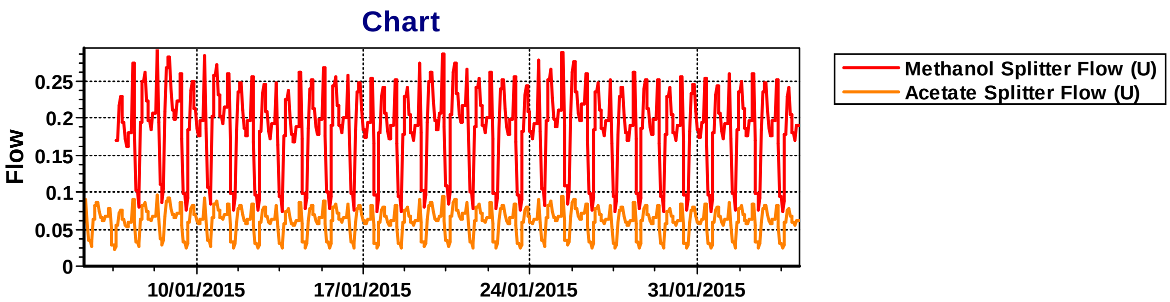

Album page - WAS Mass



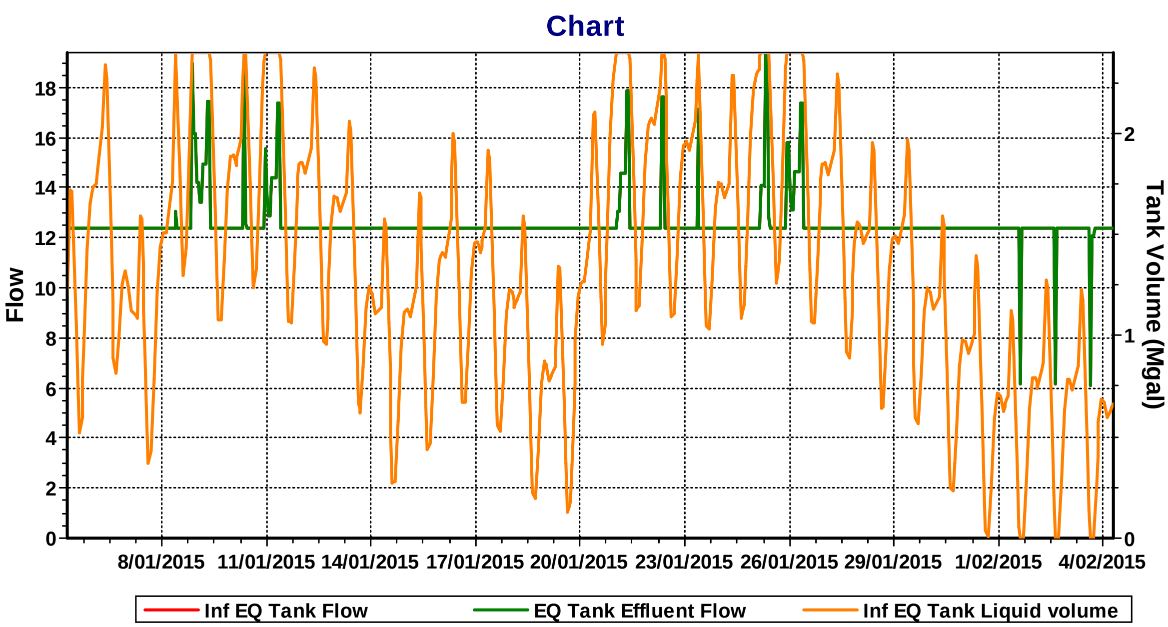

Album page - Air Flow Rate




Album page - Methanol/Acetate Flow




Album page - Inf EQ Tank




Meridian Alternative's Analysis version 1

Expansion using selectable 5 stage modified Bardenpho/A2O process

Tank sizes optimized based on individual simulations from A2O and 5 stage modified Bardenpho processes

<u>To achieve target effluent concentrations, for Bardenpho process:</u>
Set BDF IMLR at 200% influent, Set A2O IMLR at 0%
Set Swing 1 Aerated, Swing 2a and 2b unaerated.
SRT = 12 days
Acetate flow pace at 0.8% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 0.5% of PE flow rate, 1% methanol solution.  All methanol to swing 2a

**Modification for Influent Equalization**

For this model, Use Bardenpho process setup as described above (will modify volumes and chemical flow setpoints based on results. Set influent equalization tank volume to volume of existing ABs (2.4 Mgal). Operate influent EQ basin as starting 50% full with constant outflow equal to monthly average flow (12.3 MGD for winter conditions).

# BioWin user and configuration data

Winter max month conditions

## Project details

Project name: Alternatives Analysis    Project ref.: 147571

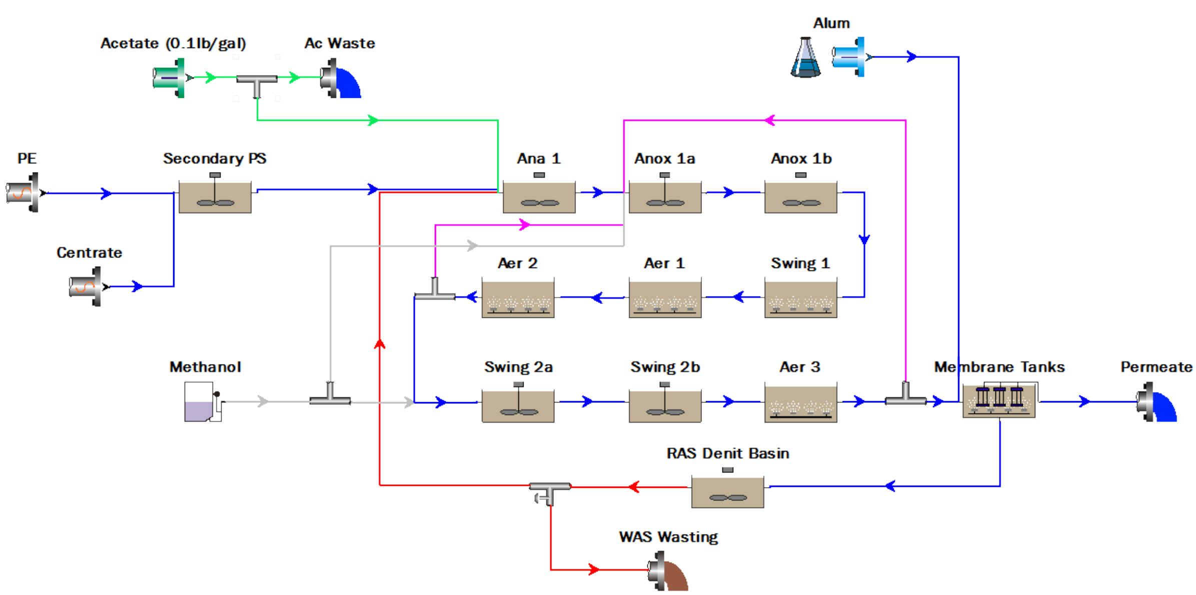
Plant name: Meridian WWTP    User name: Patricia Tam

Created: 6/29/2011    Saved: 7/8/2015

Target SRT: 12.00 days    SRT: **** days

Temperature: 14.0°C

## Flowsheet



# Configuration information for all Bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Ana 1 | 0.2500 | 2387.1529 | 14.000 | Un-aerated |
| Aer 1 | 0.7500 | 7161.4587 | 14.000 | 2596 |
| Aer 2 | 1.0000 | 9548.6117 | 14.000 | 3462 |
| Swing 2a | 0.3750 | 3580.7294 | 14.000 | Un-aerated |
| Aer 3 | 0.2500 | 2387.1529 | 14.000 | 811 |
| Anox 1a | 0.1875 | 1790.3647 | 14.000 | Un-aerated |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |
| Anox 1b | 0.1875 | 1790.3647 | 14.000 | Un-aerated |
| Swing 1 | 0.2500 | 2387.1529 | 14.000 | 974 |
| Swing 2b | 0.3750 | 3580.7294 | 14.000 | Un-aerated |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Ana 1 | 0 |
| Aer 1 | 2.5 |
| Aer 2 | 2.0 |
| Swing 2a | 0 |
| Aer 3 | 2.0 |
| Anox 1a | 0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |

| | |
|---|---|
| Anox 1b | 0 |
| Swing 1 | 2.0 |
| Swing 2b | 0 |

## Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Ana 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 16.0000 |
| Aer 2 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 16.0000 |
| Swing 2a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 3 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Anox 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Anox 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 18.0000 |
| Swing 2b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

| Element name | Alpha (surf) OR Alpha F (diff) [-] | Beta [-] | Surface pressure [kPa] | Fractional effective saturation depth (Fed) [-] |
|---|---|---|---|---|
| Aer 1 | 0.4000 | 0.9500 | 101.3250 | 0.3250 |
| Aer 2 | 0.4000 | 0.9500 | 101.3250 | 0.3250 |
| Aer 3 | 0.4000 | 0.9500 | 101.3250 | 0.3250 |
| Swing 1 | 0.4000 | 0.9500 | 101.3250 | 0.3250 |

| Element name | Supply gas CO2 content [vol. %] | Supply gas O2 [vol. %] | Off-gas CO2 [vol. %] | Off-gas O2 [vol. %] | Off-gas H2 [vol. %] | Off-gas NH3 [vol. %] | Off-gas CH4 [vol. %] | Surface turbulence factor [-] |
|---|---|---|---|---|---|---|---|---|
| Aer 1 | 0.0350 | 20.9500 | 2.0000 | 18.8000 | 0 | 0 | 0 | 2.0000 |
| Aer 2 | 0.0350 | 20.9500 | 2.0000 | 18.8000 | 0 | 0 | 0 | 2.0000 |
| Aer 3 | 0.0350 | 20.9500 | 2.0000 | 18.8000 | 0 | 0 | 0 | 2.0000 |
| Swing 1 | 0.0350 | 20.9500 | 2.0000 | 18.8000 | 0 | 0 | 0 | 2.0000 |

# Configuration information for all Membrane bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers | # of cassettes | Displaced volume / cassette [ft3/cassette] | Membrane area / cassette [ft2/cassette] | Total displaced volume [Mil. Gal] | Membrane surface area [ft2] |
|---|---|---|---|---|---|---|---|---|---|
| Membrane Tanks | 0.2848 | 4050.2366 | 9.400 | 1129 | 60.00 | 55.640 | 16576.00 | 0.02 | 994560.00 |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Membrane Tanks | 6.0 |

| Element name | Split method | Average Split specification |
|---|---|---|
| Membrane Tanks | Flow paced | 400.00 % |

## Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Membrane Tanks | 0.0500 | 0.3800 | 1.0500 | 0.5382 | 15.0000 |

| Element name | Alpha (surf) OR Alpha F (diff) [-] | Beta [-] | Surface pressure [kPa] | Fractional effective saturation depth (Fed) [-] |
|---|---|---|---|---|
| Membrane Tanks | 0.7000 | 0.9500 | 101.3250 | 0.3000 |

| Element name | Supply gas CO2 content [vol. %] | Supply gas O2 [vol. %] | Off-gas CO2 [vol. %] | Off-gas O2 [vol. %] | Off-gas H2 [vol. %] | Off-gas NH3 [vol. %] | Off-gas CH4 [vol. %] | Surface turbulence factor [-] |
|---|---|---|---|---|---|---|---|---|
| Membrane Tanks | 0.0350 | 20.9500 | 1.2000 | 19.9000 | 0 | 0 | 0 | 2.0000 |

# Configuration information for all Methanol addition units

## Operating data Average (flow/time weighted as required)

| Element name | Methanol |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |

| | |
|---|---|
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 11880.00 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |

| | |
|---|---|
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

# Configuration information for all Effluent units

# Configuration information for all COD Influent units

## Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 30.00 | 30.00 |
| Flow | 12.461167588271 | 0.100114816828393 |
| Total COD mgCOD/L | 416.48 | 1801.80 |
| Total Kjeldahl Nitrogen mgN/L | 54.01 | 934.39 |

| | | |
|---|---|---|
| Total P mgP/L | 8.12 | 529.81 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.95 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.43 | 185.22 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.5950 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 0.0392 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9931 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.0039 |
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.3197 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.9500 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5086 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0050 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0512 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9300 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.0642 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-4 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |

| | | |
|---|---|---|
| FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 | 0 |

# Configuration information for all Metal addition units

## Operating data Average (flow/time weighted as required)

| Element name | Alum |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |

| | |
|---|---|
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 56890.00 |
| Other Cations (strong bases) meq/L | 5.00 |
| Other Anions (strong acids) meq/L | 6344.83 |
| Total CO2 mmol/L | 7.00 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 9.49989063277656E-5 |

## Configuration information for all Sludge units

## Configuration information for all Splitter units

### Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| BDF IMLR | Flow paced | 200.00 % |
| RAS / WAS | Flowrate [Side] | 0.262689202292217 |
| Acetate Splitter | Flow paced | 1.20 % |
| Splitter21 | Fraction | 0.00 |
| A2O IMLR | Flow paced | 0.00 % |

## Configuration information for all Stream (SV) Influent units

### Operating data Average (flow/time weighted as required)

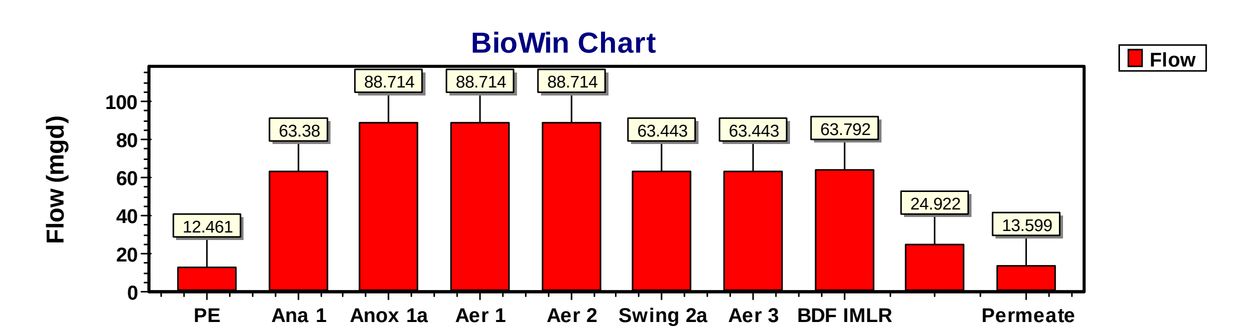
| Element name | Acetate (0.1lb/gal) |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |

| | |
|---|---|
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 11980.00 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |

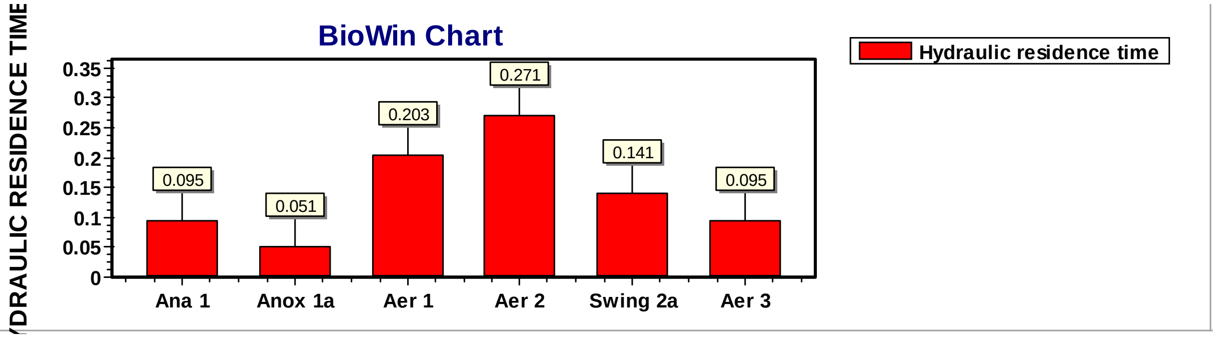
| | |
|---|---|
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

## BioWin Album

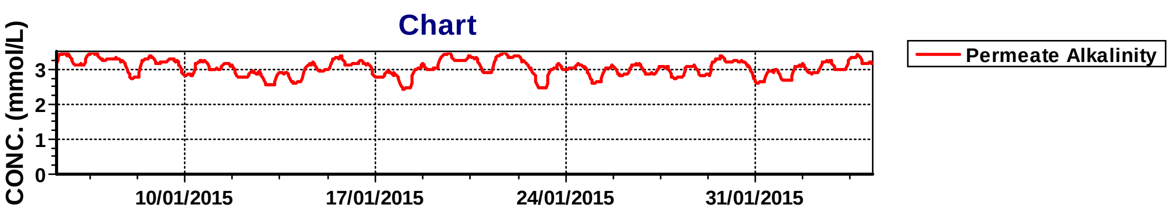
## Album page - SS Flow and HRT



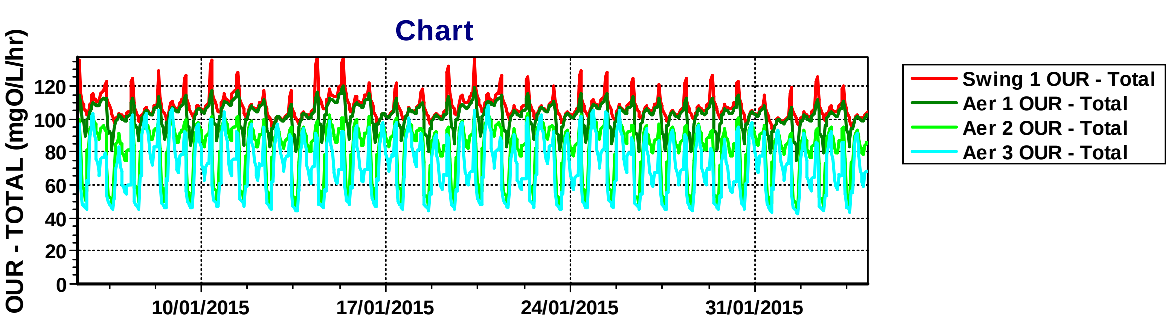
Album page - SS Flow and HRT



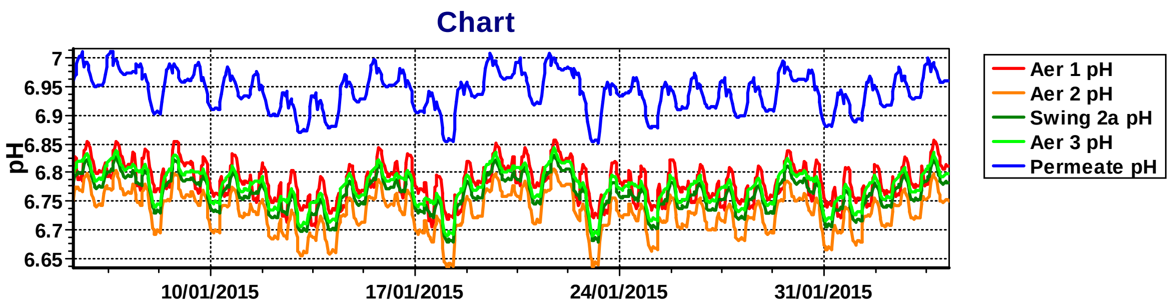

Album page – Permeate Alkalinity



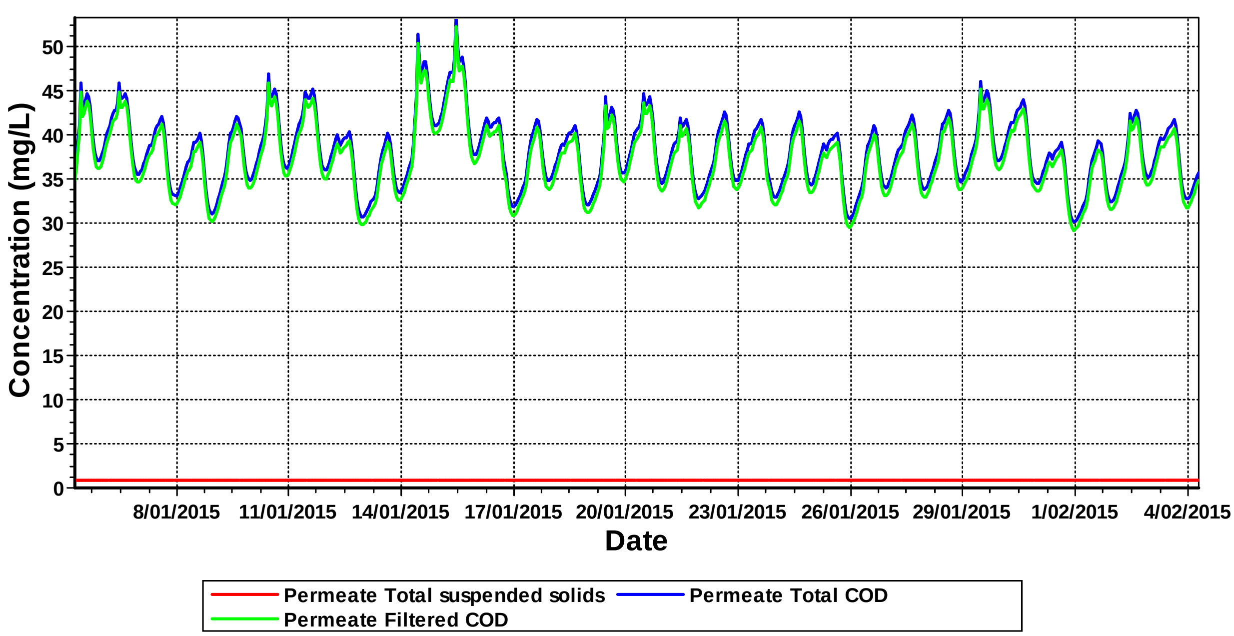

Album page - OURs



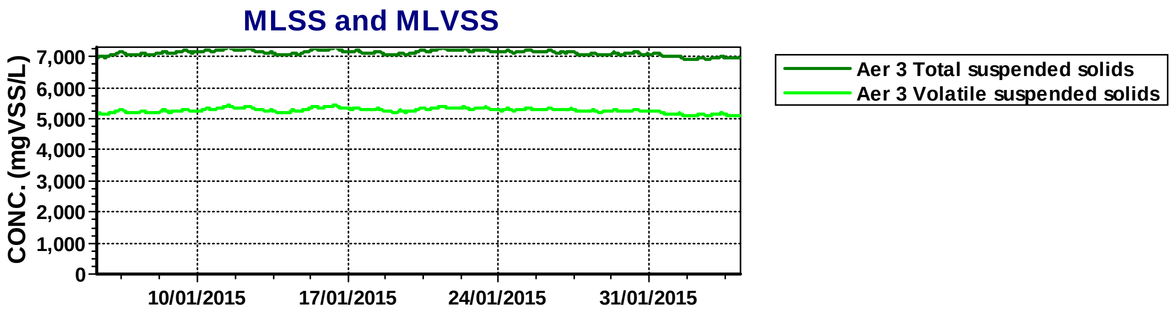
Album page - pH

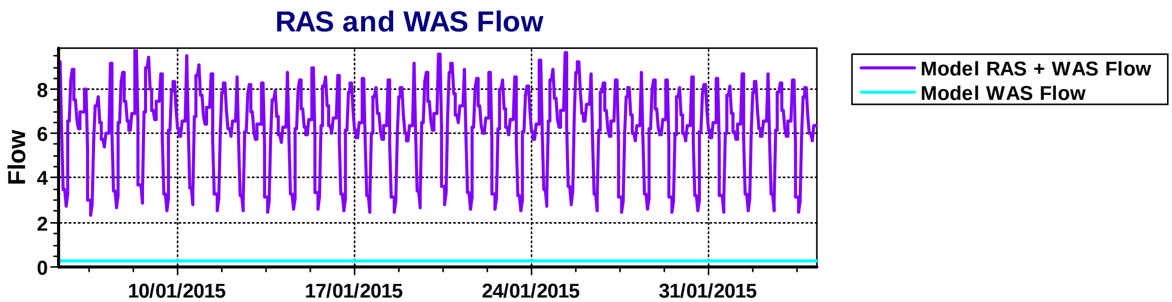



Album page - TSS, COD, BOD

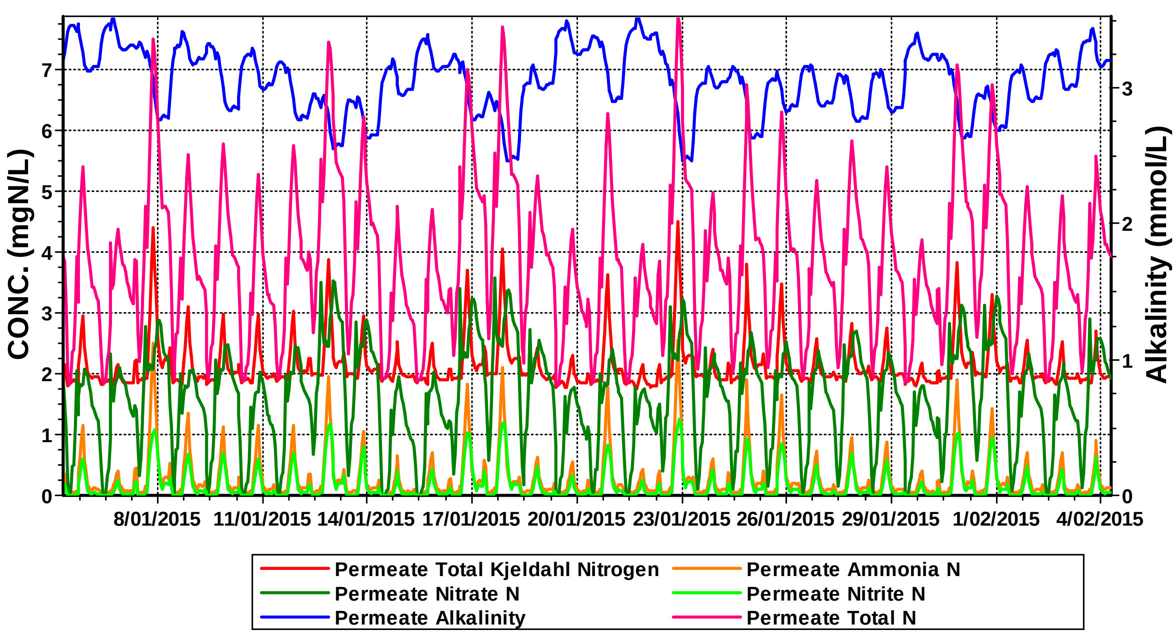


Album page - Mixed Liquor, RAS Flow

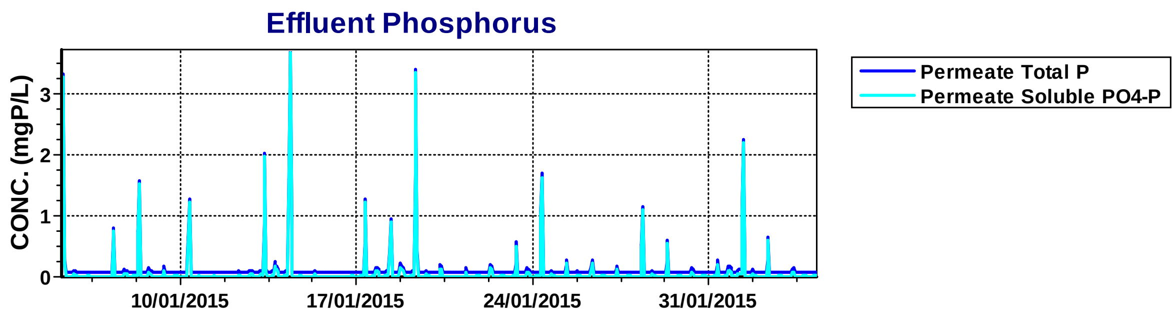


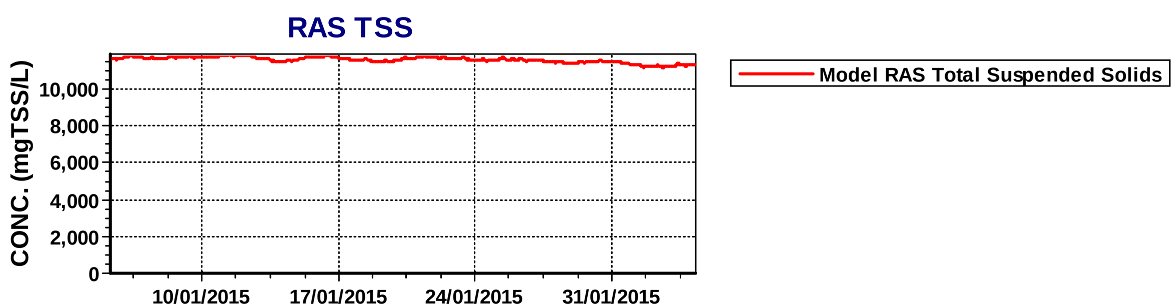




Album page - Nitrogen Sp., Alkalinity

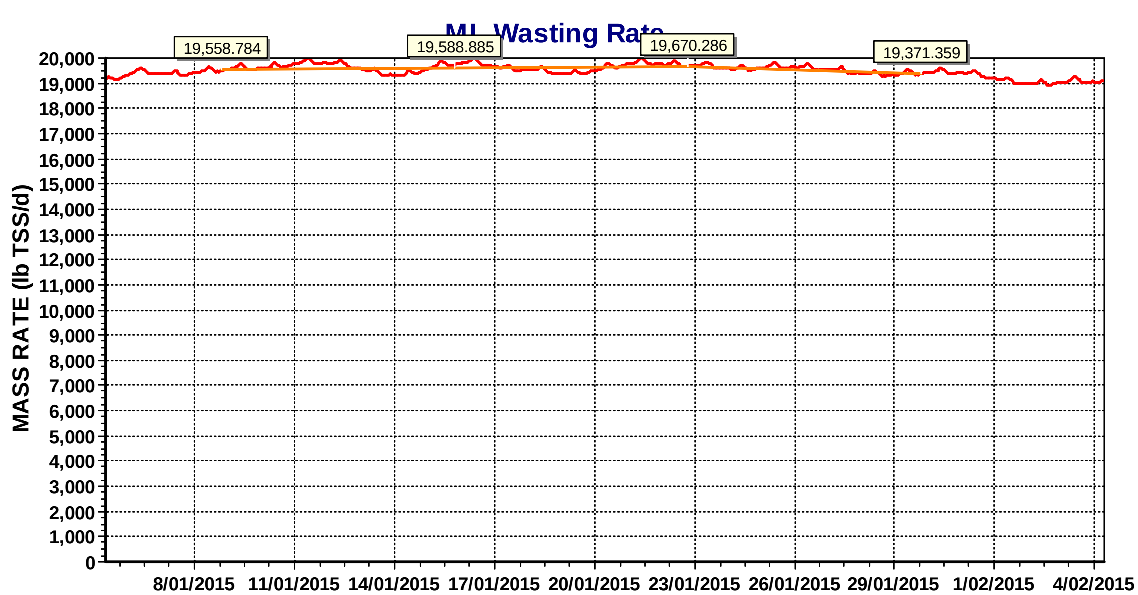


Album page - TP, RAS TSS

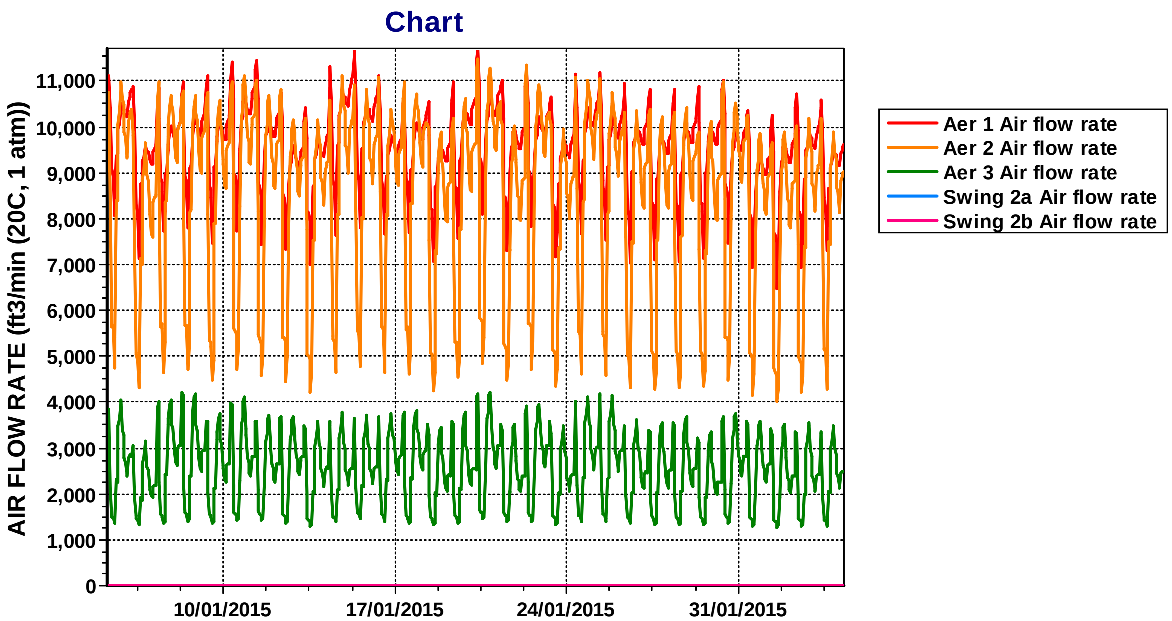



Album page - WAS Mass



## Album page - Air Flow Rate




## Album page - Page 16

| Elements | Air flow rate [ft3/min (20C, 1 atm)] | Flow [mgd] |
|---|---|---|
| Acetate Splitter (U) | ----- | 0.15 |
| Aer 1 | 9607.89 | 88.71 |
| Aer 2 | 9009.94 | 88.71 |
| Aer 3 | 2491.39 | 63.44 |
| Swing 2a | 0 | 63.44 |
| Swing 2b | 0 | 63.44 |

## Album page - Page 17

| WAS Wasting | | | |
|---|---|---|---|
| Parameters | Conc. (mg/L) | Mass rate (lb/d) | Notes |
| Volatile suspended solids | 6399.26 | 14028.77 | |
| Total suspended solids | 8712.23 | 19099.36 | |
| Particulate COD | 9312.46 | 20415.21 | |
| Filtered COD | 34.37 | 75.35 | |
| Total COD | 9346.83 | 20490.56 | |
| Soluble PO4-P | 0.05 | 0.11 | |
| Total P | 574.66 | 1259.81 | |
| Filtered TKN | 1.89 | 4.15 | |
| Particulate TKN | 633.32 | 1388.40 | |
| Total Kjeldahl Nitrogen | 635.22 | 1392.55 | |
| Filtered Carbonaceous BOD | 0.68 | 1.48 | |
| Total Carbonaceous BOD | 3775.29 | 8276.37 | |
| Nitrite + Nitrate | 1.65 | 3.61 | |
| Total N | 636.86 | 1396.16 | |
| Total inorganic N | 1.87 | 4.09 | |
| Alkalinity | -999.00 | -993.39 | mmol/L and kmol/d |
| pH | 6.97 | | |
| Volatile fatty acids | 0.02 | 0.05 | |
| ISS precipitate | 134.16 | 294.11 | |
| ISS cellular | 1561.37 | 3422.91 | |
| ISS Total | 2312.96 | 5070.59 | |
| Ammonia N | 0.22 | 0.49 | |
| Nitrate N | 1.60 | 3.51 | |
| pH | 6.97 | | |
| Ionized ammonium | 0.02 | mmol/L | |
| Unionized ammonia | 0.00 | mmol/L | |
| Nitrous acid | 0.00 | mmol/L | |

| | | |
|---|---|---|
| Nitrite | 0.00 | mmol/L |
| Total dissolved CO2 | 0.81 | mmol/L |
| Bicarbonate | 3.22 | mmol/L |
| Carbonate | 0.00 | mmol/L |
| Unionized ortho-P | 0.00 | mmol/L |
| H2PO4- | 0.00 | mmol/L |
| HPO4-- | 0.00 | mmol/L |
| PO4--- | 0.00 | mmol/L |
| Metal phosphate (solid) | 0.94 | mmol/L |
| Metal hydroxide (solid) | 0 | mmol/L |
| Metal ion | 0.00 | mmol/L |
| MeH2PO4++ | 0.00 | mmol/L |
| MeHPO4+ | 0.00 | mmol/L |
| Acetic acid | 0.00 | mmol/L |
| Acetate | 0.00 | mmol/L |
| Propionic acid | 0.00 | mmol/L |
| Propionate | 0.00 | mmol/L |
| Ionic strength | 0.02 | |
| Monovalent act. coeff. | 0.87 | |
| Divalent act. coeff. | 0.57 | |
| Trivalent act. coeff. | 0.29 | |
| Flow | 0.26 | mgd |

**Meridian Alternative's Analysis version 1**

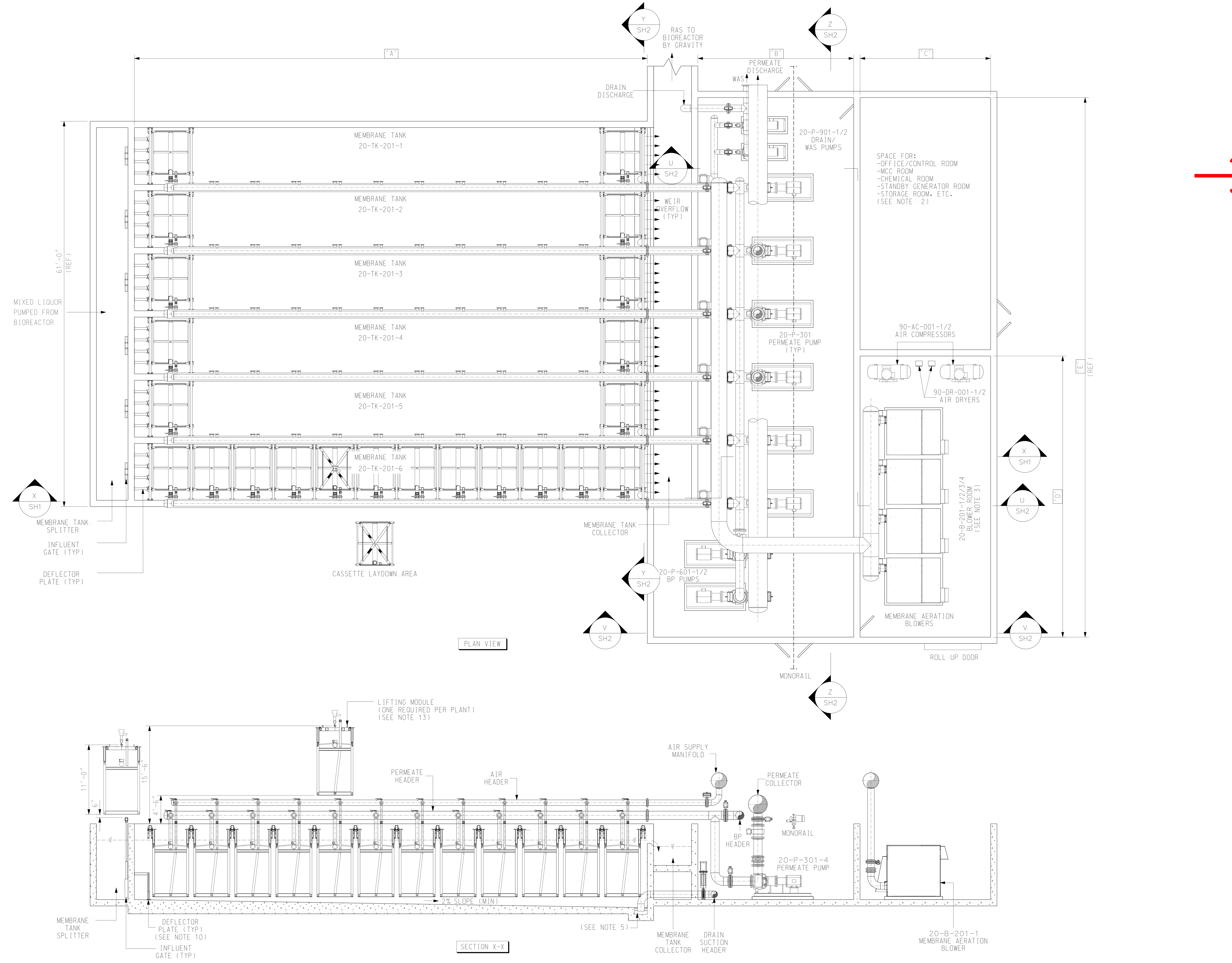
Expansion using selectable 5 stage modified Bardenpho/A2O process

Tank sizes optimized based on individual simulations from A2O and 5 stage modified Bardenpho processes

<u>To achieve target effluent concentrations, for Bardenpho process:</u>
Set BDF IMLR at 200% influent, Set A2O IMLR at 0%
Set Swing 1 Aerated, Swing 2a and 2b unaerated.
SRT = 12 days
All methanol to swing 2a

<u>To achieve target effluent concentrations, for A2O process:</u>
Set BDF IMLR at 0% influent, Set A2O IMLR at 400%
Set Swing 1 unaerated, Swing 2a and 2b aerated.
SRT = 12 days
All methanol to Anoxic 1a

For the MBR alternative, the Bardenpho process is used. Membrane tank sizing based on GE proposal dated 4/17/15
Alum addition rate was adjusted to reduce effluent PO4-P to 0.7 mg/L or lower. For the purpsoe of calculating O&M ocsts, however, the alum demand to reduce P from 0.5 to 0.07 mg/L was calculated separately for chemical precipitation.
Acetate flow pace of 1.2% of PE flow rate, 0.1 lb acetate COD per galloon used.
Methanol flow pace at 0.5% of PE flow rate, 1% methanol solution. All methanol to swing 2a.




## MAJOR TANK & BUILDING DIMENSIONS

| CASSETTES 'N' PER TRAIN | 'A' | 'B' | 'C' | 'D' | 'E' |
|---|---|---|---|---|---|
| 7 | 48'-4" | 16'-8" | 18'-8" | 33'-6" | 61'-0" |
| 8 | 55'-0" | 19'-8" | 18'-8" | 33'-6" | 74'-6" |
| 9 | 61'-8" | 19'-8" | 20'-8" | 43'-0" | 84'-0" |
| 10 | 68'-4" | 21'-8" | 20'-8" | 43'-0" | 84'-0" |
| 11 | 75'-0" | 21'-8" | 20'-8" | 44'-6" | 85'-6" |
| 12 | 81'-8" | 24'-8" | 20'-8" | 44'-6" | 85'-6" |

ALL EQUIPMENT AND PIPING SIZE SHOWN ON THIS DRAWING IS FOR THE LARGEST TRAIN SIZE (12 CASSETTES). EQUIPMENT LAYOUT CAN CHANGE WITH SMALLER TRAIN SIZES.

## NOTES

1. FOR SCOPE OF GE-SUPPLIED EQUIPMENT AND TECHNICAL DATA REFER TO THE PROPOSAL AND P&IDs.
2. SIZE AND LOCATION OF LISTED ROOMS ARE PRESENTED FOR REFERENCE ONLY. SYSTEM INTEGRATOR TO DETERMINE SIZE AND LOCATION OF ALL AMENITIES.
3. BIOLOGICAL PROCESS AERATION BLOWERS ARE NOT INCLUDED IN THE BLOWER ROOM. BOTH GROUPS OF BLOWERS CAN BE PLACED IN THE SAME ROOM.
4. SYSTEM INTEGRATOR IS RESPONSIBLE FOR DESIGN OF CONCRETE TANKS,GRAVITY CHANNELS INFLUENT GATES, EMERGENCY OVERFLOW, WALKWAYS/HANDRAILS ON TOP OF WALLS (IF REQUIRED). THESE ARE NOT SHOWN IN THIS DRAWING FOR CLARITY.
5. TANK BOTTOM AND DRAIN SUMP DESIGNS ARE NOT BY GE. HOWEVER IT IS RECOMMENDED THAT MEMBRANE TANK BOTTOM IS TO BE CONFIGURED AS A ONE WAY SLOPE TOWARDS DRAIN TRENCH CROSSING THE ENTIRE TANK WIDTH. DRAIN SUMP CAN BE LOCATED ANYWHERE INSIDE THE TRENCH, WITH A TRENCH SLOPE TAPERING INTO THE SUMP ON ONE OR BOTH SIDES OF IT, DEPENDING ON THE LOCATION OF THE DRAIN SUCTION NOZZLE.
6. DRAIN SUCTION NOZZLE OPENING HAS TO BE AT LEAST 6" BELOW ELEVATION OF A TANK BOTTOM AT ITS SHALLOW END.
7. TANKS TO BE COVERED FOR ACCESS TO CASSETTES AND EQUIPMENT. DESIGN, SUPPLY AND INSTALLATION OF MEMBRANE TANK COVERS ARE BY OTHERS (TANKS MUST BE VENTED). GE-SUPPLIED CASSETTE SUPPORT BEAMS INCLUDE A 3" ALLOWANCE FOR TANK COVERS THAT HAVE TO BE FLUSH WITH TOP OF TANKS. SPECIFIC DESIGN HAVE TO BE COORDINATED WITH GE. FOR ADDITIONAL INFORMATION REFER TO THE GE DESIGN GUIDELINE LISTED BELOW (NOTE 14a).
8. MEMBRANE TANK INTERNALS WILL BE IN CONTACT WITH MEMBRANE CLEANING CHEMICALS - TYPICALLY SODIUM HYPOCHLORITE OR CITRIC ACID SOLUTIONS. FOR ADDITIONAL INFORMATION REFER TO THE GE DOCUMENT LISTED BELOW (NOTE 14b).
9. ALL INTERNAL DIMENSIONS ARE GIVEN TO THE FINISHED CONCRETE AND COATING SURFACE; CONTRACTOR TO CALCULATE THE THICKNESS OF THE COATING BEFORE POURING THE CONCRETE (NOTE 14c).
10. DEFLECTOR PLATE DESIGN AND SUPPLY ARE BY OTHERS. FOR ADDITIONAL INFORMATION REFER TO THE GE DESIGN GUIDELINE LISTED BELOW (NOTE 14d).
11. DESIGN AND SUPPLY OF SUPPORTS FOR PERMEATE AND AIR HEADERS ARE BY OTHERS. SYSTEM INTEGRATOR TO DETERMINE DESIGN, NUMBER AND LOCATION OF SUPPORTS. GE TIE POINTS MUST NOT BE USED TO SUPPORT INTERCONNECTING PIPING.
12. SYSTEM INTEGRATOR TO CONSIDER PROVISION FOR FOAM/SLUDGE SURFACE WASTING AT THE DETAILED ENGINEERING STAGE.
13. ESTIMATED CASSETTE SHIPPING WEIGHT 4,500 LBS [2,040 KG]. ESTIMATED CASSETTE MAX WEIGHT(SLUDGED) 10,000 LBS [4,535 KG]. MEMBRANE LIFTING DEVICE (TRAVELING BRIDGE-CRANE) TO BE SIZED FOR 5,000 KG (NOTE 14e).
14. THE FOLLOWING DESIGN GUIDELINES ARE AVAILABLE FROM GE UPON REQUEST:
    a. TANK COVER GUIDELINES FOR ZEEWEED 500 SYSTEMS.
    b. MG-09012-C CONCRETE TANK COATING GUIDELINES FOR ZEEWEED SYSTEMS.
    c. MG-09011-A MEMBRANE TANK TOLERANCES.
    d. BEP #2007-04 BAFFLE DESIGN.
    e. ZEEWEED 500 SERIES MEMBRANE LIFTING EQUIPMENT GUIDELINE.
15. THIS VALUE IS BASED ON TANK SIZE, RAS FLOW AND THEREFORE REPRESENT A TYPICAL OPERATING RANGE.

GE Water & Process Technologies
ZENON Membrane Solutions

**REFERENCE ONLY DO NOT USE FOR CONSTRUCTION**

| REV | DESCRIPTION | ECO | DWN | APVD | DATE | CHKD |
|---|---|---|---|---|---|---|
| A | INITIAL RELEASE | – | JPG | JM | 10SEP12 | TA |

TOLERANCES UNLESS NOTED: DECIMALS .X .XX .XXX; ANGLES; FRAC
DIMENSIONS IN INCHES DO NOT SCALE
THIRD ANGLE

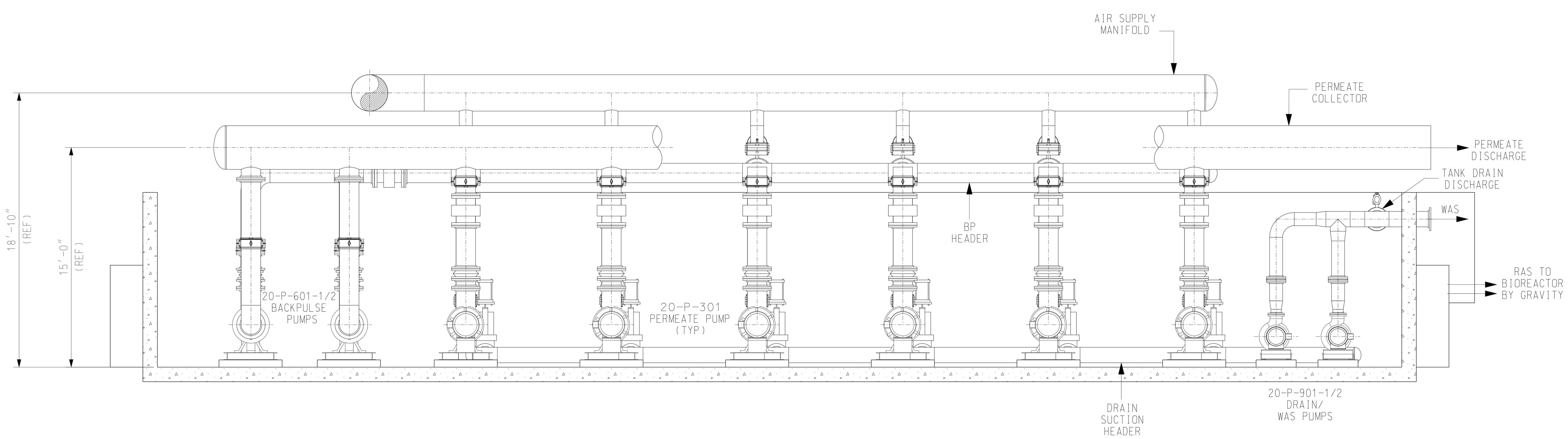
| | | |
|---|---|---|
| DRAWN BY | JPG | DATE 10SEP12 |
| CHECKED BY | TA | DATE 10SEP12 |
| APPROVED BY | JM | DATE 10SEP12 |
| APPROVED BY | | DATE |

GE Water & Process Technologies
GLOBAL HEADQUARTERS : TREVOSE, PA USA +1-215-355-3300 WWW.GEWATER.COM

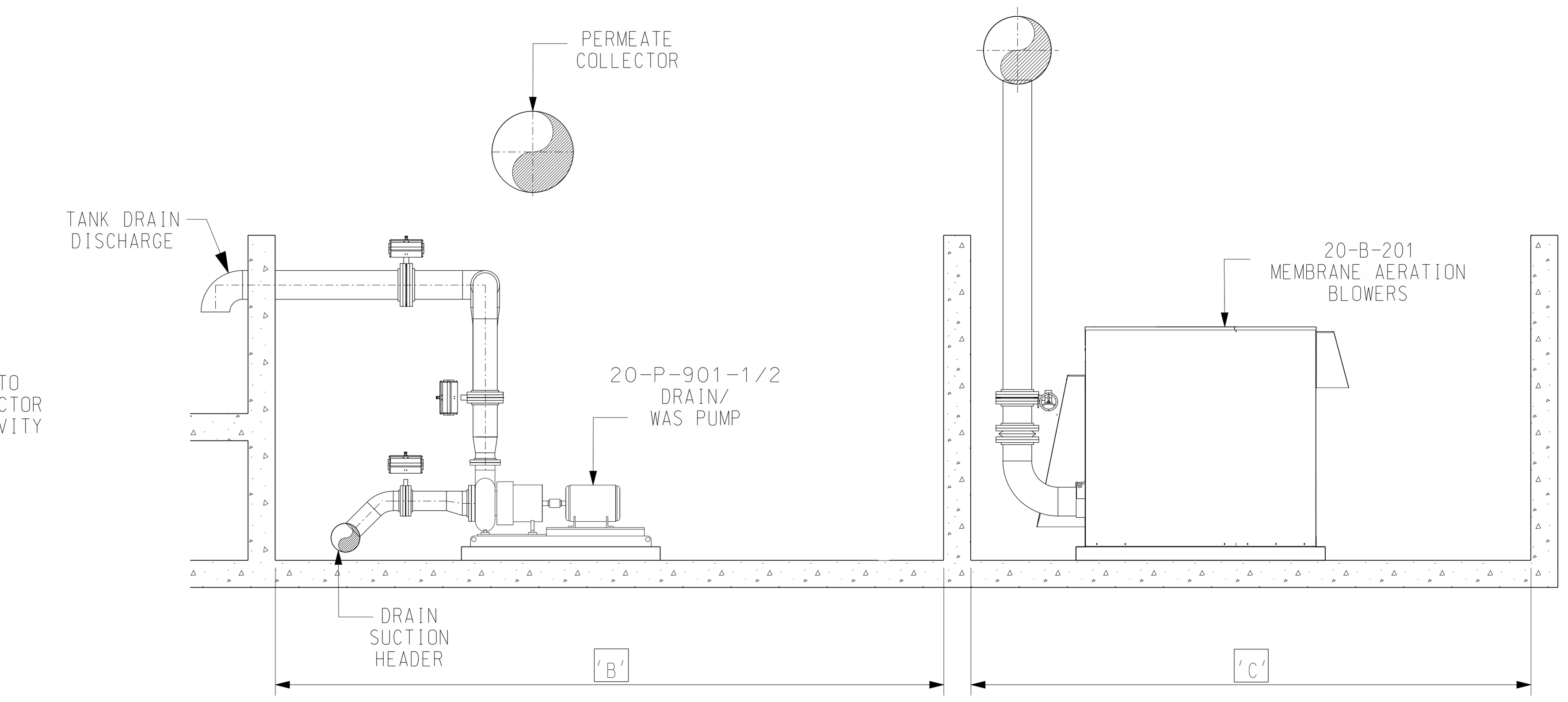


CLIENT/JOB: PRE-ENGINEERED LEAPMBR 6 TRAINS PUMP TO
FILE: MICROSTATION
TITLE: PLOT PLAN CENTRIFUGAL PROCESS PUMP
MATERIAL:
SIZE: D | DRAWING NO.: 4200000A-AG-01 | REV: A
PROJECT: 4200000
SCALE: 1:96 | SHEET: 1 OF 2

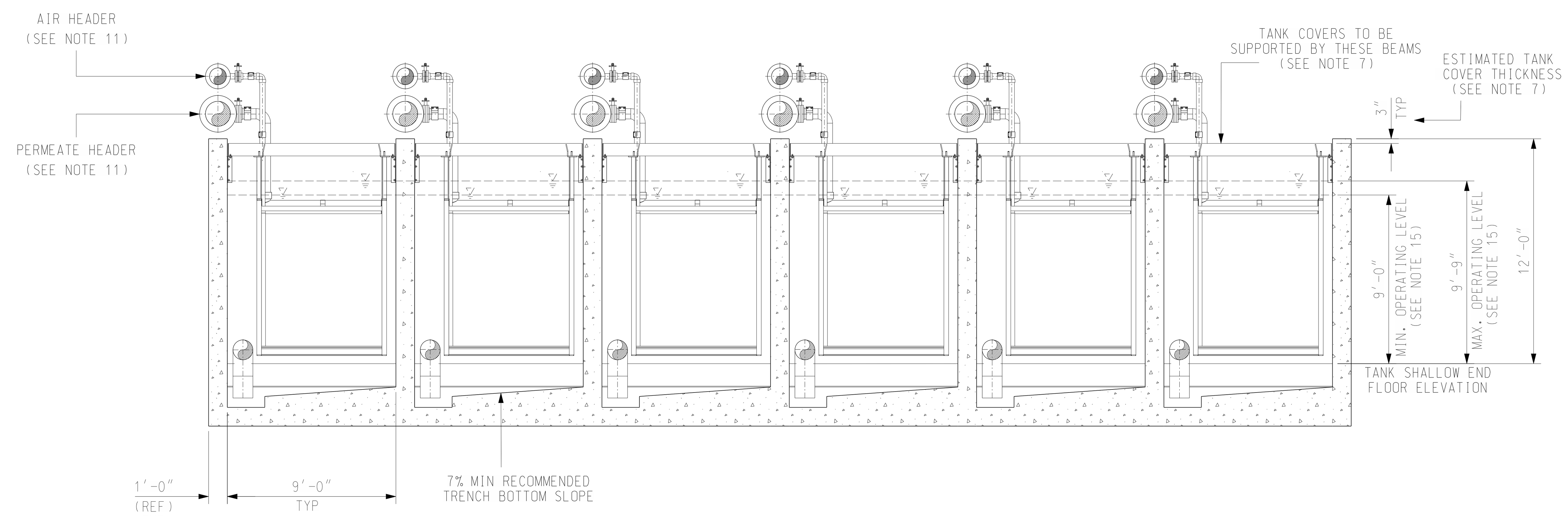
P/N 1161662-RHP01



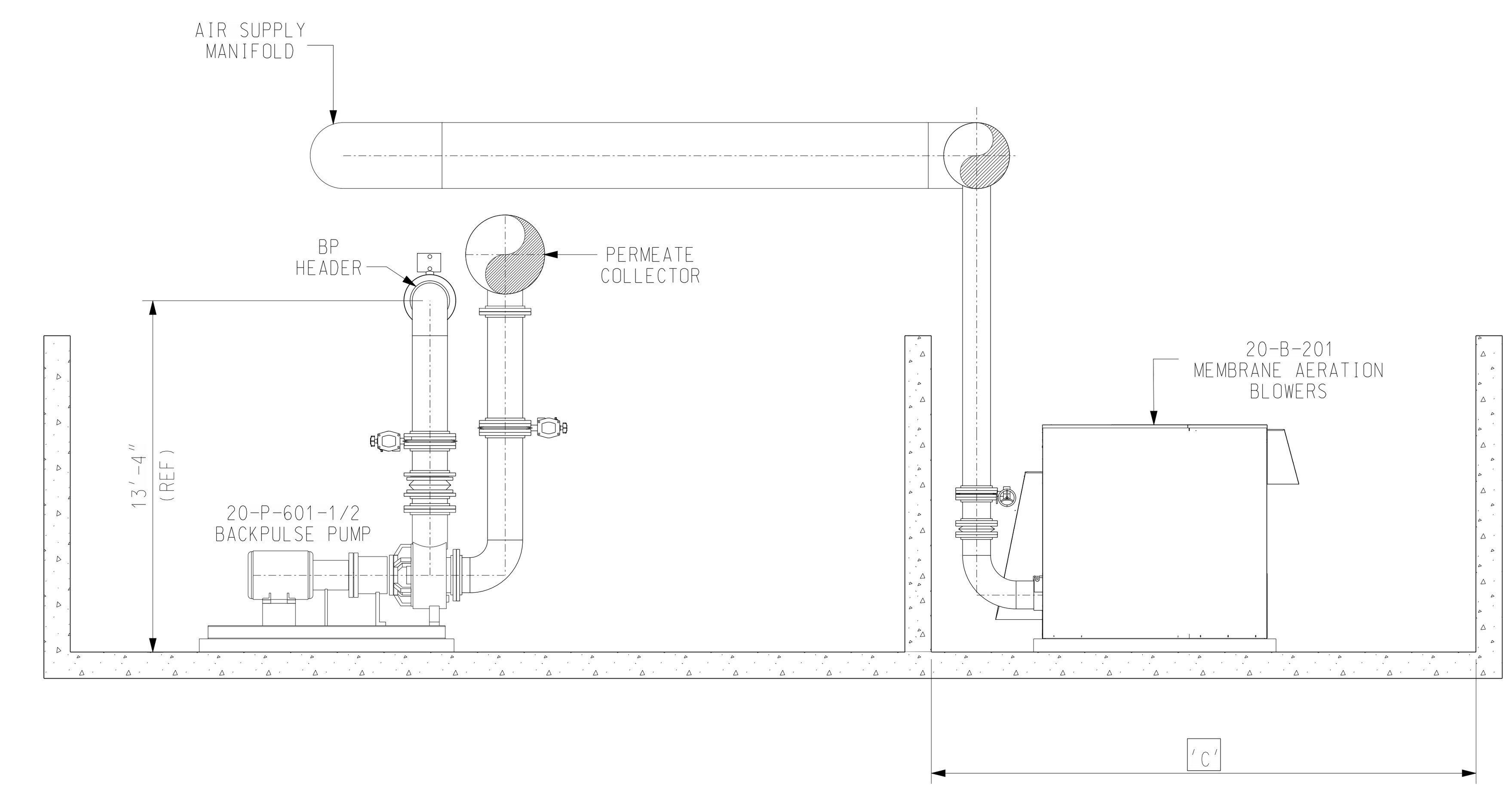

SECTION Z-Z




SECTION U-U




SECTION Y-Y




SECTION V-V

GE Water & Process Technologies
ZENON Membrane Solutions

**REFERENCE ONLY DO NOT USE FOR CONSTRUCTION**

| REV | DESCRIPTION | ECO | DWN | APVD | DATE | CHKD |
|---|---|---|---|---|---|---|
| A | INITIAL RELEASE | – | JPG | JM | 10SEP12 | TA |

TOLERANCES UNLESS NOTED: DECIMALS .X .XX .XXX; ANGLES; FRAC
DIMENSIONS IN INCHES DO NOT SCALE — THIRD ANGLE

| | | DATE |
|---|---|---|
| DRAWN BY | JPG | 10SEP12 |
| CHECKED BY | TA | 10SEP12 |
| APPROVED BY | JM | 10SEP12 |
| APPROVED BY | | |

GE Water & Process Technologies
GLOBAL HEADQUARTERS : TREVOSE, PA USA +1-215-355-3300 WWW.GEWATER.COM



CLIENT/JOB: PRE-ENGINEERED LEAPMBR 6 TRAINS PUMP TO
FILE: MICROSTATION
TITLE: PLOT PLAN CENTRIFUGAL PROCESS PUMP
MATERIAL:
SIZE: D | DRAWING NO.: 4200000A-AG-01 | REV: A
PROJECT: 4200000
SCALE: 1:64 | SHEET: 2 OF 2

P/N 1161662-RHP01

GE
Water & Process Technologies

# Budget Proposal for

# City of Meridian MBR

## ZeeWeed* Membrane Filtration System

**Submitted to:**


**Brown and Caldwell**
701 Pike Street, #1200
Seattle, WA, 98101

Attention: Patricia Tam


**April 17th , 2015**

**Proposal Number : 163962 – Rev 01**


**ZENON Environmental Corporation**
**d/b/a GE Water & Process Technologies**
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**GE Water & Process Technologies**
**Confidential and Proprietary Information**

GE Water and Process Technologies ("Seller") submits the information contained in this document for evaluation by Brown and Caldwell ("Buyer") only. Buyer agrees not to reveal its contents except to those in Buyer's organization necessary for evaluation. Copies of this document may not be made without the prior written consent of Seller's Management. If the preceding is not acceptable to Buyer, this document shall be returned to Seller.

This proposal is for budgetary purposes only and does not constitute an offer of sale.

# Table of Contents

# 1 Basis of Design

The proposed ZeeWeed Membrane Filtration System for the City of Meridian MBR is offered based on the design parameters summarized in the following sections.

## 1.1 Influent Flow Data

The influent design flows are summarized in the table below.

| | Summer | Winter |
|---|---|---|
| Average Day Flow (MGD) | 12.9 | 11.3 |
| Maximum Month Flow (MGD) | 14.2 | 12.3 |
| Maximum Day Flow (MGD) | 17.2 | 14.7 |
| Peak Hour Flow (gpm) | 19,445 | 13,889 |
| Maximum Flow with one train offline (MGD for less than one month) | 14.2 | 12.3 |
| Maximum Flow with one train in a maintenance clean (MGD for less than 2 hrs) | 17.2 | 14.7 |
| Maximum Flow with one less cassette on a single train (MGD for less than 2 hrs) | 28.0[2] | 20.0 |

Note 1: Any flow conditions that exceed the above-noted flow limits must be equalized prior to treatment in the ZeeWeed Membrane Filtration System

Note 2: At average day flow (ADF) temperature (21 C)

- Average Day Flow (ADF) – The average flow rate occurring over a 24-hour period based on annual flow rate data.
- Maximum Month Flow (MMF) – The average flow rate occurring over a 24-hour period during the 30-day period with the highest flow based on annual flow rate data.
- Maximum Day Flow (MDF) – The maximum flow rate averaged over a 24-hour period occurring within annual flow rate data.
- Peak Hour Flow (PHF) – The maximum flow rate sustained over a 1-hour period based on annual flow rate data.

## 1.2 Influent Quality

It has been assumed that the biological system design will be scoped by others. It is anticipated that the mixed liquor entering the membrane tank will meet the requirements as indicated in the table below.

| | Design Value | Unit |
|---|---|---|
| Average Temperature – Summer | 21 | °C |
| Average Temperature - Winter | 16 | °C |
| Minimum Weekly Temperature – Summer | 18 | °C |
| Minimum Weekly Temperature – Winter | 14 | °C |
| Minimum Daily Temperature – Summer | 16 | °C |

| | | |
|---|---|---|
| Minimum Daily Temperature - Winter | 12 | °C |
| Incoming MLSS concentration from bioreactor | ≤ 8000 | mg/L |
| Soluble $cBOD_5$ concentration in mixed liquor entering membrane tanks (mg/L) | ≤ 20 | mg/L |
| $NH_3$-N concentration in mixed liquor entering membrane tanks (mg/L) | ≤ 1 | mg/L |
| Colloidal TOC (cTOC) concentration in mixed liquor entering membrane tanks (mg/L) [2] | ≤ 10 | mg/L |
| Soluble alkalinity of mixed liquor entering membrane tanks (mg/L as $CaCO_3$) | n/a[7] | mg/L |
| Time to filter (TTF) of mixed liquor in membrane tanks [3] | ≤ 200 | seconds |
| Material greater than 2-mm in size in mixed liquor in membrane tanks (mg/L) [4] | ≤ 1 | - |
| Fats, Oil & Grease (FOG) (mg/L) | Refer to Note 6 | |

1. Membrane tank MLSS concentration of 12,000 mg/L is permissible during MDF and PHF events only. Membrane tank MLSS concentration to be 8,000 to 10,000 mg/L during all other flow conditions.
2. Colloidal TOC (cTOC) is the difference between the TOC measured in the filtrate passing through a 1.5 µm filter paper and the TOC measured in the ZeeWeed membrane permeate.
3. Per Seller's standard Time to Filter (TTF) procedure (available upon request).
4. Per Seller's standard Sieve Test procedure (available upon request).
5. Chemicals that are not compatible with the ZeeWeed PVDF membrane are not permitted in the membrane tank.
6. FOG concentration shall not exceed 150 mg/L of emulsified FOG in the feed with no free oil and less than 10 mg/L of mineral or non-biodegradable oil.
7. GE is assuming that sufficient influent alkalinity is available to ensure proper performance of the biological system. If influent alkalinity level is not sufficient, chemical addition by Buyer will be required.

## 1.3 Effluent Quality[Note 4]

The following performance parameters are expected upon equipment startup and once the biological system has stabilized based on the data listed in sections 1.1 and 1.2.

| | Winter | Summer | Units |
|---|---|---|---|
| BOD | <20 | <20 | mg/L |
| TSS | <20 | <20 | mg/L |
| TN [1] | <8 | <8 | mg/L |
| $NH_3$-N | <0.307 | <0.405 | mg/L |
| TP [2] | <0.07 | <0.07 | mg/L |
| Turbidity | < 1 | < 1 | NTU |

Note 1: TN less than 10mg/L corresponds to minimum design temperatures of 10°C and <1.5 mg/L recalcitrant dissolved organic nitrogen in the influent

Note 2: With coagulant addition

Note 3: After disinfection.

Note 4: From customer.

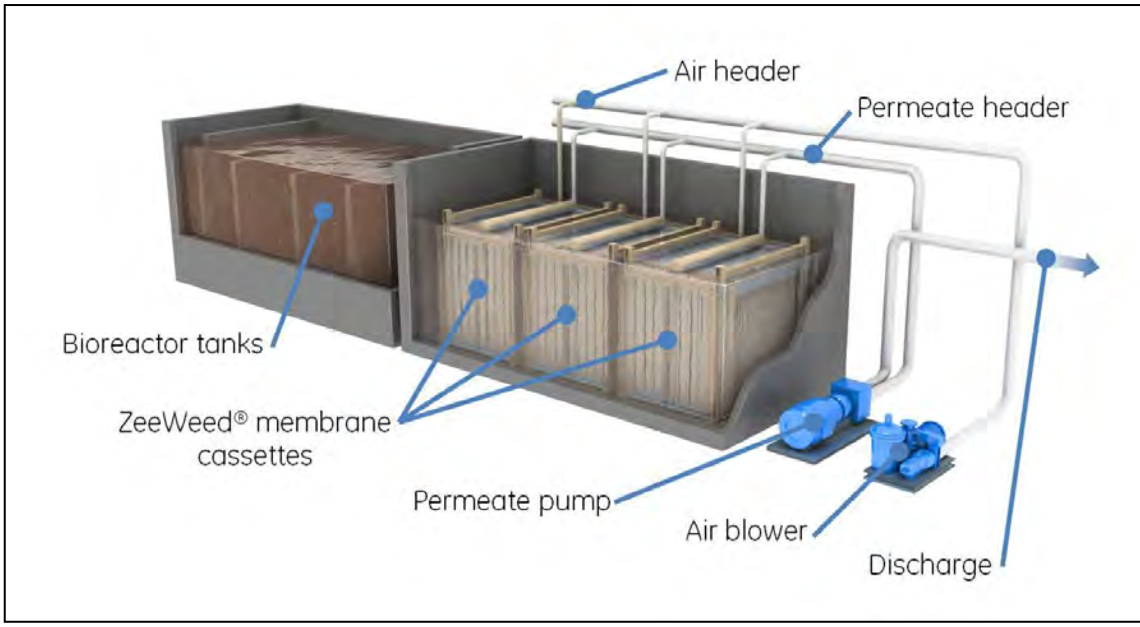
## 1.4 Influent Variability

Flows or loads in excess of the design criteria defined above must be equalized prior to the MBR system. In the event that the influent exceeds the specifications used in engineering this proposal, or the source of influent changes, the ability of the treatment system to produce the designed treated water quality and/or quantity may be impaired. Buyer may continue to operate the system, but assumes the risk of damage to the system and/or additional costs due to increased membrane cleanings, potential for biological upset and/or increased consumable usage.

# 2 System Design and Scope

The ZeeWeed Membrane Bioreactor (MBR) process consists of a suspended growth biological reactor integrated with a membrane filtration system, using the ZeeWeed hollow fiber ultrafiltration membrane. The membrane filtration system essentially replaces the solids separation function of secondary clarifiers and sand filters used in a conventional activated sludge process.

ZeeWeed ultrafiltration membranes are immersed, in direct contact with mixed liquor. Through the use of a permeate pump, a vacuum is applied to a header connected to the membranes. The vacuum draws the treated water through the hollow fiber membranes. Permeate is then directed to downstream disinfection or discharge facilities. Air, in the form of large bubbles, is introduced below the bottom of the membrane modules, producing turbulence that scours the outer surface of the hollow fibers to keep them clean.




The proposed MBR design includes LEAPmbr, GE's latest technology advancement for wastewater treatment, which offers the lowest cost of ownership in the industry. LEAPmbr incorporates several innovations, including the latest ZeeWeed 500 module with increased membrane surface area, increased productivity through proven MBR design flux improvements, an optimized membrane tank design, along with a more efficient membrane aeration system (known as LEAPmbr Aeration Technology) that simplifies the aeration system and reduces aeration requirements. These innovations combine to offer:

- 15% productivity improvement
- 20% footprint reduction
- 50% reduction in membrane aeration equipment
- 30% energy savings

The LEAPmbr advancement highlights some of the most important benefits of ZeeWeed MBR systems – simplicity, reliability, and lowest life-cycle cost.

## Simplicity

Over the years, GE has continually improved the design of ZeeWeedMBR systems, making them the simplest MBR systems in the industry to operate and maintain. The system is fully automated, with operators having the ability to review operation, adjust set points, or schedule operating tasks through the easy-to-understand HMI graphical display.

Membrane cleaning procedures are automated and do not require any manual handling or removal of the membranes from the tanks.

The LEAPmbr system uses no moving parts within the membrane aeration system. A single air pipe and a single permeate pipe (per membrane train) provide the connection between the immersed membranes and the ancillary pumps and blowers that comprise the rest of the ZeeWeed system.

## Reliability

GE's reinforced ZeeWeed hollow fiber membrane incorporates a patented internal support to which the membrane is bonded, creating the most robust membrane in the industry. In addition, GE's automated manufacturing processes ensure a consistent membrane product meeting the highest standards of workmanship and quality. This exceptionally strong and reliable membrane forms the backbone of ZeeWeed MBR systems, which consistently meet and exceed the toughest regulatory standards around the world.

GE is the world leader in MBR technology, with the majority of the industry's largest and longest-operating MBR plants. GE now has over two decades of experience with the well-proven ZeeWeed membrane. The earliest MBR plants using the ZeeWeed-500D membrane, GE's current standard for MBR applications, have now been in operation for almost 10 years. GE's long-term and wide-ranging MBR experience ensure that plant operators can count on many years of successful ZeeWeed MBR plant operation.

## Lowest Lifecycle Cost

LEAPmbr Aeration Technology is a significant innovation for ZeeWeed MBR technology that offers a 30% reduction in air flow versus GE's previous air cycling technology. When combined with LEAPmbr's other features, membrane aeration energy savings are almost 50% compared with the previous generation of ZeeWeed MBR. In addition to the substantial energy savings, LEAPmbr requires fewer membrane modules and cassettes, smaller membrane tanks, fewer valves and pipes, and lower connected horsepower. In many cases, using LEAPmbr technology, a ZeeWeed MBR system has an equivalent lifecycle cost to conventional treatment options.

## 2.1 Ultrafiltration System Design

| | |
|---|---|
| Number of Membrane Trains | 6 |
| Number of Cassettes Per Train | 10 |
| Number of Cassette Spaces Per Train | 11 |
| Number of Full (48 module) Cassettes per Train | 8 |
| Number of Partial (32 module) Cassettes per Train | 2 |
| Total Number of Installed Cassettes | 60 |
| Total Number of Installed Modules | 2688 |
| Spare Space | 15.2% |
| Membrane Tank Dimensions (L x W x H) | 9 x 75 x 12 ft |

Note 1: Tank dimensions and volumes are preliminary only and may change slightly once final detail design commences.

Note 2: The ultrafiltration system is designed for installation within concrete tanks supplied by Buyer

## 2.2 Scope of Supply by GE

Below is a general overview of equipment to be provided by GE.

| Quantity | Description |
|---|---|
| **ZeeWeed Membranes and Associated Equipment** | |
| 60 | ZeeWeed® 500D LEAP™ membrane cassettes |
| 2,688 | ZeeWeed® 500 370ft² modules. |
| Lot | Membrane tank cassette mounting assemblies for 6 trains |
| Lot | Permeate and air header pipes (within membrane tank limits only, excluding common collector and distribution pipes) for 6 trains |
| Lot | Permeate and Air Isolation Valves |
| 6 | Membrane tank level transmitters |
| 12 | Membrane tank level switches |
| **Membrane Air Scour Blower** | |
| 7 | Membrane air scour blowers supplied loose, complete with required isolation valves, pressure gauges and flow switches (6 Duty + 1 Standby) |
| **Permeate System** | |
| 6 | Permeate Pumps |
| 6 | Permeate flowmeters |
| 6 | Vacuum ejectors and associated air release valves |
| 6 | Trans-membrane pressure transmitters |
| 6 | Turbidimeters |
| **Backpulse System** | |
| 2 | Backpulse pumps supplied loose, complete with required isolation valves, flow meter. (Duty + Standby) |

| | |
|---|---|
| 1 | Backpulse/CIP Tank |
| **Drain Pump System** | |
| 2 | Drain Pumps (Duty + Standby) with associated valves and instrumentation |
| **Membrane Cleaning Systems** | |
| 2 | Sodium hypochlorite chemical feed pumps (Duty + Standby) |
| Lot | Required valves and instrumentation (feed/suction isolation valves, pressure indicators, etc.) for hypochlorite system. |
| 2 | Citric acid chemical feed pumps (Duty + Standby) |
| Lot. | Required valves and instrumentation (feed/suction isolation valves, pressure indicators, etc.) for citric acid system |
| **Electrical and Control Equipment** | |
| 1 | Master PLC control panel with touch screen HMI |
| 6 | Train I/O panels |
| **Miscellaneous** | |
| 1+1 | Air compressors and refrigerated air dryers for ejectors and pneumatic valve operation with duplex control panel. |
| **General** | |
| Incl. | Equipment general arrangement and layout drawings |
| Incl. | GE Standard Engineering Design (Equipment Tagging, Control Documents, Setpoints, Alarms, etc.). |
| Incl. | Operating & Maintenance manuals |
| Incl. | Field service and start-up assistance – 65 person-days of support over 4 total site visits from GE Water field-service personnel for installation assistance, commissioning, plant start-up and operator training. |
| Incl. | Membrane warranty – 5 year prorated |
| Incl. | Equipment mechanical warranty – 1 year or 18 months from shipment of equipment |
| Incl. | InSight Remote Monitoring & Diagnostics – Trend Service and 24/7 Emergency Telephone Technical Support Service – 1 year |

Notes:

1 Additional man-hours will be billed separately from the proposed system capital cost at a rate of $1,300 per day plus living and traveling expenses. Detailed GE Water service rates are available upon request.

2 All GE supplied equipment is designed for installation in an unclassified area.

3 A further customized package of post-commissioning Field Service support can be provided upon request. The package may include additional years of GE's Insight Remote Monitoring & Diagnostics or 24/7 services or site visits by GE Field Service personnel,

4 To receive complete 24/7 Emergency Telephone Technical Support Service and to allow for InSight Monitor/Trend Service, a suitable, secure remote internet connection, by Buyer, is required.

# 3 Buyer Scope of Supply

The following items are for supply by Buyer and will include but are not limited to:

- Overall plant design responsibility
- Review and approval of design parameters related to the membrane separation system
- Review and approval of GE supplied equipment drawings and specifications
- Detail drawings of all termination points where GE equipment or materials tie into equipment or materials supplied by Buyer
- Design, supply and installation of lifting devices including overhead traveling beam crane and monorail beam able to lift 5 ton for membrane removal, lifting davit crane and guide rails for submersible mixers and pumps, hoists, etc.
- Civil works, provision of main plant tank structures, buildings, equipment foundation pads etc. including but not limited to:
  - Common channels, Housekeeping pads, Equipment access platforms, walkways, stairs etc.
  - Equalization tank – as required
  - Bioreactor tank – complete with pre-anoxic, aerobic  and post-anoxic zones
  - Membrane tanks c/w tank coating to be suitable for appropriate chemical contact, covers, grating, and their support over membrane tanks. Note: cassette beams provided by GE are designed to provide structural support for tank grating/covers.
  - Treated water storage tank, as required
- HVAC equipment design, specifications and installation (where applicable)
- UPS, power conditioner, emergency power supply and specification (where applicable)
- 2 mm Pretreatment fine screen
- Biological process equipment – including process blowers, diffusers and mixers
- RAS pumps and associated instrumentaion and valving
- Acoustical enclosures for membrane and process blowers
- VFDs and MCC for all GE supplied equipment
- Plant SCADA system
- Process and utilities piping, pipe supports, hangers, valves, etc. including but not limited to:
  - Piping, pipe supports and valves between GE-supplied equipment and other plant process equipment
  - Piping between any loose-supplied GE equipment

- Process tank aeration system air piping, equalization tank system piping, etc.
- Interconnecting pipe between GE-supplied skids and tanks (as applicable)

- ❑ Electrical wiring, conduit and other appurtenances required to provide power connections as required from the electrical power source to the GE control panel and from the control panel to any electrical equipment, pump motors and instruments external to the GE-supplied enclosure
- ❑ Supply and installation of suitable, secure remote internet connection for 24/7 Emergency Telephone Technical Support Service and InSight Remote Monitoring & Diagnostics Service
- ❑ Design, supply and installation of equipment anchor bolts, brackets, and fasteners for GE supplied equipment. Seismic structural analysis and anchor bolt sizing.
- ❑ Receiving (confirmation versus Packing List), unloading and safe storage of GE supplied equipment at site until ready for installation
- ❑ Installation on site of all GE supplied skids and loose-shipped equipment
- ❑ Alignment of rotating equipment
- ❑ Raw materials, chemicals, and utilities during equipment start-up and operation
- ❑ Disposal of initial start-up wastewater and associated chemicals
- ❑ Supply of seed sludge for process start-up purposes
- ❑ Laboratory services, operating and maintenance personnel during equipment checkout, start-up and operation
- ❑ Touch up primer and finish paint surfaces on equipment as required at the completion of the project
- ❑ Weather protection as required for all GE supplied equipment. Skids and electrical panels are designed for indoor operation and will need shelter from the elements.

# 4 Commercial

## 4.1 Pricing Table

Pricing for the proposed equipment and services, as outlined in Section 2.2, is summarized in the table below. All pricing is based on the operating conditions and influent analysis detailed in Section 1. The pricing herein is for budgetary purposes only and does not constitute an offer of sale. No sales, consumer use or other similar taxes or duties are included in the pricing below.

| Price: All Equipment & Service | |
|---|---|
| ZeeWeed Membrane Filtration System, as per Section 2.2. | $ 6,200,000 USD |

## 4.2 Annual Power & Chemical Consumption Estimates for Membrane System

The data presented below is for information purposes only and is based on the design information provided by the Buyer and presuming that the equipment is operated according to the design basis and in accordance with Seller's Operations and Maintenance manuals.

### Annual power consumption estimate [1]

| Equipment | kWh/year |
|---|---|
| **Permeate Pumps** | 214,700 |
| **Membrane Blowers** [2] | 762,600 |
| **Air Compressors** | 23,700 |
| Total | **1,001,000 kWh/year** |

Note1: Annual Power consumption estimate is calculated with ADF conditions. A 50% split between summer and winter ADF conditions has been used.

Note2: Assumes membrane relaxation for sludge prevention method

### Annual chemical consumption estimate

| Chemical | USgal/year |
|---|---|
| Sodium Hypochlorite (10.3% w/w, SG: 1.168) | 10,630 |
| Citric Acid (50.0% w/w, SG: 1.24) | 8,310 |

Note: Cleaning chemical consumption estimates based on the following frequencies and concentrations summarized in the table below. Frequencies are assumed, actual frequency of maintenance and recovery cleans may change with final design, or may change once system is in operation.

### Basis of chemical consumption estimate

| Chemical | | Maintenance Clean | Recovery Clean |
|---|---|---|---|
| Sodium Hypochlorite solution (10.3% w/w, SG: 1.168) | Frequency | 2 times per week | 2 times per year |
| | Concentration | 200 mg/L | 1,000 mg/L |
| Citric Acid Solution (50.0% w/w, SG: 1.24) | Frequency | weekly | 2 times per year |
| | Concentration | 2,000 mg/L | 2,000 mg/L |

## 4.3 Equipment Shipment and Delivery

Equipment Shipment is estimated at 26 to 35 weeks after order acceptance. The Buyer and Seller will arrange a kick off meeting after contract acceptance to develop a firm shipment schedule.

**Typical Drawing Submission and Equipment Shipment Schedule**

| | | 8-12 weeks | 2-3 weeks | 16-20 weeks | | 2 weeks |
|---|---|---|---|---|---|---|
| Acceptance of PO | | | | | | |
| Submission of Drawings | | | | | | |
| Drawings Approval | | | | | | |
| Equipment Manufacturing | | | | | | |
| Equipment Shipment | | | | | | |
| Plant Operations Manuals | | | | | | |

The delivery schedule is presented based on current workload backlogs and production capacity. This estimated delivery schedule assumes no more than 2 weeks for Buyer review of submittal drawings. Any delays in Buyer approvals or requested changes may result in additional charges and/or a delay to the schedule.

## 4.4 Terms and Conditions of Sale

This proposal has been prepared and is submitted based on Seller's Standard Terms and Conditions of Sale.

# BioWin user and configuration data

## Project details

Project name: Alternatives Analysis    Project ref.: 147571

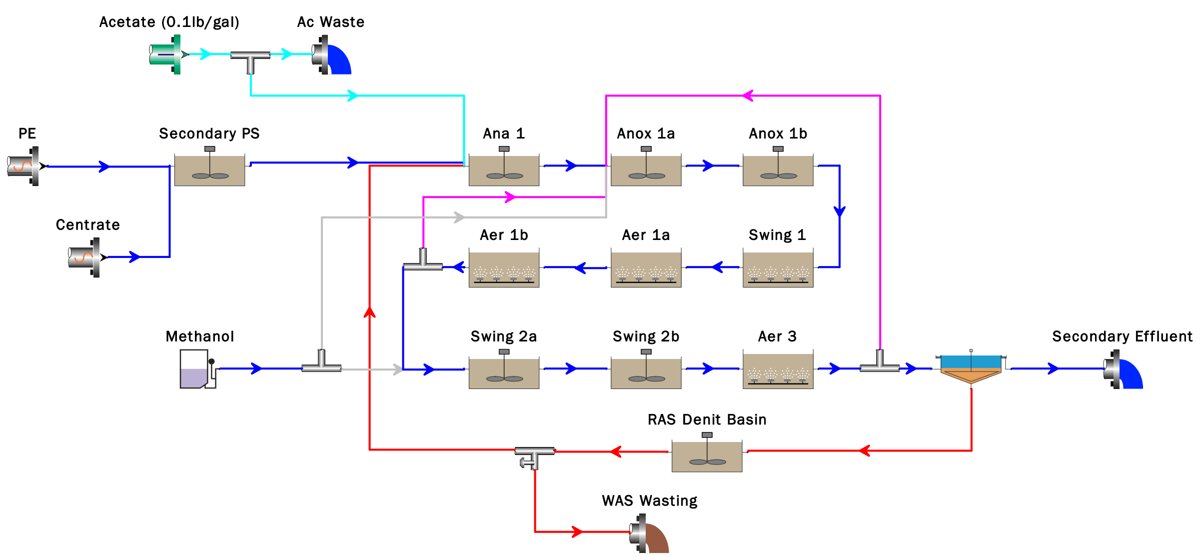
Plant name: Meridian WWTP    User name: Rick Kelly

Created: 6/29/2011    Saved: 4/30/2015

Target SRT: 12.00 days    SRT: **** days

Temperature: 14.0°C

## Flowsheet




# Configuration information for all Bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Ana 1 | 0.4000 | 3819.4447 | 14.000 | Un-aerated |
| Aer 1a | 1.4000 | 1.337E+4 | 14.000 | 4544 |
| Aer 1b | 1.5000 | 1.432E+4 | 14.000 | 4868 |
| Swing 2a | 0.6000 | 5729.1670 | 14.000 | Un-aerated |
| Aer 3 | 0.5000 | 4774.3058 | 14.000 | 1623 |
| Anox 1a | 0.3000 | 2864.5835 | 14.000 | Un-aerated |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |
| Anox 1b | 0.3000 | 2864.5835 | 14.000 | Un-aerated |
| Swing 1 | 0.4000 | 3819.4447 | 14.000 | 865 |
| Swing 2b | 0.6000 | 5729.1670 | 14.000 | Un-aerated |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Ana 1 | 0 |
| Aer 1a | 2.5 |
| Aer 1b | 2.0 |
| Swing 2a | 0 |
| Aer 3 | 2.0 |
| Anox 1a | 0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |
| Anox 1b | 0 |
| Swing 1 | 2.0 |

| | |
|---|---|
| Swing 2b | 0 |

### Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Ana 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Swing 2a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 3 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Anox 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Anox 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 2b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

## Configuration information for all Methanol addition units

### Operating data Average (flow/time weighted as required)

| Element name | Methanol |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |

| | |
|---|---|
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 11880.00 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |

| | |
|---|---|
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

## Configuration information for all Effluent units

## Configuration information for all Ideal clarifier units

### Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] |
|---|---|---|---|
| Clarifier | 2.8000 | 2.718E+4 | 13.770 |

### Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
| --- | --- | --- |
| Clarifier | Flow paced | 50.00 % |

| Element name | Average Temperature | Reactive | Percent removal | Blanket fraction |
| --- | --- | --- | --- | --- |
| Clarifier | Uses global setting | Yes | 99.90 | 0.07 |

# Configuration information for all COD Influent units

## Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
| --- | --- | --- |
| Time | 30.00 | 30.00 |
| Flow | 12.461167588271 | 0.100114816828393 |
| Total COD mgCOD/L | 416.48 | 1801.80 |
| Total Kjeldahl Nitrogen mgN/L | 54.01 | 794.23 |
| Total P mgP/L | 8.12 | 105.96 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.95 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.43 | 185.22 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.5950 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 0.0392 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9931 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.0039 |
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.3197 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.9500 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5086 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0050 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0512 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9300 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.0110 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 | 0 |

# Configuration information for all Sludge units

# Configuration information for all Splitter units

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| BDF IMLR | Flow paced | 200.00 % |
| RAS / WAS | Flowrate [Side] | 0.167116174366931 |
| Acetate Splitter | Flow paced | 0.30 % |
| Splitter21 | Fraction | 0.00 |
| A2O IMLR | Flowrate [Side] | 0 |

# Configuration information for all Stream (SV) Influent units

## Operating data Average (flow/time weighted as required)

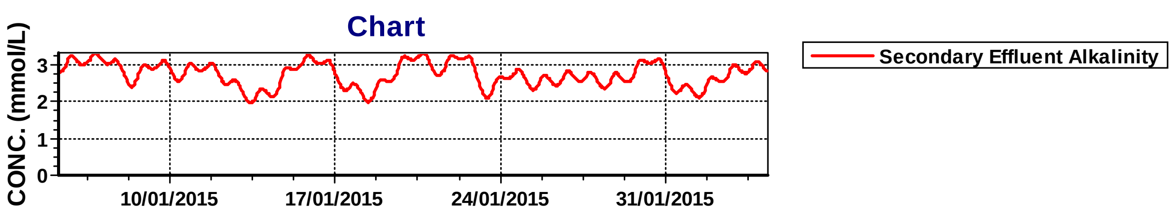
| Element name | Acetate (0.1lb/gal) |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |

| | |
|---|---|
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 11980.00 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |

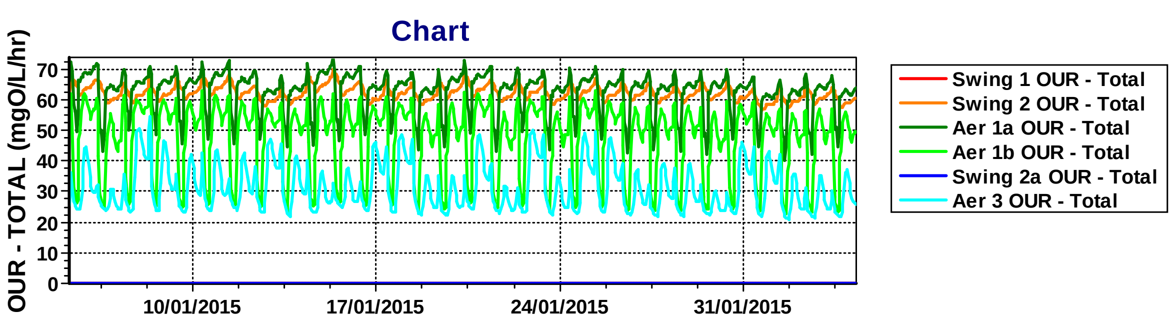
| | |
|---|---|
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

## BioWin Album

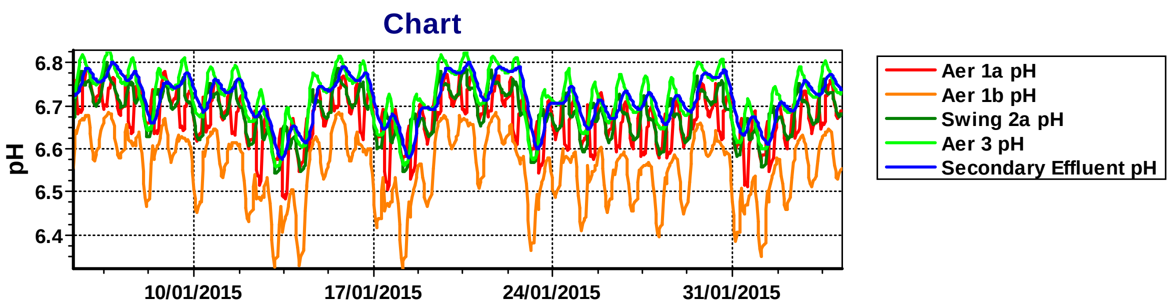
### Album page - SS AOB-NOB



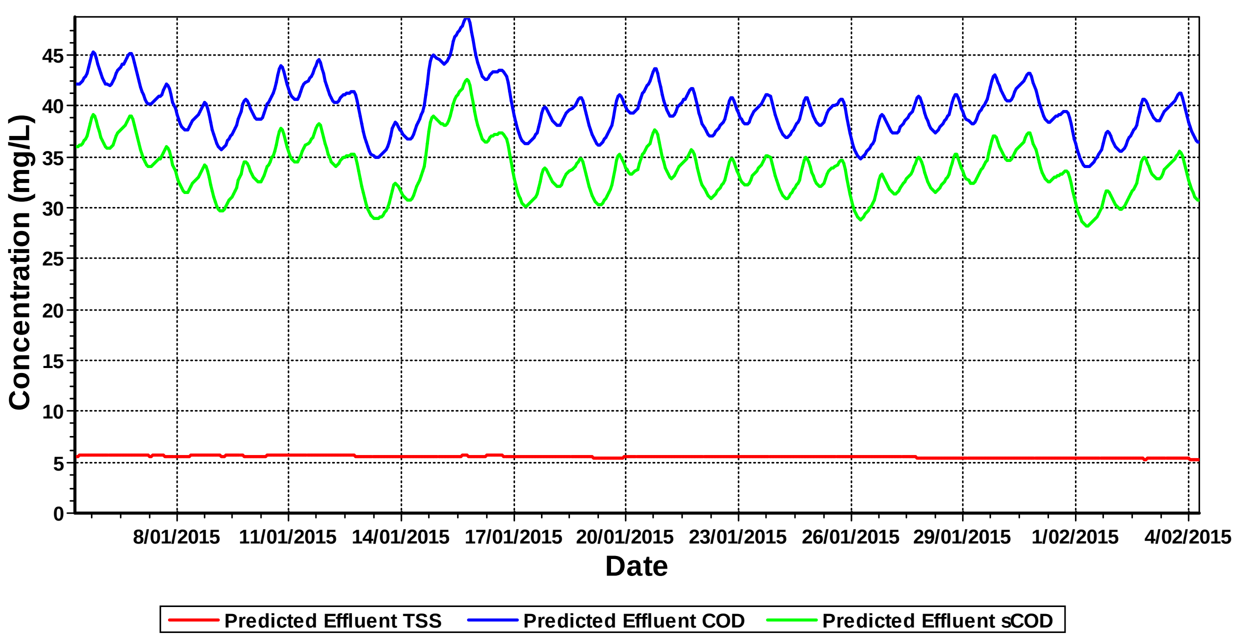

### Album page - OURs



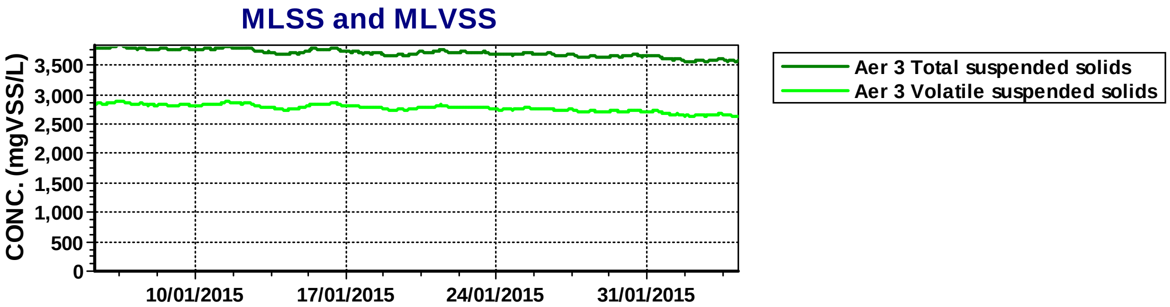

### Album page - OURs



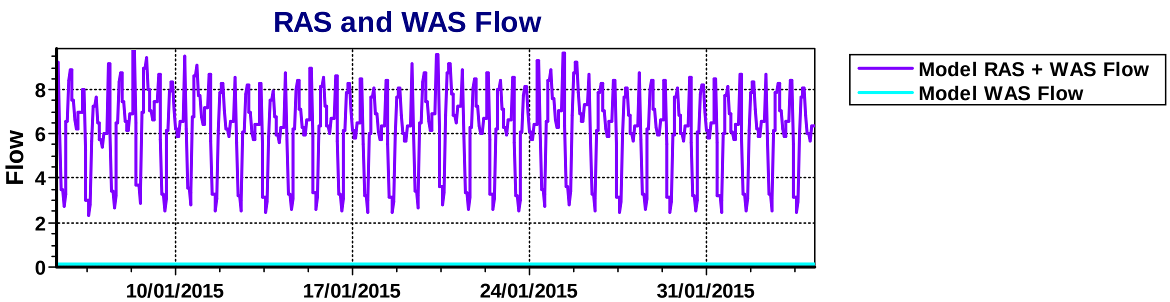

Album page - TSS, COD, BOD



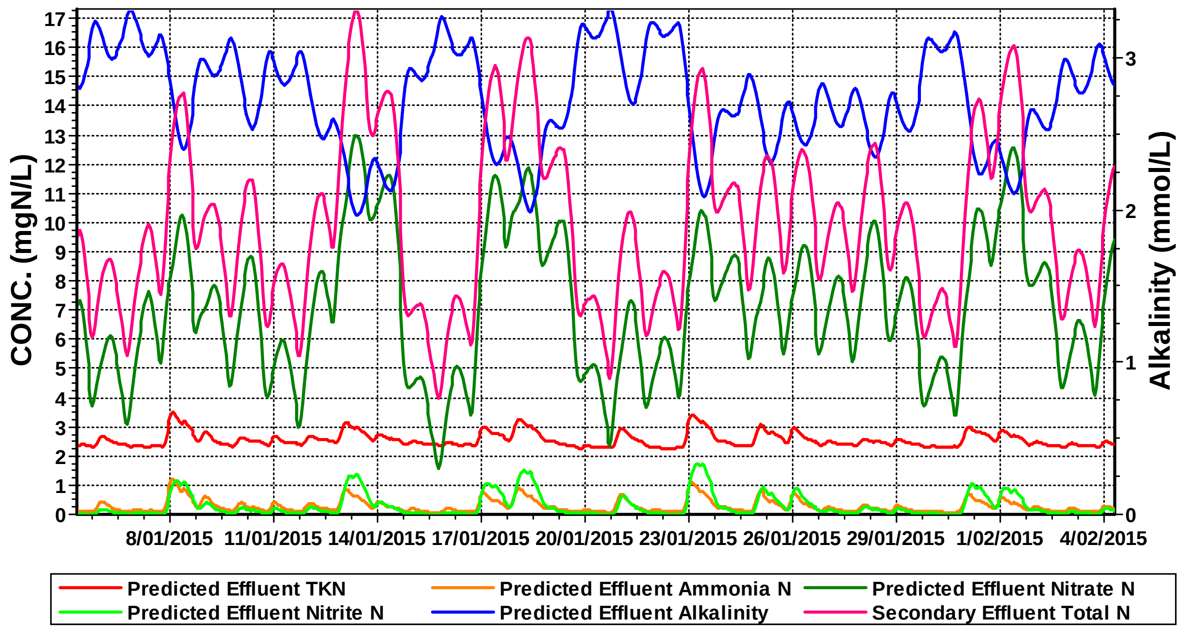

Album page - Mixed Liquor, RAS Flow



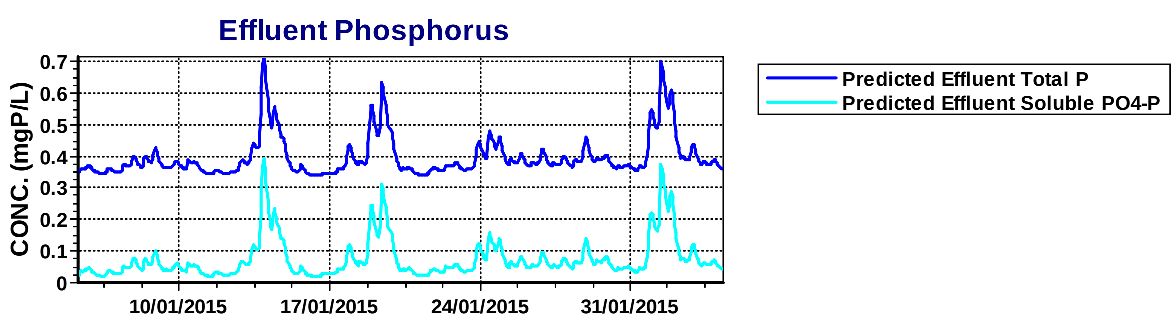

Album page - Mixed Liquor, RAS Flow



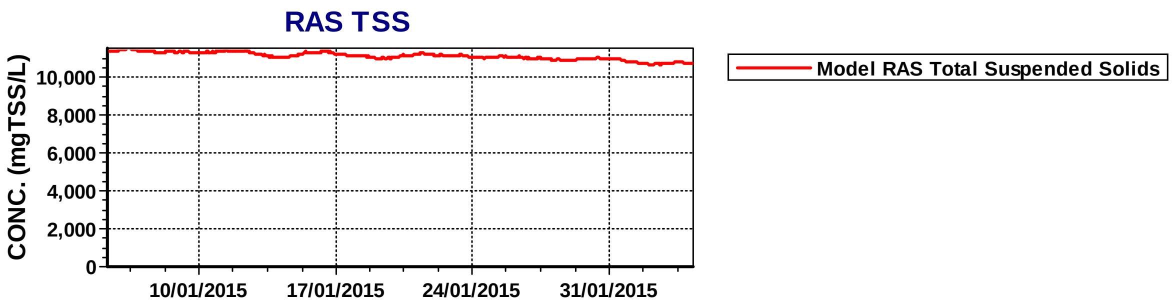

Album page - Nitrogen Sp., Alkalinity



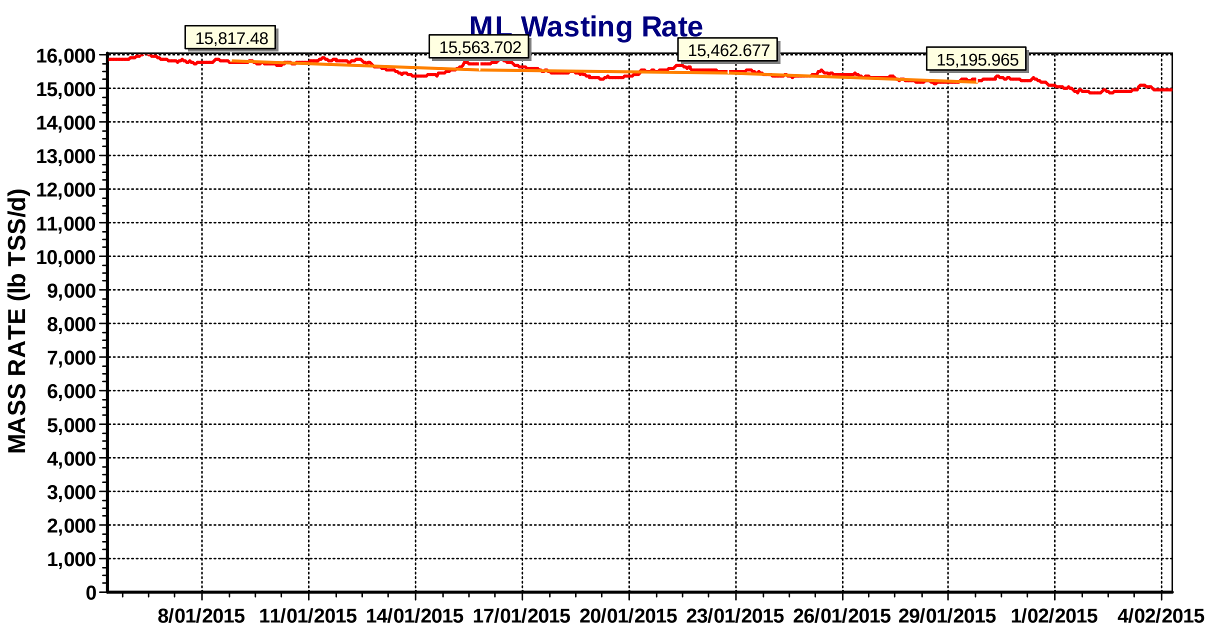

Album page - TP, RAS TSS



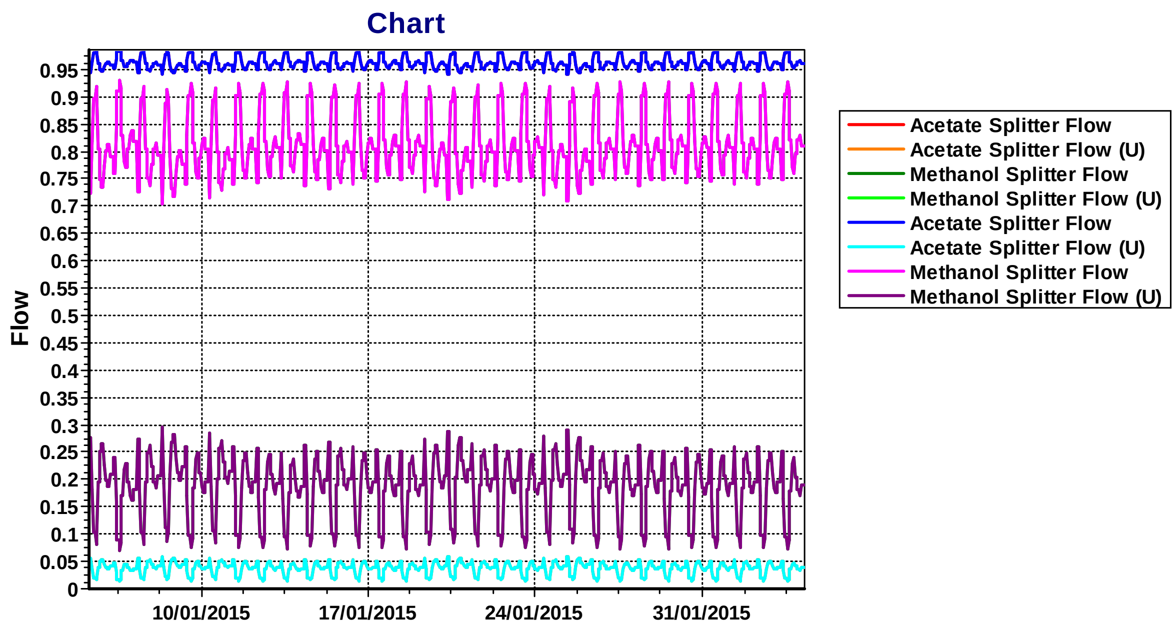

Album page - TP, RAS TSS



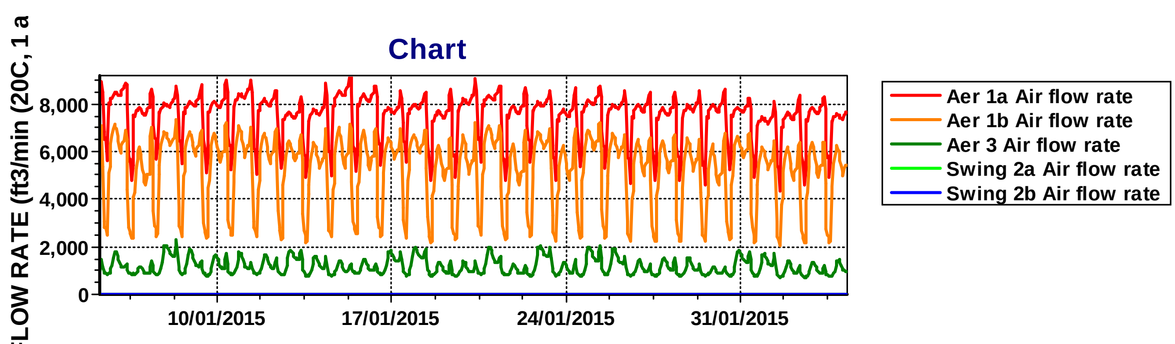

Album page - WAS Mass




Album page - Acetate and Methanol Flow




Album page - Air Flow Rates




Meridian Alternative's Analysis version 1

Expansion using selectable 5 stage modified Bardenpho/A2O process

Tank sizes optimized based on individual simulations from A2O and 5 stage modified Bardenpho processes

To achieve target effluent concentrations, for Bardenpho process:
Overall process volume = 7.25 MG
Set BDF IMLR at 200% influent, Set A2O IMLR at 0%
Set Swing 1 Aerated, Swing 2a and 2b unaerated.
SRT = 12 days
Acetate flow pace at 0.8% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 0.5% of PE flow rate, 1% methanol solution.  All methanol to swing 2a

To achieve target effluent concentrations, for A2O process:
Overall process volume = 7.25 MG

Set BDF IMLR at 0% influent, Set A2O IMLR at 400%
Set Swing 1 unaerated, Swing 2a and 2b aerated.
SRT = 12 days
Acetate flow pace at 0.6% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 1.5% of PE flow rate, 1% methanol solution. all methanol to Anoxic 1a

To achieve target effluent concentrations, for 5SB process with Ostara Centrate treatment:
tank volume for overall process volume of 6.0 MG
Reduce Nitrogen in Centrate by 15%, Reduce phosphorus in Centrate by 80%
Set BDF IMLR at 200% influent, Set A2O IMLR at 0%
Set Swing 1 aerated, Swing 2a and 2b unaerated.
SRT = 12 days
Acetate flow pace at 0.25% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 0.5% of PE flow rate, 1% methanol solution. all methanol to Swing 2a

Summary of process results:
SRT = 12 days
Steady State Acetate use: 3,690 lb/d
Steady State Methanol use: 615 gpd
SS Air Demands: 16,725 scfm
SS WAS: 16,020 lb/d
All SS parameters meet follwoing criteria: MLSS<4,000; SP/TP<0.1/0.5; TN/NH3/NOX<15.5, 0.3, 8

Diurnal effluent quality is as follows:

**Monthly Averages (all in mg/L)**

| Eff TN | Eff NH3 | Eff NOx | Eff PO4 | Eff TP | MLSS |
|---|---|---|---|---|---|
| 10.00143 | 0.281039 | 7.44645 | 0.07465 | 0.396125 | 3703.05 |

**Daily Maximums (all in mg/L)**

| Eff TN | Eff NH3 | Eff NOx | Eff PO4 | Eff TP | MLSS |
|---|---|---|---|---|---|
| 15.23801 | 0.736096 | 12.37693 | 0.250259 | 0.573554 | 3811.626 |

# BioWin user and configuration data

## Project details

Project name: Alternatives Analysis    Project ref.: 147571

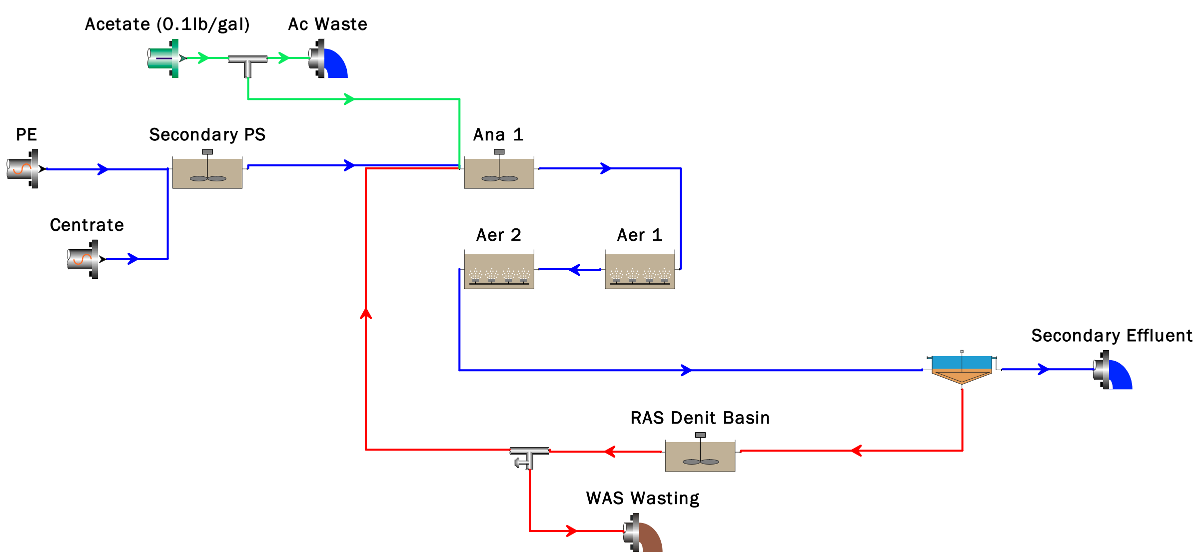
Plant name: Meridian WWTP    User name: Rick Kelly

Created: 6/29/2011    Saved: 6/30/2015

Target SRT: 3.00 days  SRT: **** days

Temperature: 14.0°C

## Flowsheet




# Configuration information for all Bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Ana 1 | 0.5000 | 4774.3058 | 14.000 | Un-aerated |
| Aer 1 | 0.8500 | 8116.3199 | 14.000 | 2759 |
| Aer 2 | 2.0000 | 1.910E+4 | 14.000 | 6491 |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Ana 1 | 0 |
| Aer 1 | 2.5 |
| Aer 2 | 2.0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |

## Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Ana 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 2 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

| | | | | | |
|---|---|---|---|---|---|
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

# Configuration information for all Effluent units

# Configuration information for all Ideal clarifier units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] |
|---|---|---|---|
| Clarifier | 2.8000 | 2.718E+4 | 13.770 |

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| Clarifier | Flow paced | 50.00 % |

| Element name | Average Temperature | Reactive | Percent removal | Blanket fraction |
|---|---|---|---|---|
| Clarifier | Uses global setting | Yes | 99.90 | 0.07 |

# Configuration information for all COD Influent units

## Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 30.00 | 30.00 |
| Flow | 12.461167588271 | 0.100114816828393 |
| Total COD mgCOD/L | 416.48 | 1801.80 |
| Total Kjeldahl Nitrogen mgN/L | 54.01 | 934.39 |
| Total P mgP/L | 8.12 | 529.81 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.95 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.43 | 185.22 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.5950 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 0.0392 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9931 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.0039 |
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.3197 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.9500 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5086 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0050 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0512 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9300 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.0642 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-4 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |

| | | |
|---|---|---|
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 | 0 |

# Configuration information for all Sludge units

# Configuration information for all Splitter units

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| RAS / WAS | Flowrate [Side] | 0.37443085010023 |
| Acetate Splitter | Flow paced | 1.00 % |

# Configuration information for all Stream (SV) Influent units

## Operating data Average (flow/time weighted as required)

| Element name | Acetate (0.1lb/gal) |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |

| | |
|---|---|
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 11980.00 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |

| | |
|---|---|
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

## BioWin Album

## Album page - Table

| Elements | Total COD [mg/L] | Total Kjeldahl Nitrog | Flow [mgd] | Dissolved oxygen | Total suspended | Volatile suspend | Filtered Carbonac | Ammonia N [mgN/ | Nitrite N [mgN/L] | Nitrate N [mgN/L] | Total P [mgP/L] | Soluble PO4-P [mg | Volatile fatty acids | Fixed stored polyP | Ammonia oxidizing | Anaerobic ammoni | Endogenous pro | Methanogens - a | Methanogens - h | Methylotrophs [mg | Nitrite oxidizing biom | Ordinary heterotrophi | Polyphosphate a | Propionic acetoge | Total solids mass [l | Methanol [mgCOD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | en [mgN/L] | | [mg/L] | solids [mgTSS/L] | edsolids [mgVSS/L] | eousBOD [mg/L] | L] | | | | P/L] | [mg/L] | [mgP/L] | biomass (AOB) [mgCOD/L] | aoxidizers (AAO) [mgCOD/L] | ducts [mgCOD/L] | cetoclastic [mgCOD/L] | ydrogenotrophic [mgCOD/L] | COD/L] | ass (NOB) [mgCOD/L] | corganisms (OHO) [mgCOD/L] | ccumulating organisms (PAO) [mgCOD/L] | ns [mgCOD/L] | b] | /L] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PE | 416.48 | 54.01 | 12.46 | 0 | 102.12 | 90.65 | 134.05 | 43.75 | 0 | 0 | 8.12 | 5.60 | 21.03 | 0 | 0.04 | 0.04 | 0 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | ----- | 0 |
| SecondaryPS | 449.80 | 63.69 | 12.82 | 0 | 112.41 | 97.14 | 146.94 | 52.96 | 0 | 0 | 14.10 | 11.26 | 22.12 | 0 | 0.04 | 0.04 | 0.00 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.04 | 0.04 | 37.81 | 0 |
| Ana1 | 2857.18 | 219.94 | 18.91 | 0 | 2191.00 | 1776.45 | 81.90 | 51.04 | 0 | 0.00 | 133.14 | 35.51 | 98.43 | 31.66 | 3.18 | 0.42 | 231.76 | 0.20 | 0.10 | 0.40 | 0.68 | 1511.43 | 458.54 | 0.22 | 9142.37 | 0 |
| Aer1 | 2756.86 | 219.31 | 18.91 | 2.50 | 2248.99 | 1808.83 | 5.49 | 45.36 | 0.22 | 0.02 | 132.85 | 27.18 | 2.63 | 32.66 | 3.24 | 0.42 | 235.30 | 0.20 | 0.09 | 0.40 | 0.68 | 1584.09 | 470.09 | 0.21 | 15953.45 | 0 |
| A | 2 | 2 | 1 | 2. | 2 | 1 | 1. | 4 | 0. | 0. | 1 | 0. | 0. | 3 | 3. | 0. | 2 | 0. | 0. | 0. | 0. | 1 | 4 | 0. | 3 | 0 |

| | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| er2 | 663.34 | 17.85 | 8.91 | 00 | 306.70 | 784.11 | 33 | 2.29 | 94 | 10 | 32.13 | 28 | 03 | 3.82 | 37 | 41 | 43.77 | 18 | 07 | 40 | 69 | 613.62 | 88.94 | 20 | 8500.63 | |
| Secondary Effluent | 32.36 | 44.15 | 12.57 | 1.80 | 3.61 | 2.69 | 1.13 | 41.74 | 0.95 | 0.11 | 0.46 | 0.22 | 0.02 | 0.05 | 0.01 | 0.00 | 0.39 | 0.00 | 0.00 | 0.00 | 0.00 | 2.49 | 0.76 | 0.00 | ----- | 0 |
| Clarifier | 32.36 | 44.15 | 12.57 | 1.80 | 3.61 | 2.69 | 1.13 | 41.74 | 0.95 | 0.11 | 0.46 | 0.22 | 0.02 | 0.05 | 0.01 | 0.00 | 0.39 | 0.00 | 0.00 | 0.00 | 0.00 | 2.49 | 0.76 | 0.00 | 11297.25 | 0 |
| Clarifier (U) | 7865.92 | 561.18 | 6.33 | 0.00 | 6858.73 | 5307.52 | 0.35 | 43.50 | 0.00 | 0.00 | 392.88 | 1.85 | 0.30 | 100.75 | 10.03 | 1.23 | 730.83 | 0.54 | 0.22 | 1.18 | 2.06 | 4793.47 | 1457.70 | 0.60 | ----- | 0 |
| RAS/WAS | 7860.31 | 561.05 | 5.96 | 0 | 6850.04 | 5303.12 | 0.20 | 43.79 | 0.00 | 0.00 | 392.64 | 2.92 | 0.20 | 100.66 | 10.02 | 1.23 | 732.20 | 0.54 | 0.22 | 1.18 | 2.06 | 4786.37 | 1456.78 | 0.60 | ----- | 0 |
| RAS/WAS (U) | 7860.31 | 561.05 | 0.37 | 0 | 6850.04 | 5303.12 | 0.20 | 43.79 | 0.00 | 0.00 | 392.64 | 2.92 | 0.20 | 100.66 | 10.02 | 1.23 | 732.20 | 0.54 | 0.22 | 1.18 | 2.06 | 4786.37 | 1456.78 | 0.60 | ----- | 0 |

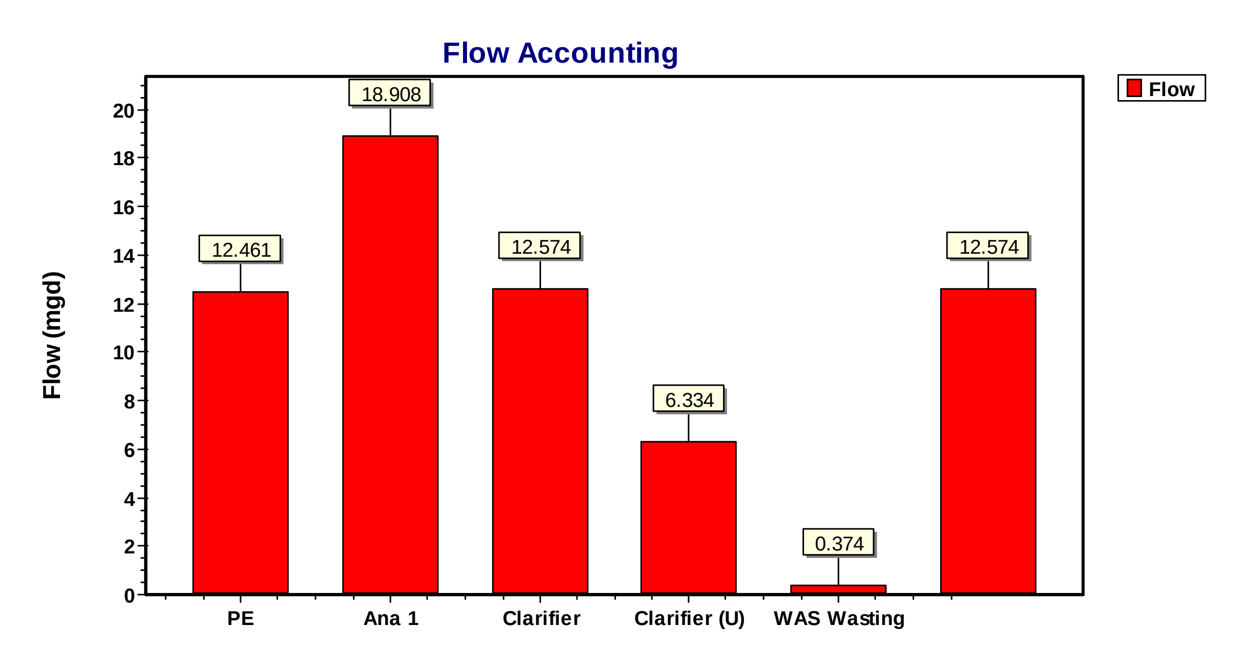
## Album page - Output Table 1

| Elements | Flow [mgd] | Liquid volume [Mil. Gal] | Temperature [deg. C] | pH [] | Total suspended solids [mg TSS/L] | Volatile suspended solids [mg VSS/L] | Total COD [mg/L] | Filtered COD [mg/L] | Volatile fatty acids [mg/L] | Total Carbonaceous BOD [mg/L] | Readily bio. COD (complex) [mg COD/L] | Slowly bio. COD (colloid.) [mg COD/L] | Slowly bio. COD (part.) [mg COD/L] | Sol. inert COD [mg COD/L] | Total Kjeldahl Nitrogen [mg N/L] | Ammonia N [mg N/L] | Nitrite N [mg N/L] | Nitrate N [mg N/L] | Total inorganic N [mg N/L] | Total N [mg N/L] | Total P [mg P/L] | Soluble PO4-P [mg P/L] | Air flowrate [ft3/min (20 C, 1 atm)] | Polyphosphate accumulating organisms (PAO) [mg COD/L] | Ammonia oxidizing biomass (AOB) [mg COD/L] | Nitrite oxidizing biomass (NOB) [mg COD/L] | Ordinary heterotrophic organisms (OHO) [mg COD/L] | Methanol [mg COD/L] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PE | 12.46 | 0 | 14.00 | 7.95 | 102.12 | 90.65 | 416.48 | 217.24 | 21.03 | 237.17 | 106.41 | 61.48 | 194.69 | 28.32 | 54.01 | 43.75 | 0 | 0 | 43.75 | 54.01 | 8.12 | 5.60 | ----- | 0.04 | 0.04 | 0.04 | 0.04 | 0 |
| Secondary PS | 12.82 | 0.04 | 14.00 | 7.95 | 112.41 | 97.14 | 449.80 | 236.31 | 22.12 | 253.85 | 121.80 | 63.20 | 201.85 | 29.19 | 63.69 | 52.96 | 0 | 0 | 52.96 | 63.69 | 14.10 | 11.26 | 0 | 0.04 | 0.04 | 0.04 | 0.05 | 0 |
| An | 18. | 0.5 | 14. | 6.8 | 21 | 17 | 28 | 16 | 98. | 13 | 7.0 | 6.9 | 26 | 28. | 21 | 51. | 0 | 0.0 | 51. | 21 | 13 | 35. | 0 | 45 | 3.1 | 0.6 | 15 | 0 |

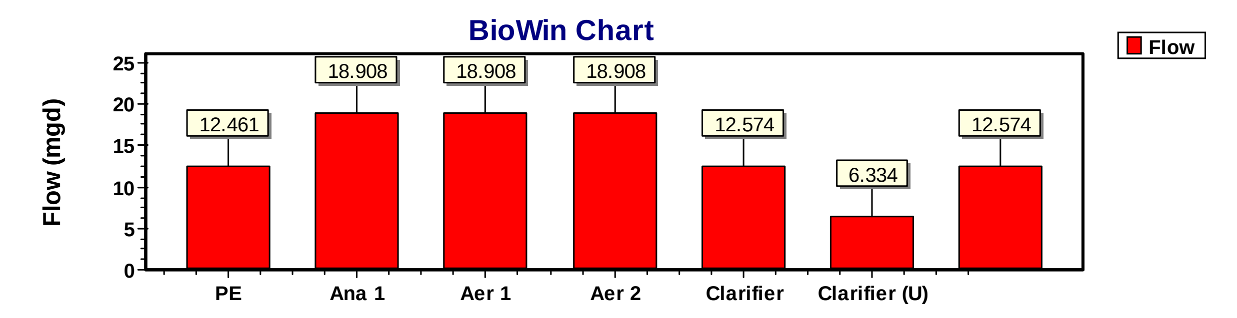
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a1 | 91 | 0 | 00 | 6 | 91.00 | 76.45 | 57.18 | 1.25 | 43 | 94.10 | 7 | 5 | 9.57 | 53 | 9.94 | 04 | | 0 | 04 | 9.94 | 3.14 | 51 | | 8.54 | 8 | 8 | 11.43 | |
| Aer1 | 18.91 | 0.85 | 14.00 | 7.08 | 2248.99 | 1808.83 | 2756.86 | 37.91 | 2.63 | 1330.76 | 4.40 | 0.65 | 205.75 | 28.55 | 219.31 | 45.36 | 0.22 | 0.02 | 45.60 | 219.55 | 132.85 | 27.18 | 4957.27 | 470.09 | 3.24 | 0.68 | 1584.09 | 0 |
| Aer2 | 18.91 | 2.00 | 14.00 | 7.09 | 2306.70 | 1784.11 | 2663.34 | 30.05 | 0.03 | 1278.84 | 1.84 | 0.02 | 105.41 | 28.04 | 217.85 | 42.29 | 0.94 | 0.10 | 43.33 | 218.89 | 132.13 | 0.28 | 4158.08 | 488.94 | 3.37 | 0.69 | 1613.62 | 0 |
| Clarifier | 12.57 | 2.80 | 14.00 | 7.09 | 3.61 | 2.69 | 32.36 | 28.45 | 0.02 | 3.02 | 1.56 | 0.02 | 0.07 | 26.72 | 44.15 | 41.74 | 0.95 | 0.11 | 42.79 | 45.21 | 0.46 | 0.22 | ----- | 0.76 | 0.01 | 0.00 | 2.49 | 0 |
| Clarifier (U) | 6.33 | 2.80 | 14.00 | 7.09 | 6858.73 | 5307.52 | 7865.92 | 33.28 | 0.30 | 3797.16 | 0.18 | 0.00 | 309.77 | 27.92 | 561.18 | 43.50 | 0.00 | 0.00 | 43.50 | 561.19 | 392.88 | 1.85 | ----- | 1457.70 | 10.03 | 2.06 | 4793.47 | 0 |
| Secondary Effluent | 12.57 | 0 | 14.00 | 7.09 | 3.61 | 2.69 | 32.36 | 28.45 | 0.02 | 3.02 | 1.56 | 0.02 | 0.07 | 26.72 | 44.15 | 41.74 | 0.95 | 0.11 | 42.79 | 45.21 | 0.46 | 0.22 | ----- | 0.76 | 0.01 | 0.00 | 2.49 | 0 |
| RAS Denit Basin | 6.33 | 0.07 | 14.00 | 7.11 | 6850.04 | 5303.12 | 7860.31 | 33.67 | 0.20 | 3793.04 | 0.08 | 0.00 | 310.02 | 27.86 | 561.05 | 43.79 | 0.00 | 0.00 | 43.79 | 561.05 | 392.64 | 2.92 | 0 | 1456.78 | 10.02 | 2.06 | 4786.37 | 0 |
| RAS/W | 5.96 | 0 | 14.00 | 7.11 | 6850.0 | 5303.1 | 7860.3 | 33.67 | 0.20 | 3793.0 | 0.08 | 0.00 | 310.0 | 27.86 | 561.0 | 43.79 | 0.00 | 0.00 | 43.79 | 561.0 | 392.6 | 2.92 | ----- | 1456.7 | 10.02 | 2.06 | 4786.3 | 0 |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AS | | | | | 4 | 2 | 1 | | | 4 | | | 2 | | 5 | | | | | 5 | 4 | | | 8 | | | 7 | |
| RAS/WAS(U) | 0.37 | 0 | 14.00 | 7.11 | 6850.04 | 5303.12 | 7860.31 | 33.67 | 0.20 | 3793.04 | 0.08 | 0.00 | 310.02 | 27.86 | 561.05 | 43.79 | 0.00 | 0.00 | 43.79 | 561.05 | 392.64 | 2.92 | ----- | 1456.78 | 10.02 | 2.06 | 4786.37 | 0 |
| WAS Wasting | 0.37 | 0 | 14.00 | 7.11 | 6850.04 | 5303.12 | 7860.31 | 33.67 | 0.20 | 3793.04 | 0.08 | 0.00 | 310.02 | 27.86 | 561.05 | 43.79 | 0.00 | 0.00 | 43.79 | 561.05 | 392.64 | 2.92 | ----- | 1456.78 | 10.02 | 2.06 | 4786.37 | 0 |

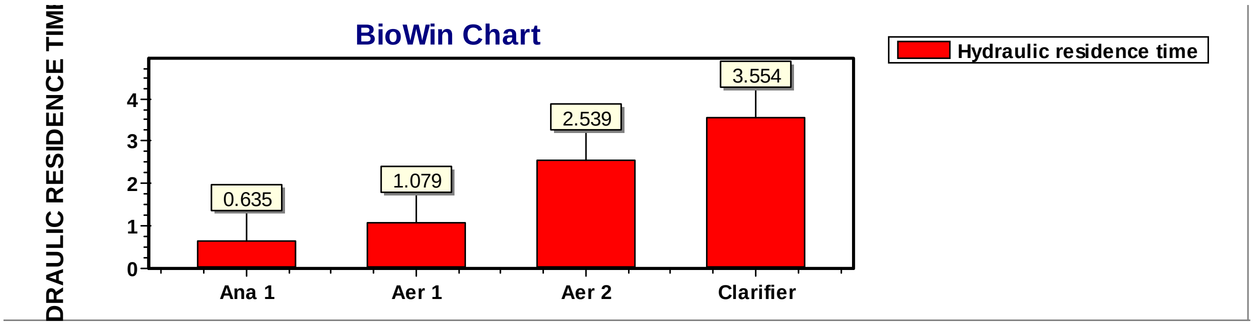
## Album page - SS Flow Accounting



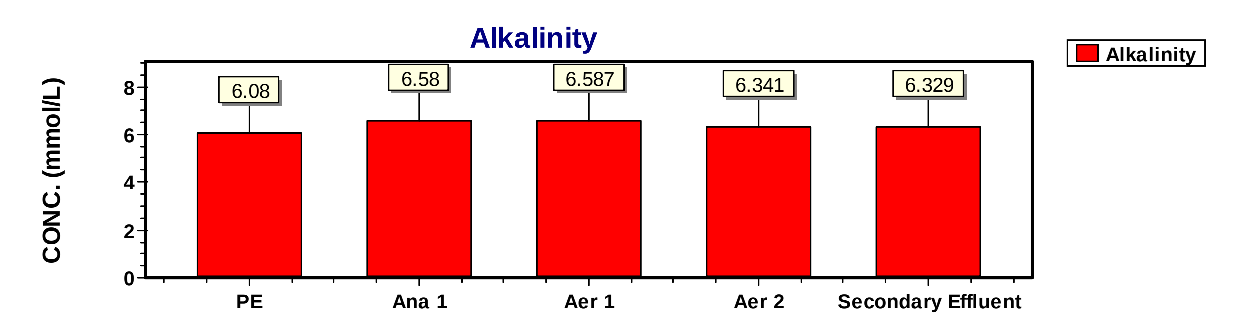

## Album page - SS Flow and HRT



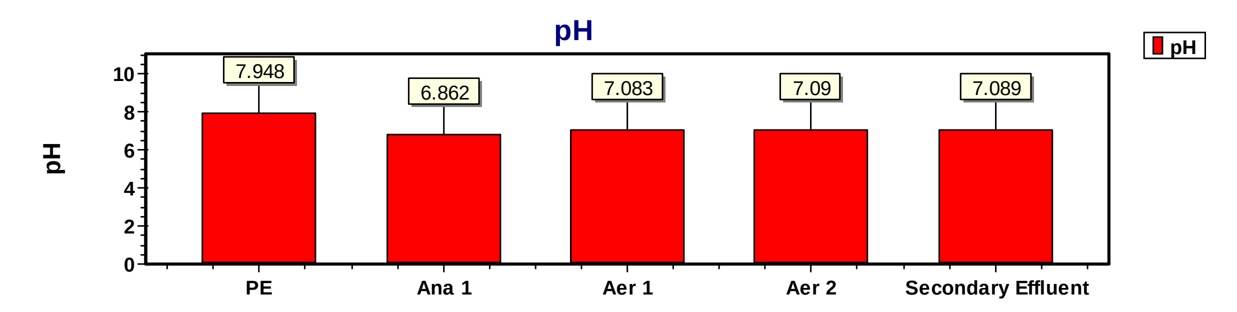

Album page - SS Flow and HRT



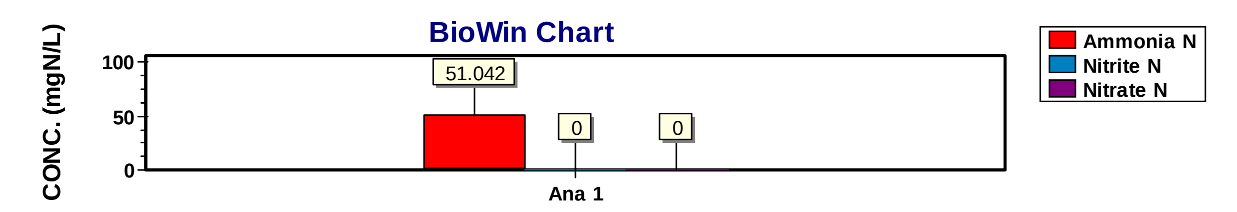

Album page - SS pH-Alkalinity



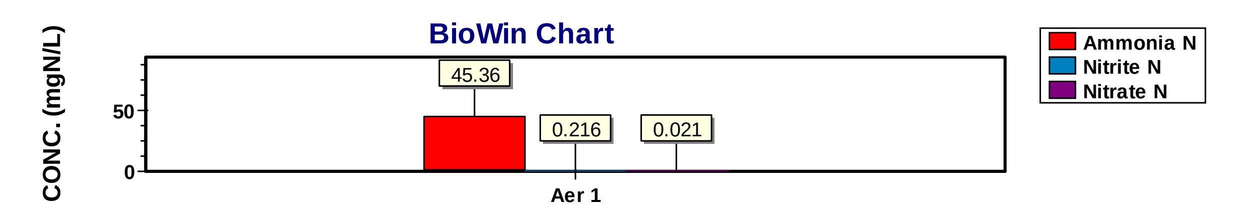

Album page - SS pH-Alkalinity



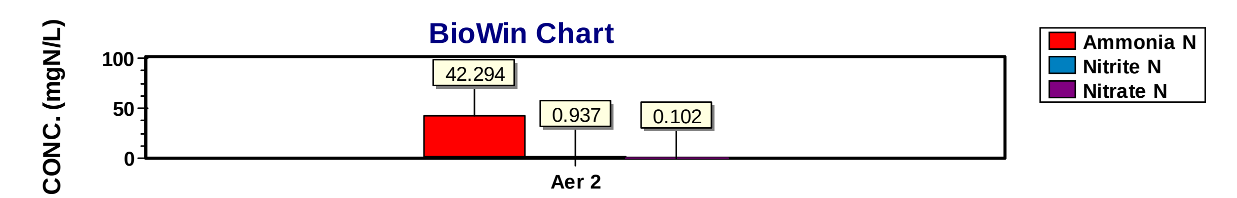

Album page - SS NH3-NO2-NO3



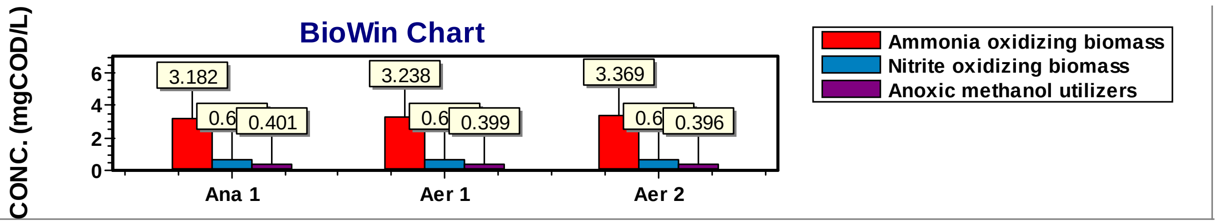

Album page - SS NH3-NO2-NO3



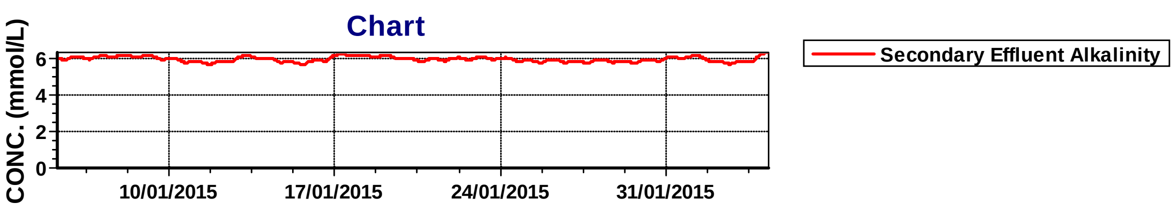

Album page - SS NH3-NO2-NO3



Album page - SS AOB-NOB

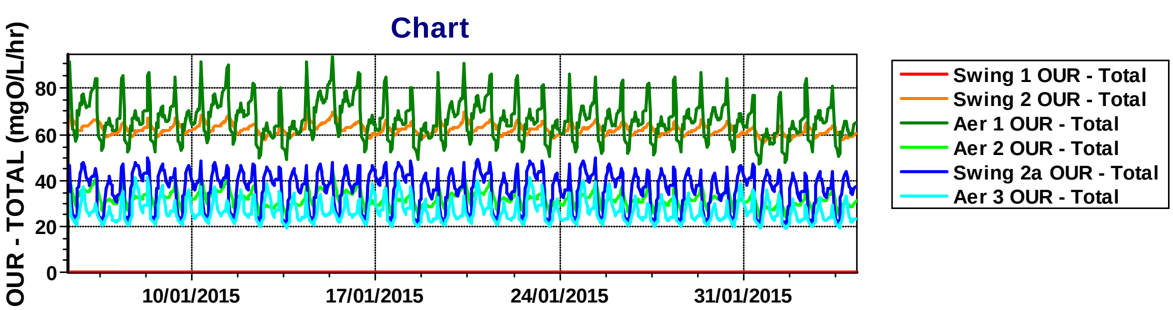



Album page - SS AOB-NOB

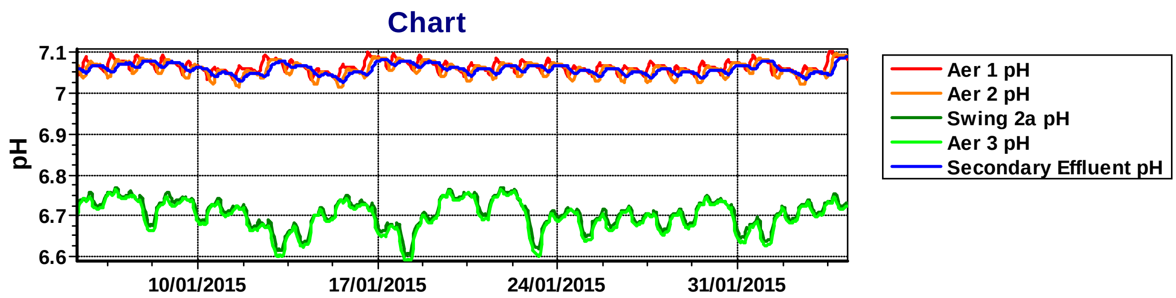



Album page - SS AOB-NOB

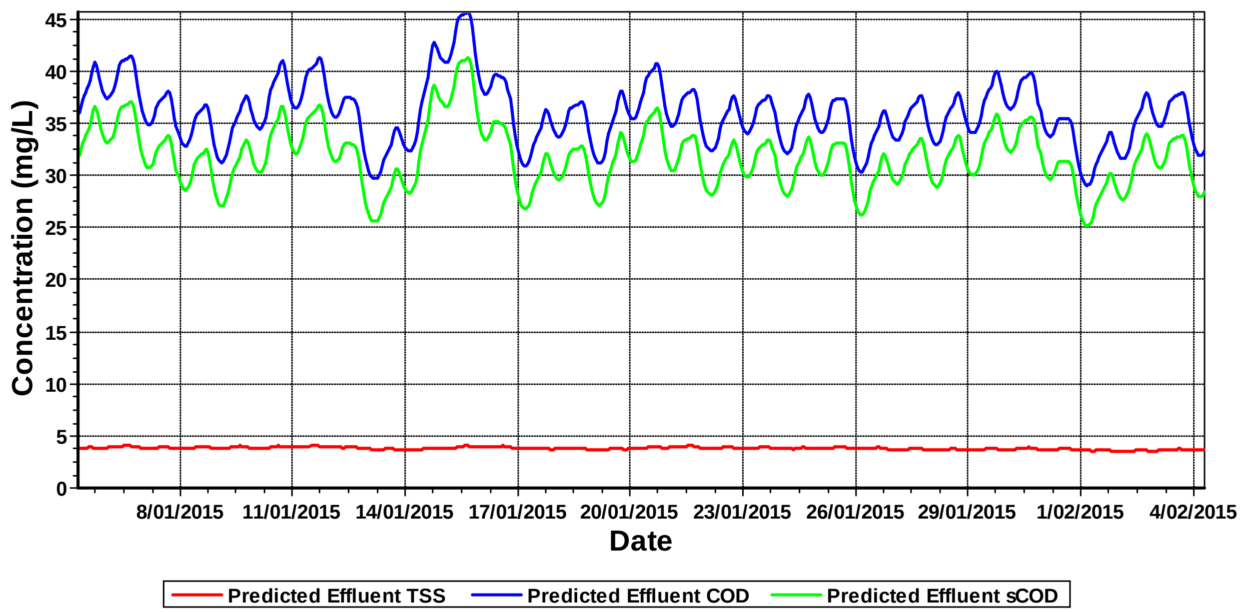
Album page - OURs



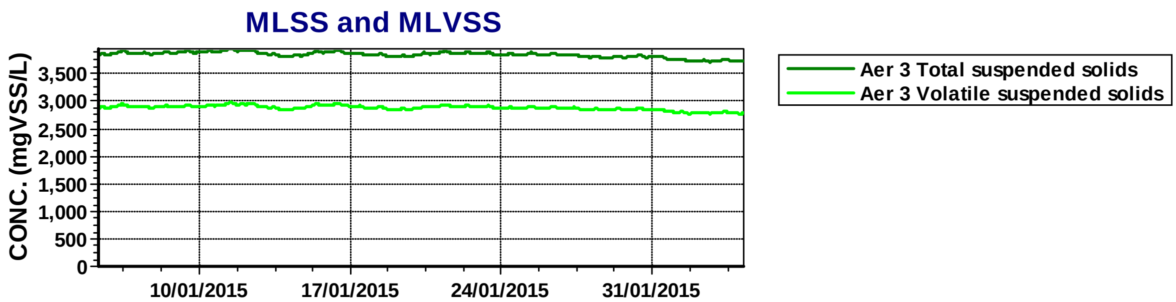

Album page - OURs



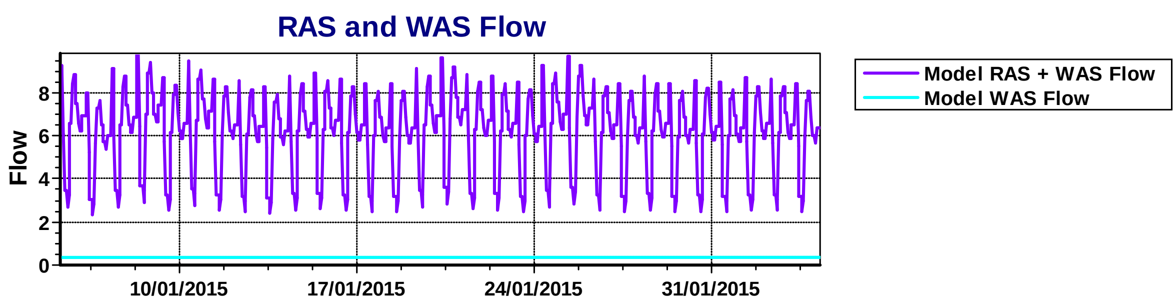

Album page - TSS, COD, BOD



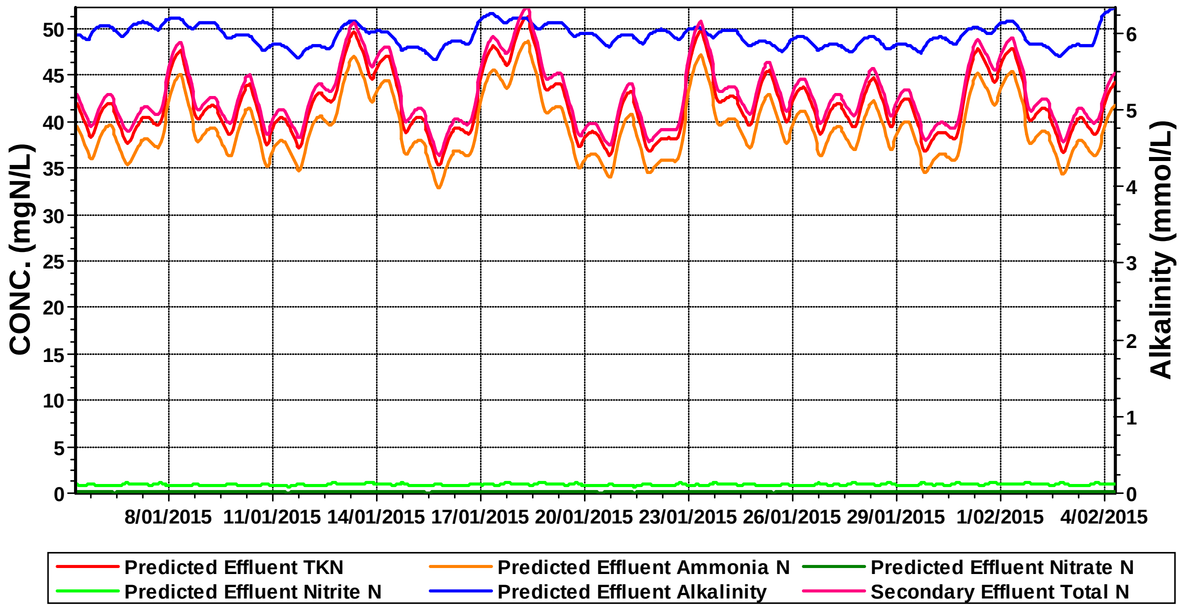

Album page - Mixed Liquor, RAS Flow



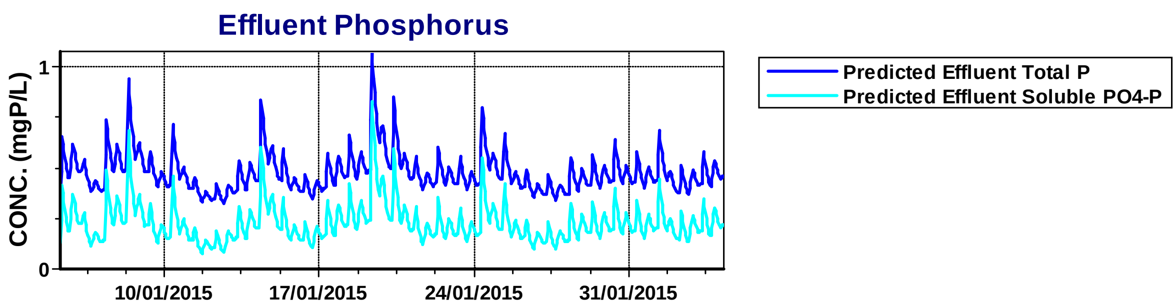

Album page - Mixed Liquor, RAS Flow



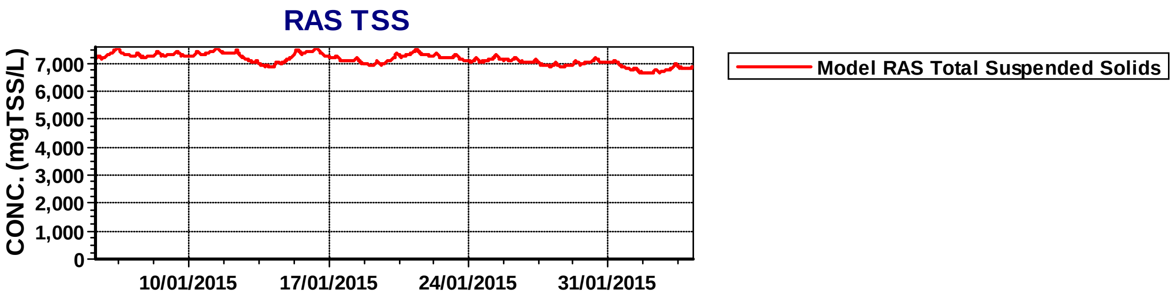

Album page - Nitrogen Sp., Alkalinity



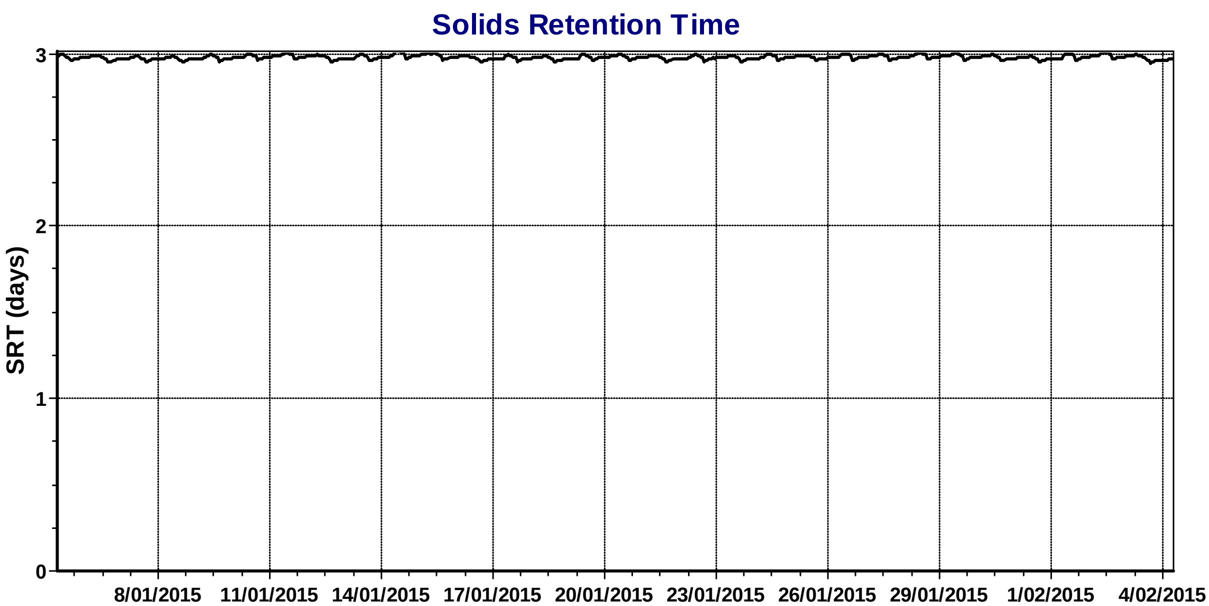

Album page - TP, RAS TSS



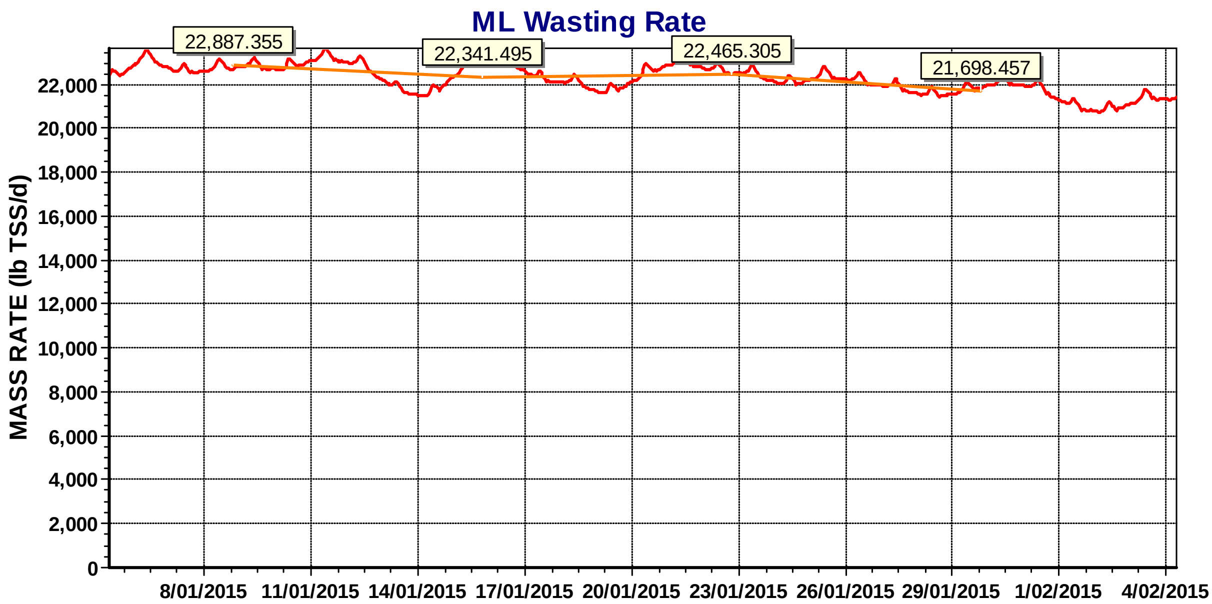

Album page - TP, RAS TSS



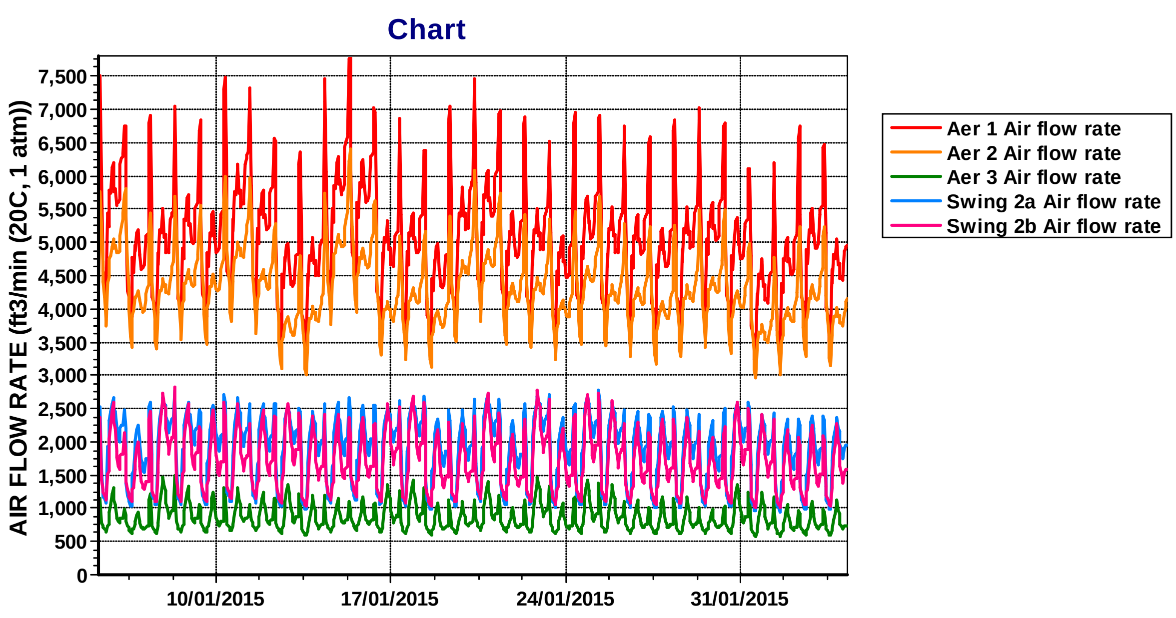

Album page - SRT




Album page - WAS Mass



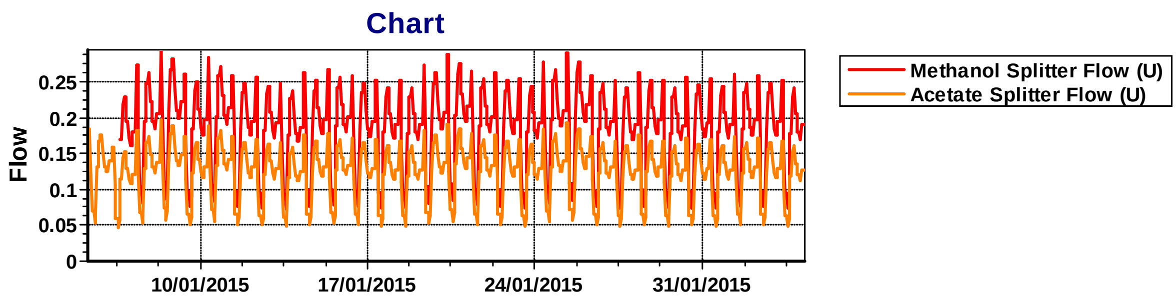

Album page - Air Flow Rate




Album page - Page 16

| Elements | Air flow rate [ft3/min (20C, 1 atm)] | Flow [mgd] |
|---|---|---|
| Acetate Splitter (U) | ---- | 0.12 |
| Aer 1 | 4957.27 | 18.91 |
| Aer 2 | 4158.08 | 18.91 |

## Album page - Page 16




## Global Parameters

## Common

| Name | Default | Value | |
|---|---|---|---|
| Hydrolysis rate [1/d] | 2.1000 | 2.1000 | 1.0290 |
| Hydrolysis half sat. [-] | 0.0600 | 0.0600 | 1.0000 |
| Anoxic hydrolysis factor [-] | 0.2800 | 0.2800 | 1.0000 |
| Anaerobic hydrolysis factor (AS) [-] | 0.0400 | 0.0400 | 1.0000 |
| Anaerobic hydrolysis factor (AD) [-] | 0.5000 | 0.5000 | 1.0000 |
| Adsorption rate of colloids [L/(mgCOD d)] | 0.1500 | 0.1500 | 1.0290 |
| Ammonification rate [L/(mgN d)] | 0.0400 | 0.0400 | 1.0290 |

| | | | |
|---|---|---|---|
| Assimilative nitrate/nitrite reduction rate [1/d] | 0.5000 | 0.5000 | 1.0000 |
| Endogenous products decay rate [1/d] | 0 | 0 | 1.0000 |

## AOB

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.9000 | 0.9000 | 1.0720 |
| Substrate (NH4) half sat. [mgN/L] | 0.7000 | 0.7000 | 1.0000 |
| Byproduct NH4 logistic slope [-] | 50.0000 | 50.0000 | 1.0000 |
| Byproduct NH4 inflection point [mgN/L] | 1.4000 | 1.4000 | 1.0000 |
| AOB denite DO half sat. [mg/L] | 0.1000 | 0.1000 | 1.0000 |
| AOB denite HNO2 half sat. [mgN/L] | 5.000E-6 | 5.000E-6 | 1.0000 |
| Aerobic decay rate [1/d] | 0.1700 | 0.1700 | 1.0290 |
| Anoxic/anaerobic decay rate [1/d] | 0.0800 | 0.0800 | 1.0290 |
| KiHNO2 [mmol/L] | 0.0050 | 0.0050 | 1.0000 |

## NOB

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.7000 | 0.7000 | 1.0600 |
| Substrate (NO2) half sat. [mgN/L] | 0.1000 | 0.1000 | 1.0000 |
| Aerobic decay rate [1/d] | 0.1700 | 0.1700 | 1.0290 |
| Anoxic/anaerobic decay rate [1/d] | 0.0800 | 0.0800 | 1.0290 |
| KiNH3 [mmol/L] | 0.0750 | 0.0750 | 1.0000 |

## AAO

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.2000 | 0.2000 | 1.1000 |
| Substrate (NH4) half sat. [mgN/L] | 2.0000 | 2.0000 | 1.0000 |
| Substrate (NO2) half sat. [mgN/L] | 1.0000 | 1.0000 | 1.0000 |
| Aerobic decay rate [1/d] | 0.0190 | 0.0190 | 1.0290 |
| Anoxic/anaerobic decay rate [1/d] | 0.0095 | 0.0095 | 1.0290 |
| Ki Nitrite [mgN/L] | 1000.0000 | 1000.0000 | 1.0000 |
| Nitrite sensitivity constant [L / (d mgN) ] | 0.0160 | 0.0160 | 1.0000 |

## OHO

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 3.2000 | 3.2000 | 1.0290 |
| Substrate half sat. [mgCOD/L] | 5.0000 | 5.0000 | 1.0000 |
| Anoxic growth factor [-] | 0.5000 | 0.5000 | 1.0000 |
| Denite N2 producers (NO3 or NO2) [-] | 0.5000 | 0.5000 | 1.0000 |
| Aerobic decay rate [1/d] | 0.6200 | 0.6200 | 1.0290 |
| Anoxic decay rate [1/d] | 0.2330 | 0.2330 | 1.0290 |
| Anaerobic decay rate [1/d] | 0.1310 | 0.1310 | 1.0290 |
| Fermentation rate [1/d] | 1.6000 | 1.6000 | 1.0290 |
| Fermentation half sat. [mgCOD/L] | 5.0000 | 5.0000 | 1.0000 |
| Fermentation growth factor (AS) [-] | 0.2500 | 0.2500 | 1.0000 |
| Free nitrous acid inhibition [mmol/L] | 1.000E-7 | 1.000E-7 | 1.0000 |

## Methylotrophs

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 1.3000 | 1.3000 | 1.0720 |
| Methanol half sat. [mgCOD/L] | 0.5000 | 0.5000 | 1.0000 |
| Denite N2 producers (NO3 or NO2) [-] | 0.5000 | 0.5000 | 1.0000 |
| Aerobic decay rate [1/d] | 0.0400 | 0.0400 | 1.0290 |
| Anoxic/anaerobic decay rate [1/d] | 0.0300 | 0.0300 | 1.0290 |
| Free nitrous acid inhibition [mmol/L] | 1.000E-7 | 1.000E-7 | 1.0000 |

## PAO

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.9500 | 0.9500 | 1.0000 |
| Max. spec. growth rate, P-limited [1/d] | 0.4200 | 0.4200 | 1.0000 |
| Substrate half sat. [mgCOD(PHB)/mgCOD(Zbp)] | 0.1000 | 0.1000 | 1.0000 |
| Substrate half sat., P-limited [mgCOD(PHB)/mgCOD(Zbp)] | 0.0500 | 0.0500 | 1.0000 |
| Magnesium half sat. [mgMg/L] | 0.1000 | 0.1000 | 1.0000 |
| Cation half sat. [mmol/L] | 0.1000 | 0.1000 | 1.0000 |
| Calcium half sat. [mgCa/L] | 0.1000 | 0.1000 | 1.0000 |
| Aerobic/anoxic decay rate [1/d] | 0.1000 | 0.1000 | 1.0000 |
| Aerobic/anoxic maintenance rate [1/d] | 0 | 0 | 1.0000 |
| Anaerobic decay rate [1/d] | 0.0400 | 0.0400 | 1.0000 |
| Anaerobic maintenance rate [1/d] | 0 | 0 | 1.0000 |
| Sequestration rate [1/d] | 4.5000 | 4.5000 | 1.0000 |
| Anoxic growth factor [-] | 0.3300 | 0.3300 | 1.0000 |

## Acetogens

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.2500 | 0.2500 | 1.0290 |
| Substrate half sat. [mgCOD/L] | 10.0000 | 10.0000 | 1.0000 |
| Acetate inhibition [mgCOD/L] | 10000.0000 | 10000.0000 | 1.0000 |
| Anaerobic decay rate [1/d] | 0.0500 | 0.0500 | 1.0290 |
| Aerobic/anoxic decay rate [1/d] | 0.5200 | 0.5200 | 1.0290 |

## Methanogens

| Name | Default | Value | |
|---|---|---|---|
| Acetoclastic max. spec. growth rate [1/d] | 0.3000 | 0.3000 | 1.0290 |
| H2-utilizing max. spec. growth rate [1/d] | 1.4000 | 1.4000 | 1.0290 |
| Acetoclastic substrate half sat. [mgCOD/L] | 100.0000 | 100.0000 | 1.0000 |
| Acetoclastic methanol half sat. [mgCOD/L] | 0.5000 | 0.5000 | 1.0000 |
| H2-utilizing CO2 half sat. [mmol/L] | 0.1000 | 0.1000 | 1.0000 |
| H2-utilizing substrate half sat. [mgCOD/L] | 0.1000 | 0.1000 | 1.0000 |
| H2-utilizing methanol half sat. [mgCOD/L] | 0.5000 | 0.5000 | 1.0000 |
| Acetoclastic propionic inhibition [mgCOD/L] | 10000.0000 | 10000.0000 | 1.0000 |
| Acetoclastic anaerobic decay rate [1/d] | 0.1300 | 0.1300 | 1.0290 |
| Acetoclastic aerobic/anoxic decay rate [1/d] | 0.6000 | 0.6000 | 1.0290 |
| H2-utilizing anaerobic decay rate [1/d] | 0.1300 | 0.1300 | 1.0290 |
| H2-utilizing aerobic/anoxic decay rate [1/d] | 2.8000 | 2.8000 | 1.0290 |

## pH

| Name | Default | Value |
|---|---|---|
| OHO low pH limit [-] | 4.0000 | 4.0000 |

| | | |
|---|---|---|
| OHO high pH limit [-] | 10.0000 | 10.0000 |
| Methylotrophs low pH limit [-] | 4.0000 | 4.0000 |
| Methylotrophs high pH limit [-] | 10.0000 | 10.0000 |
| Autotrophs low pH limit [-] | 5.5000 | 5.5000 |
| Autotrophs high pH limit [-] | 9.5000 | 9.5000 |
| PAO low pH limit [-] | 4.0000 | 4.0000 |
| PAO high pH limit [-] | 10.0000 | 10.0000 |
| OHO low pH limit (anaerobic) [-] | 5.5000 | 5.5000 |
| OHO high pH limit (anaerobic) [-] | 8.5000 | 8.5000 |
| Propionic acetogens low pH limit [-] | 4.0000 | 4.0000 |
| Propionic acetogens high pH limit [-] | 10.0000 | 10.0000 |
| Acetoclastic methanogens low pH limit [-] | 5.0000 | 5.0000 |
| Acetoclastic methanogens high pH limit [-] | 9.0000 | 9.0000 |
| H2-utilizing methanogens low pH limit [-] | 5.0000 | 5.0000 |
| H2-utilizing methanogens high pH limit [-] | 9.0000 | 9.0000 |

## Switches

| Name | Default | Value |
|---|---|---|
| Aerobic/anoxic DO half sat. [mgO2/L] | 0.0500 | 0.0500 |
| Anoxic/anaerobic NOx half sat. [mgN/L] | 0.1500 | 0.1500 |
| AOB DO half sat. [mgO2/L] | 0.2500 | 0.2500 |
| NOB DO half sat. [mgO2/L] | 0.5000 | 0.5000 |
| AAO DO half sat. [mgO2/L] | 0.0100 | 0.0100 |
| Anoxic NO3(->NO2) half sat. [mgN/L] | 0.1000 | 0.1000 |
| Anoxic NO3(->N2) half sat. [mgN/L] | 0.0500 | 0.0500 |
| Anoxic NO2(->N2) half sat. (mgN/L) | 0.0100 | 0.0100 |
| NH3 nutrient half sat. [mgN/L] | 0.0050 | 0.0050 |
| PolyP half sat. [mgP/mgCOD] | 0.0100 | 0.0100 |

| | | |
|---|---|---|
| VFA sequestration half sat. [mgCOD/L] | 5.0000 | 5.0000 |
| P uptake half sat. [mgP/L] | 0.1500 | 0.1500 |
| P nutrient half sat. [mgP/L] | 0.0010 | 0.0010 |
| Autotroph CO2 half sat. [mmol/L] | 0.1000 | 0.1000 |
| H2 low/high half sat. [mgCOD/L] | 1.0000 | 1.0000 |
| Propionic acetogens H2 inhibition [mgCOD/L] | 5.0000 | 5.0000 |
| Synthesis anion/cation half sat. [meq/L] | 0.0100 | 0.0100 |

## Common

| Name | Default | Value |
|---|---|---|
| Biomass volatile fraction (VSS/TSS) | 0.9200 | 0.9200 |
| Endogenous residue volatile fraction (VSS/TSS) | 0.9200 | 0.9200 |
| N in endogenous residue [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in endogenous residue [mgP/mgCOD] | 0.0220 | 0.0220 |
| Endogenous residue COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| Particulate substrate COD:VSS ratio [mgCOD/mgVSS] | 1.6000 | 2.2000 |
| Particulate inert COD:VSS ratio [mgCOD/mgVSS] | 1.6000 | 2.2000 |

## AOB

| Name | Default | Value |
|---|---|---|
| Yield [mgCOD/mgN] | 0.1500 | 0.1500 |
| AOB denite NO2 fraction as TEA [-] | 0.5000 | 0.5000 |
| Byproduct NH4 fraction to N2O [-] | 0.0025 | 0.0025 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |

| | | |
|---|---|---|
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## NOB

| Name | Default | Value |
|---|---|---|
| Yield [mgCOD/mgN] | 0.0900 | 0.0900 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## AAO

| Name | Default | Value |
|---|---|---|
| Yield [mgCOD/mgN] | 0.1140 | 0.1140 |
| Nitrate production [mgN/mgBiomassCOD] | 2.2800 | 2.2800 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## OHO

| Name | Default | Value |
|---|---|---|

| | | |
|---|---|---|
| Yield (aerobic) [-] | 0.6660 | 0.6660 |
| Yield (fermentation, low H2) [-] | 0.1000 | 0.1000 |
| Yield (fermentation, high H2) [-] | 0.1000 | 0.1000 |
| H2 yield (fermentation low H2) [-] | 0.3500 | 0.3500 |
| H2 yield (fermentation high H2) [-] | 0 | 0 |
| Propionate yield (fermentation, low H2) [-] | 0 | 0 |
| Propionate yield (fermentation, high H2) [-] | 0.7000 | 0.7000 |
| CO2 yield (fermentation, low H2) [-] | 0.7000 | 0.7000 |
| CO2 yield (fermentation, high H2) [-] | 0 | 0 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Endogenous fraction - aerobic [-] | 0.0800 | 0.0800 |
| Endogenous fraction - anoxic [-] | 0.1030 | 0.1030 |
| Endogenous fraction - anaerobic [-] | 0.1840 | 0.1840 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| Yield (anoxic) [-] | 0.5400 | 0.5400 |
| Yield propionic (aerobic) [-] | 0.6400 | 0.6400 |
| Yield propionic (anoxic) [-] | 0.4600 | 0.4600 |
| Yield acetic (aerobic) [-] | 0.6000 | 0.6000 |
| Yield acetic (anoxic) [-] | 0.4300 | 0.4300 |
| Yield methanol (aerobic) [-] | 0.5000 | 0.5000 |
| Adsorp. max. [-] | 1.0000 | 1.0000 |
| Max fraction to N2O at high FNA over nitrate [-] | 0.0500 | 0.0500 |
| Max fraction to N2O at high FNA over nitrite [-] | 0.1000 | 0.1000 |

## Methylotrophs

| Name | Default | Value |
|---|---|---|
| Yield (anoxic) [-] | 0.4000 | 0.4000 |

| | | |
|---|---|---|
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| Max fraction to N2O at high FNA over nitrate [-] | 0.1000 | 0.1000 |
| Max fraction to N2O at high FNA over nitrite [-] | 0.1500 | 0.1500 |

## PAO

| Name | Default | Value |
|---|---|---|
| Yield (aerobic) [-] | 0.6390 | 0.6390 |
| Yield (anoxic) [-] | 0.5200 | 0.5200 |
| Aerobic P/PHA uptake [mgP/mgCOD] | 0.9300 | 0.9300 |
| Anoxic P/PHA uptake [mgP/mgCOD] | 0.3500 | 0.3500 |
| Yield of PHA on sequestration [-] | 0.8890 | 0.8890 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| N in sol. inert [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous part. [-] | 0.2500 | 0.2500 |
| Inert fraction of endogenous sol. [-] | 0.2000 | 0.2000 |
| P/Ac release ratio [mgP/mgCOD] | 0.5100 | 0.5100 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| Yield of low PP [-] | 0.9400 | 0.9400 |

## Acetogens

| Name | Default | Value |
|---|---|---|

| | | |
|---|---|---|
| Yield [-] | 0.1000 | 0.1000 |
| H2 yield [-] | 0.4000 | 0.4000 |
| CO2 yield [-] | 1.0000 | 1.0000 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## Methanogens

| Name | Default | Value |
|---|---|---|
| Acetoclastic yield [-] | 0.1000 | 0.1000 |
| Methanol acetoclastic yield [-] | 0.1000 | 0.1000 |
| H2-utilizing yield [-] | 0.1000 | 0.1000 |
| Methanol H2-utilizing yield [-] | 0.1000 | 0.1000 |
| N in acetoclastic biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| N in H2-utilizing biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in acetoclastic biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| P in H2-utilizing biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Acetoclastic fraction to endog. residue [-] | 0.0800 | 0.0800 |
| H2-utilizing fraction to endog. residue [-] | 0.0800 | 0.0800 |
| Acetoclastic COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| H2-utilizing COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## General

| Name | Default | Value |
|---|---|---|

| | | |
|---|---|---|
| Molecular weight of other anions [mg/mmol] | 35.5000 | 35.5000 |
| Molecular weight of other cations [mg/mmol] | 39.1000 | 39.1000 |
| Mg to P mole ratio in polyphosphate [mmolMg/mmolP] | 0.3000 | 0.3000 |
| Cation to P mole ratio in polyphosphate [meq/mmolP] | 0.1500 | 0.3000 |
| Ca to P mole ratio in polyphosphate [mmolCa/mmolP] | 0.0500 | 0.0500 |
| Cation to P mole ratio in organic phosphate [meq/mmolP] | 0.0100 | 0.0100 |
| Bubble rise velocity (anaerobic digester) [cm/s] | 23.9000 | 23.9000 |
| Bubble Sauter mean diameter (anaerobic digester) [cm] | 0.3500 | 0.3500 |
| Anaerobic digester gas hold-up factor [] | 1.0000 | 1.0000 |
| Tank head loss per metre of length (from flow) [m/m] | 0.0025 | 0.0025 |

## Mass transfer

| Name | Default | Value | |
|---|---|---|---|
| Kl for H2 [m/d] | 17.0000 | 17.0000 | 1.0240 |
| Kl for CO2 [m/d] | 10.0000 | 10.0000 | 1.0240 |
| Kl for NH3 [m/d] | 1.0000 | 1.0000 | 1.0240 |
| Kl for CH4 [m/d] | 8.0000 | 8.0000 | 1.0240 |
| Kl for N2 [m/d] | 15.0000 | 15.0000 | 1.0240 |
| Kl for N2O [m/d] | 8.0000 | 8.0000 | 1.0240 |
| Kl for O2 [m/d] | 13.0000 | 13.0000 | 1.0240 |

## Henry's law constants

| Name | Default | Value | |
|---|---|---|---|
| CO2 [M/atm] | 3.4000E-2 | 3.4000E-2 | 2400.0000 |
| O2 [M/atm] | 1.3000E-3 | 1.3000E-3 | 1500.0000 |

| | | | |
|---|---|---|---|
| N2 [M/atm] | 6.5000E-4 | 6.5000E-4 | 1300.0000 |
| N2O [M/atm] | 2.5000E-2 | 2.5000E-2 | 2600.0000 |
| NH3 [M/atm] | 5.8000E+1 | 5.8000E+1 | 4100.0000 |
| CH4 [M/atm] | 1.4000E-3 | 1.4000E-3 | 1600.0000 |
| H2 [M/atm] | 7.8000E-4 | 7.8000E-4 | 500.0000 |

## Physico-chemical rates

| Name | Default | Value | |
|---|---|---|---|
| Struvite precipitation rate [1/d] | 3.000E+10 | 3.000E+10 | 1.0240 |
| Struvite redissolution rate [1/d] | 3.000E+11 | 3.000E+11 | 1.0240 |
| Struvite half sat. [mgTSS/L] | 1.0000 | 1.0000 | 1.0000 |
| HDP precipitation rate [L/(molP d)] | 1.000E+8 | 1.000E+8 | 1.0000 |
| HDP redissolution rate [L/(mol P d)] | 1.000E+8 | 1.000E+8 | 1.0000 |
| HAP precipitation rate [molHDP/(L d)] | 5.000E-4 | 5.000E-4 | 1.0000 |

## Physico-chemical constants

| Name | Default | Value |
|---|---|---|
| Struvite solubility constant [mol/L] | 6.918E-14 | 6.918E-14 |
| HDP solubility product [mol/L] | 2.750E-22 | 2.750E-22 |
| HDP half sat. [mgTSS/L] | 1.0000 | 1.0000 |
| Equilibrium soluble PO4 with Al dosing at pH 7 [mgP/L] | 0.0100 | 0.0100 |
| Al to P ratio [molAl/molP] | 0.8000 | 0.8000 |
| Al(OH)3 solubility product [mol/L] | 1.259E+9 | 1.259E+9 |
| AlHPO4+ dissociation constant [mol/L] | 7.943E-13 | 7.943E-13 |
| Equilibrium soluble PO4 with Fe dosing at pH 7 [mgP/L] | 0.0100 | 0.0100 |

| | | |
|---|---|---|
| Fe to P ratio [molFe/molP] | 1.6000 | 1.6000 |
| Fe(OH)3 solubility product [mol/L] | 0.0500 | 0.0500 |
| FeH2PO4++ dissociation constant [mol/L] | 5.012E-22 | 5.012E-22 |

## Aeration

| Name | Default | Value |
|---|---|---|
| Alpha (surf) OR Alpha F (diff) [-] | 0.5000 | 0.5000 |
| Beta [-] | 0.9500 | 0.9500 |
| Surface pressure [kPa] | 101.3250 | 101.3250 |
| Fractional effective saturation depth (Fed) [-] | 0.3250 | 0.3250 |
| Supply gas CO2 content [vol. %] | 0.0350 | 0.0350 |
| Supply gas O2 [vol. %] | 20.9500 | 20.9500 |
| Off-gas CO2 [vol. %] | 2.0000 | 2.0000 |
| Off-gas O2 [vol. %] | 18.8000 | 18.8000 |
| Off-gas H2 [vol. %] | 0 | 0 |
| Off-gas NH3 [vol. %] | 0 | 0 |
| Off-gas CH4 [vol. %] | 0 | 0 |
| Surface turbulence factor [-] | 2.0000 | 2.0000 |
| Set point controller gain [] | 1.0000 | 1.0000 |

## Modified Vesilind

| Name | Default | Value |
|---|---|---|
| Maximum Vesilind settling velocity (Vo) [ft/min] | 0.387 | 0.387 |
| Vesilind hindered zone settling parameter (K) [L/g] | 0.370 | 0.370 |
| Clarification switching function [mg/L] | 100.000 | 100.000 |

| | | |
|---|---|---|
| Specified TSS conc.for height calc. [mg/L] | 2500.000 | 2500.000 |
| Maximum compactability constant [mg/L] | 15000.000 | 15000.000 |

## Double exponential

| Name | Default | Value |
|---|---|---|
| Maximum Vesilind settling velocity (Vo) [ft/min] | 0.934 | 0.934 |
| Maximum (practical) settling velocity (Vo') [ft/min] | 0.615 | 0.615 |
| Hindered zone settling parameter (Kh) [L/g] | 0.400 | 0.400 |
| Flocculent zone settling parameter (Kf) [L/g] | 2.500 | 2.500 |
| Maximum non-settleable TSS [mg/L] | 20.0000 | 20.0000 |
| Non-settleable fraction [-] | 0.0010 | 0.0010 |
| Specified TSS conc. for height calc. [mg/L] | 2500.0000 | 2500.0000 |

## Emission factors

| Name | Default | Value |
|---|---|---|
| Carbon dioxide equivalence of nitrous oxide | 296.0000 | 296.0000 |
| Carbon dioxide equivalence of methane | 23.0000 | 23.0000 |

## Biofilm general

| Name | Default | Value | |
|---|---|---|---|
| Attachment rate [ g / (m2 d) ] | 80.0000 | 80.0000 | 1.0000 |
| Attachment TSS half sat. [mg/L] | 100.0000 | 100.0000 | 1.0000 |

| | | | |
|---|---|---|---|
| Detachment rate [g/(m3 d)] | 8.000E+4 | 8.000E+4 | 1.0000 |
| Solids movement factor [] | 10.0000 | 10.0000 | 1.0000 |
| Diffusion neta [] | 0.8000 | 0.8000 | 1.0000 |
| Thin film limit [mm] | 0.5000 | 0.5000 | 1.0000 |
| Thick film limit [mm] | 3.0000 | 3.0000 | 1.0000 |
| Assumed Film thickness for tank volume correction (temp independent) [mm] | 0.7500 | 0.7500 | 1.0000 |
| Film surface area to media area ratio - Max.[ ] | 1.0000 | 1.0000 | 1.0000 |
| Minimum biofilm conc. for streamer formation [gTSS/m2] | 4.0000 | 4.0000 | 1.0000 |

## Maximum biofilm concentrations [mg/L]

| Name | Default | Value | |
|---|---|---|---|
| Ordinary heterotrophic organisms (OHO) | 5.000E+4 | 5.000E+4 | 1.0000 |
| Methylotrophs | 5.000E+4 | 5.000E+4 | 1.0000 |
| Ammonia oxidizing biomass (AOB) | 1.000E+5 | 1.000E+5 | 1.0000 |
| Nitrite oxidizing biomass (NOB) | 1.000E+5 | 1.000E+5 | 1.0000 |
| Anaerobic ammonia oxidizers (AAO) | 5.000E+4 | 5.000E+4 | 1.0000 |
| Polyphosphate accumulating organisms (PAO) | 5.000E+4 | 5.000E+4 | 1.0000 |
| Propionic acetogens | 5.000E+4 | 5.000E+4 | 1.0000 |
| Methanogens - acetoclastic | 5.000E+4 | 5.000E+4 | 1.0000 |
| Methanogens - hydrogenotrophic | 5.000E+4 | 5.000E+4 | 1.0000 |
| Endogenous products | 3.000E+4 | 3.000E+4 | 1.0000 |
| Slowly bio. COD (part.) | 5000.0000 | 5000.0000 | 1.0000 |
| Slowly bio. COD (colloid.) | 4000.0000 | 4000.0000 | 1.0000 |
| Part. inert. COD | 5000.0000 | 5000.0000 | 1.0000 |
| Part. bio. org. N | 0 | 0 | 1.0000 |
| Part. bio. org. P | 0 | 0 | 1.0000 |
| Part. inert N | 0 | 0 | 1.0000 |
| Part. inert P | 0 | 0 | 1.0000 |

| | | | |
|---|---|---|---|
| Stored PHA | 5000.0000 | 5000.0000 | 1.0000 |
| Releasable stored polyP | 1.150E+6 | 1.150E+6 | 1.0000 |
| Fixed stored polyP | 1.150E+6 | 1.150E+6 | 1.0000 |
| Readily bio. COD (complex) | 0 | 0 | 1.0000 |
| Acetate | 0 | 0 | 1.0000 |
| Propionate | 0 | 0 | 1.0000 |
| Methanol | 0 | 0 | 1.0000 |
| Dissolved H2 | 0 | 0 | 1.0000 |
| Dissolved methane | 0 | 0 | 1.0000 |
| Ammonia N | 0 | 0 | 1.0000 |
| Sol. bio. org. N | 0 | 0 | 1.0000 |
| Nitrous Oxide N | 0 | 0 | 1.0000 |
| Nitrite N | 0 | 0 | 1.0000 |
| Nitrate N | 0 | 0 | 1.0000 |
| Dissolved nitrogen gas | 0 | 0 | 1.0000 |
| PO4-P (Sol. & Me Complexed) | 1.000E+10 | 1.000E+10 | 1.0000 |
| Sol. inert COD | 0 | 0 | 1.0000 |
| Sol. inert TKN | 0 | 0 | 1.0000 |
| ISS Influent | 1.300E+6 | 1.300E+6 | 1.0000 |
| Struvite | 8.500E+5 | 8.500E+5 | 1.0000 |
| Hydroxy-dicalcium-phosphate | 1.150E+6 | 1.150E+6 | 1.0000 |
| Hydroxy-apatite | 1.600E+6 | 1.600E+6 | 1.0000 |
| Magnesium | 0 | 0 | 1.0000 |
| Calcium | 0 | 0 | 1.0000 |
| Metal | 1.000E+10 | 1.000E+10 | 1.0000 |
| Other Cations (strong bases) | 0 | 0 | 1.0000 |
| Other Anions (strong acids) | 0 | 0 | 1.0000 |
| Total CO2 | 0 | 0 | 1.0000 |
| User defined 1 | 0 | 0 | 1.0000 |
| User defined 2 | 0 | 0 | 1.0000 |
| User defined 3 | 5.000E+4 | 5.000E+4 | 1.0000 |

| | | | |
|---|---|---|---|
| User defined 4 | 5.000E+4 | 5.000E+4 | 1.0000 |
| Dissolved oxygen | 0 | 0 | 1.0000 |

## Effective diffusivities [m2/s]

| Name | Default | Value | |
|---|---|---|---|
| Ordinary heterotrophic organisms (OHO) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Methylotrophs | 5.000E-14 | 5.000E-14 | 1.0290 |
| Ammonia oxidizing biomass (AOB) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Nitrite oxidizing biomass (NOB) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Anaerobic ammonia oxidizers (AAO) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Polyphosphate accumulating organisms (PAO) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Propionic acetogens | 5.000E-14 | 5.000E-14 | 1.0290 |
| Methanogens - acetoclastic | 5.000E-14 | 5.000E-14 | 1.0290 |
| Methanogens - hydrogenotrophic | 5.000E-14 | 5.000E-14 | 1.0290 |
| Endogenous products | 5.000E-14 | 5.000E-14 | 1.0290 |
| Slowly bio. COD (part.) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Slowly bio. COD (colloid.) | 5.000E-12 | 5.000E-12 | 1.0290 |
| Part. inert. COD | 5.000E-14 | 5.000E-14 | 1.0290 |
| Part. bio. org. N | 5.000E-14 | 5.000E-14 | 1.0290 |
| Part. bio. org. P | 5.000E-14 | 5.000E-14 | 1.0290 |
| Part. inert N | 5.000E-14 | 5.000E-14 | 1.0290 |
| Part. inert P | 5.000E-14 | 5.000E-14 | 1.0290 |
| Stored PHA | 5.000E-14 | 5.000E-14 | 1.0290 |
| Releasable stored polyP | 5.000E-14 | 5.000E-14 | 1.0290 |
| Fixed stored polyP | 5.000E-14 | 5.000E-14 | 1.0290 |
| Readily bio. COD (complex) | 6.900E-10 | 6.900E-10 | 1.0290 |
| Acetate | 1.240E-9 | 1.240E-9 | 1.0290 |
| Propionate | 8.300E-10 | 8.300E-10 | 1.0290 |

| | | | |
|---|---|---|---|
| Methanol | 1.600E-9 | 1.600E-9 | 1.0290 |
| Dissolved H2 | 5.850E-9 | 5.850E-9 | 1.0290 |
| Dissolved methane | 1.963E-9 | 1.963E-9 | 1.0290 |
| Ammonia N | 2.000E-9 | 2.000E-9 | 1.0290 |
| Sol. bio. org. N | 1.370E-9 | 1.370E-9 | 1.0290 |
| Nitrous Oxide N | 1.607E-9 | 1.607E-9 | 1.0290 |
| Nitrite N | 2.980E-9 | 2.980E-9 | 1.0290 |
| Nitrate N | 2.980E-9 | 2.980E-9 | 1.0290 |
| Dissolved nitrogen gas | 1.900E-9 | 1.900E-9 | 1.0290 |
| PO4-P (Sol. & Me Complexed) | 2.000E-9 | 2.000E-9 | 1.0290 |
| Sol. inert COD | 6.900E-10 | 6.900E-10 | 1.0290 |
| Sol. inert TKN | 6.850E-10 | 6.850E-10 | 1.0290 |
| ISS Influent | 5.000E-14 | 5.000E-14 | 1.0290 |
| Struvite | 5.000E-14 | 5.000E-14 | 1.0290 |
| Hydroxy-dicalcium-phosphate | 5.000E-14 | 5.000E-14 | 1.0290 |
| Hydroxy-apatite | 5.000E-14 | 5.000E-14 | 1.0290 |
| Magnesium | 7.200E-10 | 7.200E-10 | 1.0290 |
| Calcium | 7.200E-10 | 7.200E-10 | 1.0290 |
| Metal | 4.800E-10 | 4.800E-10 | 1.0290 |
| Other Cations (strong bases) | 1.440E-9 | 1.440E-9 | 1.0290 |
| Other Anions (strong acids) | 1.440E-9 | 1.440E-9 | 1.0290 |
| Total CO2 | 1.960E-9 | 1.960E-9 | 1.0290 |
| User defined 1 | 6.900E-10 | 6.900E-10 | 1.0290 |
| User defined 2 | 6.900E-10 | 6.900E-10 | 1.0290 |
| User defined 3 | 5.000E-14 | 5.000E-14 | 1.0290 |
| User defined 4 | 5.000E-14 | 5.000E-14 | 1.0290 |
| Dissolved oxygen | 2.500E-9 | 2.500E-9 | 1.0290 |

## EPS Strength coefficients [ ]

| Name | Default | Value | |
|---|---|---|---|
| Ordinary heterotrophic organisms (OHO) | 1.0000 | 1.0000 | 1.0000 |
| Methylotrophs | 1.0000 | 1.0000 | 1.0000 |
| Ammonia oxidizing biomass (AOB) | 5.0000 | 1.0000 | 1.0000 |
| Nitrite oxidizing biomass (NOB) | 25.0000 | 1.0000 | 1.0000 |
| Anaerobic ammonia oxidizers (AAO) | 10.0000 | 1.0000 | 1.0000 |
| Polyphosphate accumulating organisms (PAO) | 1.0000 | 1.0000 | 1.0000 |
| Propionic acetogens | 1.0000 | 1.0000 | 1.0000 |
| Methanogens - acetoclastic | 1.0000 | 1.0000 | 1.0000 |
| Methanogens - hydrogenotrophic | 1.0000 | 1.0000 | 1.0000 |
| Endogenous products | 1.0000 | 1.0000 | 1.0000 |
| Slowly bio. COD (part.) | 1.0000 | 1.0000 | 1.0000 |
| Slowly bio. COD (colloid.) | 1.0000 | 1.0000 | 1.0000 |
| Part. inert. COD | 1.0000 | 1.0000 | 1.0000 |
| Part. bio. org. N | 1.0000 | 1.0000 | 1.0000 |
| Part. bio. org. P | 1.0000 | 1.0000 | 1.0000 |
| Part. inert N | 1.0000 | 1.0000 | 1.0000 |
| Part. inert P | 1.0000 | 1.0000 | 1.0000 |
| Stored PHA | 1.0000 | 1.0000 | 1.0000 |
| Releasable stored polyP | 1.0000 | 1.0000 | 1.0000 |
| Fixed stored polyP | 1.0000 | 1.0000 | 1.0000 |
| Readily bio. COD (complex) | 0 | 0 | 1.0000 |
| Acetate | 0 | 0 | 1.0000 |
| Propionate | 0 | 0 | 1.0000 |
| Methanol | 0 | 0 | 1.0000 |
| Dissolved H2 | 0 | 0 | 1.0000 |
| Dissolved methane | 0 | 0 | 1.0000 |
| Ammonia N | 0 | 0 | 1.0000 |
| Sol. bio. org. N | 0 | 0 | 1.0000 |
| Nitrous Oxide N | 0 | 0 | 1.0000 |
| Nitrite N | 0 | 0 | 1.0000 |

| | | | |
|---|---|---|---|
| Nitrate N | 0 | 0 | 1.0000 |
| Dissolved nitrogen gas | 0 | 0 | 1.0000 |
| PO4-P (Sol. & Me Complexed) | 1.0000 | 1.0000 | 1.0000 |
| Sol. inert COD | 0 | 0 | 1.0000 |
| Sol. inert TKN | 0 | 0 | 1.0000 |
| ISS Influent | 0.3300 | 0.3300 | 1.0000 |
| Struvite | 1.0000 | 1.0000 | 1.0000 |
| Hydroxy-dicalcium-phosphate | 1.0000 | 1.0000 | 1.0000 |
| Hydroxy-apatite | 1.0000 | 1.0000 | 1.0000 |
| Magnesium | 0 | 0 | 1.0000 |
| Calcium | 0 | 0 | 1.0000 |
| Metal | 1.0000 | 1.0000 | 1.0000 |
| Other Cations (strong bases) | 0 | 0 | 1.0000 |
| Other Anions (strong acids) | 0 | 0 | 1.0000 |
| Total CO2 | 0 | 0 | 1.0000 |
| User defined 1 | 0 | 0 | 1.0000 |
| User defined 2 | 0 | 0 | 1.0000 |
| User defined 3 | 1.0000 | 1.0000 | 1.0000 |
| User defined 4 | 1.0000 | 1.0000 | 1.0000 |
| Dissolved oxygen | 0 | 0 | 1.0000 |

Meridian Alternative's Analysis version 1

Expansion using selectable 5 stage modified Bardenpho/A2O process

Tank sizes optimized based on individual simulations from A2O and 5 stage modified Bardenpho processes

<u>To achieve target effluent concentrations, for Bardenpho process:</u>
Set BDF IMLR at 200% influent, Set A2O IMLR at 0%
Set Swing 1 Aerated, Swing 2a and 2b unaerated.
SRT = 12 days
Acetate flow pace at 0.8% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 0.5% of PE flow rate, 1% methanol solution. All methanol to swing 2a

<u>To achieve target effluent concentrations, for A2O process:</u>
Set BDF IMLR at 0% influent, Set A2O IMLR at 400%
Set Swing 1 unaerated, Swing 2a and 2b aerated.
SRT = 12 days
Acetate flow pace at 0.6% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 1.5% of PE flow rate, 1% methanol solution. all methanol to Anoxic 1a

# BioWin user and configuration data

## Project details

Project name: Alternatives Analysis    Project ref.: 147571

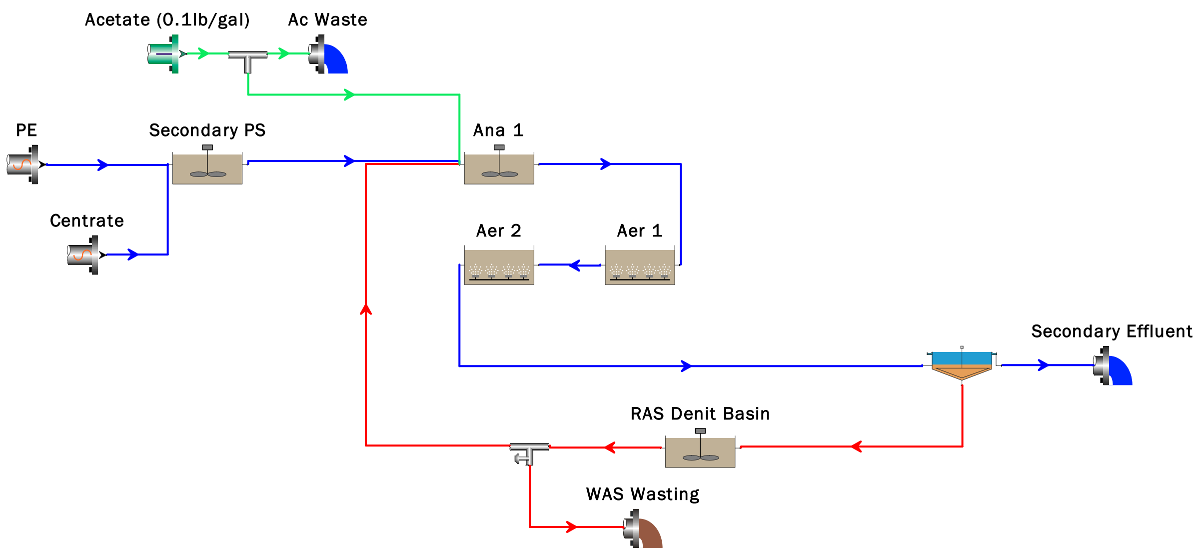
Plant name: Meridian WWTP    User name: Rick Kelly

Created: 6/29/2011    Saved: 5/1/2015

Target SRT: 4.00 days  SRT: **** days

Temperature: 14.0°C

## Flowsheet




# Configuration information for all Bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Ana 1 | 0.5000 | 4774.3058 | 14.000 | Un-aerated |
| Aer 1 | 1.2500 | 1.194E+4 | 14.000 | 4057 |
| Aer 2 | 2.0000 | 1.910E+4 | 14.000 | 6491 |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Ana 1 | 0 |
| Aer 1 | 2.5 |
| Aer 2 | 2.0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |

## Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Ana 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 2 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

| | | | | | |
|---|---|---|---|---|---|
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

# Configuration information for all Effluent units

# Configuration information for all Ideal clarifier units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] |
|---|---|---|---|
| Clarifier | 2.8000 | 2.718E+4 | 13.770 |

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| Clarifier | Flow paced | 50.00 % |

| Element name | Average Temperature | Reactive | Percent removal | Blanket fraction |
|---|---|---|---|---|
| Clarifier | Uses global setting | Yes | 99.90 | 0.07 |

# Configuration information for all COD Influent units

## Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 30.00 | 30.00 |
| Flow | 12.461167588271 | 0.100114816828393 |
| Total COD mgCOD/L | 416.48 | 1801.80 |
| Total Kjeldahl Nitrogen mgN/L | 54.01 | 934.39 |
| Total P mgP/L | 8.12 | 529.81 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.95 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.43 | 185.22 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.5950 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 0.0392 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9931 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.0039 |
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.3197 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.9500 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5086 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0050 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0512 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9300 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.0642 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-4 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |

| | | | |
|---|---|---|---|
| FZnob - NOB COD fraction | [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaao - AAO COD fraction | [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbp - PAO COD fraction | [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbpa - Propionic acetogens COD fraction | [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbam - Acetoclastic methanogens COD fraction | [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbhm - H2-utilizing methanogens COD fraction | [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZe - Endogenous products COD fraction | [gCOD/g of total COD] | 0 | 0 |

# Configuration information for all Sludge units

# Configuration information for all Splitter units

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| RAS / WAS | Flowrate [Side] | 0.313749616246609 |
| Acetate Splitter | Flow paced | 0.80 % |

# Configuration information for all Stream (SV) Influent units

## Operating data Average (flow/time weighted as required)

| Element name | Acetate (0.1lb/gal) |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |

| | |
|---|---|
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 11980.00 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |

| | |
|---|---|
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

## BioWin Album

## Album page - Table

| Elements | Total COD [mg/L] | Total Kjeldahl Nitrog | Flow [mgd] | Dissolved oxygen | Total suspended | Volatile suspend | Filtered Carbonac | Ammonia N [mgN/ | Nitrite N [mgN/L] | Nitrate N [mgN/L] | Total P [mgP/L] | Soluble PO4-P [mg | Volatile fatty acids | Fixed stored polyP | Ammonia oxidizing | Anaerobic ammoni | Endogenous pro | Methanogens - a | Methanogens - h | Methylotrophs [mg | Nitrite oxidizing biom | Ordinary heterotrophi | Polyphosphate a | Propionic acetoge | Total solids mass [l | Methanol [mgCOD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | en[mgN/L] | | [mg/L] | solids[mgTSS/L] | edsolids[mgVSS/L] | eousBOD[mg/L] | L] | | | | P/L] | [mg/L] | [mgP/L] | biomass(AOB)[mgCOD/L] | aoxidizers(AAO)[mgCOD/L] | ducts[mgCOD/L] | cetoclastic[mgCOD/L] | ydrogenotrophic[mgCOD/L] | COD/L] | ass(NOB)[mgCOD/L] | corganisms(OHO)[mgCOD/L] | ccumulatingorganisms(PAO)[mgCOD/L] | ns[mgCOD/L] | b] | /L] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PE | 416.48 | 54.01 | 12.46 | 0 | 102.12 | 90.65 | 134.05 | 43.75 | 0 | 0 | 8.12 | 5.60 | 21.03 | 0 | 0.04 | 0.04 | 0 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | ----- | 0 |
| SecondaryPS | 449.80 | 63.69 | 12.82 | 0 | 112.41 | 97.14 | 146.94 | 52.96 | 0 | 0 | 14.10 | 11.26 | 22.12 | 0 | 0.04 | 0.04 | 0.00 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.04 | 0.04 | 37.81 | 0 |
| Ana1 | 2980.01 | 224.56 | 18.94 | 0 | 2392.45 | 1895.77 | 53.27 | 42.73 | 0.00 | 0.00 | 158.33 | 41.73 | 59.05 | 37.10 | 35.97 | 0.29 | 321.13 | 0.18 | 0.07 | 0.46 | 1.91 | 1483.17 | 552.39 | 0.20 | 9982.99 | 0 |
| Aer1 | 2872.70 | 216.21 | 18.94 | 2.50 | 2471.89 | 1909.59 | 3.02 | 29.90 | 7.46 | 0.34 | 157.92 | 20.37 | 0.76 | 38.56 | 36.83 | 0.28 | 326.42 | 0.17 | 0.06 | 0.46 | 1.94 | 1546.11 | 568.92 | 0.19 | 25786.16 | 0 |
| A | 2 | 2 | 1 | 2. | 2 | 1 | 1. | 1 | 1 | 1. | 1 | 0. | 0. | 3 | 3 | 0. | 3 | 0. | 0. | 0. | 1. | 1 | 5 | 0. | 4 | 0 |

| | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| er 2 | 794.17 | 03.95 | 8.94 | 00 | 509.40 | 885.70 | 14 | 6.77 | 8.53 | 01 | 57.25 | 19 | 01 | 9.30 | 8.04 | 27 | 34.99 | 16 | 05 | 46 | 99 | 561.23 | 83.74 | 18 | 1883.89 | |
| Secondary Effluent | 33.31 | 18.53 | 12.61 | 1.72 | 3.83 | 2.83 | 0.98 | 16.21 | 18.40 | 1.03 | 0.42 | 0.16 | 0.01 | 0.06 | 0.06 | 0.00 | 0.53 | 0.00 | 0.00 | 0.00 | 0.00 | 2.37 | 0.89 | 0.00 | ----- | 0 |
| Clarifier | 33.31 | 18.53 | 12.61 | 1.72 | 3.83 | 2.83 | 0.98 | 16.21 | 18.40 | 1.03 | 0.42 | 0.16 | 0.01 | 0.06 | 0.06 | 0.00 | 0.53 | 0.00 | 0.00 | 0.00 | 0.00 | 2.37 | 0.89 | 0.00 | 12316.72 | 0 |
| Clarifier (U) | 8256.33 | 571.39 | 6.33 | 0.00 | 7479.03 | 5616.91 | 1.35 | 17.66 | 10.74 | 0.01 | 468.89 | 0.08 | 0.02 | 117.05 | 113.41 | 0.81 | 1005.58 | 0.48 | 0.13 | 1.37 | 5.93 | 4654.50 | 1740.74 | 0.53 | ----- | 0 |
| RAS/WAS | 8245.23 | 571.24 | 6.02 | 0 | 7471.24 | 5610.29 | 1.67 | 17.99 | 6.83 | 0.00 | 468.67 | 0.23 | 0.04 | 116.91 | 113.31 | 0.81 | 1007.28 | 0.48 | 0.13 | 1.37 | 5.92 | 4649.63 | 1739.41 | 0.53 | ----- | 0 |
| RAS/WAS (U) | 8245.23 | 571.24 | 0.31 | 0 | 7471.24 | 5610.29 | 1.67 | 17.99 | 6.83 | 0.00 | 468.67 | 0.23 | 0.04 | 116.91 | 113.31 | 0.81 | 1007.28 | 0.48 | 0.13 | 1.37 | 5.92 | 4649.63 | 1739.41 | 0.53 | ----- | 0 |

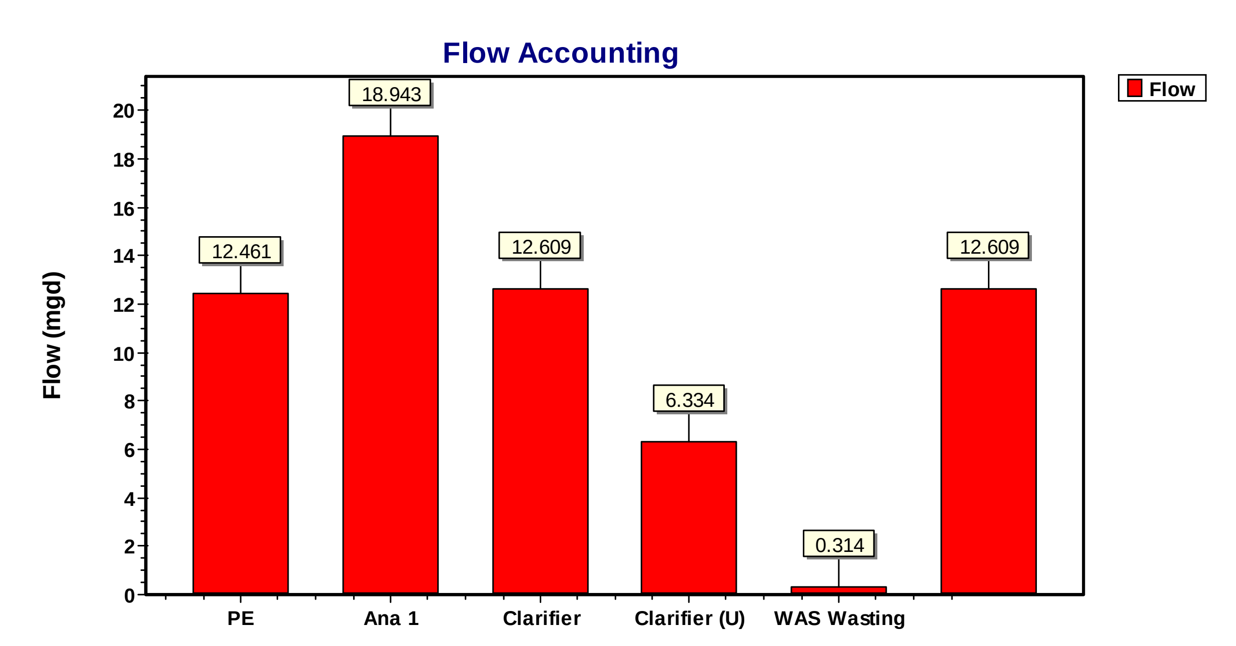
## Album page - Output Table 1

| Elements | Flow [mgd] | Liquid volume [Mil. Gal] | Temperature [deg. C] | pH [] | Total suspended solids [mgTSS/L] | Volatile suspended solids [mgVSS/L] | Total COD [mg/L] | Filtered COD [mg/L] | Volatile fatty acids [mg/L] | Total Carbonaceous BOD [mg/L] | Readily biodeg. COD (complex) [mgCOD/L] | Slowly bio. COD (colloid.) [mgCOD/L] | Slowly bio. COD (part.) [mgCOD/L] | Sol. inert COD [mgCOD/L] | Total Kjeldahl Nitrogen [mgN/L] | Ammonia N [mgN/L] | Nitrite N [mgN/L] | Nitrate N [mgN/L] | Total inorganic N [mgN/L] | Total N [mgN/L] | Total P [mgP/L] | Soluble PO4-P [mgP/L] | Air flowrate [ft3/min (20C, 1 atm)] | Polyphosphate accumulating organisms (PAO) [mgCOD/L] | Ammonia oxidizing biomass (AOB) [mgCOD/L] | Nitrite oxidizing biomass (NOB) [mgCOD/L] | Ordinary heterotrophic organisms (OHO) [mgCOD/L] | Methanol [mgCOD/L] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PE | 12.46 | 0 | 14.00 | 7.95 | 102.12 | 90.65 | 416.48 | 217.24 | 21.03 | 237.17 | 106.41 | 61.48 | 194.69 | 28.32 | 54.01 | 43.75 | 0 | 0 | 43.75 | 54.01 | 8.12 | 5.60 | ----- | 0.04 | 0.04 | 0.04 | 0.04 | 0 |
| Secondary PS | 12.82 | 0.04 | 14.00 | 7.95 | 112.41 | 97.14 | 449.80 | 236.31 | 22.12 | 253.85 | 121.80 | 63.20 | 201.85 | 29.19 | 63.69 | 52.96 | 0 | 0 | 52.96 | 63.69 | 14.10 | 11.26 | 0 | 0.04 | 0.04 | 0.04 | 0.05 | 0 |
| An | 18. | 0.5 | 14. | 6.9 | 23 | 18 | 29 | 12 | 59. | 13 | 7.6 | 6.6 | 24 | 29. | 22 | 42. | 0.0 | 0.0 | 42. | 22 | 15 | 41. | 0 | 55 | 35. | 1.9 | 14 | 0 |

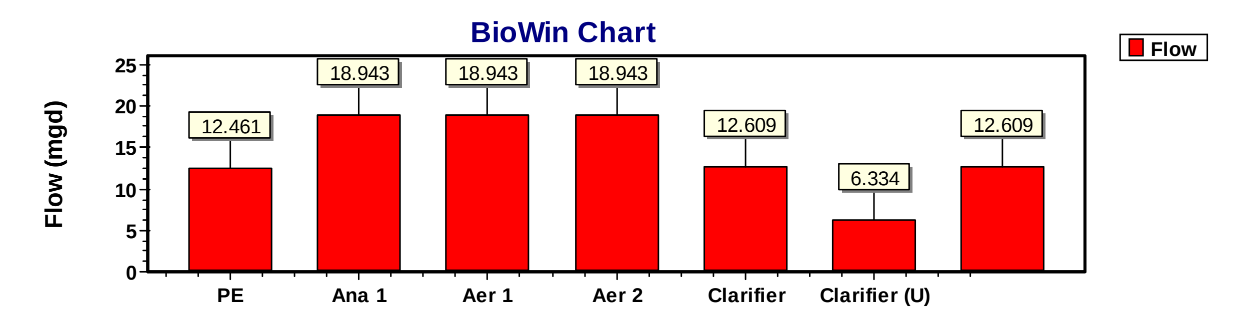
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a1 | 94 | 0 | 00 | 7 | 92.45 | 95.77 | 80.01 | 5.31 | 05 | 96.37 | 8 | 0 | 2.21 | 06 | 4.56 | 73 | 0 | 0 | 74 | 4.57 | 8.33 | 73 | | 2.39 | 97 | 1 | 83.17 | |
| Aer1 | 18.94 | 1.25 | 14.00 | 6.96 | 2471.89 | 1909.59 | 2872.70 | 34.62 | 0.76 | 1337.28 | 3.08 | 0.40 | 158.50 | 29.14 | 216.21 | 29.90 | 7.46 | 0.34 | 37.70 | 224.01 | 157.92 | 20.37 | 6974.68 | 568.92 | 36.83 | 1.94 | 1546.11 | 0 |
| Aer2 | 18.94 | 2.00 | 14.00 | 6.77 | 2509.40 | 1885.70 | 2794.17 | 30.48 | 0.01 | 1292.98 | 1.59 | 0.01 | 81.16 | 28.80 | 203.95 | 16.77 | 18.53 | 1.01 | 36.31 | 223.49 | 157.25 | 0.19 | 5860.55 | 583.74 | 38.04 | 1.99 | 1561.23 | 0 |
| Clarifier | 12.61 | 2.80 | 14.00 | 6.77 | 3.83 | 2.83 | 33.31 | 29.20 | 0.01 | 2.88 | 1.37 | 0.01 | 0.06 | 27.76 | 18.53 | 16.21 | 18.40 | 1.03 | 35.64 | 37.96 | 0.42 | 0.16 | ----- | 0.89 | 0.06 | 0.00 | 2.37 | 0 |
| Clarifier (U) | 6.33 | 2.80 | 14.00 | 6.87 | 7479.03 | 5616.91 | 8256.33 | 31.74 | 0.02 | 3841.30 | 1.89 | 0.00 | 225.14 | 29.21 | 571.39 | 17.66 | 10.74 | 0.01 | 28.41 | 582.14 | 468.89 | 0.08 | ----- | 1740.74 | 113.41 | 5.93 | 4654.50 | 0 |
| Secondary Effluent | 12.61 | 0 | 14.00 | 6.77 | 3.83 | 2.83 | 33.31 | 29.20 | 0.01 | 2.88 | 1.37 | 0.01 | 0.06 | 27.76 | 18.53 | 16.21 | 18.40 | 1.03 | 35.64 | 37.96 | 0.42 | 0.16 | ----- | 0.89 | 0.06 | 0.00 | 2.37 | 0 |
| RAS Denit Basin | 6.33 | 0.07 | 14.00 | 6.96 | 7471.24 | 5610.29 | 8245.23 | 32.68 | 0.04 | 3834.33 | 2.32 | 0.00 | 219.90 | 29.35 | 571.24 | 17.99 | 6.83 | 0.00 | 24.82 | 578.08 | 468.67 | 0.23 | 0 | 1739.41 | 113.31 | 5.92 | 4649.63 | 0 |
| RAS/W | 6.02 | 0 | 14.00 | 6.96 | 7471.2 | 5610.2 | 8245.2 | 32.68 | 0.04 | 3834.3 | 2.32 | 0.00 | 219.9 | 29.35 | 571.2 | 17.99 | 6.83 | 0.00 | 24.82 | 578.0 | 468.6 | 0.23 | ----- | 1739.4 | 113.3 | 5.92 | 4649.6 | 0 |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AS | | | | | 4 | 9 | 3 | | | 3 | | | 0 | | 4 | | | | | 8 | 7 | | | 1 | 1 | | 3 | |
| RAS/WAS(U) | 0.31 | 0 | 14.00 | 6.96 | 7471.24 | 5610.29 | 8245.23 | 32.68 | 0.04 | 3834.33 | 2.32 | 0.00 | 219.90 | 29.35 | 571.24 | 17.99 | 6.83 | 0.00 | 24.82 | 578.08 | 468.67 | 0.23 | ----- | 1739.41 | 113.31 | 5.92 | 4649.63 | 0 |
| WAS Wasting | 0.31 | 0 | 14.00 | 6.96 | 7471.24 | 5610.29 | 8245.23 | 32.68 | 0.04 | 3834.33 | 2.32 | 0.00 | 219.90 | 29.35 | 571.24 | 17.99 | 6.83 | 0.00 | 24.82 | 578.08 | 468.67 | 0.23 | ----- | 1739.41 | 113.31 | 5.92 | 4649.63 | 0 |

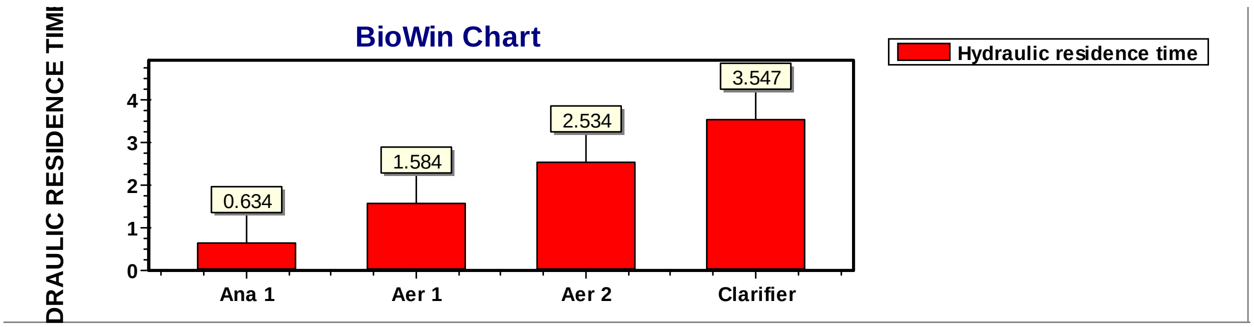
## Album page - SS Flow Accounting



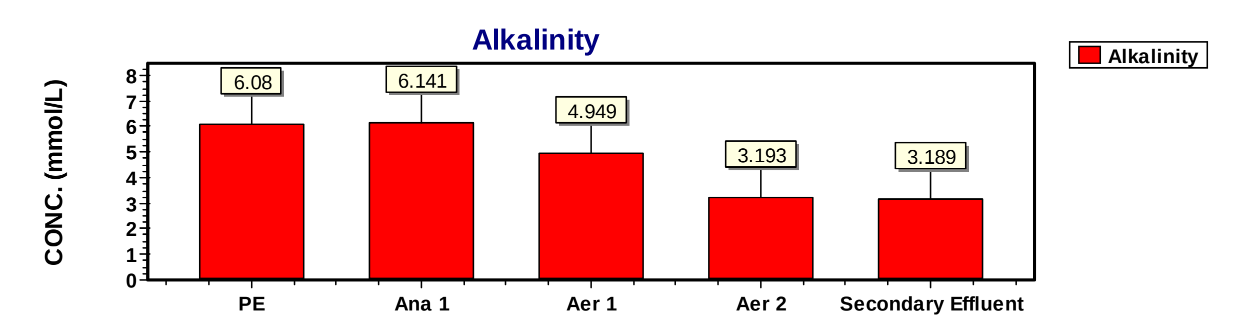

## Album page - SS Flow and HRT



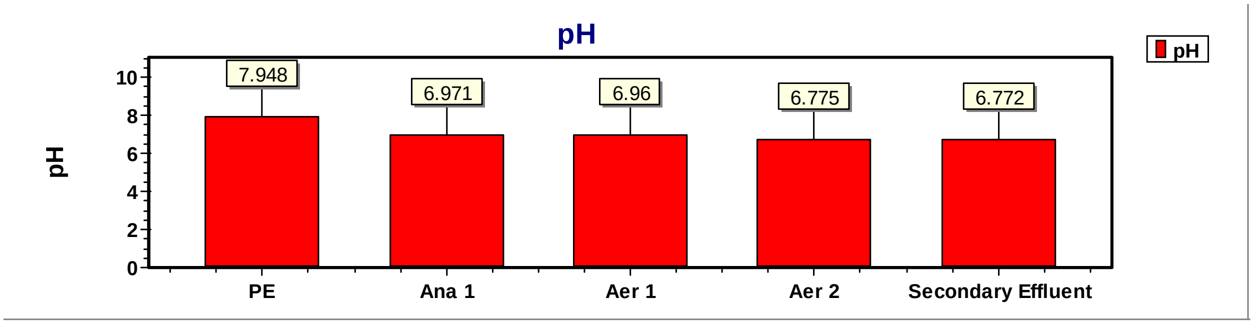

Album page - SS Flow and HRT



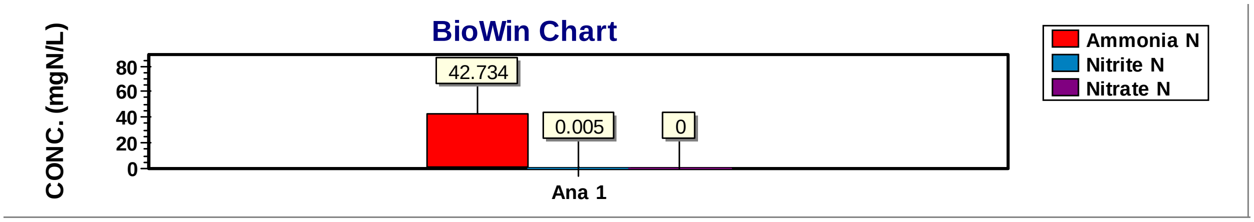

Album page - SS pH-Alkalinity



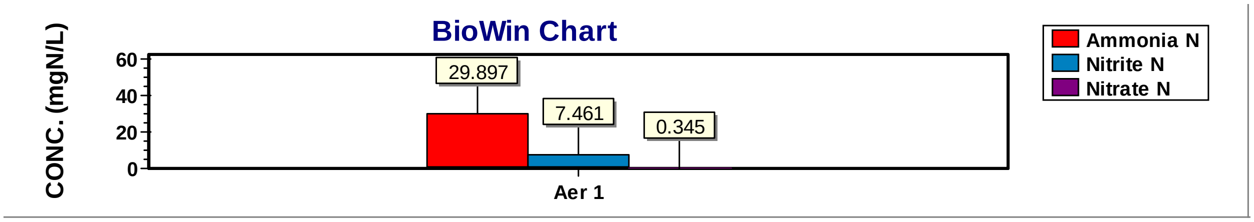

Album page - SS pH-Alkalinity



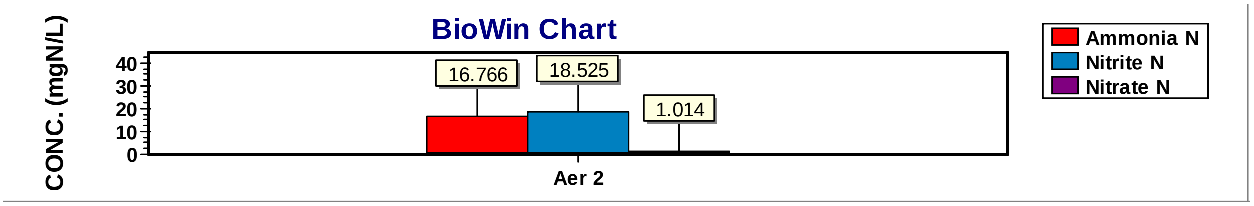

Album page - SS NH3-NO2-NO3



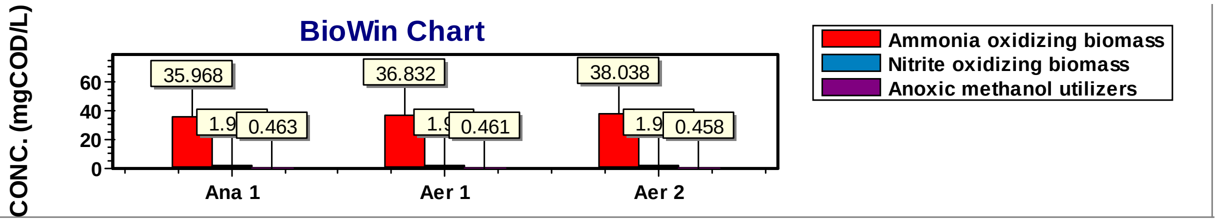

Album page - SS NH3-NO2-NO3



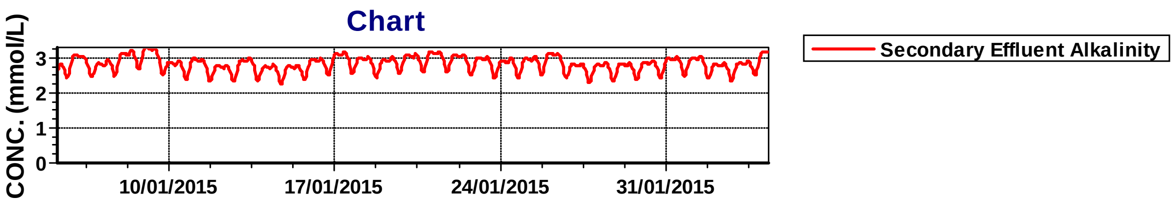

Album page - SS NH3-NO2-NO3



Album page - SS AOB-NOB

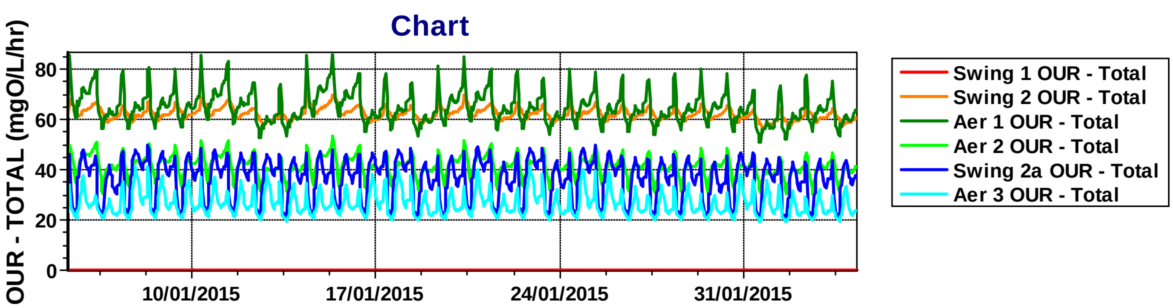



Album page - SS AOB-NOB

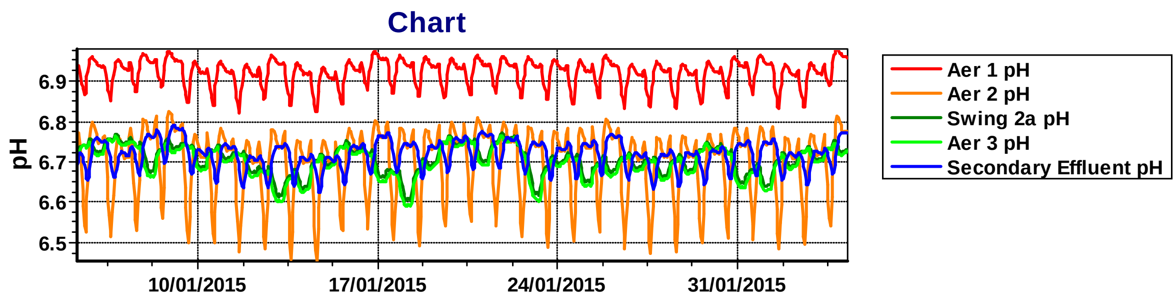



Album page - SS AOB-NOB

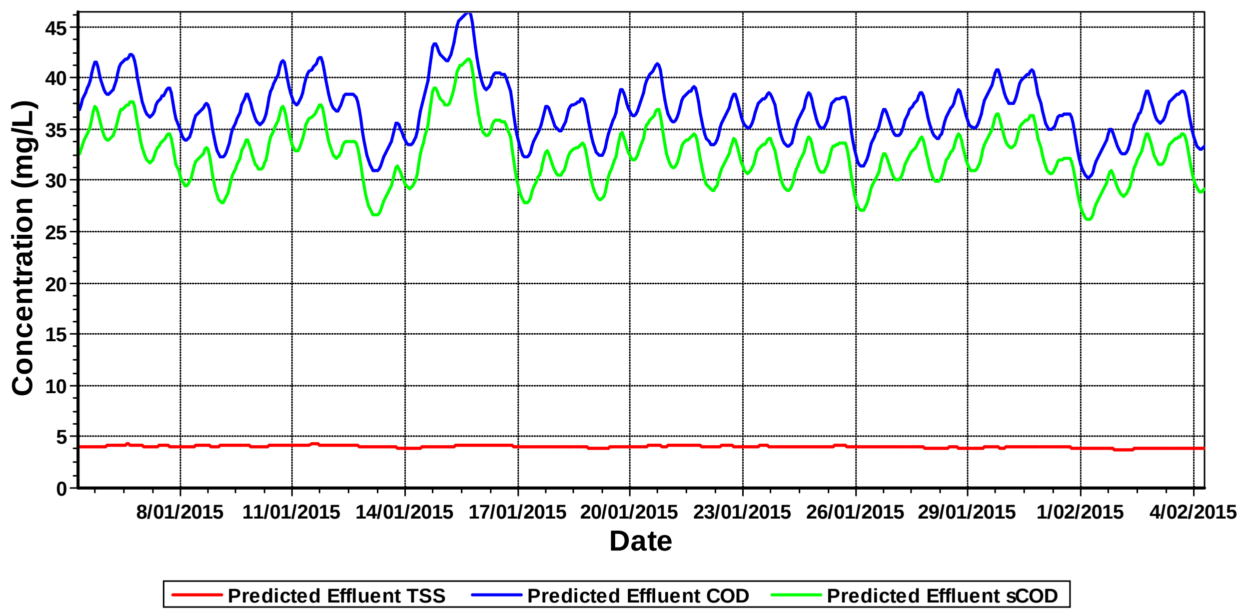
Album page - OURs



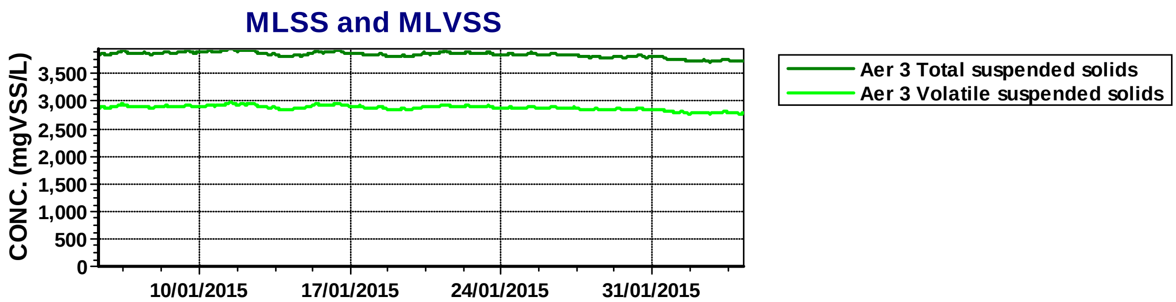

Album page - OURs



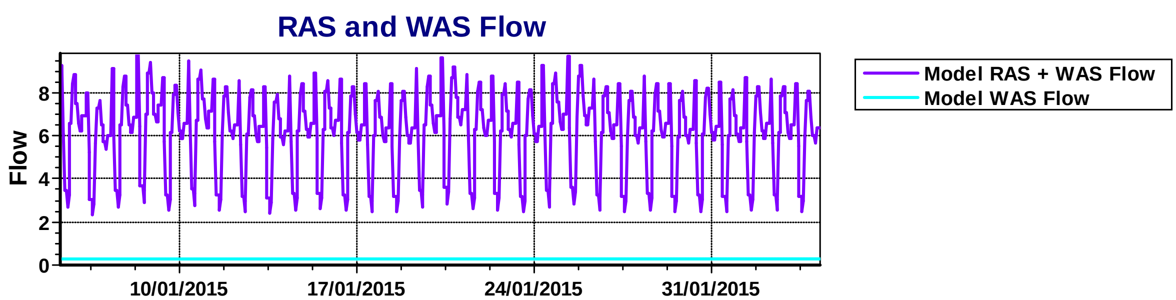

Album page - TSS, COD, BOD



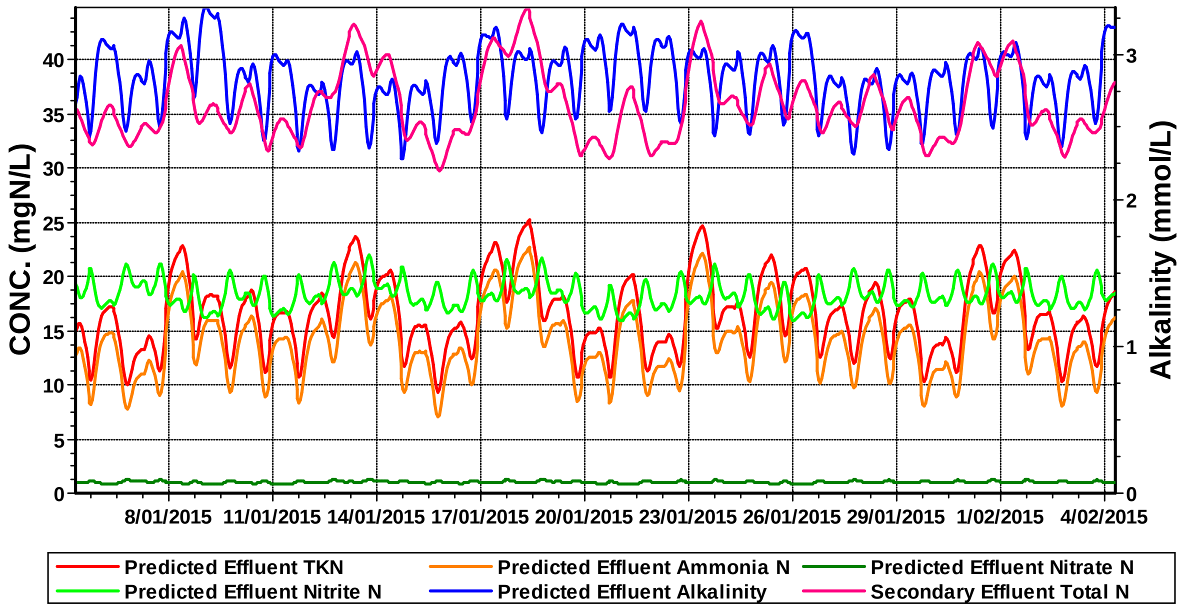

Album page - Mixed Liquor, RAS Flow



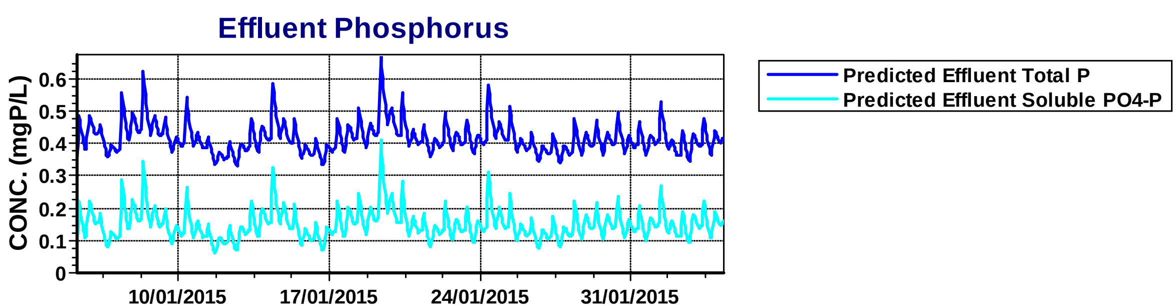

Album page - Mixed Liquor, RAS Flow



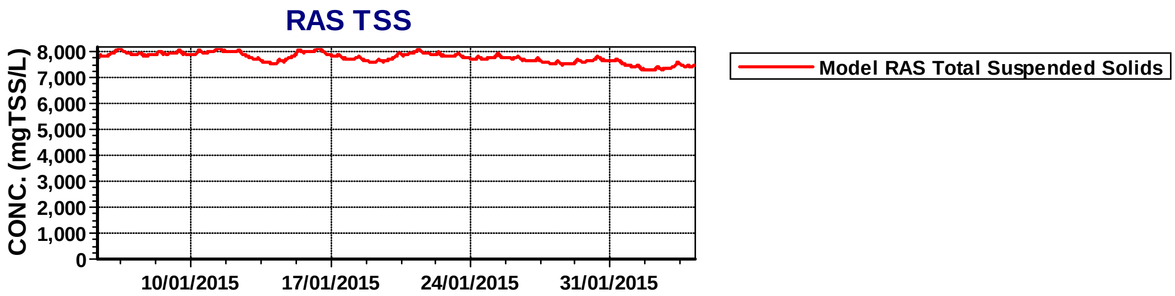

Album page - Nitrogen Sp., Alkalinity



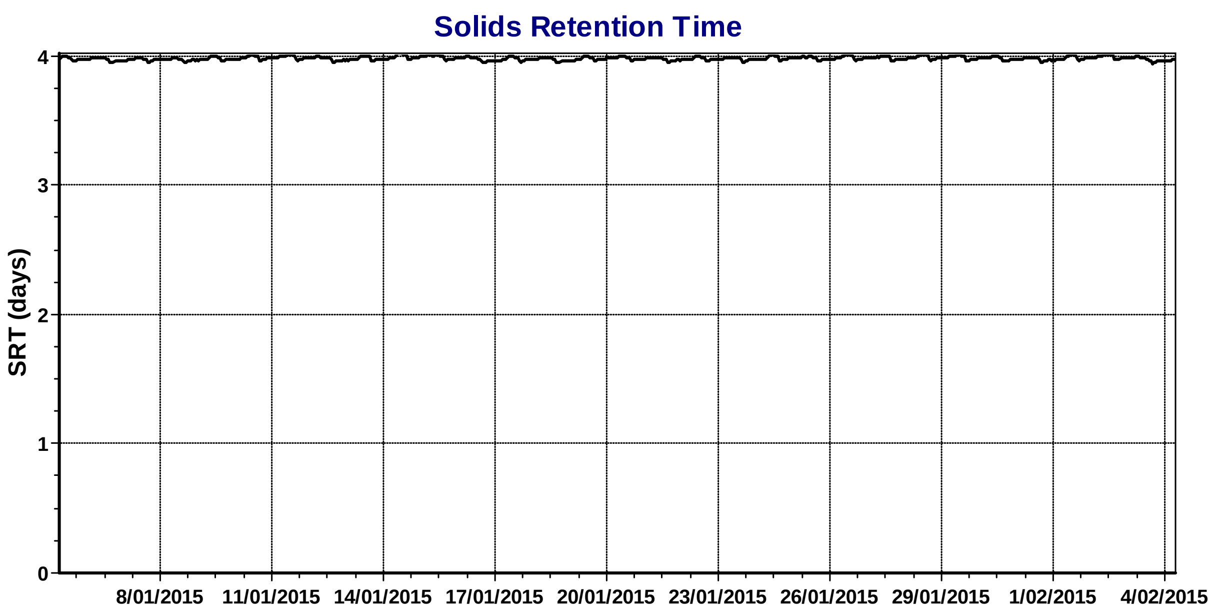

Album page - TP, RAS TSS



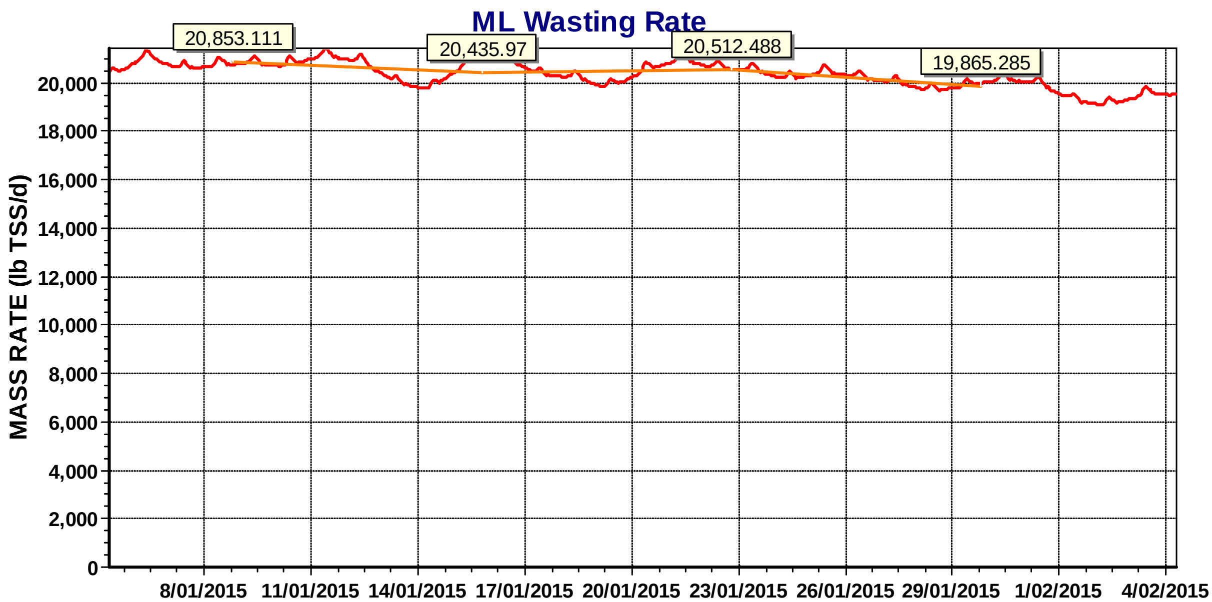

Album page - TP, RAS TSS



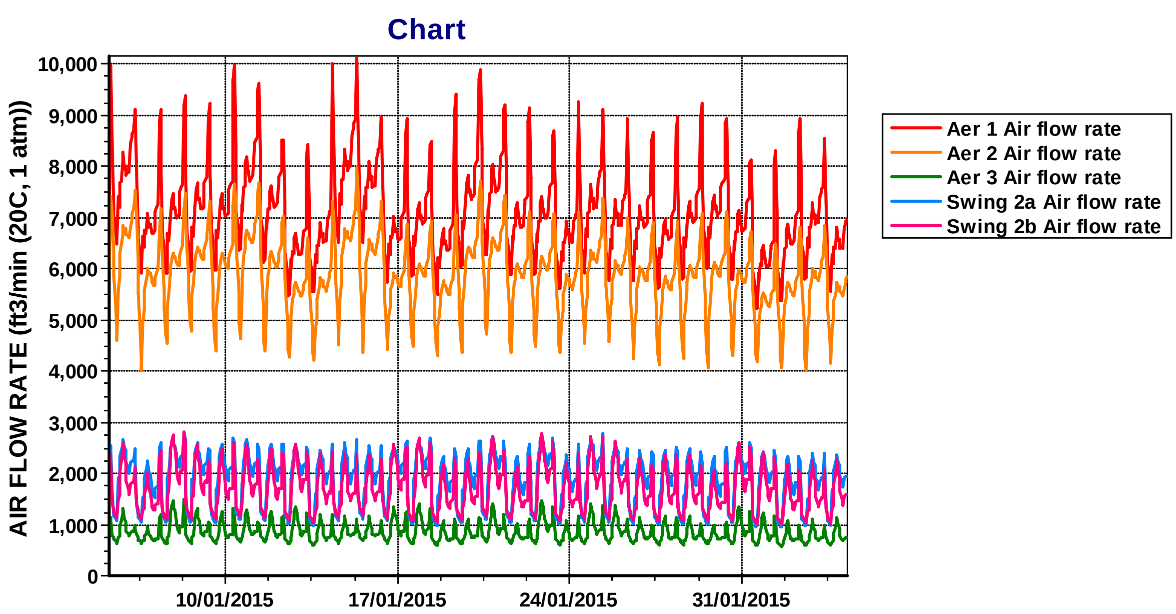

Album page - SRT




Album page - WAS Mass



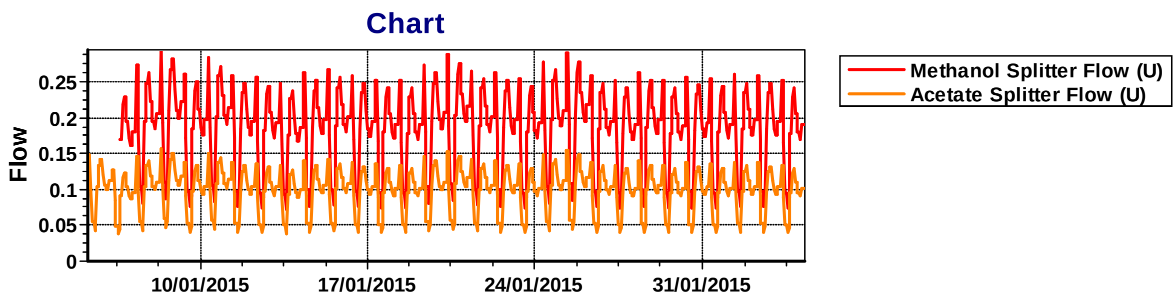

Album page - Air Flow Rate




Album page - Page 16

| Elements | Air flow rate [ft3/min (20C, 1 atm)] | Flow [mgd] |
|---|---|---|
| Acetate Splitter (U) | ---- | 0.10 |
| Aer 1 | 6974.68 | 18.94 |
| Aer 2 | 5860.55 | 18.94 |

## Album page - Page 16




## Global Parameters

## Common

| Name | Default | Value | |
|---|---|---|---|
| Hydrolysis rate [1/d] | 2.1000 | 2.1000 | 1.0290 |
| Hydrolysis half sat. [-] | 0.0600 | 0.0600 | 1.0000 |
| Anoxic hydrolysis factor [-] | 0.2800 | 0.2800 | 1.0000 |
| Anaerobic hydrolysis factor (AS) [-] | 0.0400 | 0.0400 | 1.0000 |
| Anaerobic hydrolysis factor (AD) [-] | 0.5000 | 0.5000 | 1.0000 |
| Adsorption rate of colloids [L/(mgCOD d)] | 0.1500 | 0.1500 | 1.0290 |
| Ammonification rate [L/(mgN d)] | 0.0400 | 0.0400 | 1.0290 |

| | | | |
|---|---|---|---|
| Assimilative nitrate/nitrite reduction rate [1/d] | 0.5000 | 0.5000 | 1.0000 |
| Endogenous products decay rate [1/d] | 0 | 0 | 1.0000 |

## AOB

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.9000 | 0.9000 | 1.0720 |
| Substrate (NH4) half sat. [mgN/L] | 0.7000 | 0.7000 | 1.0000 |
| Byproduct NH4 logistic slope [-] | 50.0000 | 50.0000 | 1.0000 |
| Byproduct NH4 inflection point [mgN/L] | 1.4000 | 1.4000 | 1.0000 |
| AOB denite DO half sat. [mg/L] | 0.1000 | 0.1000 | 1.0000 |
| AOB denite HNO2 half sat. [mgN/L] | 5.000E-6 | 5.000E-6 | 1.0000 |
| Aerobic decay rate [1/d] | 0.1700 | 0.1700 | 1.0290 |
| Anoxic/anaerobic decay rate [1/d] | 0.0800 | 0.0800 | 1.0290 |
| KiHNO2 [mmol/L] | 0.0050 | 0.0050 | 1.0000 |

## NOB

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.7000 | 0.7000 | 1.0600 |
| Substrate (NO2) half sat. [mgN/L] | 0.1000 | 0.1000 | 1.0000 |
| Aerobic decay rate [1/d] | 0.1700 | 0.1700 | 1.0290 |
| Anoxic/anaerobic decay rate [1/d] | 0.0800 | 0.0800 | 1.0290 |
| KiNH3 [mmol/L] | 0.0750 | 0.0750 | 1.0000 |

## AAO

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.2000 | 0.2000 | 1.1000 |
| Substrate (NH4) half sat. [mgN/L] | 2.0000 | 2.0000 | 1.0000 |
| Substrate (NO2) half sat. [mgN/L] | 1.0000 | 1.0000 | 1.0000 |
| Aerobic decay rate [1/d] | 0.0190 | 0.0190 | 1.0290 |
| Anoxic/anaerobic decay rate [1/d] | 0.0095 | 0.0095 | 1.0290 |
| Ki Nitrite [mgN/L] | 1000.0000 | 1000.0000 | 1.0000 |
| Nitrite sensitivity constant [L / (d mgN) ] | 0.0160 | 0.0160 | 1.0000 |

## OHO

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 3.2000 | 3.2000 | 1.0290 |
| Substrate half sat. [mgCOD/L] | 5.0000 | 5.0000 | 1.0000 |
| Anoxic growth factor [-] | 0.5000 | 0.5000 | 1.0000 |
| Denite N2 producers (NO3 or NO2) [-] | 0.5000 | 0.5000 | 1.0000 |
| Aerobic decay rate [1/d] | 0.6200 | 0.6200 | 1.0290 |
| Anoxic decay rate [1/d] | 0.2330 | 0.2330 | 1.0290 |
| Anaerobic decay rate [1/d] | 0.1310 | 0.1310 | 1.0290 |
| Fermentation rate [1/d] | 1.6000 | 1.6000 | 1.0290 |
| Fermentation half sat. [mgCOD/L] | 5.0000 | 5.0000 | 1.0000 |
| Fermentation growth factor (AS) [-] | 0.2500 | 0.2500 | 1.0000 |
| Free nitrous acid inhibition [mmol/L] | 1.000E-7 | 1.000E-7 | 1.0000 |

## Methylotrophs

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 1.3000 | 1.3000 | 1.0720 |
| Methanol half sat. [mgCOD/L] | 0.5000 | 0.5000 | 1.0000 |
| Denite N2 producers (NO3 or NO2) [-] | 0.5000 | 0.5000 | 1.0000 |
| Aerobic decay rate [1/d] | 0.0400 | 0.0400 | 1.0290 |
| Anoxic/anaerobic decay rate [1/d] | 0.0300 | 0.0300 | 1.0290 |
| Free nitrous acid inhibition [mmol/L] | 1.000E-7 | 1.000E-7 | 1.0000 |

## PAO

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.9500 | 0.9500 | 1.0000 |
| Max. spec. growth rate, P-limited [1/d] | 0.4200 | 0.4200 | 1.0000 |
| Substrate half sat. [mgCOD(PHB)/mgCOD(Zbp)] | 0.1000 | 0.1000 | 1.0000 |
| Substrate half sat., P-limited [mgCOD(PHB)/mgCOD(Zbp)] | 0.0500 | 0.0500 | 1.0000 |
| Magnesium half sat. [mgMg/L] | 0.1000 | 0.1000 | 1.0000 |
| Cation half sat. [mmol/L] | 0.1000 | 0.1000 | 1.0000 |
| Calcium half sat. [mgCa/L] | 0.1000 | 0.1000 | 1.0000 |
| Aerobic/anoxic decay rate [1/d] | 0.1000 | 0.1000 | 1.0000 |
| Aerobic/anoxic maintenance rate [1/d] | 0 | 0 | 1.0000 |
| Anaerobic decay rate [1/d] | 0.0400 | 0.0400 | 1.0000 |
| Anaerobic maintenance rate [1/d] | 0 | 0 | 1.0000 |
| Sequestration rate [1/d] | 4.5000 | 4.5000 | 1.0000 |
| Anoxic growth factor [-] | 0.3300 | 0.3300 | 1.0000 |

## Acetogens

| Name | Default | Value | |
|---|---|---|---|
| Max. spec. growth rate [1/d] | 0.2500 | 0.2500 | 1.0290 |
| Substrate half sat. [mgCOD/L] | 10.0000 | 10.0000 | 1.0000 |
| Acetate inhibition [mgCOD/L] | 10000.0000 | 10000.0000 | 1.0000 |
| Anaerobic decay rate [1/d] | 0.0500 | 0.0500 | 1.0290 |
| Aerobic/anoxic decay rate [1/d] | 0.5200 | 0.5200 | 1.0290 |

## Methanogens

| Name | Default | Value | |
|---|---|---|---|
| Acetoclastic max. spec. growth rate [1/d] | 0.3000 | 0.3000 | 1.0290 |
| H2-utilizing max. spec. growth rate [1/d] | 1.4000 | 1.4000 | 1.0290 |
| Acetoclastic substrate half sat. [mgCOD/L] | 100.0000 | 100.0000 | 1.0000 |
| Acetoclastic methanol half sat. [mgCOD/L] | 0.5000 | 0.5000 | 1.0000 |
| H2-utilizing CO2 half sat. [mmol/L] | 0.1000 | 0.1000 | 1.0000 |
| H2-utilizing substrate half sat. [mgCOD/L] | 0.1000 | 0.1000 | 1.0000 |
| H2-utilizing methanol half sat. [mgCOD/L] | 0.5000 | 0.5000 | 1.0000 |
| Acetoclastic propionic inhibition [mgCOD/L] | 10000.0000 | 10000.0000 | 1.0000 |
| Acetoclastic anaerobic decay rate [1/d] | 0.1300 | 0.1300 | 1.0290 |
| Acetoclastic aerobic/anoxic decay rate [1/d] | 0.6000 | 0.6000 | 1.0290 |
| H2-utilizing anaerobic decay rate [1/d] | 0.1300 | 0.1300 | 1.0290 |
| H2-utilizing aerobic/anoxic decay rate [1/d] | 2.8000 | 2.8000 | 1.0290 |

## pH

| Name | Default | Value |
|---|---|---|
| OHO low pH limit [-] | 4.0000 | 4.0000 |

| | | |
|---|---|---|
| OHO high pH limit [-] | 10.0000 | 10.0000 |
| Methylotrophs low pH limit [-] | 4.0000 | 4.0000 |
| Methylotrophs high pH limit [-] | 10.0000 | 10.0000 |
| Autotrophs low pH limit [-] | 5.5000 | 5.5000 |
| Autotrophs high pH limit [-] | 9.5000 | 9.5000 |
| PAO low pH limit [-] | 4.0000 | 4.0000 |
| PAO high pH limit [-] | 10.0000 | 10.0000 |
| OHO low pH limit (anaerobic) [-] | 5.5000 | 5.5000 |
| OHO high pH limit (anaerobic) [-] | 8.5000 | 8.5000 |
| Propionic acetogens low pH limit [-] | 4.0000 | 4.0000 |
| Propionic acetogens high pH limit [-] | 10.0000 | 10.0000 |
| Acetoclastic methanogens low pH limit [-] | 5.0000 | 5.0000 |
| Acetoclastic methanogens high pH limit [-] | 9.0000 | 9.0000 |
| H2-utilizing methanogens low pH limit [-] | 5.0000 | 5.0000 |
| H2-utilizing methanogens high pH limit [-] | 9.0000 | 9.0000 |

## Switches

| Name | Default | Value |
|---|---|---|
| Aerobic/anoxic DO half sat. [mgO2/L] | 0.0500 | 0.0500 |
| Anoxic/anaerobic NOx half sat. [mgN/L] | 0.1500 | 0.1500 |
| AOB DO half sat. [mgO2/L] | 0.2500 | 0.2500 |
| NOB DO half sat. [mgO2/L] | 0.5000 | 0.5000 |
| AAO DO half sat. [mgO2/L] | 0.0100 | 0.0100 |
| Anoxic NO3(->NO2) half sat. [mgN/L] | 0.1000 | 0.1000 |
| Anoxic NO3(->N2) half sat. [mgN/L] | 0.0500 | 0.0500 |
| Anoxic NO2(->N2) half sat. (mgN/L) | 0.0100 | 0.0100 |
| NH3 nutrient half sat. [mgN/L] | 0.0050 | 0.0050 |
| PolyP half sat. [mgP/mgCOD] | 0.0100 | 0.0100 |

| | | |
|---|---|---|
| VFA sequestration half sat. [mgCOD/L] | 5.0000 | 5.0000 |
| P uptake half sat. [mgP/L] | 0.1500 | 0.1500 |
| P nutrient half sat. [mgP/L] | 0.0010 | 0.0010 |
| Autotroph CO2 half sat. [mmol/L] | 0.1000 | 0.1000 |
| H2 low/high half sat. [mgCOD/L] | 1.0000 | 1.0000 |
| Propionic acetogens H2 inhibition [mgCOD/L] | 5.0000 | 5.0000 |
| Synthesis anion/cation half sat. [meq/L] | 0.0100 | 0.0100 |

## Common

| Name | Default | Value |
|---|---|---|
| Biomass volatile fraction (VSS/TSS) | 0.9200 | 0.9200 |
| Endogenous residue volatile fraction (VSS/TSS) | 0.9200 | 0.9200 |
| N in endogenous residue [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in endogenous residue [mgP/mgCOD] | 0.0220 | 0.0220 |
| Endogenous residue COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| Particulate substrate COD:VSS ratio [mgCOD/mgVSS] | 1.6000 | 2.2000 |
| Particulate inert COD:VSS ratio [mgCOD/mgVSS] | 1.6000 | 2.2000 |

## AOB

| Name | Default | Value |
|---|---|---|
| Yield [mgCOD/mgN] | 0.1500 | 0.1500 |
| AOB denite NO2 fraction as TEA [-] | 0.5000 | 0.5000 |
| Byproduct NH4 fraction to N2O [-] | 0.0025 | 0.0025 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |

| | | |
|---|---|---|
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## NOB

| Name | Default | Value |
|---|---|---|
| Yield [mgCOD/mgN] | 0.0900 | 0.0900 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## AAO

| Name | Default | Value |
|---|---|---|
| Yield [mgCOD/mgN] | 0.1140 | 0.1140 |
| Nitrate production [mgN/mgBiomassCOD] | 2.2800 | 2.2800 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## OHO

| Name | Default | Value |
|---|---|---|

| | | |
|---|---|---|
| Yield (aerobic) [-] | 0.6660 | 0.6660 |
| Yield (fermentation, low H2) [-] | 0.1000 | 0.1000 |
| Yield (fermentation, high H2) [-] | 0.1000 | 0.1000 |
| H2 yield (fermentation low H2) [-] | 0.3500 | 0.3500 |
| H2 yield (fermentation high H2) [-] | 0 | 0 |
| Propionate yield (fermentation, low H2) [-] | 0 | 0 |
| Propionate yield (fermentation, high H2) [-] | 0.7000 | 0.7000 |
| CO2 yield (fermentation, low H2) [-] | 0.7000 | 0.7000 |
| CO2 yield (fermentation, high H2) [-] | 0 | 0 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Endogenous fraction - aerobic [-] | 0.0800 | 0.0800 |
| Endogenous fraction - anoxic [-] | 0.1030 | 0.1030 |
| Endogenous fraction - anaerobic [-] | 0.1840 | 0.1840 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| Yield (anoxic) [-] | 0.5400 | 0.5400 |
| Yield propionic (aerobic) [-] | 0.6400 | 0.6400 |
| Yield propionic (anoxic) [-] | 0.4600 | 0.4600 |
| Yield acetic (aerobic) [-] | 0.6000 | 0.6000 |
| Yield acetic (anoxic) [-] | 0.4300 | 0.4300 |
| Yield methanol (aerobic) [-] | 0.5000 | 0.5000 |
| Adsorp. max. [-] | 1.0000 | 1.0000 |
| Max fraction to N2O at high FNA over nitrate [-] | 0.0500 | 0.0500 |
| Max fraction to N2O at high FNA over nitrite [-] | 0.1000 | 0.1000 |

## Methylotrophs

| Name | Default | Value |
|---|---|---|
| Yield (anoxic) [-] | 0.4000 | 0.4000 |

| | | |
|---|---|---|
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| Max fraction to N2O at high FNA over nitrate [-] | 0.1000 | 0.1000 |
| Max fraction to N2O at high FNA over nitrite [-] | 0.1500 | 0.1500 |

## PAO

| Name | Default | Value |
|---|---|---|
| Yield (aerobic) [-] | 0.6390 | 0.6390 |
| Yield (anoxic) [-] | 0.5200 | 0.5200 |
| Aerobic P/PHA uptake [mgP/mgCOD] | 0.9300 | 0.9300 |
| Anoxic P/PHA uptake [mgP/mgCOD] | 0.3500 | 0.3500 |
| Yield of PHA on sequestration [-] | 0.8890 | 0.8890 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| N in sol. inert [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous part. [-] | 0.2500 | 0.2500 |
| Inert fraction of endogenous sol. [-] | 0.2000 | 0.2000 |
| P/Ac release ratio [mgP/mgCOD] | 0.5100 | 0.5100 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| Yield of low PP [-] | 0.9400 | 0.9400 |

## Acetogens

| Name | Default | Value |
|---|---|---|

| | | |
|---|---|---|
| Yield [-] | 0.1000 | 0.1000 |
| H2 yield [-] | 0.4000 | 0.4000 |
| CO2 yield [-] | 1.0000 | 1.0000 |
| N in biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Fraction to endogenous residue [-] | 0.0800 | 0.0800 |
| COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## Methanogens

| Name | Default | Value |
|---|---|---|
| Acetoclastic yield [-] | 0.1000 | 0.1000 |
| Methanol acetoclastic yield [-] | 0.1000 | 0.1000 |
| H2-utilizing yield [-] | 0.1000 | 0.1000 |
| Methanol H2-utilizing yield [-] | 0.1000 | 0.1000 |
| N in acetoclastic biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| N in H2-utilizing biomass [mgN/mgCOD] | 0.0700 | 0.0700 |
| P in acetoclastic biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| P in H2-utilizing biomass [mgP/mgCOD] | 0.0220 | 0.0220 |
| Acetoclastic fraction to endog. residue [-] | 0.0800 | 0.0800 |
| H2-utilizing fraction to endog. residue [-] | 0.0800 | 0.0800 |
| Acetoclastic COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |
| H2-utilizing COD:VSS ratio [mgCOD/mgVSS] | 1.4200 | 1.4200 |

## General

| Name | Default | Value |
|---|---|---|

| | | |
|---|---|---|
| Molecular weight of other anions [mg/mmol] | 35.5000 | 35.5000 |
| Molecular weight of other cations [mg/mmol] | 39.1000 | 39.1000 |
| Mg to P mole ratio in polyphosphate [mmolMg/mmolP] | 0.3000 | 0.3000 |
| Cation to P mole ratio in polyphosphate [meq/mmolP] | 0.1500 | 0.3000 |
| Ca to P mole ratio in polyphosphate [mmolCa/mmolP] | 0.0500 | 0.0500 |
| Cation to P mole ratio in organic phosphate [meq/mmolP] | 0.0100 | 0.0100 |
| Bubble rise velocity (anaerobic digester) [cm/s] | 23.9000 | 23.9000 |
| Bubble Sauter mean diameter (anaerobic digester) [cm] | 0.3500 | 0.3500 |
| Anaerobic digester gas hold-up factor [] | 1.0000 | 1.0000 |
| Tank head loss per metre of length (from flow) [m/m] | 0.0025 | 0.0025 |

## Mass transfer

| Name | Default | Value | |
|---|---|---|---|
| Kl for H2 [m/d] | 17.0000 | 17.0000 | 1.0240 |
| Kl for CO2 [m/d] | 10.0000 | 10.0000 | 1.0240 |
| Kl for NH3 [m/d] | 1.0000 | 1.0000 | 1.0240 |
| Kl for CH4 [m/d] | 8.0000 | 8.0000 | 1.0240 |
| Kl for N2 [m/d] | 15.0000 | 15.0000 | 1.0240 |
| Kl for N2O [m/d] | 8.0000 | 8.0000 | 1.0240 |
| Kl for O2 [m/d] | 13.0000 | 13.0000 | 1.0240 |

## Henry's law constants

| Name | Default | Value | |
|---|---|---|---|
| CO2 [M/atm] | 3.4000E-2 | 3.4000E-2 | 2400.0000 |
| O2 [M/atm] | 1.3000E-3 | 1.3000E-3 | 1500.0000 |

| | | | |
|---|---|---|---|
| N2 [M/atm] | 6.5000E-4 | 6.5000E-4 | 1300.0000 |
| N2O [M/atm] | 2.5000E-2 | 2.5000E-2 | 2600.0000 |
| NH3 [M/atm] | 5.8000E+1 | 5.8000E+1 | 4100.0000 |
| CH4 [M/atm] | 1.4000E-3 | 1.4000E-3 | 1600.0000 |
| H2 [M/atm] | 7.8000E-4 | 7.8000E-4 | 500.0000 |

## Physico-chemical rates

| Name | Default | Value | |
|---|---|---|---|
| Struvite precipitation rate [1/d] | 3.000E+10 | 3.000E+10 | 1.0240 |
| Struvite redissolution rate [1/d] | 3.000E+11 | 3.000E+11 | 1.0240 |
| Struvite half sat. [mgTSS/L] | 1.0000 | 1.0000 | 1.0000 |
| HDP precipitation rate [L/(molP d)] | 1.000E+8 | 1.000E+8 | 1.0000 |
| HDP redissolution rate [L/(mol P d)] | 1.000E+8 | 1.000E+8 | 1.0000 |
| HAP precipitation rate [molHDP/(L d)] | 5.000E-4 | 5.000E-4 | 1.0000 |

## Physico-chemical constants

| Name | Default | Value |
|---|---|---|
| Struvite solubility constant [mol/L] | 6.918E-14 | 6.918E-14 |
| HDP solubility product [mol/L] | 2.750E-22 | 2.750E-22 |
| HDP half sat. [mgTSS/L] | 1.0000 | 1.0000 |
| Equilibrium soluble PO4 with Al dosing at pH 7 [mgP/L] | 0.0100 | 0.0100 |
| Al to P ratio [molAl/molP] | 0.8000 | 0.8000 |
| Al(OH)3 solubility product [mol/L] | 1.259E+9 | 1.259E+9 |
| AlHPO4+ dissociation constant [mol/L] | 7.943E-13 | 7.943E-13 |
| Equilibrium soluble PO4 with Fe dosing at pH 7 [mgP/L] | 0.0100 | 0.0100 |

| | | |
|---|---|---|
| Fe to P ratio [molFe/molP] | 1.6000 | 1.6000 |
| Fe(OH)3 solubility product [mol/L] | 0.0500 | 0.0500 |
| FeH2PO4++ dissociation constant [mol/L] | 5.012E-22 | 5.012E-22 |

## Aeration

| Name | Default | Value |
|---|---|---|
| Alpha (surf) OR Alpha F (diff) [-] | 0.5000 | 0.5000 |
| Beta [-] | 0.9500 | 0.9500 |
| Surface pressure [kPa] | 101.3250 | 101.3250 |
| Fractional effective saturation depth (Fed) [-] | 0.3250 | 0.3250 |
| Supply gas CO2 content [vol. %] | 0.0350 | 0.0350 |
| Supply gas O2 [vol. %] | 20.9500 | 20.9500 |
| Off-gas CO2 [vol. %] | 2.0000 | 2.0000 |
| Off-gas O2 [vol. %] | 18.8000 | 18.8000 |
| Off-gas H2 [vol. %] | 0 | 0 |
| Off-gas NH3 [vol. %] | 0 | 0 |
| Off-gas CH4 [vol. %] | 0 | 0 |
| Surface turbulence factor [-] | 2.0000 | 2.0000 |
| Set point controller gain [] | 1.0000 | 1.0000 |

## Modified Vesilind

| Name | Default | Value |
|---|---|---|
| Maximum Vesilind settling velocity (Vo) [ft/min] | 0.387 | 0.387 |
| Vesilind hindered zone settling parameter (K) [L/g] | 0.370 | 0.370 |
| Clarification switching function [mg/L] | 100.000 | 100.000 |

| | | |
|---|---|---|
| Specified TSS conc.for height calc. [mg/L] | 2500.000 | 2500.000 |
| Maximum compactability constant [mg/L] | 15000.000 | 15000.000 |

## Double exponential

| Name | Default | Value |
|---|---|---|
| Maximum Vesilind settling velocity (Vo) [ft/min] | 0.934 | 0.934 |
| Maximum (practical) settling velocity (Vo') [ft/min] | 0.615 | 0.615 |
| Hindered zone settling parameter (Kh) [L/g] | 0.400 | 0.400 |
| Flocculent zone settling parameter (Kf) [L/g] | 2.500 | 2.500 |
| Maximum non-settleable TSS [mg/L] | 20.0000 | 20.0000 |
| Non-settleable fraction [-] | 0.0010 | 0.0010 |
| Specified TSS conc. for height calc. [mg/L] | 2500.0000 | 2500.0000 |

## Emission factors

| Name | Default | Value |
|---|---|---|
| Carbon dioxide equivalence of nitrous oxide | 296.0000 | 296.0000 |
| Carbon dioxide equivalence of methane | 23.0000 | 23.0000 |

## Biofilm general

| Name | Default | Value | |
|---|---|---|---|
| Attachment rate [ g / (m2 d) ] | 80.0000 | 80.0000 | 1.0000 |
| Attachment TSS half sat. [mg/L] | 100.0000 | 100.0000 | 1.0000 |

| | | | |
|---|---|---|---|
| Detachment rate [g/(m3 d)] | 8.000E+4 | 8.000E+4 | 1.0000 |
| Solids movement factor [] | 10.0000 | 10.0000 | 1.0000 |
| Diffusion neta [] | 0.8000 | 0.8000 | 1.0000 |
| Thin film limit  [mm] | 0.5000 | 0.5000 | 1.0000 |
| Thick film limit [mm] | 3.0000 | 3.0000 | 1.0000 |
| Assumed Film thickness for tank volume correction (temp independent) [mm] | 0.7500 | 0.7500 | 1.0000 |
| Film surface area to media area ratio - Max.[ ] | 1.0000 | 1.0000 | 1.0000 |
| Minimum biofilm conc. for streamer formation [gTSS/m2] | 4.0000 | 4.0000 | 1.0000 |

## Maximum biofilm concentrations [mg/L]

| Name | Default | Value | |
|---|---|---|---|
| Ordinary heterotrophic organisms (OHO) | 5.000E+4 | 5.000E+4 | 1.0000 |
| Methylotrophs | 5.000E+4 | 5.000E+4 | 1.0000 |
| Ammonia oxidizing biomass (AOB) | 1.000E+5 | 1.000E+5 | 1.0000 |
| Nitrite oxidizing biomass (NOB) | 1.000E+5 | 1.000E+5 | 1.0000 |
| Anaerobic ammonia oxidizers (AAO) | 5.000E+4 | 5.000E+4 | 1.0000 |
| Polyphosphate accumulating organisms (PAO) | 5.000E+4 | 5.000E+4 | 1.0000 |
| Propionic acetogens | 5.000E+4 | 5.000E+4 | 1.0000 |
| Methanogens - acetoclastic | 5.000E+4 | 5.000E+4 | 1.0000 |
| Methanogens - hydrogenotrophic | 5.000E+4 | 5.000E+4 | 1.0000 |
| Endogenous products | 3.000E+4 | 3.000E+4 | 1.0000 |
| Slowly bio. COD (part.) | 5000.0000 | 5000.0000 | 1.0000 |
| Slowly bio. COD (colloid.) | 4000.0000 | 4000.0000 | 1.0000 |
| Part. inert. COD | 5000.0000 | 5000.0000 | 1.0000 |
| Part. bio. org. N | 0 | 0 | 1.0000 |
| Part. bio. org. P | 0 | 0 | 1.0000 |
| Part. inert N | 0 | 0 | 1.0000 |
| Part. inert P | 0 | 0 | 1.0000 |

| | | | |
|---|---|---|---|
| Stored PHA | 5000.0000 | 5000.0000 | 1.0000 |
| Releasable stored polyP | 1.150E+6 | 1.150E+6 | 1.0000 |
| Fixed stored polyP | 1.150E+6 | 1.150E+6 | 1.0000 |
| Readily bio. COD (complex) | 0 | 0 | 1.0000 |
| Acetate | 0 | 0 | 1.0000 |
| Propionate | 0 | 0 | 1.0000 |
| Methanol | 0 | 0 | 1.0000 |
| Dissolved H2 | 0 | 0 | 1.0000 |
| Dissolved methane | 0 | 0 | 1.0000 |
| Ammonia N | 0 | 0 | 1.0000 |
| Sol. bio. org. N | 0 | 0 | 1.0000 |
| Nitrous Oxide N | 0 | 0 | 1.0000 |
| Nitrite N | 0 | 0 | 1.0000 |
| Nitrate N | 0 | 0 | 1.0000 |
| Dissolved nitrogen gas | 0 | 0 | 1.0000 |
| PO4-P (Sol. & Me Complexed) | 1.000E+10 | 1.000E+10 | 1.0000 |
| Sol. inert COD | 0 | 0 | 1.0000 |
| Sol. inert TKN | 0 | 0 | 1.0000 |
| ISS Influent | 1.300E+6 | 1.300E+6 | 1.0000 |
| Struvite | 8.500E+5 | 8.500E+5 | 1.0000 |
| Hydroxy-dicalcium-phosphate | 1.150E+6 | 1.150E+6 | 1.0000 |
| Hydroxy-apatite | 1.600E+6 | 1.600E+6 | 1.0000 |
| Magnesium | 0 | 0 | 1.0000 |
| Calcium | 0 | 0 | 1.0000 |
| Metal | 1.000E+10 | 1.000E+10 | 1.0000 |
| Other Cations (strong bases) | 0 | 0 | 1.0000 |
| Other Anions (strong acids) | 0 | 0 | 1.0000 |
| Total CO2 | 0 | 0 | 1.0000 |
| User defined 1 | 0 | 0 | 1.0000 |
| User defined 2 | 0 | 0 | 1.0000 |
| User defined 3 | 5.000E+4 | 5.000E+4 | 1.0000 |

| | | | |
|---|---|---|---|
| User defined 4 | 5.000E+4 | 5.000E+4 | 1.0000 |
| Dissolved oxygen | 0 | 0 | 1.0000 |

## Effective diffusivities [m2/s]

| Name | Default | Value | |
|---|---|---|---|
| Ordinary heterotrophic organisms (OHO) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Methylotrophs | 5.000E-14 | 5.000E-14 | 1.0290 |
| Ammonia oxidizing biomass (AOB) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Nitrite oxidizing biomass (NOB) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Anaerobic ammonia oxidizers (AAO) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Polyphosphate accumulating organisms (PAO) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Propionic acetogens | 5.000E-14 | 5.000E-14 | 1.0290 |
| Methanogens - acetoclastic | 5.000E-14 | 5.000E-14 | 1.0290 |
| Methanogens - hydrogenotrophic | 5.000E-14 | 5.000E-14 | 1.0290 |
| Endogenous products | 5.000E-14 | 5.000E-14 | 1.0290 |
| Slowly bio. COD (part.) | 5.000E-14 | 5.000E-14 | 1.0290 |
| Slowly bio. COD (colloid.) | 5.000E-12 | 5.000E-12 | 1.0290 |
| Part. inert. COD | 5.000E-14 | 5.000E-14 | 1.0290 |
| Part. bio. org. N | 5.000E-14 | 5.000E-14 | 1.0290 |
| Part. bio. org. P | 5.000E-14 | 5.000E-14 | 1.0290 |
| Part. inert N | 5.000E-14 | 5.000E-14 | 1.0290 |
| Part. inert P | 5.000E-14 | 5.000E-14 | 1.0290 |
| Stored PHA | 5.000E-14 | 5.000E-14 | 1.0290 |
| Releasable stored polyP | 5.000E-14 | 5.000E-14 | 1.0290 |
| Fixed stored polyP | 5.000E-14 | 5.000E-14 | 1.0290 |
| Readily bio. COD (complex) | 6.900E-10 | 6.900E-10 | 1.0290 |
| Acetate | 1.240E-9 | 1.240E-9 | 1.0290 |
| Propionate | 8.300E-10 | 8.300E-10 | 1.0290 |

| | | | |
|---|---|---|---|
| Methanol | 1.600E-9 | 1.600E-9 | 1.0290 |
| Dissolved H2 | 5.850E-9 | 5.850E-9 | 1.0290 |
| Dissolved methane | 1.963E-9 | 1.963E-9 | 1.0290 |
| Ammonia N | 2.000E-9 | 2.000E-9 | 1.0290 |
| Sol. bio. org. N | 1.370E-9 | 1.370E-9 | 1.0290 |
| Nitrous Oxide N | 1.607E-9 | 1.607E-9 | 1.0290 |
| Nitrite N | 2.980E-9 | 2.980E-9 | 1.0290 |
| Nitrate N | 2.980E-9 | 2.980E-9 | 1.0290 |
| Dissolved nitrogen gas | 1.900E-9 | 1.900E-9 | 1.0290 |
| PO4-P (Sol. & Me Complexed) | 2.000E-9 | 2.000E-9 | 1.0290 |
| Sol. inert COD | 6.900E-10 | 6.900E-10 | 1.0290 |
| Sol. inert TKN | 6.850E-10 | 6.850E-10 | 1.0290 |
| ISS Influent | 5.000E-14 | 5.000E-14 | 1.0290 |
| Struvite | 5.000E-14 | 5.000E-14 | 1.0290 |
| Hydroxy-dicalcium-phosphate | 5.000E-14 | 5.000E-14 | 1.0290 |
| Hydroxy-apatite | 5.000E-14 | 5.000E-14 | 1.0290 |
| Magnesium | 7.200E-10 | 7.200E-10 | 1.0290 |
| Calcium | 7.200E-10 | 7.200E-10 | 1.0290 |
| Metal | 4.800E-10 | 4.800E-10 | 1.0290 |
| Other Cations (strong bases) | 1.440E-9 | 1.440E-9 | 1.0290 |
| Other Anions (strong acids) | 1.440E-9 | 1.440E-9 | 1.0290 |
| Total CO2 | 1.960E-9 | 1.960E-9 | 1.0290 |
| User defined 1 | 6.900E-10 | 6.900E-10 | 1.0290 |
| User defined 2 | 6.900E-10 | 6.900E-10 | 1.0290 |
| User defined 3 | 5.000E-14 | 5.000E-14 | 1.0290 |
| User defined 4 | 5.000E-14 | 5.000E-14 | 1.0290 |
| Dissolved oxygen | 2.500E-9 | 2.500E-9 | 1.0290 |

## EPS Strength coefficients [ ]

| Name | Default | Value | |
|---|---|---|---|
| Ordinary heterotrophic organisms (OHO) | 1.0000 | 1.0000 | 1.0000 |
| Methylotrophs | 1.0000 | 1.0000 | 1.0000 |
| Ammonia oxidizing biomass (AOB) | 5.0000 | 1.0000 | 1.0000 |
| Nitrite oxidizing biomass (NOB) | 25.0000 | 1.0000 | 1.0000 |
| Anaerobic ammonia oxidizers (AAO) | 10.0000 | 1.0000 | 1.0000 |
| Polyphosphate accumulating organisms (PAO) | 1.0000 | 1.0000 | 1.0000 |
| Propionic acetogens | 1.0000 | 1.0000 | 1.0000 |
| Methanogens - acetoclastic | 1.0000 | 1.0000 | 1.0000 |
| Methanogens - hydrogenotrophic | 1.0000 | 1.0000 | 1.0000 |
| Endogenous products | 1.0000 | 1.0000 | 1.0000 |
| Slowly bio. COD (part.) | 1.0000 | 1.0000 | 1.0000 |
| Slowly bio. COD (colloid.) | 1.0000 | 1.0000 | 1.0000 |
| Part. inert. COD | 1.0000 | 1.0000 | 1.0000 |
| Part. bio. org. N | 1.0000 | 1.0000 | 1.0000 |
| Part. bio. org. P | 1.0000 | 1.0000 | 1.0000 |
| Part. inert N | 1.0000 | 1.0000 | 1.0000 |
| Part. inert P | 1.0000 | 1.0000 | 1.0000 |
| Stored PHA | 1.0000 | 1.0000 | 1.0000 |
| Releasable stored polyP | 1.0000 | 1.0000 | 1.0000 |
| Fixed stored polyP | 1.0000 | 1.0000 | 1.0000 |
| Readily bio. COD (complex) | 0 | 0 | 1.0000 |
| Acetate | 0 | 0 | 1.0000 |
| Propionate | 0 | 0 | 1.0000 |
| Methanol | 0 | 0 | 1.0000 |
| Dissolved H2 | 0 | 0 | 1.0000 |
| Dissolved methane | 0 | 0 | 1.0000 |
| Ammonia N | 0 | 0 | 1.0000 |
| Sol. bio. org. N | 0 | 0 | 1.0000 |
| Nitrous Oxide N | 0 | 0 | 1.0000 |
| Nitrite N | 0 | 0 | 1.0000 |

| | | | |
|---|---|---|---|
| Nitrate N | 0 | 0 | 1.0000 |
| Dissolved nitrogen gas | 0 | 0 | 1.0000 |
| PO4-P (Sol. & Me Complexed) | 1.0000 | 1.0000 | 1.0000 |
| Sol. inert COD | 0 | 0 | 1.0000 |
| Sol. inert TKN | 0 | 0 | 1.0000 |
| ISS Influent | 0.3300 | 0.3300 | 1.0000 |
| Struvite | 1.0000 | 1.0000 | 1.0000 |
| Hydroxy-dicalcium-phosphate | 1.0000 | 1.0000 | 1.0000 |
| Hydroxy-apatite | 1.0000 | 1.0000 | 1.0000 |
| Magnesium | 0 | 0 | 1.0000 |
| Calcium | 0 | 0 | 1.0000 |
| Metal | 1.0000 | 1.0000 | 1.0000 |
| Other Cations (strong bases) | 0 | 0 | 1.0000 |
| Other Anions (strong acids) | 0 | 0 | 1.0000 |
| Total CO2 | 0 | 0 | 1.0000 |
| User defined 1 | 0 | 0 | 1.0000 |
| User defined 2 | 0 | 0 | 1.0000 |
| User defined 3 | 1.0000 | 1.0000 | 1.0000 |
| User defined 4 | 1.0000 | 1.0000 | 1.0000 |
| Dissolved oxygen | 0 | 0 | 1.0000 |

Meridian Alternative's Analysis version 1

Expansion using selectable 5 stage modified Bardenpho/A2O process

Tank sizes optimized based on individual simulations from A2O and 5 stage modified Bardenpho processes

<u>To achieve target effluent concentrations, for Bardenpho process:</u>
Set BDF IMLR at 200% influent, Set A2O IMLR at 0%
Set Swing 1 Aerated, Swing 2a and 2b unaerated.
SRT = 12 days
Acetate flow pace at 0.8% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 0.5% of PE flow rate, 1% methanol solution. All methanol to swing 2a

<u>To achieve target effluent concentrations, for A2O process:</u>
Set BDF IMLR at 0% influent, Set A2O IMLR at 400%
Set Swing 1 unaerated, Swing 2a and 2b aerated.
SRT = 12 days
Acetate flow pace at 0.6% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 1.5% of PE flow rate, 1% methanol solution. all methanol to Anoxic 1a

INFILCO
DEGREMONT INC.

# BIOFOR®

BIOLOGICAL AERATED FILTRATION SYSTEM

# BUDGET PROPOSAL

**PROJECT:** BOISE, ID WWTP

**ENGINEER:** BROWN & CALDWELL

**PROPOSAL#:** 50157596.01

**DATE:** MARCH 24, 2015

COMMITTED TOGETHER TO WATER, A SOURCE OF LIFE


**REGIONAL BUSINESS MANAGER:**
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March 24, 2015

Stephanie Fevig
Brown and Caldwell, Inc.

Re: Boise, ID Project
BIOFOR® Biological Filtration System

Dear Ms. Fevig:

With regard to your request for a BIOFOR® design for the wastewater facility located in Boise, ID, IDI is pleased to submit the following preliminary design proposal. This proposal describes a BIOFOR® N design for nitrification followed by a BIOFOR® DN at a design water temperature of 14 $^oC$.

The BIOFOR® N system consists of four (8) filter cells sized as follows to produce 14.2 MGD:

BIOFOR® N: 8 cells, 1200 $ft^2$ (32.0' x 37.5').

The BIOFOR® DN system consists of six (6) filter cells sized as follows to produce 14.2 MGD:

BIOFOR® DN: 6 cells, 550 $ft^2$ (22.0' x 25.0').

The system is sized for treating a design influent flow of 14.2 MGD with one cell in standby each for the BIOFOR® N stage and BIOFOR® DN. We have endeavored to provide complete information in this proposal. However, if you have any questions or need additional information, please don't hesitate to contact our Regional Business Manager, Susan Pilgram, our local representative, Scott Marshall, or me directly.

Sincerely,

Brian McGovern
Senior Process Engineer - Biological Systems Group

# TABLE OF CONTENTS

# 1. BIOFOR®- General Description

The BIOFOR® is a biological, submerged filter containing a fixed, dense granular bed with influent water flowing in the upward direction. The BIOFOR® Process is applied individually or in separate stages for nitrification (BIOFOR® -"N"), and denitrification (BIOFOR® -"DN"). In the BIOFOR® N process air is introduced at the bottom of the media bed and flows co-currently with the influent water. In the BIOFOR® DN an external carbon source is mixed with the filter influent.

The BIOFOR® is based on the following basic principles:

- a single layer of granular BIOLITE media for biomass attachment and retention of suspended solids.
- a discrete process air distribution system (for aerated systems only)
- upflow, co-current distribution of air and water
- backwash sequence automated and optimized per application requirements

***BIOLITE™ Media***

BIOLITE media is an expanded clay material with a high specific surface area, low density, and good resistance to attrition. The porosity of the material ensures biomass attachment. Different particle sizes ranging from 1mm to 5mm are available depending on the application.

***OXAZUR® Air Diffusers***

OXAZUR air diffusers, present in all aerated BIOFOR® units, are aerating devices with elastic rubber membranes enclosed in a polypropylene casing. The diffusers are installed on a series of process air distribution pipes located at the bottom of the media bed, directly above the plenum. The combination of diffused air and media retention produces a highly efficient aeration system with fine bubble diffusion characteristics. In order to assure homogeneous distribution over long-term operation, a pressurized cleaning water system is provided and operated approximately once per month to flush the diffusers.

### *Upflow Distribution of Air and Water*

Distribution of process air and influent water is upward through the BIOLITE media. This co-current, upward flow ensures an even distribution of water and air. It enables the media to retain solids and biomass throughout the entire bed depth and prevents short-circuiting and gas entrapment. In anoxic, denitrifying systems, nitrogen gas bubbles are continuously and effectively released from the media to atmosphere. The media operates in slight expansion, thereby ensuring full use of the available media volume and allowing high hydraulic loading rates.

### *MONOFLOR® Underdrain*

Concrete BIOFOR® installations have the distribution nozzles located in the poured-in-place filter floor. To ensure an accurate, grout-free installation, the MONOFLOR underdrain is used. This underdrain is simple to install, leak-proof, and has been widely used on filter systems for many years.

### *Backwash Sequence*

Backwash sequences for biological aerated filters must comply with several requirements:

- The filter bed must be cleaned of retained solids and excess biomass
- Sufficient biomass must remain in the reactor following a backwash
- Air and water flows must not cause filter media to be lost
- Water and energy consumption must be minimized
- The backwash sequence must be initiated and carried out automatically.

The standard BIOFOR® backwash sequence has been developed specifically to meet the requirements listed above. The backwash sequence may be optimized during start-up and can be modified based on operating experience.

The sequence may be initiated manually, on operating time, or upon reaching a pre-set terminal headloss. The main steps of the sequence are :

- quick drain to backflush the influent distribution nozzles
- air scour
- a series of simultaneous air/water washes
- water rinse

## 2. Design Conditions

The Submerged Biological Filter, BIOFOR® System, described herein is a dual-stage water treatment system designed for the reduction of ammonia nitrogen and nitrate nitrogen.

The dual-stage biofilter system will be furnished and installed as described herein. The system is based on treating influent water with the following characteristics:

| Influent Parameter | |
|---|---|
| Average Daily Flow – MGD | 11.3 |
| Max Month Flow – MGD | 14.2 |
| Total K Nitrogen (TKN) – mg/L | 42.0 |
| Ammonia Nitrogen ($NH_3$-N) – mg/L | 40.0 |
| Biological Oxygen Demand ($CBOD_5$) – mg/L | 20.0 |
| Total Suspended Solids (TSS) – mg/L | 20.0 |
| Design Water Temperature:  °C | 14.0 |

The BIOFOR®-N and DN system described herein shall be designed to achieve the following monthly effluent quality for the specified flow:

| Effluent Requirements | |
|---|---|
| Ammonia Nitrogen – $NH_3$-N – mg/L | $\leq$ 0.5 |
| Nitrate Nitrogen – $NO_3$-N – mg/L | $\leq$ 8.0 |
| Biological Oxygen Demand ($CBOD_5$) – mg/L | $\leq$ 20.0 |
| Total Suspended Solids (TSS) – mg/L | $\leq$ 20.0 |

The BIOFOR® N system consists of Eight (8) filters of dimensions 1200 $ft^2$ (32.0’ x 37.5’). The system will be capable of treating the design flow to meet the effluent requirements listed above with one cell in standby or backwash.

The BIOFOR® DN system consists of Six (6) filters of dimensions 550 $ft^2$ (22.0’ x 25.0’). The system will be capable of treating the design flow to meet the effluent requirements listed above with one cell in standby or backwash.

### 2.1 Description of Operation

Water is pumped to a flow channel for the BIOFOR®-N and DN units and is evenly distributed to the cells through a series of weirs in the central gallery. Water to be treated is introduced into the plenum and flows upward through the BIOLITE™ media. As the water and process airflows co-currently through the media bed, attached heterotrophic biomass oxidizes carbonaceous and nitrate compounds, autotrophic biomass oxidizes ammonia and suspended solids and biomass are retained.

Due to solids retention and biomass growth within the filter media, backwashing of the BIOFOR® units is necessary to remove retained solids and maintain a thin, active biofilm. Backwashing is initiated either manually or automatically, based upon elapsed time or on reaching a pre-set terminal headloss. The backwash sequence includes a number of distinct steps, the duration and extent of each step being optimized during plant start-up and modified based on operating experience. The basic backwash sequence includes the following steps:

- Quick drain to backflush the underdrain nozzles
- Air scour
- Combination air and water backwash
- Water rinse
- Repeat of the above steps three times
- Water rinse with influent water (filter to waste)

A centrifugal pump from the clearwell supplies clean water used for backwashing the cells. The backwash water flow rate can be controlled with an automatic flow control valve while a positive displacement blower supplies air used for air scour. Spare, installed units are provided for both the air scour blower and backwash water supply pump.

Water from the quick drain step is collected in a drain sump and typically flows into the backwash waste tank. Water from the remaining steps collects in a common backwash flume and flows to the backwash waste storage tank. Stored backwash water is normally returned to the head of the plant; if necessary, it may need to be treated in a separate side stream due to backwashing considerations.

# 3. BIOLOGICAL REACTORS

Infilco Degremont, Inc. will provide fourteen (14) upflow, biological, submerged fixed-film reactors; with BIOLITE media for biomass support: Eight (8) BIOFOR® -"N" aerobic reactors and Six (6) BIOFOR® -"DN" anaerobic reactors.

## *3.1 BIOFOR® N & DN*

| | BIOFOR® N Design |
|---|---|
| **Unit Filtration Area** | 1200 $ft^2$ |
| **Total Number of Cells** | 8 |
| **Biolite Media Depth** | 12 ft – 2 inches |

| | BIOFOR® DN Design |
|---|---|
| **Unit Filtration Area** | 550 $ft^2$ |
| **Total Number of Cells** | 6 |
| **Biolite Media Depth** | 9 ft – 6 inches |

Each reactor will consist of a concrete tank with monolithic underdrain (MONOFLOR®), bottom influent and air/water backwash distribution system, process air distribution system for N cells only, granular expanded clay media, gravel support bed, influent channel, effluent and backwash waste channels with stilling baffle. Common instrumentation furnished by IDI includes: process air blowers, air distribution system cleaning pump, air scour blowers, backwash pumps, controls and instrumentation and all associated automatic valves and skid piping. An additional Methanol dosing system will be required as a carbon source for the denitrifying bacteria population for the BIOFOR® DN.

## *3.2 Backwashing*

The BIOFOR® reactors will be washed periodically by a sequence of air scour, combination air scour/backwash water, and water only rinse steps. Water used to backwash the biofilter reactors will be pumped from a separate clearwell supplied by others. The air scour blower capacity is based on a maximum air scour rate of 5.8 scfm/sq.ft. of filter media. The backwash pump system is sized for a maximum backwash water rate of 12.0 gpm/sq.ft. of filter media.

| | BioFOR N and DN |
|---|---|
| **Clean Water Tank Volume** | 360,000 gal |
| **Dirty Water Tank Volume** | 425,000 gal |

# 4. SCOPE OF SUPPLY

## *4.1 BIOFOR®-N & DN Filter Modules*

BIOFOR® N and DN Reactors with all internals and required wall pieces.

Each reactor will include the following:

- Equipment for MONOFLOR underdrain including forms, polyethylene nozzles and accessories.
- One (1) – Tranquilizer (stilling) baffle consisting of staggered vertical aluminum slats extending across the width of the reactor. Installation of the tranquilizer baffle is by others.
- Process air distribution system in 316 stainless steel with OXAZUR® air diffusers (for BIOFOR® N only)

## *4.2 Media and Support Gravel*

- Support gravel, 20" depth in the BIOFOR®-N reactor (includes 5% extra)
- Support gravel, 12" depth in the BIOFOR®-DN reactor (includes 5% extra)
- BIOLITE-"L" media, 2.7 mm, to 12'-2" depth in the BIOFOR®-N reactors (includes 10% extra)
- BIOLITE-"P" media, 3.5 mm, to 9'-6" depth in the BIOFOR®-DN reactors (includes 10% extra)

| | N Design<br>8 Filters |
|---|---|
| **Total Gravel Volume - $ft^3$** | 16,800 |
| **Biolite L 2.7 Media Volume - $ft^3$** | 127,780 |

| | DN Design<br>6 Filters |
|---|---|
| **Total Gravel Volume - $ft^3$** | 3,470 |
| **Biolite L 2.7 Media Volume - $ft^3$** | 34,490 |

### 4.3 Centrifugal Pumps

3 - Common Backwash supply pumps, horizontal centrifugal type rated for 60' TDH (2 x 100% duty) and one (1 x 100%) Spare will be provided for the whole BIOFOR system. The BIOFOR N cells will require the operation of two pumps and the BIOFOR DN cells will require the operation of one pump.

| | BIOFOR® N |
|---|---|
| | Flow |
| **Backwash Pump Capacity** | 14,721 gpm |

| | BIOFOR® DN |
|---|---|
| | Flow |
| **Backwash Pump Capacity** | 6,747 gpm |

2 - Air distribution system cleaning pumps, horizontal centrifugal type 120' TDH (One duty and one standby) for BIOFOR® N cells

| | BIOFOR® N |
|---|---|
| | Flow |
| **Cleaning Pump Capacity** | 3,680 gpm |

Pumps will be skidded on a structural steel base with required piping, valves, flange fittings and accessories - fully assembled.

### 4.4 Blowers and Appurtenances

9 - One process air blower dedicated to each BIOFOR® N reactor. Rotary lobe type rated for 11.5 psig (1 x 100% duty per cell) and one (1 x 100%) common spare for all for BIOFOR® N Cells combined

| | BIOFOR® N |
|---|---|
| | Flow |
| **Process Air Blower Capacity** | 709 scfm |

3 - Common Air scour blowers, rotary lobe type, rated for 12.5 psig (2 x 100% duty) and one (1 x 100%) Spare for the whole system. The BIOFOR N cells will require the operation of two blowers and the BIOFOR DN cells will require the operation of one blower.

| | BIOFOR® N |
|---|---|
| | Flow |
| **Air Scour Blower Capacity** | 6,334 scfm |

| | BIOFOR® DN |
|---|---|
| | Flow |
| **Air Scour Blower Capacity** | 3,228 scfm |

Each blower provided with:

- Motor
- V-belt drive
- Inlet filter/silencer and outlet silencer
- Check valve
- Manual valve for outlet isolation
- Relief valve
- Flexible connections
- Discharge pressure gauge
- Acoustic enclosure, to meet 85 dBA free field noise requirements.

Blowers shipped to site skidded on separate structural steel bases, assembled with piping, silencers, valves and fittings.

An automatic by-pass flow control valve is included with each air scour blower.

### *4.5 Compressed Air for Automatic Valves*

One (1) – Compressed Air System, provided with:

- One (1) – dual-head reciprocating type compressor rated for 15 scfm at 100 psig
- One (1) – standby head
- One (1) – 200 gallon carbon steel receiver
- Air dryer
- Required relief, exit, and blowdown valves
- Pressure gauges

Note: System shipped to site pre-piped and skidded on a structural steel base.

Pneumatic tubing, valves, and appurtenances for air feed to automatic valves are by others.

### *4.6 Automatic and Manual Valves*

| | BIOFOR®-N | |
|---|---|---|
| **Valve Type - Open/Close** | **Quantity** | **Diameter** |
| **Influent** | 8 | 12” |
| **Process Air, Cleaning Water** | 8 | 8” |
| **Backwash Water Inlet** | 8 | 30” |
| **Air Scour Inlet** | 8 | 18” |
| **Air Cushion Vent** | 8 | 2.5” |
| **Backwash Waste** | 8 | 36” |
| **Quick Drain** | 8 | 14” |

| | BIOFOR®-DN | |
|---|---|---|
| **Valve Type - Open/Close** | **Quantity** | **Diameter** |
| **Influent** | 6 | 10” |
| **Backwash Water Inlet** | 6 | 20” |
| **Air Scour Inlet** | 4 | 12” |
| **Air Cushion Vent** | 4 | 3.5” |
| **Backwash Waste** | 4 | 24” |
| **Quick Drain** | 4 | 10” |

| Valve Type – Modulating | Design Quantity | Design Diameter |
|---|---|---|
| Air Scour Vent Flow Control | 1 | 18” |
| Backwash Water Flow Control | 1 | 30” |

- All automatic open/close valves are butterfly type equipped with double-acting pneumatic cylinder actuators. Solenoids are mounted directly on actuators. Positioners are pneumatic. Valves include open and close limit switches.

- There are no manual valves included in IDI’s Scope of Supply.

### *4.7 Flow Screens and Strainers*

| Strainer Type | Design Quantity | Design Diameter |
|---|---|---|
| Oxazur Cleaning Strainer | 1 | 8” |
| Backwash Inlet Strainer | 1 | 30” |
| Inlet Strainer | TBD | 12” N |
| | TBD | 10” DN |

- Backwash inlet strainers – In-line Y-Type, (one per system with one spare), 2.4-mm stainless steel mesh, carbon steel body with flanged ends
- Air distributor cleaning header strainers – in-line Y-Type, 2.4-mm stainless steel mesh, carbon steel body with flanged ends.

- All required process flow screens or strainers – If pumped, the system shall be provided with In-line Y-Type strainers. If flow by gravity, the system shall be provided with stainless steel wedge wire rundown screens.

### *4.8 Controls and Instrumentation*

- One (1) – PLC/PC control system, mounted in a free-standing NEMA 12 enclosure.

**Field Instruments – BIOFOR N and DN**

| Field Instruments – Lot | Design Quantity |
|---|---|
| Pressure Transmitters (Cell) | 14 |
| Pressure Transmitters (Plenum) | 14 |

Lot – pressure gauges, local indication only

**General Instruments**

| General Instruments – Lot | Design Quantity | Diameter |
|---|---|---|
| Backwash Flowmeter/Transmitter | 1 | 30" |
| Air Scour Flowmeter/Transmitter | 1 | 16" |
| Process Air Flowmeter/Transmitter | 8 | 6" |
| Level Transmitters* | 16 | N/A |
| Dissolved Oxygen (DO) Probe | 9 | N/A |
| Online Nitrate Analyzer | 2 | N/A |
| B/W Strainer Diff. Pressure Gauges | 1 | 30" |

**** Ultrasonic Level Transmitters located at Clearwell, Mudwell and individual cells***

### *4.9 Field Service*

Thirty (30) days total service time by a qualified, factory-trained service engineer to inspect the BIOFOR® equipment installation, provide start-up assistance and training of operations personnel.

Also included: Four (4) O & M Manuals.

## 5. Items By Others

The following items are specifically not by Infilco Degremont. They may or may not be required.

| General | |
|---|---|
| • Backwash Waste Holding Tank and Clearwell | • Motor Control Center (MCC) |
| • Chemical Feed Systems for alkalinity correction, methanol and defoamer | • Non-potable water supply |
| • Chemicals for operation: Including methanol, alkaline solution, defoamer | • Overflow structures including baffles and weir plates |
| • Cleanouts | • Power |
| • Concrete | • Sludge handling and disposal |
| • Control Panel | • Support Platforms |
| • Drains | • Transformers |
| • Engines/Generators | • Variable Frequency Drives |
| • Foam control | • Ventilation |
| • Hoses /Bibs | • Walkways/Roofing/Stairs/Gratings/Handrails |
| • Laboratory | • Wireways/Wiring |
| • Ladders | • Yard Hydrants |
| • Lighting | • Yard Piping |
| • Liquid sampling and analytical work | • |

## 6. Items By Installing Contractor

1. Obtain necessary construction permits and licenses, construction drawings (including interconnecting piping drawings) field office space, telephone service, and temporary electrical service.
2. All site preparation, grading, locating foundation placement, excavation for foundation, underground piping, conduits and drains.
3. Demolition and/or removal of any existing structures, equipment or facilities required for construction and installation of the BIOFOR® system.
4. Installation of all foundation - supply and installation of all embedded or underground piping, conduits and drains.
5. All backfill, compaction, finish grading, earthwork and final paving.
6. Receiving (preparation of receiving reports), unloading, storage, maintenance preservation and protection of all equipment and materials supplied by Infilco.
7. Installation of all equipment and materials supplied by Infilco.
8. Supply, fabrication, installation, cleaning, pickling and/or passivation of all interconnecting steel piping components.
9. Provide and install all embedded pipe sections and valves for tank drains and reactor inlets and elbows.
10. All cutting, welding, fitting and finishing for all field fabricated piping.
11. Supply and installation of all flange gaskets and bolts for all piping components.
12. Supply and installation of all pipe supports and wall penetrations.
13. Install and provide all motor control centers, motor starters, panels, field wiring, wireways, supports and transformers.
14. Install all control panels and instrumentation as supplied by Infilco, as applicable.
15. Supply and install all electrical power and control wiring and conduit to the equipment served plus interconnection between the Infilco equipment as required, including wire, cable, junction boxes, fittings, conduit, cable trays, safety disconnect switches, circuit breakers, etc.
16. Supply and install all insulation, supports, drains, gauges, hold down clamps, condensate drain systems, flanges, flex pipe joints, expansion joints, boots, gaskets, adhesives, fasteners, safety signs, and any specialty items such as traps.
17. All labor, materials, supplies and utilities as required for start-up including laboratory facilities and analytical work.
18. Provide all chemicals required for plant operation and all chemicals, lubricants, glycol, oils or grease and other supplies thereafter.

19. Install all anchor bolts and mounting hardware supplied by Infilco; and supply and install all anchor bolts and mounting hardware not specifically supplied by Infilco.
20. Provide all nameplates, safety signs and labels.
21. Provide all additional support beams and/or slabs.
22. Provide and install all manual valves.
23. Provide and install all piping required to interconnect to the Infilco's equipment.
24. The Contractor shall coordinate the installation and timing of interface points such as piping and electrical with the Infilco Supplier.

***All other necessary equipment and services not otherwise listed as specifically supplied by Infilco.***

## 7. Budget Estimate

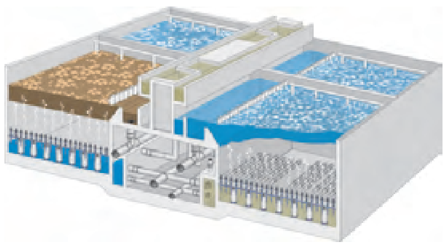
**PURCHASE PRICE**: **As Advised By Rep**

(Exclusive of taxes per Condition 6 of IDI Conditions of Sale)

1. Our Price and Payment Terms are based on IDI's standard terms and conditions, which can be provided upon request.
2. Shipping Terms: FOB Shipping point, freight allowed.
3. This price will be valid for thirty (30) days.
4. All prices are excluding state sales and use taxes and any federal taxes which shall be the sole responsibility of the Purchaser. No additional duties will have to be paid for the equipment supplied by IDI.
5. Pricing is subject to the escalation indices for the items in scope of supply calculated from the original proposal date and is in accordance with the Scope of Supply and terms of this proposal and any changes that may require the price to be adjusted. The type of escalation indices can be discussed further and mutually agreed upon.

# INFILCO
# BIOFOR®
Biological Aerated Filtration System

WASTEWATER



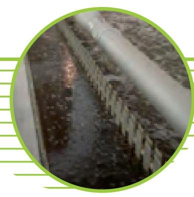
BIOFOR® filters are aerobic or anoxic biological reactors that use attached growth technology for application in municipal or industrial wastewater treatment.

## APPLICATIONS

- » BIOFOR® C for BOD, COD and TSS removal
- » BIOFOR® N for nitrification of ammonia nitrogen
- » BIOFOR® C+N for simultaneous BOD removal and nitrification
- » BIOFOR® pre-DN for nitrate removal as a predenitrifcation step without additional carbon source
- » BIOFOR® post-DN for nitrate removal as a final denitrification step with carbon addition

## MAIN FEATURES

- » Upflow filtration in which feedwater flow expands the filter media leading to an even distribution of the biomass throughout the bed
- » Co-current flow of feedwater and air prevents short circuiting and also extends the length of filter run times
- » Quick adaptability to flow and load variations
- » Exclusive nozzle floor design which allows for optimum distribution of fluids during filtration as well as wash sequences
- » Highly efficient washing system to accommodate filter bed depths up to 13 ft (4.0 m)



## BIOFOR® SPECIFIC TECHNOLOGY

The BIOFOR® process is used primarily for the removal of BOD, TSS and ammonia pollution in secondary and tertiary treatment. BIOFOR® units discharge treated water that conforms to high quality standards for every parameter thanks to the filtering action of the Biolite filter media.

Because BIOFOR® is designed to treat higher organic loadings than conventional systems, the units can accommodate higher filtration velocities. The BIOFOR® units allow treatment of soluble pollution and solids separation in one compact reactor, so no secondary clarifiers are necessary. The PLC based control system automates the filter operation.

suez environnement Degrémont

## HOW IT WORKS

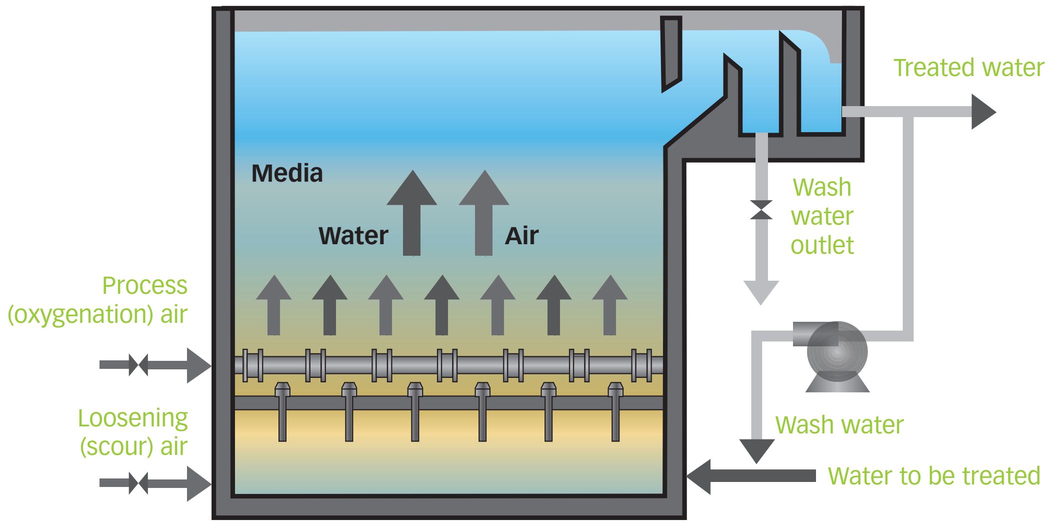
The effluent to be treated enters continuously from the bottom of the reactor and is distributed over the entire filter surface area by the nozzle underdrain.The water then passes through the Biolite filter media which retains the suspended solids. Carbonaceous and nitrogenous pollution is eliminated through the high concentration of fixed-film biomass which is retained on the filter media during the filtration cycle.

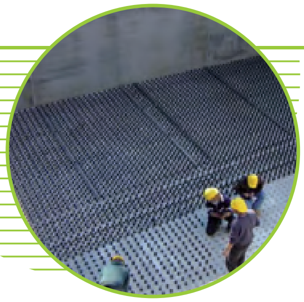
In the aerated versions (for BOD removal and nitrification) process air is introduced continuously into the lower part of the reactor by Oxazur® air diffusers.

The use of a co-current upflow design helps to limit odor generation since the treated water is situated at the surface of the filter (in contact with the atmosphere), and the untreated water enters at the bottom of the filter.

The number of filters in filtration service is according to the flow entering the plant. During low flow periods, off-duty filters are aerated periodically to maintain the biomass in optimum condition.Since filters can be taken out of service when not required, operating costs (due to process air production) can be reduced.

**BIOFOR®** PROCESS



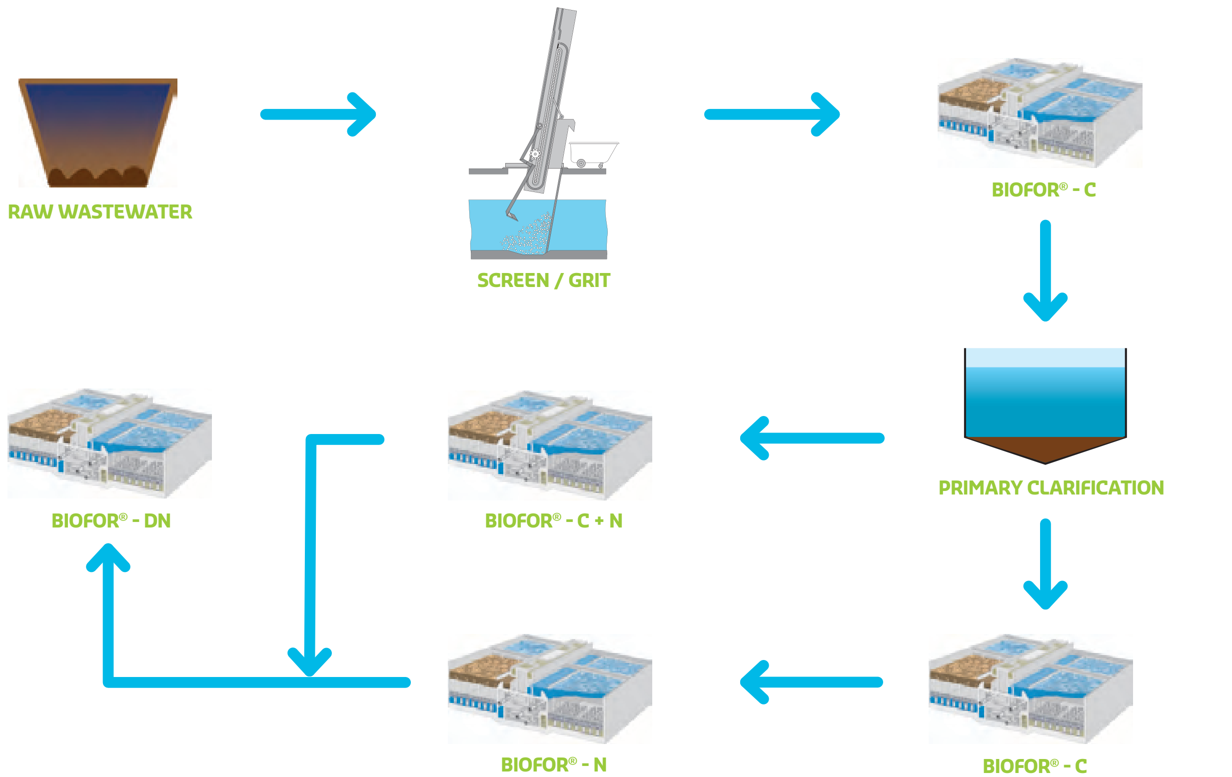



- Periodically the BIOFOR® filter is washed after a pre-determined run time (24 or 48 hours) or due to a headloss build-up in the filter.
- Filtered water and scour air are used to efficiently clean the filter, preparing it for the next filter run.
- The water for the backwashes is drawn from a dedicated clean backwash tank using pumps.
- The backwash waste water is collected in a dirty backwash water tank for pumping to the backwash water treatment.

## PRODUCT HIGHLIGHTS

- » Applicable to cold water operation
- » Easily adapts to variable flows and pollution loads
- » Treats dilute effluents
- » Excellent solution where limited space is available
- » Very limited odor production
- » Because of small foot-print, can be easily covered and enclosed
- » Modular construction allows for easy plant expansions in the future
- » Eliminates the need for secondary clarifiers

## BIOFOR® TREATMENT LINE




## TECHNICAL ADVANTAGES

- Valves and machinery (pumps / blowers) can be installed indoors for easy and convenient maintenance.
- Availaible in sizes up to 1,935 ft2 (180 m²) per filter.
- Variable numbers of filters can allow for energy savings during low flow periods.

## DESIGN LOADING

| Application | Performance | |
|---|---|---|
| BOD removal | Filtration rate | 1.2 - 4.9 gpm/ft² (3-12 m/h) |
| | Loading | 90 - 360 lb/kft³ per day<br>(2 - 8 kg $BOD_5$/m³ per day) |
| Nitrification | Filtration rate | 1.2 - 6.6 gpm/ft² (3-16 m/h) |
| | Loading | 20 - 90 lb/kft³ per day<br>(0.5 - 2 kg $NH_3$ - N/m³ per day) |
| Pre-denitrification | Filtration rate | 4.1 - 14.3 gpm/ft² (10-35 m/h) |
| | Loading | 135 - 310 lb/kft³ per day<br>(3 - 7 kg $NO_3$ - N/m³ per day) |
| Post-denitrification | Filtration rate | 4.1 - 12.3 gpm/ft² (10-30 m/h) |
| | Loading | 45 - 70 lb/kft³ per day<br>(1-1.5 kg/$NO_3$ - N/m³ per day) |

## TECHNICAL FEATURES

» TSS and BOD removal to < 10 mg/L

» Ammonia removal to < 1 mg/L $NH_3$-N

» Nitrate removal to < 1 mg/L $NO_3$-N

» Total Nitrogen removal to < 3 mg/L TN

» Aeration oxygen transfer efficiency of 15 - 25%

## COMPLETE TREATMENT SOLUTIONS

Infilco Degremont offers an array of water, wastewater and industrial treatment solutions for any size client. Headworks, clarification, filtration, biological and disinfection systems are several of the product disciplines in our portfolio.

With a variety of filtration and clarification products in our SEPARATIONS department, Infilco engineers carefully evaluate each application to provide the most cost-effective and efficient treatment solution.

If interested in this product, check out some of our complementary products:

- ABW® Automatic Backwash Filter
- AquaDAF® Clarifier
- Cleargreen™
- DensaDeg® Clarifier/Thickener
- Ferazur®/Mangazur®
- Meteor® IFAS/MBBR
- Ultragreen™
- Climber Screen®
- Vortex®
- Cannon® Mixer
- 2PAD
- Thermylis® HTFB

## PILOTING SERVICES

Infilco Degremont offers pilot systems and services for this and many other of our product offerings. Pilot studies are a practical means of optimizing physical-chemical and biological process designs and offer the client several benefits, such as:

- Proof of system reliability
- Optimal design conditions for the full-scale system
- Free raw water lab analysis
- Regulatory approval

If interested in a pilot study for this system, please contact us for a proposal and more information.

## SERVICES - INFILCARE™

### PART SALES

Infilco Degremont sells parts and components for most INFILCO brand equipment as well as parts for demineralizers, thickeners, nozzles, pressure filters, and valves. We offer reliable spare parts at competitive prices. We maintain records of previous installations to quickly identify your requirements. Many items are shipped directly from stock for quick delivery.

### REBUILDS, RETROFITS AND UPGRADES

Infilco Degremont offers cost-effective rebuilds and upgrades for INFILCO provided systems, no matter what year they were built. If you are interested in an economical alternative to installing a whole new system, contact us for a proposal.

## CONTACTS

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Fax: +1 514 683 1203
info-canada@degtec.com

**INFILCO DEGREMONT INC.**

# BIOFOR®

BIOLOGICAL AERATED FILTRATION SYSTEM


# BUDGET PROPOSAL

**PROJECT:** BOISE, ID WWTP
**ENGINEER:** BROWN & CALDWELL
**PROPOSAL#:** 50157596.01
**DATE:** APRIL 2, 2015

**COMMITTED TOGETHER TO WATER, A SOURCE OF LIFE**

**REGIONAL BUSINESS MANAGER:**
**SUSAN PILGRAM**
**INFILCO DEGREMONT, INC.**
BOULDER, CO
CELL: 303-652-7139
EMAIL: SUSAN.PILGRAM@INFILCODEGREMONT.COM

**LOCAL REPRESENTATIVE:**
**SCOTT MARSHALL**
**MISCOWATER, INC.**
651 CORPORATE CIRCLE, SUITE #100
GOLDEN, CO 80401
CELL: 303-601-5215
EMAIL: SMARSHALL@MISCOWATER.COM

**INFILCO DEGREMONT INC.**
8007 DISCOVERY DRIVE, RICHMOND, VA 23229 USA
P.O. BOX 71390, RICHMOND, VA 23255-1390 USA
TEL 804 756-7600 | FAX 804 756-7643

April 2, 2015

Stephanie Fevig
Brown and Caldwell, Inc.

Re: Boise, ID Project
BIOFOR® Biological Filtration System

Dear Ms. Fevig:

With regard to your request for a BIOFOR® design for the wastewater facility located in Boise, ID, IDI is pleased to submit the following preliminary design proposal. This proposal describes a BIOFOR® N design for nitrification followed by a BIOFOR® DN at a design water temperature of 14 $^{o}$C.

The BIOFOR® N system consists of six (6) filter cells sized as follows to produce 14.2 MGD:

BIOFOR® N: 6 cells, 850 ft$^2$ (27.0’ x 31.5’).

The BIOFOR® DN system consists of six (6) filter cells sized as follows to produce 14.2 MGD:

BIOFOR® DN: 6 cells, 550 ft$^2$ (22.0’ x 25.0’).

The system is sized for treating a design influent flow of 14.2 MGD with one cell in standby each for the BIOFOR® N stage and BIOFOR® DN. We have endeavored to provide complete information in this proposal. However, if you have any questions or need additional information, please don't hesitate to contact our Regional Business Manager, Susan Pilgram, our local representative, Scott Marshall, or me directly.

Sincerely,

Brian McGovern
Senior Process Engineer - Biological Systems Group

# TABLE OF CONTENTS

# 1. BIOFOR®- General Description

The BIOFOR® is a biological, submerged filter containing a fixed, dense granular bed with influent water flowing in the upward direction. The BIOFOR® Process is applied individually or in separate stages for nitrification (BIOFOR® -"N"), and denitrification (BIOFOR® -"DN"). In the BIOFOR® N process air is introduced at the bottom of the media bed and flows co-currently with the influent water. In the BIOFOR® DN an external carbon source is mixed with the filter influent.

The BIOFOR® is based on the following basic principles:

- a single layer of granular BIOLITE media for biomass attachment and retention of suspended solids.
- a discrete process air distribution system (for aerated systems only)
- upflow, co-current distribution of air and water
- backwash sequence automated and optimized per application requirements

***BIOLITE™ Media***

BIOLITE media is an expanded clay material with a high specific surface area, low density, and good resistance to attrition. The porosity of the material ensures biomass attachment. Different particle sizes ranging from 1mm to 5mm are available depending on the application.

***OXAZUR® Air Diffusers***

OXAZUR air diffusers, present in all aerated BIOFOR® units, are aerating devices with elastic rubber membranes enclosed in a polypropylene casing. The diffusers are installed on a series of process air distribution pipes located at the bottom of the media bed, directly above the plenum. The combination of diffused air and media retention produces a highly efficient aeration system with fine bubble diffusion characteristics. In order to assure homogeneous distribution over long-term operation, a pressurized cleaning water system is provided and operated approximately once per month to flush the diffusers.

### *Upflow Distribution of Air and Water*

Distribution of process air and influent water is upward through the BIOLITE media. This co-current, upward flow ensures an even distribution of water and air. It enables the media to retain solids and biomass throughout the entire bed depth and prevents short-circuiting and gas entrapment. In anoxic, denitrifying systems, nitrogen gas bubbles are continuously and effectively released from the media to atmosphere. The media operates in slight expansion, thereby ensuring full use of the available media volume and allowing high hydraulic loading rates.

### *MONOFLOR® Underdrain*

Concrete BIOFOR® installations have the distribution nozzles located in the poured-in-place filter floor. To ensure an accurate, grout-free installation, the MONOFLOR underdrain is used. This underdrain is simple to install, leak-proof, and has been widely used on filter systems for many years.

### *Backwash Sequence*

Backwash sequences for biological aerated filters must comply with several requirements:

- The filter bed must be cleaned of retained solids and excess biomass
- Sufficient biomass must remain in the reactor following a backwash
- Air and water flows must not cause filter media to be lost
- Water and energy consumption must be minimized
- The backwash sequence must be initiated and carried out automatically.

The standard BIOFOR® backwash sequence has been developed specifically to meet the requirements listed above. The backwash sequence may be optimized during start-up and can be modified based on operating experience.

The sequence may be initiated manually, on operating time, or upon reaching a pre-set terminal headloss. The main steps of the sequence are :

- quick drain to backflush the influent distribution nozzles
- air scour
- a series of simultaneous air/water washes
- water rinse

## 2. Design Conditions

The Submerged Biological Filter, BIOFOR® System, described herein is a dual-stage water treatment system designed for the reduction of ammonia nitrogen and nitrate nitrogen.

The dual-stage biofilter system will be furnished and installed as described herein. The system is based on treating influent water with the following characteristics:

| Influent Parameter | |
|---|---|
| Average Daily Flow – MGD | 11.3 |
| Max Month Flow – MGD | 14.2 |
| Total K Nitrogen (TKN) – mg/L | 12.0 |
| Ammonia Nitrogen ($NH_3$-N) – mg/L | 10.0 |
| Biological Oxygen Demand ($CBOD_5$) – mg/L | 20.0 |
| Total Suspended Solids (TSS) – mg/L | 20.0 |
| Design Water Temperature: °C | 14.0 |

The BIOFOR®-N and DN system described herein shall be designed to achieve the following monthly effluent quality for the specified flow:

| Effluent Requirements | |
|---|---|
| Ammonia Nitrogen – $NH_3$-N – mg/L | ≤ 0.5 |
| Nitrate Nitrogen – $NO_3$-N – mg/L | ≤ 8.0 |
| Biological Oxygen Demand ($CBOD_5$) – mg/L | ≤ 20.0 |
| Total Suspended Solids (TSS) – mg/L | ≤ 20.0 |

The BIOFOR® N system consists of six (6) filters of dimensions 850 $ft^2$ (27.0' x 31.5'). The system will be capable of treating the design flow to meet the effluent requirements listed above with one cell in standby or backwash.

The BIOFOR® DN system consists of six (6) filters of dimensions 550 $ft^2$ (22.0' x 25.0'). The system will be capable of treating the design flow to meet the effluent requirements listed above with one cell in standby or backwash.

### *2.1 Description of Operation*

Water is pumped to a flow channel for the BIOFOR®-N and DN units and is evenly distributed to the cells through a series of weirs in the central gallery. Water to be treated is introduced into the plenum and flows upward through the BIOLITE™ media. As the water and process airflows co-currently through the media bed, attached heterotrophic biomass oxidizes carbonaceous and nitrate compounds, autotrophic biomass oxidizes ammonia and suspended solids and biomass are retained.

Due to solids retention and biomass growth within the filter media, backwashing of the BIOFOR® units is necessary to remove retained solids and maintain a thin, active biofilm. Backwashing is initiated either manually or automatically, based upon elapsed time or on reaching a pre-set terminal headloss. The backwash sequence includes a number of distinct steps, the duration and extent of each step being optimized during plant start-up and modified based on operating experience. The basic backwash sequence includes the following steps:

- Quick drain to backflush the underdrain nozzles
- Air scour
- Combination air and water backwash
- Water rinse
- Repeat of the above steps three times
- Water rinse with influent water (filter to waste)

A centrifugal pump from the clearwell supplies clean water used for backwashing the cells. The backwash water flow rate can be controlled with an automatic flow control valve while a positive displacement blower supplies air used for air scour. Spare, installed units are provided for both the air scour blower and backwash water supply pump.

Water from the quick drain step is collected in a drain sump and typically flows into the backwash waste tank. Water from the remaining steps collects in a common backwash flume and flows to the backwash waste storage tank. Stored backwash water is normally returned to the head of the plant; if necessary, it may need to be treated in a separate side stream due to backwashing considerations.

# 3. BIOLOGICAL REACTORS

Infilco Degremont, Inc. will provide twelve (12) upflow, biological, submerged fixed-film reactors; with BIOLITE media for biomass support: Six (6) BIOFOR® -“N” aerobic reactors and Six (6) BIOFOR® -“DN” anaerobic reactors.

## *3.1 BIOFOR® N & DN*

| | BIOFOR® N Design |
|---|---|
| **Unit Filtration Area** | 850 $ft^2$ |
| **Total Number of Cells** | 6 |
| **Biolite Media Depth** | 12 ft – 2 inches |

| | BIOFOR® DN Design |
|---|---|
| **Unit Filtration Area** | 550 $ft^2$ |
| **Total Number of Cells** | 6 |
| **Biolite Media Depth** | 9 ft – 6 inches |

Each reactor will consist of a concrete tank with monolithic underdrain (MONOFLOR®), bottom influent and air/water backwash distribution system, process air distribution system for N cells only, granular expanded clay media, gravel support bed, influent channel, effluent and backwash waste channels with stilling baffle. Common instrumentation furnished by IDI includes: process air blowers, air distribution system cleaning pump, air scour blowers, backwash pumps, controls and instrumentation and all associated automatic valves and skid piping. An additional Methanol dosing system will be required as a carbon source for the denitrifying bacteria population for the BIOFOR® DN.

## *3.2 Backwashing*

The BIOFOR® reactors will be washed periodically by a sequence of air scour, combination air scour/backwash water, and water only rinse steps. Water used to backwash the biofilter reactors will be pumped from a separate clearwell supplied by others. The air scour blower capacity is based on a maximum air scour rate of 5.8 scfm/sq.ft. of filter media. The backwash pump system is sized for a maximum backwash water rate of 12.0 gpm/sq.ft. of filter media.

| | BioFOR N and DN |
|---|---|
| **Clean Water Tank Volume** | 255,000 gal |
| **Dirty Water Tank Volume** | 300,000 gal |

# 4. SCOPE OF SUPPLY

## *4.1 BIOFOR®-N & DN Filter Modules*

BIOFOR® N and DN Reactors with all internals and required wall pieces.

Each reactor will include the following:

- Equipment for MONOFLOR underdrain including forms, polyethylene nozzles and accessories.
- One (1) – Tranquilizer (stilling) baffle consisting of staggered vertical aluminum slats extending across the width of the reactor. Installation of the tranquilizer baffle is by others.
- Process air distribution system in 316 stainless steel with OXAZUR® air diffusers (for BIOFOR® N only)

## *4.2 Media and Support Gravel*

- Support gravel, 20" depth in the BIOFOR®-N reactor (includes 5% extra)
- Support gravel, 12" depth in the BIOFOR®-DN reactor (includes 5% extra)
- BIOLITE-"L" media, 2.7 mm, to 12'-2" depth in the BIOFOR®-N reactors (includes 10% extra)
- BIOLITE-"P" media, 3.5 mm, to 9'-6" depth in the BIOFOR®-DN reactors (includes 10% extra)

| | N Design<br>6 Filters |
|---|---|
| **Total Gravel Volume - ft$^3$** | 8,930 |
| **Biolite L 2.7 Media Volume - ft$^3$** | 67,880 |

| | DN Design<br>6 Filters |
|---|---|
| **Total Gravel Volume - ft$^3$** | 3,470 |
| **Biolite L 2.7 Media Volume - ft$^3$** | 34,490 |

### *4.3 Centrifugal Pumps*

3 - Common Backwash supply pumps, horizontal centrifugal type rated for 60' TDH (2 x 100% duty) and one (1 x 100%) Spare will be provided for the whole BIOFOR system. The BIOFOR N cells will require the operation of two pumps and the BIOFOR DN cells will require the operation of one pump.

| | BIOFOR® N |
|---|---|
| | Flow |
| **Backwash Pump Capacity** | 10,428 gpm |

| | BIOFOR® DN |
|---|---|
| | Flow |
| **Backwash Pump Capacity** | 6,747 gpm |

2 - Air distribution system cleaning pumps, horizontal centrifugal type 120' TDH (One duty and one standby) for BIOFOR® N cells

| | BIOFOR® N |
|---|---|
| | Flow |
| **Cleaning Pump Capacity** | 2,607 gpm |

Pumps will be skidded on a structural steel base with required piping, valves, flange fittings and accessories - fully assembled.

### *4.4 Blowers and Appurtenances*

7 - One process air blower dedicated to each BIOFOR® N reactor. Rotary lobe type rated for 11.5 psig (1 x 100% duty per cell) and one (1 x 100%) common spare for all for BIOFOR® N Cells combined

| | BIOFOR® N |
|---|---|
| | Flow |
| **Process Air Blower Capacity** | 502 scfm |

3 - Common Air scour blowers, rotary lobe type, rated for 12.5 psig (2 x 100% duty) and one (1 x 100%) Spare for the whole system. The BIOFOR N cells will require the operation of two blowers and the BIOFOR DN cells will require the operation of one blower.

| | BIOFOR® N |
|---|---|
| | **Flow** |
| **Air Scour Blower Capacity** | 4,487 scfm |

| | BIOFOR® DN |
|---|---|
| | **Flow** |
| **Air Scour Blower Capacity** | 3,228 scfm |

Each blower provided with:

- Motor
- V-belt drive
- Inlet filter/silencer and outlet silencer
- Check valve
- Manual valve for outlet isolation
- Relief valve
- Flexible connections
- Discharge pressure gauge
- Acoustic enclosure, to meet 85 dBA free field noise requirements.

Blowers shipped to site skidded on separate structural steel bases, assembled with piping, silencers, valves and fittings.

An automatic by-pass flow control valve is included with each air scour blower.

### *4.5 Compressed Air for Automatic Valves*

One (1) – Compressed Air System, provided with:

- One (1) – dual-head reciprocating type compressor rated for 15 scfm at 100 psig
- One (1) – standby head
- One (1) – 200 gallon carbon steel receiver
- Air dryer
- Required relief, exit, and blowdown valves
- Pressure gauges

Note: System shipped to site pre-piped and skidded on a structural steel base.

Pneumatic tubing, valves, and appurtenances for air feed to automatic valves are by others.

### *4.6 Automatic and Manual Valves*

| | **BIOFOR®-N** | |
|---|---|---|
| **Valve Type - Open/Close** | **Quantity** | **Diameter** |
| **Influent** | 6 | 16” |
| **Process Air, Cleaning Water** | 6 | 6” |
| **Backwash Water Inlet** | 6 | 24” |
| **Air Scour Inlet** | 6 | 14” |
| **Air Cushion Vent** | 6 | 2.5” |
| **Backwash Waste** | 6 | 30” |
| **Quick Drain** | 6 | 12” |

| | **BIOFOR®-DN** | |
|---|---|---|
| **Valve Type - Open/Close** | **Quantity** | **Diameter** |
| **Influent** | 6 | 10” |
| **Backwash Water Inlet** | 6 | 20” |
| **Air Scour Inlet** | 6 | 12” |
| **Air Cushion Vent** | 6 | 3.5” |
| **Backwash Waste** | 6 | 24” |
| **Quick Drain** | 6 | 10” |

| Valve Type – Modulating | Design Quantity | Design Diameter |
|---|---|---|
| Air Scour Vent Flow Control | 1 | 14” |
| Backwash Water Flow Control | 1 | 24” |

- All automatic open/close valves are butterfly type equipped with double-acting pneumatic cylinder actuators. Solenoids are mounted directly on actuators. Positioners are pneumatic. Valves include open and close limit switches.

- There are no manual valves included in IDI’s Scope of Supply.

### *4.7 Flow Screens and Strainers*

| Strainer Type | Design Quantity | Design Diameter |
|---|---|---|
| Oxazur Cleaning Strainer | 1 | 6” |
| Backwash Inlet Strainer | 1 | 30” |
| Inlet Strainer | TBD | 16” N |
| | TBD | 10” DN |

- Backwash inlet strainers – In-line Y-Type, (one per system with one spare), 2.4-mm stainless steel mesh, carbon steel body with flanged ends
- Air distributor cleaning header strainers – in-line Y-Type, 2.4-mm stainless steel mesh, carbon steel body with flanged ends.

- All required process flow screens or strainers – If pumped, the system shall be provided with In-line Y-Type strainers. If flow by gravity, the system shall be provided with stainless steel wedge wire rundown screens.

### *4.8 Controls and Instrumentation*

- One (1) – PLC/PC control system, mounted in a free-standing NEMA 12 enclosure.

**Field Instruments – BIOFOR N and DN**

| Field Instruments – Lot | Design Quantity |
|---|---|
| **Pressure Transmitters (Cell)** | 12 |
| **Pressure Transmitters (Plenum)** | 12 |

Lot – pressure gauges, local indication only

**General Instruments**

| General Instruments – Lot | Design Quantity | Design Diameter |
|---|---|---|
| **Backwash Flowmeter/Transmitter** | 1 | 24” |
| **Air Scour Flowmeter/Transmitter** | 1 | 14” |
| **Process Air Flowmeter/Transmitter** | 6 | 6” |
| **Level Transmitters*** | 14 | N/A |
| **Dissolved Oxygen (DO) Probe** | 7 | N/A |
| **Online Nitrate Analyzer** | 2 | N/A |
| **B/W Strainer Diff. Pressure Gauges** | 1 | 24” |

***** *Ultrasonic Level Transmitters located at Clearwell, Mudwell and individual cells***

### *4.9 Field Service*

Thirty (30) days total service time by a qualified, factory-trained service engineer to inspect the BIOFOR® equipment installation, provide start-up assistance and training of operations personnel.

Also included: Four (4) O & M Manuals.

## 5. Items By Others

The following items are specifically not by Infilco Degremont. They may or may not be required.

| General | |
|---|---|
| • Backwash Waste Holding Tank and Clearwell | • Motor Control Center (MCC) |
| • Chemical Feed Systems for alkalinity correction, methanol and defoamer | • Non-potable water supply |
| • Chemicals for operation: Including methanol, alkaline solution, defoamer | • Overflow structures including baffles and weir plates |
| • Cleanouts | • Power |
| • Concrete | • Sludge handling and disposal |
| • Control Panel | • Support Platforms |
| • Drains | • Transformers |
| • Engines/Generators | • Variable Frequency Drives |
| • Foam control | • Ventilation |
| • Hoses /Bibs | • Walkways/Roofing/Stairs/Gratings/Handrails |
| • Laboratory | • Wireways/Wiring |
| • Ladders | • Yard Hydrants |
| • Lighting | • Yard Piping |
| • Liquid sampling and analytical work | • |

## 6. Items By Installing Contractor

1. Obtain necessary construction permits and licenses, construction drawings (including interconnecting piping drawings) field office space, telephone service, and temporary electrical service.
2. All site preparation, grading, locating foundation placement, excavation for foundation, underground piping, conduits and drains.
3. Demolition and/or removal of any existing structures, equipment or facilities required for construction and installation of the BIOFOR® system.
4. Installation of all foundation - supply and installation of all embedded or underground piping, conduits and drains.
5. All backfill, compaction, finish grading, earthwork and final paving.
6. Receiving (preparation of receiving reports), unloading, storage, maintenance preservation and protection of all equipment and materials supplied by Infilco.
7. Installation of all equipment and materials supplied by Infilco.
8. Supply, fabrication, installation, cleaning, pickling and/or passivation of all interconnecting steel piping components.
9. Provide and install all embedded pipe sections and valves for tank drains and reactor inlets and elbows.
10. All cutting, welding, fitting and finishing for all field fabricated piping.
11. Supply and installation of all flange gaskets and bolts for all piping components.
12. Supply and installation of all pipe supports and wall penetrations.
13. Install and provide all motor control centers, motor starters, panels, field wiring, wireways, supports and transformers.
14. Install all control panels and instrumentation as supplied by Infilco, as applicable.
15. Supply and install all electrical power and control wiring and conduit to the equipment served plus interconnection between the Infilco equipment as required, including wire, cable, junction boxes, fittings, conduit, cable trays, safety disconnect switches, circuit breakers, etc.
16. Supply and install all insulation, supports, drains, gauges, hold down clamps, condensate drain systems, flanges, flex pipe joints, expansion joints, boots, gaskets, adhesives, fasteners, safety signs, and any specialty items such as traps.
17. All labor, materials, supplies and utilities as required for start-up including laboratory facilities and analytical work.
18. Provide all chemicals required for plant operation and all chemicals, lubricants, glycol, oils or grease and other supplies thereafter.

19. Install all anchor bolts and mounting hardware supplied by Infilco; and supply and install all anchor bolts and mounting hardware not specifically supplied by Infilco.
20. Provide all nameplates, safety signs and labels.
21. Provide all additional support beams and/or slabs.
22. Provide and install all manual valves.
23. Provide and install all piping required to interconnect to the Infilco's equipment.
24. The Contractor shall coordinate the installation and timing of interface points such as piping and electrical with the Infilco Supplier.

***All other necessary equipment and services not otherwise listed as specifically supplied by Infilco.***

## 7. Budget Estimate

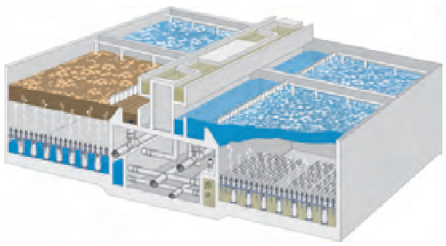
**PURCHASE PRICE**: **As Advised By Rep**

(Exclusive of taxes per Condition 6 of IDI Conditions of Sale)

1. Our Price and Payment Terms are based on IDI's standard terms and conditions, which can be provided upon request.
2. Shipping Terms: FOB Shipping point, freight allowed.
3. This price will be valid for thirty (30) days.
4. All prices are excluding state sales and use taxes and any federal taxes which shall be the sole responsibility of the Purchaser. No additional duties will have to be paid for the equipment supplied by IDI.
5. Pricing is subject to the escalation indices for the items in scope of supply calculated from the original proposal date and is in accordance with the Scope of Supply and terms of this proposal and any changes that may require the price to be adjusted. The type of escalation indices can be discussed further and mutually agreed upon.

# INFILCO
# BIOFOR®
Biological Aerated Filtration System

WASTEWATER



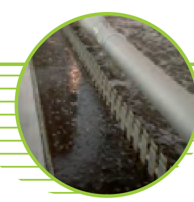
BIOFOR® filters are aerobic or anoxic biological reactors that use attached growth technology for application in municipal or industrial wastewater treatment.

## APPLICATIONS

- **BIOFOR® C for BOD, COD and TSS removal**
- **BIOFOR® N for nitrification of ammonia nitrogen**
- **BIOFOR® C+N for simultaneous BOD removal and nitrification**
- **BIOFOR® pre-DN for nitrate removal as a predenitrifcation step without additional carbon source**
- **BIOFOR® post-DN for nitrate removal as a final denitrification step with carbon addition**

## MAIN FEATURES

- Upflow filtration in which feedwater flow expands the filter media leading to an even distribution of the biomass throughout the bed
- Co-current flow of feedwater and air prevents short circuiting and also extends the length of filter run times
- Quick adaptability to flow and load variations
- Exclusive nozzle floor design which allows for optimum distribution of fluids during filtration as well as wash sequences
- Highly efficient washing system to accommodate filter bed depths up to 13 ft (4.0 m)



## BIOFOR® SPECIFIC TECHNOLOGY

The BIOFOR® process is used primarily for the removal of BOD, TSS and ammonia pollution in secondary and tertiary treatment. BIOFOR® units discharge treated water that conforms to high quality standards for every parameter thanks to the filtering action of the Biolite filter media.

Because BIOFOR® is designed to treat higher organic loadings than conventional systems, the units can accommodate higher filtration velocities. The BIOFOR® units allow treatment of soluble pollution and solids separation in one compact reactor, so no secondary clarifiers are necessary. The PLC based control system automates the filter operation.

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Degrémont

## HOW IT WORKS

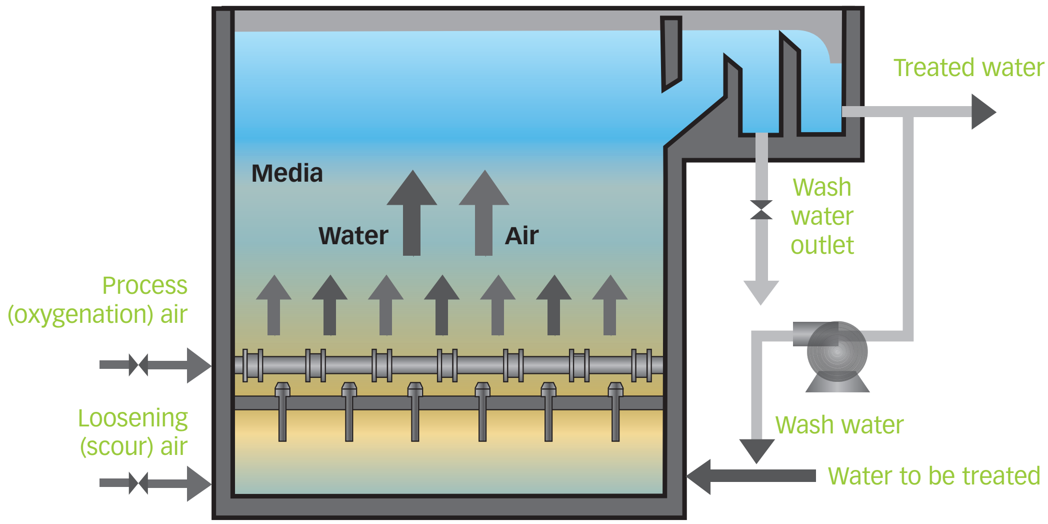
The effluent to be treated enters continuously from the bottom of the reactor and is distributed over the entire filter surface area by the nozzle underdrain.The water then passes through the Biolite filter media which retains the suspended solids. Carbonaceous and nitrogenous pollution is eliminated through the high concentration of fixed-film biomass which is retained on the filter media during the filtration cycle.

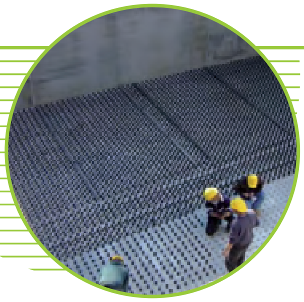
In the aerated versions (for BOD removal and nitrification) process air is introduced continuously into the lower part of the reactor by Oxazur® air diffusers.

The use of a co-current upflow design helps to limit odor generation since the treated water is situated at the surface of the filter (in contact with the atmosphere), and the untreated water enters at the bottom of the filter.

The number of filters in filtration service is according to the flow entering the plant. During low flow periods, off-duty filters are aerated periodically to maintain the biomass in optimum condition.Since filters can be taken out of service when not required, operating costs (due to process air production) can be reduced.

**BIOFOR®** PROCESS



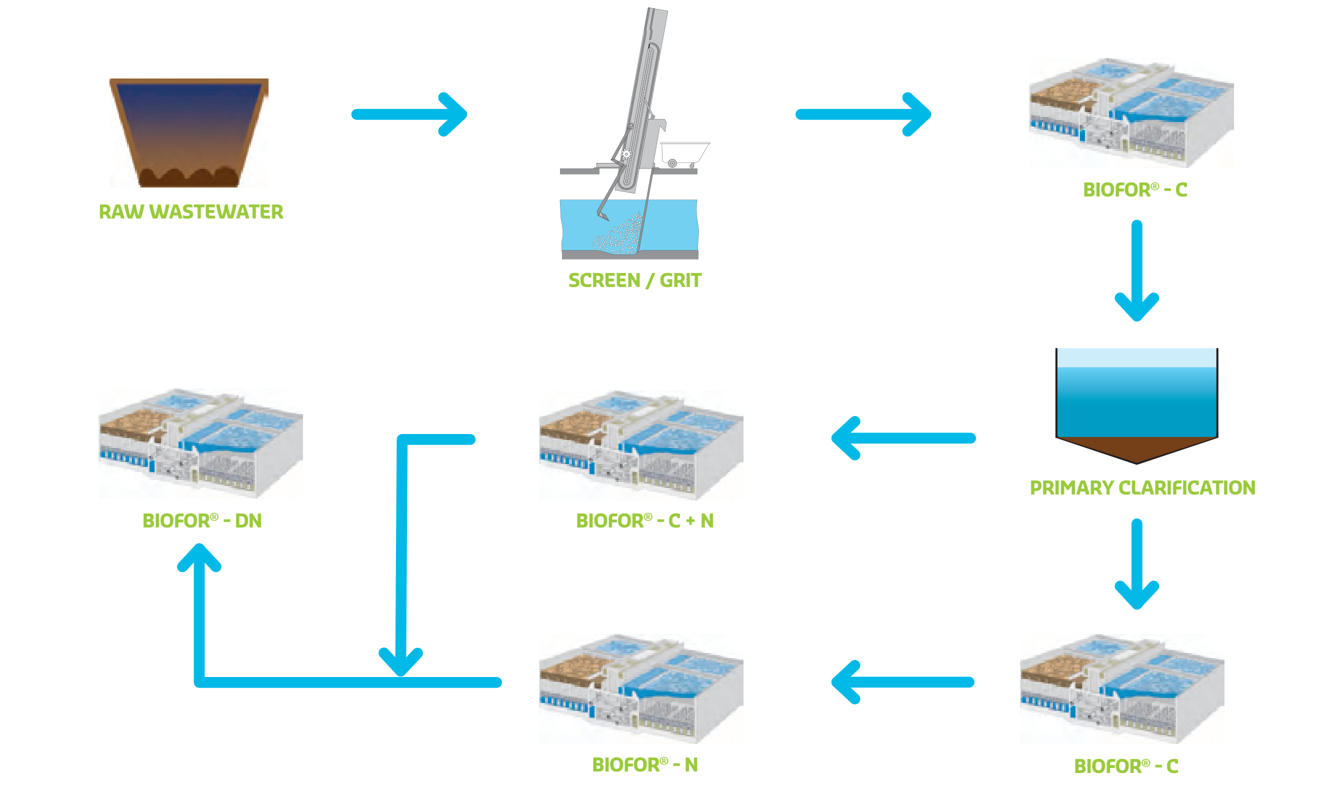



- Periodically the BIOFOR® filter is washed after a pre-determined run time (24 or 48 hours) or due to a headloss build-up in the filter.
- Filtered water and scour air are used to efficiently clean the filter, preparing it for the next filter run.
- The water for the backwashes is drawn from a dedicated clean backwash tank using pumps.
- The backwash waste water is collected in a dirty backwash water tank for pumping to the backwash water treatment.

## PRODUCT HIGHLIGHTS

- Applicable to cold water operation
- Easily adapts to variable flows and pollution loads
- Treats dilute effluents
- Excellent solution where limited space is available
- Very limited odor production
- Because of small foot-print, can be easily covered and enclosed
- Modular construction allows for easy plant expansions in the future
- Eliminates the need for secondary clarifiers

## BIOFOR® TREATMENT LINE




## TECHNICAL ADVANTAGES

- Valves and machinery (pumps / blowers) can be installed indoors for easy and convenient maintenance.
- Availaible in sizes up to 1,935 ft2 (180 m²) per filter.
- Variable numbers of filters can allow for energy savings during low flow periods.

## DESIGN LOADING

| Application | Performance | |
|---|---|---|
| BOD removal | Filtration rate | 1.2 - 4.9 gpm/ft² (3-12 m/h) |
| | Loading | 90 - 360 lb/kft³ per day (2 - 8 kg $BOD_5$ / m³ per day) |
| Nitrification | Filtration rate | 1.2 - 6.6 gpm/ft² (3-16 m/h) |
| | Loading | 20 - 90 lb/kft³ per day (0.5 - 2 kg $NH_3$ - N/m³ per day) |
| Pre-denitrification | Filtration rate | 4.1 - 14.3 gpm / ft² (10-35 m/h) |
| | Loading | 135 - 310 lb/kft³ per day (3 - 7 kg $NO_3$ - N/m³ per day) |
| Post-denitrification | Filtration rate | 4.1 - 12.3 gpm/ft² (10-30 m/h) |
| | Loading | 45 - 70 lb/kft³ per day (1-1.5 kg/$NO_3$ - N/m³ per day) |

## TECHNICAL FEATURES

» TSS and BOD removal to < 10 mg/L

» Ammonia removal to < 1 mg/L $NH_3$-N

» Nitrate removal to < 1 mg/L $NO_3$-N

» Total Nitrogen removal to < 3 mg/L TN

» Aeration oxygen transfer efficiency of 15 - 25%

## COMPLETE TREATMENT SOLUTIONS

Infilco Degremont offers an array of water, wastewater and industrial treatment solutions for any size client. Headworks, clarification, filtration, biological and disinfection systems are several of the product disciplines in our portfolio.

With a variety of filtration and clarification products in our SEPARATIONS department, Infilco engineers carefully evaluate each application to provide the most cost-effective and efficient treatment solution.

If interested in this product, check out some of our complementary products:

- ABW® Automatic Backwash Filter
- AquaDAF® Clarifier
- Cleargreen™
- DensaDeg® Clarifier/Thickener
- Ferazur®/Mangazur®
- Meteor® IFAS/MBBR
- Ultragreen™
- Climber Screen®
- Vortex®
- Cannon® Mixer
- 2PAD
- Thermylis® HTFB

## PILOTING SERVICES

Infilco Degremont offers pilot systems and services for this and many other of our product offerings. Pilot studies are a practical means of optimizing physical-chemical and biological process designs and offer the client several benefits, such as:

- Proof of system reliability
- Optimal design conditions for the full-scale system
- Free raw water lab analysis
- Regulatory approval

If interested in a pilot study for this system, please contact us for a proposal and more information.


## SERVICES - INFILCARE™

### PART SALES

Infilco Degremont sells parts and components for most INFILCO brand equipment as well as parts for demineralizers, thickeners, nozzles, pressure filters, and valves. We offer reliable spare parts at competitive prices. We maintain records of previous installations to quickly identify your requirements. Many items are shipped directly from stock for quick delivery.

### REBUILDS, RETROFITS AND UPGRADES

Infilco Degremont offers cost-effective rebuilds and upgrades for INFILCO provided systems, no matter what year they were built. If you are interested in an economical alternative to installing a whole new system, contact us for a proposal.

## CONTACTS

WWW.DEGREMONT-TECHNOLOGIES.COM

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Richmond, VA 23229-8605, USA
Tel: +1 804 756 7600
Fax: +1 804 756 7643
info-infilco@degtec.com

**DEGRÉMONT LIMITÉE**
1375, route Transcanadienne,
Bureau 400
Dorval (Qc) H9P 2W8, Canada
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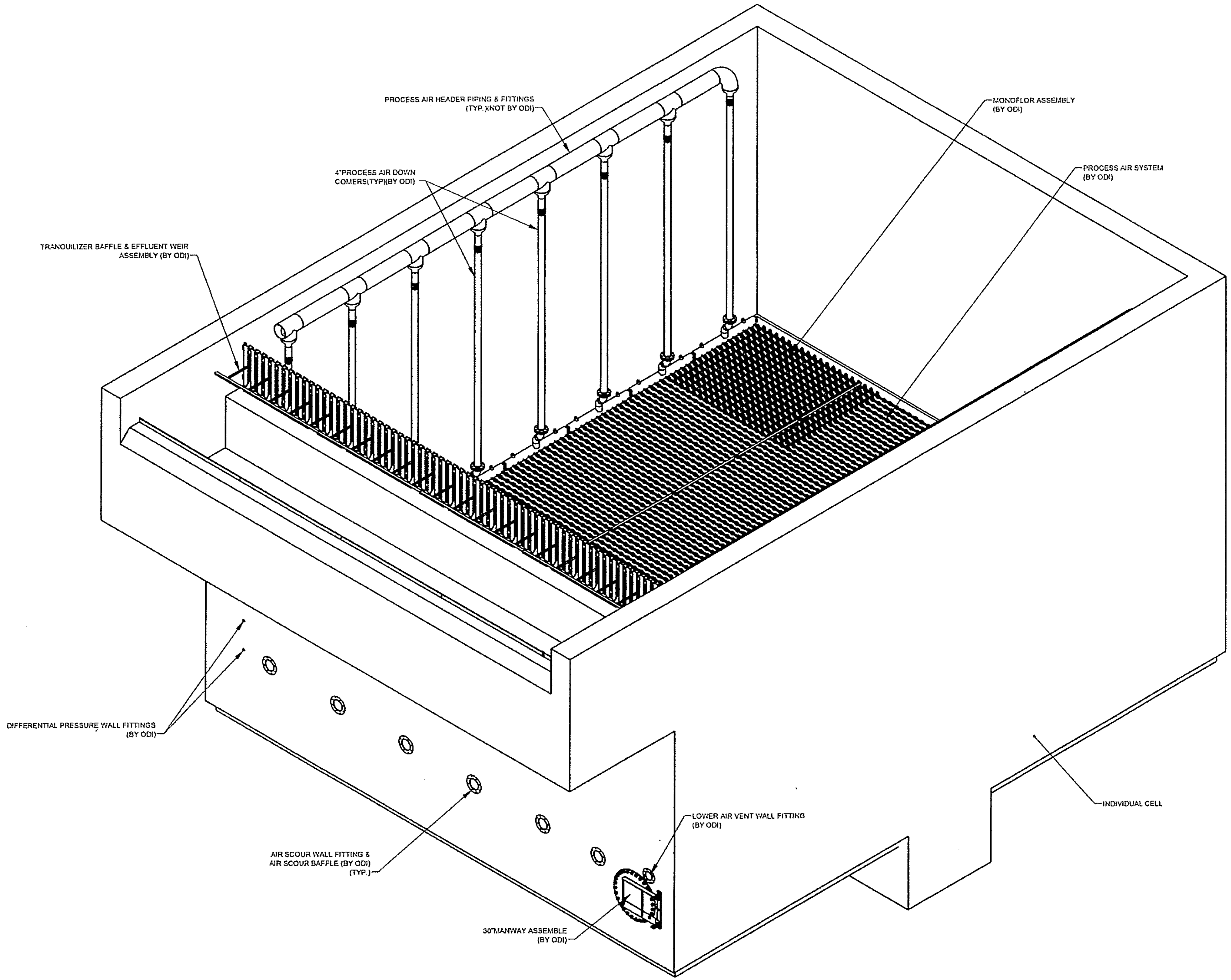
Fax: +1 514 683 1203
info-canada@degtec.com




NOTES:

1. WORK THIS DRAWING w/ DWGS. D01101153-01-100 THRU 103.
2. DESIGN OF CONCRETE STRUCTURES IS NOT BY ODI.
3. WALL FITTING LOCATIONS SHOWN ARE FOR CELLS C-1 THRU C-4, CELLS C-5 THRU C-8 ARE OPPOSITE HAND, SEE ENGINEERS PIPING DRAWINGS FOR ORIENTATION.



| REV | REVISION DESCRIPTION | DRAWN | CHECKED | APP | DATE |
|---|---|---|---|---|---|
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| REV | REVISION DESCRIPTION | DRAWN | CHECKED | APP | DATE |
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| - | ORIGINAL ISSUE | RHB | GSB | S.S. | 11/01 |
| A | WALL FITTING LOCATION CHANGED,ADDED NOTE 3. | GEP | JHM | JHM | 10/02 |
| B | NOTED 4"PROCESS AIR PIPES BY ODI | GEP | JHM | JHM | 11/03 |

PROJECT INFORMATION

Fo[redacted]

Cust. Ord. No.: -

ONDEO Degremont, Inc.
Post Office Box 71390
Richmond, Virginia 23255-1390
PH: (800) 446-1150

ONDEO Degrémont

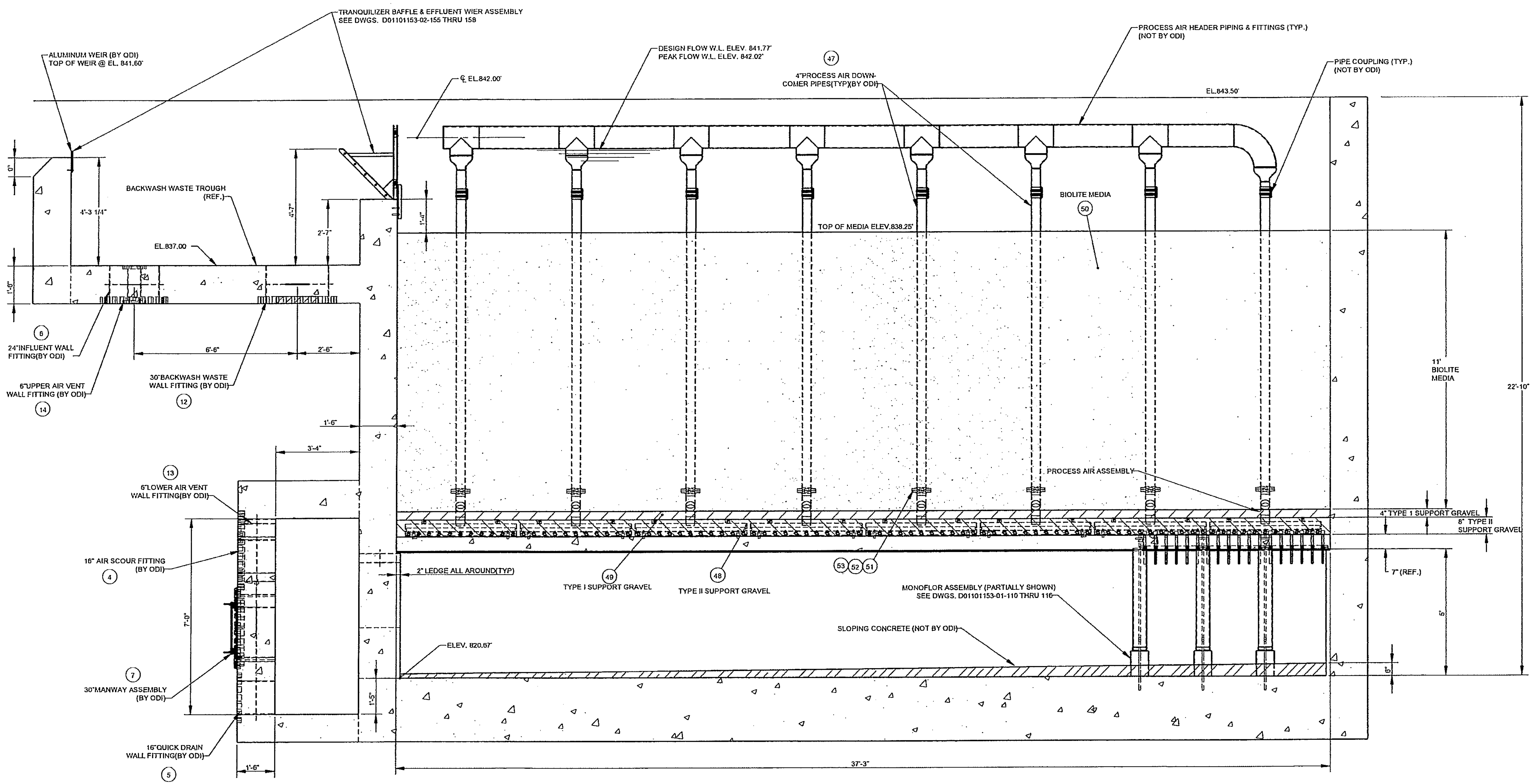
| | BY | DATE |
|---|---|---|
| DRAWN | RHB | 11/01 |
| CHECKED | GSB | 11/01 |
| APP | S.S. | 11/01 |
| REF. | 15301099 | |
| REF. | - | |
| SCALE | N.T.S. | |

ISOMETRIC

GENERAL ARANGEMENT

BIOFOR [redacted]/ MONOFLOR HD-1600

SIZE D | DWG. NO. [redacted]01-099 | REV. B




## SECTION "A-A"
## SCALE: 1/2" = 1'-0"

NOTES:

1. FOR PLAN, SEE DWG. D01101153-02-100.
2. DESIGN OF CONCRETE STRUCTURES IS NOT BY ODI.



| REV | REVISION DESCRIPTION | DRAWN | CHECKED | APP | DATE |
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| REV | REVISION DESCRIPTION | DRAWN | CHECKED | APP | DATE |
|---|---|---|---|---|---|
| - | ORIGINAL ISSUE | RHB | GSB | S.S. | 11/01 |
| A | REVISED CELL SIZE, ADJUSTED DETAILS | GEP | SSS | SSS | 2/02 |
| B | ADDED EFFLUENT WEIR | RHB | GEP | S.S. | 03/02 |
| C | REV. WALL FITTING LOCATIONS,16"QUICK DRAIN WAS 14" | GEP | JHM | JHM | 3/03 |
| D | NOTED 4"PROCESS AIR PIPES BY ODI | GEP | JHM | JHM | 11/03 |

PROJECT INFORMATION

For: [redacted]

Cust. Ord. No.: -

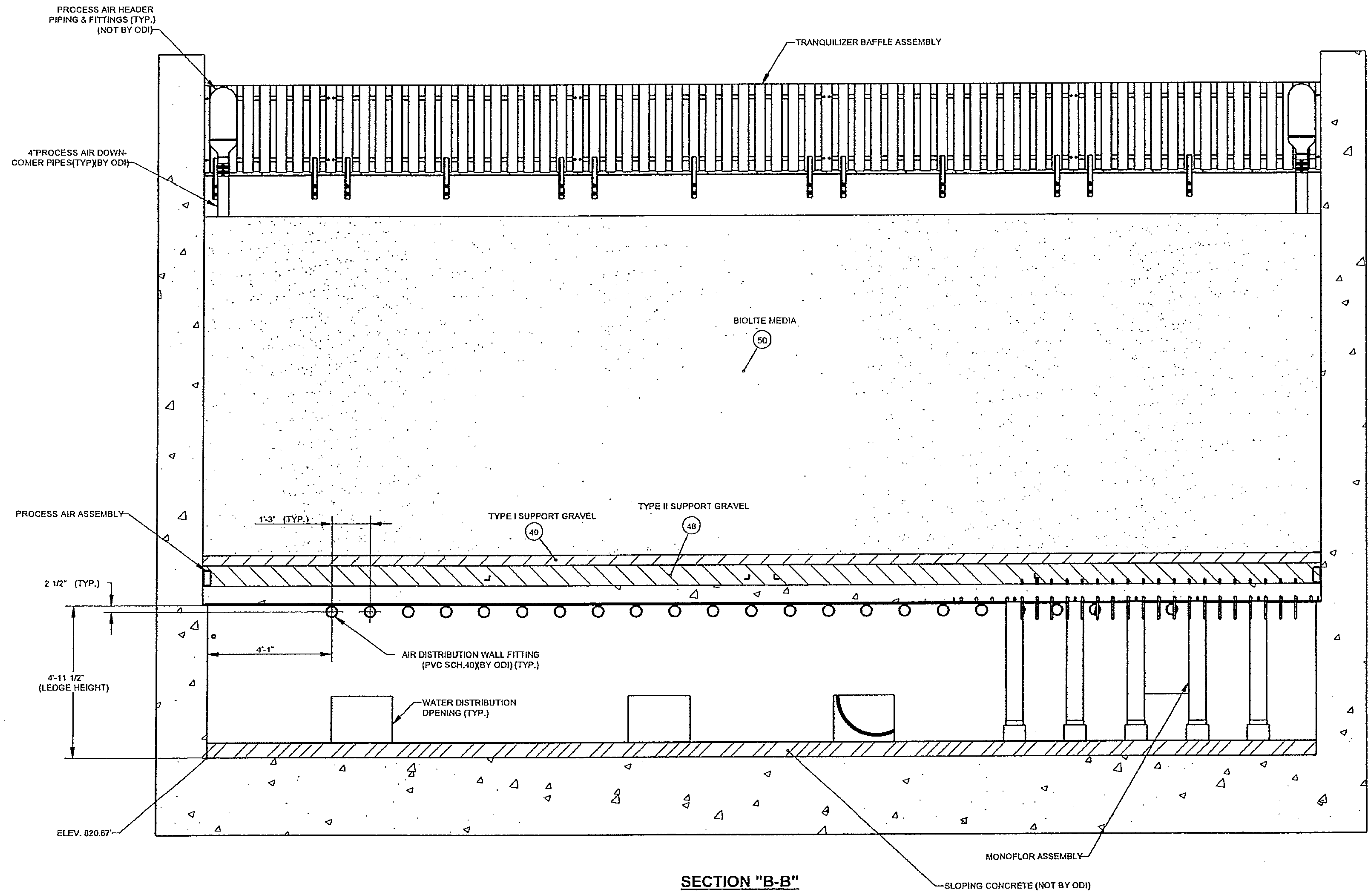
ONDEO Degremont, Inc.
Post Office Box 71390
Richmond, Virginia 23255-1390
PH: (800) 446-1150

ONDEO Degrémont

| | BY | DATE |
|---|---|---|
| DRAWN | RHB | 11/01 |
| CHECKED | GSB | 11/01 |
| APP | S.S. | 11/01 |
| REF. | 15302100 | |
| REF | - | |
| SCALE | AS NOTED | |

PLAN & SECTIONS
GENERAL ARRANGEMENT
BIOFOR "N" / MONOFLOR

SIZE D | DWG. NO. [redacted]-02-101 | REV. D




**SECTION "B-B"**
**SCALE: 1/2" = 1'-0"**

NOTES:

1. FOR PLAN, SEE DWG. D01101153-02-100.
2. DESIGN OF CONCRETE STRUCTURES IS NOT BY ODI.



| REV | REVISION DESCRIPTION | DRAWN | CHECKED | APP | DATE |
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| - | ORIGINAL ISSUE | RHB | GSB | S.S. | 11/01 |
| A | REVISED CELL SIZE, ADJUSTED DETAILS | GEP | SSS | SSS | 2/02 |
| B | GENERAL REVISION | RHB | GEP | SSS | 3/02 |
| C | REV. WALL FITTING LOCATIONS,16"QUICK DRAIN WAS 14" | GEP | JHM | JHM | 3/03 |
| D | NOTED 4"PROCESS AIR PIPES BY ODI | GEP | JHM | JHM | 11/03 |

PROJECT INFORMATION

For [redacted]

Cust. Ord. No.: -

ONDEO Degremont, Inc.
Post Office Box 71390
Richmond, Virginia 23255-1390
PH: (800) 446-1150

ONDEO Degrémont

| | BY | DATE |
|---|---|---|
| DRAWN | RHB | 11/01 |
| CHECKED | GSB | 11/01 |
| APP | S.S. | 11/01 |

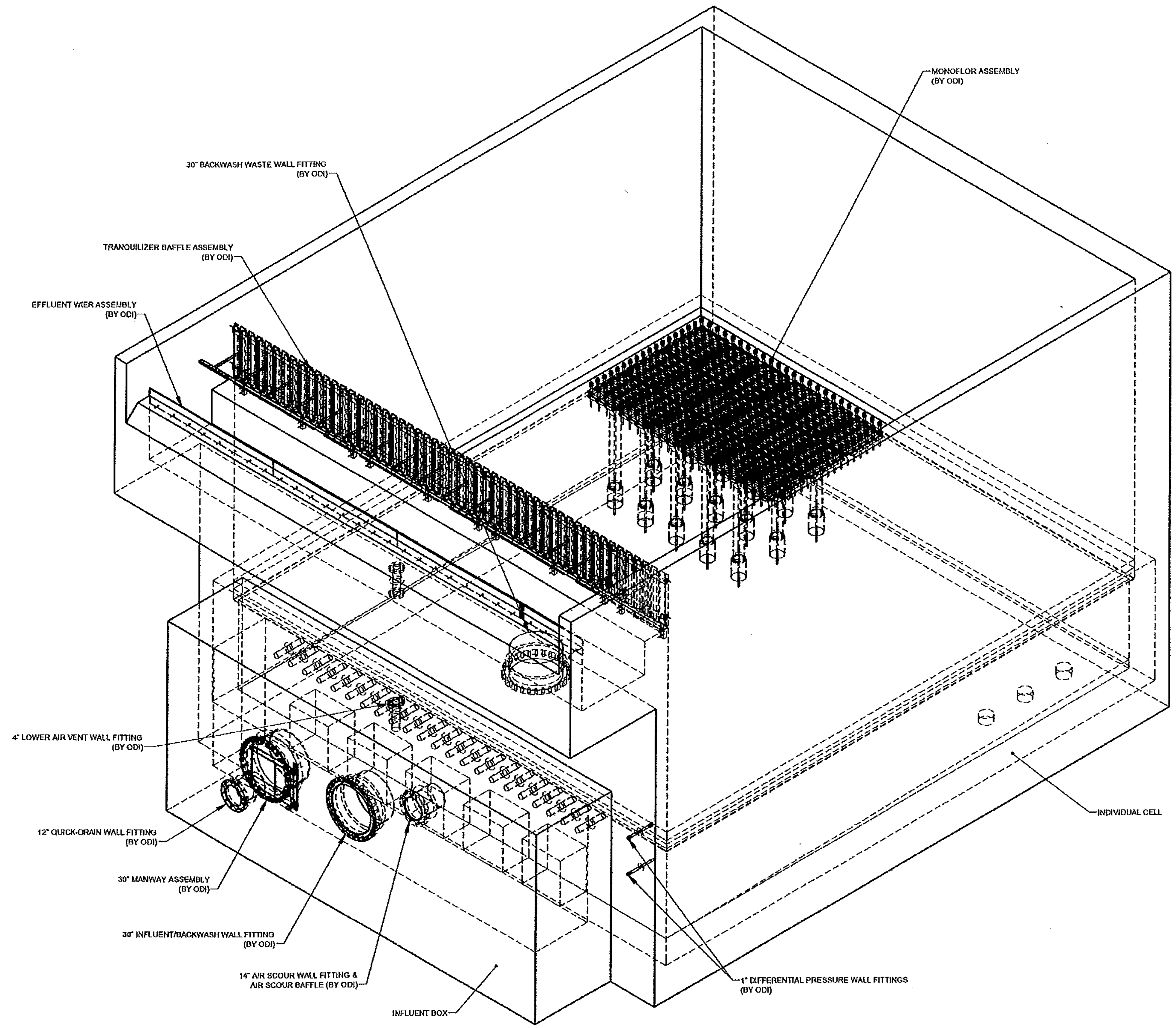
REF. 15302100
REF. -
SCALE AS NOTED

**PLAN & SECTIONS**
**GENERAL ARRANGEMENT**
**BIOFOR "N" / MONOFLOR**

SIZE D | DWG. NO. [redacted]-02-102 | REV D

NOTES:

1. WORK THIS DRAWING w/ DWGS. D01101153-03-100 THRU 103.
2. DESIGN OF CONCRETE STRUCTURES IS NOT BY ODI.






| REV | REVISION DESCRIPTION | DRAWN | CHECKED | APP | DATE |
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| - | ORIGINAL ISSUE | RHB | GSB | S.S. | 03/02 |
| A | REVISED PER CUSTOMER'S DRAWINGS | RHB | JHM | JHM | 03/04 |

PROJECT INFORMATION

For [redacted]

Cell Type : Biofor - DN

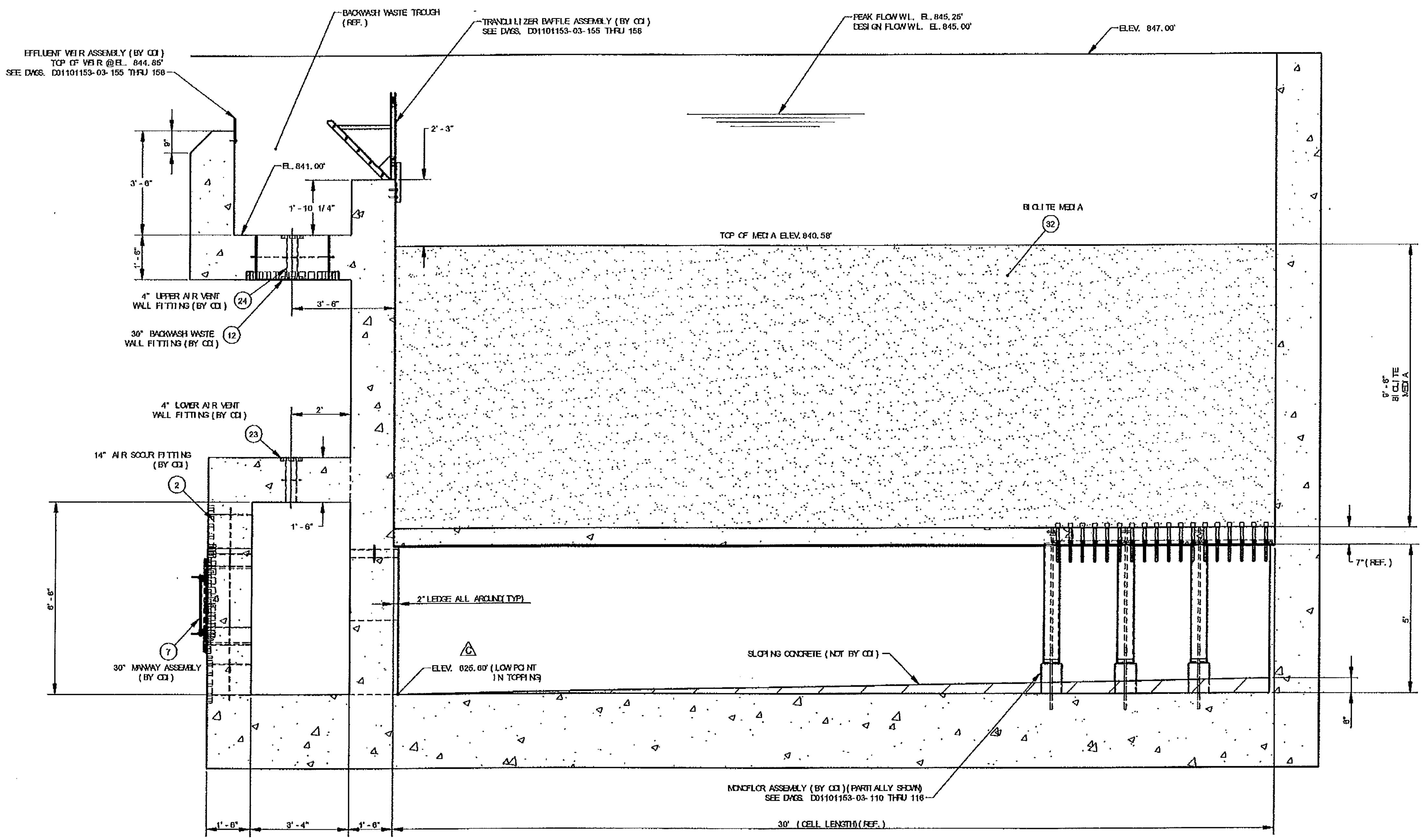
ONDEO Degremont, Inc.
Post Office Box 71390
Richmond, Virginia 23255-1390
PH: (800) 446-1150

ONDEO Degrémont

| | BY | DATE |
|---|---|---|
| DRAWN | RHB | 03/02 |
| CHECKED | GSB | 03/02 |
| APP | S.S. | 03/02 |
| REF. | 15303099 | |
| REF. | - | |
| SCALE | N.T.S. | |

ISOMETRIC
GENERAL ARANGEMENT
BIOFOR "DN" / MONOFLOR

SIZE: D | DWG. NO. [redacted]-03-099 | REV. A




**SECTION "A-A"**
**SCALE: 1/2" = 1'-0"**

NOTES:

1. FOR PLAN, SEE DWG D01101153-03-100.
2. DESIGN OF CONCRETE STRUCTURES IS NOT BY CDI.



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| - | ORIGINAL ISSUE | RHB | GSB | S.S. | 03/02 |
| A | REVISED ELEVATIONS | GEP | JHM | JHM | 6/03 |
| B | REVISED PER CUSTOMER S DRAWINGS | RHB | JHM | JHM | 03/04 |
| C | ELEV. 825.43' WAS 825.5' ON DWGS. 101, 102, & 103 | RHB | JHM | JHM | 07/04 |
| D | DELETED SUPPORT GRAVEL | GEP | JHM | JHM | 6/05 |
| E | INDICATED EL. LOW PT. OF FL. TOPPING | GEP | JHM | JHM | 7/05 |

PROJECT INFORMATION

For [redacted]

Cell Type: Biofor - DN

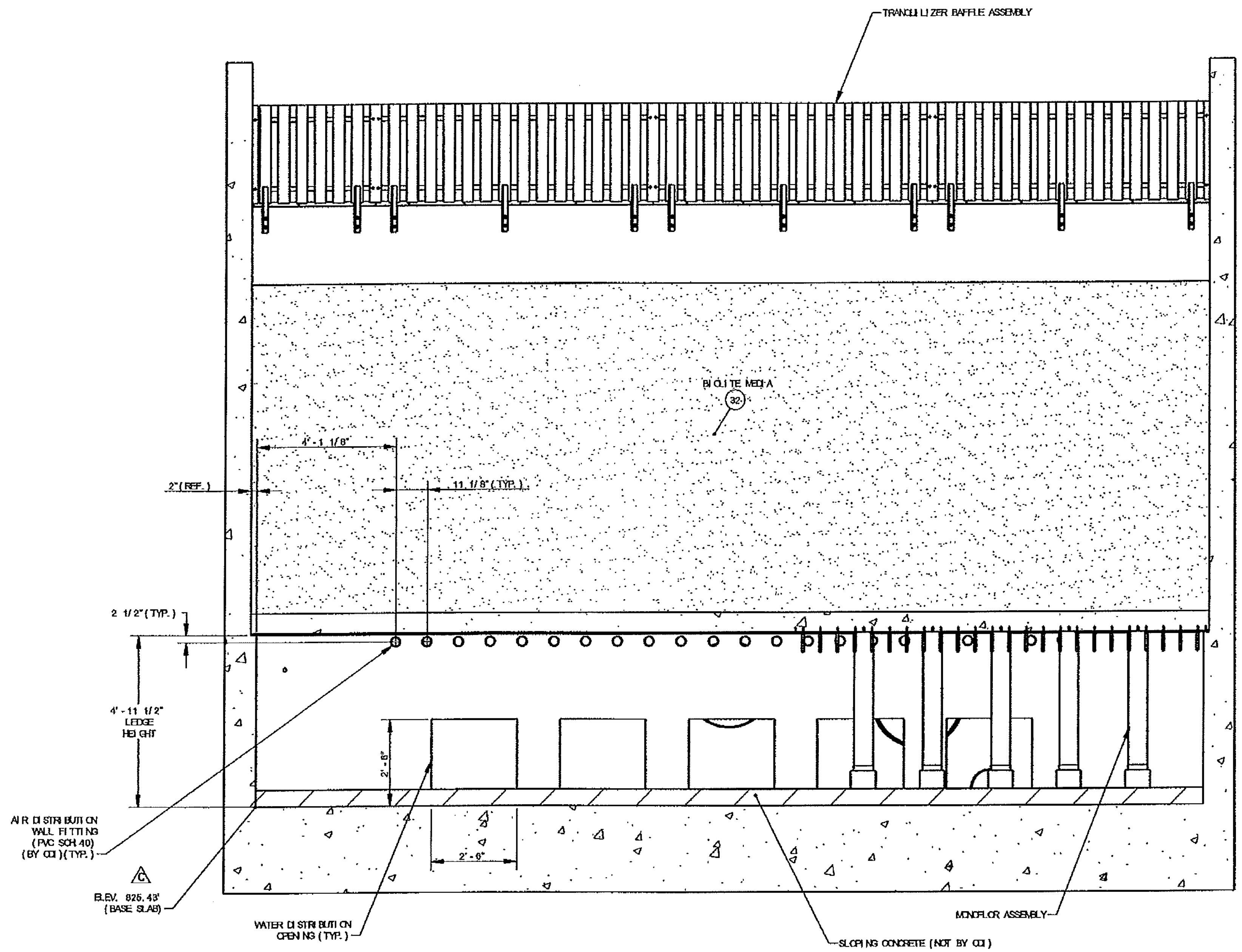
ONDEO Degremont, Inc.
Post Office Box 71390
Richmond, Virginia 23255-1390
PH: (800) 446-1150

ONDEO Degrémont

| | BY | DATE |
|---|---|---|
| DRAWN | RHB | 03/02 |
| CHECKED | GSB | 03/02 |
| APP | S.S. | 03/02 |
| REF. | 15303100 | |
| REF. | - | |
| SCALE | AS NOTED | |

**PLAN & SECTIONS**
**GENERAL ARRANGEMENT**
**BIOFOR "DN" / MONOFLOR**

SIZE D | DWG. NO. [redacted]03-101 | REV. E




SECTION "B-B"
SCALE: 1/2" = 1'-0"

NOTES:

1. FOR PLAN, SEE DWG. D01101153-03-100.
2. DESIGN OF CONCRETE STRUCTURES IS NOT BY ODI.



| REV | REVISION DESCRIPTION | DRAWN | CHECKED | APP | DATE |
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| - | ORIGINAL ISSUE | RHB | GSB | S.S. | 03/02 |
| A | REVISED ELEVATIONS | GEP | JHM | JHM | 6/03 |
| B | REVISED PER CUSTOMER'S DRAWINGS | RHB | JHM | JHM | 03/04 |
| C | ELEV. 825.43' WAS 825.6' ON DWGS. 101, 102, & 103 | RHB | JHM | JHM | 07/04 |
| D | DELETED SUPPORT GRAVEL | GEP | JHM | JHM | 6/05 |
| E | INDICATED EL. LOW PT. OF FL. TOPPING | GEP | JHM | JHM | 7/05 |

PROJECT INFORMATION

For [redacted]

Cell Type: Biofor - DN

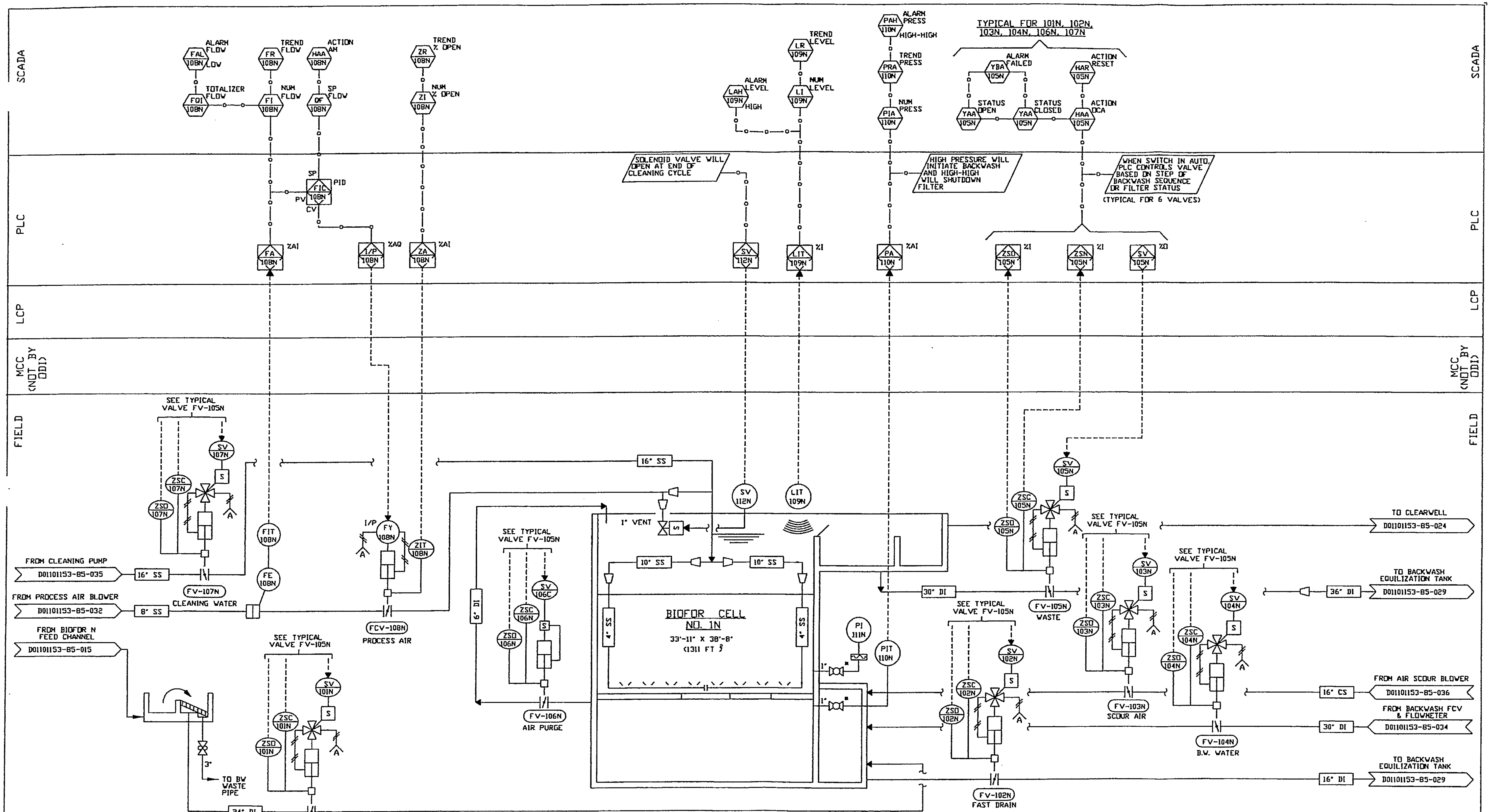
ONDEO Degremont, Inc.
Post Office Box 71390
Richmond, Virginia 23255-1390
PH: (800) 446-1150

ONDEO Degrémont

| | BY | DATE |
|---|---|---|
| DRAWN | RHB | 03/02 |
| CHECKED | GSB | 03/02 |
| APP | S.S. | 03/02 |
| REF. | 15303100 | |
| REF. | - | |
| SCALE | AS NOTED | |

PLAN & SECTIONS
GENERAL ARRANGEMENT
BIOFOR "DN" / MONOFLOR

SIZE: D | DWG NO: [redacted]-03-102 | REV.: E




NOTE:

* DENOTES EQUIPMENT NOT SUPPLIED BY ODI.

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| REV | REVISION DESCRIPTION | DRAWN | CHECKED | APP | DATE |
|---|---|---|---|---|---|
| - | ORIGINAL ISSUE FOR APPROVAL | DLD | SS | JJV | 11/01 |
| A | REVISED FILTER CELL SIZE | JV | SS | JJV | 04/02 |
| B | REVISED PER ENGINEER'S COMMENTS | DSDT | JV | JJV | 06/03 |

PROJECT INFORMATION
☐ Information Only ☐ Preliminary ■ For Approval ☐ Certified
For [redacted]
Cust. Ord. No.
Item No. 8511

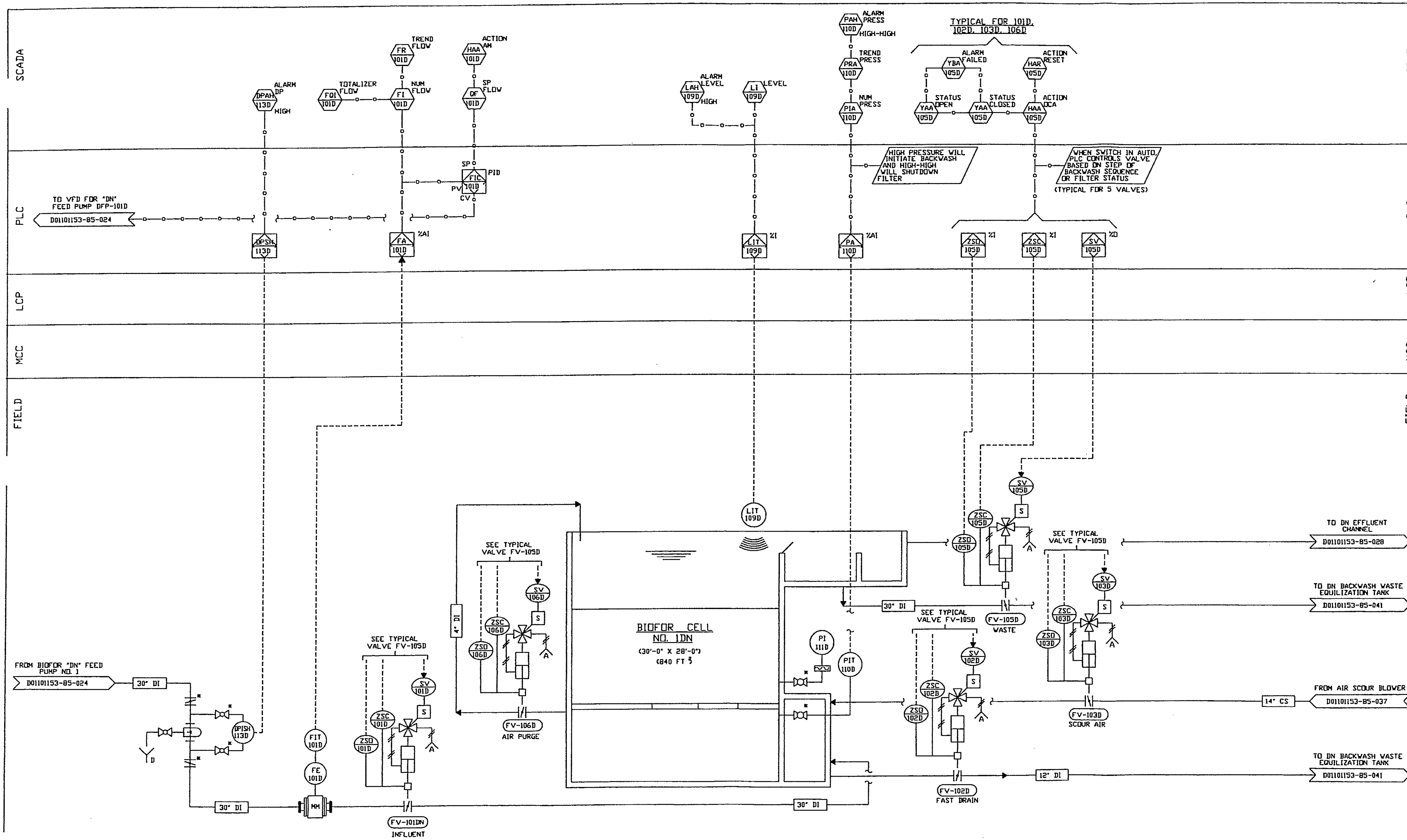
ONDEO Degremont, Inc.
Post Office Box 71390
Richmond, Virginia 23255-1390
PH: (800) 446-1150

ONDEO Degrémont

| | BY | DATE |
|---|---|---|
| DRAWN | DLD | 11/01 |
| CHECKED | SS | 11/01 |
| APP | JJV | 11/01 |
| REF. | | |
| REF. | | |
| SCALE | NONE | |

P. & I. DIAGRAM
BIOFOR FILTERS
FILTER CELL #1N

SIZE D | DWG. NO. [redacted]-85-016 | REV. B

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| REV | REVISION DESCRIPTION | DRAWN | CHECKED | APP | DATE |
|---|---|---|---|---|---|
| – | ORIGINAL ISSUE FOR APPROVAL | DLD | SS | JJV | 12/01 |
| A | ADDED FILTER CELL SIZE | JV | SS | JJV | 04/02 |
| B | REVISED PER ENGINEER'S COMMENTS | DSDT | JV | JJV | 06/03 |

PROJECT INFORMATION
☐ Information Only ■ For Approval
☐ Preliminary ☐ Certified
For [redacted]
Cust. Ord. No.
Item No. 8501

ONDEO Degremont, Inc.
Post Office Box 71390
Richmond, Virginia 23255-1390
PH: (800) 446-1150

ONDEO Degrémont

| | BY | DATE |
|---|---|---|
| DRAWN | DLD | 12/01 |
| CHECKED | SS | 12/01 |
| APP | JJV | 12/01 |
| SCALE | NONE | |

P. & I. DIAGRAM
BIOFOR FILTERS
FILTER CELL #1DN

SIZE D DWG. NO. [redacted]-85-025 REV. B

SEVERN TRENT SERVICES

2 April 2015

Severn Trent Services
Suite 600
1000 Cliff Mine Road
Pittsburgh, PA 15275
United States

T: +1 412 788 8300
TF: +1 800 364 1600
F: +1 412 788 8304

www.severntrentservices.com

Stephanie Fevig, P.E.
Brown and Caldwell
Lakewood, CO

Subject: WWTP near Boise, ID
STWP Denite® Filters
STWP Proposal P79797

Dear Ms. Fevig:

Severn Trent Water Purification, Inc. (STWP) is pleased to offer this preliminary proposal for the supply of equipment, materials and services for the WWTP in Idaho. Our proposal is based on the criteria listed in our Design Calculation sheet attached. With these criteria we sized for eight (8) 11'78" x 100'70" Denite® filters, each with 8' of Tetra® #5 media.

The process calculation sheets attached will provide additional information regarding hydraulic loading and backwash frequency at the various process conditions. Also attached is a typical general arrangement drawing and PFD.

Our Scope of supply for the filters will be;

3 Backwash Air Blowers
Positive displacement type, two operating and one stand7by

2 Backwash Water Pumps
End suction, frame mounted, centrifugal pumps with mechanical seals. Operated by a VSD supplied by MCC vendor.

2 Mudwell Pumps
End suction, frame mounted, centrifugal pumps with mechanical seals

8 lots Filter Internals
This includes sump cover plates, air headers and laterals, underdrain block (SNAP T®), gravel, Tetra® #5 media, and stainless steel weir plate.

1 lot Manual Valves
These will be the check valves and isolation valves for backwash pumps, backwash blowers and mudwell pumps.

8 lots Filter Control Valves
Electric actuated AWWA butterfly valves for open/close service, modulating service and blower unloading.



Correspondence should be addressed to:
Severn Trent Water Purification, Inc.

1 lot Filter Instruments
Backwash air pressure switch, backwash water flow meter and sonic level elements for filters, clearwell and mudwell and low level cut"off switches for clearwell and mudwell.

1 TETRAPace® Nitrate Analyzer and Sample Pumps
TETRAPace® will optimize the usage of methanol and minimize operator attention to the Denite® process, both contributing operating cost savings to the Owner.

1 Methanol Feed System
This will include three metering pumps (2 operating, 1 stand"by), stainless steel storage tank with accessories, and filter system influent flow meter.

1 Main Control Panel
NEMA 12 enclosure for indoor location with Allen"Bradley HMI and PLC

1 lot Field Service
Supervision for underdrain installation, control system start"up and operator training

The following items are not included in the STWP package

- Receiving, unloading, storing and installation of STWP supplied equipment.
- Concrete for filter vessels, building/architectural work and engineering thereof
- Grout after air/water distribution block placement in vessels
- Platform, walkways or stairways
- Anchor bolts for mechanical equipment
- Lubricants for mechanical equipment and motors
- Interconnecting piping and engineering thereof
- Electrical starters, motor control center, conduit and wire and engineering thereof
- Performance testing lab services
- Spare parts
- Methanol supply
- Phosphoric acid system storage and supply equipment.

STWP will deliver the equipment, materials and service described above for a rough"order"of" magnitude lump sum, including freight, and license to practice the Tetra® DeepBed™ Denite® Denitrification Process, TETRAPace®, SPEEDBUMP® and a Process Performance Warranty for **$5,400,000**.

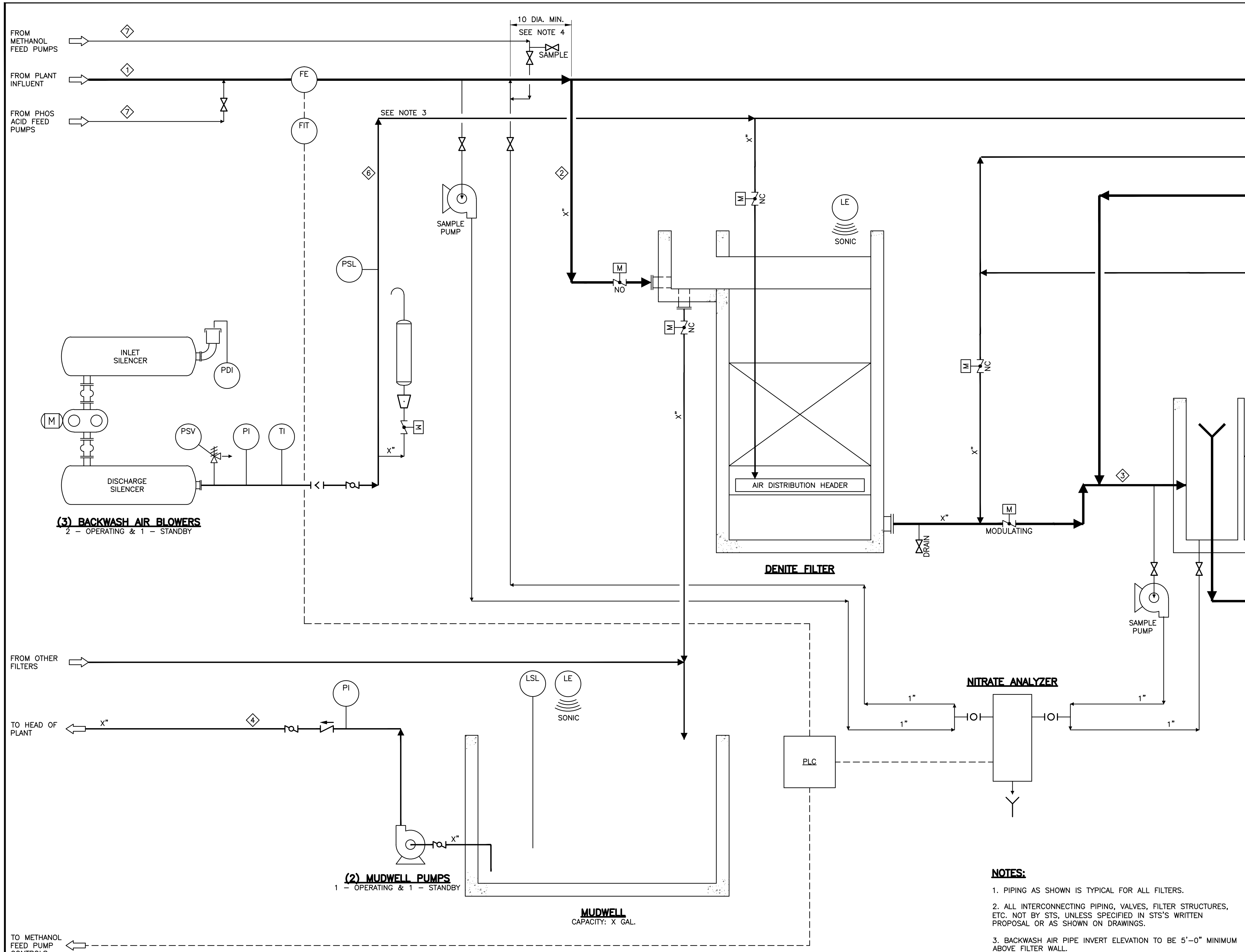
Thank you for considering Severn Trent Water Purification, Inc.

Joseph M Bonazza
Global Sales Manager – DBF & Inorganics

**Attachments:** F101 Process Flow Diagram – Denite System
G300 General Arrangement – Filters, Clearwell and Mudwell


smj/

Correspondence should be addressed to:
**Severn Trent Water Purification, Inc.**




| PARAMETER | STREAM NUMBER | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 PLANT INF. | 2 FILTER INF. | 3 PLANT EFF. | 4 DIRTY B.W. | 5 CLEAN B.W. | 6 B.W. AIR | 7 CHEM. FEED | 8 | 9 | 10 |
| FLOW MAX. GPM | | | | | | | | | | |
| AVG. GPM | | | | | | | | | | |
| MIN. GPM | | | | | | | | | | |
| TSS MAX. PPM | | | | | | | | | | |
| AVG. PPM | | | | | | | | | | |
| NO3–N MAX. PPM | | | | | | | | | | |
| AVG. PPM | | | | | | | | | | |
| TEMP. MAX. °F | | | | | | | | | | |
| MIN. °F | | | | | | | | | | |
| AIR ICFM | | | | | | | | | | |

**NOTES:**

1. PIPING AS SHOWN IS TYPICAL FOR ALL FILTERS.
2. ALL INTERCONNECTING PIPING, VALVES, FILTER STRUCTURES, ETC. NOT BY STS, UNLESS SPECIFIED IN STS'S WRITTEN PROPOSAL OR AS SHOWN ON DRAWINGS.
3. BACKWASH AIR PIPE INVERT ELEVATION TO BE 5'–0" MINIMUM ABOVE FILTER WALL.
4. IN ADDITION TO MINIMUM TEN PIPE DIAMETERS, IT IS PREFERABLE TO HAVE ADDITIONAL TURBULANCE FROM A PIPE FITTING BETWEEN INJECTION POINT AND FIRST FILTER.

| NO. | REVISIONS | BY | DATE | APP'D | NO. | REVISIONS | BY | DATE | APP'D |
|---|---|---|---|---|---|---|---|---|---|
| A | FOR PROPOSAL | SMJ | 1APRIL2015 | | | | | | |

SCALE NONE
APP'D
DATE
DESIGNED
DRAFTED
CHECKED

**FOR PROPOSAL ONLY**

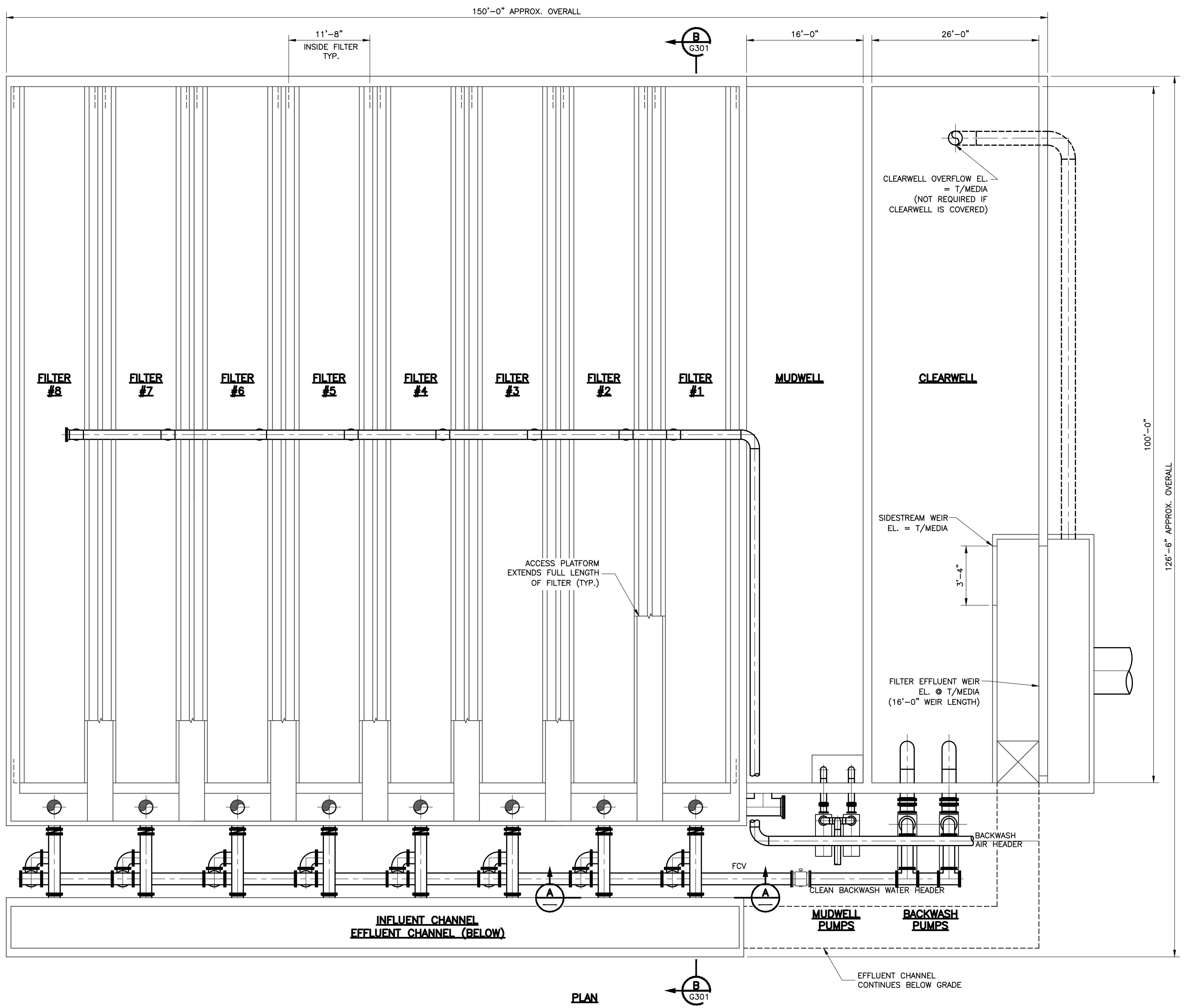


WWTP
MERIDIAN, ID
(8) 11'-8" X 100'-0" DENITE FILTERS
PROCESS FLOW DIAGRAM
DENITE FILTER SYSTEM

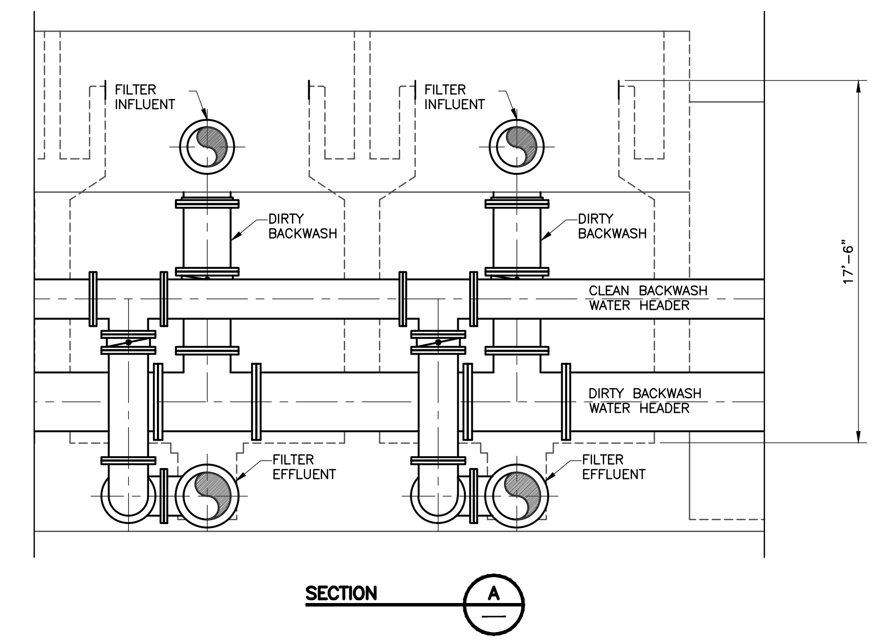
SEVERN TRENT SERVICES

FILTRATION PRODUCTS

| CONTRACT No. | DWG No. | REV. |
|---|---|---|
| | P-9797-F101 | A |




PLAN




SECTION A

**NOTE:**

DETAILS OF PUMP ARRANGEMENT, PERSONNEL ACCESS AND AUXILIARY EQUIPMENT ARE TO BE DETERMINED BY THE ENGINEER.

| NO. | REVISIONS | BY | DATE | APP'D | NO. | REVISIONS | BY | DATE | APP'D |
|---|---|---|---|---|---|---|---|---|---|
| A | FOR PROPOSAL | SMJ | 1 APRIL2015 | | | | | | |

SCALE NONE
APP'D
DATE
DESIGNED
DRAFTED
CHECKED

**FOR PROPOSAL ONLY**



WWTP
MERIDIAN, ID
(8) 11'-8" x 100'-0" DENITE FILTERS
GENERAL ARRANGEMENT
FILTERS, MUDWELL AND CLEARWELL

SEVERN TRENT SERVICES

FILTRATION PRODUCTS

| CONTRACT No. | DWG No. | REV. |
|---|---|---|
| P-9797 | G300 | A |

**DENITE[R] DESIGN CALCULATIONS**

31-Mar-2015

| | |
|---|---|
| Project Name: | City of Meridian |
| STS #: | |
| Sales Rep.: | Misco Water |
| Client: | Brown & Caldwell, Stephanie Fevig, sfevig@brwncald.com, 303-239-5403 |
| Plant Location: | ID |
| STS Engineer: | PAM |
| Comments: | |
| **Rev 0:** | ADF & MM flow given, no peak flow given |
| | No Peak Flows Giiven: Peak-Day and Peak-Hour flows/nitrate are assumed |
| | Pumped and UV Disinfection |
| | Partial Denitrification OK with UV Disinfection |
| | Given P of 0.5 mg/l. Supplemental P is required for this operation. |
| | Assume Minimum 3 week supply methanol at Max-Mo conditions |

## I. DESIGN BASIS

### A. General Design Parameters

| | | | | | |
|---|---|---|---|---|---|
| Media depth | = | 8.0 | ft of 2-3 mm | 2.44 | m |
| Media void volume factor | = | 0.4 | | | |
| Media specific surface area | = | 200 | $ft^2/ft^3$ | 656 | $m^2/m^3$ |
| Reactor width | = | 11.7 | ft | 3.56 | m |
| Reactor length | = | 100.0 | ft | 30.49 | m |
| Reactor surface area | = | 1,167 | $ft^2$, 11'-8" x 100'-0" | | |
| Type of supplemental carbon | | Methanol | | | |
| Feed strength of supplemental C | = | 100% | | | |
| Specific Gravity of supplemental C | = | 0.79 | | | |
| Supplemental C cost | = | $1.50 | per gallon | | |
| Supplemental C storage tank(s) | = | 20,000 | gallons | | |
| COD/NO3-N ratio for supplemental C | = | 4.6 | lb COD/lb NO3-N removed | | |
| COD/O2 ratio for supplemental C | = | 1.3 | lb COD/lb O2 removed | | |
| COD content of supplemental C | = | 1.50 | lb COD/lb supplemental carbon | | |
| COD content of biomass VSS | = | 1.42 | lb COD/lb VSS | | |
| Biomass yield temperature coefficient | = | 1.00 | | | |
| Solids yield factor for infl. TSS decay | = | 0.95 | lb. solids/lb. infl. TSS removed | | |
| Solids yield factor for bio. VSS decay | = | 0.90 | lb. solids/lb. bio VSS generated | | |
| S.G. of dry biosolids | = | 1.40 | | | |
| Effective MLSS assumed | = | 20,000 | mg/L average | | |
| BW initial draindown duration estimate | = | 10 | minutes | | |
| BW air scour duration | = | 2 | minutes | | |
| BW water rise time to trough estimate | = | 5 | minutes | | |
| Initial BW water rate | = | 6 | $gpm/ft^2$ | | |
| Initial BW water duration with overflow | = | 20 | minutes, 2 bed volumes | | |
| Final BW water rinse rate | = | 6 | $gpm/ft^2$ | | |
| Final BW water rinse duration | = | 5 | minutes | | |
| Final BW draindown duration estimate | = | 5 | minutes | | |
| Est. valve operating time during a BW | = | 2 | minutes (assuming pneumatic actuators) | | |
| Bump duration per filter | = | 2 | minutes | | |
| BW air rate @ std. atm pressure | = | 6 | $icfm/ft^2$ | | |
| Altitude above sea level | = | 0 | ft | 0 | m |
| Max. spec. solids loading | = | 1.33 | $lb/ft^2$ | | |
| Max. spec. $NO_X$-N loading | = | 0.07 | $lb/ft^2$ | | |
| P nutrient requirement | = | 1.5% | of biomass | | |
| Power cost | = | $0.10 | per kWh | | |

| | | | | | |
|---|---|---|---|---|---|
| Nitrate analyzer power draw | = | 6 | amps | | |
| Nitrate analyzer voltage | = | 120 | VAC | | |
| Number of analyzer sample pumps | = | 2 | pumps | | |
| Sample pump flow to analyzer | = | 15 | gpm | | |
| Sample pump head | = | 35 | ft. | | |
| Carbon feed pump head | = | 90 | psig | | |
| BW pump head | = | 10.8 | psig | 25.0 | ft TDH |
| BW pump efficiency | = | 70% | | | |
| BW pump motor efficiency | = | 90% | | | |
| BW blower head | = | 10.0 | psig | 23.1 | ft TDH |
| Mudwell pump head | = | 10.8 | psig | 25.0 | ft TDH |
| Mudwell pump efficiency | = | 70% | | | |
| Mudwell pump motor efficiency | = | 90% | | | |

**B. Flow**

| | | Summer | Winter | |
|---|---|---|---|---|
| ADF, | MGD = | 11.30 | 11.30 | Given |
| | gpm = | 7,847 | 7,847 | |
| Max-Mo, | MGD = | 14.20 | 14.20 | Given |
| Design Flow | gpm = | 9,861 | 9,861 | |
| Pk-Day, | MGD = | 18.00 | 18.00 | Assumed |
| | gpm = | 12,500 | 12,500 | |
| Pk-Hour, | MGD = | 34.00 | 34.00 | Assumed |
| | gpm = | 23,611 | 23,611 | PF = 3.01 |

**C. Hydraulic Criteria**

| | | | |
|---|---|---|---|
| Filtr. Rate @ ADF w/all in service | = | 3.0 | $gpm/ft^2$ |
| Filtr. Rate @ ADF w/1 in BW | = | 3.5 | $gpm/ft^2$ |
| Filtr. Rate @ Max-Mo w/all in service | = | 3.0 | $gpm/ft^2$ |
| Filtr. Rate @ Max-Mo w/1 in BW | = | 3.5 | $gpm/ft^2$ |
| Filtr. Rate @ Pk-Day w/all in service | = | 3.0 | $gpm/ft^2$ |
| Filtr. Rate @ Pk-Day w/1 in BW | = | 5.0 | $gpm/ft^2$ |
| Filtr. Rate @ Pk-hr w/1 in BW | = | 5.0 | $gpm/ft^2$ |

**D. Influent Characteristics**

| Parameter | | Summer | Winter | |
|---|---|---|---|---|
| Nitrate as N, mg/L @ ADF | = | 40.0 | 40.0 | Given |
| Nitrate as N, mg/L @ Max-Mo | = | 40.0 | 40.0 | Given |
| Nitrate as N, mg/L @ Pk-day | = | 33.0 | 33.0 | Assumed |
| Nitrate as N, mg/L @ Pk-hr | = | 20.0 | 20.0 | Assumed |
| TSS, mg/L | = | 20.0 | 20.0 | Given 10-20 |
| Phosphate as P, mg/L | = | 0.5 | 0.5 | Given |
| pH, SU | = | 7-8 | 7-8 | Assumed |
| DO, mg/L | = | 4.0 | 4.0 | Assumed |
| Min. wastewater temperature, deg.C | = | 20.0 | 14.0 | Given |
| Avg. wastewater temperature, deg.C | = | 22.0 | 18.0 | Assumed |
| Min. air temperature, deg.C | = | 15.0 | 8.0 | Assumed |

**E. Desired Effluent Characteristics (Discharge Limits)**

| Parameter | | Summer | Winter | |
|---|---|---|---|---|
| Nitrate as N, mg/L @ ADF | = | 7.0 | 7.0 | (8 Required) |
| Nitrate as N, mg/L @ Max-Mo | = | 7.0 | 7.0 | (8 Required) |
| Nitrate as N, mg/L @ Pk-Day | = | 7.0 | 7.0 | |
| Nitrate as N, mg/L @ Pk-hr | = | 7.0 | 7.0 | |
| TSS, mg/L | = | 5.0 | 5.0 | (20 Required) |
| pH, SU | = | 6-9 | 6-9 | |

## II. DENITE[R] CALCULATION SUMMARY

**Hydraulic Design:**

| | | Summer | | Winter | |
|---|---|---|---|---|---|
| Raw size at ADF w/all in-service | = | 2.24 | reactors | 2.24 | reactors |
| Actual size at ADF w/all in-service | = | 3.00 | reactors | 3.00 | reactors |
| Raw size at ADF w/1 in BW | = | 2.92 | reactors | 2.92 | reactors |
| Actual size at ADF w/1 in BW | = | 3.00 | reactors | 3.00 | reactors |
| Raw size at Max-Mo w/all in-service | = | 2.82 | reactors | 2.82 | reactors |
| Actual size at Max-Mo w/all in-service | = | 3.00 | reactors | 3.00 | reactors |
| Raw size at Max-Mo w/1 in BW | = | 3.41 | reactors | 3.41 | reactors |
| Actual size at Max-Mo w/1 in BW | = | 4.00 | reactors | 4.00 | reactors |
| Raw size at Pk-Day w/all in-service | = | 3.57 | reactors | 3.57 | reactors |
| Actual size at Pk-Day w/all in-service | = | 4.00 | reactors | 4.00 | reactors |
| Raw size at Pk-Day w/1 in BW | = | 3.14 | reactors | 3.14 | reactors |
| Actual size at Pk-Day w/1 in BW | = | 4.00 | reactors | 4.00 | reactors |
| Raw size at Pk-hr w/1 in BW | = | 5.05 | reactors | 5.05 | reactors |
| Actual size at Pk-hr w/1 in BW | = | 5.00 | reactors | 5.00 | reactors |
| Design based on hydraulics | = | 5 | reactors | 5 | reactors |

**Recommended Design**

**Hydraulic Loadings:**

| | | Summer | | | Winter | | |
|---|---|---|---|---|---|---|---|
| Number of reactors required | = | 8 | reactors | | 8 | reactors | |
| Total surface area | = | 9,336 | $ft^2$, | $m^2$ = 868 | 9,336 | $ft^2$, | $m^2$ = 868 |
| Total media volume | = | 74,688 | $ft^3$, | $m^3$ = 2,117 | 74,688 | $ft^3$, | $m^3$ = 2,117 |
| ADF hydraulic loading | = | 0.84 | $gpm/ft^2$, | m/h = 2.1 | 0.84 | $gpm/ft^2$, | m/h = 2.1 |
| ADF hyd. loading w/1 filter in BW | = | 0.96 | $gpm/ft^2$, | m/h = 2.3 | 0.96 | $gpm/ft^2$, | m/h = 2.3 |
| Max-Mo hydraulic loading | = | 1.06 | $gpm/ft^2$, | m/h = 2.6 | 1.06 | $gpm/ft^2$, | m/h = 2.6 |
| Max-Mo hyd. loading w/1 filter in BW | = | 1.21 | $gpm/ft^2$, | m/h = 3.0 | 1.21 | $gpm/ft^2$, | m/h = 3.0 |
| Pk-Day hydraulic loading | = | 1.34 | $gpm/ft^2$, | m/h = 3.3 | 1.34 | $gpm/ft^2$, | m/h = 3.3 |
| Pk-Day hydraulic loading w/1 filter in BW | = | 1.53 | $gpm/ft^2$, | m/h = 3.7 | 1.53 | $gpm/ft^2$, | m/h = 3.7 |
| Pk hour hydraulic loading | = | 2.53 | $gpm/ft^2$, | m/h = 6.2 | 2.53 | $gpm/ft^2$, | m/h = 6.2 |
| Pk hour hydraulic loading w/1 in BW | = | 2.89 | $gpm/ft^2$, | m/h = 7.1 | 2.89 | $gpm/ft^2$, | m/h = 7.1 |
| 75% Pk hour hydraulic loading w/1 in BW | = | 2.17 | $gpm/ft^2$, | m/h = 5.3 | 2.17 | $gpm/ft^2$, | m/h = 5.3 |
| Empty Bed D.T. @ ADF | = | 71.19 | minutes | | 71.19 | minutes | |
| Empty Bed D.T. @ Max-Mo | = | 56.65 | minutes | | 56.65 | minutes | |
| Empty Bed D.T. @ Pk-Day | = | 44.69 | minutes | | 44.69 | minutes | |
| Empty Bed D.T. @ Pk-hr | = | 23.66 | minutes | | 23.66 | minutes | |

**Volumetric Removals:**

| | | | | | |
|---|---|---|---|---|---|
| Methanol equivalent BOD removal @ ADF | = | 75 | $lb/kft^3$-d, $kg/m^3$-d = 1.20 | 75 | $lb/kft^3$-d, $kg/m^3$-d = 1.20 |
| NOx-N removal/volume @ ADF | = | 42 | $lb/kft^3$-d, $kg/m^3$-d = 0.67 | 42 | $lb/kft^3$-d, $kg/m^3$-d = 0.67 |
| NOx-N removal/volume @ ADF less DO volume | = | 42 | $lb/kft^3$-d, $kg/m^3$-d = 0.68 | 43 | $lb/kft^3$-d, $kg/m^3$-d = 0.68 |
| NOx-N removal/media SA @ ADF | = | 0.21 | $lb/kft^2$-d | 0.21 | $lb/kft^2$-d |
| NOx-N removal/reactor x-sectional SA @ ADF | = | 0.33 | $lb/ft^2$-d | 0.33 | $lb/ft^2$-d |
| Methanol equivalent BOD removal @ Max-Mo | = | 94 | $lb/kft^3$-d, $kg/m^3$-d = 1.51 | 94 | $lb/kft^3$-d, $kg/m^3$-d = 1.51 |
| NOx-N removal/volume @ Max-Mo | = | 52 | $lb/kft^3$-d, $kg/m^3$-d = 0.84 | 52 | $lb/kft^3$-d, $kg/m^3$-d = 0.84 |
| NOx-N removal/volume @ Max-Mo less DO volume | = | 54 | $lb/kft^3$-d, $kg/m^3$-d = 0.86 | 54 | $lb/kft^3$-d, $kg/m^3$-d = 0.86 |
| NOx-N removal/media SA @ Max-Mo | = | 0.26 | $lb/kft^2$-d | 0.26 | $lb/kft^2$-d |
| NOx-N removal/reactor x-sectional SA @ Max-Mo | = | 0.42 | $lb/ft^2$-d | 0.42 | $lb/ft^2$-d |
| Methanol equivalent BOD removal @ Pk-Day | = | 54 | $lb/kft^3$-d, $kg/m^3$-d = 0.87 | 54 | $lb/kft^3$-d, $kg/m^3$-d = 0.87 |
| NOx-N removal/volume @ Pk-Day | = | 52 | $lb/kft^3$-d, $kg/m^3$-d = 0.84 | 52 | $lb/kft^3$-d, $kg/m^3$-d = 0.84 |
| NOx-N removal/media SA @ Pk-Day | = | 0.26 | $lb/kft^2$-d | 0.26 | $lb/kft^2$-d |
| NOx-N removal/reactor x-sectional SA @ Pk-Day | = | 0.42 | $lb/ft^2$-d | 0.42 | $lb/ft^2$-d |
| Methanol equivalent BOD removal @ Pk-hr | = | 51 | $lb/kft^3$-d, $kg/m^3$-d = 0.82 | 51 | $lb/kft^3$-d, $kg/m^3$-d = 0.82 |
| NOx-N removal/volume @ Pk-hr | = | 49 | $lb/kft^3$-d, $kg/m^3$-d = 0.79 | 49 | $lb/kft^3$-d, $kg/m^3$-d = 0.79 |
| NOx-N removal/media SA @ Pk-hr | = | 0.25 | $lb/kft^2$-d | 0.25 | $lb/kft^2$-d |
| NOx-N removal/reactor x-sectional SA @ Pk-hr | = | 0.39 | $lb/ft^2$-d | 0.39 | $lb/ft^2$-d |

**Mass Removals:**

| | | | | | |
|---|---|---|---|---|---|
| Total NOx-N removal @ ADF | = | 3,108 | lb N/day | 3,108 | lb N/day |
| Total NOx-N removal @ Max-Mo | = | 3,905 | lb N/day | 3,905 | lb N/day |
| Total NOx-N removal @ Pk-Day | = | 3,900 | lb N/day | 3,900 | lb N/day |
| Total NOx-N removal @ Pk-hr | = | 3,683 | lb N/day | 3,683 | lb N/day |
| | | | | | |
| Spec. NOx-N removal @ ADF | = | 0.08 | lb N/lb bio | 0.08 | lb N/lb bio |
| *MESSAGE:* | | Rate ok | | Rate ok | |
| Spec. NOx-N removal @ Max-Mo | = | 0.10 | lb N/lb bio | 0.10 | lb N/lb bio |
| *MESSAGE:* | | Rate ok | | Rate ok | |
| Spec. NOx-N removal @ Pk-Day | = | 0.10 | lb N/lb bio | 0.10 | lb N/lb bio |
| *MESSAGE:* | | Rate ok | | Rate ok | |
| Spec. NOx-N removal @ Pk-hr | = | 0.10 | lb N/lb bio | 0.10 | lb N/lb bio |
| *MESSAGE:* | | Rate ok | | Rate ok | |
| | | | | | |
| Alkalinity generation @ ADF | = | 99 | mg/L $CaCO_3$ | 99 | mg/L $CaCO_3$ |
| ANX Biomass yield for selected carbon source @ 20 C | = | 0.27 | lb VSS/lb COD | 0.27 | lb VSS/lb COD |
| ANX Biomass yield for selected carbon source @ design | = | 0.27 | lb VSS/lb COD | 0.27 | lb VSS/lb COD |
| ANX Biomass generation @ ADF | = | 3,808 | lb VSS/day | 3,808 | lb VSS/day |
| AER Biomass yield for selected carbon source @ 20 C | = | 0.16 | lb VSS/lb COD | 0.16 | lb VSS/lb COD |
| AER Biomass yield for selected carbon source @ design | = | 0.16 | lb VSS/lb COD | 0.16 | lb VSS/lb COD |
| AER Biomass generation @ ADF | = | 80 | lb VSS/day | 80 | lb VSS/day |
| ANX +AER Biomass generation minus decay @ ADF | = | 3,499 | lb VSS/day | 3,499 | lb VSS/day |
| Biomass generation relative to N removed | = | 1.13 | lb VSS/lb N rem | 1.13 | lb VSS/lb N rem |
| Influent TSS removal @ ADF | = | 1,413 | lb/day | 1,413 | lb/day |
| Influent TSS removal ADF minus decay @ ADF | = | 1,342 | lb/day | 1,342 | lb/day |
| | | | | | |
| Alkalinity generation @ Max-Mo | = | 99 | mg/L $CaCO_3$ | 99 | mg/L $CaCO_3$ |
| ANX Biomass yield for selected carbon source @ 20 C | = | 0.27 | lb VSS/lb COD | 0.27 | lb VSS/lb COD |
| ANX Biomass yield for selected carbon source @ design | = | 0.27 | lb VSS/lb COD | 0.27 | lb VSS/lb COD |
| ANX Biomass generation @ Max-Mo | = | 4,785 | lb VSS/day | 4,785 | lb VSS/day |
| AER Biomass yield for selected carbon source @ 20 C | = | 0.16 | lb VSS/lb COD | 0.16 | lb VSS/lb COD |
| AER Biomass yield for selected carbon source @ design | = | 0.16 | lb VSS/lb COD | 0.16 | lb VSS/lb COD |
| AER Biomass generation @ Max-Mo | = | 80 | lb VSS/day | 80 | lb VSS/day |
| ANX + AER Biomass generation minus decay @ Max-Mo | = | 4,378 | lb VSS/day | 4,378 | lb VSS/day |
| Biomass generation relative to N removed | = | 1.12 | lb VSS/lb N rem | 1.12 | lb VSS/lb N rem |
| Influent TSS removal @ Max-Mo | = | 1,775 | lb/day | 1,775 | lb/day |
| Influent TSS removal minus decay @ Max-Mo | = | 1,686 | lb/day | 1,686 | lb/day |
| | | | | | |
| Alkalinity generation @ Pk-Day | = | 78 | mg/L $CaCO_3$ | 78 | mg/L $CaCO_3$ |
| ANX + AER Biomasss generation @ Pk-D minus decay | = | 4,415 | lb VSS/day | 4,415 | lb VSS/day |
| Influent TSS removal @ Pk-Day | = | 2,250 | lb/day | 2,250 | lb/day |
| Influent TSS removal minus decay @ Pk-Day | = | 2,138 | lb/day | 2,138 | lb/day |
| | | | | | |
| Alkalinity generation @ Pk-hr | = | 39 | mg/L $CaCO_3$ | 39 | mg/L $CaCO_3$ |
| ANX + AER Biomass generation @ Pk-hr minus decay | = | 4,278 | lb VSS/day | 4,278 | lb VSS/day |
| Influent TSS removal @ Pk-hr | = | 4,250 | lb/day | 4,250 | lb/day |
| Influent TSS removal minus decay @ Pk-hr | = | 4,038 | lb/day | 4,038 | lb/day |

**BW Air and Water Flows:**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| BW air @ standard baro psi = | 14.7 | = | 7,002 | icfm, | $m^3/h$ = | 11,908 | 7,002 | icfm, | $m^3/h$ = | 11,908 |
| BW air @ actual baro psia = | 14.7 | = | 7,002 | icfm, | $m^3/h$ = | 11,908 | 7,002 | icfm, | $m^3/h$ = | 11,908 |
| BW air rate at corrected pressure | | = | 6 | icfm/sf, | m/h = | 110 | 6 | icfm/sf, | m/h = | 110 |
| Estimated BW blower motor | | = | 392 | hp @ psig = | | 10.0 | 393 | hp @ psig = | | 10.0 |
| Initial BW water flow | | = | 7,002 | gpm, | $m^3/h$ = | 1,590 | 7,002 | gpm, | $m^3/h$ = | 1,590 |
| Final BW water flow | | = | 7,002 | gpm, | $m^3/h$ = | 1,590 | 7,002 | gpm, | $m^3/h$ = | 1,590 |
| Estimated BW pump brake horsepower | | = | 63 | hp @ psig = | | 10.8 | 63 | hp @ psig = | | 10.8 |
| Estimated electrical power to BW pump motor | | = | 70 | hp @ psig = | | 10.8 | 70 | hp @ psig = | | 10.8 |
| BW water volume required per BW | | = | 209,687 | gallons, | $m^3$ = | 794 | 209,687 | gallons, | $m^3$ = | 794 |
| Dirty BW volume discharged per BW | | = | 174,677 | gallons, | $m^3$ = | 661 | 174,677 | gallons, | $m^3$ = | 661 |
| Clearwell size DF = | 1.2 | = | 251,624 | gallons, | $m^3$ = | 952 | 251,624 | gallons, | $m^3$ = | 952 |
| Min. Clearwell size req'd @ Max-Mo forward flow | | = | 0 | gallons, | $m^3$ = | 0 | 0 | gallons, | $m^3$ = | 0 |
| Mudwell size DF = | 1.2 | = | 209,612 | gallons, | $m^3$ = | 793 | 209,612 | gallons, | $m^3$ = | 793 |
| Mudwell pump, return @min(BI or 2 hrs) | | = | 1,456 | gpm, | $m^3/h$ = | 331 | 1,456 | gpm, | $m^3/h$ = | 331 |
| Estimated mudwell pump brake horsepower | | = | 13 | hp @ psig = | | 10.8 | 13 | hp @ psig = | | 10.8 |
| Estimated electrical power to mudwell pump motor | | = | 15 | hp @ psig = | | 10.8 | 15 | hp @ psig = | | 10.8 |

**Backwash & Bump Frequencies:**

| | | | | | |
|---|---|---|---|---|---|
| Backwash frequency @ ADF | = | 2.57 | days/reactor | 2.57 | days/reactor |
| | = | 61.72 | hrs/reactor | 61.72 | hrs/reactor |
| BW Sys. Interval, start to next start | = | 7.71 | hrs/syst. BW | 7.71 | hrs/syst. BW |
| | = | 3.11 | system BW/day | 3.11 | system BW/day |
| BW sequence duration | = | 48.95 | minutes | 48.95 | minutes |
| BW Sys. Interval, finish to next start (time for bump & MV | = | 6.90 | hrs/syst. BW | 6.90 | hrs/syst. BW |
| | = | 10.57% | BW as % op. time | 10.57% | BW as % op. time |
| BW: % of forward flow @ ADF w/o draindown | = | 5.77% | | 5.77% | |
| BW: % of forward flow @ ADF w/draindown | = | 4.81% | | 4.81% | |
| SpeedBump frequency @ ADF (including all filters) | = | 4.81 | hrs/system SBump | 4.81 | hrs/system SBump |
| | = | 4.99 | SBumps/day | 4.99 | SBumps/day |
| SpeedBump duration including all filters | = | 17.0 | minutes | 17.0 | minutes |
| Max # SpeedBumps that can occur btw. System BWs | = | 24.3 | Sbumps/BI | 24.3 | Sbumps/BI |
| | = | 5.89% | SBump as % op. time | 5.89% | Sbump as % ot |
| Number of bumps btw. reactor BW if no SpeedBump | = | 12.84 | bumps/ BW | 12.84 | bumps/ BW |
| Biomass accum. btw BWs after decay | = | 1,125 | lbs | 1,125 | lbs |
| Influent TSS accum. btw BWs after decay | = | 431 | lbs | 431 | lbs |
| Total solids accum. btw BWs | = | 1,556 | lbs | 1,556 | lbs |
| Average TSS in BW | = | 1,070 | mg/L | 1,070 | mg/L |

| | | | | | |
|---|---|---|---|---|---|
| Backwash frequency @ Max-Mo | = | 2.05 | days/reactor | 2.05 | days/reactor |
| | = | 49.26 | hrs/reactor | 49.26 | hrs/reactor |
| BW Sys. Interval, start to next start | = | 6.16 | hrs/syst. BW | 6.16 | hrs/syst. BW |
| | = | 3.90 | system BW/day | 3.90 | system BW/day |
| BW Sys. Interval, finish to next start (time for bump & MV | = | 5.34 | hrs/syst. BW | 5.34 | hrs/syst. BW |
| | = | 13.25% | BW as % op. time | 13.25% | BW as % op. time |
| BW: % of forward flow @ Max-Mo w/o draindown | = | 5.76% | | 5.76% | |
| BW: % of forward flow @ Max-Mo w/draindown | = | 4.79% | | 4.79% | |
| SpeedBump frequency @ Max-Mo (including all filters) | = | 3.83 | hrs/system SBump | 3.83 | hrs/system SBump |
| | = | 6.27 | SBumps/day | 6.27 | SBumps/day |
| Max # SpeedBumps that can occur btw. System BWs | = | 18.9 | Sbumps/BI | 18.9 | Sbumps/BI |
| | = | 6.97% | Sbump as % op. time | 6.97% | Sbump as % ot |
| Number of bumps btw. reactor BW if no SpeedBump | = | 12.88 | bumps/ BW | 12.88 | bumps/ BW |
| Biomass accum. btw BWs after decay | = | 1,123 | lbs | 1,123 | lbs |
| Influent TSS accum. btw BWs after decay | = | 433 | lbs | 433 | lbs |
| Total solids accum. btw BWs | = | 1,556 | lbs | 1,556 | lbs |
| Average TSS in BW | = | 1,070 | mg/L | 1,070 | mg/L |

| | | | | | |
|---|---|---|---|---|---|
| Backwash frequency @ Pk-Day | = | 1.90 | days/reactor | 1.90 | days/reactor |
| | = | 45.59 | hrs/reactor | 45.59 | hrs/reactor |
| BW Sys. Interval, start to next start | = | 5.70 | hrs/syst. BW | 5.70 | hrs/syst. BW |
| | | 4.21 | system BW/day | 4.21 | system BW/day |
| | | 10.22% | BW as % op. time | 10.22% | BW as % op. time |
| BW: % of forward flow @ Pk-Day w/o draindown | = | 4.91% | | 4.91% | |
| BW: % of forward flow @ Pk-Day w/draindown | = | 4.09% | | 4.09% | |
| Bump frequency @ Pk-Day | = | 3.83 | hrs/system SBump | 3.83 | hrs/system SBump |
| | = | 6.27 | SBumps/day | 6.27 | SBumps/day |
| Number of bumps btw. reactor BW | = | 11.90 | bumps/ BW | 11.90 | bumps/ BW |
| Biomass accum. btw BWs after decay | = | 1,048 | lbs | 1,048 | lbs |
| Influent TSS accum. btw BWs after decay | = | 508 | lbs | 508 | lbs |
| Total solids accum. btw BWs | = | 1,556 | lbs | 1,556 | lbs |
| Average TSS in BW | = | 1,070 | mg/L | 1,070 | mg/L |

| | | | | | |
|---|---|---|---|---|---|
| Backwash frequency @ Pk-hr | = | 1.50 | days/reactor | 1.50 | days/reactor |
| | = | 35.93 | hrs/reactor | 35.93 | hrs/reactor |
| BW Sys. Interval, start to next start | = | 4.49 | hrs/syst. BW | 4.49 | hrs/syst. BW |
| | | 5.34 | system BW/day | 5.34 | system BW/day |
| | | 12.97% | BW as % op. time | 12.97% | BW as % op. time |
| BW: % of forward flow @ Pk-hr w/o draindown | = | 3.30% | | 3.30% | |
| BW: % of forward flow @ Pk-hr w/draindown | = | 2.75% | | 2.75% | |
| Bump frequency @ Pk-hr | = | 4.06 | hrs/system SBump | 4.06 | hrs/system SBump |
| | = | 5.92 | SBumps/day | 5.92 | SBumps/day |
| Number of bumps btw. reactor BW | = | 8.86 | bumps/ BW | 8.86 | bumps/ BW |
| Biomass accum. btw BWs after decay | = | 800 | lbs | 800 | lbs |
| Influent TSS accum. btw BWs after decay | = | 756 | lbs | 756 | lbs |
| Total solids accum. btw BWs | = | 1,556 | lbs | 1,556 | lbs |
| Average TSS in BW | = | 1,070 | mg/L | 1,070 | mg/L |

**Sidestream Clearwell Fill Rate (for UV disinfection applications):**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Clearwell Fill Rate After Backwash, 2-hr fill period | = | 1,747 | gpm | | 1,747 | gpm | |
| ADF Percent of Forward Flow Used for Fill | = | 22% | | | 22% | | |
| Flow to Disinfection During Fill @ ADF | = | 8.8 | MGD | | 8.8 | MGD | |

**Supplemental Carbon choice is Methanol**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Theoretical C:N ratio @ ADF | = | 3.07 | | | 3.07 | | |
| Theoretical C:DO ratio @ ADF | = | 0.87 | | | 0.87 | | |
| Carbon required @ ADF conditions for N & DO, DF = 1.0 | = | 9,856 | lb/d | | 9,856 | lb/d | |
| 100% feed solution @ SG = 0.79 | = | 62.19 | gph | | 62.19 | gph | |
| Carbon pump power @ ADF conditions | = | 0.09 | hp@psig= | 90 | 0.09 | hp@psig= | 90 |
| Carbon storage @ ADF conditions | = | 27 | days | | 27 | days | |
| Theoretical C:N ratio @ Max-Mo | = | 3.07 | | | 3.07 | | |
| Theoretical C:DO ratio @ Max-Mo | = | 0.87 | | | 0.87 | | |
| Carbon required @ MM conditions for N & DO, DF = 1.0 | = | 12,386 | lb/d | | 12,386 | lb/d | |
| 100% feed solution @ SG = 0.79 | = | 78.15 | gph | | 78.15 | gph | |
| Carbon pump power @ Max-Mo conditions | = | 0.12 | hp@psig= | 90 | 0.12 | hp@psig= | 90 |
| Carbon storage @ Max-Mo conditions | = | 21 | days | | 21 | days | |
| Theoretical C:N ratio @ Pk-Day | = | 3.07 | | | 3.07 | | |
| Theoretical C:DO ratio @ Pk-Day | = | 0.87 | | | 0.87 | | |
| Carbon required @ Pk-D conditions for N & DO, DF = 1.( | = | 12,480 | lb/d | | 12,480 | lb/d | |
| DO, DF feed solution @ SG = 0.79 | = | 78.74 | gph | | 78.74 | gph | |
| Carbon pump power @ Pk-Day conditions | = | 0.12 | hp@psig= | 90 | 0.12 | hp@psig= | 90 |
| Carbon storage @ Pk-Day conditions | = | 21 | days | | 21 | days | |
| Theoretical C:N ratio @ Pk-hr | = | 3.07 | | | 3.07 | | |
| Theoretical C:DO ratio @ Pk-hr | = | 0.87 | | | 0.87 | | |
| Carbon required @ Pk-hr conditions | = | 12,278 | lb/d | | 12,278 | lb/d | |
| 100% feed solution @ SG = 0.79 | = | 77.47 | gph | | 77.47 | gph | |
| Carbon pump power @ Pk-hr conditions | = | 0.12 | hp@psig= | 90 | 0.12 | hp@psig= | 90 |
| Carbon storage @ Pk-hr conditions | = | 22 | days | | 22 | days | |

**Nutrient Requirements:**

| | | | | | |
|---|---|---|---|---|---|
| Theoretical P required as nutrient @ ADF | = | 52.48 | lb/day, temp adj | 62.66 | lb/day, temp adj |
| | = | 0.56 | mg/L P | 0.67 | mg/L P |
| | = | 0.017 | mg P/mg Nr | 0.020 | mg P/mg Nr |
| Est. actual P required, DF = 1 | = | 52.48 | lb/day | 62.66 | lb/day |
| P available in raw wastewater @ ADF | = | 47.08 | lb/day | 47.08 | lb/day |
| Supplemental P required | = | 5.40 | lb/day | 15.58 | lb/day |
| Supplemental P as 75% $H_3PO_4$ | = | 1.69 | gpd | 4.87 | gpd |
| 275-gal Tote of 75% $H_3PO_4$ will last | = | 163.06 | days | 56.48 | days |
| Theoretical P required as nutrient @ Max-Mo | = | 65.67 | lb/day, temp adj | 78.42 | lb/day, temp adj |
| | = | 0.55 | mg/L P | 0.66 | mg/L P |
| | = | 0.017 | mg P/mg Nr | 0.020 | mg P/mg Nr |
| Est. actual P required, DF = 1 | = | 65.67 | lb/day | 78.42 | lb/day |
| P available in raw wastewater @ Max-Mo | = | 59.17 | lb/day | 59.17 | lb/day |
| Supplemental P required | = | 6.51 | lb/day | 19.25 | lb/day |
| Supplemental P as 75% $H_3PO_4$ | = | 2.03 | gpd | 6.02 | gpd |
| 275-gal Tote of 75% $H_3PO_4$ will last | = | 135.26 | days | 45.71 | days |
| Theoretical P required as nutrient @ Pk-Day | = | 66.23 | lb/day, temp adj | 79.08 | lb/day, temp adj |
| Est. actual P required, DF = 1 | = | 66.23 | lb/day | 79.08 | lb/day |
| P available in raw wastewater @ Pk-Day | = | 75.00 | lb/day | 75.00 | lb/day |
| Supplemental P required | = | 0.00 | lb/day | 4.08 | lb/day |
| Supplemental P as 75% $H_3PO_4$ | = | 0.00 | gpd | 1.27 | gpd |
| 275-gal Tote of 75% $H_3PO_4$ will last | = | 0.00 | days | 215.80 | days |
| Theoretical P required as nutrient @ Pk-hr | = | 64.16 | lb/day, temp adj | 76.61 | lb/day, temp adj |
| Est. actual P required, DF = 1 | = | 64.16 | lb/day | 76.61 | lb/day |
| P available in raw wastewater @ Pk-hr | = | 141.67 | lb/day | 141.67 | lb/day |
| Supplemental P required | = | 0.00 | lb/day | 0.00 | lb/day |
| Supplemental P as 75% $H_3PO_4$ | = | 0.00 | gpd | 0.00 | gpd |
| 275-gal Tote of 75% $H_3PO_4$ will last | = | 0.00 | days | 0.00 | days |

## III. ESTIMATED OPERATING COSTS

**A. Chemical @ ADF**

| | | | Summer | | | Winter | |
|---|---|---|---|---|---|---|---|
| Carbon cost/gal @ | $1.50 | = | $408,581 | per 6 mos. | | $408,581 | per 6 mos. |
| $H_3PO_4$ cost /lb @ | $0.50 | = | $492 | per 6 mos. | | $1,422 | per 6 mos. |
| | | Subtotal = | $409,073 | per 6 mos. | + | $410,003 | per 6 mos. |
| | | | | | | $819,076 | per year |

**B. Power @ ADF**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | $/kWh = $0.10 | | | | | | |
| BW pump power w/draindown | | = | $1,483 | per 6 mos. | | $1,483 | per 6 mos. |
| BW blower power | | = | $7,327 | per 6 mos. | | $7,328 | per 6 mos. |
| Bump pump power | | = | $1,272 | per 6 mos. | | $1,272 | per 6 mos. |
| Mudwell pump power | | = | $1,236 | per 6 mos. | | $1,236 | per 6 mos. |
| Nitrate analyzer power | | = | $315 | per 6 mos. | | $315 | per 6 mos. |
| Analyzer sample pump(s) power | | = | $149 | per 6 mos. | | $149 | per 6 mos. |
| Carbon feed pump(s) power | | = | $31 | per 6 mos. | | $31 | per 6 mos. |
| | | Subtotal = | $11,813 | per 6 mos. | + | $11,814 | per 6 mos. |
| | | | | | | $23,627 | per year |

## IV. EQUIPMENT LIST FOR ROM-TYPE ESTIMATE (based on winter conditions)

Final equip. selection to be made by Mechanical Dept. after design is finalized.
HP and psig values are estimated typical operating conditions.

| Qty | Description | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | Denite[R] hardware @ | 1,167.0 | ft2, 11'-8" x 100'-0" | | | 108 | $m^2$ |
| 1 lot | TETRA #5 Denite media @ | 3,734.4 | tons of 2-3 mm ES silica sand | 8.0 | ft | 2.44 | m |
| 1 lot | Denite gravel @ | 700.2 | tons | 1.5 | ft | 0.46 | m |
| 1 | Mudwell basin @ | 209,612 | gallons | | | 793 | $m^3$ |
| 1 | Clearwell basin @ | 251,624 | gallons | | | 952 | $m^3$ |
| 2 | BW water pumps @ | 7,002 | gpm @ psig= 10.8 | 25.0 | ft TDH | 1,590 | $m^3/h$ |
| 3 | BW air blowers @ | 3,501 | icfm @ psig= 10.0 | 23.1 | ft TDH | 5,954 | $m^3/h$ |
| 2 | Carbon storage system @ | 20,000 | gallons | | | 76 | $m^3$ |
| 3 | 50% Carbon pumps @ | 39.37 | gph = | 2,484 | ml/min | Methanol | 100% |
| 2 | Phos. acid pumps @ | 0.25 | gph = | 16 | ml/min | $H_3PO_4$ | 75% |
| 2 | Mudwell pumps @ | 1,456 | gpm @ psig= 10.8 | 25.0 | ft TDH | 331 | $m^3/h$ |
| ~~1~~ | ~~Instrument air comp~~ | ~~10~~ | ~~scfm @ 100 psig~~ | | | | |
| ~~1~~ | ~~Instrument air dryer~~ | ~~20~~ | ~~scfm @ 100 psig~~ | | | | |
| 1 | Control system | | | | | | |
| 1 | TETRAPace Carbon Dosing System | | | | | | |
| 1 | Filter Water Level Control | | | | | | |
| 1 lot | Weir Plate | | | | | | |

| Date | Eff NH3 mg/L | Eff NO3 mg/L | Eff TN mg/L | Eff TP mg/L | Aer 1 Air flow rate scfm | Aer 2 Air flow rate scfm | WAS Mas Rate lb/d | Acetate mgd |
|---|---|---|---|---|---|---|---|---|
| 1/5/2015 | 38.30 | 0.11 | 41.76 | 0.55 | 4957.52 | 4550.09 | 21769 | 0.10 |
| 1/6/2015 | 38.45 | 0.11 | 41.88 | 0.47 | 4698.85 | 4475.13 | 22303 | 0.10 |
| 1/7/2015 | 38.86 | 0.12 | 42.36 | 0.53 | 4428.50 | 4114.24 | 21887 | 0.10 |
| 1/8/2015 | 42.50 | 0.11 | 45.99 | 0.62 | 4571.24 | 4304.67 | 22001 | 0.11 |
| 1/9/2015 | 38.86 | 0.11 | 42.25 | 0.49 | 4549.24 | 4302.26 | 22052 | 0.10 |
| 1/10/2015 | 39.51 | 0.11 | 43.00 | 0.51 | 4833.06 | 4546.70 | 22075 | 0.10 |
| 1/11/2015 | 37.46 | 0.10 | 40.90 | 0.41 | 4948.60 | 4603.32 | 22404 | 0.10 |
| 1/12/2015 | 41.06 | 0.12 | 44.66 | 0.38 | 4390.20 | 4005.60 | 21998 | 0.10 |
| 1/13/2015 | 45.54 | 0.13 | 49.24 | 0.45 | 4096.51 | 3690.05 | 21062 | 0.09 |
| 1/14/2015 | 42.02 | 0.12 | 45.64 | 0.59 | 4772.97 | 4356.41 | 21021 | 0.10 |
| 1/15/2015 | 36.60 | 0.10 | 40.06 | 0.49 | 5273.96 | 4896.73 | 22131 | 0.10 |
| 1/16/2015 | 37.95 | 0.11 | 41.42 | 0.41 | 4730.28 | 4297.42 | 22304 | 0.10 |
| 1/17/2015 | 45.20 | 0.12 | 48.85 | 0.47 | 4412.57 | 3945.92 | 21557 | 0.10 |
| 1/18/2015 | 46.21 | 0.12 | 49.92 | 0.52 | 4257.38 | 3942.19 | 21275 | 0.10 |
| 1/19/2015 | 39.63 | 0.12 | 43.13 | 0.68 | 4454.48 | 4113.37 | 21054 | 0.10 |
| 1/20/2015 | 36.43 | 0.10 | 39.79 | 0.60 | 4925.18 | 4635.49 | 21813 | 0.11 |
| 1/21/2015 | 38.69 | 0.10 | 42.12 | 0.47 | 4703.08 | 4413.73 | 22207 | 0.10 |
| 1/22/2015 | 37.53 | 0.12 | 40.96 | 0.48 | 4490.16 | 4176.09 | 21870 | 0.10 |
| 1/23/2015 | 44.56 | 0.12 | 48.22 | 0.46 | 4346.49 | 4092.26 | 21669 | 0.10 |
| 1/24/2015 | 39.92 | 0.12 | 43.43 | 0.55 | 4443.34 | 4143.00 | 21351 | 0.10 |
| 1/25/2015 | 41.32 | 0.10 | 44.84 | 0.51 | 4566.33 | 4300.20 | 21580 | 0.11 |
| 1/26/2015 | 39.91 | 0.11 | 43.40 | 0.42 | 4437.22 | 4079.72 | 21357 | 0.10 |
| 1/27/2015 | 39.24 | 0.12 | 42.80 | 0.40 | 4361.00 | 3996.26 | 21081 | 0.10 |
| 1/28/2015 | 40.70 | 0.12 | 44.29 | 0.45 | 4426.00 | 4004.84 | 20794 | 0.10 |
| 1/29/2015 | 38.45 | 0.11 | 41.97 | 0.47 | 4618.13 | 4207.84 | 21021 | 0.10 |
| 1/30/2015 | 37.49 | 0.11 | 40.99 | 0.50 | 4531.17 | 4181.75 | 21316 | 0.10 |
| 1/31/2015 | 44.17 | 0.12 | 47.84 | 0.47 | 4085.57 | 3789.10 | 21007 | 0.10 |
| 2/1/2015 | 43.00 | 0.13 | 46.64 | 0.50 | 3969.78 | 3638.54 | 20293 | 0.10 |
| 2/2/2015 | 37.84 | 0.12 | 41.36 | 0.44 | 4382.96 | 3977.39 | 20154 | 0.10 |
| 2/3/2015 | 38.08 | 0.11 | 41.59 | 0.49 | 4334.61 | 3989.44 | 20611 | 0.10 |
| 2/4/2015 | 41.57 | 0.12 | 45.09 | 0.47 | 4179.17 | 3792.43 | 20569 | 0.10 |
| **Average** | **40.23** | **0.11** | **43.75** | **0.49** | **4521.79** | **4179.42** | **21,470** | **0.10** |
| **Max** | **46.21** | **0.13** | **49.92** | **0.68** | **5273.96** | **4896.73** | **22,404** | **0.11** |

| | | | |
|---|---|---|---|
| **Total Ave Air** | **8,701** | **scfm** | |
| **Total Max Air** | **10,171** | **scfm** | |
| **BIOFOR N Air** | **5,672** | **scfm** | provided by IDI - 8 blowers @ 709 scfm |
| **Total Ave Air with BIOFOR** | **14,373** | **scfm** | |
| **Total Acetate** | **3.0** | **MG** | |
| **ADF MeOH** | **9900** | **lb/d** | provided by Severn Trent |
| **ADF MeOH** | **1493** | **gpd** | provided by Severn Trent |
| **Monthly Use** | **44790** | **gallons** | |
| **Ave WAS calc** | **27,912** | **lb/d** | with 1.3 factor |
| **Denite Backwash TSS** | **1,070** | **mg/L** | provided by Severn Trent |
| **Dirty BW volume discharge** | **174,677** | **gallons** | provided by Severn Trent, per BW |
| **BW frequency Max Month** | **3.9** | **per day** | provided by Severn Trent, per BW |
| **BW TSS Load** | **6,079** | **lb/d** | |
| **Total Wastage** | **33,991** | **lb/d** | |

| | | |
|---|---|---|
| **Info from :** | 30-DaySimulationWithQAir | |
| power/scfm/yr | | 350 |
| $/kwhr | | 0.069 |
| WAS Rate increase | | 1.3 |
| | mg COD/L | |
| Methanol Solution | | 11880 |
| Purchased Methanol | | 1188000 |
| Methanol Price $/gal | $ | 2.25 |
| **Monthly** | | |
| **Ave Air Cost** | **$** | **29,000.00** |
| **Ave MeOH Cost** | **$** | **101,000.00** |
| **MeOH Facilities** | | |
| 5-Stage Bardenpho Facility Cost | $ | 568,000.00 |
| MeOH Use | | 615 gpd |
| PostDN MeOH Use | | 1493 gpd |
| Ratio | | 2.427642276 |
| **Est MeOH Facility Cost for Post DN** | **$** | **1,379,000.00** |

| Date | Eff NH3 mg/L | Eff NO3 mg/L | Eff TN mg/L | Eff TP mg/L | Aer 1 Air flow rate scfm | Aer 2 Air flow rate scfm | WAS Mas Rate lb/d | Acetate mgd |
|---|---|---|---|---|---|---|---|---|
| 1/5/2015 | 11.16 | 1.03 | 33.50 | 0.43 | 7743.58 | 6218.68 | 20544 | 0.10 |
| 1/6/2015 | 12.09 | 1.00 | 33.98 | 0.41 | 7406.64 | 6113.16 | 20974 | 0.10 |
| 1/7/2015 | 11.30 | 1.09 | 33.98 | 0.44 | 7043.55 | 5883.68 | 20670 | 0.10 |
| 1/8/2015 | 16.81 | 0.96 | 38.04 | 0.48 | 7259.41 | 6157.53 | 20773 | 0.11 |
| 1/9/2015 | 13.72 | 0.96 | 34.65 | 0.42 | 7252.98 | 6072.20 | 20823 | 0.10 |
| 1/10/2015 | 13.41 | 0.99 | 34.99 | 0.43 | 7585.26 | 6256.47 | 20846 | 0.10 |
| 1/11/2015 | 12.35 | 0.96 | 33.31 | 0.38 | 7630.64 | 6254.04 | 21105 | 0.10 |
| 1/12/2015 | 14.55 | 1.05 | 36.73 | 0.37 | 6873.77 | 5769.04 | 20801 | 0.10 |
| 1/13/2015 | 18.12 | 1.10 | 41.07 | 0.41 | 6571.65 | 5505.67 | 20064 | 0.09 |
| 1/14/2015 | 14.78 | 1.06 | 37.35 | 0.46 | 7482.46 | 6018.36 | 19998 | 0.10 |
| 1/15/2015 | 11.02 | 0.97 | 32.20 | 0.40 | 7999.05 | 6415.99 | 20841 | 0.10 |
| 1/16/2015 | 12.45 | 1.01 | 33.76 | 0.37 | 7224.97 | 5993.34 | 20992 | 0.10 |
| 1/17/2015 | 18.35 | 1.07 | 40.78 | 0.41 | 6921.30 | 5752.95 | 20422 | 0.10 |
| 1/18/2015 | 18.95 | 1.07 | 41.76 | 0.43 | 6771.90 | 5708.47 | 20194 | 0.10 |
| 1/19/2015 | 13.17 | 1.05 | 35.06 | 0.50 | 7073.50 | 5820.99 | 20007 | 0.10 |
| 1/20/2015 | 11.65 | 0.94 | 32.06 | 0.45 | 7640.26 | 6305.49 | 20587 | 0.11 |
| 1/21/2015 | 14.25 | 0.95 | 34.77 | 0.40 | 7315.93 | 6097.30 | 20909 | 0.10 |
| 1/22/2015 | 11.87 | 1.03 | 33.17 | 0.42 | 7074.46 | 5893.99 | 20662 | 0.10 |
| 1/23/2015 | 18.19 | 1.04 | 40.28 | 0.41 | 6898.82 | 5823.08 | 20510 | 0.10 |
| 1/24/2015 | 13.82 | 1.04 | 35.44 | 0.45 | 7040.14 | 5869.17 | 20255 | 0.10 |
| 1/25/2015 | 16.59 | 0.94 | 37.19 | 0.42 | 7167.64 | 6051.54 | 20425 | 0.11 |
| 1/26/2015 | 15.28 | 0.97 | 36.02 | 0.38 | 6989.16 | 5804.50 | 20247 | 0.10 |
| 1/27/2015 | 13.11 | 1.05 | 34.96 | 0.38 | 6859.82 | 5665.42 | 20018 | 0.10 |
| 1/28/2015 | 14.28 | 1.05 | 36.30 | 0.40 | 6929.90 | 5686.62 | 19770 | 0.10 |
| 1/29/2015 | 12.66 | 1.03 | 34.20 | 0.41 | 7175.46 | 5800.36 | 19927 | 0.10 |
| 1/30/2015 | 11.28 | 1.05 | 33.03 | 0.41 | 7060.20 | 5810.04 | 20149 | 0.10 |
| 1/31/2015 | 17.64 | 1.05 | 39.80 | 0.40 | 6512.57 | 5532.85 | 19913 | 0.10 |
| 2/1/2015 | 16.52 | 1.07 | 38.65 | 0.42 | 6406.62 | 5366.20 | 19342 | 0.10 |
| 2/2/2015 | 12.19 | 1.03 | 33.54 | 0.38 | 6883.04 | 5583.43 | 19201 | 0.10 |
| 2/3/2015 | 12.29 | 1.03 | 33.79 | 0.41 | 6804.44 | 5630.76 | 19541 | 0.10 |
| 2/4/2015 | 15.43 | 1.03 | 36.88 | 0.41 | 6662.85 | 5630.61 | 19503 | 0.10 |
| **Average** | **14.17** | **1.02** | **35.85** | **0.42** | **7105.22** | **5886.84** | **20,323** | **0.10** |
| **Max** | **18.95** | **1.10** | **41.76** | **0.50** | **7999.05** | **6415.99** | **21,105** | **0.11** |

| | | | |
|---|---|---|---|
| **Total Ave Air** | **12,992** | **scfm** | |
| **Total Max Air** | **14,415** | **scfm** | |
| **BIOFOR N Air** | **3,012** | **scfm** | provided by IDI - 6 blowers @ 502 scfm |
| **Total Ave Air with B** | **16,004** | **scfm** | |
| **Total Acetate** | **3.0** | **MG** | |
| **ADF MeOH** | **7425** | **lb/d** | provided by Severn Trent assume only treating 30mg/L as NOx so reduced by 30/40 |
| **ADF MeOH** | **1120** | **gpd** | provided by Severn Trent assume only treating 30mg/L as NOx so reduced by 30/40 |
| **Monthly Use** | **33592.5** | **gallons** | |
| **Ave WAS calc** | **26,420** | **lb/d** | |
| **Est BW TSS Load** | **4,559** | **lb/d** | provided by Severn Trent assume only treating 30mg/L as NOx so reduced by 30/40 |
| **Total Wastage** | **30,979** | **lb/d** | |

| **Info from :** | 30-DaySimulationWithQAir | |
|---|---|---|
| power/scfm/yr | | 350 |
| $/kwhr | | 0.069 |
| WAS Rate increase | | 1.3 |
| | mg COD/L | |
| Methanol Solution | | 11880 |
| Purchased Methanol | | 1188000 |
| Methanol Price $/gal | $ | 2.25 |
| **Monthly** | | |
| **Ave Air Cost** | **$** | **32,000.00** |
| **Ave MeOH Cost** | **$** | **76,000.00** |
| **MeOH Facilities** | | |
| 5-Stage Bardenpho Facility Cost | $ | 568,000.00 |
| MeOH Use | | 615 gpd |
| PostDN MeOH Use | | 1119.75 gpd |
| Ratio | | 1.820731707 |
| **Est MeOH Facility Cost for Post DN** | **$** | **1,034,000.00** |

## Summary of Costs without Markups

| | Direct Cost | Notes |
|---|---|---|
| **Denite Filters** | $ 11,500,000 | Does not include MeOH Facility and piping |
| **BioFor N - 40** | $ 12,200,000 | |
| **BioForN - 10** | $ 7,700,000 | |
| | | |

| Preliminary Capital Costs for Denite Filters (based on similar footprint as LE WWTP) | | | |
|---|---|---|---|
| **Cost Element** | | | **Cost** |
| Equipment – Main Component | | | |
| Item | Number of Units | Unit Price | |
| Denite Equipment | 1 | $ 5,400,000 | $ 5,400,000 |
| | | Equipment Installation[a] | $ 540,000 |
| | | Mechanical Allowance[b] | $ 810,000 |
| Denite Filters, Clearwell, Mudwell, Inf and Eff Channels and Gallery | 1 | $ 4,310,000 | $ 4,310,000 |
| Other Equipment | | | |
| Electrical Support Building by square foot | 1,560 | $ 250 | $ 390,000 |
| Electrical Building Foundation Construction by cubic yard | 60 | $ 350 | $ 21,000 |
| Methanol Support Building by square foot | 544 | $ 250 | $ 136,000 |
| Methanol Foundation Construction by cubic yard | 46 | $ 350 | $ 16,204 |
| Double Containment Piping for Methanol by foot | 500 | $ 100 | $ 50,000 |
| | | **Subtotal A:** | **$ 11,673,204** |
| | | Contractor General Conditions[c] | $ 1,167,320 |
| | | Site Civil and Grading[d] | $ 933,856 |
| | | EI&C Allowance[e] | $ 2,918,301 |
| | | **Subtotal B:** | **$ 16,692,681** |
| | | Contractor Overhead and Profit[f] | $ 2,503,902 |
| | | **Subtotal C:** | **$ 19,196,583** |
| | | Contractor Contigency[g] | $ 5,758,975 |
| | | **Subtotal D:** | **$ 24,955,559** |
| | | Engineering and SDC[h] | $ 4,991,112 |
| | | **Subtotal E:** | **$ 29,946,670** |
| | | | |
| | | **Total Capital Cost:** | **$ 30,000,000** |

| | |
|---|---|
| [a] *Equipment Installation Cost calculated as 10% of vendor supplied equipment.* | 10% |
| [b] *Mechanical Allowance calculated as 15% of vendor supplied equipment.* | 15% |
| [c] *Contractor general conditions calculated as 10% of subtotal A.* | 10% |
| [d] *Site civil and grading calculated as 8% of subtotal A.* | 8% |
| [e] *EI&C allowance calculated as 25% of subtotal A.* | 25% |
| *f Contractor Overhead and Profit calculated as 15% of subtotal B.* | 15% |
| [g] *Contractor Contingency calculated as 30% of subtotal C.* | 30% |
| [h] *Engineering and SDC calculated as 20% of subtotal D.* | 20% |

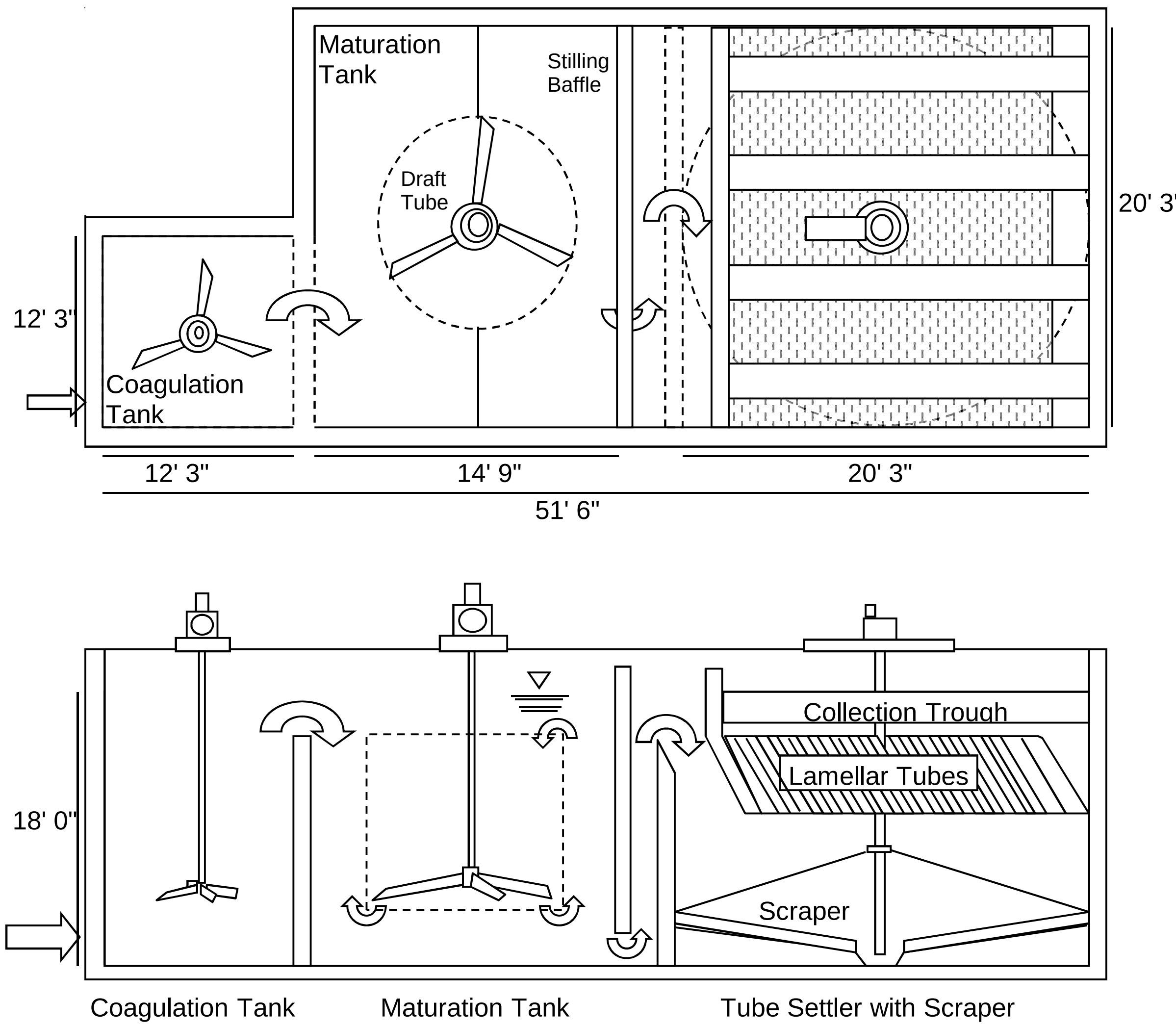
| Preliminary Capital Costs for BioForN [10 mg/L Influent Ammonia] | | | | |
|---|---|---|---|---|
| Cost Element | | | | Cost |
| Equipment – Main Component | | | | |
| Item | Number of Units | Unit Price | | |
| BioFor N Equipment | 1 | $ | 3,900,000 | $ 3,900,000 |
| | | | Equipment Installation[a] | $ 390,000 |
| | | | Mechanical Allowance[b] | $ 585,000 |
| Cells, Clearwell, Mudwell, Inf and Eff Channels and Gallery[1] | 1 | $ | 2,400,000 | $ 2,400,000 |
| Other Equipment | | | | |
| Electrical Support Building by square foot | 1,560 | $ | 250 | $ 390,000 |
| Electrical Building Foundation Construction by cubic yard | 60 | $ | 350 | $ 21,000 |
| | | | **Subtotal A:** | **$ 7,686,000** |
| | | | Contractor General Conditions[c] | $ 768,600 |
| | | | Site Civil and Grading[d] | $ 614,880.00 |
| | | | EI&C Allowance[e] | $ 1,921,500.00 |
| | | | **Subtotal B:** | **$ 10,990,980** |
| | | | Contractor Overhead and Profit[f] | $ 1,648,647 |
| | | | **Subtotal C:** | **$ 12,639,627** |
| | | | Contractor Contigency[g] | $ 3,791,888.10 |
| | | | **Subtotal D:** | **$ 16,431,515** |
| | | | Engineering and SDC[h] | $ 3,286,303.02 |
| | | | **Subtotal E:** | **$ 19,717,818** |
| | | | | |
| | | | **Total Capital Cost:** | **$ 20,000,000** |

| | |
|---|---|
| [a] *Equipment Installation Cost calculated as 10% of vendor supplied equipment.* | 10% |
| [b] *Mechanical Allowance calculated as 15% of vendor supplied equipment.* | 15% |
| [c] *Contractor general conditions calculated as 10% of subtotal A.* | 10% |
| [d] *Site civil and grading calculated as 8% of subtotal A.* | 8% |
| [e] *EI&C allowance calculated as 25% of subtotal A.* | 25% |
| *f Contractor Overhead and Profit calculated as 15% of subtotal B.* | 15% |
| [g] *Contractor Contingency calculated as 30% of subtotal C.* | 30% |
| [h] *Engineering and SDC calculated as 20% of subtotal D.* | 20% |

| Preliminary Capital Costs for BioForN [40 mg/L Influent Ammonia] | | | | |
|---|---|---|---|---|
| **Cost Element** | | | | **Cost** |
| Equipment – Main Component | | | | |
| Item | Number of Units | Unit Price | | |
| BioFor N Equipment | 1 | $ | 5,900,000 | $ 5,900,000 |
| | | | Equipment Installation[a] | $ 590,000 |
| | | | Mechanical Allowance[b] | $ 885,000 |
| Cells, Clearwell, Mudwell, Inf and Eff Channels and Gallery[1] | 1 | $ | 4,400,000 | $ 4,400,000 |
| Other Equipment | | | | |
| Electrical Support Building by square foot | 1,560 | $ | 250 | $ 390,000 |
| Electrical Building Foundation Construction by cubic yard | 60 | $ | 350 | $ 21,000 |
| | | | **Subtotal A:** | **$ 12,186,000** |
| | | | Contractor General Conditions[c] | $ 1,218,600 |
| | | | Site Civil and Grading[d] | $ 974,880.00 |
| | | | EI&C Allowance[e] | $ 3,046,500.00 |
| | | | **Subtotal B:** | **$ 17,425,980** |
| | | | Contractor Overhead and Profit[f] | $ 2,613,897 |
| | | | **Subtotal C:** | **$ 20,039,877** |
| | | | Contractor Contigency[g] | $ 6,011,963.10 |
| | | | **Subtotal D:** | **$ 26,051,840** |
| | | | Engineering and SDC[h] | $ 5,210,368.02 |
| | | | **Subtotal E:** | **$ 31,262,208** |
| | | | | |
| | | | **Total Capital Cost:** | **$ 31,000,000** |

| | |
|---|---|
| [a] *Equipment Installation Cost calculated as 10% of vendor supplied equipment.* | 10% |
| [b] *Mechanical Allowance calculated as 15% of vendor supplied equipment.* | 15% |
| [c] *Contractor general conditions calculated as 10% of subtotal A.* | 10% |
| [d] *Site civil and grading calculated as 8% of subtotal A.* | 8% |
| [e] *EI&C allowance calculated as 25% of subtotal A.* | 25% |
| *f Contractor Overhead and Profit calculated as 15% of subtotal B.* | 15% |
| [g] *Contractor Contingency calculated as 30% of subtotal C.* | 30% |
| [h] *Engineering and SDC calculated as 20% of subtotal D.* | 20% |

## 14.2 MGD ACTIFLO
## Total Capacity = 14 MGD
## Capacity per Train: 2 x 14 MGD



On Wed, Apr 22, 2015 at 7:37 AM, Georger, Jim <jim.georger@veolia.com> wrote:
Ben

Please see attached Preliminary Proposal for Actiflo. This will help you better understand our typical scope. Budget Price for the Actiflo only with Chemical Feed Systems is $2.3 MM.

I have also requested our Typical O&M Table based on the Proposal and shroud have for you today.

As far as discfilters go:

Our typical media replacement estimates is: (percent of panels replaced)

- Years 1-5: ~0% Annual Replacement
- Years 6-8: ~4-6% Annual Replacement
- Years 7-20: ~6-8% Annual Replacement

Cost per Media Panel for HSF2200: ~$125

We expect that a full replacement of the filters' media will occur after 20 years. As a rule of thumb we estimate that 5% of the media panels are replaced in Years 6-8; and 7% of the media panels annually thereafter. We feel confident that these are conservative estimates. We know of sites that have operated for more than 10 years with original media.

We like to stress that individual media panels can be replaced, replacing an entire disc, drum, and tank is not necessary.

Please let me know what else you may need. Actiflo O&M Table is coming. I have also requested Budget Prices for the Discfilters and typical drawings for each size noted in the Table.

Jim

**James T. Georger, P.E.**
***Regional Sales Manager, US Municipal Solutions***
***WATER TECHNOLOGIES***

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Resourcing the world VEOLIA

Brown and Caldwell

# Meridian, ID

4/21/2015

## ACTIFLO® Proposal

Kruger Project No.: - 5700112503

Submitted to:
Ben Watson
Wastewater Engineer
Brown and Caldwell
701 Pike St # 1200, Seattle, WA 98101

Submitted by:

Daniel M. Austria Jr.
ACTIFLO® Systems Application Engineer
I Kruger Inc.
4001 Weston Parkway
Cary, NC  27513  USA

## Introduction

I Kruger Inc (Krüger) is pleased to present this budgetary ACTIFLO® System proposal for a potential tertiary waste water treatment project in Meridian, ID.

Enclosed is the preliminary process description, design summary, scope of supply, design options, procurement schedule, and price estimate for the following offering:

2 x 14.2 MGD ACTIFLO® System

Over the past 11 years, Kruger has been very active in establishing performance expectations and specific design criteria for our ACTIFLO® process in regards to TP removal. This process knowledge development has come from Kruger design engineers working closely with our full- scale tertiary WW removal installations (11 currently in operation with 2 more currently under construction) coupled with our research and development efforts in pilot testing different wastewater sources throughout the country. Our efforts over the years have proven that the ACTIFLO® process can treat clarified effluent from numerous biological treatment processes (fixed film, activated sludge, processes with or without biological phosphorus removal) and still achieve extremely low TP.

The ACTIFLO® process offers many advantages to include:

1) Well established Tertiary WW removal installation base in the US to include cold climates.
2) A small process footprint that can fit into the existing site or be retro-fitted into existing basins no longer in use.
3) A low system head loss that allows for incorporation of ACTIFLO® system into the existing hydraulic profile without the need for pumping.
4) Low power demand and overall operating costs with the ability to start and stop the process for extended periods of time without having a negative impact on process performance or start-up time.
5) The ability to meet future phosphorus limits by adding more chemicals as opposed to adding more equipment .
6) Can be operated with multiple coagulant types.
7) The ability to handle an increase in solids loading for a prolonged period of time while maintaining consistent effluent quality (solids washout during peak flow conditions).
8) Readily available ballast material (microsand) that can be purchased from multiple suppliers in the US to include a supplier in the regional ID area.

We appreciate the opportunity to provide this proposal to you. If you have any questions or need further information, please contact our local representative, Mike Brown (Coombs Hopkins) or our Regional Product Manager, Jim Georger (jim.georger@veolia.com, 972-377-2927).

cc: Sales/Proces Dept, project file (Kruger)
Mike Brown (Cooms Hopkins)

| Revision | Date | Process Eng. | Comments |
|---|---|---|---|
| 0 | 4/21/2015 | MDC | Initial request for 2 x 14.2 MGD ACTIFLO system |

## We Know Water

**I. Kruger Inc. (Kruger)** is a water and wastewater solutions provider specializing in advanced and differentiating technologies. Kruger provides complete processes and systems ranging from biological nutrient removal to mobile surface water treatment. The ACTIFLO® Microsand Ballasted Clarifier, BioCon® Dryer, BIOSTYR® Biological Aerated Filter (BAF) and NEOSEP™ MBR are just a few of the innovative technologies offered by Kruger. Kruger is a subsidiary of Veolia Water, a world leader in engineering and technological solutions in water treatment for industrial companies and municipal authorities.

**Veolia Water Solutions & Technologies**, the fully-owned subsidiary of **Veolia Water**, is the world leader in water and wastewater treatment with over 155 years of experience. As an experienced design-build company and a specialized provider of technological solutions in water treatment, Veolia combines proven expertise with unsurpassed innovation to offer technological excellence to our industrial customers. Based on this expertise, we believe that we have developed the best solution for your application. Below is a brief description of the proposed project.

**Energy Focus**

Kruger, along with Veolia Water Solutions & Technologies (VWS) is dedicated to delivering sustainable and innovative technologies and solutions.

We offer our customers integrated solutions which include resource-efficient technology to improve operations, reduce costs, achieve sustainability goals, decrease dependency on limited resources, and comply with current and anticipated regulations.

Veolia's investments in R&D outpace that of our competition. Our focus is on delivering

- neutral or positive energy solutions
- migration towards green chemicals or zero chemical consumption
- water-footprint-efficient technologies with high recovery rates

Our carbon footprint reduction program drives innovation, accelerates adoption and development of clean technologies, and offers our customers sustainable solutions.

Kruger is benchmarking its technologies and solutions by working with our customers and performing total carbon cost analysis over the lifetime of the installation.

By committing to the innovative development of clean and sustainable technologies and solutions worldwide, Kruger and VWS will continue to maximize the financial benefits for every customer.

# Process Description

## ACTIFLO® Process

The ACTIFLO® process is a compact clarification system that utilizes microsand as a seed for floc formation. The microsand serves several important roles in the ACTIFLO® process such as forming a seed which promotes the formation of large stable, high-density floc, dampens the effects of changes in the raw water quality due to its high concentration within in the process, and is effectively removed from the chemical sludge and reused in the process due to its chemically inert qualities. This floc has considerably higher settling velocities than conventional floc and allows significantly higher clarifier overflow rates. The higher overflow rates possible with ACTIFLO® translate directly into reduced process volume, reduced system footprint, and significant reductions in total civil cost. Overall, these factors provide a process that is extremely efficient in the treatment of "difficult" waters, stable with changes in raw water quality, and relatively easy to operate and optimize. ACTIFLO designs result in system footprints that are between 5 and 20 times smaller for water and 5 to 50 times smaller for wastewater applications when compared to conventional clarification systems of similar capacity.

In wastewater treatment, the ACTIFLO® process is appropriate for use in any application that would benefit from physical-chemical treatment including coagulation, flocculation and settling. It can be applied to primary and tertiary wastewater treatment where either better performance or cost reduction is desired. It is ideally suited for storm water treatment including CSO, SSO or other overflows due to its high performance, small footprint, and extremely short start-up time. The process consistently displays efficient removals of TSS, BOD, Total P, COD, metals, fecal coliform, and other typical wastewater contaminants, which can be removed by physical-chemical processes.

The ACTIFLO® process is currently in operation worldwide in small communities as well as large metropolitan areas.

## Design Summary

Tables 1 and 2 summarize the design criteria and preliminary process parameters for the proposed design option(s).

**Table 1: General Design Summary**

| Parameter | Unit | Values |
|---|---|---|
| ACTIFLO System Trains | # | 2 |
| Total Influent Flow per ACTIFLO Train | MGD | 14.2 |
| Total Influent Flow to ACTIFLO System | MGD | 28 |
| Total Effluent Flow per ACTIFLO Train | MGD | 13.6 |
| Total Effluent Flow per ACTIFLO System | MGD | 27.2 |
| Peak Hourly Flow | MGD | 28 |
| Max Month Flow | MGD | 14.2 |
| Average Daily Flow | MGD | 5.5 |
| Max Influent TSS | mg/L | TBD |
| Max Influent Total Phosphorus | mg/L | TBD |
| Max Influent Un-reactive Phosphorus | mg/L | < 0.02 |
| | | |
| Target Effluent TSS | mg/L | TBD |
| Target Effluent Total Phosphorus | mg/L | < 0.07 mg/L |
| Assumed Effluent pH | --- | TBD |

**Table 2: ACTIFLO SINGLE TRAIN Design Criteria**

| Parameter | Unit | Values |
|---|---|---|
| Coagulation Tank HRT | min | 2.0 |
| Maturation Tank HRT | min | 4.6 |
| Settling Tank HLR | gpm/sf | 32.5 |
| Sand Recirculation Flow (per pump) +/- 10% | gpm | 300 |
| Estimated Total Sludge Waste Flow +/- 10% (per train) | gpm | 240 |
| Estimated Sludge Solids Concentration | % | 0.1-0.5 |
| | | |
| ACTIFLO Train Dimensions | --- | See General Arrangement DWG |

## Scope of Supply

Kruger is pleased to present our scope of supply which includes process engineering design, package plant fabrication, equipment procurement, and field services required for the proposed treatment system. The work will be performed to Kruger's high standards under the direction of a Project Manager. All matters related to the design, installation, or performance of the system shall be communicated through the Kruger representative giving the Engineer and Owner ready access to Kruger's extensive capabilities.

### Process and Design Engineering

Kruger will provide process engineering and design support for the system as follows:

- Equipment specifications for equipment supplied by Kruger
- Technical instructions for operation and start-up of the system
- Equipment drawings and installation instructions
- Project specific O&M manuals

### Field Services

Kruger will furnish a Service Engineer as specified at the time of start-up to inspect the installation of the system, place the system in initial operation, and to instruct operating personnel on the proper use of the equipment. Specifically, Kruger will provide:

- Field Service Engineer/Technician – Fifteen (15) man days on site in not more than four (4) site visits to assist with inspection check-out, start-up, and operator training.

### Equipment Supply

| ACTIFLO System General Equipment | Quantity (Details) |
|---|---|
| **In-Line Mechanical Mixer** | |
| In-line rapid mixer: TEFC 460/3/60 premium efficient – inverter duty – AC induction motor, low pressure stuffing box type seal, 316 SS internal baffles, dual chemical injection ports, epoxy-coated carbon steel body, 316 SS radial flow turbine impellers, 316 SS shaft. | 1<br>(2 HP) |
| **Coagulation Tank (s)** | |
| Top Entering Type Mixer: TEFC 460/3/60 premium efficient – severe duty - AC induction motor. 304 SS shaft and hydrofoil impeller. | 2<br>(5 HP) |
| **Maturation Tank (s)** | |

| ACTIFLO System General Equipment | Quantity (Details) |
|---|---|
| Top Entering Type Mixer: TEFC 460/3/60 premium efficient – inverter duty - AC induction motor, 304SS shaft and draft tube impeller. | 2<br><br>(7.5 HP) |
| TURBOMIX Draft Tube: 304 SS with supports, flux converter cells | 2 |
| **Settling Tank(s)** | |
| Scraper Drive: TEFC 460/3/60 premium efficient –inverter duty – AC induction motor, hydrostatic primary reducer, final reduction planetary gearbox, torque indication and overload protection | 2<br><br>(0.75 HP) |
| Scraper Assembly: 304 SS torque tube shaft, 304 SS rake arms, 304 SS blades, 304SS shaft protector and 304 SS squeegees. | 2 |
| Lamella Settler Set: Polystyrene tube modules | 2 |
| Lamella Settler Support Set: 304 SS tube type supports | 2 |
| Lamella Tube Tie-down Assembly: Appurtenances including wire rope, clips | 2 |
| Effluent Collection Trough Set: 304 SS troughs and supports | 2 |
| **Microsand Recycle Circuits** | |
| Microsand Recirculation Pumps: TEFC, 460/3/60 premium efficient – severe duty – AC induction motor, centrifugal, cast iron body, with rubber-lined volute and closed-vane impeller, dry gland seal, drip pan, with V-belt and pulley drive. | 1 duty + 1 standby (per train)<br><br>(20 HP) |
| Discharge Side Pump Isolation Valve: Manual eccentric plug type | 4<br><br>(4“) |
| Suction Side Pump Isolation Valve: Manual eccentric plug type | 4<br><br>(4”) |

| ACTIFLO System General Equipment | Quantity (Details) |
|---|---|
| Flush Connection Valve: Ball valve, 304 SS, manual. | 4<br><br>(2”) |
| Microsand Recirculation Pump Pressure Transmitter Isolation Valve: Ball valve, 304 SS, manual. | 4<br><br>(0.5”) |
| Sand Sampling Valve: Ball valve, 304 SS, manual. | 4<br><br>(0.5”) |
| **Hydrocyclone Recycle Equipment** | |
| Hydrocyclones: Urethane body | 1 duty + 1 standby (per train) |
| Hydrocyclone Support Stand: 304 SS | 4 |
| Sand Concentration Sampling Device: Imhoff Cone, plastic | 4 |
| **Commissioning Consumables** | |
| Microsand Ballast (Tons) | 28 |
| Polymer Flocculant (lbs) | 1500 |

| ACTIFLO System Spare Parts | Quantity (Details) |
|---|---|
| **Mechanical Spare Parts** | |
| Inline Mixer bearings and seals set | 1 |
| Coagulation Tank mixer bearings and seals set | 1 |
| Maturation Tank mixer bearings and seals set | 1 |
| Microsand Pump V-belt sets | 4 |
| Hydrocyclone Apex Tip | 4 |

| ACTIFLO System Controls | Quantity (Details) |
|---|---|
| **Control Panels** | |
| NEMA 12 Painted Steel (for indoor use only) Panel, to control the ACTIFLO® System based on operator setpoints, completely assembled, tested, and programmed for the required functionality | 1 |
| Back Panel for Control Panel | 1 |
| Panelview Plus 6 1000 Color Touchscreen Operator Interface w/Ethernet – ALLEN BRADLEY | 1 |
| Control Logix PLC Processor – ALLEN BRADLEY | 1 |
| UPS 850VA 120VAC Input/ 120VAC Output – SOLA | 1 |
| | |
| PLC Control Panel I/O + 20% "LIVE" spare wired signals for additional signal interface - KRUGER | 1 |
| Complete Set of Control Panel Internals per Kruger Standard Scope - KRUGER | 1 |
| PLC and Operator Interface Programming – KRUGER | 1 |
| PLC site Start-Up and Testing – KRUGER | 1 |

| ACTIFLO System Instrumentation | Quantity (Details) |
|---|---|
| **Instrumentation** | |
| Influent Pipe Turbidity (pre-chem feed): NTU Sensor, Pipe Insertion Mounting (Hach Solitax NTU Analyzer LVX424), Controller (SC200) | 1 |
| Influent Pipe pH (pre-chem feed): pH Sensor Pipe Insertion Mounting (Hach DPD1P1), Controller (SC200) | 1 |
| Settling Tank Turbidity (post chem feed): NTU Sensor, Tank Immersion Mounting (Hach Solitax NTU Analyzer LVX423), Controller (SC200) | 2 |
| Settling Tank pH (post-chem feed): pH Sensor, Immersion Mounting (Hach DPD1P1), Controller (SC200) | 2 |

| ACTIFLO System Instrumentation | Quantity (Details) |
|---|---|
| Sand Recirculation Pumps Pressure Indicating Transmitter: Ceramic Diaphragm (E+H PMC71) | 4 |
| Sand Recirculation Pump Discharge Flowmeter: Magnetic flowmeter (E+H ProMag W), Controller (ProMag 50) | 4 |

**Notable Scope of Supply Items BY INSTALLER/PURCHASER**

- General Installation of all equipment and materials provided by Krüger Inc.
- Provisions for pH/Alkalinity adjustment
- Reliable and accurate flow signal for each ACTIFLO System Train for chem feed pacing
- Pre-screening equipment prior to ACTIFLO System (typically not required for tertiary ww projects as screening upstream is sufficient)
- All VFDs for ACTIFLO Equipment (Mixers, Scrapers, Recirculation Pumps)
- Scraper support bridge design/supply
- Dispersion Device (if not supplied by Kruger), for properly dispersing Coagulant upstream of the ACTIFLO system
- Water Heater, for maintaining potable polymer solution make-up water temperature between 55 – 90 °F
- Turbidimeter sensors which require angled tap/weld to influent piping
- If the Influent Turbidimeter is to be installed in Ductile Iron Pipe a Stainless Steel spool piece with flanged ends will be required
  - Turbidimeter flanged adapter will require welding to the spool piece
  - Supply, installation and welding of the described spool piece
- Bulk storage tanks, pads, and supports including the concrete basins required for the ACTIFLO® system
- Provide all concrete work for the ACTIFLO® tankage, including all corner fillets.
- Install and terminate all motor control centers, motor starters, panels, transformers, instrumentation, and VFD's.
- Supply and install all electrical power and control wiring and conduit to the equipment served plus interconnection between the ACTIFLO® Supplier's furnished equipment as required, including wire, cable, junction boxes, fittings, conduit, etc.
- Provide all chemicals (not provided by Kruger), lubricants, glycol, oils, or grease and other supplies required for equipment start-up or plant operation.
- Provide all anchor bolts and mounting hardware.
- Labor and material for winterizing the ACTIFLO® System (insulating/heat tracing piping for example). Provisions for insulating the hydrocyclone may also be required.
- Supply and install all sunshields and/or additional enclosures as needed when installing ACTIFLO® equipment and instrumentation outdoors.
- Plumbing/interconnecting piping, weather protection, electrical connections, access platforms, grating & handrails
- Control Panels are shipped loose and require installation and field wiring
- Field Instruments are shipped loose and require installation and field wiring
- All other necessary equipment and services not otherwise listed as specifically supplied by Kruger Inc.

## Design Options

In addition to the proposed system as detailed herein, Kruger is able to further incorporate our equipment, process, and controls expertise into treatment plants, allowing municipalities to meet stringent effluent requirements and future plant upgrades. Kruger is able to offer the following, providing clients single source responsibility:

- Customized plant-wide SCADA system
- Motor Control Center (MCC) design
- Chemicals
- Influent screening
- Rotary drum thickeners
- HCS system
- Equipment installation service
- Commissioning services

Please contact Kruger if the options above are of interest or are to be included in the current proposed system or future upgrades. ***Please note that the Design Options listed above are not included in the pricing noted herein.*

## Schedule

- Shop drawings will be submitted within 6-8 weeks of receipt of an executed contract by all parties.
- All equipment will be delivered within 18-20 weeks after receipt of written approval of the shop drawings.
- Installation manuals will be furnished upon delivery of equipment.
- Operation and Maintenance Manuals will be submitted within 90 days after receipt of approved shop drawings.

## Pricing

The pricing for the ACTIFLO System offering(s) as defined herein, including process and design engineering, field services, and equipment supply is:

<u>2 x 14.2 MGD ACTIFLO® System: $TBD.</u>

Pricing is FOB shipping point, with freight allowed to the job site. This pricing does not include any sales or use taxes. In addition, pricing is valid for ninety (90) days from the date of issue and is subject to negotiation of a mutually acceptable contract.

***Please note that the above pricing is expressly contingent upon the items in this proposal and are subject to I. Kruger Inc. Standard Terms of Sale detailed herein.***

**Kruger Standard Terms of Payment**

The terms of payment are as follows:

- 10% on receipt of fully executed contract
- 15% on submittal of shop drawings
- 75% on the delivery of equipment to the site

Payment shall not be contingent upon receipt of funds by the Contractor from the Owner. There shall be no retention in payments due to I. Kruger Inc. All other terms per our Standard Terms of Sale are attached.

All payment terms are net 30 days from the date of invoice. Final payment not to exceed 120 days from delivery of equipment.

# I. Kruger Inc. Standard Terms of Sale

1. Applicable Terms. These terms govern the purchase and sale of the equipment and related services, if any (collectively, "Equipment"), referred to in Seller's purchase order, quotation, proposal or acknowledgment, as the case may be ("Seller's Documentation"). Whether these terms are included in an offer or an acceptance by Seller, such offer or acceptance is conditioned on Buyer's assent to these terms. Seller rejects all additional or different terms in any of Buyer's forms or documents.

2. Payment. Buyer shall pay Seller the full purchase price as set forth in Seller's Documentation. Unless Seller's Documentation provides otherwise, freight, storage, insurance and all taxes, duties or other governmental charges relating to the Equipment shall be paid by Buyer. If Seller is required to pay any such charges, Buyer shall immediately reimburse Seller. All payments are due within 30 days after receipt of invoice. Buyer shall be charged the lower of 1 ½% interest per month or the maximum legal rate on all amounts not received by the due date and shall pay all of Seller's reasonable costs (including attorneys' fees) of collecting amounts due but unpaid. All orders are subject to credit approval.

3. Delivery. Delivery of the Equipment shall be in material compliance with the schedule in Seller's Documentation. Unless Seller's Documentation provides otherwise, Delivery terms are F.O.B. Seller's facility.

4. Ownership of Materials. All devices, designs (including drawings, plans and specifications), estimates, prices, notes, electronic data and other documents or information prepared or disclosed by Seller, and all related intellectual property rights, shall remain Seller's property. Seller grants Buyer a non-exclusive, non-transferable license to use any such material solely for Buyer's use of the Equipment. Buyer shall not disclose any such material to third parties without Seller's prior written consent.

5. Changes. Seller shall not implement any changes in the scope of work described in Seller's Documentation unless Buyer and Seller agree in writing to the details of the change and any resulting price, schedule or other contractual modifications. This includes any changes necessitated by a change in applicable law occurring after the effective date of any contract including these terms.

6. Warranty. Subject to the following sentence, Seller warrants to Buyer that the Equipment shall materially conform to the description in Seller's Documentation and shall be free from defects in material and workmanship. The foregoing warranty shall not apply to any Equipment that is specified or otherwise demanded by Buyer and is not manufactured or selected by Seller, as to which (i) Seller hereby assigns to Buyer, to the extent assignable, any warranties made to Seller and (ii) Seller shall have no other liability to Buyer under warranty, tort or any other legal theory. If Buyer gives Seller prompt written notice of breach of this warranty within 18 months from delivery or 1 year from beneficial use, whichever occurs first (the "Warranty Period"), Seller shall, at its sole option and as Buyer's sole remedy, repair or replace the subject parts or refund the purchase price therefore. If Seller determines that any claimed breach is not, in fact, covered by this warranty, Buyer shall pay Seller its then customary charges for any repair or replacement made by Seller. Seller's warranty is conditioned on Buyer's (a) operating and maintaining the Equipment in accordance with Seller's instructions, (b) not making any unauthorized repairs or alterations, and (c) not being in default of any payment obligation to Seller. Seller's warranty does not cover damage caused by chemical action or abrasive material, misuse or improper installation (unless installed by Seller). THE WARRANTIES SET FORTH IN THIS SECTION ARE SELLER'S SOLE AND EXCLUSIVE WARRANTIES AND ARE SUBJECT TO SECTION 10 BELOW. SELLER MAKES NO OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE.

7. Indemnity. Seller shall indemnify, defend and hold Buyer harmless from any claim, cause of action or liability incurred by Buyer as a result of third party claims for personal injury, death or damage to tangible property, to the extent caused by Seller's negligence. Seller shall have the sole authority to direct the defense of and settle any indemnified claim. Seller's indemnification is conditioned on Buyer (a) promptly, within the Warranty Period, notifying Seller of any claim, and (b) providing reasonable cooperation in the defense of any claim.

8. Force Majeure. Neither Seller nor Buyer shall have any liability for any breach (except for breach of payment obligations) caused by extreme weather or other act of God, strike or other labor shortage or disturbance, fire, accident, war or civil disturbance, delay of carriers, failure of normal sources of supply, act of government or any other cause beyond such party's reasonable control.

9. Cancellation. If Buyer cancels or suspends its order for any reason other than Seller's breach, Buyer shall promptly pay Seller for work performed prior to cancellation or suspension and any other direct costs incurred by Seller as a result of such cancellation or suspension.

10. LIMITATION OF LIABILITY. NOTWITHSTANDING ANYTHING ELSE TO THE CONTRARY, SELLER SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER INDIRECT DAMAGES, AND SELLER'S TOTAL LIABILITY ARISING AT ANY TIME FROM THE SALE OR USE OF THE EQUIPMENT SHALL NOT EXCEED THE PURCHASE PRICE PAID FOR THE EQUIPMENT. THESE LIMITATIONS APPLY WHETHER THE LIABILITY IS BASED ON CONTRACT, TORT, STRICT LIABILITY OR ANY OTHER THEORY.

11. Miscellaneous. If these terms are issued in connection with a government contract, they shall be deemed to include those federal acquisition regulations that are required by law to be included. These terms, together with any quotation, purchase order or acknowledgement issued or signed by the Seller, comprise the complete and exclusive statement of the agreement between the parties (the "Agreement") and supersede any terms contained in Buyer's documents, unless separately signed by Seller. No part of the Agreement may be changed or cancelled except by a written document signed by Seller and Buyer. No course of dealing or performance, usage of trade or failure to enforce any term shall be used to modify the Agreement. If any of these terms is unenforceable, such term shall be limited only to the extent necessary to make it enforceable, and all other terms shall remain in full force and effect. Buyer may not assign or permit any other transfer of the Agreement without Seller's prior written consent. The Agreement shall be governed by the laws of the State of North Carolina without regard to its conflict of laws provisions.

**Preliminary Operating Cost Estimate**
**2 x 14.2 ACTIFLO System**
**Meridian, ID**
**5.5 MGD ADF/ 2 x 14.2 MGD PHF**

**Mechanical Equipment Summary**

| Equipment | 1 x 14.2 MGD | |
|---|---|---|
| Inline Mechanical Mixer | 2 | HP |
| Coagulation Tank Mixer | 5 | HP |
| Maturation Tank Mixer | 7.5 | HP |
| Scraper Motor | 0.75 | HP |
| Sand Recirculation Pump[A] | 20 | HP |
| **Total Power Requirements[B]:** | **35.25** | **HP** |

A. Each train has 1 duty + 1 standby sand pump each with a 20 HP motor.
B. Total operating HP to be used in table below assumes power draw of 90% of total nameplate HP and does not include standby equipment. Only includes single train equipment.

**Estimated Operating Costs**

| **ACTIFLO® System:** | | | **5.50 MGD** |
|---|---|---|---|
| **Item** | **Estimated Average Dose[D]** | **Estimated Unit Cost[E]** | **Estimated Daily Operating Cost** |
| Polymer | 0.50 mg/L (dry) | $ 4500 / ton | $51.60 |
| Sand Loss | 2.0 mg/L | $ 200 / ton | $9.17 |
| Coagulant (Aluminum Sulfate) | 25 mg/L (dry) | $ 480 / ton | $275.22 |
| Power Consumption | See table above. | $ 0.10 / KWhr | $56.78 |
| **Total Estimated Daily Operating Cost[F]** | | | **$392.78** |
| **Total Estimated Annual Operating Cost[F]** | | | **$143,363.00** |
| **Operating Cost per 1,000 Gallons** | | | **$0.071** |

D. Chemical Dosages are estimates only. Pilot and/or jar testing is required in order to verify all chemical dosages.

E. Estimated chemical and power costs may vary. It is recommended that the engineer utilize regional contract pricing to afford the end user the most economical operating costs available.
F. For ADF of 5.5MGD operating 24 hours per day.

**March 20, 2015**

**Brown & Caldwell**
**701 Pike Street, Suite 1200**
**Seattle, WA 98101**
**ATTENTION: BEN WATSON**
**E-MAIL**: bswatson@brnwcald.com

Phone: 206-749-2220

**Subject:** Quotation
AFC REF #79032 (1503-92) HN

AUGUSTA FIBERGLASS® is pleased to furnish this quotation per your request.

**DESCRIPTION OF QUOTE:**
AFC'S QUOTATION IS CONDITIONED UPON THE ATTACHED AUGUSTA FIBERGLASS COMMERCIAL TERMS AND CONDITIONS.

**SCOPE OF WORK:**

Two (2) 8,500 Gallon FRP Tanks, 9' I.D. x 18' Straight Shell Height with Flat Bottom, Dome Top.

**Fabrication**: Hand Lay-up per NBS PS 15-69, Hand Lay-up per ASTM D 4097-01 and Filament Wound per ASTM D 3299-10

**Resin**: Isophthalic

**Thickness:** Suitable for hydrostatic pressures

**Nozzles, etc.:**
3 – 3" Flanged Nozzles
1 – 24" Side Manway
1 – 6" V-Vent
2 – Carbon Steel Galvanized Lifting Lugs
12 – Carbon Steel Galvanized Hold Down Lugs

Price (Each)……………………………………………………………$14,040.00 x 2 = $28,080.00

AFC will fabricate items shown above at its Blackville South Carolina facility or its facility in Ocean Springs, Mississippi at Augusta Fiberglass' option.

Estimated Freight to Meridian, ID is $12,080.00 and subject to change depending on final nozzle orientation and projections.

**NOTES:**

1. Bolting and Gaskets will be by others.
2. All fabrication, inspection and tolerances to be upheld to the referenced above industry standard specifications.
3. Design Conditions:

| | |
|---|---|
| Temperature | 160ºF |
| Pressure | ATM |
| Seismic Zone | 3 |
| Wind Zone | 90 MPH |
| Snow Load | 20 PSF |
| Specific Gravity | 1.35 |
| Contents | Alum |

**TERMS OF PAYMENT**: Net 30 days from date of invoice.

- 25% after first submission of shop approval drawing to customer
- Balance invoiced as items become ready for shipment

A finance charge of 1 ½% per month (18% APR) will be assessed on any balance not paid within 30 days of the invoice date. If it is necessary to place the account into collection proceedings, purchaser shall be responsible for all collection costs including witness's and attorney's fees.

**ANY MATERIALS OR FABRICATION NOT LISTED ON OUR QUOTE WILL NOT BE FURNISHED AT THIS PRICE.**

**PRICE IS F.O.B. POINT OF SHIPMENT**

**NO TAXES ARE INCLUDED**

**PRICES WILL BE FIRM FOR 30 DAYS**

**SCHEDULE:**

Drawings: 2 – 3 weeks ARO

Fabrication: 10 – 12 weeks after customer's release of full fabrication drawings

Delivery to be confirmed upon receipt of approved drawings and release for fabrication. Please call if delivery is not acceptable. We will store the completed vessels at our facility for no additional charge for a period of two weeks, after which you will be responsible for a charge of 1 ½% of the purchase order value per month for each tank which remains in storage. Stored vessels will be invoiced, and payment is required, in accordance with the terms above.

**CONTACT INFORMATION:**

| | |
|---|---|
| For questions please call (800-527-1572) or email | |
| Commercial Questions: | Margie Green at m.green@augustafiberglass.com |
| Bid Documents: | Matt Swift at m.swift@augustafiberglass.com or James Lockwood at j.lockwood@augustafiberglass.com |
| Technical Questions: | Craig Winningham at c.winningham@augustafiberglass.com |

**HN/bhp**

**AUGUSTA FIBERGLASS® TERMS AND CONDITIONS**

1. **The prices quoted are expressly conditioned upon the terms and conditions in this document. The terms hereinafter stated supersede all other terms, understandings and customs inconsistent with this document.**

   A. The prices quoted will be effective for a period of thirty (30) days from the date of this quotation. If Augusta Fiberglass (hereinafter "AFC") receives Purchaser's acceptance after the expiration date, the quoted prices, and such acceptance shall only be binding upon AFC by AFC's written confirmation of such prices.

   B. Prices for undelivered portions of continuing installment orders are subject to change whenever AFC's costs are affected by Federal or State legislation, changes in costs of raw materials and/or labor rates, together with applicable overhead for such costs.

2. **AFC warrants that the goods provided shall be free of defects in its design (if provided by AFC), material and workmanship for a period of one year from the date of shipment.**

   **THE WARRANTY SET FORTH ABOVE IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED BY LAW OR TRADE USAGE, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. AFC IS NOT LIABLE FOR DEFECTS OR DAMAGE DUE TO NEGLIGENCE (OTHER THAN THAT OF THE SELLER), ACCIDENT, ABUSE, IMPROPER INSTALLATION (OTHER THAT BY AFC) IMPROPER OPERATION, OR MAINTENANCE, OR ABNORMAL CONDITIONS.**

   **AFC SHALL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES. AFC'S WARRANTY LIABILITY IS LIMITED TO THE REPAIR OR REPLACEMENT OF THE GOODS AT AFC'S DISCRETION. AFC SHALL NOT BE RESPONSIBLE FOR COSTS IN EXCESS OF THE PURCHASE PRICE. THIS WARRANTY SHALL ONLY APPLY TO GOODS LOCATED/USED IN THE CONTINENTAL UNITED STATES.**

3. AFC shall not be responsible for errors, or defects in the work on account of plans, designs, specifications or drawings furnished by the Purchaser. AFC's quotation is based upon reliance in the accuracy of data supplied by Purchaser.

4. AFC will not recognize claims or make allowances for replacement of materials or correction of AFC's error unless AFC is given notice in writing of such defect at least 10 days prior to the Purchaser incurring any cost or expense on account thereof.

5. AFC shall not be considered in default in the performance of its obligations hereunder if such performance of its obligations is prevented or delayed by an Act of God, Outbreak of Hostilities, War, Revolution, Civil Commotion, Riot, Epidemic, Wind, Flood, Earthquake, any Law Order, Proclamation, Regulation, or Ordinance of any Government or subdivision of Government, delay in delivery of materials, delay of subcontractors, or any other cause, whether similar or different from those listed, which are beyond the reasonable control of the party affected.

6. All goods shall be subject to normal manufacturing variations of Seller and its raw materials supplies such as are recognized in the reinforced plastics industry.

7. In the event of a dispute arising from the manufacture, sale, delivery, or performance of a purchase order and any amendments or additions thereto issued pursuant to the attached bid and any amendments or additions thereto, jurisdiction and venue for such dispute is exclusively vested in the Court of Common Pleas, Barnwell County, South Carolina, and construed exclusively in accordance with the laws of the State of South Carolina.

8. Quotations and sales are F.O.B. Point of Shipment unless otherwise expressly stipulated.

Augusta Fiberglass has been a world leader in the design, fabrication, and erection of Fiberglass related products since its inception in 1974. We are an industry leader when it comes to quality, precision craftsmanship, and customer service and are one of only nine distinguished **ASME RTP-1 certified fabricators** in the world. Our product and service offerings include:

- **Tanks**
- **Process equipment**
- **Scrubber Vessels**
- **Stacks, Stack liners**
- **Piping and Ductwork**
- **FRP field fabrication**
- **Field Services**

Our production personnel have the capability to fabricate tanks and other fiberglass vessels of virtually any size or shape to meet your project requirements, either at your plant site or shipped from our facility in Blackville, South Carolina. We also have a sister company, **B&D Plastics**, that specializes in **Dual Laminate Fiberglass** equipment like tanks, scrubber vessels, stacks, pipes and ductwork – located in Ocean Springs, MS. To complement our tank portfolio, we offer industrial grade polyethylene day and storage tanks to complete your storage needs.

Augusta Fiberglass is a full service provider with experienced field engineers and trained field technicians ready to support your projects with the following field services:

- **Emergency response service**
- **Field Fabrication or Installations**
- **Scheduled and Unscheduled Shutdowns**
- **Routine Maintenance and General Repairs**
- **Field Modification**

Please visit our web sites at www.augustafiberglass.com and www.bdplastics.com for a complete description of our full line of products and service capabilities. Or contact us directly at 800-527-1572.

Patricia,
Here is the remaining information for the tertiary design for Meridian.

# Operation and Maintenance Information

## A. Chemical Consumption

**Assumptions:**

1) Membrane tank dimensions are GE's standard membrane tank dimensions.

2) One (1) Maintenance Clean is performed per membrane train per day. Six (6) times per week a Sodium Hypochlorite Maintenance Clean will be performed using approximately 250 mg/L of NaOCl. One (1) time per week a Citric Acid Maintenance Clean will be performed using approximately 500 mg/L citric acid. It is assumed a mineral acid will also be required to reduce the pH of the cleaning solution to 2.1. For the purpose of this calculation, it is assumed hydrochloric acid will be used at a dose of 250 mg/L. The amount of mineral acid will need to be verified with testing.

3) Twelve (12) Chlorine Recovery Cleans will be performed per membrane train per year using 500 mg/L of NaOCl.

4) Twelve (12) Citric Acid Recovery Cleans will be performed per membrane train per year using 2 g/L of citric acid. It is assumed a mineral acid will also be required to reduce the pH of the cleaning solution to 2.1. For the purpose of this calculation, it is assumed hydrochloric acid will be used at a dose of 200 mg/L. The amount of mineral acid will need to be verified with testing.

5) All chemical cleans (Maintenance Cleans and Recovery Cleans) will be fully de-chlorinated (using sodium bisulphite) and neutralized (using sodium hydroxide) to a pH between 6.0 and 9.0. It is assumed 30% of the cleaning chemical is consumed with each clean.

6) There is no reuse of chemical cleaning solutions.

7) Sodium hypochlorite: 12.5% (10.3% wt% as $Cl_2$), s.g. = 1.168
Citric acid: 50% solution (by weight), s.g. = 1.24
HCl: 33% (by weight), s.g. = 1.15
Sodium bisulfite: 38% (by weight), s.g. = 1.29
Sodium hydroxide: 50% (by weight), s.g. = 1.52

| Chemical | Approximate Annual Consumption |
|---|---|
| NaOCl | 32,300 gal/year |
| Citric acid | 3,800 gal/year |
| HCl | 1,900 gal/year |
| $NaHSO_3$ | 7,800 gal/year |
| NaOH | 4,000 gal/year |

## B. Power Consumption

The largest contributor to power consumption from the membrane system are the permeate pumps. The exact system headloss depends on the length and size of the piping run from the discharge of the permeate pumps to the clearwell. It is assumed the permeate pumps are pumping the finished water to an elevation similar to the water level in the membrane tank.

Annual power consumption estimate is calculated at ADF conditions as an average of summer and winter conditions.

The estimated power consumption includes the following pieces of equipment in operation on average:

- One (1) blower (intermittent operation)
- Four (4) permeate pumps
- One (1) backwash pump (intermittent operation)
- One (1) CIP pump (intermittent operation)
- One (1) CIP in-line heater (intermittent operation)
- One (1) air compressor (intermittent operation)

The estimated power consumption does not take into account the power required for the PLC, chemical dosing pumps, and the air drier, as these pieces of equipment contribute very little to the overall power consumption of the plant.

The estimated power consumption is 620,000 kWh/year.

# Membrane Replacement

The cost of membrane replacement can be estimated based on the assumption of a membrane life of 10 years and a membrane replacement price of **$1,040.00 USD per module**.

Note that the membrane replacement price refers to the replacement of installed membranes under the following two scenarios;

- Replacement of membrane modules under warranty,
- Replacement of membrane modules no longer under warranty per the original terms and conditions of sale.

Under the first scenario, membrane modules replaced under warranty shall assume the remainder of the warranty for the membrane modules being replaced, with such warranty to be not less than a two (2) year full replacement warranty from the date of replacement with a new membrane module.

Under the second scenario, membrane modules purchased to replace a membrane module whose warranty has expired shall be provided with a standard two (2) year full replacement warranty.

The membrane module replacement price is not applicable for membrane modules purchased for any non-warranty purposes, such as for flux reduction or hydraulic capacity increase. Modules purchased under these scenarios will be purchased at the list price at the time of order.

Membrane module replacement price does not include bagging, boxing, crating, and will be shipped on the basis of INCOTERMS 2010 FCA GE Manufacturing Facility. Membrane module replacement price is quoted without taxes. As this is not an offer of sale, GE reserves the right to the change the membrane replacement price at any time.

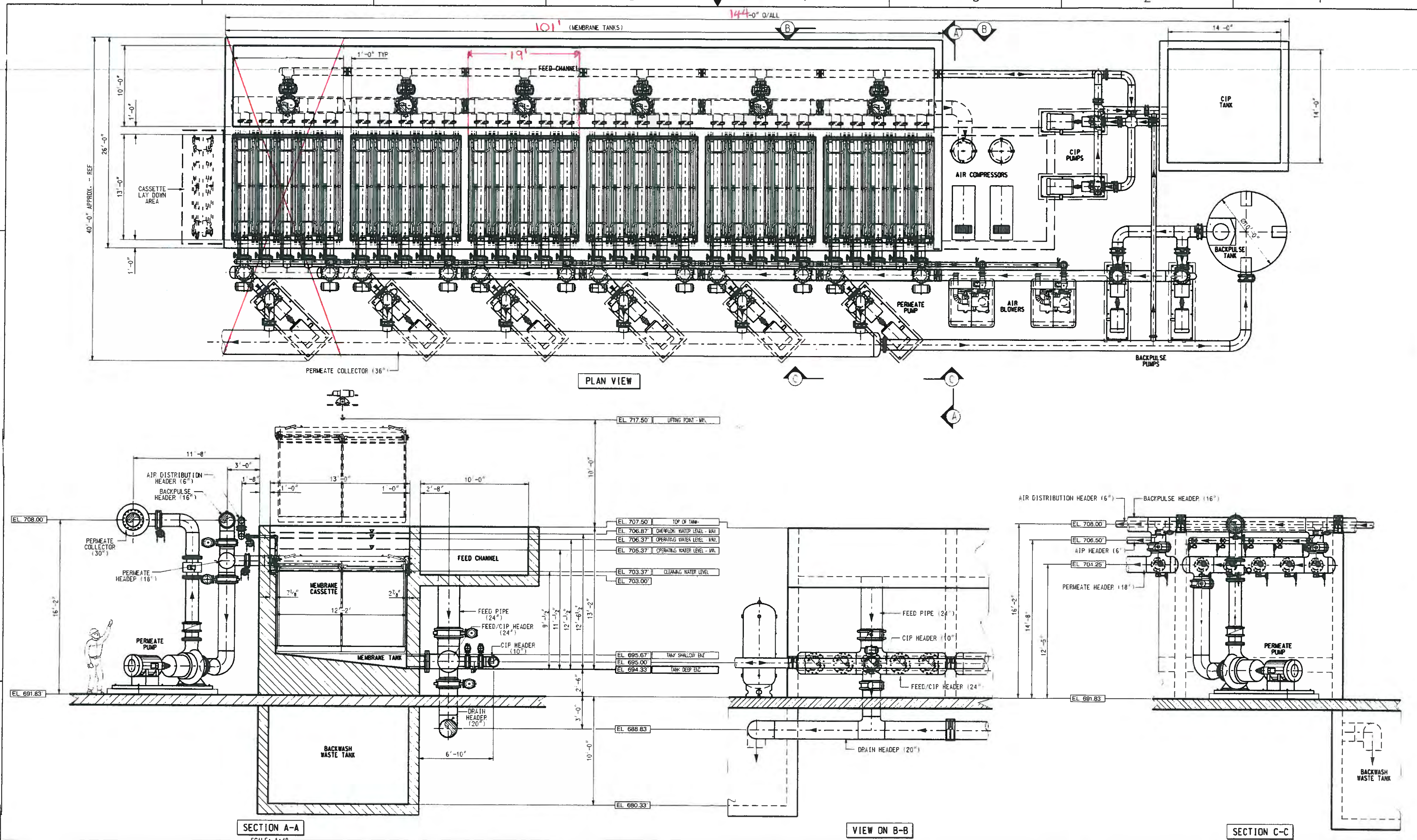
## Layout

The GA layout drawing can be found in the attachment. The drawing is marked up to reflect the five (5) trains for this system. Each train contains seven (7) cassettes and the length of each train is 19 feet. The overall length of the plant is 144 feet which includes the membrane trains and ancillary equipment.

Regards,
Chris

**Chris Allen, P.E.** | **Regional Manager**
GE Water & Process Technologies
950 W. Bannock Street, Suite 1100, Boise, ID, 83702 USA
Tel: 208 319-3512 | Mobile: 503 307-2238
chris.allen@ge.com

GE imagination at work




| REV | DESCRIPTION | ECO | DWN | APVD | DATE | CHKD |
|---|---|---|---|---|---|---|
| A1 | PRELIMINARY – NOT FOR CONSTRUCTION | | MGA | J.J | 03APR14 | J.J |

TOLERANCES UNLESS NOTED: DECIMALS .X, .XX ± 0.50, .XXX; ANGLES ± 0.5; FRAC ± 1/2"

DIMENSIONS IN INCHES — DO NOT SCALE — THIRD ANGLE

DRAWN BY: MGA — DATE: 03APR14
CHECKED BY: J.J — DATE: 03APR14
APPROVED BY: J.J — DATE: 03APR14
APPROVED BY: — DATE:

**GE Water & Process Technologies**
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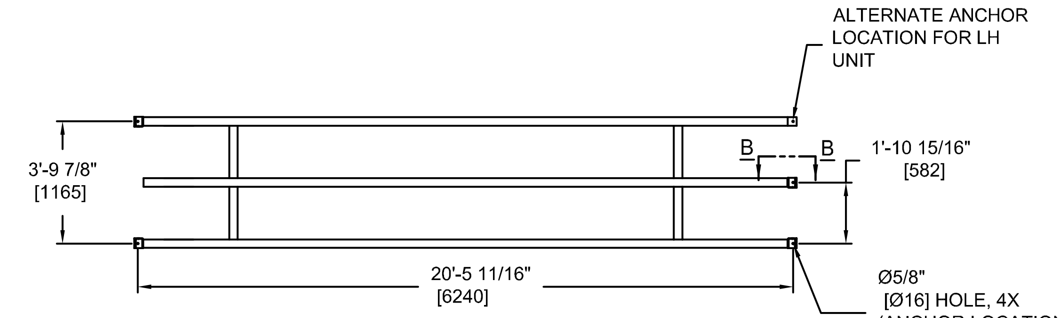
CLIENT/JOB:
FILE: MICROSTATION

TITLE: PLOT PLAN LAYOUT MEMBRANE SYSTEM
MATERIAL:

SIZE: D — DRAWING NO.: — REV: A1
PROJECT:
SCALE: 1:64 — SHEET: 1 OF 1

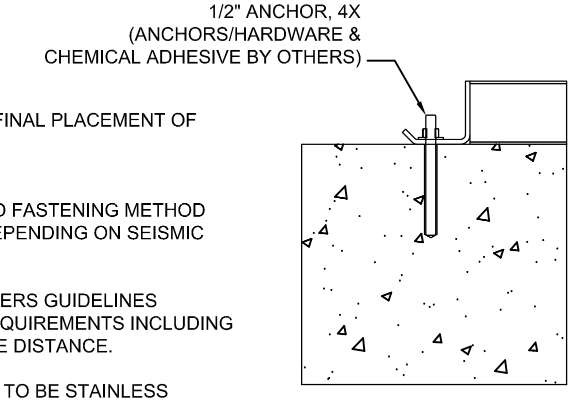
P/N 1161662-RHP01

NOTES:
1. QUANTITY OF FILTER DISCS: 18 (504 FILTER PANELS)
2. UNIT WEIGHT (DRY): 12,320 LBS. (5,600 KG) APPROX.
3. UNIT WEIGHT (OPERATIONAL): 49,940 LBS. (22,700 KG) APPROX.
4. BACKWASH PUMP: GRUNDFOS, MTR20-16/6, 15 HP, 480V/3PH/60HZ
5. DRIVE MOTOR: 1.5 HP, 480V/3PH/60HZ
6. INLET & OUTLET CONNECTIONS: ANSI B16.5 FLANGE (SEE TABLE 1 FOR AVAILABLE SIZES)
BYPASS CONNECTION: ANSI 20" 150# B16.5 FLANGE
LAP JOINT FLANGE: GALVANIZED, LAP JOINT STUB ENDS: AISI 304 OR 316
7. BACKWASH CONNECTION: ANSI 6" 150# B16.5 FLANGE
LAP JOINT FLANGE: GALVANIZED, LAP JOINT STUB ENDS: AISI 304 OR 316
8. DRUM, WALLS & FRAME MATERIAL: AISI 304 OR 316
9. COVER MATERIAL: FIBERGLASS REINFORCED PLASTIC (FRP)
OPTIONAL: ALUMINUM COVERS/AISI 304 FRAME, AISI 304 COVERS/FRAME,
AISI 316 COVERS/FRAME
10. WEIGHT OF OPTIONAL COVERS (LARGEST) = 19 LBS. (8.6 KG) - ALUMINUM
50 LBS. (23 KG) - AISI 304/316
11. DIMENSIONS ARE IN INCHES, [ ] ARE IN MILLIMETERS
12. WORK PLATFORM GRATING AND SUPPORT NOT ATTACHED TO FILTERS AND
DESIGNED/PROVIDED BY OTHERS. DO NOT SUPPORT PLATFORMS OR OTHER
LOAD BEARING MEMBERS FROM THE DISCFILTER.
13. RECOMMEND 24" MINIMUM MAINTENANCE ACCESS AROUND ENTIRE PERIMETER
OF DISCFILTER
14. CONTROL PANEL NOT SHOWN

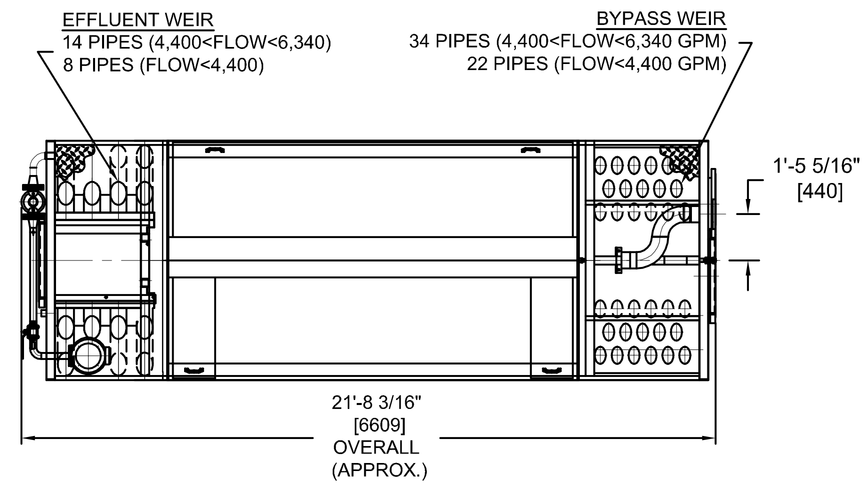


SECTION A-A

1. MATCH DRILL ANCHORS AFTER FINAL PLACEMENT OF UNIT IS DETERMINED
2. ANCHOR SIZE, EMBEDMENT, AND FASTENING METHOD MAY REQUIRE MODIFICATION DEPENDING ON SEISMIC REQUIREMENTS.
3. FOLLOW ANCHOR MANUFACTURERS GUIDELINES FOR SPECIFIC INSTALLATION REQUIREMENTS INCLUDING ANCHOR EMBEDMENT AND EDGE DISTANCE.
4. ALL ANCHORS AND FASTENERS TO BE STAINLESS STEEL. APPLY ANTI-SEIZE TO ALL CONNECTIONS.



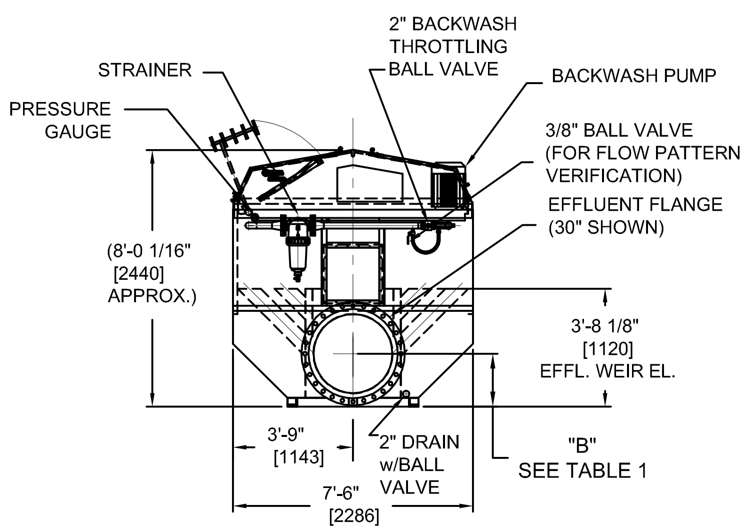
SECTION B-B
NTS



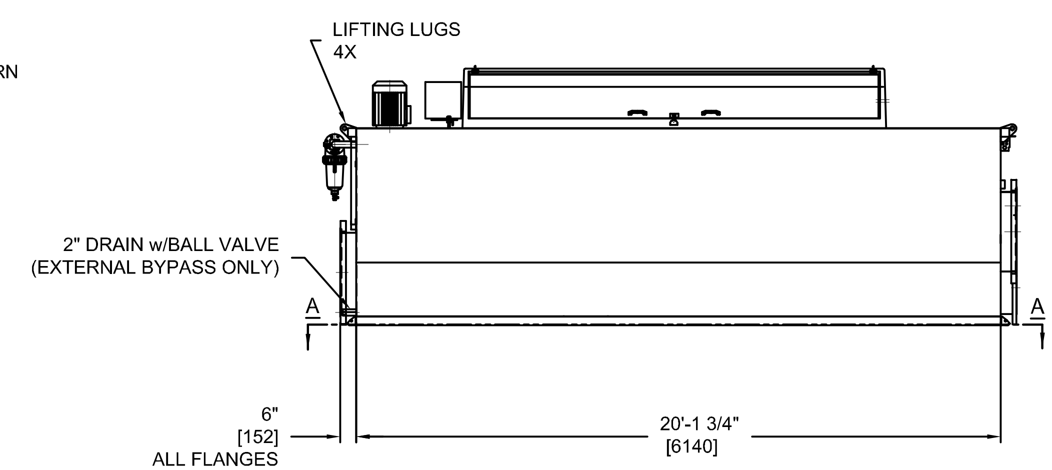
TOP VIEW

TABLE 1

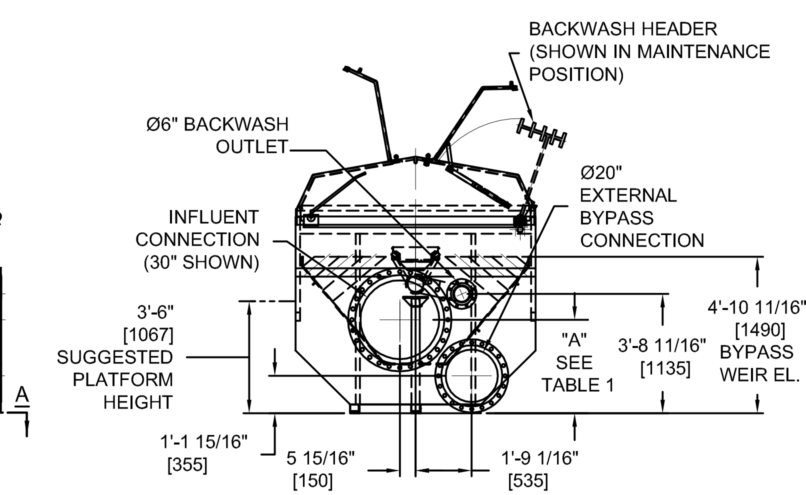
| FLANGE SIZE | DIMENSION "A" | DIMENSION "B" |
|---|---|---|
| 24" | 2'-8 3/32" (815 MM) | 1'-4 13/16" (427 MM) |
| 30" | 2'-11 1/32" (890 MM) | 1'-7 13/16" (503MM) |



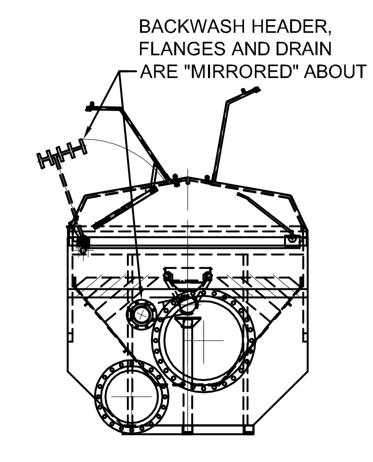
EFFLUENT SIDE VIEW



SIDE VIEW



INFLUENT SIDE VIEW
RH BACKWASH (STD.)



INFLUENT SIDE VIEW
LH BACKWASH (OPTIONAL)

| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|
| D | 14 PIPES WAS 15 | CDP | CSR | 10.17.11 |
| C | RELOCATE DRAIN TO OUTLET SIDE OF DISCFILTER | DSD | CDP | 07.05.11 |
| B | SEC. A-A ANCHOR LOCATION REVISED | CDP | BDR | 02.08.11 |
| A | RELEASED | CDP | MHS | 02.01.11 |



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(919) 677-8310

STANDARD

DISCFILTER
2218-1F
HIGH FLOW OPTION

| DRAWN | CHECKED | SCALE | DRAWING NO | SHEET | REV |
|---|---|---|---|---|---|
| CDP | MHS | 1 : 72 | 675M-0014 | 1 of 1 | D |

# Appendix C: BioWin Modeling Results from Final Alternatives Evaluation

# BioWin user and configuration data

Annual average conditions

## Project details

Project name: Alternatives Analysis    Project ref.: 147571

Plant name: Meridian WWTP    User name: Patricia Tam

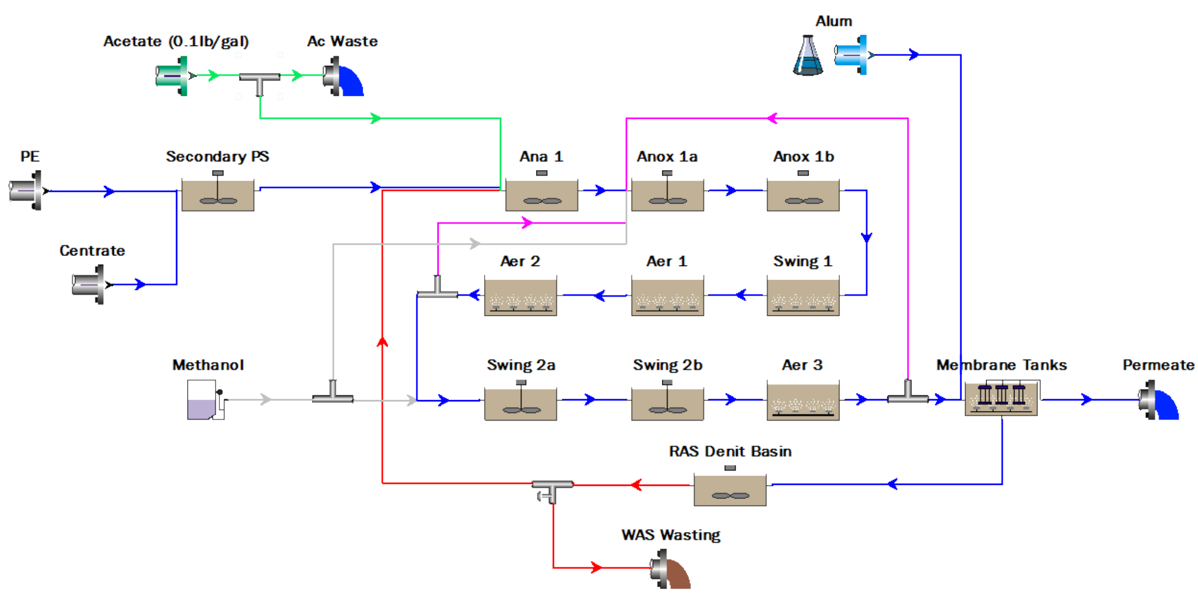
Created: 6/29/2011    Saved: 5/27/2015

## Steady state solution

Target SRT: 8.00 days  SRT #0: 8.01 days

Temperature: 18.0°C

## Flowsheet



# Configuration information for all Bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Ana 1 | 0.1667 | 1591.7536 | 14.000 | Un-aerated |
| Aer 1 | 0.5000 | 4774.3058 | 14.000 | 1731 |
| Aer 2 | 0.6667 | 6366.0594 | 14.000 | 2308 |
| Swing 2a | 0.2500 | 2387.1529 | 14.000 | Un-aerated |
| Aer 3 | 0.1667 | 1591.7536 | 14.000 | 541 |
| Anox 1a | 0.1250 | 1193.5765 | 14.000 | Un-aerated |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |
| Anox 1b | 0.1250 | 1193.5765 | 14.000 | Un-aerated |
| Swing 1 | 0.1667 | 1591.7536 | 14.000 | 649 |
| Swing 2b | 0.2500 | 2387.1529 | 14.000 | Un-aerated |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Ana 1 | 0 |
| Aer 1 | 2.5 |
| Aer 2 | 2.0 |
| Swing 2a | 0 |
| Aer 3 | 2.0 |
| Anox 1a | 0 |
| Secondary PS | 0 |

| | |
|---|---|
| RAS Denit Basin | 0 |
| Anox 1b | 0 |
| Swing 1 | 2.0 |
| Swing 2b | 0 |

## Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Ana 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 16.0000 |
| Aer 2 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 16.0000 |
| Swing 2a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 3 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Anox 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Anox 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 18.0000 |
| Swing 2b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

| Element name | Alpha (surf) OR Alpha F (diff) [-] | Beta [-] | Surface pressure [kPa] | Fractional effective saturation depth (Fed) [-] |
|---|---|---|---|---|
| Aer 1 | 0.4000 | 0.9500 | 101.3250 | 0.3250 |
| Aer 2 | 0.4000 | 0.9500 | 101.3250 | 0.3250 |
| Aer 3 | 0.4000 | 0.9500 | 101.3250 | 0.3250 |
| Swing 1 | 0.4000 | 0.9500 | 101.3250 | 0.3250 |

| Element name | Supply gas CO2 content [vol. %] | Supply gas O2 [vol. %] | Off-gas CO2 [vol. %] | Off-gas O2 [vol. %] | Off-gas H2 [vol. %] | Off-gas NH3 [vol. %] | Off-gas CH4 [vol. %] | Surface turbulence factor [-] |
|---|---|---|---|---|---|---|---|---|
| Aer 1 | 0.0350 | 20.9500 | 2.0000 | 18.8000 | 0 | 0 | 0 | 2.0000 |
| Aer 2 | 0.0350 | 20.9500 | 2.0000 | 18.8000 | 0 | 0 | 0 | 2.0000 |
| Aer 3 | 0.0350 | 20.9500 | 2.0000 | 18.8000 | 0 | 0 | 0 | 2.0000 |
| Swing 1 | 0.0350 | 20.9500 | 2.0000 | 18.8000 | 0 | 0 | 0 | 2.0000 |

# Configuration information for all Membrane bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers | # of cassettes | Displaced volume / cassette [ft3/cassette] | Membrane area / cassette [ft2/cassette] | Total displaced volume [Mil. Gal] | Membrane surface area [ft2] |
|---|---|---|---|---|---|---|---|---|---|
| Membrane Tanks | 0.2373 | 3374.7232 | 9.400 | 941 | 50.00 | 55.640 | 16576.00 | 0.02 | 828800.00 |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Membrane Tanks | 6.0 |

| Element name | Split method | Average Split specification |
|---|---|---|
| Membrane Tanks | Flow paced | 400.00 % |

### Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Membrane Tanks | 0.0500 | 0.3800 | 1.0500 | 0.5382 | 15.0000 |

| Element name | Alpha (surf) OR Alpha F (diff) [-] | Beta [-] | Surface pressure [kPa] | Fractional effective saturation depth (Fed) [-] |
|---|---|---|---|---|
| Membrane Tanks | 0.7000 | 0.9500 | 101.3250 | 0.3000 |

| Element name | Supply gas CO2 content [vol. %] | Supply gas O2 [vol. %] | Off-gas CO2 [vol. %] | Off-gas O2 [vol. %] | Off-gas H2 [vol. %] | Off-gas NH3 [vol. %] | Off-gas CH4 [vol. %] | Surface turbulence factor [-] |
|---|---|---|---|---|---|---|---|---|
| Membrane Tanks | 0.0350 | 20.9500 | 1.2000 | 19.9000 | 0 | 0 | 0 | 2.0000 |

## Configuration information for all Methanol addition units

### Operating data Average (flow/time weighted as required)

| Element name | Methanol |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |

| | |
|---|---|
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 11880.00 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |

| | |
|---|---|
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

# Configuration information for all Effluent units

# Configuration information for all COD Influent units

## Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 0 | 0 |
| Flow | 12.08909091 | 0.103 |
| Total COD mgCOD/L | 379.27 | 1801.80 |

| | | |
|---|---|---|
| Total Kjeldahl Nitrogen mgN/L | 48.77 | 959.63 |
| Total P mgP/L | 6.57 | 529.81 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.88 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.03 | 185.00 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.5950 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 0.0392 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9931 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.0039 |
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.3197 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.9500 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5086 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0050 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0512 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9300 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.0642 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-4 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |

| | | | |
|---|---|---|---|
| FZbam - Acetoclastic methanogens COD fraction | [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbhm - H2-utilizing methanogens COD fraction | [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZe - Endogenous products COD fraction | [gCOD/g of total COD] | 0 | 0 |

# Configuration information for all Metal addition units

## Operating data Average (flow/time weighted as required)

| Element name | Alum |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |

| | |
|---|---|
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 56890.00 |
| Other Cations (strong bases) meq/L | 5.00 |
| Other Anions (strong acids) meq/L | 6344.83 |
| Total CO2 mmol/L | 7.00 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |

| | |
|---|---|
| Flow | 0 |

# Configuration information for all Sludge units

# Configuration information for all Splitter units

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| BDF IMLR | Flow paced | 200.00 % |
| RAS / WAS | Flowrate [Side] | 0.268272155890301 |
| Acetate Splitter | Flow paced | 1.05 % |
| Splitter21 | Fraction | 0.00 |
| A2O IMLR | Flow paced | 0.00 % |

# Configuration information for all Stream (SV) Influent units

## Operating data Average (flow/time weighted as required)

| Element name | Acetate (0.1lb/gal) |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |

| | |
|---|---|
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 11980.00 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |

| | |
|---|---|
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

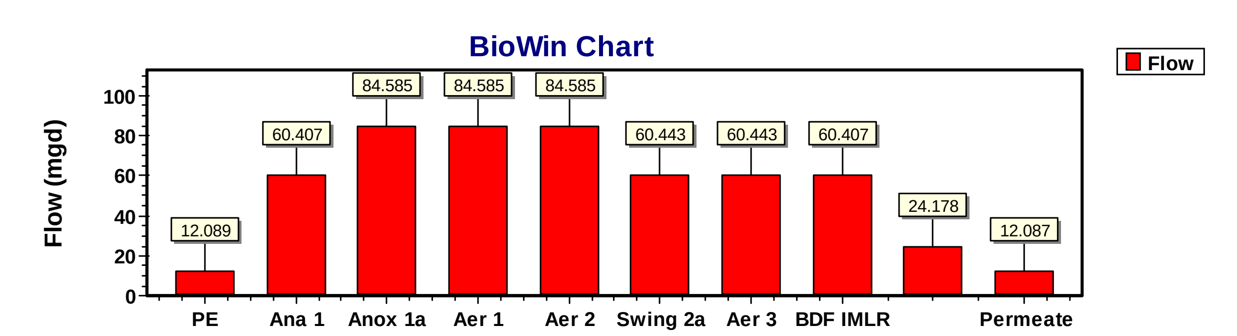
## BioWin Album

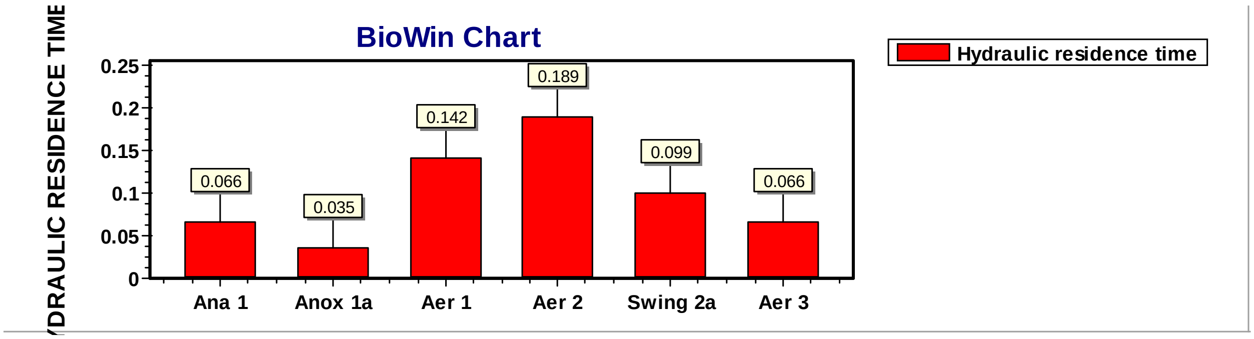
## Album page - Table

| Elements | Total COD [mg/L] | Total Kjeldahl Nitrogen [mgN/L] | Total suspended solids [mgTSS/L] | Volatile suspended solids [mgVSS/L] | Ammonia N [mgN/L] | Nitrite N [mgN /L] | Nitrate N [mgN/L] | Total N [mgN/L ] | Total P [mgP/L] | Soluble PO4-P [mgP/L] |
|---|---|---|---|---|---|---|---|---|---|---|
| PE | 379.27 | 48.77 | 93.62 | 82.56 | 39.50 | 0 | 0 | 48.77 | 6.57 | 4.53 |
| Secondary PS | 391.29 | 56.46 | 97.17 | 84.63 | 46.87 | 0 | 0 | 56.46 | 10.99 | 8.66 |
| Ana 1 | 6951.0 1 | 474.87 | 6260.76 | 4704.51 | 9.65 | 0.00 | 0.04 | 474.92 | 397.53 | 9.05 |
| Anox 1a | 6935.1 8 | 472.64 | 6265.77 | 4708.71 | 7.07 | 0.04 | 0.18 | 472.86 | 397.53 | 8.85 |
| Anox 1b | 6934.6 1 | 472.64 | 6263.11 | 4710.25 | 7.17 | 0.00 | 0.01 | 472.65 | 397.53 | 10.21 |

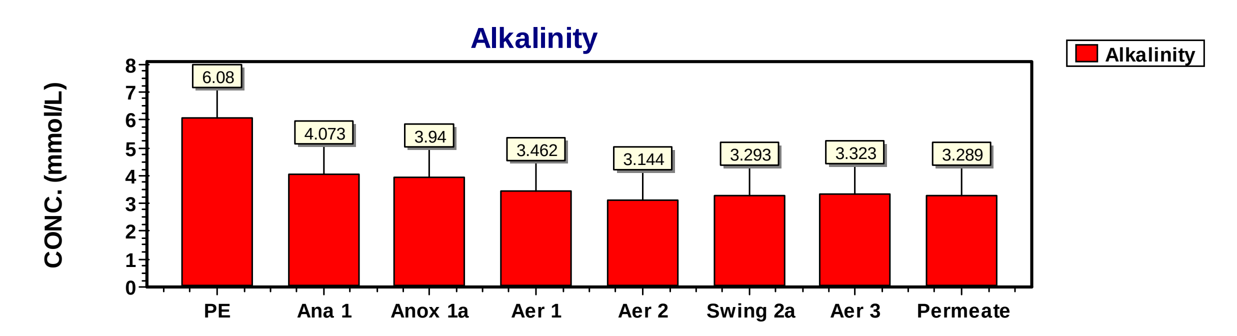
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Swing 1 | 6928.30 | 471.73 | 6266.29 | 4710.21 | 6.08 | 0.41 | 0.50 | 472.63 | 397.53 | 9.19 |
| Aer 1 | 6918.82 | 469.20 | 6276.15 | 4708.33 | 3.21 | 1.14 | 2.25 | 472.59 | 397.53 | 5.43 |
| Aer 2 | 6908.42 | 467.07 | 6286.74 | 4705.43 | 0.81 | 1.00 | 4.45 | 472.51 | 397.53 | 1.12 |
| Swing 2a | 6906.24 | 466.79 | 6284.14 | 4702.85 | 0.93 | 0.55 | 2.91 | 470.25 | 397.29 | 0.82 |
| Swing 2b | 6902.50 | 466.80 | 6284.41 | 4702.39 | 1.03 | 0.26 | 1.78 | 468.83 | 397.29 | 0.58 |
| Aer 3 | 6898.97 | 466.31 | 6284.78 | 4701.12 | 0.38 | 0.18 | 2.31 | 468.81 | 397.29 | 0.08 |
| Membrane Tanks (U) | 8608.33 | 582.19 | 7853.28 | 5873.38 | 0.08 | 0.03 | 2.63 | 584.85 | 496.58 | 0.01 |
| BDF IMLR | 6908.42 | 467.07 | 6286.74 | 4705.43 | 0.81 | 1.00 | 4.45 | 472.51 | 397.53 | 1.12 |
| BDF IMLR (U) | 6908.42 | 467.07 | 6286.74 | 4705.43 | 0.81 | 1.00 | 4.45 | 472.51 | 397.53 | 1.12 |
| Permeate | 32.23 | 1.87 | 0.79 | 0.59 | 0.08 | 0.03 | 2.63 | 4.52 | 0.06 | 0.01 |
| RAS Denit Basin | 8607.16 | 582.21 | 7852.92 | 5873.10 | 0.21 | 0.04 | 2.22 | 584.46 | 496.58 | 0.04 |
| RAS / WAS | 8607.16 | 582.21 | 7852.92 | 5873.10 | 0.21 | 0.04 | 2.22 | 584.46 | 496.58 | 0.04 |
| RAS / WAS (U) | 8607.16 | 582.21 | 7852.92 | 5873.10 | 0.21 | 0.04 | 2.22 | 584.46 | 496.58 | 0.04 |

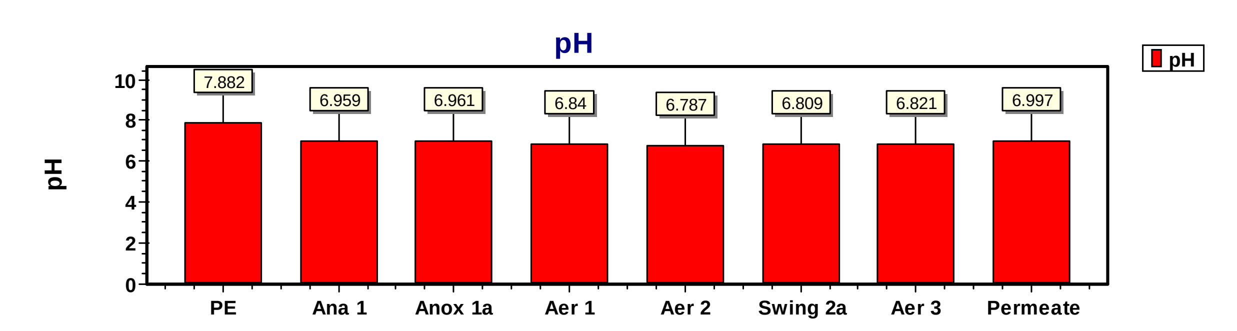
## Album page - SS Flow and HRT



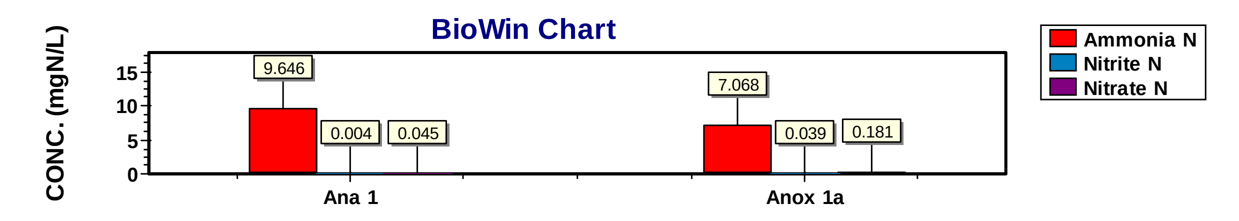


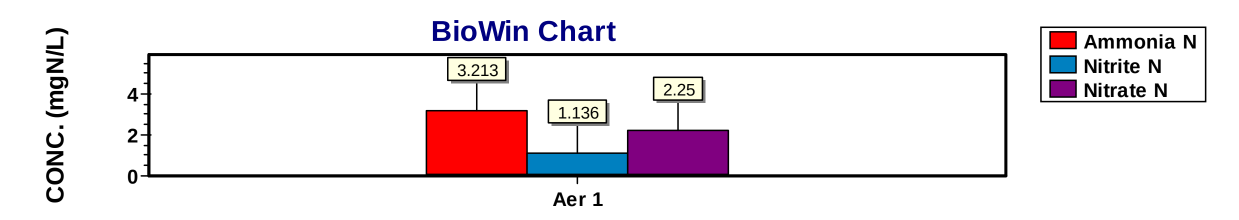

Album page - SS pH-Alkalinity

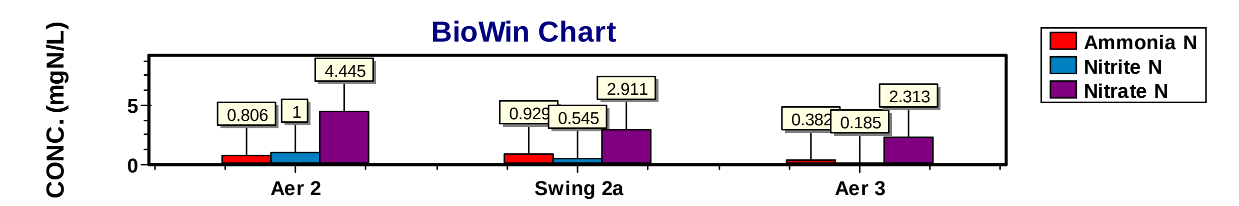


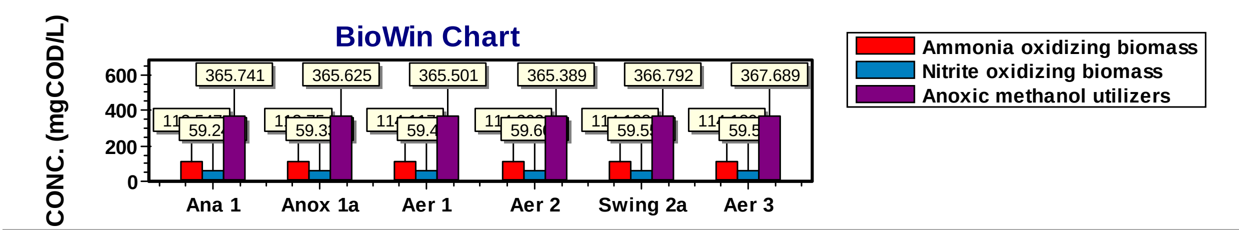

Album page - SS NH3-NO2-NO3




## Album page - SS AOB-NOB




## Album page - Page 16

| Elements | Air flow rate [ft3/min (20C, 1 atm)] | Flow [mgd] |
|---|---|---|
| Acetate Splitter (U) | ----- | 0.13 |
| Aer 1 | 8655.21 | 84.59 |
| Aer 2 | 7614.04 | 84.59 |
| Aer 3 | 2244.96 | 60.44 |
| Swing 2a | 0 | 60.44 |
| Swing 2b | 0 | 60.44 |

## Album page - Page 17

| WAS Wasting | | | |
|---|---|---|---|
| Parameters | Conc. (mg/L) | Mass rate (lb/d) | Notes |
| Volatile suspended solids | 5873.10 | 13148.93 | |
| Total suspended solids | 7852.92 | 17581.43 | |
| Particulate COD | 8576.41 | 19201.20 | |
| Filtered COD | 30.75 | 68.85 | |
| Total COD | 8607.16 | 19270.05 | |
| Soluble PO4-P | 0.04 | 0.09 | |
| Total P | 496.58 | 1111.77 | |
| Filtered TKN | 1.82 | 4.08 | |
| Particulate TKN | 580.39 | 1299.39 | |
| Total Kjeldahl Nitrogen | 582.21 | 1303.47 | |
| Filtered Carbonaceous BOD | 0.66 | 1.48 | |
| Total Carbonaceous BOD | 3685.88 | 8252.10 | |
| Nitrite + Nitrate | 2.26 | 5.06 | |
| Total N | 584.46 | 1308.52 | |
| Total inorganic N | 2.47 | 5.53 | |
| Alkalinity | 3.33 | 3.38 | mmol/L and kmol/d |
| pH | 7.00 | | |
| Volatile fatty acids | 0.02 | 0.05 | |
| ISS precipitate | 0 | 0.00 | |
| ISS cellular | 1414.14 | 3166.04 | |
| ISS Total | 1979.82 | 4432.50 | |
| Ammonia N | 0.21 | 0.47 | |
| Nitrate N | 2.22 | 4.96 | |

| Parameters | Value | Units |
| --- | --- | --- |
| pH | 7.00 | |
| Ionized ammonium | 0.01 | mmol/L |
| Unionized ammonia | 0.00 | mmol/L |
| Nitrous acid | 0.00 | mmol/L |
| Nitrite | 0.00 | mmol/L |
| Total dissolved CO2 | 0.71 | mmol/L |
| Bicarbonate | 3.32 | mmol/L |
| Carbonate | 0.00 | mmol/L |
| Unionized ortho-P | 0.00 | mmol/L |
| H2PO4- | 0.00 | mmol/L |
| HPO4-- | 0.00 | mmol/L |
| PO4--- | 0.00 | mmol/L |
| Metal phosphate (solid) | 0 | mmol/L |
| Metal hydroxide (solid) | 0 | mmol/L |
| Metal ion | 0 | mmol/L |
| MeH2PO4++ | 0 | mmol/L |
| MeHPO4+ | 0 | mmol/L |
| Acetic acid | 0.00 | mmol/L |
| Acetate | 0.00 | mmol/L |
| Propionic acid | 0.00 | mmol/L |
| Propionate | 0.00 | mmol/L |
| Ionic strength | 0.02 | |
| Monovalent act. coeff. | 0.87 | |
| Divalent act. coeff. | 0.57 | |
| Trivalent act. coeff. | 0.29 | |
| Flow | 0.27 | mgd |

**Meridian Alternative's Analysis version 1**

Expansion using selectable 5 stage modified Bardenpho/A2O process

Tank sizes optimized based on individual simulations from A2O and 5 stage modified Bardenpho processes

To achieve target effluent concentrations, for Bardenpho process:
Set BDF IMLR at 200% influent, Set A2O IMLR at 0%
Set Swing 1 Aerated, Swing 2a and 2b unaerated.
SRT = 12 days
All methanol to swing 2a

To achieve target effluent concentrations, for A2O process:
Set BDF IMLR at 0% influent, Set A2O IMLR at 400%
Set Swing 1 unaerated, Swing 2a and 2b aerated.
SRT = 12 days
All methanol to Anoxic 1a

For the MBR alternative, the Bardenpho process is used. Membrane tank sizing based on GE proposal dated 4/17/15
Alum addition rate was adjusted to reduce effluent PO4-P to 0.7 mg/L or lower. For the purpsoe of calculating O&M ocsts, however, the alum demand to reduce P from 0.5 to 0.07 mg/L was calculated separately for chemical precipitation.
Acetate flow pace of 1.05% of PE flow rate, 0.1 lb acetate COD per galloon used.
Methanol flow pace at 0.3% of PE flow rate, 1% methanol solution. All methanol to swing 2a.

# BioWin user and configuration data

Summer max month conditions

## Project details

Project name: Alternatives Analysis    Project ref.: 147571

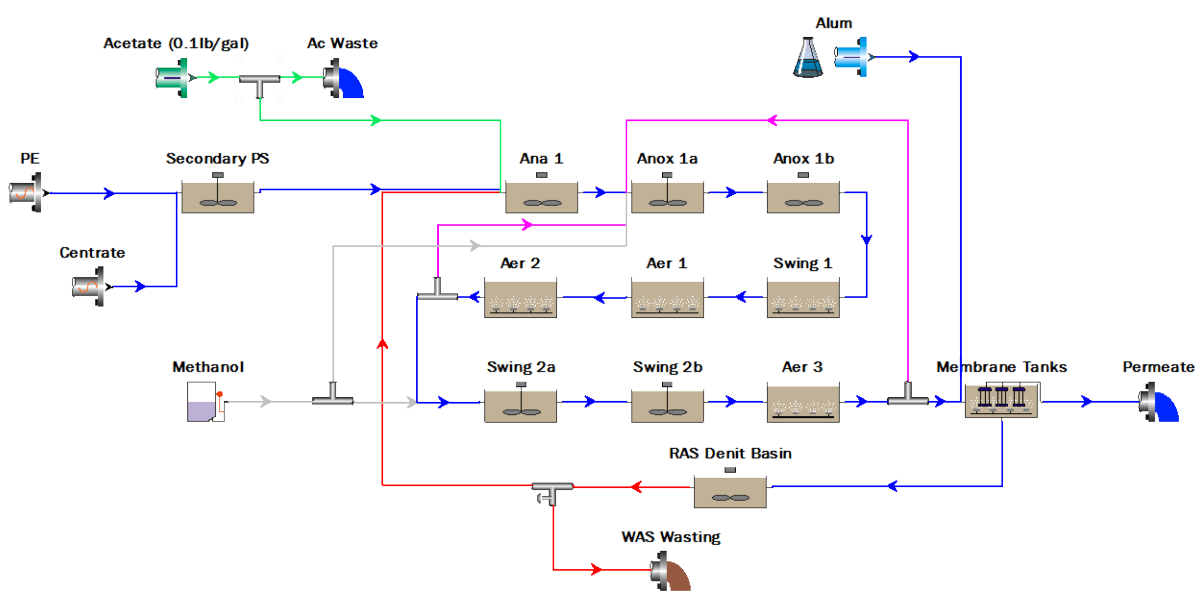
Plant name: Meridian WWTP    User name: Patricia Tam

Created: 6/29/2011    Saved: 5/19/2015

Target SRT: 8.00 days  SRT: **** days

Temperature: 18.0°C

## Flowsheet



# Configuration information for all Bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Ana 1 | 0.2083 | 1988.9758 | 14.000 | Un-aerated |
| Aer 1 | 0.6250 | 5967.8823 | 14.000 | 2164 |
| Aer 2 | 0.8333 | 7956.8581 | 14.000 | 2885 |
| Swing 2a | 0.3125 | 2983.9411 | 14.000 | Un-aerated |
| Aer 3 | 0.2083 | 1988.9758 | 14.000 | 676 |
| Anox 1a | 0.1563 | 1492.4480 | 14.000 | Un-aerated |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |
| Anox 1b | 0.1563 | 1492.4480 | 14.000 | Un-aerated |
| Swing 1 | 0.2083 | 1988.9758 | 14.000 | 811 |
| Swing 2b | 0.3125 | 2983.9411 | 14.000 | Un-aerated |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Ana 1 | 0 |
| Aer 1 | 2.5 |
| Aer 2 | 2.0 |
| Swing 2a | 0 |
| Aer 3 | 2.0 |
| Anox 1a | 0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |

| | |
|---|---|
| Anox 1b | 0 |
| Swing 1 | 2.0 |
| Swing 2b | 0 |

## Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Ana 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 16.0000 |
| Aer 2 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 16.0000 |
| Swing 2a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 3 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Anox 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Anox 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 18.0000 |
| Swing 2b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

| Element name | Alpha (surf) OR Alpha F (diff) [-] | Beta [-] | Surface pressure [kPa] | Fractional effective saturation depth (Fed) [-] |
|---|---|---|---|---|
| Aer 1 | 0.4000 | 0.9500 | 101.3250 | 0.3250 |
| Aer 2 | 0.4000 | 0.9500 | 101.3250 | 0.3250 |
| Aer 3 | 0.4000 | 0.9500 | 101.3250 | 0.3250 |
| Swing 1 | 0.4000 | 0.9500 | 101.3250 | 0.3250 |

| Element name | Supply gas CO2 content [vol. %] | Supply gas O2 [vol. %] | Off-gas CO2 [vol. %] | Off-gas O2 [vol. %] | Off-gas H2 [vol. %] | Off-gas NH3 [vol. %] | Off-gas CH4 [vol. %] | Surface turbulence factor [-] |
|---|---|---|---|---|---|---|---|---|
| Aer 1 | 0.0350 | 20.9500 | 2.0000 | 18.8000 | 0 | 0 | 0 | 2.0000 |
| Aer 2 | 0.0350 | 20.9500 | 2.0000 | 18.8000 | 0 | 0 | 0 | 2.0000 |
| Aer 3 | 0.0350 | 20.9500 | 2.0000 | 18.8000 | 0 | 0 | 0 | 2.0000 |
| Swing 1 | 0.0350 | 20.9500 | 2.0000 | 18.8000 | 0 | 0 | 0 | 2.0000 |

# Configuration information for all Membrane bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers | # of cassettes | Displaced volume / cassette [ft3/cassette] | Membrane area / cassette [ft2/cassette] | Total displaced volume [Mil. Gal] | Membrane surface area [ft2] |
|---|---|---|---|---|---|---|---|---|---|
| Membrane Tanks | 0.2848 | 4050.2366 | 9.400 | 1129 | 60.00 | 55.640 | 16576.00 | 0.02 | 994560.00 |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Membrane Tanks | 6.0 |

| Element name | Split method | Average Split specification |
|---|---|---|
| Membrane Tanks | Flow paced | 400.00 % |

### Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Membrane Tanks | 0.0500 | 0.3800 | 1.0500 | 0.5382 | 15.0000 |

| Element name | Alpha (surf) OR Alpha F (diff) [-] | Beta [-] | Surface pressure [kPa] | Fractional effective saturation depth (Fed) [-] |
|---|---|---|---|---|
| Membrane Tanks | 0.7000 | 0.9500 | 101.3250 | 0.3000 |

| Element name | Supply gas CO2 content [vol. %] | Supply gas O2 [vol. %] | Off-gas CO2 [vol. %] | Off-gas O2 [vol. %] | Off-gas H2 [vol. %] | Off-gas NH3 [vol. %] | Off-gas CH4 [vol. %] | Surface turbulence factor [-] |
|---|---|---|---|---|---|---|---|---|
| Membrane Tanks | 0.0350 | 20.9500 | 1.2000 | 19.9000 | 0 | 0 | 0 | 2.0000 |

## Configuration information for all Methanol addition units

### Operating data Average (flow/time weighted as required)

| Element name | Methanol |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |

| | |
|---|---|
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 1188000.00 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |

| | |
|---|---|
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 5.00 |
| Other Anions (strong acids) meq/L | 5.00 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 2.64172037284185E-5 |

# Configuration information for all Effluent units

# Configuration information for all COD Influent units

## Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 30.00 | 30.00 |
| Flow | 14.3106974874421 | 0.100114816828393 |
| Total COD mgCOD/L | 387.35 | 1801.80 |
| Total Kjeldahl Nitrogen mgN/L | 47.17 | 934.39 |

| | | |
|---|---|---|
| Total P mgP/L | 6.89 | 529.81 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.82 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.23 | 185.22 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.5950 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 0.0392 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9931 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.0039 |
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.3197 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.9500 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5086 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0050 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0512 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9300 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.0642 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-4 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |

| | | |
|---|---|---|
| FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 5.550E-5 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 | 0 |

# Configuration information for all Metal addition units

## Operating data Average (flow/time weighted as required)

| Element name | Alum |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |

| | |
|---|---|
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 56890.00 |
| Other Cations (strong bases) meq/L | 5.00 |
| Other Anions (strong acids) meq/L | 6344.83 |
| Total CO2 mmol/L | 7.00 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 0.00012 |

## Configuration information for all Sludge units

## Configuration information for all Splitter units

### Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| BDF IMLR | Flow paced | 200.00 % |
| RAS / WAS | Flowrate [Side] | 0.334155926161449 |
| Acetate Splitter | Flow paced | 1.00 % |
| Splitter21 | Fraction | 0.00 |
| A2O IMLR | Flow paced | 0.00 % |

## Configuration information for all Stream (SV) Influent units

### Operating data Average (flow/time weighted as required)

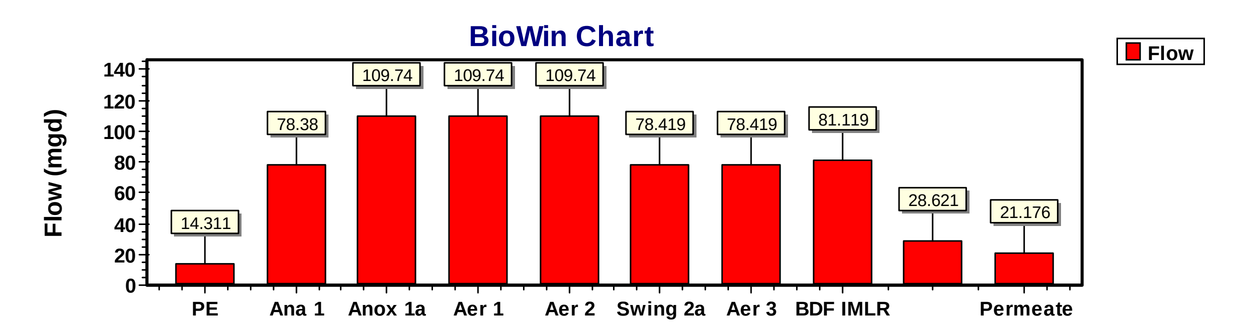
| Element name | Acetate (0.1lb/gal) |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |

| | |
|---|---|
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 11980.00 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |

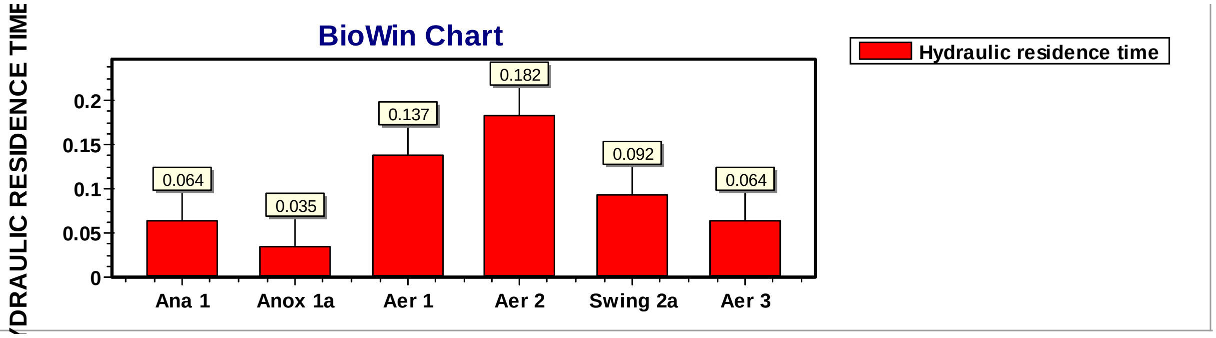
| | |
|---|---|
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

## BioWin Album

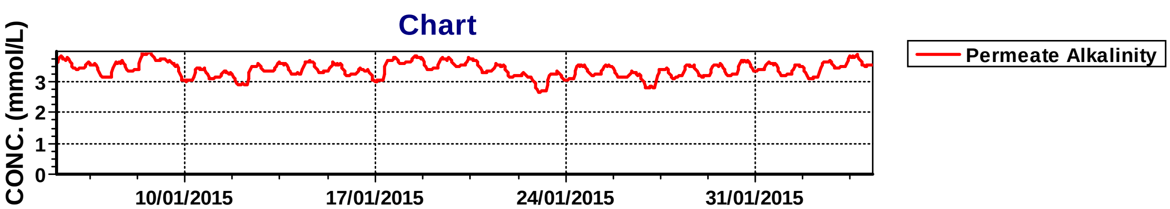
## Album page - SS Flow and HRT



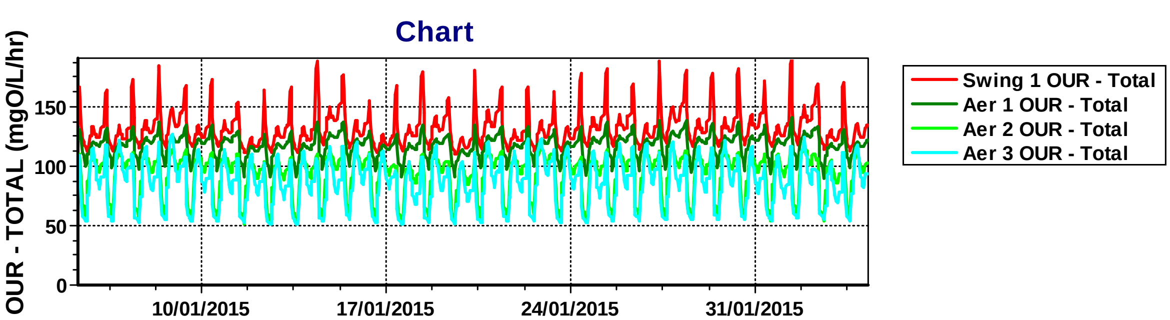
Album page - SS Flow and HRT



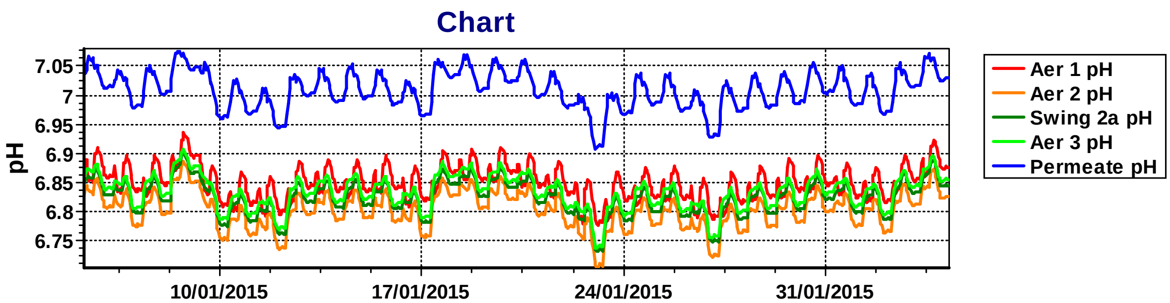

Album page – Permeate Alkalinity



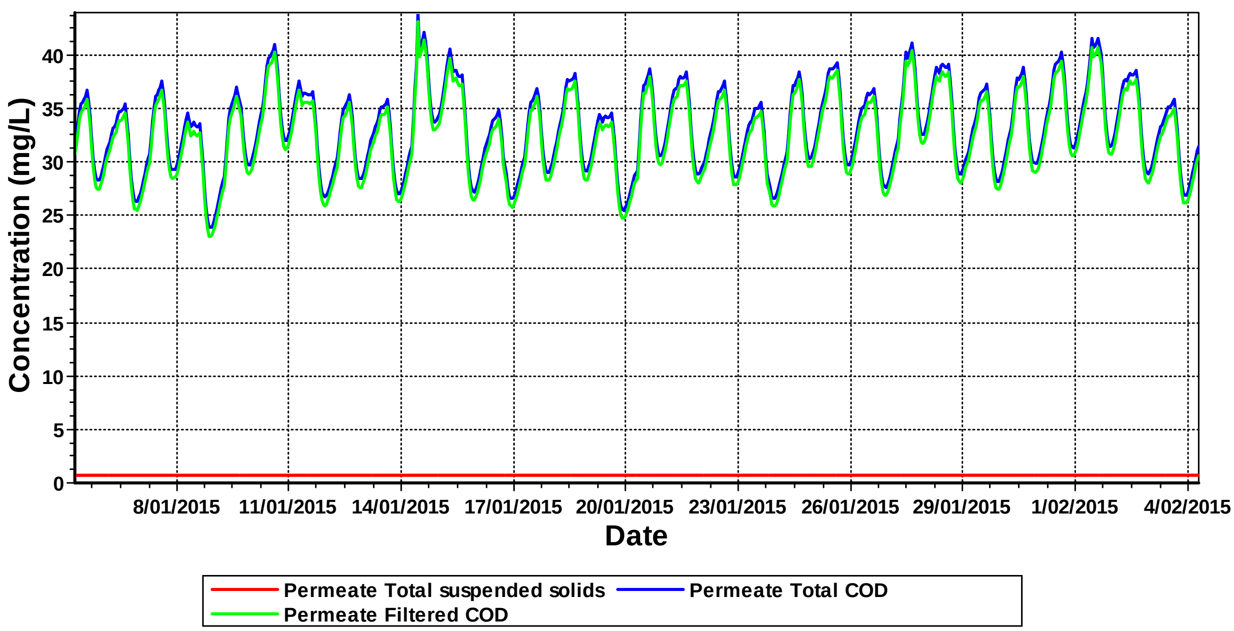

Album page - OURs



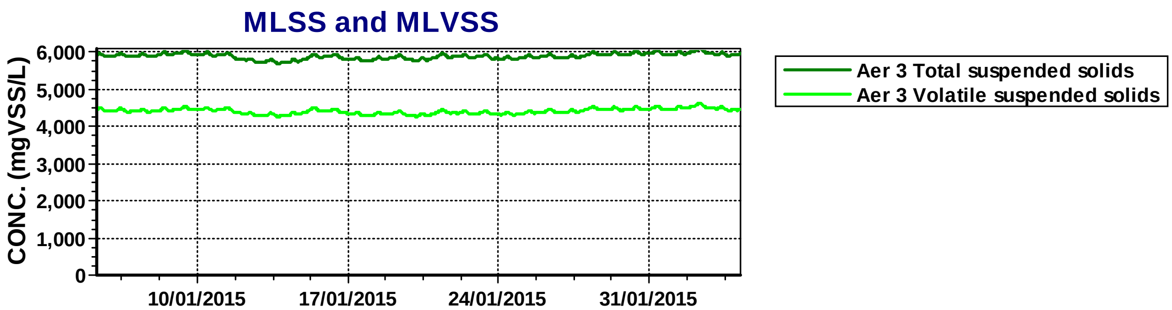
Album page - pH

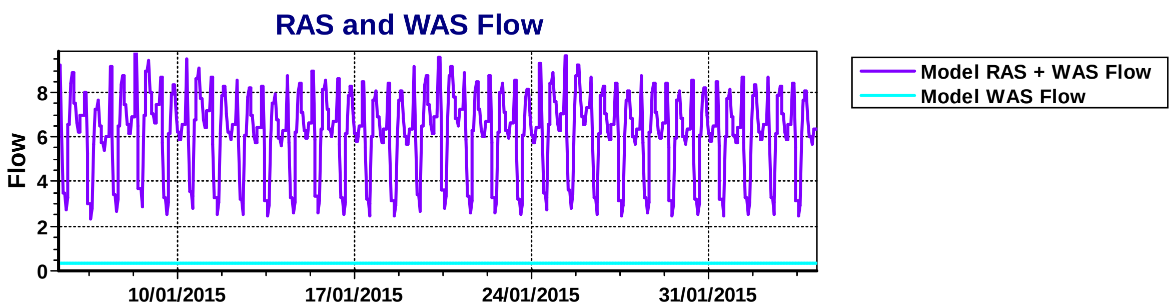



Album page - TSS, COD, BOD

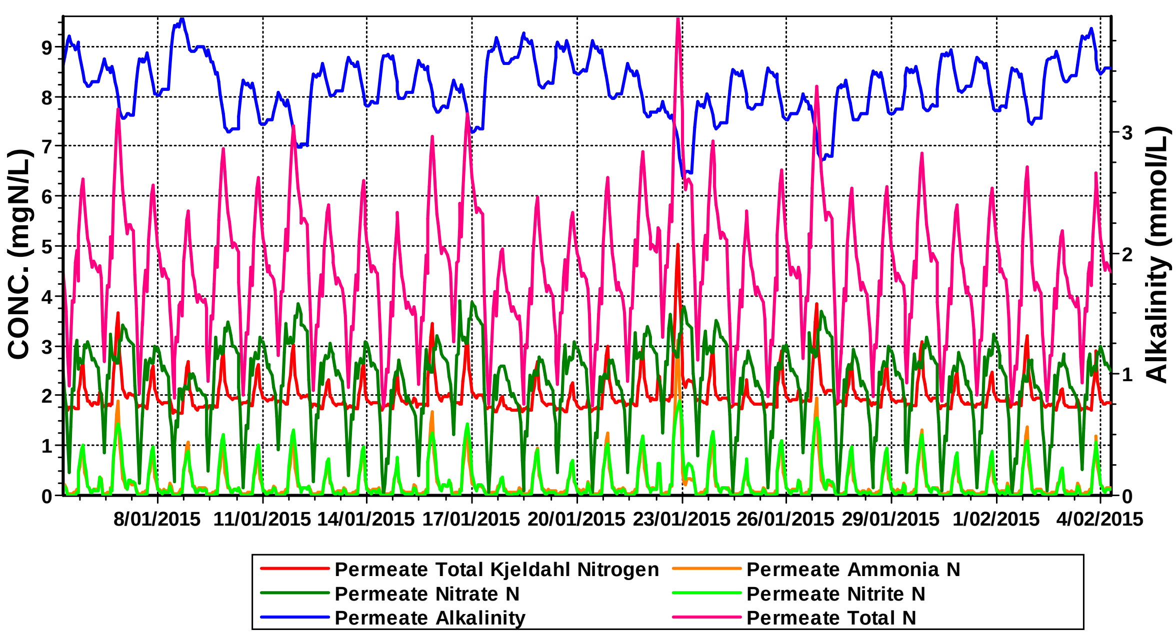


Album page - Mixed Liquor, RAS Flow

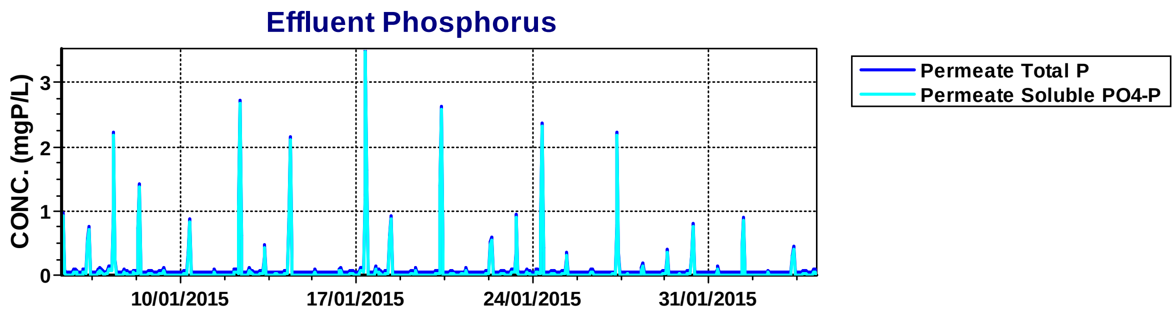


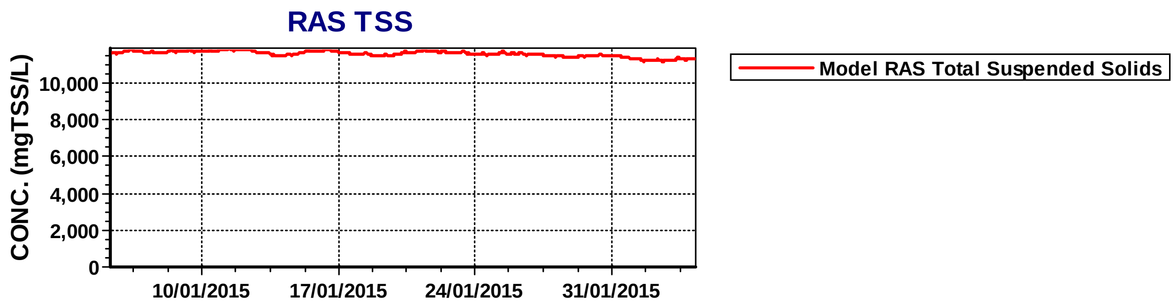




Album page - Nitrogen Sp., Alkalinity

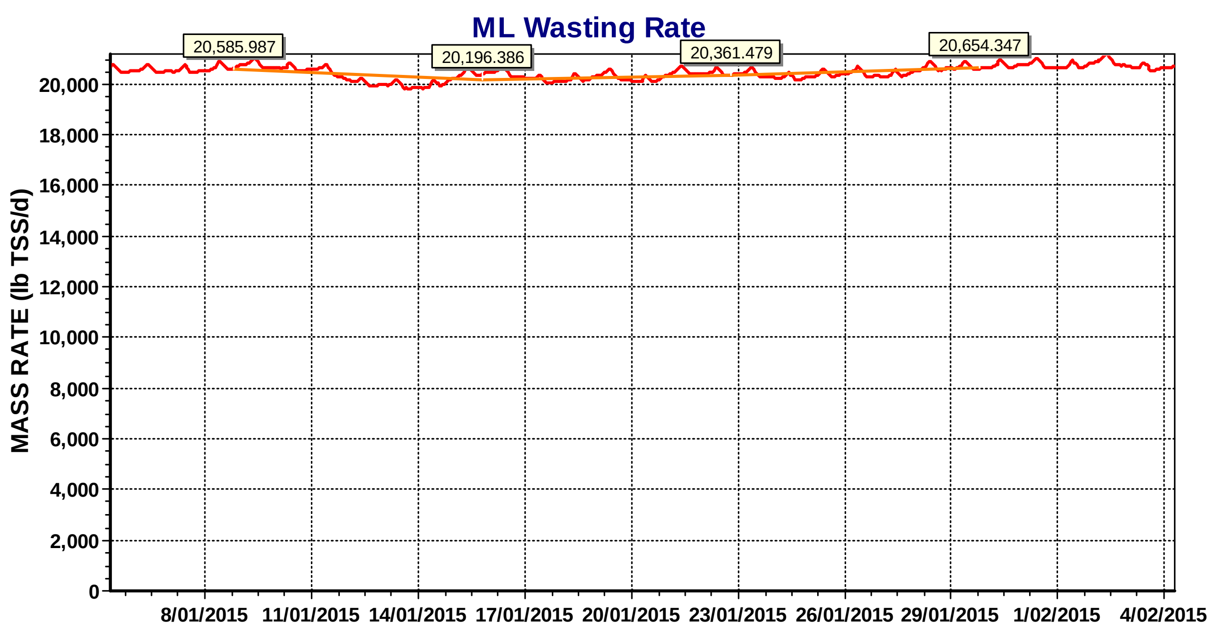


## Album page - TP, RAS TSS

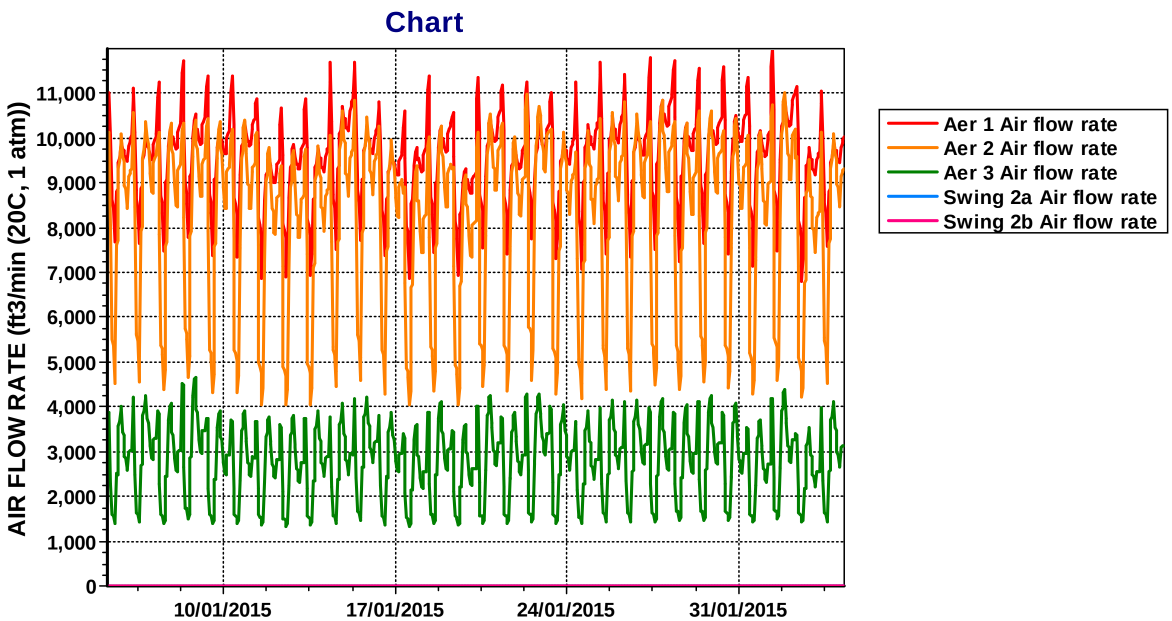



## Album page - WAS Mass



## Album page - Air Flow Rate




## Album page - Page 16

| Elements | Air flow rate [ft3/min (20C, 1 atm)] | Flow [mgd] |
|---|---|---|
| Acetate Splitter (U) | ----- | 0.14 |
| Aer 1 | 10009.44 | 109.74 |
| Aer 2 | 9325.85 | 109.74 |
| Aer 3 | 3110.97 | 78.42 |
| Swing 2a | 0 | 78.42 |
| Swing 2b | 0 | 78.42 |

## Album page - Page 17

WAS Wasting

| Parameters | Conc. (mg/L) | Mass rate (lb/d) | Notes |
|---|---|---|---|
| Volatile suspended solids | 5559.95 | 15504.84 | |
| Total suspended solids | 7431.52 | 20724.02 | |
| Particulate COD | 8110.86 | 22618.47 | |
| Filtered COD | 30.07 | 83.87 | |
| Total COD | 8140.93 | 22702.34 | |
| Soluble PO4-P | 0.04 | 0.12 | |
| Total P | 448.55 | 1250.86 | |
| Filtered TKN | 1.81 | 5.04 | |
| Particulate TKN | 548.78 | 1530.35 | |
| Total Kjeldahl Nitrogen | 550.58 | 1535.39 | |
| Filtered Carbonaceous BOD | 0.69 | 1.93 | |
| Total Carbonaceous BOD | 3490.07 | 9732.65 | |
| Nitrite + Nitrate | 2.28 | 6.37 | |
| Total N | 552.87 | 1541.76 | |
| Total inorganic N | 2.52 | 7.02 | |
| Alkalinity | -999.00 | -1263.65 | mmol/L and kmol/d |
| pH | 7.04 | | |
| Volatile fatty acids | 0.02 | 0.06 | |
| ISS precipitate | 130.07 | 362.72 | |
| ISS cellular | 1193.53 | 3328.36 | |
| ISS Total | 1871.57 | 5219.18 | |
| Ammonia N | 0.23 | 0.65 | |
| Nitrate N | 2.18 | 6.09 | |

| Parameters | Value | Units |
| --- | --- | --- |
| pH | 7.04 | |
| Ionized ammonium | 0.02 | mmol/L |
| Unionized ammonia | 0.00 | mmol/L |
| Nitrous acid | 0.00 | mmol/L |
| Nitrite | 0.01 | mmol/L |
| Total dissolved CO2 | 0.71 | mmol/L |
| Bicarbonate | 3.56 | mmol/L |
| Carbonate | 0.00 | mmol/L |
| Unionized ortho-P | 0.00 | mmol/L |
| H2PO4- | 0.00 | mmol/L |
| HPO4-- | 0.00 | mmol/L |
| PO4--- | 0.00 | mmol/L |
| Metal phosphate (solid) | 0.91 | mmol/L |
| Metal hydroxide (solid) | 0 | mmol/L |
| Metal ion | 0.00 | mmol/L |
| MeH2PO4++ | 0.00 | mmol/L |
| MeHPO4+ | 0.00 | mmol/L |
| Acetic acid | 0.00 | mmol/L |
| Acetate | 0.00 | mmol/L |
| Propionic acid | 0.00 | mmol/L |
| Propionate | 0.00 | mmol/L |
| Ionic strength | 0.02 | |
| Monovalent act. coeff. | 0.87 | |
| Divalent act. coeff. | 0.57 | |
| Trivalent act. coeff. | 0.29 | |
| Flow | 0.33 | mgd |

**Meridian Alternative's Analysis version1**

Expansion using selectable 5 stage modified Bardenpho/A2O process

Tank sizes optimized based on individual simulations from A2O and 5 stage modified Bardenpho processes

<u>To achieve target effluent concentrations, for Bardenpho process:</u>
Set BDF IMLR at 200% influent, Set A2O IMLR at 0%
Set Swing 1 Aerated, Swing 2a and 2b unaerated.
SRT = 12 days
All methanol to swing 2a

<u>To achieve target effluent concentrations, for A2O process:</u>
Set BDF IMLR at 0% influent, Set A2O IMLR at 400%
Set Swing 1 unaerated, Swing 2a and 2b aerated.
SRT = 12 days
All methanol to Anoxic 1a

For the MBR alternative, the Bardenpho process is used. Membrane tank sizing based on GE proposal dated 4/17/15
Alum addition rate was adjusted to reduce effluent PO4-P to 0.7 mg/L or lower. For the purpsoe of calculating O&M ocsts, however, the alum demand to reduce P from 0.5 to 0.07 mg/L was calculated separately for chemical precipitation.
Acetate flow pace of 1% of PE flow rate, 0.1 lb acetate COD per galloon used.
Methanol flow pace at 0.25% of PE flow rate, 1% methanol solution. All methanol to swing 2a.

# BioWin user and configuration data

## Project details

Project name: Alternatives Analysis     Project ref.: 147571

Plant name: Meridian WWTP     User name: Rick Kelly

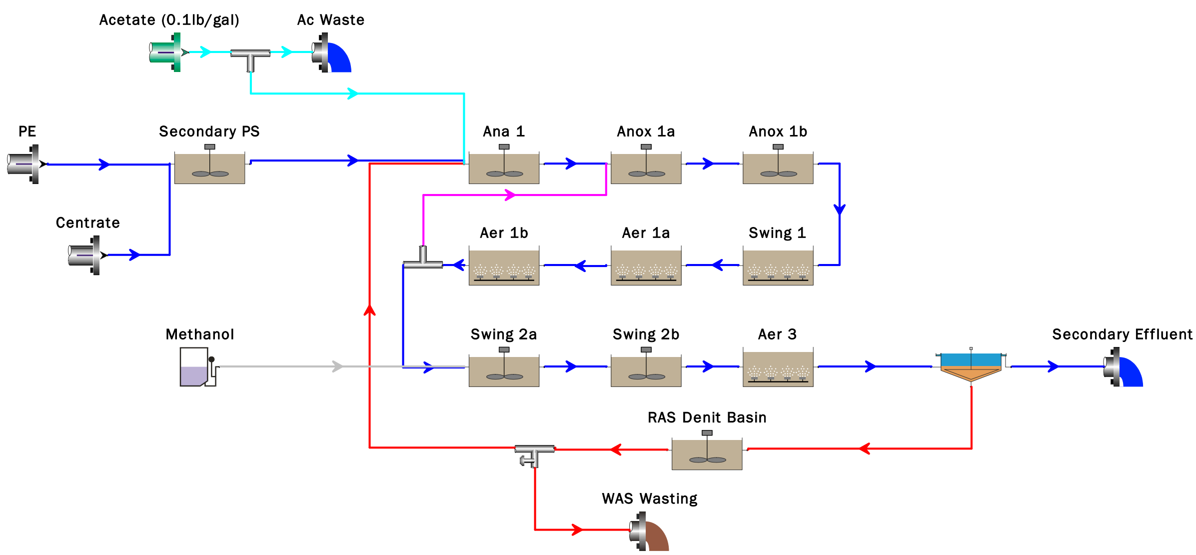
Created: 6/29/2011     Saved: 5/26/2015

## Steady state solution

Target SRT: 8.00 days  SRT #0: 7.97 days

Temperature: 18.0°C

## Flowsheet



# Configuration information for all Bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Ana 1 | 0.3200 | 3055.5557 | 14.000 | Un-aerated |
| Aer 1a | 1.1200 | 1.069E+4 | 14.000 | 3635 |
| Aer 1b | 1.1200 | 1.069E+4 | 14.000 | 3635 |
| Swing 2a | 0.4800 | 4583.3336 | 14.000 | Un-aerated |
| Aer 3 | 0.4000 | 3819.4447 | 14.000 | 1298 |
| Anox 1a | 0.2400 | 2291.6668 | 14.000 | Un-aerated |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |
| Anox 1b | 0.2400 | 2291.6668 | 14.000 | Un-aerated |
| Swing 1 | 0.3200 | 3055.5557 | 14.000 | 692 |
| Swing 2b | 0.4800 | 4583.3336 | 14.000 | Un-aerated |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Ana 1 | 0 |
| Aer 1a | 2.5 |
| Aer 1b | 2.0 |
| Swing 2a | 0 |
| Aer 3 | 2.0 |
| Anox 1a | 0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |

| | |
|---|---|
| Anox 1b | 0 |
| Swing 1 | 2.0 |
| Swing 2b | 0 |

### Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Ana 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Swing 2a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 3 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Anox 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Anox 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 2b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

## Configuration information for all Methanol addition units

### Operating data Average (flow/time weighted as required)

| Element name | Methanol |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |

| | |
|---|---|
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 11880.00 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |

| | |
|---|---|
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

## Configuration information for all Effluent units

## Configuration information for all Ideal clarifier units

### Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] |
|---|---|---|---|
| Clarifier | 2.8000 | 2.718E+4 | 13.770 |

### Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| Clarifier | Flow paced | 50.00 % |

| Element name | Average Temperature | Reactive | Percent removal | Blanket fraction |
|---|---|---|---|---|
| Clarifier | Uses global setting | Yes | 99.90 | 0.07 |

## Configuration information for all COD Influent units

### Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 0 | 0 |
| Flow | 12.08909091 | 0.103000001056688 |
| Total COD mgCOD/L | 379.27 | 1801.80 |
| Total Kjeldahl Nitrogen mgN/L | 48.77 | 795.73 |
| Total P mgP/L | 6.57 | 105.96 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.88 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.03 | 185.00 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.5950 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 0.0392 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9931 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.0039 |
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.3197 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.9500 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5086 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0050 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0512 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9300 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.0110 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 | 0 |

# Configuration information for all Sludge units

# Configuration information for all Splitter units

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| BDF IMLR | Flow paced | 200.00 % |
| RAS / WAS | Flowrate [Side] | 0.198121786411554 |
| Acetate Splitter | Flow paced | 0.15 % |

# Configuration information for all Stream (SV) Influent units

## Operating data Average (flow/time weighted as required)

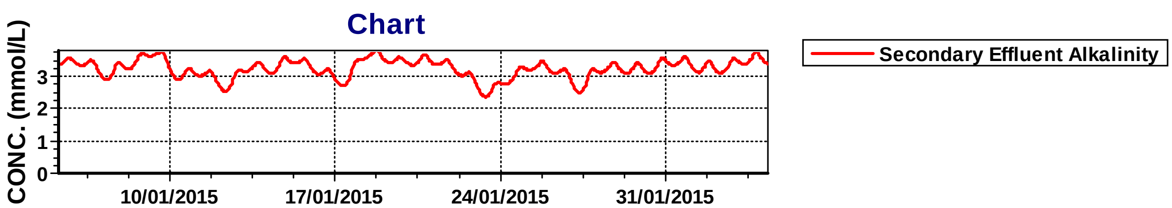
| Element name | Acetate (0.1lb/gal) |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |

| | |
|---|---|
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 11980.00 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |

| | |
|---|---|
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

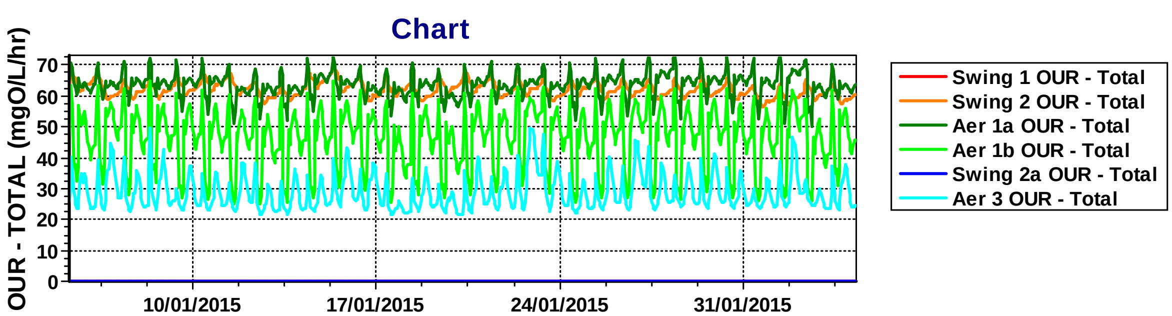
## BioWin Album

### Album page - SS AOB-NOB

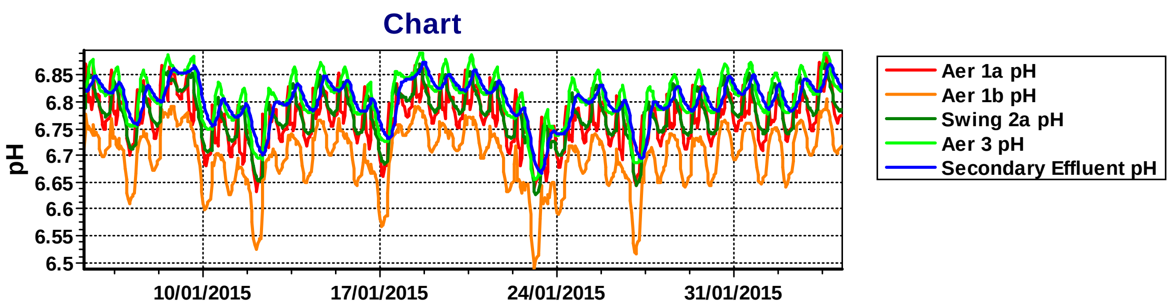



### Album page - SS AOB-NOB

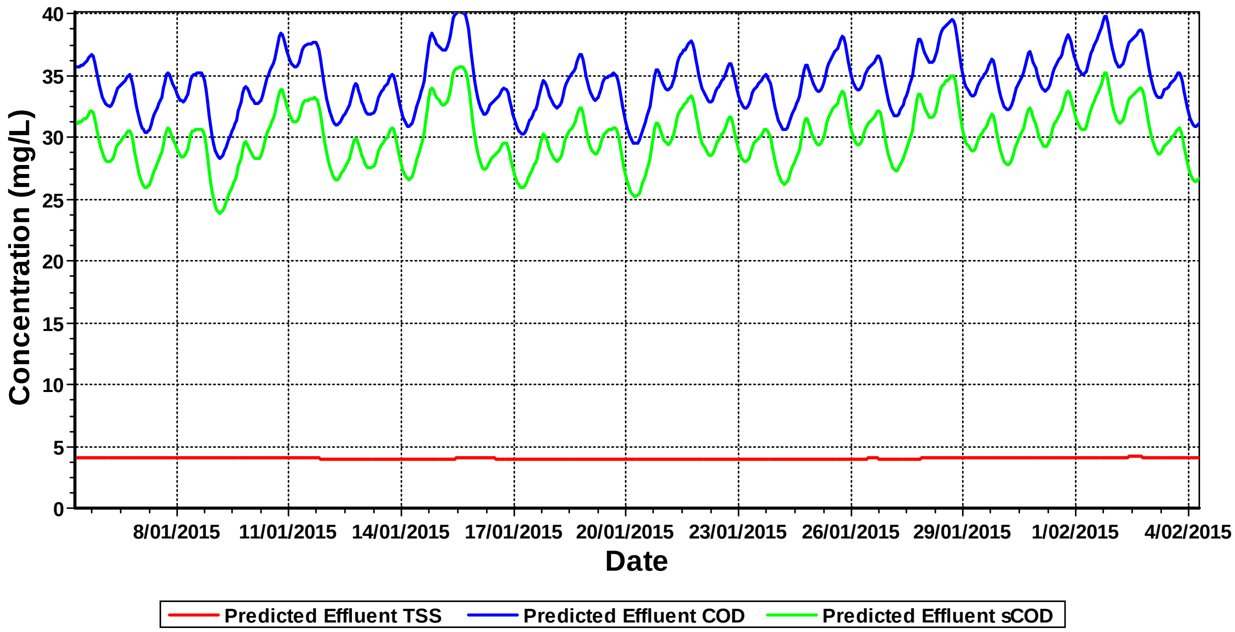
### Album page - OURs



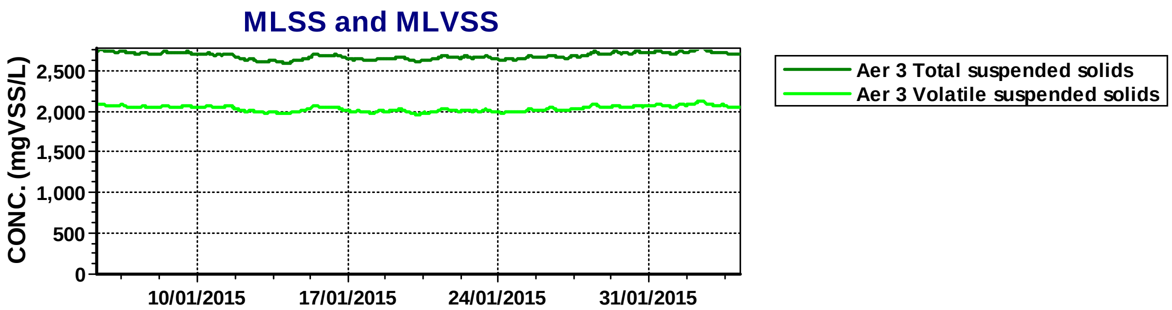

### Album page - OURs



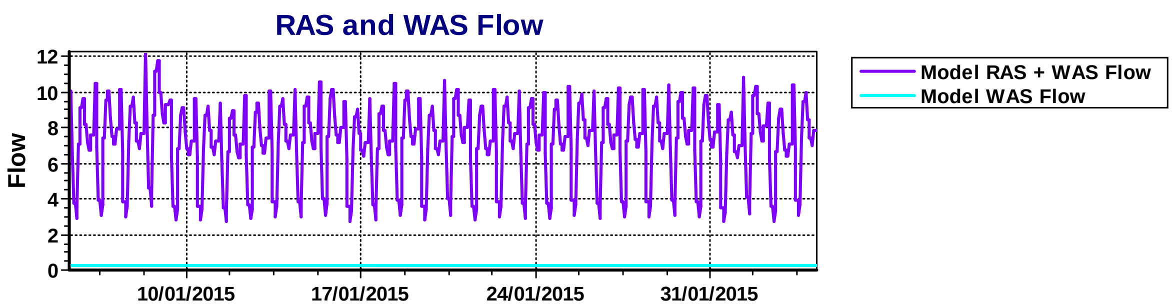

Album page - TSS, COD, BOD



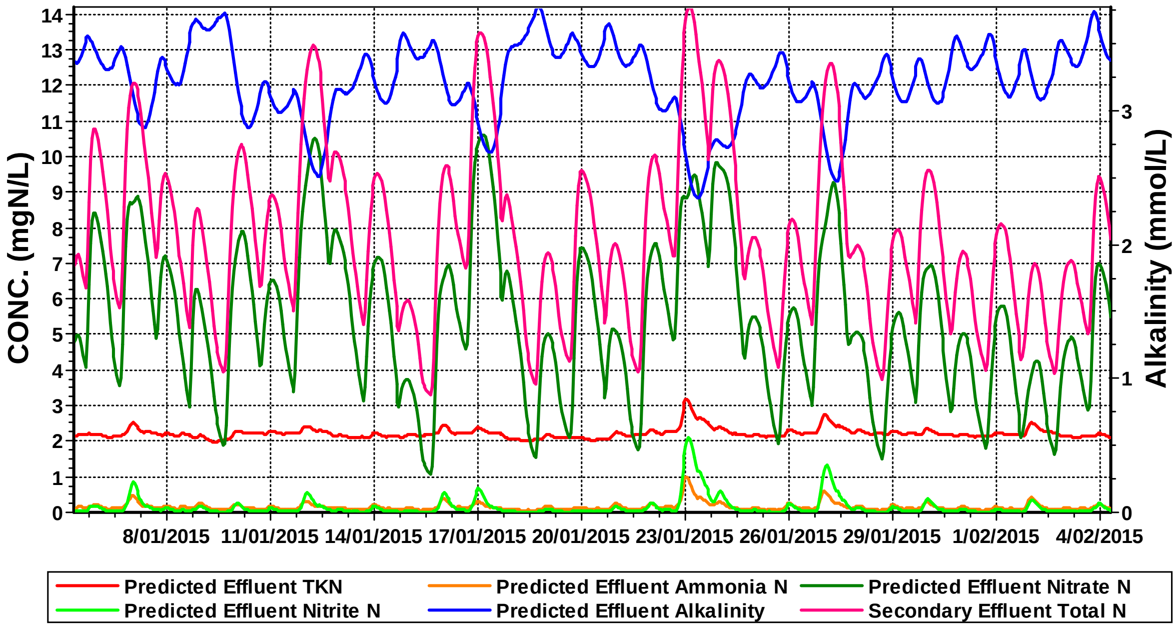

Album page - Mixed Liquor, RAS Flow



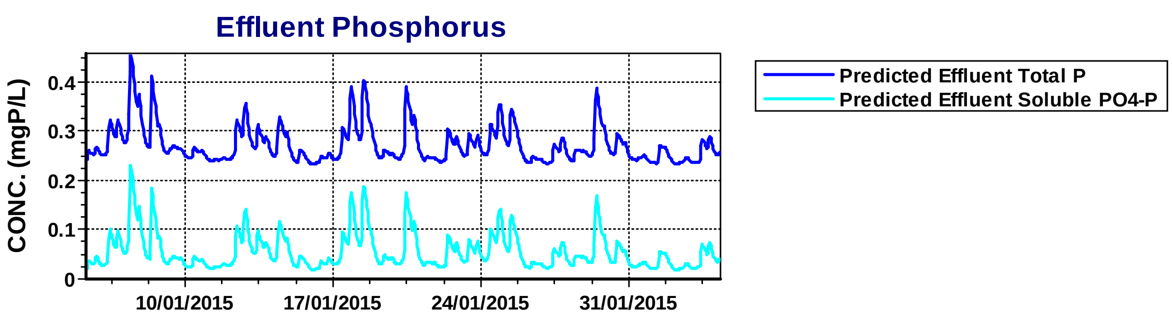

Album page - Mixed Liquor, RAS Flow



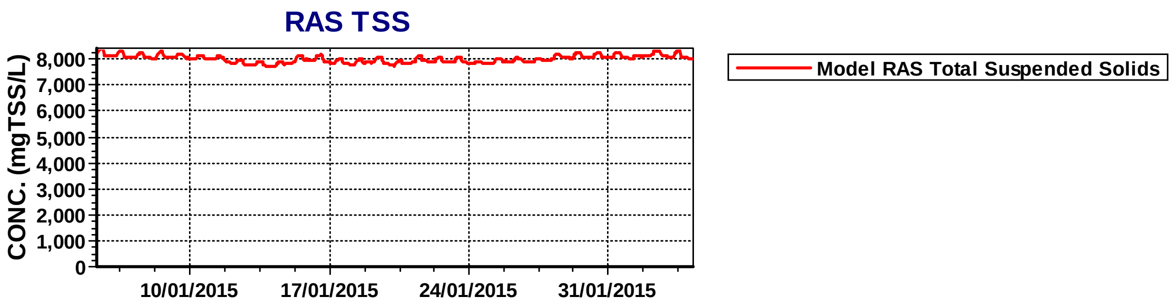

Album page - Nitrogen Sp., Alkalinity



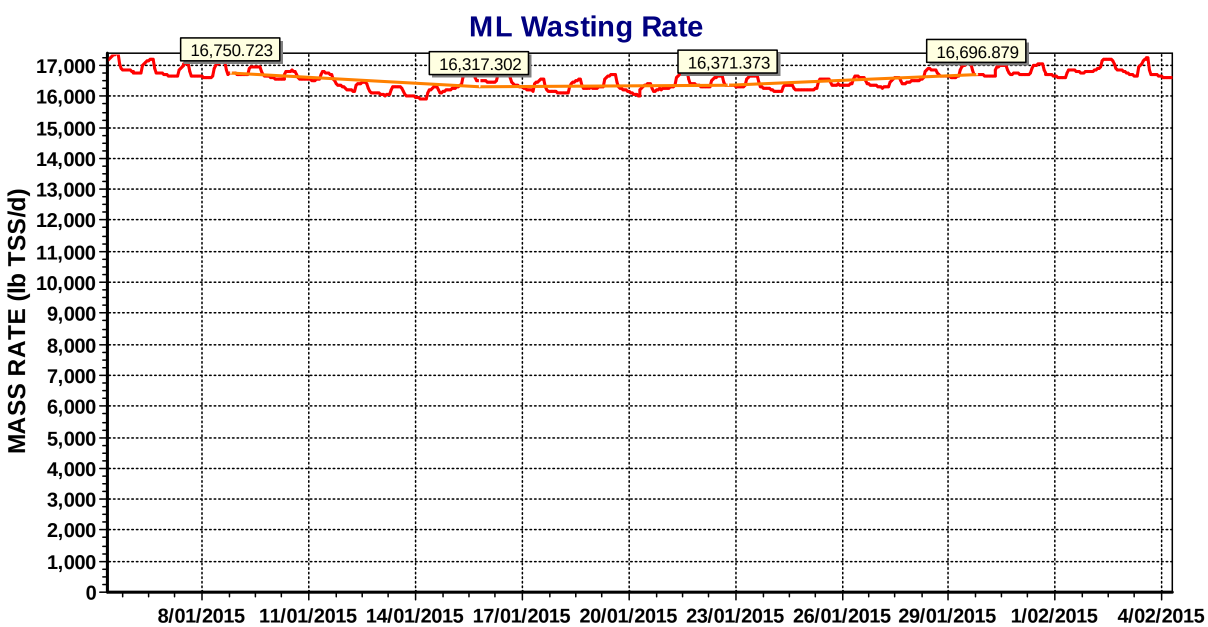

Album page - TP, RAS TSS



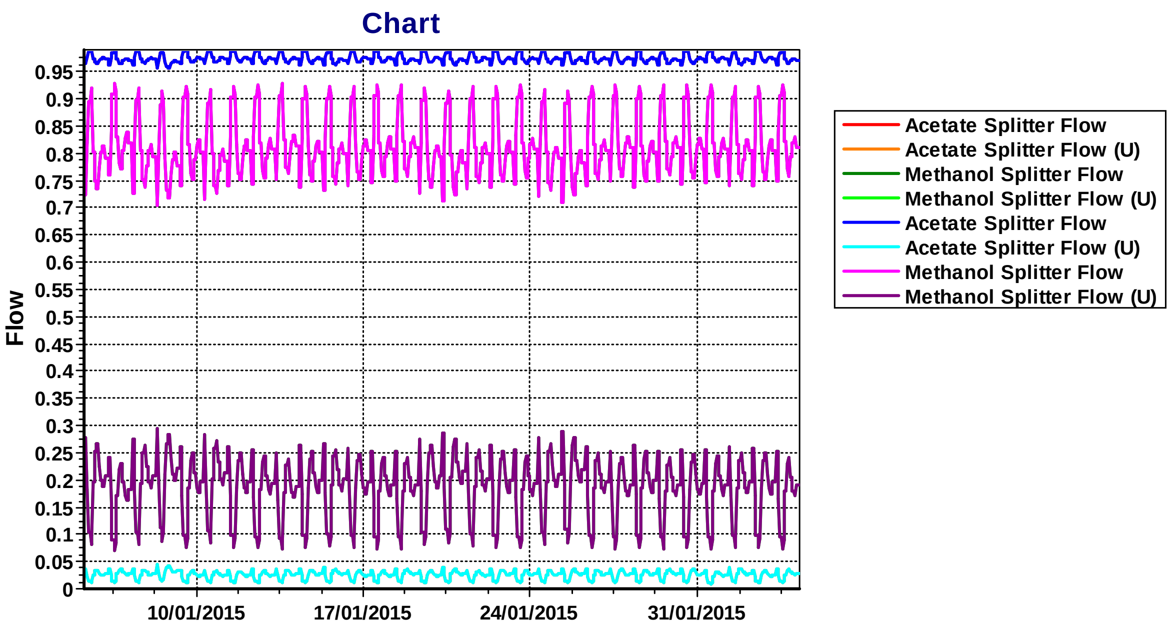

Album page - TP, RAS TSS



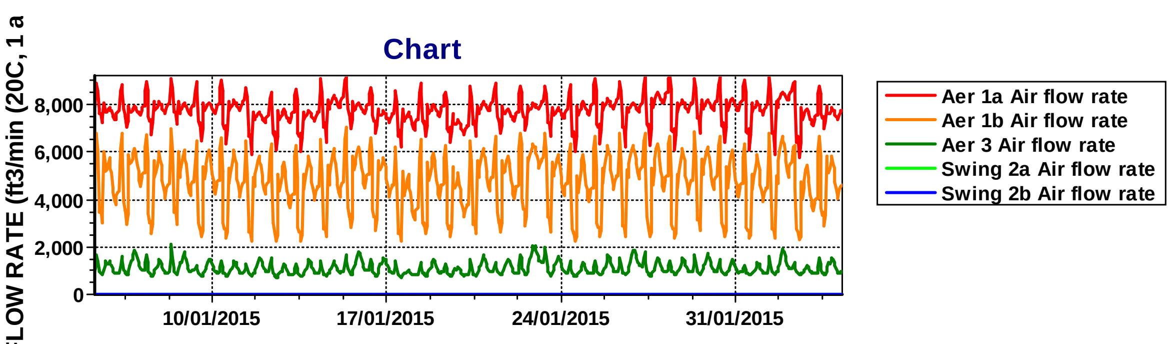

Album page - WAS Mass




Album page - Acetate and Methanol Flow




Album page - Air Flow Rates



# BioWin user and configuration data

## Project details

Project name: Alternatives Analysis Project ref.: 147571

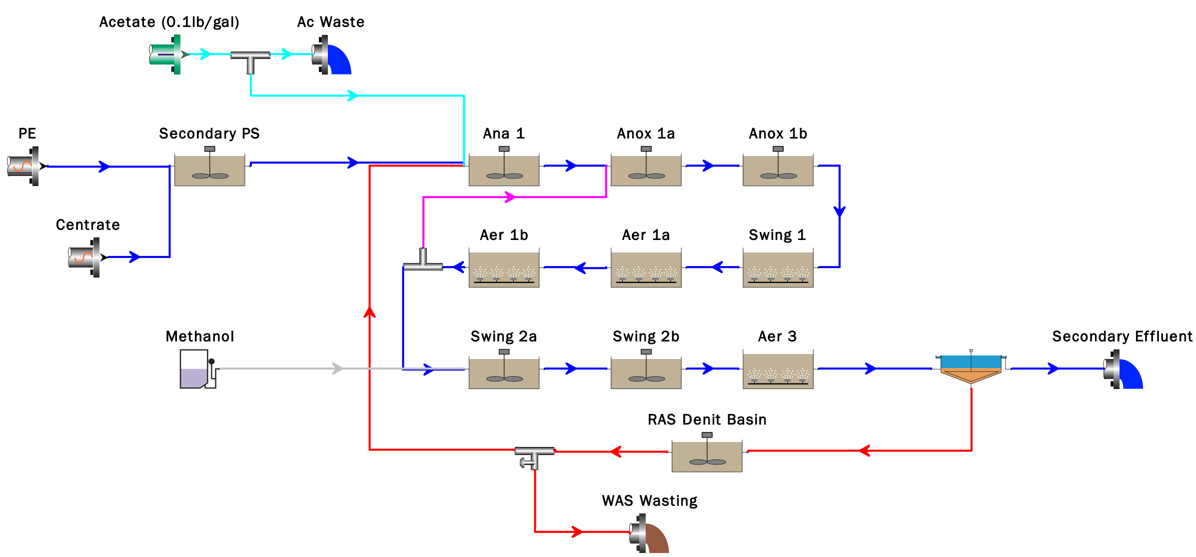
Plant name: Meridian WWTP User name: Rick Kelly

Created: 6/29/2011 Saved: 5/12/2015

Target SRT: 8.00 days SRT: **** days

Temperature: 18.0°C

## Flowsheet




# Configuration information for all Bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Ana 1 | 0.4000 | 3819.4447 | 14.000 | Un-aerated |
| Aer 1a | 1.4000 | 1.337E+4 | 14.000 | 4544 |
| Aer 1b | 1.4000 | 1.337E+4 | 14.000 | 4544 |
| Swing 2a | 0.6000 | 5729.1670 | 14.000 | Un-aerated |
| Aer 3 | 0.5000 | 4774.3058 | 14.000 | 1623 |
| Anox 1a | 0.3000 | 2864.5835 | 14.000 | Un-aerated |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |
| Anox 1b | 0.3000 | 2864.5835 | 14.000 | Un-aerated |
| Swing 1 | 0.4000 | 3819.4447 | 14.000 | 865 |
| Swing 2b | 0.6000 | 5729.1670 | 14.000 | Un-aerated |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Ana 1 | 0 |
| Aer 1a | 2.5 |
| Aer 1b | 2.0 |
| Swing 2a | 0 |
| Aer 3 | 2.0 |
| Anox 1a | 0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |
| Anox 1b | 0 |
| Swing 1 | 2.0 |

| | |
|---|---|
| Swing 2b | 0 |

### Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Ana 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Swing 2a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 3 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Anox 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Anox 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 2b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

## Configuration information for all Methanol addition units

### Operating data Average (flow/time weighted as required)

| Element name | Methanol |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |

| | |
|---|---|
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 11880.00 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |

| | |
|---|---|
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

## Configuration information for all Effluent units

## Configuration information for all Ideal clarifier units

### Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] |
|---|---|---|---|
| Clarifier | 2.8000 | 2.718E+4 | 13.770 |

### Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| Clarifier | Flow paced | 50.00 % |

| Element name | Average Temperature | Reactive | Percent removal | Blanket fraction |
|---|---|---|---|---|
| Clarifier | Uses global setting | Yes | 99.90 | 0.07 |

# Configuration information for all COD Influent units

## Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 30.00 | 30.00 |
| Flow | 14.310695600311 | 0.100113815696276 |
| Total COD mgCOD/L | 387.35 | 1801.80 |
| Total Kjeldahl Nitrogen mgN/L | 47.17 | 794.23 |
| Total P mgP/L | 6.89 | 105.96 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.82 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.23 | 185.22 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.5950 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 0.0392 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9931 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.0039 |
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.3197 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.9500 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5086 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0050 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0512 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9300 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.0110 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 | 0 |

# Configuration information for all Sludge units

# Configuration information for all Splitter units

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| BDF IMLR | Flow paced | 200.00 % |
| RAS / WAS | Flowrate [Side] | 0.247910155784548 |
| Acetate Splitter | Flow paced | 0.18 % |

# Configuration information for all Stream (SV) Influent units

## Operating data Average (flow/time weighted as required)

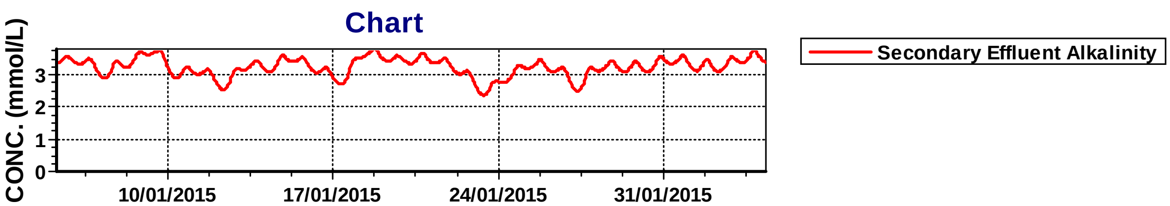
| Element name | Acetate (0.1lb/gal) |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |

| | |
|---|---|
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 11980.00 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |

| | |
|---|---|
| Flow | 1 |

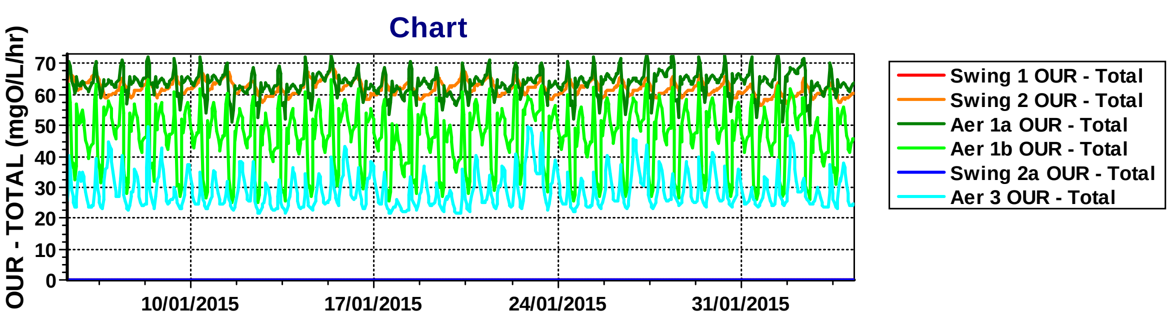
BioWin Album

Album page - SS AOB-NOB

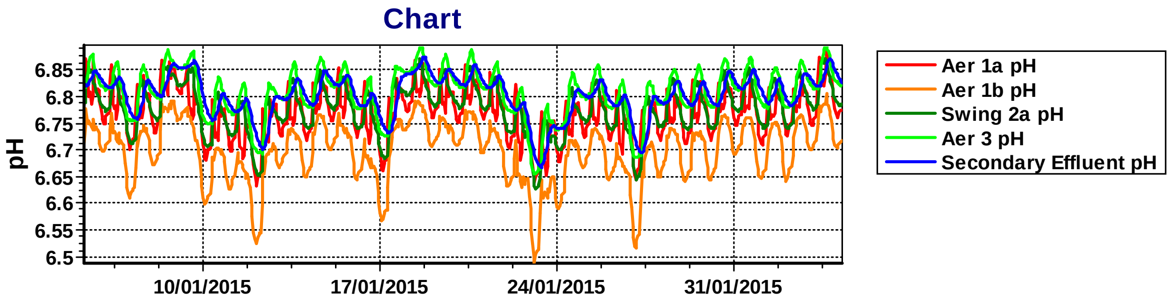



Album page - SS AOB-NOB

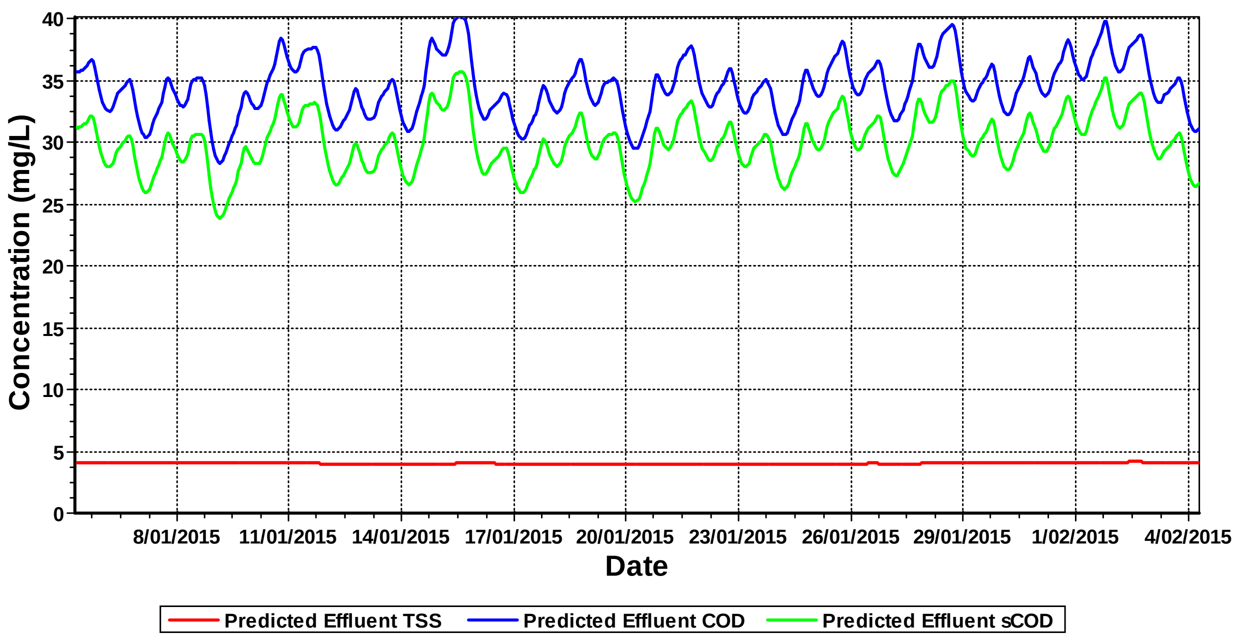
Album page - OURs



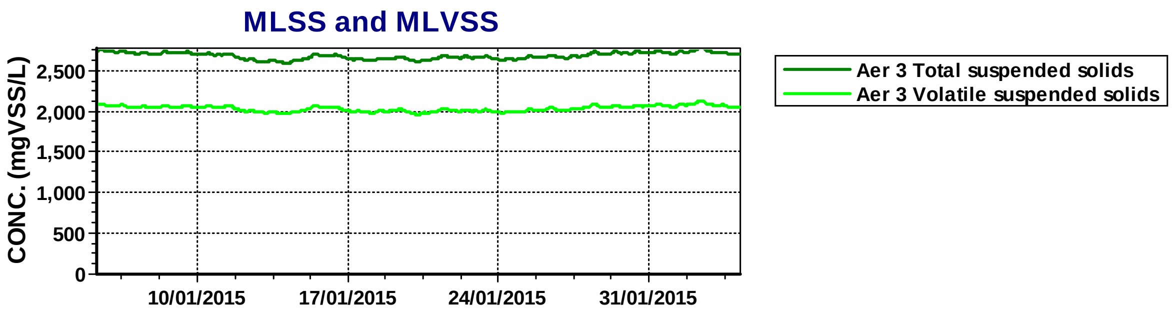

Album page - OURs



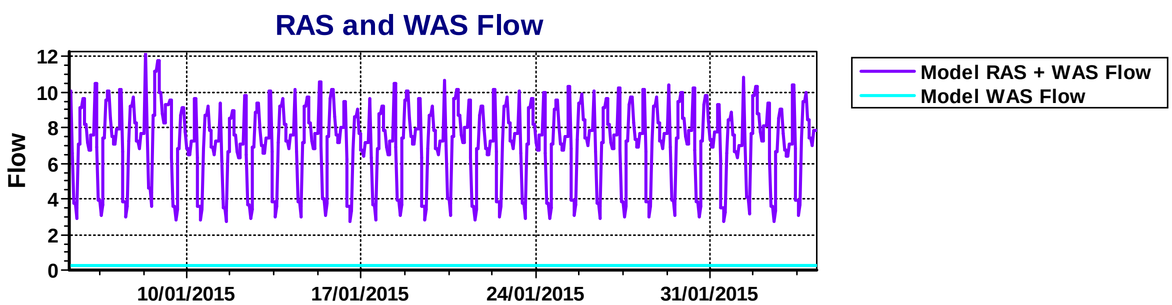

Album page - TSS, COD, BOD



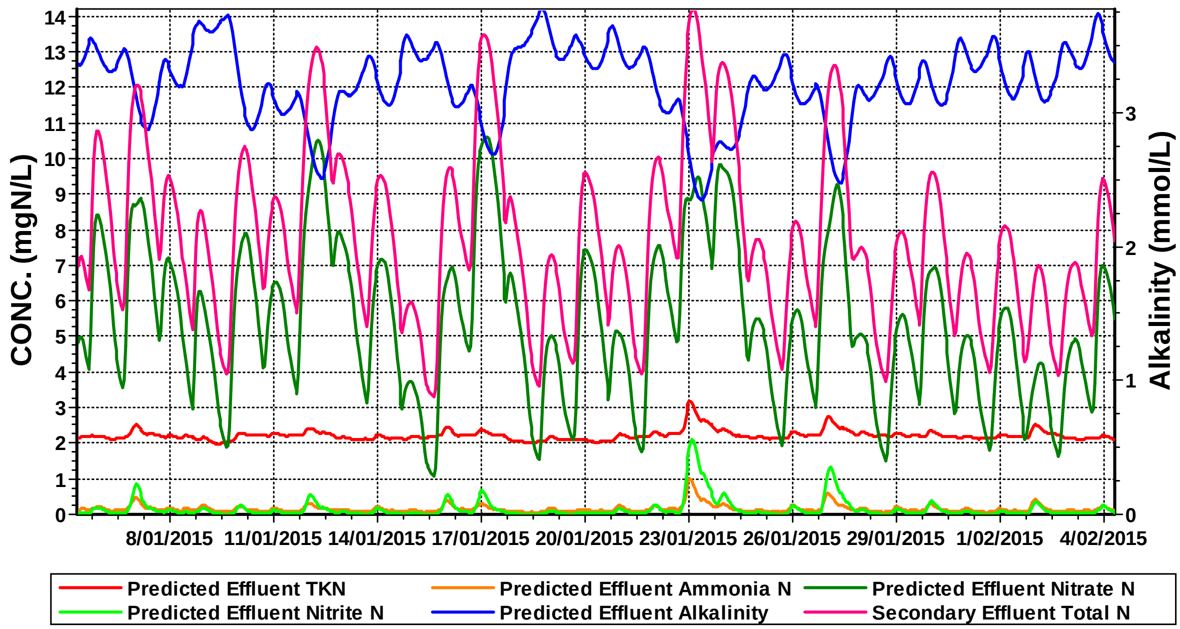

Album page - Mixed Liquor, RAS Flow



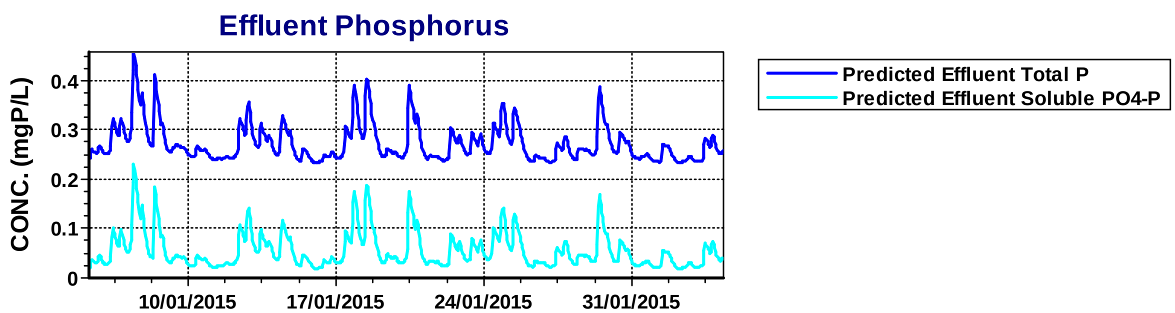

Album page - Mixed Liquor, RAS Flow



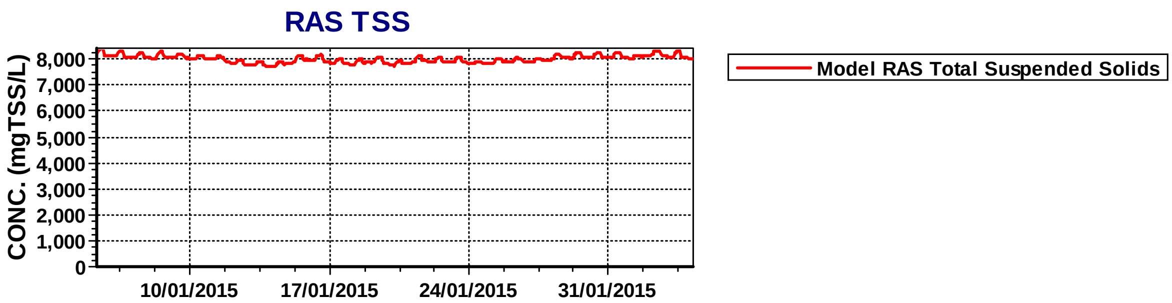

Album page - Nitrogen Sp., Alkalinity



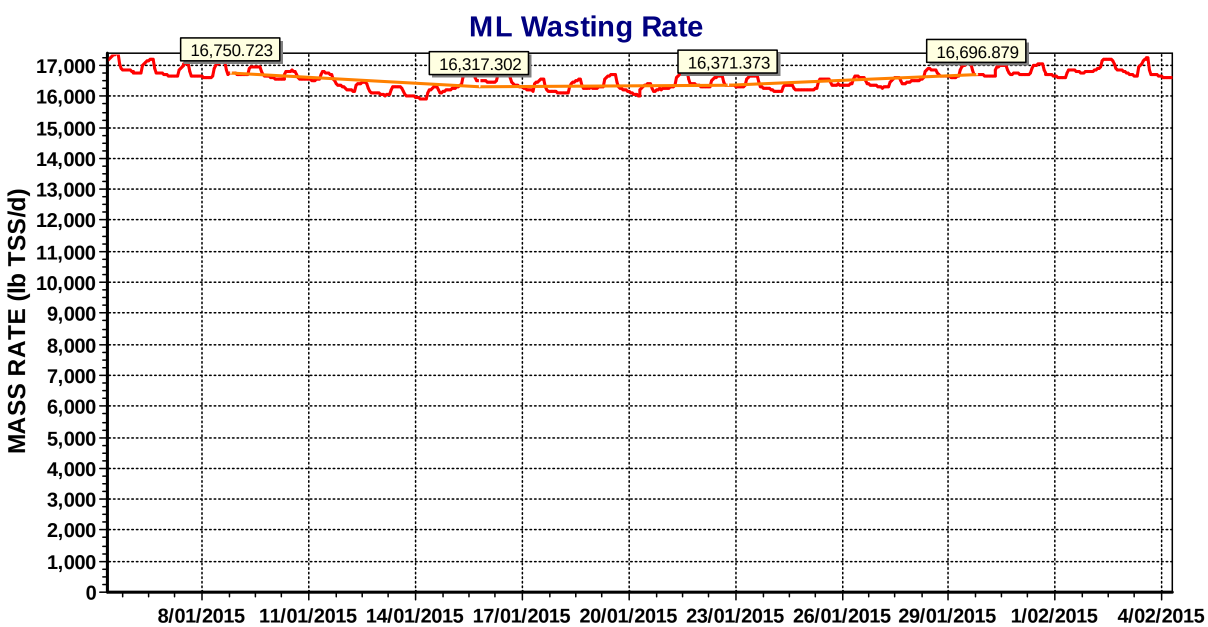

Album page - TP, RAS TSS



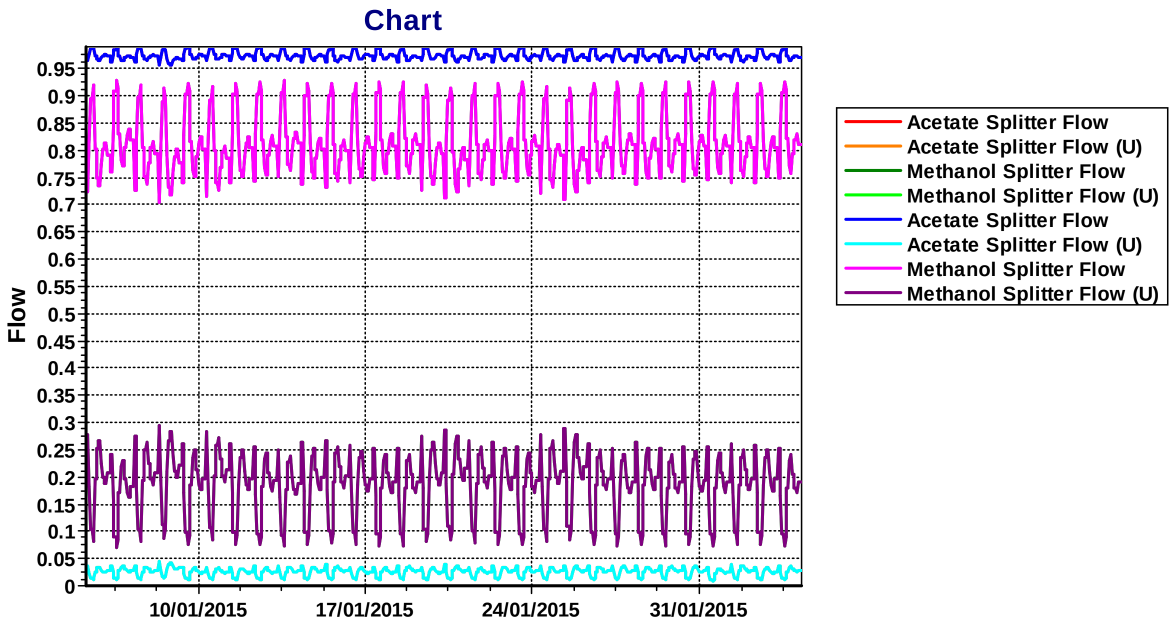

Album page - TP, RAS TSS



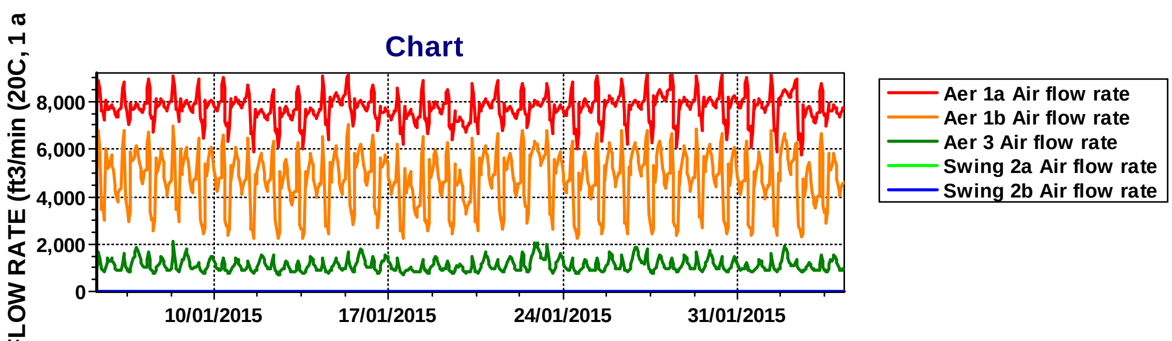

Album page - WAS Mass




Album page - Acetate and Methanol Flow




Album page - Air Flow Rates



# BioWin user and configuration data

## Project details

Project name: Alternatives Analysis　　Project ref.: 147571

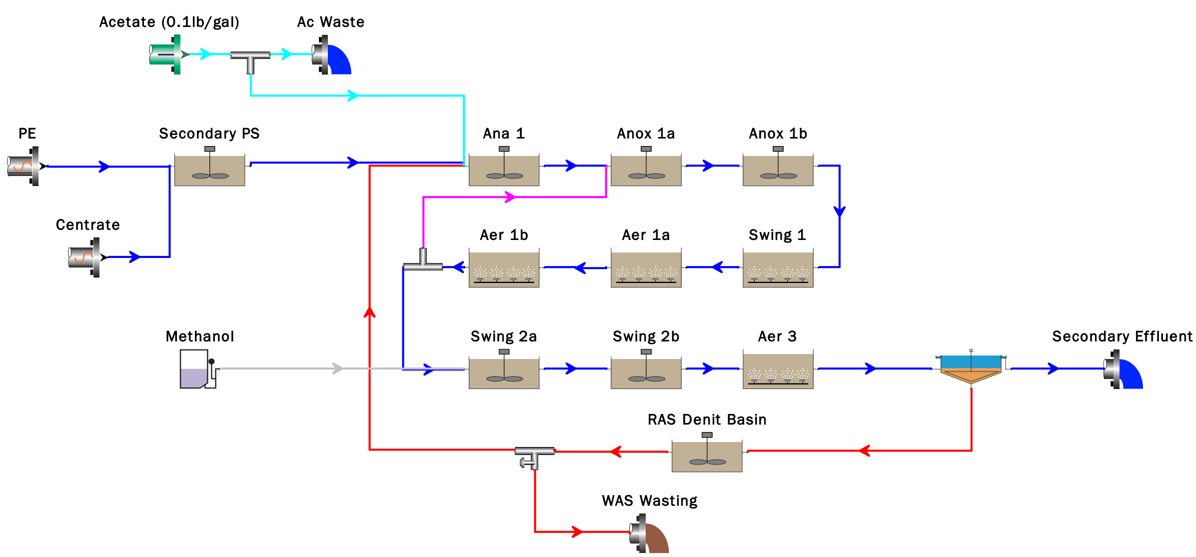
Plant name: Meridian WWTP　　User name: Rick Kelly

Created: 6/29/2011　　Saved: 5/8/2015

Target SRT: 11.00 days　　SRT: **** days

Temperature: 14.0°C

## Flowsheet




# Configuration information for all Bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Ana 1 | 0.4000 | 3819.4447 | 14.000 | Un-aerated |
| Aer 1a | 1.4000 | 1.337E+4 | 14.000 | 4544 |
| Aer 1b | 1.4000 | 1.337E+4 | 14.000 | 4544 |
| Swing 2a | 0.6000 | 5729.1670 | 14.000 | Un-aerated |
| Aer 3 | 0.5000 | 4774.3058 | 14.000 | 1623 |
| Anox 1a | 0.3000 | 2864.5835 | 14.000 | Un-aerated |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |
| Anox 1b | 0.3000 | 2864.5835 | 14.000 | Un-aerated |
| Swing 1 | 0.4000 | 3819.4447 | 14.000 | 865 |
| Swing 2b | 0.6000 | 5729.1670 | 14.000 | Un-aerated |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Ana 1 | 0 |
| Aer 1a | 2.5 |
| Aer 1b | 2.0 |
| Swing 2a | 0 |
| Aer 3 | 2.0 |
| Anox 1a | 0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |
| Anox 1b | 0 |
| Swing 1 | 2.0 |

| | |
|---|---|
| Swing 2b | 0 |

### Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Ana 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Swing 2a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 3 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Anox 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Anox 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 2b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

## Configuration information for all Methanol addition units

### Operating data Average (flow/time weighted as required)

| Element name | Methanol |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |

| | |
|---|---|
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 11880.00 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |

| | |
|---|---|
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

## Configuration information for all Effluent units

## Configuration information for all Ideal clarifier units

### Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] |
|---|---|---|---|
| Clarifier | 2.8000 | 2.718E+4 | 13.770 |

### Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| Clarifier | Flow paced | 50.00 % |

| Element name | Average Temperature | Reactive | Percent removal | Blanket fraction |
|---|---|---|---|---|
| Clarifier | Uses global setting | Yes | 99.90 | 0.07 |

# Configuration information for all COD Influent units

## Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 30.00 | 30.00 |
| Flow | 12.4611703212226 | 0.100113815696276 |
| Total COD mgCOD/L | 416.48 | 1801.80 |
| Total Kjeldahl Nitrogen mgN/L | 54.01 | 794.23 |
| Total P mgP/L | 8.12 | 105.96 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.95 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.43 | 185.22 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.5950 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 0.0392 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9931 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.0039 |
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.3197 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.9500 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5086 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0050 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0512 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9300 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.0110 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 | 0 |

# Configuration information for all Sludge units

# Configuration information for all Splitter units

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
| --- | --- | --- |
| BDF IMLR | Flow paced | 200.00 % |
| RAS / WAS | Flowrate [Side] | 0.179489419551172 |
| Acetate Splitter | Flow paced | 0.25 % |

# Configuration information for all Stream (SV) Influent units

## Operating data Average (flow/time weighted as required)

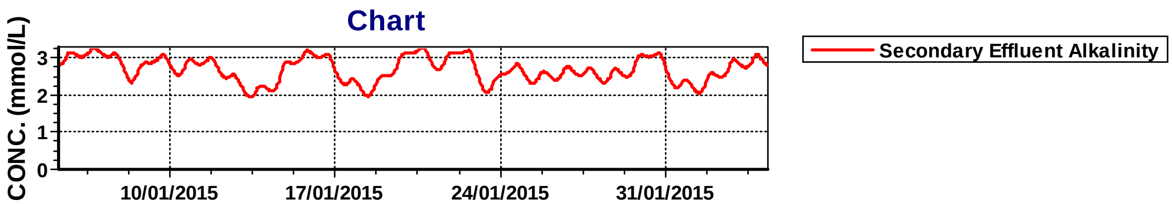
| Element name | Acetate (0.1lb/gal) |
| --- | --- |
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |

| | |
|---|---|
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 11980.00 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |

| Flow | 1 |
|---|---|

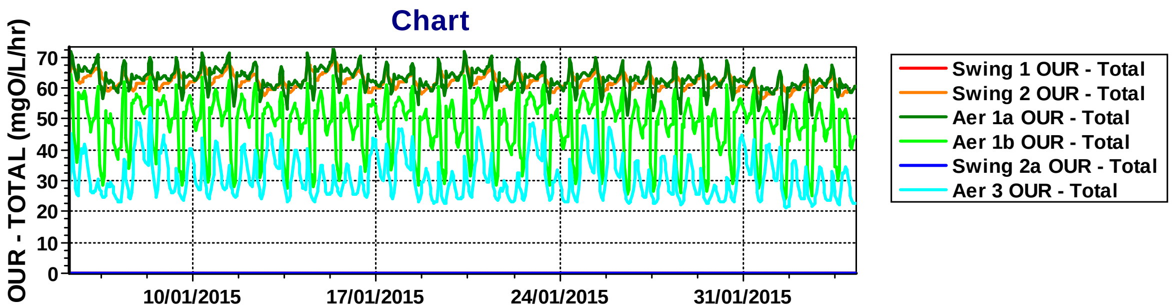
BioWin Album

Album page - SS AOB-NOB

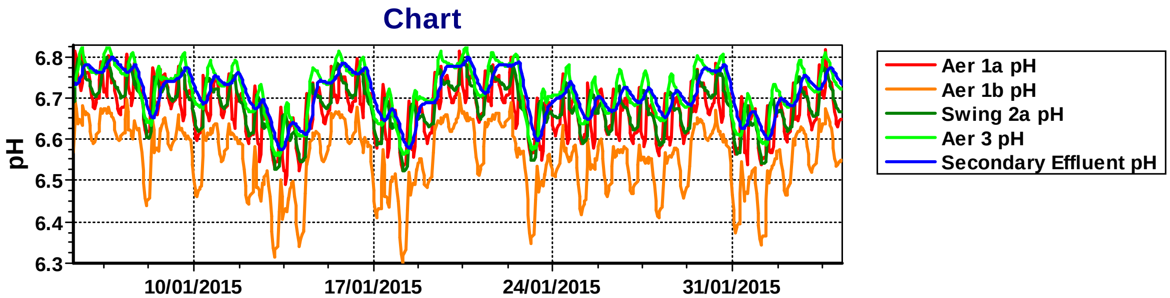



Album page - SS AOB-NOB

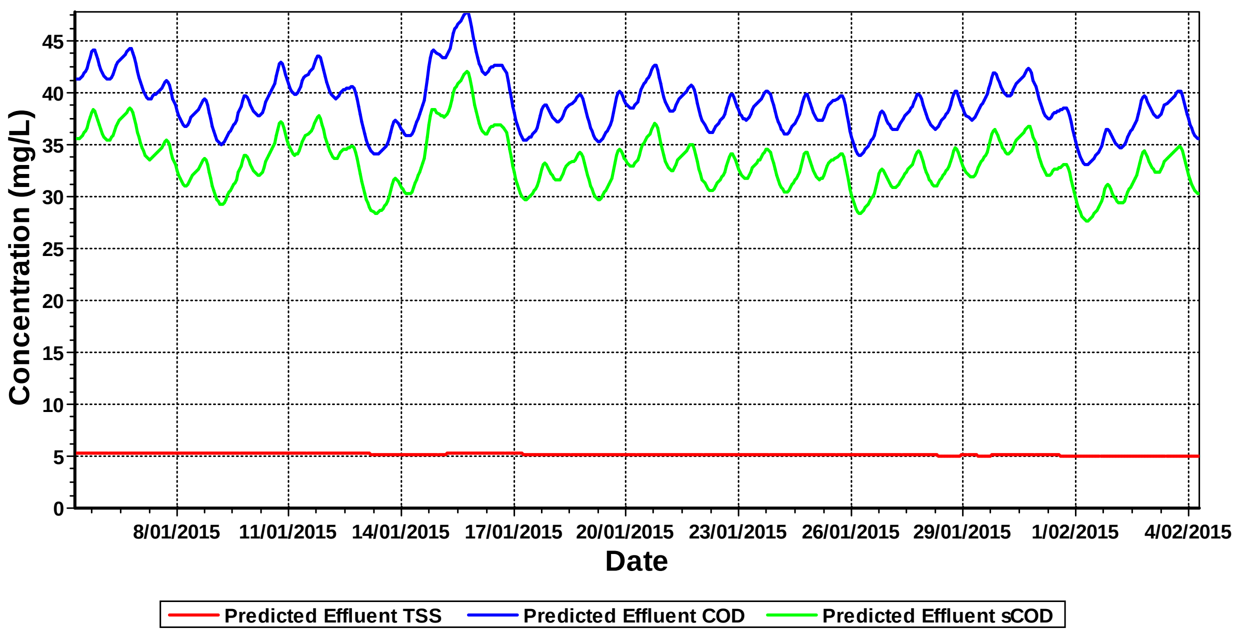
Album page - OURs



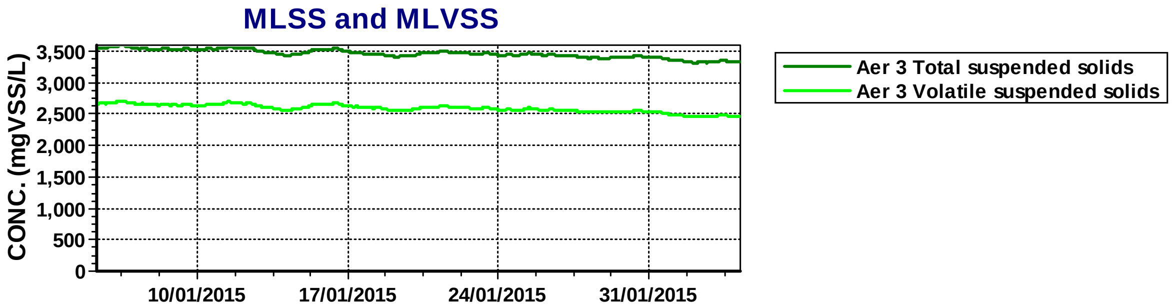

Album page - OURs



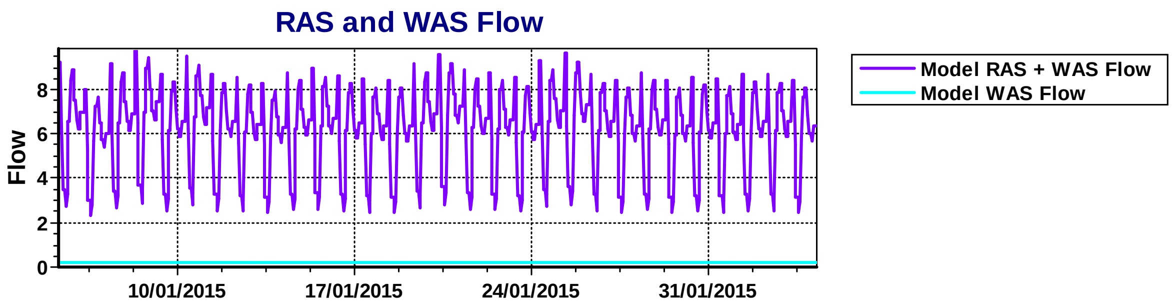

Album page - TSS, COD, BOD



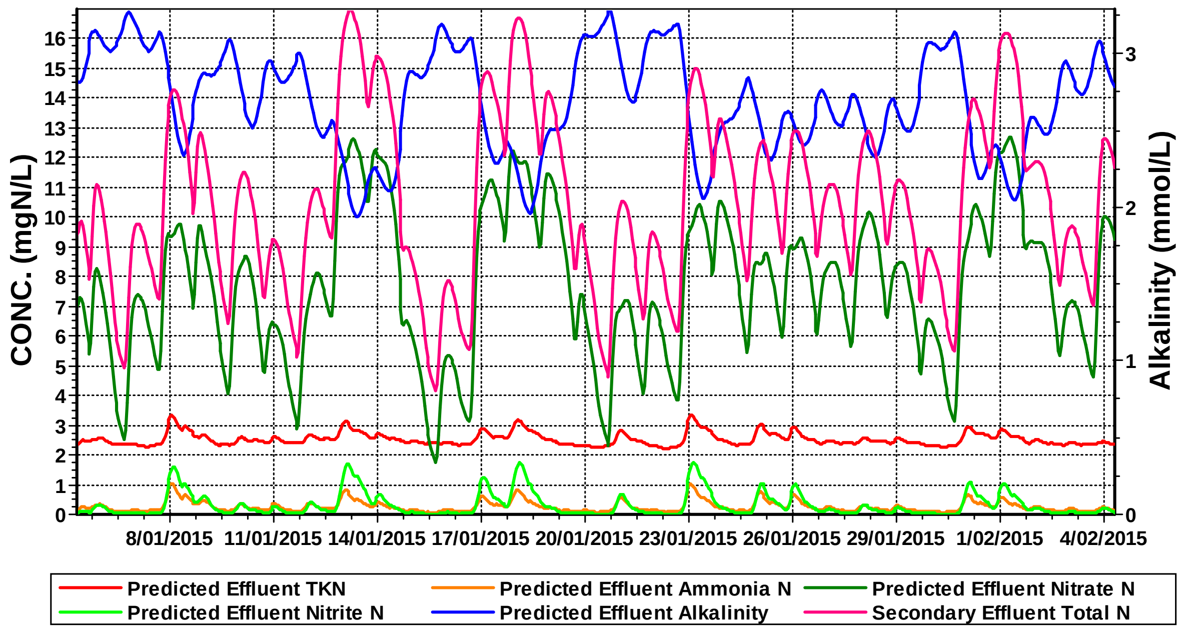

Album page - Mixed Liquor, RAS Flow



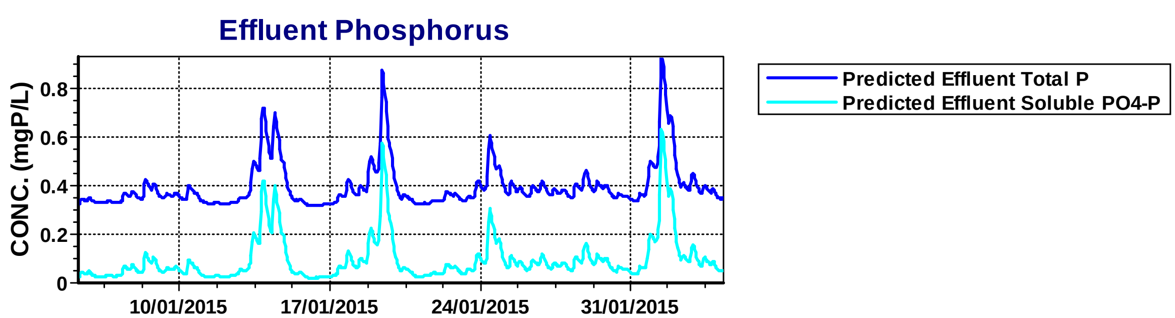

Album page - Mixed Liquor, RAS Flow



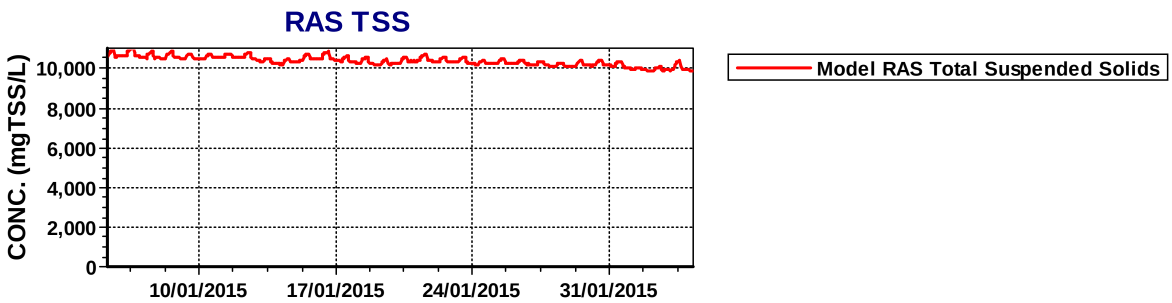

Album page - Nitrogen Sp., Alkalinity



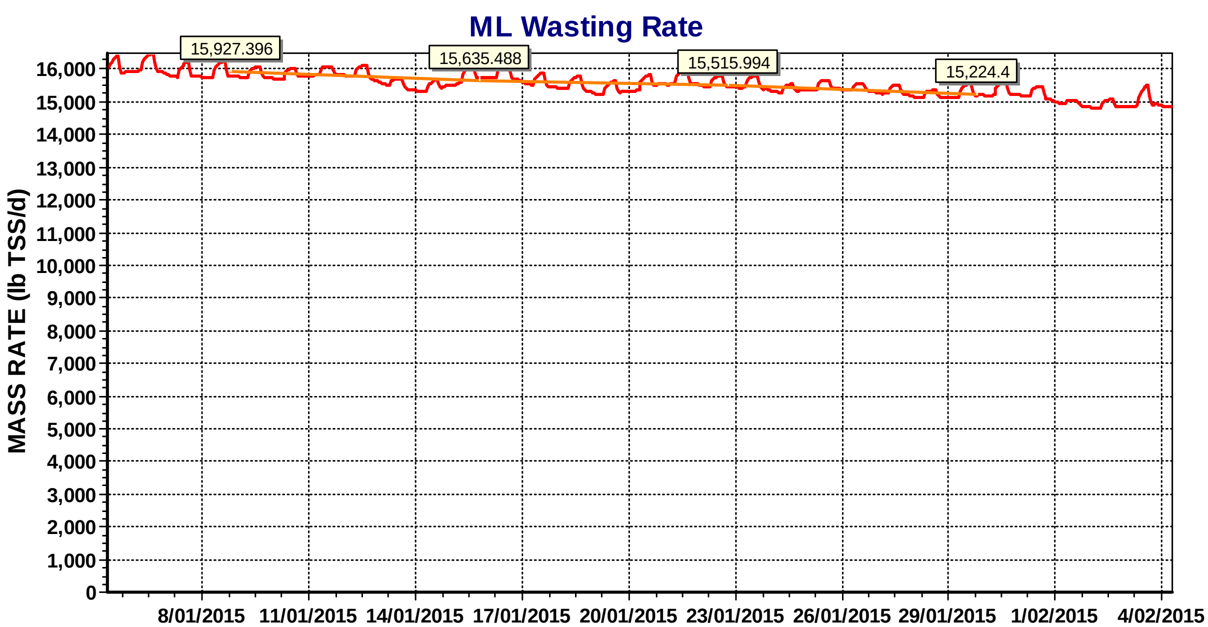

Album page - TP, RAS TSS



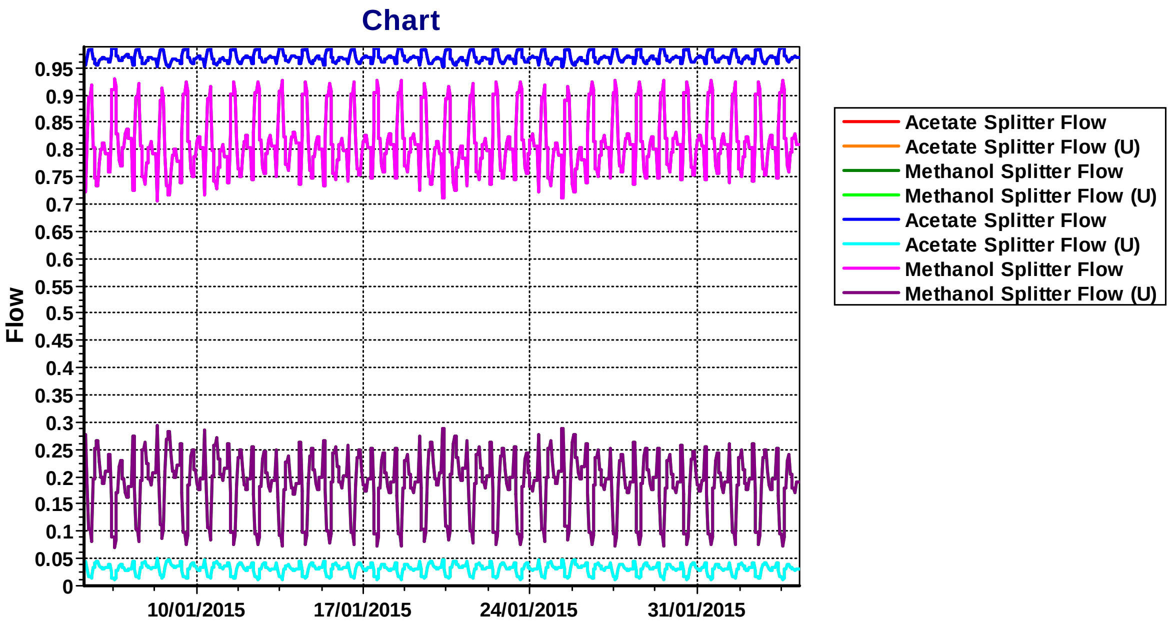

Album page - TP, RAS TSS



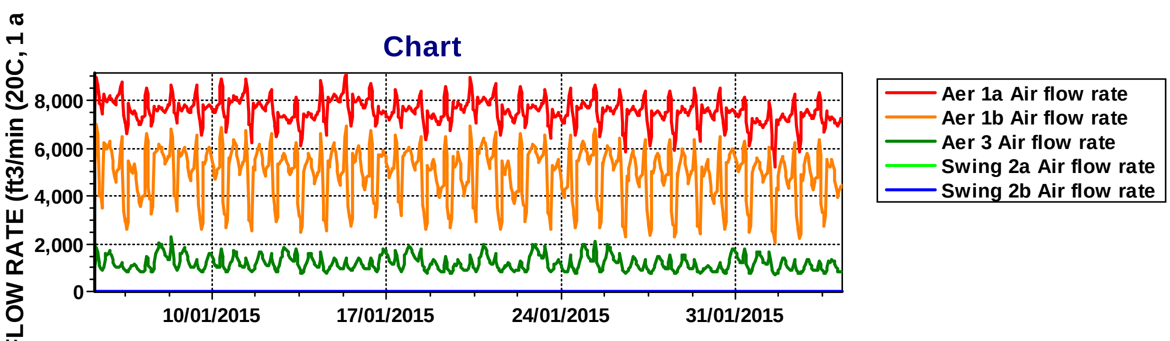

Album page - WAS Mass




Album page - Acetate and Methanol Flow




Album page - Air Flow Rates



# BioWin user and configuration data

## Project details

Project name: Alternatives Analysis    Project ref.: 147571

Plant name: Meridian WWTP    User name: Rick Kelly

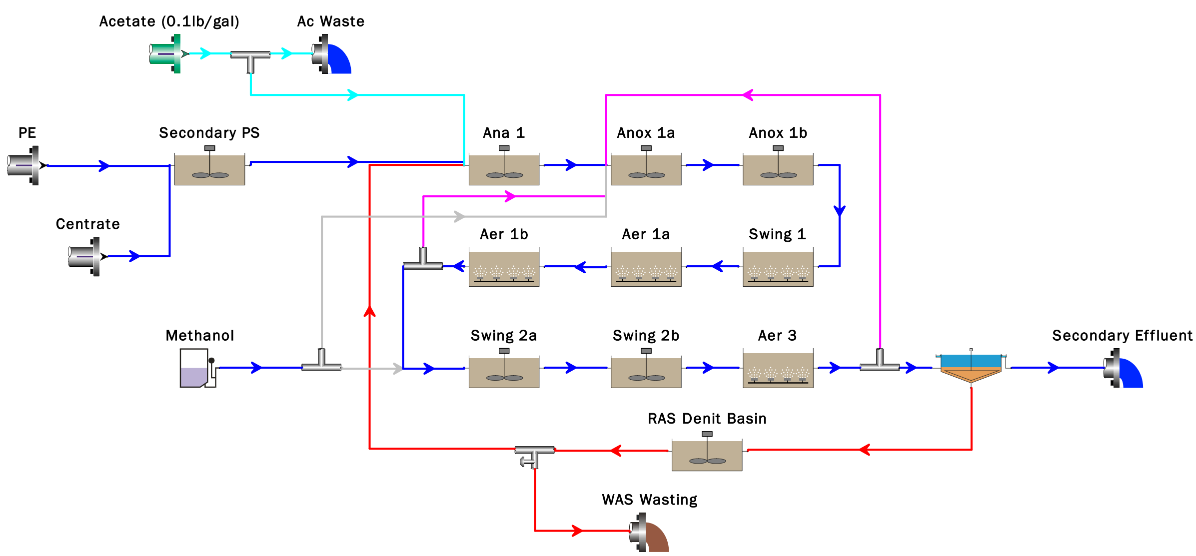
Created: 6/29/2011    Saved: 5/26/2015

## Steady state solution

Target SRT: 8.00 days  SRT #0: 7.97 days

Temperature: 18.0°C

## Flowsheet



# Configuration information for all Bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Ana 1 | 0.3200 | 3055.5557 | 14.000 | Un-aerated |
| Aer 1a | 1.1200 | 1.069E+4 | 14.000 | 3635 |
| Aer 1b | 1.1200 | 1.069E+4 | 14.000 | 3635 |
| Swing 2a | 0.4800 | 4583.3336 | 14.000 | Un-aerated |
| Aer 3 | 0.4000 | 3819.4447 | 14.000 | 1298 |
| Anox 1a | 0.2400 | 2291.6668 | 14.000 | Un-aerated |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |
| Anox 1b | 0.2400 | 2291.6668 | 14.000 | Un-aerated |
| Swing 1 | 0.3200 | 3055.5557 | 14.000 | 692 |
| Swing 2b | 0.4800 | 4583.3336 | 14.000 | Un-aerated |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Ana 1 | 0 |
| Aer 1a | 2.5 |
| Aer 1b | 2.0 |
| Swing 2a | 0 |
| Aer 3 | 2.0 |
| Anox 1a | 0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |

| | |
|---|---|
| Anox 1b | 0 |
| Swing 1 | 2.0 |
| Swing 2b | 0 |

### Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Ana 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Swing 2a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 3 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Anox 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Anox 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 2b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

## Configuration information for all Methanol addition units

### Operating data Average (flow/time weighted as required)

| Element name | Methanol |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |

| | |
|---|---|
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 11880.00 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |

| | |
|---|---|
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

## Configuration information for all Effluent units

## Configuration information for all Ideal clarifier units

### Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] |
|---|---|---|---|
| Clarifier | 2.8000 | 2.718E+4 | 13.770 |

### Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| Clarifier | Flow paced | 50.00 % |

| Element name | Average Temperature | Reactive | Percent removal | Blanket fraction |
|---|---|---|---|---|
| Clarifier | Uses global setting | Yes | 99.90 | 0.07 |

## Configuration information for all COD Influent units

### Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 0 | 0 |
| Flow | 12.08909091 | 0.103000001056688 |
| Total COD mgCOD/L | 379.27 | 1801.80 |
| Total Kjeldahl Nitrogen mgN/L | 48.77 | 795.73 |
| Total P mgP/L | 6.57 | 105.96 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.88 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.03 | 185.00 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.5950 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 0.0392 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9931 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.0039 |
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.3197 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.9500 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5086 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0050 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0512 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9300 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.0110 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 | 0 |

# Configuration information for all Sludge units

# Configuration information for all Splitter units

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
| --- | --- | --- |
| BDF IMLR | Flow paced | 200.00 % |
| RAS / WAS | Flowrate [Side] | 0.198120216171885 |
| Acetate Splitter | Flow paced | 0.15 % |
| Splitter21 | Fraction | 0.00 |
| A2O IMLR | Flowrate [Side] | 0 |

# Configuration information for all Stream (SV) Influent units

## Operating data Average (flow/time weighted as required)

| Element name | Acetate (0.1lb/gal) |
| --- | --- |
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |

| | |
|---|---|
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 11980.00 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |

| | |
|---|---|
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

# BioWin user and configuration data

## Project details

Project name: Alternatives Analysis    Project ref.: 147571

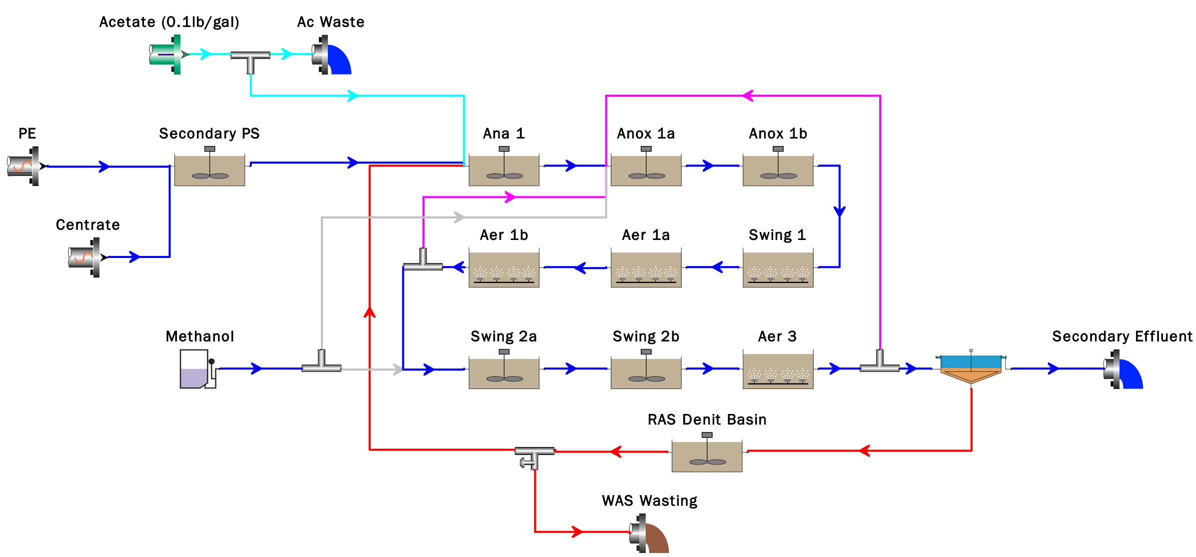
Plant name: Meridian WWTP    User name: Rick Kelly

Created: 6/29/2011    Saved: 5/12/2015

Target SRT: 8.00 days  SRT: **** days

Temperature: 18.0°C

## Flowsheet




# Configuration information for all Bioreactor units

## Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] | # of diffusers |
|---|---|---|---|---|
| Ana 1 | 0.4000 | 3819.4447 | 14.000 | Un-aerated |
| Aer 1a | 1.4000 | 1.337E+4 | 14.000 | 4544 |
| Aer 1b | 1.5000 | 1.432E+4 | 14.000 | 4868 |
| Swing 2a | 0.6000 | 5729.1670 | 14.000 | Un-aerated |
| Aer 3 | 0.5000 | 4774.3058 | 14.000 | 1623 |
| Anox 1a | 0.3000 | 2864.5835 | 14.000 | Un-aerated |
| Secondary PS | 0.0403 | 771.8233 | 6.980 | Un-aerated |
| RAS Denit Basin | 0.0743 | 1387.2159 | 7.160 | Un-aerated |
| Anox 1b | 0.3000 | 2864.5835 | 14.000 | Un-aerated |
| Swing 1 | 0.4000 | 3819.4447 | 14.000 | 865 |
| Swing 2b | 0.6000 | 5729.1670 | 14.000 | Un-aerated |

## Operating data Average (flow/time weighted as required)

| Element name | Average DO Setpoint [mg/L] |
|---|---|
| Ana 1 | 0 |
| Aer 1a | 2.5 |
| Aer 1b | 2.0 |
| Swing 2a | 0 |
| Aer 3 | 2.0 |
| Anox 1a | 0 |
| Secondary PS | 0 |
| RAS Denit Basin | 0 |
| Anox 1b | 0 |
| Swing 1 | 2.0 |

| | |
|---|---|
| Swing 2b | 0 |

### Aeration equipment parameters

| Element name | k1 in C = k1(PC)^0.25 + k2 | k2 in C = k1(PC)^0.25 + k2 | Y in Kla = C Usg ^ Y - Usg in [m3/(m2 d)] | Area of one diffuser | % of tank area covered by diffusers [%] |
|---|---|---|---|---|---|
| Ana 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Aer 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Swing 2a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Aer 3 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 15.0000 |
| Anox 1a | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Secondary PS | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| RAS Denit Basin | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Anox 1b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 1 | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |
| Swing 2b | 2.5656 | 0.0432 | 0.8200 | 0.4413 | 10.0000 |

## Configuration information for all Methanol addition units

### Operating data Average (flow/time weighted as required)

| Element name | Methanol |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |

| | |
|---|---|
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 0 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 11880.00 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |

| | |
|---|---|
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

## Configuration information for all Effluent units

## Configuration information for all Ideal clarifier units

### Physical data

| Element name | Volume [Mil. Gal] | Area [ft2] | Depth [ft] |
|---|---|---|---|
| Clarifier | 2.8000 | 2.718E+4 | 13.770 |

### Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| Clarifier | Flow paced | 50.00 % |

| Element name | Average Temperature | Reactive | Percent removal | Blanket fraction |
|---|---|---|---|---|
| Clarifier | Uses global setting | Yes | 99.90 | 0.07 |

# Configuration information for all COD Influent units

## Operating data Average (flow/time weighted as required)

| Element name | PE | Centrate |
|---|---|---|
| Time | 30.00 | 30.00 |
| Flow | 14.3106974874421 | 0.100114816828393 |
| Total COD mgCOD/L | 387.35 | 1801.80 |
| Total Kjeldahl Nitrogen mgN/L | 47.17 | 794.23 |
| Total P mgP/L | 6.89 | 105.96 |
| Nitrate N mgN/L | 0 | 0 |
| pH | 7.82 | 7.90 |
| Alkalinity mmol/L | 6.08 | 82.00 |
| ISS Influent mgISS/L | 11.23 | 185.22 |
| Calcium mg/L | 160.00 | 24.80 |
| Magnesium mg/L | 30.00 | 2.72 |
| Dissolved oxygen mg/L | 0 | 0 |

| Element name | PE | Centrate |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD] | 0.3060 | 0.5950 |
| Fac - Acetate [gCOD/g of readily biodegradable COD] | 0.1650 | 0.0392 |
| Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD] | 0.7600 | 0.9931 |
| Fus - Unbiodegradable soluble [gCOD/g of total COD] | 0.0680 | 0.0039 |
| Fup - Unbiodegradable particulate [gCOD/g of total COD] | 0.0100 | 0.3197 |
| Fna - Ammonia [gNH3-N/gTKN] | 0.8100 | 0.9500 |
| Fnox - Particulate organic nitrogen [gN/g Organic N] | 0.5500 | 0.5086 |
| Fnus - Soluble unbiodegradable TKN [gN/gTKN] | 0.0200 | 0.0050 |
| FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD] | 0.0350 | 0.0512 |
| Fpo4 - Phosphate [gPO4-P/gTP] | 0.6900 | 0.9300 |
| FupP - P:COD ratio for unbiodegradable part. COD [gP/gCOD] | 0.0110 | 0.0110 |
| FZbh - OHO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbm - Methylotroph COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZaob - AOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZnob - NOB COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZaao - AAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbp - PAO COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbpa - Propionic acetogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbam - Acetoclastic methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZbhm - H2-utilizing methanogens COD fraction [gCOD/g of total COD] | 1.000E-4 | 1.000E-4 |
| FZe - Endogenous products COD fraction [gCOD/g of total COD] | 0 | 0 |

# Configuration information for all Sludge units

# Configuration information for all Splitter units

## Operating data Average (flow/time weighted as required)

| Element name | Split method | Average Split specification |
|---|---|---|
| BDF IMLR | Flow paced | 200.00 % |
| RAS / WAS | Flowrate [Side] | 0.251935227963428 |
| Acetate Splitter | Flow paced | 0.23 % |
| Splitter21 | Fraction | 0.00 |
| A2O IMLR | Flowrate [Side] | 0 |

# Configuration information for all Stream (SV) Influent units

## Operating data Average (flow/time weighted as required)

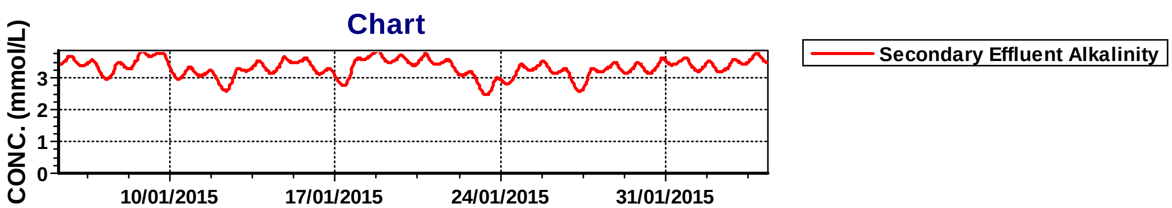
| Element name | Acetate (0.1lb/gal) |
|---|---|
| Ordinary heterotrophic organisms (OHO) mgCOD/L | 0 |
| Methylotrophs mgCOD/L | 0 |
| Ammonia oxidizing biomass (AOB) mgCOD/L | 0 |
| Nitrite oxidizing biomass (NOB) mgCOD/L | 0 |
| Anaerobic ammonia oxidizers (AAO) mgCOD/L | 0 |
| Polyphosphate accumulating organisms (PAO) mgCOD/L | 0 |
| Propionic acetogens mgCOD/L | 0 |
| Methanogens - acetoclastic mgCOD/L | 0 |
| Methanogens - hydrogenotrophic mgCOD/L | 0 |
| Endogenous products mgCOD/L | 0 |
| Slowly bio. COD (part.) mgCOD/L | 0 |
| Slowly bio. COD (colloid.) mgCOD/L | 0 |
| Part. inert. COD mgCOD/L | 0 |
| Part. bio. org. N mgN/L | 0 |
| Part. bio. org. P mgP/L | 0 |
| Part. inert N mgN/L | 0 |
| Part. inert P mgP/L | 0 |

| | |
|---|---|
| Stored PHA mgCOD/L | 0 |
| Releasable stored polyP mgP/L | 0 |
| Fixed stored polyP mgP/L | 0 |
| Readily bio. COD (complex) mgCOD/L | 0 |
| Acetate mgCOD/L | 11980.00 |
| Propionate mgCOD/L | 0 |
| Methanol mgCOD/L | 0 |
| Dissolved H2 mgCOD/L | 0 |
| Dissolved methane mg/L | 0 |
| Ammonia N mgN/L | 0 |
| Sol. bio. org. N mgN/L | 0 |
| Nitrous Oxide N mgN/L | 0 |
| Nitrite N mgN/L | 0 |
| Nitrate N mgN/L | 0 |
| Dissolved nitrogen gas mgN/L | 0 |
| PO4-P (Sol. & Me Complexed) mgP/L | 0 |
| Sol. inert COD mgCOD/L | 0 |
| Sol. inert TKN mgN/L | 0 |
| ISS Influent mgISS/L | 0 |
| Struvite mgISS/L | 0 |
| Hydroxy-dicalcium-phosphate mgISS/L | 0 |
| Hydroxy-apatite mgISS/L | 0 |
| Magnesium mg/L | 0 |
| Calcium mg/L | 0 |
| Metal mg/L | 0 |
| Other Cations (strong bases) meq/L | 0 |
| Other Anions (strong acids) meq/L | 0 |
| Total CO2 mmol/L | 0 |
| User defined 1 mg/L | 0 |
| User defined 2 mg/L | 0 |
| User defined 3 mgVSS/L | 0 |

| | |
|---|---|
| User defined 4 mgISS/L | 0 |
| Dissolved oxygen mg/L | 0 |
| Flow | 1 |

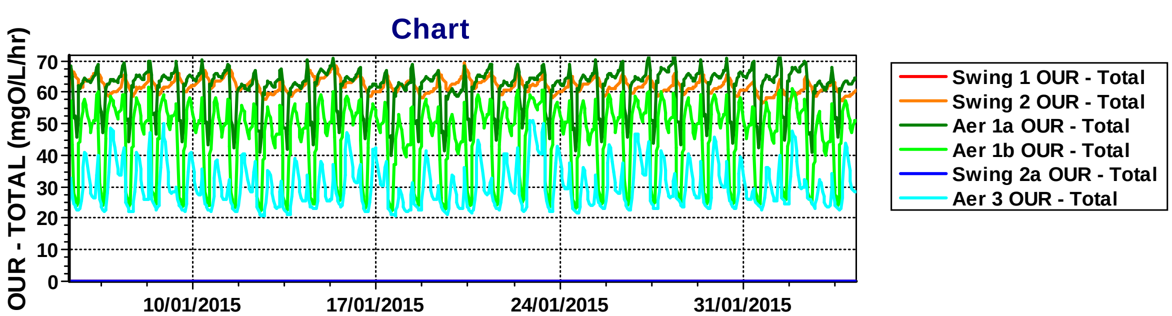
## BioWin Album

### Album page - SS AOB-NOB

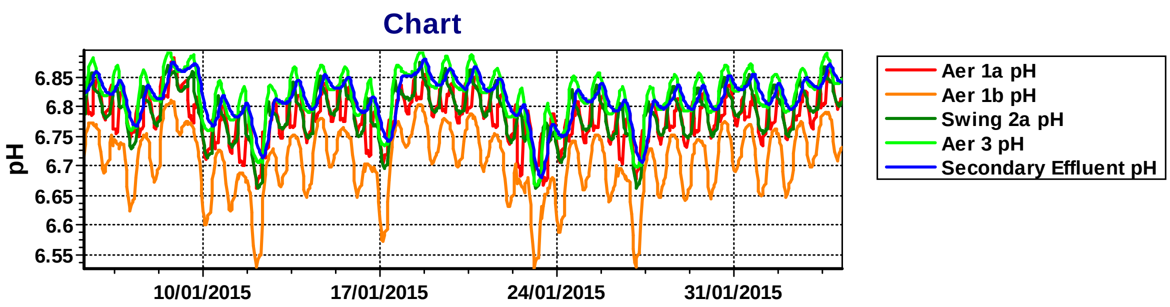



### Album page - SS AOB-NOB

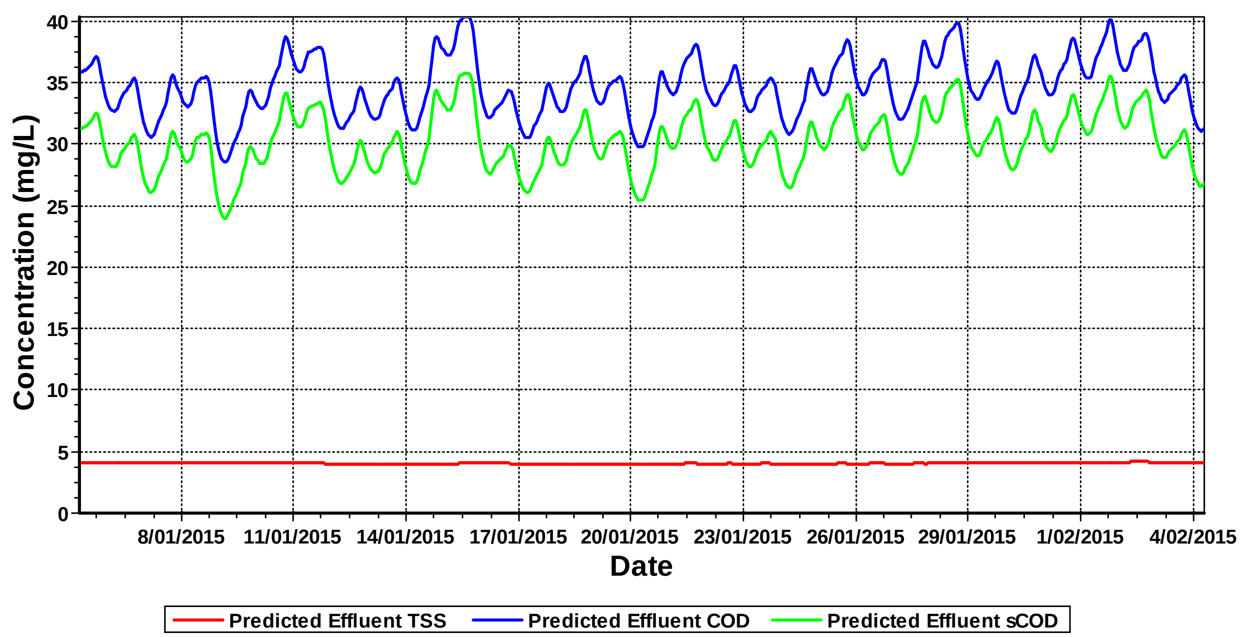
### Album page - OURs



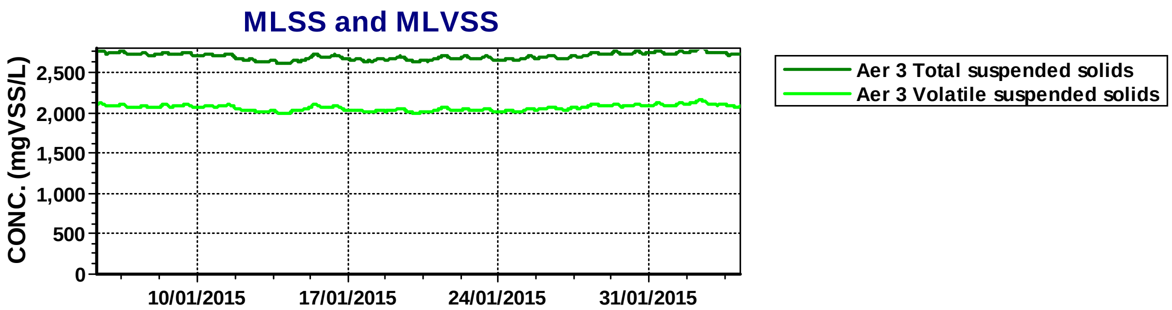

### Album page - OURs



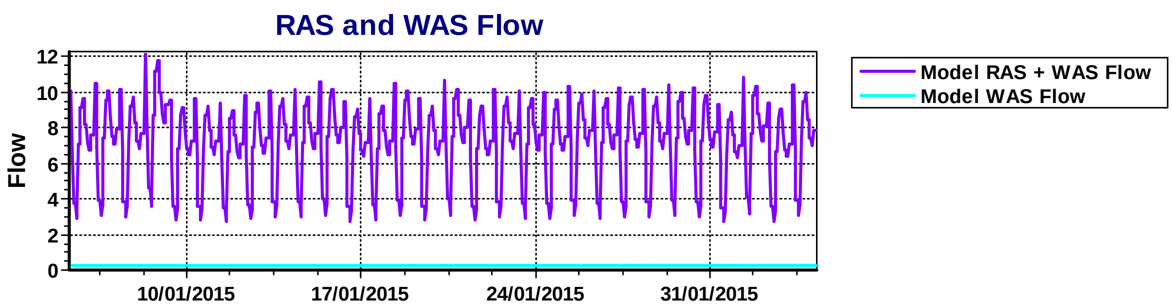

Album page - TSS, COD, BOD



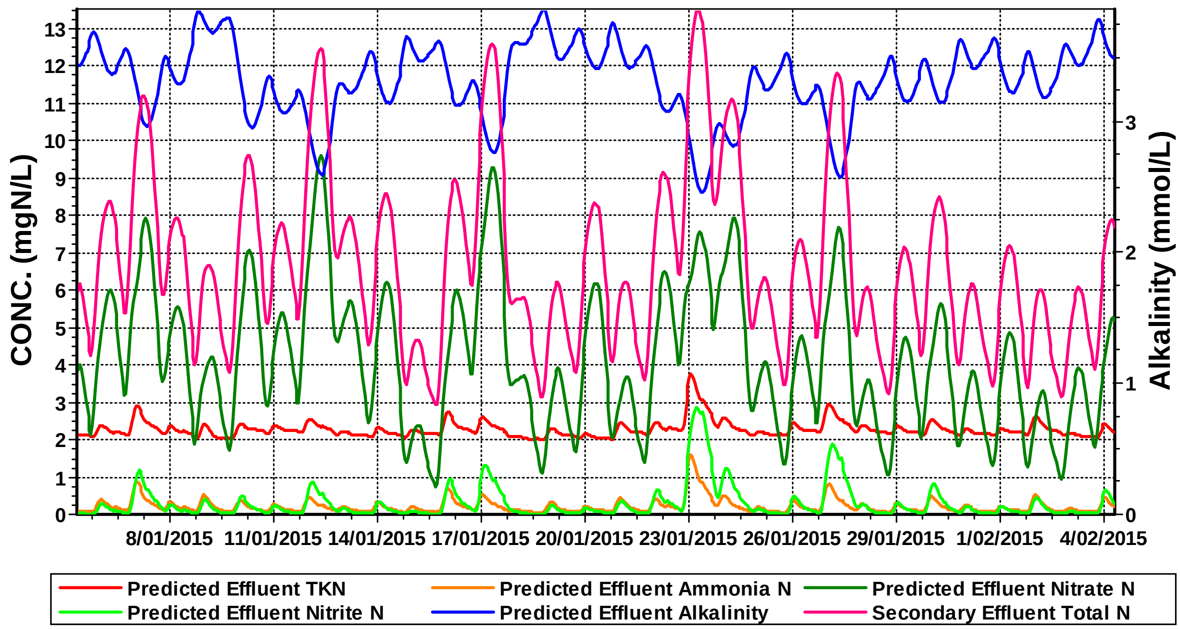

Album page - Mixed Liquor, RAS Flow



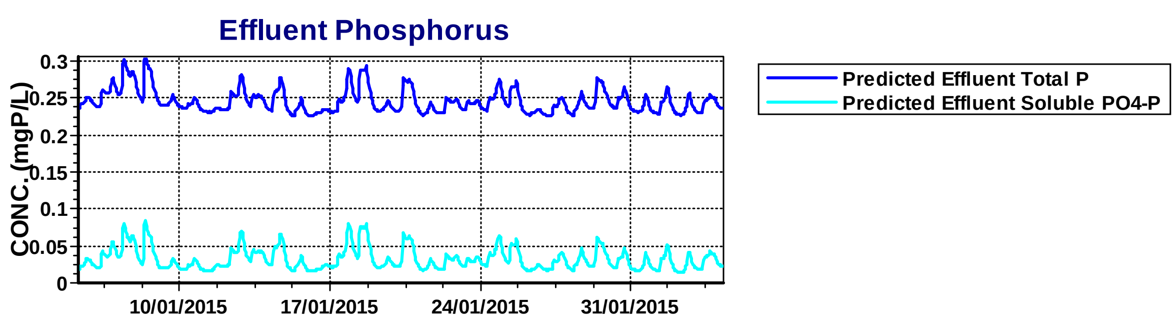

Album page - Mixed Liquor, RAS Flow



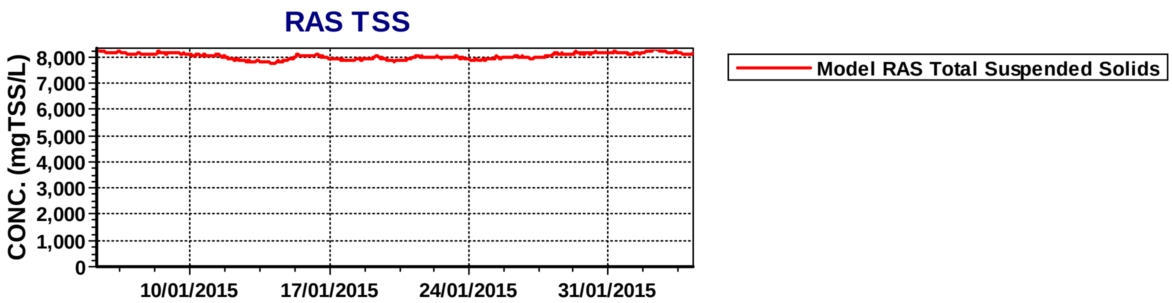

Album page - Nitrogen Sp., Alkalinity



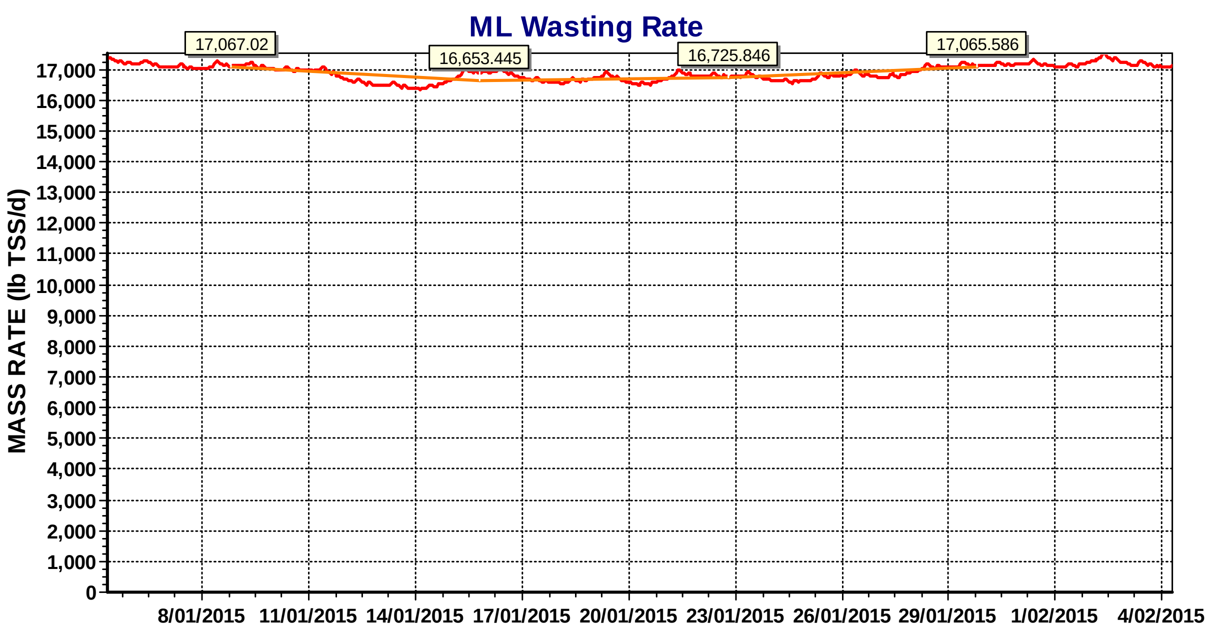

Album page - TP, RAS TSS



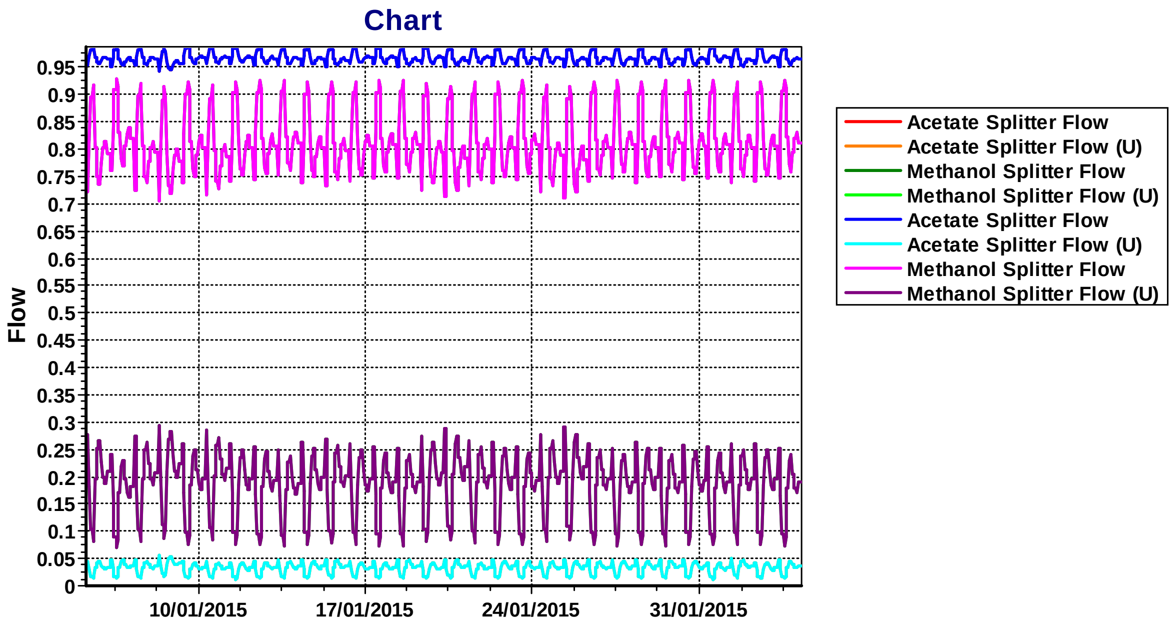

Album page - TP, RAS TSS




Album page - WAS Mass



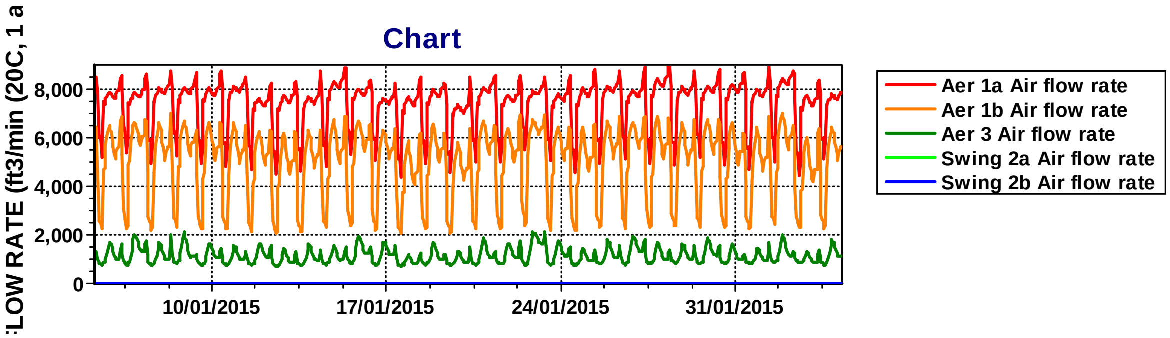

Album page - Acetate and Methanol Flow




## Album page - Air Flow Rates

| Elements | Air flow rate [ft3/min (20C, 1 atm)] |
|---|---|
| Aer 1a | 7915.94 |
| Aer 1b | 5630.66 |
| Aer 3 | 1097.42 |
| Swing 2a | 0 |
| Swing 2b | 0 |

## Album page - Air Flow Rates




Meridian Alternative's Analysis version 1

Expansion using selectable 5 stage modified Bardenpho/A2O process

Tank sizes optimized based on individual simulations from A2O and 5 stage modified Bardenpho processes

To achieve target effluent concentrations, for Bardenpho process:
Overall process volume = 7.25 MG
Set BDF IMLR at 200% influent, Set A2O IMLR at 0%
Set Swing 1 Aerated, Swing 2a and 2b unaerated.
SRT = 12 days
Acetate flow pace at 0.8% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 0.5% of PE flow rate, 1% methanol solution.  All methanol to swing 2a

To achieve target effluent concentrations, for A2O process:
Overall process volume = 7.25 MG
Set BDF IMLR at 0% influent, Set A2O IMLR at 400%
Set Swing 1 unaerated, Swing 2a and 2b aerated.
SRT = 12 days
Acetate flow pace at 0.6% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 1.5% of PE flow rate, 1% methanol solution.  all methanol to Anoxic 1a

To achieve target effluent concentrations, for 5SB process with Ostara Centrate treatment:
tank volume for overall process volume of 6.0 MG
Reduce Nitrogen in Centrate by 15%, Reduce phosphorus in Centrate by 80%
Set BDF IMLR at 200% influent, Set A2O IMLR at 0%
Set Swing 1 aerated, Swing 2a and 2b unaerated.
SRT = 12 days
Acetate flow pace at 0.25% of PE flow rate, 0.1lb acetate COD per gallon used.
Methanol flow pace at 0.5% of PE flow rate, 1% methanol solution.  all methanol to Swing 2a

Summary of process results:
SRT = 12 days
Steady State Acetate use: 3,690 lb/d
Steady State Methanol use: 615 gpd
SS Air Demands: 16,725 scfm
SS WAS: 16,020 lb/d
All SS parameters meet follwoing criteria: MLSS<4,000; SP/TP<0.1/0.5; TN/NH3/NOX<15.5, 0.3, 8

# Appendix D: Cost Estimates

# Memorandum

Date: June 24, 2015

To: Rick Kelly, Seattle

From: Dan Goodburn, Parker

Internal ESG Review By: Don Sowden, West Monroe

Copy to: Butch Matthews, Jacksonville

Project No.: 147571-040

Subject: Meridian COM Alternative Analysis
Conceptual Design Completion
Basis of Estimate of Probable Construction Cost

The Basis of Estimate Report and supporting estimate reports for the subject project are attached. Please call me if you have questions or need additional information.

DG:dg

Enclosures (3):

1. Basis of Estimate Report
2. Summary Estimate
3. Detailed Estimate

## Basis of Estimate Report

# Meridian COM Alternative Analysis

## Introduction

Brown and Caldwell (BC) is pleased to present this opinion of probable construction cost (estimate) prepared for the Meridian COM Alternative Analysis in Meridian, Idaho.

## Summary

This Basis of Estimate contains the following information:

- Scope of work
- Background of this estimate
- Class of estimate
- Estimating methodology
- Direct cost development
- Indirect cost development
- Bidding assumptions
- Estimating assumptions
- Estimating exclusions
- Allowances for known but undefined work
- Contractor and other estimate markups

## Scope of Work

This project is a comparative estimate between conceptual alternatives for new treatment plant upgrades to the existing Meridian WWTP. There are three alternatives in the comparison. Alternative 1 is a new treatment train including a secondary influent pumping station, primary clarifiers, sludge pumping station, aeration basins, acetate and methanol chemical addition, secondary clarifiers, retrofits to existing aeration basins and RAS pumping station, ACTIFLO tertiary treatment, Ostara nutrient removal, and centrate equalization tank and pumping. Alternate 2 is identical to Alternate 1 minus the centrate equalization tank and pumping. Alternate 3 reduces the influent pumping station and aeration basin capacity, removes secondary clarifiers, ACTIFLO and Ostara processes and adds an MBR treatment train, fine screening, and demolition of existing secondary clarifier equipment.

## Background of this Estimate of Probable Construction Cost

The attached estimate of probable construction cost is based on documents dated May, 2015, received by the ESG. These documents are described as conceptual based on the current project progression, additional or updated scope and/or quantities, and ongoing discussions with the project team. Further information can be found in the detailed estimate reports.

## AACEI Estimate Classification

In accordance with the Association for the Advancement of Cost Engineering International (AACE) criteria, this is a Class 5 estimate. A Class 5 estimate is defined as a Conceptual Level or Project Viability Estimate. Typically, engineering is from 0 to 2 percent complete. Class 5 estimates are used to prepare planning level cost scopes or evaluation of alternative schemes, long range capital outlay planning and can also form the base work for the Class 4 Planning Level or Design Technical Feasibility Estimate.

Expected accuracy for Class 5 estimates typically ranges from -50 to +100 percent, depending on the technological complexity of the project, appropriate reference information and the inclusion of an appropriate contingency determination. In unusual circumstances, ranges could exceed those shown.

## Estimating Methodology

This estimate was prepared using quantity take-offs, vendor quotes and equipment pricing furnished either by the project team or by the estimator. The estimate includes direct labor costs and anticipated productivity adjustments to labor, and equipment. Where possible, estimates for work anticipated to be performed by specialty subcontractors have been identified.

Construction labor crew and equipment hours were calculated from production rates contained in documents and electronic databases published by R.S. Means, Mechanical Contractors Association (MCA), National Electrical Contractors Association (NECA), and Rental Rate Blue Book for Construction Equipment (Blue Book).

This estimate was prepared using BC's estimating system, which consists of a Windows-based commercial estimating software engine using BC's material and labor database, historical project data, the latest vendor and material cost information, and other costs specific to the project locale.

## Direct Cost Development

Costs associated with the General Provisions and the Special Provisions of the construction documents, which are collectively referred to as Contractor General Conditions (CGC), were based on the estimator's interpretation of the contract documents. The estimates for CGCs are divided into two groups: a time-related group (e.g., field personnel), and non-time-related group (e.g., bonds and insurance). Labor burdens such as health and welfare, vacation, union benefits, payroll taxes, and workers compensation insurance are included in the labor rates. No trade discounts were considered.

## Indirect Cost Development

A percentage allowance for contractor's home office expense has been included in the overall rate markups. The rate is standard for this type of heavy construction and is based on typical percentages outlined in Means Heavy Construction Cost Data.

The contractor's cost for builder's risk, general liability and vehicle insurance has been included in this estimate. Based on historical data, this is typically two to four percent of the overall construction contract amount. These indirect costs have been included in this estimate as a percentage of the gross cost, and are added after the net markups have been applied to the appropriate items.

## Bidding Assumptions

The following bidding assumptions were considered in the development of this estimate.

1. Bidders must hold a valid, current Contractor's credentials, applicable to the type of project.

2. Bidders will develop estimates with a competitive approach to material pricing and labor productivity, and will not include allowances for changes, extra work, unforeseen conditions or any other unplanned costs.
3. Estimated costs are based on a minimum of four bidders. Actual bid prices may increase for fewer bidders or decrease for a greater number of bidders.
4. Bidders will account for General Provisions and Special Provisions of the contract documents and will perform all work except that which will be performed by traditional specialty subcontractors as identified here:

– Electrical and Instrumentation

– Painting and Coatings

## Estimating Assumptions

As the design progresses through different completion stages, it is customary for the estimator to make assumptions to account for details that may not be evident from the documents. The following assumptions were used in the development of this estimate.

1. Contractor performs the work during normal daylight hours, nominally 7 a.m. to 5 p.m., Monday through Friday, in an 8-hour shift. No allowance has been made for additional shift work or weekend work.
2. Contractor has complete access for lay-down areas and mobile equipment.
3. Equipment rental rates are based on verifiable pricing from the local project area rental yards, Blue Book rates and/or rates contained in the estimating database.
4. Contractor markup is based on conventionally accepted values that have been adjusted for project-area economic factors.
5. Major equipment costs are based on both vendor supplied price quotes obtained by the project design team and/or estimators, and on historical pricing of like equipment.
6. Process equipment vendor training using vendors' standard Operations and Maintenance (O&M) material, is included in the purchase price of major equipment items where so stated in that quotation.
7. Bulk material quantities are based on manual quantity take-offs.
8. There is sufficient electrical power to feed the specified equipment. The local power company will supply power and transformers suitable for this facility.
9. Soils are of adequate nature to support the structures. No piles have been included in this estimate.
10. Influent pump station is based on wet well addition with submersible pumps.
11. Blowers for new aeration tanks are high speed turbo type.
12. Submerged anoxic mixers are propellar type mounted on guiderails.
13. Modifications to existing aeration tanks are to in basin piping only and will re-use existing air header piping and blowers.
14. RAS pump station has existing cans for installation of new pumps.
15. Centrate pumps are installed in existing building and are horizontal base mounted centrifugal pumps. Discharge ties into existing centrate line and will feed to Ostara process.
16. ACTIFLO tanks are buried tanks gravity fed from secondary clarifiers.
17. Disk filters are above grade on slab and piped influent and effluent.
18. Alum tanks and pumps are outdoor exposed on grade, heat traced and insulated.

19. Methanol and acetate chemical pumps are in same building. Methanol tank is above grade double wall steel/concrete tank type.

## Estimating Exclusions

The following estimating exclusions were assumed in the development of this estimate.

1. Hazardous materials remediation and/or disposal.
2. O&M costs for the project with the exception of the vendor supplied O&M manuals.
3. Utility agency costs for incoming power modifications.
4. Permits beyond those normally needed for the type of project and project conditions.
5. RAS pump station addition.

## Allowances for Known but Undefined Work

The following allowances were made in the development of this estimate.

1. Tie-in to influent pipe and/or structure for new influent pumping station
2. Coating systems
3. Process piping
4. Tie-in to RAS pumping station
5. Electrical and Instrumentation
6. Civil, sitework and misc small diameter yard piping

## Contractor and Other Estimate Markups

Contractor markup is based on conventionally accepted values which have been adjusted for project-area economic factors. Estimate markups are shown in Table 1.

**Table 2. Estimate Markups**

| Item | Rate (%) |
|---|---|
| **Net Cost Markups** | |
| Labor (employer payroll burden) | 10 |
| Materials and process equipment | 8 |
| Equipment (construction-related) | 8 |
| Subcontractor | 5 |
| Sales Tax (State and local for materials, process equipment and construction equipment rentals, etc.) | 6 |
| Material Shipping and Handling | 2 |
| **Gross Cost Markups** | |
| Contractors General Conditions | 10 |
| Start-up, Training and O&M | 2 |
| Undesigned/Undeveloped Detail Construction Contingency | 30 |
| Builders Risk, Liability and Auto Insurance | 2 |
| Performance and Payment Bonds | 1.5 |

## Labor Markup

The labor rates used in the estimate were derived chiefly from the latest published State Prevailing Wage Rates. These include base rate paid to the laborer plus fringes. A labor burden factor is applied to these such that the final rates include all employer paid taxes. These taxes are FICA (which covers social security plus Medicare), Workers Comp (which varies based on state, employer experience and history) and unemployment insurance. The result is fully loaded labor rates. In addition to the fully loaded labor rate, an overhead and profit markup is applied at the back end of the estimate. This covers payroll and accounting, estimator's wages, home office rent, advertising and owner profit.

## Materials and Process Equipment Markup

This markup consists of the additional cost to the contractor beyond the raw dollar amount for material and process equipment. This includes shop drawing preparation, submittal and/or re-submittal cost, purchasing and scheduling materials and equipment, accounting charges including invoicing and payment, inspection of received goods, receiving, storage, overhead and profit.

## Equipment (Construction) Markup

This markup consists of the costs associated with operating the construction equipment used in the project. Most GCs will rent rather than own the equipment and then charge each project for its equipment cost. The equipment rental cost does not include fuel, delivery and pick-up charges, additional insurance requirements on rental equipment, accounting costs related to home office receiving invoices and payment.

However, the crew rates used in the estimate do account for the equipment rental cost. Occasionally, larger contractors will have some or all of the equipment needed for the job, but in order to recoup their initial purchasing cost they will charge the project an internal rate for equipment use which is similar to the rental cost of equipment. The GC will apply an overhead and profit percentage to each individual piece of equipment whether rented or owned.

## Subcontractor Markup

This markup consists of the GC's costs for subcontractors who perform work on the site. This includes costs associated with shop drawings, review of subcontractor's submittals, scheduling of subcontractor work, inspections, processing of payment requests, home office accounting, and overhead and profit on subcontracts.

## Sales Tax (Materials, Process Equipment and Construction Equipment)

This is the tax that the contractor must pay according to state and local tax laws. The percentage is applied to both the material and equipment the GC purchases as well as the cost for rental equipment. The percentage is based on the local rates in place at the time the estimate was prepared.

## Contractor Startup, Training, and O&M Manuals

This cost markup is often confused with either vendor startup or owner startup. It is the cost the GC incurs on the project beyond the vendor startup and owner startup costs. The GC generally will have project personnel assigned to facilitate the installation, testing, startup and O&M Manual preparation for equipment that is put into operation by either the vendor or owner. These project personnel often include an electrician, pipe fitter or millwright, and/or I&E technician. These personnel are not included in the basic crew makeup to install the equipment but are there to assist and trouble shoot the startup and proper running of the equipment. The GC also incurs a cost for startup for such things as consumables (oil, fuel, filters, etc.), startup drawings and schedules, startup meetings and coordination with the plant personnel in other areas of the plant operation.

## Builders Risk, Liability, and Vehicle Insurance

This percentage comprises all three items. There are many factors which make up this percentage, including the contractor's track record for claims in each of the categories. Another factor affecting insurance rates has been a dramatic price increase across the country over the past several years due to domestic and foreign influences. Consequently, in the construction industry we have observed a range of 0.5 to 1 percent for Builders Risk Insurance, 1 to 1.25 percent for General Liability Insurance, and 0.85 to 1 percent for Vehicle Insurance. Many factors affect each area of insurance, including project complexity and contractor's requirements and history. Instead of using numbers from a select few contractors, we believe it is more prudent to use a combined 2 percent to better reflect the general costs across the country. Consequently, the actual cost could be higher or lower based on the bidder, region, insurance climate, and on the contractor's insurability at the time the project is bid.

## Material Shipping and Handling

This can range from 2 to 6 percent, and is based on the type of project, material makeup of the project, and the region and location of the project. Material shipping and handling covers delivery costs from vendors, unloading costs (and in some instances loading and shipment back to vendors for rebuilt equipment), site paper work, and inspection of materials prior to unloading at the project site. BC typically adjusts this percentage by the amount of materials and whether vendors have included shipping costs in the quotes that were used to prepare the estimate. This cost also includes the GC's cost to obtain local supplies; e.g., oil, gaskets and bolts that may be missing from the equipment or materials shipped.

## Undesigned/Undeveloped Detail Construction Contingency

The contingency factor covers unforeseen conditions, area economic factors, and general project complexity. This contingency is used to account for those factors that cannot be addressed in each of the labor and/or material installation costs. Based on industry standards, completeness of the project documents, project complexity, the current design stage and area factors, construction contingency can range from 10 to 50 percent. Contingency is applied at the estimators discretion based on the amount of Undesigned/undeveloped detail for the particular project

## Performance and Payment Bonds

Based on historical and industry data, this can range from 0.75 to 3 percent of the project total. There are several contributing factors including such items as size of the project, regional costs, and contractor's historical record on similar projects, complexity and current bonding limits. BC uses 1.5 percent for bonds, which we have determined to be reasonable for most heavy construction projects.

| | |
|---|---|
| Project Number: | 147571-040 |
| Estimate Issue Number: | 2 |
| Bid Date: | 6/24/2015 |
| Estimator: | DG-NDG-FB-IK |

## COM ALTERNATIVES ANALYSIS - ALT 1

# CITY OF MERIDIAN
# COM ALTERNATIVES ANALYSIS - ALT 1
# PRE-BODR - FACILITY PLANNING

| | |
|---|---|
| **Estimator** | DG-NDG-FB-IK |
| **BC Project Manager** | Richard Kelly |
| **BC Office** | Seattle |
| **Estimate Issue No.** | 2 |
| **QA/QC Reviewer** | Don Snowden |
| **QA/QC Review Date** | 5/26/2015 |
| **BC Estimate Number** | 147571-040 |

**Notes**

**PROCESS LOCATION/AREA INDEX**

01 Primary Clarifiers
02 Aeration Tanks
03 Secondary Clarifiers
04 Existing Aeration Tanks/RAS Tanks Retrofit
05 Tertiary Treatment Process
06 Centrate EQ and Treatment
08 Influent Pump Station
09 Acetate/Methanol
10 Sidestream P Removal

Brown AND Caldwell

# Estimate Summary Report

6/24/2015 9:16 AM

| | |
|---|---|
| Project Number: | 147571-040 |
| Estimate Issue Number: | 2 |
| Bid Date: | 6/24/2015 |
| Estimator: | DG-NDG-FB-IK |

## COM ALTERNATIVES ANALYSIS - ALT 1

| Estimate Breakdown | Gross Total Cost w/Markups |
|---|---|
| 01 TOTAL AMOUNT | |
| 01 Primary Clarifiers | 5,648,272 |
| 02 Aeration Tanks | 18,065,049 |
| 03 Seconday Clarifiers | 6,455,871 |
| 04 Existing aeration Tanks/RAS Tank Retrofit | 5,191,784 |
| 05 Tertiary Treatment Processes | 12,327,209 |
| 06 Centrate EQ | 724,071 |
| 08 Influent Pump Station | 4,958,850 |
| 09 Acetate/Methanol | 675,590 |
| 10 Sidestream P Removal | 4,657,723 |
| 01 TOTAL AMOUNT | 58,704,420 |

# CITY OF MERIDIAN
# COM ALTERNATIVES ANALYSIS - ALT 2
# PRE-BODR - FACILITY PLANNING

| | |
|---|---|
| **Estimator** | DG-NDG-FB-IK |
| **BC Project Manager** | Richard Kelly |
| **BC Office** | Seattle |
| **Estimate Issue No.** | 2 |
| **QA/QC Reviewer** | Don Snowden |
| **QA/QC Review Date** | 5/26/2015 |
| **BC Estimate Number** | 147571-040 |
| **Notes** | **PROCESS LOCATION/AREA INDEX** |

**01 Primary Clarifiers**
**02 Aeration Tanks**
**03 Secondary Clarifiers**
**04 Existing Aeration Tanks/RAS Tanks Retrofit**
**05 Tertiary Treatment Process**
**07 MBR Treatment**
**08 Influent Pump Station**
**09 Acetate/Methanol**
**10 Sidestream P Removal**

Brown AND Caldwell

# Estimate Summary Report

6/24/2015 9:18 AM

| | |
|---|---|
| Project Number: | 147571-040 |
| Estimate Issue Number: | 2 |
| Bid Date: | 6/24/2015 |
| Estimator: | DG-NDG-FB-IK |

## COM ALTERNATIVES ANALYSIS - ALT 2

| Estimate Breakdown | Gross Total Cost w/Markups |
|---|---|
| 01 TOTAL AMOUNT | |
| 01 Primary Clarifiers | 5,649,530 |
| 02 Aeration Tanks | 18,069,011 |
| 03 Seconday Clarifiers | 6,457,335 |
| 04 Existing aeration Tanks/RAS Tank Retrofit | 5,192,945 |
| 05 Tertiary Treatment Processes | 12,280,905 |
| 08 Influent Pump Station | 4,959,908 |
| 09 Acetate/Methanol | 675,737 |
| 10 Sidestream P Removal | 4,672,206 |
| 01 TOTAL AMOUNT | 57,957,577 |

# CITY OF MERIDIAN
# COM ALTERNATIVES ANALYSIS - ALT 3
# PRE-BODR - FACILITY PLANNING

| | |
|---|---|
| **Estimator** | DG-NDG-FB-IK |
| **BC Project Manager** | Richard Kelly |
| **BC Office** | Seattle |
| **Estimate Issue No.** | 1 |
| **QA/QC Reviewer** | Don Snowden |
| **QA/QC Review Date** | 5/26/2015 |
| **BC Estimate Number** | 147571-040 |

**Notes**

**PROCESS LOCATION/AREA INDEX**

**01 Primary Clarifiers**
**02 Aeration Tanks**
**03 Secondary Clarifiers**
**04 Existing Aeration Tanks/RAS Tanks Retrofit**
**05 Tertiary Treatment Process**
**07 MBR Treatment**
**08 Influent Pump Station**
**09 Acetate/Methanol**

## COM ALTERNATIVES ANALYSIS - ALT 3

| Estimate Breakdown | Gross Total Cost w/Markups |
|---|---|
| 01 TOTAL AMOUNT | |
| 01 Primary Clarifiers | 5,649,962 |
| 02 Aeration Tanks | 5,932,901 |
| 04 Existing aeration Tanks/RAS Tank Retrofit | 5,578,250 |
| 05 Tertiary Treatment Processes | 234,486 |
| 07 MBR Treatment | 22,659,145 |
| 08 Influent Pump Station | 3,228,258 |
| 09 Acetate/Methanol | 680,594 |
| 01 TOTAL AMOUNT | 43,963,595 |

# CITY OF MERIDIAN
# COM ALTERNATIVES ANALYSIS - ALT 1
# PRE-BODR - FACILITY PLANNING

| | |
|---|---|
| **Estimator** | DG-NDG-FB-IK |
| **BC Project Manager** | Richard Kelly |
| **BC Office** | Seattle |
| **Estimate Issue No.** | 2 |
| **QA/QC Reviewer** | Don Snowden |
| **QA/QC Review Date** | 5/26/2015 |
| **Notes** | **PROCESS LOCATION/AREA INDEX** |

**01 Primary Clarifiers**
**02 Aeration Tanks**
**03 Secondary Clarifiers**
**04 Existing Aeration Tanks/RAS Tanks Retrofit**
**05 Tertiary Treatment Process**
**06 Centrate EQ and Treatment**
**08 Influent Pump Station**
**09 Acetate/Methanol**
**10 Sidestream P Removal**

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **01 Primary Clarifiers** | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | |
| **03330 Slabs Primary Clarifiers** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 210.1 cy | - | 33.69 | - | - | - | 33.69 /cy | 7,078 |
| 03-11-13.85 | C.I.P. concrete forms, wall, job built, plywood, to 8' high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 360.0 sfca | 6.39 | 1.76 | - | - | - | 8.16 /sfca | 2,937 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 252.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 2,022 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 21.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 1,203 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 31.5 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 63,905 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, walls, #8 to #18 | 0760 | 1,800.0 lb | 0.30 | 0.48 | - | - | - | 0.77 /lb | 1,393 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 32.4 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 1,536 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 32.4 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 1,669 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 455.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 44,611 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 441.2 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 5,154 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 8" thick, includes vibrating, excludes material | 4950 | 14.0 cy | 38.75 | - | - | 7.98 | - | 46.73 /cy | 654 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 5,672.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 5,167 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 5,672.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 5,640 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 56.7 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 1,123 |
| | **Slabs Primary Clarifiers** | | **22.2 cy** | **2,413.50** | **3,996.12** | | **75.13** | | **6,484.75 /cy** | **144,091** |
| **03330 Slabs Pump Station** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 14.8 cy | - | 33.69 | - | - | - | 33.69 /cy | 499 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 21.3 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 184 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 80.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 642 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 7.0 ea | 9.38 | 47.88 | - | - | - | 57.26 /ea | 401 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 2.2 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 4,506 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7 | 0610 | 31.6 lb | 0.52 | 0.48 | - | - | - | 0.99 /lb | 31 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 2.2 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 106 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 2.2 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 115 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 31.9 cy | - | 98.01 | - | - | - | 98.01 /cy | 3,131 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03330 Slabs Pump Station** | | | | | | | | | | |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 31.9 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 373 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed and bull float(darby) finish | 0100 | 400.0 sf | 0.38 | - | - | - | - | 0.38 /sf | 151 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 400.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 398 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 4.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 79 |
| | **Slabs Pump Station** | | **400.0 cy** | **9.48** | **16.81** | | **0.25** | | **26.54 /cy** | **10,616** |
| **03330 Slabs Splitter Box** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 5.3 cy | - | 33.69 | - | - | - | 33.69 /cy | 180 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 48.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 385 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 4.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 229 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.8 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 1,622 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.8 ton | 39.88 | - | - | 7.51 | - | 47.39 /ton | 38 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.8 ton | 43.34 | - | - | 8.16 | - | 51.50 /ton | 41 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 11.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,098 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 11.2 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 131 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed and bull float(darby) finish | 0100 | 144.0 sf | 0.38 | - | - | - | - | 0.38 /sf | 54 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 144.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 143 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 1.4 csf | 9.68 | 10.13 | - | - | - | 19.81 /csf | 29 |
| | **Slabs Splitter Box** | | **11.2 cy** | **123.57** | **226.00** | | **3.12** | | **352.69 /cy** | **3,950** |
| **03330 Slabs Scum Pump** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 1.3 cy | - | 33.69 | - | - | - | 33.69 /cy | 45 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 5.3 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 46 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 24.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 193 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 2.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 115 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.2 ton | 1,036.00 | 992.00 | - | - | - | 2,028.00 /ton | 406 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7 | 0610 | 4.0 lb | 0.52 | 0.48 | - | - | - | 1.00 /lb | 4 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.2 ton | 39.85 | - | - | 7.50 | - | 47.40 /ton | 10 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.2 ton | 43.30 | - | - | 8.17 | - | 51.50 /ton | 10 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03330 Slabs Scum Pump** | | | | | | | | | | |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.9 cy | - | 98.01 | - | - | - | 98.01 /cy | 285 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 2.9 cy | 9.69 | - | - | 1.99 | - | 11.68 /cy | 34 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and hand trowel finish | 0200 | 36.0 sf | 1.20 | - | - | - | - | 1.20 /sf | 43 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 36.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 36 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 0.4 csf | 9.67 | 10.10 | - | - | - | 19.78 /csf | 7 |
| | **Slabs Scum Pump** | | **2.9 cy** | **162.05** | **259.65** | | **3.09** | | **424.79 /cy** | **1,232** |
| **03330 Slabs Primary Clarifiers** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 210.1 cy | - | 33.69 | - | - | - | 33.69 /cy | 7,078 |
| 03-11-13.85 | C.I.P. concrete forms, wall, job built, plywood, to 8' high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 360.0 sfca | 6.39 | 1.76 | - | - | - | 8.16 /sfca | 2,937 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 252.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 2,022 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 21.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 1,203 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 31.5 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 63,905 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, walls, #8 to #18 | 0760 | 1,800.0 lb | 0.30 | 0.48 | - | - | - | 0.77 /lb | 1,393 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 32.4 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 1,536 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 32.4 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 1,669 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 455.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 44,611 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 441.2 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 5,154 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 8" thick, includes vibrating, excludes material | 4950 | 14.0 cy | 38.75 | - | - | 7.98 | - | 46.73 /cy | 654 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 5,672.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 5,167 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 5,672.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 5,640 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 56.7 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 1,123 |
| | **Slabs Primary Clarifiers** | | **455.2 cy** | **117.82** | **195.08** | | **3.67** | | **316.57 /cy** | **144,091** |
| **03330 Slabs Scum Pump** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 1.3 cy | - | 33.69 | - | - | - | 33.69 /cy | 45 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 5.3 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 46 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 24.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 193 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 2.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 115 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03330 Slabs Scum Pump** | | | | | | | | | | | | |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.2 | ton | 1,036.00 | 992.00 | - | - | - | 2,028.00 | /ton | 406 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7 | 0610 | 4.0 | lb | 0.52 | 0.48 | - | - | - | 1.00 | /lb | 4 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.2 | ton | 39.85 | - | - | 7.50 | - | 47.40 | /ton | 10 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.2 | ton | 43.30 | - | - | 8.17 | - | 51.50 | /ton | 10 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.9 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 285 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 2.9 | cy | 9.69 | - | - | 1.99 | - | 11.68 | /cy | 34 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and hand trowel finish | 0200 | 36.0 | sf | 1.20 | - | - | - | - | 1.20 | /sf | 43 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 36.0 | sf | 0.70 | 0.29 | - | - | - | 0.99 | /sf | 36 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 0.4 | csf | 9.67 | 10.10 | - | - | - | 19.78 | /csf | 7 |
| | **Slabs Scum Pump** | | **2.9** | **cy** | **162.05** | **259.65** | | **3.09** | | **424.79** | **/cy** | **1,232** |
| **03333 Primary sludge pump equipment Pads** | | | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 60.0 | sfca | 7.24 | 1.36 | - | - | - | 8.60 | /sfca | 516 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.1 | ton | 39.80 | - | - | 7.50 | - | 47.30 | /ton | 2 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.1 | ton | 43.30 | - | - | 8.00 | - | 51.30 | /ton | 3 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.6 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 254 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 2.6 | cy | 27.68 | - | - | 5.70 | - | 33.38 | /cy | 87 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 2.6 | cy | 46.13 | - | - | 13.04 | - | 59.16 | /cy | 153 |
| | **Primary sludge pump equipment Pads** | | **2.6** | **cy** | **243.02** | **129.51** | | **19.05** | | **391.58** | **/cy** | **1,015** |
| **03345 Concrete Walls Primary Carifiers** | | | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 7,056.0 | sfca | 6.18 | 0.75 | - | - | - | 6.93 | /sfca | 48,881 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 18.8 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 389 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 9.8 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 17,506 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 9.8 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 464 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 9.8 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 505 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 137.2 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 13,447 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 137.2 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 5,343 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls Primary Carifiers** | | | | | | | | | | |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 7,056.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 17,826 |
| | **Concrete Walls Primary Carifiers** | | **137.2 cy** | **509.91** | **231.72** | | **19.02** | | **760.65 /cy** | **104,361** |
| **03345 Concrete Walls Pump Station** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 20.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 253 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 3,200.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 24,640 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 8.5 gal | - | 20.66 | - | - | - | 20.66 /gal | 176 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 4.4 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 7,938 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 4.4 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 211 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 4.4 ton | 43.34 | - | - | 8.17 | - | 51.50 /ton | 229 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 62.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 6,099 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 62.2 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 2,423 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 3,200.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 8,084 |
| | **Concrete Walls Pump Station** | | **62.2 cy** | **553.02** | **232.41** | | **19.02** | | **804.45 /cy** | **50,053** |
| **03345 Concrete Walls Splitter Box** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 20.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 253 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 1,920.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 14,784 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 5.1 gal | - | 20.66 | - | - | - | 20.66 /gal | 106 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 4.7 ton | 794.28 | 992.00 | - | - | - | 1,786.27 /ton | 8,337 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 4.7 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 221 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 4.7 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 240 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 56.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 5,489 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 56.0 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 2,181 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 1,920.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 4,851 |
| | **Concrete Walls Splitter Box** | | **56.0 cy** | **412.28** | **223.35** | | **15.46** | | **651.08 /cy** | **36,461** |
| **03345 Concrete Walls scum pump** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 20.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 253 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls scum pump** | | | | | | | | | | |
| 03-11-13.85 | Cip concrete forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 960.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 7,392 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 2.6 gal | - | 20.66 | - | - | - | 20.66 /gal | 53 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 20.0 lf | 3.24 | 14.92 | - | - | - | 18.15 /lf | 363 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 2.0 ea | 9.39 | 35.79 | - | - | - | 45.17 /ea | 90 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 2.0 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 3,573 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 2.0 ton | 39.87 | - | - | 7.52 | - | 47.39 /ton | 95 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 2.0 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 103 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 28.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 2,744 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 28.0 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 1,090 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 960.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 2,425 |
| | **Concrete Walls scum pump** | | **28.0 cy** | **408.56** | **225.51** | | **15.27** | | **649.34 /cy** | **18,181** |
| **03345 Concrete Walls Primary Carifiers** | | | | | | | | | | |
| 03-11-13.85 | Cip concrete forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 7,056.0 sfca | 6.18 | 0.75 | - | - | - | 6.93 /sfca | 48,881 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 18.8 gal | - | 20.66 | - | - | - | 20.66 /gal | 389 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 9.8 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 17,506 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 9.8 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 464 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 9.8 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 505 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 137.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 13,447 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 137.2 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 5,343 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 7,056.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 17,826 |
| | **Concrete Walls Primary Carifiers** | | **137.2 cy** | **509.91** | **231.72** | | **19.02** | | **760.65 /cy** | **104,361** |
| **03345 Concrete Walls scum pump** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 20.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 253 |
| 03-11-13.85 | Cip concrete forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 960.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 7,392 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 2.6 gal | - | 20.66 | - | - | - | 20.66 /gal | 53 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls scum pump** | | | | | | | | | | |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 20.0 lf | 3.24 | 14.92 | - | - | - | 18.15 /lf | 363 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 2.0 ea | 9.39 | 35.79 | - | - | - | 45.17 /ea | 90 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 2.0 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 3,573 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 2.0 ton | 39.87 | - | - | 7.52 | - | 47.39 /ton | 95 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 2.0 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 103 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 28.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 2,744 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 28.0 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 1,090 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 960.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 2,425 |
| | **Concrete Walls scum pump** | | **28.0 cy** | **408.56** | **225.51** | | **15.27** | | **649.34 /cy** | **18,181** |
| **03350 Elevated Slab Pump station** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 400.0 sf | 4.97 | 1.27 | - | - | - | 6.24 /sf | 2,495 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 24.0 lf | 4.64 | 1.62 | - | - | - | 6.26 /lf | 150 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 80.0 lf | 3.62 | 0.21 | - | - | - | 3.83 /lf | 307 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, perimeter deck and rail, straight, includes shoring, erecting, bracing, stripping and cleaning | 8000 | 80.0 lf | 20.11 | 12.55 | - | - | - | 32.66 /lf | 2,613 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.0 ton | 822.00 | 992.00 | - | - | - | 1,814.00 /ton | 29 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 ton | 40.00 | - | - | 8.00 | - | 48.00 /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 ton | 114.00 | - | - | 21.00 | - | 135.00 /ton | 1 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 15.6 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,525 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 15.6 cy | 21.53 | - | - | 4.43 | - | 25.96 /cy | 404 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed finish | 0020 | 400.0 sf | 0.32 | - | - | - | - | 0.32 /sf | 126 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 400.0 sf | 0.62 | 0.19 | - | - | - | 0.81 /sf | 324 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 4.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 79 |
| | **Elevated Slab Pump station** | | **15.6 cy** | **305.79** | **207.31** | | **4.45** | | **517.55 /cy** | **8,053** |
| **03350 Elevated Slab Splitter Box** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 144.0 sf | 4.97 | 1.27 | - | - | - | 6.24 /sf | 898 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 24.0 lf | 4.64 | 1.62 | - | - | - | 6.26 /lf | 150 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03350 Elevated Slab Splitter Box** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 48.0 lf | 3.62 | 0.21 | - | - | - | 3.83 /lf | 184 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, perimeter deck and rail, straight, includes shoring, erecting, bracing, stripping and cleaning | 8000 | 48.0 lf | 20.11 | 12.55 | - | - | - | 32.66 /lf | 1,568 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.4 ton | 821.66 | 992.00 | - | - | - | 1,813.66 /ton | 635 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 ton | 40.00 | - | - | 7.00 | - | 46.67 /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 ton | 113.00 | - | - | 20.00 | - | 133.00 /ton | 0 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 5.6 cy | - | 98.01 | - | - | - | 98.01 /cy | 549 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 5.6 cy | 21.53 | - | - | 4.43 | - | 25.96 /cy | 145 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed finish | 0020 | 144.0 sf | 0.32 | - | - | - | - | 0.32 /sf | 45 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 144.0 sf | 0.62 | 0.19 | - | - | - | 0.81 /sf | 117 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 1.4 csf | 9.68 | 10.13 | - | - | - | 19.81 /csf | 29 |
| | **Elevated Slab Splitter Box** | | **5.6 cy** | **450.48** | **316.56** | | **4.45** | | **771.49 /cy** | **4,320** |
| **03350 Elevated Slab Scum pump** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 36.0 sf | 4.97 | 1.27 | - | - | - | 6.24 /sf | 225 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 24.0 lf | 4.64 | 1.62 | - | - | - | 6.26 /lf | 150 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 36.0 lf | 3.62 | 0.21 | - | - | - | 3.83 /lf | 138 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.1 ton | 821.70 | 992.00 | - | - | - | 1,813.71 /ton | 127 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 ton | 40.00 | - | - | 10.00 | - | 50.00 /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 ton | 110.00 | - | - | 20.00 | - | 130.00 /ton | 0 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 1.4 cy | - | 98.01 | - | - | - | 98.01 /cy | 137 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 1.4 cy | 21.53 | - | - | 4.44 | - | 25.96 /cy | 36 |
| 03-35-29.30 | Finishing elev slab, manual screed, bull float, machine float & trowel | 0275 | 36.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 33 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 36.0 sf | 0.62 | 0.19 | - | - | - | 0.81 /sf | 29 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 0.4 csf | 9.67 | 10.10 | - | - | - | 19.78 /csf | 7 |
| | **Elevated Slab Scum pump** | | **1.4 cy** | **404.06** | **221.08** | | **5.22** | | **630.36 /cy** | **883** |

**03350 Elevated Slab Scum pump**

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03350 Elevated Slab Scum pump** | | | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 36.0 | sf | 4.97 | 1.27 | - | - | - | 6.24 | /sf | 225 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 24.0 | lf | 4.64 | 1.62 | - | - | - | 6.26 | /lf | 150 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 36.0 | lf | 3.62 | 0.21 | - | - | - | 3.83 | /lf | 138 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.1 | ton | 821.70 | 992.00 | - | - | - | 1,813.71 | /ton | 127 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 | ton | 40.00 | - | - | 10.00 | - | 50.00 | /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 | ton | 110.00 | - | - | 20.00 | - | 130.00 | /ton | 0 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 1.4 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 137 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 1.4 | cy | 21.53 | - | - | 4.44 | - | 25.96 | /cy | 36 |
| 03-35-29.30 | Finishing elev slab, manual screed, bull float, machine float & trowel | 0275 | 36.0 | sf | 0.88 | - | - | 0.03 | - | 0.91 | /sf | 33 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 36.0 | sf | 0.62 | 0.19 | - | - | - | 0.81 | /sf | 29 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 0.4 | csf | 9.67 | 10.10 | - | - | - | 19.78 | /csf | 7 |
| | **Elevated Slab Scum pump** | | **1.4** | **cy** | **404.06** | **221.08** | | **5.22** | | **630.36** | **/cy** | **883** |
| | **03 CONCRETE** | | | | | | | | | | | **651,964** |
| **05 METALS** | | | | | | | | | | | | |
| **11999 Primary Clarifier** | | | | | | | | | | | | |
| 05-01-10.51 | Metal cleaning, steel surface treatment, 5.6 lb sand per S.F., near white blast, loose scale, fine powder rust (SSPC-SP10) | 6255 | 3,200.0 | sf | 4.22 | 0.88 | - | 0.54 | - | 5.63 | /sf | 18,030 |
| 05-01-10.51 | Metal cleaning, steel surface treatment, 5.6 lb sand per S.F., near white blast, loose scale, fine powder rust (SSPC-SP10) | 6255 | 3,200.0 | sf | 4.22 | 0.88 | - | 0.54 | - | 5.63 | /sf | 18,030 |
| 09-91-06.41 | Coatings & paints, B & C coating system E-2 (Epoxy, metal tanks, structures) | BC-0021 | 6,400.0 | sqft | 0.28 | 1.40 | - | - | - | 1.69 | /sqft | 10,797 |
| | **Primary Clarifier** | | **1.0** | **LS** | **28,823.45** | **14,611.20** | | **3,421.32** | | **46,855.97** | **/LS** | **46,856** |
| **11999 Sludge Pumps and Piping** | | | | | | | | | | | | |
| 05-58-09.50 | Pump mounting base plate, complete w/ anchor bolts, 4 sf | BC-0001 | 2.0 | ea | 622.68 | 795.79 | - | - | - | 1,418.47 | /ea | 2,837 |
| | **Sludge Pumps and Piping** | | **1.0** | **LS** | **1,245.35** | **1,591.58** | | | | **2,836.93** | **/LS** | **2,837** |
| | **05 METALS** | | | | | | | | | | | **49,693** |
| **07 THERMAL PROTECTION** | | | | | | | | | | | | |
| **05999 Misc. Structural Steel Work** | | | | | | | | | | | | |
| 07-72-33.10 | Manhole cover | 1100 | 1.0 | ea | 249.60 | 1,584.55 | - | - | - | 1,834.15 | /ea | 1,834 |
| | **Misc. Structural Steel Work** | | **1.0** | **LS** | **249.60** | **1,584.55** | | | | **1,834.15** | **/LS** | **1,834** |
| | **07 THERMAL PROTECTION** | | | | | | | | | | | **1,834** |
| **09 FINISHES** | | | | | | | | | | | | |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **11999 Primary Clarifier** | | | | | | | | | | |
| 09-91-06.41 | Coatings & paints, B & C coating system E-2 (Epoxy, metal tanks, structures) | BC-0021 | 6,400.0 sqft | 0.28 | 1.40 | - | - | - | 1.69 /sqft | 10,797 |
| | **Primary Clarifier** | | **1.0 LS** | **1,811.25** | **8,985.60** | | | | **10,796.85 /LS** | **10,797** |
| **11999 Sludge Pumps and Piping** | | | | | | | | | | |
| 09-99-99.99 | Coatings allowance | MISC | 1.0 LS | - | - | 20,000.00 | - | - | 20,000.00 /LS | 20,000 |
| | **Sludge Pumps and Piping** | | **1.0 LS** | | | **20,000.00** | | | **20,000.00 /LS** | **20,000** |
| | **09 FINISHES** | | | | | | | | | **30,797** |
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Primary Clarifier** | | | | | | | | | | |
| 11-00-01.00 | Mechanical, clarifier mechanism, primary, 80' dia., 14' sidewall, w/ bridge, cage, launders, FRP weirs, & baffles | BC-1036 | 1.0 ea | 30,631.78 | 215,000.00 | - | 8,710.92 | - | 254,342.70 /ea | 254,343 |
| 11-00-01.00 | Mechanical, clarifier mechanism, primary, 80' dia., 14' sidewall, w/ bridge, cage, launders, FRP weirs, & baffles | BC-1036 | 1.0 ea | 30,631.78 | 215,000.00 | - | 8,710.92 | - | 254,342.70 /ea | 254,343 |
| 11-00-11.05 | Wastewater, submersible, 3-inch, 6.5 hp,,guide rails, base elbow, scum pump | BC-0071 | 1.0 ea | 1,194.45 | 7,510.00 | - | - | - | 8,704.45 /ea | 8,704 |
| 11-00-11.05 | Wastewater, submersible, 3-inch, 6.5 hp,,guide rails, base elbow, scum pump | BC-0071 | 1.0 ea | 1,194.45 | 7,510.00 | - | - | - | 8,704.45 /ea | 8,704 |
| | **Primary Clarifier** | | **1.0 LS** | **63,652.46** | **445,020.00** | | **17,421.84** | | **526,094.30 /LS** | **526,094** |
| **11999 Sludge Pumps and Piping** | | | | | | | | | | |
| 11-00-10.00 | Pump, double disc diaphragm, sludge pump | BC-0176 | 2.0 ea | 2,789.95 | 31,000.00 | - | 333.44 | - | 34,123.39 /ea | 68,247 |
| | **Sludge Pumps and Piping** | | **1.0 LS** | **5,579.90** | **62,000.00** | | **666.88** | | **68,246.78 /LS** | **68,247** |
| | **11 EQUIPMENT** | | | | | | | | | **594,341** |
| **22 PLUMBING** | | | | | | | | | | |
| **11999 Primary Clarifier** | | | | | | | | | | |
| 11-00-04.00 | Hydraulic structures, slide gate, stainless stl, ab & grout,36" x 36" | BC-0101 | 1.0 ea | 2,455.44 | 4,774.77 | - | 554.07 | - | 7,784.28 /ea | 7,784 |
| 11-00-04.00 | Hydraulic structures, slide gate, stainless stl, ab & grout,36" x 36" | BC-0101 | 1.0 ea | 2,455.44 | 4,774.77 | - | 554.07 | - | 7,784.28 /ea | 7,784 |
| 22-05-23.70 | Valves, semi-steel, lubricated plug valve, flanged, 200 psi, 12" | 7070 | 1.0 ea | 907.31 | 4,700.00 | - | - | - | 5,607.31 /ea | 5,607 |
| 22-05-23.70 | Valves, semi-steel, lubricated plug valve, flanged, 200 psi, 12" | 7070 | 1.0 ea | 907.31 | 4,700.00 | - | - | - | 5,607.31 /ea | 5,607 |
| 22-11-13.44 | Pipe, steel, black, welded, 36" diameter, schedule 40, Spec. A-53, includes two rod, roll hanger & saddle, sized for covering, 10' OC | 2220 | 75.0 lf | 280.75 | 275.00 | - | 9.20 | - | 564.94 /lf | 42,371 |
| 22-11-13.44 | Pipe, steel, black, welded, 36" diameter, schedule 40, Spec. A-53, includes two rod, roll hanger & saddle, sized for covering, 10' OC | 2220 | 75.0 lf | 280.75 | 275.00 | - | 9.20 | - | 564.94 /lf | 42,371 |
| 22-11-13.47 | Elbow, 90 Deg., steel, carbon steel, black, long radius, butt weld, standard weight, 36" pipe size, includes 1 weld per joint and weld machine | 3194 | 1.0 ea | 1,554.30 | 3,450.00 | - | 57.70 | - | 5,062.00 /ea | 5,062 |
| 22-11-13.47 | Elbow, 90 Deg., steel, carbon steel, black, long radius, butt weld, standard weight, 36" pipe size, includes 1 weld per joint and weld machine | 3194 | 1.0 ea | 1,554.30 | 3,450.00 | - | 57.70 | - | 5,062.00 /ea | 5,062 |
| 22-20-00.30 | Piping, water dist, DI, cement lined, 18' L, restrained jt, 12" dia | BC-0001 | 45.0 lnft | 6.58 | 25.25 | - | | - | 31.83 /lnft | 1,432 |
| 22-20-00.30 | Piping, water dist, DI, cement lined, 18' L, restrained jt, 12" dia | BC-0001 | 45.0 lnft | 6.58 | 25.25 | - | | - | 31.83 /lnft | 1,432 |
| 22-20-00.31 | Piping, water dist, DI, 90< bend or elbow, 12" dia | BC-0026 | 1.0 ea | 212.17 | 228.00 | - | 45.86 | - | 486.03 /ea | 486 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **11999 Primary Clarifier** | | | | | | | | | | |
| 22-20-00.31 | Piping, water dist, DI, 90< bend or elbow, 12" dia | BC-0026 | 1.0 ea | 212.17 | 228.00 | - | 45.86 | - | 486.03 /ea | 486 |
| 22-20-01.95 | Pipe, steel ftngs, sch 40, tee 54" X 36" welded | BC-2866 | 1.0 ea | 1,843.18 | 13,429.84 | - | 995.92 | - | 16,268.94 /ea | 16,269 |
| 22-20-01.95 | Pipe, steel ftngs, sch 40, tee 54" X 36" welded | BC-2866 | 1.0 ea | 1,843.18 | 13,429.84 | - | 995.92 | - | 16,268.94 /ea | 16,269 |
| | **Primary Clarifier** | | **1.0 LS** | **56,648.84** | **96,687.72** | | **4,686.54** | | **158,023.10 /LS** | **158,023** |
| **11999 Sludge Pumps and Piping** | | | | | | | | | | |
| 22-99-99.99 | Sludge piping allowance | MISC | 1.0 LS | 25,130.00 | 35,000.00 | | - | - | 60,130.00 /LS | 60,130 |
| 22-99-99.99 | Scum piping allowance | MISC | 1.0 LS | 7,180.00 | 10,000.00 | | - | - | 17,180.00 /LS | 17,180 |
| | **Sludge Pumps and Piping** | | **1.0 LS** | **32,310.00** | **45,000.00** | | | | **77,310.00 /LS** | **77,310** |
| **33500 PC Yard Piping** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1-1/2 C.Y. excavator, 10' to 14' deep, excludes sheeting or dewatering | 1000 | 699.1 bcy | 2.07 | - | - | 1.95 | - | 4.02 /bcy | 2,808 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with sheepsfoot roller | 2300 | 427.1 ecy | 1.32 | - | - | 2.85 | - | 4.16 /ecy | 1,779 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 213.8 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 5,122 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 213.8 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 1,278 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 272.0 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 3,121 |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 1.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 9 |
| | **PC Yard Piping** | | **125.0 LF** | **57.32** | **18.67** | | **36.94** | | **112.93 /LF** | **14,117** |
| **33500 Sludge Piping** | | | | | | | | | | |
| 22-20-00.65 | Piping, DI, glass lined, CL 50, 10" dia | BC-0326 | 1,325.0 lnft | 19.55 | 100.00 | - | 4.23 | - | 123.77 /lnft | 164,001 |
| | **Sludge Piping** | | **1,325.0 LF** | **19.55** | **100.00** | | **4.23** | | **123.77 /LF** | **164,001** |
| | **22 PLUMBING** | | | | | | | | | **413,450** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **01999 ADDITIONAL COST: Service to New Primary Clarifiers** | | | | | | | | | | |
| 01-99-99.99 | Additional Cost associated with Primary Clarifiers - Electrical Service in Ductbank | MISC | 450.0 LF | - | - | 250.00 | - | - | 250.00 /LF | 112,500 |
| | **ADDITIONAL COST: Service to New Primary Clarifiers** | | **450.0 LF** | | | **250.00** | | | **250.00 /LF** | **112,500** |
| **26001 Primary Clarifiers - E&I (#1,2,3)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 491,472.24 | - | - | 491,472.24 /LS | 491,472 |
| | **Primary Clarifiers - E&I (#1,2,3)** | | **1.0 LS** | | | **491,472.24** | | | **491,472.24 /LS** | **491,472** |
| | **26 ELECTRICAL** | | | | | | | | | **603,972** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Primary Clarifiers - E&I (#1,2,3)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 122,868.07 | - | - | 122,868.07 /LS | 122,868 |
| | **Primary Clarifiers - E&I (#1,2,3)** | | **1.0 LS** | | | **122,868.07** | | | **122,868.07 /LS** | **122,868** |
| | **27 COMMUNICATIONS** | | | | | | | | | **122,868** |
| **31 EARTHWORK** | | | | | | | | | | |
| **01999 Dewatering** | | | | | | | | | | |
| 01-54-33.70 | Rent wellpoint header pipe, 6" diameter, 400 gpm | 0500 | 1,760.0 day | - | - | - | 0.40 | - | 0.40 /day | 704 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **01999 Dewatering** | | | | | | | | | | | | |
| 31-23-19.20 | Dewatering, pumping 8 hours, attended 2 hrs per day, 6" centrifugal pump, includes 20 LF of suction hose and 100 LF of discharge hose | 1100 | 176.0 | day | 857.51 | - | - | 377.70 | - | 1,235.21 | /day | 217,397 |
| 31-23-19.30 | Wells, for dewatering, with steel casing, 10' to 20' deep, 2' diameter, minimum | 0020 | 250.0 | vlf | 76.64 | 184.52 | - | 17.92 | - | 279.08 | /vlf | 69,770 |
| | **Dewatering** | | **1.0** | **LS** | **170,081.77** | **46,130.81** | | **71,658.65** | | **287,871.23** | **/LS** | **287,871** |
| **03330 Slabs Primary Clarifiers** | | | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 630.2 | sy | 1.07 | - | - | 0.72 | - | 1.79 | /sy | 1,126 |
| 31-23-16.16 | Strt excvtn for minor strtrs,bank measur,for spread and mat footngs,elevatr pits,and small buildng fndtns,3/4 cy bucket,machine excavtn,hydrlc backhoe | 6035 | 22.2 | bcy | 12.43 | - | - | 7.42 | - | 19.86 | /bcy | 441 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 1 mile round trip, 2.2 loads/hour, 12 C.Y. truck, highway haulers, excludes loading | 0400 | 22.2 | lcy | 2.77 | - | - | 3.92 | - | 6.69 | /lcy | 149 |
| | **Slabs Primary Clarifiers** | | **22.2** | **cy** | **45.41** | | | **31.81** | | **77.22** | **/cy** | **1,716** |
| **03330 Slabs Pump Station** | | | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 44.4 | sy | 1.07 | - | - | 0.72 | - | 1.79 | /sy | 79 |
| | **Slabs Pump Station** | | **400.0** | **cy** | **0.12** | | | **0.08** | | **0.20** | **/cy** | **79** |
| **03330 Slabs Splitter Box** | | | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 16.0 | sy | 1.07 | - | - | 0.72 | - | 1.79 | /sy | 29 |
| | **Slabs Splitter Box** | | **11.2** | **cy** | **1.52** | | | **1.03** | | **2.55** | **/cy** | **29** |
| **03330 Slabs Scum Pump** | | | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 4.0 | sy | 1.07 | - | - | 0.72 | - | 1.79 | /sy | 7 |
| | **Slabs Scum Pump** | | **2.9** | **cy** | **1.47** | | | **1.00** | | **2.47** | **/cy** | **7** |
| **03330 Slabs Primary Clarifiers** | | | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 630.2 | sy | 1.07 | - | - | 0.72 | - | 1.79 | /sy | 1,126 |
| 31-23-16.16 | Strt excvtn for minor strtrs,bank measur,for spread and mat footngs,elevatr pits,and small buildng fndtns,3/4 cy bucket,machine excavtn,hydrlc backhoe | 6035 | 22.2 | bcy | 12.43 | - | - | 7.42 | - | 19.86 | /bcy | 441 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 1 mile round trip, 2.2 loads/hour, 12 C.Y. truck, highway haulers, excludes loading | 0400 | 22.2 | lcy | 2.77 | - | - | 3.92 | - | 6.69 | /lcy | 149 |
| | **Slabs Primary Clarifiers** | | **455.2** | **cy** | **2.22** | | | **1.55** | | **3.77** | **/cy** | **1,716** |
| **03330 Slabs Scum Pump** | | | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 4.0 | sy | 1.07 | - | - | 0.72 | - | 1.79 | /sy | 7 |
| | **Slabs Scum Pump** | | **2.9** | **cy** | **1.47** | | | **1.00** | | **2.47** | **/cy** | **7** |
| **31315 Excavation and Backfill prim Clarifier** | | | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 1,177.0 | bcy | 6.99 | - | - | 7.64 | - | 14.63 | /bcy | 17,220 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 495.0 | ecy | 5.30 | - | - | 1.50 | - | 6.80 | /ecy | 3,364 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 682.0 | lcy | 3.08 | - | - | 5.47 | - | 8.55 | /lcy | 5,830 |
| | **Excavation and Backfill prim Clarifier** | | **1,177.0** | **cy** | **11.01** | | | **11.44** | | **22.44** | **/cy** | **26,414** |
| **31315 Excavation and Backfill splitter Box** | | | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 3,497.8 | bcy | 6.99 | - | - | 7.64 | - | 14.63 | /bcy | 51,173 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 2,088.9 | ecy | 5.30 | - | - | 1.50 | - | 6.80 | /ecy | 14,197 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **31315 Excavation and Backfill splitter Box** | | | | | | | | | | |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 106.7 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 912 |
| | **Excavation and Backfill splitter Box** | | **2,195.6 cy** | **16.33** | | | **13.86** | | **30.19 /cy** | **66,282** |
| **31315 Excavation and Backfill Pump station** | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 3,629.6 bcy | 6.99 | - | - | 7.64 | - | 14.63 /bcy | 53,102 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 3,333.3 ecy | 13.60 | - | - | 3.85 | - | 17.44 /ecy | 58,141 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 296.3 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 2,533 |
| | **Excavation and Backfill Pump station** | | **3,629.6 cy** | **19.73** | | | **11.61** | | **31.35 /cy** | **113,776** |
| **31315 Excavation and Backfill prim Clarifier** | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 1,177.0 bcy | 6.99 | - | - | 7.64 | - | 14.63 /bcy | 17,220 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 495.0 ecy | 5.30 | - | - | 1.50 | - | 6.80 /ecy | 3,364 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 682.0 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 5,830 |
| | **Excavation and Backfill prim Clarifier** | | **1,177.0 cy** | **11.01** | | | **11.44** | | **22.44 /cy** | **26,414** |
| **33500 Sludge Piping** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering | 0110 | 613.4 bcy | 3.73 | - | - | 2.23 | - | 5.96 /bcy | 3,654 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 327.2 ecy | 1.23 | - | - | 2.60 | - | 3.82 /ecy | 1,251 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 259.5 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 6,217 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 259.5 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 1,551 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 286.3 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 3,285 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 13,250.0 sf | - | - | 0.08 | - | - | 0.08 /sf | 1,060 |
| | **Sludge Piping** | | **1,325.0 LF** | **6.54** | **2.13** | **0.80** | **3.37** | | **12.84 /LF** | **17,017** |
| **33500 Primary Effluent Piping** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 1,115.3 bcy | 2.80 | - | - | 2.07 | - | 4.87 /bcy | 5,431 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 390.3 ecy | 1.23 | - | - | 2.60 | - | 3.82 /ecy | 1,492 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 477.9 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 11,449 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 477.9 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 2,856 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 725.0 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 8,320 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 8,350.0 sf | - | - | 0.08 | - | - | 0.08 /sf | 668 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Primary Effluent Piping** | | **1,225.0 LF** | **12.93** | **4.25** | **0.55** | **6.94** | | **24.67 /LF** | **30,216** |
| | **31 EARTHWORK** | | | | | | | | | **571,544** |
| **33 UTILITIES** | | | | | | | | | | |
| **33500 Sludge Piping** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 13.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 116 |
| | **Sludge Piping** | | **1,325.0 LF** | **0.03** | **0.06** | | | | **0.09 /LF** | **116** |
| **33500 Primary Effluent Piping** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 6.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 53 |
| | **Primary Effluent Piping** | | **1,225.0 LF** | **0.02** | **0.03** | | | | **0.04 /LF** | **53** |
| | **33 UTILITIES** | | | | | | | | | **169** |
| **40** | | | | | | | | | | |
| **33500 PC Yard Piping** | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 54 Inch (1350mm) | A541002 0000EA | 125.0 lf | - | 333.54 | - | - | - | 333.54 /lf | 41,692 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 54 Inch (1350mm) | L544002 0000P1 | 125.0 lf | 32.59 | - | - | 6.43 | - | 39.02 /lf | 4,877 |
| 40-05-24.10 | Field Other Weld-CS A53/A106-Non-Specific 54 Inch (1350mm) | L545502 000000 | 3.0 ea | 3,900.77 | 78.79 | - | 312.41 | - | 4,291.97 /ea | 12,876 |
| 40-05-24.10 | Misc process/utility piping allowance | ---- | 1.0 ls | 7,860.00 | 10,010.00 | - | - | - | 17,870.00 /ls | 17,870 |
| 40-05-24.10 | Misc process/utility piping allowance | ---- | 1.0 ls | 7,860.00 | 10,010.00 | - | - | - | 17,870.00 /ls | 17,870 |
| | **PC Yard Piping** | | **125.0 LF** | **251.97** | **495.59** | | **13.93** | | **761.49 /LF** | **95,186** |
| **33500 Primary Effluent Piping** | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Std 36 Inch (900mm) | A361002 0100EA | 100.0 lf | - | 168.69 | - | - | - | 168.69 /lf | 16,869 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std 36 Inch (900mm) | A362112 010000 | 2.0 ea | 2,580.88 | 4,053.57 | - | 488.91 | - | 7,123.36 /ea | 14,247 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 54 Inch (1350mm) | A541002 0000EA | 375.0 lf | - | 333.54 | - | - | - | 333.54 /lf | 125,077 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Tee-Non-Specific 54 Inch (1350mm) | A542114 000000 | 1.0 ea | - | 11,667.66 | - | - | - | 11,667.66 /ea | 11,668 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 36 Inch (900mm) | L364002 0100P1 | 100.0 lf | 24.46 | - | - | 4.83 | - | 29.29 /lf | 2,929 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std 36 Inch (900mm) | L365102 010000 | 2.0 ea | 929.47 | 17.51 | - | 74.44 | - | 1,021.42 /ea | 2,043 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 54 Inch (1350mm) | L544002 0000P1 | 375.0 lf | 32.59 | - | - | 6.43 | - | 39.02 /lf | 14,632 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Non-Specific 54 Inch (1350mm) | L545102 000000 | 10.0 ea | 1,950.39 | 39.40 | - | 156.21 | - | 2,145.99 /ea | 21,460 |
| | **Primary Effluent Piping** | | **1,225.0 LF** | **33.63** | **132.37** | | **4.56** | | **170.55 /LF** | **208,924** |
| | **40** | | | | | | | | | **304,109** |
| | **01 Primary Clarifiers** | | **1.0 LS** | **968,910.86** | **1,386,162.29** | **748,568.31** | **241,100.14** | | **3,344,741.60 /LS** | **3,344,742** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **02 Aeration Tanks** | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | |
| **03330 Slabs Aeration Basins** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 853.3 cy | - | 33.69 | - | - | - | 33.69 /cy | 28,752 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 1,696.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 13,610 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 140.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 8,017 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 128.0 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 259,585 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 128.0 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 6,065 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 128.0 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 6,593 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 1,792.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 175,638 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 1,792.0 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 20,936 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 23,040.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 20,987 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 23,040.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 22,910 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 230.4 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 4,562 |
| | **Slabs Aeration Basins** | | **1,792.0 cy** | **115.37** | **197.90** | | **3.50** | | **316.77 /cy** | **567,654** |
| **03330 Slabs Pipe Utilidor** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 138.9 cy | - | 33.69 | - | - | - | 33.69 /cy | 4,680 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 32.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 275 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 350.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 2,809 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 29.0 ea | 9.38 | 47.88 | - | - | - | 57.26 /ea | 1,661 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 8.3 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 16,899 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7 | 0610 | 47.4 lb | 0.52 | 0.48 | - | - | - | 0.99 /lb | 47 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 8.4 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 396 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 8.4 ton | 43.34 | - | - | 8.17 | - | 51.50 /ton | 430 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 292.9 cy | - | 98.01 | - | - | - | 98.01 /cy | 28,709 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 292.9 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 3,422 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed and bull float(darby) finish | 0100 | 3,750.0 sf | 0.38 | - | - | - | - | 0.38 /sf | 1,417 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03330 Slabs Pipe Utilidor** | | | | | | | | | | | | |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 3,750.0 | sf | 0.70 | 0.29 | - | - | - | 0.99 | /sf | 3,729 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 37.5 | csf | 9.68 | 10.12 | - | - | - | 19.80 | /csf | 743 |
| | **Slabs Pipe Utilidor** | | **3,750.0** | **cy** | **4.90** | **12.30** | | **0.19** | | **17.39** | **/cy** | **65,216** |
| **03330 Slabs Aeration Basins** | | | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 426.7 | cy | - | 33.69 | - | - | - | 33.69 | /cy | 14,376 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 848.0 | lf | 3.61 | 4.42 | - | - | - | 8.03 | /lf | 6,805 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 70.0 | ea | 9.39 | 47.88 | - | - | - | 57.27 | /ea | 4,009 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 64.0 | ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 | /ton | 129,793 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 64.0 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 3,033 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 64.0 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 3,296 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 896.0 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 87,819 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 896.0 | cy | 9.69 | - | - | 2.00 | - | 11.68 | /cy | 10,468 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 11,520.0 | sf | 0.88 | - | - | 0.03 | - | 0.91 | /sf | 10,493 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 11,520.0 | sf | 0.70 | 0.29 | - | - | - | 0.99 | /sf | 11,455 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 115.2 | csf | 9.68 | 10.12 | - | - | - | 19.80 | /csf | 2,281 |
| | **Slabs Aeration Basins** | | **896.0** | **CY** | **115.37** | **197.90** | | **3.50** | | **316.77** | **/CY** | **283,827** |
| **03333 Blower Equipment Pads** | | | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 120.0 | sfca | 7.24 | 1.36 | - | - | - | 8.60 | /sfca | 1,032 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.1 | ton | 39.87 | - | - | 7.50 | - | 47.37 | /ton | 7 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.1 | ton | 43.30 | - | - | 8.20 | - | 51.50 | /ton | 8 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 7.4 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 726 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 7.4 | cy | 27.68 | - | - | 5.70 | - | 33.38 | /cy | 247 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 7.4 | cy | 46.13 | - | - | 13.04 | - | 59.17 | /cy | 438 |
| | **Blower Equipment Pads** | | **7.4** | **cy** | **192.78** | **120.06** | | **19.05** | | **331.89** | **/cy** | **2,458** |
| **03345 Concrete Walls Aeration Basin** | | | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 56.0 | lf | 10.50 | 2.14 | - | - | - | 12.63 | /lf | 707 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 47,488.0 | sfca | 6.18 | 0.75 | - | - | - | 6.93 | /sfca | 328,975 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls Aeration Basin** | | | | | | | | | | | | |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 126.6 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 2,617 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 56.0 | lf | 3.24 | 14.92 | - | - | - | 18.15 | /lf | 1,017 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 4.0 | ea | 9.39 | 35.79 | - | - | - | 45.17 | /ea | 181 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 82.4 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 147,268 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 82.4 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 3,907 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 82.4 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 4,246 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 1,385.1 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 135,753 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 1,385.1 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 53,938 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 47,488.0 | sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 | /sf | 119,974 |
| | **Concrete Walls Aeration Basin** | | **1,385.1** | **cy** | **361.73** | **199.75** | | **15.08** | | **576.57** | **/cy** | **798,582** |
| **03345 Concrete Walls Baffle walls** | | | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 672.0 | lf | 10.50 | 2.14 | - | - | - | 12.63 | /lf | 8,490 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 21,504.0 | sfca | 6.18 | 0.75 | - | - | - | 6.93 | /sfca | 148,970 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 57.3 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 1,185 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 672.0 | lf | 3.24 | 14.92 | - | - | - | 18.15 | /lf | 12,199 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 48.0 | ea | 9.39 | 35.78 | - | - | - | 45.17 | /ea | 2,168 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 82.1 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 146,712 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 82.1 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 3,892 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 82.1 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 4,230 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 627.2 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 61,473 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 627.2 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 24,425 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 21,504.0 | sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 | /sf | 54,328 |
| | **Concrete Walls Baffle walls** | | **627.2** | **cy** | **439.26** | **290.83** | | **16.20** | | **746.29** | **/cy** | **468,072** |
| **03345 Concrete Walls Pipe Utilidor** | | | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 14,000.0 | sfca | 6.95 | 0.75 | - | - | - | 7.70 | /sfca | 107,800 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 37.3 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 771 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls Pipe Utilidor** | | | | | | | | | | |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 19.4 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 34,732 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 19.4 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 921 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 19.4 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 1,001 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 272.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 26,681 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 272.2 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 10,601 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 14,000.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 35,370 |
| | **Concrete Walls Pipe Utilidor** | | **272.2 cy** | **549.64** | **231.72** | | **19.02** | | **800.38 /cy** | **217,879** |
| **03345 Concrete Walls Aeration Basin** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 28.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 354 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 19,264.0 sfca | 6.18 | 0.75 | - | - | - | 6.93 /sfca | 133,452 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 63.3 gal | - | 20.66 | - | - | - | 20.66 /gal | 1,308 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 28.0 lf | 3.24 | 14.92 | - | - | - | 18.15 /lf | 508 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 2.0 ea | 9.39 | 35.79 | - | - | - | 45.17 /ea | 90 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 41.2 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 73,634 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 41.2 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 1,953 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 41.2 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 2,123 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 692.5 cy | - | 98.01 | - | - | - | 98.01 /cy | 67,877 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 692.5 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 26,969 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 23,744.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 59,987 |
| | **Concrete Walls Aeration Basin** | | **692.5 cy** | **321.74** | **194.93** | | **15.08** | | **531.75 /cy** | **368,256** |
| **03345 Concrete Walls Baffle walls** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 504.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 6,367 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 10,752.0 sfca | 6.18 | 0.75 | - | - | - | 6.93 /sfca | 74,485 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 28.7 gal | - | 20.66 | - | - | - | 20.66 /gal | 592 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 504.0 lf | 3.24 | 14.92 | - | - | - | 18.15 /lf | 9,150 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 12.0 ea | 9.39 | 35.78 | - | - | - | 45.17 /ea | 542 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls Baffle walls** | | | | | | | | | | |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 63.5 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 113,364 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 63.5 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 3,007 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 63.5 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 3,269 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 313.6 cy | - | 98.01 | - | - | - | 98.01 /cy | 30,737 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 313.6 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 12,212 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 10,752.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 27,164 |
| | **Concrete Walls Baffle walls** | | **313.6 cy** | **508.93** | **369.45** | | **17.32** | | **895.69 /cy** | **280,889** |
| **03350 Elevated Slabs Pipe Utilidor** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 3,750.0 sf | 4.97 | 1.27 | - | - | - | 6.24 /sf | 23,388 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 32.0 lf | 4.64 | 1.62 | - | - | - | 6.26 /lf | 200 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 350.0 lf | 3.62 | 0.21 | - | - | - | 3.83 /lf | 1,341 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 9.1 ton | 821.66 | 992.00 | - | - | - | 1,813.66 /ton | 16,532 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.1 ton | 39.90 | - | - | 7.50 | - | 47.40 /ton | 3 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.1 ton | 114.00 | - | - | 21.50 | - | 135.50 /ton | 10 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 145.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 14,293 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 145.8 cy | 21.53 | - | - | 4.43 | - | 25.96 /cy | 3,786 |
| 03-35-29.30 | Finishing elev slab, manual screed, bull float, machine float & trowel | 0275 | 3,750.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 3,416 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 3,750.0 sf | 0.62 | 0.19 | - | - | - | 0.81 /sf | 3,039 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 37.5 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 743 |
| | **Elevated Slabs Pipe Utilidor** | | **145.8 cy** | **251.44** | **201.08** | | **5.22** | | **457.74 /cy** | **66,752** |
| | **03 CONCRETE** | | | | | | | | | **3,119,585** |
| **05 METALS** | | | | | | | | | | |
| **05999 Misc. Structural Steel Work** | | | | | | | | | | |
| 05-52-13.50 | Railing, pipe, aluminum, clear finish, 3 rails, 3'-6" high, posts @ 5' O.C., 1-1/2" dia, shop fabricated | 0210 | 2,640.0 lf | 18.34 | 74.00 | - | 1.09 | - | 93.43 /lf | 246,655 |
| 05-53-21.50 | Floor grating, steel, expanded mesh, 7.0# per S.F., field fabricated from panels | 2900 | 2,880.0 sf | 3.59 | 19.65 | - | 0.21 | - | 23.45 /sf | 67,543 |
| | **Misc. Structural Steel Work** | | **1.0 LS** | **58,767.13** | **251,952.00** | | **3,478.72** | | **314,197.85 /LS** | **314,198** |
| **05999 Misc. Structural Steel Work** | | | | | | | | | | |
| 05-52-13.50 | Railing, pipe, aluminum, clear finish, 3 rails, 3'-6" high, posts @ 5' O.C., 1-1/2" dia, shop fabricated | 0210 | 1,320.0 lf | 18.34 | 74.00 | - | 1.09 | - | 93.43 /lf | 123,328 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **05999 Misc. Structural Steel Work** | | | | | | | | | | |
| 05-53-21.50 | Floor grating, steel, expanded mesh, 7.0# per S.F., field fabricated from panels | 2900 | 1,440.0 sf | 3.59 | 19.65 | - | 0.21 | - | 23.45 /sf | 33,771 |
| | **Misc. Structural Steel Work** | | **1.0 LS** | **29,383.69** | **125,976.00** | | **1,739.36** | | **157,099.05 /LS** | **157,099** |
| | **05 METALS** | | | | | | | | | **471,297** |
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Aeration Equipment** | | | | | | | | | | |
| 11-00-01.00 | Aeration diffusers, fine bubble, complete with headers | BC-0031 | 10,432.0 ea | 13.11 | 35.00 | - | - | - | 48.11 /ea | 501,883 |
| 11-00-01.00 | Aeration diffusers, fine bubble, complete with headers | BC-0031 | 5,216.0 ea | 13.11 | 35.00 | - | - | - | 48.11 /ea | 250,933 |
| 11-00-01.00 | Aeration Blower, high speed turbo, (5,000 scfm at 10 psig) | BC-0336 | 4.0 ea | 5,654.22 | 200,000.00 | - | - | - | 205,654.22 /ea | 822,617 |
| 11-00-01.00 | Mixer, submerged propellar type, 10 hp, Flygt, with guiderail | BC-0621 | 24.0 ea | 2,261.69 | 30,000.00 | - | 380.00 | - | 32,641.69 /ea | 783,401 |
| 11-00-01.00 | Mixer, submerged propellar type, 10 hp, Flygt, with guiderail | BC-0621 | 12.0 ea | 2,261.69 | 30,000.00 | - | 380.00 | - | 32,641.69 /ea | 391,700 |
| 11-00-09.00 | Pump, submerged axial flow. 18" Dia., wall pump, 3-hp, 2.5 mgd, IMLR pump | BC-0316 | 4.0 ea | 1,696.27 | 25,000.00 | - | 190.00 | - | 26,886.26 /ea | 107,545 |
| 11-00-09.00 | Pump, submerged axial flow. 18" Dia., wall pump, 3-hp, 2.5 mgd, IMLR pump | BC-0316 | 2.0 ea | 1,696.27 | 25,000.00 | - | 190.00 | - | 26,886.26 /ea | 53,773 |
| | **Aeration Equipment** | | **1.0 LS** | **319,350.54** | **2,577,680.00** | | **14,820.00** | | **2,911,850.54 /LS** | **2,911,851** |
| | **11 EQUIPMENT** | | | | | | | | | **2,911,851** |
| **22 PLUMBING** | | | | | | | | | | |
| **22999 Aeration Piping** | | | | | | | | | | |
| 22-99-99.99 | Aeration piping allowance | MISC | 4.0 LS | 17,950.00 | 75,000.00 | | - | - | 92,950.00 /LS | 371,800 |
| 22-99-99.99 | Aeration piping allowance | MISC | 2.0 LS | 17,950.00 | 75,000.00 | | - | - | 92,950.00 /LS | 185,900 |
| | **Aeration Piping** | | **1.0 LS** | **107,700.00** | **450,000.00** | | | | **557,700.00 /LS** | **557,700** |
| | **22 PLUMBING** | | | | | | | | | **557,700** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **01999 ADDITIONAL COST: Service to New Aeration Basis** | | | | | | | | | | |
| 01-99-99.99 | Additional Cost associated with Aeration Basin - Electrical Service in Ductbank | MISC | 750.0 LF | - | - | 250.00 | - | - | 250.00 /LF | 187,500 |
| | **ADDITIONAL COST: Service to New Aeration Basis** | | **750.0 LF** | | | **250.00** | | | **250.00 /LF** | **187,500** |
| **26001 Aeration Tanks - E&I (#4, #5, #6)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 1,719,975.06 | - | - | 1,719,975.06 /LS | 1,719,975 |
| | **Aeration Tanks - E&I (#4, #5, #6)** | | **1.0 LS** | | | **1,719,975.06** | | | **1,719,975.06 /LS** | **1,719,975** |
| | **26 ELECTRICAL** | | | | | | | | | **1,907,475** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Aeration Tanks - E&I (#4, #5, #6)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 429,993.77 | - | - | 429,993.77 /LS | 429,994 |
| | **Aeration Tanks - E&I (#4, #5, #6)** | | **1.0 LS** | | | **429,993.77** | | | **429,993.77 /LS** | **429,994** |
| | **27 COMMUNICATIONS** | | | | | | | | | **429,994** |
| **31 EARTHWORK** | | | | | | | | | | |
| **01999 Dewatering** | | | | | | | | | | |
| 01-54-33.70 | Rent wellpoint header pipe, 6" diameter, 400 gpm | 0500 | 2,600.0 day | - | - | - | 0.40 | - | 0.40 /day | 1,040 |
| 31-23-19.20 | Dewatering, pumping 8 hours, attended 2 hrs per day, 6" centrifugal pump, includes 20 LF of suction hose and 100 LF of discharge hose | 1100 | 260.0 day | 857.51 | - | - | 377.70 | - | 1,235.21 /day | 321,154 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **01999 Dewatering** | | | | | | | | | | |
| 31-23-19.30 | Wells, for dewatering, with steel casing, 10' to 20' deep, 2' diameter, minimum | 0020 | 175.0 vlf | 76.64 | 184.52 | - | 17.92 | - | 279.08 /vlf | 48,839 |
| | **Dewatering** | | **1.0 LS** | **236,365.01** | **32,291.57** | | **102,377.06** | | **371,033.64 /LS** | **371,034** |
| **03330 Slabs Aeration Basins** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 2,560.0 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 4,574 |
| | **Slabs Aeration Basins** | | **1,792.0 cy** | **1.52** | | | **1.03** | | **2.55 /cy** | **4,574** |
| **03330 Slabs Pipe Utilidor** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 416.7 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 745 |
| | **Slabs Pipe Utilidor** | | **3,750.0 cy** | **0.12** | | | **0.08** | | **0.20 /cy** | **745** |
| **03330 Slabs Aeration Basins** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 1,280.0 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 2,287 |
| | **Slabs Aeration Basins** | | **896.0 CY** | **1.52** | | | **1.03** | | **2.55 /CY** | **2,287** |
| **31315 Excavation and Backfill Aeration Basin** | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 18,848.2 bcy | 6.99 | - | - | 7.64 | - | 14.63 /bcy | 275,750 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 4,611.1 ecy | 5.30 | - | - | 1.50 | - | 6.80 /ecy | 31,339 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 14,237.0 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 121,712 |
| | **Excavation and Backfill Aeration Basin** | | **18,848.2 cy** | **10.62** | | | **12.14** | | **22.75 /cy** | **428,801** |
| **31315 Excavation and Backfill Aeration Basin** | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 23,644.0 bcy | 6.99 | - | - | 7.64 | - | 14.63 /bcy | 345,914 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 2,022.0 ecy | 5.30 | - | - | 1.50 | - | 6.80 /ecy | 13,742 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 21,622.0 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 184,846 |
| | **Excavation and Backfill Aeration Basin** | | **23,644.0 cy** | **10.26** | | | **12.77** | | **23.03 /cy** | **544,502** |
| | **31 EARTHWORK** | | | | | | | | | **1,351,943** |
| | **02 Aeration Tanks** | | **1.0 LS** | **2,873,941.91** | **4,819,214.20** | **2,337,468.83** | **719,219.14** | | **10,749,844.08 /LS** | **10,749,844** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03 Seconday Clarifiers** | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | |
| **03330 Slabs Secondary Clarifier** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 205.1 cy | - | 33.69 | - | - | - | 33.69 /cy | 6,912 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, slab blockouts, wood, to 24" high, 1 use, includes erecting, bracing, stripping and cleaning | 4050 | 32.0 lf | 15.09 | 1.02 | - | - | - | 16.10 /lf | 515 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 264.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 2,118 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 22.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 1,260 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 30.8 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 62,406 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 30.8 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 1,458 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 30.8 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 1,585 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 430.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 42,225 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 430.8 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 5,033 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 5,539.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 5,045 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 5,539.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 5,508 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 55.4 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 1,097 |
| | **Slabs Secondary Clarifier** | | **615.4 SY** | **80.52** | **136.65** | | **2.45** | | **219.62 /SY** | **135,162** |
| **03330 Slabs Splitter Box** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 14.8 cy | - | 33.69 | - | - | - | 33.69 /cy | 499 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 80.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 642 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 7.0 ea | 9.38 | 47.88 | - | - | - | 57.26 /ea | 401 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 2.2 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 4,506 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 2.2 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 105 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 2.2 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 114 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 31.1 cy | - | 98.01 | - | - | - | 98.01 /cy | 3,049 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 31.1 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 363 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed and bull float(darby) finish | 0100 | 400.0 sf | 0.38 | - | - | - | - | 0.38 /sf | 151 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 400.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 398 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 4.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 79 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Slabs Splitter Box** | | **31.1** | **cy** | **116.18** | **212.18** | | **3.12** | | **331.47** | **/cy** | **10,309** |
| **03330 Slabs Scum Pump** | | | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 1.3 | cy | - | 33.69 | - | - | - | 33.69 | /cy | 45 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 36.0 | lf | 3.61 | 4.42 | - | - | - | 8.02 | /lf | 289 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 3.0 | ea | 9.38 | 47.88 | - | - | - | 57.26 | /ea | 172 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.2 | ton | 1,036.00 | 992.00 | - | - | - | 2,028.00 | /ton | 406 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.2 | ton | 39.85 | - | - | 7.50 | - | 47.35 | /ton | 9 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.2 | ton | 43.35 | - | - | 8.15 | - | 51.50 | /ton | 10 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.8 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 274 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 2.8 | cy | 9.69 | - | - | 2.00 | - | 11.69 | /cy | 33 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and hand trowel finish | 0200 | 36.0 | sf | 1.20 | - | - | - | - | 1.20 | /sf | 43 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 36.0 | sf | 0.70 | 0.29 | - | - | - | 0.99 | /sf | 36 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 0.4 | csf | 9.67 | 10.10 | - | - | - | 19.78 | /csf | 7 |
| | **Slabs Scum Pump** | | **4.0** | **sy** | **120.20** | **208.63** | | **2.18** | | **331.01** | **/sy** | **1,324** |
| **03330 Slabs Secondary Clarifier** | | | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 205.1 | cy | - | 33.69 | - | - | - | 33.69 | /cy | 6,912 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, slab blockouts, wood, to 24" high, 1 use, includes erecting, bracing, stripping and cleaning | 4050 | 32.0 | lf | 15.09 | 1.02 | - | - | - | 16.10 | /lf | 515 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 264.0 | lf | 3.61 | 4.42 | - | - | - | 8.03 | /lf | 2,118 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 22.0 | ea | 9.39 | 47.88 | - | - | - | 57.27 | /ea | 1,260 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 30.8 | ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 | /ton | 62,406 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 30.8 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 1,458 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 30.8 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 1,585 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 430.8 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 42,225 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 430.8 | cy | 9.69 | - | - | 2.00 | - | 11.68 | /cy | 5,033 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 5,539.0 | sf | 0.88 | - | - | 0.03 | - | 0.91 | /sf | 5,045 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 5,539.0 | sf | 0.70 | 0.29 | - | - | - | 0.99 | /sf | 5,508 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 55.4 | csf | 9.68 | 10.12 | - | - | - | 19.80 | /csf | 1,097 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Slabs Secondary Clarifier** | | **430.8** | **CY** | **115.03** | **195.21** | | **3.50** | | **313.74** | **/CY** | **135,162** |
| **03330 Slabs Scum Pump** | | | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 1.3 | cy | - | 33.69 | - | - | - | 33.69 | /cy | 45 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 36.0 | lf | 3.61 | 4.42 | - | - | - | 8.02 | /lf | 289 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 3.0 | ea | 9.38 | 47.88 | - | - | - | 57.26 | /ea | 172 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.2 | ton | 1,036.00 | 992.00 | - | - | - | 2,028.00 | /ton | 406 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.2 | ton | 39.85 | - | - | 7.50 | - | 47.35 | /ton | 9 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.2 | ton | 43.35 | - | - | 8.15 | - | 51.50 | /ton | 10 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.8 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 274 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 2.8 | cy | 9.69 | - | - | 2.00 | - | 11.69 | /cy | 33 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and hand trowel finish | 0200 | 36.0 | sf | 1.20 | - | - | - | - | 1.20 | /sf | 43 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 36.0 | sf | 0.70 | 0.29 | - | - | - | 0.99 | /sf | 36 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 0.4 | csf | 9.67 | 10.10 | - | - | - | 19.78 | /csf | 7 |
| | **Slabs Scum Pump** | | **2.8** | **cy** | **171.71** | **298.04** | | **3.11** | | **472.87** | **/cy** | **1,324** |
| **03345 Concrete Walls Secondary Clarifiers** | | | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 11,304.0 | sfca | 6.95 | 0.75 | - | - | - | 7.70 | /sfca | 87,041 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 30.1 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 623 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 15.7 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 28,045 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 15.7 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 744 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 15.7 | ton | 43.34 | - | - | 8.17 | - | 51.50 | /ton | 809 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 219.8 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 21,543 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 219.8 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 8,560 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 11,304.0 | sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 | /sf | 28,558 |
| | **Concrete Walls Secondary Clarifiers** | | **219.8** | **cy** | **549.63** | **231.72** | | **19.02** | | **800.37** | **/cy** | **175,922** |
| **03345 Concrete Walls scum pump** | | | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 864.0 | sfca | 6.95 | 0.75 | - | - | - | 7.70 | /sfca | 6,653 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 2.3 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 48 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls scum pump** | | | | | | | | | | | | |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 1.2 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 2,144 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 1.2 | ton | 39.87 | - | - | 7.52 | - | 47.38 | /ton | 57 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 1.2 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 62 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 5000 psi | 0407 | 16.8 | cy | - | 103.51 | - | - | - | 103.51 | /cy | 1,739 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 16.8 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 654 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 864.0 | sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 | /sf | 2,183 |
| | **Concrete Walls scum pump** | | **16.8** | **cy** | **549.63** | **237.22** | | **19.02** | | **805.87** | **/cy** | **13,539** |
| **03345 Concrete Walls Secondary Clarifiers** | | | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 11,304.0 | sfca | 6.95 | 0.75 | - | - | - | 7.70 | /sfca | 87,041 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 30.1 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 623 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 15.7 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 28,045 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 15.7 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 744 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 15.7 | ton | 43.34 | - | - | 8.17 | - | 51.50 | /ton | 809 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 219.8 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 21,543 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 219.8 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 8,560 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 11,304.0 | sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 | /sf | 28,558 |
| | **Concrete Walls Secondary Clarifiers** | | **219.8** | **cy** | **549.63** | **231.72** | | **19.02** | | **800.37** | **/cy** | **175,922** |
| **03345 Concrete Walls scum pump** | | | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 864.0 | sfca | 6.95 | 0.75 | - | - | - | 7.70 | /sfca | 6,653 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 2.3 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 48 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 1.2 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 2,144 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 1.2 | ton | 39.87 | - | - | 7.52 | - | 47.38 | /ton | 57 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 1.2 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 62 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 5000 psi | 0407 | 16.8 | cy | - | 103.51 | - | - | - | 103.51 | /cy | 1,739 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 16.8 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 654 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 864.0 | sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 | /sf | 2,183 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Concrete Walls scum pump** | | **16.8 cy** | **549.63** | **237.22** | | **19.02** | | **805.87 /cy** | **13,539** |
| **03345 Concrete Walls Splitter Box** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 20.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 253 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 3,200.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 24,640 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 8.5 gal | - | 20.66 | - | - | - | 20.66 /gal | 176 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 7.8 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 13,894 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 7.8 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 369 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 7.8 ton | 43.34 | - | - | 8.17 | - | 51.50 /ton | 401 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 93.3 cy | - | 98.01 | - | - | - | 98.01 /cy | 9,148 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 93.3 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 3,635 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 3,200.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 8,084 |
| | **Concrete Walls Splitter Box** | | **93.3 cy** | **410.92** | **223.12** | | **15.46** | | **649.50 /cy** | **60,599** |
| **03350 Elevated Slab Splitter Box** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 400.0 sf | 4.97 | 1.27 | - | - | - | 6.24 /sf | 2,495 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 24.0 lf | 4.64 | 1.62 | - | - | - | 6.26 /lf | 150 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 80.0 lf | 3.62 | 0.21 | - | - | - | 3.83 /lf | 307 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, perimeter deck and rail, straight, includes shoring, erecting, bracing, stripping and cleaning | 8000 | 80.0 lf | 20.11 | 12.55 | - | - | - | 32.66 /lf | 2,613 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.0 ton | 822.00 | 992.00 | - | - | - | 1,814.00 /ton | 29 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 ton | 40.00 | - | - | 8.00 | - | 48.00 /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 ton | 114.00 | - | - | 21.00 | - | 135.00 /ton | 1 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 15.6 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,525 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 15.6 cy | 21.53 | - | - | 4.43 | - | 25.96 /cy | 404 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed finish | 0020 | 400.0 sf | 0.32 | - | - | - | - | 0.32 /sf | 126 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 400.0 sf | 0.62 | 0.19 | - | - | - | 0.81 /sf | 324 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 4.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 79 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Elevated Slab Splitter Box** | | **15.6 cy** | **305.79** | **207.31** | | **4.45** | | **517.55 /cy** | **8,053** |
| **03350 Elevated Slabs Scum Pump** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 72.0 sf | 4.97 | 1.27 | - | - | - | 6.24 /sf | 449 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 64.0 lf | 4.64 | 1.62 | - | - | - | 6.26 /lf | 401 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 700.0 lf | 3.62 | 0.21 | - | - | - | 3.83 /lf | 2,683 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.2 ton | 821.67 | 992.00 | - | - | - | 1,813.67 /ton | 381 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 ton | 40.00 | - | - | 10.00 | - | 50.00 /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 ton | 110.00 | - | - | 20.00 | - | 130.00 /ton | 0 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 2.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 274 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 2.8 cy | 21.53 | - | - | 4.43 | - | 25.96 /cy | 73 |
| 03-35-29.30 | Finishing elev slab, manual screed, bull float, machine float & trowel | 0275 | 72.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 66 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 72.0 sf | 0.62 | 0.19 | - | - | - | 0.81 /sf | 58 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 0.7 csf | 9.68 | 10.13 | - | - | - | 19.80 /csf | 14 |
| | **Elevated Slabs Scum Pump** | | **2.8 cy** | **1,263.06** | **302.70** | | **5.21** | | **1,570.98 /cy** | **4,399** |
| **03350 Elevated Slabs Scum Pump** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 72.0 sf | 4.97 | 1.27 | - | - | - | 6.24 /sf | 449 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 64.0 lf | 4.64 | 1.62 | - | - | - | 6.26 /lf | 401 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 700.0 lf | 3.62 | 0.21 | - | - | - | 3.83 /lf | 2,683 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.2 ton | 821.67 | 992.00 | - | - | - | 1,813.67 /ton | 381 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 ton | 40.00 | - | - | 10.00 | - | 50.00 /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 ton | 110.00 | - | - | 20.00 | - | 130.00 /ton | 0 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 2.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 274 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 2.8 cy | 21.53 | - | - | 4.43 | - | 25.96 /cy | 73 |
| 03-35-29.30 | Finishing elev slab, manual screed, bull float, machine float & trowel | 0275 | 72.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 66 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 72.0 sf | 0.62 | 0.19 | - | - | - | 0.81 /sf | 58 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03350 Elevated Slabs Scum Pump** | | | | | | | | | | |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 0.7 csf | 9.68 | 10.13 | - | - | - | 19.80 /csf | 14 |
| | **Elevated Slabs Scum Pump** | | **72.0 cy** | **49.12** | **11.77** | | **0.20** | | **61.09 /cy** | **4,399** |
| | **03 CONCRETE** | | | | | | | | | **739,652** |
| **05 METALS** | | | | | | | | | | |
| **11999 Secondary Clarifier** | | | | | | | | | | |
| 05-01-10.51 | Metal cleaning, steel surface treatment, 5.6 lb sand per S.F., near white blast, loose scale, fine powder rust (SSPC-SP10) | 6255 | 6,400.0 sf | 4.22 | 0.88 | - | 0.54 | - | 5.63 /sf | 36,059 |
| 05-01-10.51 | Metal cleaning, steel surface treatment, 5.6 lb sand per S.F., near white blast, loose scale, fine powder rust (SSPC-SP10) | 6255 | 6,400.0 sf | 4.22 | 0.88 | - | 0.54 | - | 5.63 /sf | 36,059 |
| 09-91-06.41 | Coatings & paints, B & C coating system E-2 (Epoxy, metal tanks, structures) | BC-0021 | 12,800.0 sqft | 0.28 | 1.40 | - | - | - | 1.69 /sqft | 21,594 |
| | **Secondary Clarifier** | | **1.0 LS** | **57,646.89** | **29,222.40** | | **6,842.62** | | **93,711.91 /LS** | **93,712** |
| | **05 METALS** | | | | | | | | | **93,712** |
| **09 FINISHES** | | | | | | | | | | |
| **11999 Secondary Clarifier** | | | | | | | | | | |
| 09-91-06.41 | Coatings & paints, B & C coating system E-2 (Epoxy, metal tanks, structures) | BC-0021 | 12,800.0 sqft | 0.28 | 1.40 | - | - | - | 1.69 /sqft | 21,594 |
| | **Secondary Clarifier** | | **1.0 LS** | **3,622.49** | **17,971.20** | | | | **21,593.69 /LS** | **21,594** |
| | **09 FINISHES** | | | | | | | | | **21,594** |
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Secondary Clarifier** | | | | | | | | | | |
| 11-00-01.00 | Mechanical, clarifier mechanism, secondary, 100' dia., 18' sidewall, w/ bridge, cage, FRP weirs, & baffles | BC-1036 | 1.0 ea | 34,035.31 | 270,000.00 | - | 9,678.80 | - | 313,714.11 /ea | 313,714 |
| 11-00-01.00 | Mechanical, clarifier mechanism, secondary, 100' dia., 18' sidewall, w/ bridge, cage, FRP weirs, & baffles | BC-1036 | 1.0 ea | 34,035.31 | 270,000.00 | - | 9,678.80 | - | 313,714.11 /ea | 313,714 |
| 11-00-11.05 | Wastewater, submersible, 3-inch, 6.5 hp,,guide rails, base elbow, scum pump | BC-0071 | 1.0 ea | 1,194.45 | 7,510.00 | - | - | - | 8,704.45 /ea | 8,704 |
| 11-00-11.05 | Wastewater, submersible, 3-inch, 6.5 hp,,guide rails, base elbow, scum pump | BC-0071 | 1.0 ea | 1,194.45 | 7,510.00 | - | - | - | 8,704.45 /ea | 8,704 |
| | **Secondary Clarifier** | | **1.0 LS** | **70,459.52** | **555,020.00** | | **19,357.60** | | **644,837.12 /LS** | **644,837** |
| | **11 EQUIPMENT** | | | | | | | | | **644,837** |
| **22 PLUMBING** | | | | | | | | | | |
| **11999 Secondary Clarifier** | | | | | | | | | | |
| 11-00-04.00 | Hydraulic structures, slide gate, stainless stl, ab & grout,36" x 36" | BC-0101 | 1.0 ea | 2,455.44 | 4,774.77 | - | 554.07 | - | 7,784.28 /ea | 7,784 |
| 11-00-04.00 | Hydraulic structures, slide gate, stainless stl, ab & grout,36" x 36" | BC-0101 | 1.0 ea | 2,455.44 | 4,774.77 | - | 554.07 | - | 7,784.28 /ea | 7,784 |
| 22-05-23.70 | Valves, semi-steel, lubricated plug valve, flanged, 200 psi, 12" | 7070 | 1.0 ea | 907.31 | 4,700.00 | - | - | - | 5,607.31 /ea | 5,607 |
| 22-05-23.70 | Valves, semi-steel, lubricated plug valve, flanged, 200 psi, 12" | 7070 | 1.0 ea | 907.31 | 4,700.00 | - | - | - | 5,607.31 /ea | 5,607 |
| 22-11-13.44 | Pipe, steel, black, welded, 36" diameter, schedule 40, Spec. A-53, includes two rod, roll hanger & saddle, sized for covering, 10' OC | 2220 | 75.0 lf | 280.75 | 275.00 | - | 9.20 | - | 564.94 /lf | 42,371 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **11999 Secondary Clarifier** | | | | | | | | | | |
| 22-11-13.44 | Pipe, steel, black, welded, 36" diameter, schedule 40, Spec. A-53, includes two rod, roll hanger & saddle, sized for covering, 10' OC | 2220 | 75.0 lf | 280.75 | 275.00 | - | 9.20 | - | 564.94 /lf | 42,371 |
| 22-11-13.47 | Elbow, 90 Deg., steel, carbon steel, black, long radius, butt weld, standard weight, 36" pipe size, includes 1 weld per joint and weld machine | 3194 | 1.0 ea | 1,554.30 | 3,450.00 | - | 57.70 | - | 5,062.00 /ea | 5,062 |
| 22-11-13.47 | Elbow, 90 Deg., steel, carbon steel, black, long radius, butt weld, standard weight, 36" pipe size, includes 1 weld per joint and weld machine | 3194 | 1.0 ea | 1,554.30 | 3,450.00 | - | 57.70 | - | 5,062.00 /ea | 5,062 |
| 22-20-00.30 | Piping, water dist, DI, cement lined, 18' L, restrained jt, 12" dia | BC-0001 | 55.0 lnft | 6.58 | 25.25 | - | | - | 31.83 /lnft | 1,751 |
| 22-20-00.30 | Piping, water dist, DI, cement lined, 18' L, restrained jt, 12" dia | BC-0001 | 55.0 lnft | 6.58 | 25.25 | - | | - | 31.83 /lnft | 1,751 |
| 22-20-00.31 | Piping, water dist, DI, 90< bend or elbow, 12" dia | BC-0026 | 1.0 ea | 212.17 | 228.00 | - | 45.86 | - | 486.03 /ea | 486 |
| 22-20-00.31 | Piping, water dist, DI, 90< bend or elbow, 12" dia | BC-0026 | 1.0 ea | 212.17 | 228.00 | - | 45.86 | - | 486.03 /ea | 486 |
| 22-20-01.95 | Pipe, steel ftngs, sch 40, tee 54" X 36" welded | BC-2866 | 1.0 ea | 1,843.18 | 13,429.84 | - | 995.92 | - | 16,268.94 /ea | 16,269 |
| 22-20-01.95 | Pipe, steel ftngs, sch 40, tee 54" X 36" welded | BC-2866 | 1.0 ea | 1,843.18 | 13,429.84 | - | 995.92 | - | 16,268.94 /ea | 16,269 |
| | **Secondary Clarifier** | | **1.0 LS** | **56,780.46** | **97,192.72** | | **4,686.54** | | **158,659.72 /LS** | **158,660** |
| | **22 PLUMBING** | | | | | | | | | **158,660** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **26001 Secondary Clarifiers - E&I (#7, #8, #9)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 475,884.95 | - | - | 475,884.95 /LS | 475,885 |
| | **Secondary Clarifiers - E&I (#7, #8, #9)** | | **1.0 LS** | | | **475,884.95** | | | **475,884.95 /LS** | **475,885** |
| | **26 ELECTRICAL** | | | | | | | | | **475,885** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Secondary Clarifiers - E&I (#7, #8, #9)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 133,842.65 | - | - | 133,842.65 /LS | 133,843 |
| | **Secondary Clarifiers - E&I (#7, #8, #9)** | | **1.0 LS** | | | **133,842.65** | | | **133,842.65 /LS** | **133,843** |
| | **27 COMMUNICATIONS** | | | | | | | | | **133,843** |
| **31 EARTHWORK** | | | | | | | | | | |
| **01999 Dewatering** | | | | | | | | | | |
| 01-54-33.70 | Rent wellpoint header pipe, 6" diameter, 400 gpm | 0500 | 1,760.0 day | - | - | - | 0.40 | - | 0.40 /day | 704 |
| 31-23-19.20 | Dewatering, pumping 8 hours, attended 2 hrs per day, 6" centrifugal pump, includes 20 LF of suction hose and 100 LF of discharge hose | 1100 | 176.0 day | 857.51 | - | - | 377.70 | - | 1,235.21 /day | 217,397 |
| 31-23-19.30 | Wells, for dewatering, with steel casing, 10' to 20' deep, 2' diameter, minimum | 0020 | 250.0 vlf | 9.63 | 23.18 | - | 2.25 | - | 35.06 /vlf | 8,765 |
| | **Dewatering** | | **1.0 LS** | **153,329.11** | **5,795.00** | | **67,741.30** | | **226,865.41 /LS** | **226,865** |
| **03330 Slabs Secondary Clarifier** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 615.4 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 1,100 |
| | **Slabs Secondary Clarifier** | | **615.4 SY** | **1.07** | | | **0.72** | | **1.79 /SY** | **1,100** |
| **03330 Slabs Splitter Box** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 44.4 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 79 |
| | **Slabs Splitter Box** | | **31.1 cy** | **1.52** | | | **1.03** | | **2.55 /cy** | **79** |
| **03330 Slabs Scum Pump** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 4.0 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 7 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Slabs Scum Pump** | | **4.0** | **sy** | **1.07** | | | **0.72** | | **1.79** | **/sy** | **7** |
| **03330 Slabs Secondary Clarifier** | | | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 615.4 | sy | 1.07 | - | - | 0.72 | - | 1.79 | /sy | 1,100 |
| | **Slabs Secondary Clarifier** | | **430.8** | **CY** | **1.52** | | | **1.03** | | **2.55** | **/CY** | **1,100** |
| **03330 Slabs Scum Pump** | | | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 4.0 | sy | 1.07 | - | - | 0.72 | - | 1.79 | /sy | 7 |
| | **Slabs Scum Pump** | | **2.8** | **cy** | **1.52** | | | **1.03** | | **2.55** | **/cy** | **7** |
| **31315 Excavation and Backfill secondary Clarifier** | | | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 8,744.0 | bcy | 6.99 | - | - | 7.64 | - | 14.63 | /bcy | 127,926 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 4,900.0 | ecy | 5.30 | - | - | 1.50 | - | 6.80 | /ecy | 33,302 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 4,289.0 | lcy | 3.08 | - | - | 5.47 | - | 8.55 | /lcy | 36,667 |
| | **Excavation and Backfill secondary Clarifier** | | **19,218.4** | **cy** | **5.22** | | | **5.08** | | **10.30** | **/cy** | **197,894** |
| **31315 Excavation and Backfill splitter Box** | | | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 3,888.9 | bcy | 6.99 | - | - | 7.64 | - | 14.63 | /bcy | 56,895 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 2,444.4 | ecy | 5.30 | - | - | 1.50 | - | 6.80 | /ecy | 16,613 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 296.3 | lcy | 3.08 | - | - | 5.47 | - | 8.55 | /lcy | 2,533 |
| | **Excavation and Backfill splitter Box** | | **3,889.0** | **cy** | **10.56** | | | **8.99** | | **19.55** | **/cy** | **76,041** |
| **31315 Excavation and Backfill secondary Clarifier** | | | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 8,744.0 | bcy | 6.99 | - | - | 7.64 | - | 14.63 | /bcy | 127,926 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 4,900.0 | ecy | 5.30 | - | - | 1.50 | - | 6.80 | /ecy | 33,302 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 4,289.0 | lcy | 3.08 | - | - | 5.47 | - | 8.55 | /lcy | 36,667 |
| | **Excavation and Backfill secondary Clarifier** | | **19,218.4** | **cy** | **5.22** | | | **5.08** | | **10.30** | **/cy** | **197,894** |
| **33500 Secondary RAS Piping** | | | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 1,333.3 | bcy | 2.80 | - | - | 2.07 | - | 4.87 | /bcy | 6,493 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 627.8 | ecy | 1.23 | - | - | 2.60 | - | 3.82 | /ecy | 2,400 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 538.3 | lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 | /lcy | 12,895 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 538.3 | ecy | 5.57 | - | - | 0.41 | - | 5.98 | /ecy | 3,216 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 705.6 | lcy | 6.23 | - | - | 5.24 | - | 11.48 | /lcy | 8,097 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 12,000.0 | sf | - | - | 0.08 | - | - | 0.08 | /sf | 960 |
| | **Secondary RAS Piping** | | **750.0** | **LF** | **23.46** | **7.82** | **1.28** | **12.86** | | **45.42** | **/LF** | **34,062** |
| **33500 Secondary Clarifier ML Piping** | | | | | | | | | | | | |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **33500 Secondary Clarifier ML Piping** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 1,168.1 bcy | 2.80 | - | - | 2.07 | - | 4.87 /bcy | 5,688 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 426.4 ecy | 1.23 | - | - | 2.60 | - | 3.82 /ecy | 1,630 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 497.9 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 11,927 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 497.9 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 2,975 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 741.7 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 8,511 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 9,050.0 sf | - | - | 0.08 | - | - | 0.08 /sf | 724 |
| | **Secondary Clarifier ML Piping** | | **525.0 LF** | **31.35** | **10.33** | **1.38** | **16.87** | | **59.91 /LF** | **31,455** |
| **33500 Secondary Clarifier SE Piping** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 1,480.6 bcy | 2.80 | - | - | 2.07 | - | 4.87 /bcy | 7,210 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 530.6 ecy | 1.23 | - | - | 2.60 | - | 3.82 /ecy | 2,028 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 632.6 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 15,154 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 632.6 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 3,780 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 950.0 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 10,902 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 11,300.0 sf | - | - | 0.08 | - | - | 0.08 /sf | 904 |
| | **Secondary Clarifier SE Piping** | | **650.0 LF** | **32.20** | **10.60** | **1.39** | **17.31** | | **61.50 /LF** | **39,978** |
| | **31 EARTHWORK** | | | | | | | | | **806,482** |
| **33 UTILITIES** | | | | | | | | | | |
| **33500 Secondary RAS Piping** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 8.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 71 |
| | **Secondary RAS Piping** | | **750.0 LF** | **0.04** | **0.06** | | | | **0.10 /LF** | **71** |
| **33500 Secondary Clarifier ML Piping** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 5.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 44 |
| | **Secondary Clarifier ML Piping** | | **525.0 LF** | **0.03** | **0.05** | | | | **0.09 /LF** | **44** |
| **33500 Secondary Clarifier SE Piping** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 7.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 62 |
| | **Secondary Clarifier SE Piping** | | **650.0 LF** | **0.04** | **0.06** | | | | **0.10 /LF** | **62** |
| | **33 UTILITIES** | | | | | | | | | **178** |

**40**

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **33500 Secondary RAS Piping** | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 24 Inch (600mm) | A241002 0000EA | 100.0 lf | - | 56.88 | - | - | - | 56.88 /lf | 5,688 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 24 Inch (600mm) | A241002 0000EA | 100.0 lf | - | 56.88 | - | - | - | 56.88 /lf | 5,688 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Non-Specific 24 Inch (600mm) | A242112 000000 | 1.0 ea | - | 1,678.64 | - | - | - | 1,678.64 /ea | 1,679 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Non-Specific 24 Inch (600mm) | A242112 000000 | 1.0 ea | - | 1,678.64 | - | - | - | 1,678.64 /ea | 1,679 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Std 36 Inch (900mm) | A361002 0100EA | 550.0 lf | - | 168.69 | - | - | - | 168.69 /lf | 92,779 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std 36 Inch (900mm) | A362112 010000 | 3.0 ea | 2,580.88 | 4,053.57 | - | 488.91 | - | 7,123.35 /ea | 21,370 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 24 Inch (600mm) | L244002 0000P1 | 100.0 lf | 19.57 | - | - | 3.62 | - | 23.19 /lf | 2,319 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 24 Inch (600mm) | L244002 0000P1 | 100.0 lf | 19.57 | - | - | 3.62 | - | 23.19 /lf | 2,319 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Non-Specific 24 Inch (600mm) | L245102 000000 | 2.0 ea | 983.77 | 17.51 | - | 78.79 | - | 1,080.06 /ea | 2,160 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Non-Specific 24 Inch (600mm) | L245102 000000 | 2.0 ea | 983.77 | 17.51 | - | 78.79 | - | 1,080.06 /ea | 2,160 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 36 Inch (900mm) | L364002 0100P1 | 550.0 lf | 24.46 | - | - | 4.83 | - | 29.29 /lf | 16,107 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std 36 Inch (900mm) | L365102 010000 | 14.0 ea | 929.47 | 17.51 | - | 74.44 | - | 1,021.42 /ea | 14,300 |
| 40-05-24.10 | RAS 36" tie-in at existing pump station allowance | ---- | 1.0 ls | 3,930.00 | 15,015.00 | | 5,000.00 | - | 23,945.00 /ls | 23,945 |
| | **Secondary RAS Piping** | | **750.0 LF** | **61.31** | **180.01** | | **14.94** | | **256.26 /LF** | **192,193** |
| **33500 Secondary Clarifier ML Piping** | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Std 36 Inch (900mm) | A361002 0100EA | 100.0 lf | - | 168.69 | - | - | - | 168.69 /lf | 16,869 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Std 36 Inch (900mm) | A361002 0100EA | 100.0 lf | - | 168.69 | - | - | - | 168.69 /lf | 16,869 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std 36 Inch (900mm) | A362112 010000 | 1.0 ea | 2,580.88 | 4,053.57 | - | 488.91 | - | 7,123.36 /ea | 7,123 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std 36 Inch (900mm) | A362112 010000 | 1.0 ea | 2,580.88 | 4,053.57 | - | 488.91 | - | 7,123.36 /ea | 7,123 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 54 Inch (1350mm) | A541002 0000EA | 327.0 lf | - | 333.54 | - | - | - | 333.54 /lf | 109,068 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Non-Specific 54 Inch (1350mm) | A542112 000000 | 4.0 ea | - | 9,273.91 | - | - | - | 9,273.91 /ea | 37,096 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 36 Inch (900mm) | L364002 0100P1 | 100.0 lf | 24.46 | - | - | 4.83 | - | 29.29 /lf | 2,929 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 36 Inch (900mm) | L364002 0100P1 | 100.0 lf | 24.46 | - | - | 4.83 | - | 29.29 /lf | 2,929 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std 36 Inch (900mm) | L365102 010000 | 2.0 ea | 929.47 | 17.51 | - | 74.44 | - | 1,021.42 /ea | 2,043 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std 36 Inch (900mm) | L365102 010000 | 2.0 ea | 929.47 | 17.51 | - | 74.44 | - | 1,021.42 /ea | 2,043 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 54 Inch (1350mm) | L544002 0000P1 | 327.0 lf | 32.59 | - | - | 6.43 | - | 39.02 /lf | 12,759 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Non-Specific 54 Inch (1350mm) | L545102 000000 | 11.0 ea | 1,950.39 | 39.40 | - | 156.21 | - | 2,145.99 /ea | 23,606 |
| | **Secondary Clarifier ML Piping** | | **525.0 LF** | **87.40** | **359.07** | | **11.55** | | **458.01 /LF** | **240,455** |

**33500 Secondary Clarifier SE Piping**

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **33500 Secondary Clarifier SE Piping** | | | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Std 36 Inch (900mm) | A361002 0100EA | 100.0 | lf | - | 168.69 | - | - | - | 168.69 | /lf | 16,869 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Std 36 Inch (900mm) | A361002 0100EA | 100.0 | lf | - | 168.69 | - | - | - | 168.69 | /lf | 16,869 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std 36 Inch (900mm) | A362112 010000 | 1.0 | ea | 2,580.88 | 4,053.57 | - | 488.91 | - | 7,123.36 | /ea | 7,123 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std 36 Inch (900mm) | A362112 010000 | 1.0 | ea | 2,580.88 | 4,053.57 | - | 488.91 | - | 7,123.36 | /ea | 7,123 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 54 Inch (1350mm) | A541002 0000EA | 450.0 | lf | - | 333.54 | - | - | - | 333.54 | /lf | 150,093 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Non-Specific 54 Inch (1350mm) | A542112 000000 | 3.0 | ea | - | 9,273.90 | - | - | - | 9,273.90 | /ea | 27,822 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 36 Inch (900mm) | L364002 0100P1 | 100.0 | lf | 24.46 | - | - | 4.83 | - | 29.29 | /lf | 2,929 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 36 Inch (900mm) | L364002 0100P1 | 100.0 | lf | 24.46 | - | - | 4.83 | - | 29.29 | /lf | 2,929 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std 36 Inch (900mm) | L365102 010000 | 2.0 | ea | 929.47 | 17.51 | - | 74.44 | - | 1,021.42 | /ea | 2,043 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std 36 Inch (900mm) | L365102 010000 | 2.0 | ea | 929.47 | 17.51 | - | 74.44 | - | 1,021.42 | /ea | 2,043 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 54 Inch (1350mm) | L544002 0000P1 | 450.0 | lf | 32.59 | - | - | 6.43 | - | 39.02 | /lf | 17,558 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Non-Specific 54 Inch (1350mm) | L545102 000000 | 12.0 | ea | 1,950.39 | 39.40 | - | 156.21 | - | 2,145.99 | /ea | 25,752 |
| | **Secondary Clarifier SE Piping** | | **650.0** | **LF** | **79.76** | **338.93** | | **10.78** | | **429.47** | **/LF** | **279,152** |
| | **40** | | | | | | | | | | | **711,800** |
| | **03 Seconday Clarifiers** | | **1.0** | **LS** | **1,197,603.36** | **1,579,336.35** | **612,315.60** | **397,387.24** | | **3,786,642.55** | **/LS** | **3,786,643** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **04 Existing aeration Tanks/RAS Tank Retrofit** | | | | | | | | | | |
| **01 GENERAL CONDITIONS** | | | | | | | | | | |
| **02999 Aeration tank demolition** | | | | | | | | | | |
| 01-54-33.40 | Pressure Washer 7 gpm, 3000 psi | 5460 | 16.0 day | - | - | - | 87.60 | - | 87.60 /day | 1,402 |
| 01-54-33.40 | Rent trash pump self-prime 4" diameter, diesel drive | 5600 | 16.0 day | - | - | - | 126.20 | - | 126.20 /day | 2,019 |
| | **Aeration tank demolition** | | **1.0 LS** | | | | **3,420.80** | | **3,420.80 /LS** | **3,421** |
| | **01 GENERAL CONDITIONS** | | | | | | | | | **3,421** |
| **02 SITEWORK & DEMOLITION** | | | | | | | | | | |
| **02225 Demo Baffle walls** | | | | | | | | | | |
| 02-41-19.23 | Rubbish handling, loading & trucking, machine loading truck, includes 2 mile haul, cost to be added to demolition cost. | 3080 | 93.3 cy | 17.39 | - | - | 6.59 | - | 23.98 /cy | 2,239 |
| 02-41-19.25 | Sawcutting, concrete walls, rod reinforcing, per inch of depth | 0820 | 2,016.0 lf | 7.17 | 0.05 | - | 5.84 | - | 13.06 /lf | 26,328 |
| 03-05-05.10 | Selective concrete demolition, 2 - 5 tons, remove whole pieces, incl loading, excludes shoring, bracing, saw or torch cutting, hauling, dumping | 0160 | 96.0 ea | 106.31 | - | - | 32.26 | - | 138.57 /ea | 13,303 |
| | **Demo Baffle walls** | | **6,720.0 sf** | **3.91** | **0.02** | | **2.30** | | **6.23 /sf** | **41,870** |
| **02999 Aeration tank demolition** | | | | | | | | | | |
| 02-22-03.30 | Dump Charge, typical urban city, fees only, bldg constr mat'ls | BC-0006 | 16.0 ton | - | - | - | - | 33.00 | 33.00 /ton | 528 |
| 02-22-04.50 | Demo fine bubble aeration discs, piping, headers, laterals and drop legs, mixers, in basin only | BC-0071 | 16.0 days | 2,284.78 | - | - | 967.88 | - | 3,252.66 /days | 52,043 |
| | **Aeration tank demolition** | | **1.0 LS** | **36,556.52** | | | **15,486.08** | **528.00** | **52,570.60 /LS** | **52,571** |
| | **02 SITEWORK & DEMOLITION** | | | | | | | | | **94,440** |
| **03 CONCRETE** | | | | | | | | | | |
| **03345 Baffle walls** | | | | | | | | | | |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 35.0 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 62,520 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 35.0 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 1,658 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 35.0 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 1,803 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 588.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 57,631 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 588.0 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 22,898 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 20,160.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 50,932 |
| 04-05-19.16 | Masonry anchors, wall tie dowels, plain, 3/4" diameter x 6" long | 6150 | 28.0 c | - | 313.83 | - | - | - | 313.83 /c | 8,787 |
| | **Baffle walls** | | **588.0 cy** | **149.21** | **186.44** | | **15.08** | | **350.73 /cy** | **206,230** |
| | **03 CONCRETE** | | | | | | | | | **206,230** |
| **05 METALS** | | | | | | | | | | |
| **11999 RAS Pumps** | | | | | | | | | | |
| 05-58-09.50 | Pump mounting base plate, complete w/ anchor bolts, 4 sf | BC-0001 | 2.0 ea | 622.68 | 795.79 | - | - | - | 1,418.47 /ea | 2,837 |
| | **RAS Pumps** | | **1.0 LS** | **1,245.35** | **1,591.58** | | | | **2,836.93 /LS** | **2,837** |
| | **05 METALS** | | | | | | | | | **2,837** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Aeration Equipment** | | | | | | | | | | |
| 11-00-01.00 | Aeration diffusers, fine bubble, complete with headers | BC-0031 | 10,432.0 ea | 13.11 | 35.00 | - | - | - | 48.11 /ea | 501,883 |
| 11-00-01.00 | Mixer, submerged propellar type, 10 hp, Flygt, with guiderail | BC-0621 | 24.0 ea | 2,261.69 | 30,000.00 | - | 380.00 | - | 32,641.69 /ea | 783,401 |
| 11-00-09.00 | Pump, submerged axial flow. 18" Dia., wall pump, 3-hp, 2.5 mgd, IMLR pump | BC-0316 | 4.0 ea | 1,696.27 | 25,000.00 | - | 190.00 | - | 26,886.26 /ea | 107,545 |
| | **Aeration Equipment** | | **1.0 LS** | **197,828.19** | **1,185,120.00** | | **9,880.00** | | **1,392,828.19 /LS** | **1,392,828** |
| **11999 RAS Pumps** | | | | | | | | | | |
| 11-00-01.00 | Pump,vertical turbine, solids handling, can type, 50hp, VFD driven | BC-0791 | 2.0 ea | 2,827.11 | 30,000.00 | - | 380.00 | - | 33,207.11 /ea | 66,414 |
| | **RAS Pumps** | | **1.0 LS** | **5,654.22** | **60,000.00** | | **760.00** | | **66,414.22 /LS** | **66,414** |
| | **11 EQUIPMENT** | | | | | | | | | **1,459,242** |
| **22 PLUMBING** | | | | | | | | | | |
| **22999 RAS Piping** | | | | | | | | | | |
| 22-99-99.99 | RAS above grade piping allowance | ---- | 2.0 ls | 8,975.00 | 12,500.00 | - | - | - | 21,475.00 /ls | 42,950 |
| | **RAS Piping** | | **1.0 LS** | **17,950.00** | **25,000.00** | | | | **42,950.00 /LS** | **42,950** |
| | **22 PLUMBING** | | | | | | | | | **42,950** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **26001 Existing Aeration Tanks/RAS Tank Retrofit - E&I (#13, #14)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 445,133.73 | - | - | 445,133.73 /LS | 445,134 |
| | **Existing Aeration Tanks/RAS Tank Retrofit - E&I (#13, #14)** | | **1.0 LS** | | | **445,133.73** | | | **445,133.73 /LS** | **445,134** |
| | **26 ELECTRICAL** | | | | | | | | | **445,134** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Existing Aeration Tanks/RAS Tank Retrofit - E&I (#13, #14)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 74,188.96 | - | - | 74,188.96 /LS | 74,189 |
| | **Existing Aeration Tanks/RAS Tank Retrofit - E&I (#13, #14)** | | **1.0 LS** | | | **74,188.96** | | | **74,188.96 /LS** | **74,189** |
| | **27 COMMUNICATIONS** | | | | | | | | | **74,189** |
| **31 EARTHWORK** | | | | | | | | | | |
| **02999 Aeration tank demolition** | | | | | | | | | | |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 240.0 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 2,052 |
| | **Aeration tank demolition** | | **1.0 LS** | **738.66** | | | **1,313.09** | | **2,051.75 /LS** | **2,052** |
| **33500 Secondary Clarifier ML Piping Exist Train** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 812.5 bcy | 2.80 | - | - | 2.07 | - | 4.87 /bcy | 3,957 |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1-1/2 C.Y. excavator, 10' to 14' deep, excludes sheeting or dewatering | 1000 | 3,066.7 bcy | 2.07 | - | - | 1.95 | - | 4.02 /bcy | 12,320 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 2,187.5 ecy | 1.23 | - | - | 2.60 | - | 3.82 /ecy | 8,363 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **33500 Secondary Clarifier ML Piping Exist Train** | | | | | | | | | | |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 1,199.2 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 28,727 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 1,199.2 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 7,165 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 1,691.7 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 19,413 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 33,450.0 sf | - | - | 0.08 | - | - | 0.08 /sf | 2,676 |
| | **Secondary Clarifier ML Piping Exist Train** | | **1,475.0 LF** | **27.95** | **8.85** | **1.81** | **17.40** | | **56.01 /LF** | **82,621** |
| **33500 RAS Pump Discharge** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 902.8 bcy | 2.80 | - | - | 2.07 | - | 4.87 /bcy | 4,396 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 416.7 ecy | 1.23 | - | - | 2.60 | - | 3.82 /ecy | 1,593 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 398.8 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 9,555 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 398.8 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 2,383 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 486.1 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 5,578 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 9,750.0 sf | - | - | 0.08 | - | - | 0.08 /sf | 780 |
| | **RAS Pump Discharge** | | **750.0 LF** | **16.68** | **5.79** | **1.04** | **8.87** | | **32.38 /LF** | **24,286** |
| | **31 EARTHWORK** | | | | | | | | | **108,958** |
| **33 UTILITIES** | | | | | | | | | | |
| **33500 Secondary Clarifier ML Piping Exist Train** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 15.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 133 |
| | **Secondary Clarifier ML Piping Exist Train** | | **1,475.0 LF** | **0.03** | **0.06** | | | | **0.09 /LF** | **133** |
| **33500 RAS Pump Discharge** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 8.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 71 |
| | **RAS Pump Discharge** | | **750.0 LF** | **0.04** | **0.06** | | | | **0.10 /LF** | **71** |
| | **33 UTILITIES** | | | | | | | | | **205** |
| **40** | | | | | | | | | | |
| **33500 Secondary Clarifier ML Piping Exist Train** | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Std 36 Inch (900mm) | A361002 0100EA | 1,150.0 lf | - | 168.69 | - | - | - | 168.69 /lf | 193,992 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std 36 Inch (900mm) | A362112 010000 | 6.0 ea | 2,580.88 | 6,067.82 | - | 488.91 | - | 9,137.60 /ea | 54,826 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 54 Inch (1350mm) | A541002 0000EA | 328.0 lf | - | 333.54 | - | - | - | 333.54 /lf | 109,401 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Non-Specific 54 Inch (1350mm) | A542112 000000 | 5.0 ea | - | 9,273.90 | - | - | - | 9,273.90 /ea | 46,370 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 36 Inch (900mm) | L364002 0100P1 | 1,150.0 lf | 24.46 | - | - | 4.83 | - | 29.29 /lf | 33,679 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **33500 Secondary Clarifier ML Piping Exist Train** | | | | | | | | | | |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std 36 Inch (900mm) | L365102 010000 | 32.0 ea | 929.47 | 17.51 | - | 74.44 | - | 1,021.42 /ea | 32,685 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 54 Inch (1350mm) | L544002 0000P1 | 328.0 lf | 32.59 | - | - | 6.43 | - | 39.02 /lf | 12,798 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Non-Specific 54 Inch (1350mm) | L545102 000000 | 12.0 ea | 1,950.39 | 39.40 | - | 156.21 | - | 2,145.99 /ea | 25,752 |
| | **Secondary Clarifier ML Piping Exist Train** | | **1,475.0 LF** | **72.85** | **262.51** | | **10.07** | | **345.43 /LF** | **509,503** |
| **33500 RAS Pump Discharge** | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 24 Inch (600mm) | A241002 0000EA | 750.0 lf | - | 56.88 | - | - | - | 56.88 /lf | 42,661 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Non-Specific 24 Inch (600mm) | A242112 000000 | 6.0 ea | - | 1,678.64 | - | - | - | 1,678.64 /ea | 10,072 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 24 Inch (600mm) | L244002 0000P1 | 750.0 lf | 19.57 | - | - | 3.62 | - | 23.19 /lf | 17,391 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Non-Specific 24 Inch (600mm) | L245102 000000 | 19.0 ea | 983.77 | 17.51 | - | 78.79 | - | 1,080.06 /ea | 20,521 |
| | **RAS Pump Discharge** | | **750.0 LF** | **44.49** | **70.75** | | **5.62** | | **120.86 /LF** | **90,645** |
| | **40** | | | | | | | | | **600,148** |
| | **04 Existing aeration Tanks/RAS Tank Retrofit** | | **1.0 LS** | **568,618.20** | **1,839,237.11** | **522,778.69** | **106,590.89** | **528.00** | **3,037,752.89 /LS** | **3,037,753** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **05 Tertiary Treatment Processes** | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | |
| **03330 Slabs Actiflow tank** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 29.6 cy | - | 33.69 | - | - | - | 33.69 /cy | 998 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 120.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 963 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 10.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 573 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 4.4 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 9,012 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 4.4 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 211 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 4.4 ton | 43.34 | - | - | 8.17 | - | 51.50 /ton | 229 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 62.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 6,099 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 62.2 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 727 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 800.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 729 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 800.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 795 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 8.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 158 |
| | **Slabs Actiflow tank** | | **800.0 cy** | **9.31** | **16.04** | | **0.27** | | **25.62 /cy** | **20,494** |
| **03330 Slabs Coagulaton Tank** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 5.3 cy | - | 33.69 | - | - | - | 33.69 /cy | 180 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 48.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 385 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 4.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 229 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.8 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 1,622 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.8 ton | 39.88 | - | - | 7.51 | - | 47.39 /ton | 38 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.8 ton | 43.34 | - | - | 8.16 | - | 51.50 /ton | 41 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 11.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,098 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 11.2 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 131 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 144.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 131 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 144.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 143 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 1.4 csf | 9.68 | 10.13 | - | - | - | 19.81 /csf | 29 |
| | **Slabs Coagulaton Tank** | | **144.0 cy** | **10.11** | **17.58** | | **0.27** | | **27.97 /cy** | **4,027** |
| **03330 Slabs Hydrocone** | | | | | | | | | | |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03330 Slabs Hydrocone** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 5.6 cy | - | 33.69 | - | - | - | 33.69 /cy | 187 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning | 3050 | 60.0 sfca | 4.16 | 0.80 | - | - | - | 4.96 /sfca | 297 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.6 ton | 1,036.02 | 992.00 | - | - | - | 2,028.02 /ton | 1,268 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.6 ton | 39.87 | - | - | 7.52 | - | 47.39 /ton | 30 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 8.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 858 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, direct chute, over 6" thick, includes vibrating, excludes material | 4600 | 8.8 cy | 17.32 | - | - | 0.39 | - | 17.71 /cy | 155 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and broom finish | 0150 | 225.0 sf | 0.82 | - | - | - | - | 0.82 /sf | 184 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 2.3 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 45 |
| | **Slabs Hydrocone** | | **8.3 cy** | **153.51** | **208.25** | | **0.97** | | **362.73 /cy** | **3,023** |
| **03330 Slabs Disc Filters** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 14.8 cy | - | 33.69 | - | - | - | 33.69 /cy | 499 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 40.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 344 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning | 3050 | 100.0 sfca | 4.16 | 0.80 | - | - | - | 4.96 /sfca | 496 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 1.7 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 3,381 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7 | 0610 | 148.1 lb | 0.52 | 0.48 | - | - | - | 0.99 /lb | 147 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 1.7 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 82 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 27.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 2,668 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, direct chute, over 6" thick, includes vibrating, excludes material | 4600 | 27.2 cy | 17.32 | - | - | 0.39 | - | 17.71 /cy | 482 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and broom finish | 0150 | 600.0 sf | 0.82 | - | - | - | - | 0.82 /sf | 490 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 6.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 119 |
| | **Slabs Disc Filters** | | **25.9 cy** | **138.81** | **196.18** | | **0.91** | | **335.90 /cy** | **8,708** |
| **03330 Slabs Alum Storage and Pumps** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 14.8 cy | - | 33.69 | - | - | - | 33.69 /cy | 499 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 56.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 482 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning | 3050 | 110.0 sfca | 4.16 | 0.80 | - | - | - | 4.96 /sfca | 545 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03330 Slabs Alum Storage and Pumps** | | | | | | | | | | |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 1.7 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 3,381 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7 | 0610 | 170.4 lb | 0.52 | 0.48 | - | - | - | 0.99 /lb | 169 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 1.8 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 83 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 27.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 2,725 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, direct chute, over 6" thick, includes vibrating, excludes material | 4600 | 27.8 cy | 17.32 | - | - | 0.39 | - | 17.71 /cy | 492 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and broom finish | 0150 | 600.0 sf | 0.82 | - | - | - | - | 0.82 /sf | 490 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 6.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 119 |
| | **Slabs Alum Storage and Pumps** | | **26.5 cy** | **142.68** | **195.75** | | **0.90** | | **339.33 /cy** | **8,986** |
| **03333 Alum tank/pump equipment Pads and containment** | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 740.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 6,365 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.3 ton | 39.90 | - | - | 7.50 | - | 47.41 /ton | 13 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.3 ton | 43.33 | - | - | 8.20 | - | 51.50 /ton | 14 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 13.5 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,325 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 13.5 cy | 27.68 | - | - | 5.70 | - | 33.38 /cy | 451 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 13.5 cy | 46.13 | - | - | 13.04 | - | 59.17 /cy | 800 |
| | **Alum tank/pump equipment Pads and containment** | | **13.5 cy** | **471.83** | **172.51** | | **19.05** | | **663.39 /cy** | **8,968** |
| **03333 Alum pumps Equipment Pads** | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 72.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 619 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.0 ton | 39.80 | - | - | 7.50 | - | 47.25 /ton | 2 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.0 ton | 43.30 | - | - | 8.30 | - | 51.50 /ton | 2 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 196 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 2.0 cy | 27.68 | - | - | 5.70 | - | 33.38 /cy | 67 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 2.0 cy | 46.13 | - | - | 13.04 | - | 59.17 /cy | 118 |
| | **Alum pumps Equipment Pads** | | **2.0 cy** | **336.15** | **147.01** | | **19.05** | | **502.20 /cy** | **1,004** |
| **03345 Concrete Walls actiflow Tank** | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 4,320.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 33,264 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls actiflow Tank** | | | | | | | | | | |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 11.5 gal | - | 20.66 | - | - | - | 20.66 /gal | 238 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 10.5 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 18,756 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 10.5 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 498 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 10.5 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 541 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 126.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 12,350 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 126.0 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 4,907 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 4,320.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 10,914 |
| | **Concrete Walls actiflow Tank** | | **126.0 cy** | **408.53** | **222.58** | | **15.46** | | **646.56 /cy** | **81,467** |
| **03345 Concrete Walls Coagulation Tank** | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 1,728.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 13,306 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 4.6 gal | - | 20.66 | - | - | - | 20.66 /gal | 95 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 3.6 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 6,431 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 3.6 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 171 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 3.6 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 185 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 50.4 cy | - | 98.01 | - | - | - | 98.01 /cy | 4,940 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 50.4 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 1,963 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 1,728.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 4,366 |
| | **Concrete Walls Coagulation Tank** | | **50.4 cy** | **398.08** | **210.77** | | **15.27** | | **624.12 /cy** | **31,456** |
| | **03 CONCRETE** | | | | | | | | | **168,133** |
| **05 METALS** | | | | | | | | | | |
| **05999 Actiflo clarifier bridge** | | | | | | | | | | |
| 05-99-99.99 | Clarifier bridge supports, structural steel, grating, handrail, allowance | MISC | 2.0 LS | 8,090.00 | 10,220.00 | | 2,000.00 | - | 20,310.00 /LS | 40,620 |
| | **Actiflo clarifier bridge** | | **1.0 LS** | **16,180.00** | **20,440.00** | | **4,000.00** | | **40,620.00 /LS** | **40,620** |
| | **05 METALS** | | | | | | | | | **40,620** |
| **11 EQUIPMENT** | | | | | | | | | | |
| **03330 Slabs Actiflow tank** | | | | | | | | | | |
| 11-00-01.00 | 14.2 mgd Actiflow systems - Vendor quote | ---- | 1.0 LS | 4,544.80 | 2,300,000.00 | | - | - | 2,304,544.80 /LS | 2,304,545 |
| | **Slabs Actiflow tank** | | **800.0 cy** | **5.68** | **2,875.00** | | | | **2,880.68 /cy** | **2,304,545** |
| **11999 ACTIFLO** | | | | | | | | | | |
| 11-00-01.00 | Filter units, rotating disc, complete | BC-0696 | 2.0 ea | 8,481.33 | 257,500.00 | - | 1,200.00 | | 267,181.33 /ea | 534,363 |
| 11-00-01.00 | ACTIFLO clarifier bridge and supports allowance | ---- | 2.0 ls | | 22,000.00 | - | | - | 22,000.00 /ls | 44,000 |
| 11-00-01.00 | ACTIFLO - misc anchor bolts, mounting hardware allowance | ---- | 2.0 ls | - | 10,000.00 | - | - | - | 10,000.00 /ls | 20,000 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **11999 ACTIFLO** | | | | | | | | | | |
| 11-00-06.00 | FRP tank, alum,7,500 gal.,UV resistant | BC-0016 | 2.0 ea | 2,022.71 | 21,000.00 | - | 622.71 | | 23,645.42 /ea | 47,291 |
| 11-00-08.00 | Chemical metering pump, alum | BC-0001 | 2.0 ea | 459.41 | 11,000.00 | - | - | - | 11,459.41 /ea | 22,919 |
| 11-00-08.00 | Chemical metering pump, methanol | BC-0041 | 2.0 ea | 565.42 | 11,000.00 | - | - | - | 11,565.42 /ea | 23,131 |
| 11-00-08.00 | Hydrocyclone installation | ---- | 2.0 ea | 3,347.94 | - | - | 747.26 | - | 4,095.19 /ea | 8,190 |
| 11-99-99.99 | ACTIFLO treatment system,14.2 MGD per train,incl in-line rapid mix,coag mixer,draft tube mix,lamella settler,scraper,troughs,recirc pumps,hydrocyclone | MISC | 2.0 LS | 31,386.92 | 1,150,000.00 | | 7,502.40 | - | 1,188,889.31 /LS | 2,377,779 |
| | **ACTIFLO** | | **1.0 LS** | **92,527.43** | **2,965,000.00** | | **20,144.73** | | **3,077,672.16 /LS** | **3,077,672** |
| | **11 EQUIPMENT** | | | | | | | | | **5,382,217** |
| **22 PLUMBING** | | | | | | | | | | |
| **11999 ACTIFLO** | | | | | | | | | | |
| 22-07-19.10 | Alum tank and pump heat trace and insulation allowance | ---- | 1.0 ls | 17,950.00 | 25,000.00 | - | - | - | 42,950.00 /ls | 42,950 |
| | **ACTIFLO** | | **1.0 LS** | **17,950.00** | **25,000.00** | | | | **42,950.00 /LS** | **42,950** |
| | **22 PLUMBING** | | | | | | | | | **42,950** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **26001 Tertiary Treatment Process - E&I (#12)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 1,071,705.26 | - | - | 1,071,705.26 /LS | 1,071,705 |
| | **Tertiary Treatment Process - E&I (#12)** | | **1.0 LS** | | | **1,071,705.26** | | | **1,071,705.26 /LS** | **1,071,705** |
| | **26 ELECTRICAL** | | | | | | | | | **1,071,705** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Tertiary Treatment Process - E&I (#12)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 357,235.09 | - | - | 357,235.09 /LS | 357,235 |
| | **Tertiary Treatment Process - E&I (#12)** | | **1.0 LS** | | | **357,235.09** | | | **357,235.09 /LS** | **357,235** |
| | **27 COMMUNICATIONS** | | | | | | | | | **357,235** |
| **31 EARTHWORK** | | | | | | | | | | |
| **01999 Dewatering** | | | | | | | | | | |
| 01-54-33.70 | Rent wellpoint header pipe, 6" diameter, 400 gpm | 0500 | 1,200.0 day | - | - | - | 0.40 | - | 0.40 /day | 480 |
| 31-23-19.20 | Dewatering, pumping 8 hours, attended 2 hrs per day, 6" centrifugal pump, includes 20 LF of suction hose and 100 LF of discharge hose | 1100 | 120.0 day | 857.51 | - | - | 377.70 | - | 1,235.21 /day | 148,225 |
| 31-23-19.30 | Wells, for dewatering, with steel casing, 10' to 20' deep, 2' diameter, minimum | 0020 | 150.0 vlf | 9.63 | 23.18 | - | 2.25 | - | 35.06 /vlf | 5,259 |
| | **Dewatering** | | **1.0 LS** | **104,345.66** | **3,477.00** | | **46,141.20** | | **153,963.86 /LS** | **153,964** |
| **03330 Slabs Actiflow tank** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 88.9 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 159 |
| | **Slabs Actiflow tank** | | **800.0 cy** | **0.12** | | | **0.08** | | **0.20 /cy** | **159** |
| **03330 Slabs Coagulaton Tank** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 16.0 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 29 |
| | **Slabs Coagulaton Tank** | | **144.0 cy** | **0.12** | | | **0.08** | | **0.20 /cy** | **29** |
| **03330 Slabs Hydrocone** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 25.0 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 45 |
| | **Slabs Hydrocone** | | **8.3 cy** | **3.20** | | | **2.17** | | **5.36 /cy** | **45** |
| **03330 Slabs Disc Filters** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 66.7 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 119 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Slabs Disc Filters** | | **25.9 cy** | **2.74** | | | **1.86** | | **4.60 /cy** | **119** |
| **03330 Slabs Alum Storage and Pumps** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 66.7 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 119 |
| | **Slabs Alum Storage and Pumps** | | **26.5 cy** | **2.68** | | | **1.82** | | **4.50 /cy** | **119** |
| **31250 Shoring Systems** | | | | | | | | | | |
| 31-41-16.10 | Sheet piling, steel, 27 psf, 20' excavation, per S.F., drive, extract and salvage, excludes wales | 1600 | 4,374.0 sf | 9.83 | 6.37 | - | 7.87 | - | 24.07 /sf | 105,281 |
| 31-41-16.10 | Sheet piling, wales, connections and struts, 2/3 salvage | 2500 | 5.9 ton | - | 410.40 | - | - | - | 410.40 /ton | 2,421 |
| | **Shoring Systems** | | **4,374.0 sf** | **9.83** | **6.92** | | **7.87** | | **24.62 /sf** | **107,703** |
| **31315 Excavation and Backfill ACTIFLO** | | | | | | | | | | |
| 31-05-16.10 | Aggregate for earthwork, bank run gravel, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction | 0100 | 100.0 lcy | 2.52 | 22.02 | - | 4.71 | - | 29.25 /lcy | 2,925 |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 2,430.0 bcy | 6.99 | - | - | 7.64 | - | 14.63 /bcy | 35,551 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 90.0 ecy | 5.30 | - | - | 1.50 | - | 6.80 /ecy | 612 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 2,196.0 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 18,774 |
| | **Excavation and Backfill ACTIFLO** | | **2,451.3 cy** | **9.99** | **0.90** | | **12.72** | | **23.60 /cy** | **57,862** |
| | **31 EARTHWORK** | | | | | | | | | **319,998** |
| | **05 Tertiary Treatment Processes** | | **1.0 LS** | **399,446.39** | **5,415,062.74** | **1,428,940.35** | **139,408.91** | | **7,382,858.39 /LS** | **7,382,858** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **06 Centrate EQ** | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | |
| **03330 Slabs Centrate Tank No. 2 - 100,000 gal** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 48.0 cy | - | 33.69 | - | - | - | 33.69 /cy | 1,617 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 144.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 1,156 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 12.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 687 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 7.2 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 14,602 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 7.2 ton | 39.87 | - | - | 7.51 | - | 47.39 /ton | 341 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 7.2 ton | 43.34 | - | - | 8.17 | - | 51.50 /ton | 371 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 100.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 9,880 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 100.8 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 1,178 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 1,296.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 1,181 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 1,296.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 1,289 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 13.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 257 |
| | **Slabs Centrate Tank No. 2 - 100,000 gal** | | **100.8 cy** | **117.50** | **201.99** | | **3.50** | | **322.98 /cy** | **32,557** |
| **03333 Centrate pumps equipment Pads** | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 120.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 1,032 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.1 ton | 39.90 | - | - | 7.50 | - | 47.40 /ton | 5 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.1 ton | 43.40 | - | - | 8.20 | - | 51.54 /ton | 5 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 5.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 508 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 5.2 cy | 27.68 | - | - | 5.70 | - | 33.38 /cy | 173 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 5.2 cy | 46.13 | - | - | 13.04 | - | 59.17 /cy | 307 |
| | **Centrate pumps equipment Pads** | | **5.2 cy** | **243.06** | **129.51** | | **19.05** | | **391.63 /cy** | **2,031** |
| **03345 Concrete Walls - Centrate Tank** | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 3,168.0 sfca | 6.18 | 0.75 | - | - | - | 6.93 /sfca | 21,946 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 8.4 gal | - | 20.66 | - | - | - | 20.66 /gal | 175 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 5.5 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 9,825 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls - Centrate Tank** | | | | | | | | | | |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 5.5 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 261 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 5.5 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 283 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 92.4 cy | - | 98.01 | - | - | - | 98.01 /cy | 9,056 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 92.4 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 3,598 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 3,168.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 8,004 |
| | **Concrete Walls - Centrate Tank** | | **92.4 cy** | **361.15** | **198.96** | | **15.08** | | **575.19 /cy** | **53,148** |
| | **03 CONCRETE** | | | | | | | | | **87,735** |
| **05 METALS** | | | | | | | | | | |
| **11999 Centrate** | | | | | | | | | | |
| 05-58-09.50 | Pump mounting base plate, complete w/ anchor bolts, 4 sf | BC-0001 | 4.0 ea | 622.68 | 795.79 | - | - | - | 1,418.47 /ea | 5,674 |
| | **Centrate** | | **1.0 LS** | **2,490.70** | **3,183.16** | | | | **5,673.86 /LS** | **5,674** |
| | **05 METALS** | | | | | | | | | **5,674** |
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Centrate** | | | | | | | | | | |
| 11-00-09.00 | Pump, cntfgl, horiz mtd, end suct,vert splt,sgl stg,70GPM,5HP,2"D | BC-0076 | 4.0 ea | 1,255.48 | 4,000.00 | - | 150.05 | - | 5,405.53 /ea | 21,622 |
| | **Centrate** | | **1.0 LS** | **5,021.91** | **16,000.00** | | **600.19** | | **21,622.10 /LS** | **21,622** |
| | **11 EQUIPMENT** | | | | | | | | | **21,622** |
| **13 SPECIAL CONSTRUCTION** | | | | | | | | | | |
| **13999 Aluminum dome** | | | | | | | | | | |
| 01-54-19.50 | Crane crew, daily use for small jobs, 100-ton truck-mounted hydraulic crane, portal to portal | 0600 | 2.0 day | 955.55 | - | - | 2,382.93 | - | 3,338.48 /day | 6,677 |
| 13-34-23.35 | Geodesic dome, shell only, aluminum framed, aluminum closure panels, 40' diameter | 2200 | 1,100.0 sffl | 0.60 | 24.50 | - | - | - | 25.10 /sffl | 27,613 |
| | **Aluminum dome** | | **1.0 LS** | **2,574.47** | **26,950.00** | | **4,765.86** | | **34,290.33 /LS** | **34,290** |
| | **13 SPECIAL CONSTRUCTION** | | | | | | | | | **34,290** |
| **22 PLUMBING** | | | | | | | | | | |
| **22999 Centrate Piping** | | | | | | | | | | |
| 22-99-99.99 | Centrate above grade piping allowance | MISC | 4.0 LS | 4,487.50 | 6,250.00 | | - | - | 10,737.50 /LS | 42,950 |
| | **Centrate Piping** | | **1.0 LS** | **17,950.00** | **25,000.00** | | | | **42,950.00 /LS** | **42,950** |
| **33500 Centrate** | | | | | | | | | | |
| 22-20-00.65 | Piping, DI, glass lined, CL 50, 6" dia | BC-0311 | 50.0 lnft | 13.96 | 60.00 | - | 3.02 | - | 76.98 /lnft | 3,849 |
| 22-20-00.65 | Tie-in to existing centrate discharge piping | ---- | 1.0 ls | 718.00 | 2,000.00 | - | 1,000.00 | - | 3,718.00 /ls | 3,718 |
| | **Centrate** | | **50.0 LF** | **28.32** | **100.00** | | **23.02** | | **151.34 /LF** | **7,567** |
| | **22 PLUMBING** | | | | | | | | | **50,517** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **26001 Centrate EQ and Treatment - E&I (#10)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 43,439.03 | - | - | 43,439.03 /LS | 43,439 |
| | **Centrate EQ and Treatment - E&I (#10)** | | **1.0 LS** | | | **43,439.03** | | | **43,439.03 /LS** | **43,439** |
| | **26 ELECTRICAL** | | | | | | | | | **43,439** |
| **27 COMMUNICATIONS** | | | | | | | | | | |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **26001 Centrate EQ and Treatment - E&I (#10)** | | | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 | LS | - | - | 14,479.68 | - | - | 14,479.68 | /LS | 14,480 |
| | **Centrate EQ and Treatment - E&I (#10)** | | **1.0** | **LS** | | | **14,479.68** | | | **14,479.68** | **/LS** | **14,480** |
| | **27 COMMUNICATIONS** | | | | | | | | | | | **14,480** |
| **31 EARTHWORK** | | | | | | | | | | | | |
| **01999 Dewatering** | | | | | | | | | | | | |
| 31-23-19.20 | Dewatering, pumping 8 hours, attended 2 hrs per day, 6" centrifugal pump, includes 20 LF of suction hose and 100 LF of discharge hose | 1100 | 88.0 | day | 857.51 | - | - | 377.70 | - | 1,235.21 | /day | 108,698 |
| 31-23-19.30 | Wells, for dewatering, with steel casing, 10' to 20' deep, 2' diameter, minimum | 0020 | 150.0 | vlf | 76.64 | 184.52 | - | 17.92 | - | 279.08 | /vlf | 41,862 |
| | **Dewatering** | | **1.0** | **LS** | **86,956.83** | **27,678.48** | | **35,925.34** | | **150,560.65** | **/LS** | **150,561** |
| **03330 Slabs Centrate Tank No. 2 - 100,000 gal** | | | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 144.0 | sy | 1.07 | - | - | 0.72 | - | 1.79 | /sy | 257 |
| | **Slabs Centrate Tank No. 2 - 100,000 gal** | | **100.8** | **cy** | **1.52** | | | **1.03** | | **2.55** | **/cy** | **257** |
| **31315 Excavation and Backfill 100,000 gal tank** | | | | | | | | | | | | |
| 31-05-16.10 | Aggregate for earthwork, bank run gravel, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction | 0100 | 111.1 | lcy | 2.52 | 22.02 | - | 4.71 | - | 29.25 | /lcy | 3,250 |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 207.1 | bcy | 6.99 | - | - | 7.64 | - | 14.63 | /bcy | 3,030 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 111.1 | ecy | 13.60 | - | - | 3.85 | - | 17.44 | /ecy | 1,938 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 207.1 | lcy | 3.08 | - | - | 5.47 | - | 8.55 | /lcy | 1,771 |
| | **Excavation and Backfill 100,000 gal tank** | | **207.1** | **cy** | **18.72** | **11.81** | | **17.70** | | **48.23** | **/cy** | **9,989** |
| **33500 Centrate** | | | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering | 0110 | 48.1 | bcy | 3.73 | - | - | 2.23 | - | 5.96 | /bcy | 287 |
| 31-23-23.13 | Backfill, trench, air tamped compaction, add | 2000 | 38.9 | ecy | 13.60 | - | - | 3.85 | - | 17.44 | /ecy | 678 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 8.9 | lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 | /lcy | 213 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 8.9 | ecy | 5.57 | - | - | 0.41 | - | 5.98 | /ecy | 53 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 9.3 | lcy | 6.23 | - | - | 5.24 | - | 11.48 | /lcy | 106 |
| | **Centrate** | | **50.0** | **LF** | **18.20** | **1.94** | | **6.62** | | **26.75** | **/LF** | **1,338** |
| | **31 EARTHWORK** | | | | | | | | | | | **162,145** |
| **33 UTILITIES** | | | | | | | | | | | | |
| **33500 Centrate** | | | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 1.0 | clf | 3.34 | 5.56 | - | - | - | 8.90 | /clf | 9 |
| | **Centrate** | | **50.0** | **LF** | **0.07** | **0.11** | | | | **0.18** | **/LF** | **9** |
| | **33 UTILITIES** | | | | | | | | | | | **9** |
| | **06 Centrate EQ** | | **1.0** | **LS** | **167,827.55** | **145,776.96** | **57,918.71** | **48,387.31** | | **419,910.53** | **/LS** | **419,911** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **08 Influent Pump Station** | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | |
| **03330 Slabs Pump station wet well** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 55.6 cy | - | 33.69 | - | - | - | 33.69 /cy | 1,872 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 130.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 1,043 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 11.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 630 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 11.1 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 22,533 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 11.1 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 526 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 11.1 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 572 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 116.7 cy | - | 98.01 | - | - | - | 98.01 /cy | 11,435 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 116.7 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 1,363 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed and bull float(darby) finish | 0100 | 1,500.0 sf | 0.38 | - | - | - | - | 0.38 /sf | 567 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 15.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 297 |
| | **Slabs Pump station wet well** | | **116.7 cy** | **127.29** | **219.26** | | **3.49** | | **350.04 /cy** | **40,839** |
| **03330 Slabs Pump station slab** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 37.0 cy | - | 33.69 | - | - | - | 33.69 /cy | 1,248 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning | 3050 | 140.0 sfca | 4.16 | 0.80 | - | - | - | 4.96 /sfca | 694 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 2.8 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 5,634 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 2.8 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 132 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 2.8 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 143 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 38.9 cy | - | 98.01 | - | - | - | 98.01 /cy | 3,812 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, pumped, over 6" thick, includes vibrating, excludes material | 4650 | 38.9 cy | 20.95 | - | - | 4.31 | - | 25.26 /cy | 982 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 1,000.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 911 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 1,000.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 994 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 10.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 198 |
| | **Slabs Pump station slab** | | **38.9 cy** | **159.05** | **213.96** | | **6.20** | | **379.22 /cy** | **14,748** |
| **03345 Concrete Walls wet well** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, box out for opening, to 16" thick, over 10 S.F. (use perimeter), includes erecting, bracing, stripping and cleaning | 0150 | 16.0 lf | 9.93 | 2.33 | - | - | - | 12.26 /lf | 196 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls wet well** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 36.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 455 |
| 03-11-13.85 | Cip concrete forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 4,680.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 36,036 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 12.5 gal | - | 20.66 | - | - | - | 20.66 /gal | 258 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 36.0 lf | 3.24 | 14.92 | - | - | - | 18.15 /lf | 654 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 3.0 ea | 9.38 | 35.78 | - | - | - | 45.17 /ea | 136 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 12.9 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 23,063 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 12.9 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 612 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 12.9 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 665 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 135.6 cy | - | 98.01 | - | - | - | 98.01 /cy | 13,287 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 135.6 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 5,279 |
| 03-35-29.60 | Finishing: break ties & patch voids (walls, cols or beams) | 0010 | 4,648.0 sf | 0.97 | 0.03 | - | - | - | 1.00 /sf | 4,650 |
| | **Concrete Walls wet well** | | **135.6 cy** | **394.32** | **226.66** | | **8.14** | | **629.12 /cy** | **85,290** |
| **03350 Wet well elev slab** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 750.0 sf | 4.97 | 1.27 | - | - | - | 6.24 /sf | 4,678 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 140.0 lf | 3.62 | 0.21 | - | - | - | 3.83 /lf | 537 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 2.4 ton | 821.66 | 992.00 | - | - | - | 1,813.66 /ton | 4,416 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 ton | 40.00 | - | - | 7.00 | - | 47.00 /ton | 1 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 ton | 114.00 | - | - | 21.00 | - | 135.00 /ton | 2 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 29.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 2,859 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, with crane and bucket, over 10" thick, includes vibrating, excludes material | 1650 | 29.2 cy | 33.71 | - | - | 9.53 | - | 43.24 /cy | 1,261 |
| 03-35-29.30 | Finishing elev slab, manual screed, bull float, machine float & trowel | 0275 | 750.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 683 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 7.5 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 149 |
| | **Wet well elev slab** | | **27.8 cy** | **286.26** | **227.96** | | **10.82** | | **525.05 /cy** | **14,585** |
| | **03 CONCRETE** | | | | | | | | | **155,461** |

**04 STONE & MASONRY**

**04220 Exterior Masonry Walls Pump station**

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **04220 Exterior Masonry Walls Pump station** | | | | | | | | | | |
| 04-05-16.30 | Grout, door frames, 3' x 7' opening, 2.5 CF per opening | 0800 | 2.0 opng | 32.67 | 10.51 | - | 2.27 | - | 45.45 /opng | 91 |
| 04-05-16.30 | Grout, door frames, 6' x 7' opening, 3.5 CF per opening | 0850 | 2.0 opng | 43.56 | 14.70 | - | 3.03 | - | 61.28 /opng | 123 |
| 04-05-16.30 | Grout, for bond beams, lintels and concrete masonry unit (CMU) cores, C476, includes material only | 2000 | 1,428.0 cf | 5.60 | 4.20 | - | 0.39 | - | 10.19 /cf | 14,555 |
| 04-05-19.26 | Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed horizontally, ASTM A615 | 0020 | 1,156.0 lb | 0.65 | 0.46 | - | - | - | 1.11 /lb | 1,280 |
| 04-05-19.26 | Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed vertically, ASTM A615 | 0060 | 2,652.0 lb | 0.80 | 0.46 | - | - | - | 1.26 /lb | 3,337 |
| 04-05-19.26 | Masonry reinforcing bars, truss type steel joint reinforcing, mill standard galvanized, 12" wide | 0250 | 25.5 clf | 26.07 | 24.73 | - | - | - | 50.79 /clf | 1,295 |
| 04-05-19.26 | Allow - shoring and bracing at CMU walls (percentage wall area) | 0500 | 1,700.0 sfwa | 0.75 | 0.17 | - | - | - | 0.93 /sfwa | 1,572 |
| 04-22-10.28 | Concrt block,high strngt,hollow,3500 psi,12"8"16",inclds mortar and horzntl joint rnfrcng every other course,excluds scffldn,grout and verticl rnfrcng | 0350 | 3,400.0 sf | 11.33 | 5.95 | - | - | - | 17.28 /sf | 58,748 |
| 04-72-10.10 | Precast concrete coping, stock units, 12" wall, 14" wide, 4" tapers to 3-1/2", includes mortar, excludes scaffolding | 0110 | 170.0 lf | 14.53 | 24.89 | - | - | - | 39.42 /lf | 6,700 |
| | **Exterior Masonry Walls Pump station** | | **3,400.0 sf** | **15.88** | **9.75** | | **0.17** | | **25.79 /sf** | **87,701** |
| | **04 STONE & MASONRY** | | | | | | | | | **87,701** |
| **06 WOOD & PLASTICS** | | | | | | | | | | |
| **06120 Wood Framing -Roof, Pump Station** | | | | | | | | | | |
| 06-05-23.10 | Nails, floor or roof sheathing | 1025 | 29.3 lb | - | 2.45 | - | - | - | 2.45 /lb | 72 |
| 06-05-23.10 | Nails, roof framing, sinkers, 8d to 16d, allow 20 lbs per MBF | 5625 | 107.0 lb | - | 2.33 | - | - | - | 2.33 /lb | 249 |
| 06-05-23.60 | Average cost, hold downs (HD's), 7 to 12 gauge, glulams/beams | 1230 | 4.0 ea | - | 23.28 | - | - | - | 23.28 /ea | 93 |
| 06-05-23.60 | Threaded rod for hold downs, to 1-1/4" diameter, glulams/beams | 1295 | 40.0 lf | 3.08 | 1.03 | - | 0.25 | - | 4.36 /lf | 174 |
| 06-05-23.60 | Rafter anchors, 18 ga galv, 1.5" wide, 5.25" L, cost per 100 | 3525 | 0.2 c | 317.30 | 37.25 | - | - | - | 354.55 /c | 71 |
| 06-11-10.10 | Framing, beams/girders, 6x or larger, allow average cost per MBF | 3800 | 1.0 mbf | 1,150.34 | 1,539.45 | - | - | - | 2,689.79 /mbf | 2,690 |
| 06-11-10.30 | Wood framing, roofs, fascia boards, 2" x 8" | 6070 | 0.2 mbf | 3,067.58 | 601.80 | - | - | - | 3,669.40 /mbf | 833 |
| 06-11-10.30 | Wood framing, roofs, rafters, to 4 in 12 pitch, 2" x 8" | 7060 | 2.0 mbf | 730.37 | 601.79 | - | - | - | 1,332.16 /mbf | 2,611 |
| 06-11-10.30 | Framing, roofs, hip and valley rafters, 2" x 10" | 7365 | 0.0 mbf | 862.90 | 681.20 | - | - | - | 1,544.00 /mbf | 65 |
| 06-11-10.30 | Wood framing, roofs, hip and valley rafters, to 4 in 12 pitch, 2" x 8" | 7600 | 2.0 mbf | 1,415.80 | 601.79 | - | - | - | 2,017.59 /mbf | 4,067 |
| 06-11-10.30 | Wood framing, roofs, rafter ties, #3, 1" x 4" | 7800 | 0.0 mbf | 3,409.00 | 1,306.00 | - | - | - | 4,714.00 /mbf | 33 |
| 06-11-10.30 | Framing, roofs, ridge board, #2 or better, 2" x 12" | 7922 | 0.1 mbf | 1,207.90 | 690.40 | - | - | - | 1,898.30 /mbf | 190 |
| 06-11-10.42 | Furring, wood, on ceilings, on wood, 1" x 3" | 0850 | 160.0 lf | 1.32 | 0.36 | - | - | - | 1.68 /lf | 269 |
| 06-16-36.10 | Sheathing, plywood on roof, CDX, 1/2" thick, pneumatic nailed | 0105 | 1,800.0 sf | 0.54 | 0.56 | - | - | - | 1.10 /sf | 1,978 |
| 06-16-36.10 | Sheathing, with boards, on roof, laid horizontal, 1" x 6" | 1400 | 150.0 sf | 1.27 | 1.47 | - | - | - | 2.73 /sf | 410 |
| | **Wood Framing -Roof, Pump Station** | | **1,800.0 sf** | **4.37** | **3.29** | | **0.01** | | **7.67 /sf** | **13,805** |
| | **06 WOOD & PLASTICS** | | | | | | | | | **13,805** |
| **07 THERMAL PROTECTION** | | | | | | | | | | |
| **04220 Exterior Masonry Walls Pump station** | | | | | | | | | | |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **04220 Exterior Masonry Walls Pump station** | | | | | | | | | | |
| 07-19-19.10 | Silicone water repellants, sprayed on CMU, 2 coat | 0300 | 6,800.0 sf | 0.16 | 0.53 | - | - | - | 0.69 /sf | 4,683 |
| | **Exterior Masonry Walls Pump station** | | **3,400.0 sf** | **0.31** | **1.07** | | | | **1.38 /sf** | **4,683** |
| **06120 Wood Framing -Roof, Pump Station** | | | | | | | | | | |
| 07-21-16.20 | Blanket insulation, for walls or ceilings, kraft faced fiberglass, 6" thick, R19, 23" wide | 0180 | 1,800.0 sf | 0.28 | 0.37 | - | - | - | 0.65 /sf | 1,175 |
| 07-26-10.10 | Building Paper, vapor barrier, asphalt felt sheathing paper, 15# | 0400 | 18.0 sq | 12.06 | 4.81 | - | - | - | 16.87 /sq | 304 |
| 07-41-13.20 | Steel roofing panels, on steel frame, flat profile, standard finish, 1-3/4" standing seams, 10" wide, 26 gauge | 0710 | 1,800.0 sf | 2.41 | 3.73 | - | - | - | 6.14 /sf | 11,048 |
| | **Wood Framing -Roof, Pump Station** | | **1,800.0 sf** | **2.81** | **4.15** | | | | **6.96 /sf** | **12,526** |
| | **07 THERMAL PROTECTION** | | | | | | | | | **17,210** |
| **09 FINISHES** | | | | | | | | | | |
| **06120 Wood Framing -Roof, Pump Station** | | | | | | | | | | |
| 09-91-06.41 | Coatings & paints, B & C coating system E-8 (Clear epoxy, wood) | BC-0051 | 1,800.0 sqft | 0.26 | 0.44 | - | - | - | 0.70 /sqft | 1,262 |
| | **Wood Framing -Roof, Pump Station** | | **1,800.0 sf** | **0.26** | **0.44** | | | | **0.70 /sf** | **1,262** |
| | **09 FINISHES** | | | | | | | | | **1,262** |
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Influent Pump Station** | | | | | | | | | | |
| 09-99-99.99 | Coatings allowance | MISC | 1.0 LS | - | - | 30,000.00 | - | - | 30,000.00 /LS | 30,000 |
| 11-00-04.00 | Hydraulic structures, slide gate, stainless stl, ab & grout,48" x 48" | BC-0106 | 1.0 ea | 2,540.11 | 7,957.95 | - | 573.18 | - | 11,071.24 /ea | 11,071 |
| 11-00-11.05 | Wastewater, submersible,4400 GPM gpm,guide rails, base elbow,175 hp, VFD driven | BC-0011 | 4.0 ea | 9,199.66 | 130,000.00 | - | - | - | 139,199.66 /ea | 556,799 |
| 41-21-23.16 | Conveyors, material handling, monorail, overhead, manual, channel type, 500 lb per LF | 3900 | 40.0 lf | 26.93 | 20.50 | - | - | - | 47.43 /lf | 1,897 |
| 41-21-23.16 | Conveyors, material handling, monorail, overhead, manual, channel type, trolleys for, 8 wheel, 500 lb capacity | 4300 | 1.0 ea | - | 770.00 | 300.00 | - | - | 1,070.00 /ea | 1,070 |
| 41-22-23.10 | Hoists, material handling, electric overhead, chain, hook hung, 15' lift, 5 ton capacity | 2500 | 1.0 ea | - | 6,925.00 | 350.00 | - | - | 7,275.00 /ea | 7,275 |
| 41-22-23.10 | Hoists, material handling, electric overhead, chain, hook hung, 15' lift, 1 ton capacity, for lifts over 15', 5 ton, add | 3100 | 5.0 lf | - | 56.50 | 12.00 | - | - | 68.50 /lf | 343 |
| | **Influent Pump Station** | | **1.0 LS** | **40,415.72** | **536,755.45** | **30,710.00** | **573.18** | | **608,454.35 /LS** | **608,454** |
| | **11 EQUIPMENT** | | | | | | | | | **608,454** |
| **22 PLUMBING** | | | | | | | | | | |
| **22999 Influent Pump piping** | | | | | | | | | | |
| 09-99-99.99 | Coating systems allowance | MISC | 1.0 LS | - | - | 20,000.00 | - | - | 20,000.00 /LS | 20,000 |
| 22-11-13.44 | Pump discharge piping allowance | ---- | 1.0 ls | 29,520.00 | 100,000.00 | - | 20,000.00 | - | 149,520.00 /ls | 149,520 |
| | **Influent Pump piping** | | **1.0 LS** | **29,520.00** | **100,000.00** | **20,000.00** | **20,000.00** | | **169,520.00 /LS** | **169,520** |
| **33500 Influent PS Yard Piping** | | | | | | | | | | |
| 22-20-01.90 | Piping, pipe, Welded Steel, Welded Jt, 36" diameter | BC-1256 | 1,625.0 lnft | 20.11 | 244.00 | - | 4.35 | - | 268.45 /lnft | 436,237 |
| 22-20-01.90 | Pipe, steel, welding labor per joint, 36"dia | BC-1306 | 45.0 ea | 1,979.44 | | - | 75.78 | - | 2,055.22 /ea | 92,485 |
| 22-20-01.95 | Pipe, steel ftngs, CI, standard weight, black, 90< elb, straight, 36" | BC-0116 | 5.0 ea | 1,843.18 | 3,042.00 | - | 995.92 | - | 5,881.10 /ea | 29,406 |
| 22-99-99.99 | Tie into existing influent piping/structure allowance | ---- | 1.0 LS | 50,000.00 | 250,000.00 | - | - | - | 300,000.00 /LS | 300,000 |
| | **Influent PS Yard Piping** | | **1,625.0 LF** | **111.36** | **407.21** | | **9.51** | | **528.08 /LF** | **858,127** |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **22 PLUMBING** | | | | | | | | | | | **1,027,647** |
| **26 ELECTRICAL** | | | | | | | | | | | | |
| **26001 Influent Pump Station - E&I** | | | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 | LS | - | - | 597,328.02 | - | - | 597,328.02 | /LS | 597,328 |
| | **Influent Pump Station - E&I** | | **1.0** | **LS** | | | **597,328.02** | | | **597,328.02** | **/LS** | **597,328** |
| | **26 ELECTRICAL** | | | | | | | | | | | **597,328** |
| **27 COMMUNICATIONS** | | | | | | | | | | | | |
| **26001 Influent Pump Station - E&I** | | | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 | LS | - | - | 114,870.78 | - | - | 114,870.78 | /LS | 114,871 |
| | **Influent Pump Station - E&I** | | **1.0** | **LS** | | | **114,870.78** | | | **114,870.78** | **/LS** | **114,871** |
| | **27 COMMUNICATIONS** | | | | | | | | | | | **114,871** |
| **31 EARTHWORK** | | | | | | | | | | | | |
| **01999 Dewatering** | | | | | | | | | | | | |
| 01-54-33.70 | Rent wellpoint header pipe, 6" diameter, 400 gpm | 0500 | 900.0 | day | - | - | - | 0.40 | - | 0.40 | /day | 360 |
| 31-23-19.20 | Dewatering, pumping 8 hours, attended 2 hrs per day, 6" centrifugal pump, includes 20 LF of suction hose and 100 LF of discharge hose | 1100 | 90.0 | day | 857.51 | - | - | 377.70 | - | 1,235.21 | /day | 111,169 |
| 31-23-19.30 | Wells, for dewatering, with steel casing, 10' to 20' deep, 2' diameter, minimum | 0020 | 100.0 | vlf | 76.64 | 184.52 | - | 17.92 | - | 279.08 | /vlf | 27,908 |
| | **Dewatering** | | **1.0** | **LS** | **84,839.97** | **18,452.33** | | **36,144.70** | | **139,437.00** | **/LS** | **139,437** |
| **03330 Slabs Pump station wet well** | | | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 166.7 | sy | 1.07 | - | - | 0.72 | - | 1.79 | /sy | 298 |
| | **Slabs Pump station wet well** | | **116.7** | **cy** | **1.52** | | | **1.03** | | **2.55** | **/cy** | **298** |
| **03330 Slabs Pump station slab** | | | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 111.1 | sy | 1.07 | - | - | 0.72 | - | 1.79 | /sy | 199 |
| | **Slabs Pump station slab** | | **38.9** | **cy** | **3.04** | | | **2.06** | | **5.11** | **/cy** | **199** |
| **31250 Shoring Systems** | | | | | | | | | | | | |
| 31-41-16.10 | Sheet piling, steel, 27 psf, 20' excavation, per S.F., drive, extract and salvage, excludes wales | 1600 | 3,400.0 | sf | 9.83 | 6.37 | - | 7.87 | - | 24.07 | /sf | 81,837 |
| 31-41-16.10 | Sheet piling, wales, connections and struts, 2/3 salvage | 2500 | 9.0 | ton | - | 410.40 | - | - | - | 410.40 | /ton | 3,698 |
| | **Shoring Systems** | | **3,400.0** | **sf** | **9.83** | **7.46** | | **7.87** | | **25.16** | **/sf** | **85,535** |
| **31315 Excavation and Backfill pump station** | | | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 1,296.0 | bcy | 6.99 | - | - | 7.64 | - | 14.63 | /bcy | 18,961 |
| 31-23-23.14 | Backfill, structural, common earth, 105 H.P. dozer, 50' haul, from existing stockpile, excludes compaction | 3020 | 964.0 | lcy | 0.70 | - | - | 0.50 | - | 1.20 | /lcy | 1,159 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 724.0 | lcy | 3.08 | - | - | 5.47 | - | 8.55 | /lcy | 6,189 |
| 31-23-23.23 | Compaction, 3 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller | 5700 | 668.0 | ecy | 0.25 | - | - | 0.35 | - | 0.60 | /ecy | 399 |
| | **Excavation and Backfill pump station** | | **648.0** | **cy** | **18.72** | | | **22.50** | | **41.22** | **/cy** | **26,708** |
| **33500 Influent PS Yard Piping** | | | | | | | | | | | | |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **33500 Influent PS Yard Piping** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 6,454.9 bcy | 2.80 | - | - | 2.07 | - | 4.87 /bcy | 31,434 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with sheepsfoot roller | 2300 | 4,092.6 ecy | 1.32 | - | - | 2.85 | - | 4.16 /ecy | 17,043 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 1,936.8 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 46,399 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 1,936.8 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 11,573 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 2,362.3 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 27,109 |
| | **Influent PS Yard Piping** | | **1,625.0 LF** | **42.75** | **12.98** | | **26.46** | | **82.19 /LF** | **133,557** |
| | **31 EARTHWORK** | | | | | | | | | **385,733** |
| **33 UTILITIES** | | | | | | | | | | |
| **33500 Influent PS Yard Piping** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 16.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 142 |
| | **Influent PS Yard Piping** | | **1,625.0 LF** | **0.03** | **0.06** | | | | **0.09 /LF** | **142** |
| | **33 UTILITIES** | | | | | | | | | **142** |
| | **08 Influent Pump Station** | | **1.0 LS** | **601,963.90** | **1,485,405.99** | **762,908.80** | **159,335.54** | | **3,009,614.23 /LS** | **3,009,614** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **09 Acetate/Methanol** | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | |
| **03330 Slabs Chemical Storage** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 5.6 cy | - | 33.69 | - | - | - | 33.69 /cy | 187 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, slab blockouts, wood, to 12" high, 1 use, includes erecting, bracing, stripping and cleaning | 4000 | 32.0 lf | 9.05 | 0.81 | - | - | - | 9.86 /lf | 315 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.6 ton | 1,036.00 | 992.00 | - | - | - | 2,028.00 /ton | 1,128 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.6 ton | 39.87 | - | - | 7.52 | - | 47.40 /ton | 26 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.6 ton | 43.35 | - | - | 8.17 | - | 51.51 /ton | 29 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 11.7 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,144 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, pumped, over 6" thick, includes vibrating, excludes material | 4650 | 11.7 cy | 20.95 | - | - | 4.31 | - | 25.26 /cy | 295 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 300.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 273 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 300.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 298 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 3.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 59 |
| | **Slabs Chemical Storage** | | **300.0 cy** | **5.53** | **6.75** | | **0.23** | | **12.52 /cy** | **3,754** |
| **03330 Slabs tank** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 14.8 cy | - | 33.69 | - | - | - | 33.69 /cy | 499 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning | 3050 | 110.0 sfca | 4.16 | 0.80 | - | - | - | 4.96 /sfca | 545 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 1.4 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 2,817 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 1.4 ton | 39.87 | - | - | 7.52 | - | 47.39 /ton | 66 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 1.4 ton | 43.34 | - | - | 8.16 | - | 51.51 /ton | 72 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 22.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 2,178 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, pumped, over 6" thick, includes vibrating, excludes material | 4650 | 22.2 cy | 20.95 | - | - | 4.31 | - | 25.26 /cy | 561 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and broom finish | 0150 | 600.0 sf | 0.82 | - | - | - | - | 0.82 /sf | 490 |
| | **Slabs tank** | | **22.2 cy** | **133.56** | **186.42** | | **5.29** | | **325.27 /cy** | **7,228** |
| **03333 Acetate tanks/pumps equipment Pads and containment** | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 740.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 6,365 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.3 ton | 39.90 | - | - | 7.50 | - | 47.41 /ton | 13 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.3 ton | 43.33 | - | - | 8.20 | - | 51.50 /ton | 14 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03333 Acetate tanks/pumps equipment Pads and containment** | | | | | | | | | | |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 13.5 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,325 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 13.5 cy | 27.68 | - | - | 5.70 | - | 33.38 /cy | 451 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 13.5 cy | 46.13 | - | - | 13.04 | - | 59.17 /cy | 800 |
| | **Acetate tanks/pumps equipment Pads and containment** | | **13.5 cy** | **471.83** | **172.51** | | **19.05** | | **663.39 /cy** | **8,968** |
| **03333 Acetate pumps Equipment Pads** | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 72.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 619 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.0 ton | 39.80 | - | - | 7.50 | - | 47.25 /ton | 2 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.0 ton | 43.30 | - | - | 8.30 | - | 51.50 /ton | 2 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 196 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 2.0 cy | 27.68 | - | - | 5.70 | - | 33.38 /cy | 67 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 2.0 cy | 46.13 | - | - | 13.04 | - | 59.17 /cy | 118 |
| | **Acetate pumps Equipment Pads** | | **2.0 cy** | **336.15** | **147.01** | | **19.05** | | **502.20 /cy** | **1,004** |
| **03333 Methanol tank/pump Equipment Pads and containment** | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 374.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 3,217 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.3 ton | 39.86 | - | - | 7.50 | - | 47.37 /ton | 13 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.3 ton | 43.35 | - | - | 8.17 | - | 51.50 /ton | 14 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 13.9 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,361 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 13.9 cy | 27.68 | - | - | 5.70 | - | 33.38 /cy | 464 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 13.9 cy | 46.13 | - | - | 13.04 | - | 59.17 /cy | 822 |
| | **Methanol tank/pump Equipment Pads and containment** | | **13.9 cy** | **270.46** | **134.66** | | **19.05** | | **424.17 /cy** | **5,891** |
| | **03 CONCRETE** | | | | | | | | | **26,847** |
| **04 STONE & MASONRY** | | | | | | | | | | |
| **04220 Exterior Masonry Walls chemical storage** | | | | | | | | | | |
| 04-05-16.30 | Grout, door frames, 3' x 7' opening, 2.5 CF per opening | 0800 | 2.0 opng | 32.67 | 10.51 | - | 2.27 | - | 45.45 /opng | 91 |
| 04-05-16.30 | Grout, door frames, 6' x 7' opening, 3.5 CF per opening | 0850 | 2.0 opng | 43.56 | 14.70 | - | 3.03 | - | 61.28 /opng | 123 |
| 04-05-16.30 | Grout, for bond beams, lintels and concrete masonry unit (CMU) cores, C476, includes material only | 2000 | 441.0 cf | 5.60 | 4.20 | - | 0.39 | - | 10.19 /cf | 4,495 |
| 04-05-19.26 | Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed horizontally, ASTM A615 | 0020 | 1,575.0 lb | 0.65 | 0.46 | - | - | - | 1.11 /lb | 1,745 |
| 04-05-19.26 | Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed vertically, ASTM A615 | 0060 | 819.0 lb | 0.80 | 0.46 | - | - | - | 1.26 /lb | 1,030 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **04220 Exterior Masonry Walls chemical storage** | | | | | | | | | | |
| 04-05-19.26 | Masonry reinforcing bars, truss type steel joint reinforcing, mill standard galvanized, 12" wide | 0250 | 7.7 clf | 26.07 | 24.73 | - | - | - | 50.79 /clf | 391 |
| 04-22-10.28 | Concrt block,high strngt,hollow,3500 psi,12"8"16",inclds mortar and horzntl joint rnfrcng every other course,excluds scffldn,grout and verticl rnfrcng | 0350 | 1,050.0 sf | 11.33 | 5.95 | - | - | - | 17.28 /sf | 18,143 |
| | **Exterior Masonry Walls chemical storage** | | **1,050.0 sf** | **15.62** | **8.98** | | **0.17** | | **24.78 /sf** | **26,017** |
| | **04 STONE & MASONRY** | | | | | | | | | **26,017** |
| **06 WOOD & PLASTICS** | | | | | | | | | | |
| **06120 Wood Framing - Roof Chemical Storage** | | | | | | | | | | |
| 06-05-23.10 | Nails, floor or roof sheathing | 1025 | 6.0 lb | - | 2.45 | - | - | - | 2.45 /lb | 15 |
| 06-05-23.10 | Nails, roof framing, sinkers, 8d to 16d, allow 20 lbs per MBF | 5625 | 6.0 lb | - | 2.33 | - | - | - | 2.33 /lb | 14 |
| 06-05-23.60 | Average cost, hold downs (HD's), 7 to 12 gauge, glulams/beams | 1230 | 4.0 ea | - | 23.28 | - | - | - | 23.28 /ea | 93 |
| 06-05-23.60 | Threaded rod for hold downs, to 1-1/4" diameter, glulams/beams | 1295 | 40.0 lf | 3.08 | 1.03 | - | 0.25 | - | 4.36 /lf | 174 |
| 06-05-23.60 | I-joist hanger (EWP), 12 to 16 ga., per 100, avg cost | 1460 | 0.1 c | 296.80 | 656.40 | - | - | - | 953.20 /c | 95 |
| 06-05-23.60 | Rafter anchors, 18 ga galv, 1.5" wide, 5.25" L, cost per 100 | 3525 | 0.2 c | 317.30 | 37.25 | - | - | - | 354.55 /c | 71 |
| 06-11-10.10 | Framing, beams/girders, 6x or larger, allow average cost per MBF | 3800 | 0.6 mbf | 1,150.34 | 1,539.44 | - | - | - | 2,689.79 /mbf | 1,641 |
| 06-11-10.30 | I-joist (composite) rafters , 24" o.c., w/ blocking, avg cost/sf | 1050 | 320.0 sffl | 0.78 | 1.92 | - | - | - | 2.70 /sffl | 865 |
| 06-11-10.30 | Wood framing, roofs, fascia boards, 2" x 8" | 6070 | 0.2 mbf | 3,067.58 | 601.80 | - | - | - | 3,669.40 /mbf | 833 |
| 06-11-10.30 | Wood framing, roofs, rafters, to 4 in 12 pitch, 2" x 8" | 7060 | 2.0 mbf | 730.37 | 601.79 | - | - | - | 1,332.16 /mbf | 2,611 |
| 06-11-10.30 | Framing, roofs, hip and valley rafters, 2" x 10" | 7365 | 0.0 mbf | 862.90 | 681.20 | - | - | - | 1,544.00 /mbf | 65 |
| 06-11-10.30 | Wood framing, roofs, hip and valley rafters, to 4 in 12 pitch, 2" x 8" | 7600 | 2.0 mbf | 1,415.80 | 601.79 | - | - | - | 2,017.59 /mbf | 4,067 |
| 06-11-10.30 | Wood framing, roofs, rafter ties, #3, 1" x 4" | 7800 | 0.0 mbf | 3,409.00 | 1,306.00 | - | - | - | 4,714.00 /mbf | 33 |
| 06-11-10.30 | Framing, roofs, ridge board, #2 or better, 2" x 12" | 7922 | 0.1 mbf | 1,207.90 | 690.40 | - | - | - | 1,898.30 /mbf | 190 |
| 06-11-10.42 | Furring, wood, on ceilings, on wood, 1" x 3" | 0850 | 320.0 lf | 1.32 | 0.36 | - | - | - | 1.68 /lf | 537 |
| 06-16-36.10 | Sheathing, plywood on roof, CDX, 1/2" thick, pneumatic nailed | 0105 | 300.0 sf | 0.54 | 0.56 | - | - | - | 1.10 /sf | 330 |
| 06-16-36.10 | Sheathing, with boards, on roof, laid horizontal, 1" x 6" | 1400 | 150.0 sf | 1.27 | 1.47 | - | - | - | 2.73 /sf | 410 |
| | **Wood Framing - Roof Chemical Storage** | | **300.0 sf** | **23.68** | **16.44** | | **0.03** | | **40.15 /sf** | **12,044** |
| | **06 WOOD & PLASTICS** | | | | | | | | | **12,044** |
| **07 THERMAL PROTECTION** | | | | | | | | | | |
| **04220 Exterior Masonry Walls chemical storage** | | | | | | | | | | |
| 07-19-19.10 | Silicone water repellants, sprayed on CMU, 2 coat | 0300 | 2,100.0 sf | 0.16 | 0.53 | - | - | - | 0.69 /sf | 1,446 |
| | **Exterior Masonry Walls chemical storage** | | **1,050.0 sf** | **0.31** | **1.07** | | | | **1.38 /sf** | **1,446** |
| **06120 Wood Framing - Roof Chemical Storage** | | | | | | | | | | |
| 07-21-16.20 | Blanket insulation, for walls or ceilings, kraft faced fiberglass, 6" thick, R19, 23" wide | 0180 | 300.0 sf | 0.28 | 0.37 | - | - | - | 0.65 /sf | 196 |
| 07-26-10.10 | Building Paper, vapor barrier, asphalt felt sheathing paper, 15# | 0400 | 3.0 sq | 12.06 | 4.81 | - | - | - | 16.87 /sq | 51 |
| 07-41-13.20 | Steel roofing panels, on steel frame, flat profile, standard finish, 1-3/4" standing seams, 10" wide, 26 gauge | 0710 | 300.0 sf | 2.41 | 3.73 | - | - | - | 6.14 /sf | 1,841 |
| | **Wood Framing - Roof Chemical Storage** | | **300.0 sf** | **2.81** | **4.15** | | | | **6.96 /sf** | **2,088** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **07 THERMAL PROTECTION** | | | | | | | | | **3,534** |
| **09 FINISHES** | | | | | | | | | | |
| **06120 Wood Framing - Roof Chemical Storage** | | | | | | | | | | |
| 09-91-06.41 | Coatings & paints, B & C coating system E-8 (Clear epoxy, wood) | BC-0051 | 320.0 sqft | 0.26 | 0.44 | - | - | - | 0.70 /sqft | 224 |
| | **Wood Framing - Roof Chemical Storage** | | **300.0 sf** | **0.27** | **0.47** | | | | **0.75 /sf** | **224** |
| | **09 FINISHES** | | | | | | | | | **224** |
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Aeration Chemical** | | | | | | | | | | |
| 11-00-06.00 | FRP tank, acetate, 7,500 gal., | BC-0016 | 1.0 ea | 2,022.71 | 21,000.00 | - | 622.71 | | 23,645.42 /ea | 23,645 |
| 11-00-08.00 | Chemical metering pump, acetate | BC-0011 | 2.0 ea | 459.41 | 11,000.00 | - | - | - | 11,459.41 /ea | 22,919 |
| 11-00-08.00 | Chemical metering pump, methanol | BC-0041 | 2.0 ea | 565.42 | 11,000.00 | - | - | - | 11,565.42 /ea | 23,131 |
| 23-13-23.26 | Storage tank, horizontal, concrete, above ground, fuel-oil, vaulted, 20,000 gallon, incl. pad & pump | 0600 | 1.0 ea | 2,722.91 | 108,000.00 | - | 1,150.56 | - | 111,873.47 /ea | 111,873 |
| | **Aeration Chemical** | | **1.0 LS** | **6,795.27** | **173,000.00** | | **1,773.27** | | **181,568.54 /LS** | **181,569** |
| | **11 EQUIPMENT** | | | | | | | | | **181,569** |
| **21 FIRE SUPPRESSION** | | | | | | | | | | |
| **22999 Chemical Piping** | | | | | | | | | | |
| 21-99-99.99 | Fire suppression system allowance | MISC | 1.0 LS | - | - | 20,000.00 | - | - | 20,000.00 /LS | 20,000 |
| | **Chemical Piping** | | **1.0 LS** | | | **20,000.00** | | | **20,000.00 /LS** | **20,000** |
| | **21 FIRE SUPPRESSION** | | | | | | | | | **20,000** |
| **22 PLUMBING** | | | | | | | | | | |
| **22999 Chemical Piping** | | | | | | | | | | |
| 22-99-99.99 | Chemical piping allowance acetate tank/pumps | MISC | 2.0 LS | 1,795.00 | 2,500.00 | | - | - | 4,295.00 /LS | 8,590 |
| 22-99-99.99 | Chemical piping allowance methanol tank/pumps | MISC | 2.0 LS | 2,692.50 | 3,750.00 | | - | - | 6,442.50 /LS | 12,885 |
| | **Chemical Piping** | | **1.0 LS** | **8,975.00** | **12,500.00** | | | | **21,475.00 /LS** | **21,475** |
| | **22 PLUMBING** | | | | | | | | | **21,475** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **26001 Aeration Chemical Storage - E&I ( #15)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 64,012.09 | - | - | 64,012.09 /LS | 64,012 |
| | **Aeration Chemical Storage - E&I ( #15)** | | **1.0 LS** | | | **64,012.09** | | | **64,012.09 /LS** | **64,012** |
| | **26 ELECTRICAL** | | | | | | | | | **64,012** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Aeration Chemical Storage - E&I ( #15)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 16,003.03 | - | - | 16,003.03 /LS | 16,003 |
| | **Aeration Chemical Storage - E&I ( #15)** | | **1.0 LS** | | | **16,003.03** | | | **16,003.03 /LS** | **16,003** |
| | **27 COMMUNICATIONS** | | | | | | | | | **16,003** |
| **31 EARTHWORK** | | | | | | | | | | |
| **03330 Slabs Chemical Storage** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 33.3 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 60 |
| | **Slabs Chemical Storage** | | **300.0 cy** | **0.12** | | | **0.08** | | **0.20 /cy** | **60** |
| **03330 Slabs tank** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 66.7 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 119 |
| | **Slabs tank** | | **22.2 cy** | **3.20** | | | **2.17** | | **5.36 /cy** | **119** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **31 EARTHWORK** | | | | | | | | | **179** |
| **33 UTILITIES** | | | | | | | | | | |
| **33999 Chemical feed yard piping** | | | | | | | | | | |
| 33-11-13.25 | Chemical piping, double contained, allowance | ---- | 1.0 ls | 6,152.00 | 20,020.00 | - | 2,000.00 | - | 28,172.00 /ls | 28,172 |
| | **Chemical feed yard piping** | | **1.0 LS** | **6,152.00** | **20,020.00** | | **2,000.00** | | **28,172.00 /LS** | **28,172** |
| | **33 UTILITIES** | | | | | | | | | **28,172** |
| | **09 Acetate/Methanol** | | **1.0 LS** | **62,221.40** | **233,055.77** | **100,015.12** | **4,783.21** | | **400,075.50 /LS** | **400,076** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **10 Sidestream P Removal** | | | | | | | | | | |
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Ostara Pearl Nutrient Removal** | | | | | | | | | | |
| 11-99-99.99 | Ostara Pearl nutrient removal process, quote from 2010 project, including all equip, conc, bldngs for complete turnkey system, increased for inflation | MISC | 1.0 LS | - | - | 2,400,000.00 | - | - | 2,400,000.00 /LS | 2,400,000 |
| | **Ostara Pearl Nutrient Removal** | | **1.0 LS** | | | **2,400,000.00** | | | **2,400,000.00 /LS** | **2,400,000** |
| | **11 EQUIPMENT** | | | | | | | | | **2,400,000** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **26001 Ostara - E&I (#10)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 289,158.69 | - | - | 289,158.69 /LS | 289,159 |
| | **Ostara - E&I (#10)** | | **1.0 LS** | | | **289,158.69** | | | **289,158.69 /LS** | **289,159** |
| | **26 ELECTRICAL** | | | | | | | | | **289,159** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Ostara - E&I (#10)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 96,386.24 | - | - | 96,386.24 /LS | 96,386 |
| | **Ostara - E&I (#10)** | | **1.0 LS** | | | **96,386.24** | | | **96,386.24 /LS** | **96,386** |
| | **27 COMMUNICATIONS** | | | | | | | | | **96,386** |
| **31 EARTHWORK** | | | | | | | | | | |
| **33500 Centrate Discharge** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering | 0110 | 63.3 bcy | 3.73 | - | - | 2.23 | - | 5.96 /bcy | 377 |
| 31-23-23.13 | Backfill, trench, air tamped compaction, add | 2000 | 39.3 ecy | 13.60 | - | - | 3.85 | - | 17.44 /ecy | 685 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 22.8 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 546 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 22.8 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 136 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 24.1 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 276 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 1,140.0 sf | - | - | 6.69 | - | - | 6.69 /sf | 7,627 |
| | **Centrate Discharge** | | **100.0 unit** | **12.88** | **2.48** | **76.27** | **4.84** | | **96.47 /unit** | **9,647** |
| | **31 EARTHWORK** | | | | | | | | | **9,647** |
| **33 UTILITIES** | | | | | | | | | | |
| **33500 Centrate Discharge** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 1.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 9 |
| | **Centrate Discharge** | | **100.0 unit** | **0.03** | **0.06** | | | | **0.09 /unit** | **9** |
| | **33 UTILITIES** | | | | | | | | | **9** |
| | **10 Sidestream P Removal** | | **1.0 LS** | **1,291.44** | **253.62** | **2,793,171.53** | **483.98** | | **2,795,200.57 /LS** | **2,795,201** |
| | **01 TOTAL AMOUNT** | | | | | | | | | **34,926,640** |

## Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | 97,664 hrs | 6,841,825 | |
| Material | | | 16,903,505 | |
| Subcontract | | | 9,364,086 | |
| Equipment | | 124,550 hrs | 1,816,696 | |
| Other | | | 528 | |
| | | | **34,926,640** | **34,926,640** |
| Civil and Misc. Yard Piping | 5.000 % | | 1,746,332 | |
| | | | **1,746,332** | **36,672,972** |
| Labor Mark-up | 10.000 % | | 684,183 | |
| Material Mark-up | 8.000 % | | 1,352,280 | |
| Subcontractor Mark-up | 5.000 % | | 140,305 | |
| Construction Equipment Mark-up | 8.000 % | | 145,336 | |
| Other - Process Equip Mark-up | 8.000 % | | 42 | |
| Material Shipping & Handling | 2.000 % | | 338,070 | |
| Material Sales Tax | 6.000 % | | 609,942 | |
| | | | **3,270,158** | **39,943,130** |
| Contractor General Conditions | 10.000 % | | 3,994,313 | |
| Start-Up, Training, O&M | 2.000 % | | 798,863 | |
| Undesign/Undevelop Contingency | 30.000 % | | 11,982,939 | |
| | | | **16,776,115** | **56,719,245** |
| Bldg Risk, Liability Auto Ins | 2.000 % | | 1,134,385 | |
| Contractor Bonds & Insurance | 1.500 % | | 850,789 | |
| | | | **1,985,174** | **58,704,419** |
| **Total** | | | | **58,704,419** |

# CITY OF MERIDIAN
# COM ALTERNATIVES ANALYSIS - ALT 2
# PRE-BODR - FACILITY PLANNING

| | |
|---|---|
| **Estimator** | DG-NDG-FB-IK |
| **BC Project Manager** | Richard Kelly |
| **BC Office** | Seattle |
| **Estimate Issue No.** | 2 |
| **QA/QC Reviewer** | Don Snowden |
| **QA/QC Review Date** | 5/26/2015 |
| **Notes** | **PROCESS LOCATION/AREA INDEX** |

**01 Primary Clarifiers**
**02 Aeration Tanks**
**03 Secondary Clarifiers**
**04 Existing Aeration Tanks/RAS Tanks Retrofit**
**05 Tertiary Treatment Process**
**07 MBR Treatment**
**08 Influent Pump Station**
**09 Acetate/Methanol**
**10 Sidestream P Removal**

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **01 Primary Clarifiers** | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | |
| **03330 Slabs Primary Clarifiers** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 210.1 cy | - | 33.69 | - | - | - | 33.69 /cy | 7,078 |
| 03-11-13.85 | C.I.P. concrete forms, wall, job built, plywood, to 8' high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 360.0 sfca | 6.39 | 1.76 | - | - | - | 8.16 /sfca | 2,937 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 252.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 2,022 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 21.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 1,203 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 31.5 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 63,905 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, walls, #8 to #18 | 0760 | 1,800.0 lb | 0.30 | 0.48 | - | - | - | 0.77 /lb | 1,393 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 32.4 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 1,536 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 32.4 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 1,669 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 455.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 44,611 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 441.2 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 5,154 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 8" thick, includes vibrating, excludes material | 4950 | 14.0 cy | 38.75 | - | - | 7.98 | - | 46.73 /cy | 654 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 5,672.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 5,167 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 5,672.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 5,640 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 56.7 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 1,123 |
| | **Slabs Primary Clarifiers** | | **22.2 cy** | **2,413.50** | **3,996.12** | | **75.13** | | **6,484.75 /cy** | **144,091** |
| **03330 Slabs Pump Station** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 14.8 cy | - | 33.69 | - | - | - | 33.69 /cy | 499 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 21.3 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 184 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 80.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 642 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 7.0 ea | 9.38 | 47.88 | - | - | - | 57.26 /ea | 401 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 2.2 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 4,506 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7 | 0610 | 31.6 lb | 0.52 | 0.48 | - | - | - | 0.99 /lb | 31 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 2.2 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 106 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 2.2 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 115 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 31.9 cy | - | 98.01 | - | - | - | 98.01 /cy | 3,131 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03330 Slabs Pump Station** | | | | | | | | | | |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 31.9 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 373 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed and bull float(darby) finish | 0100 | 400.0 sf | 0.38 | - | - | - | - | 0.38 /sf | 151 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 400.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 398 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 4.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 79 |
| | **Slabs Pump Station** | | **400.0 cy** | **9.48** | **16.81** | | **0.25** | | **26.54 /cy** | **10,616** |
| **03330 Slabs Splitter Box** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 5.3 cy | - | 33.69 | - | - | - | 33.69 /cy | 180 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 48.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 385 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 4.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 229 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.8 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 1,622 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.8 ton | 39.88 | - | - | 7.51 | - | 47.39 /ton | 38 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.8 ton | 43.34 | - | - | 8.16 | - | 51.50 /ton | 41 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 11.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,098 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 11.2 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 131 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed and bull float(darby) finish | 0100 | 144.0 sf | 0.38 | - | - | - | - | 0.38 /sf | 54 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 144.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 143 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 1.4 csf | 9.68 | 10.13 | - | - | - | 19.81 /csf | 29 |
| | **Slabs Splitter Box** | | **11.2 cy** | **123.57** | **226.00** | | **3.12** | | **352.69 /cy** | **3,950** |
| **03330 Slabs Scum Pump** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 1.3 cy | - | 33.69 | - | - | - | 33.69 /cy | 45 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 5.3 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 46 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 24.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 193 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 2.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 115 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.2 ton | 1,036.00 | 992.00 | - | - | - | 2,028.00 /ton | 406 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7 | 0610 | 4.0 lb | 0.52 | 0.48 | - | - | - | 1.00 /lb | 4 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.2 ton | 39.85 | - | - | 7.50 | - | 47.40 /ton | 10 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.2 ton | 43.30 | - | - | 8.17 | - | 51.50 /ton | 10 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03330 Slabs Scum Pump** | | | | | | | | | | |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.9 cy | - | 98.01 | - | - | - | 98.01 /cy | 285 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 2.9 cy | 9.69 | - | - | 1.99 | - | 11.68 /cy | 34 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and hand trowel finish | 0200 | 36.0 sf | 1.20 | - | - | - | - | 1.20 /sf | 43 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 36.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 36 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 0.4 csf | 9.67 | 10.10 | - | - | - | 19.78 /csf | 7 |
| | **Slabs Scum Pump** | | **2.9 cy** | **162.05** | **259.65** | | **3.09** | | **424.79 /cy** | **1,232** |
| **03330 Slabs Primary Clarifiers** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 210.1 cy | - | 33.69 | - | - | - | 33.69 /cy | 7,078 |
| 03-11-13.85 | C.I.P. concrete forms, wall, job built, plywood, to 8' high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 360.0 sfca | 6.39 | 1.76 | - | - | - | 8.16 /sfca | 2,937 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 252.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 2,022 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 21.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 1,203 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 31.5 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 63,905 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, walls, #8 to #18 | 0760 | 1,800.0 lb | 0.30 | 0.48 | - | - | - | 0.77 /lb | 1,393 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 32.4 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 1,536 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 32.4 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 1,669 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 455.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 44,611 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 441.2 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 5,154 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 8" thick, includes vibrating, excludes material | 4950 | 14.0 cy | 38.75 | - | - | 7.98 | - | 46.73 /cy | 654 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 5,672.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 5,167 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 5,672.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 5,640 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 56.7 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 1,123 |
| | **Slabs Primary Clarifiers** | | **455.2 cy** | **117.82** | **195.08** | | **3.67** | | **316.57 /cy** | **144,091** |
| **03330 Slabs Scum Pump** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 1.3 cy | - | 33.69 | - | - | - | 33.69 /cy | 45 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 5.3 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 46 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 24.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 193 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 2.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 115 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03330 Slabs Scum Pump** | | | | | | | | | | | | |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.2 | ton | 1,036.00 | 992.00 | - | - | - | 2,028.00 | /ton | 406 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7 | 0610 | 4.0 | lb | 0.52 | 0.48 | - | - | - | 1.00 | /lb | 4 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.2 | ton | 39.85 | - | - | 7.50 | - | 47.40 | /ton | 10 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.2 | ton | 43.30 | - | - | 8.17 | - | 51.50 | /ton | 10 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.9 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 285 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 2.9 | cy | 9.69 | - | - | 1.99 | - | 11.68 | /cy | 34 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and hand trowel finish | 0200 | 36.0 | sf | 1.20 | - | - | - | - | 1.20 | /sf | 43 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 36.0 | sf | 0.70 | 0.29 | - | - | - | 0.99 | /sf | 36 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 0.4 | csf | 9.67 | 10.10 | - | - | - | 19.78 | /csf | 7 |
| | **Slabs Scum Pump** | | **2.9** | **cy** | **162.05** | **259.65** | | **3.09** | | **424.79** | **/cy** | **1,232** |
| **03333 Primary sludge pump equipment Pads** | | | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 60.0 | sfca | 7.24 | 1.36 | - | - | - | 8.60 | /sfca | 516 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.1 | ton | 39.80 | - | - | 7.50 | - | 47.30 | /ton | 2 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.1 | ton | 43.30 | - | - | 8.00 | - | 51.30 | /ton | 3 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.6 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 254 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 2.6 | cy | 27.68 | - | - | 5.70 | - | 33.38 | /cy | 87 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 2.6 | cy | 46.13 | - | - | 13.04 | - | 59.16 | /cy | 153 |
| | **Primary sludge pump equipment Pads** | | **2.6** | **cy** | **243.02** | **129.51** | | **19.05** | | **391.58** | **/cy** | **1,015** |
| **03345 Concrete Walls Primary Carifiers** | | | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 7,056.0 | sfca | 6.18 | 0.75 | - | - | - | 6.93 | /sfca | 48,881 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 18.8 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 389 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 9.8 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 17,506 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 9.8 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 464 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 9.8 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 505 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 137.2 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 13,447 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 137.2 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 5,343 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls Primary Carifiers** | | | | | | | | | | | | |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 7,056.0 | sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 | /sf | 17,826 |
| | **Concrete Walls Primary Carifiers** | | **137.2** | **cy** | **509.91** | **231.72** | | **19.02** | | **760.65** | **/cy** | **104,361** |
| **03345 Concrete Walls Pump Station** | | | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 20.0 | lf | 10.50 | 2.14 | - | - | - | 12.63 | /lf | 253 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 3,200.0 | sfca | 6.95 | 0.75 | - | - | - | 7.70 | /sfca | 24,640 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 8.5 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 176 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 4.4 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 7,938 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 4.4 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 211 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 4.4 | ton | 43.34 | - | - | 8.17 | - | 51.50 | /ton | 229 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 62.2 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 6,099 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 62.2 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 2,423 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 3,200.0 | sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 | /sf | 8,084 |
| | **Concrete Walls Pump Station** | | **62.2** | **cy** | **553.02** | **232.41** | | **19.02** | | **804.45** | **/cy** | **50,053** |
| **03345 Concrete Walls Splitter Box** | | | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 20.0 | lf | 10.50 | 2.14 | - | - | - | 12.63 | /lf | 253 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 1,920.0 | sfca | 6.95 | 0.75 | - | - | - | 7.70 | /sfca | 14,784 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 5.1 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 106 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 4.7 | ton | 794.28 | 992.00 | - | - | - | 1,786.27 | /ton | 8,337 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 4.7 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 221 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 4.7 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 240 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 56.0 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 5,489 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 56.0 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 2,181 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 1,920.0 | sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 | /sf | 4,851 |
| | **Concrete Walls Splitter Box** | | **56.0** | **cy** | **412.28** | **223.35** | | **15.46** | | **651.08** | **/cy** | **36,461** |
| **03345 Concrete Walls scum pump** | | | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 20.0 | lf | 10.50 | 2.14 | - | - | - | 12.63 | /lf | 253 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls scum pump** | | | | | | | | | | |
| 03-11-13.85 | Cip concrete forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 960.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 7,392 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 2.6 gal | - | 20.66 | - | - | - | 20.66 /gal | 53 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 20.0 lf | 3.24 | 14.92 | - | - | - | 18.15 /lf | 363 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 2.0 ea | 9.39 | 35.79 | - | - | - | 45.17 /ea | 90 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 2.0 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 3,573 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 2.0 ton | 39.87 | - | - | 7.52 | - | 47.39 /ton | 95 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 2.0 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 103 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 28.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 2,744 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 28.0 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 1,090 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 960.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 2,425 |
| | **Concrete Walls scum pump** | | **28.0 cy** | **408.56** | **225.51** | | **15.27** | | **649.34 /cy** | **18,181** |
| **03345 Concrete Walls Primary Carifiers** | | | | | | | | | | |
| 03-11-13.85 | Cip concrete forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 7,056.0 sfca | 6.18 | 0.75 | - | - | - | 6.93 /sfca | 48,881 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 18.8 gal | - | 20.66 | - | - | - | 20.66 /gal | 389 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 9.8 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 17,506 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 9.8 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 464 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 9.8 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 505 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 137.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 13,447 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 137.2 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 5,343 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 7,056.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 17,826 |
| | **Concrete Walls Primary Carifiers** | | **137.2 cy** | **509.91** | **231.72** | | **19.02** | | **760.65 /cy** | **104,361** |
| **03345 Concrete Walls scum pump** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 20.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 253 |
| 03-11-13.85 | Cip concrete forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 960.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 7,392 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 2.6 gal | - | 20.66 | - | - | - | 20.66 /gal | 53 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls scum pump** | | | | | | | | | | | | |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 20.0 | lf | 3.24 | 14.92 | - | - | - | 18.15 | /lf | 363 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 2.0 | ea | 9.39 | 35.79 | - | - | - | 45.17 | /ea | 90 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 2.0 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 3,573 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 2.0 | ton | 39.87 | - | - | 7.52 | - | 47.39 | /ton | 95 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 2.0 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 103 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 28.0 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 2,744 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 28.0 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 1,090 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 960.0 | sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 | /sf | 2,425 |
| | **Concrete Walls scum pump** | | **28.0** | **cy** | **408.56** | **225.51** | | **15.27** | | **649.34** | **/cy** | **18,181** |
| **03350 Elevated Slab Pump station** | | | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 400.0 | sf | 4.97 | 1.27 | - | - | - | 6.24 | /sf | 2,495 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 24.0 | lf | 4.64 | 1.62 | - | - | - | 6.26 | /lf | 150 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 80.0 | lf | 3.62 | 0.21 | - | - | - | 3.83 | /lf | 307 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, perimeter deck and rail, straight, includes shoring, erecting, bracing, stripping and cleaning | 8000 | 80.0 | lf | 20.11 | 12.55 | - | - | - | 32.66 | /lf | 2,613 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.0 | ton | 822.00 | 992.00 | - | - | - | 1,814.00 | /ton | 29 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 | ton | 40.00 | - | - | 8.00 | - | 48.00 | /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 | ton | 114.00 | - | - | 21.00 | - | 135.00 | /ton | 1 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 15.6 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 1,525 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 15.6 | cy | 21.53 | - | - | 4.43 | - | 25.96 | /cy | 404 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed finish | 0020 | 400.0 | sf | 0.32 | - | - | - | - | 0.32 | /sf | 126 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 400.0 | sf | 0.62 | 0.19 | - | - | - | 0.81 | /sf | 324 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 4.0 | csf | 9.68 | 10.12 | - | - | - | 19.80 | /csf | 79 |
| | **Elevated Slab Pump station** | | **15.6** | **cy** | **305.79** | **207.31** | | **4.45** | | **517.55** | **/cy** | **8,053** |
| **03350 Elevated Slab Splitter Box** | | | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 144.0 | sf | 4.97 | 1.27 | - | - | - | 6.24 | /sf | 898 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 24.0 | lf | 4.64 | 1.62 | - | - | - | 6.26 | /lf | 150 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03350 Elevated Slab Splitter Box** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 48.0 lf | 3.62 | 0.21 | - | - | - | 3.83 /lf | 184 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, perimeter deck and rail, straight, includes shoring, erecting, bracing, stripping and cleaning | 8000 | 48.0 lf | 20.11 | 12.55 | - | - | - | 32.66 /lf | 1,568 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.4 ton | 821.66 | 992.00 | - | - | - | 1,813.66 /ton | 635 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 ton | 40.00 | - | - | 7.00 | - | 46.67 /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 ton | 113.00 | - | - | 20.00 | - | 133.00 /ton | 0 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 5.6 cy | - | 98.01 | - | - | - | 98.01 /cy | 549 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 5.6 cy | 21.53 | - | - | 4.43 | - | 25.96 /cy | 145 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed finish | 0020 | 144.0 sf | 0.32 | - | - | - | - | 0.32 /sf | 45 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 144.0 sf | 0.62 | 0.19 | - | - | - | 0.81 /sf | 117 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 1.4 csf | 9.68 | 10.13 | - | - | - | 19.81 /csf | 29 |
| | **Elevated Slab Splitter Box** | | **5.6 cy** | **450.48** | **316.56** | | **4.45** | | **771.49 /cy** | **4,320** |
| **03350 Elevated Slab Scum pump** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 36.0 sf | 4.97 | 1.27 | - | - | - | 6.24 /sf | 225 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 24.0 lf | 4.64 | 1.62 | - | - | - | 6.26 /lf | 150 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 36.0 lf | 3.62 | 0.21 | - | - | - | 3.83 /lf | 138 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.1 ton | 821.70 | 992.00 | - | - | - | 1,813.71 /ton | 127 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 ton | 40.00 | - | - | 10.00 | - | 50.00 /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 ton | 110.00 | - | - | 20.00 | - | 130.00 /ton | 0 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 1.4 cy | - | 98.01 | - | - | - | 98.01 /cy | 137 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 1.4 cy | 21.53 | - | - | 4.44 | - | 25.96 /cy | 36 |
| 03-35-29.30 | Finishing elev slab, manual screed, bull float, machine float & trowel | 0275 | 36.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 33 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 36.0 sf | 0.62 | 0.19 | - | - | - | 0.81 /sf | 29 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 0.4 csf | 9.67 | 10.10 | - | - | - | 19.78 /csf | 7 |
| | **Elevated Slab Scum pump** | | **1.4 cy** | **404.06** | **221.08** | | **5.22** | | **630.36 /cy** | **883** |

**03350 Elevated Slab Scum pump**

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03350 Elevated Slab Scum pump** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 36.0 sf | 4.97 | 1.27 | - | - | - | 6.24 /sf | 225 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 24.0 lf | 4.64 | 1.62 | - | - | - | 6.26 /lf | 150 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 36.0 lf | 3.62 | 0.21 | - | - | - | 3.83 /lf | 138 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.1 ton | 821.70 | 992.00 | - | - | - | 1,813.71 /ton | 127 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 ton | 40.00 | - | - | 10.00 | - | 50.00 /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 ton | 110.00 | - | - | 20.00 | - | 130.00 /ton | 0 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 1.4 cy | - | 98.01 | - | - | - | 98.01 /cy | 137 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 1.4 cy | 21.53 | - | - | 4.44 | - | 25.96 /cy | 36 |
| 03-35-29.30 | Finishing elev slab, manual screed, bull float, machine float & trowel | 0275 | 36.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 33 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 36.0 sf | 0.62 | 0.19 | - | - | - | 0.81 /sf | 29 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 0.4 csf | 9.67 | 10.10 | - | - | - | 19.78 /csf | 7 |
| | **Elevated Slab Scum pump** | | **1.4 cy** | **404.06** | **221.08** | | **5.22** | | **630.36 /cy** | **883** |
| | **03 CONCRETE** | | | | | | | | | **651,964** |
| **05 METALS** | | | | | | | | | | |
| **11999 Primary Clarifier** | | | | | | | | | | |
| 05-01-10.51 | Metal cleaning, steel surface treatment, 5.6 lb sand per S.F., near white blast, loose scale, fine powder rust (SSPC-SP10) | 6255 | 3,200.0 sf | 4.22 | 0.88 | - | 0.54 | - | 5.63 /sf | 18,030 |
| 05-01-10.51 | Metal cleaning, steel surface treatment, 5.6 lb sand per S.F., near white blast, loose scale, fine powder rust (SSPC-SP10) | 6255 | 3,200.0 sf | 4.22 | 0.88 | - | 0.54 | - | 5.63 /sf | 18,030 |
| 09-91-06.41 | Coatings & paints, B & C coating system E-2 (Epoxy, metal tanks, structures) | BC-0021 | 6,400.0 sqft | 0.28 | 1.40 | - | - | - | 1.69 /sqft | 10,797 |
| | **Primary Clarifier** | | **1.0 LS** | **28,823.45** | **14,611.20** | | **3,421.32** | | **46,855.97 /LS** | **46,856** |
| **11999 Sludge Pumps and Piping** | | | | | | | | | | |
| 05-58-09.50 | Pump mounting base plate, complete w/ anchor bolts, 4 sf | BC-0001 | 2.0 ea | 622.68 | 795.79 | - | - | - | 1,418.47 /ea | 2,837 |
| | **Sludge Pumps and Piping** | | **1.0 LS** | **1,245.35** | **1,591.58** | | | | **2,836.93 /LS** | **2,837** |
| | **05 METALS** | | | | | | | | | **49,693** |
| **07 THERMAL PROTECTION** | | | | | | | | | | |
| **05999 Misc. Structural Steel Work** | | | | | | | | | | |
| 07-72-33.10 | Manhole cover | 1100 | 1.0 ea | 249.60 | 1,584.55 | - | - | - | 1,834.15 /ea | 1,834 |
| | **Misc. Structural Steel Work** | | **1.0 LS** | **249.60** | **1,584.55** | | | | **1,834.15 /LS** | **1,834** |
| | **07 THERMAL PROTECTION** | | | | | | | | | **1,834** |
| **09 FINISHES** | | | | | | | | | | |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **11999 Primary Clarifier** | | | | | | | | | | |
| 09-91-06.41 | Coatings & paints, B & C coating system E-2 (Epoxy, metal tanks, structures) | BC-0021 | 6,400.0 sqft | 0.28 | 1.40 | - | - | - | 1.69 /sqft | 10,797 |
| | **Primary Clarifier** | | **1.0 LS** | **1,811.25** | **8,985.60** | | | | **10,796.85 /LS** | **10,797** |
| **11999 Sludge Pumps and Piping** | | | | | | | | | | |
| 09-99-99.99 | Coatings allowance | MISC | 1.0 LS | - | - | 20,000.00 | - | - | 20,000.00 /LS | 20,000 |
| | **Sludge Pumps and Piping** | | **1.0 LS** | | | **20,000.00** | | | **20,000.00 /LS** | **20,000** |
| | **09 FINISHES** | | | | | | | | | **30,797** |
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Primary Clarifier** | | | | | | | | | | |
| 11-00-01.00 | Mechanical, clarifier mechanism, primary, 80' dia., 14' sidewall, w/ bridge, cage, launders, FRP weirs, & baffles | BC-1036 | 1.0 ea | 30,631.78 | 215,000.00 | - | 8,710.92 | - | 254,342.70 /ea | 254,343 |
| 11-00-01.00 | Mechanical, clarifier mechanism, primary, 80' dia., 14' sidewall, w/ bridge, cage, launders, FRP weirs, & baffles | BC-1036 | 1.0 ea | 30,631.78 | 215,000.00 | - | 8,710.92 | - | 254,342.70 /ea | 254,343 |
| 11-00-11.05 | Wastewater, submersible, 3-inch, 6.5 hp,,guide rails, base elbow, scum pump | BC-0071 | 1.0 ea | 1,194.45 | 7,510.00 | - | - | - | 8,704.45 /ea | 8,704 |
| 11-00-11.05 | Wastewater, submersible, 3-inch, 6.5 hp,,guide rails, base elbow, scum pump | BC-0071 | 1.0 ea | 1,194.45 | 7,510.00 | - | - | - | 8,704.45 /ea | 8,704 |
| | **Primary Clarifier** | | **1.0 LS** | **63,652.46** | **445,020.00** | | **17,421.84** | | **526,094.30 /LS** | **526,094** |
| **11999 Sludge Pumps and Piping** | | | | | | | | | | |
| 11-00-10.00 | Pump, double disc diaphragm, sludge pump | BC-0176 | 2.0 ea | 2,789.95 | 31,000.00 | - | 333.44 | - | 34,123.39 /ea | 68,247 |
| | **Sludge Pumps and Piping** | | **1.0 LS** | **5,579.90** | **62,000.00** | | **666.88** | | **68,246.78 /LS** | **68,247** |
| | **11 EQUIPMENT** | | | | | | | | | **594,341** |
| **22 PLUMBING** | | | | | | | | | | |
| **11999 Primary Clarifier** | | | | | | | | | | |
| 11-00-04.00 | Hydraulic structures, slide gate, stainless stl, ab & grout,36" x 36" | BC-0101 | 1.0 ea | 2,455.44 | 4,774.77 | - | 554.07 | - | 7,784.28 /ea | 7,784 |
| 11-00-04.00 | Hydraulic structures, slide gate, stainless stl, ab & grout,36" x 36" | BC-0101 | 1.0 ea | 2,455.44 | 4,774.77 | - | 554.07 | - | 7,784.28 /ea | 7,784 |
| 22-05-23.70 | Valves, semi-steel, lubricated plug valve, flanged, 200 psi, 12" | 7070 | 1.0 ea | 907.31 | 4,700.00 | - | - | - | 5,607.31 /ea | 5,607 |
| 22-05-23.70 | Valves, semi-steel, lubricated plug valve, flanged, 200 psi, 12" | 7070 | 1.0 ea | 907.31 | 4,700.00 | - | - | - | 5,607.31 /ea | 5,607 |
| 22-11-13.44 | Pipe, steel, black, welded, 36" diameter, schedule 40, Spec. A-53, includes two rod, roll hanger & saddle, sized for covering, 10' OC | 2220 | 75.0 lf | 280.75 | 275.00 | - | 9.20 | - | 564.94 /lf | 42,371 |
| 22-11-13.44 | Pipe, steel, black, welded, 36" diameter, schedule 40, Spec. A-53, includes two rod, roll hanger & saddle, sized for covering, 10' OC | 2220 | 75.0 lf | 280.75 | 275.00 | - | 9.20 | - | 564.94 /lf | 42,371 |
| 22-11-13.47 | Elbow, 90 Deg., steel, carbon steel, black, long radius, butt weld, standard weight, 36" pipe size, includes 1 weld per joint and weld machine | 3194 | 1.0 ea | 1,554.30 | 3,450.00 | - | 57.70 | - | 5,062.00 /ea | 5,062 |
| 22-11-13.47 | Elbow, 90 Deg., steel, carbon steel, black, long radius, butt weld, standard weight, 36" pipe size, includes 1 weld per joint and weld machine | 3194 | 1.0 ea | 1,554.30 | 3,450.00 | - | 57.70 | - | 5,062.00 /ea | 5,062 |
| 22-20-00.30 | Piping, water dist, DI, cement lined, 18' L, restrained jt, 12" dia | BC-0001 | 45.0 lnft | 6.58 | 25.25 | - | | - | 31.83 /lnft | 1,432 |
| 22-20-00.30 | Piping, water dist, DI, cement lined, 18' L, restrained jt, 12" dia | BC-0001 | 45.0 lnft | 6.58 | 25.25 | - | | - | 31.83 /lnft | 1,432 |
| 22-20-00.31 | Piping, water dist, DI, 90< bend or elbow, 12" dia | BC-0026 | 1.0 ea | 212.17 | 228.00 | - | 45.86 | - | 486.03 /ea | 486 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **11999 Primary Clarifier** | | | | | | | | | | |
| 22-20-00.31 | Piping, water dist, DI, 90< bend or elbow, 12" dia | BC-0026 | 1.0 ea | 212.17 | 228.00 | - | 45.86 | - | 486.03 /ea | 486 |
| 22-20-01.95 | Pipe, steel ftngs, sch 40, tee 54" X 36" welded | BC-2866 | 1.0 ea | 1,843.18 | 13,429.84 | - | 995.92 | - | 16,268.94 /ea | 16,269 |
| 22-20-01.95 | Pipe, steel ftngs, sch 40, tee 54" X 36" welded | BC-2866 | 1.0 ea | 1,843.18 | 13,429.84 | - | 995.92 | - | 16,268.94 /ea | 16,269 |
| | **Primary Clarifier** | | **1.0 LS** | **56,648.84** | **96,687.72** | | **4,686.54** | | **158,023.10 /LS** | **158,023** |
| **11999 Sludge Pumps and Piping** | | | | | | | | | | |
| 22-99-99.99 | Sludge piping allowance | MISC | 1.0 LS | 25,130.00 | 35,000.00 | | - | - | 60,130.00 /LS | 60,130 |
| 22-99-99.99 | Scum piping allowance | MISC | 1.0 LS | 7,180.00 | 10,000.00 | | - | - | 17,180.00 /LS | 17,180 |
| | **Sludge Pumps and Piping** | | **1.0 LS** | **32,310.00** | **45,000.00** | | | | **77,310.00 /LS** | **77,310** |
| **33500 PC Yard Piping** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1-1/2 C.Y. excavator, 10' to 14' deep, excludes sheeting or dewatering | 1000 | 699.1 bcy | 2.07 | - | - | 1.95 | - | 4.02 /bcy | 2,808 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with sheepsfoot roller | 2300 | 427.1 ecy | 1.32 | - | - | 2.85 | - | 4.16 /ecy | 1,779 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 213.8 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 5,122 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 213.8 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 1,278 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 272.0 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 3,121 |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 1.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 9 |
| | **PC Yard Piping** | | **125.0 LF** | **57.32** | **18.67** | | **36.94** | | **112.93 /LF** | **14,117** |
| **33500 Sludge Piping** | | | | | | | | | | |
| 22-20-00.65 | Piping, DI, glass lined, CL 50, 10" dia | BC-0326 | 1,325.0 lnft | 19.55 | 100.00 | - | 4.23 | - | 123.77 /lnft | 164,001 |
| | **Sludge Piping** | | **1,325.0 LF** | **19.55** | **100.00** | | **4.23** | | **123.77 /LF** | **164,001** |
| | **22 PLUMBING** | | | | | | | | | **413,450** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **01999 ADDITIONAL COST: Service to New Primary Clarifiers** | | | | | | | | | | |
| 01-99-99.99 | Additional Cost associated with Primary Clarifiers - Electrical Service in Ductbank | MISC | 450.0 LF | - | - | 250.00 | - | - | 250.00 /LF | 112,500 |
| | **ADDITIONAL COST: Service to New Primary Clarifiers** | | **450.0 LF** | | | **250.00** | | | **250.00 /LF** | **112,500** |
| **26001 Primary Clarifiers - E&I (#1,2,3)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 491,472.24 | - | - | 491,472.24 /LS | 491,472 |
| | **Primary Clarifiers - E&I (#1,2,3)** | | **1.0 LS** | | | **491,472.24** | | | **491,472.24 /LS** | **491,472** |
| | **26 ELECTRICAL** | | | | | | | | | **603,972** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Primary Clarifiers - E&I (#1,2,3)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 122,868.07 | - | - | 122,868.07 /LS | 122,868 |
| | **Primary Clarifiers - E&I (#1,2,3)** | | **1.0 LS** | | | **122,868.07** | | | **122,868.07 /LS** | **122,868** |
| | **27 COMMUNICATIONS** | | | | | | | | | **122,868** |
| **31 EARTHWORK** | | | | | | | | | | |
| **01999 Dewatering** | | | | | | | | | | |
| 01-54-33.70 | Rent wellpoint header pipe, 6" diameter, 400 gpm | 0500 | 1,760.0 day | - | - | - | 0.40 | - | 0.40 /day | 704 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **01999 Dewatering** | | | | | | | | | | |
| 31-23-19.20 | Dewatering, pumping 8 hours, attended 2 hrs per day, 6" centrifugal pump, includes 20 LF of suction hose and 100 LF of discharge hose | 1100 | 176.0 day | 857.51 | - | - | 377.70 | - | 1,235.21 /day | 217,397 |
| 31-23-19.30 | Wells, for dewatering, with steel casing, 10' to 20' deep, 2' diameter, minimum | 0020 | 250.0 vlf | 76.64 | 184.52 | - | 17.92 | - | 279.08 /vlf | 69,770 |
| | **Dewatering** | | **1.0 LS** | **170,081.77** | **46,130.81** | | **71,658.65** | | **287,871.23 /LS** | **287,871** |
| **03330 Slabs Primary Clarifiers** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 630.2 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 1,126 |
| 31-23-16.16 | Strt excvtn for minor strtrs,bank measur,for spread and mat footngs,elevatr pits,and small buildng fndtns,3/4 cy bucket,machine excavtn,hydrlc backhoe | 6035 | 22.2 bcy | 12.43 | - | - | 7.42 | - | 19.86 /bcy | 441 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 1 mile round trip, 2.2 loads/hour, 12 C.Y. truck, highway haulers, excludes loading | 0400 | 22.2 lcy | 2.77 | - | - | 3.92 | - | 6.69 /lcy | 149 |
| | **Slabs Primary Clarifiers** | | **22.2 cy** | **45.41** | | | **31.81** | | **77.22 /cy** | **1,716** |
| **03330 Slabs Pump Station** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 44.4 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 79 |
| | **Slabs Pump Station** | | **400.0 cy** | **0.12** | | | **0.08** | | **0.20 /cy** | **79** |
| **03330 Slabs Splitter Box** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 16.0 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 29 |
| | **Slabs Splitter Box** | | **11.2 cy** | **1.52** | | | **1.03** | | **2.55 /cy** | **29** |
| **03330 Slabs Scum Pump** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 4.0 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 7 |
| | **Slabs Scum Pump** | | **2.9 cy** | **1.47** | | | **1.00** | | **2.47 /cy** | **7** |
| **03330 Slabs Primary Clarifiers** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 630.2 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 1,126 |
| 31-23-16.16 | Strt excvtn for minor strtrs,bank measur,for spread and mat footngs,elevatr pits,and small buildng fndtns,3/4 cy bucket,machine excavtn,hydrlc backhoe | 6035 | 22.2 bcy | 12.43 | - | - | 7.42 | - | 19.86 /bcy | 441 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 1 mile round trip, 2.2 loads/hour, 12 C.Y. truck, highway haulers, excludes loading | 0400 | 22.2 lcy | 2.77 | - | - | 3.92 | - | 6.69 /lcy | 149 |
| | **Slabs Primary Clarifiers** | | **455.2 cy** | **2.22** | | | **1.55** | | **3.77 /cy** | **1,716** |
| **03330 Slabs Scum Pump** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 4.0 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 7 |
| | **Slabs Scum Pump** | | **2.9 cy** | **1.47** | | | **1.00** | | **2.47 /cy** | **7** |
| **31315 Excavation and Backfill prim Clarifier** | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 1,177.0 bcy | 6.99 | - | - | 7.64 | - | 14.63 /bcy | 17,220 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 495.0 ecy | 5.30 | - | - | 1.50 | - | 6.80 /ecy | 3,364 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 682.0 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 5,830 |
| | **Excavation and Backfill prim Clarifier** | | **1,177.0 cy** | **11.01** | | | **11.44** | | **22.44 /cy** | **26,414** |
| **31315 Excavation and Backfill splitter Box** | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 3,497.8 bcy | 6.99 | - | - | 7.64 | - | 14.63 /bcy | 51,173 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 2,088.9 ecy | 5.30 | - | - | 1.50 | - | 6.80 /ecy | 14,197 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **31315 Excavation and Backfill splitter Box** | | | | | | | | | | |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 106.7 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 912 |
| | **Excavation and Backfill splitter Box** | | **2,195.6 cy** | **16.33** | | | **13.86** | | **30.19 /cy** | **66,282** |
| **31315 Excavation and Backfill Pump station** | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 3,629.6 bcy | 6.99 | - | - | 7.64 | - | 14.63 /bcy | 53,102 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 3,333.3 ecy | 13.60 | - | - | 3.85 | - | 17.44 /ecy | 58,141 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 296.3 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 2,533 |
| | **Excavation and Backfill Pump station** | | **3,629.6 cy** | **19.73** | | | **11.61** | | **31.35 /cy** | **113,776** |
| **31315 Excavation and Backfill prim Clarifier** | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 1,177.0 bcy | 6.99 | - | - | 7.64 | - | 14.63 /bcy | 17,220 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 495.0 ecy | 5.30 | - | - | 1.50 | - | 6.80 /ecy | 3,364 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 682.0 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 5,830 |
| | **Excavation and Backfill prim Clarifier** | | **1,177.0 cy** | **11.01** | | | **11.44** | | **22.44 /cy** | **26,414** |
| **33500 Sludge Piping** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering | 0110 | 613.4 bcy | 3.73 | - | - | 2.23 | - | 5.96 /bcy | 3,654 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 327.2 ecy | 1.23 | - | - | 2.60 | - | 3.82 /ecy | 1,251 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 259.5 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 6,217 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 259.5 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 1,551 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 286.3 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 3,285 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 13,250.0 sf | - | - | 0.08 | - | - | 0.08 /sf | 1,060 |
| | **Sludge Piping** | | **1,325.0 LF** | **6.54** | **2.13** | **0.80** | **3.37** | | **12.84 /LF** | **17,017** |
| **33500 Primary Effluent Piping** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 1,115.3 bcy | 2.80 | - | - | 2.07 | - | 4.87 /bcy | 5,431 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 390.3 ecy | 1.23 | - | - | 2.60 | - | 3.82 /ecy | 1,492 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 477.9 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 11,449 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 477.9 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 2,856 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 725.0 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 8,320 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 8,350.0 sf | - | - | 0.08 | - | - | 0.08 /sf | 668 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Primary Effluent Piping** | | **1,225.0 LF** | **12.93** | **4.25** | **0.55** | **6.94** | | **24.67 /LF** | **30,216** |
| | **31 EARTHWORK** | | | | | | | | | **571,544** |
| **33 UTILITIES** | | | | | | | | | | |
| **33500 Sludge Piping** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 13.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 116 |
| | **Sludge Piping** | | **1,325.0 LF** | **0.03** | **0.06** | | | | **0.09 /LF** | **116** |
| **33500 Primary Effluent Piping** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 6.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 53 |
| | **Primary Effluent Piping** | | **1,225.0 LF** | **0.02** | **0.03** | | | | **0.04 /LF** | **53** |
| | **33 UTILITIES** | | | | | | | | | **169** |
| **40** | | | | | | | | | | |
| **33500 PC Yard Piping** | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 54 Inch (1350mm) | A541002 0000EA | 125.0 lf | - | 333.54 | - | - | - | 333.54 /lf | 41,692 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 54 Inch (1350mm) | L544002 0000P1 | 125.0 lf | 32.59 | - | - | 6.43 | - | 39.02 /lf | 4,877 |
| 40-05-24.10 | Field Other Weld-CS A53/A106-Non-Specific 54 Inch (1350mm) | L545502 000000 | 3.0 ea | 3,900.77 | 78.79 | - | 312.41 | - | 4,291.97 /ea | 12,876 |
| 40-05-24.10 | Misc process/utility piping allowance | ---- | 1.0 ls | 7,860.00 | 10,010.00 | - | - | - | 17,870.00 /ls | 17,870 |
| 40-05-24.10 | Misc process/utility piping allowance | ---- | 1.0 ls | 7,860.00 | 10,010.00 | - | - | - | 17,870.00 /ls | 17,870 |
| | **PC Yard Piping** | | **125.0 LF** | **251.97** | **495.59** | | **13.93** | | **761.49 /LF** | **95,186** |
| **33500 Primary Effluent Piping** | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Std 36 Inch (900mm) | A361002 0100EA | 100.0 lf | - | 168.69 | - | - | - | 168.69 /lf | 16,869 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std 36 Inch (900mm) | A362112 010000 | 2.0 ea | 2,580.88 | 4,053.57 | - | 488.91 | - | 7,123.36 /ea | 14,247 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 54 Inch (1350mm) | A541002 0000EA | 375.0 lf | - | 333.54 | - | - | - | 333.54 /lf | 125,077 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Tee-Non-Specific 54 Inch (1350mm) | A542114 000000 | 1.0 ea | - | 11,667.66 | - | - | - | 11,667.66 /ea | 11,668 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 36 Inch (900mm) | L364002 0100P1 | 100.0 lf | 24.46 | - | - | 4.83 | - | 29.29 /lf | 2,929 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std 36 Inch (900mm) | L365102 010000 | 2.0 ea | 929.47 | 17.51 | - | 74.44 | - | 1,021.42 /ea | 2,043 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 54 Inch (1350mm) | L544002 0000P1 | 375.0 lf | 32.59 | - | - | 6.43 | - | 39.02 /lf | 14,632 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Non-Specific 54 Inch (1350mm) | L545102 000000 | 10.0 ea | 1,950.39 | 39.40 | - | 156.21 | - | 2,145.99 /ea | 21,460 |
| | **Primary Effluent Piping** | | **1,225.0 LF** | **33.63** | **132.37** | | **4.56** | | **170.55 /LF** | **208,924** |
| | **40** | | | | | | | | | **304,109** |
| | **01 Primary Clarifiers** | | **1.0 LS** | **968,910.86** | **1,386,162.29** | **748,568.31** | **241,100.14** | | **3,344,741.60 /LS** | **3,344,742** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **02 Aeration Tanks** | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | |
| **03330 Slabs Aeration Basins** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 853.3 cy | - | 33.69 | - | - | - | 33.69 /cy | 28,752 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 1,696.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 13,610 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 140.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 8,017 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 128.0 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 259,585 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 128.0 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 6,065 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 128.0 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 6,593 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 1,792.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 175,638 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 1,792.0 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 20,936 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 23,040.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 20,987 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 23,040.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 22,910 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 230.4 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 4,562 |
| | **Slabs Aeration Basins** | | **2,560.0 SY** | **80.76** | **138.53** | | **2.45** | | **221.74 /SY** | **567,654** |
| **03330 Slabs Pipe Utilidor** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 138.9 cy | - | 33.69 | - | - | - | 33.69 /cy | 4,680 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 32.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 275 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 350.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 2,809 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 29.0 ea | 9.38 | 47.88 | - | - | - | 57.26 /ea | 1,661 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 8.3 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 16,899 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7 | 0610 | 47.4 lb | 0.52 | 0.48 | - | - | - | 0.99 /lb | 47 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 8.4 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 396 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 8.4 ton | 43.34 | - | - | 8.17 | - | 51.50 /ton | 430 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 292.9 cy | - | 98.01 | - | - | - | 98.01 /cy | 28,709 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 292.9 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 3,422 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed and bull float(darby) finish | 0100 | 3,750.0 sf | 0.38 | - | - | - | - | 0.38 /sf | 1,417 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03330 Slabs Pipe Utilidor** | | | | | | | | | | | | |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 3,750.0 | sf | 0.70 | 0.29 | - | - | - | 0.99 | /sf | 3,729 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 37.5 | csf | 9.68 | 10.12 | - | - | - | 19.80 | /csf | 743 |
| | **Slabs Pipe Utilidor** | | **3,750.0** | **cy** | **4.90** | **12.30** | | **0.19** | | **17.39** | **/cy** | **65,216** |
| **03330 Slabs Aeration Basins** | | | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 426.7 | cy | - | 33.69 | - | - | - | 33.69 | /cy | 14,376 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 848.0 | lf | 3.61 | 4.42 | - | - | - | 8.03 | /lf | 6,805 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 70.0 | ea | 9.39 | 47.88 | - | - | - | 57.27 | /ea | 4,009 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 64.0 | ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 | /ton | 129,793 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 64.0 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 3,033 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 64.0 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 3,296 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 896.0 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 87,819 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 896.0 | cy | 9.69 | - | - | 2.00 | - | 11.68 | /cy | 10,468 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 11,520.0 | sf | 0.88 | - | - | 0.03 | - | 0.91 | /sf | 10,493 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 11,520.0 | sf | 0.70 | 0.29 | - | - | - | 0.99 | /sf | 11,455 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 115.2 | csf | 9.68 | 10.12 | - | - | - | 19.80 | /csf | 2,281 |
| | **Slabs Aeration Basins** | | **896.0** | **CY** | **115.37** | **197.90** | | **3.50** | | **316.77** | **/CY** | **283,827** |
| **03333 Blower Equipment Pads** | | | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 120.0 | sfca | 7.24 | 1.36 | - | - | - | 8.60 | /sfca | 1,032 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.1 | ton | 39.87 | - | - | 7.50 | - | 47.37 | /ton | 7 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.1 | ton | 43.30 | - | - | 8.20 | - | 51.50 | /ton | 8 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 7.4 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 726 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 7.4 | cy | 27.68 | - | - | 5.70 | - | 33.38 | /cy | 247 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 7.4 | cy | 46.13 | - | - | 13.04 | - | 59.17 | /cy | 438 |
| | **Blower Equipment Pads** | | **7.4** | **cy** | **192.78** | **120.06** | | **19.05** | | **331.89** | **/cy** | **2,458** |
| **03345 Concrete Walls Aeration Basin** | | | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 56.0 | lf | 10.50 | 2.14 | - | - | - | 12.63 | /lf | 707 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 47,488.0 | sfca | 6.18 | 0.75 | - | - | - | 6.93 | /sfca | 328,975 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls Aeration Basin** | | | | | | | | | | |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 126.6 gal | - | 20.66 | - | - | - | 20.66 /gal | 2,617 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 56.0 lf | 3.24 | 14.92 | - | - | - | 18.15 /lf | 1,017 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 4.0 ea | 9.39 | 35.79 | - | - | - | 45.17 /ea | 181 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 82.4 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 147,268 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 82.4 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 3,907 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 82.4 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 4,246 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 1,385.1 cy | - | 98.01 | - | - | - | 98.01 /cy | 135,753 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 1,385.1 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 53,938 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 47,488.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 119,974 |
| | **Concrete Walls Aeration Basin** | | **1,385.1 cy** | **361.73** | **199.75** | | **15.08** | | **576.57 /cy** | **798,582** |
| **03345 Concrete Walls Baffle walls** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 672.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 8,490 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 21,504.0 sfca | 6.18 | 0.75 | - | - | - | 6.93 /sfca | 148,970 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 57.3 gal | - | 20.66 | - | - | - | 20.66 /gal | 1,185 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 672.0 lf | 3.24 | 14.92 | - | - | - | 18.15 /lf | 12,199 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 48.0 ea | 9.39 | 35.78 | - | - | - | 45.17 /ea | 2,168 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 82.1 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 146,712 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 82.1 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 3,892 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 82.1 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 4,230 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 627.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 61,473 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 627.2 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 24,425 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 21,504.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 54,328 |
| | **Concrete Walls Baffle walls** | | **627.2 cy** | **439.26** | **290.83** | | **16.20** | | **746.29 /cy** | **468,072** |
| **03345 Concrete Walls Pipe Utilidor** | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 14,000.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 107,800 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 37.3 gal | - | 20.66 | - | - | - | 20.66 /gal | 771 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls Pipe Utilidor** | | | | | | | | | | |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 19.4 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 34,732 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 19.4 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 921 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 19.4 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 1,001 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 272.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 26,681 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 272.2 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 10,601 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 14,000.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 35,370 |
| | **Concrete Walls Pipe Utilidor** | | **272.2 cy** | **549.64** | **231.72** | | **19.02** | | **800.38 /cy** | **217,879** |
| **03345 Concrete Walls Aeration Basin** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 28.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 354 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 19,264.0 sfca | 6.18 | 0.75 | - | - | - | 6.93 /sfca | 133,452 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 63.3 gal | - | 20.66 | - | - | - | 20.66 /gal | 1,308 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 28.0 lf | 3.24 | 14.92 | - | - | - | 18.15 /lf | 508 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 2.0 ea | 9.39 | 35.79 | - | - | - | 45.17 /ea | 90 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 41.2 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 73,634 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 41.2 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 1,953 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 41.2 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 2,123 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 692.5 cy | - | 98.01 | - | - | - | 98.01 /cy | 67,877 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 692.5 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 26,969 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 23,744.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 59,987 |
| | **Concrete Walls Aeration Basin** | | **-10,486.9 cy** | **(21.25)** | **(12.87)** | | **(1.00)** | | **(35.12) /cy** | **368,256** |
| **03345 Concrete Walls Baffle walls** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 504.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 6,367 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 10,752.0 sfca | 6.18 | 0.75 | - | - | - | 6.93 /sfca | 74,485 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 28.7 gal | - | 20.66 | - | - | - | 20.66 /gal | 592 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 504.0 lf | 3.24 | 14.92 | - | - | - | 18.15 /lf | 9,150 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 12.0 ea | 9.39 | 35.78 | - | - | - | 45.17 /ea | 542 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls Baffle walls** | | | | | | | | | | |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 63.5 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 113,364 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 63.5 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 3,007 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 63.5 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 3,269 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 313.6 cy | - | 98.01 | - | - | - | 98.01 /cy | 30,737 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 313.6 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 12,212 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 10,752.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 27,164 |
| | **Concrete Walls Baffle walls** | | **313.6 cy** | **508.93** | **369.45** | | **17.32** | | **895.69 /cy** | **280,889** |
| **03350 Elevated Slabs Pipe Utilidor** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 3,750.0 sf | 4.97 | 1.27 | - | - | - | 6.24 /sf | 23,388 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 32.0 lf | 4.64 | 1.62 | - | - | - | 6.26 /lf | 200 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 350.0 lf | 3.62 | 0.21 | - | - | - | 3.83 /lf | 1,341 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 9.1 ton | 821.66 | 992.00 | - | - | - | 1,813.66 /ton | 16,532 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.1 ton | 39.90 | - | - | 7.50 | - | 47.40 /ton | 3 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.1 ton | 114.00 | - | - | 21.50 | - | 135.50 /ton | 10 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 145.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 14,293 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 145.8 cy | 21.53 | - | - | 4.43 | - | 25.96 /cy | 3,786 |
| 03-35-29.30 | Finishing elev slab, manual screed, bull float, machine float & trowel | 0275 | 3,750.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 3,416 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 3,750.0 sf | 0.62 | 0.19 | - | - | - | 0.81 /sf | 3,039 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 37.5 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 743 |
| | **Elevated Slabs Pipe Utilidor** | | **145.8 cy** | **251.44** | **201.08** | | **5.22** | | **457.74 /cy** | **66,752** |
| | **03 CONCRETE** | | | | | | | | | **3,119,585** |
| **05 METALS** | | | | | | | | | | |
| **05999 Misc. Structural Steel Work** | | | | | | | | | | |
| 05-52-13.50 | Railing, pipe, aluminum, clear finish, 3 rails, 3'-6" high, posts @ 5' O.C., 1-1/2" dia, shop fabricated | 0210 | 2,640.0 lf | 18.34 | 74.00 | - | 1.09 | - | 93.43 /lf | 246,655 |
| 05-53-21.50 | Floor grating, steel, expanded mesh, 7.0# per S.F., field fabricated from panels | 2900 | 2,880.0 sf | 3.59 | 19.65 | - | 0.21 | - | 23.45 /sf | 67,543 |
| | **Misc. Structural Steel Work** | | **1.0 LS** | **58,767.13** | **251,952.00** | | **3,478.72** | | **314,197.85 /LS** | **314,198** |
| **05999 Misc. Structural Steel Work** | | | | | | | | | | |
| 05-52-13.50 | Railing, pipe, aluminum, clear finish, 3 rails, 3'-6" high, posts @ 5' O.C., 1-1/2" dia, shop fabricated | 0210 | 1,320.0 lf | 18.34 | 74.00 | - | 1.09 | - | 93.43 /lf | 123,328 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **05999 Misc. Structural Steel Work** | | | | | | | | | | |
| 05-53-21.50 | Floor grating, steel, expanded mesh, 7.0# per S.F., field fabricated from panels | 2900 | 1,440.0 sf | 3.59 | 19.65 | - | 0.21 | - | 23.45 /sf | 33,771 |
| | **Misc. Structural Steel Work** | | **1.0 LS** | **29,383.57** | **125,976.00** | | **1,739.36** | | **157,098.93 /LS** | **157,099** |
| | **05 METALS** | | | | | | | | | **471,297** |
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Aeration Equipment** | | | | | | | | | | |
| 11-00-01.00 | Aeration diffusers, fine bubble, complete with headers | BC-0031 | 10,432.0 ea | 13.11 | 35.00 | - | - | - | 48.11 /ea | 501,883 |
| 11-00-01.00 | Aeration diffusers, fine bubble, complete with headers | BC-0031 | 5,216.0 ea | 13.11 | 35.00 | - | - | - | 48.11 /ea | 250,933 |
| 11-00-01.00 | Aeration Blower, high speed turbo, (5,000 scfm at 10 psig) | BC-0336 | 4.0 ea | 5,654.22 | 200,000.00 | - | - | - | 205,654.22 /ea | 822,617 |
| 11-00-01.00 | Mixer, submerged propellar type, 10 hp, Flygt, with guiderail | BC-0621 | 24.0 ea | 2,261.69 | 30,000.00 | - | 380.00 | - | 32,641.69 /ea | 783,401 |
| 11-00-01.00 | Mixer, submerged propellar type, 10 hp, Flygt, with guiderail | BC-0621 | 12.0 ea | 2,261.69 | 30,000.00 | - | 380.00 | - | 32,641.69 /ea | 391,700 |
| 11-00-09.00 | Pump, submerged axial flow. 18" Dia., wall pump, 3-hp, 2.5 mgd, IMLR pump | BC-0316 | 4.0 ea | 1,696.27 | 25,000.00 | - | 190.00 | - | 26,886.26 /ea | 107,545 |
| 11-00-09.00 | Pump, submerged axial flow. 18" Dia., wall pump, 3-hp, 2.5 mgd, IMLR pump | BC-0316 | 2.0 ea | 1,696.27 | 25,000.00 | - | 190.00 | - | 26,886.26 /ea | 53,773 |
| | **Aeration Equipment** | | **1.0 LS** | **319,350.54** | **2,577,680.00** | | **14,820.00** | | **2,911,850.54 /LS** | **2,911,851** |
| | **11 EQUIPMENT** | | | | | | | | | **2,911,851** |
| **22 PLUMBING** | | | | | | | | | | |
| **22999 Aeration Piping** | | | | | | | | | | |
| 22-99-99.99 | Aeration piping allowance | MISC | 4.0 LS | 17,950.00 | 75,000.00 | | - | - | 92,950.00 /LS | 371,800 |
| 22-99-99.99 | Aeration piping allowance | MISC | 2.0 LS | 17,950.00 | 75,000.00 | | - | - | 92,950.00 /LS | 185,900 |
| | **Aeration Piping** | | **1.0 LS** | **107,700.00** | **450,000.00** | | | | **557,700.00 /LS** | **557,700** |
| | **22 PLUMBING** | | | | | | | | | **557,700** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **01999 ADDITIONAL COST: Service to New Aeration Basis** | | | | | | | | | | |
| 01-99-99.99 | Additional Cost associated with Aeration Basin - Electrical Service in Ductbank | MISC | 750.0 LF | - | - | 250.00 | - | - | 250.00 /LF | 187,500 |
| | **ADDITIONAL COST: Service to New Aeration Basis** | | **750.0 LF** | | | **250.00** | | | **250.00 /LF** | **187,500** |
| **26001 Aeration Tanks - E&I (#4, #5, #6)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 1,719,975.04 | - | - | 1,719,975.04 /LS | 1,719,975 |
| | **Aeration Tanks - E&I (#4, #5, #6)** | | **2.0 LS** | | | **859,987.52** | | | **859,987.52 /LS** | **1,719,975** |
| | **26 ELECTRICAL** | | | | | | | | | **1,907,475** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Aeration Tanks - E&I (#4, #5, #6)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 429,993.77 | - | - | 429,993.77 /LS | 429,994 |
| | **Aeration Tanks - E&I (#4, #5, #6)** | | **2.0 LS** | | | **214,996.89** | | | **214,996.89 /LS** | **429,994** |
| | **27 COMMUNICATIONS** | | | | | | | | | **429,994** |
| **31 EARTHWORK** | | | | | | | | | | |
| **01999 Dewatering** | | | | | | | | | | |
| 01-54-33.70 | Rent wellpoint header pipe, 6" diameter, 400 gpm | 0500 | 2,600.0 day | - | - | - | 0.40 | - | 0.40 /day | 1,040 |
| 31-23-19.20 | Dewatering, pumping 8 hours, attended 2 hrs per day, 6" centrifugal pump, includes 20 LF of suction hose and 100 LF of discharge hose | 1100 | 260.0 day | 857.51 | - | - | 377.70 | - | 1,235.21 /day | 321,154 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **01999 Dewatering** | | | | | | | | | | | | |
| 31-23-19.30 | Wells, for dewatering, with steel casing, 10' to 20' deep, 2' diameter, minimum | 0020 | 175.0 | vlf | 76.64 | 184.52 | - | 17.92 | - | 279.08 | /vlf | 48,839 |
| | **Dewatering** | | **1.0** | **LS** | **236,365.01** | **32,291.57** | | **102,377.06** | | **371,033.64** | **/LS** | **371,034** |
| **03330 Slabs Aeration Basins** | | | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 2,560.0 | sy | 1.07 | - | - | 0.72 | - | 1.79 | /sy | 4,574 |
| | **Slabs Aeration Basins** | | **2,560.0** | **SY** | **1.07** | | | **0.72** | | **1.79** | **/SY** | **4,574** |
| **03330 Slabs Pipe Utilidor** | | | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 416.7 | sy | 1.07 | - | - | 0.72 | - | 1.79 | /sy | 745 |
| | **Slabs Pipe Utilidor** | | **3,750.0** | **cy** | **0.12** | | | **0.08** | | **0.20** | **/cy** | **745** |
| **03330 Slabs Aeration Basins** | | | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 1,280.0 | sy | 1.07 | - | - | 0.72 | - | 1.79 | /sy | 2,287 |
| | **Slabs Aeration Basins** | | **896.0** | **CY** | **1.52** | | | **1.03** | | **2.55** | **/CY** | **2,287** |
| **31315 Excavation and Backfill Aeration Basin** | | | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 18,848.2 | bcy | 6.99 | - | - | 7.64 | - | 14.63 | /bcy | 275,750 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 4,611.1 | ecy | 5.30 | - | - | 1.50 | - | 6.80 | /ecy | 31,339 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 14,237.0 | lcy | 3.08 | - | - | 5.47 | - | 8.55 | /lcy | 121,712 |
| | **Excavation and Backfill Aeration Basin** | | **18,848.2** | **cy** | **10.62** | | | **12.14** | | **22.75** | **/cy** | **428,801** |
| **31315 Excavation and Backfill Aeration Basin** | | | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 23,644.0 | bcy | 6.99 | - | - | 7.64 | - | 14.63 | /bcy | 345,914 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 2,022.0 | ecy | 5.30 | - | - | 1.50 | - | 6.80 | /ecy | 13,742 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 21,622.0 | lcy | 3.08 | - | - | 5.47 | - | 8.55 | /lcy | 184,846 |
| | **Excavation and Backfill Aeration Basin** | | **23,644.0** | **cy** | **10.26** | | | **12.77** | | **23.03** | **/cy** | **544,502** |
| | **31 EARTHWORK** | | | | | | | | | | | **1,351,943** |
| | **02 Aeration Tanks** | | **1.0** | **LS** | **2,873,941.79** | **4,819,214.20** | **2,337,468.81** | **719,219.14** | | **10,749,843.94** | **/LS** | **10,749,844** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03 Seconday Clarifiers** | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | |
| **03330 Slabs Secondary Clarifier** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 205.1 cy | - | 33.69 | - | - | - | 33.69 /cy | 6,912 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, slab blockouts, wood, to 24" high, 1 use, includes erecting, bracing, stripping and cleaning | 4050 | 32.0 lf | 15.09 | 1.02 | - | - | - | 16.10 /lf | 515 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 264.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 2,118 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 22.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 1,260 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 30.8 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 62,406 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 30.8 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 1,458 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 30.8 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 1,585 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 430.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 42,225 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 430.8 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 5,033 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 5,539.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 5,045 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 5,539.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 5,508 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 55.4 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 1,097 |
| | **Slabs Secondary Clarifier** | | **615.4 SY** | **80.52** | **136.65** | | **2.45** | | **219.62 /SY** | **135,162** |
| **03330 Slabs Splitter Box** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 14.8 cy | - | 33.69 | - | - | - | 33.69 /cy | 499 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 80.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 642 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 7.0 ea | 9.38 | 47.88 | - | - | - | 57.26 /ea | 401 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 2.2 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 4,506 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 2.2 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 105 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 2.2 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 114 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 31.1 cy | - | 98.01 | - | - | - | 98.01 /cy | 3,049 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 31.1 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 363 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed and bull float(darby) finish | 0100 | 400.0 sf | 0.38 | - | - | - | - | 0.38 /sf | 151 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 400.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 398 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 4.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 79 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Slabs Splitter Box** | | **31.1 cy** | **116.18** | **212.18** | | **3.12** | | **331.47 /cy** | **10,309** |
| **03330 Slabs Scum Pump** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 1.3 cy | - | 33.69 | - | - | - | 33.69 /cy | 45 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 36.0 lf | 3.61 | 4.42 | - | - | - | 8.02 /lf | 289 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 3.0 ea | 9.38 | 47.88 | - | - | - | 57.26 /ea | 172 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.2 ton | 1,036.00 | 992.00 | - | - | - | 2,028.00 /ton | 406 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.2 ton | 39.85 | - | - | 7.50 | - | 47.35 /ton | 9 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.2 ton | 43.35 | - | - | 8.15 | - | 51.50 /ton | 10 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 274 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 2.8 cy | 9.69 | - | - | 2.00 | - | 11.69 /cy | 33 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and hand trowel finish | 0200 | 36.0 sf | 1.20 | - | - | - | - | 1.20 /sf | 43 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 36.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 36 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 0.4 csf | 9.67 | 10.10 | - | - | - | 19.78 /csf | 7 |
| | **Slabs Scum Pump** | | **4.0 sy** | **120.20** | **208.63** | | **2.18** | | **331.01 /sy** | **1,324** |
| **03330 Slabs Secondary Clarifier** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 205.1 cy | - | 33.69 | - | - | - | 33.69 /cy | 6,912 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, slab blockouts, wood, to 24" high, 1 use, includes erecting, bracing, stripping and cleaning | 4050 | 32.0 lf | 15.09 | 1.02 | - | - | - | 16.10 /lf | 515 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 264.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 2,118 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 22.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 1,260 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 30.8 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 62,406 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 30.8 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 1,458 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 30.8 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 1,585 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 430.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 42,225 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 430.8 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 5,033 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 5,539.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 5,045 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 5,539.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 5,508 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 55.4 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 1,097 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Slabs Secondary Clarifier** | | **430.8** | **CY** | **115.03** | **195.21** | | **3.50** | | **313.74** | **/CY** | **135,162** |
| **03330 Slabs Scum Pump** | | | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 1.3 | cy | - | 33.69 | - | - | - | 33.69 | /cy | 45 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 36.0 | lf | 3.61 | 4.42 | - | - | - | 8.02 | /lf | 289 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 3.0 | ea | 9.38 | 47.88 | - | - | - | 57.26 | /ea | 172 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.2 | ton | 1,036.00 | 992.00 | - | - | - | 2,028.00 | /ton | 406 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.2 | ton | 39.85 | - | - | 7.50 | - | 47.35 | /ton | 9 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.2 | ton | 43.35 | - | - | 8.15 | - | 51.50 | /ton | 10 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.8 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 274 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 2.8 | cy | 9.69 | - | - | 2.00 | - | 11.69 | /cy | 33 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and hand trowel finish | 0200 | 36.0 | sf | 1.20 | - | - | - | - | 1.20 | /sf | 43 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 36.0 | sf | 0.70 | 0.29 | - | - | - | 0.99 | /sf | 36 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 0.4 | csf | 9.67 | 10.10 | - | - | - | 19.78 | /csf | 7 |
| | **Slabs Scum Pump** | | **2.8** | **cy** | **171.71** | **298.04** | | **3.11** | | **472.87** | **/cy** | **1,324** |
| **03345 Concrete Walls Secondary Clarifiers** | | | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 11,304.0 | sfca | 6.95 | 0.75 | - | - | - | 7.70 | /sfca | 87,041 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 30.1 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 623 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 15.7 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 28,045 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 15.7 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 744 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 15.7 | ton | 43.34 | - | - | 8.17 | - | 51.50 | /ton | 809 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 219.8 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 21,543 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 219.8 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 8,560 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 11,304.0 | sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 | /sf | 28,558 |
| | **Concrete Walls Secondary Clarifiers** | | **219.8** | **cy** | **549.63** | **231.72** | | **19.02** | | **800.37** | **/cy** | **175,922** |
| **03345 Concrete Walls scum pump** | | | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 864.0 | sfca | 6.95 | 0.75 | - | - | - | 7.70 | /sfca | 6,653 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 2.3 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 48 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls scum pump** | | | | | | | | | | |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 1.2 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 2,144 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 1.2 ton | 39.87 | - | - | 7.52 | - | 47.38 /ton | 57 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 1.2 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 62 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 5000 psi | 0407 | 16.8 cy | - | 103.51 | - | - | - | 103.51 /cy | 1,739 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 16.8 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 654 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 864.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 2,183 |
| | **Concrete Walls scum pump** | | **16.8 cy** | **549.63** | **237.22** | | **19.02** | | **805.87 /cy** | **13,539** |
| **03345 Concrete Walls Secondary Clarifiers** | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 11,304.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 87,041 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 30.1 gal | - | 20.66 | - | - | - | 20.66 /gal | 623 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 15.7 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 28,045 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 15.7 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 744 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 15.7 ton | 43.34 | - | - | 8.17 | - | 51.50 /ton | 809 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 219.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 21,543 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 219.8 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 8,560 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 11,304.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 28,558 |
| | **Concrete Walls Secondary Clarifiers** | | **219.8 cy** | **549.63** | **231.72** | | **19.02** | | **800.37 /cy** | **175,922** |
| **03345 Concrete Walls scum pump** | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 864.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 6,653 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 2.3 gal | - | 20.66 | - | - | - | 20.66 /gal | 48 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 1.2 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 2,144 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 1.2 ton | 39.87 | - | - | 7.52 | - | 47.38 /ton | 57 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 1.2 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 62 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 5000 psi | 0407 | 16.8 cy | - | 103.51 | - | - | - | 103.51 /cy | 1,739 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 16.8 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 654 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 864.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 2,183 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Concrete Walls scum pump** | | **16.8** | **cy** | **549.63** | **237.22** | | **19.02** | | **805.87** | **/cy** | **13,539** |
| **03345 Concrete Walls Splitter Box** | | | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 20.0 | lf | 10.50 | 2.14 | - | - | - | 12.63 | /lf | 253 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 3,200.0 | sfca | 6.95 | 0.75 | - | - | - | 7.70 | /sfca | 24,640 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 8.5 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 176 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 7.8 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 13,894 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 7.8 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 369 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 7.8 | ton | 43.34 | - | - | 8.17 | - | 51.50 | /ton | 401 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 93.3 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 9,148 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 93.3 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 3,635 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 3,200.0 | sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 | /sf | 8,084 |
| | **Concrete Walls Splitter Box** | | **3,200.0** | **cy** | **11.98** | **6.51** | | **0.45** | | **18.94** | **/cy** | **60,599** |
| **03350 Elevated Slab Splitter Box** | | | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 400.0 | sf | 4.97 | 1.27 | - | - | - | 6.24 | /sf | 2,495 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 24.0 | lf | 4.64 | 1.62 | - | - | - | 6.26 | /lf | 150 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 80.0 | lf | 3.62 | 0.21 | - | - | - | 3.83 | /lf | 307 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, perimeter deck and rail, straight, includes shoring, erecting, bracing, stripping and cleaning | 8000 | 80.0 | lf | 20.11 | 12.55 | - | - | - | 32.66 | /lf | 2,613 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.0 | ton | 822.00 | 992.00 | - | - | - | 1,814.00 | /ton | 29 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 | ton | 40.00 | - | - | 8.00 | - | 48.00 | /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 | ton | 114.00 | - | - | 21.00 | - | 135.00 | /ton | 1 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 15.6 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 1,525 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 15.6 | cy | 21.53 | - | - | 4.43 | - | 25.96 | /cy | 404 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed finish | 0020 | 400.0 | sf | 0.32 | - | - | - | - | 0.32 | /sf | 126 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 400.0 | sf | 0.62 | 0.19 | - | - | - | 0.81 | /sf | 324 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 4.0 | csf | 9.68 | 10.12 | - | - | - | 19.80 | /csf | 79 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Elevated Slab Splitter Box** | | **15.6 cy** | **305.79** | **207.31** | | **4.45** | | **517.55 /cy** | **8,053** |
| **03350 Elevated Slabs Scum Pump** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 72.0 sf | 4.97 | 1.27 | - | - | - | 6.24 /sf | 449 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 64.0 lf | 4.64 | 1.62 | - | - | - | 6.26 /lf | 401 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 700.0 lf | 3.62 | 0.21 | - | - | - | 3.83 /lf | 2,683 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.2 ton | 821.67 | 992.00 | - | - | - | 1,813.67 /ton | 381 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 ton | 40.00 | - | - | 10.00 | - | 50.00 /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 ton | 110.00 | - | - | 20.00 | - | 130.00 /ton | 0 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 2.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 274 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 2.8 cy | 21.53 | - | - | 4.43 | - | 25.96 /cy | 73 |
| 03-35-29.30 | Finishing elev slab, manual screed, bull float, machine float & trowel | 0275 | 72.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 66 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 72.0 sf | 0.62 | 0.19 | - | - | - | 0.81 /sf | 58 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 0.7 csf | 9.68 | 10.13 | - | - | - | 19.80 /csf | 14 |
| | **Elevated Slabs Scum Pump** | | **2.8 cy** | **1,263.06** | **302.70** | | **5.21** | | **1,570.98 /cy** | **4,399** |
| **03350 Elevated Slabs Scum Pump** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 72.0 sf | 4.97 | 1.27 | - | - | - | 6.24 /sf | 449 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 64.0 lf | 4.64 | 1.62 | - | - | - | 6.26 /lf | 401 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 700.0 lf | 3.62 | 0.21 | - | - | - | 3.83 /lf | 2,683 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.2 ton | 821.67 | 992.00 | - | - | - | 1,813.67 /ton | 381 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 ton | 40.00 | - | - | 10.00 | - | 50.00 /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 ton | 110.00 | - | - | 20.00 | - | 130.00 /ton | 0 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 2.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 274 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 2.8 cy | 21.53 | - | - | 4.43 | - | 25.96 /cy | 73 |
| 03-35-29.30 | Finishing elev slab, manual screed, bull float, machine float & trowel | 0275 | 72.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 66 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 72.0 sf | 0.62 | 0.19 | - | - | - | 0.81 /sf | 58 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03350 Elevated Slabs Scum Pump** | | | | | | | | | | |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 0.7 csf | 9.68 | 10.13 | - | - | - | 19.80 /csf | 14 |
| | **Elevated Slabs Scum Pump** | | **72.0 cy** | **49.12** | **11.77** | | **0.20** | | **61.09 /cy** | **4,399** |
| | **03 CONCRETE** | | | | | | | | | **739,652** |
| **05 METALS** | | | | | | | | | | |
| **11999 Secondary Clarifier** | | | | | | | | | | |
| 05-01-10.51 | Metal cleaning, steel surface treatment, 5.6 lb sand per S.F., near white blast, loose scale, fine powder rust (SSPC-SP10) | 6255 | 6,400.0 sf | 4.22 | 0.88 | - | 0.54 | - | 5.63 /sf | 36,059 |
| 05-01-10.51 | Metal cleaning, steel surface treatment, 5.6 lb sand per S.F., near white blast, loose scale, fine powder rust (SSPC-SP10) | 6255 | 6,400.0 sf | 4.22 | 0.88 | - | 0.54 | - | 5.63 /sf | 36,059 |
| 09-91-06.41 | Coatings & paints, B & C coating system E-2 (Epoxy, metal tanks, structures) | BC-0021 | 12,800.0 sqft | 0.28 | 1.40 | - | - | - | 1.69 /sqft | 21,594 |
| | **Secondary Clarifier** | | **1.0 LS** | **57,646.89** | **29,222.40** | | **6,842.62** | | **93,711.91 /LS** | **93,712** |
| | **05 METALS** | | | | | | | | | **93,712** |
| **09 FINISHES** | | | | | | | | | | |
| **11999 Secondary Clarifier** | | | | | | | | | | |
| 09-91-06.41 | Coatings & paints, B & C coating system E-2 (Epoxy, metal tanks, structures) | BC-0021 | 12,800.0 sqft | 0.28 | 1.40 | - | - | - | 1.69 /sqft | 21,594 |
| | **Secondary Clarifier** | | **1.0 LS** | **3,622.49** | **17,971.20** | | | | **21,593.69 /LS** | **21,594** |
| | **09 FINISHES** | | | | | | | | | **21,594** |
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Secondary Clarifier** | | | | | | | | | | |
| 11-00-01.00 | Mechanical, clarifier mechanism, secondary, 100' dia., 18' sidewall, w/ bridge, cage, FRP weirs, & baffles | BC-1036 | 1.0 ea | 34,035.31 | 270,000.00 | - | 9,678.80 | - | 313,714.11 /ea | 313,714 |
| 11-00-01.00 | Mechanical, clarifier mechanism, secondary, 100' dia., 18' sidewall, w/ bridge, cage, FRP weirs, & baffles | BC-1036 | 1.0 ea | 34,035.31 | 270,000.00 | - | 9,678.80 | - | 313,714.11 /ea | 313,714 |
| 11-00-11.05 | Wastewater, submersible, 3-inch, 6.5 hp,,guide rails, base elbow, scum pump | BC-0071 | 1.0 ea | 1,194.45 | 7,510.00 | - | - | - | 8,704.45 /ea | 8,704 |
| 11-00-11.05 | Wastewater, submersible, 3-inch, 6.5 hp,,guide rails, base elbow, scum pump | BC-0071 | 1.0 ea | 1,194.45 | 7,510.00 | - | - | - | 8,704.45 /ea | 8,704 |
| | **Secondary Clarifier** | | **1.0 LS** | **70,459.52** | **555,020.00** | | **19,357.60** | | **644,837.12 /LS** | **644,837** |
| | **11 EQUIPMENT** | | | | | | | | | **644,837** |
| **22 PLUMBING** | | | | | | | | | | |
| **11999 Secondary Clarifier** | | | | | | | | | | |
| 11-00-04.00 | Hydraulic structures, slide gate, stainless stl, ab & grout,36" x 36" | BC-0101 | 1.0 ea | 2,455.44 | 4,774.77 | - | 554.07 | - | 7,784.28 /ea | 7,784 |
| 11-00-04.00 | Hydraulic structures, slide gate, stainless stl, ab & grout,36" x 36" | BC-0101 | 1.0 ea | 2,455.44 | 4,774.77 | - | 554.07 | - | 7,784.28 /ea | 7,784 |
| 22-05-23.70 | Valves, semi-steel, lubricated plug valve, flanged, 200 psi, 12" | 7070 | 1.0 ea | 907.31 | 4,700.00 | - | - | - | 5,607.31 /ea | 5,607 |
| 22-05-23.70 | Valves, semi-steel, lubricated plug valve, flanged, 200 psi, 12" | 7070 | 1.0 ea | 907.31 | 4,700.00 | - | - | - | 5,607.31 /ea | 5,607 |
| 22-11-13.44 | Pipe, steel, black, welded, 36" diameter, schedule 40, Spec. A-53, includes two rod, roll hanger & saddle, sized for covering, 10' OC | 2220 | 75.0 lf | 280.75 | 275.00 | - | 9.20 | - | 564.94 /lf | 42,371 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **11999 Secondary Clarifier** | | | | | | | | | | |
| 22-11-13.44 | Pipe, steel, black, welded, 36" diameter, schedule 40, Spec. A-53, includes two rod, roll hanger & saddle, sized for covering, 10' OC | 2220 | 75.0 lf | 280.75 | 275.00 | - | 9.20 | - | 564.94 /lf | 42,371 |
| 22-11-13.47 | Elbow, 90 Deg., steel, carbon steel, black, long radius, butt weld, standard weight, 36" pipe size, includes 1 weld per joint and weld machine | 3194 | 1.0 ea | 1,554.30 | 3,450.00 | - | 57.70 | - | 5,062.00 /ea | 5,062 |
| 22-11-13.47 | Elbow, 90 Deg., steel, carbon steel, black, long radius, butt weld, standard weight, 36" pipe size, includes 1 weld per joint and weld machine | 3194 | 1.0 ea | 1,554.30 | 3,450.00 | - | 57.70 | - | 5,062.00 /ea | 5,062 |
| 22-20-00.30 | Piping, water dist, DI, cement lined, 18' L, restrained jt, 12" dia | BC-0001 | 55.0 lnft | 6.58 | 25.25 | - | | - | 31.83 /lnft | 1,751 |
| 22-20-00.30 | Piping, water dist, DI, cement lined, 18' L, restrained jt, 12" dia | BC-0001 | 55.0 lnft | 6.58 | 25.25 | - | | - | 31.83 /lnft | 1,751 |
| 22-20-00.31 | Piping, water dist, DI, 90< bend or elbow, 12" dia | BC-0026 | 1.0 ea | 212.17 | 228.00 | - | 45.86 | - | 486.03 /ea | 486 |
| 22-20-00.31 | Piping, water dist, DI, 90< bend or elbow, 12" dia | BC-0026 | 1.0 ea | 212.17 | 228.00 | - | 45.86 | - | 486.03 /ea | 486 |
| 22-20-01.95 | Pipe, steel ftngs, sch 40, tee 54" X 36" welded | BC-2866 | 1.0 ea | 1,843.18 | 13,429.84 | - | 995.92 | - | 16,268.94 /ea | 16,269 |
| 22-20-01.95 | Pipe, steel ftngs, sch 40, tee 54" X 36" welded | BC-2866 | 1.0 ea | 1,843.18 | 13,429.84 | - | 995.92 | - | 16,268.94 /ea | 16,269 |
| | **Secondary Clarifier** | | **1.0 LS** | **56,780.46** | **97,192.72** | | **4,686.54** | | **158,659.72 /LS** | **158,660** |
| | **22 PLUMBING** | | | | | | | | | **158,660** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **26001 Secondary Clarifiers - E&I (#7, #8, #9)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 475,884.95 | - | - | 475,884.95 /LS | 475,885 |
| | **Secondary Clarifiers - E&I (#7, #8, #9)** | | **2.0 LS** | | | **237,942.48** | | | **237,942.48 /LS** | **475,885** |
| | **26 ELECTRICAL** | | | | | | | | | **475,885** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Secondary Clarifiers - E&I (#7, #8, #9)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 133,842.65 | - | - | 133,842.65 /LS | 133,843 |
| | **Secondary Clarifiers - E&I (#7, #8, #9)** | | **2.0 LS** | | | **66,921.32** | | | **66,921.32 /LS** | **133,843** |
| | **27 COMMUNICATIONS** | | | | | | | | | **133,843** |
| **31 EARTHWORK** | | | | | | | | | | |
| **01999 Dewatering** | | | | | | | | | | |
| 01-54-33.70 | Rent wellpoint header pipe, 6" diameter, 400 gpm | 0500 | 1,760.0 day | - | - | - | 0.40 | - | 0.40 /day | 704 |
| 31-23-19.20 | Dewatering, pumping 8 hours, attended 2 hrs per day, 6" centrifugal pump, includes 20 LF of suction hose and 100 LF of discharge hose | 1100 | 176.0 day | 857.51 | - | - | 377.70 | - | 1,235.21 /day | 217,397 |
| 31-23-19.30 | Wells, for dewatering, with steel casing, 10' to 20' deep, 2' diameter, minimum | 0020 | 250.0 vlf | 9.63 | 23.18 | - | 2.25 | - | 35.06 /vlf | 8,765 |
| | **Dewatering** | | **1.0 LS** | **153,329.11** | **5,795.00** | | **67,741.30** | | **226,865.41 /LS** | **226,865** |
| **03330 Slabs Secondary Clarifier** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 615.4 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 1,100 |
| | **Slabs Secondary Clarifier** | | **615.4 SY** | **1.07** | | | **0.72** | | **1.79 /SY** | **1,100** |
| **03330 Slabs Splitter Box** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 44.4 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 79 |
| | **Slabs Splitter Box** | | **31.1 cy** | **1.52** | | | **1.03** | | **2.55 /cy** | **79** |
| **03330 Slabs Scum Pump** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 4.0 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 7 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Slabs Scum Pump** | | **4.0** | **sy** | **1.07** | | | **0.72** | | **1.79** | **/sy** | **7** |
| **03330 Slabs Secondary Clarifier** | | | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 615.4 | sy | 1.07 | - | - | 0.72 | - | 1.79 | /sy | 1,100 |
| | **Slabs Secondary Clarifier** | | **430.8** | **CY** | **1.52** | | | **1.03** | | **2.55** | **/CY** | **1,100** |
| **03330 Slabs Scum Pump** | | | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 4.0 | sy | 1.07 | - | - | 0.72 | - | 1.79 | /sy | 7 |
| | **Slabs Scum Pump** | | **2.8** | **cy** | **1.52** | | | **1.03** | | **2.55** | **/cy** | **7** |
| **31315 Excavation and Backfill secondary Clarifier** | | | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 8,744.0 | bcy | 6.99 | - | - | 7.64 | - | 14.63 | /bcy | 127,926 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 4,900.0 | ecy | 5.30 | - | - | 1.50 | - | 6.80 | /ecy | 33,302 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 4,289.0 | lcy | 3.08 | - | - | 5.47 | - | 8.55 | /lcy | 36,667 |
| | **Excavation and Backfill secondary Clarifier** | | **19,218.4** | **cy** | **5.22** | | | **5.08** | | **10.30** | **/cy** | **197,894** |
| **31315 Excavation and Backfill splitter Box** | | | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 3,888.9 | bcy | 6.99 | - | - | 7.64 | - | 14.63 | /bcy | 56,895 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 2,444.4 | ecy | 5.30 | - | - | 1.50 | - | 6.80 | /ecy | 16,613 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 296.3 | lcy | 3.08 | - | - | 5.47 | - | 8.55 | /lcy | 2,533 |
| | **Excavation and Backfill splitter Box** | | **3,889.0** | **cy** | **10.56** | | | **8.99** | | **19.55** | **/cy** | **76,041** |
| **31315 Excavation and Backfill secondary Clarifier** | | | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 8,744.0 | bcy | 6.99 | - | - | 7.64 | - | 14.63 | /bcy | 127,926 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 4,900.0 | ecy | 5.30 | - | - | 1.50 | - | 6.80 | /ecy | 33,302 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 4,289.0 | lcy | 3.08 | - | - | 5.47 | - | 8.55 | /lcy | 36,667 |
| | **Excavation and Backfill secondary Clarifier** | | **8,744.0** | **cy** | **11.47** | | | **11.16** | | **22.63** | **/cy** | **197,894** |
| **33500 Secondary RAS Piping** | | | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 1,333.3 | bcy | 2.80 | - | - | 2.07 | - | 4.87 | /bcy | 6,493 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 627.8 | ecy | 1.23 | - | - | 2.60 | - | 3.82 | /ecy | 2,400 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 538.3 | lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 | /lcy | 12,895 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 538.3 | ecy | 5.57 | - | - | 0.41 | - | 5.98 | /ecy | 3,216 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 705.6 | lcy | 6.23 | - | - | 5.24 | - | 11.48 | /lcy | 8,097 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 12,000.0 | sf | - | - | 0.08 | - | - | 0.08 | /sf | 960 |
| | **Secondary RAS Piping** | | **750.0** | **LF** | **23.46** | **7.82** | **1.28** | **12.86** | | **45.42** | **/LF** | **34,062** |
| **33500 Secondary Clarifier ML Piping** | | | | | | | | | | | | |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **33500 Secondary Clarifier ML Piping** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 1,168.1 bcy | 2.80 | - | - | 2.07 | - | 4.87 /bcy | 5,688 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 426.4 ecy | 1.23 | - | - | 2.60 | - | 3.82 /ecy | 1,630 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 497.9 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 11,927 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 497.9 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 2,975 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 741.7 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 8,511 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 9,050.0 sf | - | - | 0.08 | - | - | 0.08 /sf | 724 |
| | **Secondary Clarifier ML Piping** | | **525.0 LF** | **31.35** | **10.33** | **1.38** | **16.87** | | **59.91 /LF** | **31,455** |
| **33500 Secondary Clarifier SE Piping** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 1,480.6 bcy | 2.80 | - | - | 2.07 | - | 4.87 /bcy | 7,210 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 530.6 ecy | 1.23 | - | - | 2.60 | - | 3.82 /ecy | 2,028 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 632.6 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 15,154 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 632.6 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 3,780 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 950.0 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 10,902 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 11,300.0 sf | - | - | 0.08 | - | - | 0.08 /sf | 904 |
| | **Secondary Clarifier SE Piping** | | **650.0 LF** | **32.20** | **10.60** | **1.39** | **17.31** | | **61.50 /LF** | **39,978** |
| | **31 EARTHWORK** | | | | | | | | | **806,482** |
| **33 UTILITIES** | | | | | | | | | | |
| **33500 Secondary RAS Piping** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 8.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 71 |
| | **Secondary RAS Piping** | | **750.0 LF** | **0.04** | **0.06** | | | | **0.10 /LF** | **71** |
| **33500 Secondary Clarifier ML Piping** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 5.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 44 |
| | **Secondary Clarifier ML Piping** | | **525.0 LF** | **0.03** | **0.05** | | | | **0.09 /LF** | **44** |
| **33500 Secondary Clarifier SE Piping** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 7.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 62 |
| | **Secondary Clarifier SE Piping** | | **650.0 LF** | **0.04** | **0.06** | | | | **0.10 /LF** | **62** |
| | **33 UTILITIES** | | | | | | | | | **178** |

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| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **33500 Secondary RAS Piping** | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 24 Inch (600mm) | A241002 0000EA | 100.0 lf | - | 56.88 | - | - | - | 56.88 /lf | 5,688 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 24 Inch (600mm) | A241002 0000EA | 100.0 lf | - | 56.88 | - | - | - | 56.88 /lf | 5,688 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Non-Specific 24 Inch (600mm) | A242112 000000 | 1.0 ea | - | 1,678.64 | - | - | - | 1,678.64 /ea | 1,679 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Non-Specific 24 Inch (600mm) | A242112 000000 | 1.0 ea | - | 1,678.64 | - | - | - | 1,678.64 /ea | 1,679 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Std 36 Inch (900mm) | A361002 0100EA | 550.0 lf | - | 168.69 | - | - | - | 168.69 /lf | 92,779 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std 36 Inch (900mm) | A362112 010000 | 3.0 ea | 2,580.88 | 4,053.57 | - | 488.91 | - | 7,123.35 /ea | 21,370 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 24 Inch (600mm) | L244002 0000P1 | 100.0 lf | 19.57 | - | - | 3.62 | - | 23.19 /lf | 2,319 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 24 Inch (600mm) | L244002 0000P1 | 100.0 lf | 19.57 | - | - | 3.62 | - | 23.19 /lf | 2,319 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Non-Specific 24 Inch (600mm) | L245102 000000 | 2.0 ea | 983.77 | 17.51 | - | 78.79 | - | 1,080.06 /ea | 2,160 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Non-Specific 24 Inch (600mm) | L245102 000000 | 2.0 ea | 983.77 | 17.51 | - | 78.79 | - | 1,080.06 /ea | 2,160 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 36 Inch (900mm) | L364002 0100P1 | 550.0 lf | 24.46 | - | - | 4.83 | - | 29.29 /lf | 16,107 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std 36 Inch (900mm) | L365102 010000 | 14.0 ea | 929.47 | 17.51 | - | 74.44 | - | 1,021.42 /ea | 14,300 |
| 40-05-24.10 | RAS 36" tie-in at existing pump station allowance | ---- | 1.0 ls | 3,930.00 | 15,015.00 | | 5,000.00 | - | 23,945.00 /ls | 23,945 |
| | **Secondary RAS Piping** | | **750.0 LF** | **61.31** | **180.01** | | **14.94** | | **256.26 /LF** | **192,193** |
| **33500 Secondary Clarifier ML Piping** | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Std 36 Inch (900mm) | A361002 0100EA | 100.0 lf | - | 168.69 | - | - | - | 168.69 /lf | 16,869 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Std 36 Inch (900mm) | A361002 0100EA | 100.0 lf | - | 168.69 | - | - | - | 168.69 /lf | 16,869 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std 36 Inch (900mm) | A362112 010000 | 1.0 ea | 2,580.88 | 4,053.57 | - | 488.91 | - | 7,123.36 /ea | 7,123 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std 36 Inch (900mm) | A362112 010000 | 1.0 ea | 2,580.88 | 4,053.57 | - | 488.91 | - | 7,123.36 /ea | 7,123 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 54 Inch (1350mm) | A541002 0000EA | 327.0 lf | - | 333.54 | - | - | - | 333.54 /lf | 109,068 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Non-Specific 54 Inch (1350mm) | A542112 000000 | 4.0 ea | - | 9,273.91 | - | - | - | 9,273.91 /ea | 37,096 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 36 Inch (900mm) | L364002 0100P1 | 100.0 lf | 24.46 | - | - | 4.83 | - | 29.29 /lf | 2,929 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 36 Inch (900mm) | L364002 0100P1 | 100.0 lf | 24.46 | - | - | 4.83 | - | 29.29 /lf | 2,929 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std 36 Inch (900mm) | L365102 010000 | 2.0 ea | 929.47 | 17.51 | - | 74.44 | - | 1,021.42 /ea | 2,043 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std 36 Inch (900mm) | L365102 010000 | 2.0 ea | 929.47 | 17.51 | - | 74.44 | - | 1,021.42 /ea | 2,043 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 54 Inch (1350mm) | L544002 0000P1 | 327.0 lf | 32.59 | - | - | 6.43 | - | 39.02 /lf | 12,759 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Non-Specific 54 Inch (1350mm) | L545102 000000 | 11.0 ea | 1,950.39 | 39.40 | - | 156.21 | - | 2,145.99 /ea | 23,606 |
| | **Secondary Clarifier ML Piping** | | **525.0 LF** | **87.40** | **359.07** | | **11.55** | | **458.01 /LF** | **240,455** |

**33500 Secondary Clarifier SE Piping**

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **33500 Secondary Clarifier SE Piping** | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Std 36 Inch (900mm) | A361002 0100EA | 100.0 lf | - | 168.69 | - | - | - | 168.69 /lf | 16,869 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Std 36 Inch (900mm) | A361002 0100EA | 100.0 lf | - | 168.69 | - | - | - | 168.69 /lf | 16,869 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std 36 Inch (900mm) | A362112 010000 | 1.0 ea | 2,580.88 | 4,053.57 | - | 488.91 | - | 7,123.36 /ea | 7,123 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std 36 Inch (900mm) | A362112 010000 | 1.0 ea | 2,580.88 | 4,053.57 | - | 488.91 | - | 7,123.36 /ea | 7,123 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 54 Inch (1350mm) | A541002 0000EA | 450.0 lf | - | 333.54 | - | - | - | 333.54 /lf | 150,093 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Non-Specific 54 Inch (1350mm) | A542112 000000 | 3.0 ea | - | 9,273.90 | - | - | - | 9,273.90 /ea | 27,822 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 36 Inch (900mm) | L364002 0100P1 | 100.0 lf | 24.46 | - | - | 4.83 | - | 29.29 /lf | 2,929 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 36 Inch (900mm) | L364002 0100P1 | 100.0 lf | 24.46 | - | - | 4.83 | - | 29.29 /lf | 2,929 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std 36 Inch (900mm) | L365102 010000 | 2.0 ea | 929.47 | 17.51 | - | 74.44 | - | 1,021.42 /ea | 2,043 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std 36 Inch (900mm) | L365102 010000 | 2.0 ea | 929.47 | 17.51 | - | 74.44 | - | 1,021.42 /ea | 2,043 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 54 Inch (1350mm) | L544002 0000P1 | 450.0 lf | 32.59 | - | - | 6.43 | - | 39.02 /lf | 17,558 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Non-Specific 54 Inch (1350mm) | L545102 000000 | 12.0 ea | 1,950.39 | 39.40 | - | 156.21 | - | 2,145.99 /ea | 25,752 |
| | **Secondary Clarifier SE Piping** | | **650.0 LF** | **79.76** | **338.93** | | **10.78** | | **429.47 /LF** | **279,152** |
| | | 40 | | | | | | | | 711,800 |
| | **03 Seconday Clarifiers** | | **1.0 LS** | **1,197,603.36** | **1,579,336.35** | **612,315.60** | **397,387.24** | | **3,786,642.55 /LS** | **3,786,643** |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **04 Existing aeration Tanks/RAS Tank Retrofit** | | | | | | | | | | | | |
| **01 GENERAL CONDITIONS** | | | | | | | | | | | | |
| **02999 Aeration tank demolition** | | | | | | | | | | | | |
| 01-54-33.40 | Pressure Washer 7 gpm, 3000 psi | 5460 | 16.0 | day | - | - | - | 87.60 | - | 87.60 | /day | 1,402 |
| 01-54-33.40 | Rent trash pump self-prime 4" diameter, diesel drive | 5600 | 16.0 | day | - | - | - | 126.20 | - | 126.20 | /day | 2,019 |
| | **Aeration tank demolition** | | **1.0** | **LS** | | | | **3,420.80** | | **3,420.80** | **/LS** | **3,421** |
| | **01 GENERAL CONDITIONS** | | | | | | | | | | | **3,421** |
| **02 SITEWORK & DEMOLITION** | | | | | | | | | | | | |
| **02225 Demo Baffle walls** | | | | | | | | | | | | |
| 02-41-19.23 | Rubbish handling, loading & trucking, machine loading truck, includes 2 mile haul, cost to be added to demolition cost. | 3080 | 93.3 | cy | 17.39 | - | - | 6.59 | - | 23.98 | /cy | 2,239 |
| 02-41-19.25 | Sawcutting, concrete walls, rod reinforcing, per inch of depth | 0820 | 2,016.0 | lf | 7.17 | 0.05 | - | 5.84 | - | 13.06 | /lf | 26,328 |
| 03-05-05.10 | Selective concrete demolition, 2 - 5 tons, remove whole pieces, incl loading, excludes shoring, bracing, saw or torch cutting, hauling, dumping | 0160 | 96.0 | ea | 106.31 | - | - | 32.26 | - | 138.57 | /ea | 13,303 |
| | **Demo Baffle walls** | | **6,720.0** | **sf** | **3.91** | **0.02** | | **2.30** | | **6.23** | **/sf** | **41,870** |
| **02999 Aeration tank demolition** | | | | | | | | | | | | |
| 02-22-03.30 | Dump Charge, typical urban city, fees only, bldg constr mat'ls | BC-0006 | 16.0 | ton | - | - | - | - | 33.00 | 33.00 | /ton | 528 |
| 02-22-04.50 | Demo fine bubble aeration discs, piping, headers, laterals and drop legs, in basin only | BC-0071 | 16.0 | days | 2,284.78 | - | - | 967.88 | - | 3,252.66 | /days | 52,043 |
| | **Aeration tank demolition** | | **1.0** | **LS** | **36,556.52** | | | **15,486.08** | **528.00** | **52,570.60** | **/LS** | **52,571** |
| | **02 SITEWORK & DEMOLITION** | | | | | | | | | | | **94,440** |
| **03 CONCRETE** | | | | | | | | | | | | |
| **03345 Baffle walls** | | | | | | | | | | | | |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 35.0 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 62,520 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 35.0 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 1,658 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 35.0 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 1,803 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 588.0 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 57,631 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 588.0 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 22,898 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 20,160.0 | sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 | /sf | 50,932 |
| 04-05-19.16 | Masonry anchors, wall tie dowels, plain, 3/4" diameter x 6" long | 6150 | 28.0 | c | - | 313.83 | - | - | - | 313.83 | /c | 8,787 |
| | **Baffle walls** | | **588.0** | **cy** | **149.21** | **186.44** | | **15.08** | | **350.73** | **/cy** | **206,230** |
| | **03 CONCRETE** | | | | | | | | | | | **206,230** |
| **05 METALS** | | | | | | | | | | | | |
| **11999 RAS Pumps** | | | | | | | | | | | | |
| 05-58-09.50 | Pump mounting base plate, complete w/ anchor bolts, 4 sf | BC-0001 | 2.0 | ea | 622.68 | 795.79 | - | - | - | 1,418.47 | /ea | 2,837 |
| | **RAS Pumps** | | **1.0** | **LS** | **1,245.35** | **1,591.58** | | | | **2,836.93** | **/LS** | **2,837** |
| | **05 METALS** | | | | | | | | | | | **2,837** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Aeration Equipment** | | | | | | | | | | |
| 11-00-01.00 | Aeration diffusers, fine bubble, complete with headers | BC-0031 | 10,432.0 ea | 13.11 | 35.00 | - | - | - | 48.11 /ea | 501,883 |
| 11-00-01.00 | Mixer, submerged propellar type, 10 hp, Flygt, with guiderail | BC-0621 | 24.0 ea | 2,261.69 | 30,000.00 | - | 380.00 | - | 32,641.69 /ea | 783,401 |
| 11-00-09.00 | Pump, submerged axial flow. 18" Dia., wall pump, 3-hp, 2.5 mgd, IMLR pump | BC-0316 | 4.0 ea | 1,696.27 | 25,000.00 | - | 190.00 | - | 26,886.26 /ea | 107,545 |
| | **Aeration Equipment** | | **1.0 LS** | **197,828.19** | **1,185,120.00** | | **9,880.00** | | **1,392,828.19 /LS** | **1,392,828** |
| **11999 RAS Pumps** | | | | | | | | | | |
| 11-00-01.00 | Pump,vertical turbine, solids handling, can type, 50hp, VFD driven | BC-0791 | 2.0 ea | 2,827.11 | 30,000.00 | - | 380.00 | - | 33,207.11 /ea | 66,414 |
| | **RAS Pumps** | | **1.0 LS** | **5,654.22** | **60,000.00** | | **760.00** | | **66,414.22 /LS** | **66,414** |
| | **11 EQUIPMENT** | | | | | | | | | **1,459,242** |
| **22 PLUMBING** | | | | | | | | | | |
| **22999 RAS Piping** | | | | | | | | | | |
| 22-99-99.99 | RAS above grade piping allowance | ---- | 2.0 ls | 8,975.00 | 12,500.00 | - | - | - | 21,475.00 /ls | 42,950 |
| | **RAS Piping** | | **1.0 LS** | **17,950.00** | **25,000.00** | | | | **42,950.00 /LS** | **42,950** |
| | **22 PLUMBING** | | | | | | | | | **42,950** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **26001 Existing Aeration Tanks/RAS Tank Retrofit - E&I (#13, #14)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 445,133.73 | - | - | 445,133.73 /LS | 445,134 |
| | **Existing Aeration Tanks/RAS Tank Retrofit - E&I (#13, #14)** | | **2.0 LS** | | | **222,566.86** | | | **222,566.86 /LS** | **445,134** |
| | **26 ELECTRICAL** | | | | | | | | | **445,134** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Existing Aeration Tanks/RAS Tank Retrofit - E&I (#13, #14)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 74,188.96 | - | - | 74,188.96 /LS | 74,189 |
| | **Existing Aeration Tanks/RAS Tank Retrofit - E&I (#13, #14)** | | **2.0 LS** | | | **37,094.48** | | | **37,094.48 /LS** | **74,189** |
| | **27 COMMUNICATIONS** | | | | | | | | | **74,189** |
| **31 EARTHWORK** | | | | | | | | | | |
| **02999 Aeration tank demolition** | | | | | | | | | | |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 240.0 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 2,052 |
| | **Aeration tank demolition** | | **1.0 LS** | **738.66** | | | **1,313.09** | | **2,051.75 /LS** | **2,052** |
| **33500 Secondary Clarifier ML Piping Exist Train** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 812.5 bcy | 2.80 | - | - | 2.07 | - | 4.87 /bcy | 3,957 |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1-1/2 C.Y. excavator, 10' to 14' deep, excludes sheeting or dewatering | 1000 | 3,066.7 bcy | 2.07 | - | - | 1.95 | - | 4.02 /bcy | 12,320 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 2,187.5 ecy | 1.23 | - | - | 2.60 | - | 3.82 /ecy | 8,363 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **33500 Secondary Clarifier ML Piping Exist Train** | | | | | | | | | | |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 1,199.2 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 28,727 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 1,199.2 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 7,165 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 1,691.7 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 19,413 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 33,450.0 sf | - | - | 0.08 | - | - | 0.08 /sf | 2,676 |
| | **Secondary Clarifier ML Piping Exist Train** | | **1,475.0 LF** | **27.95** | **8.85** | **1.81** | **17.40** | | **56.01 /LF** | **82,621** |
| **33500 RAS Pump Discharge** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 902.8 bcy | 2.80 | - | - | 2.07 | - | 4.87 /bcy | 4,396 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 416.7 ecy | 1.23 | - | - | 2.60 | - | 3.82 /ecy | 1,593 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 398.8 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 9,555 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 398.8 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 2,383 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 486.1 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 5,578 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 9,750.0 sf | - | - | 0.08 | - | - | 0.08 /sf | 780 |
| | **RAS Pump Discharge** | | **750.0 LF** | **16.68** | **5.79** | **1.04** | **8.87** | | **32.38 /LF** | **24,286** |
| | **31 EARTHWORK** | | | | | | | | | **108,958** |
| **33 UTILITIES** | | | | | | | | | | |
| **33500 Secondary Clarifier ML Piping Exist Train** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 15.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 133 |
| | **Secondary Clarifier ML Piping Exist Train** | | **1,475.0 LF** | **0.03** | **0.06** | | | | **0.09 /LF** | **133** |
| **33500 RAS Pump Discharge** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 8.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 71 |
| | **RAS Pump Discharge** | | **750.0 LF** | **0.04** | **0.06** | | | | **0.10 /LF** | **71** |
| | **33 UTILITIES** | | | | | | | | | **205** |
| **40** | | | | | | | | | | |
| **33500 Secondary Clarifier ML Piping Exist Train** | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Std 36 Inch (900mm) | A361002 0100EA | 1,150.0 lf | - | 168.69 | - | - | - | 168.69 /lf | 193,992 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std 36 Inch (900mm) | A362112 010000 | 6.0 ea | 2,580.88 | 6,067.82 | - | 488.91 | - | 9,137.60 /ea | 54,826 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 54 Inch (1350mm) | A541002 0000EA | 328.0 lf | - | 333.54 | - | - | - | 333.54 /lf | 109,401 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Non-Specific 54 Inch (1350mm) | A542112 000000 | 5.0 ea | - | 9,273.90 | - | - | - | 9,273.90 /ea | 46,370 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 36 Inch (900mm) | L364002 0100P1 | 1,150.0 lf | 24.46 | - | - | 4.83 | - | 29.29 /lf | 33,679 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **33500 Secondary Clarifier ML Piping Exist Train** | | | | | | | | | | |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std 36 Inch (900mm) | L365102 010000 | 32.0 ea | 929.47 | 17.51 | - | 74.44 | - | 1,021.42 /ea | 32,685 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 54 Inch (1350mm) | L544002 0000P1 | 328.0 lf | 32.59 | - | - | 6.43 | - | 39.02 /lf | 12,798 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Non-Specific 54 Inch (1350mm) | L545102 000000 | 12.0 ea | 1,950.39 | 39.40 | - | 156.21 | - | 2,145.99 /ea | 25,752 |
| | **Secondary Clarifier ML Piping Exist Train** | | **1,475.0 LF** | **72.85** | **262.51** | | **10.07** | | **345.43 /LF** | **509,503** |
| **33500 RAS Pump Discharge** | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 24 Inch (600mm) | A241002 0000EA | 750.0 lf | - | 56.88 | - | - | - | 56.88 /lf | 42,661 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Non-Specific 24 Inch (600mm) | A242112 000000 | 6.0 ea | - | 1,678.64 | - | - | - | 1,678.64 /ea | 10,072 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 24 Inch (600mm) | L244002 0000P1 | 750.0 lf | 19.57 | - | - | 3.62 | - | 23.19 /lf | 17,391 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Non-Specific 24 Inch (600mm) | L245102 000000 | 19.0 ea | 983.77 | 17.51 | - | 78.79 | - | 1,080.06 /ea | 20,521 |
| | **RAS Pump Discharge** | | **750.0 LF** | **44.49** | **70.75** | | **5.62** | | **120.86 /LF** | **90,645** |
| | | **40** | | | | | | | | **600,148** |
| | **04 Existing aeration Tanks/RAS Tank Retrofit** | | **1.0 LS** | **568,618.20** | **1,839,237.11** | **522,778.69** | **106,590.89** | **528.00** | **3,037,752.89 /LS** | **3,037,753** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **05 Tertiary Treatment Processes** | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | |
| **03330 Slabs Actiflow tank** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 29.6 cy | - | 33.69 | - | - | - | 33.69 /cy | 998 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 120.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 963 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 10.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 573 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 4.4 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 9,012 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 4.4 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 211 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 4.4 ton | 43.34 | - | - | 8.17 | - | 51.50 /ton | 229 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 62.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 6,099 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 62.2 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 727 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 800.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 729 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 800.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 795 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 8.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 158 |
| | **Slabs Actiflow tank** | | **800.0 cy** | **9.31** | **16.04** | | **0.27** | | **25.62 /cy** | **20,494** |
| **03330 Slabs Coagulaton Tank** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 5.3 cy | - | 33.69 | - | - | - | 33.69 /cy | 180 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 48.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 385 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 4.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 229 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.8 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 1,622 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.8 ton | 39.88 | - | - | 7.51 | - | 47.39 /ton | 38 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.8 ton | 43.34 | - | - | 8.16 | - | 51.50 /ton | 41 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 11.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,098 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 11.2 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 131 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 144.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 131 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 144.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 143 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 1.4 csf | 9.68 | 10.13 | - | - | - | 19.81 /csf | 29 |
| | **Slabs Coagulaton Tank** | | **144.0 cy** | **10.11** | **17.58** | | **0.27** | | **27.97 /cy** | **4,027** |
| **03330 Slabs Hydrocone** | | | | | | | | | | |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03330 Slabs Hydrocone** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 5.6 cy | - | 33.69 | - | - | - | 33.69 /cy | 187 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning | 3050 | 60.0 sfca | 4.16 | 0.80 | - | - | - | 4.96 /sfca | 297 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.6 ton | 1,036.02 | 992.00 | - | - | - | 2,028.02 /ton | 1,268 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.6 ton | 39.87 | - | - | 7.52 | - | 47.39 /ton | 30 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 8.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 858 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, direct chute, over 6" thick, includes vibrating, excludes material | 4600 | 8.8 cy | 17.32 | - | - | 0.39 | - | 17.71 /cy | 155 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and broom finish | 0150 | 225.0 sf | 0.82 | - | - | - | - | 0.82 /sf | 184 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 2.3 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 45 |
| | **Slabs Hydrocone** | | **8.3 cy** | **153.51** | **208.25** | | **0.97** | | **362.73 /cy** | **3,023** |
| **03330 Slabs Disc Filters** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 14.8 cy | - | 33.69 | - | - | - | 33.69 /cy | 499 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 40.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 344 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning | 3050 | 100.0 sfca | 4.16 | 0.80 | - | - | - | 4.96 /sfca | 496 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 1.7 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 3,381 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7 | 0610 | 148.1 lb | 0.52 | 0.48 | - | - | - | 0.99 /lb | 147 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 1.7 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 82 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 27.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 2,668 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, direct chute, over 6" thick, includes vibrating, excludes material | 4600 | 27.2 cy | 17.32 | - | - | 0.39 | - | 17.71 /cy | 482 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and broom finish | 0150 | 600.0 sf | 0.82 | - | - | - | - | 0.82 /sf | 490 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 6.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 119 |
| | **Slabs Disc Filters** | | **25.9 cy** | **138.81** | **196.18** | | **0.91** | | **335.90 /cy** | **8,708** |
| **03330 Slabs Alum Storage and Pumps** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 14.8 cy | - | 33.69 | - | - | - | 33.69 /cy | 499 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 56.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 482 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning | 3050 | 110.0 sfca | 4.16 | 0.80 | - | - | - | 4.96 /sfca | 545 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03330 Slabs Alum Storage and Pumps** | | | | | | | | | | |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 1.7 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 3,381 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7 | 0610 | 170.4 lb | 0.52 | 0.48 | - | - | - | 0.99 /lb | 169 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 1.8 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 83 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 27.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 2,725 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, direct chute, over 6" thick, includes vibrating, excludes material | 4600 | 27.8 cy | 17.32 | - | - | 0.39 | - | 17.71 /cy | 492 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and broom finish | 0150 | 600.0 sf | 0.82 | - | - | - | - | 0.82 /sf | 490 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 6.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 119 |
| | **Slabs Alum Storage and Pumps** | | **26.5 cy** | **142.68** | **195.75** | | **0.90** | | **339.33 /cy** | **8,986** |
| **03333 Alum tank/pump equipment Pads and containment** | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 740.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 6,365 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.3 ton | 39.90 | - | - | 7.50 | - | 47.41 /ton | 13 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.3 ton | 43.33 | - | - | 8.20 | - | 51.50 /ton | 14 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 13.5 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,325 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 13.5 cy | 27.68 | - | - | 5.70 | - | 33.38 /cy | 451 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 13.5 cy | 46.13 | - | - | 13.04 | - | 59.17 /cy | 800 |
| | **Alum tank/pump equipment Pads and containment** | | **13.5 cy** | **471.83** | **172.51** | | **19.05** | | **663.39 /cy** | **8,968** |
| **03333 Alum pumps Equipment Pads** | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 72.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 619 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.0 ton | 39.80 | - | - | 7.50 | - | 47.25 /ton | 2 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.0 ton | 43.30 | - | - | 8.30 | - | 51.50 /ton | 2 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 196 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 2.0 cy | 27.68 | - | - | 5.70 | - | 33.38 /cy | 67 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 2.0 cy | 46.13 | - | - | 13.04 | - | 59.17 /cy | 118 |
| | **Alum pumps Equipment Pads** | | **2.0 cy** | **336.15** | **147.01** | | **19.05** | | **502.20 /cy** | **1,004** |
| **03345 Concrete Walls actiflow Tank** | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 4,320.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 33,264 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls actiflow Tank** | | | | | | | | | | | | |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 11.5 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 238 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 10.5 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 18,756 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 10.5 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 498 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 10.5 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 541 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 126.0 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 12,350 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 126.0 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 4,907 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 4,320.0 | sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 | /sf | 10,914 |
| | **Concrete Walls actiflow Tank** | | **126.0** | **cy** | **408.53** | **222.58** | | **15.46** | | **646.56** | **/cy** | **81,467** |
| **03345 Concrete Walls Coagulation Tank** | | | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 1,728.0 | sfca | 6.95 | 0.75 | - | - | - | 7.70 | /sfca | 13,306 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 4.6 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 95 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 3.6 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 6,431 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 3.6 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 171 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 3.6 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 185 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 50.4 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 4,940 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 50.4 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 1,963 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 1,728.0 | sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 | /sf | 4,366 |
| | **Concrete Walls Coagulation Tank** | | **50.4** | **cy** | **398.08** | **210.77** | | **15.27** | | **624.12** | **/cy** | **31,456** |
| | **03 CONCRETE** | | | | | | | | | | | **168,133** |
| **05 METALS** | | | | | | | | | | | | |
| **05999 Actiflo clarifier bridge** | | | | | | | | | | | | |
| 05-99-99.99 | Clarifier bridge supports, structural steel, grating, handrail, allowance | MISC | 2.0 | LS | 8,090.00 | 10,220.00 | | 2,000.00 | - | 20,310.00 | /LS | 40,620 |
| | **Actiflo clarifier bridge** | | **1.0** | **LS** | **16,180.00** | **20,440.00** | | **4,000.00** | | **40,620.00** | **/LS** | **40,620** |
| | **05 METALS** | | | | | | | | | | | **40,620** |
| **11 EQUIPMENT** | | | | | | | | | | | | |
| **03330 Slabs Actiflow tank** | | | | | | | | | | | | |
| 11-00-01.00 | 14.2 mgd Actiflow systems - Vendor quote | ---- | 1.0 | LS | 4,544.80 | 2,300,000.00 | | - | - | 2,304,544.80 | /LS | 2,304,545 |
| | **Slabs Actiflow tank** | | **800.0** | **cy** | **5.68** | **2,875.00** | | | | **2,880.68** | **/cy** | **2,304,545** |
| **11999 ACTIFLO** | | | | | | | | | | | | |
| 11-00-01.00 | Filter units, rotating disc, complete | BC-0696 | 2.0 | ea | 8,481.33 | 257,500.00 | - | 1,200.00 | | 267,181.33 | /ea | 534,363 |
| 11-00-01.00 | ACTIFLO clarifier bridge and supports allowance | ---- | 2.0 | ls | | 22,000.00 | - | | - | 22,000.00 | /ls | 44,000 |
| 11-00-01.00 | ACTIFLO - misc anchor bolts, mounting hardware allowance | ---- | 2.0 | ls | - | 10,000.00 | - | - | - | 10,000.00 | /ls | 20,000 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **11999 ACTIFLO** | | | | | | | | | | |
| 11-00-06.00 | FRP tank, alum,7,500 gal.,UV resistant | BC-0016 | 2.0 ea | 2,022.71 | 21,000.00 | - | 622.71 | | 23,645.42 /ea | 47,291 |
| 11-00-08.00 | Chemical metering pump, alum | BC-0001 | 2.0 ea | 459.41 | 11,000.00 | - | - | - | 11,459.41 /ea | 22,919 |
| 11-00-08.00 | Hydrocyclone installation | ---- | 2.0 ea | 3,347.94 | - | - | 747.26 | - | 4,095.19 /ea | 8,190 |
| 11-99-99.99 | ACTIFLO treatment system,14.2 MGD per train,incl in-line rapid mix,coag mixer,draft tube mix,lamella settler,scraper,troughs,recirc pumps,hydrocyclone | MISC | 2.0 LS | 31,386.92 | 1,150,000.00 | | 7,502.40 | - | 1,188,889.31 /LS | 2,377,779 |
| | **ACTIFLO** | | **1.0 LS** | **91,396.59** | **2,943,000.00** | | **20,144.73** | | **3,054,541.32 /LS** | **3,054,541** |
| | **11 EQUIPMENT** | | | | | | | | | **5,359,086** |
| **22 PLUMBING** | | | | | | | | | | |
| **11999 ACTIFLO** | | | | | | | | | | |
| 22-07-19.10 | Alum tank and pump heat trace and insulation allowance | ---- | 1.0 ls | 17,950.00 | 25,000.00 | - | - | - | 42,950.00 /ls | 42,950 |
| | **ACTIFLO** | | **1.0 LS** | **17,950.00** | **25,000.00** | | | | **42,950.00 /LS** | **42,950** |
| | **22 PLUMBING** | | | | | | | | | **42,950** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **26001 Tertiary Treatment Process - E&I (#12)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 1,067,541.71 | - | - | 1,067,541.71 /LS | 1,067,542 |
| | **Tertiary Treatment Process - E&I (#12)** | | **2.0 LS** | | | **533,770.85** | | | **533,770.85 /LS** | **1,067,542** |
| | **26 ELECTRICAL** | | | | | | | | | **1,067,542** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Tertiary Treatment Process - E&I (#12)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 355,847.24 | - | - | 355,847.24 /LS | 355,847 |
| | **Tertiary Treatment Process - E&I (#12)** | | **2.0 LS** | | | **177,923.62** | | | **177,923.62 /LS** | **355,847** |
| | **27 COMMUNICATIONS** | | | | | | | | | **355,847** |
| **31 EARTHWORK** | | | | | | | | | | |
| **01999 Dewatering** | | | | | | | | | | |
| 01-54-33.70 | Rent wellpoint header pipe, 6" diameter, 400 gpm | 0500 | 1,200.0 day | - | - | - | 0.40 | - | 0.40 /day | 480 |
| 31-23-19.20 | Dewatering, pumping 8 hours, attended 2 hrs per day, 6" centrifugal pump, includes 20 LF of suction hose and 100 LF of discharge hose | 1100 | 120.0 day | 857.51 | - | - | 377.70 | - | 1,235.21 /day | 148,225 |
| 31-23-19.30 | Wells, for dewatering, with steel casing, 10' to 20' deep, 2' diameter, minimum | 0020 | 150.0 vlf | 9.63 | 23.18 | - | 2.25 | - | 35.06 /vlf | 5,259 |
| | **Dewatering** | | **1.0 LS** | **104,345.66** | **3,477.00** | | **46,141.20** | | **153,963.86 /LS** | **153,964** |
| **03330 Slabs Actiflow tank** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 88.9 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 159 |
| | **Slabs Actiflow tank** | | **800.0 cy** | **0.12** | | | **0.08** | | **0.20 /cy** | **159** |
| **03330 Slabs Coagulaton Tank** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 16.0 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 29 |
| | **Slabs Coagulaton Tank** | | **144.0 cy** | **0.12** | | | **0.08** | | **0.20 /cy** | **29** |
| **03330 Slabs Hydrocone** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 25.0 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 45 |
| | **Slabs Hydrocone** | | **8.3 cy** | **3.20** | | | **2.17** | | **5.36 /cy** | **45** |
| **03330 Slabs Disc Filters** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 66.7 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 119 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Slabs Disc Filters** | | **25.9** | **cy** | **2.74** | | | **1.86** | | **4.60** | **/cy** | **119** |
| **03330 Slabs Alum Storage and Pumps** | | | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 66.7 | sy | 1.07 | - | - | 0.72 | - | 1.79 | /sy | 119 |
| | **Slabs Alum Storage and Pumps** | | **26.5** | **cy** | **2.68** | | | **1.82** | | **4.50** | **/cy** | **119** |
| **31250 Shoring Systems** | | | | | | | | | | | | |
| 31-41-16.10 | Sheet piling, steel, 27 psf, 20' excavation, per S.F., drive, extract and salvage, excludes wales | 1600 | 4,374.0 | sf | 9.83 | 6.37 | - | 7.87 | - | 24.07 | /sf | 105,281 |
| 31-41-16.10 | Sheet piling, wales, connections and struts, 2/3 salvage | 2500 | 5.9 | ton | - | 410.40 | - | - | - | 410.40 | /ton | 2,421 |
| | **Shoring Systems** | | **4,374.0** | **unit** | **9.83** | **6.92** | | **7.87** | | **24.62** | **/unit** | **107,703** |
| **31315 Excavation and Backfill ACTIFLO** | | | | | | | | | | | | |
| 31-05-16.10 | Aggregate for earthwork, bank run gravel, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction | 0100 | 100.0 | lcy | 2.52 | 22.02 | - | 4.71 | - | 29.25 | /lcy | 2,925 |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 2,430.0 | bcy | 6.99 | - | - | 7.64 | - | 14.63 | /bcy | 35,551 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 90.0 | ecy | 5.30 | - | - | 1.50 | - | 6.80 | /ecy | 612 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 2,196.0 | lcy | 3.08 | - | - | 5.47 | - | 8.55 | /lcy | 18,774 |
| | **Excavation and Backfill ACTIFLO** | | **6,230.0** | **cy** | **3.93** | **0.35** | | **5.00** | | **9.29** | **/cy** | **57,862** |
| | **31 EARTHWORK** | | | | | | | | | | | **319,998** |
| | **05 Tertiary Treatment Processes** | | **1.0** | **LS** | **398,315.55** | **5,393,062.74** | **1,423,388.95** | **139,408.91** | | **7,354,176.15** | **/LS** | **7,354,176** |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **08 Influent Pump Station** | | | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | | | |
| **03330 Slabs Pump station wet well** | | | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 55.6 | cy | - | 33.69 | - | - | - | 33.69 | /cy | 1,872 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 130.0 | lf | 3.61 | 4.42 | - | - | - | 8.03 | /lf | 1,043 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 11.0 | ea | 9.39 | 47.88 | - | - | - | 57.27 | /ea | 630 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 11.1 | ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 | /ton | 22,533 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 11.1 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 526 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 11.1 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 572 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 116.7 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 11,435 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 116.7 | cy | 9.69 | - | - | 2.00 | - | 11.68 | /cy | 1,363 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed and bull float(darby) finish | 0100 | 1,500.0 | sf | 0.38 | - | - | - | - | 0.38 | /sf | 567 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 15.0 | csf | 9.68 | 10.12 | - | - | - | 19.80 | /csf | 297 |
| | **Slabs Pump station wet well** | | **116.7** | **cy** | **127.29** | **219.26** | | **3.49** | | **350.04** | **/cy** | **40,839** |
| **03330 Slabs Pump station slab** | | | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 37.0 | cy | - | 33.69 | - | - | - | 33.69 | /cy | 1,248 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning | 3050 | 140.0 | sfca | 4.16 | 0.80 | - | - | - | 4.96 | /sfca | 694 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 2.8 | ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 | /ton | 5,634 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 2.8 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 132 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 2.8 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 143 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 38.9 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 3,812 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, pumped, over 6" thick, includes vibrating, excludes material | 4650 | 38.9 | cy | 20.95 | - | - | 4.31 | - | 25.26 | /cy | 982 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 1,000.0 | sf | 0.88 | - | - | 0.03 | - | 0.91 | /sf | 911 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 1,000.0 | sf | 0.70 | 0.29 | - | - | - | 0.99 | /sf | 994 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 10.0 | csf | 9.68 | 10.12 | - | - | - | 19.80 | /csf | 198 |
| | **Slabs Pump station slab** | | **38.9** | **cy** | **159.05** | **213.96** | | **6.20** | | **379.22** | **/cy** | **14,748** |
| **03345 Concrete Walls wet well** | | | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, box out for opening, to 16" thick, over 10 S.F. (use perimeter), includes erecting, bracing, stripping and cleaning | 0150 | 16.0 | lf | 9.93 | 2.33 | - | - | - | 12.26 | /lf | 196 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls wet well** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 36.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 455 |
| 03-11-13.85 | Cip concrete forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 4,680.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 36,036 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 12.5 gal | - | 20.66 | - | - | - | 20.66 /gal | 258 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 36.0 lf | 3.24 | 14.92 | - | - | - | 18.15 /lf | 654 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 3.0 ea | 9.38 | 35.78 | - | - | - | 45.17 /ea | 136 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 12.9 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 23,063 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 12.9 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 612 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 12.9 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 665 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 135.6 cy | - | 98.01 | - | - | - | 98.01 /cy | 13,287 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 135.6 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 5,279 |
| 03-35-29.60 | Finishing: break ties & patch voids (walls, cols or beams) | 0010 | 4,648.0 sf | 0.97 | 0.03 | - | - | - | 1.00 /sf | 4,650 |
| | **Concrete Walls wet well** | | **135.6 cy** | **394.32** | **226.66** | | **8.14** | | **629.12 /cy** | **85,290** |
| **03350 Wet well elev slab** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 750.0 sf | 4.97 | 1.27 | - | - | - | 6.24 /sf | 4,678 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 140.0 lf | 3.62 | 0.21 | - | - | - | 3.83 /lf | 537 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 2.4 ton | 821.66 | 992.00 | - | - | - | 1,813.66 /ton | 4,416 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 ton | 40.00 | - | - | 7.00 | - | 47.00 /ton | 1 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 ton | 114.00 | - | - | 21.00 | - | 135.00 /ton | 2 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 29.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 2,859 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, with crane and bucket, over 10" thick, includes vibrating, excludes material | 1650 | 29.2 cy | 33.71 | - | - | 9.53 | - | 43.24 /cy | 1,261 |
| 03-35-29.30 | Finishing elev slab, manual screed, bull float, machine float & trowel | 0275 | 750.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 683 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 7.5 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 149 |
| | **Wet well elev slab** | | **27.8 cy** | **286.26** | **227.96** | | **10.82** | | **525.05 /cy** | **14,585** |
| | **03 CONCRETE** | | | | | | | | | **155,461** |

**04 STONE & MASONRY**

**04220 Exterior Masonry Walls Pump station**

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **04220 Exterior Masonry Walls Pump station** | | | | | | | | | | |
| 04-05-16.30 | Grout, door frames, 3' x 7' opening, 2.5 CF per opening | 0800 | 2.0 opng | 32.67 | 10.51 | - | 2.27 | - | 45.45 /opng | 91 |
| 04-05-16.30 | Grout, door frames, 6' x 7' opening, 3.5 CF per opening | 0850 | 2.0 opng | 43.56 | 14.70 | - | 3.03 | - | 61.28 /opng | 123 |
| 04-05-16.30 | Grout, for bond beams, lintels and concrete masonry unit (CMU) cores, C476, includes material only | 2000 | 1,428.0 cf | 5.60 | 4.20 | - | 0.39 | - | 10.19 /cf | 14,555 |
| 04-05-19.26 | Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed horizontally, ASTM A615 | 0020 | 1,156.0 lb | 0.65 | 0.46 | - | - | - | 1.11 /lb | 1,280 |
| 04-05-19.26 | Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed vertically, ASTM A615 | 0060 | 2,652.0 lb | 0.80 | 0.46 | - | - | - | 1.26 /lb | 3,337 |
| 04-05-19.26 | Masonry reinforcing bars, truss type steel joint reinforcing, mill standard galvanized, 12" wide | 0250 | 25.5 clf | 26.07 | 24.73 | - | - | - | 50.79 /clf | 1,295 |
| 04-05-19.26 | Allow - shoring and bracing at CMU walls (percentage wall area) | 0500 | 1,700.0 sfwa | 0.75 | 0.17 | - | - | - | 0.93 /sfwa | 1,572 |
| 04-22-10.28 | Concrt block,high strngt,hollow,3500 psi,12"8"16",inclds mortar and horzntl joint rnfrcng every other course,excluds scffldn,grout and verticl rnfrcng | 0350 | 3,400.0 sf | 11.33 | 5.95 | - | - | - | 17.28 /sf | 58,748 |
| 04-72-10.10 | Precast concrete coping, stock units, 12" wall, 14" wide, 4" tapers to 3-1/2", includes mortar, excludes scaffolding | 0110 | 170.0 lf | 14.53 | 24.89 | - | - | - | 39.42 /lf | 6,700 |
| | **Exterior Masonry Walls Pump station** | | **3,400.0 sf** | **15.88** | **9.75** | | **0.17** | | **25.79 /sf** | **87,701** |
| | **04 STONE & MASONRY** | | | | | | | | | **87,701** |
| **06 WOOD & PLASTICS** | | | | | | | | | | |
| **06120 Wood Framing -Roof, Pump Station** | | | | | | | | | | |
| 06-05-23.10 | Nails, floor or roof sheathing | 1025 | 29.3 lb | - | 2.45 | - | - | - | 2.45 /lb | 72 |
| 06-05-23.10 | Nails, roof framing, sinkers, 8d to 16d, allow 20 lbs per MBF | 5625 | 107.0 lb | - | 2.33 | - | - | - | 2.33 /lb | 249 |
| 06-05-23.60 | Average cost, hold downs (HD's), 7 to 12 gauge, glulams/beams | 1230 | 4.0 ea | - | 23.28 | - | - | - | 23.28 /ea | 93 |
| 06-05-23.60 | Threaded rod for hold downs, to 1-1/4" diameter, glulams/beams | 1295 | 40.0 lf | 3.08 | 1.03 | - | 0.25 | - | 4.36 /lf | 174 |
| 06-05-23.60 | Rafter anchors, 18 ga galv, 1.5" wide, 5.25" L, cost per 100 | 3525 | 0.2 c | 317.30 | 37.25 | - | - | - | 354.55 /c | 71 |
| 06-11-10.10 | Framing, beams/girders, 6x or larger, allow average cost per MBF | 3800 | 1.0 mbf | 1,150.34 | 1,539.45 | - | - | - | 2,689.79 /mbf | 2,690 |
| 06-11-10.30 | Wood framing, roofs, fascia boards, 2" x 8" | 6070 | 0.2 mbf | 3,067.58 | 601.80 | - | - | - | 3,669.40 /mbf | 833 |
| 06-11-10.30 | Wood framing, roofs, rafters, to 4 in 12 pitch, 2" x 8" | 7060 | 2.0 mbf | 730.37 | 601.79 | - | - | - | 1,332.16 /mbf | 2,611 |
| 06-11-10.30 | Framing, roofs, hip and valley rafters, 2" x 10" | 7365 | 0.0 mbf | 862.90 | 681.20 | - | - | - | 1,544.00 /mbf | 65 |
| 06-11-10.30 | Wood framing, roofs, hip and valley rafters, to 4 in 12 pitch, 2" x 8" | 7600 | 2.0 mbf | 1,415.80 | 601.79 | - | - | - | 2,017.59 /mbf | 4,067 |
| 06-11-10.30 | Wood framing, roofs, rafter ties, #3, 1" x 4" | 7800 | 0.0 mbf | 3,409.00 | 1,306.00 | - | - | - | 4,714.00 /mbf | 33 |
| 06-11-10.30 | Framing, roofs, ridge board, #2 or better, 2" x 12" | 7922 | 0.1 mbf | 1,207.90 | 690.40 | - | - | - | 1,898.30 /mbf | 190 |
| 06-11-10.42 | Furring, wood, on ceilings, on wood, 1" x 3" | 0850 | 160.0 lf | 1.32 | 0.36 | - | - | - | 1.68 /lf | 269 |
| 06-16-36.10 | Sheathing, plywood on roof, CDX, 1/2" thick, pneumatic nailed | 0105 | 1,800.0 sf | 0.54 | 0.56 | - | - | - | 1.10 /sf | 1,978 |
| 06-16-36.10 | Sheathing, with boards, on roof, laid horizontal, 1" x 6" | 1400 | 150.0 sf | 1.27 | 1.47 | - | - | - | 2.73 /sf | 410 |
| | **Wood Framing -Roof, Pump Station** | | **1,800.0 sf** | **4.37** | **3.29** | | **0.01** | | **7.67 /sf** | **13,805** |
| | **06 WOOD & PLASTICS** | | | | | | | | | **13,805** |
| **07 THERMAL PROTECTION** | | | | | | | | | | |
| **04220 Exterior Masonry Walls Pump station** | | | | | | | | | | |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **04220 Exterior Masonry Walls Pump station** | | | | | | | | | | |
| 07-19-19.10 | Silicone water repellants, sprayed on CMU, 2 coat | 0300 | 6,800.0 sf | 0.16 | 0.53 | - | - | - | 0.69 /sf | 4,683 |
| | **Exterior Masonry Walls Pump station** | | **3,400.0 sf** | **0.31** | **1.07** | | | | **1.38 /sf** | **4,683** |
| **06120 Wood Framing -Roof, Pump Station** | | | | | | | | | | |
| 07-21-16.20 | Blanket insulation, for walls or ceilings, kraft faced fiberglass, 6" thick, R19, 23" wide | 0180 | 1,800.0 sf | 0.28 | 0.37 | - | - | - | 0.65 /sf | 1,175 |
| 07-26-10.10 | Building Paper, vapor barrier, asphalt felt sheathing paper, 15# | 0400 | 18.0 sq | 12.06 | 4.81 | - | - | - | 16.87 /sq | 304 |
| 07-41-13.20 | Steel roofing panels, on steel frame, flat profile, standard finish, 1-3/4" standing seams, 10" wide, 26 gauge | 0710 | 1,800.0 sf | 2.41 | 3.73 | - | - | - | 6.14 /sf | 11,048 |
| | **Wood Framing -Roof, Pump Station** | | **1,800.0 sf** | **2.81** | **4.15** | | | | **6.96 /sf** | **12,526** |
| | **07 THERMAL PROTECTION** | | | | | | | | | **17,210** |
| **09 FINISHES** | | | | | | | | | | |
| **06120 Wood Framing -Roof, Pump Station** | | | | | | | | | | |
| 09-91-06.41 | Coatings & paints, B & C coating system E-8 (Clear epoxy, wood) | BC-0051 | 1,800.0 sqft | 0.26 | 0.44 | - | - | - | 0.70 /sqft | 1,262 |
| | **Wood Framing -Roof, Pump Station** | | **1,800.0 sf** | **0.26** | **0.44** | | | | **0.70 /sf** | **1,262** |
| | **09 FINISHES** | | | | | | | | | **1,262** |
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Influent Pump Station** | | | | | | | | | | |
| 09-99-99.99 | Coatings allowance | MISC | 1.0 LS | - | - | 30,000.00 | - | - | 30,000.00 /LS | 30,000 |
| 11-00-04.00 | Hydraulic structures, slide gate, stainless stl, ab & grout,48" x 48" | BC-0106 | 1.0 ea | 2,540.11 | 7,957.95 | - | 573.18 | - | 11,071.24 /ea | 11,071 |
| 11-00-11.05 | Wastewater, submersible,4400 GPM gpm,guide rails, base elbow,175 hp, VFD driven | BC-0011 | 4.0 ea | 9,199.66 | 130,000.00 | - | - | - | 139,199.66 /ea | 556,799 |
| 41-21-23.16 | Conveyors, material handling, monorail, overhead, manual, channel type, 500 lb per LF | 3900 | 40.0 lf | 26.93 | 20.50 | - | - | - | 47.43 /lf | 1,897 |
| 41-21-23.16 | Conveyors, material handling, monorail, overhead, manual, channel type, trolleys for, 8 wheel, 500 lb capacity | 4300 | 1.0 ea | - | 770.00 | 300.00 | - | - | 1,070.00 /ea | 1,070 |
| 41-22-23.10 | Hoists, material handling, electric overhead, chain, hook hung, 15' lift, 5 ton capacity | 2500 | 1.0 ea | - | 6,925.00 | 350.00 | - | - | 7,275.00 /ea | 7,275 |
| 41-22-23.10 | Hoists, material handling, electric overhead, chain, hook hung, 15' lift, 1 ton capacity, for lifts over 15', 5 ton, add | 3100 | 5.0 lf | - | 56.50 | 12.00 | - | - | 68.50 /lf | 343 |
| | **Influent Pump Station** | | **1.0 LS** | **40,415.72** | **536,755.45** | **30,710.00** | **573.18** | | **608,454.35 /LS** | **608,454** |
| | **11 EQUIPMENT** | | | | | | | | | **608,454** |
| **22 PLUMBING** | | | | | | | | | | |
| **22999 Influent Pump piping** | | | | | | | | | | |
| 09-99-99.99 | Coating systems allowance | MISC | 1.0 LS | - | - | 20,000.00 | - | - | 20,000.00 /LS | 20,000 |
| 22-11-13.44 | Pump discharge piping allowance | ---- | 1.0 ls | 29,520.00 | 100,000.00 | - | 20,000.00 | - | 149,520.00 /ls | 149,520 |
| | **Influent Pump piping** | | **1.0 LS** | **29,520.00** | **100,000.00** | **20,000.00** | **20,000.00** | | **169,520.00 /LS** | **169,520** |
| **33500 Influent PS Yard Piping** | | | | | | | | | | |
| 22-20-01.90 | Piping, pipe, Welded Steel, Welded Jt, 36" diameter | BC-1256 | 1,625.0 lnft | 20.11 | 244.00 | - | 4.35 | - | 268.45 /lnft | 436,237 |
| 22-20-01.90 | Pipe, steel, welding labor per joint, 36"dia | BC-1306 | 45.0 ea | 1,979.44 | | - | 75.78 | - | 2,055.22 /ea | 92,485 |
| 22-20-01.95 | Pipe, steel ftngs, CI, standard weight, black, 90< elb, straight, 36" | BC-0116 | 5.0 ea | 1,843.18 | 3,042.00 | - | 995.92 | - | 5,881.10 /ea | 29,406 |
| 22-99-99.99 | Tie into existing influent piping/structure allowance | ---- | 1.0 LS | 50,000.00 | 250,000.00 | - | - | - | 300,000.00 /LS | 300,000 |
| | **Influent PS Yard Piping** | | **1,625.0 LF** | **111.36** | **407.21** | | **9.51** | | **528.08 /LF** | **858,127** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **22 PLUMBING** | | | | | | | | | **1,027,647** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **26001 Influent Pump Station - E&I** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 597,328.02 | - | - | 597,328.02 /LS | 597,328 |
| | **Influent Pump Station - E&I** | | **1.0 LS** | | | **597,328.02** | | | **597,328.02 /LS** | **597,328** |
| | **26 ELECTRICAL** | | | | | | | | | **597,328** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Influent Pump Station - E&I** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 114,870.78 | - | - | 114,870.78 /LS | 114,871 |
| | **Influent Pump Station - E&I** | | **1.0 LS** | | | **114,870.78** | | | **114,870.78 /LS** | **114,871** |
| | **27 COMMUNICATIONS** | | | | | | | | | **114,871** |
| **31 EARTHWORK** | | | | | | | | | | |
| **01999 Dewatering** | | | | | | | | | | |
| 01-54-33.70 | Rent wellpoint header pipe, 6" diameter, 400 gpm | 0500 | 900.0 day | - | - | - | 0.40 | - | 0.40 /day | 360 |
| 31-23-19.20 | Dewatering, pumping 8 hours, attended 2 hrs per day, 6" centrifugal pump, includes 20 LF of suction hose and 100 LF of discharge hose | 1100 | 90.0 day | 857.51 | - | - | 377.70 | - | 1,235.21 /day | 111,169 |
| 31-23-19.30 | Wells, for dewatering, with steel casing, 10' to 20' deep, 2' diameter, minimum | 0020 | 100.0 vlf | 76.64 | 184.52 | - | 17.92 | - | 279.08 /vlf | 27,908 |
| | **Dewatering** | | **1.0 LS** | **84,839.97** | **18,452.33** | | **36,144.70** | | **139,437.00 /LS** | **139,437** |
| **03330 Slabs Pump station wet well** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 166.7 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 298 |
| | **Slabs Pump station wet well** | | **116.7 cy** | **1.52** | | | **1.03** | | **2.55 /cy** | **298** |
| **03330 Slabs Pump station slab** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 111.1 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 199 |
| | **Slabs Pump station slab** | | **38.9 cy** | **3.04** | | | **2.06** | | **5.11 /cy** | **199** |
| **31250 Shoring Systems** | | | | | | | | | | |
| 31-41-16.10 | Sheet piling, steel, 27 psf, 20' excavation, per S.F., drive, extract and salvage, excludes wales | 1600 | 3,400.0 sf | 9.83 | 6.37 | - | 7.87 | - | 24.07 /sf | 81,837 |
| 31-41-16.10 | Sheet piling, wales, connections and struts, 2/3 salvage | 2500 | 9.0 ton | - | 410.40 | - | - | - | 410.40 /ton | 3,698 |
| | **Shoring Systems** | | **3,400.0 unit** | **9.83** | **7.46** | | **7.87** | | **25.16 /unit** | **85,535** |
| **31315 Excavation and Backfill pump station** | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 1,296.0 bcy | 6.99 | - | - | 7.64 | - | 14.63 /bcy | 18,961 |
| 31-23-23.14 | Backfill, structural, common earth, 105 H.P. dozer, 50' haul, from existing stockpile, excludes compaction | 3020 | 964.0 lcy | 0.70 | - | - | 0.50 | - | 1.20 /lcy | 1,159 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 724.0 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 6,189 |
| 31-23-23.23 | Compaction, 3 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller | 5700 | 668.0 ecy | 0.25 | - | - | 0.35 | - | 0.60 /ecy | 399 |
| | **Excavation and Backfill pump station** | | **925.9 cy** | **13.10** | | | **15.74** | | **28.85 /cy** | **26,708** |
| **33500 Influent PS Yard Piping** | | | | | | | | | | |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **33500 Influent PS Yard Piping** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 6,454.9 bcy | 2.80 | - | - | 2.07 | - | 4.87 /bcy | 31,434 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with sheepsfoot roller | 2300 | 4,092.6 ecy | 1.32 | - | - | 2.85 | - | 4.16 /ecy | 17,043 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 1,936.8 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 46,399 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 1,936.8 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 11,573 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 2,362.3 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 27,109 |
| | **Influent PS Yard Piping** | | **1,625.0 LF** | **42.75** | **12.98** | | **26.46** | | **82.19 /LF** | **133,557** |
| | **31 EARTHWORK** | | | | | | | | | **385,733** |
| **33 UTILITIES** | | | | | | | | | | |
| **33500 Influent PS Yard Piping** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 16.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 142 |
| | **Influent PS Yard Piping** | | **1,625.0 LF** | **0.03** | **0.06** | | | | **0.09 /LF** | **142** |
| | **33 UTILITIES** | | | | | | | | | **142** |
| | **08 Influent Pump Station** | | **1.0 LS** | **601,963.90** | **1,485,405.99** | **762,908.80** | **159,335.54** | | **3,009,614.23 /LS** | **3,009,614** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **09 Acetate/Methanol** | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | |
| **03330 Slabs Chemical Storage** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 5.6 cy | - | 33.69 | - | - | - | 33.69 /cy | 187 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, slab blockouts, wood, to 12" high, 1 use, includes erecting, bracing, stripping and cleaning | 4000 | 32.0 lf | 9.05 | 0.81 | - | - | - | 9.86 /lf | 315 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.6 ton | 1,036.00 | 992.00 | - | - | - | 2,028.00 /ton | 1,128 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.6 ton | 39.87 | - | - | 7.52 | - | 47.40 /ton | 26 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.6 ton | 43.35 | - | - | 8.17 | - | 51.51 /ton | 29 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 11.7 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,144 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, pumped, over 6" thick, includes vibrating, excludes material | 4650 | 11.7 cy | 20.95 | - | - | 4.31 | - | 25.26 /cy | 295 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 300.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 273 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 300.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 298 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 3.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 59 |
| | **Slabs Chemical Storage** | | **300.0 cy** | **5.53** | **6.75** | | **0.23** | | **12.52 /cy** | **3,754** |
| **03330 Slabs tanks** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 14.8 cy | - | 33.69 | - | - | - | 33.69 /cy | 499 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning | 3050 | 110.0 sfca | 4.16 | 0.80 | - | - | - | 4.96 /sfca | 545 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 1.4 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 2,817 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 1.4 ton | 39.87 | - | - | 7.52 | - | 47.39 /ton | 66 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 1.4 ton | 43.34 | - | - | 8.16 | - | 51.51 /ton | 72 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 22.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 2,178 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, pumped, over 6" thick, includes vibrating, excludes material | 4650 | 22.2 cy | 20.95 | - | - | 4.31 | - | 25.26 /cy | 561 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and broom finish | 0150 | 600.0 sf | 0.82 | - | - | - | - | 0.82 /sf | 490 |
| | **Slabs tanks** | | **22.2 cy** | **133.56** | **186.42** | | **5.29** | | **325.27 /cy** | **7,228** |
| **03333 Acetate tanks/pumps equipment Pads and containment** | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 740.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 6,365 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.3 ton | 39.90 | - | - | 7.50 | - | 47.41 /ton | 13 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.3 ton | 43.33 | - | - | 8.20 | - | 51.50 /ton | 14 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03333 Acetate tanks/pumps equipment Pads and containment** | | | | | | | | | | |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 13.5 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,325 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 13.5 cy | 27.68 | - | - | 5.70 | - | 33.38 /cy | 451 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 13.5 cy | 46.13 | - | - | 13.04 | - | 59.17 /cy | 800 |
| | **Acetate tanks/pumps equipment Pads and containment** | | **13.5 cy** | **471.83** | **172.51** | | **19.05** | | **663.39 /cy** | **8,968** |
| **03333 Acetate pumps Equipment Pads** | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 72.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 619 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.0 ton | 39.80 | - | - | 7.50 | - | 47.25 /ton | 2 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.0 ton | 43.30 | - | - | 8.30 | - | 51.50 /ton | 2 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 196 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 2.0 cy | 27.68 | - | - | 5.70 | - | 33.38 /cy | 67 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 2.0 cy | 46.13 | - | - | 13.04 | - | 59.17 /cy | 118 |
| | **Acetate pumps Equipment Pads** | | **2.0 cy** | **336.15** | **147.01** | | **19.05** | | **502.20 /cy** | **1,004** |
| **03333 Methanol tank/pump Equipment Pads and containment** | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 374.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 3,217 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.3 ton | 39.86 | - | - | 7.50 | - | 47.37 /ton | 13 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.3 ton | 43.35 | - | - | 8.17 | - | 51.50 /ton | 14 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 13.9 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,361 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 13.9 cy | 27.68 | - | - | 5.70 | - | 33.38 /cy | 464 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 13.9 cy | 46.13 | - | - | 13.04 | - | 59.17 /cy | 822 |
| | **Methanol tank/pump Equipment Pads and containment** | | **13.9 cy** | **270.46** | **134.66** | | **19.05** | | **424.17 /cy** | **5,891** |
| | **03 CONCRETE** | | | | | | | | | **26,847** |
| **04 STONE & MASONRY** | | | | | | | | | | |
| **04220 Exterior Masonry Walls chemical storage** | | | | | | | | | | |
| 04-05-16.30 | Grout, door frames, 3' x 7' opening, 2.5 CF per opening | 0800 | 2.0 opng | 32.67 | 10.51 | - | 2.27 | - | 45.45 /opng | 91 |
| 04-05-16.30 | Grout, door frames, 6' x 7' opening, 3.5 CF per opening | 0850 | 2.0 opng | 43.56 | 14.70 | - | 3.03 | - | 61.28 /opng | 123 |
| 04-05-16.30 | Grout, for bond beams, lintels and concrete masonry unit (CMU) cores, C476, includes material only | 2000 | 441.0 cf | 5.60 | 4.20 | - | 0.39 | - | 10.19 /cf | 4,495 |
| 04-05-19.26 | Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed horizontally, ASTM A615 | 0020 | 1,575.0 lb | 0.65 | 0.46 | - | - | - | 1.11 /lb | 1,745 |
| 04-05-19.26 | Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed vertically, ASTM A615 | 0060 | 819.0 lb | 0.80 | 0.46 | - | - | - | 1.26 /lb | 1,030 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **04220 Exterior Masonry Walls chemical storage** | | | | | | | | | | |
| 04-05-19.26 | Masonry reinforcing bars, truss type steel joint reinforcing, mill standard galvanized, 12" wide | 0250 | 7.7 clf | 26.07 | 24.73 | - | - | - | 50.79 /clf | 391 |
| 04-22-10.28 | Concrt block,high strngt,hollow,3500 psi,12"8"16",inclds mortar and horzntl joint rnfrcng every other course,excluds scffldn,grout and verticl rnfrcng | 0350 | 1,050.0 sf | 11.33 | 5.95 | - | - | - | 17.28 /sf | 18,143 |
| | **Exterior Masonry Walls chemical storage** | | **1,050.0 sf** | **15.62** | **8.98** | | **0.17** | | **24.78 /sf** | **26,017** |
| | **04 STONE & MASONRY** | | | | | | | | | **26,017** |
| **06 WOOD & PLASTICS** | | | | | | | | | | |
| **06120 Wood Framing - Roof Chemical Storage** | | | | | | | | | | |
| 06-05-23.10 | Nails, floor or roof sheathing | 1025 | 6.0 lb | - | 2.45 | - | - | - | 2.45 /lb | 15 |
| 06-05-23.10 | Nails, roof framing, sinkers, 8d to 16d, allow 20 lbs per MBF | 5625 | 6.0 lb | - | 2.33 | - | - | - | 2.33 /lb | 14 |
| 06-05-23.60 | Average cost, hold downs (HD's), 7 to 12 gauge, glulams/beams | 1230 | 4.0 ea | - | 23.28 | - | - | - | 23.28 /ea | 93 |
| 06-05-23.60 | Threaded rod for hold downs, to 1-1/4" diameter, glulams/beams | 1295 | 40.0 lf | 3.08 | 1.03 | - | 0.25 | - | 4.36 /lf | 174 |
| 06-05-23.60 | I-joist hanger (EWP), 12 to 16 ga., per 100, avg cost | 1460 | 0.1 c | 296.80 | 656.40 | - | - | - | 953.20 /c | 95 |
| 06-05-23.60 | Rafter anchors, 18 ga galv, 1.5" wide, 5.25" L, cost per 100 | 3525 | 0.2 c | 317.30 | 37.25 | - | - | - | 354.55 /c | 71 |
| 06-11-10.10 | Framing, beams/girders, 6x or larger, allow average cost per MBF | 3800 | 0.6 mbf | 1,150.34 | 1,539.44 | - | - | - | 2,689.79 /mbf | 1,641 |
| 06-11-10.30 | I-joist (composite) rafters , 24" o.c., w/ blocking, avg cost/sf | 1050 | 320.0 sffl | 0.78 | 1.92 | - | - | - | 2.70 /sffl | 865 |
| 06-11-10.30 | Wood framing, roofs, fascia boards, 2" x 8" | 6070 | 0.2 mbf | 3,067.58 | 601.80 | - | - | - | 3,669.40 /mbf | 833 |
| 06-11-10.30 | Wood framing, roofs, rafters, to 4 in 12 pitch, 2" x 8" | 7060 | 2.0 mbf | 730.37 | 601.79 | - | - | - | 1,332.16 /mbf | 2,611 |
| 06-11-10.30 | Framing, roofs, hip and valley rafters, 2" x 10" | 7365 | 0.0 mbf | 862.90 | 681.20 | - | - | - | 1,544.00 /mbf | 65 |
| 06-11-10.30 | Wood framing, roofs, hip and valley rafters, to 4 in 12 pitch, 2" x 8" | 7600 | 2.0 mbf | 1,415.80 | 601.79 | - | - | - | 2,017.59 /mbf | 4,067 |
| 06-11-10.30 | Wood framing, roofs, rafter ties, #3, 1" x 4" | 7800 | 0.0 mbf | 3,409.00 | 1,306.00 | - | - | - | 4,714.00 /mbf | 33 |
| 06-11-10.30 | Framing, roofs, ridge board, #2 or better, 2" x 12" | 7922 | 0.1 mbf | 1,207.90 | 690.40 | - | - | - | 1,898.30 /mbf | 190 |
| 06-11-10.42 | Furring, wood, on ceilings, on wood, 1" x 3" | 0850 | 320.0 lf | 1.32 | 0.36 | - | - | - | 1.68 /lf | 537 |
| 06-16-36.10 | Sheathing, plywood on roof, CDX, 1/2" thick, pneumatic nailed | 0105 | 300.0 sf | 0.54 | 0.56 | - | - | - | 1.10 /sf | 330 |
| 06-16-36.10 | Sheathing, with boards, on roof, laid horizontal, 1" x 6" | 1400 | 150.0 sf | 1.27 | 1.47 | - | - | - | 2.73 /sf | 410 |
| | **Wood Framing - Roof Chemical Storage** | | **300.0 sf** | **23.68** | **16.44** | | **0.03** | | **40.15 /sf** | **12,044** |
| | **06 WOOD & PLASTICS** | | | | | | | | | **12,044** |
| **07 THERMAL PROTECTION** | | | | | | | | | | |
| **04220 Exterior Masonry Walls chemical storage** | | | | | | | | | | |
| 07-19-19.10 | Silicone water repellants, sprayed on CMU, 2 coat | 0300 | 2,100.0 sf | 0.16 | 0.53 | - | - | - | 0.69 /sf | 1,446 |
| | **Exterior Masonry Walls chemical storage** | | **1,050.0 sf** | **0.31** | **1.07** | | | | **1.38 /sf** | **1,446** |
| **06120 Wood Framing - Roof Chemical Storage** | | | | | | | | | | |
| 07-21-16.20 | Blanket insulation, for walls or ceilings, kraft faced fiberglass, 6" thick, R19, 23" wide | 0180 | 300.0 sf | 0.28 | 0.37 | - | - | - | 0.65 /sf | 196 |
| 07-26-10.10 | Building Paper, vapor barrier, asphalt felt sheathing paper, 15# | 0400 | 3.0 sq | 12.06 | 4.81 | - | - | - | 16.87 /sq | 51 |
| 07-41-13.20 | Steel roofing panels, on steel frame, flat profile, standard finish, 1-3/4" standing seams, 10" wide, 26 gauge | 0710 | 300.0 sf | 2.41 | 3.73 | - | - | - | 6.14 /sf | 1,841 |
| | **Wood Framing - Roof Chemical Storage** | | **300.0 sf** | **2.81** | **4.15** | | | | **6.96 /sf** | **2,088** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **07 THERMAL PROTECTION** | | | | | | | | | **3,534** |
| **09 FINISHES** | | | | | | | | | | |
| **06120 Wood Framing - Roof Chemical Storage** | | | | | | | | | | |
| 09-91-06.41 | Coatings & paints, B & C coating system E-8 (Clear epoxy, wood) | BC-0051 | 320.0 sqft | 0.26 | 0.44 | - | - | - | 0.70 /sqft | 224 |
| | **Wood Framing - Roof Chemical Storage** | | **300.0 sf** | **0.27** | **0.47** | | | | **0.75 /sf** | **224** |
| | **09 FINISHES** | | | | | | | | | **224** |
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Aeration Chemical** | | | | | | | | | | |
| 11-00-06.00 | FRP tank, acetate, 7,500 gal., | BC-0016 | 1.0 ea | 2,022.71 | 21,000.00 | - | 622.71 | | 23,645.42 /ea | 23,645 |
| 11-00-08.00 | Chemical metering pump, acetate | BC-0011 | 2.0 ea | 459.41 | 11,000.00 | - | - | - | 11,459.41 /ea | 22,919 |
| 11-00-08.00 | Chemical metering pump, methanol | BC-0041 | 2.0 ea | 565.42 | 11,000.00 | - | - | - | 11,565.42 /ea | 23,131 |
| 23-13-23.26 | Storage tank, horizontal, concrete, above ground, fuel-oil, vaulted, 20,000 gallon, incl. pad & pump | 0600 | 1.0 ea | 2,722.91 | 108,000.00 | - | 1,150.56 | - | 111,873.47 /ea | 111,873 |
| | **Aeration Chemical** | | **1.0 LS** | **6,795.27** | **173,000.00** | | **1,773.27** | | **181,568.54 /LS** | **181,569** |
| | **11 EQUIPMENT** | | | | | | | | | **181,569** |
| **21 FIRE SUPPRESSION** | | | | | | | | | | |
| **22999 Chemical Piping** | | | | | | | | | | |
| 21-99-99.99 | Fire suppression system allowance | MISC | 1.0 LS | - | - | 20,000.00 | - | - | 20,000.00 /LS | 20,000 |
| | **Chemical Piping** | | **1.0 LS** | | | **20,000.00** | | | **20,000.00 /LS** | **20,000** |
| | **21 FIRE SUPPRESSION** | | | | | | | | | **20,000** |
| **22 PLUMBING** | | | | | | | | | | |
| **22999 Chemical Piping** | | | | | | | | | | |
| 22-99-99.99 | Chemical piping allowance acetate tank/pumps | MISC | 2.0 LS | 1,795.00 | 2,500.00 | | - | - | 4,295.00 /LS | 8,590 |
| 22-99-99.99 | Chemical piping allowance methanol tank/pumps | MISC | 2.0 LS | 2,692.50 | 3,750.00 | | - | - | 6,442.50 /LS | 12,885 |
| | **Chemical Piping** | | **1.0 LS** | **8,975.00** | **12,500.00** | | | | **21,475.00 /LS** | **21,475** |
| | **22 PLUMBING** | | | | | | | | | **21,475** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **26001 Aeration Chemical Storage - E&I (#15)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 64,012.09 | - | - | 64,012.09 /LS | 64,012 |
| | **Aeration Chemical Storage - E&I (#15)** | | **2.0 LS** | | | **32,006.04** | | | **32,006.04 /LS** | **64,012** |
| | **26 ELECTRICAL** | | | | | | | | | **64,012** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Aeration Chemical Storage - E&I (#15)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 16,003.03 | - | - | 16,003.03 /LS | 16,003 |
| | **Aeration Chemical Storage - E&I (#15)** | | **2.0 LS** | | | **8,001.52** | | | **8,001.52 /LS** | **16,003** |
| | **27 COMMUNICATIONS** | | | | | | | | | **16,003** |
| **31 EARTHWORK** | | | | | | | | | | |
| **03330 Slabs Chemical Storage** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 33.3 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 60 |
| | **Slabs Chemical Storage** | | **300.0 cy** | **0.12** | | | **0.08** | | **0.20 /cy** | **60** |
| **03330 Slabs tanks** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 66.7 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 119 |
| | **Slabs tanks** | | **22.2 cy** | **3.20** | | | **2.17** | | **5.36 /cy** | **119** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **31 EARTHWORK** | | | | | | | | | **179** |
| **33 UTILITIES** | | | | | | | | | | |
| **33999 Chemical feed yard piping** | | | | | | | | | | |
| 33-11-13.25 | Chemical piping, double contained, allowance | ---- | 1.0 ls | 6,152.00 | 20,020.00 | - | 2,000.00 | - | 28,172.00 /ls | 28,172 |
| | **Chemical feed yard piping** | | **1.0 LS** | **6,152.00** | **20,020.00** | | **2,000.00** | | **28,172.00 /LS** | **28,172** |
| | **33 UTILITIES** | | | | | | | | | **28,172** |
| | **09 Acetate/Methanol** | | | | | | | | **/LS** | **400,076** |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 Sidestream P Removal | | | | | | | | | | | | |
| 11 EQUIPMENT | | | | | | | | | | | | |
| 11999 Ostara Pearl Nutrient Removal | | | | | | | | | | | | |
| 11-99-99.99 | Ostara Pearl nutrient removal process, quote from 2010 project, including all equip, conc, bldngs for complete turnkey system, increased for inflation | MISC | 1.0 | LS | - | - | 2,400,000.00 | - | - | 2,400,000.00 | /LS | 2,400,000 |
| | **Ostara Pearl Nutrient Removal** | | **1.0** | **LS** | | | **2,400,000.00** | | | **2,400,000.00** | **/LS** | **2,400,000** |
| | 11 EQUIPMENT | | | | | | | | | | | 2,400,000 |
| 26 ELECTRICAL | | | | | | | | | | | | |
| 26001 Ostara - E&I (#11) | | | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 | LS | - | - | 289,952.05 | - | - | 289,952.05 | /LS | 289,952 |
| | **Ostara - E&I (#11)** | | **1.0** | **LS** | | | **289,952.05** | | | **289,952.05** | **/LS** | **289,952** |
| | 26 ELECTRICAL | | | | | | | | | | | 289,952 |
| 27 COMMUNICATIONS | | | | | | | | | | | | |
| 26001 Ostara - E&I (#11) | | | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 | LS | - | - | 96,650.69 | - | - | 96,650.69 | /LS | 96,651 |
| | **Ostara - E&I (#11)** | | **1.0** | **LS** | | | **96,650.69** | | | **96,650.69** | **/LS** | **96,651** |
| | 27 COMMUNICATIONS | | | | | | | | | | | 96,651 |
| 31 EARTHWORK | | | | | | | | | | | | |
| 33500 Centrate Discharge | | | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering | 0110 | 63.3 | bcy | 3.73 | - | - | 2.23 | - | 5.96 | /bcy | 377 |
| 31-23-23.13 | Backfill, trench, air tamped compaction, add | 2000 | 39.3 | ecy | 13.60 | - | - | 3.85 | - | 17.44 | /ecy | 685 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 22.8 | lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 | /lcy | 546 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 22.8 | ecy | 5.57 | - | - | 0.41 | - | 5.98 | /ecy | 136 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 24.1 | lcy | 6.23 | - | - | 5.24 | - | 11.48 | /lcy | 276 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 1,140.0 | sf | - | - | 6.69 | - | - | 6.69 | /sf | 7,627 |
| | **Centrate Discharge** | | **100.0** | **unit** | **12.88** | **2.48** | **76.27** | **4.84** | | **96.47** | **/unit** | **9,647** |
| | 31 EARTHWORK | | | | | | | | | | | 9,647 |
| 33 UTILITIES | | | | | | | | | | | | |
| 33500 Centrate Discharge | | | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 1.0 | clf | 3.34 | 5.56 | - | - | - | 8.90 | /clf | 9 |
| 33-11-13.15 | Water supply distribution piping,ductile iron pipe,cement lined,mechanical joint,fittings,18'lengths,8"diameter,class 50,excludes excavation backfill | 2060 | 100.0 | lf | 17.95 | 44.55 | - | 3.62 | - | 66.11 | /lf | 6,611 |
| | **Centrate Discharge** | | **100.0** | **unit** | **17.98** | **44.60** | | **3.62** | | **66.20** | **/unit** | **6,620** |
| | 33 UTILITIES | | | | | | | | | | | 6,620 |
| | 10 Sidestream P Removal | | | | | | | | | | /LS | 2,802,870 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | 01 TOTAL AMOUNT | | | | | | | | | 34,485,717 |

## Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | 95,482 hrs | 6,674,661 | |
| Material | | | 16,740,183 | |
| Subcontract | | | 9,301,674 | |
| Equipment | | 121,436 hrs | 1,768,671 | |
| Other | | | 528 | |
| | | | **34,485,717** | **34,485,717** |
| Civil and Misc. Yard Piping | 5.000 % | | 1,724,286 | |
| | | | **1,724,286** | **36,210,003** |
| Labor Mark-up | 10.000 % | | 667,466 | |
| Material Mark-up | 8.000 % | | 1,339,215 | |
| Subcontractor Mark-up | 5.000 % | | 140,305 | |
| Construction Equipment Mark-up | 8.000 % | | 141,494 | |
| Other - Process Equip Mark-up | 8.000 % | | 42 | |
| Material Shipping & Handling | 2.000 % | | 334,804 | |
| Material Sales Tax | 6.000 % | | 601,643 | |
| | | | **3,224,969** | **39,434,972** |
| Contractor General Conditions | 10.000 % | | 3,943,497 | |
| Start-Up, Training, O&M | 2.000 % | | 788,699 | |
| Undesign/Undevelop Contingency | 30.000 % | | 11,830,491 | |
| | | | **16,562,687** | **55,997,659** |
| Bldg Risk, Liability Auto Ins | 2.000 % | | 1,119,953 | |
| Contractor Bonds & Insurance | 1.500 % | | 839,965 | |
| | | | **1,959,918** | **57,957,577** |
| **Total** | | | | **57,957,577** |

# CITY OF MERIDIAN
# COM ALTERNATIVES ANALYSIS - ALT 3
# PRE-BODR - FACILITY PLANNING

| | |
|---|---|
| **Estimator** | DG-NDG-FB-IK |
| **BC Project Manager** | Richard Kelly |
| **BC Office** | Seattle |
| **Estimate Issue No.** | 1 |
| **QA/QC Reviewer** | Don Snowden |
| **QA/QC Review Date** | 5/26/2015 |
| **Notes** | **PROCESS LOCATION/AREA INDEX** |

**01 Primary Clarifiers**
**02 Aeration Tanks**
**03 Secondary Clarifiers**
**04 Existing Aeration Tanks/RAS Tanks Retrofit**
**05 Tertiary Treatment Process**
**07 MBR Treatment**
**08 Influent Pump Station**
**09 Acetate/Methanol**

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **01 Primary Clarifiers** | | | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | | | |
| **03330 Slabs Primary Clarifiers** | | | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 210.1 | cy | - | 33.69 | - | - | - | 33.69 | /cy | 7,078 |
| 03-11-13.85 | C.I.P. concrete forms, wall, job built, plywood, to 8' high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 360.0 | sfca | 6.39 | 1.76 | - | - | - | 8.16 | /sfca | 2,937 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 252.0 | lf | 3.61 | 4.42 | - | - | - | 8.03 | /lf | 2,022 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 21.0 | ea | 9.39 | 47.88 | - | - | - | 57.27 | /ea | 1,203 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 31.5 | ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 | /ton | 63,905 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, walls, #8 to #18 | 0760 | 1,800.0 | lb | 0.30 | 0.48 | - | - | - | 0.77 | /lb | 1,393 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 32.4 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 1,536 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 32.4 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 1,669 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 455.2 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 44,611 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 441.2 | cy | 9.69 | - | - | 2.00 | - | 11.68 | /cy | 5,154 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 8" thick, includes vibrating, excludes material | 4950 | 14.0 | cy | 38.75 | - | - | 7.98 | - | 46.73 | /cy | 654 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 5,672.0 | sf | 0.88 | - | - | 0.03 | - | 0.91 | /sf | 5,167 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 5,672.0 | sf | 0.70 | 0.29 | - | - | - | 0.99 | /sf | 5,640 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 56.7 | csf | 9.68 | 10.12 | - | - | - | 19.80 | /csf | 1,123 |
| | **Slabs Primary Clarifiers** | | **455.2** | **cy** | **117.82** | **195.08** | | **3.67** | | **316.57** | **/cy** | **144,091** |
| **03330 Slabs Pump Station** | | | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 14.8 | cy | - | 33.69 | - | - | - | 33.69 | /cy | 499 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 21.3 | sfca | 7.24 | 1.36 | - | - | - | 8.60 | /sfca | 184 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 80.0 | lf | 3.61 | 4.42 | - | - | - | 8.03 | /lf | 642 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 7.0 | ea | 9.38 | 47.88 | - | - | - | 57.26 | /ea | 401 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 2.2 | ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 | /ton | 4,506 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7 | 0610 | 31.6 | lb | 0.52 | 0.48 | - | - | - | 0.99 | /lb | 31 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 2.2 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 106 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 2.2 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 115 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 31.9 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 3,131 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03330 Slabs Pump Station** | | | | | | | | | | |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 31.9 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 373 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed and bull float(darby) finish | 0100 | 400.0 sf | 0.38 | - | - | - | - | 0.38 /sf | 151 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 400.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 398 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 4.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 79 |
| | **Slabs Pump Station** | | **400.0 cy** | **9.48** | **16.81** | | **0.25** | | **26.54 /cy** | **10,616** |
| **03330 Slabs Splitter Box** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 5.3 cy | - | 33.69 | - | - | - | 33.69 /cy | 180 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 48.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 385 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 4.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 229 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.8 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 1,622 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.8 ton | 39.88 | - | - | 7.51 | - | 47.39 /ton | 38 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.8 ton | 43.34 | - | - | 8.16 | - | 51.50 /ton | 41 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 11.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,098 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 11.2 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 131 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed and bull float(darby) finish | 0100 | 144.0 sf | 0.38 | - | - | - | - | 0.38 /sf | 54 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 144.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 143 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 1.4 csf | 9.68 | 10.13 | - | - | - | 19.81 /csf | 29 |
| | **Slabs Splitter Box** | | **11.2 cy** | **123.57** | **226.00** | | **3.12** | | **352.69 /cy** | **3,950** |
| **03330 Slabs Scum Pump** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 1.3 cy | - | 33.69 | - | - | - | 33.69 /cy | 45 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 5.3 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 46 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 24.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 193 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 2.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 115 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.2 ton | 1,036.00 | 992.00 | - | - | - | 2,028.00 /ton | 406 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7 | 0610 | 4.0 lb | 0.52 | 0.48 | - | - | - | 1.00 /lb | 4 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.2 ton | 39.85 | - | - | 7.50 | - | 47.40 /ton | 10 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.2 ton | 43.30 | - | - | 8.17 | - | 51.50 /ton | 10 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03330 Slabs Scum Pump** | | | | | | | | | | |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.9 cy | - | 98.01 | - | - | - | 98.01 /cy | 285 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 2.9 cy | 9.69 | - | - | 1.99 | - | 11.68 /cy | 34 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and hand trowel finish | 0200 | 36.0 sf | 1.20 | - | - | - | - | 1.20 /sf | 43 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 36.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 36 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 0.4 csf | 9.67 | 10.10 | - | - | - | 19.78 /csf | 7 |
| | **Slabs Scum Pump** | | **36.0 cy** | **13.05** | **20.92** | | **0.25** | | **34.22 /cy** | **1,232** |
| **03330 Slabs Primary Clarifiers** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 210.1 cy | - | 33.69 | - | - | - | 33.69 /cy | 7,078 |
| 03-11-13.85 | C.I.P. concrete forms, wall, job built, plywood, to 8' high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 360.0 sfca | 6.39 | 1.76 | - | - | - | 8.16 /sfca | 2,937 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 252.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 2,022 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 21.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 1,203 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 31.5 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 63,905 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, walls, #8 to #18 | 0760 | 1,800.0 lb | 0.30 | 0.48 | - | - | - | 0.77 /lb | 1,393 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 32.4 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 1,536 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 32.4 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 1,669 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 455.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 44,611 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 441.2 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 5,154 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 8" thick, includes vibrating, excludes material | 4950 | 14.0 cy | 38.75 | - | - | 7.98 | - | 46.73 /cy | 654 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 5,672.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 5,167 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 5,672.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 5,640 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 56.7 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 1,123 |
| | **Slabs Primary Clarifiers** | | **5,672.0 cy** | **9.46** | **15.66** | | **0.29** | | **25.40 /cy** | **144,091** |
| **03330 Slabs Scum Pump** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 1.3 cy | - | 33.69 | - | - | - | 33.69 /cy | 45 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 5.3 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 46 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 24.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 193 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 2.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 115 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03330 Slabs Scum Pump** | | | | | | | | | | | | |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.2 | ton | 1,036.00 | 992.00 | - | - | - | 2,028.00 | /ton | 406 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7 | 0610 | 4.0 | lb | 0.52 | 0.48 | - | - | - | 1.00 | /lb | 4 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.2 | ton | 39.85 | - | - | 7.50 | - | 47.40 | /ton | 10 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.2 | ton | 43.30 | - | - | 8.17 | - | 51.50 | /ton | 10 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.9 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 285 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 2.9 | cy | 9.69 | - | - | 1.99 | - | 11.68 | /cy | 34 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and hand trowel finish | 0200 | 36.0 | sf | 1.20 | - | - | - | - | 1.20 | /sf | 43 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 36.0 | sf | 0.70 | 0.29 | - | - | - | 0.99 | /sf | 36 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 0.4 | csf | 9.67 | 10.10 | - | - | - | 19.78 | /csf | 7 |
| | **Slabs Scum Pump** | | **36.0** | **cy** | **13.05** | **20.92** | | **0.25** | | **34.22** | **/cy** | **1,232** |
| **03333 Primary sludge pump equipment Pads** | | | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 60.0 | sfca | 7.24 | 1.36 | - | - | - | 8.60 | /sfca | 516 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.1 | ton | 39.80 | - | - | 7.50 | - | 47.30 | /ton | 2 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.1 | ton | 43.30 | - | - | 8.00 | - | 51.30 | /ton | 3 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.6 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 254 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 2.6 | cy | 27.68 | - | - | 5.70 | - | 33.38 | /cy | 87 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 2.6 | cy | 46.13 | - | - | 13.04 | - | 59.16 | /cy | 153 |
| | **Primary sludge pump equipment Pads** | | **2.6** | **cy** | **243.02** | **129.51** | | **19.05** | | **391.58** | **/cy** | **1,015** |
| **03345 Concrete Walls Primary Carifiers** | | | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 7,056.0 | sfca | 6.18 | 0.75 | - | - | - | 6.93 | /sfca | 48,881 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 18.8 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 389 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 9.8 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 17,506 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 9.8 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 464 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 9.8 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 505 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 137.2 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 13,447 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 137.2 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 5,343 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls Primary Carifiers** | | | | | | | | | | |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 7,056.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 17,826 |
| | **Concrete Walls Primary Carifiers** | | **137.2 cy** | **509.91** | **231.72** | | **19.02** | | **760.65 /cy** | **104,361** |
| **03345 Concrete Walls Pump Station** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 20.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 253 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 3,200.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 24,640 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 8.5 gal | - | 20.66 | - | - | - | 20.66 /gal | 176 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 4.4 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 7,938 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 4.4 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 211 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 4.4 ton | 43.34 | - | - | 8.17 | - | 51.50 /ton | 229 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 62.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 6,099 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 62.2 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 2,423 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 3,200.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 8,084 |
| | **Concrete Walls Pump Station** | | **62.2 cy** | **553.02** | **232.41** | | **19.02** | | **804.45 /cy** | **50,053** |
| **03345 Concrete Walls Splitter Box** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 20.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 253 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 1,920.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 14,784 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 5.1 gal | - | 20.66 | - | - | - | 20.66 /gal | 106 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 4.7 ton | 794.28 | 992.00 | - | - | - | 1,786.27 /ton | 8,337 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 4.7 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 221 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 4.7 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 240 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 56.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 5,489 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 56.0 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 2,181 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 1,920.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 4,851 |
| | **Concrete Walls Splitter Box** | | **56.0 cy** | **412.28** | **223.35** | | **15.46** | | **651.08 /cy** | **36,461** |
| **03345 Concrete Walls scum pump** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 20.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 253 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls scum pump** | | | | | | | | | | |
| 03-11-13.85 | Cip concrete forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 960.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 7,392 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 2.6 gal | - | 20.66 | - | - | - | 20.66 /gal | 53 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 20.0 lf | 3.24 | 14.92 | - | - | - | 18.15 /lf | 363 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 2.0 ea | 9.39 | 35.79 | - | - | - | 45.17 /ea | 90 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 2.0 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 3,573 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 2.0 ton | 39.87 | - | - | 7.52 | - | 47.39 /ton | 95 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 2.0 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 103 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 28.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 2,744 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 28.0 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 1,090 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 960.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 2,425 |
| | **Concrete Walls scum pump** | | **28.0 cy** | **408.56** | **225.51** | | **15.27** | | **649.34 /cy** | **18,181** |
| **03345 Concrete Walls Primary Carifiers** | | | | | | | | | | |
| 03-11-13.85 | Cip concrete forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 7,056.0 sfca | 6.18 | 0.75 | - | - | - | 6.93 /sfca | 48,881 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 18.8 gal | - | 20.66 | - | - | - | 20.66 /gal | 389 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 9.8 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 17,506 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 9.8 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 464 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 9.8 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 505 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 137.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 13,447 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 137.2 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 5,343 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 7,056.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 17,826 |
| | **Concrete Walls Primary Carifiers** | | **137.2 cy** | **509.91** | **231.72** | | **19.02** | | **760.65 /cy** | **104,361** |
| **03345 Concrete Walls scum pump** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 20.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 253 |
| 03-11-13.85 | Cip concrete forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 960.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 7,392 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 2.6 gal | - | 20.66 | - | - | - | 20.66 /gal | 53 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls scum pump** | | | | | | | | | | | | |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 20.0 | lf | 3.24 | 14.92 | - | - | - | 18.15 | /lf | 363 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 2.0 | ea | 9.39 | 35.79 | - | - | - | 45.17 | /ea | 90 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 2.0 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 3,573 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 2.0 | ton | 39.87 | - | - | 7.52 | - | 47.39 | /ton | 95 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 2.0 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 103 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 28.0 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 2,744 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 28.0 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 1,090 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 960.0 | sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 | /sf | 2,425 |
| | **Concrete Walls scum pump** | | **28.0** | **cy** | **408.56** | **225.51** | | **15.27** | | **649.34** | **/cy** | **18,181** |
| **03350 Elevated Slab Pump station** | | | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 200.0 | sf | 4.97 | 1.27 | - | - | - | 6.24 | /sf | 1,247 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 12.0 | lf | 4.64 | 1.62 | - | - | - | 6.26 | /lf | 75 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 40.0 | lf | 3.62 | 0.21 | - | - | - | 3.83 | /lf | 153 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, perimeter deck and rail, straight, includes shoring, erecting, bracing, stripping and cleaning | 8000 | 40.0 | lf | 20.11 | 12.55 | - | - | - | 32.66 | /lf | 1,307 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.0 | ton | 821.00 | 993.00 | - | - | - | 1,813.75 | /ton | 15 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 | ton | 40.00 | - | - | 8.00 | - | 48.00 | /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 | ton | 115.00 | - | - | 23.00 | - | 138.00 | /ton | 1 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 7.8 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 762 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 7.8 | cy | 21.53 | - | - | 4.43 | - | 25.96 | /cy | 202 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed finish | 0020 | 200.0 | sf | 0.32 | - | - | - | - | 0.32 | /sf | 63 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 200.0 | sf | 0.62 | 0.19 | - | - | - | 0.81 | /sf | 162 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 2.0 | csf | 9.68 | 10.12 | - | - | - | 19.80 | /csf | 40 |
| | **Elevated Slab Pump station** | | **7.8** | **cy** | **305.79** | **207.31** | | **4.45** | | **517.55** | **/cy** | **4,027** |
| **03350 Elevated Slab Splitter Box** | | | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 144.0 | sf | 4.97 | 1.27 | - | - | - | 6.24 | /sf | 898 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 24.0 | lf | 4.64 | 1.62 | - | - | - | 6.26 | /lf | 150 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03350 Elevated Slab Splitter Box** | | | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 48.0 | lf | 3.62 | 0.21 | - | - | - | 3.83 | /lf | 184 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, perimeter deck and rail, straight, includes shoring, erecting, bracing, stripping and cleaning | 8000 | 48.0 | lf | 20.11 | 12.55 | - | - | - | 32.66 | /lf | 1,568 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.4 | ton | 821.66 | 992.00 | - | - | - | 1,813.66 | /ton | 635 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 | ton | 40.00 | - | - | 7.00 | - | 46.67 | /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 | ton | 113.00 | - | - | 20.00 | - | 133.00 | /ton | 0 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 5.6 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 549 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 5.6 | cy | 21.53 | - | - | 4.43 | - | 25.96 | /cy | 145 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed finish | 0020 | 144.0 | sf | 0.32 | - | - | - | - | 0.32 | /sf | 45 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 144.0 | sf | 0.62 | 0.19 | - | - | - | 0.81 | /sf | 117 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 1.4 | csf | 9.68 | 10.13 | - | - | - | 19.81 | /csf | 29 |
| | **Elevated Slab Splitter Box** | | **5.6** | **cy** | **450.48** | **316.56** | | **4.45** | | **771.49** | **/cy** | **4,320** |
| **03350 Elevated Slab Scum pump** | | | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 36.0 | sf | 4.97 | 1.27 | - | - | - | 6.24 | /sf | 225 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 24.0 | lf | 4.64 | 1.62 | - | - | - | 6.26 | /lf | 150 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 36.0 | lf | 3.62 | 0.21 | - | - | - | 3.83 | /lf | 138 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.1 | ton | 821.70 | 992.00 | - | - | - | 1,813.71 | /ton | 127 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 | ton | 40.00 | - | - | 10.00 | - | 50.00 | /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 | ton | 110.00 | - | - | 20.00 | - | 130.00 | /ton | 0 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 1.4 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 137 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 1.4 | cy | 21.53 | - | - | 4.44 | - | 25.96 | /cy | 36 |
| 03-35-29.30 | Finishing elev slab, manual screed, bull float, machine float & trowel | 0275 | 36.0 | sf | 0.88 | - | - | 0.03 | - | 0.91 | /sf | 33 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 36.0 | sf | 0.62 | 0.19 | - | - | - | 0.81 | /sf | 29 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 0.4 | csf | 9.67 | 10.10 | - | - | - | 19.78 | /csf | 7 |
| | **Elevated Slab Scum pump** | | **1.4** | **cy** | **404.06** | **221.08** | | **5.22** | | **630.36** | **/cy** | **883** |

**03350 Elevated Slab Scum pump**

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03350 Elevated Slab Scum pump** | | | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 36.0 | sf | 4.97 | 1.27 | - | - | - | 6.24 | /sf | 225 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 24.0 | lf | 4.64 | 1.62 | - | - | - | 6.26 | /lf | 150 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 36.0 | lf | 3.62 | 0.21 | - | - | - | 3.83 | /lf | 138 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 0.1 | ton | 821.70 | 992.00 | - | - | - | 1,813.71 | /ton | 127 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 | ton | 40.00 | - | - | 10.00 | - | 50.00 | /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 | ton | 110.00 | - | - | 20.00 | - | 130.00 | /ton | 0 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 1.4 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 137 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 1.4 | cy | 21.53 | - | - | 4.44 | - | 25.96 | /cy | 36 |
| 03-35-29.30 | Finishing elev slab, manual screed, bull float, machine float & trowel | 0275 | 36.0 | sf | 0.88 | - | - | 0.03 | - | 0.91 | /sf | 33 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 36.0 | sf | 0.62 | 0.19 | - | - | - | 0.81 | /sf | 29 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 0.4 | csf | 9.67 | 10.10 | - | - | - | 19.78 | /csf | 7 |
| | **Elevated Slab Scum pump** | | **1.4** | **cy** | **404.06** | **221.08** | | **5.22** | | **630.36** | **/cy** | **883** |
| | **03 CONCRETE** | | | | | | | | | | | **647,937** |
| **05 METALS** | | | | | | | | | | | | |
| **11999 Primary Clarifier** | | | | | | | | | | | | |
| 05-01-10.51 | Metal cleaning, steel surface treatment, 5.6 lb sand per S.F., near white blast, loose scale, fine powder rust (SSPC-SP10) | 6255 | 3,200.0 | sf | 4.22 | 0.88 | - | 0.54 | - | 5.63 | /sf | 18,030 |
| 05-01-10.51 | Metal cleaning, steel surface treatment, 5.6 lb sand per S.F., near white blast, loose scale, fine powder rust (SSPC-SP10) | 6255 | 3,200.0 | sf | 4.22 | 0.88 | - | 0.54 | - | 5.63 | /sf | 18,030 |
| 09-91-06.41 | Coatings & paints, B & C coating system E-2 (Epoxy, metal tanks, structures) | BC-0021 | 6,400.0 | sqft | 0.28 | 1.40 | - | - | - | 1.69 | /sqft | 10,797 |
| | **Primary Clarifier** | | **1.0** | **LS** | **28,823.45** | **14,611.20** | | **3,421.32** | | **46,855.97** | **/LS** | **46,856** |
| **11999 Sludge Pumps and Piping** | | | | | | | | | | | | |
| 05-58-09.50 | Pump mounting base plate, complete w/ anchor bolts, 4 sf | BC-0001 | 2.0 | ea | 622.68 | 795.79 | - | - | - | 1,418.47 | /ea | 2,837 |
| | **Sludge Pumps and Piping** | | **1.0** | **LS** | **1,245.35** | **1,591.58** | | | | **2,836.93** | **/LS** | **2,837** |
| | **05 METALS** | | | | | | | | | | | **49,693** |
| **07 THERMAL PROTECTION** | | | | | | | | | | | | |
| **05999 Misc. Structural Steel Work** | | | | | | | | | | | | |
| 07-72-33.10 | Manhole cover | 1100 | 1.0 | ea | 249.60 | 1,584.55 | - | - | - | 1,834.15 | /ea | 1,834 |
| | **Misc. Structural Steel Work** | | **1.0** | **LS** | **249.60** | **1,584.55** | | | | **1,834.15** | **/LS** | **1,834** |
| | **07 THERMAL PROTECTION** | | | | | | | | | | | **1,834** |
| **09 FINISHES** | | | | | | | | | | | | |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **11999 Primary Clarifier** | | | | | | | | | | |
| 09-91-06.41 | Coatings & paints, B & C coating system E-2 (Epoxy, metal tanks, structures) | BC-0021 | 6,400.0 sqft | 0.28 | 1.40 | - | - | - | 1.69 /sqft | 10,797 |
| | **Primary Clarifier** | | **1.0 LS** | **1,811.25** | **8,985.60** | | | | **10,796.85 /LS** | **10,797** |
| **11999 Sludge Pumps and Piping** | | | | | | | | | | |
| 09-99-99.99 | Coatings allowance | MISC | 1.0 LS | - | - | 20,000.00 | - | - | 20,000.00 /LS | 20,000 |
| | **Sludge Pumps and Piping** | | **1.0 LS** | | | **20,000.00** | | | **20,000.00 /LS** | **20,000** |
| | **09 FINISHES** | | | | | | | | | **30,797** |
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Primary Clarifier** | | | | | | | | | | |
| 11-00-01.00 | Mechanical, clarifier mechanism, primary, 80' dia., 14' sidewall, w/ bridge, cage, launders, FRP weirs, & baffles | BC-1036 | 1.0 ea | 30,631.78 | 215,000.00 | - | 8,710.92 | - | 254,342.70 /ea | 254,343 |
| 11-00-01.00 | Mechanical, clarifier mechanism, primary, 80' dia., 14' sidewall, w/ bridge, cage, launders, FRP weirs, & baffles | BC-1036 | 1.0 ea | 30,631.78 | 215,000.00 | - | 8,710.92 | - | 254,342.70 /ea | 254,343 |
| 11-00-11.05 | Wastewater, submersible, 3-inch, 6.5 hp,,guide rails, base elbow, scum pump | BC-0071 | 1.0 ea | 1,194.45 | 7,510.00 | - | - | - | 8,704.45 /ea | 8,704 |
| 11-00-11.05 | Wastewater, submersible, 3-inch, 6.5 hp,,guide rails, base elbow, scum pump | BC-0071 | 1.0 ea | 1,194.45 | 7,510.00 | - | - | - | 8,704.45 /ea | 8,704 |
| | **Primary Clarifier** | | **1.0 LS** | **63,652.46** | **445,020.00** | | **17,421.84** | | **526,094.30 /LS** | **526,094** |
| **11999 Sludge Pumps and Piping** | | | | | | | | | | |
| 11-00-10.00 | Pump, double disc diaphragm, sludge pump | BC-0176 | 2.0 ea | 2,789.95 | 31,000.00 | - | 333.44 | - | 34,123.39 /ea | 68,247 |
| | **Sludge Pumps and Piping** | | **1.0 LS** | **5,579.90** | **62,000.00** | | **666.88** | | **68,246.78 /LS** | **68,247** |
| | **11 EQUIPMENT** | | | | | | | | | **594,341** |
| **22 PLUMBING** | | | | | | | | | | |
| **11999 Primary Clarifier** | | | | | | | | | | |
| 11-00-04.00 | Hydraulic structures, slide gate, stainless stl, ab & grout,36" x 36" | BC-0101 | 1.0 ea | 2,455.44 | 4,774.77 | - | 554.07 | - | 7,784.28 /ea | 7,784 |
| 11-00-04.00 | Hydraulic structures, slide gate, stainless stl, ab & grout,36" x 36" | BC-0101 | 1.0 ea | 2,455.44 | 4,774.77 | - | 554.07 | - | 7,784.28 /ea | 7,784 |
| 22-05-23.70 | Valves, semi-steel, lubricated plug valve, flanged, 200 psi, 12" | 7070 | 1.0 ea | 907.31 | 4,700.00 | - | - | - | 5,607.31 /ea | 5,607 |
| 22-05-23.70 | Valves, semi-steel, lubricated plug valve, flanged, 200 psi, 12" | 7070 | 1.0 ea | 907.31 | 4,700.00 | - | - | - | 5,607.31 /ea | 5,607 |
| 22-11-13.44 | Pipe, steel, black, welded, 36" diameter, schedule 40, Spec. A-53, includes two rod, roll hanger & saddle, sized for covering, 10' OC | 2220 | 75.0 lf | 280.75 | 275.00 | - | 9.20 | - | 564.94 /lf | 42,371 |
| 22-11-13.44 | Pipe, steel, black, welded, 36" diameter, schedule 40, Spec. A-53, includes two rod, roll hanger & saddle, sized for covering, 10' OC | 2220 | 75.0 lf | 280.75 | 275.00 | - | 9.20 | - | 564.94 /lf | 42,371 |
| 22-11-13.47 | Elbow, 90 Deg., steel, carbon steel, black, long radius, butt weld, standard weight, 36" pipe size, includes 1 weld per joint and weld machine | 3194 | 1.0 ea | 1,554.30 | 3,450.00 | - | 57.70 | - | 5,062.00 /ea | 5,062 |
| 22-11-13.47 | Elbow, 90 Deg., steel, carbon steel, black, long radius, butt weld, standard weight, 36" pipe size, includes 1 weld per joint and weld machine | 3194 | 1.0 ea | 1,554.30 | 3,450.00 | - | 57.70 | - | 5,062.00 /ea | 5,062 |
| 22-20-00.30 | Piping, water dist, DI, cement lined, 18' L, restrained jt, 12" dia | BC-0001 | 45.0 lnft | 6.58 | 25.25 | - | | - | 31.83 /lnft | 1,432 |
| 22-20-00.30 | Piping, water dist, DI, cement lined, 18' L, restrained jt, 12" dia | BC-0001 | 45.0 lnft | 6.58 | 25.25 | - | | - | 31.83 /lnft | 1,432 |
| 22-20-00.31 | Piping, water dist, DI, 90< bend or elbow, 12" dia | BC-0026 | 1.0 ea | 212.17 | 228.00 | - | 45.86 | - | 486.03 /ea | 486 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **11999 Primary Clarifier** | | | | | | | | | | |
| 22-20-00.31 | Piping, water dist, DI, 90< bend or elbow, 12" dia | BC-0026 | 1.0 ea | 212.17 | 228.00 | - | 45.86 | - | 486.03 /ea | 486 |
| 22-20-01.95 | Pipe, steel ftngs, sch 40, tee 54" X 36" welded | BC-2866 | 1.0 ea | 1,843.18 | 13,429.84 | - | 995.92 | - | 16,268.94 /ea | 16,269 |
| 22-20-01.95 | Pipe, steel ftngs, sch 40, tee 54" X 36" welded | BC-2866 | 1.0 ea | 1,843.18 | 13,429.84 | - | 995.92 | - | 16,268.94 /ea | 16,269 |
| | **Primary Clarifier** | | **1.0 LS** | **56,648.84** | **96,687.72** | | **4,686.54** | | **158,023.10 /LS** | **158,023** |
| **11999 Sludge Pumps and Piping** | | | | | | | | | | |
| 22-99-99.99 | Sludge piping allowance | MISC | 1.0 LS | 25,130.00 | 35,000.00 | | - | - | 60,130.00 /LS | 60,130 |
| 22-99-99.99 | Scum piping allowance | MISC | 1.0 LS | 7,180.00 | 10,000.00 | | - | - | 17,180.00 /LS | 17,180 |
| | **Sludge Pumps and Piping** | | **1.0 LS** | **32,310.00** | **45,000.00** | | | | **77,310.00 /LS** | **77,310** |
| **33500 PC Yard Piping** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1-1/2 C.Y. excavator, 10' to 14' deep, excludes sheeting or dewatering | 1000 | 699.1 bcy | 2.07 | - | - | 1.95 | - | 4.02 /bcy | 2,808 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with sheepsfoot roller | 2300 | 427.1 ecy | 1.32 | - | - | 2.85 | - | 4.16 /ecy | 1,779 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 213.8 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 5,122 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 213.8 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 1,278 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 272.0 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 3,121 |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 1.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 9 |
| | **PC Yard Piping** | | **125.0 LF** | **57.32** | **18.67** | | **36.94** | | **112.93 /LF** | **14,117** |
| **33500 Sludge Piping** | | | | | | | | | | |
| 22-20-00.65 | Piping, DI, glass lined, CL 50, 10" dia | BC-0326 | 1,325.0 lnft | 19.55 | 100.00 | - | 4.23 | - | 123.77 /lnft | 164,001 |
| | **Sludge Piping** | | **1,325.0 LF** | **19.55** | **100.00** | | **4.23** | | **123.77 /LF** | **164,001** |
| | **22 PLUMBING** | | | | | | | | | **413,450** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **01999 ADDITIONAL COST: Service to New Primary Clarifiers** | | | | | | | | | | |
| 01-99-99.99 | Additional Cost associated with Primary Clarifiers - Electrical Service in Ductbank | MISC | 450.0 LF | - | - | 250.00 | - | - | 250.00 /LF | 112,500 |
| | **ADDITIONAL COST: Service to New Primary Clarifiers** | | **450.0 LF** | | | **250.00** | | | **250.00 /LF** | **112,500** |
| **26001 Primary Clarifiers - E&I (#1,2,3)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 487,902.48 | - | - | 487,902.48 /LS | 487,902 |
| | **Primary Clarifiers - E&I (#1,2,3)** | | **1.0 LS** | | | **487,902.48** | | | **487,902.48 /LS** | **487,902** |
| | **26 ELECTRICAL** | | | | | | | | | **600,402** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Primary Clarifiers - E&I (#1,2,3)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 121,975.63 | - | - | 121,975.63 /LS | 121,976 |
| | **Primary Clarifiers - E&I (#1,2,3)** | | **1.0 LS** | | | **121,975.63** | | | **121,975.63 /LS** | **121,976** |
| | **27 COMMUNICATIONS** | | | | | | | | | **121,976** |
| **31 EARTHWORK** | | | | | | | | | | |
| **01999 Dewatering** | | | | | | | | | | |
| 01-54-33.70 | Rent wellpoint header pipe, 6" diameter, 400 gpm | 0500 | 1,760.0 day | - | - | - | 0.40 | - | 0.40 /day | 704 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **01999 Dewatering** | | | | | | | | | | |
| 31-23-19.20 | Dewatering, pumping 8 hours, attended 2 hrs per day, 6" centrifugal pump, includes 20 LF of suction hose and 100 LF of discharge hose | 1100 | 176.0 day | 857.51 | - | - | 377.70 | - | 1,235.21 /day | 217,397 |
| 31-23-19.30 | Wells, for dewatering, with steel casing, 10' to 20' deep, 2' diameter, minimum | 0020 | 250.0 vlf | 76.64 | 184.52 | - | 17.92 | - | 279.08 /vlf | 69,770 |
| | **Dewatering** | | **1.0 LS** | **170,081.77** | **46,130.81** | | **71,658.65** | | **287,871.23 /LS** | **287,871** |
| **03330 Slabs Primary Clarifiers** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 630.2 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 1,126 |
| 31-23-16.16 | Strt excvtn for minor strtrs,bank measur,for spread and mat footngs,elevatr pits,and small buildng fndtns,3/4 cy bucket,machine excavtn,hydrlc backhoe | 6035 | 22.2 bcy | 12.43 | - | - | 7.42 | - | 19.86 /bcy | 441 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 1 mile round trip, 2.2 loads/hour, 12 C.Y. truck, highway haulers, excludes loading | 0400 | 22.2 lcy | 2.77 | - | - | 3.92 | - | 6.69 /lcy | 149 |
| | **Slabs Primary Clarifiers** | | **455.2 cy** | **2.22** | | | **1.55** | | **3.77 /cy** | **1,716** |
| **03330 Slabs Pump Station** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 44.4 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 79 |
| | **Slabs Pump Station** | | **400.0 cy** | **0.12** | | | **0.08** | | **0.20 /cy** | **79** |
| **03330 Slabs Splitter Box** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 16.0 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 29 |
| | **Slabs Splitter Box** | | **11.2 cy** | **1.52** | | | **1.03** | | **2.55 /cy** | **29** |
| **03330 Slabs Scum Pump** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 4.0 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 7 |
| | **Slabs Scum Pump** | | **36.0 cy** | **0.12** | | | **0.08** | | **0.20 /cy** | **7** |
| **03330 Slabs Primary Clarifiers** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 630.2 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 1,126 |
| 31-23-16.16 | Strt excvtn for minor strtrs,bank measur,for spread and mat footngs,elevatr pits,and small buildng fndtns,3/4 cy bucket,machine excavtn,hydrlc backhoe | 6035 | 22.2 bcy | 12.43 | - | - | 7.42 | - | 19.86 /bcy | 441 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 1 mile round trip, 2.2 loads/hour, 12 C.Y. truck, highway haulers, excludes loading | 0400 | 22.2 lcy | 2.77 | - | - | 3.92 | - | 6.69 /lcy | 149 |
| | **Slabs Primary Clarifiers** | | **5,672.0 cy** | **0.18** | | | **0.13** | | **0.30 /cy** | **1,716** |
| **03330 Slabs Scum Pump** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 4.0 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 7 |
| | **Slabs Scum Pump** | | **36.0 cy** | **0.12** | | | **0.08** | | **0.20 /cy** | **7** |
| **31315 Excavation and Backfill prim Clarifier** | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 2,106.1 bcy | 6.99 | - | - | 7.64 | - | 14.63 /bcy | 30,813 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 1,062.6 ecy | 5.30 | - | - | 1.50 | - | 6.80 /ecy | 7,222 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 1,043.5 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 8,921 |
| | **Excavation and Backfill prim Clarifier** | | **2,106.1 cy** | **11.19** | | | **11.10** | | **22.30 /cy** | **46,955** |
| **31315 Excavation and Backfill splitter Box** | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 3,497.8 bcy | 6.99 | - | - | 7.64 | - | 14.63 /bcy | 51,173 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 2,088.9 ecy | 5.30 | - | - | 1.50 | - | 6.80 /ecy | 14,197 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **31315 Excavation and Backfill splitter Box** | | | | | | | | | | | | |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 106.7 | lcy | 3.08 | - | - | 5.47 | - | 8.55 | /lcy | 912 |
| | **Excavation and Backfill splitter Box** | | **2,195.6** | **cy** | **16.33** | | | **13.86** | | **30.19** | **/cy** | **66,282** |
| **31315 Excavation and Backfill Pump station** | | | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 1,814.8 | bcy | 6.99 | - | - | 7.64 | - | 14.63 | /bcy | 26,551 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 1,666.7 | ecy | 13.60 | - | - | 3.85 | - | 17.44 | /ecy | 29,070 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 148.1 | lcy | 3.08 | - | - | 5.47 | - | 8.55 | /lcy | 1,267 |
| | **Excavation and Backfill Pump station** | | **1,814.8** | **cy** | **19.73** | | | **11.61** | | **31.35** | **/cy** | **56,888** |
| **31315 Excavation and Backfill prim Clarifier** | | | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 2,106.1 | bcy | 6.99 | - | - | 7.64 | - | 14.63 | /bcy | 30,813 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 1,062.6 | ecy | 5.30 | - | - | 1.50 | - | 6.80 | /ecy | 7,222 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 1,043.5 | lcy | 3.08 | - | - | 5.47 | - | 8.55 | /lcy | 8,921 |
| | **Excavation and Backfill prim Clarifier** | | **2,106.1** | **cy** | **11.19** | | | **11.10** | | **22.30** | **/cy** | **46,955** |
| **33500 Sludge Piping** | | | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering | 0110 | 613.4 | bcy | 3.73 | - | - | 2.23 | - | 5.96 | /bcy | 3,654 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 327.2 | ecy | 1.23 | - | - | 2.60 | - | 3.82 | /ecy | 1,251 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 259.5 | lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 | /lcy | 6,217 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 259.5 | ecy | 5.57 | - | - | 0.41 | - | 5.98 | /ecy | 1,551 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 286.3 | lcy | 6.23 | - | - | 5.24 | - | 11.48 | /lcy | 3,285 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 13,250.0 | sf | - | - | 0.08 | - | - | 0.08 | /sf | 1,060 |
| | **Sludge Piping** | | **1,325.0** | **LF** | **6.54** | **2.13** | **0.80** | **3.37** | | **12.84** | **/LF** | **17,017** |
| **33500 Primary Effluent Piping** | | | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 1,115.3 | bcy | 2.80 | - | - | 2.07 | - | 4.87 | /bcy | 5,431 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 390.3 | ecy | 1.23 | - | - | 2.60 | - | 3.82 | /ecy | 1,492 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 477.9 | lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 | /lcy | 11,449 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 477.9 | ecy | 5.57 | - | - | 0.41 | - | 5.98 | /ecy | 2,856 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 725.0 | lcy | 6.23 | - | - | 5.24 | - | 11.48 | /lcy | 8,320 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 8,350.0 | sf | - | - | 0.08 | - | - | 0.08 | /sf | 668 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Primary Effluent Piping** | | **1,225.0 LF** | **12.93** | **4.25** | **0.55** | **6.94** | | **24.67 /LF** | **30,216** |
| | **31 EARTHWORK** | | | | | | | | | **555,738** |
| **33 UTILITIES** | | | | | | | | | | |
| **33500 Sludge Piping** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 13.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 116 |
| | **Sludge Piping** | | **1,325.0 LF** | **0.03** | **0.06** | | | | **0.09 /LF** | **116** |
| **33500 Primary Effluent Piping** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 6.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 53 |
| | **Primary Effluent Piping** | | **1,225.0 LF** | **0.02** | **0.03** | | | | **0.04 /LF** | **53** |
| | **33 UTILITIES** | | | | | | | | | **169** |
| **40** | | | | | | | | | | |
| **33500 PC Yard Piping** | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 54 Inch (1350mm) | A541002 0000EA | 125.0 lf | - | 333.54 | - | - | - | 333.54 /lf | 41,692 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 54 Inch (1350mm) | L544002 0000P1 | 125.0 lf | 32.59 | - | - | 6.43 | - | 39.02 /lf | 4,877 |
| 40-05-24.10 | Field Other Weld-CS A53/A106-Non-Specific 54 Inch (1350mm) | L545502 000000 | 3.0 ea | 3,900.77 | 78.79 | - | 312.41 | - | 4,291.97 /ea | 12,876 |
| 40-05-24.10 | Misc process/utility piping allowance | ---- | 1.0 ls | 7,860.00 | 10,010.00 | - | - | - | 17,870.00 /ls | 17,870 |
| 40-05-24.10 | Misc process/utility piping allowance | ---- | 1.0 ls | 7,860.00 | 10,010.00 | - | - | - | 17,870.00 /ls | 17,870 |
| | **PC Yard Piping** | | **125.0 LF** | **251.97** | **495.59** | | **13.93** | | **761.49 /LF** | **95,186** |
| **33500 Primary Effluent Piping** | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Std 36 Inch (900mm) | A361002 0100EA | 100.0 lf | - | 168.69 | - | - | - | 168.69 /lf | 16,869 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std 36 Inch (900mm) | A362112 010000 | 2.0 ea | 2,580.88 | 4,053.57 | - | 488.91 | - | 7,123.36 /ea | 14,247 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 54 Inch (1350mm) | A541002 0000EA | 375.0 lf | - | 333.54 | - | - | - | 333.54 /lf | 125,077 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Tee-Non-Specific 54 Inch (1350mm) | A542114 000000 | 1.0 ea | - | 11,667.66 | - | - | - | 11,667.66 /ea | 11,668 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 36 Inch (900mm) | L364002 0100P1 | 100.0 lf | 24.46 | - | - | 4.83 | - | 29.29 /lf | 2,929 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std 36 Inch (900mm) | L365102 010000 | 2.0 ea | 929.47 | 17.51 | - | 74.44 | - | 1,021.42 /ea | 2,043 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 54 Inch (1350mm) | L544002 0000P1 | 375.0 lf | 32.59 | - | - | 6.43 | - | 39.02 /lf | 14,632 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Non-Specific 54 Inch (1350mm) | L545102 000000 | 10.0 ea | 1,950.39 | 39.40 | - | 156.21 | - | 2,145.99 /ea | 21,460 |
| | **Primary Effluent Piping** | | **1,225.0 LF** | **33.63** | **132.37** | | **4.56** | | **170.55 /LF** | **208,924** |
| | **40** | | | | | | | | | **304,109** |
| | **01 Primary Clarifiers** | | **1.0 LS** | **951,957.85** | **1,384,549.43** | **744,106.11** | **239,834.01** | | **3,320,447.40 /LS** | **3,320,447** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **02 Aeration Tanks** | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | |
| **03330 Slabs Aeration Basins** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 426.7 cy | - | 33.69 | - | - | - | 33.69 /cy | 14,376 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 840.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 6,741 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 70.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 4,009 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 64.0 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 129,793 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 64.0 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 3,033 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 64.0 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 3,296 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 896.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 87,819 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 896.0 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 10,468 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 11,520.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 10,493 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 11,520.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 11,455 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 115.2 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 2,281 |
| | **Slabs Aeration Basins** | | **11,520.0 SF** | **8.97** | **15.39** | | **0.27** | | **24.63 /SF** | **283,763** |
| **03330 Slabs Pipe Utilidor** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 46.3 cy | - | 33.69 | - | - | - | 33.69 /cy | 1,560 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 32.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 275 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 140.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 1,123 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 12.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 687 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 2.8 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 5,634 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7 | 0610 | 47.4 lb | 0.52 | 0.48 | - | - | - | 0.99 /lb | 47 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 2.8 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 133 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 2.8 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 144 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 98.5 cy | - | 98.01 | - | - | - | 98.01 /cy | 9,651 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 98.5 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 1,150 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed and bull float(darby) finish | 0100 | 1,250.0 sf | 0.38 | - | - | - | - | 0.38 /sf | 472 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03330 Slabs Pipe Utilidor** | | | | | | | | | | | | |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 1,250.0 | sf | 0.70 | 0.29 | - | - | - | 0.99 | /sf | 1,243 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 12.5 | csf | 9.68 | 10.12 | - | - | - | 19.80 | /csf | 248 |
| | **Slabs Pipe Utilidor** | | **1,250.0** | **cy** | **5.13** | **12.58** | | **0.19** | | **17.89** | **/cy** | **22,368** |
| **03333 Blower Equipment Pads** | | | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 60.0 | sfca | 7.24 | 1.36 | - | - | - | 8.60 | /sfca | 516 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.1 | ton | 39.90 | - | - | 7.60 | - | 47.43 | /ton | 4 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.1 | ton | 43.40 | - | - | 8.10 | - | 51.50 | /ton | 4 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 3.7 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 363 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 3.7 | cy | 27.68 | - | - | 5.70 | - | 33.38 | /cy | 124 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 3.7 | cy | 46.13 | - | - | 13.04 | - | 59.17 | /cy | 219 |
| | **Blower Equipment Pads** | | **7.4** | **cy** | **96.36** | **59.98** | | **9.52** | | **165.86** | **/cy** | **1,229** |
| **03345 Concrete Walls Aeration Basin** | | | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 28.0 | lf | 10.50 | 2.14 | - | - | - | 12.63 | /lf | 354 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 19,320.0 | sfca | 6.18 | 0.75 | - | - | - | 6.93 | /sfca | 133,840 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 51.5 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 1,065 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 28.0 | lf | 3.24 | 14.92 | - | - | - | 18.15 | /lf | 508 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 2.0 | ea | 9.39 | 35.79 | - | - | - | 45.17 | /ea | 90 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 47.0 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 83,880 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 47.0 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 2,225 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 47.0 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 2,419 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 563.5 | cy | - | 98.01 | - | - | - | 98.01 | /cy | 55,230 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 563.5 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 21,944 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 19,320.0 | sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 | /sf | 48,810 |
| | **Concrete Walls Aeration Basin** | | **563.5** | **cy** | **382.76** | **223.55** | | **15.46** | | **621.77** | **/cy** | **350,365** |
| **03345 Concrete Walls Baffle walls** | | | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 168.0 | lf | 10.50 | 2.14 | - | - | - | 12.63 | /lf | 2,122 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls Baffle walls** | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 10,752.0 sfca | 6.18 | 0.75 | - | - | - | 6.93 /sfca | 74,485 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 28.7 gal | - | 20.66 | - | - | - | 20.66 /gal | 592 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 168.0 lf | 3.24 | 14.92 | - | - | - | 18.15 /lf | 3,050 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 12.0 ea | 9.39 | 35.78 | - | - | - | 45.17 /ea | 542 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 22.4 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 40,013 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 22.4 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 1,061 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 22.4 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 1,154 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 313.6 cy | - | 98.01 | - | - | - | 98.01 /cy | 30,737 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 313.6 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 12,212 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 10,752.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 27,164 |
| | **Concrete Walls Baffle walls** | | **313.6 cy** | **379.31** | **221.28** | | **15.27** | | **615.86 /cy** | **193,132** |
| **03345 Concrete Walls Pipe Utilidor** | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 4,800.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 36,960 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 12.8 gal | - | 20.66 | - | - | - | 20.66 /gal | 265 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 6.7 ton | 794.28 | 992.00 | - | - | - | 1,786.27 /ton | 11,909 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 6.7 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 316 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 6.7 ton | 43.34 | - | - | 8.17 | - | 51.50 /ton | 343 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 93.3 cy | - | 98.01 | - | - | - | 98.01 /cy | 9,148 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 93.3 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 3,635 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 4,800.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 12,127 |
| | **Concrete Walls Pipe Utilidor** | | **93.3 cy** | **549.66** | **231.73** | | **19.02** | | **800.41 /cy** | **74,702** |
| **03350 Elevated Slabs Pipe Utilidor** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 1,250.0 sf | 4.97 | 1.27 | - | - | - | 6.24 /sf | 7,796 |
| 03-11-13.35 | Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning | 5550 | 32.0 lf | 4.64 | 1.62 | - | - | - | 6.26 /lf | 200 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 120.0 lf | 3.62 | 0.21 | - | - | - | 3.83 /lf | 460 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03350 Elevated Slabs Pipe Utilidor** | | | | | | | | | | |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 3.0 ton | 821.66 | 992.00 | - | - | - | 1,813.66 /ton | 5,510 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 ton | 40.00 | - | - | 7.50 | - | 47.50 /ton | 1 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 ton | 113.80 | - | - | 21.70 | - | 135.40 /ton | 3 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 48.6 cy | - | 98.01 | - | - | - | 98.01 /cy | 4,764 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, pumped, over 10" thick, includes vibrating, excludes material | 1600 | 48.6 cy | 21.53 | - | - | 4.43 | - | 25.96 /cy | 1,262 |
| 03-35-29.30 | Finishing elev slab, manual screed, bull float, machine float & trowel | 0275 | 1,250.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 1,139 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 1,250.0 sf | 0.62 | 0.19 | - | - | - | 0.81 /sf | 1,013 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 12.5 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 248 |
| | **Elevated Slabs Pipe Utilidor** | | **48.6 cy** | **253.72** | **201.80** | | **5.22** | | **460.74 /cy** | **22,396** |
| | **03 CONCRETE** | | | | | | | | | **947,954** |
| **05 METALS** | | | | | | | | | | |
| **05999 Misc. Structural Steel Work** | | | | | | | | | | |
| 05-52-13.50 | Railing, pipe, aluminum, clear finish, 3 rails, 3'-6" high, posts @ 5' O.C., 1-1/2" dia, shop fabricated | 0210 | 880.0 lf | 18.34 | 74.00 | - | 1.09 | - | 93.43 /lf | 82,218 |
| 05-53-21.50 | Floor grating, steel, expanded mesh, 7.0# per S.F., field fabricated from panels | 2900 | 960.0 sf | 3.59 | 19.65 | - | 0.21 | - | 23.45 /sf | 22,514 |
| | **Misc. Structural Steel Work** | | **1.0 LS** | **19,589.04** | **83,984.00** | | **1,159.57** | | **104,732.61 /LS** | **104,733** |
| | **05 METALS** | | | | | | | | | **104,733** |
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Aeration Equipment** | | | | | | | | | | |
| 11-00-01.00 | Aeration diffusers, fine bubble, complete with headers | BC-0031 | 5,216.0 ea | 13.11 | 35.00 | - | - | - | 48.11 /ea | 250,941 |
| 11-00-01.00 | Aeration Blower, high speed turbo, (5,000 scfm at 10 psig) | BC-0336 | 2.0 ea | 5,654.22 | 200,000.00 | - | - | - | 205,654.22 /ea | 411,308 |
| 11-00-01.00 | Mixer, submerged propellar type, 10 hp, Flygt, with guiderail | BC-0621 | 12.0 ea | 2,261.69 | 30,000.00 | - | 380.00 | - | 32,641.69 /ea | 391,700 |
| 11-00-09.00 | Pump, submerged axial flow. 18" Dia., wall pump, 3-hp, 2.5 mgd, IMLR pump | BC-0316 | 2.0 ea | 1,696.27 | 25,000.00 | - | 190.00 | - | 26,886.26 /ea | 53,773 |
| | **Aeration Equipment** | | **1.0 LS** | **110,222.54** | **992,560.00** | | **4,940.00** | | **1,107,722.54 /LS** | **1,107,723** |
| | **11 EQUIPMENT** | | | | | | | | | **1,107,723** |
| **22 PLUMBING** | | | | | | | | | | |
| **22999 Aeration Piping** | | | | | | | | | | |
| 22-99-99.99 | Aeration piping allowance | MISC | 2.0 LS | 17,950.00 | 75,000.00 | | - | - | 92,950.00 /LS | 185,900 |
| | **Aeration Piping** | | **1.0 LS** | **35,900.00** | **150,000.00** | | | | **185,900.00 /LS** | **185,900** |
| | **22 PLUMBING** | | | | | | | | | **185,900** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **01999 ADDITIONAL COST: Service to New Aeration Basis** | | | | | | | | | | |
| 01-99-99.99 | Additional Cost associated with Aeration Basin - Electrical Service in Ductbank | MISC | 750.0 LF | - | - | 250.00 | - | - | 250.00 /LF | 187,500 |
| | **ADDITIONAL COST: Service to New Aeration Basis** | | **750.0 LF** | | | **250.00** | | | **250.00 /LF** | **187,500** |
| **26001 Aeration Tanks - E&I (#4, #5, #6)** | | | | | | | | | | |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **26001 Aeration Tanks - E&I (#4, #5, #6)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 560,615.20 | - | - | 560,615.20 /LS | 560,615 |
| | **Aeration Tanks - E&I (#4, #5, #6)** | | **1.0 LS** | | | **560,615.20** | | | **560,615.20 /LS** | **560,615** |
| | **26 ELECTRICAL** | | | | | | | | | **748,115** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Aeration Tanks - E&I (#4, #5, #6)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 140,153.81 | - | - | 140,153.81 /LS | 140,154 |
| | **Aeration Tanks - E&I (#4, #5, #6)** | | **1.0 LS** | | | **140,153.81** | | | **140,153.81 /LS** | **140,154** |
| | **27 COMMUNICATIONS** | | | | | | | | | **140,154** |
| **31 EARTHWORK** | | | | | | | | | | |
| **01999 Dewatering** | | | | | | | | | | |
| 01-54-33.70 | Rent wellpoint header pipe, 6" diameter, 400 gpm | 0500 | 900.0 day | - | - | - | 0.40 | - | 0.40 /day | 360 |
| 31-23-19.20 | Dewatering, pumping 8 hours, attended 2 hrs per day, 6" centrifugal pump, includes 20 LF of suction hose and 100 LF of discharge hose | 1100 | 90.0 day | 857.51 | - | - | 377.70 | - | 1,235.21 /day | 111,169 |
| 31-23-19.30 | Wells, for dewatering, with steel casing, 10' to 20' deep, 2' diameter, minimum | 0020 | 60.0 vlf | 76.64 | 184.52 | - | 17.92 | - | 279.08 /vlf | 16,745 |
| | **Dewatering** | | **1.0 LS** | **81,774.45** | **11,071.39** | | **35,427.87** | | **128,273.71 /LS** | **128,274** |
| **03330 Slabs Aeration Basins** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 1,280.0 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 2,287 |
| | **Slabs Aeration Basins** | | **11,520.0 SF** | **0.12** | | | **0.08** | | **0.20 /SF** | **2,287** |
| **03330 Slabs Pipe Utilidor** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 138.9 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 248 |
| | **Slabs Pipe Utilidor** | | **1,250.0 cy** | **0.12** | | | **0.08** | | **0.20 /cy** | **248** |
| **31315 Excavation and Backfill Aeration Basin** | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 4,814.8 bcy | 6.99 | - | - | 7.64 | - | 14.63 /bcy | 70,441 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 5,814.8 ecy | 5.30 | - | - | 1.50 | - | 6.80 /ecy | 39,520 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 3,333.3 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 28,497 |
| | **Excavation and Backfill Aeration Basin** | | **4,814.8 cy** | **15.52** | | | **13.23** | | **28.76 /cy** | **138,457** |
| | **31 EARTHWORK** | | | | | | | | | **269,266** |
| | **02 Aeration Tanks** | | **1.0 LS** | **832,471.76** | **1,657,863.77** | **888,269.01** | **125,240.43** | | **3,503,844.97 /LS** | **3,503,845** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **04 Existing aeration Tanks/RAS Tank Retrofit** | | | | | | | | | | |
| **01 GENERAL CONDITIONS** | | | | | | | | | | |
| **02999 Aeration tank demolition** | | | | | | | | | | |
| 01-54-33.40 | Pressure Washer 7 gpm, 3000 psi | 5460 | 16.0 day | - | - | - | 87.60 | - | 87.60 /day | 1,402 |
| 01-54-33.40 | Rent trash pump self-prime 4" diameter, diesel drive | 5600 | 16.0 day | - | - | - | 126.20 | - | 126.20 /day | 2,019 |
| | **Aeration tank demolition** | | **1.0 LS** | | | | **3,420.80** | | **3,420.80 /LS** | **3,421** |
| | **01 GENERAL CONDITIONS** | | | | | | | | | **3,421** |
| **02 SITEWORK & DEMOLITION** | | | | | | | | | | |
| **02225 Demo Baffle walls** | | | | | | | | | | |
| 02-41-19.23 | Rubbish handling, loading & trucking, machine loading truck, includes 2 mile haul, cost to be added to demolition cost. | 3080 | 93.3 cy | 17.39 | - | - | 6.59 | - | 23.98 /cy | 2,239 |
| 02-41-19.25 | Sawcutting, concrete walls, rod reinforcing, per inch of depth | 0820 | 2,016.0 lf | 7.17 | 0.05 | - | 5.84 | - | 13.06 /lf | 26,328 |
| 03-05-05.10 | Selective concrete demolition, 2 - 5 tons, remove whole pieces, incl loading, excludes shoring, bracing, saw or torch cutting, hauling, dumping | 0160 | 96.0 ea | 106.31 | - | - | 32.26 | - | 138.57 /ea | 13,303 |
| | **Demo Baffle walls** | | **6,720.0 sf** | **3.91** | **0.02** | | **2.30** | | **6.23 /sf** | **41,870** |
| **02999 Aeration tank demolition** | | | | | | | | | | |
| 02-22-03.30 | Dump Charge, typical urban city, fees only, bldg constr mat'ls | BC-0006 | 16.0 ton | - | - | - | - | 33.00 | 33.00 /ton | 528 |
| 02-22-04.50 | Demo fine bubble aeration discs, piping, headers, laterals and drop legs, in basin only | BC-0071 | 16.0 days | 2,284.78 | - | - | 967.88 | - | 3,252.66 /days | 52,043 |
| | **Aeration tank demolition** | | **1.0 LS** | **36,556.52** | | | **15,486.08** | **528.00** | **52,570.60 /LS** | **52,571** |
| | **02 SITEWORK & DEMOLITION** | | | | | | | | | **94,440** |
| **03 CONCRETE** | | | | | | | | | | |
| **03345 Baffle walls** | | | | | | | | | | |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 35.0 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 62,520 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 35.0 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 1,658 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 35.0 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 1,803 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 588.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 57,631 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 588.0 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 22,898 |
| 03-35-29.60 | Concrete finishing, walls, sandblast, light penetration | 0700 | 20,160.0 sf | 1.89 | 0.42 | - | 0.22 | - | 2.53 /sf | 50,932 |
| 04-05-19.16 | Masonry anchors, wall tie dowels, plain, 3/4" diameter x 6" long | 6150 | 28.0 c | - | 313.83 | - | - | - | 313.83 /c | 8,787 |
| | **Baffle walls** | | **588.0 cy** | **149.21** | **186.44** | | **15.08** | | **350.73 /cy** | **206,230** |
| | **03 CONCRETE** | | | | | | | | | **206,230** |
| **05 METALS** | | | | | | | | | | |
| **11999 RAS Pumps** | | | | | | | | | | |
| 05-58-09.50 | Pump mounting base plate, complete w/ anchor bolts, 4 sf | BC-0001 | 5.0 ea | 622.68 | 795.79 | - | - | - | 1,418.47 /ea | 7,092 |
| | **RAS Pumps** | | **1.0 LS** | **3,113.38** | **3,978.95** | | | | **7,092.33 /LS** | **7,092** |
| | **05 METALS** | | | | | | | | | **7,092** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Aeration Equipment** | | | | | | | | | | |
| 11-00-01.00 | Aeration diffusers, fine bubble, complete with headers | BC-0031 | 10,432.0 ea | 13.11 | 35.00 | - | - | - | 48.11 /ea | 501,883 |
| 11-00-01.00 | Mixer, submerged propellar type, 10 hp, Flygt, with guiderail | BC-0621 | 24.0 ea | 2,261.69 | 30,000.00 | - | 380.00 | - | 32,641.69 /ea | 783,401 |
| 11-00-09.00 | Pump, submerged axial flow. 18" Dia., wall pump, 3-hp, 2.5 mgd, IMLR pump | BC-0316 | 4.0 ea | 1,696.27 | 25,000.00 | - | 190.00 | - | 26,886.26 /ea | 107,545 |
| | **Aeration Equipment** | | **1.0 LS** | **197,828.19** | **1,185,120.00** | | **9,880.00** | | **1,392,828.19 /LS** | **1,392,828** |
| **11999 RAS Pumps** | | | | | | | | | | |
| 11-00-01.00 | Pump,vertical turbine, solids handling, can type, 150hp, VFD driven | BC-0791 | 5.0 ea | 3,957.95 | 100,000.00 | - | 532.00 | - | 104,489.95 /ea | 522,450 |
| | **RAS Pumps** | | **1.0 LS** | **19,789.77** | **500,000.00** | | **2,660.00** | | **522,449.77 /LS** | **522,450** |
| | **11 EQUIPMENT** | | | | | | | | | **1,915,278** |
| **22 PLUMBING** | | | | | | | | | | |
| **22999 RAS Piping** | | | | | | | | | | |
| 22-99-99.99 | RAS above grade piping allowance | ---- | 5.0 ls | 15,000.00 | 15,000.00 | - | - | - | 30,000.00 /ls | 150,000 |
| | **RAS Piping** | | **1.0 LS** | **75,000.00** | **75,000.00** | | | | **150,000.00 /LS** | **150,000** |
| **33500 RAS Pump Discharge** | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 48 Inch (1200mm) | A481002 0000EA | 600.0 lf | - | 238.89 | - | - | - | 238.89 /lf | 143,332 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Non-Specific 48 Inch (1200mm) | A482112 000000 | 15.0 ea | - | 7,320.51 | - | - | - | 7,320.51 /ea | 109,808 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 48 Inch (1200mm) | L484002 0000P1 | 600.0 lf | 28.49 | - | - | 5.63 | - | 34.12 /lf | 20,473 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Non-Specific 48 Inch (1200mm) | L485102 000000 | 3.0 ea | 1,772.49 | 35.02 | - | 141.96 | - | 1,949.47 /ea | 5,848 |
| | **RAS Pump Discharge** | | **600.0 LF** | **37.36** | **422.08** | | **6.34** | | **465.77 /LF** | **279,461** |
| | **22 PLUMBING** | | | | | | | | | **429,461** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **26001 Existing Aeration Tanks/RAS Tank Retrofit - E&I (#13, #14)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTOR ED | 1.0 LS | - | - | 440,286.27 | - | - | 440,286.27 /LS | 440,286 |
| | **Existing Aeration Tanks/RAS Tank Retrofit - E&I (#13, #14)** | | **1.0 LS** | | | **440,286.27** | | | **440,286.27 /LS** | **440,286** |
| | **26 ELECTRICAL** | | | | | | | | | **440,286** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Existing Aeration Tanks/RAS Tank Retrofit - E&I (#13, #14)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTOR ED | 1.0 LS | - | - | 73,381.05 | - | - | 73,381.05 /LS | 73,381 |
| | **Existing Aeration Tanks/RAS Tank Retrofit - E&I (#13, #14)** | | **1.0 LS** | | | **73,381.05** | | | **73,381.05 /LS** | **73,381** |
| | **27 COMMUNICATIONS** | | | | | | | | | **73,381** |
| **31 EARTHWORK** | | | | | | | | | | |
| **02999 Aeration tank demolition** | | | | | | | | | | |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 240.0 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 2,052 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Aeration tank demolition** | | **1.0 LS** | **738.66** | | | **1,313.09** | | **2,051.75 /LS** | **2,052** |
| **33500 RAS Pump Discharge** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 1,322.2 bcy | 2.80 | - | - | 2.07 | - | 4.87 /bcy | 6,439 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 466.7 ecy | 1.23 | - | - | 2.60 | - | 3.82 /ecy | 1,784 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 576.3 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 13,806 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 576.3 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 3,444 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 855.6 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 9,818 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 10,200.0 sf | - | - | 0.08 | - | - | 0.08 /sf | 816 |
| | **RAS Pump Discharge** | | **600.0 LF** | **31.52** | **10.46** | **1.36** | **16.84** | | **60.18 /LF** | **36,107** |
| | **31 EARTHWORK** | | | | | | | | | **38,158** |
| **33 UTILITIES** | | | | | | | | | | |
| **33500 RAS Pump Discharge** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 6.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 53 |
| | **RAS Pump Discharge** | | **600.0 LF** | **0.03** | **0.06** | | | | **0.09 /LF** | **53** |
| | **33 UTILITIES** | | | | | | | | | **53** |
| | **04 Existing aeration Tanks/RAS Tank Retrofit** | | **1.0 LS** | **488,393.99** | **2,133,381.35** | **514,483.32** | **71,014.61** | **528.00** | **3,207,801.27 /LS** | **3,207,801** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **05 Tertiary Treatment Processes** | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | |
| **03330 Slabs Alum Storage and Pumps** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 14.8 cy | - | 33.69 | - | - | - | 33.69 /cy | 499 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 56.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 482 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning | 3050 | 110.0 sfca | 4.16 | 0.80 | - | - | - | 4.96 /sfca | 545 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 1.7 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 3,381 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7 | 0610 | 170.4 lb | 0.52 | 0.48 | - | - | - | 0.99 /lb | 169 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 1.8 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 83 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 27.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 2,725 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, direct chute, over 6" thick, includes vibrating, excludes material | 4600 | 27.8 cy | 17.32 | - | - | 0.39 | - | 17.71 /cy | 492 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and broom finish | 0150 | 600.0 sf | 0.82 | - | - | - | - | 0.82 /sf | 490 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 6.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 119 |
| | **Slabs Alum Storage and Pumps** | | **26.5 cy** | **142.68** | **195.75** | | **0.90** | | **339.33 /cy** | **8,986** |
| **03333 Alum tank/pump equipment Pads and containment** | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 740.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 6,365 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.3 ton | 39.90 | - | - | 7.50 | - | 47.41 /ton | 13 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.3 ton | 43.33 | - | - | 8.20 | - | 51.50 /ton | 14 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 13.5 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,325 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 13.5 cy | 27.68 | - | - | 5.70 | - | 33.38 /cy | 451 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 13.5 cy | 46.13 | - | - | 13.04 | - | 59.17 /cy | 800 |
| | **Alum tank/pump equipment Pads and containment** | | **13.5 cy** | **471.83** | **172.51** | | **19.05** | | **663.39 /cy** | **8,968** |
| **03333 Alum pumps Equipment Pads** | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 72.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 619 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.0 ton | 39.80 | - | - | 7.50 | - | 47.25 /ton | 2 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.0 ton | 43.30 | - | - | 8.30 | - | 51.50 /ton | 2 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 196 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03333 Alum pumps Equipment Pads** | | | | | | | | | | |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 2.0 cy | 27.68 | - | - | 5.70 | - | 33.38 /cy | 67 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 2.0 cy | 46.13 | - | - | 13.04 | - | 59.17 /cy | 118 |
| | **Alum pumps Equipment Pads** | | **2.0 cy** | **336.15** | **147.01** | | **19.05** | | **502.20 /cy** | **1,004** |
| | **03 CONCRETE** | | | | | | | | | **18,959** |
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 P Removal** | | | | | | | | | | |
| 11-00-06.00 | FRP tank, alum,7,500 gal.,UV resistant | BC-0016 | 2.0 ea | 1,733.90 | 21,000.00 | - | 924.95 | | 23,658.85 /ea | 47,318 |
| 11-00-08.00 | Chemical metering pump, alum | BC-0001 | 2.0 ea | 459.41 | 11,000.00 | - | - | - | 11,459.41 /ea | 22,919 |
| 22-07-19.10 | Heat trace and insulate alum tank and piping allowance | ---- | 1.0 ls | 2,500.00 | 12,500.00 | - | - | - | 15,000.00 /ls | 15,000 |
| 22-11-13.74 | Chemical piping allowance | ---- | 1.0 ls | 3,000.00 | 3,000.00 | - | - | - | 6,000.00 /ls | 6,000 |
| | **P Removal** | | | | | | | | **/LS** | **91,237** |
| | **11 EQUIPMENT** | | | | | | | | | **91,237** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **26001 Tertiary Treatment Process - E&I (#12)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 19,856.57 | - | - | 19,856.57 /LS | 19,857 |
| | **Tertiary Treatment Process - E&I (#12)** | | **1.0 LS** | | | **19,856.57** | | | **19,856.57 /LS** | **19,857** |
| | **26 ELECTRICAL** | | | | | | | | | **19,857** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Tertiary Treatment Process - E&I (#12)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 6,618.86 | - | - | 6,618.86 /LS | 6,619 |
| | **Tertiary Treatment Process - E&I (#12)** | | **1.0 LS** | | | **6,618.86** | | | **6,618.86 /LS** | **6,619** |
| | **27 COMMUNICATIONS** | | | | | | | | | **6,619** |
| **31 EARTHWORK** | | | | | | | | | | |
| **03330 Slabs Alum Storage and Pumps** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 66.7 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 119 |
| | **Slabs Alum Storage and Pumps** | | **26.5 cy** | **2.68** | | | **1.82** | | **4.50 /cy** | **119** |
| | **31 EARTHWORK** | | | | | | | | | **119** |
| | **05 Tertiary Treatment Processes** | | **1.0 LS** | **20,786.71** | **87,309.94** | **26,475.43** | **2,217.55** | | **136,789.63 /LS** | **136,790** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **07 MBR Treatment** | | | | | | | | | | |
| **02 SITEWORK & DEMOLITION** | | | | | | | | | | |
| **02999 Secondary Clafifier Demo** | | | | | | | | | | |
| 02-22-03.30 | Dump Charge, typical urban city, fees only, bldg constr mat'ls | BC-0006 | 240.0 ton | - | - | - | - | 33.00 | 33.00 /ton | 7,920 |
| 02-22-04.50 | Selective demolition, clarifier mechanism, 110' diam, incl launders, supports, center col, scum beach, baffles, weirs, bridge, 3 each | BC-0071 | 14.0 days | 1,968.35 | - | - | 960.00 | - | 2,928.35 /days | 40,997 |
| 02-22-04.50 | Selective demolition, RAS pumps, 50hp, including discharge piping and valves, 3 each | BC-0071 | 3.0 days | 1,968.35 | - | - | 760.00 | - | 2,728.35 /days | 8,185 |
| 31-23-23.19 | Loading Trucks, F.E. Loader, 3 C.Y. | BC-0006 | 240.0 cuyd | 0.88 | - | - | 1.24 | - | 2.12 /cuyd | 509 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 240.0 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 2,052 |
| | **Secondary Clafifier Demo** | | | | | | | | **/LS** | **59,663** |
| | **02 SITEWORK & DEMOLITION** | | | | | | | | | **59,663** |
| **03 CONCRETE** | | | | | | | | | | |
| **03330 Slabs Fine Screens** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 17.8 cy | - | 33.69 | - | - | - | 33.69 /cy | 599 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 92.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 738 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 8.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 458 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 3.1 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 6,309 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 3.1 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 147 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 3.1 ton | 43.34 | - | - | 8.17 | - | 51.50 /ton | 160 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 37.3 cy | - | 98.01 | - | - | - | 98.01 /cy | 3,659 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 37.3 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 436 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed and bull float(darby) finish | 0100 | 480.0 sf | 0.38 | - | - | - | - | 0.38 /sf | 181 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 4.8 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 95 |
| | **Slabs Fine Screens** | | **480.0 cy** | **9.33** | **17.05** | | **0.26** | | **26.63 /cy** | **12,784** |
| **03330 Slabs Fine Screens** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 29.6 cy | - | 33.69 | - | - | - | 33.69 /cy | 998 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 2.6 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 5,259 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 2.6 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 123 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 2.6 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 134 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 3500 psi | 0205 | 31.1 cy | - | 95.26 | - | - | - | 95.26 /cy | 2,964 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03330 Slabs Fine Screens** | | | | | | | | | | |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 31.1 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 363 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed and bull float(darby) finish | 0100 | 800.0 sf | 0.38 | - | - | - | - | 0.38 /sf | 302 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 8.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 158 |
| | **Slabs Fine Screens** | | **800.0 cy** | **4.48** | **8.27** | | **0.13** | | **12.88 /cy** | **10,301** |
| **03330 SBG - A - 61' X 75' X 24"** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 169.4 cy | - | 33.69 | - | - | - | 33.69 /cy | 5,709 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning | 3050 | 272.0 sfca | 4.16 | 0.80 | - | - | - | 4.96 /sfca | 1,348 |
| 03-11-13.85 | C.I.P. concrete forms, wall, job built, plywood, to 8' high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 5,984.0 sfca | 6.39 | 1.76 | - | - | - | 8.16 /sfca | 48,819 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 708.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 5,681 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 59.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 3,379 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 3.4 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 6,958 |
| 03-21-10.60 | Reinforcing, a615 60, sog, thickened edge, allow 28 lbs/cy, #3 to #7 | 0605 | 1.7 ton | 1,036.01 | 962.24 | - | - | - | 1,998.25 /ton | 3,381 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, walls, #8 to #18 | 0760 | 14,960.0 lb | 0.30 | 0.48 | - | - | - | 0.77 /lb | 11,577 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 12.6 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 597 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 12.6 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 649 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 5000 psi | 0405 | 587.7 cy | - | 103.51 | - | - | - | 103.51 /cy | 60,833 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, pumped, over 6" thick, includes vibrating, excludes material | 4650 | 473.6 cy | 20.95 | - | - | 4.31 | - | 25.26 /cy | 11,963 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 8" thick, includes vibrating, excludes material | 4950 | 114.1 cy | 38.75 | - | - | 7.98 | - | 46.73 /cy | 5,334 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and broom finish | 0150 | 4,575.0 sf | 0.82 | - | - | - | - | 0.82 /sf | 3,737 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 4,575.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 4,549 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 45.8 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 906 |
| | **SBG - A - 61' X 75' X 24"** | | **4,575.0 SQFT** | **16.40** | **21.25** | | **0.69** | | **38.34 /SQFT** | **175,420** |
| **03330 SOG-PER AG - 01 -(B + C + CC AREA)- BLOWER BUILDING - 50' X 85.6 X 12"** | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning | 3050 | 270.0 sfca | 4.16 | 0.80 | - | - | - | 4.96 /sfca | 1,338 |
| 03-11-13.85 | C.I.P. concrete forms, wall, job built, plywood, to 8' high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 1,350.0 sfca | 6.39 | 1.76 | - | - | - | 8.16 /sfca | 11,014 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 3.2 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 6,502 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03330 SOG-PER AG - 01 -(B + C + CC AREA)- BLOWER BUILDING - 50' X 85.6 X 12"** | | | | | | | | | | |
| 03-21-10.60 | Reinforcing, a615 60, sog, thickened edge, allow 28 lbs/cy, #3 to #7 | 0605 | 0.8 ton | 1,036.01 | 962.24 | - | - | - | 1,998.25 /ton | 1,679 |
| 03-21-10.60 | Reinforcing in place, A615 Gr 60, walls, #8 to #18 | 0760 | 6,750.0 lb | 0.30 | 0.48 | - | - | - | 0.77 /lb | 5,224 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 7.4 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 352 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 7.4 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 382 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 5000 psi | 0405 | 276.4 cy | - | 103.51 | - | - | - | 103.51 /cy | 28,608 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, pumped, over 6" thick, includes vibrating, excludes material | 4650 | 224.9 cy | 20.95 | - | - | 4.31 | - | 25.26 /cy | 5,681 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 8" thick, includes vibrating, excludes material | 4950 | 51.5 cy | 38.75 | - | - | 7.98 | - | 46.73 /cy | 2,407 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and broom finish | 0150 | 4,275.0 sf | 0.82 | - | - | - | - | 0.82 /sf | 3,492 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 4,275.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 4,251 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 42.8 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 846 |
| | **SOG-PER AG - 01 -(B + C + CC AREA)- BLOWER BUILDING - 50' X 85.6 X 12"** | | **4,275.0 SQFT** | **7.06** | **9.38** | | **0.35** | | **16.79 /SQFT** | **71,774** |
| **03330 SBG - MIXED LIQUOR CHANNEL- 61' X 10' X 18"** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 22.6 cy | - | 33.69 | - | - | - | 33.69 /cy | 761 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning | 3050 | 142.0 sfca | 4.16 | 0.80 | - | - | - | 4.96 /sfca | 704 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 140.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 1,123 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 12.0 ea | 9.39 | 47.88 | - | - | - | 57.27 /ea | 687 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.5 ton | 1,036.00 | 992.00 | - | - | - | 2,028.01 /ton | 929 |
| 03-21-10.60 | Reinforcing, a615 60, sog, thickened edge, allow 28 lbs/cy, #3 to #7 | 0605 | 0.4 ton | 1,036.02 | 962.24 | - | - | - | 1,998.26 /ton | 883 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.9 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 43 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.9 ton | 43.34 | - | - | 8.17 | - | 51.50 /ton | 46 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 5000 psi | 0405 | 67.4 cy | - | 103.51 | - | - | - | 103.51 /cy | 6,977 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, pumped, over 6" thick, includes vibrating, excludes material | 4650 | 67.4 cy | 20.95 | - | - | 4.31 | - | 25.26 /cy | 1,703 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and broom finish | 0150 | 610.0 sf | 0.82 | - | - | - | - | 0.82 /sf | 498 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 610.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 607 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 6.1 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 121 |
| | **SBG - MIXED LIQUOR CHANNEL- 61' X 10' X 18"** | | **610.0 SQFT** | **7.56** | **16.66** | | **0.50** | | **24.73 /SQFT** | **15,082** |
| **03345 Concrete Walls Fine Screens** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 15.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 190 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls Fine Screens** | | | | | | | | | | |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 3,180.0 sfca | 6.18 | 0.75 | - | - | - | 6.93 /sfca | 22,030 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 8.5 gal | - | 20.66 | - | - | - | 20.66 /gal | 175 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 5.2 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 9,205 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 5.2 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 244 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 5.2 ton | 43.34 | - | - | 8.17 | - | 51.50 /ton | 265 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 61.8 cy | - | 98.01 | - | - | - | 98.01 /cy | 6,060 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 61.8 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 2,408 |
| 03-35-29.60 | Finishing: break ties & patch voids (walls, cols or beams) | 0010 | 3,180.0 sf | 0.97 | 0.03 | - | - | - | 1.00 /sf | 3,182 |
| | **Concrete Walls Fine Screens** | | **61.8 cy** | **475.96** | **223.80** | | **7.96** | | **707.72 /cy** | **43,758** |
| **03345 MIXED LIQUOR CHANNEL WALLS - 61' X 11' X 18" (2 TYP)** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, box out for opening, to 16" thick, over 10 S.F. (use perimeter), includes erecting, bracing, stripping and cleaning | 0150 | 20.0 lf | 9.94 | 2.33 | - | - | - | 12.26 /lf | 245 |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 44.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 556 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 2,684.0 sfca | 6.18 | 0.75 | - | - | - | 6.93 /sfca | 18,594 |
| 03-15-05.12 | Chamfer strip, polyvinyl chloride, 3/4" wide with leg | 2200 | 40.0 lf | 0.89 | 0.69 | - | - | - | 1.58 /lf | 63 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 7.2 gal | - | 20.66 | - | - | - | 20.66 /gal | 148 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 44.0 lf | 3.24 | 14.92 | - | - | - | 18.15 /lf | 799 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 4.0 ea | 9.39 | 35.79 | - | - | - | 45.17 /ea | 181 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 4.0 ton | 794.28 | 992.00 | - | - | - | 1,786.27 /ton | 7,192 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 4.0 ton | 39.87 | - | - | 7.51 | - | 47.39 /ton | 191 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 4.0 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 207 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 5000 psi | 0407 | 69.9 cy | - | 103.51 | - | - | - | 103.51 /cy | 7,238 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 69.9 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 2,723 |
| 03-35-29.60 | Finishing: break ties & patch voids (walls, cols or beams) | 0010 | 2,444.0 sf | 0.97 | 0.03 | - | - | - | 1.00 /sf | 2,445 |
| | **MIXED LIQUOR CHANNEL WALLS - 61' X 11' X 18" (2 TYP)** | | **2.0 EACH** | **12,818.74** | **7,207.68** | | **264.09** | | **20,290.49 /EACH** | **40,581** |
| **03345 MIXED LIQUOR CHANNEL END WALLS - 10' X 11' X 18" (2 TYP)** | | | | | | | | | | |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03345 MIXED LIQUOR CHANNEL END WALLS - 10' X 11' X 18" (2 TYP)** | | | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, box out for opening, to 16" thick, over 10 S.F. (use perimeter), includes erecting, bracing, stripping and cleaning | 0150 | 10.0 | lf | 9.93 | 2.33 | - | - | - | 12.26 | /lf | 123 |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 44.0 | lf | 10.50 | 2.14 | - | - | - | 12.63 | /lf | 556 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 440.0 | sfca | 6.18 | 0.75 | - | - | - | 6.93 | /sfca | 3,048 |
| 03-15-05.12 | Chamfer strip, polyvinyl chloride, 3/4" wide with leg | 2200 | 20.0 | lf | 0.89 | 0.69 | - | - | - | 1.58 | /lf | 32 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 1.2 | gal | - | 20.67 | - | - | - | 20.67 | /gal | 24 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 44.0 | lf | 3.24 | 14.92 | - | - | - | 18.15 | /lf | 799 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 4.0 | ea | 9.39 | 35.79 | - | - | - | 45.17 | /ea | 181 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 0.7 | ton | 794.27 | 992.00 | - | - | - | 1,786.27 | /ton | 1,179 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 0.7 | ton | 39.86 | - | - | 7.52 | - | 47.38 | /ton | 31 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 0.7 | ton | 43.33 | - | - | 8.17 | - | 51.50 | /ton | 34 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 5000 psi | 0407 | 11.4 | cy | - | 103.51 | - | - | - | 103.51 | /cy | 1,185 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 11.4 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 446 |
| 03-35-29.60 | Finishing: break ties & patch voids (walls, cols or beams) | 0010 | 400.0 | sf | 0.97 | 0.03 | - | - | - | 1.00 | /sf | 400 |
| | **MIXED LIQUOR CHANNEL END WALLS - 10' X 11' X 18" (2 TYP)** | | **2.0** | **EACH** | **2,408.47** | **1,566.55** | | **43.23** | | **4,018.25** | **/EACH** | **8,036** |
| **03345 MEMBRANE TANK EXTRIOR WALLS - 75' X 11' X 18" (2 TYP)** | | | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 44.0 | lf | 10.50 | 2.14 | - | - | - | 12.63 | /lf | 556 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 3,300.0 | sfca | 6.18 | 0.75 | - | - | - | 6.93 | /sfca | 22,861 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 8.8 | gal | - | 20.66 | - | - | - | 20.66 | /gal | 182 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 44.0 | lf | 3.24 | 14.92 | - | - | - | 18.15 | /lf | 799 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 4.0 | ea | 9.39 | 35.79 | - | - | - | 45.17 | /ea | 181 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 5.0 | ton | 794.28 | 992.00 | - | - | - | 1,786.28 | /ton | 8,842 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 5.0 | ton | 39.87 | - | - | 7.51 | - | 47.38 | /ton | 235 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 5.0 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 255 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 5000 psi | 0407 | 94.4 | cy | - | 103.51 | - | - | - | 103.51 | /cy | 9,773 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 MEMBRANE TANK EXTRIOR WALLS - 75' X 11' X 18" (2 TYP)** | | | | | | | | | | |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 94.4 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 3,677 |
| 03-35-29.60 | Finishing: break ties & patch voids (walls, cols or beams) | 0010 | 3,300.0 sf | 0.97 | 0.03 | - | - | - | 1.00 /sf | 3,302 |
| | **MEMBRANE TANK EXTRIOR WALLS - 75' X 11' X 18" (2 TYP)** | | **2.0 EACH** | **15,822.91** | **9,154.81** | | **352.77** | | **25,330.47 /EACH** | **50,661** |
| **03345 MEMBRANE TANK INTERIOR WALLS - 75' X 11' X 12" (5 TYP)** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 110.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 1,390 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 8,250.0 sfca | 6.18 | 0.75 | - | - | - | 6.93 /sfca | 57,152 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 22.0 gal | - | 20.66 | - | - | - | 20.66 /gal | 455 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 110.0 lf | 3.24 | 14.92 | - | - | - | 18.15 /lf | 1,997 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 10.0 ea | 9.39 | 35.78 | - | - | - | 45.17 /ea | 452 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 12.4 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 22,105 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 12.4 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 586 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 12.4 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 637 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 5000 psi | 0407 | 157.4 cy | - | 103.51 | - | - | - | 103.51 /cy | 16,288 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 157.4 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 6,128 |
| 03-35-29.60 | Finishing: break ties & patch voids (walls, cols or beams) | 0010 | 8,250.0 sf | 0.97 | 0.03 | - | - | - | 1.00 /sf | 8,254 |
| | **MEMBRANE TANK INTERIOR WALLS - 75' X 11' X 12" (5 TYP)** | | **5.0 EACH** | **15,314.74** | **7,525.97** | | **248.11** | | **23,088.83 /EACH** | **115,444** |
| **03345 COLLECTOR CHANNEL WALLS - 61' X 11' X 18" (2 TYP)** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, box out for opening, to 16" thick, over 10 S.F. (use perimeter), includes erecting, bracing, stripping and cleaning | 0150 | 20.0 lf | 9.94 | 2.33 | - | - | - | 12.26 /lf | 245 |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 44.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 556 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 2,684.0 sfca | 6.18 | 0.75 | - | - | - | 6.93 /sfca | 18,594 |
| 03-15-05.12 | Chamfer strip, polyvinyl chloride, 3/4" wide with leg | 2200 | 40.0 lf | 0.89 | 0.69 | - | - | - | 1.58 /lf | 63 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 7.2 gal | - | 20.66 | - | - | - | 20.66 /gal | 148 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 44.0 lf | 3.24 | 14.92 | - | - | - | 18.15 /lf | 799 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 4.0 ea | 9.39 | 35.79 | - | - | - | 45.17 /ea | 181 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03345 COLLECTOR CHANNEL WALLS - 61' X 11' X 18" (2 TYP)** | | | | | | | | | | | | |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 4.0 | ton | 794.28 | 992.00 | - | - | - | 1,786.27 | /ton | 7,192 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 4.0 | ton | 39.87 | - | - | 7.51 | - | 47.39 | /ton | 191 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 4.0 | ton | 43.34 | - | - | 8.17 | - | 51.51 | /ton | 207 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 5000 psi | 0407 | 69.9 | cy | - | 103.51 | - | - | - | 103.51 | /cy | 7,238 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 69.9 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 2,723 |
| 03-35-29.60 | Finishing: break ties & patch voids (walls, cols or beams) | 0010 | 2,444.0 | sf | 0.97 | 0.03 | - | - | - | 1.00 | /sf | 2,445 |
| | **COLLECTOR CHANNEL WALLS - 61' X 11' X 18" (2 TYP)** | | **2.0** | **EACH** | **12,818.74** | **7,207.68** | | **264.09** | | **20,290.49** | **/EACH** | **40,581** |
| **03345 COLLECTOR CHANNEL END WALLS - 10' X 11' X 18" (2 TYP)** | | | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, box out for opening, to 16" thick, over 10 S.F. (use perimeter), includes erecting, bracing, stripping and cleaning | 0150 | 10.0 | lf | 9.93 | 2.33 | - | - | - | 12.26 | /lf | 123 |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 44.0 | lf | 10.50 | 2.14 | - | - | - | 12.63 | /lf | 556 |
| 03-11-13.85 | Cip concret forms,walls,steel framed plywd,over 8'16'hg,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9260 | 440.0 | sfca | 6.18 | 0.75 | - | - | - | 6.93 | /sfca | 3,048 |
| 03-15-05.12 | Chamfer strip, polyvinyl chloride, 3/4" wide with leg | 2200 | 20.0 | lf | 0.89 | 0.69 | - | - | - | 1.58 | /lf | 32 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 1.2 | gal | - | 20.67 | - | - | - | 20.67 | /gal | 24 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 44.0 | lf | 3.24 | 14.92 | - | - | - | 18.15 | /lf | 799 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 4.0 | ea | 9.39 | 35.79 | - | - | - | 45.17 | /ea | 181 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 0.7 | ton | 794.27 | 992.00 | - | - | - | 1,786.27 | /ton | 1,179 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 0.7 | ton | 39.86 | - | - | 7.52 | - | 47.38 | /ton | 31 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 0.7 | ton | 43.33 | - | - | 8.17 | - | 51.50 | /ton | 34 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 5000 psi | 0407 | 11.4 | cy | - | 103.51 | - | - | - | 103.51 | /cy | 1,185 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 11.4 | cy | 32.29 | - | - | 6.65 | - | 38.94 | /cy | 446 |
| 03-35-29.60 | Finishing: break ties & patch voids (walls, cols or beams) | 0010 | 400.0 | sf | 0.97 | 0.03 | - | - | - | 1.00 | /sf | 400 |
| | **COLLECTOR CHANNEL END WALLS - 10' X 11' X 18" (2 TYP)** | | **2.0** | **EACH** | **2,408.47** | **1,566.55** | | **43.23** | | **4,018.25** | **/EACH** | **8,036** |
| **03350 COLLECTOR CHANNEL - Elevated Slab - 9' X 61' X 12"** | | | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 549.0 | sf | 4.97 | 1.27 | - | - | - | 6.24 | /sf | 3,424 |
| 03-15-05.70 | Shores, reshoring at elevated decks, allow | 1550 | 549.0 | sf | 0.67 | 0.59 | - | - | - | 1.26 | /sf | 689 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03350 COLLECTOR CHANNEL - Elevated Slab - 9' X 61' X 12"** | | | | | | | | | | | | |
| 03-15-05.75 | Accessories, can and sleeve elev deck penetrations, avg. 12" diameter | 0275 | 2.0 | ea | 7.82 | 31.75 | - | - | - | 39.57 | /ea | 79 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 1.3 | ton | 821.67 | 992.00 | - | - | - | 1,813.67 | /ton | 2,374 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.2 | ton | 39.87 | - | - | 7.50 | - | 47.40 | /ton | 11 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.2 | ton | 113.90 | - | - | 21.48 | - | 135.40 | /ton | 31 |
| 03-23-05.50 | Prestressing steel, ungrouted single strand, 100' elevated slab, 35 kip, post-tensioned in field | 2250 | 439.2 | lb | 1.64 | 0.63 | - | 0.02 | - | 2.28 | /lb | 1,002 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 5000 psi | 0402 | 20.9 | cy | - | 103.51 | - | - | - | 103.51 | /cy | 2,168 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, with crane and bucket, over 10" thick, includes vibrating, excludes material | 1650 | 20.9 | cy | 33.71 | - | - | 9.53 | - | 43.24 | /cy | 906 |
| 03-35-29.30 | Finishing elev slab, manual screed, bull float, manual float & steel trowel | 0225 | 549.0 | sf | 1.20 | - | - | - | - | 1.20 | /sf | 656 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, light service, 0.50 psf, add | 2300 | 549.0 | sf | 0.62 | 0.19 | - | - | - | 0.81 | /sf | 445 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 5.5 | csf | 9.68 | 10.12 | - | - | - | 19.80 | /csf | 109 |
| | **COLLECTOR CHANNEL - Elevated Slab - 9' X 61' X 12"** | | **549.0** | **SQFT** | **12.19** | **9.08** | | **0.39** | | **21.67** | **/SQFT** | **11,894** |
| | **03 CONCRETE** | | | | | | | | | | | **604,354** |
| **09 FINISHES** | | | | | | | | | | | | |
| **09999 MBR Tank Coating** | | | | | | | | | | | | |
| 09-91-06.41 | Coatings & Paint, Sauereisen Sewergard 2T | BC-0181 | 14,719.0 | sqft | 3.11 | 12.38 | - | - | - | 15.49 | /sqft | 228,026 |
| | **MBR Tank Coating** | | | | | | | | | | **/LS** | **228,026** |
| | **09 FINISHES** | | | | | | | | | | | **228,026** |
| **11 EQUIPMENT** | | | | | | | | | | | | |
| **11999 Fine Screens** | | | | | | | | | | | | |
| 11-00-01.00 | Fine Screen, traveling belt, from previous project, allowance | BC-0311 | 2.0 | ls | 19,789.77 | 500,000.00 | - | 3,360.00 | - | 523,149.77 | /ls | 1,046,300 |
| | **Fine Screens** | | **1.0** | **LS** | **39,579.54** | **1,000,000.00** | | **6,720.00** | | **1,046,299.54** | **/LS** | **1,046,300** |
| **11999 GE MBR Package - Intallation Labor, Equipment and Vendor Testing** | | | | | | | | | | | | |
| 11-00-01.00 | Mixer, propellar type, 5 hp,submerged, misc equipment - install labor only | BC-0616 | 1.0 | ls | 8,481.33 | | - | - | | 8,481.33 | /ls | 8,481 |
| 11-00-08.00 | CHEMICAL - CITRIC ACID FEED PUMPS - install labor only - included installation of all " required valves and instrumentation" | BC-0006 | 2.0 | ea | 1,413.56 | | - | - | 400.00 | 1,813.56 | /ea | 3,627 |
| 11-00-08.00 | CHEMICAL - SODIUM HYPOCHLORITE FEED PUMPS - install labor only - included installation of all " required valves and instrumentation" | BC-0056 | 2.0 | ea | 1,413.56 | | - | - | 400.00 | 1,813.56 | /ea | 3,627 |
| 11-99-99.99 | BACKPULSE CIP TANK - install labor only | MISC | 1.0 | ea | 3,000.00 | - | | 300.00 | - | 3,300.00 | /ea | 3,300 |
| 11-99-99.99 | MEBRANE AERATION BLOWERS INSTALL - includes all ancialry vendor supplied items, vendor Testing and inspection(other) | ---- | 7.0 | Each | 9,000.00 | - | - | 300.00 | 500.00 | 9,800.00 | /Each | 68,600 |
| 11-99-99.99 | PERMEATE PUMPS INSTALL - includes all ancialry vendor supplied items, vendor Testing and inspection(other) | ---- | 6.0 | Each | 5,000.00 | - | - | 150.00 | 500.00 | 5,650.00 | /Each | 33,900 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **11999 GE MBR Package - Intallation Labor, Equipment and Vendor Testing** | | | | | | | | | | |
| 11-99-99.99 | BACKPULSE PUMPS INSTALL - includes all ancialry vendor supplied items, vendor Testing and inspection(other) | ---- | 2.0 Each | 4,400.00 | - | - | 150.00 | 400.00 | 4,950.00 /Each | 9,900 |
| 11-99-99.99 | DRAIN PUMPS INSTALL - includes all ancialry vendor supplied items, vendor Testing and inspection(other) | ---- | 2.0 Each | 4,000.00 | - | - | 150.00 | 300.00 | 4,450.00 /Each | 8,900 |
| 11-99-99.99 | AIR COMPRESSOR AND REFRIGIRATED AIR DRYER INSTALL - includes all ancialry vendor supplied items, vendor Testing and inspection(other) | ---- | 2.0 Each | 3,000.00 | - | - | 100.00 | 150.00 | 3,250.00 /Each | 6,500 |
| 11-99-99.99 | MBR CASSETTE INSTALL - includes all ancialry vendor supplied items, vendor Testing and inspection(other) | ---- | 60.0 Each | 1,500.00 | - | - | 500.00 | 350.00 | 2,350.00 /Each | 141,000 |
| 27-20-02.00 | PERMEATE - MEMBRANE PRESSURE TRANSMITTERS - install labor only | BC-0026 | 6.0 ea | 258.75 | | - | - | 100.00 | 358.75 /ea | 2,152 |
| 27-20-03.00 | PERMEATE - TRUBIDIMETERS - install labor only | BC-0016 | 6.0 ea | 1,101.49 | | - | - | 200.00 | 1,301.49 /ea | 7,809 |
| 27-20-03.00 | PERMEATE FLOW METERS - install labor only | BC-0021 | 6.0 ea | 137.69 | | - | - | 200.00 | 337.69 /ea | 2,026 |
| 27-20-05.00 | LEVEL SWITCHES - Install Labor Only | BC-0006 | 12.0 ea | 129.37 | | - | - | 100.00 | 229.37 /ea | 2,752 |
| 27-20-07.00 | LEVEL TRANSIMITTERS - Install Labor Only | BC-0006 | 6.0 ea | 129.38 | | - | - | 100.00 | 229.38 /ea | 1,376 |
| | **GE MBR Package - Intallation Labor, Equipment and Vendor Testing** | | **6.0 Each** | **39,041.98** | | | **5,683.33** | **5,933.33** | **50,658.64 /Each** | **303,952** |
| **11999 GE - ZEEWEED MEBRAIN FILTRATION SYSTEM** | | | | | | | | | | |
| 05-05-23.20 | Wedge anchor, carbon steel, 5/8" dia x 3-1/2" L, in concrete, brick or stone, excl layout & drilling | 8350 | 108.8 ea | 3.77 | 1.90 | - | - | - | 5.67 /ea | 617 |
| 05-52-13.50 | Railing, pipe, aluminum, clear finish, 3 rails, 3'-6" high, posts @ 5' O.C., 1-1/2" dia, shop fabricated | 0210 | 272.0 lf | 18.34 | 74.00 | - | 1.09 | - | 93.43 /lf | 25,413 |
| 05-58-09.50 | Aluminum MBR Tank Covers - Supported by Cassettes | BC-0046 | 4,575.0 sqft | 9.34 | 33.95 | - | - | - | 43.29 /sqft | 198,052 |
| 06-52-10.30 | Fiberglass grating, pultruded, green (for moderate corrosive environment), 1-1/2" O.C. bar spacing, 1" thick | 3120 | 1,000.0 sf | 3.06 | 12.76 | - | - | - | 15.81 /sf | 15,813 |
| 11-99-99.99 | GE ZEEWEED MBR PACKAGE - BUDGETARY PROPOSAL - #163962 -R1 -4/17/2015 | ---- | 6.0 SETS | - | 1,033,333.33 | - | - | - | 1,033,333.33 /SETS | 6,200,000 |
| | **GE - ZEEWEED MEBRAIN FILTRATION SYSTEM** | | **1.0 LS** | **51,188.74** | **6,388,411.08** | | **295.34** | | **6,439,895.16 /LS** | **6,439,895** |
| | **11 EQUIPMENT** | | | | | | | | | **7,790,147** |
| **13 SPECIAL CONSTRUCTION** | | | | | | | | | | |
| **05999 DuroBEAM - PREFABRICATED INSULATED METAL BUILDING 50 X 85** | | | | | | | | | | |
| 08-99-99.99 | Misc. Doors and Windows, skylights, misc architectural items allowance | MISC | 1.0 LS | 20,000.00 | 20,000.00 | | - | - | 40,000.00 /LS | 40,000 |
| 13-34-19.50 | Pre-egineered steel building complete -50 X 60 X 18 - DuroBEAM Steel Building (Factory direct pricing plus installation) | 2410 | 4,250.0 SF | 4.94 | 5.99 | - | 1.65 | - | 12.58 /SF | 53,461 |
| 13-34-19.50 | Pre-engineered steel building - insulation, metalized polyester/scrim/kraft (PSK) faced, rated .6 lb density, R-30, 10" thick | 7320 | 6,680.0 SF | 0.46 | 1.18 | - | - | - | 1.64 /SF | 10,962 |
| 23-05-00.00 | Allowance - HVAC $15.00/sf Minimum | BC-0001 | 4,250.0 SF | - | - | 15.00 | - | - | 15.00 /SF | 63,750 |
| | **DuroBEAM - PREFABRICATED INSULATED METAL BUILDING 50 X 85** | | **4,250.0 SQFT** | **10.37** | **12.55** | **15.00** | **1.65** | | **39.57 /SQFT** | **168,173** |
| **05999 DuroBEAM - PREFABRICATED INSULATED METAL BUILDING 61 X 75** | | | | | | | | | | |
| 08-99-99.99 | Misc. Doors and Windows, skylights, misc architectural items allowance | MISC | 1.0 LS | 25,000.00 | 25,000.00 | | - | - | 50,000.00 /LS | 50,000 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **05999 DuroBEAM - PREFABRICATED INSULATED METAL BUILDING 61 X 75** | | | | | | | | | | |
| 13-34-19.50 | Pre-egineered steel building complete -50 X 60 X 18 - DuroBEAM Steel Building (Factory direct pricing plus installation) | 2410 | 4,575.0 SF | 4.94 | 5.99 | - | 1.65 | - | 12.58 /SF | 57,550 |
| 13-34-19.50 | Pre-engineered steel building - insulation, metalized polyester/scrim/kraft (PSK) faced, rated .6 lb density, R-30, 10" thick | 7320 | 10,000.0 SF | 0.46 | 1.18 | - | - | - | 1.64 /SF | 16,410 |
| 23-05-00.00 | Allowance - HVAC $15.00/sf Minimum | BC-0001 | 4,575.0 SF | - | - | 15.00 | - | - | 15.00 /SF | 68,625 |
| | **DuroBEAM - PREFABRICATED INSULATED METAL BUILDING 61 X 75** | | **4,575.0 SQFT** | **11.41** | **14.03** | **15.00** | **1.65** | | **42.10 /SQFT** | **192,584** |
| **13999 Fine Screen Building** | | | | | | | | | | |
| 13-34-19.50 | Pre-engn stl bldn,clr span rigid frame,30 psf roof and 20 psf wind load,50'100' x 20'v h,incl 26ga colrd ribbd rfng&sidng,excl ftngs,slab,anchr bolts | 1000 | 2,000.0 sffl | 9.43 | 7.15 | - | 3.15 | - | 19.72 /sffl | 39,447 |
| 13-34-19.50 | Pre-engineered steel building accessory items, eave overhang, with soffit, 26 gauge, 2' W | 5250 | 100.0 lf | 12.83 | 31.50 | - | 4.28 | - | 48.61 /lf | 4,861 |
| 13-34-19.50 | Pre-engineered steel building accessory items, entrance canopy, 4' x 8', incl. frame | 5550 | 1.0 ea | 243.12 | 550.00 | - | 81.12 | - | 874.24 /ea | 874 |
| 13-34-19.50 | Pre-engineered steel building accessory items, end wall roof overhang, with soffit, 4' w | 5650 | 80.0 lf | 9.24 | 28.00 | - | 3.08 | - | 40.32 /lf | 3,226 |
| 13-34-19.50 | Pre-engineered steel building accessory items, doors, hollow metal self framing, single leaf, deluxe, 3' x 7', incl. butts, lockset & trim | 5800 | 1.0 opng | 352.08 | 640.00 | - | - | - | 992.08 /opng | 992 |
| 13-34-19.50 | Pre-engineered steel building accessory items, pre-engineered steel doors, double leaf, glazed, 6' x 7' | 6000 | 1.0 opng | 704.16 | 1,400.00 | - | - | - | 2,104.16 /opng | 2,104 |
| 13-34-19.50 | Pre-engineered steel building accessory items, framing only, for openings, 3' x 7' | 6050 | 1.0 opng | 352.08 | 185.00 | - | - | - | 537.08 /opng | 537 |
| 13-34-19.50 | Pre-engineered steel building accessory items, gutter, eave type, painted, 26 gauge | 6550 | 180.0 lf | 4.40 | 6.95 | - | - | - | 11.35 /lf | 2,043 |
| 13-34-19.50 | Pre-engineered steel building accessory items, insulation, poly/scrim/foil faced, rated .6 lb density, 9 1/2" thick, R-30 | 6780 | 2,000.0 sf | 0.46 | 0.98 | - | - | - | 1.44 /sf | 2,882 |
| 13-34-19.50 | Pre-engineered steel building accessory items, insulation, vinyl faced, rated .6 lb density, R19, 6" thick | 6920 | 3,600.0 sf | 0.46 | 0.55 | - | - | - | 1.01 /sf | 3,640 |
| | **Fine Screen Building** | | **1.0 LS** | **25,901.82** | **27,656.00** | | **7,047.84** | | **60,605.66 /LS** | **60,606** |
| | **13 SPECIAL CONSTRUCTION** | | | | | | | | | **421,363** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **26001 Option #3 Only** | | | | | | | | | | |
| 26-00-00.02 | Primary Effluent Fine Screen Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 2,122,796.18 | - | - | 2,122,796.18 /LS | 2,122,796 |
| | **Option #3 Only** | | **1.0 LS** | | | **2,122,796.18** | | | **2,122,796.18 /LS** | **2,122,796** |
| | **26 ELECTRICAL** | | | | | | | | | **2,122,796** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Option #3 Only** | | | | | | | | | | |
| 27-20-00.01 | Primary Effluent Fine Screen Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 530,699.05 | - | - | 530,699.05 /LS | 530,699 |
| | **Option #3 Only** | | **1.0 LS** | | | **530,699.05** | | | **530,699.05 /LS** | **530,699** |
| | **27 COMMUNICATIONS** | | | | | | | | | **530,699** |
| **31 EARTHWORK** | | | | | | | | | | |
| **01999 Dewatering** | | | | | | | | | | |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **01999 Dewatering** | | | | | | | | | | |
| 01-54-33.70 | Rent wellpoint header pipe, 6" diameter, 400 gpm | 0500 | 900.0 day | - | - | - | 0.40 | - | 0.40 /day | 360 |
| 31-23-19.20 | Dewatering, pumping 8 hours, attended 2 hrs per day, 6" centrifugal pump, includes 20 LF of suction hose and 100 LF of discharge hose | 1100 | 90.0 day | 857.51 | - | - | 377.70 | - | 1,235.21 /day | 111,169 |
| 31-23-19.30 | Wells, for dewatering, with steel casing, 10' to 20' deep, 2' diameter, minimum | 0020 | 175.0 vlf | 9.63 | 23.18 | - | 2.25 | - | 35.06 /vlf | 6,135 |
| | **Dewatering** | | **1.0 LS** | **78,860.95** | **4,056.50** | | **34,746.60** | | **117,664.05 /LS** | **117,664** |
| **03330 Slabs Fine Screens** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 53.3 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 95 |
| | **Slabs Fine Screens** | | **480.0 cy** | **0.12** | | | **0.08** | | **0.20 /cy** | **95** |
| **03330 Slabs Fine Screens** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 88.9 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 159 |
| | **Slabs Fine Screens** | | **800.0 cy** | **0.12** | | | **0.08** | | **0.20 /cy** | **159** |
| **03330 SBG - A - 61' X 75' X 24"** | | | | | | | | | | |
| 31-05-16.10 | Aggregate for earthwork, select structural fill, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction | 0600 | 508.0 lcy | 2.52 | 21.02 | - | 4.71 | - | 28.25 /lcy | 14,352 |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 508.3 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 908 |
| 31-23-16.16 | Strt excvtn for minor strtrs,bank measur,for spread and mat footngs,elevatr pits,and small buildng fndtns,3/4 cy bucket,machine excavtn,hydrlc backhoe | 6035 | 1,806.5 bcy | 12.43 | - | - | 7.42 | - | 19.86 /bcy | 35,869 |
| 31-23-23.13 | Backfill, trench, to 300' haul, dozer backfilling, excludes compaction | 1900 | 360.3 lcy | 0.95 | - | - | 1.57 | - | 2.53 /lcy | 910 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 1 mile round trip, 2.2 loads/hour, 12 C.Y. truck, highway haulers, excludes loading | 0400 | 1,446.2 lcy | 2.77 | - | - | 3.92 | - | 6.69 /lcy | 9,668 |
| 31-23-23.24 | Compaction, structural, common fill, 8" lifts, vibratory plate | 0600 | 360.3 ecy | 2.50 | - | - | 0.19 | - | 2.69 /ecy | 969 |
| 31-23-23.24 | Compaction, structural, select fill, 8" lifts, vibratory plate | 0700 | 508.0 ecy | 2.32 | - | - | 0.17 | - | 2.49 /ecy | 1,265 |
| | **SBG - A - 61' X 75' X 24"** | | **4,575.0 SQFT** | **6.71** | **2.33** | | **4.93** | | **13.98 /SQFT** | **63,940** |
| **03330 SOG-PER AG - 01 -(B + C + CC AREA)- BLOWER BUILDING - 50' X 85.6 X 12"** | | | | | | | | | | |
| 31-05-16.10 | Aggregate for earthwork, select structural fill, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction | 0600 | 335.3 lcy | 2.52 | 21.02 | - | 4.71 | - | 28.25 /lcy | 9,472 |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 475.0 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 849 |
| 31-23-16.16 | Strt excvtn for minor strtrs,bank measur,for spread and mat footngs,elevatr pits,and small buildng fndtns,3/4 cy bucket,machine excavtn,hydrlc backhoe | 6035 | 737.8 bcy | 12.43 | - | - | 7.42 | - | 19.86 /bcy | 14,649 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 1 mile round trip, 2.2 loads/hour, 12 C.Y. truck, highway haulers, excludes loading | 0400 | 737.8 lcy | 2.77 | - | - | 3.92 | - | 6.69 /lcy | 4,932 |
| 31-23-23.24 | Compaction, structural, select fill, 8" lifts, vibratory plate | 0700 | 335.3 ecy | 2.32 | - | - | 0.17 | - | 2.49 /ecy | 835 |
| | **SOG-PER AG - 01 -(B + C + CC AREA)- BLOWER BUILDING - 50' X 85.6 X 12"** | | **4,275.0 SQFT** | **3.12** | **1.65** | | **2.42** | | **7.19 /SQFT** | **30,737** |
| **03330 SBG - MIXED LIQUOR CHANNEL- 61' X 10' X 18"** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 67.8 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 121 |

| Phase | Estimate Breakdown | Item | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **03330 SBG - MIXED LIQUOR CHANNEL- 61' X 10' X 18"** | | | | | | | | | | | | |
| 31-23-16.16 | Strt excvtn for minor strtrs,bank measur,for spread and mat footngs,elevatr pits,and small buildng fndtns,3/4 cy bucket,machine excavtn,hydrlc backhoe | 6035 | 21.0 | bcy | 12.43 | - | - | 7.42 | - | 19.86 | /bcy | 418 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 1 mile round trip, 2.2 loads/hour, 12 C.Y. truck, highway haulers, excludes loading | 0400 | 21.0 | lcy | 2.77 | - | - | 3.92 | - | 6.69 | /lcy | 141 |
| | **SBG - MIXED LIQUOR CHANNEL- 61' X 10' X 18"** | | **610.0** | **SQFT** | **0.64** | | | **0.47** | | **1.11** | **/SQFT** | **679** |
| **31315 Excavation and Backfill Fine Screens** | | | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 1,691.7 | bcy | 6.99 | - | - | 7.64 | - | 14.63 | /bcy | 24,749 |
| 31-23-23.13 | Backfill, bulk, air tamped compaction, add | 1400 | 1,402.8 | ecy | 5.30 | - | - | 1.50 | - | 6.80 | /ecy | 9,534 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 250.0 | lcy | 3.08 | - | - | 5.47 | - | 8.55 | /lcy | 2,137 |
| | **Excavation and Backfill Fine Screens** | | **1,652.8** | **cy** | **12.12** | | | **9.92** | | **22.04** | **/cy** | **36,420** |
| **33500 MBR Influent/Effluent Piping** | | | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 1,168.1 | bcy | 2.80 | - | - | 2.07 | - | 4.87 | /bcy | 5,688 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller | 2200 | 426.4 | ecy | 1.23 | - | - | 2.60 | - | 3.82 | /ecy | 1,630 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 497.9 | lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 | /lcy | 11,927 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 497.9 | ecy | 5.57 | - | - | 0.41 | - | 5.98 | /ecy | 2,975 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 741.7 | lcy | 6.23 | - | - | 5.24 | - | 11.48 | /lcy | 8,511 |
| 31-41-13.10 | Trench box and jacks, cost per sfca trench wall, monthly rental | 2000 | 9,050.0 | sf | - | - | 0.08 | - | - | 0.08 | /sf | 724 |
| | **MBR Influent/Effluent Piping** | | **525.0** | **LF** | **31.35** | **10.33** | **1.38** | **16.87** | | **59.91** | **/LF** | **31,455** |
| | **31 EARTHWORK** | | | | | | | | | | | **281,150** |
| **33 UTILITIES** | | | | | | | | | | | | |
| **33500 MBR Influent/Effluent Piping** | | | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 5.0 | clf | 3.34 | 5.56 | - | - | - | 8.90 | /clf | 44 |
| | **MBR Influent/Effluent Piping** | | **525.0** | **LF** | **0.03** | **0.05** | | | | **0.09** | **/LF** | **44** |
| | **33 UTILITIES** | | | | | | | | | | | **44** |
| **40** | | | | | | | | | | | | |
| **11999 GE MBR Package - Intallation Labor, Equipment and Vendor Testing** | | | | | | | | | | | | |
| 40-05-67.39 | PERMEATE - VACUUM EJECTORS- install labor only | A10633D 006100 | 6.0 | ea | 428.66 | | - | - | 100.00 | 528.66 | /ea | 3,172 |
| | **GE MBR Package - Intallation Labor, Equipment and Vendor Testing** | | **6.0** | **Each** | **428.66** | | | | **100.00** | **528.66** | **/Each** | **3,172** |
| **33500 MBR Influent/Effluent Piping** | | | | | | | | | | | | |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Std 36 Inch (900mm) | A361002 0100EA | 100.0 | lf | - | 168.69 | - | - | - | 168.69 | /lf | 16,869 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Std 36 Inch (900mm) | A361002 0100EA | 100.0 | lf | - | 168.69 | - | - | - | 168.69 | /lf | 16,869 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **33500 MBR Influent/Effluent Piping** | | | | | | | | | | |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std 36 Inch (900mm) | A362112 010000 | 1.0 ea | 2,580.88 | 4,053.57 | - | 488.91 | - | 7,123.36 /ea | 7,123 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std 36 Inch (900mm) | A362112 010000 | 1.0 ea | 2,580.88 | 4,053.57 | - | 488.91 | - | 7,123.36 /ea | 7,123 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade A-Non-Specific 54 Inch (1350mm) | A541002 0000EA | 327.0 lf | - | 333.54 | - | - | - | 333.54 /lf | 109,068 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Non-Specific 54 Inch (1350mm) | A542112 000000 | 4.0 ea | - | 9,273.91 | - | - | - | 9,273.91 /ea | 37,096 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 36 Inch (900mm) | L364002 0100P1 | 100.0 lf | 24.46 | - | - | 4.83 | - | 29.29 /lf | 2,929 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 36 Inch (900mm) | L364002 0100P1 | 100.0 lf | 24.46 | - | - | 4.83 | - | 29.29 /lf | 2,929 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std 36 Inch (900mm) | L365102 010000 | 2.0 ea | 929.47 | 17.51 | - | 74.44 | - | 1,021.42 /ea | 2,043 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std 36 Inch (900mm) | L365102 010000 | 2.0 ea | 929.47 | 17.51 | - | 74.44 | - | 1,021.42 /ea | 2,043 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Non-Specific 54 Inch (1350mm) | L544002 0000P1 | 327.0 lf | 32.59 | - | - | 6.43 | - | 39.02 /lf | 12,759 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Non-Specific 54 Inch (1350mm) | L545102 000000 | 11.0 ea | 1,950.39 | 39.40 | - | 156.21 | - | 2,145.99 /ea | 23,606 |
| | **MBR Influent/Effluent Piping** | | **525.0 LF** | **87.40** | **359.07** | | **11.55** | | **458.01 /LF** | **240,455** |
| **40150 1" Air and Instument Systems** | | | | | | | | | | |
| 40-05-05.00 | Pipe Erection-Make Threaded Joint-Non-Specific 1 Inch (25mm) | L063467 000000 | 100.0 ea | 13.59 | - | - | - | - | 13.59 /ea | 1,359 |
| 40-05-05.00 | Field Fabrication-Cut & Thread-Std 1 Inch (25mm) | L066065 010000 | 100.0 ea | 13.95 | - | - | - | - | 13.95 /ea | 1,395 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 1 Inch (25mm) | L069048 000000 | 828.0 lf | 0.59 | - | - | - | - | 0.59 /lf | 485 |
| 40-05-07.00 | Hangers & Supports-Anchor 1 Inch (25mm) | A066043 000000 | 100.0 ea | 14.65 | 20.00 | - | - | - | 34.65 /ea | 3,465 |
| 40-05-07.00 | Hangers & Supports-Support 1 Inch (25mm) | A066044 000000 | 100.0 ea | 14.65 | 20.00 | - | - | - | 34.65 /ea | 3,465 |
| 40-05-07.00 | Hangers & Supports-Hanger 1 Inch (25mm) | A066045 000000 | 100.0 ea | 14.65 | 20.00 | - | - | - | 34.65 /ea | 3,465 |
| 40-05-19.50 | Fitting Threaded-Galv Malleable Iron-Ell90-Non-Specific 1 Inch (25mm) | A062312 000000 | 112.5 ea | - | 14.44 | - | - | - | 14.44 /ea | 1,625 |
| 40-05-19.50 | Fitting Threaded-Galv Malleable Iron-Tee-Non-Specific 1 Inch (25mm) | A062314 000000 | 75.0 ea | - | 14.44 | - | - | - | 14.44 /ea | 1,083 |
| 40-05-19.50 | Fitting Threaded-Galv Malleable Iron-Reducer 1 Dia-Non-Specific 1 Inch (25mm) | A062316 000000 | 75.0 ea | - | 14.44 | - | - | - | 14.44 /ea | 1,083 |
| 40-05-19.50 | Fitting Threaded-Galv Malleable Iron-Cap-Non-Specific 1 Inch (25mm) | A062317 000000 | 75.0 ea | - | 14.44 | - | - | - | 14.44 /ea | 1,083 |
| 40-05-24.40 | Pipe Threaded & Coupled-Steel Galv A120-Welded (ERW/CW)-Std/Sch 40 1 Inch (25mm) | A061303 0100W | 825.0 lf | - | 1.67 | - | - | - | 1.67 /lf | 1,377 |
| 40-05-24.40 | Pipe Erection-Straight Run-Steel Galv A120-Std/Sch 40 1 Inch (25mm) | L064002 0100P1 | 825.0 lf | 6.45 | - | - | - | - | 6.45 /lf | 5,318 |
| 40-05-51.00 | Pipe Erection-Handle Valves-Metal-Cls 900 (PN150) 1 Inch (25mm) | L064062 006800 | 105.0 ea | 28.13 | - | - | - | - | 28.13 /ea | 2,953 |
| 40-05-62.00 | Valve Threaded-Cast Steel-Plug-Cls 900 (PN150) 1 Inch (25mm) | A066337 016800 | 30.0 ea | 58.60 | 1.20 | - | - | - | 59.80 /ea | 1,794 |
| 40-05-63.00 | Valve Threaded-Cast Steel-Ball-Cls 900 (PN150) 1 Inch (25mm) | A066333 016800 | 60.0 ea | 58.60 | 31.22 | - | - | - | 89.82 /ea | 5,389 |
| 40-05-65.23 | Valve Threaded-Cast Steel-Check-Cls 900 (PN150) 1 Inch (25mm) | A066335 016800 | 15.0 ea | 58.60 | 31.24 | - | - | - | 89.84 /ea | 1,348 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1" Air and Instument Systems** | | **825.0 lf** | **26.74** | **17.73** | | | | **44.47 /lf** | **36,687** |
| **40150 Reuse - 3W - From Permeate to MBR - 3/4"** | | | | | | | | | | |
| 11-00-07.00 | Hose station,complete,hose,valve,stand | BC-0026 | 5.0 ea | 181.65 | 344.84 | - | - | - | 526.49 /ea | 2,632 |
| 40-05-05.00 | Pipe Erection-Handle Fittings-Metal-Std 3/4 Inch (19mm) | L053466 010000 | 60.0 ea | 8.03 | - | - | - | - | 8.03 /ea | 482 |
| 40-05-05.00 | Pipe Erection-Make Threaded Joint-Non-Specific 3/4 Inch (19mm) | L053467 000000 | 190.0 ea | 12.01 | - | - | - | - | 12.01 /ea | 2,282 |
| 40-05-05.00 | Field Fabrication-Cut & Thread-Std 3/4 Inch (19mm) | L056065 010000 | 190.0 ea | 10.78 | - | - | - | - | 10.78 /ea | 2,049 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 3/4 Inch (19mm) | L059048 000000 | 650.0 lf | 0.65 | - | - | - | - | 0.65 /lf | 419 |
| 40-05-07.00 | Hangers & Supports-Anchor 3/4 Inch (19mm) | A056043 000000 | 65.0 ea | 79.11 | 20.00 | - | - | - | 99.11 /ea | 6,442 |
| 40-05-07.00 | Hangers & Supports-Support 3/4 Inch (19mm) | A056044 000000 | 65.0 ea | 70.32 | 20.00 | - | - | - | 90.32 /ea | 5,871 |
| 40-05-19.50 | Fitting Threaded-Galv Malleable Iron-Ell90-Cls 150-Std/Sch 40 3/4 Inch (19mm) | A052312 016200 | 40.0 ea | 40.43 | 6.03 | - | - | - | 46.46 /ea | 1,858 |
| 40-05-19.50 | Fitting Threaded-Galv Malleable Iron-Tee-Cls 150-Std/Sch 40 3/4 Inch (19mm) | A052314 016200 | 20.0 ea | 14.65 | 10.47 | - | - | - | 25.12 /ea | 502 |
| 40-05-24.40 | Pipe Threaded & Coupled-Steel Galv A120-Welded (ERW/CW)-Std/Sch 40 3/4 Inch (19mm) | A051303 0100W | 641.2 lf | - | 1.12 | - | - | - | 1.12 /lf | 721 |
| 40-05-24.40 | Pipe Erection-Straight Run-Steel Galv A120-Std/Sch 40 3/4 Inch (19mm) | L054002 0100P1 | 650.0 lf | 5.27 | - | - | - | - | 5.27 /lf | 3,428 |
| 40-05-51.00 | Pipe Erection-Handle Valves-Metal-Cls 150 (PN20) 3/4 Inch (19mm) | L054062 006200 | 25.0 ea | 18.17 | - | - | - | - | 18.17 /ea | 454 |
| 40-05-62.00 | Valve Threaded-Cast Steel-Plug-Cls 150 (PN20) 3/4 Inch (19mm) | A056337 016200 | 10.0 ea | 58.60 | 99.10 | - | - | - | 157.70 /ea | 1,577 |
| 40-05-63.00 | Valve Threaded-Cast Steel-Ball-Cls 150 (PN20) 3/4 Inch (19mm) | A056333 016200 | 10.0 ea | 58.60 | 183.80 | - | - | - | 242.40 /ea | 2,424 |
| 40-05-65.23 | Valve Threaded-Cast Steel-Check-Cls 150 (PN20) 3/4 Inch (19mm) | A056335 016200 | 5.0 ea | 58.60 | 120.93 | - | - | - | 179.53 /ea | 898 |
| 40-42-13.00 | Insulation-Calcium Silicate Aluminum Jacket 3/4 Inch (19mm) Dia 1 Inch (25mm) Thk | A050091 1406 | 650.0 lf | 9.96 | 3.68 | - | - | - | 13.64 /lf | 8,865 |
| | **Reuse - 3W - From Permeate to MBR - 3/4"** | | **650.0 lf** | **45.52** | **17.41** | | | | **62.93 /lf** | **40,903** |
| **40150 Reuse - 3W - Proccess Building hose Racks - 3/4"** | | | | | | | | | | |
| 11-00-07.00 | Hose station,complete,hose,valve,stand | BC-0026 | 5.0 ea | 181.65 | 344.84 | - | - | - | 526.49 /ea | 2,632 |
| 40-05-05.00 | Pipe Erection-Handle Fittings-Metal-Std 3/4 Inch (19mm) | L053466 010000 | 60.0 ea | 8.03 | - | - | - | - | 8.03 /ea | 482 |
| 40-05-05.00 | Pipe Erection-Make Threaded Joint-Non-Specific 3/4 Inch (19mm) | L053467 000000 | 190.0 ea | 12.01 | - | - | - | - | 12.01 /ea | 2,282 |
| 40-05-05.00 | Field Fabrication-Cut & Thread-Std 3/4 Inch (19mm) | L056065 010000 | 190.0 ea | 10.78 | - | - | - | - | 10.78 /ea | 2,049 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 3/4 Inch (19mm) | L059048 000000 | 400.0 lf | 0.65 | - | - | - | - | 0.65 /lf | 258 |
| 40-05-07.00 | Hangers & Supports-Anchor 3/4 Inch (19mm) | A056043 000000 | 40.0 ea | 79.11 | 20.00 | - | - | - | 99.11 /ea | 3,964 |
| 40-05-07.00 | Hangers & Supports-Support 3/4 Inch (19mm) | A056044 000000 | 40.0 ea | 70.32 | 20.00 | - | - | - | 90.32 /ea | 3,613 |
| 40-05-19.50 | Fitting Threaded-Galv Malleable Iron-Ell90-Cls 150-Std/Sch 40 3/4 Inch (19mm) | A052312 016200 | 40.0 ea | 40.43 | 6.03 | - | - | - | 46.46 /ea | 1,858 |
| 40-05-19.50 | Fitting Threaded-Galv Malleable Iron-Tee-Cls 150-Std/Sch 40 3/4 Inch (19mm) | A052314 016200 | 20.0 ea | 14.65 | 10.47 | - | - | - | 25.12 /ea | 502 |
| 40-05-24.40 | Pipe Threaded & Coupled-Steel Galv A120-Welded (ERW/CW)-Std/Sch 40 3/4 Inch (19mm) | A051303 0100W | 391.2 lf | - | 1.12 | - | - | - | 1.12 /lf | 440 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **40150 Reuse - 3W - Proccess Building hose Racks - 3/4"** | | | | | | | | | | |
| 40-05-24.40 | Pipe Erection-Straight Run-Steel Galv A120-Std/Sch 40 3/4 Inch (19mm) | L054002 0100P1 | 400.0 lf | 5.27 | - | - | - | - | 5.27 /lf | 2,109 |
| 40-05-51.00 | Pipe Erection-Handle Valves-Metal-Cls 150 (PN20) 3/4 Inch (19mm) | L054062 006200 | 25.0 ea | 18.17 | - | - | - | - | 18.17 /ea | 454 |
| 40-05-62.00 | Valve Threaded-Cast Steel-Plug-Cls 150 (PN20) 3/4 Inch (19mm) | A056337 016200 | 10.0 ea | 58.60 | 99.10 | - | - | - | 157.70 /ea | 1,577 |
| 40-05-63.00 | Valve Threaded-Cast Steel-Ball-Cls 150 (PN20) 3/4 Inch (19mm) | A056333 016200 | 10.0 ea | 58.60 | 183.80 | - | - | - | 242.40 /ea | 2,424 |
| 40-05-65.23 | Valve Threaded-Cast Steel-Check-Cls 150 (PN20) 3/4 Inch (19mm) | A056335 016200 | 5.0 ea | 58.60 | 120.93 | - | - | - | 179.53 /ea | 898 |
| | **Reuse - 3W - Proccess Building hose Racks - 3/4"** | | **500.0 lf** | **35.79** | **15.30** | | | | **51.09 /lf** | **25,542** |
| **40160 BACKPULSE PUMP PIPING TO MBR 4"** | | | | | | | | | | |
| 40-05-05.00 | Make Up Bolted Joint incl B-7 Nuts, Bolts, 1/16 Inch Rubber Gasket-Cls 150 (PN20) 3 Inch (80mm) | A113400 006200 | 8.0 ea | 49.22 | 2.12 | - | - | - | 51.34 /ea | 411 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 3 Inch (80mm) | L119048 000000 | 300.0 lf | 1.23 | - | - | - | - | 1.23 /lf | 369 |
| 40-05-05.00 | Field Welds-Radiographic Inspection-Non-Specific 3 Inch (80mm) | L119063 000000 | 2.5 ea | 10.00 | 0.00 | - | | - | 10.00 /ea | 25 |
| 40-05-07.00 | Hangers & Supports-Anchor 3 Inch (80mm) | A116043 000000 | 20.0 ea | 53.47 | 50.00 | - | - | - | 103.47 /ea | 2,069 |
| 40-05-07.00 | Hangers & Supports-Support 3 Inch (80mm) | A116044 000000 | 20.0 ea | 88.05 | 150.00 | - | - | - | 238.05 /ea | 4,761 |
| 40-05-24.10 | Pipe Plain End-CS A53/A106-ERW Grade B-Std/Sch 40 3 Inch (80mm) | A111002 0100EB | 300.0 lf | - | 14.15 | - | - | - | 14.15 /lf | 4,246 |
| 40-05-24.10 | Fitting Butt Weld-CS A53/A106-Ell90-Std/Sch 40 3 Inch (80mm) | A112112 010000 | 9.0 ea | 227.35 | 25.71 | - | - | - | 253.06 /ea | 2,278 |
| 40-05-24.10 | Shop Butt Weld-CS A53/A106-Std/Sch 40 3 Inch (80mm) | L113102 010000 | 32.0 ea | - | 72.75 | - | - | - | 72.75 /ea | 2,328 |
| 40-05-24.10 | Pipe Erection-Spools-CS A53/A106-Std/Sch 40 3 Inch (80mm) | L114002 0100P2 | 300.0 lf | 15.24 | - | - | - | - | 15.24 /lf | 4,571 |
| 40-05-24.10 | Field Butt Weld-CS A53/A106-Std/Sch 40 3 Inch (80mm) | L115102 010000 | 10.0 ea | 81.45 | 0.00 | - | 7.95 | - | 89.40 /ea | 894 |
| 40-46-16.00 | Coatings Shop-Misc-Non-Specific 3 Inch (80mm) | A110092 0100 | 300.0 lf | 1.00 | 2.28 | - | - | - | 3.28 /lf | 983 |
| | **BACKPULSE PUMP PIPING TO MBR 4"** | | **300.0 lf** | **37.83** | **38.35** | | **0.27** | | **76.45 /lf** | **22,934** |
| **40200 Scour Air Piping -GRV-FTG A53 CS SCH 40 8",12"** | | | | | | | | | | |
| 40-05-05.00 | Pipe Erection-Make Up Clamped Joint-Non-Specific 8 Inch (200mm) | L163447 000000 | 28.0 ea | 27.66 | - | - | - | - | 27.66 /ea | 774 |
| 40-05-05.00 | Pipe Erection-Handle Fittings-Metal-Std 8 Inch (200mm) | L163466 010000 | 21.0 ea | 51.39 | - | - | - | - | 51.39 /ea | 1,079 |
| 40-05-05.00 | Field Welds-Cut & Bevel-Std 8 Inch (200mm) | L166064 010000 | 28.0 ea | 102.84 | - | - | - | - | 102.84 /ea | 2,880 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 8 Inch (200mm) | L169048 000000 | 52.5 lf | 4.51 | - | - | - | - | 4.51 /lf | 237 |
| 40-05-05.00 | Pipe Erection-Make Up Clamped Joint-Non-Specific 12 Inch (300mm) | L183447 000000 | 28.0 ea | 53.50 | - | - | - | - | 53.50 /ea | 1,498 |
| 40-05-05.00 | Pipe Erection-Handle Fittings-Metal-Std 12 Inch (300mm) | L183466 010000 | 8.8 ea | 78.00 | - | - | - | - | 78.00 /ea | 682 |
| 40-05-05.00 | Field Welds-Cut & Bevel-Std 12 Inch (300mm) | L186064 010000 | 7.0 ea | 156.05 | - | - | - | - | 156.05 /ea | 1,092 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 12 Inch (300mm) | L189048 000000 | 210.0 lf | 9.14 | - | - | - | - | 9.14 /lf | 1,920 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **40200 Scour Air Piping -GRV-FTG A53 CS SCH 40 8",12"** | | | | | | | | | | |
| 40-05-07.00 | Hangers & Supports-Anchor 8 Inch (200mm) | A166043 000000 | 7.0 ea | 155.88 | 591.54 | - | - | - | 747.41 /ea | 5,232 |
| 40-05-07.00 | Hangers & Supports-Support 8 Inch (200mm) | A166044 000000 | 7.0 ea | 97.28 | 219.09 | - | - | - | 316.36 /ea | 2,215 |
| 40-05-07.00 | Hangers & Supports-Anchor 12 Inch (300mm) | A186043 000000 | 14.0 ea | 161.74 | 300.00 | - | - | - | 461.74 /ea | 6,464 |
| 40-05-07.00 | Hangers & Supports-Support 12 Inch (300mm) | A186044 000000 | 14.0 ea | 113.10 | 372.45 | - | - | - | 485.55 /ea | 6,798 |
| 40-05-24.10 | Pipe Grooved & Clamped-CS A53/A106-ERW Grade B-Std/Sch 40 8 Inch (200mm) | A161504 0100EB | 38.5 lf | - | 63.16 | - | - | - | 63.16 /lf | 2,432 |
| 40-05-24.10 | Fitting Grooved & Clamped-CS A53/A106-Ell90-Std/Sch 40 8 Inch (200mm) | A162512 010000 | 7.0 ea | 302.96 | 155.08 | - | - | - | 458.05 /ea | 3,206 |
| 40-05-24.10 | Fitting Grooved & Clamped-CS A53/A106-Reducer 1 Dia-Std/Sch 40 8 Inch (200mm) | A162516 010000 | 7.0 ea | 174.63 | 118.13 | - | - | - | 292.76 /ea | 2,049 |
| 40-05-24.10 | Fitting Grooved & Clamped-CS A53/A106-Coupling-Std/Sch 40 8 Inch (200mm) | A162519 010000 | 7.0 ea | 15.82 | 61.12 | - | - | - | 76.95 /ea | 539 |
| 40-05-24.10 | Pipe Grooved & Clamped-CS A53/A106-ERW Grade B-Std 12 Inch (300mm) | A181504 0100EB | 197.2 lf | - | 121.93 | - | - | - | 121.93 /lf | 24,041 |
| 40-05-24.10 | Fitting Grooved & Clamped-CS A53/A106-Tee-Std 12 Inch (300mm) | A182514 010000 | 7.0 ea | 452.39 | 708.85 | - | - | - | 1,161.24 /ea | 8,129 |
| 40-05-24.10 | Fitting Grooved & Clamped-CS A53/A106-Cap-Std 12 Inch (300mm) | A182517 010000 | 2.0 ea | 28.13 | 160.25 | - | - | - | 188.38 /ea | 377 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std/Sch 40 8 Inch (200mm) | L164002 0100P1 | 52.5 lf | 31.06 | - | - | - | - | 31.06 /lf | 1,631 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std 12 Inch (300mm) | L184002 0100P1 | 210.0 lf | 45.12 | - | - | - | - | 45.12 /lf | 9,476 |
| 40-46-16.00 | FBEpoxy Coating 40 mil-Factory-8 Inch (200mm) | A160088 010000 | 52.5 lf | 1.00 | 3.30 | - | - | - | 4.30 /lf | 226 |
| 40-46-16.00 | FBEpoxy Coating 40 mil-Factory-12 Inch (300mm) | A180088 010000 | 210.0 lf | 1.00 | 4.86 | - | - | - | 5.86 /lf | 1,231 |
| | **Scour Air Piping -GRV-FTG A53 CS SCH 40 8",12"** | | **150.0 lf** | **225.52** | **335.86** | | | | **561.38 /lf** | **84,207** |
| **40200 WAS DRAIN- GRV-FTG A53 CS SCH 40 - 4"** | | | | | | | | | | |
| 40-05-05.00 | Pipe Erection-Make Up Clamped Joint-Non-Specific 4 Inch (100mm) | L133447 000000 | 40.0 ea | 11.78 | - | - | - | - | 11.78 /ea | 471 |
| 40-05-05.00 | Pipe Erection-Handle Fittings-Metal-Std 4 Inch (100mm) | L133466 010000 | 23.0 ea | 26.37 | - | - | - | - | 26.37 /ea | 607 |
| 40-05-05.00 | Field Welds-Cut & Bevel-Std 4 Inch (100mm) | L136064 010000 | 40.0 ea | 52.80 | - | - | - | - | 52.80 /ea | 2,112 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 4 Inch (100mm) | L139048 000000 | 150.0 lf | 1.64 | - | - | - | - | 1.64 /lf | 246 |
| 40-05-07.00 | Hangers & Supports-Anchor 4 Inch (100mm) | A136043 000000 | 2.0 ea | 119.55 | 160.00 | - | - | - | 279.55 /ea | 559 |
| 40-05-07.00 | Hangers & Supports-Support 4 Inch (100mm) | A136044 000000 | 6.0 ea | 61.53 | 113.93 | - | - | - | 175.46 /ea | 1,053 |
| 40-05-24.10 | Pipe Grooved & Clamped-CS A53/A106-ERW Grade B-Std/Sch 40 4 Inch (100mm) | A131504 0100EB | 145.4 lf | - | 21.06 | - | - | - | 21.06 /lf | 3,063 |
| 40-05-24.10 | Fitting Grooved & Clamped-CS A53/A106-Ell90-Std/Sch 40 4 Inch (100mm) | A132512 010000 | 5.0 ea | 100.79 | 114.64 | - | - | - | 215.43 /ea | 1,077 |
| 40-05-24.10 | Fitting Grooved & Clamped-CS A53/A106-Tee-Std/Sch 40 4 Inch (100mm) | A132514 010000 | 2.0 ea | 128.92 | 109.05 | - | - | - | 237.97 /ea | 476 |
| 40-05-24.10 | Fitting Grooved & Clamped-CS A53/A106-Coupling-Std/Sch 40 4 Inch (100mm) | A132519 010000 | 16.0 ea | 7.03 | 24.51 | - | - | - | 31.54 /ea | 505 |
| 40-05-24.10 | Pipe Erection-Straight Run-CS A53/A106-Std/Sch 40 4 Inch (100mm) | L134002 0100P1 | 150.0 lf | 19.34 | - | - | - | - | 19.34 /lf | 2,901 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **40200 WAS DRAIN- GRV-FTG A53 CS SCH 40 - 4"** | | | | | | | | | | |
| 40-05-62.00 | Valve Threaded-Iron Body-Plug-Cls 150 (PN20) 4 Inch (100mm) | A136337 026200 | 3.0 ea | 152.36 | 1,263.29 | - | - | - | 1,415.65 /ea | 4,247 |
| 40-46-16.00 | FBEpoxy Coating 40 mil-Factory-4 Inch (100mm) | A130088 010000 | 150.0 lf | 1.00 | 2.11 | - | - | - | 3.11 /lf | 466 |
| | **WAS DRAIN- GRV-FTG A53 CS SCH 40 - 4"** | | **198.0 lf** | **42.56** | **47.25** | | | | **89.81 /lf** | **17,782** |
| **40300 Aeration Piping _ Prefab Shop installed 24" Main to Headers** | | | | | | | | | | |
| 40-05-05.00 | Shop Testing-NDT Testing-Non-Specific 24 Inch (600mm) | A249049 000000 | 200.0 lf | - | 35.71 | - | - | - | 35.71 /lf | 7,142 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 24 Inch (600mm) | L249048 000000 | 217.0 lf | 14.65 | - | - | - | - | 14.65 /lf | 3,179 |
| 40-05-05.00 | Field Welds-Radiographic Inspection-Non-Specific 24 Inch (600mm) | L249063 000000 | 1.0 ea | 50.00 | 0.00 | - | | - | 50.00 /ea | 50 |
| 40-05-07.00 | Hangers & Supports-Anchor 24 Inch (600mm) | A246043 000000 | 14.0 ea | 146.49 | 500.00 | - | 18.60 | - | 665.09 /ea | 9,311 |
| 40-05-07.00 | Hangers & Supports-Support 24 Inch (600mm) | A246044 000000 | 14.0 ea | 201.57 | 650.00 | - | - | - | 851.57 /ea | 11,922 |
| 40-05-07.00 | Hangers & Supports-Hanger 24 Inch (600mm) | A246045 000000 | 14.0 ea | 103.13 | 650.00 | - | - | - | 753.13 /ea | 10,544 |
| 40-05-23.10 | Pipe Plain End-Stainless 304/304L-Seamless-Sch 10S 24 Inch (600mm) | A241005 1600S | 200.0 lf | 58.60 | 654.02 | - | - | - | 712.62 /lf | 142,524 |
| 40-05-23.10 | Fitting Butt Weld-Stainless 304/304L-Ell90-Sch 10S 24 Inch (600mm) | A242112 160000 | 1.0 ea | 146.49 | 3,080.40 | - | - | - | 3,226.89 /ea | 3,227 |
| 40-05-23.10 | Fitting Butt Weld-Stainless 304/304L-Tee-Sch 10S 24 Inch (600mm) | A242114 160000 | 3.0 ea | 175.79 | 2,570.40 | - | - | - | 2,746.19 /ea | 8,239 |
| 40-05-23.10 | Fitting Butt Weld-Stainless 304/304L-Reducer 1 Dia-Sch 10S 24 Inch (600mm) | A242116 160000 | 3.0 ea | 146.49 | 1,560.60 | - | - | - | 1,707.09 /ea | 5,121 |
| 40-05-23.10 | Shop Butt Weld-Stainless 304/304L-Sch 10S 24 Inch (600mm) | L243102 160000 | 25.0 ea | 58.60 | 42.90 | - | - | - | 101.50 /ea | 2,537 |
| 40-05-23.10 | Pipe Erection-Spools-Stainless 304/304L-Sch 10S 24 Inch (600mm) | L244002 1600P2 | 200.0 lf | 86.14 | - | - | 24.10 | - | 110.24 /lf | 22,047 |
| 40-05-23.10 | Field Butt Weld-Stainless 304/304L-Sch 10S 24 Inch (600mm) | L245102 160000 | 4.0 ea | 146.49 | 49.54 | - | 68.26 | - | 264.30 /ea | 1,057 |
| | **Aeration Piping _ Prefab Shop installed 24" Main to Headers** | | **200.0 lf** | **208.28** | **899.45** | | **26.77** | | **1,134.50 /lf** | **226,901** |
| **40300 Aeration Piping - Prefab Shop - Field installed 12" Headers** | | | | | | | | | | |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 12 Inch (300mm) | L189048 000000 | 600.0 lf | 9.14 | - | - | - | - | 9.14 /lf | 5,485 |
| 40-05-05.00 | Field Welds-Radiographic Inspection-Non-Specific 12 Inch (300mm) | L189063 000000 | 3.0 ea | 30.00 | 0.00 | - | | - | 30.00 /ea | 90 |
| 40-05-07.00 | Hangers & Supports-Anchor 12 Inch (300mm) | A186043 000000 | 40.0 ea | 87.90 | 300.00 | - | - | - | 387.90 /ea | 15,516 |
| 40-05-07.00 | Hangers & Supports-Support 12 Inch (300mm) | A186044 000000 | 40.0 ea | 113.10 | 372.45 | - | - | - | 485.55 /ea | 19,422 |
| 40-05-07.00 | Hangers & Supports-Hanger 12 Inch (300mm) | A186045 000000 | 40.0 ea | 68.56 | 339.58 | - | - | - | 408.14 /ea | 16,326 |
| 40-05-23.10 | Fitting Butt Weld-Stainless 304/304L-Fitting Weldolet-Cls 2000-Std/Sch 40 3 Inch (80mm) | A112171 017000 | 60.0 ea | 87.90 | 165.33 | - | - | - | 253.22 /ea | 15,193 |
| 40-05-23.10 | Pipe Plain End-Stainless 304/304L-Seamless-Sch 10S 12 Inch (300mm) | A181005 1600S | 600.0 lf | - | 39.51 | - | - | - | 39.51 /lf | 23,705 |
| 40-05-23.10 | Fitting Butt Weld-Stainless 304/304L-Ell90-Sch 10S 12 Inch (300mm) | A182112 160000 | 6.0 ea | 117.19 | 938.44 | - | - | - | 1,055.63 /ea | 6,334 |
| 40-05-23.10 | Fitting Butt Weld-Stainless 304/304L-Cap-Sch 10S 12 Inch (300mm) | A182117 160000 | 6.0 ea | 117.19 | 390.39 | - | - | - | 507.58 /ea | 3,046 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **40300 Aeration Piping - Prefab Shop - Field installed 12" Headers** | | | | | | | | | | |
| 40-05-23.10 | Shop OLet Weld-Stainless 304/304L-Cls 2000 (135 Bar)-Std/Sch 40 3 Inch (80mm) | L113602 017000 | 60.0 ea | 29.30 | 5.10 | - | - | - | 34.40 /ea | 2,064 |
| 40-05-23.10 | Shop Butt Weld-Stainless 304/304L-Sch 10S 12 Inch (300mm) | L183102 160000 | 48.0 ea | 55.34 | 10.20 | - | - | - | 65.54 /ea | 3,146 |
| 40-05-23.10 | Pipe Erection-Spools-Stainless 304/304L-Sch 10S 12 Inch (300mm) | L184002 1600P2 | 600.0 lf | 29.30 | 10.20 | - | 12.05 | - | 51.55 /lf | 30,929 |
| 40-05-23.10 | Field Butt Weld-Stainless 304/304L-Sch 10S 12 Inch (300mm) | L185102 160000 | 12.0 ea | 205.09 | 12.59 | - | 20.03 | - | 237.71 /ea | 2,852 |
| | **Aeration Piping - Prefab Shop - Field installed 12" Headers** | | **600.0 lf** | **79.15** | **148.58** | | **12.45** | | **240.18 /lf** | **144,108** |
| **40300 Premeate Piping - Prefab Shop - Field installed 8",10",12",14" 304SS** | | | | | | | | | | |
| 40-05-05.00 | Make Up Bolted Joint incl B-7 Nuts, Bolts, 1/16 Inch Rubber Gasket-Cls 150 (PN20) 8 Inch (200mm) | A163400 006200 | 30.0 ea | 88.48 | 6.35 | - | - | - | 94.83 /ea | 2,845 |
| 40-05-05.00 | Make Up Bolted Joint incl B-7 Nuts, Bolts, 1/16 Inch Rubber Gasket-Cls 150 (PN20) 10 Inch (250mm) | A173400 006200 | 8.0 ea | 118.37 | 12.35 | - | - | - | 130.72 /ea | 1,046 |
| 40-05-05.00 | Make Up Bolted Joint incl B-7 Nuts, Bolts, 1/16 Inch Rubber Gasket-Cls 150 (PN20) 14 Inch (350mm) | A193400 006200 | 6.0 ea | 134.77 | 21.43 | - | - | - | 156.20 /ea | 937 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 8 Inch (200mm) | L169048 000000 | 100.0 lf | 4.51 | - | - | - | - | 4.51 /lf | 451 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 10 Inch (250mm) | L179048 000000 | 140.0 lf | 6.68 | - | - | - | - | 6.68 /lf | 935 |
| 40-05-05.00 | Field Welds-Radiographic Inspection-Non-Specific 10 Inch (250mm) | L179063 000000 | 2.0 ea | 24.00 | 0.00 | - | | - | 24.00 /ea | 48 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 12 Inch (300mm) | L189048 000000 | 170.0 lf | 9.14 | - | - | - | - | 9.14 /lf | 1,554 |
| 40-05-05.00 | Field Welds-Radiographic Inspection-Non-Specific 12 Inch (300mm) | L189063 000000 | 2.0 ea | 30.00 | 0.00 | - | | - | 30.00 /ea | 60 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 14 Inch (350mm) | L199048 000000 | 40.0 lf | 10.90 | - | - | - | - | 10.90 /lf | 436 |
| 40-05-05.00 | Field Welds-Radiographic Inspection-Non-Specific 14 Inch (350mm) | L199063 000000 | 2.0 ea | 34.00 | 0.00 | - | | - | 34.00 /ea | 68 |
| 40-05-07.00 | Hangers & Supports-Anchor 8 Inch (200mm) | A166043 000000 | 6.0 ea | 155.88 | 591.54 | - | - | - | 747.41 /ea | 4,484 |
| 40-05-07.00 | Hangers & Supports-Support 8 Inch (200mm) | A166044 000000 | 6.0 ea | 97.28 | 219.09 | - | - | - | 316.36 /ea | 1,898 |
| 40-05-07.00 | Hangers & Supports-Anchor 10 Inch (250mm) | A176043 000000 | 10.0 ea | 155.87 | 801.86 | - | - | - | 957.73 /ea | 9,577 |
| 40-05-07.00 | Hangers & Supports-Support 10 Inch (250mm) | A176044 000000 | 10.0 ea | 103.13 | 293.58 | - | - | - | 396.71 /ea | 3,967 |
| 40-05-07.00 | Hangers & Supports-Anchor 12 Inch (300mm) | A186043 000000 | 12.0 ea | 87.90 | 300.00 | - | - | - | 387.90 /ea | 4,655 |
| 40-05-07.00 | Hangers & Supports-Support 12 Inch (300mm) | A186044 000000 | 12.0 ea | 113.10 | 372.45 | - | - | - | 485.55 /ea | 5,827 |
| 40-05-23.10 | Fitting Butt Weld-Stainless 304/304L-Fitting Weldolet-Cls 3000-XH/Sch 80 1 Inch (25mm) | A062171 027200 | 12.0 ea | 298.84 | 30.91 | - | - | - | 329.75 /ea | 3,957 |
| 40-05-23.10 | Pipe Plain End-Stainless 304/304L-Seamless-Sch 10S 8 Inch (200mm) | A161005 1600S | 68.0 lf | - | 22.88 | - | - | - | 22.88 /lf | 1,556 |
| 40-05-23.10 | Fitting Butt Weld-Stainless 304/304L-Ell90-Sch 10S 8 Inch (200mm) | A162112 160000 | 12.0 ea | 683.82 | 427.93 | - | - | - | 1,111.75 /ea | 13,341 |
| 40-05-23.10 | Fitting Butt Weld-Stainless 304/304L-Tee-Sch 10S 8 Inch (200mm) | A162114 160000 | 8.0 ea | 1,023.10 | 510.51 | - | - | - | 1,533.61 /ea | 12,269 |
| 40-05-23.10 | Fitting Flanged & Bolted-Stainless 304/304L-Flange SO-Cls 150 8 Inch (200mm) | A162422 006200 | 30.0 ea | 515.06 | 306.00 | - | - | - | 821.06 /ea | 24,632 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **40300 Premeate Piping - Prefab Shop - Field installed 8",10",12",14" 304SS** | | | | | | | | | | |
| 40-05-23.10 | Pipe Plain End-Stainless 304/304L-Seamless-Sch 10S 10 Inch (250mm) | A171005 1600S | 119.0 lf | - | 28.38 | - | - | - | 28.38 /lf | 3,377 |
| 40-05-23.10 | Fitting Butt Weld-Stainless 304/304L-Ell90-Sch 10S 10 Inch (250mm) | A172112 160000 | 2.0 ea | 866.06 | 660.66 | - | - | - | 1,526.72 /ea | 3,053 |
| 40-05-23.10 | Fitting Butt Weld-Stainless 304/304L-Tee-Sch 10S 10 Inch (250mm) | A172114 160000 | 8.0 ea | 1,292.64 | 825.83 | - | - | - | 2,118.47 /ea | 16,948 |
| 40-05-23.10 | Fitting Flanged & Bolted-Stainless 304/304L-Flange SO-Cls 150 10 Inch (250mm) | A172422 006200 | 8.0 ea | 664.49 | 428.40 | - | - | - | 1,092.89 /ea | 8,743 |
| 40-05-23.10 | Fitting Flanged & Bolted-Stainless 304/304L-Flange Blind-Cls 150 10 Inch (250mm) | A172424 006200 | 2.0 ea | 142.98 | 714.00 | - | - | - | 856.98 /ea | 1,714 |
| 40-05-23.10 | Pipe Plain End-Stainless 304/304L-Seamless-Sch 10S 12 Inch (300mm) | A181005 1600S | 152.0 lf | - | 39.51 | - | - | - | 39.51 /lf | 6,005 |
| 40-05-23.10 | Fitting Butt Weld-Stainless 304/304L-Ell90-Sch 10S 12 Inch (300mm) | A182112 160000 | 6.0 ea | 117.19 | 938.44 | - | - | - | 1,055.63 /ea | 6,334 |
| 40-05-23.10 | Pipe Plain End-Stainless 304/304L-Seamless-Sch 10S 14 Inch (350mm) | A191005 1600S | 9.2 lf | - | 290.99 | - | - | - | 290.99 /lf | 2,682 |
| 40-05-23.10 | Fitting Butt Weld-Stainless 304/304L-Ell90-Sch 10S 14 Inch (350mm) | A192112 160000 | 4.0 ea | 1,379.95 | 2,477.48 | - | - | - | 3,857.43 /ea | 15,430 |
| 40-05-23.10 | Fitting Butt Weld-Stainless 304/304L-Tee-Sch 10S 14 Inch (350mm) | A192114 160000 | 2.0 ea | 2,056.74 | 2,972.97 | - | - | - | 5,029.71 /ea | 10,059 |
| 40-05-23.10 | Fitting Butt Weld-Stainless 304/304L-Reducer 1 Dia-Sch 10S 14 Inch (350mm) | A192116 160000 | 6.0 ea | 1,246.94 | 841.59 | - | - | - | 2,088.53 /ea | 12,531 |
| 40-05-23.10 | Fitting Flanged & Bolted-Stainless 304/304L-Flange SO-Cls 150 14 Inch (350mm) | A192422 006200 | 6.0 ea | 927.00 | 1,607.18 | - | - | - | 2,534.18 /ea | 15,205 |
| 40-05-23.10 | Shop OLet Weld-Stainless 304/304L-Cls 3000 (200 Bar)-XH/Sch 80 1 Inch (25mm) | L063602 027200 | 12.0 ea | 58.60 | 13.60 | - | - | - | 72.20 /ea | 866 |
| 40-05-23.10 | Shop Butt Weld-Stainless 304/304L-Sch 10S 8 Inch (200mm) | L163102 160000 | 54.0 ea | 58.60 | 42.17 | - | - | - | 100.77 /ea | 5,441 |
| 40-05-23.10 | Shop Flange Weld-Stainless 304/304L-Cls 150 (PN20) 8 Inch (200mm) | L163402 006200 | 30.0 ea | 58.60 | 42.17 | - | - | - | 100.77 /ea | 3,023 |
| 40-05-23.10 | Pipe Erection-Spools-Stainless 304/304L-Sch 10S 8 Inch (200mm) | L164002 1600P2 | 100.0 lf | 30.47 | 10.20 | - | - | - | 40.67 /lf | 4,067 |
| 40-05-23.10 | Shop Butt Weld-Stainless 304/304L-Sch 10S 10 Inch (250mm) | L173102 160000 | 36.0 ea | 58.60 | 10.20 | - | - | - | 68.80 /ea | 2,477 |
| 40-05-23.10 | Shop Flange Weld-Stainless 304/304L-Cls 150 (PN20) 10 Inch (250mm) | L173402 006200 | 8.0 ea | 58.60 | 10.20 | - | - | - | 68.80 /ea | 550 |
| 40-05-23.10 | Pipe Erection-Spools-Stainless 304/304L-Sch 10S 10 Inch (250mm) | L174002 1600P2 | 140.0 lf | 36.92 | 10.20 | - | - | - | 47.12 /lf | 6,596 |
| 40-05-23.10 | Field Butt Weld-Stainless 304/304L-Sch 10S 10 Inch (250mm) | L175102 160000 | 2.0 ea | 162.90 | 9.55 | - | 15.91 | - | 188.35 /ea | 377 |
| 40-05-23.10 | Shop Butt Weld-Stainless 304/304L-Sch 10S 12 Inch (300mm) | L183102 160000 | 22.0 ea | 55.34 | 10.20 | - | - | - | 65.54 /ea | 1,442 |
| 40-05-23.10 | Pipe Erection-Spools-Stainless 304/304L-Sch 10S 12 Inch (300mm) | L184002 1600P2 | 170.0 lf | 29.30 | 10.20 | - | 12.05 | - | 51.55 /lf | 8,763 |
| 40-05-23.10 | Field Butt Weld-Stainless 304/304L-Sch 10S 12 Inch (300mm) | L185102 160000 | 6.0 ea | 205.09 | 12.59 | - | 20.03 | - | 237.71 /ea | 1,426 |
| 40-05-23.10 | Shop Butt Weld-Stainless 304/304L-Sch 10S 14 Inch (350mm) | L193102 160000 | 20.0 ea | 58.60 | 42.90 | - | - | - | 101.50 /ea | 2,030 |
| 40-05-23.10 | Shop Flange Weld-Stainless 304/304L-Cls 150 (PN20) 14 Inch (350mm) | L193402 006200 | 6.0 ea | 58.60 | 42.90 | - | - | - | 101.50 /ea | 609 |
| 40-05-23.10 | Pipe Erection-Spools-Stainless 304/304L-Sch 10S 14 Inch (350mm) | L194002 1600P2 | 40.0 lf | 52.74 | - | - | - | - | 52.74 /lf | 2,109 |
| 40-05-23.10 | Field Butt Weld-Stainless 304/304L-Sch 10S 14 Inch (350mm) | L195102 160000 | 2.0 ea | 232.63 | 14.60 | - | 22.72 | - | 269.94 /ea | 540 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **40300 Premeate Piping - Prefab Shop - Field installed 8",10",12",14" 304SS** | | | | | | | | | | |
| 40-05-51.00 | Pipe Erection-Handle Valves-Metal-Cls 150 (PN20) 14 Inch (350mm) | L194062 006200 | 2.0 ea | 321.70 | - | - | - | - | 321.70 /ea | 643 |
| 40-05-64.00 | Valve Flanged & Bolted-Stainless Steel-Butterfly-Cls 150 (PN20) 14 Inch (350mm) | A196434 206200 | 2.0 ea | 457.64 | 23,794.02 | - | - | - | 24,251.66 /ea | 48,503 |
| | **Premeate Piping - Prefab Shop - Field installed 8",10",12",14" 304SS** | | **348.2 lf** | **346.90** | **468.23** | | **6.45** | | **821.58 /lf** | **286,090** |
| **40510 SODIUM HYPOCHLORITE SYSTEM** | | | | | | | | | | |
| 40-05-05.00 | Pipe Erection-Make Up Cemented Plastic Socket Joint-Non-Specific 1/2 Inch (13mm) | L043461 000000 | 52.0 ea | 6.09 | - | - | - | - | 6.09 /ea | 317 |
| 40-05-05.00 | Pipe Erection-Handle Fittings-Plastic-Sch 80 1/2 Inch (13mm) | L043466 100001 | 24.0 ea | 3.52 | - | - | - | - | 3.52 /ea | 84 |
| 40-05-05.00 | Field Welds-Cut & Bevel-Std 1/2 Inch (13mm) | L046064 010000 | 52.0 ea | 14.94 | - | - | - | - | 14.94 /ea | 777 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 1/2 Inch (13mm) | L049048 000000 | 40.0 lf | 0.65 | - | - | - | - | 0.65 /lf | 26 |
| 40-05-05.00 | Pipe Erection-Make Up Cemented Plastic Socket Joint-Non-Specific 1 Inch (25mm) | L063461 000000 | 77.0 ea | 6.39 | - | - | - | - | 6.39 /ea | 492 |
| 40-05-05.00 | Pipe Erection-Handle Fittings-Plastic-Sch 80 1 Inch (25mm) | L063466 100001 | 48.0 ea | 4.63 | - | - | - | - | 4.63 /ea | 222 |
| 40-05-05.00 | Field Welds-Cut & Bevel-Std 1 Inch (25mm) | L066064 010000 | 77.0 ea | 19.69 | - | - | - | - | 19.69 /ea | 1,516 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 1 Inch (25mm) | L069048 000000 | 400.0 lf | 0.70 | - | - | - | - | 0.70 /lf | 281 |
| 40-05-05.00 | Pipe Erection-Make Up Cemented Plastic Socket Joint-Non-Specific 1-1/2 Inch (40mm) | L083461 000000 | 52.0 ea | 6.92 | - | - | - | - | 6.92 /ea | 360 |
| 40-05-05.00 | Pipe Erection-Handle Fittings-Plastic-Sch 80 1-1/2 Inch (40mm) | L083466 100001 | 24.0 ea | 5.68 | - | - | - | - | 5.68 /ea | 136 |
| 40-05-05.00 | Field Welds-Cut & Bevel-Std 1-1/2 Inch (40mm) | L086064 010000 | 52.0 ea | 23.44 | - | - | - | - | 23.44 /ea | 1,219 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 1-1/2 Inch (40mm) | L089048 000000 | 40.0 lf | 0.76 | - | - | - | - | 0.76 /lf | 30 |
| 40-05-07.00 | Hangers & Supports-Support 1/2 Inch (13mm) | A046044 000000 | 2.0 ea | 58.60 | 20.00 | - | - | - | 78.60 /ea | 157 |
| 40-05-07.00 | Hangers & Supports-Hanger 1/2 Inch (13mm) | A046045 000000 | 2.0 ea | 54.50 | 20.00 | - | - | - | 74.50 /ea | 149 |
| 40-05-07.00 | Hangers & Supports-Anchor 1 Inch (25mm) | A066043 000000 | 2.0 ea | 79.11 | 20.00 | - | - | - | 99.11 /ea | 198 |
| 40-05-07.00 | Hangers & Supports-Support 1 Inch (25mm) | A066044 000000 | 8.0 ea | 70.32 | 20.00 | - | - | - | 90.32 /ea | 723 |
| 40-05-07.00 | Hangers & Supports-Hanger 1 Inch (25mm) | A066045 000000 | 18.0 ea | 54.50 | 20.00 | - | - | - | 74.50 /ea | 1,341 |
| 40-05-07.00 | Hangers & Supports-Support 1-1/2 Inch (40mm) | A086044 000000 | 2.0 ea | 70.32 | 40.00 | - | - | - | 110.32 /ea | 221 |
| 40-05-07.00 | Hangers & Supports-Hanger 1-1/2 Inch (40mm) | A086045 000000 | 2.0 ea | 54.50 | 40.00 | - | - | - | 94.50 /ea | 189 |
| 40-05-31.23 | Pipe Plain End-CPVC--Sch 80 1/2 Inch (13mm) | A041002 100000 | 39.1 lf | - | 0.82 | - | - | - | 0.82 /lf | 32 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Ell90-Non-Specific 1/2 Inch (13mm) | A042212 000000 | 10.0 ea | - | 5.09 | - | - | - | 5.09 /ea | 51 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Tee-Non-Specific 1/2 Inch (13mm) | A042214 000000 | 4.0 ea | - | 6.79 | - | - | - | 6.79 /ea | 27 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Coupling-Non-Specific 1/2 Inch (13mm) | A042219 000000 | 10.0 ea | - | 3.82 | - | - | - | 3.82 /ea | 38 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **40510 SODIUM HYPOCHLORITE SYSTEM** | | | | | | | | | | |
| 40-05-31.23 | Pipe Plain End-CPVC--Sch 80 1 Inch (25mm) | A061002 100000 | 250.0 lf | - | 1.64 | - | - | - | 1.64 /lf | 411 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Ell90-Sch 80 1 Inch (25mm) | A062212 100000 | 20.0 ea | 11.13 | 7.71 | - | - | - | 18.84 /ea | 377 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Tee-Sch 80 1 Inch (25mm) | A062214 100000 | 8.0 ea | 15.24 | 11.13 | - | - | - | 26.37 /ea | 211 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Coupling-Sch 80 1 Inch (25mm) | A062219 100000 | 20.0 ea | 11.13 | 7.58 | - | - | - | 18.71 /ea | 374 |
| 40-05-31.23 | Pipe Plain End-CPVC--Sch 80 1-1/2 Inch (40mm) | A081002 100000 | 37.3 lf | - | 2.75 | - | - | - | 2.75 /lf | 103 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Ell90-Sch 80 1-1/2 Inch (40mm) | A082212 100000 | 10.0 ea | 15.24 | 18.62 | - | - | - | 33.86 /ea | 339 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Tee-Sch 80 1-1/2 Inch (40mm) | A082214 100000 | 4.0 ea | 21.10 | 26.89 | - | - | - | 47.98 /ea | 192 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Coupling-Sch 80 1-1/2 Inch (40mm) | A082219 100000 | 10.0 ea | 15.24 | 14.27 | - | - | - | 29.51 /ea | 295 |
| 40-05-31.23 | Pipe Erection-Straight Run-CPVC-Sch 80 1/2 Inch (13mm) | L044002 1000P1 | 40.0 lf | 2.93 | - | - | - | - | 2.93 /lf | 117 |
| 40-05-31.23 | Pipe Erection-Straight Run-CPVC-Sch 80 1 Inch (25mm) | L064002 1000P1 | 400.0 lf | 3.52 | - | - | - | - | 3.52 /lf | 1,406 |
| 40-05-31.23 | Pipe Erection-Straight Run-CPVC-Sch 80 1-1/2 Inch (40mm) | L084002 1000P1 | 40.0 lf | 3.52 | - | - | - | - | 3.52 /lf | 141 |
| | **SODIUM HYPOCHLORITE SYSTEM** | | **340.0 lf** | **30.17** | **6.74** | | | | **36.92 /lf** | **12,552** |
| **40510 CITRIC ACID SYSTEM** | | | | | | | | | | |
| 40-05-05.00 | Pipe Erection-Make Up Cemented Plastic Socket Joint-Non-Specific 1/2 Inch (13mm) | L043461 000000 | 52.0 ea | 6.09 | - | - | - | - | 6.09 /ea | 317 |
| 40-05-05.00 | Pipe Erection-Handle Fittings-Plastic-Sch 80 1/2 Inch (13mm) | L043466 100001 | 24.0 ea | 3.52 | - | - | - | - | 3.52 /ea | 84 |
| 40-05-05.00 | Field Welds-Cut & Bevel-Std 1/2 Inch (13mm) | L046064 010000 | 52.0 ea | 14.94 | - | - | - | - | 14.94 /ea | 777 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 1/2 Inch (13mm) | L049048 000000 | 40.0 lf | 0.65 | - | - | - | - | 0.65 /lf | 26 |
| 40-05-05.00 | Pipe Erection-Make Up Cemented Plastic Socket Joint-Non-Specific 1 Inch (25mm) | L063461 000000 | 77.0 ea | 6.39 | - | - | - | - | 6.39 /ea | 492 |
| 40-05-05.00 | Pipe Erection-Handle Fittings-Plastic-Sch 80 1 Inch (25mm) | L063466 100001 | 48.0 ea | 4.63 | - | - | - | - | 4.63 /ea | 222 |
| 40-05-05.00 | Field Welds-Cut & Bevel-Std 1 Inch (25mm) | L066064 010000 | 77.0 ea | 19.69 | - | - | - | - | 19.69 /ea | 1,516 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 1 Inch (25mm) | L069048 000000 | 400.0 lf | 0.70 | - | - | - | - | 0.70 /lf | 281 |
| 40-05-05.00 | Pipe Erection-Make Up Cemented Plastic Socket Joint-Non-Specific 1-1/2 Inch (40mm) | L083461 000000 | 52.0 ea | 6.92 | - | - | - | - | 6.92 /ea | 360 |
| 40-05-05.00 | Pipe Erection-Handle Fittings-Plastic-Sch 80 1-1/2 Inch (40mm) | L083466 100001 | 24.0 ea | 5.68 | - | - | - | - | 5.68 /ea | 136 |
| 40-05-05.00 | Field Welds-Cut & Bevel-Std 1-1/2 Inch (40mm) | L086064 010000 | 52.0 ea | 23.44 | - | - | - | - | 23.44 /ea | 1,219 |
| 40-05-05.00 | Field Testing-Hydrotest-Non-Specific 1-1/2 Inch (40mm) | L089048 000000 | 40.0 lf | 0.76 | - | - | - | - | 0.76 /lf | 30 |
| 40-05-07.00 | Hangers & Supports-Support 1/2 Inch (13mm) | A046044 000000 | 2.0 ea | 58.60 | 20.00 | - | - | - | 78.60 /ea | 157 |
| 40-05-07.00 | Hangers & Supports-Hanger 1/2 Inch (13mm) | A046045 000000 | 2.0 ea | 54.50 | 20.00 | - | - | - | 74.50 /ea | 149 |
| 40-05-07.00 | Hangers & Supports-Anchor 1 Inch (25mm) | A066043 000000 | 2.0 ea | 79.11 | 20.00 | - | - | - | 99.11 /ea | 198 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **40510 CITRIC ACID SYSTEM** | | | | | | | | | | |
| 40-05-07.00 | Hangers & Supports-Support 1 Inch (25mm) | A066044 000000 | 8.0 ea | 70.32 | 20.00 | - | - | - | 90.32 /ea | 723 |
| 40-05-07.00 | Hangers & Supports-Hanger 1 Inch (25mm) | A066045 000000 | 18.0 ea | 54.50 | 20.00 | - | - | - | 74.50 /ea | 1,341 |
| 40-05-07.00 | Hangers & Supports-Support 1-1/2 Inch (40mm) | A086044 000000 | 2.0 ea | 70.32 | 40.00 | - | - | - | 110.32 /ea | 221 |
| 40-05-07.00 | Hangers & Supports-Hanger 1-1/2 Inch (40mm) | A086045 000000 | 2.0 ea | 54.50 | 40.00 | - | - | - | 94.50 /ea | 189 |
| 40-05-31.23 | Pipe Plain End-CPVC--Sch 80 1/2 Inch (13mm) | A041002 100000 | 39.1 lf | - | 0.82 | - | - | - | 0.82 /lf | 32 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Ell90-Non-Specific 1/2 Inch (13mm) | A042212 000000 | 10.0 ea | - | 5.09 | - | - | - | 5.09 /ea | 51 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Tee-Non-Specific 1/2 Inch (13mm) | A042214 000000 | 4.0 ea | - | 6.79 | - | - | - | 6.79 /ea | 27 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Coupling-Non-Specific 1/2 Inch (13mm) | A042219 000000 | 10.0 ea | - | 3.82 | - | - | - | 3.82 /ea | 38 |
| 40-05-31.23 | Pipe Plain End-CPVC--Sch 80 1 Inch (25mm) | A061002 100000 | 250.0 lf | - | 1.64 | - | - | - | 1.64 /lf | 411 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Ell90-Sch 80 1 Inch (25mm) | A062212 100000 | 20.0 ea | 11.13 | 7.71 | - | - | - | 18.84 /ea | 377 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Tee-Sch 80 1 Inch (25mm) | A062214 100000 | 8.0 ea | 15.24 | 11.13 | - | - | - | 26.37 /ea | 211 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Coupling-Sch 80 1 Inch (25mm) | A062219 100000 | 20.0 ea | 11.13 | 7.58 | - | - | - | 18.71 /ea | 374 |
| 40-05-31.23 | Pipe Plain End-CPVC--Sch 80 1-1/2 Inch (40mm) | A081002 100000 | 37.3 lf | - | 2.75 | - | - | - | 2.75 /lf | 103 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Ell90-Sch 80 1-1/2 Inch (40mm) | A082212 100000 | 10.0 ea | 15.24 | 18.62 | - | - | - | 33.86 /ea | 339 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Tee-Sch 80 1-1/2 Inch (40mm) | A082214 100000 | 4.0 ea | 21.10 | 26.89 | - | - | - | 47.98 /ea | 192 |
| 40-05-31.23 | Fitting Socket Weld-CPVC-Coupling-Sch 80 1-1/2 Inch (40mm) | A082219 100000 | 10.0 ea | 15.24 | 14.27 | - | - | - | 29.51 /ea | 295 |
| 40-05-31.23 | Pipe Erection-Straight Run-CPVC-Sch 80 1/2 Inch (13mm) | L044002 1000P1 | 40.0 lf | 2.93 | - | - | - | - | 2.93 /lf | 117 |
| 40-05-31.23 | Pipe Erection-Straight Run-CPVC-Sch 80 1 Inch (25mm) | L064002 1000P1 | 400.0 lf | 3.52 | - | - | - | - | 3.52 /lf | 1,406 |
| 40-05-31.23 | Pipe Erection-Straight Run-CPVC-Sch 80 1-1/2 Inch (40mm) | L084002 1000P1 | 40.0 lf | 3.52 | - | - | - | - | 3.52 /lf | 141 |
| | **CITRIC ACID SYSTEM** | | **340.0 lf** | **30.17** | **6.74** | | | | **36.92 /lf** | **12,552** |
| | **40** | | | | | | | | | **1,153,885** |
| **41 MATERIAL PROCESSING AND HANDLING EQUIPMENT** | | | | | | | | | | |
| **11999 GE MBR Package - Intallation Labor, Equipment and Vendor Testing** | | | | | | | | | | |
| 41-00-00.01 | Bridge crane supports and rail allowance | BC-0001 | 1.0 ls | 10,000.00 | 30,000.00 | 0.01 | 10,000.00 | - | 50,000.01 /ls | 50,000 |
| 41-22-13.13 | Overhead bridge crane, under hung hoist, electric operating, 2 girder, 7.5 ton, 50' span | 0550 | 1.0 ea | 5,710.84 | 55,500.00 | - | 358.53 | - | 61,569.37 /ea | 61,569 |
| 41-22-23.10 | Cranes, material handling, movable gantry type, 2,000 lb. capacity, 12' to 15' range | 1800 | 2.0 ea | - | 3,950.00 | - | - | - | 3,950.00 /ea | 7,900 |
| | **GE MBR Package - Intallation Labor, Equipment and Vendor Testing** | | **6.0 Each** | **2,618.47** | **15,566.67** | **0.00** | **1,726.42** | | **19,911.56 /Each** | **119,469** |
| | **41 MATERIAL PROCESSING AND HANDLING EQUIPMENT** | | | | | | | | | **119,469** |
| | **07 MBR Treatment** | | **1.0 LS** | **1,428,264.69** | **8,838,670.34** | **2,786,594.24** | **213,946.82** | **44,120.00** | **13,311,596.09 /LS** | **13,311,596** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **08 Influent Pump Station** | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | |
| **03330 Slabs Pump station wet well** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 27.8 cy | - | 33.69 | - | - | - | 33.69 /cy | 936 |
| 03-15-13.50 | Waterstop, PVC, ribbed type, split, 3/8" thick x 6" wide | 1300 | 65.0 lf | 3.61 | 4.42 | - | - | - | 8.03 /lf | 522 |
| 03-15-13.50 | Waterstop, fittings, rubber, flat, dumbbell or center bulb, field union, 3/8" thick x 9" wide | 5250 | 5.0 ea | 9.38 | 47.88 | - | - | - | 57.26 /ea | 286 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 5.6 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 11,268 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 5.6 ton | 39.87 | - | - | 7.51 | - | 47.38 /ton | 263 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 5.6 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 286 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 58.3 cy | - | 98.01 | - | - | - | 98.01 /cy | 5,717 |
| 03-31-05.70 | Structural concrete, placing, foundation mat, pumped, over 20 C.Y., includes vibrating, excludes material | 2950 | 58.3 cy | 9.69 | - | - | 2.00 | - | 11.68 /cy | 682 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed and bull float(darby) finish | 0100 | 750.0 sf | 0.38 | - | - | - | - | 0.38 /sf | 283 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 7.5 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 149 |
| | **Slabs Pump station wet well** | | **58.3 cy** | **127.23** | **218.88** | | **3.49** | | **349.59 /cy** | **20,392** |
| **03330 Slabs Pump station slab** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 18.5 cy | - | 33.69 | - | - | - | 33.69 /cy | 624 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning | 3050 | 70.0 sfca | 4.16 | 0.80 | - | - | - | 4.96 /sfca | 347 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 1.4 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 2,817 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 1.4 ton | 39.87 | - | - | 7.52 | - | 47.39 /ton | 66 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 1.4 ton | 43.34 | - | - | 8.16 | - | 51.51 /ton | 72 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 19.4 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,906 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, pumped, over 6" thick, includes vibrating, excludes material | 4650 | 19.4 cy | 20.95 | - | - | 4.31 | - | 25.26 /cy | 491 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 500.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 455 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 500.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 497 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 5.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 99 |
| | **Slabs Pump station slab** | | **20.4 cy** | **151.81** | **204.22** | | **5.92** | | **361.96 /cy** | **7,374** |
| **03345 Concrete Walls wet well** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, box out for opening, to 16" thick, over 10 S.F. (use perimeter), includes erecting, bracing, stripping and cleaning | 0150 | 16.0 lf | 9.93 | 2.33 | - | - | - | 12.26 /lf | 196 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03345 Concrete Walls wet well** | | | | | | | | | | |
| 03-11-13.85 | C.I.P. concrete forms, wall, wood bulkhead with 2 piece keyway, 1 use, includes erecting, bracing, stripping and cleaning | 0500 | 36.0 lf | 10.50 | 2.14 | - | - | - | 12.63 /lf | 455 |
| 03-11-13.85 | Cip concrete forms,walls,steel framed plywd,over 16'20'h,based 50 us purchsd forms,4 us bracing lumber,includes erecting,bracing,stripping and cleaning | 9460 | 2,880.0 sfca | 6.95 | 0.75 | - | - | - | 7.70 /sfca | 22,176 |
| 03-15-05.95 | Form oil, up to 800 S.F. per gallon, coverage, includes material only | 3050 | 7.7 gal | - | 20.66 | - | - | - | 20.66 /gal | 159 |
| 03-15-13.50 | Waterstop, rubber, center bulb, split, 3/8" thick x 6" wide | 3500 | 36.0 lf | 3.24 | 14.92 | - | - | - | 18.15 /lf | 654 |
| 03-15-13.50 | Waterstop, rubber, field union, 3/8" x 6" wide, walls | 5205 | 3.0 ea | 9.38 | 35.78 | - | - | - | 45.17 /ea | 136 |
| 03-21-10.60 | Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0700 | 7.9 ton | 794.28 | 992.00 | - | - | - | 1,786.28 /ton | 14,131 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add - walls, cols, beams | 2010 | 7.9 ton | 39.87 | - | - | 7.51 | - | 47.39 /ton | 375 |
| 03-21-10.60 | Reinforcing, crane cost for handling, add to above, walls, cols, beams | 2225 | 7.9 ton | 43.34 | - | - | 8.17 | - | 51.51 /ton | 407 |
| 03-31-05.35 | Concrete, ready mix, regular weight, walls/cols/beams, 4000 psi | 0320 | 83.1 cy | - | 98.01 | - | - | - | 98.01 /cy | 8,142 |
| 03-31-05.70 | Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material | 5350 | 83.1 cy | 32.29 | - | - | 6.65 | - | 38.94 /cy | 3,235 |
| 03-35-29.60 | Finishing: break ties & patch voids (walls, cols or beams) | 0010 | 2,848.0 sf | 0.97 | 0.03 | - | - | - | 1.00 /sf | 2,849 |
| | **Concrete Walls wet well** | | **85.6 cy** | **386.88** | **223.58** | | **7.91** | | **618.37 /cy** | **52,914** |
| **03350 Wet well elev slab** | | | | | | | | | | |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 1150 | 375.0 sf | 4.97 | 1.27 | - | - | - | 6.24 /sf | 2,339 |
| 03-11-13.35 | C.I.P. concrete forms, elevated slab, edge forms, to 6" high, 4 use, includes shoring, erecting, bracing, stripping and cleaning | 7000 | 65.0 lf | 3.62 | 0.21 | - | - | - | 3.83 /lf | 249 |
| 03-21-10.60 | Reinforcing steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0400 | 1.2 ton | 821.67 | 992.00 | - | - | - | 1,813.67 /ton | 2,209 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - decks | 2050 | 0.0 ton | 40.00 | - | - | 7.00 | - | 47.00 /ton | 0 |
| 03-21-10.60 | Reinforcing steel, crane cost for handling, maximum, add | 2220 | 0.0 ton | 114.00 | - | - | 21.00 | - | 135.71 /ton | 1 |
| 03-31-05.35 | Concrete, ready mix, regular weight, elevated decks, 4000 psi | 0325 | 14.6 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,429 |
| 03-31-05.70 | Structural concrete, placing, elevated slab, with crane and bucket, over 10" thick, includes vibrating, excludes material | 1650 | 14.6 cy | 33.71 | - | - | 9.53 | - | 43.24 /cy | 631 |
| 03-35-29.30 | Finishing elev slab, manual screed, bull float, machine float & trowel | 0275 | 375.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 342 |
| 03-39-13.50 | Curing, sprayed membrane curing compound, elevated decks | 0310 | 3.8 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 74 |
| | **Wet well elev slab** | | **14.6 cy** | **271.47** | **217.12** | | **10.31** | | **498.90 /cy** | **7,274** |
| | **03 CONCRETE** | | | | | | | | | **87,954** |

**04 STONE & MASONRY**

**04220 Exterior Masonry Walls Pump station**

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **04220 Exterior Masonry Walls Pump station** | | | | | | | | | | |
| 04-05-16.30 | Grout, door frames, 3' x 7' opening, 2.5 CF per opening | 0800 | 2.0 opng | 32.67 | 10.51 | - | 2.27 | - | 45.45 /opng | 91 |
| 04-05-16.30 | Grout, door frames, 6' x 7' opening, 3.5 CF per opening | 0850 | 2.0 opng | 43.56 | 14.70 | - | 3.03 | - | 61.28 /opng | 123 |
| 04-05-16.30 | Grout, for bond beams, lintels and concrete masonry unit (CMU) cores, C476, includes material only | 2000 | 840.0 cf | 5.60 | 4.20 | - | 0.39 | - | 10.19 /cf | 8,562 |
| 04-05-19.26 | Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed horizontally, ASTM A615 | 0020 | 680.0 lb | 0.65 | 0.46 | - | - | - | 1.11 /lb | 753 |
| 04-05-19.26 | Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed vertically, ASTM A615 | 0060 | 1,560.0 lb | 0.80 | 0.46 | - | - | - | 1.26 /lb | 1,963 |
| 04-05-19.26 | Masonry reinforcing bars, truss type steel joint reinforcing, mill standard galvanized, 12" wide | 0250 | 15.0 clf | 26.07 | 24.73 | - | - | - | 50.79 /clf | 762 |
| 04-05-19.26 | Allow - shoring and bracing at CMU walls (percentage wall area) | 0500 | 1,000.0 sfwa | 0.75 | 0.17 | - | - | - | 0.93 /sfwa | 925 |
| 04-22-10.28 | Concrt block,high strngt,hollow,3500 psi,12"8"16",inclds mortar and horzntl joint rnfrcng every other course,excluds scffldn,grout and verticl rnfrcng | 0350 | 2,000.0 sf | 11.33 | 5.95 | - | - | - | 17.28 /sf | 34,557 |
| 04-72-10.10 | Precast concrete coping, stock units, 12" wall, 14" wide, 4" tapers to 3-1/2", includes mortar, excludes scaffolding | 0110 | 100.0 lf | 14.53 | 24.89 | - | - | - | 39.42 /lf | 3,941 |
| | **Exterior Masonry Walls Pump station** | | **2,000.0 sf** | **15.91** | **9.76** | | **0.17** | | **25.84 /sf** | **51,677** |
| | **04 STONE & MASONRY** | | | | | | | | | **51,677** |
| **06 WOOD & PLASTICS** | | | | | | | | | | |
| **06120 Wood Framing -Roof, Pump Station** | | | | | | | | | | |
| 06-05-23.10 | Nails, floor or roof sheathing | 1025 | 14.6 lb | - | 2.45 | - | - | - | 2.45 /lb | 36 |
| 06-05-23.10 | Nails, roof framing, sinkers, 8d to 16d, allow 20 lbs per MBF | 5625 | 643.6 lb | - | 2.33 | - | - | - | 2.33 /lb | 1,498 |
| 06-05-23.60 | Average cost, hold downs (HD's), 7 to 12 gauge, glulams/beams | 1230 | 4.0 ea | - | 23.28 | - | - | - | 23.28 /ea | 93 |
| 06-05-23.60 | Threaded rod for hold downs, to 1-1/4" diameter, glulams/beams | 1295 | 40.0 lf | 3.08 | 1.03 | - | 0.25 | - | 4.36 /lf | 174 |
| 06-11-10.10 | Framing, beams/girders, 6x or larger, allow average cost per MBF | 3800 | 0.5 mbf | 1,150.34 | 1,539.46 | - | - | - | 2,689.80 /mbf | 1,345 |
| 06-11-10.30 | Wood framing, roofs, fascia boards, 2" x 8" | 6070 | 0.1 mbf | 3,067.60 | 601.80 | - | - | - | 3,669.40 /mbf | 415 |
| 06-11-10.30 | Wood framing, roofs, rafters, to 4 in 12 pitch, 2" x 8" | 7060 | 1.0 mbf | 730.38 | 601.79 | - | - | - | 1,332.16 /mbf | 1,306 |
| 06-11-10.30 | Framing, roofs, hip and valley rafters, 2" x 10" | 7365 | 0.0 mbf | 863.00 | 681.00 | - | - | - | 1,544.00 /mbf | 32 |
| 06-11-10.30 | Wood framing, roofs, hip and valley rafters, to 4 in 12 pitch, 2" x 8" | 7600 | 1.0 mbf | 1,415.80 | 601.79 | - | - | - | 2,017.59 /mbf | 2,034 |
| 06-11-10.30 | Wood framing, roofs, rafter ties, #3, 1" x 4" | 7800 | 0.0 mbf | 3,409.00 | 1,306.00 | - | - | - | 4,714.00 /mbf | 33 |
| 06-11-10.30 | Framing, roofs, ridge board, #2 or better, 2" x 12" | 7922 | 0.1 mbf | 1,207.80 | 690.40 | - | - | - | 1,898.20 /mbf | 95 |
| 06-11-10.42 | Furring, wood, on ceilings, on wood, 1" x 3" | 0850 | 80.0 lf | 1.32 | 0.36 | - | - | - | 1.68 /lf | 134 |
| 06-16-36.10 | Sheathing, plywood on roof, CDX, 1/2" thick, pneumatic nailed | 0105 | 900.0 sf | 0.54 | 0.56 | - | - | - | 1.10 /sf | 989 |
| 06-16-36.10 | Sheathing, with boards, on roof, laid horizontal, 1" x 6" | 1400 | 75.0 sf | 1.27 | 1.47 | - | - | - | 2.74 /sf | 205 |
| | **Wood Framing -Roof, Pump Station** | | **1,775.0 sf** | **2.24** | **2.48** | | **0.01** | | **4.73 /sf** | **8,389** |
| | **06 WOOD & PLASTICS** | | | | | | | | | **8,389** |
| **07 THERMAL PROTECTION** | | | | | | | | | | |
| **04220 Exterior Masonry Walls Pump station** | | | | | | | | | | |
| 07-19-19.10 | Silicone water repellants, sprayed on CMU, 2 coat | 0300 | 4,000.0 sf | 0.16 | 0.53 | - | - | - | 0.69 /sf | 2,755 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Exterior Masonry Walls Pump station** | | **2,000.0 sf** | **0.31** | **1.07** | | | | **1.38 /sf** | **2,755** |
| **06120 Wood Framing -Roof, Pump Station** | | | | | | | | | | |
| 07-21-16.20 | Blanket insulation, for walls or ceilings, kraft faced fiberglass, 6" thick, R19, 23" wide | 0180 | 900.0 sf | 0.28 | 0.37 | - | - | - | 0.65 /sf | 588 |
| 07-26-10.10 | Building Paper, vapor barrier, asphalt felt sheathing paper, 15# | 0400 | 9.0 sq | 12.06 | 4.81 | - | - | - | 16.87 /sq | 152 |
| 07-41-13.20 | Steel roofing panels, on steel frame, flat profile, standard finish, 1-3/4" standing seams, 10" wide, 26 gauge | 0710 | 900.0 sf | 2.41 | 3.73 | - | - | - | 6.14 /sf | 5,524 |
| | **Wood Framing -Roof, Pump Station** | | **1,775.0 sf** | **1.42** | **2.11** | | | | **3.53 /sf** | **6,263** |
| | **07 THERMAL PROTECTION** | | | | | | | | | **9,018** |
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Influent Pump Station** | | | | | | | | | | |
| 09-99-99.99 | Coatings allowance | MISC | 1.0 LS | - | - | 15,000.00 | - | - | 15,000.00 /LS | 15,000 |
| 11-00-04.00 | Hydraulic structures, slide gate, stainless stl, ab & grout,48" x 48" | BC-0106 | 1.0 ea | 2,540.11 | 7,957.95 | - | 573.18 | - | 11,071.24 /ea | 11,071 |
| 11-00-11.05 | Wastewater, submersible,4400 GPM gpm,guide rails, base elbow,175 hp, VFD driven | BC-0011 | 2.0 ea | 9,199.66 | 130,000.00 | - | - | - | 139,199.66 /ea | 278,399 |
| 41-21-23.16 | Conveyors, material handling, monorail, overhead, manual, channel type, 500 lb per LF | 3900 | 20.0 lf | 26.93 | 20.50 | - | - | - | 47.43 /lf | 948 |
| 41-21-23.16 | Conveyors, material handling, monorail, overhead, manual, channel type, trolleys for, 8 wheel, 500 lb capacity | 4300 | 1.0 ea | - | 770.00 | 300.00 | - | - | 1,070.00 /ea | 1,070 |
| 41-22-23.10 | Hoists, material handling, electric overhead, chain, hook hung, 15' lift, 5 ton capacity | 2500 | 1.0 ea | - | 6,925.00 | 350.00 | - | - | 7,275.00 /ea | 7,275 |
| 41-22-23.10 | Hoists, material handling, electric overhead, chain, hook hung, 15' lift, 1 ton capacity, for lifts over 15', 5 ton, add | 3100 | 5.0 lf | - | 56.50 | 12.00 | - | - | 68.50 /lf | 343 |
| | **Influent Pump Station** | | **1.0 LS** | **21,477.91** | **276,345.45** | **15,710.00** | **573.18** | | **314,106.54 /LS** | **314,107** |
| | **11 EQUIPMENT** | | | | | | | | | **314,107** |
| **22 PLUMBING** | | | | | | | | | | |
| **22999 Influent Pump piping** | | | | | | | | | | |
| 09-99-99.99 | Coating systems allowance | MISC | 1.0 LS | - | - | 10,000.00 | - | - | 10,000.00 /LS | 10,000 |
| 22-11-13.44 | Pump discharge piping allowance | ---- | 1.0 ls | 14,760.00 | 50,000.00 | - | 10,000.00 | - | 74,760.00 /ls | 74,760 |
| | **Influent Pump piping** | | **1.0 LS** | **14,760.00** | **50,000.00** | **10,000.00** | **10,000.00** | | **84,760.00 /LS** | **84,760** |
| **33500 Influent PS Yard Piping** | | | | | | | | | | |
| 22-11-13.44 | Pipe, steel, black, welded, 24" diameter, schedule 40, Spec. A-53, includes two rod, roll hanger & saddle, sized for covering, 10' OC | 2220 | 1,625.0 lf | 21.14 | 183.00 | - | 0.44 | - | 204.58 /lf | 332,442 |
| 22-11-13.44 | Pipe, steel, Welding labor per joint, 24" pipe size, schedule 40, welding | 9420 | 45.0 ea | 684.72 | - | - | 39.24 | - | 723.95 /ea | 32,578 |
| 22-11-13.47 | Elbow, 90 Deg., steel, carbon steel, black, long radius, butt weld, standard weight, 24" pipe size, includes 1 weld per joint and weld machine | 3194 | 5.0 ea | 1,554.30 | 3,450.00 | - | 57.70 | - | 5,062.00 /ea | 25,310 |
| 22-99-99.99 | Tie into existing influent piping/structure allowance | ---- | 1.0 ls | 35,900.00 | 250,000.00 | - | - | - | 285,900.00 /ls | 285,900 |
| | **Influent PS Yard Piping** | | **1,625.0 LF** | **66.98** | **347.46** | | **1.71** | | **416.14 /LF** | **676,230** |
| | **22 PLUMBING** | | | | | | | | | **760,990** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **26001 Influent Pump Station - E&I** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 383,779.99 | - | - | 383,779.99 /LS | 383,780 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Influent Pump Station - E&I** | | **1.0 LS** | | | **383,779.99** | | | **383,779.99 /LS** | **383,780** |
| | **26 ELECTRICAL** | | | | | | | | | **383,780** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Influent Pump Station - E&I** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 73,803.85 | - | - | 73,803.85 /LS | 73,804 |
| | **Influent Pump Station - E&I** | | **1.0 LS** | | | **73,803.85** | | | **73,803.85 /LS** | **73,804** |
| | **27 COMMUNICATIONS** | | | | | | | | | **73,804** |
| **31 EARTHWORK** | | | | | | | | | | |
| **01999 Dewatering** | | | | | | | | | | |
| 01-54-33.70 | Rent wellpoint header pipe, 6" diameter, 400 gpm | 0500 | 600.0 day | - | - | - | 0.40 | - | 0.40 /day | 240 |
| 31-23-19.20 | Dewatering, pumping 8 hours, attended 2 hrs per day, 6" centrifugal pump, includes 20 LF of suction hose and 100 LF of discharge hose | 1100 | 60.0 day | 857.51 | - | - | 377.70 | - | 1,235.21 /day | 74,113 |
| 31-23-19.30 | Wells, for dewatering, with steel casing, 10' to 20' deep, 2' diameter, minimum | 0020 | 75.0 vlf | 76.64 | 184.52 | - | 17.92 | - | 279.08 /vlf | 20,931 |
| | **Dewatering** | | **1.0 LS** | **57,198.63** | **13,839.25** | | **24,245.80** | | **95,283.68 /LS** | **95,284** |
| **03330 Slabs Pump station wet well** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 83.3 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 149 |
| | **Slabs Pump station wet well** | | **58.3 cy** | **1.52** | | | **1.03** | | **2.55 /cy** | **149** |
| **03330 Slabs Pump station slab** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 55.6 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 99 |
| | **Slabs Pump station slab** | | **20.4 cy** | **2.90** | | | **1.97** | | **4.87 /cy** | **99** |
| **31250 Shoring Systems** | | | | | | | | | | |
| 31-41-16.10 | Sheet piling, steel, 27 psf, 20' excavation, per S.F., drive, extract and salvage, excludes wales | 1600 | 1,800.0 sf | 9.83 | 6.37 | - | 7.87 | - | 24.07 /sf | 43,326 |
| 31-41-16.10 | Sheet piling, wales, connections and struts, 2/3 salvage | 2500 | 1.6 ton | - | 410.40 | - | - | - | 410.40 /ton | 653 |
| | **Shoring Systems** | | **1,800.0 sf** | **9.83** | **6.73** | | **7.87** | | **24.43 /sf** | **43,978** |
| **31315 Excavation and Backfill pump station** | | | | | | | | | | |
| 31-23-16.42 | Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum | 4400 | 648.0 bcy | 6.99 | - | - | 7.64 | - | 14.63 /bcy | 9,480 |
| 31-23-23.14 | Backfill, structural, common earth, 105 H.P. dozer, 50' haul, from existing stockpile, excludes compaction | 3020 | 482.0 lcy | 0.70 | - | - | 0.50 | - | 1.20 /lcy | 579 |
| 31-23-23.20 | Cycl hln(,load,trvl,unld dump&rtr) time per cycl,excv borrw,loose cubic yards,25 min ld/w/,18 cy 8 wheel truck,cycle 20 miles,45 mph,excld ldng eqpmnt | 9498 | 362.0 lcy | 3.08 | - | - | 5.47 | - | 8.55 /lcy | 3,095 |
| 31-23-23.23 | Compaction, 3 passes, 12" lifts, riding, sheepsfoot or wobbly wheel roller | 5700 | 334.0 ecy | 0.25 | - | - | 0.35 | - | 0.60 /ecy | 199 |
| | **Excavation and Backfill pump station** | | **925.9 cy** | **6.55** | | | **7.87** | | **14.42 /cy** | **13,354** |
| **33500 Influent PS Yard Piping** | | | | | | | | | | |
| 31-23-16.13 | Excavating, trench or continuous footing, common earth, 1 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering | 0510 | 4,799.8 bcy | 2.80 | - | - | 2.07 | - | 4.87 /bcy | 23,374 |
| 31-23-23.13 | Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with sheepsfoot roller | 2300 | 3,370.4 ecy | 1.32 | - | - | 2.85 | - | 4.16 /ecy | 14,036 |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, sand, dead or bank, excludes compaction | 0200 | 1,240.3 lcy | 10.59 | 10.89 | - | 2.48 | - | 23.96 /lcy | 29,713 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **33500 Influent PS Yard Piping** | | | | | | | | | | |
| 31-23-23.16 | Fill by borrow and utility bedding, for pipe and conduit, compacting bedding in trench | 0500 | 1,240.3 ecy | 5.57 | - | - | 0.41 | - | 5.98 /ecy | 7,411 |
| 31-23-23.18 | Hauling, excavated or borrow material, loose cubic yards, 3 mile round trip, 2.1 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading | 0150 | 1,429.4 lcy | 6.23 | - | - | 5.24 | - | 11.48 /lcy | 16,403 |
| | **Influent PS Yard Piping** | | **1,625.0 LF** | **28.81** | **8.31** | | **18.84** | | **55.96 /LF** | **90,937** |
| | **31 EARTHWORK** | | | | | | | | | **243,801** |
| **33 UTILITIES** | | | | | | | | | | |
| **33500 Influent PS Yard Piping** | | | | | | | | | | |
| 33-05-26.10 | Utility line signs, markers, and flags, underground tape, detectable, reinforced, aluminum foil core, 2", excludes excavation and backfill | 0400 | 16.0 clf | 3.34 | 5.56 | - | - | - | 8.90 /clf | 142 |
| | **Influent PS Yard Piping** | | **1,625.0 LF** | **0.03** | **0.06** | | | | **0.09 /LF** | **142** |
| | **33 UTILITIES** | | | | | | | | | **142** |
| | **08 Influent Pump Station** | | **1.0 LS** | **359,558.19** | **999,552.34** | **483,293.84** | **91,256.30** | | **1,933,660.67 /LS** | **1,933,661** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **09 Acetate/Methanol** | | | | | | | | | | |
| **03 CONCRETE** | | | | | | | | | | |
| **03330 Slabs Chemical Storage** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 5.6 cy | - | 33.69 | - | - | - | 33.69 /cy | 187 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, slab blockouts, wood, to 12" high, 1 use, includes erecting, bracing, stripping and cleaning | 4000 | 32.0 lf | 9.05 | 0.81 | - | - | - | 9.86 /lf | 315 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 0.6 ton | 1,036.00 | 992.00 | - | - | - | 2,028.00 /ton | 1,128 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.6 ton | 39.87 | - | - | 7.52 | - | 47.40 /ton | 26 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.6 ton | 43.35 | - | - | 8.17 | - | 51.51 /ton | 29 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 11.7 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,144 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, pumped, over 6" thick, includes vibrating, excludes material | 4650 | 11.7 cy | 20.95 | - | - | 4.31 | - | 25.26 /cy | 295 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, machine trowel finish | 0250 | 300.0 sf | 0.88 | - | - | 0.03 | - | 0.91 /sf | 273 |
| 03-35-29.30 | Concrete finishing, floor, hardener, non-metallic, medium service, 0.75 psf, add | 2350 | 300.0 sf | 0.70 | 0.29 | - | - | - | 0.99 /sf | 298 |
| 03-39-13.50 | Curing, sprayed membrane curing compound | 0300 | 3.0 csf | 9.68 | 10.12 | - | - | - | 19.80 /csf | 59 |
| | **Slabs Chemical Storage** | | **300.0 cy** | **5.53** | **6.75** | | **0.23** | | **12.52 /cy** | **3,754** |
| **03330 Slabs tanks** | | | | | | | | | | |
| 03-05-13.25 | Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only | 1050 | 14.8 cy | - | 33.69 | - | - | - | 33.69 /cy | 499 |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning | 3050 | 110.0 sfca | 4.16 | 0.80 | - | - | - | 4.96 /sfca | 545 |
| 03-21-10.60 | Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories | 0600 | 1.4 ton | 1,036.01 | 992.00 | - | - | - | 2,028.01 /ton | 2,817 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 1.4 ton | 39.87 | - | - | 7.52 | - | 47.39 /ton | 66 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 1.4 ton | 43.34 | - | - | 8.16 | - | 51.51 /ton | 72 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 22.2 cy | - | 98.01 | - | - | - | 98.01 /cy | 2,178 |
| 03-31-05.70 | Structural concrete, placing, slab on grade, pumped, over 6" thick, includes vibrating, excludes material | 4650 | 22.2 cy | 20.95 | - | - | 4.31 | - | 25.26 /cy | 561 |
| 03-35-29.30 | Concrete finishing, floors, monolithic, screed, float and broom finish | 0150 | 600.0 sf | 0.82 | - | - | - | - | 0.82 /sf | 490 |
| | **Slabs tanks** | | **22.2 cy** | **133.56** | **186.42** | | **5.29** | | **325.27 /cy** | **7,228** |
| **03333 Acetate tanks/pumps equipment Pads and containment** | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 740.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 6,365 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.3 ton | 39.90 | - | - | 7.50 | - | 47.41 /ton | 13 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.3 ton | 43.33 | - | - | 8.20 | - | 51.50 /ton | 14 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **03333 Acetate tanks/pumps equipment Pads and containment** | | | | | | | | | | |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 13.5 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,325 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 13.5 cy | 27.68 | - | - | 5.70 | - | 33.38 /cy | 451 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 13.5 cy | 46.13 | - | - | 13.04 | - | 59.17 /cy | 800 |
| | **Acetate tanks/pumps equipment Pads and containment** | | **13.5 cy** | **471.83** | **172.51** | | **19.05** | | **663.39 /cy** | **8,968** |
| **03333 Acetate pumps Equipment Pads** | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 72.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 619 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.0 ton | 39.80 | - | - | 7.50 | - | 47.25 /ton | 2 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.0 ton | 43.30 | - | - | 8.30 | - | 51.50 /ton | 2 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 2.0 cy | - | 98.01 | - | - | - | 98.01 /cy | 196 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 2.0 cy | 27.68 | - | - | 5.70 | - | 33.38 /cy | 67 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 2.0 cy | 46.13 | - | - | 13.04 | - | 59.17 /cy | 118 |
| | **Acetate pumps Equipment Pads** | | **2.0 cy** | **336.15** | **147.01** | | **19.05** | | **502.20 /cy** | **1,004** |
| **03333 Methanol tank/pump Equipment Pads and containment** | | | | | | | | | | |
| 03-11-13.65 | C.I.P. concrete forms, slab on grade, curb, wood, 6" to 12" high, 2 use, includes erecting, bracing, stripping and cleaning | 2050 | 374.0 sfca | 7.24 | 1.36 | - | - | - | 8.60 /sfca | 3,217 |
| 03-21-10.60 | Reinforcing in place, unloading & sorting, add to above - slabs | 2005 | 0.3 ton | 39.86 | - | - | 7.50 | - | 47.37 /ton | 13 |
| 03-21-10.60 | Reinforcing in place, crane cost for handling, add to above, slabs | 2215 | 0.3 ton | 43.35 | - | - | 8.17 | - | 51.50 /ton | 14 |
| 03-31-05.35 | Concrete, ready mix, regular weight, slabs/mats, 4000 psi | 0305 | 13.9 cy | - | 98.01 | - | - | - | 98.01 /cy | 1,361 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, pumped | 1425 | 13.9 cy | 27.68 | - | - | 5.70 | - | 33.38 /cy | 464 |
| 03-31-05.70 | Placing conc, curbs/pads, elev slab, less than 6" thick, w/crane & bucket | 1460 | 13.9 cy | 46.13 | - | - | 13.04 | - | 59.17 /cy | 822 |
| | **Methanol tank/pump Equipment Pads and containment** | | **13.9 cy** | **270.46** | **134.66** | | **19.05** | | **424.17 /cy** | **5,891** |
| | **03 CONCRETE** | | | | | | | | | **26,847** |
| **04 STONE & MASONRY** | | | | | | | | | | |
| **04220 Exterior Masonry Walls chemical storage** | | | | | | | | | | |
| 04-05-16.30 | Grout, door frames, 3' x 7' opening, 2.5 CF per opening | 0800 | 2.0 opng | 32.67 | 10.51 | - | 2.27 | - | 45.45 /opng | 91 |
| 04-05-16.30 | Grout, door frames, 6' x 7' opening, 3.5 CF per opening | 0850 | 2.0 opng | 43.56 | 14.70 | - | 3.03 | - | 61.28 /opng | 123 |
| 04-05-16.30 | Grout, for bond beams, lintels and concrete masonry unit (CMU) cores, C476, includes material only | 2000 | 441.0 cf | 5.60 | 4.20 | - | 0.39 | - | 10.19 /cf | 4,495 |
| 04-05-19.26 | Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed horizontally, ASTM A615 | 0020 | 1,575.0 lb | 0.65 | 0.46 | - | - | - | 1.11 /lb | 1,745 |
| 04-05-19.26 | Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed vertically, ASTM A615 | 0060 | 819.0 lb | 0.80 | 0.46 | - | - | - | 1.26 /lb | 1,030 |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| **04220 Exterior Masonry Walls chemical storage** | | | | | | | | | | |
| 04-05-19.26 | Masonry reinforcing bars, truss type steel joint reinforcing, mill standard galvanized, 12" wide | 0250 | 7.7 clf | 26.07 | 24.73 | - | - | - | 50.79 /clf | 391 |
| 04-22-10.28 | Concrt block,high strngt,hollow,3500 psi,12"8"16",inclds mortar and horzntl joint rnfrcng every other course,excluds scffldn,grout and verticl rnfrcng | 0350 | 1,050.0 sf | 11.33 | 5.95 | - | - | - | 17.28 /sf | 18,143 |
| | **Exterior Masonry Walls chemical storage** | | **1,050.0 sf** | **15.62** | **8.98** | | **0.17** | | **24.78 /sf** | **26,017** |
| | **04 STONE & MASONRY** | | | | | | | | | **26,017** |
| **06 WOOD & PLASTICS** | | | | | | | | | | |
| **06120 Wood Framing - Roof Chemical Storage** | | | | | | | | | | |
| 06-05-23.10 | Nails, floor or roof sheathing | 1025 | 6.0 lb | - | 2.45 | - | - | - | 2.45 /lb | 15 |
| 06-05-23.10 | Nails, roof framing, sinkers, 8d to 16d, allow 20 lbs per MBF | 5625 | 6.0 lb | - | 2.33 | - | - | - | 2.33 /lb | 14 |
| 06-05-23.60 | Average cost, hold downs (HD's), 7 to 12 gauge, glulams/beams | 1230 | 4.0 ea | - | 23.28 | - | - | - | 23.28 /ea | 93 |
| 06-05-23.60 | Threaded rod for hold downs, to 1-1/4" diameter, glulams/beams | 1295 | 40.0 lf | 3.08 | 1.03 | - | 0.25 | - | 4.36 /lf | 174 |
| 06-05-23.60 | I-joist hanger (EWP), 12 to 16 ga., per 100, avg cost | 1460 | 0.1 c | 296.80 | 656.40 | - | - | - | 953.20 /c | 95 |
| 06-05-23.60 | Rafter anchors, 18 ga galv, 1.5" wide, 5.25" L, cost per 100 | 3525 | 0.2 c | 317.30 | 37.25 | - | - | - | 354.55 /c | 71 |
| 06-11-10.10 | Framing, beams/girders, 6x or larger, allow average cost per MBF | 3800 | 0.6 mbf | 1,150.34 | 1,539.44 | - | - | - | 2,689.79 /mbf | 1,641 |
| 06-11-10.30 | I-joist (composite) rafters , 24" o.c., w/ blocking, avg cost/sf | 1050 | 320.0 sffl | 0.78 | 1.92 | - | - | - | 2.70 /sffl | 865 |
| 06-11-10.30 | Wood framing, roofs, fascia boards, 2" x 8" | 6070 | 0.2 mbf | 3,067.58 | 601.80 | - | - | - | 3,669.40 /mbf | 833 |
| 06-11-10.30 | Wood framing, roofs, rafters, to 4 in 12 pitch, 2" x 8" | 7060 | 2.0 mbf | 730.37 | 601.79 | - | - | - | 1,332.16 /mbf | 2,611 |
| 06-11-10.30 | Framing, roofs, hip and valley rafters, 2" x 10" | 7365 | 0.0 mbf | 862.90 | 681.20 | - | - | - | 1,544.00 /mbf | 65 |
| 06-11-10.30 | Wood framing, roofs, hip and valley rafters, to 4 in 12 pitch, 2" x 8" | 7600 | 2.0 mbf | 1,415.80 | 601.79 | - | - | - | 2,017.59 /mbf | 4,067 |
| 06-11-10.30 | Wood framing, roofs, rafter ties, #3, 1" x 4" | 7800 | 0.0 mbf | 3,409.00 | 1,306.00 | - | - | - | 4,714.00 /mbf | 33 |
| 06-11-10.30 | Framing, roofs, ridge board, #2 or better, 2" x 12" | 7922 | 0.1 mbf | 1,207.90 | 690.40 | - | - | - | 1,898.30 /mbf | 190 |
| 06-11-10.42 | Furring, wood, on ceilings, on wood, 1" x 3" | 0850 | 320.0 lf | 1.32 | 0.36 | - | - | - | 1.68 /lf | 537 |
| 06-16-36.10 | Sheathing, plywood on roof, CDX, 1/2" thick, pneumatic nailed | 0105 | 300.0 sf | 0.54 | 0.56 | - | - | - | 1.10 /sf | 330 |
| 06-16-36.10 | Sheathing, with boards, on roof, laid horizontal, 1" x 6" | 1400 | 150.0 sf | 1.27 | 1.47 | - | - | - | 2.73 /sf | 410 |
| | **Wood Framing - Roof Chemical Storage** | | **320.0 sf** | **22.20** | **15.41** | | **0.03** | | **37.64 /sf** | **12,044** |
| | **06 WOOD & PLASTICS** | | | | | | | | | **12,044** |
| **07 THERMAL PROTECTION** | | | | | | | | | | |
| **04220 Exterior Masonry Walls chemical storage** | | | | | | | | | | |
| 07-19-19.10 | Silicone water repellants, sprayed on CMU, 2 coat | 0300 | 2,100.0 sf | 0.16 | 0.53 | - | - | - | 0.69 /sf | 1,446 |
| | **Exterior Masonry Walls chemical storage** | | **1,050.0 sf** | **0.31** | **1.07** | | | | **1.38 /sf** | **1,446** |
| **06120 Wood Framing - Roof Chemical Storage** | | | | | | | | | | |
| 07-21-16.20 | Blanket insulation, for walls or ceilings, kraft faced fiberglass, 6" thick, R19, 23" wide | 0180 | 300.0 sf | 0.28 | 0.37 | - | - | - | 0.65 /sf | 196 |
| 07-26-10.10 | Building Paper, vapor barrier, asphalt felt sheathing paper, 15# | 0400 | 3.0 sq | 12.06 | 4.81 | - | - | - | 16.87 /sq | 51 |
| 07-41-13.20 | Steel roofing panels, on steel frame, flat profile, standard finish, 1-3/4" standing seams, 10" wide, 26 gauge | 0710 | 300.0 sf | 2.41 | 3.73 | - | - | - | 6.14 /sf | 1,841 |
| | **Wood Framing - Roof Chemical Storage** | | **320.0 sf** | **2.63** | **3.89** | | | | **6.52 /sf** | **2,088** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **07 THERMAL PROTECTION** | | | | | | | | | **3,534** |
| **09 FINISHES** | | | | | | | | | | |
| **06120 Wood Framing - Roof Chemical Storage** | | | | | | | | | | |
| 09-91-06.41 | Coatings & paints, B & C coating system E-8 (Clear epoxy, wood) | BC-0051 | 320.0 sqft | 0.26 | 0.44 | - | - | - | 0.70 /sqft | 224 |
| | **Wood Framing - Roof Chemical Storage** | | **320.0 sf** | **0.26** | **0.44** | | | | **0.70 /sf** | **224** |
| | **09 FINISHES** | | | | | | | | | **224** |
| **11 EQUIPMENT** | | | | | | | | | | |
| **11999 Aeration Chemical** | | | | | | | | | | |
| 11-00-06.00 | FRP tank, acetate, 7,500 gal., | BC-0016 | 1.0 ea | 2,022.71 | 21,000.00 | - | 622.71 | | 23,645.42 /ea | 23,645 |
| 11-00-08.00 | Chemical metering pump, acetate | BC-0011 | 2.0 ea | 459.41 | 11,000.00 | - | - | - | 11,459.41 /ea | 22,919 |
| 11-00-08.00 | Chemical metering pump, methanol | BC-0041 | 2.0 ea | 565.42 | 11,000.00 | - | - | - | 11,565.42 /ea | 23,131 |
| 23-13-23.26 | Storage tank, horizontal, concrete, above ground, fuel-oil, vaulted, 20,000 gallon, incl. pad & pump | 0600 | 1.0 ea | 2,722.91 | 108,000.00 | - | 1,150.56 | - | 111,873.47 /ea | 111,873 |
| | **Aeration Chemical** | | **1.0 LS** | **6,795.27** | **173,000.00** | | **1,773.27** | | **181,568.54 /LS** | **181,569** |
| | **11 EQUIPMENT** | | | | | | | | | **181,569** |
| **21 FIRE SUPPRESSION** | | | | | | | | | | |
| **22999 Chemical Piping** | | | | | | | | | | |
| 21-99-99.99 | Fire suppression system allowance | MISC | 1.0 LS | - | - | 20,000.00 | - | - | 20,000.00 /LS | 20,000 |
| | **Chemical Piping** | | **1.0 LS** | | | **20,000.00** | | | **20,000.00 /LS** | **20,000** |
| | **21 FIRE SUPPRESSION** | | | | | | | | | **20,000** |
| **22 PLUMBING** | | | | | | | | | | |
| **22999 Chemical Piping** | | | | | | | | | | |
| 22-99-99.99 | Chemical piping allowance acetate tank/pumps | MISC | 2.0 LS | 1,795.00 | 2,500.00 | | - | - | 4,295.00 /LS | 8,590 |
| 22-99-99.99 | Chemical piping allowance methanol tank/pumps | MISC | 2.0 LS | 2,692.50 | 3,750.00 | | - | - | 6,442.50 /LS | 12,885 |
| | **Chemical Piping** | | **1.0 LS** | **8,975.00** | **12,500.00** | | | | **21,475.00 /LS** | **21,475** |
| | **22 PLUMBING** | | | | | | | | | **21,475** |
| **26 ELECTRICAL** | | | | | | | | | | |
| **26001 Aeration Tanks - E&I (#15)** | | | | | | | | | | |
| 26-00-00.02 | Electrical (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 64,012.09 | - | - | 64,012.09 /LS | 64,012 |
| | **Aeration Tanks - E&I (#15)** | | **1.0 LS** | | | **64,012.09** | | | **64,012.09 /LS** | **64,012** |
| | **26 ELECTRICAL** | | | | | | | | | **64,012** |
| **27 COMMUNICATIONS** | | | | | | | | | | |
| **26001 Aeration Tanks - E&I (#15)** | | | | | | | | | | |
| 27-20-00.01 | Instrumentation (This is based on a percentage of the Total Project Costs) | FACTORED | 1.0 LS | - | - | 16,003.03 | - | - | 16,003.03 /LS | 16,003 |
| | **Aeration Tanks - E&I (#15)** | | **1.0 LS** | | | **16,003.03** | | | **16,003.03 /LS** | **16,003** |
| | **27 COMMUNICATIONS** | | | | | | | | | **16,003** |
| **31 EARTHWORK** | | | | | | | | | | |
| **03330 Slabs Chemical Storage** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 33.3 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 60 |
| | **Slabs Chemical Storage** | | **300.0 cy** | **0.12** | | | **0.08** | | **0.20 /cy** | **60** |
| **03330 Slabs tanks** | | | | | | | | | | |
| 31-22-16.10 | Fine grading, fine grade for slab on grade, machine | 1100 | 66.7 sy | 1.07 | - | - | 0.72 | - | 1.79 /sy | 119 |
| | **Slabs tanks** | | **22.2 cy** | **3.20** | | | **2.17** | | **5.36 /cy** | **119** |

| Phase | Estimate Breakdown | Item | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| | **31 EARTHWORK** | | | | | | | | | **179** |
| **33 UTILITIES** | | | | | | | | | | |
| **33999 Chemical feed yard piping** | | | | | | | | | | |
| 33-11-13.25 | Chemical piping, double contained, allowance | ---- | 1.0 ls | 6,152.00 | 20,020.00 | - | 2,000.00 | - | 28,172.00 /ls | 28,172 |
| | **Chemical feed yard piping** | | **1.0 LS** | **6,152.00** | **20,020.00** | | **2,000.00** | | **28,172.00 /LS** | **28,172** |
| | **33 UTILITIES** | | | | | | | | | **28,172** |
| | **09 Acetate/Methanol** | | **1.0 LS** | **62,221.40** | **233,055.77** | **100,015.12** | **4,783.21** | | **400,075.50 /LS** | **400,076** |
| | **01 TOTAL AMOUNT** | | | | | | | | | **25,814,216** |

## Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | 55,976 hrs | 4,143,655 | |
| Material | | | 15,334,383 | |
| Subcontract | | | 5,543,237 | |
| Equipment | | 59,320 hrs | 748,293 | |
| Other | | | 44,648 | |
| | | | **25,814,216** | **25,814,216** |
| Civil and Misc. Yard Piping | 5.000 % | | 1,290,711 | |
| | | | **1,290,711** | **27,104,927** |
| Labor Mark-up | 10.000 % | | 414,365 | |
| Material Mark-up | 8.000 % | | 1,226,751 | |
| Subcontractor Mark-up | 5.000 % | | 25,068 | |
| Construction Equipment Mark-up | 8.000 % | | 59,863 | |
| Other - Process Equip Mark-up | 8.000 % | | 3,572 | |
| Material Shipping & Handling | 2.000 % | | 306,688 | |
| Material Sales Tax | 6.000 % | | 772,080 | |
| | | | **2,808,387** | **29,913,314** |
| Contractor General Conditions | 10.000 % | | 2,991,331 | |
| Start-Up, Training, O&M | 2.000 % | | 598,266 | |
| Undesign/Undevelop Contingency | 30.000 % | | 8,973,994 | |
| | | | **12,563,591** | **42,476,905** |
| Bldg Risk, Liability Auto Ins | 2.000 % | | 849,538 | |
| Contractor Bonds & Insurance | 1.500 % | | 637,154 | |
| | | | **1,486,692** | **43,963,597** |
| **Total** | | | | **43,963,597** |

# Appendix D: Sidestream Nitrogen Removal Report

Brown AND Caldwell

950 West Bannock Street
Boise, Idaho 83702
208.389.7700

# Technical Memorandum

Prepared for: City of Meridian

Project Title: Side Stream Nitrogen Evaluation

Project No.: 146999

**Technical Memorandum**

Subject: Meridian Wastewater Treatment Plant Side Stream Nitrogen Evaluation

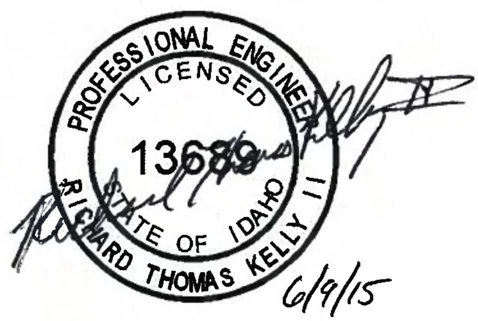
Date: January 9, 2015 (Revised June 9, 2015)

To: David Allison, P.E., City of Meridian Project Manager

From: Rick Kelly, Ph.D., P.E., Brown and Caldwell

Copy to: Clint Dolsby, P.E., City of Meridian

Laurelei McVey, City of Meridian




Prepared by: Adam Klein, P.E. (Washington only), Brown and Caldwell

Zach Dobroth, P.E., Brown and Caldwell

Reviewed by: Henryk Melcer, Ph.D., P.E., Brown and Caldwell

Rick Kelly, Ph.D., P.E., Brown and Caldwell

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# List of Abbreviations

| | |
|---|---|
| AB | aeration basin |
| Anammox | anaerobic ammonia-oxidizers |
| AOB | ammonia-oxidizing bacteria |
| BCE | business case evaluation |
| BOD | biochemical oxygen demand (5-day) |
| °C | degree(s) Celsius |
| $CaCO_3$ | calcium carbonate |
| City | City of Meridian |
| COD | chemical oxygen demand |
| d | day(s) |
| DO | dissolved oxygen |
| EPS | extracellular polymeric substance |
| FE | final effluent |
| ft | foot/feet |
| $ft^2$ | square foot/feet |
| $ft^3$ | cubic foot/feet |
| FTE | full-time equivalent |
| gal | gallon(s) |
| gpd | gallon(s) per day |
| HRT | hydraulic retention time |
| IMLR | internal mixed liquor recycle |
| ISS | inert suspended solids |
| kg | kilogram(s) |
| kWh | kilowatt-hour(s) |
| L | liter(s) |
| lb | pound(s) |
| $m^3$ | cubic meter(s) |
| mg | milligram(s) |
| Mgal | million gallon(s) |
| mgd | million gallon(s) per day |
| mg/L | milligram(s) per liter |
| min | minute(s) |
| MLSS | mixed liquor suspended solids |
| mM | millimolar |
| mmol | millimole(s) |
| N | nitrogen |
| NF | no fermenter |
| $NH_4$ | ammonia |
| $NH_4$-N | ammonia-nitrogen |
| NOB | nitrite-oxidizing bacteria |
| NOx | nitrate + nitrite |
| NOx-N | nitrate nitrogen + nitrite nitrogen |
| NPDES | National Pollutant Discharge Elimination System |
| NPV | net present value |
| OHO | ordinary heterotrophic organism |
| P | phosphorus |
| PAO | phosphorus accumulating organism |
| PE | primary effluent |
| PHA | polyhydroxyalkanoate |
| $PO_4$-P | ortho-phosphate |
| RAS | return activated sludge |
| RBCOD | readily biodegradable chemical oxygen demand |
| RI | raw influent |
| RMSE | root-mean-squared-error |
| R&R | repair and replacement |
| scfm | standard cubic foot/feet per minute |
| sCOD | soluble chemical oxygen demand |
| SLR | solids loading rate |
| SOR | surface overflow rate |
| SPA | state point analysis |
| SRT | solids retention time |
| SVI | sludge volume index |
| TIN | total inorganic nitrogen |
| TKN | total Kjeldahl nitrogen |
| TP | total phosphorus |
| TSS | total suspended solids |
| VFAs | volatile fatty acids |
| VSS | volatile suspended solids |
| WAS | waste activated sludge |
| WWTP | wastewater treatment plant |

# 1. Introduction

The City of Meridian (City) has received a preliminary draft of its new National Pollutant Discharge Elimination System (NPDES) permit, which calls for decreased wastewater treatment plant (WWTP) effluent limitations for ammonia-nitrogen ($NH_4$-N), total phosphorus (TP), and other constituents. To prepare for the new permit, the City requested help in determining the benefit of implementing a side stream treatment process for nitrogen removal at the WWTP.

This technical memorandum provides a summary of the evaluation, which included the following tasks:

- updating a previously calibrated BioWin model to determine the impact of removing a portion of the side stream nitrogen load on the capacity of the existing secondary activated sludge process
- evaluating the impact of yearly digester maintenance, including the potential for ammonia and phosphorus breakthrough
- determining the upgrades (with and without side stream treatment) necessary to meet a proposed maximum month influent flow of 15 million gallons per day (mgd) while maintaining effluent quality parameters
- developing planning-level capital and operational cost estimates for facility expansion with and without side stream treatment

Following this introduction, this technical memorandum is organized into four main parts. Sections 2 through 6 discuss the preparation of a biological process model, which was used to assess the impacts of side stream treatment on Plant operation and capacity. Sections 7 and 8 discuss the modeling itself, with presentation of data and conclusions. Sections 9 and 10 detail a life-cycle cost analysis of side stream treatment, using a business case evaluation (BCE). Section 11 includes recommendations for the City.

# 2. Model Description

This section provides a description of updates to the biological process model that was developed and calibrated in 2011.

## 2.1 BioWin Calibration (2011)

In September 2011, Brown and Caldwell developed a biological process model for the Meridian WWTP activated sludge secondary treatment process using the BioWin simulator (produced by EnviroSim Associates Ltd., Hamilton, Ontario, Canada). BioWin allows the prediction of complex biological interactions using various mechanistic and empirical models to represent material transformations and pollutant removals in the plant for both liquid and solids process streams. It enables the user to simulate carbonaceous oxidation and the fate of nutrients in activated sludge treatment facilities.

The 2011 model was developed as part of a study on controlling *Microthrix parvicella* bacteria, which were seasonally disrupting mixed liquor settling at the WWTP. Data collected during a 2-week wastewater sampling period in May 2011 were used to calibrate the model, with adjustments made to the simulator to reach agreement between the measured effluent characteristics and the simulated effluent quality.

Details of the calibration process and results of the analysis can be reviewed in the *Microthrix* Control technical memorandum (submitted to the City on September 9, 2011).

## 2.2 Updates to the Meridian WWTP Model

The model developed in 2011 was used as the basis for the current analysis. Figure 1 depicts the Meridian WWTP process flow schematic in the 2011 model. Shown are the secondary pump station, the anaerobic zone (Ana 1), the two anoxic zones (Anox/Ana 1 and 2), the two swing zones (Swing 1 and 2), the four aerated zones (Aer 1, 2, 3, and 4) and the secondary clarifiers. Also shown is the internal mixed liquor recycle (IMLR) stream, the clarifier return activated sludge (RAS) and waste activated sludge (WAS) streams, and the secondary effluent. Feed to the system was the primary effluent (PE), as measured during the wastewater characterization period, and inclusive of dewatering centrate.

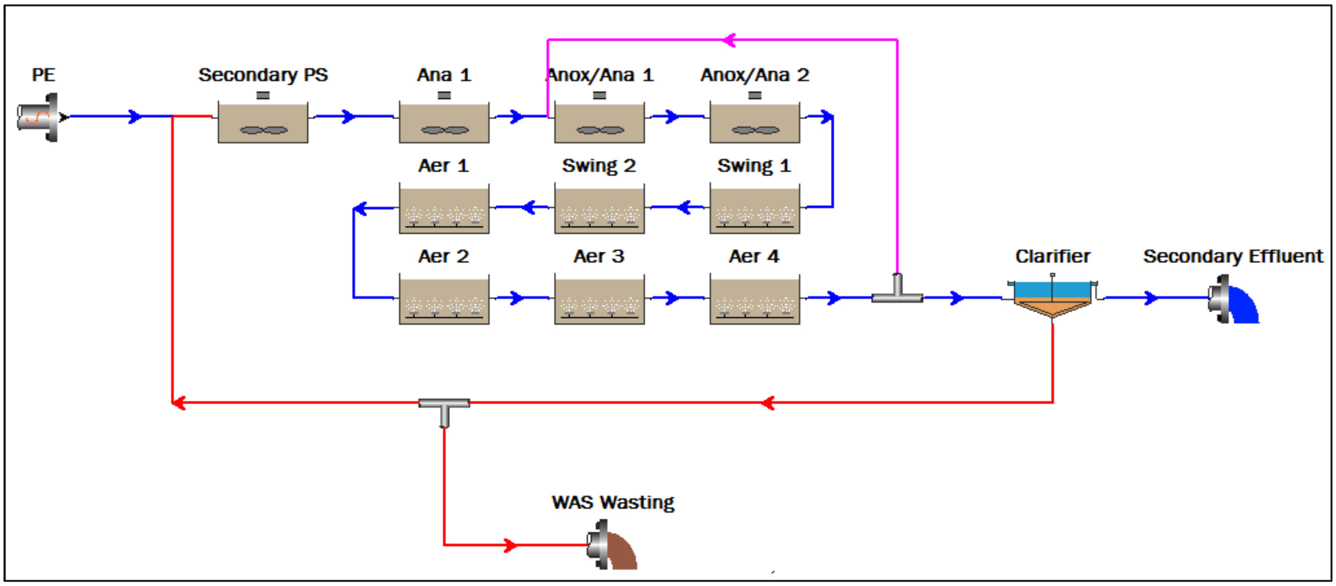


**Figure 1. Process flow schematic in BioWin simulator (2011 model)**

Several updates to the model were made for the current analysis. Figure 2 presents the updated process flow schematic used for this evaluation. Four new flow inputs were added: centrate (from solids dewatering), DEMON effluent (from nitrogen side stream treatment process), fermentate (fermented liquor from the new primary sludge fermenter), and methanol. These inputs were toggled on or off depending on the scenario being evaluated. Each simulation included either centrate flow (no side stream treatment) or DEMON effluent flow (side stream treatment included). A RAS denitrification basin was added on the RAS line exiting the secondary clarifiers.

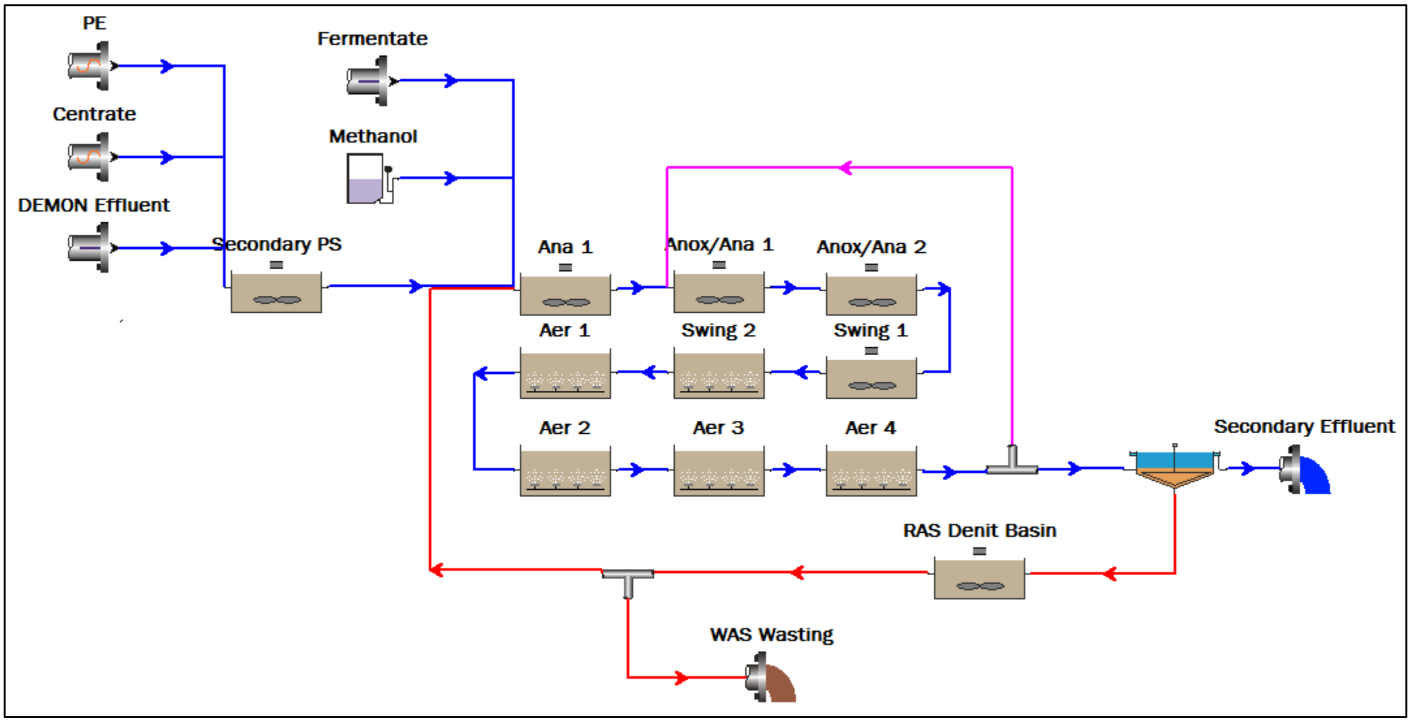


**Figure 2. Process flow schematic in BioWin simulator (updated model)**

Physical and process data were entered into the simulator to build the model; pertinent inputs are summarized in Table 1. The anaerobic and anoxic zones were configured as separate cells in the model because they are separated by baffle walls. The aeration basins were configured with two swing cells and four additional aerobic cells, all separated by baffle walls. Total basin volume was approximately 2.4 million gallons (Mgal). Dissolved oxygen (DO) set points for the cells were based on actual operating conditions. While the City will soon be implementing tighter DO control with dedicated control valves and probes in each cell, the first two aerobic cells (and the swing cells, if aerated) currently operate at a high DO concentration (modeled at 5.3 milligrams per liter [mg/L]).

| Table 1. Meridian WWTP Model: Physical Data Inputs | | | | | |
|---|---|---|---|---|---|
| Unit Process | Volume (gal) | Surface Area ($ft^2$) | Depth (ft) | Width (ft) | DO Set Point (mg/L) |
| Secondary pump station | 40,300 | 772 | 6.98 | 8.63 | 0 |
| Anaerobic cell 1 | 220,800 | 2,108 | 14 | 136 | 0 |
| Anoxic/anaerobic cell 1 | 142,400 | 1,360 | 14 | 136 | 0 |
| Anoxic/anaerobic cell 2 | 185,200 | 1,768 | 14 | 136 | 0 |
| Swing cell 1 | 170,900 | 1,632 | 14 | 136 | 0 or 5.3[a] |
| Swing cell 2 | 156,700 | 1,496 | 14 | 136 | 0 or 5.3[a] |
| Aerobic cell 1 | 384,600 | 3,672 | 14 | 136 | 5.3 |
| Aerobic cell 2 | 427,300 | 4,080 | 14 | 136 | 5.3 |
| Aerobic cell 3 | 327,600 | 3,128 | 14 | 136 | 3.0 |
| Aerobic cell 4 | 384,600 | 3,672 | 14 | 136 | 1.3 |
| Secondary clarifiers[b] | 1,674,000 | 15,700 | 14.25 | – | – |
| RAS denitrification basin | 74,300 | 1,387 | 7.16 | 20 | 0 |

a. *Depending on aeration status of swing cell; when aerated, a DO set point of 5.3 mg/L was used.*

b. *Assuming secondary clarifiers 4 and 5 are in service.*

The secondary clarifiers were initially set to remove a constant value of 99.81 percent of incoming solids; this value was adjusted very slightly during the simulations to achieve an effluent total suspended solids (TSS) of approximately 10 mg/L. The clarifier sludge blanket was assumed to be 7 percent of the settler height, and the clarifier solids underflow rate was paced at 50 percent of the PE. Initially set at 100,000 gallons per day (gpd), the WAS flow rate was adjusted during modeling to regulate the solids retention time (SRT) of the process.

Simulations were performed at summer and winter conditions. Aeration basin temperatures were either set at minimum or maximum seasonal values (14°C winter and 16°C [min] or 23°C [max] summer) or average seasonal values (16°C winter and 21°C summer), depending on the scenario being modeled.

Calibration parameters within the BioWin model were unchanged from the 2011 model. This resulted in several parameters differing from the current BioWin default, since the current version of BioWin (version 4.0 was used in this evaluation) differed from the version used in 2011 (version 3.2). However, side by side comparison of the 2011 calibration simulations and simulations run using BioWin 4.0 showed very little change. Table 2 summarizes some of the key simulator parameters which differ from version 4.0 default values.

| Table 2. Model Inputs Differing from BioWin 4.0 Defaults | | | |
|---|---|---|---|
| Parameter | Unit | BioWin Default | Model Value |
| Nitrite-oxidizing bacteria (NOB): | | | |
| Maximum specific growth rate | 1/d | 0.7 | 0.725 |
| Phosphorus accumulating organisms (PAOs): | | | |
| Sequestration rate | 1/d | 4.5 | 6.0 |
| Aerobic P/PHA uptake | mg P/mg COD | 0.93 | 0.95 |
| P/Ac release ratio | mg P/mg COD | 0.51 | 0.49 |

| Table 2. Model Inputs Differing from BioWin 4.0 Defaults | | | |
|---|---|---|---|
| Parameter | Unit | BioWin Default | Model Value |
| Switches: NH4 nutrient half sat. | mg N/L | 0.005 | 0.0001 |
| Cation to P mole ratio in polyphosphate | meq/mmol P | 0.15 | 0.3 |

# 3. Model Input File Development

Four types of model inputs were developed: PE, centrate, treated centrate, and fermentate. Inputs were developed for three basic conditions:

- present-day maximum month
- 2030 maximum month
- planning period midpoint average day

For each condition, separate inputs were developed for the summer and winter seasonal conditions.

## 3.1 Primary Effluent

PE is defined as raw influent (RI) treated in the plant's primary clarifiers. The PE input files do not include contributions from the dewatering centrate.

The present-day scenarios were developed based upon an assessment of historical RI flows and loadings. Data from 2009–14 were reviewed to determine current average loadings, along with peak month and peak day peaking factors, and day-to-day variability. These data are summarized in Table 3.

| Table 3. Historical Raw Influent Data Analysis[a] | | | | | |
|---|---|---|---|---|---|
| Parameter | RI Flow, mgd | RI BOD, lb/d | RI TSS, lb/d | RI $NH_4$-N, lb/d | RI TP, lb/d |
| Summer[b] | | | | | |
| Average | 5.8 | 14,000 | 14,000 | 1,400 | 300 |
| Max month | 6.6 | 16,250 | 17,300 | 1,700 | 350 |
| Max day | 7.5 | 22,000 | 24,000 | 2,000 | 420 |
| Standard Error[c] | 0.05 | 0.1 | 0.13 | 0.065 | 0.09 |
| Winter[b] | | | | | |
| Average | 5.1 | 14,500 | 13,750 | 1,570 | 310 |
| Max month | 5.7 | 16,500 | 16,250 | 1,800 | 345 |
| Max day | 6.4 | 21,000 | 28,000 | 1,950 | 375 |
| Standard Error[c] | 0.05 | 0.1 | 0.13 | 0.065 | 0.08 |

a. *The values in this table reflect averages over the period from 2009–14.*

b. *Summer data include May–September; winter data include November–March.*

c. *The standard error is calculated by dividing the standard deviation by the mean value. The values in the table represent the average variability in that data over a 30-day period.*

The 2030 scenarios were taken from the Facilities Plan, and are summarized in Table 4.

| Table 4. Facilities Plan 2030 Residential/Commercial Flows and Loads[a] | | | | | |
|---|---|---|---|---|---|
| Parameter | Unit | Average | Maximum Month | Maximum Week | Maximum Day |
| Flow | mgd | 12.2 | 14.2 | 15.5 | 17.2 |
| BOD | lb/d | 27,100 | 34,900 | 42,900 | 46,500 |
| TSS | lb/d | 26,700 | 34,500 | 41,700 | 45,900 |
| $NH_4$-N | lb/d | 3,200 | 3,900 | 4,200 | 4,900 |
| TKN | lb/d | 4,900 | 5,500 | 5,800 | 6,400 |
| TP | lb/d | 660 | 850 | 1070 | 1100 |
| $PO_4$-P | lb/d | 330 | 430 | 500 | 580 |

a. *Table 3-4 of the Facilities Plan.*

Influent loadings (Table 3) were used to develop the present-day scenarios, the Facilities Plan projections (Table 4) were used to develop 2030 scenarios, and other projections were based on linear extrapolation between those two datasets. Primary clarifier removal of TSS and biochemical oxygen demand (BOD) were estimated using a pair of empirical models, based on historical performance.

The primary clarifier TSS removal model is based on the following equation, which relates performance to the influent TSS concentration ($TSS_{inf}$) and the surface overflow rate (SOR, gpd/ft$^2$):

$$\text{TSS removal} = E_o \exp(-b/TSS_{inf} - c*SOR)$$

The model was first proposed by Tebbutt and Christoulas (1975) and reprinted in Wahlberg (1997). In the equatino, $E_o$, b, and c are regression parameters. The model was calibrated against daily operating data from 2009–14, resulting in the following fit:

- $E_o$ = 0.9566
- b = 83.999
- c = 0

The historical data are plotted against the model on Figure 3.

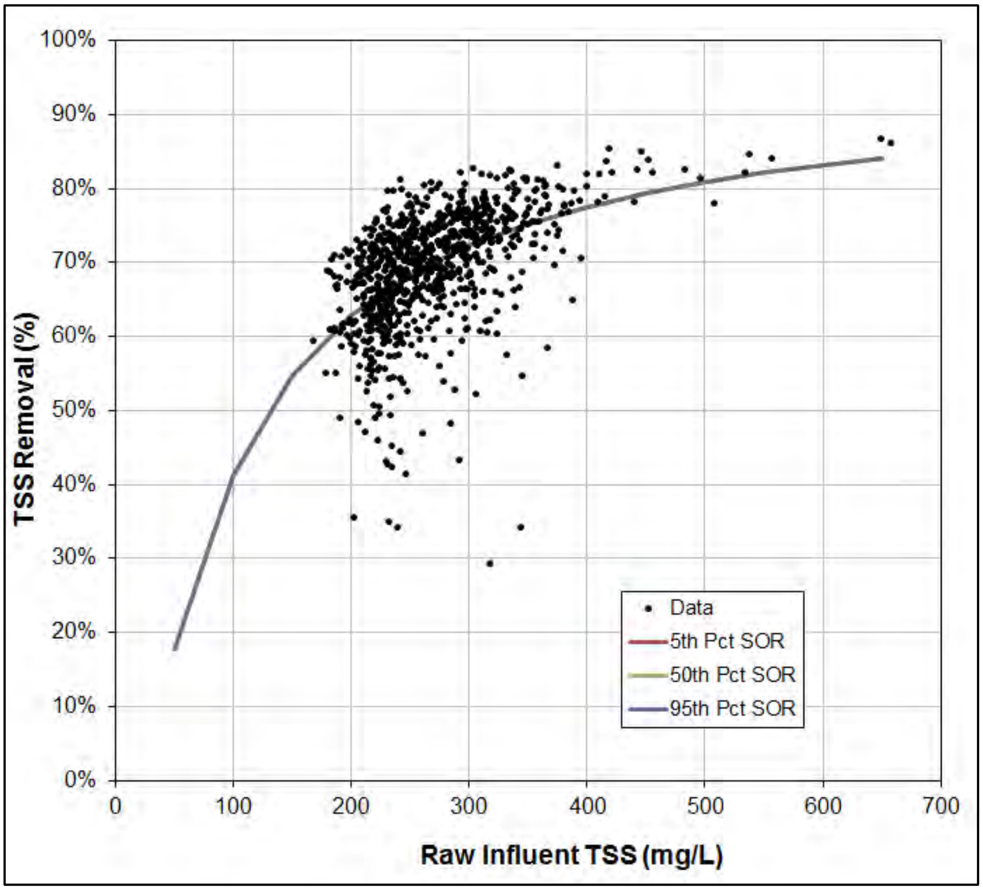


**Figure 3. Primary clarifier TSS removal model**

The model projects zero dependence of performance on SOR (the 5th, 50th, and 95th percentile SOR lines on Figure 3 overlap, so only the 95th percentile curve is visible), which suggests that the primary clarifiers have historically not been stressed in terms of hydraulic capacity. In fact, the highest daily SOR recorded in the 2009–14 period is 799 gallons per day per square foot (gpd/ft$^2$), which is quite low (primary clarifiers are commonly designed to a peak SOR up to 3,000 gpd/ft$^2$).

The model fit is rather poor, with a negative R squared value. This means that a better fit would be obtained by simply assuming the average removal over the entire period, versus using the model. Even so, the model provides a conservative approximation of clarifier performance under typical conditions, with a root-mean-squared-error (RMSE) of 6.6 percent. The poor model fit is likely the result of the clarifiers never being stressed, and performance appears to be linked more closely to random factors such as influent characteristics rather than to the design and operation of the clarifiers themselves.

The primary clarifier BOD removal model takes the form of the following equation, which relates BOD removal to the influent BOD ($BOD_{inf}$) and TSS concentrations, as well as to the clarifier's TSS removal rate:

$$BOD\ removal = 1 - [A+B*TSS_{inf}/BOD_{inf}*(1\text{-}TSS\ removal)]$$

where A and B are regression parameters. The model was calibrated against daily operating data from 2009–14, resulting in the following fit:

- A = 0.366
- B = 1.016

The historical data are plotted against the model output on Figure 4.

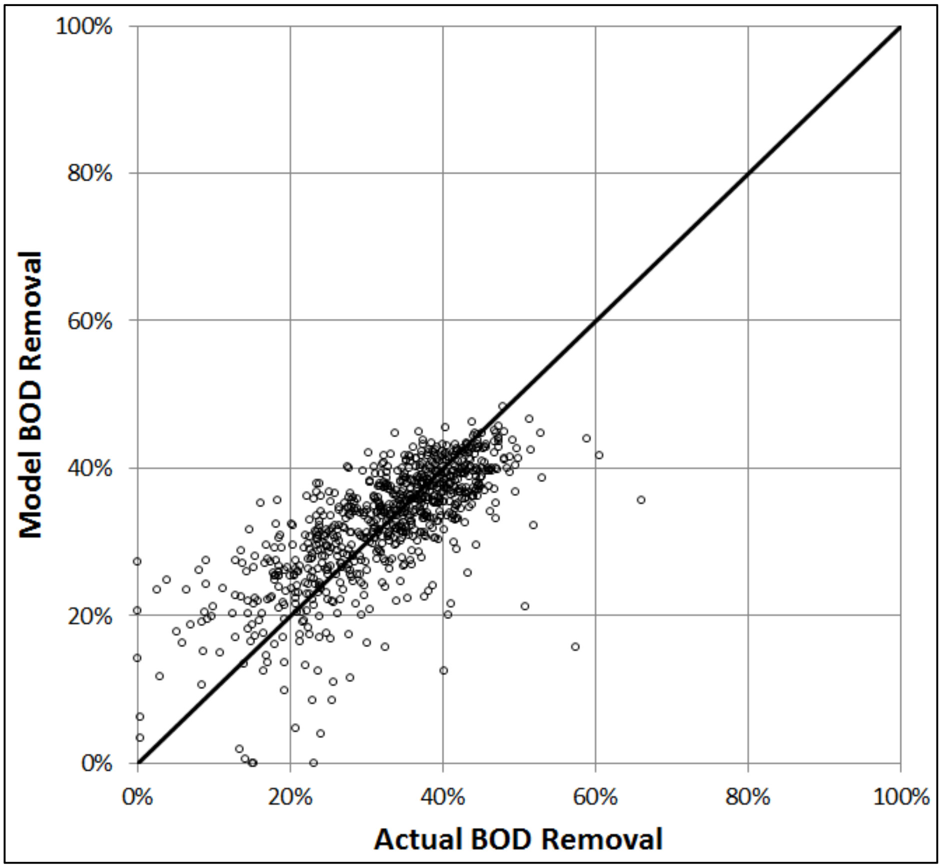


**Figure 4. Primary clarifier BOD removal model**

In this case, the model fits with a positive R squared (0.26), and an RMSE of 6.8 percent.

The primary clarifier performance models were used to translate RI BOD and TSS projections into PE loadings. RI total Kjeldahl nitrogen (TKN) and total phosphorus (TP) loadings were assumed to pass through the primary clarifiers unchanged. $NH_4$-N loadings based on Table 3 were translated into TKN loadings using the following ratio:

- RI $NH_4$-N/TKN = 0.65

which is based on historical averages over the period 2009–14.

Other assumptions include the following:

- PE pH was 7.8 in the summer and 7.9 in the winter, based on historical RI data from 2009–14.
- PE alkalinity was 304 mg/L calcium carbonate ($CaCO_3$), based on data from the May 2011 wastewater characterization.

- PE volatile suspended solids (VSS):TSS ratio was 0.86, based on the May 2011 wastewater characterization.
- PE chemical oxygen demand (COD):BOD ratio was 2.10, based on the May 2011 wastewater characterization.

The PE inputs for each of the model scenarios are summarized in Table 5.

**Table 5. Primary Effluent Characteristics for each Model Scenario**

| Year | 2030 | 2030 | Current | Current | Midpoint | Midpoint |
|---|---|---|---|---|---|---|
| Season | Summer | Winter | Summer | Winter | Summer | Winter |
| Flow condition | Max month | Max month | Max month | Max month | Average day | Average day |
| Load condition | Max month | Max month | Max month | Max month | Average day | Average day |
| Raw Influent Loadings (from Tables 3 and 4) | | | | | | |
| BOD lb/d | 34,900 | 34,900 | 16,250 | 16,500 | 20,550 | 20,800 |
| TSS lb/d | 34,500 | 34,500 | 17,300 | 16,250 | 20,350 | 20,225 |
| TKN lb/d | 5,500 | 5,500 | 2,615 | 2,769 | 3,527 | 3,658 |
| TP lb/d | 850 | 850 | 350 | 345 | 480 | 485 |
| Primary Clarifier Performance (from empirical models) | | | | | | |
| Primary TSS rem % | 71.7% | 74.6% | 73.2% | 74.8% | 69.4% | 72.0% |
| Primary BOD rem % | 34.9% | 37.8% | 34.4% | 38.2% | 32.6% | 35.7% |
| Primary Effluent Characteristics (BioWin inputs) | | | | | | |
| Flow, mgd | 14.2 | 12.3 | 6.6 | 5.7 | 9.3 | 8.2 |
| COD, mg/L | 403 | 446 | 407 | 451 | 374 | 410 |
| TKN, mg/L | 46.4 | 53.7 | 47.5 | 58.2 | 45.3 | 53.4 |
| TP, mg/L | 7.2 | 8.3 | 6.4 | 7.3 | 6.2 | 7.1 |
| NOx, mg/L | 0 | 0 | 0 | 0 | 0 | 0 |
| pH | 7.8 | 7.9 | 7.8 | 7.9 | 7.8 | 7.9 |
| Alkalinity, mg/L $CaCO_3$ | 304 | 304 | 304 | 304 | 304 | 304 |
| ISS, mg/L | 11.3 | 11.8 | 11.5 | 11.8 | 11.0 | 11.4 |

The PE characteristics were translated into 30-day, hourly model input files according to the following procedure.

Day-to-day variability in loadings was based on the standard errors presented in Table 3. It was assumed that the PE variability in flow, COD, TKN, TP, and inert suspended solids (ISS) would match the RI variability in flow, BOD, $NH_4$-N, TP, and TSS, respectively.

Maximum day loadings were incorporated into maximum month scenarios using peaking factors developed from the historical data (Table 3), or as presented in the Facilities Plan.

Diurnal variability was based on a diurnal normalization of key parameters developed during the May 2011 wastewater characterization. The values from the 2011 characterization are plotted on Figure 5.

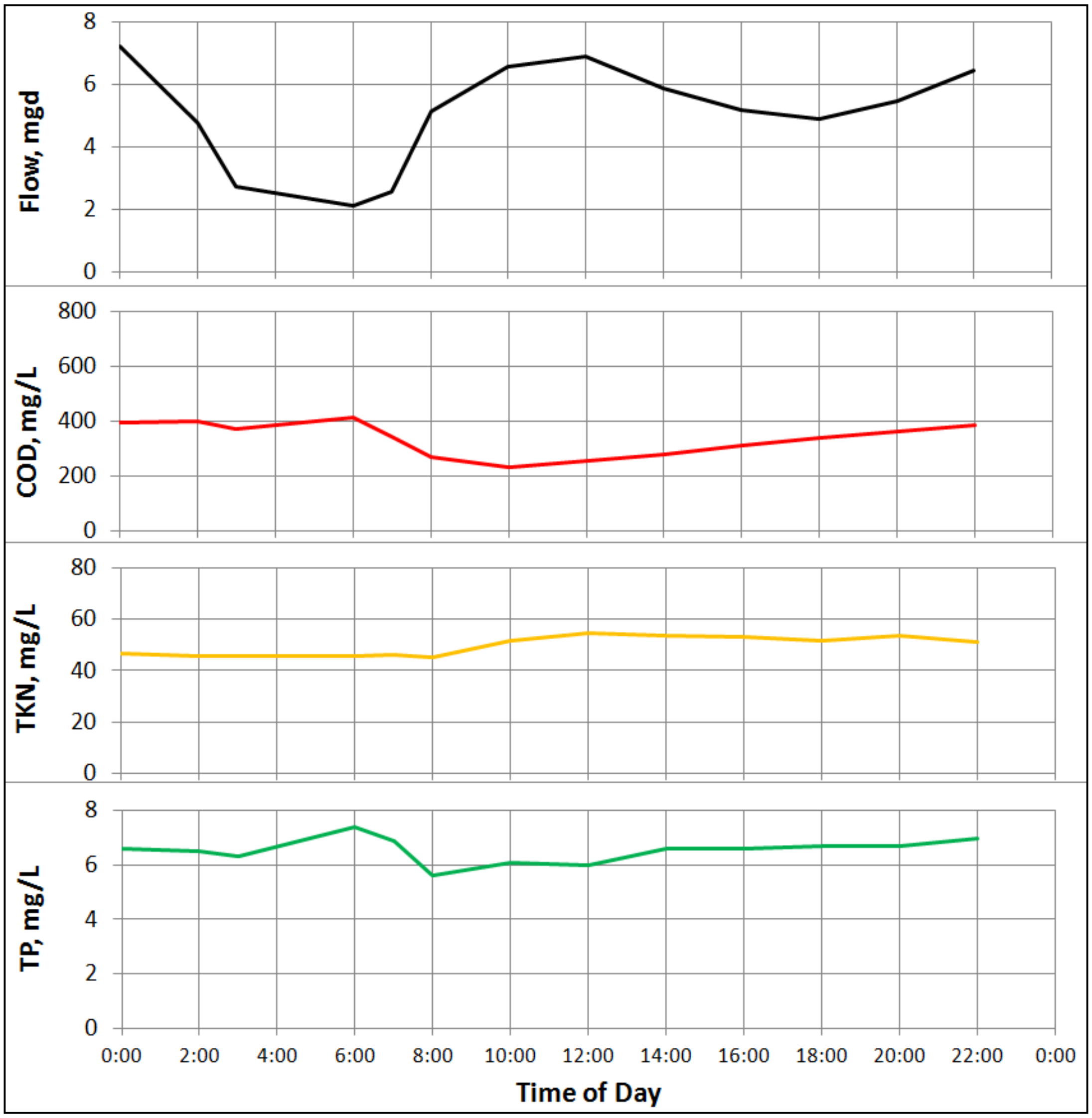


**Figure 5. Diurnal variability of raw influent parameters (from May 2011 wastewater characterization)**

Figure 6 presents the randomized 30-day model input file for the 2030 summer maximum month condition. This input file includes a peak day flow of 16.9 mgd, which occurs on day 3 of the scenario, a peak day TKN load of 6,320 pounds (lb), which occurs on day 17 of the scenario, and a peak day TP load of 1,080 lb, which occurs on day 23 of the model. These values are all within 12 percent of Facilities Plan peak day projections (Table 3); the small deviation reflects the inherent randomization of the model file development.

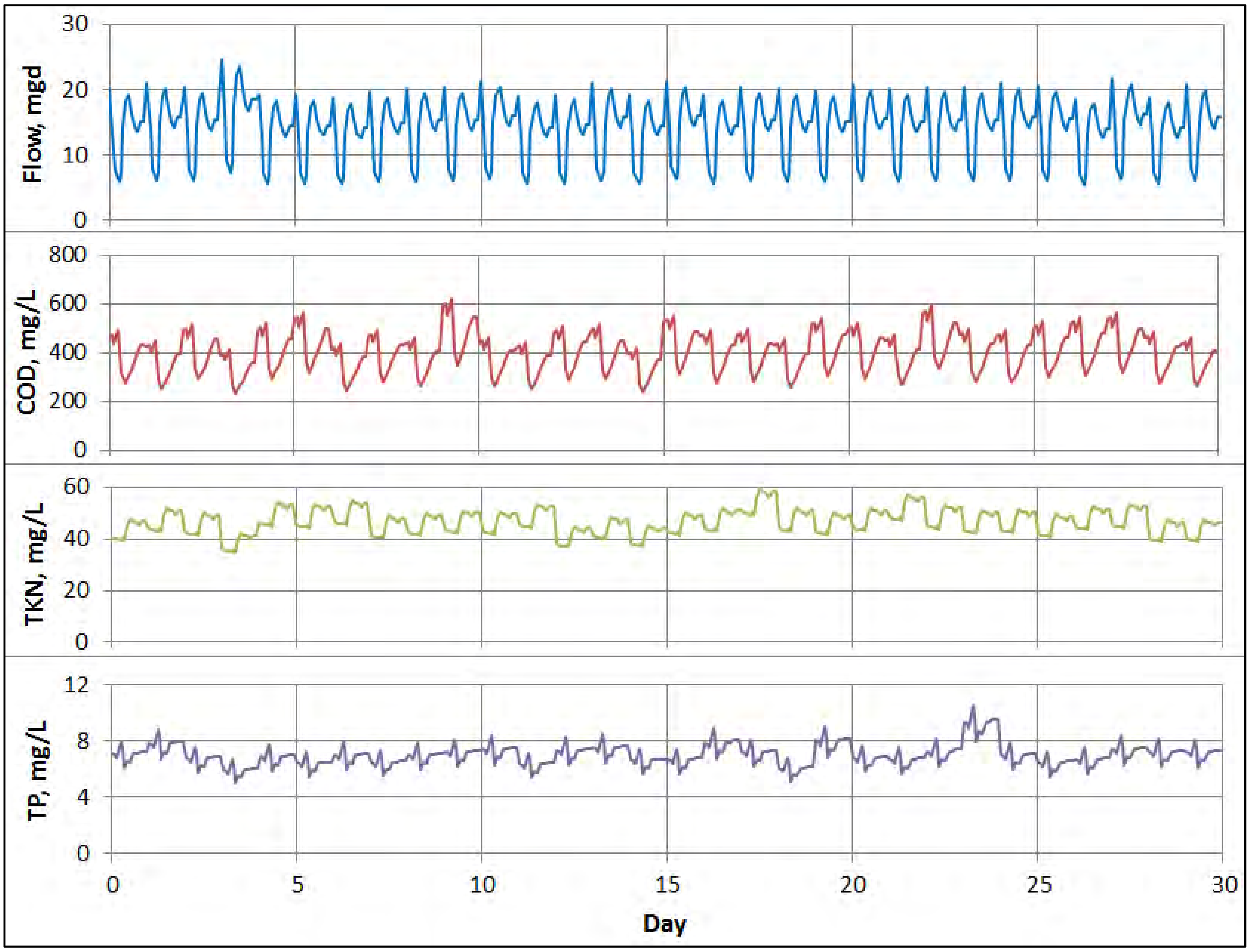


Figure 6. 2030 summer maximum month model input parameters

## 3.2 Centrate

Centrate parameters were developed based on the following sources of information:

- Facilities Plan. Table 5-1 in the Facilities Plan summarizes projected centrate characteristics for the 2030 maximum month condition. The basis of these projections is not known. This table is reproduced below as Table 6.

| Table 6. Facilities Plan Centrate Projections[a] | | | |
|---|---|---|---|
| Parameter | Unit | 2010 | 2030 |
| Flow | mgd | 0.045 | 0.103 |
| TKN | mg/L | 1,108 | 960 |
| $NH_4$-N | mg/L | 1,057 | 910 |
| TP | mg/L | 501 | 530 |
| $PO_4$-P | mg/L | 489 | 520 |
| TSS | mg/L | 711 | 640 |
| VSS | mg/L | 522 | 455 |
| BOD | mg/L | 173 | 315 |
| COD | mg/L | 1,756 | 1,805 |
| Alkalinity | mg/L $CaCO_3$ | 3,625 | 4,100 |

a. *Table 5-1 of the Facilities Plan.*

- Historical plant data. The plant collects weekly data on centrate $NH_4$-N and TSS, and monthly data on centrate TP. These data were used to project the typical variability in centrate characteristics. As centrate flow is not actively metered, centrate flow was assumed to be equal to the "gallons dewatered," which is recorded in the plant's data historian. The historical data are summarized in Table 7.

| Table 7. Historical Centrate Data Analysis[a] | | | | |
|---|---|---|---|---|
| Parameter | $NH_4$-N | TSS | TP | Gallons Dewatered |
| Unit | mg/L | mg/L | mg/L | gpd |
| Summer[b] | | | | |
| Average | 865 | 185 | 165 | 54,000 |
| Max month | 945 | 270 | – | 68,000 |
| Standard Error[c] | 0.050 | 0.36 | – | 0.185 |
| Winter[b] | | | | |
| Average | 850 | 145 | 170 | 59,000 |
| Max month | 930 | 230 | – | 70,000 |
| Standard Error[c] | 0.045 | 0.28 | – | 0.15 |

a. *The values in this table reflect averages over the period from 2009–14.*

b. *Summer data include May–September; winter data include November–March.*

c. *The standard error is calculated by dividing the standard deviation by the mean value. The values in the table represent the average variability in that data over a 30-day period.*

- Data from other plants. Detailed centrate characterization data from the Chambers Creek Regional WWTP in Pierce County, Washington, were used to define the input fractions when information on the Meridian centrate stream was not available. Table 8 summarizes the centrate input parameters.

| Table 8. Centrate Parameters | | |
|---|---|---|
| Parameter | Value | Source |
| Total COD, mgCOD/L | 1,802 | Facilities Plan |
| Total Kjeldahl nitrogen, mgN/L | 960 | Facilities Plan |
| Total P, mgP/L | 530 | Facilities Plan |
| Nitrate N, mgN/L | 0 | Chambers Creek |
| pH | 7.9 | Chambers Creek |
| Alkalinity, mmol/L | 82 | Facilities Plan |
| Inorganic S.S., mgISS/L | 185 | Facilities Plan |
| Calcium, mg/L | 24.8 | Chambers Creek |
| Magnesium, mg/L | 2.72 | Chambers Creek |
| Dissolved oxygen, mg/L | 0 | Chambers Creek |
| Fractions | | |
| Fbs: readily biodegradable | 0.595 | Calculated[a] |
| Fac: acetate | 0.039 | Calculated[a] |
| Fxsp: non-colloidal slowly biodegradable | 0.993 | Calculated[a] |
| Fus: unbiodegradable soluble | 0.0039 | Calculated[a] |
| Fup: unbiodegradable particulate | 0.320 | Calculated[a] |
| Fna: ammonia | 0.900 | Calculated[a] |
| Fnox: particulate organic nitrogen | 0.509 | Calculated[a] |
| Fnus: soluble unbiodegradable TKN | 0.015 | Calculated[a] |
| FupN: N:COD ratio for unbiodegradable part. COD | 0.051 | Calculated[a] |
| Fpo4: phosphate | 0.850 | Calculated[a] |
| FupP: P:COD ratio for unbiodegradable part. COD | 0.064 | Calculated[a] |

*a. Fractions were calculated based on a combination of data from the Facilities Plan and Chambers Creek.*

A 30-day randomized centrate itinerary was developed. Day-to-day variability (Figure 7) was based on historical data for flow, $NH_4$-N (used as surrogate for TKN), and TSS (used as surrogate for ISS). Other parameters were held constant over the 30 days. The centrate was assumed to be returned continuously over each 24-hour period. No diurnal variability in centrate flow was modeled.

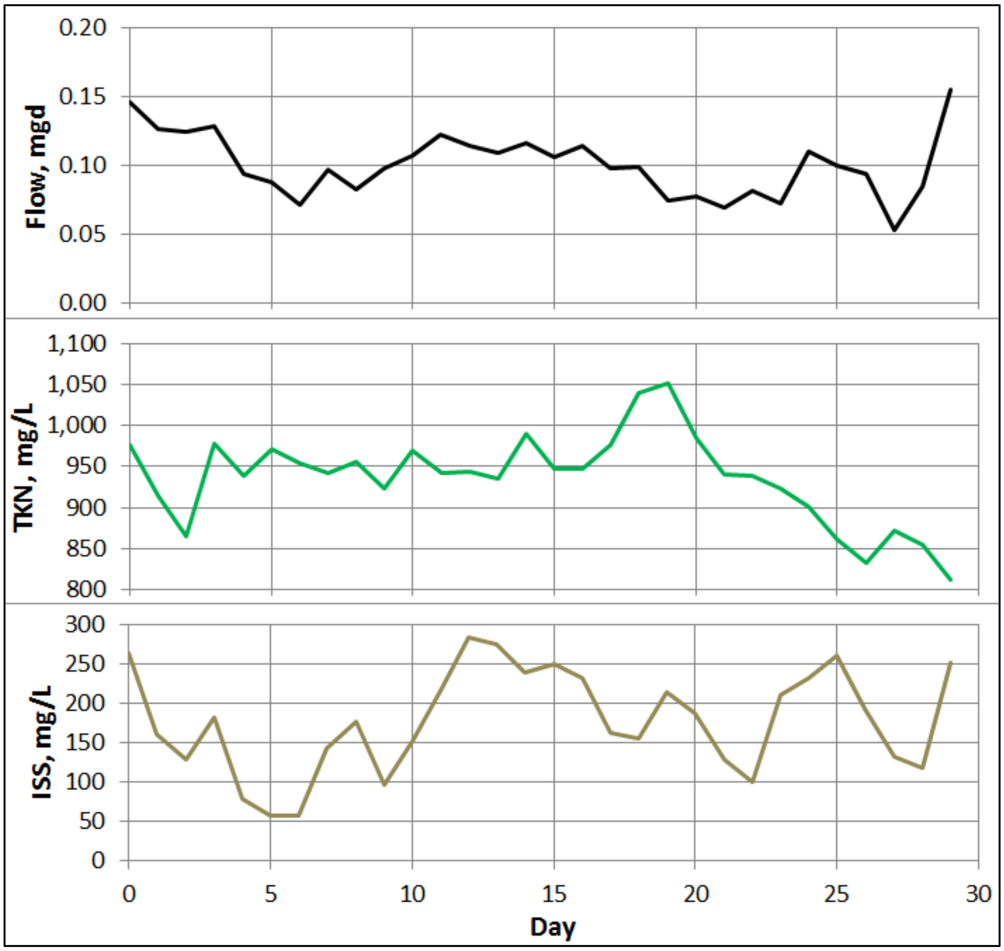


**Figure 7. Centrate input variability**

## 3.3 Treated Centrate

Centrate was assumed to be treated by an Anammox-type process. The process was assumed to remove 80 percent of the centrate ammonia and 75 percent of the centrate total inorganic nitrogen (TIN) based on performance data from worldwide installations. The Anammox effluent characteristics were based on data from the pilot investigation at Chambers Creek. Input parameters are summarized in Table 9.

| Table 9. Treated Centrate Parameters | | |
|---|---|---|
| Parameter | Value | Source |
| Total COD mgCOD/L | 1,081 | Chambers Creek |
| Total Kjeldahl nitrogen mgN/L | 195 | Chambers Creek |
| Total P mgP/L | 478 | Chambers Creek |
| Nitrate N mgN/L | 37 | Chambers Creek |
| pH | 6.76 | Chambers Creek |
| Alkalinity mmol/L | 13.2 | Chambers Creek |
| Inorganic S.S. mgISS/L | 68 | Chambers Creek |
| Calcium mg/L | 24.8 | Chambers Creek |
| Magnesium mg/L | 2.72 | Chambers Creek |
| Dissolved oxygen mg/L | 0 | Chambers Creek |
| Fractions | | |
| Fbs: readily biodegradable | 0.0014 | Chambers Creek |
| Fac: acetate | 0.00043 | Chambers Creek |
| Fxsp: non-colloidal slowly biodegradable | 0.998 | Chambers Creek |
| Fus: unbiodegradable soluble | 0.598 | Chambers Creek |
| Fup: unbiodegradable particulate | 0.087 | Chambers Creek |
| Fna: ammonia | 0.884 | Chambers Creek |
| Fnox: particulate organic nitrogen | 0.500 | Chambers Creek |
| Fnus: soluble unbiodegradable TKN | 0.010 | Chambers Creek |
| FupN: N:COD ratio for unbiodegradable part. COD | 0.032 | Chambers Creek |
| Fpo4: Phosphate | 0.943 | Chambers Creek |
| FupP: P:COD ratio for unbiodegradable part. COD | 0.128 | Chambers Creek |

A randomized 30-day itinerary of treated centrate characteristics were developed. Day-to-day variability was based on that observed during the Chambers Creek pilot investigation. Because the side stream treatment system is a process, the treated centrate characteristics have limited variability from one day to the next, and instead tend to follow a trend. In this input file, the COD and TKN trends both follow a pattern of gradual decline across the 30-day itinerary. Maximum and minimum values, along with the overall variability, match that observed in the Chambers Creek pilot investigation.

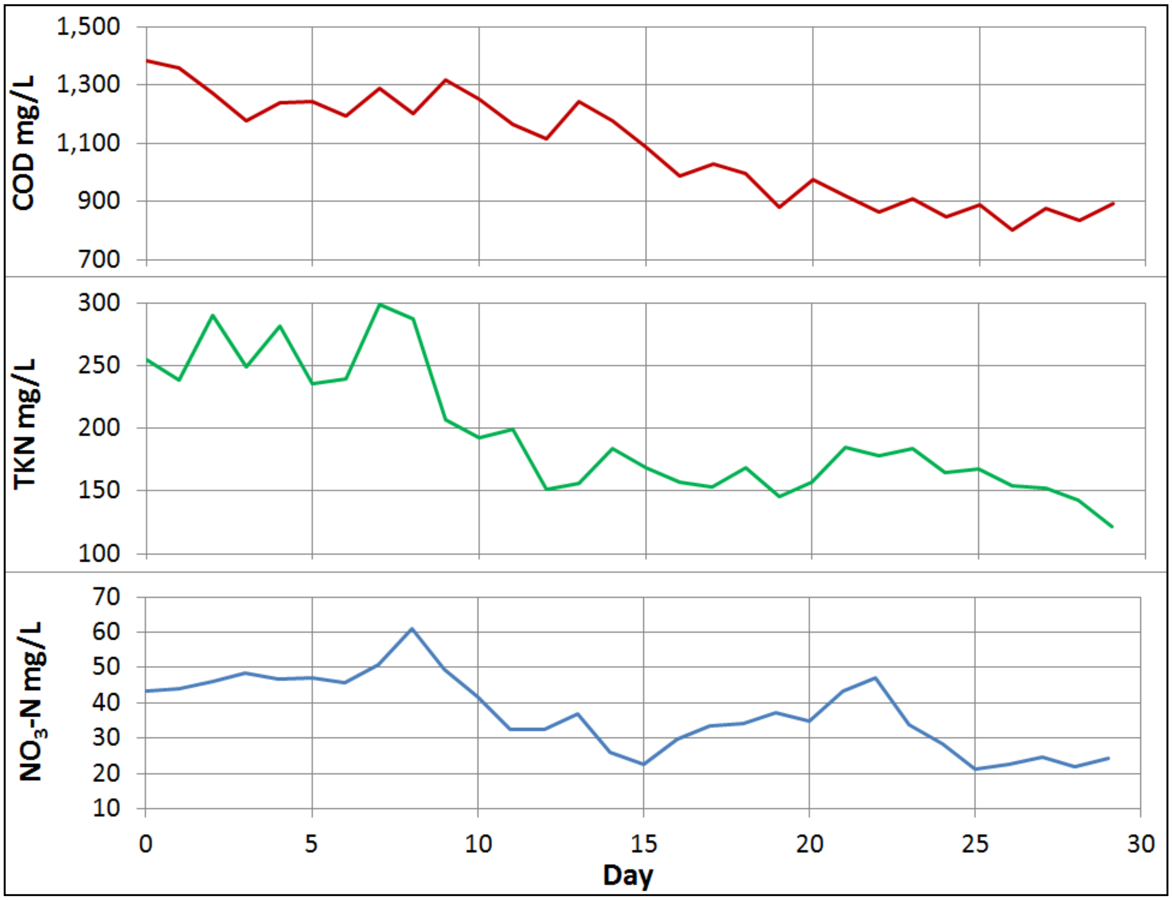


**Figure 8. Treated centrate input variability**

Treated centrate flows were assumed to be identical to the centrate flows assumed for the cases without side stream treatment. Treated centrate was assumed to be returned continuously over each 24-hour period. No diurnal variability in treated centrate flow was modeled.

## 3.4 Fermentate

The primary sludge fermenter was modeled using characteristics primarily developed from other facilities. At the time of modeling, very little data was available for the Plant fermenter, which was out of service during the winter season. For that reason, discussion of the fermenter in this document is limited, and no conclusions should be drawn about the role of the fermenter in the treatment process until further data are collected.

Fermentate characteristics were based on the following sources of data:

- Data from August through October 2014, when the fermenter was in service. Table 10 summarizes the data from this period.

| Table 10. Meridian Fermenter Data from August–October 2014[a,b,c] | | | | | | |
|---|---|---|---|---|---|---|
| Parameter | Feed | Fermented Primary Solids | Thickened Fermented Primary Solids | Recycle | Elutriation | Fermentate |
| Flow, gpd | 53,250 | 58,360 | 26,700 | 71,310 | 275,300 | 291,300 |
| Solids concentration, %TS | 3.29 | 2.67 | 3.56 | | | |
| TSS, mg/L | | | | | | 765 |
| pH | 6.36 | 5.07 | 5.31 | | | 5.97 |
| Volatile acids, mg/L | | | | | | 391 |
| Solids load, lb/d TS | 14,600 | 13,000 | 7,900 | | | 1,860 |
| Volatile acid load, lb/d | | | | | | 950 |

a. *Data represent averages from period spanning 8/20/2014 through 10/15/2014.*

b. *Limited data available for many of these parameters.*

c. *Data reflects grab sampling.*

Although not specified, it was assumed that the volatile acids measured was specific to acetate, the 391 mg/L would translate to 423 mg/L as COD. As it is likely that other volatile acids were present, the model has assumed an average volatile fatty acid (VFA) concentration of 450 mg/L as COD.

The VFA production per pound of feed solids projects to 0.065 lb acetate/lb TSS. Converting to COD units increases this to 0.070 lb COD/lb TSS.

- Data from bench-scale testing conducted at Chambers Creek.
- Data from bench-scale testing conducted at the Pueblo, Colorado, facility.

Table 11 summarizes the fermentate input characteristics used in the model.

| Table 11. Fermentate Parameters | | |
|---|---|---|
| Parameter | Value | Source |
| Ratios and Assumed Concentrations | | |
| VFA/sCOD | 0.333 | Chambers Creek |
| RBCOD/sCOD | 0.953 | Chambers Creek |
| COD/sCOD | 0.507 | Chambers Creek |
| VSS/TSS | 0.950 | Chambers Creek |
| VFA, mg COD/L | 450 | 2014 data |
| TSS, mg/L | 750 | 2014 data |
| Input Values | | |
| Total COD mgCOD/L | 2,672 | Calculated |
| Total Kjeldahl nitrogen mgN/L | 100 | Chambers Creek, Pueblo |
| Total P mgP/L | 150 | Chambers Creek |
| Nitrate N mgN/L | 0 | Chambers Creek |
| pH | 6.0 | 2014 data |
| Alkalinity mmol/L | 7.36 | Chambers Creek |
| Inorganic S.S. mgISS/L | 38 | Calculated |
| Calcium mg/L | 160 | BioWin default |
| Magnesium mg/L | 30 | BioWin default |
| Dissolved oxygen mg/L | 0 | BioWin default |
| Fractions | | |
| Fbs: readily biodegradable | 0.482 | Calculated[a] |
| Fac: acetate | 0.350 | Calculated[a] |
| Fxsp: non-colloidal slowly biodegradable | 0.999 | Calculated[a] |
| Fus: unbiodegradable soluble | 0.023 | Calculated[a] |
| Fup: unbiodegradable particulate | 0.165 | Calculated[a] |
| Fna: ammonia | 0.499 | Calculated[a] |
| Fnox: particulate organic nitrogen | 0.500 | Calculated[a] |
| Fnus: soluble unbiodegradable TKN | 0.100 | Calculated[a] |
| FupN: N:COD ratio for unbiodegradable part. COD | 0.028 | Calculated[a] |
| Fpo4: phosphate | 0.500 | Calculated[a] |
| FupP: P:COD ratio for unbiodegradable part. COD | 0.085 | Calculated[a] |

a. *Fractions were calculated based on a combination of data from the Plant, Chambers Creek, and Pueblo.*

One of the key parameters absent from the Meridian data is the nitrogen content of the fermentate. At Chambers Creek, the fermentate had a very high TKN (> 200 mg/L). At Pueblo, the TKN content was not measured, but the $NH_4$-N concentration was only 24 mg/L. For this evaluation, a fermentate TKN of 100 mg/L is assumed.

Fermentate was assumed to be added at a constant flow rate over the 30-day input period.

# 4. Target Conditions

The goal of each modeling scenario was to generate effluent characteristics that conform to a set of target conditions. The target conditions were based on draft NPDES permit documents, as well as operational targets discussed with City staff prior to the modeling effort. Target conditions were developed for ammonia, oxidized nitrogen (NOx-N), and $PO_4$-P.

The draft NPDES permit includes limits for TP, BOD, TSS, ammonia, and a variety of other parameters, including metals. Table 12 summarizes the permit limits that relate directly to this evaluation.

Table 12. October 2014 Draft NPDES Permit (all values in mg/L)

| | Discharge Location 001, Fivemile Creek | | | | | Discharge Location 002, Boise River | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Period | Season | Month | Week | Day | Period | Season | Month | Week | Day |
| Summer | | | | | | | | | | |
| BOD | May–Sept | – | 20 | 30 | – | May–Sept | – | 30 | 45 | – |
| TSS | May–Sept | – | 20 | 30 | – | May–Sept | – | 30 | 45 | – |
| TP | May–Sept | 0.12 | – | – | | May–Sept | – | 0.07 | 0.165 | – |
| $NH_4$-N | May–Sept | – | 0.405 | – | 1.65 | July–Oct | – | 0.242 | – | 1.06 |
| Winter | | | | | | | | | | |
| BOD | Oct–April | – | 20 | 30 | – | Oct–April | – | 30 | 45 | – |
| TSS | Oct–April | – | 20 | 30 | – | Oct–April | – | 30 | 45 | – |
| TP | Oct–April | – | – | – | – | Oct–April | – | – | – | – |
| $NH_4$-N | Oct–April | – | 0.307 | – | 1.25 | Nov–Jun | – | 0.255 | – | 1.04 |

## 4.1 Ammonia

Draft NPDES permit documents specify maximum day ammonia limits for the summer and winter conditions. The limits for discharge location 001 (Fivemile Creek) have been used as the basis of this evaluation, as that is the primary discharge location.

- summer: 1.65 mgN/L
- winter: 1.25 mgN/L

The monthly average ammonia limitations included in Table 12 were often more restrictive than the peak day limits. These limits were also considered when assessing capacity.

## 4.2 Oxidized Nitrogen

Oxidized nitrogen can denitrify within the secondary clarifier, resulting in bubbling of nitrogen gas, which can impair mixed liquor settleability. In order to reduce the risk of clarifier denitrification, the target effluent oxidized nitrogen (NOx-N) concentration was set at 8.0 mg/L (monthly average). Maintaining an effluent NOx-N less than 8.0 mg/L will also guarantee that effluent TN remains less than 15.5 mg/L, as required for Class A reclaimed water.

## 4.3 Phosphorus

Draft NPDES permit documents specify restrictions on phosphorus in the effluent. This will likely require the plant to commence chemical addition to remove phosphorus. To reduce chemical demands, biological phosphorus removal should be maximized. The modeling effort aimed to minimize effluent orthophosphate, as much as reasonably possible, giving priority to meeting the above targets for ammonia and oxidized nitrogen. A PO4-P concentration of less than 0.1 mg/L was used as a goal.

# 5. Secondary Clarifier Capacity

The capacity of the secondary process is constrained by the ability of the secondary clarifiers to retain mixed liquor solids. The capacity of the secondary clarifiers was defined in the Facilities Plan on the basis of the solids loading rate (SLR) to be 36.5 lb/d/ft$^2$, and on the basis of the SOR to be 1,200 gpd/ft$^2$. Both of these capacity projections were based on an assumed mixed liquor sludge volume index (SVI) of 120 mL/g.

The plant has three secondary clarifiers: two with a diameter of 100 feet, and one with an 80-foot diameter. For the purpose of capacity modeling, the smaller unit has been assumed to remain out of service. The SOR capacity of 1,200 gpd/ft$^2$ would equate to an effluent flow of 18.8 mgd with the two larger clarifiers in service. This flow exceeds the projected maximum day flow in the Facilities Plan (17.2 mgd), but is less than the projected maximum hour flow (28.0 mgd). Even with all three clarifiers in service, the SOR capacity would equate to an effluent flow of 24.9 mgd, which is less than the projected peak hour flow. At peak hour flows, the clarifiers may experience a rising sludge blanket. If sustained, this could lead to loss of solids in the effluent. However, the nature of the peak hour flow implies a short duration, so it may be possible to absorb such flows provided that the sludge blanket is typically maintained at a low level. For the purpose of this evaluation, clarifier capacity will be judged against peak month and peak day conditions.

The peak hour condition will be revisited as part of the upcoming plant capacity assessment.

The SLR capacity of 36.5 lb/d/ft$^2$ is specific to the SVI condition projected in the Facilities Plan (120 mL/g). Typically, plant capacity is determined based on the 90th or 95th percentile of historical SVI data. Historical SVI data are plotted on Figure 9.

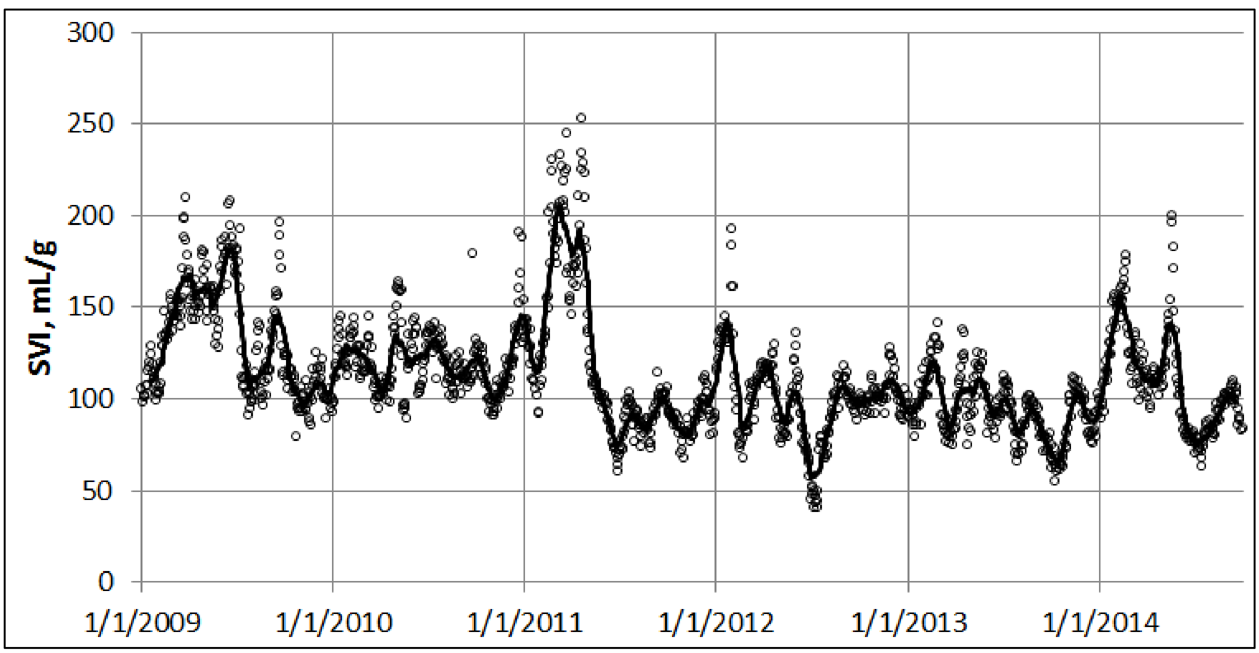


**Figure 9. Mixed liquor SVI with 30-day moving average**

Over the past 5 years, the 95th percentile SVI was 177 mL/g. This is influenced by the spike in SVI observed in early 2011, which was likely related to the *Microthrix* issues observed at that time. If the period of analysis is limited to 1 or 3 years, the 95th percentile SVI is closer to 150 mL/g.

State point analysis (SPA) is a graphical technique that may be used to estimate the capacity of secondary clarifiers, given inputs of effluent flow, RAS flow, MLSS concentration, and SVI. The SPA model may be calibrated to a specific treatment plant or SVI condition through detailed settling tests. In the absence of such tests, several "generic" correlations exist, based on observations at a number of facilities. One such correlation, developed by Wahlberg and Keinath (1988), has been used to project the capacity of the two larger clarifiers, at SVIs of 150 and 177 mL/g, over a range of flow and MLSS conditions (Figure 10).

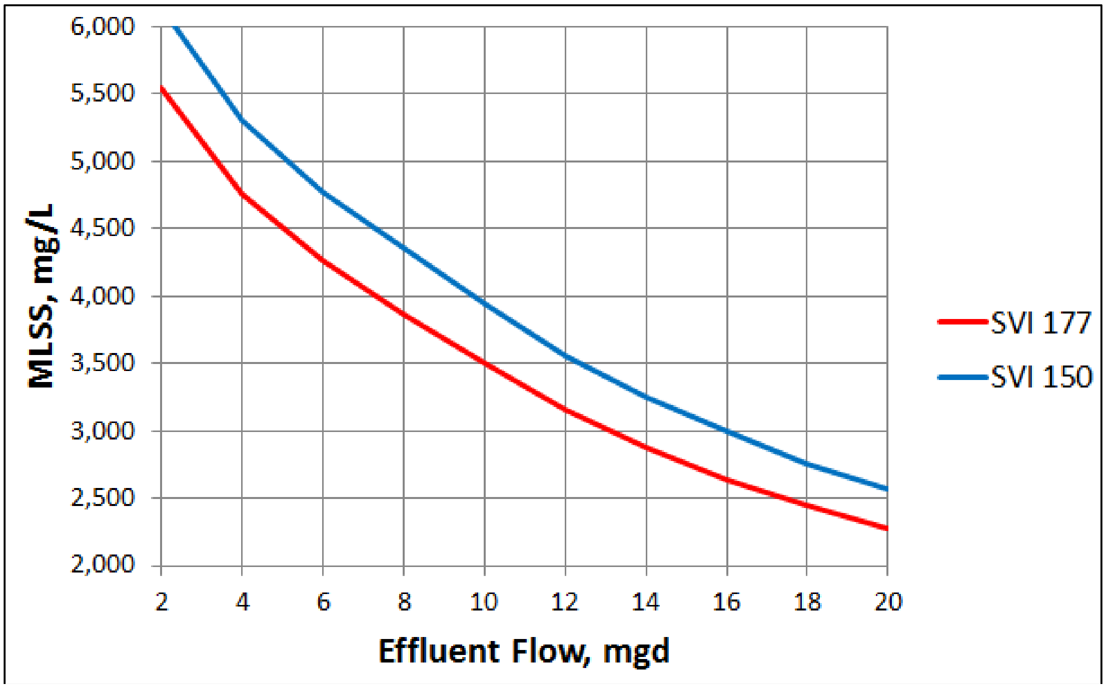


**Figure 10. Combined capacity of secondary clarifiers 4 and 5, based on state point analysis**

*Capacity with RAS flow capped at 8.64 mgd, which is the capacity of the existing system.*

For context, at an effluent flow of 10 mgd, a RAS flow of 8.64 mgd, and an MLSS concentration of 3,500 mg/L, the SLR would be 34.7 lb/d/ft$^2$.

# 6. Model Scenarios

A total of 16 scenarios were modeled as part of this evaluation. The scenarios are summarized in Table 13 and discussed in the following sections.

| Table 13. Summary of Conditions for All Simulations | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Case | Year | Flow | Load | Season | Side stream? | Fermentate? | Digester Cleanout? | Swing 1 Air | Swing 2 Air |
| Scenarios to Evaluate Infrastructure Requirements | | | | | | | | | |
| 001 | 2030 | Max month | Max month | Summer | No | Yes | No | Off | Off |
| 002 | 2030 | Max month | Max month | Winter | No | Yes | No | Off | On |
| 003 | 2030 | Max month | Max month | Summer | Yes | Yes | No | Off | Off |
| 004 | 2030 | Max month | Max month | Winter | Yes | Yes | No | Off | On |
| Scenarios to Evaluate Average Operating Costs | | | | | | | | | |
| 007 | Midpoint | Average day | Average day | Summer | No | Yes | No | Off | Off |
| 008 | Midpoint | Average day | Average day | Winter | No | Yes | No | Off | On |
| 009 | Midpoint | Average day | Average day | Summer | Yes | Yes | No | Off | Off |
| 010 | Midpoint | Average day | Average day | Winter | Yes | Yes | No | Off | On |
| Scenarios to Evaluate Capacity of Existing System | | | | | | | | | |
| 011 | Current | Max month | Max month | Summer | No | Yes | No | Off | Off |
| 012 | Current | Max month | Max month | Winter | No | Yes | No | Off | On |
| 013 | 75% Current | Max month | Max month | Summer | No | Yes | No | Off | Off |
| 014 | 75% Current | Max month | Max month | Winter | No | Yes | No | Off | On |
| Scenarios to Evaluate the Impact of Digester Cleaning | | | | | | | | | |
| 002_DC14 | 2030 | Max month | Max month | Winter | No | Yes | Yes, 14-day | Off | On |
| 004_DC14 | 2030 | Max month | Max month | Winter | Yes | Yes | Yes, 14-day | Off | On |

## 6.1 Scenarios to Evaluate Infrastructure Requirements

Cases 001–004 represent maximum month conditions, as specified in the Facilities Plan. Summer and winter scenarios were modeled, with and without side stream treatment. The goal of these cases was to assess the volume of aeration basins required. The unlikely combination of maximum month flow and maximum month loading was modeled in order to ensure conservatism in basin sizing. This was done in place of imposing a safety factor.

The key parameter is the peak day effluent ammonia concentration. In order to meet that limitation, the SRT must be increased enough to ensure a high level of nitrification, even during peak events. The high SRT results in a high MLSS concentration, which results in a high clarifier solids loading. The secondary clarifier model (Figure 10) was used to determine the maximum MLSS concentration at the projected flow conditions, and the volume of the aeration basins was increased to ensure that the MLSS concentration remained below that level.

## 6.2 Scenarios to Evaluate Average Operating Costs

Cases 007–010 represent average conditions, midway between the current flows and loadings and the average flows and loadings projected for 2030 in the Facilities Plan. The goal of these cases was to compare average operating costs with and without side stream treatment.

## 6.3 Scenarios to Evaluate Capacity of Existing System

Cases 011–014 were intended to assess the capacity of the existing system. These cases were set up with maximum month flows and loads, as currently observed at the plant. Cases 011 and 012 determine that the Plant cannot meet the effluent targets, so Cases 013 and 014, at 25 percent reduced flows and loadings, were developed to project capacity backwards.

## 6.4 Scenarios to Evaluate the Impact of Digester Cleaning

Cases 002 and 004 were simulated again, this time with increase centrate flows, as would be observed during a period of digester cleaning. When a digester is cleaned, the digester volume (750,000 gallons) is pumped down and dewatered. If 14 days are allowed to empty a digester, the increased centrate flow will be 54,000 gpd.

# 7. Model Results

This section presents the results of the BioWin simulations. Section 7.1 provides an overview of the modeling process, and how the model was used to arrive at an optimal operating condition for each scenario. The subsequent sections provide details on each of the model scenarios.

## 7.1 Modeling Procedure

This section provides a detailed example of the modeling process, with a step-by-step look at how the model was used to reach an optimized result for each case. The iterative process included the following steps:

1. Simulate condition at existing aeration basin volume (2.4 Mgal) with no IMLR, fermentate, or methanol addition. The first swing zone was aerated for winter cases, but unaerated for summer cases. The second swing zone was always unaerated. The swing zone settings were optimized, in this way, based on preliminary modeling.
2. Assess the peak day effluent $NH_4$-N concentration. If the effluent $NH_4$-N is too high, increase the SRT by reducing the WAS flow rate.
3. Repeat step 2 until the peak day effluent $NH_4$-N limit is satisfied.
4. The effluent will now have a high NOx-N concentration. Increase IMLR flow to optimal level. The goal is to remove as much of the NOx-N as possible, using carbon in the plant influent. The IMLR flow may be increased, to bring back enough NOx-N to the anoxic zones to allow full utilization of readily biodegradable carbon in the influent.
5. Add fermentate. With no IMLR, the anoxic and swing zones will all function as extensions of the anaerobic selector. Phosphorus removal may be very efficient, with fermentation occurring in these zones and supplementing the readily biodegradable carbon in the influent. Once IMLR is activated, only the anaerobic selector will remain anaerobic, and the anoxic and swing zones will become anoxic. This tends to reduce the amount of phosphorus removal, as the influent readily biodegradable carbon is not sufficient to maximize phosphorus removal. The fermentate adds a large amount of readily biodegradable carbon to the anaerobic selector, which restores phosphorus removal.
6. Increase IMLR flow to optimal level. Much of the carbon in the fermentate is taken up by phosphorus-accumulating organisms in the anaerobic selector. The remaining readily biodegradable carbon drives nitrogen removal in the anoxic cells. When fermentate is added, the IMLR flow must be increased to provide enough NOx-N back to the anoxic zones to fully utilize the fermentate carbon.
7. Add methanol until effluent target NOx-N is achieved. In all of the cases modeled, readily biodegradable carbon in the influent and the fermentate was not sufficient to remove enough nitrogen to meet the effluent target NOx-N of 8.0 mg/L. Methanol is another source of readily biodegradable carbon. In the sim-

ulations, the methanol largely passes through the anaerobic selector (phosphorus accumulating organisms [PAOs] cannot use methanol directly as a carbon source), and is used for nitrogen removal in the anoxic cells.

8. Increase IMLR flow to optimal level. With methanol addition, the existing IMLR flow is not sufficient to meet the effluent target NOx-N. For this modeling effort, it was assumed that the IMLR system was expanded to allow pumping of four times the PE flow (4Q). In all model scenarios, the IMLR was increased to 4Q to optimize both nitrogen and phosphorus removal.
9. If effluent targets are not achievable, increase methanol dose to optimal level. Increasing the methanol dose will reduce effluent NOx-N as well as effluent $PO_4$-P. However, once the methanol dose reaches a certain level, further increase yields a diminishing level of return. This is because a fraction of the methanol begins to pass through the anoxic cells and discharge into the aerated cells, where it is rapidly oxidized. With the IMLR flow maximized at 4Q, there may not be enough NOx-N in the return to allow full utilization of the dosed methanol. In these cases, the methanol dose was held at an "optimal" level, beyond which excessive breakthrough resulted in wasted methanol, with little improvement in effluent parameters. This is discussed in detail in the subsequent examples.
10. Increase aeration basin volume. Once all of the other parameters have been optimized, the aeration basin volume must be adjusted to ensure that the secondary clarifier solids loading capacity is not exceeded. The model MLSS is compared with the maximum allowable MLSS from Figure 10, and the aeration basin volume is increased proportionally.
11. Make minor adjustments. The increase in aeration basin volume may require small adjustments to the SRT or methanol dose to achieve an optimal solution. This in turn may require further adjustment of the aeration basin volume. This iterative process continues until all effluent targets have been met, or until an optimal solution is achieved.

The following sections provide detail on how the model was used. Case 004 has been used as an example, as it was modeled over a wide range of SRT and methanol doses in order to achieve an optimal condition.

### 7.1.1 SRT and Activated Sludge Volume Optimization

The draft permit includes maximum day and maximum month limits for ammonia. In order to ensure that the effluent ammonia concentration does not exceed these limits, the SRT must be increased. Figure 11 shows the effect of SRT on the effluent ammonia over the 30-day simulation.

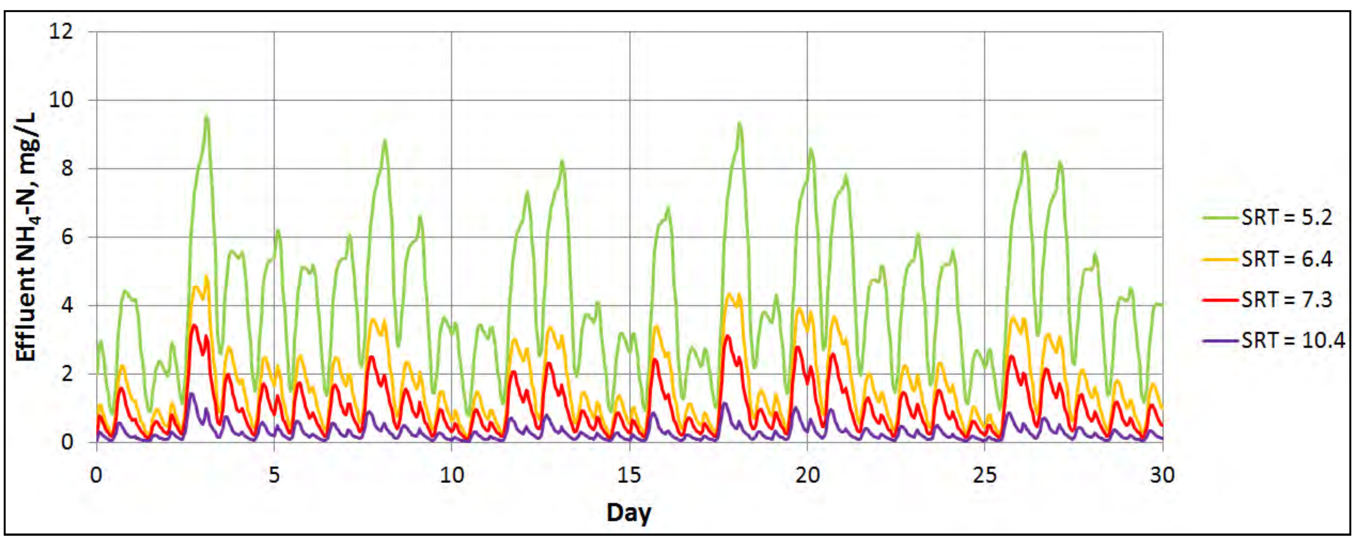


**Figure 11. Effect of SRT on effluent ammonia concentration (Case 004)**

In this case, the SRT was optimized at approximately 10.4 days, which was the minimum SRT required to meet the peak month effluent ammonia concentration (Figure 12).

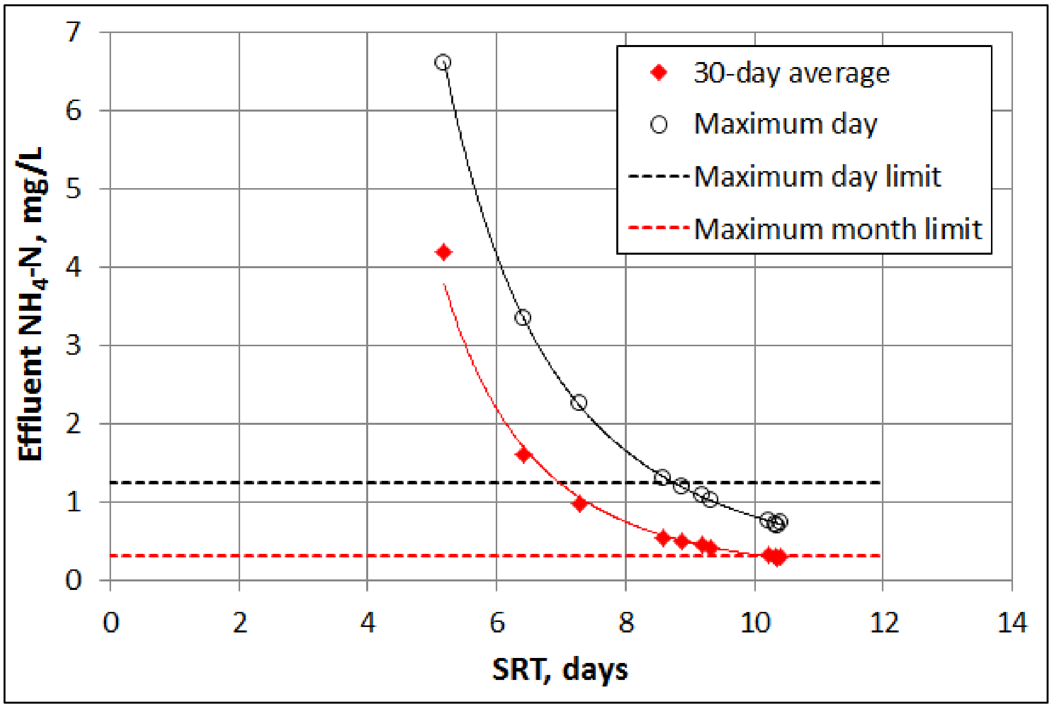


**Figure 12. Determining the minimum SRT required to meet the peak day effluent ammonia limit**

At an SRT of 10.4 days, the MLSS concentration within the existing 2.4 Mgal of aeration basins would have been 12,050 mg/L. In order to reduce the MLSS concentration below the maximum allowable level (3,150 mg/L, from Figure 10), the aeration basin volume was increased to 9.2 Mgal.

### 7.1.2 Methanol Dose Optimization

Methanol is used to drive nitrogen removal in the anoxic cells, and may also be used by PAOs in the anaerobic selector (although the PAOs prefer to use volatile acids as a carbon source). Increasing the methanol dose results in decreased effluent NOx-N, as well as decreased effluent $PO_4$-P. When there is sufficient NOx-N in the anoxic cells to fully utilize the methanol, the relationship between methanol dose rate and effluent NOx-N will be approximately linear. This is observed at methanol flows less than 700 gpd on Figure 13. At higher methanol flows, the NOx-N concentration at the downstream end of the anoxic zone will be zero, and methanol will break through into the aerated cells, where it is rapidly oxidized and lost. Further methanol dosing will result in only minimal reduction of effluent NOx-N, and increasing wastage of methanol into the aerated cells.

Although the PAOs do not uptake methanol in the anaerobic selector, increased methanol results in a decreased effluent $PO_4$-P, mainly by an indirect mechanism. The methanol removes nitrogen, which reduces the amount of NOx-N returned in the RAS from the secondary clarifier. This reduces the amount of NOx-N in the anaerobic selector, which enhances the ability of the PAOs to release phosphorus and uptake carbon.

On Figure 13, the optimal methanol dose appears to be approximately 900 gpd. Dosing rates exceeding 900 gpd yield very little change in effluent NOx-N or $PO_4$-P, with high rates of breakthrough of methanol into the aerated cells.

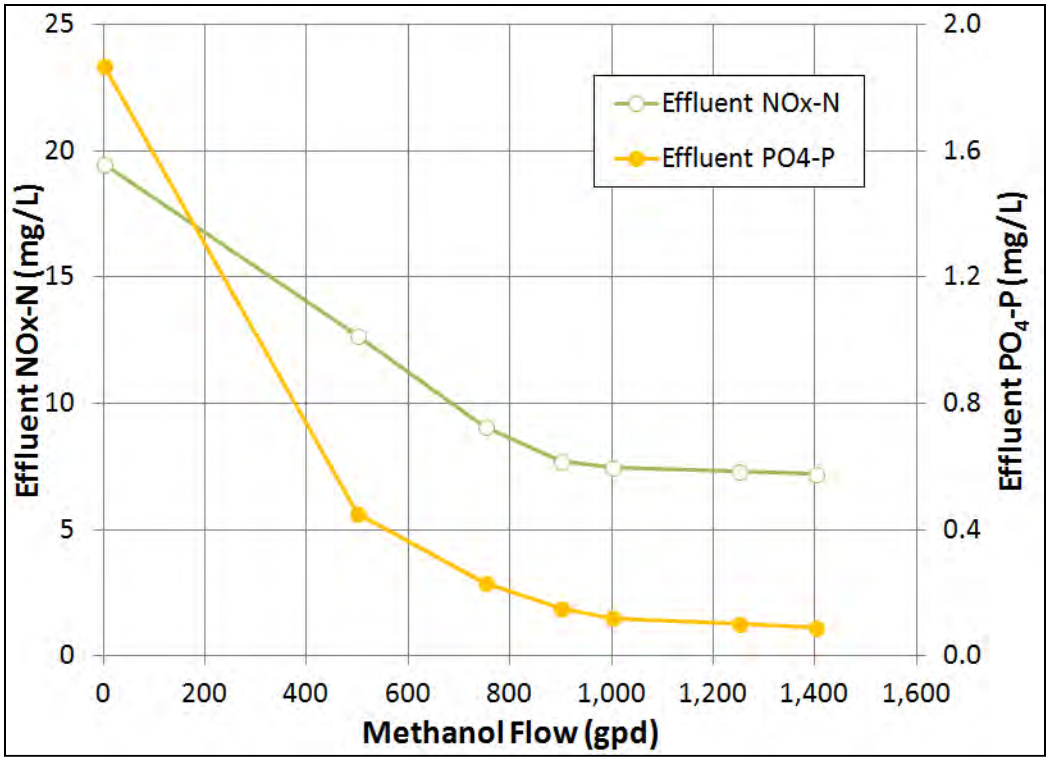


**Figure 13. Relationship between methanol dose rate and effluent NOx-N and $PO_4$-P (Case 004)**

Figures 14 and 15 depict the impact of methanol on effluent NOx-N and $PO_4$-P concentrations over the 30-day simulation. These data mirror those observed on Figure 13, showing the diminishing return gained by increasing methanol dose beyond a certain point.

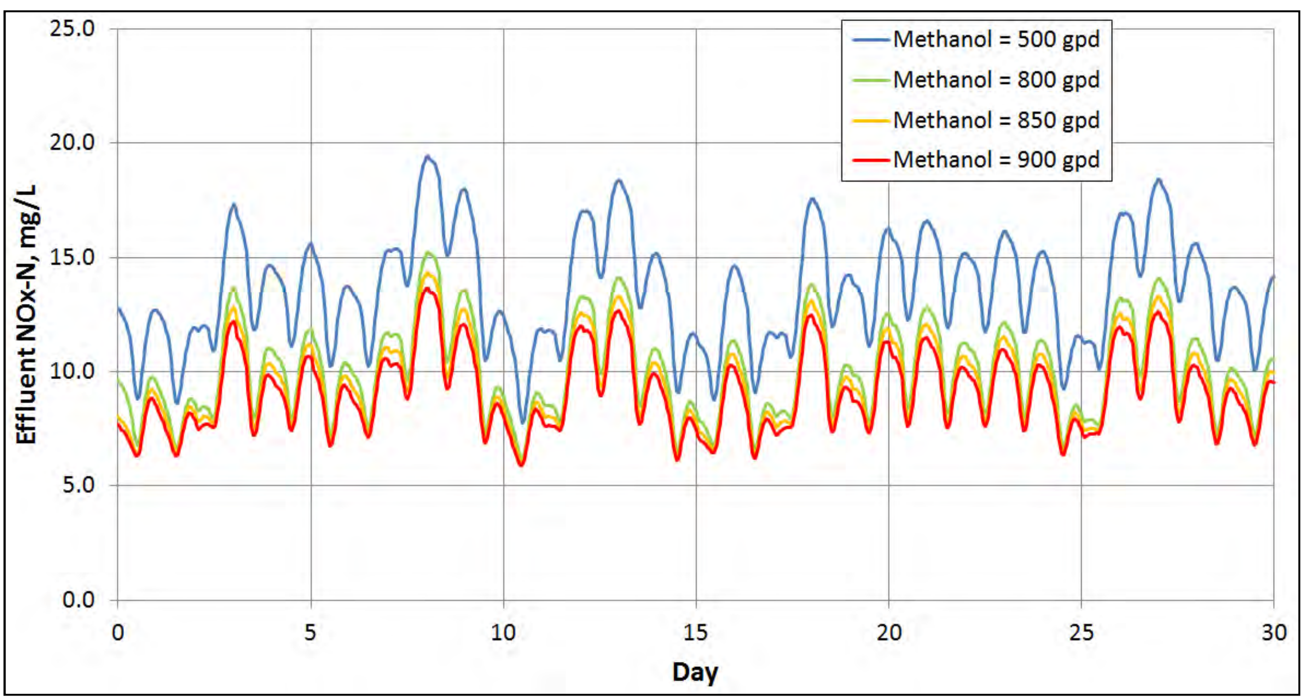


**Figure 14. Effect of methanol dose on effluent NOx-N (Case 004)**

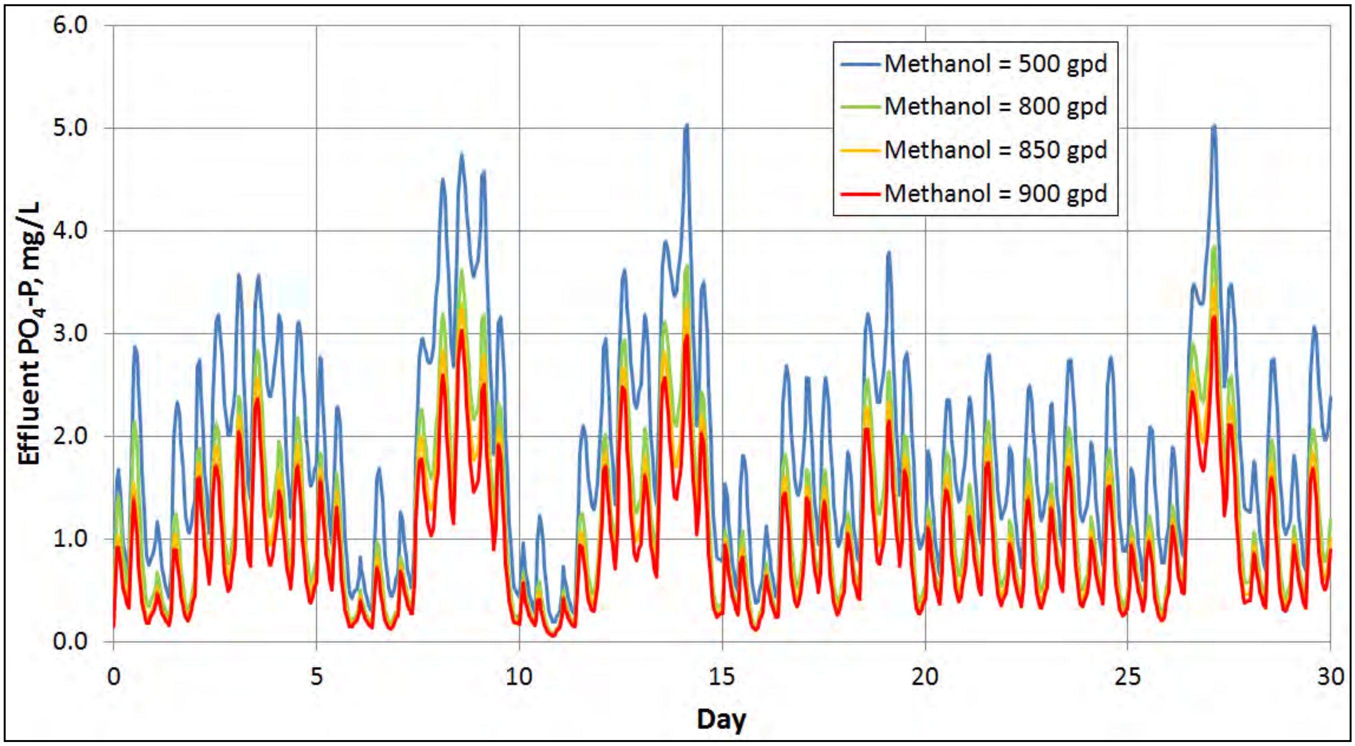


**Figure 15. Effect of methanol dose on effluent $PO_4$-P (Case 004)**

## 7.2 Cases 001 through 004

The first four cases were designed to evaluate the 2030 maximum month condition with and without side stream nitrogen treatment. The purpose of these cases was to determine the potential savings in activated sludge volume that could be realized with side stream treatment, while also determining the impacts of seasonal variations. Key results of these cases are summarized in Table 14.

**Table 14. Summary of Key Results for Cases 001–004**

| Parameter | Target | Cases | | | |
|---|---|---|---|---|---|
| | | 001 | 002 | 003 | 004 |
| Season | – | Summer | Winter | Summer | Winter |
| Flow (mgd) | – | 14.20 | 12.26 | 14.20 | 12.26 |
| Temperature (°C) | – | 23 | 14 | 23 | 14 |
| Aeration basin volume (Mgal) | – | 5.28 | 9.70 | 5.04 | 9.16 |
| SRT (d) | – | 4.69 | 10.22 | 4.78 | 10.35 |
| Methanol flow (gpd) | – | 800 | 1,250 | 525 | 900 |
| MLSS (mg/L) | <2,800 summer<br><3,150 winter | 2,801 | 3,159 | 2,817 | 3,157 |
| BioWin $O_2$ ($ft^3$/min) | – | 31,350 | 26,074 | 29,259 | 23,910 |
| WAS (lb/d) | – | 25,220 | 23,974 | 23,684 | 22,386 |
| FE TSS (mg/L) | 10 | 9.73 | 9.27 | 10.20 | 9.26 |
| FE $PO_4$-P (mg/L) | <0.1 | 0.44 | 0.70 | 0.59 | 1.13 |
| FE $NH_4$-N (mg/L) | <0.405 summer<br><0.307 winter | 0.35 | 0.29 | 0.32 | 0.28 |
| FE NOx (mg/L) | <8 | 8.05 | 9.27 | 8.03 | 9.31 |
| FE TN (mg/L) | <15.5 | 11.31 | 12.57 | 11.21 | 12.50 |
| Peak day $NH_4$-N (mg/L) | <1.65 summer<br><1.25 winter | 0.94 | 0.68 | 0.92 | 0.70 |

In each case, the SRT was gradually increased in order to ensure sufficient nitrification to achieve the monthly average and peak day effluent ammonia criteria. During the summer, the minimum SRT was approximately 4–5 days. During the winter, the SRT had to be increased to approximately 10 days. This reflects the impact of temperature. In these cases, 14°C was assumed for the winter cases, and 23°C was assumed for the summer cases.

To keep the MLSS concentration low enough to avoid clarifier capacity limitations, the activated sludge volume then had to be increased from the existing 2.4 Mgal in all four cases. The winter cases indicated a need for up to 9.7 Mgal of aeration basin volume. The summer cases required only 5.3Mgal.

Methanol addition was required for all cases to limit NOx and $PO_4$-P in the final effluent (FE). Higher methanol doses and/or lower SRTs resulted in methanol breakthrough from the selector zones to the aerobic cell. Selector effluent methanol was limited to 7 mg/L or less for these four cases. Even with the optimized methanol addition, effluent $PO_4$-P was above the target for all four cases and effluent NOx was above the target for the winter cases (002 and 004). During the winter, the effluent NOx-N could not be maintained lower than 9.3 mg/L (monthly average) without excessive waste of methanol into the aerated cells.

The addition of side stream nitrogen treatment (in Cases 003 and 004) allowed for a slight (approximately 6 percent) reduction in the aeration basin volume requirement, and a larger (approximately 30 percent) reduction in the methanol demand. Aerated demands and WAS production was were also reduced for the side stream treatment cases.

## 7.3 Cases 007 through 010

Cases 007 through 010 were designed to evaluate the average day condition mid-way through the planning period. Key results for these cases are summarized in Table 15.

Table 15. Summary of Key Results for Cases 007–010

| Parameter | Target | Cases | | | |
|---|---|---|---|---|---|
| | | 007 | 008 | 009 | 010 |
| Season | – | Summer | Winter | Summer | Winter |
| Flow (mgd( | – | 9.3 | 8.2 | 9.3 | 8.2 |
| Temperature (°C) | – | 21 | 16 | 21 | 16 |
| Act. sludge volume (Mgal) | – | 4.8 | 4.8 | 4.8 | 4.8 |
| SRT (d) | – | 6.0 | 9.1 | 6.0 | 9.1 |
| Methanol flow (gpd) | – | 630 | 1,000 | 430 | 750 |
| MLSS (mg/L) | – | 2,363 | 3,559 | 2,215 | 3,336 |
| BioWin $O_2$ ($ft^3$/min) | – | 17,905 | 19,006 | 16,377 | 16,786 |
| WAS (lb/d) | – | 15,096 | 14,968 | 14,146 | 14,032 |
| FE TSS (mg/L) | 10 | 8.2 | 12.2 | 7.7 | 11.4 |
| FE $PO_4$-P (mg/L) | <0.1 | 0.47 | 0.44 | 0.69 | 0.66 |
| FE $NH_4$-N (mg/L) | <0.405 summer<br><0.307 winter | 0.32 | 0.28 | 0.31 | 0.27 |
| FE NOx (mg/L) | <8 | 7.98 | 8.97 | 7.88 | 8.69 |
| FE TN (mg/L) | <15.5 | 11.0 | 12.4 | 10.8 | 12.0 |
| Peak day $NH_4$-N (mg/L) | <1.65 summer<br><1.25 winter | 0.78 | 0.70 | 0.79 | 0.81 |

The aeration basin volume was assumed to be 4.8 Mgal in all of these cases, to ensure that secondary clarifier capacity would not be an issue. Most of the modeling work involved optimizing the methanol dose to meet the target effluent NOx-N and $PO_4$-P requirements.

As observed with Cases 002 and 004, the effluent NOx-N target of 8.0 mg/L could not be efficiently achieved in the winter. Likewise, the effluent $PO_4$-P could not meet its target of 0.1 mg/L for any of the four cases while also attempting to maintain effluent NOx-N concentrations below 8.0 mg/L.

The addition of side stream nitrogen treatment (in Cases 009 and 010) resulted in reductions in the aeration demand, methanol dose, and WAS loading.

## 7.4 Cases 011 and 012

Cases 011 and 012 were used to evaluate the capacity of the existing process, without side stream treatment. These cases input current maximum month flows and loads. Key results for these cases are summarized in Table 16.

| Table 16. Summary of Key Results for Cases 011 and 012 | | | |
|---|---|---|---|
| Parameter | Target | Cases | |
| | | 011 | 012 |
| Season | – | Summer | Winter |
| Flow (mgd) | – | 6.60 | 5.70 |
| Temperature (°C) | – | 16 | 14 |
| Act. sludge volume (Mgal) | – | 2.40 | 2.40 |
| SRT (d) | – | 9.91 | 11.26 |
| Methanol flow (gpd) | – | 650 | 900 |
| MLSS (mg/L) | < 4,100 summer<br>< 4,300 winter | 6,098 | 6,879 |
| BioWin $O_2$ ($ft^3$/min) | – | 14,818 | 16,660 |
| WAS (lb/d) | – | 11,538 | 11,474 |
| FE TSS (mg/L) | 10 | 17.26 | 19.34 |
| FE $PO_4$-P (mg/L) | <0.1 | 0.69 | 0.80 |
| FE $NH_4$-N (mg/L) | <0.405 summer<br><0.307 winter | 0.42 | 0.28 |
| FE NOx (mg/L) | <8 | 8.01 | 9.95 |
| FE TN (mg/L) | <15.5 | 11.83 | 14.09 |
| Peak day $NH_4$-N (mg/L) | <1.65 summer<br><1.25 winter | 1.01 | 0.61 |

For these cases, the activated sludge volume was fixed to match existing capacity. The SRT was modified (by adjusting the WAS flow) in order to meet the peak day $NH_4$-N concentration. Then, the methanol dose was optimized.

With a fixed activated sludge volume, the MLSS concentrations for these cases were much higher than the target. At these flows, the secondary clarifiers would be overloaded (based on Figure 10).

These results indicate that the existing WWTP does not have the capacity required to meet the proposed effluent requirements and would require substantial expansion to add activated sludge volume. Significant methanol dosing (650–900 gpd) would also be required.

## 7.5 Cases 013 and 014

As the plant did not have capacity to treat existing flows and loads to the specified effluent targets, Cases 013 and 014 were designed to project performance at reduced flows and loads. These cases decrease influent flows and loads by 25 percent. Table 17 provides a summary of key results for these cases.

**Table 17. Summary of Key Results for Cases 013 and 014**

| Parameter | Target | Cases | |
|---|---|---|---|
| | | 013 | 014 |
| Season | – | Summer | Winter |
| Flow (mgd) | – | 4.95 | 4.28 |
| Temperature (°C) | – | 16 | 14 |
| Act. sludge volume (Mgal) | – | 2.40 | 2.40 |
| SRT (d) | – | 10.00 | 11.50 |
| Methanol flow (gpd) | – | 475 | 600 |
| MLSS (mg/L) | <4,850 summer<br><5,000 winter | 4,548 | 5,145 |
| BioWin $O_2$ (ft$^3$/min) | – | 10,463 | 11,350 |
| WAS (lb/d) | – | 8,691 | 8,549 |
| FE TSS (mg/L) | 10 | 12.87 | 14.45 |
| FE $PO_4$-P (mg/L) | <0.1 | 0.78 | 0.95 |
| FE $NH_4$-N (mg/L) | <0.405 summer<br><0.307 winter | 0.38 | 0.25 |
| FE NOx (mg/L) | <8 | 8.19 | 10.20 |
| FE TN (mg/L) | <15.5 | 11.71 | 13.96 |
| Peak day $NH_4$-N (mg/L) | <1.65 summer<br><1.25 winter | 1.22 | 0.61 |

While still high (over 4,500 mg/L), the MLSS concentrations are close to the maximum allowable concentrations at these flow rates. This indicates that the existing plant would have the capacity to meet some of the effluent targets at these flows and loadings. It is important to point out that while these MLSS concentrations are low enough to meet SLR limitations in the secondary clarifiers, these concentrations are very high and could impact oxygen transfer efficiency of the aeration system and are above typical recommended maximum values for conventional activated sludge systems. Further, the winter case would still not be able to efficiently meet the target NOx-N concentration of 8.0 mg/L.

Combining the projected MLSS concentrations from Cases 011–014, with the maximum allowable MLSS concentrations from Figure 10, the capacity of the existing treatment plant would project to the following maximum month flows:

- summer: 5.20 mgd
- winter: 4.20 mgd

## 7.6 Digester Cleaning Cases

Cases 002 and 004 were remodeled to assess the impact of digester cleaning. When periodic digester cleaning is required, the WWTP experiences a larger-than-normal centrate dose over a fairly short period of time, which could stress the treatment process. The goal of this evaluation was to determine the impact of this added centrate with and without side stream treatment.

A digester emptying time of 14 days was evaluated, assuming a constant flow of centrate delivered to the plant over that times. The digester cleaning scenario was evaluated with the 2030 maximum month flows and loads, in the winter condition. This condition was selected because this condition drove the projected aeration basin volume requirement. In practice, it would be unlikely to schedule a cleaning action during the most limiting loading condition. However, the goal was to assess sensitivity, and this case was assumed to be the most sensitive to digester cleaning activity. Key results for the digester cleaning cases are summarized in Table 18.

**Table 18. Summary of Key Results for Digester Cleaning Cases**

| Parameter | Target | Cases | |
|---|---|---|---|
| | | 002_DC14 | 004_DC14 |
| Season | – | Winter | Winter |
| Flow (mgd) | – | 12.26 | 12.26 |
| Temperature (°C) | – | 14 | 14 |
| Side stream? | – | No | Yes |
| Digester cleanout time | d | 14 | 14 |
| Act. sludge volume (Mgal) | – | 9.70 | 9.16 |
| SRT (d) | – | 10.07 | 9.81 |
| Methanol flow (gpd) | – | 1,425 | 950 |
| MLSS (mg/L) | <3,150 | 3,188 | 3,059 |
| BioWin $O_2$ ($ft^3$/min) | – | 27,006 | 23,735 |
| WAS (lb/d) | – | 24,710 | 22,945 |
| FE TSS (mg/L) | 10 | 9.35 | 8.97 |
| FE $PO_4$-P (mg/L) | <0.1 | 0.80 | 1.31 |
| FE $NH_4$-N (mg/L) | <0.405 summer<br><0.307 winter | 0.31 | 0.31 |
| FE NOx (mg/L) | <8 | 9.18 | 9.00 |
| FE TN (mg/L) | <15.5 | 12.54 | 12.21 |
| Peak day $NH_4$-N (mg/L) | <1.65 summer<br><1.25 winter | 0.73 | 0.82 |

When compared to simulations without the added digester cleanout load (see Cases 002 and 004 in Table 14) the results (summarized in Table 19) show that digester cleanout has surprisingly little impact on plant performance.

| Table 19. Impact of Digester Cleaning on Selected Performance Criteria, 2030 Maximum Month Winter Condition | | | |
|---|---|---|---|
| | No Digester Cleaning | 14-day Digester Cleaning | Change (14-day Cleaning) |
| No Side stream Treatment | | | |
| Methanol requirement, gpd | 1250 | 1425 | 14% |
| Aeration demand, scfm | 26,074 | 27,006 | 4% |
| WAS production, lb/d | 23,974 | 24,710 | 3% |
| MLSS, mg/L | 3,159 | 3,188 | 1% |
| With Side stream Treatment | | | |
| Methanol requirement, gpd | 900 | 950 | 6% |
| Aeration demand, scfm | 23,910 | 23,735 | -1% |
| WAS production, lb/d | 22,386 | 22,945 | 2% |
| MLSS, mg/L | 3,157 | 3,059 | -3% |

The main impact is to the methanol dose, which had to be increased by approximately 14 percent (no side stream treatment) or 6 percent (with side stream treatment). Otherwise, impacts to MLSS, aeration demand, WAS production, and the ability to meet effluent targets were limited (less than 5 percent).

# 8. Model Conclusions

The BioWin side stream nitrogen treatment modeling effort has produced the following results and conclusions.

## 8.1 Existing Plant Capacity

The existing facility does not have the capacity to meet the proposed effluent targets. Plant capacity is estimated to be approximately 5.2 mgd in the summer and 4.2 mgd in the winter. The main factors driving the capacity estimate are the winter effluent ammonia requirements, which forces an increase in SRT leading to an increase in MLSS, and increase in solids loading to the secondary clarifiers. While the Plant has successfully nitrified in the past, it has not consistently reduced effluent ammonia to the proposed criteria, especially during the winter season (Figure 16).

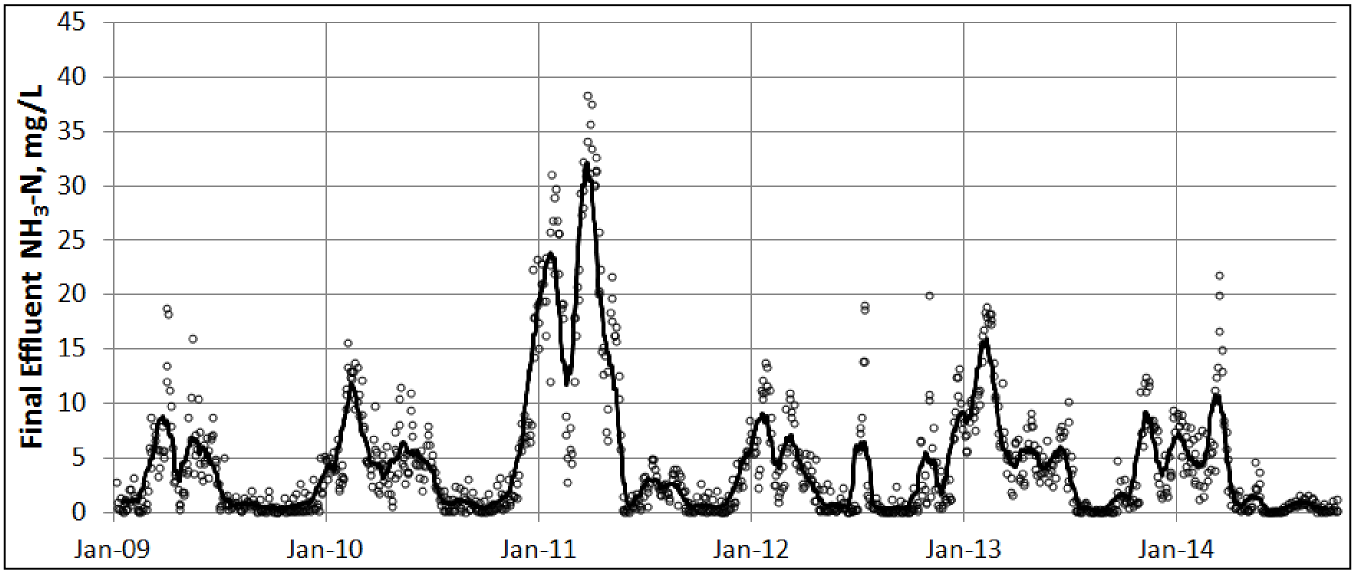


**Figure 16. Historical final effluent NH3-N concentration, with 30-day moving average**

Aside from capacity, the existing facility would require a large amount (500–800 gpd) of supplemental carbon to meet targeted effluent NOx-N and $PO_4$-P requirements. It is possible that these requirements could be reduced through a process reconfiguration. The existing $A^2O$ process is inefficient with respect to nitrogen removal. A more efficient configuration would provide for two separate stages of denitrification. A five-stage Bardenpho process (Figure 17) is a textbook example of a configuration aimed for both phosphorus removal and efficient nitrogen removal.

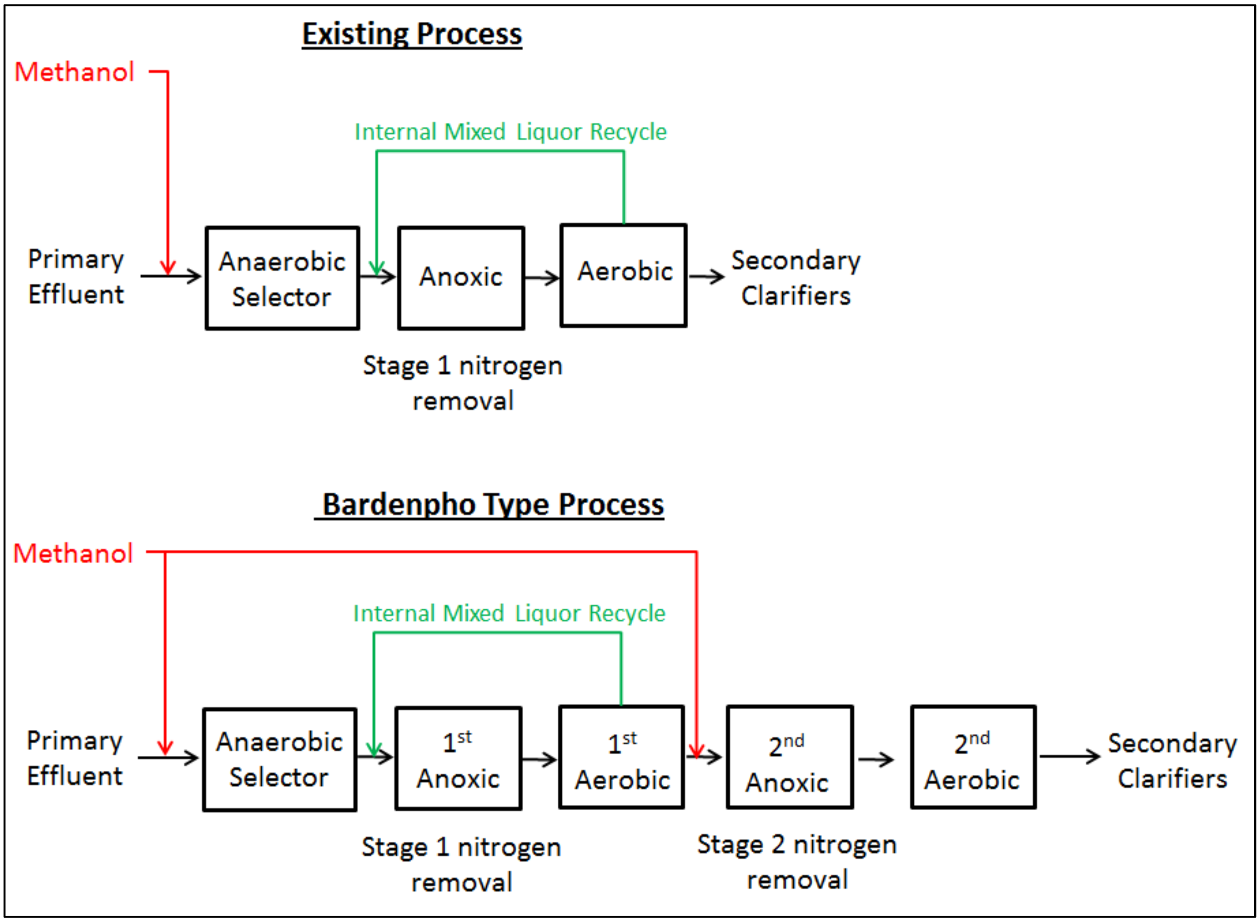


**Figure 17. Comparison of existing process configuration and a two-stage nitrogen removal configuration**

Changing the process configuration would also allow the plant to achieve the effluent NOx-N target conditions more efficiently. As noted in the results presentation, there were several scenarios, primarily in the winter, when the plant could not achieve an effluent NOx-N of 8.0 mg/L without excessive wasting of methanol.

## 8.2 Future Plant Requirements

In order to meet the target effluent criteria for the 2030 maximum month condition, the plant would require 9.7 Mgal of aeration basins, or additional secondary clarifiers. The plant projects a demand for large volumes of methanol (500–1,000 gpd, year round) to meet the target effluent NOx-N and $PO_4$-P conditions.

## 8.3 Role of Centrate

Treating the centrate using an Anammox-type process would have several advantages. These include a reduction in the size of future aeration basins (9.2 Mgal versus the 9.7 Mgal required without side stream treatment), and a reduction in annual operating costs. Side stream treatment would reduce methanol requirements by approximately 30 percent and aeration demand by approximately 10 percent, and would generate 6 percent less WAS solids. This comparison is expanded upon in detail in Section 9.

## 8.4 Digester Cleaning

Digester cleaning had relatively small impact on plant operation or performance. The additional centrate load associated with emptying one of the digesters results in an increased methanol demand. However, the centrate has little effect on performance in terms of meeting the target effluent conditions. Notably, the additional centrate load has little impact on the SRT required to meet the peak day effluent ammonia limit, and therefore little impact on the MLSS concentration, clarifier solids loading, or required aeration basin volume. The reason for this appears to be related to the diurnal pattern of nitrogen loading in the PE (Figure 5). The plant observes very low flow and loads overnight, a condition that can starve the nitrifying bacterial community, resulting in inefficient nitrification. The additional nitrogen load associated with centrate helps to reduce those overnight limitations, and improves the overall performance of the nitrifying community. In a counterintuitive way, additional centrate may actually increase process capacity by resulting in a more stable nitrogen loading pattern. This impact is discussed further in Section 10.

## 8.5 Summary

Table 20 summarizes the key findings of the biological process modeling.

| Table 20. Summary of Biological Process Modeling Results | |
|---|---|
| Existing Plant Capacity | |
| Summer, maximum month | 5.2 mgd |
| Winter, maximum month | 4.2 mgd |
| Projected Facility Needs | |
| Aeration basin volume | 9.7 Mgal |
| Average methanol demand | 815 gpd |
| Peak month methanol demand | 1,250 gpd |
| Peak month aeration demand | 31,350 scfm |
| Digester Cleaning (14- or 30-day period) | |
| Increase methanol requirement | 6%–14% |
| Effect on process capacity | Minimal |
| Effect of Side Stream Treatment | To be discussed in Section 9 |

# 9. Business Case Evaluation

The BCE is a tool that seeks to determine the most cost-effective solution to a specific issue or problem. The BCE considers five categories of costs: capital, operating, replacement, risk, and benefit. The BCE differs from traditional life-cycle cost analyses in its inclusion of risk and benefit costs, which broaden the scope of the comparison. The BCE approach was used to determine whether the plant should implement side stream treatment of its dewatering centrate. The results of the modeling (Section 8) were used as the basis for much of the comparative analysis.

## 9.1 Problem Statement and Level of Service

The plant is facing increased regulation on effluent discharge of nitrogen and phosphorus. Should the plant implement side stream treatment of its dewatering centrate as part of upcoming facility upgrades?

Level-of-service considerations include the following:

- Expansion of the secondary process (aeration basins and secondary clarifiers) is likely to be required in order to meet future loadings and regulatory requirements. Side stream treatment of the centrate may impact the scope of such expansion.
- Side stream treatment of the centrate may impact operational costs related to the main biological process. Impacts may include process aeration demands, supplemental carbon (methanol), biosolids processing, hauling and disposal, and chemical addition for phosphorus removal.
- The side stream process will have a capital cost associated with implementation.
- The side stream process will have annual operating costs.
- The side stream process will have replacement costs. Replacement costs related to the main biological process are assumed to be independent of side stream treatment.
- The risk of side stream process upset and resulting impacts on the main biological process must be considered in this evaluation.

## 9.2 Current and Design Conditions

Dewatering centrate is currently returned to the primary influent, and treated in the main biological process. Centrate flows and characteristics were summarized in Section 3.2.

## 9.3 Alternatives

There are two alternatives in this evaluation: side stream treatment, and no side stream treatment. The side stream treatment alternative assumes an Anammox-type process, capable of removing 80 percent of $NH_4$-N and 75 percent of TIN from the centrate. For costing purposes, a DEMON-type Anammox system was assumed for this alternative.

The side stream process was assumed to treat 100 percent of the dewatering centrate. The process includes a pretreatment stage aimed at removing solids from the centrate, a flow equalization basin, two parallel reactors, and an effluent storage basin (Figure 18).

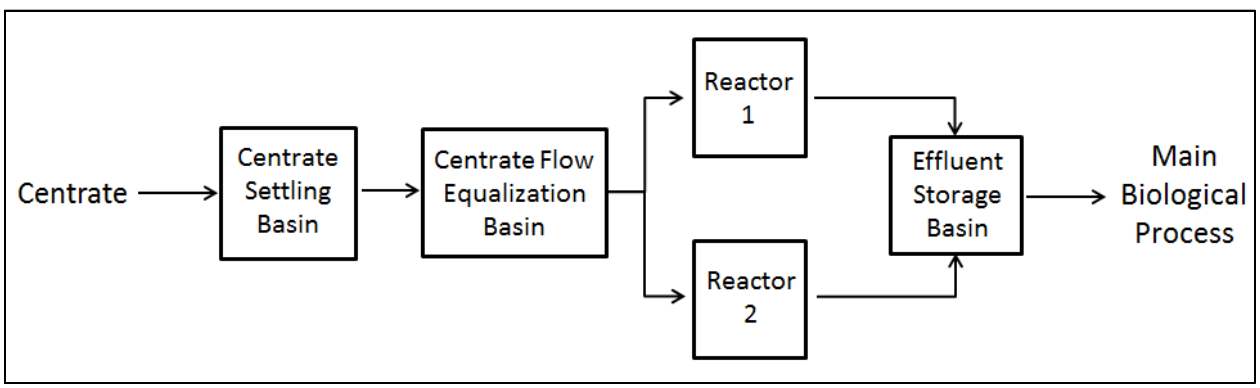


**Figure 18. Side stream process schematic**

Design criteria for the side stream process are summarized in Table 21.

| Table 21. Side Stream Treatment Design Criteria | | | | |
|---|---|---|---|---|
| Parameter | Average Day | Max Month | Peak 2-week | Peak Day |
| Centrate flow, gpd | 78,967 | 103,000 | 109,867 | 137,333 |
| Centrate $NH_4$-N load, lb/d | 600 | 782 | 834 | 1,043 |
| Days/week of operation | 7 | | | |
| Centrate Settling Basin | | | | |
| Surface overflow rate, gpd/ft$^2$ | 359 | 469 | 500 | 625 |
| L, ft | 11.0 | | | |
| W, ft | 20.0 | | | |
| D, ft | 21.0 | | | |
| Volume, gal | 34,518 | | | |
| Centrate Flow Equalization Basin | | | | |
| HRT, hours | 15.7 | 12.0 | 11.3 | 9.0 |
| L, ft | 17.2 | | | |
| W, ft | 20.0 | | | |
| D, ft | 20.0 | | | |
| Volume, gal | 51,500 | | | |
| DEMON reactors | 2 | | | |
| Solids loading rate, firm, kg/m$^3$/d | 1.15 | 1.50 | 1.60 | 2.00 |
| Solids loading rate, total, kg/m$^3$/d | 0.57 | 0.75 | 0.80 | 1.00 |
| Reactor Dimensions | | | | |
| L, ft | 19.9 | | | |
| W, ft | 20.0 | | | |
| D, ft | 21.0 | | | |
| Volume, gal | 62,500 | | | |
| Effluent Storage Basin | | | | |
| HRT, hours | 5.6 | 4.3 | 4.0 | 3.2 |
| L, ft | 8.2 | | | |
| W, ft | 20.0 | | | |
| D, ft | 15.0 | | | |
| Active volume, gal | 18,311 | | | |

For cost estimating purposes, it was assumed that the centrate treatment system would be built in new structures, with the settling tank and flow equalization basins covered to limit odors and cooling.

## 9.4 Comparative Analysis

The BioWin model was used to compare the two alternatives, and the results of that modeling have been presented in Section 8. Table 22 summarizes the key results that pertain to this BCE.

| Table 22. Model Comparison of Side stream Alternatives | | | |
|---|---|---|---|
| Side stream treatment? | No | Yes | |
| Aeration basin volume required | 9.70 | 9.16 | Mgal |
| Average methanol dose | 815 | 590 | gpd |
| Maximum month methanol dose | 1250 | 900 | gpd |
| Average aeration demand | 18,455 | 16,581 | scfm |
| Maximum month aeration demand | 31,350 | 29,260 | scfm |
| Average WAS production | 15,032 | 14,089 | lb/d |
| Average mass of $PO_4$-P over target[a] | 0.96 | 1.54 | lb/month |

a. *Target effluent $PO_4$-P was 0.1 mg/L.*

The BCE considers only costs that differentiate between the alternatives; non-differential costs are not considered. The following sections detail the costs included in this BCE.

### 9.4.1 Capital Costs

In order to meet the 2030 maximum month conditions, the main secondary treatment process will need to be expanded. The critical factor is maintaining a high enough SRT to ensure that the maximum day ammonia concentration is not exceeded. This results in a high MLSS concentration, which imposes a high solids loading to the secondary clarifiers. For the summer condition, with a maximum month flow of 14.2 mgd, and a maximum day flow of 17.2 mgd, the maximum allowable MLSS concentration will be approximately 2,800 mg/L (Figure 10). For the winter condition, with a maximum month flow of 12.3 mgd, and a maximum day flow of 13.8 mgd, the maximum allowable MLSS concentration will be approximately 3,150 mg/L.

Using these criteria, the sizes of the aeration basins required to meet the effluent targets for the 2030 maximum month condition were 9.70 Mgal (no side stream), and 9.16 Mgal (with side stream). Given 2.4 Mgal of existing volume, the scope of the basin expansion would be either 7.30 Mgal or 6.76 Mgal.

The City of Nampa, Idaho, is currently expanding its aeration basins by 3.3 Mgal. Given the proximity to Meridian, and the similarity between projects, the costs from the Nampa expansion have been used to project relative costs of aeration basin expansion at Meridian. The Nampa aeration basin expansion is projected to have a direct cost of $2.55M, which computes to $771,900/Mgal. Extrapolating to the two alternatives in this BCE, the following cost estimates were derived for the two alternatives:

- Alternative 1, no side stream: $5.64M
- Alternative 2, side stream: $5.22M

These direct cost projections were expanded to include markups, contingency, and allied costs such as engineering, construction management, and administration, resulting in the following total project costs (refer to Appendix A for details):

- Alternative 1, no side stream: $13.6M
- Alternative 2, side stream: $12.6M

The cost to implement side stream treatment includes a vendor package, a set of concrete basins, and materials and equipment not included within the vendor package (equipment located outside of the two reactors). Costs are summarized in Table 23.

| Table 23. Capital Costs to Implement Side stream Treatment | | | | | |
|---|---|---|---|---|---|
| | Direct Costs | Contractor Costs[a] | Contingency[b] | Allied Costs[c] | Total |
| Vendor quoted equipment and coordination | $1,563,139 | $93,788 | $0 | $198,831 | $1,855,759 |
| Greenfield tank construction | $145,464 | $49,589 | $48,763 | $97,526 | $351,582 |
| Vendor system installation, and material outside of vendor package | $1,951,225 | $66,911 | $68,490 | $834,650 | $3,008,914 |
| Total | $3,659,828 | $210,288 | $117,253 | $1,131,008 | $5,216,254 |

a. *Includes 10% field overhead, bonds, and insurance; 15% contractor overhead and profit; and 6% state sales tax. Vendor package includes only the sales tax. Material outside of vendor package eliminates field overhead and profit and tax, and reduces contractor overhead and profit to 3%, because these costs are based on final realized costs at Chambers Creek.*

b. *25% for greenfield expansion and material outside of vendor package; 3% for vendor package.*

c. *Includes 2% legal, 5% administrative, 3% permitting and scope, 5% preliminary engineering, 15% final engineering, 10% construction management. Vendor package costs do not include legal, administrative, and permitting/scope, and reduce preliminary engineering to 0.5% and final engineering to 1.5%.*

### 9.4.2 Operating Costs

The modeling results in Table 22 translate into operating costs associated with methanol dosing, aeration demand, biosolids hauling, and chemical addition for phosphorus removal. The following assumptions were used to develop these costs:

- electricity: $0.069 per kilowatt-hour (kWh)
- biosolids hauling and application: $5.933 per wet ton
- methanol: $2.25 per gallon
- aeration energy demand: 350 kWh per standard cubic foot per minute (scfm) per year
- chemical addition for phosphorus removal: $10 per lb P removed

The electric and biosolids costs come from the plant. The methanol cost is a long-term average value from Olympia, Washington. The price of methanol is unstable, and has varied from close to $1.00 per gallon to over $4.50 per gallon during the past 10 years. The aeration energy demand is based on data from other plants with similar process demands. The chemical addition cost for phosphorus removal is an average value considering several chemical formulations (alum, ferric chloride, ferrous chloride, and polyaluminum chloride), with costs developed for the City of Nampa in 2013.

The annual operating costs are summarized in Table 24.

| Table 24. Average Annual Operating Costs | | |
|---|---|---|
| Parameter | Alternative 1: No Side stream | Alternative 2: Side stream |
| Methanol[a] | $669,319 | $484,538 |
| Process aeration[b] | $445,694 | $400,439 |
| Biosolids hauling[c] | $16,277 | $15,256 |
| P removal chemical[d] | $117 | $188 |

a. *Methanol at $2.25/gallon.*

b. *Assumes 350 kWh/scfm/year and $0.069/kWh.*

c. *Hauling and application at $5.933/wet ton.*

d. *Chemical cost of $10/lb P. This cost considers removal of $PO_4$-P only down to a concentration of 0.1 mg/L. Removal below that concentration is considered to be the same for both alternatives (non-differential).*

Annual operating costs for the side stream treatment system include $13,300 for aeration, and $2,250 for pumping. A single full-time equivalent (FTE) is assumed to be required to operate and maintain the system, at a cost of $62,400 per year.

### 9.4.3 Replacement Costs

Major replacement items within the side stream treatment system include aeration blowers ($50k cost with 10-year service life), pumps ($50k cost with 15-year service life), instruments ($100k cost with 5-year service life), and other miscellaneous equipment ($25k cost with 10-year service life). Replacements within the mainstream process are assumed to be non-differential.

### 9.4.4 Risk Costs

If the side stream process were to suffer an upset, there would be costs associated with restoring the system, as well as costs associated with treating the centrate in the main biological process during the upset. It is assumed that it would take 6 months to reestablish the process, given the need to import bio-mass, potentially from abroad. The total cost associated with such an event is estimated to be approximately $165k. The annual likelihood of an upset is assumed to be 10 percent. This means there would be an 88 percent chance of having at least one upset during the 20-year planning window.

There is some risk of methanol price instability. At times, the cost of methanol has doubled from historical averages. To accommodate this risk, the BCE assumes a 20 percent annual risk of the methanol price doubling.

### 9.4.5 Benefit Costs

Benefits associated with side stream treatment have been accounted for in the capital and operating costs.

### 9.4.6 Summary

The two alternatives are compared side by side in Table 25.

| Table 25. Pro and Con Analysis of Side stream Treatment | |
|---|---|
| Alternative 1: No Side stream Treatment | Alternative 2: Side stream Treatment |
| Capital costs:<br>• AB expansion: $13.6M<br>• Side stream treatment: zero<br>Operating costs (annual):<br>• Methanol: $669,300<br>• Aeration: $445,700<br>• Biosolids: $16,300<br>• Chemical: $120<br>Replacement costs:<br>• Non-differential<br>Risk costs (annual):<br>• Methanol price instability: $133,900 | Capital costs:<br>• AB expansion: $12.6M<br>• Side stream treatment: $5.22M<br>Operating costs (annual):<br>• Methanol: $485,500<br>• Aeration: $400,400<br>• Biosolids: $15,300<br>• Chemical: $190<br>• Side stream treatment:$78,000<br>Replacement costs (annual):<br>• Equipment: $30,800<br>Risk costs (annual):<br>• Process upset: $16,500<br>• Methanol price instability: $96,900 |

## 9.5 Business Case Evaluation and Recommendation

The BCE projects the net present value (NPV) of each alternative. As we are considering two alternatives that both impose high capital and operating costs, the NPVs are negative. The favored alternative is the alternative that is less costly. In this case, as shown in Table 26, the BCE favors Alternative 1 (no side stream treatment) by a margin of $1.62M.

Table 26. Business Case Evaluation[a,b,c,d]

| | Alternative | Capital Outlays | Benefits | Running Costs | Risk Costs | R&R Costs | NPV[a] |
|---|---|---|---|---|---|---|---|
| 1 | No side stream treatment | $13,620,287 | $0 | $23,759,530 | $2,811,139 | $0 | ($33,690,409) |
| 2 | Side stream treatment | $17,828,654 | $0 | $20,545,786 | $2,382,411 | $647,500 | ($35,314,533) |

a. *The BCE considers 20 years of operation, assuming installation in 2018 and operation through 2038.*

b. *All costs are presented in 2015 dollars.*

c. *The BCE assumes an escalation rate of 3% and a discount rate of 5%.*

d. *Costs that are common to both alternatives are not included in this evaluation.*

The BCE result is driven by the cost to install the side stream treatment system. The BCE suggests that side stream treatment may save the City $3.3M over 20 years. However, with a $5.2M cost to install, those savings are not enough to overcome the difference in up-front capital expenditures. In fact, it would take approximately 20 more years for the evaluation to reach a break-even point.

From another perspective, one might say that the reduced operating costs ($153k per year) would result in a payback period of 28 years to overcome the $4.2M difference in capital costs between the alternatives. That assessment is somewhat more aggressive than the BCE and does not consider the replacement costs, risks, or time value of money.

# 10. BCE Sensitivity

Several factors impact the BCE recommendation. The section identifies several of the most important of these factors, and discusses the sensitivity of the BCE to each of them.

## 10.1 Proportion of Nitrogen in the Centrate

The BCE recommendation reflects the relatively low load of nitrogen present in the plant centrate. Typically, side stream treatment is targeted toward plants that observe 25–33 percent of their total nitrogen load in the centrate. In this case, the proportion of nitrogen in the centrate is much lower. Table 27 summarizes an assessment of centrate nitrogen, considering a number of data sources.

**Table 27. Proportion of Nitrogen Load in Centrate**

| | Historical Data (2009–14) | May 2011 Wastewater Characterization | Facilities Plan 2030 Maximum Month Projection |
|---|---|---|---|
| Centrate $NH_4$/PE $NH_4$ | 0.21 | 0.17 | |
| Centrate $NH_4$/(RI+Centrate $NH_4$) | 0.20 | 0.18 | 0.17 |
| Centrate TKN/PE TKN[a] | 0.17–0.18 | 0.13–0.14 | |
| Centrate TKN/(RI+Centrate TKN)[a] | 0.15–0.16 | 0.12–0.13 | 0.13 |

a. *TKN is not typically measured in the centrate, and was not measured during the May 2011 wastewater characterization. Therefore, high and low ranges were assumed based on ratios of ammonia to TKN observed at Chambers Creek (0.90) and projected in the Facilities Plan (0.95).*

In general, it appears that between 17 and 21 percent of the PE ammonia load is derived from the centrate, and between 12 and 18 percent of the PE TKN load is derived from the centrate. These ratios, and particularly the TKN ratio, are lower than what would typically be expected for a municipal wastewater treatment plant. The amount of nitrogen in the centrate is a function of cell destruction within the digesters. The relatively low nitrogen content of this centrate may indicate lower-than-normal volatile cell destruction. This could be evaluated further during the capacity assessment.

It is also possible that the “gallons dewatered” parameter is not an accurate measure of centrate flow. If, for example, the City uses a very high wash water flow at its centrifuges, the centrate flow volume may be considerably larger than the feed flow. It is possible that this is leading to an underestimate of centrate nitrogen loading.

The relatively low proportion of nitrogen in the centrate diminishes the benefits of side stream treatment. For example, if the centrate composes only 15 percent of the secondary influent nitrogen, and the side stream process removes only 75–80 percent of that nitrogen, then the net reduction in carbon load to the main biological process is only 11–12 percent.

## 10.2 Diurnal Load Pattern

One of the main drivers of the BCE is the size and scope of aeration basin expansion. The aeration basin volume requirement is linked mainly to the increase in SRT required to meet the peak day effluent ammonia limit. The efficiency of nitrification depends upon the presence of nitrifying bacteria. These bacteria oxidize ammonia to nitrite and nitrate, and function best when the substrate is supplied consistently and continuously.

The RI exhibits an extremely sharp diurnal flow curve (Figure 5). Overnight flows decrease to less than 50 percent of the daily average. The TKN concentration also decreases overnight. When the TKN load is calculated, these factors combine, resulting in overnight TKN loads that are only 38 percent of the daily average, and only 25 percent of the peak. The diurnal fluctuation in TKN loading has a destabilizing effect on the nitrifying community. Overnight, the community is starved for ammonia.

In this assessment, centrate is returned at a constant rate throughout the day. This has a stabilizing effect on the nitrifying community. While the centrate results in some increase in peak TKN loading, the increase is a small percentage relative to the PE peaks. Overnight, however, the centrate acts to sustain the nitrifying community (Figure 19). The result is that increased centrate loadings actually improve the performance of the nitrifying community, and have little impact on the required size of the aeration basins. If the centrate loading were doubled from the projection, this would have almost no impact on the plant's ability to meet the peak day ammonia requirement, and the model actually suggests some degree of improvement in certain scenarios.

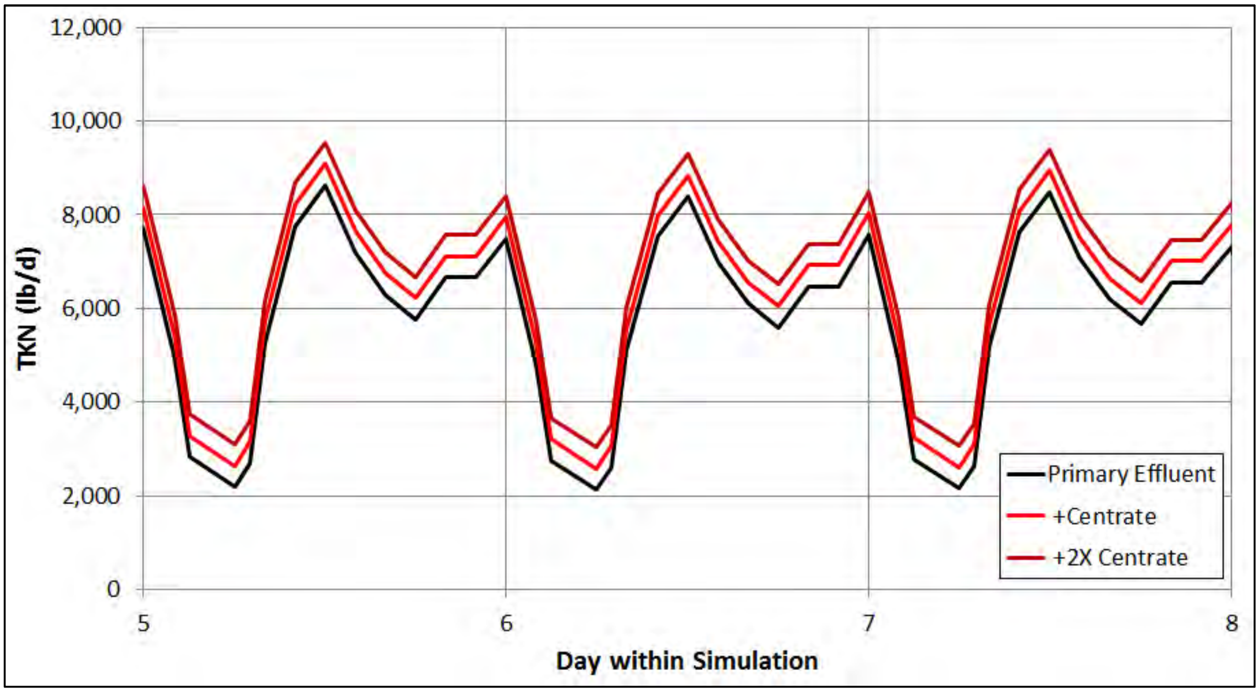


**Figure 19. Secondary influent TKN loading pattern**

In this light, treating the centrate may actually have a negative impact on nitrifying performance. The ability of the centrate to "fill in" the overnight dips in TKN loading is eliminated when the centrate is treated. This explains why side stream treatment allowed for only a modest reduction in aeration basin volume, and why the digester cleaning scenarios did not impact the volume requirement.

Rather than treating the centrate, switching to a load-pace centrate return, where centrate is exclusively returned during the overnight period, may offer increased cost savings in terms of basin volume requirements. Figure 20 plots the effluent ammonia concentration for the 2030 winter maximum month condition and the following three scenarios:

- centrate returned at a constant flow rate over each 24-hour period
- twice the centrate flow returned at a constant flow rate over each 24-hour period
- centrate returned primarily during the overnight period

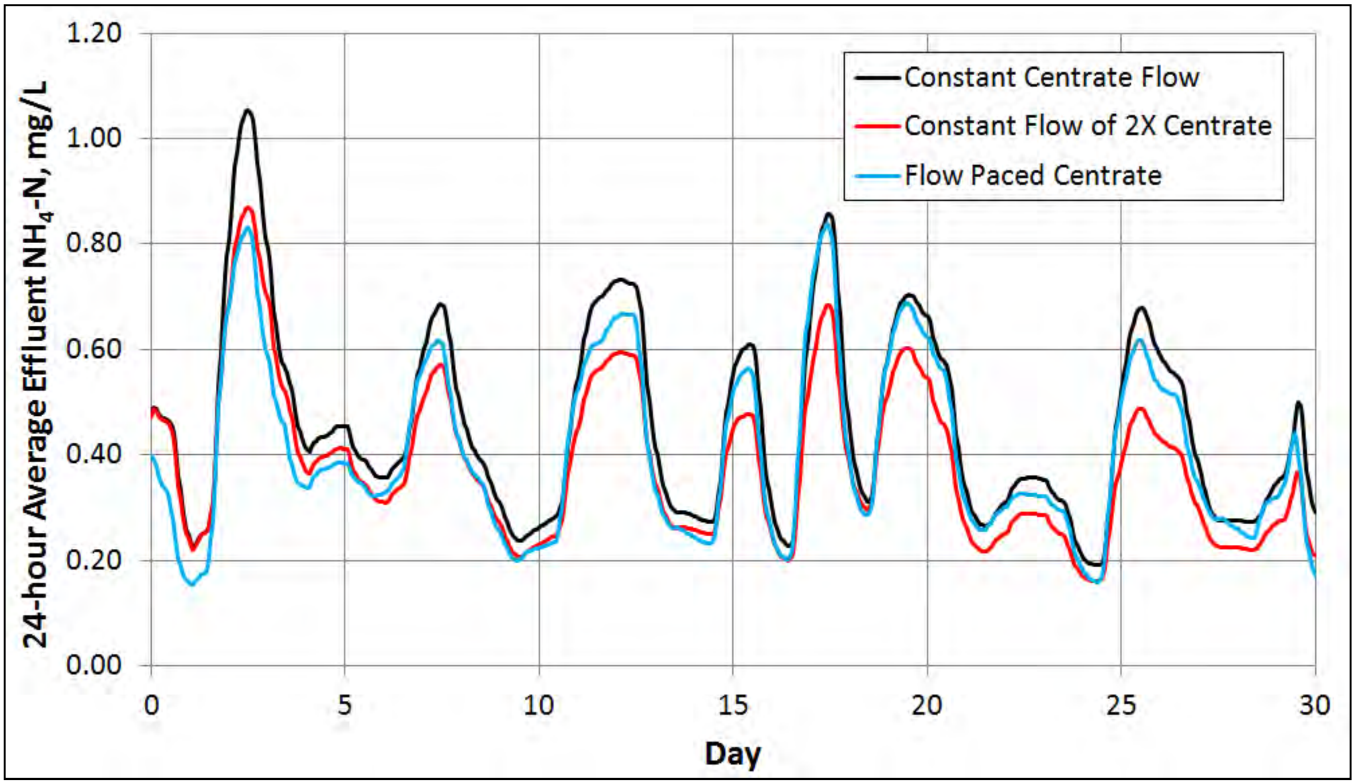


**Figure 20. The effect of centrate return pattern on the peak day effluent ammonia concentration**

It is likely that the load-pacing schedule can be optimized further, but Figure 19 demonstrates the potential benefit with respect to meeting the peak day ammonia requirement.

In summary, Anammox-based centrate treatment, which completely removes nitrogen from the centrate, has only a small effect on the required size of the aeration basin. This is because the volume requirement is driven mainly by the large diurnal fluctuations in nitrogen loading in the RI, which results in inefficient nitrification.

## 10.3 Methanol Demand

The methanol demand is largely a function of the ratio of carbon to nitrogen in the secondary influent. Typically, a secondary influent COD:TKN ratio of approximately 10.0 would be required to allow full denitrification. Plants with ratios lower than 10 will require a supplemental source of carbon, such as methanol, to drive nitrogen removal. Phosphorus removal also requires carbon. Therefore, plants that aim to remove both phosphorus and nitrogen require COD:TKN ratios greater than 10 to achieve target removal. Historically, the plant's secondary influent (PE that includes the centrate return) has averaged a COD:TKN ratio of less than 8.0.

In all of the scenarios modeled, methanol was required to meet the effluent target NOx-N. In some cases, the target was not achievable. Given the A2O process configuration, the efficiency of carbon addition is limited by the IMLR flow. Even with an IMLR ratio of 4Q, only 80 percent of nitrate generated within the aeration basins is returned for denitrification. In some of the cases, the ammonia load is such that no amount of methanol addition will produce an effluent NOx-N of less than 8 mg/L with this configuration.

The relationship between nitrogen loading and the required methanol dose is approximately linear for those cases in which the effluent target was achievable. To demonstrate, the following scenario was developed to assess the impact of increasing the TKN loading with all other parameters held constant (Figure 21).

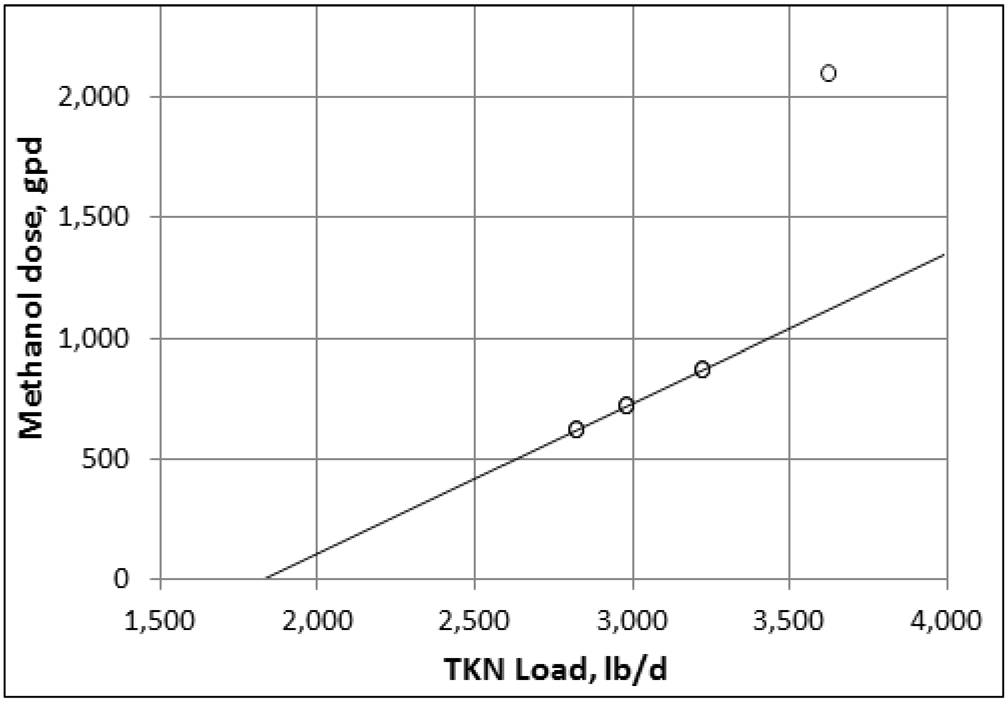


**Figure 21. Relationship between the TKN load and the methanol dose required to achieve an effluent NOx-N of 8 mg/L**

As the TKN load is increased, the required methanol dose increases linearly up to a load of approximately 3,330 lb/d. Beyond that point, excess methanol passes through the selector and is oxidized in the aeration basin.

In summary, the required methanol dose is generally proportional to the nitrogen loading. Because centrate treatment removes nitrogen from the feed, this reduces the required methanol dose. On average, side stream treatment resulted in a 28 percent reduction in the methanol requirement.

## 10.4 Methanol Cost

The BCE is highly sensitive to the cost of the methanol (Figure 22). At the assumed price of $2.25 per gallon, the BCE favors no side stream treatment by an NPV margin of $1.64M. The break-even cost of methanol would be $3.31. At its highest price in recent years ($4.50 per gallon), the BCE would favor side stream treatment by an NPV margin of $1.8M.

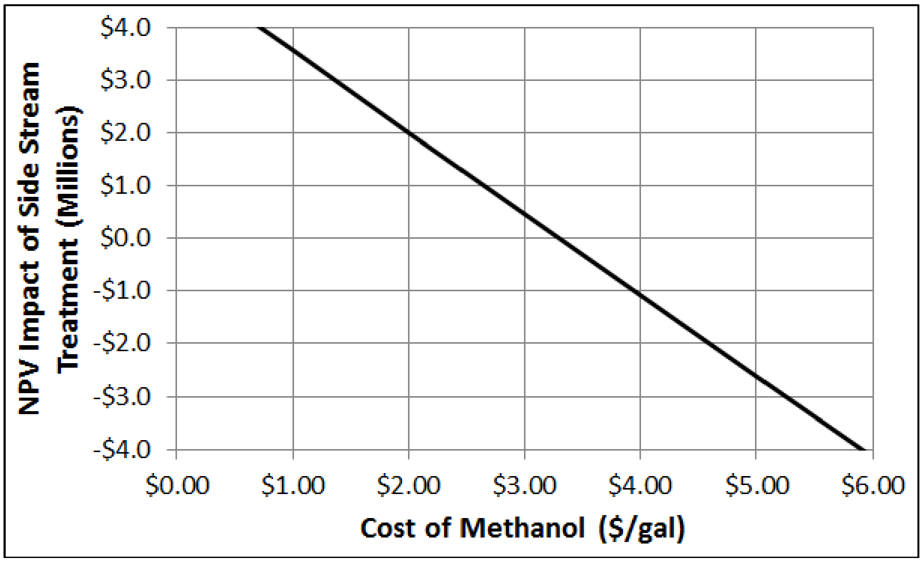


**Figure 22. Effect of methanol cost on BCE recommendation**

*Negative values indicate cases where side stream treatment is favored.*

## 10.5 Sensitivity Matrix

The two most sensitive parameters in the BCE are the required volume of the aeration basins and the methanol demand. As summarized in Table 22, side stream treatment offers a 5 percent reduction in the required aeration basin volume, and a 28 percent reduction in the methanol demand. Figure 23 demonstrates the sensitivity of the BCE to those two factors.

Current assumption
5.6% reduced volume
27.6% reduced methanol

| Reduction in Methanol Dose | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 50.0% | -$0.23 | -$0.66 | -$1.09 | -$1.52 | -$1.94 | -$2.37 | -$2.80 | -$3.22 | -$3.65 |
| 45.0% | $0.39 | -$0.03 | -$0.46 | -$0.89 | -$1.31 | -$1.74 | -$2.17 | -$2.60 | -$3.02 |
| 40.0% | $1.02 | $0.59 | $0.17 | -$0.26 | -$0.69 | -$1.11 | -$1.54 | -$1.97 | -$2.40 |
| 35.0% | $1.65 | $1.22 | $0.79 | $0.37 | -$0.06 | -$0.49 | -$0.91 | -$1.34 | -$1.77 |
| 30.0% | $2.28 | $1.85 | $1.42 | $0.99 | $0.57 | $0.14 | -$0.29 | -$0.71 | -$1.14 |
| 25.0% | $2.90 | $2.48 | $2.05 | $1.62 | $1.19 | $0.77 | $0.34 | -$0.09 | -$0.51 |
| 20.0% | $3.53 | $3.10 | $2.68 | $2.25 | $1.82 | $1.39 | $0.97 | $0.54 | $0.11 |
| 15.0% | $4.16 | $3.73 | $3.30 | $2.88 | $2.45 | $2.02 | $1.59 | $1.17 | $0.74 |
| 10.0% | $4.78 | $4.36 | $3.93 | $3.50 | $3.08 | $2.65 | $2.22 | $1.79 | $1.37 |
| 0.0% | $6.04 | $5.61 | $5.18 | $4.76 | $4.33 | $3.90 | $3.48 | $3.05 | $2.62 |
| Reduction in Aeration Basin Volume | 0.0% | 2.5% | 5.0% | 7.5% | 10.0% | 12.5% | 15.0% | 17.5% | 20.0% |

**Figure 23. 20-year NPV impact of side stream treatment (millions)**

*Negative values indicate cases where side stream treatment is favored.*

In order to be cost-effective, the side stream process would need to reduce the required aeration basin volume by an additional 2.5 percent and reduce the methanol demand by an additional 10 percent. Given the impact of the diurnal flow pattern, centrate treatment has only a small impact on the required aeration basin volume. Without some form of raw wastewater influent flow equalization, centrate treatment would be unlikely to provide better than the 6 percent volume reduction currently assumed. The relatively low proportion of nitrogen in the centrate limits the projected methanol dose reduction. If the nitrogen loading in the centrate is higher than assumed, or if the side stream treatment process performs better than expected (greater than 75 percent TIN removal), then the methanol dose may be reduced accordingly.

# 11. Conclusions and Recommendations

Given the relatively low carbon content of the plant influent, and the very aggressive projected regulations, Anammox-based side stream treatment was thought to potentially offer substantial life-cycle cost savings to the City. However, the current analysis has uncovered other factors that limit the benefits of this type of side stream treatment. Specifically, the high diurnal fluctuation in RI nitrogen loading mutes the impact of nitrogen removal from the centrate, and suggests a load pacing scheme as a more efficient solution. Also, the relatively low fraction of the total nitrogen load associated with the centrate limits the operational benefits of side stream treatment. These factors result in a projected $3.3M net benefit of side stream treatment, which does not offset the projected $5.2M cost to install the side stream treatment process.

In the near term, the draft permit and proposed effluent targets would not be achievable given the existing plant infrastructure and configuration. While side stream treatment may play a role in helping the City reduce capital and operating costs, a large-scale increase in process capacity will be required shortly. The City should explore options to expand the capacity of the biological process through aeration basin volume expansion, additional secondary clarifiers, or process modification.

The modeling projects a large requirement for supplemental carbon, on the order of 500–1,000 gpd. . At peak, the projected carbon demand would impose a large annual operating cost on the City ($900k per year), making carbon efficiency a key driver of any future plant expansion or upgrade. The City should explore alternatives to reconfigure the biological process basins, including options to install a two-stage nitrogen removal system, to reduce projected methanol demands.

Leading into the upcoming capacity assessment, the results of this evaluation offer the following conclusions and recommendations:

### Conclusions

1. The existing plant does not have capacity to meet the proposed effluent target conditions.
2. Side stream treatment is unlikely to be helpful for nitrogen removal, unless the existing diurnal loading pattern is modified (for example, by flow equalization), or the relative proportion of nitrogen in the centrate is determined to be higher than what has been modeled.
3. Load-pacing of the centrate may be a cost-effective way to improve nitrification efficiency and reduce the scope of secondary process expansion. This will not, however, reduce projected carbon demands.

### Recommendations

1. Anammox-type side stream treatment is not recommended at this time. This recommendation may change based on more detailed characterization of the Plant centrate.
2. A detailed characterization of the centrate, and investigation of centrate flows, is recommended.
3. A large-scale expansion and reconfiguration of the biological process is recommended.
4. The process reconfiguration should be targeted toward carbon efficiency.
5. The primary sludge fermentate should be characterized in detail, with particular attention to the loading of nutrients (ammonia, nitrogen, and phosphorus) in the fermentate.

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# Appendix E: Side Stream P Removal Report

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# Technical Memorandum

Prepared for: City of Meridian

Project Title: WRRF Sidestream Phosphorus Removal Technology Evaluation

Project No.: 148698

**Technical Memorandum**

Subject: Sidestream Phosphorus Removal Technology Evaluation

Date: May 19, 2016

To: Emily Skoro, P.E., City of Meridian Project Manager

From: Dave Bergdolt, P.E., Project Manager

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# List of Abbreviations

| | |
|---|---|
| BC | Brown and Caldwell |
| Bio-P | biological phosphorus removal |
| BOD | biochemical oxygen demand |
| $CaCO_3$ | calcium carbonate |
| City | City of Meridian |
| CNP | CNP Corporation |
| $CO_2$ | carbon dioxide |
| COD | chemical oxygen demand |
| d | day |
| DAFT | dissolved air flotation thickener |
| EPA | United States Environmental Protection Agency |
| Facility | Meridian Wastewater Resource Recovery Facility |
| Facility Plan | *City of Meridian Wastewater Facility Plan* |
| gal | gallon(s) |
| gpd | gallon(s) per day |
| hr | hour(s) |
| kWh | kilowatt-hour(s) |
| lb | pound(s) |
| lb/d | pound(s) per day |
| LCCA | life-cycle cost analysis |
| Mg | magnesium |
| MG | million gallons |
| mg/L-P | milligram(s) per liter phosphorus |
| $MgCl_2$ | magnesium chloride |
| mgd | million gallons per day |
| MgO | magnesium oxide |
| $Mg(OH)_2$ | magnesium hydroxide |
| mm | millimeter(s) |
| NaOH | sodium hydroxide |
| $NH_4$-N | ammonia-N |
| NPV | net present value |
| O&M | operations and maintenance |
| Ostara | Ostara Nutrient Recovery Technologies Inc. |
| PAC | polyaluminum chloride |
| PAO | phosphorus-accumulating organism |
| PAQUES | PAQUES Corporation |
| $PO_4$ | phosphate |
| TKN | total Kjeldahl nitrogen |
| TM | technical memorandum |
| TP | total phosphorus |
| TS | total solids |
| TSS | total suspended solids |
| UDC | uniform distributed cost |
| VFA | volatile fatty acid |
| VSS | volatile suspended solids |
| WAS | waste activated sludge |
| WASSTRIP® | Waste Activated Sludge Stripping to Remove Internal Phosphorus |
| yr | year(s) |

# Section 1: Introduction

The City of Meridian (City) is currently experiencing rapid population growth. Consequently, the Meridian Wastewater Resource Recovery Facility (Facility) is quickly reaching its capacity limit. The City has begun planning and designing for expansion of the Facility to meet both anticipated growth and future permit limits for nutrients. Of particular concern is the future effluent total phosphorus (TP) requirement of 0.05 milligram phosphorus per 1 liter (mg/L-P), which is driving much of the new Facility upgrade design.

The *City of Meridian Wastewater Facility Plan* (Facility Plan) discussed the addition of sidestream phosphorus removal technologies to help reduce the amount of internally recycled phosphorus at the Facility to improve secondary performance with respect to biological phosphorus removal (Bio-P) (CH2M and HDR 2012). The specific recommendation was for a struvite recovery system, which removes the phosphorus by precipitating it as the mineral struvite, where struvite is a solid composed of equimolar amounts of magnesium (Mg), ammonium, and phosphate ($PO_4$) (chemical formula: $MgNH_4PO_4{\cdot}6H_2O$). A later investigation into expansion alternatives for the Facility confirmed that adding a sidestream phosphorus removal facility would significantly reduce the amount of supplemental carbon required to drive the Bio-P process in the main stream, potentially saving the City hundreds of thousands of dollars per year (BC 2015). Phosphorus removed from the sidestream has the potential for reducing high operations and maintenance (O&M) costs associated with controlling and mitigating struvite precipitation within the solids handling processes at the Facility, which has been an issue with the City because of the nature of struvite precipitating out on solids handling pipelines and equipment.

Because of the potential benefits associated with a sidestream phosphorus removal process, the City has requested that Brown and Caldwell (BC) investigate potential options for implementation of sidestream phosphorus removal and struvite recovery. To complete this request, an initial review of available technologies was performed, with three systems being selected to cover the breadth of current struvite recovery technologies. Each selected technology has been reviewed with a description of differences and advantages. Based on the selected technologies, a life-cycle cost analysis (LCCA) was performed to provide a means of fiscal comparison of the alternatives. This technical memorandum (TM) presents the findings of the study, including the benefits, costs, and preliminary sizing of each struvite recovery technology, as well as a final recommendation for implementation.

## 1.1 Basis for Struvite Recovery Technology Sizing

This work was based on the future flows and loads presented in the Facility Plan for a 15-million-gallon per day (mgd) maximum month influent load condition, which corresponds with the flow and load conditions that provide the basis for the secondary treatment expansion project that is currently in design. Each vendor was provided a copy of the sidestream treatment design flows and concentrations table shown below in Table 1, which was developed from the Facility Plan. The vendors were asked to size their technologies from these data.

Table 1. Sidestream Treatment Design Flows and concentrations (2030)

| Parameter | Unit | Demand |
|---|---|---|
| Flow | mgd | 0.103 |
| TKN | mg/L | 960 |
| $NH_4$-N | mg/L | 910 |

**Table 1. Sidestream Treatment Design Flows and concentrations (2030)**

| Parameter | Unit | Demand |
|---|---|---|
| TP | mg/L | 530 |
| $PO_4$-P | mg/L | 520 |
| TSS | mg/L | 640 |
| VSS | mg/L | 455 |
| BOD | mg/L | 315 |
| COD | mg/L | 1,805 |
| Alkalinity | mg/L as $CaCO_3$ | 4,100 |

*Source: CH2M and HDR 2012*

*BOD = biochemical oxygen demand.*

*$CaCO_3$ = calcium carbonate.*

*COD = chemical oxygen demand*

*$NH_4$-N = ammonium-N.*

*TKN = total Kjeldahl nitrogen.*

*VSS = volatile suspended solids.*

All vendors commented on the unusually high phosphorus content of the centrate stream. This too was noted in the previous Alternatives Assessment project (Brown and Caldwell, 2015). The Facility Plan value was used as it provides a conservative approach to sizing of systems. The use of the higher centrate phosphate concentrations as a basis of design may result in a lower quantity of chemicals used and a lower level of struvite harvested than what is reported here. However, as the same conditions are being applied to all options, it is not anticipated that the results of this analysis will be impacted by the high centrate phosphate. It is also important to note that centrate values presented here are for undiluted centrate (without mixing dilution water). While mixing dilution water is not anticipated to alter the conclusions of this analysis, it will need to be accounted for in the final design of any struvite recovery system.

The current O&M costs incurred by the City while mitigating its existing struvite issues were used to properly estimate savings associated with reduced O&M for each of the three struvite recovery technologies. The City provided BC with these, which include:

- Additional chemical use
- Small O&M performed by operators (e.g., pipe replacement, equipment cleanings/maintenance)
- Larger capital projects (centrifuge replacement, pump replacement)

As a part of each of the O&M tasks, the City estimated that it spends an annual labor amount on struvite; 6 to 8 hours per week for general maintenance, 30 to 40 hours per month for preventive maintenance, and 50 to 150 hours per year on equipment repairs for an averaged total of 884 hours per year. All reported costs from the City were converted to an annual uniform distributed cost (UDC) for struvite-related O&M, reported in Table 2 below. For non-annual repair work the annual UDC is calculated by dividing the cost of the project by the original anticipated service life (e.g., centrifuge replacement in seven years versus a typical annual service life of eighteen years means at least half of the cost associated with centrifuge replacement is due to struvite and calculated to the UDC). The UDC reported in Table 2 represents only the struvite-related cost, which was calculated by subtracting the design UDC from the observed UDC.

| Table 2. Struvite Related Operations and Maintenance | | | | |
|---|---|---|---|---|
| Parameter | Cost | Observed life (years) | Design life (years) | UDC per year |
| Labor | $25,500 | 1.0 | NA | $25,500 |
| Ferric dosed for struvite control | $102,000 | 1.0 | NA | $102,000 |
| PAC | $12,000 | 1.0 | NA | $12,000 |
| Polygon (cleaning product) | $12,000 | 1.0 | NA | $12,000 |
| Chemical metering pump replacement | $1,100 | 0.5 | NA | $2,200 |
| Small valve replacement | $600 | 0.5 | 50.0 | $1,200 |
| Large valve replacement | $74,000 | 8.0 | 50.0 | $7,800 |
| Pipe replacement | $41,000 | 10.0 | 50.0 | $3,300 |
| Sludge pump rebuild | $36,000 | 5.0 | 10.0 | $3,600 |
| Centrifuge rebuild | $300,000 | 7.0 | 18.0 | $26,200 |
| Annual struvite O&M distributed cost | | | | $195,800 |

*PAC = polyaluminum chloride.*

*UDC Uniform Distributed Cost*

# Section 2: Sidestream Phosphorus Removal Technology Review

An initial review of available technologies led to the selection of three that cover the breadth of current side-stream treatment approaches. Each selected technology has been reviewed with a description of differences and advantages. The final sidestream phosphorus removal technologies include the Ostara Nutrient Recovery Technologies Inc. (Ostara) Pearl® reactor with WASSTRIP® (Waste Activated Sludge Stripping to Remove Internal Phosphorus), the CNP Corporation's (CNP) AirPrex® reactor, and the PAQUES Corporation's (PAQUES) PHOSPAQ™ reactor.

## 2.1 Ostara with WASSTRIP

Ostara markets the Pearl reactor, which produces a struvite precipitate from the dewatering filtrate or centrate stream. To maximize phosphorus release and recovery while minimizing struvite precipitation upstream of the Pearl reactor, the Pearl process will be combined with Clean Water Institute' patented process for Bio-P plants called WASSTRIP. The combined process minimizes the sidestream phosphorus load and struvite formation within the biosolids system, while also partially reducing sidestream ammonium loads and solids quantities for disposal. Ostara also claims that the combined processes can reclaim lost dewatering performance (which is often observed in Bio-P facilities), increasing the dewatered biosolids concentrations and reducing polymer demand for dewatering. The resulting struvite product is purchased by Ostara and sold to the public or to other fertilizer manufacturers as Crystal Green®. The Ostara/WASSTRIP process has eight current installations with another five currently under construction or design. Most projects are within the United States and Canada.

### 2.1.1 Principles of Operation

The WASSTRIP process is designed to release the phosphate from the waste activated sludge (WAS) that was taken up during the Bio-P process. To do this, the WASSTRIP process holds waste activated sludge (WAS) for approximately 12 hours (6 to 20 hours) in an anaerobic environment while providing a form of readily biodegradable chemical oxygen demand (COD).These conditions mimic the anaerobic environment in the anaerobic selector that allows the phosphorus-accumulating organisms' (PAOs') to release internal reserves of polyphosphate. Effluent from the WASSTRIP tank is then thickened to 2 to 3 percent solids using a thickening process (dissolved air flotation thickeners [DAFTs] in the case of Meridian). The thickener subnatant, rich in phosphate, is then combined with centrate from the centrifuges and passed to the Pearl reactor. The thickened WAS is sent to digestion for solids stabilization.

The Pearl reactor creates an environment that promotes struvite formation in a controlled location. It does this by treating thickening and dewatering streams in a high-pH environment with added magnesium to increase the struvite precipitation potential in a location that will not cause O&M issues. To do this, Ostara increases the pH of the treated streams (filtrate, centrate, etc.) in the Pearl reactor to approximately 9 using caustic soda (i.e., sodium hydroxide [NaOH]). Additional magnesium is also added, most commonly as magnesium chloride ($MgCl_2$), because magnesium is typically the limiting component (lowest concentration) for precipitating struvite. A process flow diagram for the Ostara Pearl system with WASSTRIP is presented in Figure 1 below.

The Pearl reactor operates as a fluidized bed reactor, growing the struvite crystals until they reach 0.9 to 3.0 millimeters (mm) in diameter. The large struvite crystals or "prills" (see Figure 2 below) are then harvested for use as fertilizer or to supplement a fertilizer product. Ostara claims to remove up to 88 percent of the sidestream phosphorus load.

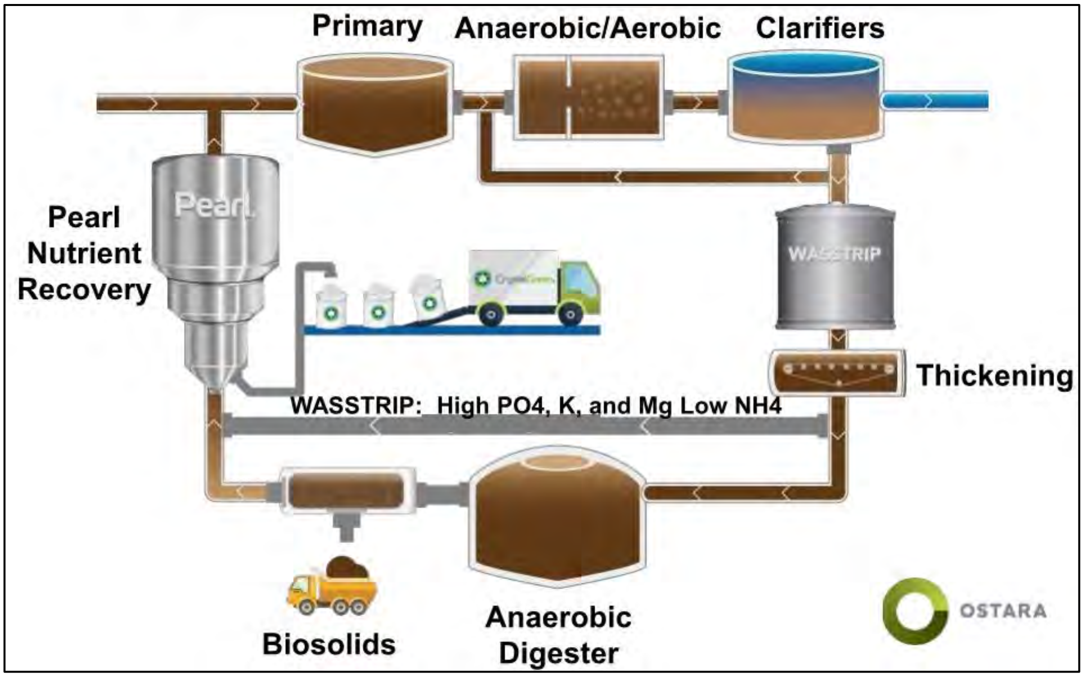



**Figure 1. Ostara sidestream phosphorus-removal process diagram**

*Source: Ostara*


**Figure 2. Struvite produced in a Pearl reactor**

*0.9, 1.5, 3.0, and 4.5 mm prill size (Source: Ostara)*

### 2.1.2 Required Equipment

The WASSTRIP process will require a source of volatile fatty acid (VFA) (in this analysis it will be acetic acid), and a completely mixed tank with approximately 10 hours of retention time (~500,000 gallons). The Ostara solution requires a Pearl reactor, sodium hydroxide for pH control, and magnesium chloride, as well as the associated equipment for chemical pumping and feeding of centrate and DAFT subnatant into the reactor. Struvite harvesting requires grit dewatering, washing, and drying systems, as well as all necessary equipment for bagging, moving, and storing the crystalized struvite product. The drying system is required by Ostara to remove excess moisture—not for regulatory requirements. Centrate equalization will also be required to ensure that WASSTRIP and post-digester filtrate are continuously fed in the correct flow ratio, though it is anticipated that the upgraded centrate equalization system will be sufficiently sized for this purpose. A building will also be required to house the chemical storage, Pearl reactor, and struvite harvesting/handling equipment.

### 2.1.3 Product and Equipment Contracting

Ostara's standard project delivery contract includes a 20-year offtake commitment between the City and Ostara. The offtake contract is mutually exclusive, requiring the City to sell all crystalized struvite product to Ostara. The purchase price of the struvite product is a commodity indexed value (price as of February 12, 2016, is $300 per ton). For quality control the City must sample every 1-ton bag and send the samples to Ostara at pre-agreed-upon intervals for analysis and confirmation on product purity. If the product does not meet Ostara's specifications, the City must dispose of the product at its expense. The City is also responsible for the procurement of all consumables (chemicals such as $MgCl_2$ and NaOH, 1-ton bags, pallets, etc.). Ostara will pick up and transport the fertilizer (40 tons per load), and provide a base level of operational support through the life of the offtake agreement. The typically 20-year agreement can be renewed at the end of the cycle, or the City can take over operation and marketing of the product at that time.

## 2.2 AirPrex

CNP markets the AirPrex reactor, which, like Ostara's Pearl system, precipitates struvite. However, where Ostara precipitates struvite on "clean" sidestreams of thickener and dewatering filtrate and centrate, the AirPrex system is designed to remove struvite from the digested sludge stream prior to dewatering . The AirPrex system has two modes of operation: struvite "harvesting" and the option to leave the struvite in the sludge (called "sequestering") rather than separating it for sale. CNP offers the client the ability to sell precipitated struvite back to CNP or sell it on the open market, if it is removed from the sludge. The AirPrex system will minimize sidestream P load and struvite formation within the biosolids system while also reducing sidestream ammonium loads and solids quantities for disposal. CNP also claims that the AirPrex system can reclaim lost dewatering performance, increasing the dewatered biosolids concentrations and reducing polymer demand for dewatering. The CNP AirPrex system has six European installations and one Chinese installation, and 28 projects in planning or design in the United States.

### 2.2.1 Principles of Operation

The AirPrex reactor relies on the anaerobic digester to release the phosphate stored within the WAS biomass and primary sludge and to generate a high ammonium concentration from the breakdown of organic content. The digested sludge is transferred into the AirPrex reactor, where it is aerated using coarse-bubble diffusers to strip carbon dioxide ($CO_2$) and increase the pH. This is done in lieu of chemical pH adjustment, like with the Ostara Pearl reactor. A supplemental source of magnesium (typically $MgCl_2$) is injected to increase the magnesium concentration and create conditions ideal for struvite precipitation. CNP claims that the AirPrex reactor will remove up to 95 percent of the sidestream phosphorus load. If sequestration of the struvite is all that is desired (i.e., no interest in producing a fertilizer product), then the digested sludge stream with precipitated struvite is sent to dewatering. If harvesting of struvite is desired, struvite-rich digested solids are removed from the bottom of the AirPrex reactor and a Huber Coanda grit washer is used to rinse the majority of organics from the struvite. See Figure 3 below for a process flow diagram of the AirPrex system. See Figure 4 below for a picture of the struvite product.

### 2.2.2 Equipment of Operation

The AirPrex reactor is a 40-foot-tall circular steel tank with a 20-foot diameter. The dimensions of the reactor have been optimized for air stripping of residual $CO_2$. Feed to the reactor typically requires pumping from the digesters because of the height of the reactor. The reactor requires a supply of $MgCl_2$ (and associated chemical metering equipment) and a blower to provide the air for $CO_2$ stripping. If sequestration is all that is required, then no other equipment is needed. If harvesting of the struvite for recovery is desired, then a Huber Coanda grit washer and handling equipment are also required.

The equipment for the harvesting option of AirPrex will fit within a 24-by-43-foot building with the reactor, and an 8,000-gallon $MgCl_2$ tank located outside the building footprint. The non-harvesting option requires a smaller 24-by-33-foot structure, a smaller reactor (13 feet in diameter by 36 feet high), and no struvite separation or washing equipment. The AirPrex vendor package includes the reactor vessel, $MgCl_2$ storage and dosing system, additional chemical storage and metering, blowers, pumps, and struvite washing equipment (if applicable).

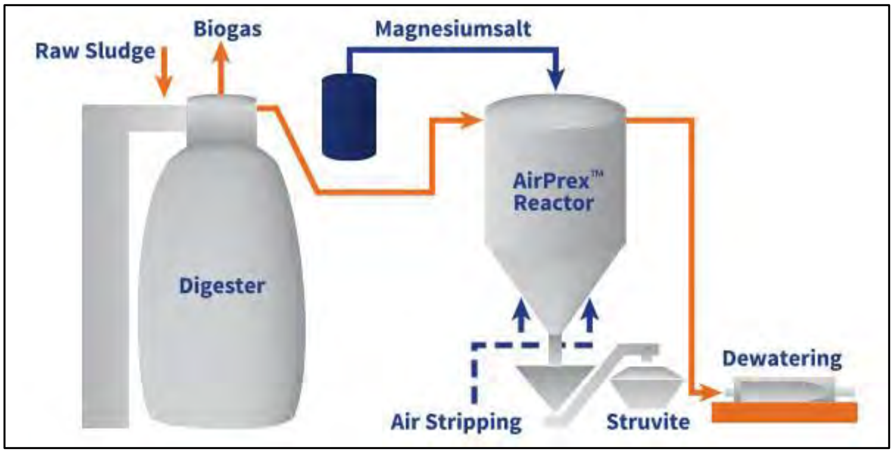



**Figure 3. AirPrex process flow diagram**

*Source: CNP*

**Figure 4. Struvite produced in AirPrex reactor, and packaged struvite fertilizer product**

### 2.2.3 Product and Equipment Contracting

CNP provides the AirPrex system as a standard quote and delivery between CNP and a City-selected contractor. Though not required if the struvite is only sequestered or if the City wants to sell the struvite on its own, CNP will provide a guaranteed struvite purchase agreement between the City and CNP for a period of 3 years at a current quoted price of $100 per ton (as of February 22, 2016). After 3 years the contract can be renegotiated or the owner may sell the product themselves.

## 2.3 PHOSPAQ

PAQUES markets the PHOSPAQ reactor for struvite precipitation and recovery. PHOSPAQ is designed to recover phosphorus in the form of struvite from “clean” dewatering return streams (e.g., centrate). The system operates in a manner similar to a hybrid of the Ostara Pearl system and the CNP AirPrex system in that pH control is achieved with a combination of chemical addition and aeration. A magnesium salt is added to provide an additional driver for struvite precipitation. The removed struvite is separated via gravity systems and recovered. The City can then independently sell the struvite on the open market as a slow-release fertilizer; there is no contracting mechanism with PAQUES for purchase of the struvite from the City. The PHOSPAQ system is relatively new to the North American market with one confidential installation in the United States, and a total of nine systems installed in Europe and China.

### 2.3.1 Principles of Operation

The PHOSPAQ reactor requires an anaerobic digester to release phosphorus from PAOs and to generate high ammonium concentrations. Similar to Ostara’s Pearl reactor, the process is inserted directly into the centrate stream and creates an environment favorable to struvite precipitation. The PHOSPAQ reactor does this by increasing the pH using coarse-bubble diffusers to strip $CO_2$, similar to AirPrex. However, PAQUES’s reactor is not as tall and has a lower retention time than the AirPrex reactor, so supplemental chemical pH control is required to further increase the pH. The PHOSPAQ reactor uses magnesium oxide (MgO) or magnesium hydroxide ($Mg(OH)_2$) to further increase the pH, which doubles as the supplemental magnesium source. Struvite is allowed to settle either within the reactor or, if low total suspended solids (TSS) effluent is required, a separate proprietary gravity settler (ASTRASEPARATOR™) is used to further refine the solids separation. PAQUES claims that the PHOSPAQ reactor will achieve 70 to 90 percent removal of sidestream phosphorus loads. Figure 5 shows the struvite product provided by PHOSPAQ. PAQUES would not provide a PHOSPAQ process flow diagram when requested.

**Figure 5. Struvite produced by PHOSPAQ reactor**

### 2.3.2 Equipment of Operation

The PHOSPAQ reactor consists of a 26-foot-tall circular tank at least 13 feet in diameter, fitted with the proprietary PHOSPAQ internals. To improve TSS separation and struvite capture, a PAQUES ASTRASEPARATOR has been recommended for the Meridian application. The ASTRASEPARATOR is a propriety lamellae plate settler. No building dimensions were provided to house the additional equipment; however, because of the similarity of the equipment with AirPrex it can be assumed the 24-by-45-foot building would be sufficient. The PHOSPAQ system requires the City to provide a blower, chemical storage and metering system, equipment for struvite washing and dewatering, and pumps to feed the PHOSPAQ reactor. All equipment for struvite handling and storage is also required to be provided by the City.

### 2.3.3 Product and Equipment Contracting

A standard quote and supply to a City-selected contractor is the only method for procurement provided by PAQUES. PAQUES does not offer a guaranteed purchase agreement. All of the product would be handled and sold by the owner.

# Section 3: Life-Cycle Cost Analysis

To compare each of the three technologies and provide a recommendation to the City for implementation, an LCCA was completed. The LCCA incorporated four different costs for the evaluation. These cost categories included capital investment, O&M, risks, and benefits. The final evaluation calculates a 20-year net present value (NPV) for each alternative by summing the capital investments, O&M, and risk and subtracting them from the benefits. The alternative with the highest NPV is deemed the most fiscally beneficial.

## 3.1 Capital Investment Costs

All equipment quotes were marked up to include construction fees, contingency, and allied fees. Ostara opted to provide a complete design-build quote, which includes all additional costs. Therefore, a separate markup was applied to the Ostara quote to account for sales tax and contingency. The markups are listed in Table 3**Error! Reference source not found.**. The equipment markup was applied to the quotes and equipment costs supplied by CNP for the AirPrex system and by PAQUES for the PHOSPAQ system. The design-build markup was applied to the Ostara Pearl system and the equipment markup was also applied to equipment and tanks not included in the Ostara scope of supply.

**Table 3: Equipment capital cost markups**

| Parameter | Equipment markup (%) | Design-build markup (%) |
|---|---|---|
| **Construction fees** | | |
| Contractor field overhead, bonds, insurance | 12 | - |
| Overhead and profit | 15 | - |
| Contingency | 25 | 10 |
| **Allied fees** | | |
| Legal | 2 | - |
| Administrative | 5 | - |
| Permitting and scope | 3 | - |
| Preliminary engineering | 5 | - |
| Final engineering | 15 | - |
| Construction engineering | 10 | - |
| Escalation | 2.3 | - |
| Total markup | 2.43 | 1.19 |

### 3.1.1 Ostara

The Ostara Pearl and WASSTRIP proposal included a lump construction fee for all equipment and construction. An additional 0.5 million gallons (MG) tank for the WASSTRIP process was priced separately, with all other equipment and structures included in the Ostara estimate. Ostara estimated a total project cost in the range of $5 million to $6 million based on the data provided. For this analysis, an average value of $5.5 million was used. With a 10 percent contingency and the additional tank, the total capital cost for Ostara was $6,728,200.

### 3.1.2 AirPrex

The AirPrex estimate included an itemized list of provided equipment with a lump sum depending on the harvesting alternative. AirPrex included building footprints, but no estimate for the cost of construction. A cost estimate was performed for the two alternatives to assign costs to the housing structures, additional sludge piping, and a struvite storage area. For the harvesting option the equipment costs from the vendor were $1,450,700. With the additional structures and estimated markups the final cost was $3,890,000.

The non-harvesting option requires a smaller footprint and less equipment. The equipment cost from the vendor was $980,000. With the additional equipment and markups the final cost was $2,705,000.

### 3.1.3 PHOSPAQ

The PHOSPAQ estimate included only the internal components to a reactor; no mechanical equipment was included. The internal components were quoted at $425,000. Based on recommendations from the vendor and experience with previous projects, an extensive list of mechanical equipment was compiled for cost estimating. Once the appropriate markups were applied the final cost was $2,450,000.

## 3.2 Operations and Maintenance Costs

The estimates for O&M were based on projections of chemical dose, power demand, and maintenance hours provided by each of the vendors. Chemical costs were based on quotes provided by UNIVAR®, a local chemical sales representative, with the exception of the price for $MgCl_2$, which was provided by Dustbusters Inc., a company that typically provides the product for Ostara installations. The cost of power and labor was defined by the City. The cost of annual O&M supplies was either an estimate provided by each system vendor or, if no estimate was offered, an estimate of 1 percent of the equipment capital value was used.

### 3.2.1 Ostara

O&M costs associated with the Pearl system are presented in Table 4. The Ostara process requires $MgCl_2$ as a magnesium source, NaOH for pH control, and acetic acid to initiate a phosphorus release in the WASSTRIP process. Power is required for operation of the equipment associated with the Pearl reactor and to dry the struvite prills. The annual labor includes typical O&M as well as bagging of the struvite product. The maintenance supplies are for general maintenance and the purchase of 1-ton super sacks to store the struvite prills. The $MgCl_2$ dose provided by Ostara is reduced relative to other vendors as they account for an assumed 106 pounds per day (lb/d) of magnesium both released in the WASSTRIP process and naturally occurring magnesium in the relatively hard groundwater present in Idaho. In the event that the assumed residual magnesium is not available, a risk factor has been added (described in Section 3.3) to the Ostara option to add additional $MgCl_2$ to account for the credit that Ostara takes for WASSTRIP released and naturally occurring magnesium.

Table 4: Ostara O&M

| Parameter | Unit cost | Demand | Annual cost |
|---|---|---|---|
| Labor | $28.75/hr | 4 hr/d | $30,000 |
| Power | $0.06/kWh | 990 kWh/d | $21,700 |
| $MgCl_2$ | $0.60/gal | 300 gpd | $65,200 |
| Caustic (NaOH) | $0.145/lb | 0.069 ton/d | $7,300 |
| Acetic acid | $0.74/lb | 133 lb/d | $35,800 |
| Maintenance supplies | $15,000/yr | - | $15,000 |
| Total cost | | | $175,00 |

### 3.2.2 AirPrex

O&M costs associated with the AirPrex system are presented in Table 5. The AirPrex reactor requires only $MgCl_2$ for a magnesium source. The AirPrex system was conservative for the amount of $MgCl_2$ to add as it did not account for any residual magnesium from phosphorus release in the digester or naturally occurring in the water source. Therefore, no risk was assigned to the $MgCl_2$ costs. Power costs include struvite harvesting equipment, pumping, and blower demands. No maintenance estimate was available from the vendor; therefore, a value of 1 percent of vendor-supplied capital cost was used.

Table 5: AirPrex O&M

| | | Harvesting | | Sequestration | |
|---|---|---|---|---|---|
| Parameter | Unit cost | Demand | Annual cost | Demand | Annual cost |
| Labor | $28.75/hr | 1.0 hr/d | $10,500 | 1.0 hr/d | $10,500 |
| Power | $0.06 kWh | 313 kWh/d | $6,900 | 219 kWh/d | $4,800 |
| $MgCl_2$ | $0.60/gal | 505 gpd | $110,000 | 505 gpd | $110,000 |
| Maintenance supplies | - | $14,600 | $14,600 | $9,800 | $9,800 |
| Total cost | | - | $142,000 | - | $135,000 |

### 3.2.3 PHOSPAQ

O&M costs associated with the PHOSPAQ system are presented in Table 6. The PHOSPAQ process prefers to use MgO as the magnesium source and pH buffer but, because of limitations in supply and cost, will defer to using $Mg(OH)_2$, which is quoted here. As with AirPrex, the PHOSPAQ system did not take credit for any existing magnesium, so no risk cost associated with the $Mg(OH)_2$ addition is included in the LCCA for this vendor. No moving equipment was provided with the vendor's quote; therefore, the estimate for the AirPrex harvesting solution was used as a substitute because of similar processes like blowers and pumps. No maintenance estimate was available because the vendor provides none of the mechanical equipment, so an estimate was made using 1 percent of the value of the combined mechanical equipment estimate and vendor-supplied equipment.

Table 6: PHOSPAQ O&M

| Parameter | Demand | Unit cost | Annual cost |
|---|---|---|---|
| Labor | 4 hr/d | $28.75/hr | $30,000 |
| Power | 313 kWh/d | $0.06 kWh | $6,900 |
| $Mg(OH)_2$ | 811 lb/d | $0.2702/lb | $49,900 |
| Maintenance supplies | - | $10,700/yr | $10,700 |
| Total cost | | - | $97,000 |

## 3.3 Risks Costs

Each technology was reviewed for potential risks to the City and each risk was considered for all technologies, however due to differences in the alternatives not all risk were applied to each alternative. An annual UDC was assessed based on the potential capital and O&M costs of a risk. The following sections describe the associated costs for the evaluated risks of each system.

### 3.3.1 Service and Accessibility of Spare Parts

While investigated, service and accessibility of spare parts was not included in the analysis as it was found that each vendor maintains suitable stockpiles of spare parts on hand for equipment failure. Ostara and Air-Prex have vested interests in optimizing the production of struvite because of their purchase agreements; therefore, access to service was assumed to be of minimal concern. The PHOSPAQ package does not include any moving parts and it is not likely to need servicing; any supplementary equipment required by the system would be serviced by the provider of that equipment. All options have a similar level of risk; therefore, the value of this risk was considered common among all options and was not quantified.

### 3.3.2 Supplemental Magnesium

The Ostara estimate for required magnesium takes credit for residual magnesium in the water from the WASSTRIP process and the hard groundwater in Idaho. This assumption accounts for 106 lb/d of the required magnesium for the Ostara process. Because the actual magnesium concentrations are unknown, a risk was assigned to the Ostara process for an additional 128 gallons per day (gpd) of $MgCl_2$ to account for the assumed available magnesium. As no other vendors took credit for the potential for existing magnesium in the system, this risk is applied only to the Ostara option. Costs associated with this risk are provided in Table 7.

**Table 7: Cost of Supplemental $MgCl_2$**

| Parameter | Ostara |
|---|---|
| Probability of risk | 50% |
| Capital investment | $0 |
| Annual O&M costs | $27,800 |
| Annual UDC [a] | $13,900 |

*a. Annual cost assigned to this risk for the LCCA.*

### 3.3.3 Sidestream Treatment Failure

The inherent risk of failure is common to all options; however, the probability of risk of failure is different among options because of their responsiveness and the number of installations currently in place in North America and worldwide. Additional weight was placed on North American installations. The cost of failure was calculated based on using chemical precipitation to remove the phosphorus prior to being returned to the headworks. No additional infrastructure would be required because the reaction vessel for each option would provide the mixing and flocculation required for chemical phosphorus treatment. The alum dose was based on a 48 percent liquid solution costing $1.22/gal, the removal of 402 lb/d of $PO_4$-P at a molar ratio of 2.5 mol-Al/mol-P. The cost shown in Table 8 is the same for each option; the difference in distributed cost is the effects of the risk probability.

**Table 8: Cost of Sidestream Treatment Failure**

| Parameter | Ostara | AirPrex (all options) | PHOSPAQ |
|---|---|---|---|
| Probability of risk | 10% | 10% | 20% |
| Capital investment | $0 | $0 | $0 |
| Annual O&M costs | $806,500 | $806,500 | $806,500 |
| Annual UDC | $80,650 | $80,650 | $161,300 |

### 3.3.4 Meeting Class A Biosolids Requirements

While struvite produced from a wastewater treatment plant has been exempted from meeting the United States Environmental Protection Agency (EPA) 503 regulations on biosolids by some governing bodies, the EPA does not necessarily provide that exemption, as evidenced with the City of Boise (City of Boise, July 2, 2015 Interoffice Memorandum). Therefore, each vendor was informed of the unique requirements faced in Idaho and offered solutions to this issue. Two plausible options were provided by the vendors. First, the produced struvite is sold directly to the vendors, which take responsibility (and associated risk) for ensuring that the product meets any potential applicable EPA 503 requirements. This option is viable for both Ostara and AirPrex, so no risk was included for these alternatives. The second solution is to install additional dryers capable of meeting the time and temperature requirements stated in the EPA 503 regulation. When these criteria have been met, the product qualifies as Class A biosolids and can be marketed to the public. The City of Boise has recently been forced to follow this option, and costs from that project have been scaled to meet the size of this analysis and are included in the results shown in Table 9. PHOSPAQ is the only option affected by this risk, and based on the experience of the City of Boise, a probability of 50 percent was assigned and the cost was distributed across the 20-year analysis period.

**Table 9: Cost of Meeting Class A Biosolids Regulations**

| Parameter | Ostara | AirPrex (Harvesting) | PHOSPAQ |
|---|---|---|---|
| Probability of risk | 50% | 50% | 50% |
| Capital investment [a] | $1,000,000 | $1,000,000 | $1,000,000 |
| Annual O&M costs | $90,300 | $90,300 | $90,300 |
| Annual UDC | $70,150 | $70,150 | $70,150 |

*a City of Boise, July 2, 2015 Interoffice Memorandum*

## 3.4 Benefits

Each option includes benefits based on the expected improvements observed by each system. Some benefits add cash value to the system from sale of products while others represent a reduction in overhead expenses, such as chemical demand or maintenance. Where a reduction was expected, the benefit becomes the difference between a “do nothing” option (no sidestream phosphorus installation) and the anticipated results for the vendor system.

### 3.4.1 Reduced Struvite Operations and Maintenance

The baseline for struvite-related O&M was provided by plant staff. Projects included pipe replacement, valve replacement, pump rebuilding, and centrifuge replacement. The annual distributed cost was calculated for each item based on expected life, observed life, and replacement value. The location of the repairs was also noted because the technologies intercept the process flows at different locations, and therefore some observed O&M issues may not be eliminated by that technology. Based on the technology interception point, the O&M values have been categorized as shown in Table 10. Digester cleaning is not included in this analysis as the impact of struvite accumulation and the required interval for maintenance cleaning is currently unknown.

| Table 10: Annual Struvite Related O&M Costs | | |
|---|---|---|
| Pre-sludge storage (Ostara) | Pre-dewatering (AirPrex and Ostara) | Post-dewatering (PHOSPAQ, AirPrex, and Ostara) |
| Valve replacement: $8,900 | Ferric dose: $102,000 | PAC dose: $12,000 |
| Pipe replacement: $3,280 | Chemical metering: $2,200 | |
| Sludge pumping: $3,600 | PolyGone: $12,000 | |
| | Centrifuge rebuild: $26,190 | |

The Ostara system will require the least struvite-related O&M because it diverts phosphorus around digestion with the use of WASSTRIP. The WASSTRIP reactor will remove approximately 60 percent of the phosphorus from the WAS, which ensures that conditions for struvite precipitation will not likely form in the digester. Because the system prevents struvite-forming conditions, not all of the material costs listed in Table 10 are deemed necessary—only labor associated with checking and cleaning the equipment. Labor was estimated to be 244 hours per year. This yields the greatest reduction in O&M-related costs of $188,600 per year.

The AirPrex reactor treats the sludge post-digestion, but prior to dewatering. Therefore, it will have little to no effect on any O&M upstream of digester 3 (currently used for sludge storage and dewatering equalization). While not captured in this analysis, some capital improvements can be made to the system to reduce the maintenance required. All materials in the pre-dewatering column of Table 10 were included in the struvite-related O&M, along with an additional 376 hours per year, resulting in an O&M reduction of $169,000 per year.

The PHOSPAQ reactor treats the centrate stream only and will reduce O&M only on systems downstream of the centrifuge. All material in the pre-sludge storage and pre-dewatering cells was included in the estimate for struvite-related O&M, in addition to the current struvite-related O&M labor of 884 hours per year. The total reduction in struvite-related O&M cost was the price of PAC used for struvite control in the centrate equalization tank, which amounts to approximately $12,000 per year.

### 3.4.2 Struvite Sales

Each vendor supplied different options for the sale and handling of the struvite product. If available, a purchase agreement with the vendor was the preferred method for the sale and distribution of struvite. Ostara provides a 20-year agreement with a price indexed to the market value (currently $300 per ton according to Ostara). AirPrex offered a 3-year contract at a fixed price with the price and contract renegotiated every third year (currently $100 per ton according to AirPrex). PHOSPAQ did not provide a purchase agreement or a current market price so the market value recommended by AirPrex was used. The calculated struvite harvest and subsequent value for each option is presented in Table 11.

| Table 11: Annual Value of Struvite Sales | | | | |
|---|---|---|---|---|
| Parameter | Ostara | AirPrex (Harvesting) | AirPrex (Sequestration) | PHOSPAQ |
| Vendor-estimated annual struvite harvest | 450 tons | 233 tons | NA | 491 tons |
| Vendor-quoted price | $300/ton | $100/ton | NA | $100/ton [a] |
| Annual benefit | $135,000 | $23,300 | NA | $49,100 |

a. *No vendor quote was provided; the current market value as quoted by the AirPrex vendor was used.*

### 3.4.3 Hauling Reduction

A reduction of hauled sludge was anticipated by the vendors as a result of:

(1) the removal of the struvite mass in the sludge

(2) the increase in percent total solids (TS) content of dewatered solids.

The PHOSPAQ option treats centrate only and no reduction in solids hauled is anticipated. The price of hauling and disposal was provided by the City at $20.68/wet ton; costs for each option are shown in Table 12. The proposed reduction in solids volume can be verified only with pilot testing.

**Table 12: Annual Value of Reduced Hauling**

| Parameter | Ostara | AirPrex (Harvesting) | AirPrex (Sequestration) | PHOSPAQ |
|---|---|---|---|---|
| Vendor-estimated annual struvite harvest | 450 tons | 233 tons | 0 tons | 491 tons |
| Average annual wet haul | 14,073 tons | 15,102 tons | 16,206 tons | 17,911 tons |
| Average annual value of reduced hauling | $99,650 | $78,400 | $55,500 | $0 |

### 3.4.4 Polymer Reduction

All systems that treat flow prior to dewatering steps claim a reduction in required dewatering polymer. Both AirPrex and Ostara claim a 15 percent reduction in polymer dose; PHOSPAQ does not treat flow prior to dewatering and therefore no reduction in polymer use is anticipated. The value of these benefits is shown in Table 13, with the difference between the Ostara and AirPrex benefit due to differences in the mass of solids being dewatered between the two processes. Polymer reduction claims can be verified only with pilot testing.

**Table 13: Annual Value of Reduced Polymer Dosing**

| Parameter | Ostara | AirPrex (Harvesting) | AirPrex (Sequestration) | PHOSPAQ |
|---|---|---|---|---|
| Vendor-estimated polymer reduction | 15% | 15% | 15% | 15% |
| Average annual reduction in polymer demand | 7,765 gal | 6,117 gal | 4,292 gal | 0 gal |
| Average annual value of reduced polymer demand | $82,538 | $65,071 | $46,199 | $0 |

## 3.5 Net Present Value: Results

NPV is the difference between present value of investments and the present value of predicted incomes or expenses. Calculating the NPV requires two rates: the discount rate and the escalation rate. The escalation rate, which is based on the current rate of inflation, is used to increase the summed value of O&M, risks, and benefits to the year of analysis (i.e., $1 spent on O&M in 2016 is equivalent to a higher dollar value in 2036, because of inflation). The discount rate is typically based on the inflation rate plus an anticipated interest rate. This rate is used to discount the future value to present value (2016) for comparison of options. This analysis assumed a 3.06 percent inflation rate and 4.6 percent discount rate. Results of the analysis are summarized on Table 14.

| Table 14: 20-Year Summed Cost and NPV | | | | | | |
|---|---|---|---|---|---|---|
| Alternative | Capital | Benefits | O&M | Risks | NPV | Difference from cheapest alter-native |
| Ostara and WASSTRIP | $6,728,200 | $10,540,000 | $3,674,100 | $3,458,800 | ($3,517,700) | ($1,409,000) |
| AirPrex (Harvesting) | $3,889,000 | $6,753,100 | $2,975,900 | $3,166,800 | ($3,325,600) | ($1,216,900) |
| AirPrex (Sequestration) | $2,673,000 | $5,137,000 | $2,831,900 | $1,693,700 | ($2,108,700) | $0 |
| PHOSPAQ | $2,451,000 | $1,031,200 | $2,768,100 | $4,860,400 | ($8,695,400) | ($6,586,700) |

All alternatives have a negative NPV at the end of the 20-year analysis period, indicating that the systems will not have paid back the initial investment. However, this does not include the savings that would be realized by the mainstream process currently in design. Based on the LCCA, AirPrex sequestration has the highest NPV (smallest negative value), meaning it will have the fastest payback and lowest overall cost to the City.

Because of the high centrate phosphorus concentration, the actual struvite sales may be less than anticipated and the consumption of magnesium may be lower than anticipated. As all options (with the exception of AirPrex Sequestration) include struvite sales, all options (with the exception of AirPrex Sequestration) may see lowered benefit costs due to reduced sales. Furthermore, all options may also experience lower O&M costs because of reductions in magnesium chemical use, with the AirPrex options experiencing the largest reduction because of the highest associated costs for magnesium. Therefore, it is not anticipated that changing the assumption associated with centrate phosphorus concentration would change the overall outcome of this LCCA.

# Section 4: Conclusions and Recommendations

Based on this analysis, the 20 year NPV of the four evaluated options are:

1. AirPrex (No Harvesting): -$2,109,000
2. AirPrex (Harvesting): -$3,326,000
3. Ostara: -$3,518,000
4. PhosPAQ: -$8,011,000

From these NPVs, the recommended solution is the AirPrex system with phosphorus sequestration (no harvesting of the struvite). While all alternatives have a negative NPV at the end of the 20-year analysis, the AirPrex Sequestration alternative has the highest value, demonstrating that it will have the shortest payback period. However, it is important to point out that, with the exception of PhosPAQ, all other options were within $1.5M over a 20 year life cycle to AirPrex with sequestration. Because of the closeness of this analysis and the dependence on the cost of hauling biosolids, power costs, and chemical costs, minor changes in these prices could impact the NPV of the different AirPrex and Ostara options to the point that it may alter the final selection of AirPrex with sequestration. However, as AirPrex with sequestration could easily be converted to a harvesting system in the future, it does provide a distinct advantage that is not captured in the LCCA.

This analysis was based on the 2012 Facility Plan and included unusually high predicted centrate phosphorus concentrations. If observed, phosphorus is less than the predicted concentrations. The NPV for the no-harvesting alternative will improve because of lower magnesium doses while the NPV for harvesting options will further decrease because of decreased struvite sales. An additional benefit of the AirPrex system is the ability to add harvesting at a later date should it become more economically beneficial. While all three technologies will achieve the desired removal of sidestream phosphorus, the most fiscally beneficial alternative, as demonstrated by this analysis, is the AirPrex system with phosphorus sequestration. The final recommendation of this report is that the claims of AirPrex (No Harvesting) with regard to polymer reduction and improved solids dewaterability be confirmed with a pilot study. This will ensure that the assumptions made in this LCCA with respect to the benefits of AirPrex can be confirmed to validate the overall finding that AirPrex has the lowest 20 year NPV.

# Section 5: References

CH2M and HDR. 2012. City of Meridian Wastewater Facility Plan, July.

Brown and Caldwell (BC). 2015. Secondary Treatment Alternatives Evaluation, September.

City of Boise, July 2, 2015 Interoffice Memorandum to Boise Public Works Commission, Directors Report – Sewer

# Section 6: Update to Sidestream P Evaluation

## 6.1 Purpose of Update

During the initial study, the City was aware of struvite precipitation in the pipes and pumps after the secondary digester. However, in 2017 the secondary digester was taken offline and cleaned as part of normal operations and maintenance. The cleaning work uncovered struvite deposits inside the digester and throughout internal piping that resulted in higher than anticipated maintenance costs. Based on the new information, the City requested that an update to the sidestream P evaluation be conducted using the higher operation and maintenance cost estimates. The results of this update are presented in this section of the Evaluation and is meant to present an updated final recommendation to that presented initially in Section 4. For this update, the City also requested that an additional add-on process for the AirPrex system, called CalPrex, be evaluated. CalPrex is a new technology from CNP which removes phosphorus prior to digestion and has the potential to reduce or eliminate struvite formation ahead of digestion processes.

## 6.2 OSTARA Update

### 6.2.1 Updated Equipment Package and Contract Option

At the City's request, a unique equipment package and contract option has been provided by OSTARA. The new package reduces the capital cost and simplifies operations by removing the drying and processing equipment. The unclassified product will be purchased by OSTARA at a reduced rate and processed at an offsite facility.

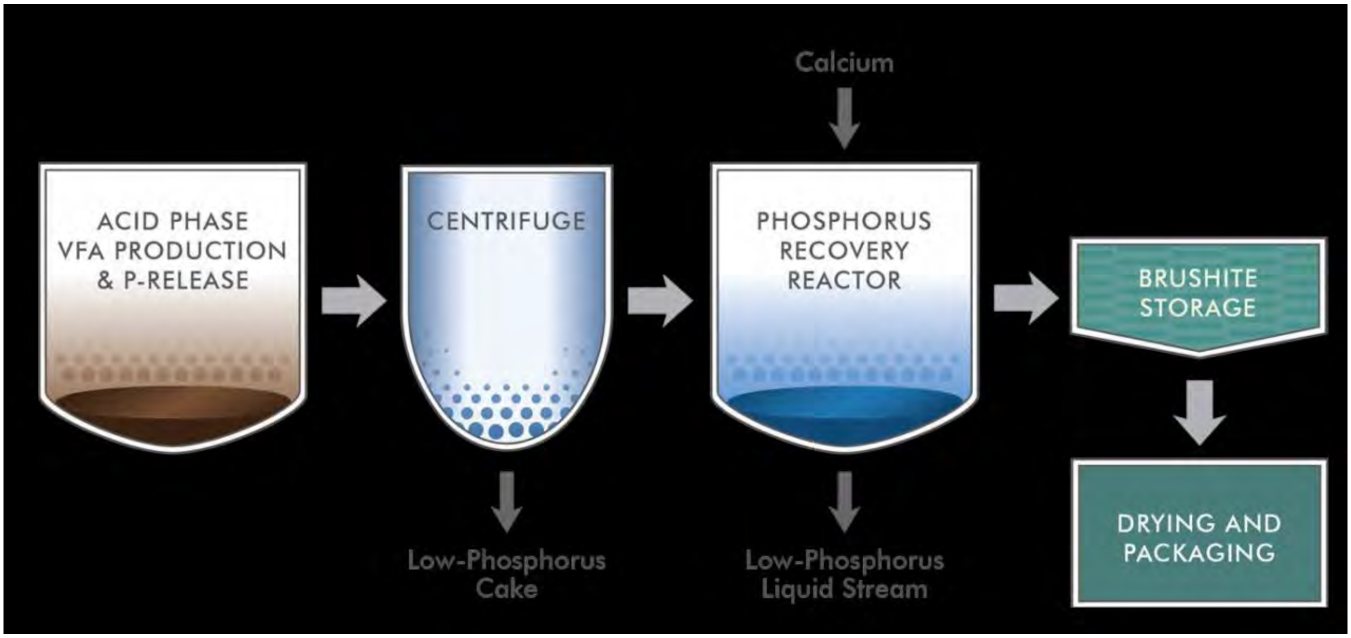
## 6.3 CalPrex Process

CNP has brought a new process to the US market called CalPrex. The CalPrex reactor precipitates phosphorus with calcium in the form of Brushite ($CaHPO_4 \cdot 2H_2O$) in a pH controlled environment by using an acid phase digester to release biologically bound phosphorus then precipitates the phosphorus prior to mesophilic or thermophilic digestion in a dedicated precipitation reactor. Brushite has an equivalent value to struvite as a slow release fertilizer.

### 6.3.1 Principles of Operation

The CalPrex process is outlined in Figure 6. This process feeds primary solids and WAS to an acid phase digester to release the biologically bound phosphate. Effluent from the acid phase digester is dewatered using a centrifuge to separate the phosphorus rich centrate from the solids. The centrate is fed into the CalPrex reactor along with a source of calcium. The process relies on maintaining a pH of 6.5 to form brushite, and depending on the centrate feedpH, either calcium chloride ($CaCl_2$) or calcium hydroxide ($Ca(OH)_2$) is used as the calcium source. The brushite formed is settled in the recovery reactor for havesting, while the treated centrate is mixed back into the cake produced by the acid phase centrifuge. The combined slurry is the new mesophilic gas digester feed source. The harvested brushite is mechanically dried per EPA 503 regulations for a class A biosolid then sold as a fertilizer on the local market.

As the City does not current operate an acid-gas digestion process, and relies on primary sludge fermentation as a source of volatile acids for promoting nutrient removal, modification to the typical operation of the CalPrex system would be required to allow for operability within the City's current system. For example, the City would likely have to convert to an acid-gas digestion system. However, the City could harvest the VFA's from the CalPrex reactor effluent by recycling it back to the mainstream process while plant effluent is used to dilute the acid phase digester cake and re-dilute prior to gas-phase digestion. This has not been completed by CalPrex yet, and the loss of high temperature centrate and additional low temperature water would increase heating requirements for the digesters. This may not be an ideal operating condition for the City.




### 6.3.2 Equipment for Operation

The first phase of Calprex is acid phase digestion of primary solids and WAS. The existing fermenter could be repurposed into acid phase digesters by adding a gas handling system and heating elements. An additional 180,000-gallon acid phase digester is required to maintain a typical acid phase digester HRT of 4 days. A 21 inch centrifuge is also required to separate the low P solids from the phosphate rich liquid; the cake is temporarily stored in a tank while the centrate passes to the next stage. A CalPrex reactor complete with instrumentation to control pH and feed locations for either $CaCl_2$ or $Ca(OH)_2$, is also required, as well as chemical storage and metering equipment for the calcium chemicals . A 10 inch centrifuge is required to separate brushite crystals from the centrate. Finally, a brushite dryer is needed to meet the time and temperature requirements for a Class A Biosolids.

**Figure 6: Process Calprex process flow diagram (Source: CNP™)**

### 6.3.3 Product and Equipment Contract

CNP provides the CalPrex system as an equipment package and will deliver it to a City selected contractor for installation. It does not include the acid phase digester, structures to house the dewatering equipment, or storage space for the Brushite fertilizer. These pieces of equipment and tankage are separately supplied or constructed by others.

## 6.4 Updated Capital Investments

Based on the additional information on struvite maintenance control from the City, CNP technologies and Ostara were provided the opportunity to revise the previous capital estimates to allow for more complete removal of phosphorus to protect digestion equipment, as possible.

### 6.4.1 Ostara

Based on discussions with the City Ostara provided a simplified process which produces a struvite product that is not completely processed. The newly proposed Ostara PEARL reactor process removes all processing equipment from the original quote, and leaving Ostara to process the struvite pearls at an offsite location. This reduced the capital cost from $5.5 million to $4.25 million. The size of the WASSTRIP tank was increased to accommodate a 24 hr holding time, which increase the cost of WASSTRIP process to $1.27 million. With a 10 percent contingency and a revised WASSTRIP tank quote, the total capital cost was $6,056,000 for the revised Ostara system.

### 6.4.2 AirPrex

No update to the AirPrex sequestration or harvesting quotes was necessary. See section 3 for the original capital cost quote for AirPrex

### 6.4.3 CalPrex

The CalPrex system was evaluated to reduce the phosphate entering the digestion system. The CalPrex quote included the feed pumps, centrifuges, CalPrex reactor, and sludge recombination systems; the equipment quote came to $3.02 million. Costs were also estimated for converting existing fermenters to acid phase digesters, installation of an additional 180,000 gallon acid phase digester, and upgrades to plant infrastructure to allow for transfer of centrate liquids around. With the markups applied the total capital cost was $8.6 million for the CalPrex and AirPrex systems together.

## 6.5 Updated Operations and Maintenance

The estimates for O&M were based on projections of chemical dose, power demand, and maintenance hours provided by each of the vendors. Chemical costs were based on previous quotes or provided by UNIVAR®, a local chemical sales representative. The cost of power and labor was defined by the City and has not been updated. The cost of annual O&M supplies was either an estimate provided by each system vendor or, if no estimate was offered, an estimate of 1 percent of the equipment capital value was used.

### 6.5.1 Ostara

The O&M estimates for Ostara were updated based on the reduced processing layout. Table 15 presents the new O&M estimates. There were several changes from the previous O&M estimates provided in Section 3. These include:

- The required labor dropped from 0.5 FTE to 0.4 FTE.
- The electrical demands of the reduced processing layout did not diminish significantly.
- Caustic addition was updated by OSTARA.
- Acetic acid is no longer required for the WASSTRIP tank, which was enlarged to allow for a 24 hour retention time, which is typically sufficient to ensure P release without VFA addition.

**Table 15: Updated Ostara O&M**

| Parameter | Unit cost | Demand | Annual cost |
|---|---|---|---|
| Labor | $28.75/hr | 4 hr/d | $24,000 |
| Power | $0.06/kWh | 990 kWh/d | $21,700 |
| $MgCl_2$ | $0.60/gal | 300 gpd | $65,200 |
| Caustic (NaOH) | $0.145/lb | 0.25 ton/d | $26,100 |

| Table 15: Updated Ostara O&M | | | |
|---|---|---|---|
| Parameter | Unit cost | Demand | Annual cost |
| Acetic acid | \$0.74/lb | - lb/d | \$- |
| Maintenance supplies | \$20,300/yr | - | \$20,300 |
| Total cost | | | \$157,300 |

### 6.5.2 AirPrex

No updates were necessary for the AirPrex Sequestration or Harvesting quotes. See Section 3 for the original O&M quotes.

### 6.5.3 CalPrex

O&M costs associated with the CalPrex System are presented in Table 16. The CalPrex system requires $CaCl_2$ and $Ca(OH)_2$ for pH control and as a source of calcium. The calcium dose was calculated based on the stoichiometric mass required to precipitate 85 percent of the phosphorus load applied to the system. The dose was based on the conservative estimate that no calcium is present in the water source. and the vendor provided an estimate for the ratio of $CaCl_2$ and $Ca(OH)_2$ required. Power costs include operating both centrifuges continuously, all internal pumps, and the brushite dryers. Power costs do not include the heating or mixing estimates for the acid phase digesters. No maintenance estimate was available from the vendorso a value of 1 percent of vendor supplied capital cost was used.

| Table 16: Calprex O&M | | | |
|---|---|---|---|
| Parameter | Unit cost | Demand | Annual cost |
| Labor | \$28.75/hr | 3 hr/d | \$23,600 |
| Power | \$0.06/kWh | 4,750 kWh/d | \$103,900 |
| $CaCl_2$ | \$0.38/lb | 7 lb/d | \$1,000 |
| $Ca(OH)_2$ | \$0.174/lb | 740 lb/d | \$39,700 |
| Acid Phase Centrifuge Polymer | \$10.63/gal | 9.4 gal/d | \$36,300 |
| Maintenance supplies | \$32,900/yr | - | \$86,000 |
| Total cost | | | \$290,500 |

## 6.6 Updated Risk Cost

Risks costs were generated for the CalPrex alternative and the Ostara process risk costs were updated. No update was required for the Airprex alternatives. Sections covering service and accessibility of spare parts and supplemental magnesium have not been modified.

### 6.6.1 Sidestream Treatment Failure

CalPrex is currently being piloted tested at one facility in the United States and does not currently have any full-scale installations in North America. To account for this uncertainty, it was assessed a higher probability of process failure. The risk of Ostara and AirPrex failing was not modified. The value of the risk is summarized in Table 17.

| Table 17: Cost of Sidestream Treatment Failure | | | |
|---|---|---|---|
| Parameter | Ostara | AirPrex (all options) | CalPrex |
| Probability of risk | 10% | 10% | 20% |
| Capital investment | $0 | $0 | 0$ |
| Annual O&M costs | $806,500 | $806,500 | $806,500 |
| Annual UDC | $80,650 | $80,650 | $161,300 |

### 6.6.2 Meeting Class A Biosolids Requirements

Under the updated Ostara alternative, final handling and processing of Crystal Green Pearls will be the responsibility of Ostara. This places the burden of meeting Class A Biosolids on Ostara and removes the risk from this analysis. The AirPrex alternative still carries the risk, while the CalPrex process already includes driers designed to meet Class A requirements.

### 6.6.3 Market Stability of Phosphorus Fertilizer

The market stability risk accounts for both lost struvite sales revenue due to struvite market value or reduced struvite production. The risk is different between the alternatives due to the guaranteed sales contracts offered by OSTARA. OSTARA renews contracts with a guaranteed purchase price every ten years, while AirPrex and CalPrex purchase prices are based on a market value. Under the initial contract with OSTARA, there is a small risk the Pearl product will not be acceptable and must be landfilled. After the initial 10-year purchase agreement ends, risks were assessed for devalued product (i.e. low market value, increased processing costs), no value product, and no change. The AirPrex and CalPrex alternatives carry the same risk for devalued product as the 10 year OSTARA contract renewal. The annual UDC posed by these risks is presented in Table 18 for all alternatives.

| Table 18: Fertilizer Market Stability | | | |
|---|---|---|---|
| Parameter | Applicable Period | Risk | Annual UDC |
| OSTARA | | | |
| Unacceptable Product | 0-10 yr | 2% | $2,700 |
| Contract Renewed | 11-20 yr | 70% | $- |
| Product Devalued 50% | 11-20 yr | 10% | $4,500 |
| Product Devalued 100% | 11-20 yr | 20% | $19,800 |
| AirPrex | | | |
| Product Devalued 50% | 0-20 yr | 10% | $1,200 |
| Product Devalued 100% | 0-20 yr | 20% | $5,600 |
| CalPrex | | | |
| Product Devalued 50% | 0-20 yr | 10% | $800 |
| Product Devalued 100% | 0-20 yr | 20% | $3,600 |

### 6.6.4 Supplemental Acetic Acid

The WASSTRIP process requires either sufficient sludge retention time for full phosphorus release, or a source of supplemental VFA's. The update to the analysis has enlarged the WASSTRIP tank changing the design intent from VFA supplementation to a 24-hour retention time. If the process is not capable of full phosphorus release supplemental VFA's will still be required. Therefore the VFA cost has been moved from an O&M item to a risk cost as shown in Table 19.

Table 19: Supplemental Acetic Acid

| Parameter | Ostara | AirPrex (all options) | CalPrex |
|---|---|---|---|
| Probability of risk | 33% | 0% | 0% |
| Capital investment | $0 | $0 | $0 |
| Annual O&M costs | $35,800 | $0 | $0 |
| Annual UDC | $11,800 | $0 | $0 |

## 6.7 Updated Benefits

The Ostara benefits have been updated per the changes described in Section 6.2.1. The current struvite related O&M has been updated with new information provided by the City. CalPrex is not predicted to reduce polymer demand beyond the original estimates for AirPrex,therefore the original table was not modified. All other benefits have been modified to include the CalPrex alternative and are discussed below.

### 6.7.1 Reduced Struvite Operations and Maintenance

The previous estimate of struvite related O&M costs have been updated based on new information from the 2016 primary digester cleaning. The digester required additional cleaning and contract work to deal with the buildup of struvite in the reactor, piping, and equipment. The city provided the cost of the additional cleaning as an update to the sidestream phosphorus evaluation TM. The increases costs are summarized in Table 20.

Table 20. Updated Struvite Related Operations and Maintenance

| Parameter | Cost | Observed life (years) | Design life (years) | UDC per year |
|---|---|---|---|---|
| General Struvite Maintenance | | | | |
| Labor | $25,500 | 1.0 | NA | $25,500 |
| Ferric dosed for struvite control | $102,000 | 1.0 | NA | $102,000 |
| PAC | $12,000 | 1.0 | NA | $12,000 |
| Polygon (cleaning product) | $12,000 | 1.0 | NA | $12,000 |
| Chemical metering pump replacement | $1,100 | 0.5 | NA | $2,200 |
| Small valve replacement | $600 | 0.5 | 50.0 | $1,200 |
| **Large valve replacement** | **$74,000** | **2.0** | **50.0** | **$16,600** |
| Pipe replacement | $41,000 | 10.0 | 50.0 | $3,300 |
| Sludge pump rebuild | $36,000 | 5.0 | 10.0 | $3,600 |
| Centrifuge rebuild | $300,000 | 7.0 | 18.0 | $26,200 |

| | | | | |
|---|---|---|---|---|
| **Primary Digester Maintenance** | | | | |
| **Labor** | **$5,800** | **2.5** | **NA** | **$2,300** |
| **Miscellaneous valves, piping, and equipment** | **$3,000** | **2.5** | **20** | **$1,100** |
| **Additional Cleaning Chemicals** | **$17,500** | **2.5** | **NA** | **$7,000** |
| **Struvite Removal Contract Work** | **$16,500** | **2.5** | **NA** | **$6,600** |
| **Secondary Digester Maintenance** | | | | |
| **Labor** | **$11,500** | **5** | **NA** | **$2,300** |
| **Miscellaneous valves, piping, and equipment** | **$3,000** | **5** | **20** | **$500** |
| **Additional Cleaning Chemicals** | **$35,000** | **5** | **NA** | **$7,000** |
| **Struvite Removal Contract Work** | **$33,000** | **5** | **NA** | **$6,600** |
| Annual struvite O&M distributed cost | | | | **$238,000** |

*PAC = polyaluminum chloride.*

*UDC Uniform Distributed Cost*

*Bold Text indicates new information*

The struvite related O&M has been estimated for each technology based on where it interrupts the process flow. The updated calculations are provided in Table 21 in a revised format.

**Table 21: Percent of UDC Applied to Alternatives**

| | Ostara | AirPrex (Sequestration, Harvest Alternatives) | CalPrex |
|---|---|---|---|
| General Struvite Maintenance | | | |
| Labor | 30% | 50% | 30% |
| Ferric dosed for struvite control | 20% | 20% | 20% |
| PAC | 20% | 20% | 20% |
| Polygon (cleaning product) | 0% | 0% | 0% |
| Chemical metering pump replacement | 20% | 50% | 0% |
| Small valve replacement | 20% | 50% | 0% |
| Large valve replacement | 20% | 50% | 0% |
| Pipe replacement | 20% | 50% | 0% |
| Sludge pump rebuild | 20% | 50% | 0% |
| Centrifuge rebuild | 20% | 0% | 0% |
| Primary Digester Maintenance | | | |
| Labor | 20% | 50% | 0% |
| Miscellaneous valves, piping, and equipment | 20% | 50% | 0% |
| Additional Cleaning Chemicals | 20% | 50% | 0% |
| Struvite Removal Contract Work | 20% | 50% | 0% |
| Secondary Digester Maintenance | | | |

| | | | |
|---|---|---|---|
| Labor | 20% | 0% | 0% |
| Miscellaneous valves, piping, and equipment | 20% | 0% | 0% |
| Additional Cleaning Chemicals | 20% | 0% | 0% |
| Struvite Removal Contract Work | 20% | 0% | 0% |
| Total benefit from reduced struvite O+M | $190,100 | $180,300 | $230,100 |

### 6.7.2 Phosphorus Fertilizer Sales

The vendor estimates for struvite production with Ostara and the AirPrex harvesting option have not been modified. The value of the Ostara Pearl product was reduced because OSTARA is taking over the final classifying and packaging of the product. CalPrex provided a range of 250 to 500 tons of brushite harvested per year, so for this analysis the average of 375 tons per year was used. The CalPrex vendor provided the market value of brushite of $250 per ton, the highest of the three alternatives. The net benefit for each alternative is shown in Table 22 below.

**Table 22: Annual Value of Struvite Sales**

| Parameter | Ostara | AirPrex (Harvesting) | AirPrex (Sequestration) | CalPrex |
|---|---|---|---|---|
| Vendor-estimated annual struvite harvest | 450 tons | 233 tons | NA | 375 tons |
| Vendor-quoted price | $200/ton | $100/ton | NA | $250/ton |
| Annual benefit | $90,000 | $23,300 | NA | $93,800 |

### 6.7.3 Hauling Reduction

A slight reduction in the base (no sidestream treatment) estimate of average annual sludge hauling has resulted in the reduction of the benefits as shown in Table 23 below. The CalPrex alternative is not anticipated to increase dewatered cake total solids content unlike the other three alternatives. CalPrex does remove 375 tons per year of precipitate resulting in a reduction of sludge hauled.

**Table 23: Annual Value of Reduced Hauling**

| Parameter | Ostara | AirPrex (Harvesting) | AirPrex (Sequestration) | CalPrex |
|---|---|---|---|---|
| Vendor-estimate increase in dewatered cake total solids content | 3% | 3% | 3% | 0% |
| Vendor-estimated annual precipitate harvest | 450 tons | 233 tons | 0 tons | 375 tons |
| Average annual wet haul | 13,230 tons | 14,260 tons | 15,360 tons | 15,840 tons |
| Average annual value of reduced hauling | $96,800 | $75,500 | $52,700 | $42,900 |

## 6.8 Net Present Value: Results

The results from the NPV calculation based on new information from the City and the new alternative are provided in Table 24. The escalation rate and discount rate discussed in Section 3.5 have not been modified for this update.

Table 24: 20-Year Summed Cost and NPV

| Alternative | Capital | Benefits | O&M | Risks | NPV | Difference from cheapest alternative |
|---|---|---|---|---|---|---|
| Ostara and WASSTRIP | $6,056,000 | $9,624,700 | $3,303,200 | $2,596,600 | ($2,538,100) | ($1,096,200) |
| AirPrex (Harvesting) | $3,889,000 | $7,419,200 | $2,975,900 | $3,309,300 | ($2,830,100) | ($1,590,300) |
| AirPrex (Sequestration) | $2,673,000 | $6,055,100 | $2,831,900 | $1,693,700 | ($1,239,800) | $0 |
| CalPrex | $8,592,000 | $7,703,000 | $6,602,600 | $3,912,600 | ($11,244,900) | ($9,803,000) |

All alternatives have a negative NPV at the end of the 20-year analysis period, the updated information caused all NPV values to increase. This analysis does not include the savings associated with main process carbon purchase as it is anticipated this savings would be the same with all approaches. With the updated information AirPrex sequestration has the highest NPV (smallest negative value), meaning it will have the fastest payback and lowest overall cost to the City. The OSTARA alternative is the next highest NPV and is now better than the AirPrex Harvesting alternative due to the reduced risk of primary digester cleaning. CalPrex was unable to generate sufficient benefits to offset the high initial investment and O&M cost associated with the dryers and centrifuges.

## 6.9 Conclusions and Recommendations

AirPrex with phosphorus sequestration (no struvite harvesting) is the preferred alternative based on the LCCA. The updates to the LCCA caused a small increase in all NPV's due to higher struvite O&M costs providing greater benefit when removing struvite. The updated analysis also reduced the NPV difference between AirPrex and OSTARA to approximately 1.1 million over a twenty year period, which is within the margin of error for this analysis. Small changes to O&M, benefits, or risks could sway the NPV analysis in favor of OSTARA. In addition to the lowest NPV, AirPrex also has the lowest capital investment making it the preferred alternative. The AirPrex (sequestration) alternative also has an unquantified advantage that it can be modified to harvest struvite later should the market change to favor struvite sales.

# Appendix F: Detailed Cost Estimates

# Projects starting in Fiscal Year 2020

| | |
|---|---|
| **Project Number:** | **150058.200** |
| **Estimate Issue:** | **5** |
| **Due Date:** | **3/8/2018** |
| **Estimator:** | **IAN KRULJAC** |

***BID ITEM 011 - OSTARA***

# CITY OF MERIDIAN FACILITY MASTER PLAN 2020 EXPANSION PROJECTS
# BID ITEM 011 - OSTARA
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 5 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/09/2017 |
| **Notes** | **PROJECT 011 - OSTARA** |

**The quoted item in this estimate includes costs of general conditions, sales tax, startup, O&M manuals, training, electrical and instrumentation, bonds and insurance, site improvments and overhead and profit.**

***BID ITEM 011 - OSTARA***

| Phase | Estimate Breakdown | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 011 OSTARA | | | | | | | | | | | |
| 46999 OSTARA QUOTE | | 180,500.0 | GPD | | | 23.55 | | | 23.55 | /GPD | 4,250,000 |
| | 011 OSTARA | 1.0 | LSUM | | | 4,250,000.00 | | | 4,250,000.00 | /LSUM | 4,250,000 |
| | 01 2020 EXPANSION PROJECTS | 1.0 | LSUM | | | 4,250,000.00 | | | 4,250,000.00 | /LSUM | 4,250,000 |

## Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | | | |
| Material | | | | |
| Subcontract | | | 4,250,000 | |
| Equipment | | | | |
| Other | | | | |
| | | | **4,250,000** | **4,250,000** |
| Contingency | 30.000 % | | 1,275,000 | |
| | | | **1,275,000** | **5,525,000** |
| ESC. TO MIDPOINT 2020 | 12.170 % | | 517,225 | |
| **Gross Markups** | | | **517,225** | **6,042,225** |
| **Total** | | | | **6,042,225** |

# CITY OF MERIDIAN FACILITY MASTER PLAN 2020 EXPANSION PROJECTS
# BID ITEM 010 WASSTRIP
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 3 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/09/2017 |
| **Notes** | **PROJECT 010 - WASSTRIP** |

Project Number: 150058.200
Estimate Issue: 3
Due Date: 2/15/2018
Estimator: IAN KRULJAC

## *BID ITEM 010 WASSTRIP*

| Phase | Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|
| 03330 | SOG - WASSTRIP | 4,464.0 SQFT | 7.00 | 16.55 | | 0.57 | | 24.11 /SQFT | 107,606 |
| 03345 | CONC WALLS - WASSTRIP TANK | 4,550.0 SQFT | 36.80 | 17.34 | | 0.49 | | 54.63 /SQFT | 248,563 |
| 05999 | RAILINGS, GRATING AND STRUCTURAL STEEL | 630.0 SQFT | 56.03 | 45.17 | | 1.87 | | 103.07 /SQFT | 64,934 |
| 26999 | ELECTRICAL ALLOWANCE - place holder | 1.0 LSUM | | | 111,636.67 | | | 111,636.67 /LSUM | 111,637 |
| 27999 | INSTRUMENTATION ALLOWANCE - place holder | 1.0 LSUM | | | 55,818.34 | | | 55,818.34 /LSUM | 55,818 |
| 31315 | EX AND BACKFILL - WASSTRIP 3:1 | 7,349.0 CYD | 7.38 | 14.44 | | 7.21 | | 29.03 /CYD | 213,333 |
| 32999 | SITE RESTORATION ALLOWANCE | 4,200.0 SQFT | 6.68 | 10.77 | | 2.96 | | 20.41 /SQFT | 85,709 |
| 33500 | WASSTRIP - 6" DIPGL - TRENCH | 430.0 LNFT | 8.97 | 2.85 | | 6.54 | | 18.36 /LNFT | 7,895 |
| 40120 | 6" DIPGL | 430.0 LNFT | 53.47 | 82.50 | 47.42 | | | 183.39 /LNFT | 78,856 |
| 46999 | WASSTRIP PUMPS | 2.0 EACH | 42,493.08 | 85,335.36 | 18,315.39 | 2,963.65 | | 149,107.48 /EACH | 298,215 |
| | 010 WASSTRIP | | | | | | | /LSUM | 1,272,566 |

### Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | 3,105 hrs | 428,085 | |
| Material | | | 539,892 | |
| Subcontract | | | 224,476 | |
| Equipment | | 845 hrs | 80,113 | |
| Other | | | | |
| | | | 1,272,566 | 1,272,566 |
| Contingency | 30.000 % | | 365,019 | |
| | | | 365,019 | 1,637,585 |
| ESC. TO MIDPOINT 2020 | 12.170 % | | 112,900 | |
| Gross Markups | | | 112,900 | 1,750,485 |
| **Total** | | | | **1,750,485** |

# CITY OF MERIDIAN FACILITY MATER PLAN 2020 EXPANSION PROJECTS
# BID ITEM 013 - DAFT AUTOMATION
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 4 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/09/2017 |
| **Notes** | **PROJECT 013 - DAFT AUTOMATION** |

## *BID ITEM 013 - DAFT AUTOMATION*

| Phase | Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|
| 013 DAFT AUTOMATION | | | | | | | | | |
| 27999 DAFT AUTOMATION | | 1.0 LSUM | | 79,166.03 | 39,999.63 | | | 119,165.66 /LSUM | 119,166 |
| 40120 6" DIPGL | | 160.0 LNFT | 49.13 | 40.24 | 44.93 | | | 134.31 /LNFT | 21,490 |
| | 013 DAFT AUTOMATION | 1.0 LSUM | 7,861.42 | 85,604.86 | 47,188.88 | | | 140,655.16 /LSUM | 140,655 |
| | 01 2020 EXPANSION PROJECTS | 1.0 LSUM | 7,861.42 | 85,604.86 | 47,188.88 | | | 140,655.16 /LSUM | 140,655 |

### Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | 66 hrs | 7,861 | |
| Material | | | 85,605 | |
| Subcontract | | | 47,189 | |
| Equipment | | | | |
| Other | | | | |
| | | | **140,655** | **140,655** |
| Contingency | 30.000 % | | 40,345 | |
| | | | **40,345** | **181,000** |
| ESC. TO MIDPOINT 2020 | 12.170 % | | 11,837 | |
| **Gross Markups** | | | **11,837** | **192,837** |
| **Total** | | | | **192,837** |

# CITY OF MERIDIAN FACILITY MASTER PLAN 2020 EXPANSION PROJECTS
# BID ITEM 027 - ANAEROBIC DIGESTER WITH CONTROL BUILDING
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 5 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/24/2018 |
| **Notes** | **PROJECT 027 - ANAEROBIC DIGESTER WITH CONTROL BUILDING** |

## BID ITEM 027 - ANAEROBIC DIGESTER WITH CONTROL BUILDING

| Phase | Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|
| 26999 ELECTRICAL ALLOWANCE | | 1.0 LSUM | | | 492,189.25 | | | 492,189.25 /LSUM | 492,189 |
| 46999 ANAEROBIC DIGESTER | | 750.0 KGAL | 2,682.05 | 5,659.68 | | 1,747.85 | | 10,089.58 /KGAL | 7,567,185 |
| | 027 ANAEROBIC DIGESTER WITH CONTROL BUILDING | | | | | | | /LSUM | 8,059,374 |

### Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | | 2,011,541 | |
| Material | | | 4,244,758 | |
| Subcontract | | | 492,189 | |
| Equipment | | | 1,310,886 | |
| Other | | | | |
| | | | 8,059,374 | 8,059,374 |
| Contingency | 30.000 % | | 2,311,727 | |
| | | | 2,311,727 | 10,371,101 |
| Esc. To Midpoint 2020 | 12.170 % | | 714,988 | |
| Gross Markups | | | 714,988 | 11,086,089 |
| **Total** | | | | **11,086,089** |

# CITY OF MERIDIAN FACILITY MASTER PLAN 2020 EXPANSION PROJECTS
# BID ITEM 016 - CENTRIFUGE FEED
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 3 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/09/2017 |
| **Notes** | **PROJECT 016 - CENTRIFUGE FEED** |

## *BID ITEM 016 - CENTRIFUGE FEED*

| Phase | Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|
| 40120 CENTRIFUGE FEED PIPING | | 1.0 LSUM | 67,909.32 | 72,909.31 | | | | 140,818.63 /LSUM | 140,819 |
| | 016 CENTRIFUGE FEED | | | | | | | /LSUM | 140,819 |

### Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | | 67,909 | |
| Material | | | 72,909 | |
| Subcontract | | | | |
| Equipment | | | | |
| Other | | | | |
| | | | **140,818** | **140,818** |
| Contingency | 30.000 % | | 40,392 | |
| | | | **40,392** | **181,210** |
| ESC. TO MIDPOINT 2020 | 12.170 % | | 12,170 | |
| **Gross Markups** | | | **12,170** | **193,380** |
| **Total** | | | | **193,380** |

# CITY OF MERIDIAN FACILITY MASTER PLAN 2020 EXPANSION PROJECTS
# BID ITEM 025 - NEW ENTRANCE
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 7 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/09/2017 |
| **Notes** | **PROJECT 025 - NEW ENTRANCE** |

Brown AND Caldwell

| | |
|---|---|
| Project Number: | 150058.200 |
| Estimate Issue: | 7 |
| Due Date: | 5/11/2018 |
| Estimator: | IAN KRULJAC |

## *BID ITEM 025 - NEW ENTRANCE*

| Phase | Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|
| 32999 NEW SECONDARY ENTRANCE | | 1.0 LSUM | 114,064.64 | 569,389.07 | | 32,320.12 | | 715,773.83 /LSUM | 715,774 |
| | 025 NEW ENTRANCE | | | | | | | /LSUM | 715,774 |

### Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | 694 hrs | 114,065 | |
| Material | | | 569,389 | |
| Subcontract | | | | |
| Equipment | | 110 hrs | 32,320 | |
| Other | | | | |
| | | | 715,774 | 715,774 |
| Contingency | 30.000 % | | 205,310 | |
| | | | 205,310 | 921,084 |
| Esc. To Midpoint 2020 | 12.170 % | | 60,850 | |
| Gross Markups | | | 60,850 | 981,934 |
| **Total** | | | | **981,934** |

# Projects starting in
# Fiscal Year 2022

| | |
|---|---|
| **Project Number:** | **150058.200** |
| **Estimate Issue:** | **6** |
| **Due Date:** | **5/11/2018** |
| **Estimator:** | **IAN KRULJAC** |

*BID ITEM 023 - AERATION BASIN RETROFIT 1 TO 4*

# CITY OF MERIDIAN - FACILITY MASTER PLAN 2022 EXPANSION PROJECTS
# BID ITEM 023 - AERATION BASIN RETROFIT 1 TO 4
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 6 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/09/2017 |
| **Notes** | **PROJECT 023 - AERATION BASIN RETROFIT - 1-4** |

## *BID ITEM 023 - AERATION BASIN RETROFIT 1 TO 4*

| Phase | Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|
| 26999 ELECTRICAL ALLOWANCE | | 1.0 LSUM | | | 731,197.98 | | | 731,197.98 /LSUM | 731,198 |
| 46999 AERATION BASIN RETROFIT 1-4 | | 1.0 LSUM | 761,196.28 | 2,646,069.38 | | 126,701.18 | | 3,533,966.84 /LSUM | 3,533,967 |
| | 023 AERATION BASIN RETROFIT - 1-4 | | | | | | | /LSUM | 4,265,165 |

### Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | | 761,196 | |
| Material | | | 2,646,069 | |
| Subcontract | | | 731,198 | |
| Equipment | | | 126,701 | |
| Other | | | | |
| | | | **4,265,164** | **4,265,164** |
| Contingency | 30.000 % | | 1,223,407 | |
| | | | **1,223,407** | **5,488,571** |
| Esc. To Midpoint 2022 | 24.860 % | | 755,054 | |
| **Gross Markups** | | | **755,054** | **6,243,625** |
| **Total** | | | | **6,243,625** |

# CITY OF MERIDIAN - FACILITY PLAN 2022 EXPANSION PROJECTS
# BID ITEM 020 - AERATION BASIN
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 6 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/09/2017 |
| **Notes** | |

**2022 EXPANSION PROJECTS. PROJECT 020 - AERATION BASIN 9 AND 10**

| | |
|---|---|
| Project Number: | 150058.200 |
| Estimate Issue: | 6 |
| Due Date: | 5/11/2018 |
| Estimator: | IAN KRULJAC |

# *BID ITEM 020 - AERATION BASIN*

| Phase | Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|
| 46999 AREATION BASIN 9 AND 10 | | 2.0 EACH | 379,181.48 | 802,150.39 | | 49,626.93 | | 1,230,958.80 /EACH | 2,461,918 |
| 46999 AREATION BASIN BLOWERS | | 1.0 LSUM | 82,458.13 | 154,423.29 | | 12,076.23 | 638,679.53 | 887,637.18 /LSUM | 887,637 |
| | 020 AREATION BASIN CONSTRUCTION | | | | | | | /LSUM | 3,349,555 |

## Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | 124 hrs | 840,821 | |
| Material | | | 1,758,724 | |
| Subcontract | | | | |
| Equipment | | | 111,330 | |
| Other | | | 638,680 | |
| | | | **3,349,555** | **3,349,555** |
| Contingency | 30.000 % | | 960,776 | |
| | | | **960,776** | **4,310,331** |
| Esc. To Midpoint 2022 | 24.860 % | | 592,934 | |
| **Gross Markups** | | | **592,934** | **4,903,265** |
| **Total** | | | | **4,903,265** |

# CITY OF MERIDIAN - FACILITY PLAN 2022 EXPANSION PROJECTS
# BID ITEM 021 - BLOWER BUILDING NO. 1
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 6 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/09/2017 |
| **Notes** | **PROCESS LOCATION/AREA INDEX** |

**2022 EXPANSION PROJECTS. 021 - BLOWER BUILDING NO. 1**

Brown AND Caldwell

SUMMARY REPORT

5/11/2018 2:31 PM

Project Number: 150058.200
Estimate Issue: 6
Due Date: 5/11/2018
Estimator: IAN KRULJAC

## BID ITEM 021 - BLOWER BUILDING NO. 1

| Phase / Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|
| 02220 BLOWER BUILDING DEMOLITION | 1,225.0 GSF | 7.76 | 1.82 | | 6.24 | | 15.81 /GSF | 19,364 |
| 03200 Inverted "T" Stem Wall | 460.0 LNFT | 112.01 | 103.00 | | 6.80 | | 221.80 /LNFT | 102,029 |
| 03330 SOG - 55 X 75 X 8" | 4,125.0 SQFT | 4.93 | 5.93 | | 0.27 | | 11.13 /SQFT | 45,893 |
| 03355 Slab over Metal Deck Roof | 4,125.0 SQFT | 6.43 | 9.86 | | 0.23 | | 16.52 /SQFT | 68,147 |
| 04220 CMU WALLS 12" THK | 5,000.0 SQFT | 37.89 | 22.39 | | 0.21 | | 60.48 /SQFT | 302,419 |
| 26024 BUILDING ELECTRICAL FIT OUT ALLOWANCE | 4,125.0 SQFT | 19.59 | 16.35 | 1.26 | | | 37.20 /SQFT | 153,463 |
| 26999 ELECTRICAL ALLOWANCE- BLOWERS | 1.0 LSUM | | | 334,581.49 | | | 334,581.49 /LSUM | 334,581 |
| 46999 BLOWER BUILDING NO. 1 | 750.0 KGAL | 127.75 | 202.57 | 97.69 | 18.16 | 2,023.12 | 2,469.29 /KGAL | 1,851,971 |
| 021 BLOWER BUILDING NO.1 | | | | | | | /LSUM | 2,877,867 |

### Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | 3,663 hrs | 473,975 | |
| Material | | | 446,061 | |
| Subcontract | | | 413,023 | |
| Equipment | | 264 hrs | 27,466 | |
| Other | | | 1,517,343 | |
| | | | 2,877,868 | 2,877,868 |
| Contingency | 30.000 % | | 825,479 | |
| | | | 825,479 | 3,703,347 |
| Esc. To Midpoint 2022 | 24.860 % | | 524,485 | |
| Gross Markups | | | 524,485 | 4,227,832 |
| **Total** | | | | **4,227,832** |

# Projects starting in
# Fiscal Year 2024

# CITY OF MERIDIAN FACILITY MASTER PLAN 2024 EXPANSION PROJECTS
# BID ITEM 014 - FERMENTER
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 4 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/24/2018 |
| **Notes** | **PROJECT - 014 - FERMENTER** |

## *BID ITEM 014 - FERMENTER*

| Phase | Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|
| 02228 | DEMOLITION | 1.0 LSUM | 33,456.51 | | | | | 33,456.51 /LSUM | 33,457 |
| 03999 | MISC STRUCTURAL | 1.0 LSUM | 113,752.19 | 122,252.17 | | | | 236,004.36 /LSUM | 236,004 |
| 26999 | ELECTRICAL ALLOWANCE | 1.0 LSUM | | | 223,721.73 | | | 223,721.73 /LSUM | 223,722 |
| 27999 | INSTRUMENTATION ALLOWANCE | 1.0 LSUM | | | 55,930.45 | | | 55,930.45 /LSUM | 55,930 |
| 40120 | PIPING | 1.0 LSUM | 80,295.64 | 86,295.65 | | | | 166,591.29 /LSUM | 166,591 |
| 46999 | FERMENTER EQUIPMENT | 1.0 LSUM | 133,826.08 | 719,130.44 | | | | 852,956.52 /LSUM | 852,957 |
| | 014 FERMENTER | | | | | | | /LSUM | 1,568,661 |

### Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | | 361,330 | |
| Material | | | 927,678 | |
| Subcontract | | | 279,652 | |
| Equipment | | | | |
| Other | | | | |
| | | | 1,568,660 | 1,568,660 |
| Contingency | 30.000 % | | 449,950 | |
| | | | 449,950 | 2,018,610 |
| ESC. TO MIDPOINT 2024 | 35.240 % | | 392,926 | |
| Gross Markups | | | 392,926 | 2,411,536 |
| **Total** | | | | **2,411,536** |

# CITY OF MERIDIAN FACILITY MASTER PLAN 2024 EXPANSION PROJECTS
# BID ITEM 015 - GRAVITY THICKENER
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 4 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/24/2018 |
| **Notes** | **PROJECT 015 - GRAVITY THICKENER** |

## *BID ITEM 015 - GRAVITY THICKENER*

| Phase | Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|
| 02228 DEMOLITION | | 1.0 LSUM | 66,856.18 | | | | | 66,856.18 /LSUM | 66,856 |
| 03999 MISC STRUCTURAL | | 1.0 LSUM | 80,227.40 | 86,227.43 | | | | 166,454.83 /LSUM | 166,455 |
| 26999 ELECTRICAL ALLOWANCE | | 1.0 LSUM | | | 251,482.23 | | | 251,482.23 /LSUM | 251,482 |
| 27999 INSTRUMENTATION ALLOWANCE | | 1.0 LSUM | | | 69,856.18 | | | 69,856.18 /LSUM | 69,856 |
| 40120 PIPING | | 1.0 LSUM | 113,655.49 | 122,155.49 | | | | 235,810.98 /LSUM | 235,811 |
| 46999 GRAVITY THICKENER EQUIPMENT | | 1.0 LSUM | 147,083.60 | 790,417.93 | | | | 937,501.53 /LSUM | 937,502 |
| | 015 GRAVITY THICKENER | | | | | | | /LSUM | 1,727,962 |

### Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | | 407,823 | |
| Material | | | 998,801 | |
| Subcontract | | | 321,338 | |
| Equipment | | | | |
| Other | | | | |
| | | | 1,727,962 | 1,727,962 |
| Contingency | 30.000 % | | 495,644 | |
| | | | 495,644 | 2,223,606 |
| ESC. TO MIDPOINT 2024 | 35.240 % | | 433,452 | |
| **Gross Markups** | | | 433,452 | 2,657,058 |
| **Total** | | | | **2,657,058** |

# CITY OF MERIDIAN - FACILTY MASTER PLAN 2024 EXPANSION PROJECTS
# BID ITEM 022 - TERTIARY MEMBRANE BASIN
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 4 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/09/2017 |
| **Notes** | **PROJECT 022 - TERTIARY MEMBRANE BASIN** |

## *BID ITEM 022 - TERTIARY MEMBRANE BASIN*

| Phase | Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|
| 03330 | SLAB ON GRADE | 148.0 CYD | 234.46 | 306.99 | | 8.80 | | 550.25 /CYD | 81,437 |
| 03330 | SOG - TM BUILDING 60 X 80 X 12" | 4,800.0 SQFT | 5.03 | 8.35 | | 0.35 | | 13.74 /SQFT | 65,927 |
| 03330 | SOG - TM2 BUILDING 150 X 15 X 12" | 2,250.0 SQFT | 5.03 | 8.35 | | 0.35 | | 13.74 /SQFT | 30,905 |
| 03345 | WALLS | 234.8 CYD | 620.85 | 618.97 | | 10.53 | | 1,250.35 /CYD | 293,552 |
| 03350 | ELEVATED SLAB | 8.9 CYD | 719.25 | 420.35 | | 11.13 | | 1,150.73 /CYD | 10,229 |
| 05120 | TM1 - PREFAB STEEL BUILDING - Conceptual | 4,800.0 SQFT | 6.64 | 22.48 | | 1.33 | | 30.44 /SQFT | 146,129 |
| 05120 | TM2 - PREFAB STEEL BUILDING - Conceptual | 2,250.0 SQFT | 6.64 | 22.48 | | 1.33 | | 30.44 /SQFT | 68,498 |
| 05300 | TANK COVERS | 2,500.0 SQFT | 5.28 | 87.73 | | 0.18 | | 93.19 /SQFT | 232,967 |
| 22202 | 66" SRPE | 340.0 LNFT | 179.63 | 607.05 | | 13.54 | | 800.22 /LNFT | 272,074 |
| 22405 | TM1 - Building Plumbing, Conceptual | 4,800.0 SQFT | 8.37 | 16.93 | | 0.07 | | 25.37 /SQFT | 121,782 |
| 22405 | TM2 - Building Plumbing, Conceptual | 2,250.0 SQFT | 7.46 | 21.74 | | 0.07 | | 29.27 /SQFT | 65,853 |
| 26024 | TM1 - Building Electrical Fitout, Conceptual | 4,800.0 SQFT | 12.11 | 15.09 | 0.71 | 0.05 | | 27.95 /SQFT | 134,147 |
| 26024 | TM2 - Building Electrical Fitout, Conceptual | 2,250.0 SQFT | 9.19 | 10.13 | 0.71 | | | 20.02 /SQFT | 45,055 |
| 26999 | ELECTRICAL ALLOWANCE | 1.0 LSUM | | | 987,063.76 | | | 987,063.76 /LSUM | 987,064 |
| 31315 | EXCAVATION AND BACKFILL | 1,434.2 SYD | 49.76 | | | 45.45 | | 95.21 /SYD | 136,542 |
| 33500 | 66" SRPE TRENCH | 1,133.3 LNFT | 30.28 | 15.31 | 1.65 | 10.63 | | 57.87 /LNFT | 65,580 |
| 40120 | PIPING | 1.0 LSUM | 67,504.55 | 72,504.57 | | | | 140,009.12 /LSUM | 140,009 |
| 46999 | TERTIARY MEMBRANE EQUIPMENT | 1.0 LSUM | 558,504.53 | 7,945,048.97 | | 380,070.16 | 1,326.09 | 8,884,949.75 /LSUM | 8,884,950 |
| | 022 TERTIARY MEMEBRANE BASINS | | | | | | | /LSUM | 11,782,698 |

### Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | 4,255 hrs | 1,210,801 | |
| Material | | | 9,097,881 | |
| Subcontract | | | 993,903 | |
| Equipment | | 918 hrs | 478,787 | |
| Other | | | 1,326 | |
| | | | 11,782,698 | 11,782,698 |
| Contingency | 30.000 % | | 3,379,714 | |
| | | | 3,379,714 | 15,162,412 |
| Esc. To Midpoint 2024 | 35.240 % | | 2,910,705 | |
| **Gross Markups** | | | 2,910,705 | 18,073,117 |
| **Total** | | | | **18,073,117** |

# CITY OF MERIDIAN - FACILITY MASTER PLAN 2024 EXPANSION PROJECTS
# BID ITEM 024 - NEW PARKING AREA
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 4 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/09/2017 |
| **Notes** | **PROJECT 024 NEW PARKING AREA** |

| | |
|---|---|
| Project Number: | 150058.200 |
| Estimate Issue: | 4 |
| Due Date: | 2/14/2018 |
| Estimator: | IAN KRULJAC |

## *BID ITEM 024 - NEW PARKING AREA*

| Phase | Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|
| 32740 NEW PARKING LOT | | 16,000.0 SQFT | 0.86 | 2.78 | | 0.46 | | 4.09 /SQFT | 65,494 |
| | 024 NEW PARKING AREA | | | | | | | /LSUM | 65,494 |

### Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | 132 hrs | 13,714 | |
| Material | | | 44,481 | |
| Subcontract | | | | |
| Equipment | | 70 hrs | 7,299 | |
| Other | | | | |
| | | | 65,494 | 65,494 |
| Contingency | 30.000 % | | 18,786 | |
| | | | 18,786 | 84,280 |
| Esc. To Midpoint 2024 | 35.240 % | | 16,445 | |
| Gross Markups | | | 16,445 | 100,725 |
| **Total** | | | | **100,725** |

# CITY OF MERIDIAN FACILITY MASTER PLAN 2024 EXPANSION PROJECTS
# BID ITEM 026 - CENTRIFUGE
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 4 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/09/2017 |
| **Notes** | **PROJECT 026 - CENTRIFUGE** |

| | |
|---|---|
| Project Number: | 150058.200 |
| Estimate Issue: | 4 |
| Due Date: | 2/15/2018 |
| Estimator: | IAN KRULJAC |

## *BID ITEM 026 - CENTRIFUGE*

| Phase | Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|
| 03333 EQUIPMENT PAD | | 3.7 CYD | 288.05 | 255.46 | | 1.86 | | 545.37 /CYD | 2,018 |
| 26999 ELECTRICAL ALLOWANCE | | 1.0 LSUM | | | 168,367.06 | | | 168,367.06 /LSUM | 168,367 |
| 40120 PIPING | | 1.0 LSUM | 10,072.94 | 10,822.94 | | | | 20,895.88 /LSUM | 20,896 |
| 46999 CENTRIFUGE | | 1.0 LSUM | 34,888.64 | 793,682.35 | | 2,415.94 | | 830,986.93 /LSUM | 830,987 |
| | 026 CENTRIFUGE | | | | | | | /LSUM | 1,022,268 |

### Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | 310 hrs | 46,027 | |
| Material | | | 805,450 | |
| Subcontract | | | 168,367 | |
| Equipment | | 17 hrs | 2,423 | |
| Other | | | | |
| | | | **1,022,267** | **1,022,267** |
| Contingency | 30.000 % | | 293,224 | |
| | | | **293,224** | **1,315,491** |
| Esc. To Midpoint 2024 | 35.240 % | | 251,774 | |
| **Gross Markups** | | | **251,774** | **1,567,265** |
| **Total** | | | | **1,567,265** |

# CITY OF MERIDIAN FACILITY MASTER PLAN 2024 EXPANSION PROJECTS
# BID ITEM 028 - BOILER
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 4 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/09/2017 |
| **Notes** | **PROJECT 028 - BOILER** |

## *BID ITEM 028 - BOILER*

| Phase | Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|
| 03999 EQUIPMENT PAD | | 1.0 LSUM | 941.62 | 553.31 | | 5.21 | | 1,500.14 /LSUM | 1,500 |
| 22999 BOILER | | 1.0 LSUM | 20,136.13 | 167,448.88 | | 704.68 | | 188,289.69 /LSUM | 188,290 |
| 22999 STACK | | 1.0 LSUM | 2,069.12 | 14,560.76 | | | | 16,629.88 /LSUM | 16,630 |
| 26999 ELECTRICAL ALLOWANCE | | 1.0 LSUM | | | 14,160.78 | | | 14,160.78 /LSUM | 14,161 |
| 40120 PIPING | | 1.0 LSUM | 10,170.58 | 10,920.58 | | | | 21,091.16 /LSUM | 21,091 |
| | 028 BOILER | | | | | | | /LSUM | 241,672 |

### Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | 184 hrs | 33,317 | |
| Material | | | 193,484 | |
| Subcontract | | | 14,161 | |
| Equipment | | 9 hrs | 710 | |
| Other | | | | |
| | | | 241,672 | 241,672 |
| Contingency | 30.000 % | | 69,320 | |
| | | | 69,320 | 310,992 |
| Esc. To Midpoint 2024 | 35.240 % | | 59,216 | |
| Gross Markups | | | 59,216 | 370,208 |
| **Total** | | | | **370,208** |

# Projects starting in Fiscal Year 2025

# CITY OF MERIDIAN FACILITY MASTER PLAN 2025 EXPANSION PROJECTS
# BID ITEM - TWO UV CHANNELS - MODIFY CHANNELS AND REPLACE UV
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 1 |
| **QA/QC Reviewer** | BILL AGSTER |
| **Notes** | **PROJECT - TWO UV CHANNELS - MODIFY CHANNELS AND REPLACE UV** |

***BID ITEM - TWO UV CHANNELS - MODIFY CHANNELS AND REPLACE UV***

| Phase | Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|
| 02228 DEMO/PREP/REFURB | | 1.0 LSUM | 12,996.08 | 24,861.17 | | 69.10 | | 37,926.35 /LSUM | 37,926 |
| 03345 CONCRETE | | 14.2 cy | 1,527.70 | 599.60 | | 1.37 | | 2,128.67 /cy | 30,227 |
| 26999 ELECTRICAL | | 1.0 LSUM | | | 70,735.98 | | | 70,735.98 /LSUM | 70,736 |
| 40120 MECHANICAL | | 1.0 LSUM | 13,547.19 | 14,547.21 | | | | 28,094.40 /LSUM | 28,094 |
| 46999 UV EQUIPMENT | | 1.0 LSUM | 60,962.38 | 744,816.47 | | | | 805,778.85 /LSUM | 805,779 |
| | 026 UV SYSTEM | | | | | | | | 972,763 |

## Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | 307 hrs | 109,199 | |
| Material | | | 792,739 | |
| Subcontract | | | 70,736 | |
| Equipment | | 6 hrs | 89 | |
| Other | | | | |
| | | | **972,763** | **972,763** |
| Contingency | 30.000 % | | 279,024 | |
| | | | **279,024** | **1,251,787** |
| ESC. TO MIDPOINT 2025 | 36.190 % | | 236,589 | |
| **Gross Markups** | | | **236,589** | **1,488,376** |
| **Total** | | | | **1,488,376** |

# Projects starting in Fiscal Year 2030

# CITY OF MERIDIAN
# FACILTY MASTER PLAN 2030 EXPANSION PROJECTS
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 2 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/09/2017 |
| **Notes** | **PROCESS LOCATION/AREA INDEX** |

Brown AND Caldwell

**Project Number:** 150058.200
**Estimate Issue:** 2
**Due Date:** 12/12/2017
**Estimator:** IAN KRULJAC

## *FACILTY MASTER PLAN 2030 EXPANSION PROJECTS*

| Phase | Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|
| 030 WASTE GAS BURNER | | | | | | | | | |
| 26999 ELECTRICAL ALLOWANCE | | 1.0 LSUM | | | 27,224.42 | | | 27,224.42 /LSUM | 27,224 |
| 46999 WASTE GAS BURNER | | 1.0 LSUM | 37,603.99 | | | 626.26 | | 38,230.25 /LSUM | 38,230 |
| | 030 WASTE GAS BURNER | 1.0 LSUM | 37,603.99 | | 27,224.42 | 626.26 | | 65,454.67 /LSUM | 65,455 |
| | 03 2030 EXPANSION PROJECTS | 1.0 LSUM | 37,603.99 | | 27,224.42 | 626.26 | | 65,454.67 /LSUM | 65,455 |

### Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | | 37,604 | |
| Material | | | | |
| Subcontract | | | 27,224 | |
| Equipment | | | 626 | |
| Other | | | | |
| | | | **65,454** | **65,454** |
| Contingency | 30.000 % | | 18,775 | |
| | | | **18,775** | **84,229** |
| Ecs to Midpoint 2030 | 68.480 % | | 33,859 | |
| **Gross Markups** | | | **33,859** | **118,088** |
| **Total** | | | | **118,088** |

# CITY OF MERIDIAN
# FACILTY MASTER PLAN 2030 EXPANSION PROJECTS
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 2 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/09/2017 |
| **Notes** | **PROCESS LOCATION/AREA INDEX** |

## *FACILTY MASTER PLAN 2030 EXPANSION PROJECTS*

| Phase | Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|
| **030 WASTE GAS BURNER** | | | | | | | | | |
| **26999 ELECTRICAL ALLOWANCE** | | | | | | | | | |
| 26-99-99.99 | ELECTRICAL ALLOWANCE | 1.0 LS | - | - | 20,000.00 | - | - | 20,000.00 /LS | 20,000 |
| | **ELECTRICAL ALLOWANCE** | **1.0 LSUM** | | | **20,000.00** | | | **20,000.00 /LSUM** | **20,000** |
| **46999 WASTE GAS BURNER** | | | | | | | | | |
| 46-99-99.99 | WASTE GAS BURNER - LC 90 PCT 12-4-15 | 1.0 LSUM | 28,899.00 | 0.00 | | 544.00 | - | 29,443.00 /LSUM | 29,443 |
| | **WASTE GAS BURNER** | **1.0 LSUM** | **28,899.00** | | | **544.00** | | **29,443.00 /LSUM** | **29,443** |
| | **030 WASTE GAS BURNER** | **1.0 LSUM** | **28,899.00** | | **20,000.00** | **544.00** | | **49,443.00 /LSUM** | **49,443** |
| | **03 2030 EXPANSION PROJECTS** | **1.0 LSUM** | **28,899.00** | | **20,000.00** | **544.00** | | **49,443.00 /LSUM** | **49,443** |

## Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | | 28,899 | |
| Material | | | | |
| Subcontract | | | 20,000 | |
| Equipment | | | 544 | |
| Other | | | | |
| | | | **49,443** | **49,443** |
| Labor Mark-up | 15.000 % | | 4,335 | |
| Material Mark-up | 15.000 % | | | |
| Other - Process Equip Mark-up | 8.000 % | | | |
| | | | **4,335** | **53,778** |
| Material Shipping & Handling | 2.000 % | | | |
| Material Sales Tax | 8.000 % | | | |
| Other - Process Eqp Sales Tax | 8.000 % | | | |
| **Net Markups** | | | | **53,778** |
| Contractor General Conditions | 10.000 % | | 3,378 | |
| E&I General Conditions | 10.000 % | | 2,000 | |
| GC Electrical Mark-Up | 10.000 % | | 2,200 | |
| | | | **7,578** | |
| | | | | **61,356** |
| Start-Up, Training, O&M | 2.000 % | | 1,227 | |
| | | | **1,227** | **62,583** |
| Contingency | 30.000 % | | 18,775 | |
| | | | **18,775** | **81,358** |
| Bldg Risk, Liability Auto Ins | 2.000 % | | 1,627 | |
| | | | **1,627** | **82,985** |
| Payment and Performance Bonds | 1.500 % | | 1,245 | |
| | | | **1,245** | **84,230** |
| Ecs to Midpoint 2030 | 68.480 % | | 33,859 | |
| **Gross Markups** | | | **33,859** | **118,089** |
| **Total** | | | | **118,089** |

# Projects starting in Fiscal Year 2037

# CITY OF MERIDIAN
# FACILTY MASTER PLAN 2038 EXPANSION PROJECTS
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 2 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/09/2017 |
| **Notes** | **PROCESS LOCATION/AREA INDEX** |

SUMMARY REPORT

*12/12/2017 2:58 PM*

Project Number: 150058.200
Estimate Issue: 2
Due Date: 12/12/2017
Estimator: IAN KRULJAC

## *FACILTY MASTER PLAN 2038 EXPANSION PROJECTS*

| Phase | Estimate Breakdown | Quantity | | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 040 SECONDARY CLARIFIER NO. 8 | | | | | | | | | | | |
| 26999 ELECTRICAL ALLOWANCE | | 1.0 | LSUM | | | 191,929.93 | | | 191,929.93 | /LSUM | 191,930 |
| 46999 CLARIFIER NO.8 100' DIA | | 1.0 | LSUM | 223,037.32 | 925,985.65 | | 104,465.13 | | 1,253,488.10 | /LSUM | 1,253,488 |
| | 040 SECONDARY CLARIFIER NO. 8 | 1.0 | LSUM | 223,037.32 | 925,985.65 | 191,929.93 | 104,465.13 | | 1,445,418.03 | /LSUM | 1,445,418 |
| | 04 2038 EXPANSION PROJECTS | 1.0 | LSUM | 223,037.32 | 925,985.65 | 191,929.93 | 104,465.13 | | 1,445,418.03 | /LSUM | 1,445,418 |

### Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | | 223,037 | |
| Material | | | 925,986 | |
| Subcontract | | | 191,930 | |
| Equipment | | | 104,465 | |
| Other | | | | |
| | | | **1,445,418** | **1,445,418** |
| Contingency | 30.000 % | | 414,599 | |
| | | | **414,599** | **1,860,017** |
| Esc. To Midpoint 2038 | 127.240 % | | 1,313,906 | |
| **Gross Markups** | | | **1,313,906** | **3,173,923** |
| **Total** | | | | **3,173,923** |

# CITY OF MERIDIAN
# FACILTY MASTER PLAN 2038 EXPANSION PROJECTS
# BODR ESTIMATE - CLASS 5 REVIEW

| | |
|---|---|
| **Engineer** | BROWN AND CALDWELL |
| **Estimator** | IAN KRULJAC |
| **BC Project Manager** | RICK KELLY |
| **BC Office** | SALT LAKE |
| **Estimate Issue No.** | 2 |
| **QA/QC Reviewer** | BILL AGSTER |
| **QA/QC Review Date** | 08/09/2017 |
| **Notes** | **PROCESS LOCATION/AREA INDEX** |

## *FACILTY MASTER PLAN 2038 EXPANSION PROJECTS*

| Phase | Estimate Breakdown | Quantity | Labor Cost/Unit | Material Cost/Unit | Sub Cost/Unit | Equip Cost/Unit | Other Cost/Unit | Total Cost/Unit | Total Net Amount |
|---|---|---|---|---|---|---|---|---|---|
| **040 SECONDARY CLARIFIER NO. 8** | | | | | | | | | |
| **26999 ELECTRICAL ALLOWANCE** | | | | | | | | | |
| 26-99-99.99 | ELECTRICAL ALLOWANCE - from CL No. 6 90pct est | 1.0 LS | - | - | 136,862.00 | - | - | 136,862.00 /LS | 136,862 |
| | **ELECTRICAL ALLOWANCE** | **1.0 LSUM** | | | **136,862.00** | | | **136,862.00 /LSUM** | **136,862** |
| **46999 CLARIFIER NO.8 100' DIA** | | | | | | | | | |
| 46-99-99.99 | CLARIFIER NO. 6 BARE COST from 90pct est | 1.0 LSUM | 166,153.00 | 641,993.00 | | 87,612.00 | - | 895,758.00 /LSUM | 895,758 |
| | **CLARIFIER NO.8 100' DIA** | **1.0 LSUM** | **166,153.00** | **641,993.00** | | **87,612.00** | | **895,758.00 /LSUM** | **895,758** |
| | **040 SECONDARY CLARIFIER NO. 8** | **1.0 LSUM** | **166,153.00** | **641,993.00** | **136,862.00** | **87,612.00** | | **1,032,620.00 /LSUM** | **1,032,620** |
| | **04 2038 EXPANSION PROJECTS** | **1.0 LSUM** | **166,153.00** | **641,993.00** | **136,862.00** | **87,612.00** | | **1,032,620.00 /LSUM** | **1,032,620** |

## Estimate Totals

| Description | Rate | Hours | Amount | Totals |
|---|---|---|---|---|
| Labor | | | 166,153 | |
| Material | | | 641,993 | |
| Subcontract | | | 136,862 | |
| Equipment | | | 87,612 | |
| Other | | | | |
| | | | **1,032,620** | **1,032,620** |
| Labor Mark-up | 15.000 % | | 24,923 | |
| Material Mark-up | 15.000 % | | 96,299 | |
| Other - Process Equip Mark-up | 8.000 % | | | |
| | | | **121,222** | **1,153,842** |
| Material Shipping & Handling | 2.000 % | | 12,840 | |
| Material Sales Tax | 8.000 % | | 51,359 | |
| Other - Process Eqp Sales Tax | 8.000 % | | | |
| **Net Markups** | | | **64,199** | **1,218,041** |
| Contractor General Conditions | 10.000 % | | 108,118 | |
| E&I General Conditions | 10.000 % | | 13,686 | |
| GC Electrical Mark-Up | 10.000 % | | 15,055 | |
| | | | **136,859** | |
| | | | | **1,354,900** |
| Start-Up, Training, O&M | 2.000 % | | 27,098 | |
| | | | **27,098** | **1,381,998** |
| Contingency | 30.000 % | | 414,599 | |
| | | | **414,599** | **1,796,597** |
| Bldg Risk, Liability Auto Ins | 2.000 % | | 35,932 | |
| | | | **35,932** | **1,832,529** |
| Payment and Performance Bonds | 1.500 % | | 27,488 | |
| | | | **27,488** | **1,860,017** |
| Esc. To Midpoint 2038 | 127.240 % | | 1,313,906 | |
| **Gross Markups** | | | **1,313,906** | **3,173,923** |
| **Total** | | | | **3,173,923** |