City of Arcata

Predesign Report

FINAL MAY 2019

City of Arcata
Wastewater Treatment Facilities Improvements

Executive Summary
PREDESIGN REPORT
PHASED PROJECT

FINAL | May 2019

City of Arcata
Wastewater Treatment Facilities Improvements

EXECUTIVE SUMMARY

PREDESIGN REPORT

PHASED PROJECT

FINAL | May 2019

REGISTERED PROFESSIONAL ENGINEER
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CIVIL
STATE OF CALIFORNIA

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Abbreviations

AMWS	Arcata marsh wildlife sanctuary
AWTF	Arcata wastewater treatment facility
BOD	biological oxygen demand
Carollo	Engineers, Inc.
City	City of Arcata
NPDES	National Pollutant Discharge Elimination System
RWQCB	Regional Water Quality Control Board
SCADA	Supervisory control and data acquisition
TM	Technical Memorandum

Executive Summary

PREDESIGN REPORT

1.1 Purpose

The purpose of this Executive Summary is to outline the recommended improvements, new site plan and site constraints, and construction cost estimate for the City of Arcata (City) Wastewater Treatment Facilities Improvement project. The improvement project elements are detailed in a series of Technical Memorandums (TMs), briefly described below, and included as appendices in this Predesign Report.

1.2 Background

The City Wastewater Treatment Facility (WTF) currently discharges treated wastewater to Humboldt Bay in conjunction with enhanced treatment occurring in the Arcata Marsh Wildlife Sanctuary (AMWS). Discharges are regulated by the North Coast Regional Water Quality Control Board (RWQCB) through application of the National Pollutant Discharge Elimination System (NPDES) permit.

The AWTF operates under an NPDES permit issued in 2012 and updated in 2014, which includes requirements for disinfection, treatment processes, and outfalls. Due to compliance problems, the permit required that changes be made to improve wastewater treatment, protect beneficial uses, and reduce chemical usage. A new permit was due in 2017 and is currently expected to be issued in June 2019. It is anticipated that the new permit will introduce new lower limits for effluent ammonia. The permit will also include a Time Schedule Order compliance schedule, and revised requirements for the new ultraviolet light (UV) disinfection system.

1.3 Project Goals

The AWTF improvements will be sized to meet the community needs now and for growth envisioned by the City General Plan 2020. The facility design criteria are reviewed in TM No. 1. The City currently has under taken a separate program to reduce the peak wet weather flows and volumes that must be treated at the AWTF.

The overall project goal is to improve the AWTF infrastructure with the addition of a new secondary treatment system while preserving the natural treatment system of ponds and wetlands. The City has proposed to complete the project in two phases. Phase 1 will include improvements to optimize the existing oxidation ponds, improve the efficiency of the treatment wetlands and enhancement wetlands to meet the treatment requirements, and move the final discharge to the brackish marsh (Outfall Pt 003) location. The Phase 1 will also replace/update aged infrastructure within the plant and the new UV disinfection system will also be installed to eliminate the use of chlorine for disinfection. Phase 2 will include construction of a parallel secondary treatment system to meet the anticipated long-term treatment requirements. The second phase will also include upgrades and rehabilitation of the solids treatment and handling process. This two-phase project will replace, repair, or rehabilitate aging AWTF facilities to meet the community's current and future needs.

The project environmental goal is to improve water management by addressing existing and proposed NPDES requirements for wastewater treatment and by providing reliable hydraulic capacity and treatment capacity for wet weather flows.

The project will also prepare the AWTF for future infrastructure needs and will provide a resilient system that will address future concerns such as sea level rise. New facilities will be elevated above the projected flood and sea level rise elevations, and the project will be coordinate with the anticipated City project to raise the plant levees.

1.4 Anticipated Improvements

The phased project elements includes the anticipated improvements listed below.

Phase 1 – Flow Reconfiguration and Existing Plant Rehabilitation:

1. Flow reconfiguration to single pass system, to meet permit objectives is described in TM No. 2 and includes:
   - New outfall (Outfall 003) into brackish marsh.
   - Treatment Wetlands (TW) Pump Station rehabilitation.
   - Enhancement Wetlands (EW) Pump Station improvements and inlet structure replacement.
   - Piping modifications required for the flow reconfiguration.
2. Headworks rehabilitation/replacement and Primary Clarifier No. 2 rehabilitation to replace aging facilities and provide additional treatment capacity are described in TM No. 3 and Appendix M. The improvements include:
   - New Influent Pump Station utilizing screw type pumps.
   - New bar screens and screenings treatment
   - New grit removal system and grit handling system.
   - New influent flow metering.
   - Rehabilitate Primary Clarifier No. 2, including a new mechanism.
   - Plant water system modifications.
   - New primary sludge and scum pumping system.
3. Pond and treatment wetland improvements to provide increased treatment and hydraulic capacity are discussed in TM No. 4, and also addresses wet weather flows management. The improvements include:
   - Oxidation Pond No. 1 aeration system, up to 8 aerators. (Separate City project).
   - Oxidation Pond No. 1 transfer piping modification to allow for peak wet weather flow storage and attenuation.
   - Oxidation Pond No. 2 transfer structure improvements.
   - Oxidation Pond No. 2 aeration system, including the infrastructure for up to 24 new aerators, with installation of up to 16 aerators.
   - Oxidation Pond No. 2 baffle wall installation to reduce short circuiting. (Separate City project)
   - Installation of a new gravity transfer line from TW 5 and 6 (and future TW 7) and elimination of Pump Station No. 2.
   - Treatment Wetlands Nos. 1 to 4 regrading and revegetation. (Separate City projects).
   - Treatment Wetland No. 3 piping repairs.

- Electrical conduit for Blue Frog aerators in TW.
- Treatment Wetlands No. 7 construction. (Separate City project)
- New Treatment Wetland No. 4 pump station. (Separate City Project with electrical included in the Phase 1 project)
- Enhancement Wetlands vegetation management and excavation for the pump station improvements. (Other vegetation management will be part of a separate City Project)
- Enhancement wetlands bypass piping improvements utilizing existing infrastructure.
- Enhancement wetlands transfer structure improvement.
- Pump Station No. 1 and Pond Pump Station rehabilitation.
- Emergency Pond Pump Station maintenance improvements and interconnection to new transfer piping.

4. Disinfection system improvements to improve water quality and meet anticipated permit requirements are described in TM No. 7, and Appendix N. These include:
    - New 9.8 mgd effluent UV disinfection facility.
    - New UV and EW effluent flow meters.
5. Electrical, instrumentation and control facilities improvements described in TM No. 9 to address aging infrastructure, and designed for new Phase 1 facilities and to accommodate Phase 2 in the future buildout for a complete treatment plant facilities, and includes:
    - New plant utility service.
    - Electrical improvements including new switchgear, transformers, motor control centers and duct banks for power distribution.
    - Instrumentation improvements including new analyzers and field devices.
    - Expansion of the plant Wonder-ware SCADA system.
    - Ethernet network for plant, including hardwired facilities where possible.

Phase 2 – Secondary Treatment Additions and Solids Handling Improvements (Completed as a separate project):

1. New parallel/series secondary treatment to provide additional treatment capacity, to improve water quality and meet anticipated new permit requirements is described in TM No. 5. The proposed facilities include:
    - New oxidation ditch (design for one new and one future).
    - New secondary clarifiers (design for two new and one future).
    - RAS and WAS pumping facility.
    - Alkalinity addition facility to meet permit requirements for ammonia removal (if required).
2. Solids handling and treatment upgrades to replace aging facilities, provide additional treatment capacity is described in TM No. 6, and includes:
    - Thickener addition for waste primary and secondary sludge.
    - Digester rehabilitation and improvements.
    - Digester mixing and pumping improvements.
    - Digester heating boiler replacement.
3. Miscellaneous site improvements to address aging infrastructure, to add all the ancillary and support facilities required for a complete treatment plant, and to accommodate

corporation yard facilities impacted by new treatment plant facilities is described in TMs No. 8 and includes:

- Bus Barn, maintenance shop, and biosolids composting relocation (By City as necessary).
- Relocation and reuse of facilities for plant maintenance and parts storage facilities (By City as necessary).
- Demolish the existing chlorine contact basin and repurpose the chlorine building for storage and maintenance, depending on operation of the Phase 1 UV disinfection system (By City as necessary).
- Demolition of Primary Clarifier No. 1

4. Electrical, instrumentation and control facilities improvements described in TM No. 9 to address aging infrastructure, to accommodate Phase 2 project for a complete treatment plant facilities, and includes:
   - Electrical improvements including new motor control centers and duct banks for power distribution.
   - Instrumentation improvements including new analyzers and field devices.
   - Expansion of the plant Wonder-ware SCADA system.
   - Ethernet network for plant, including hardwired facilities where possible.

1.5 Improvement Siting and Site Constraints

The new treatment processes will be constructed within the existing plant site while maintaining operation of existing wastewater treatment processes. The overall site plan with the proposed location of the new facilities is presented in Figures ES-1, ES-2, and ES-3. It is assumed that the new influent pump station and headworks will be sited in the same location as the existing influent pump station and headworks.

The City will also maintain the City Corporation Yard in conjunction with the AWTF, at the treatment plant site. As noted, the corporation yard will need to be consolidated and several areas relocated to accommodate the new Phase 2 plant facilities.

1.6 Proposed Process Flow Diagram

The proposed process changes are outlined on the process flow diagram presented in Figure ES-4. The flow reconfiguration to discharge to the new brackish marsh outfall (003) and the new UV disinfection system are shown on the diagram. Flows up to 5.9 mgd will be pumped to the headworks for preliminary treatment and then split between the existing pond / wetland treatment and the new secondary treatment. Influent flows greater than 5.9 mgd will be sent directly to the ponds for equalization of the wet weather peaks using the existing storm and First Street pump stations. Secondary effluent flows up to 9.8 mgd will be combined and disinfected in the new UV disinfection system.

1.7 Construction and Project Costs Estimate

The estimated construction cost of the recommended improvements for Phase 1 is $23.3 M when escalated to the mid-point of construction of January 2021, and for Phase 2 is $24.5 M when escalated to the mid-point of construction of January 2023. A breakdown of the construction costs for the AWTF improvements is outlined in TM No. 10, with an update of the phased project costs included in Appendix O. The costs to meet the main project objectives are presented in Table ES-1.

TREATMENT WETLANDS SITE PLAN

FIGURE ES.1

CITY OF ARCATA

WASTEWATER TREATMENT PLANT IMPROVEMENTS PROJECT

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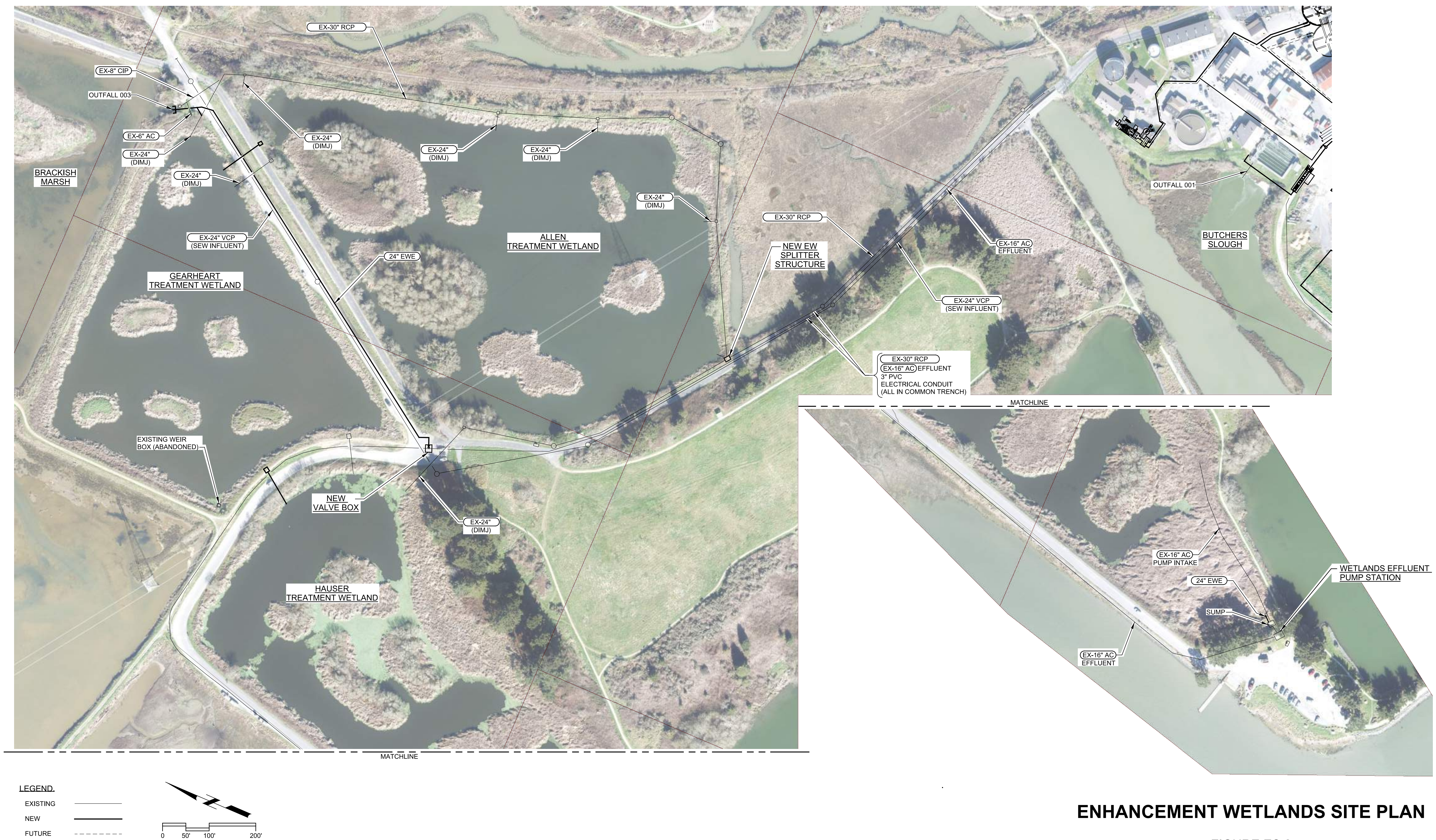

ENHANCEMENT WETLANDS SITE PLAN

FIGURE ES.2

CITY OF ARCATA

WASTEWATER TREATMENT PLANT IMPROVEMENTS PROJECT

carollo

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CENTRAL SITE PLAN

FIGURE ES.3

CITY OF ARCATA

WASTEWATER TREATMENT PLANT IMPROVEMENTS PROJECT

carollo

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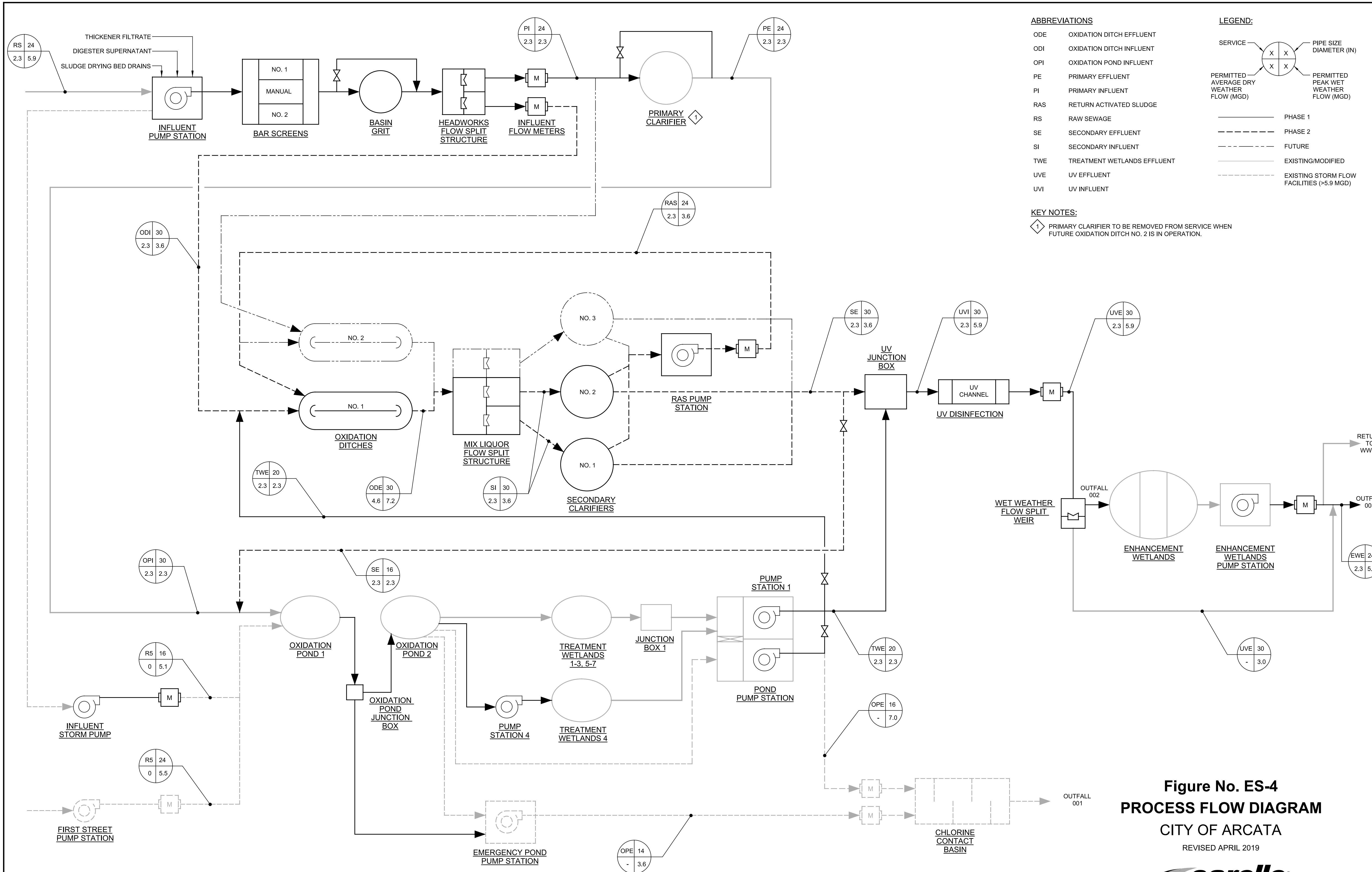


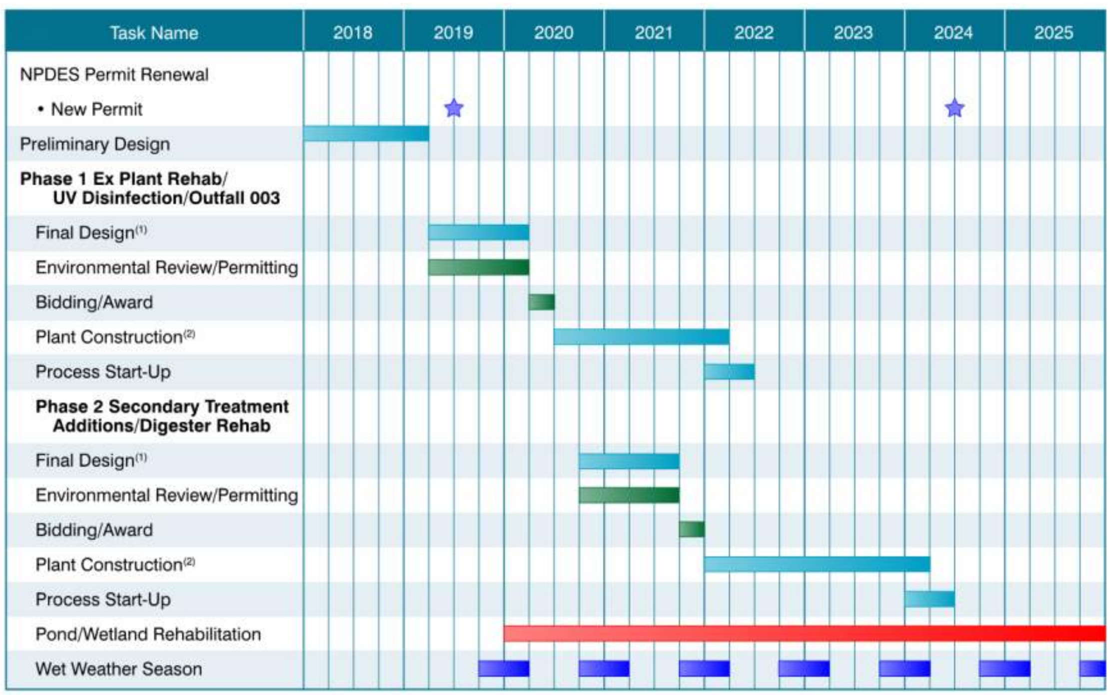
Figure No. ES-4
PROCESS FLOW DIAGRAM
CITY OF ARCATA
REVISED APRIL 2019

carollo

Therefore the City should consider these factors when finalizing the construction cost estimate projection and the City project cost estimate used in budgeting for the project. The escalated construction cost estimate should be reviewed based on local experience and adjusted if needed to account for the current bid climate and construction cost inflation.

1.8 Implementation Plan and Schedule

The updated implementation schedule is outlined below in Figure ES-5. The plan has been revised based on a 2-phase construction project. The next step is to complete the Phase 1 engineering design required to develop documents to obtain construction bids. Parallel with the design activity, environmental review for CEQA compliance will be completed, and any required permits will be identified. Then the permits will be obtained for the improvements project. A financing plan including a rate study will also be developed parallel to the design activities to ensure the City can fund the project. The Phase 2 engineering design will start once the Phase 1 construction has started. The City has discussed the potential to complete the Phase 2 improvements using a design build approach. Alternative delivery methods require careful consideration as to the cost and schedule impacts and will require a consultant to develop the alternative delivery contract/bridging documents.



Notes:
(1) To be finalized after completion of the Preliminary Design.
(2) Construction schedule is preliminary, constraints to be determined in Final Design.

Figure ES-5 Overall Schedule – Two Phase Project

It is anticipated that construction documents for each phase could be prepared in about 12 months, and a project could then be bid and awarded in three or more months. The phased construction, shown in 2020 to early 2022 for Phase 1 and 2022 to early 2024 for Phase 2, includes two dry weather construction seasons for each phase. The startup would be two or three months for the mechanical portion of the plant. The startup for wetlands that might be revegetated could take up to 12 to 18 months. In addition, it is anticipated that ongoing pond and wetland rehabilitation will continue into the future, on a regular schedule.

The City has indicated that several recommended elements of the AWTF improvements would be completed by the City as separate projects. These include:

- Oxidation Pond No. 1 aerator installation,
- Oxidation Pond No. 2 baffle wall,
- TW 7 construction,
- TW 4 construction including regrading, vegetation planting, and inlet pump station, except for the power supply for the new pump station,
- TW 1 and 4 vegetation management and grading/excavation,
- Enhancement wetlands vegetation management and excavation, except as required for pump station improvements.

These projects can be completed as maintenance projects and do not require the same level of permit review, design and construction support as the other elements.

1.9 Conclusion

In conclusion, it is anticipated that a combination of new plant facilities and plant rehabilitation improvements can be completed within the next five year NPDES permit cycle. The new permit, which is likely to be issued in June 2019, will set new discharge criteria, and will have a compliance schedule included for meeting water quality improvements. This preliminary design report outlines the facilities needed to comply with the anticipated new standards as well as lays out an implementation schedule that is achievable within the anticipated time schedule requirements of a five year permit window.

Appendix A

TM 1 BASIS OF DESIGN

City of Arcata
Wastewater Treatment Facilities Improvements

Technical Memorandum 1
BASIS OF DESIGN

FINAL | APRIL 2019

City of Arcata
Wastewater Treatment Facilities Improvements

TECHNICAL MEMORANDUM 1
BASIS OF DESIGN

FINAL | APRIL 2019

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Abbreviations

AMWS	Arcata marsh wildlife sanctuary
AWTF	Arcata wastewater treatment facility
BOD	biological oxygen demand
Carollo	Carollo Engineers, Inc.
CIP	Capital Improvement Program
City	City of Arcata
MLFSS	mixed liquor flow split structure
NH3	ammonia
NPDES	National Pollutant Discharge Elimination System
RWQCB	Regional Water Quality Control Board
SRT	solids residence time
TM	Technical Memorandum
TSS	total suspended solids

Technical Memorandum 1

BASIS OF DESIGN

1.1 Purpose

The purpose of this Technical Memorandum (TM) is to confirm the project goals, plant flow and loads, improvement siting and site constraints, and reliability requirements. In addition a regulatory kickoff workshop is proposed to review the new National Pollutant Discharge Elimination System (NPDES) requirements, compliance issues, and compliance schedule. The TM will document the Basis of Design from these meetings/workshops.

1.2 Background

The City of Arcata (City) Wastewater Treatment Facility (AWTF) currently discharges treated wastewater to Humboldt Bay in conjunction with enhanced treatment occurring in the Arcata Marsh Wildlife Sanctuary (AMWS). Discharges are regulated by the North Coast Regional Water Quality Control Board (RWQCB) through application of the NPDES permit.

The AWTF operates under a NPDES permit issued in 2012 and updated in 2014 which includes requirements for disinfection, treatment processes, and outfalls. Due to compliance problems, the permit required changes be made to improve wastewater treatment, protect beneficial uses, and reduce chemical usage. A new permit was due in 2017 and is expected to be issued in early 2019. It is anticipated that the new permit will introduce new limits for effluent ammonia.

A Facility Plan was prepared by LACO and Carollo Engineers in July 2017 which provided overall direction for the current permit compliance project as well as a future Capital Improvements Program (CIP) needed to maintain the treatment facility assets, repair, and rehabilitate existing assets, and modernize the facility to meet current levels of service. The findings from the facility are the basis for the information presented in this TM.

1.3 Project Goals

The project goals are based on addressing the ongoing NPDES permit violations and meeting the anticipated regulatory requirements by providing reliable hydraulic and treatment capacity for both wet and dry weather flows now and in the future.

This project will meet these goals by repairing or rehabilitating aging infrastructure and constructing a new influent pump station, headworks, oxidation ditches, secondary clarifiers, UV disinfection, and sludge thickening.

A community goal is to preserve the natural treatment system of ponds and wetlands. The objective is to optimize the existing oxidation ponds, treatment wetlands, and enhancement wetlands in conjunction with a parallel secondary treatment system to meet the treatment capacity requirements.

1.4 Design Influent Flows and Loads

The influent flows and loads used for the basis of design for the new and upgraded treatment processes are presented in Table 1.1. Current average dry weather flow is approximately 1.1 million gallons per day (mgd); however, permitted dry weather flow is 2.3 mgd. During wet weather, flows greater than 5.9 mgd will bypass the headworks and be pumped to the oxidation ponds. If necessary, the Emergency Pond Pump Station will pump to the chlorine contact basins for disinfection and discharge via Outfall 001.

Table 1.1 Plant Influent Flow and Loads

	Current (mgd or lb/day)	Future (mgd or lb/day)	Permitted (mgd)
Minimum Flow	0.3 (1)	0.3 (1)	-
Average Dry Weather Flow	1.1 (2)	1.3 (3)	2.3 (4)
Peak Dry Weather Flow	1.8 (5)	2.2 (6)	-
Maximum Month Flow	3.0 (7)	3.6 (8)	5.0 (9)
Peak Wet Weather Flow	5.9 (4)	5.9 (4)	5.9 (4)
Peak Instantaneous Flow	16.5(4)	16.5(4)	16.5(4)
BOD	4,000 (10)	4,800 (11)	See Table 1.2
TSS (12)	5,760 (10)	6,910 (11)	See Table 1.2
NH_3	880 (13)	1,060 (14)	See Table 1.2
TKN (15)	1,330	1,610	See Table 1.2

Notes:
(1) Based on City diurnal flow data from 7/23/17 through 7/30/17.
(2) 50th percentile flow during dry weather using City data from 2003 to 2015.
(3) Current Average Dry Weather Flow plus 20 percent growth.
(4) Existing permit capacity.
(5) Diurnal peaking factor of 1.6 multiplied by Average Dry Weather Flow. Peaking factor based on City diurnal flow data from 7/23/17 through 7/30/17.
(6) Current Peak Dry Weather Flow plus 20 percent growth.
(7) 92nd percentile flow using City data from 2003 to 2015.
(8) Current Maximum Month Flow plus 20 percent growth.
(9) Existing permitted Average Wet Weather Design Flow.
(10) 90th percentile load using City data from 2003 to 2015.
(11) 90th percentile load using City data from 2003 to 2015 plus 20% for growth.
(12) It is suspected that these values may be high.
(13) 90th percentile load using City data from 2013 to 2015.
(14) 90th percentile load using City data from 2013 to 2015 plus 20% for growth.
(15) Estimated based on NH_3 data.

The assumed discharge requirements are presented in Table 1.2. These values will be confirmed once the new permit is issued.

It is anticipated that dual or split compliance point locations will be used for permitting. One compliance point at Outfall 002 for disinfection compliance (fecal coliform), BOD, TSS, and pH, downstream of the UV discharge and before entering into the enhancement wetlands. The other compliance point at Outfall 003 for BOD, TSS, ammonia, pH, metals, etc., downstream of the enhancement wetlands.

Table 1.2 Anticipated Discharge Permit Requirements

	Anticipated Permit Values		
Design Flows			
Design Dry Weather Flow (Maximum Month Flow), mgd		2.3	
Peak Wet Weather Flow, mgd		5.9	
Instantons Peak Flow, mgd		16.5	
Effluent Limitations	**Average Monthly**	**Average Weekly**	**Maximum Daily**
BOD, mg/L (4)	30	45	
BOD, lb/d (1) (4)	575	863	
TSS, mg/L (4)	30	45	
TSS, lb/d (1) (4)	575	863	
NH_3, mg/L (2) (4)	Varies	-	Varies
Fecal Coliform, MPN/100 mL (3)	14	-	43
Settleable Solids, mg/L (4)	0.1	-	0.2
Chlorine, Total Residual, mg/L (5)	0.01	-	0.02
pH		6.0-9.0 all times	

Notes:
(1) Mass-based effluent limitations based on average dry weather design flow.
(2) Ammonia limits assumed based on correspondence with NCRWQCB. May be based on floating limit method. To be confirmed when new NPDES permit is issued.
(3) Limit at Outfall 002.
(4) Limit at Outfall 003.
(5) Interim limit for Outfall 001.

1.4.1 Process Capacities

The treatment capacities of the new and upgraded unit processes are presented in Table 1.3. The secondary treatment processes will be designed for a solids retention time (SRT) of 16 days and a mixed liquor suspended solids (MLSS) concentration of 1,800 mg/L at current average dry weather conditions.

Table 1.3 Treatment Process Capacities

	Unit Process Treatment Capacity, mgd
Headworks - Bar Screens, Grit Removal, Flow Metering (New)	5.9
Primary Clarifier No. 2 (Rehabilitated)	2.3
Oxidation Ponds Nos. 1 and 2 (Upgraded)	2.3
Treatment Wetlands Nos. 1 through 6 (Existing)	1.8
Treatment Wetlands Nos. 7 (New)	0.5
Oxidation Ditch No. 1 (New)	3.6
Oxidation Ditch No. 1 and 2 (Future) (1)	3.0, each
Secondary Clarifier No. 1 and 2 (New)	1.8, each
Secondary Clarifier No. 1, 2, and 3 (Future) (1)	2.0, each
UV Disinfection (New)	5.9
Enhancement Wetlands (Existing)	5.9

Notes:
(1) Hydraulic capacities are revised for future flows and loads to account for the future unit needed and anticipated BOD and TSS loading.

1.4.2 Pump Station Capacities

The design pumping capacities for the existing, new, and upgraded pump stations are presented in Table 1.4. Total influent pumping capacity is proposed for the instantaneous peak wet weather flow of 16.5 mgd. Pump Station No. 2 will be removed from service as part of this project.

Table 1.4 Pump Station Capacities

	Capacity, mgd	
	Duty	Standby
Influent Pump Stations		
First Street Pump Station (Existing)	5.5	5.5
Influent Storm Pump Station (Existing)	5.1	0
Influent Pump Station (New)	5.9	2.5
Process Pump Stations		
Pond Pump Station (Upgraded)	7.0	3.5
Pump Station No. 1 (Upgraded)	2.3	1.2
Emergency Pond Pump Station (Upgraded)	7.2	0
Enhancement Wetlands Pump Station (Upgraded)	4.0	2.0

1.5 Anticipated Improvements

The project includes the anticipated improvements listed below.

Flow Reconfiguration to single pass, to meet permit objectives including:

- New outfall into brackish marsh.
- Treatment Wetlands Pump Station rehabilitation.
- Enhancement Wetlands Pump Station project.
- Piping for single pass flow schematic.

Headworks replacement and Primary Clarifier rehabilitation including:

- New Influent Pump Station.
- New bar screens and screenings treatment.
- New grit removal system and grit handling system.
- New influent flow meters.
- Rehabilitate Primary Clarifier No. 2.
- Demolish Primary Clarifier No. 1.
- New primary sludge and scum pumping system.

Pond and treatment wetland improvements to provide increased treatment and hydraulic capacity, while addressing wet weather flows including:

- Oxidation Pond No. 1 outlet piping and transfer structure modifications.
- Oxidation Pond No. 2 transfer structure improvements.
- Oxidation Pond No. 2 aeration system.
- Oxidation Pond No. 2 baffle wall.
- Treatment Wetlands Nos. 1 to 4 regrading and revegetation (City project).
- Treatment Wetlands No. 7 construction (City project).

- New Treatment Wetland No. 4 pump station (City project).
- Pond Pump Station rehabilitation.
- Emergency Pond Pump Station improvements.

New parallel/series secondary treatment to provide additional treatment capacity and to improve water quality and meet anticipated permit requirements including:

- New oxidation ditch (design for one new and one future).
- New secondary clarifiers (design for two new and one future).
- RAS and WAS pumping facility.

Disinfection system improvements to improve water quality and meet anticipated permit requirements including:

- New effluent UV disinfection facility.
- Chlorine system conversion to liquid chlorine system for peak wet weather flows.
- New effluent flow meters.

Solids handling and treatment upgrades to replace aging facilities, provide additional treatment scapacity, and potentially address plant energy use including:

- Thickener addition for primary and waste secondary sludge.
- Digester rehabilitation and improvements.

Miscellaneous site improvements to address aging infrastructure, to add all the ancillary and support facilities required for a complete treatment plant, and to accommodate corporation yard facilities impacted by new treatment plant facilities:

- Bus barn and biosolids composting relocation.
- Electrical and Instrumentation improvements.
- Plant water system modifications.

1.6 Improvement Siting and Site Constraints

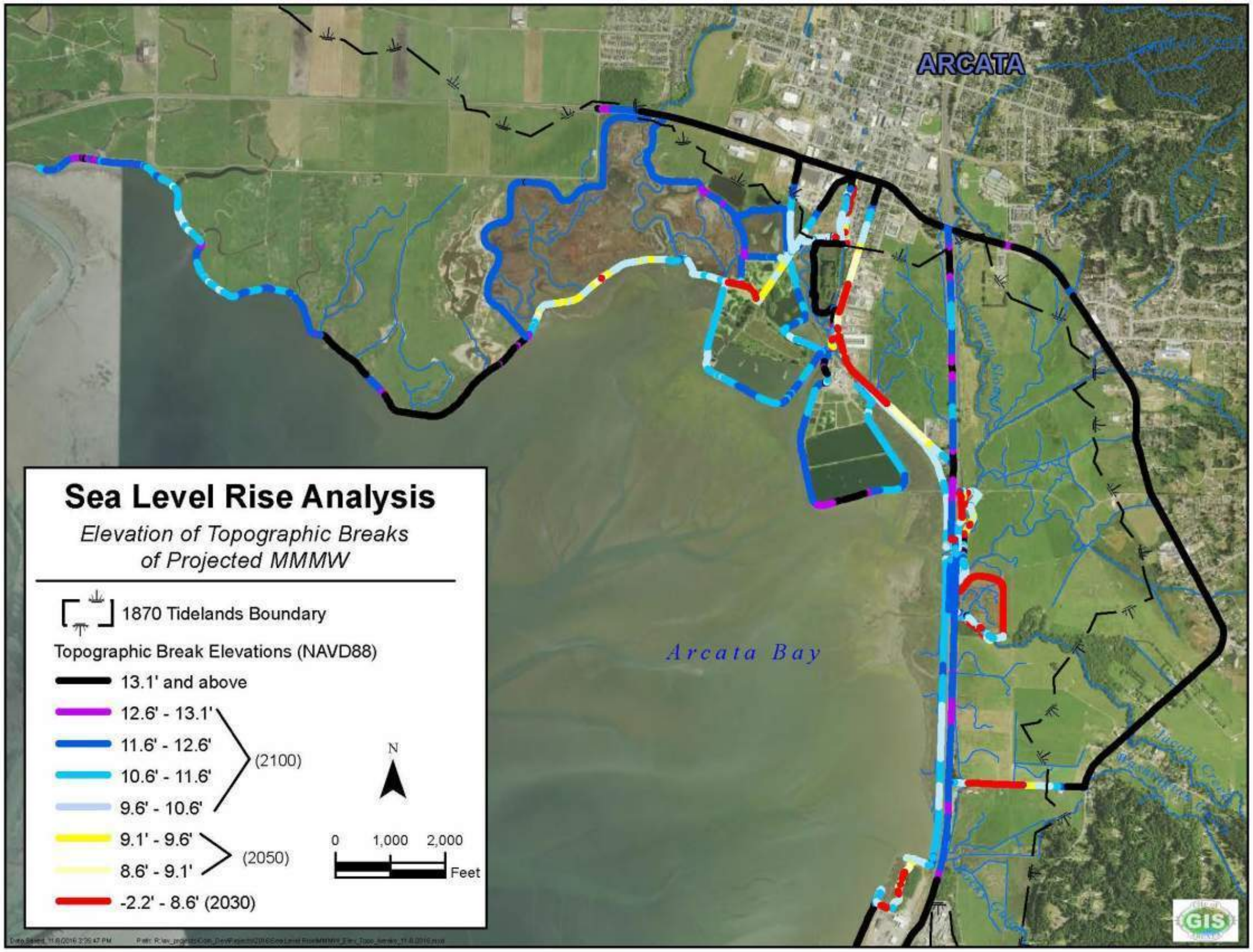
The AWTF is constrained on the north and east side by the plant property boundaries and on the west and south side by treatment wetlands and Arcata Bay. Figure 1.1 shows a site plan of existing facilities as well as these constraints. Due to the facility's low elevation, sea level rise is also considered in improvement siting. Figure 1.2 shows the potential impacts of sea level rise.

The new treatment processes will be constructed within the existing plant site while maintaining operation of existing treatment processes. New facility layouts are shown in TM No. 8, Site Improvements. It is assumed that the new influent pump station and headworks will be sited in the same location as the existing influent pump station and headworks.

1.7 Reliability Requirements

The treatment processes will be designed to meet BOD, TSS, ammonia, and disinfection NPDES discharge requirements for influent flows up to 5.9 mgd.

Figure 1.1 Existing Site Plan



Source: October 2017 City of Arcata Presentation "Economic Evaluation of Sea Level Rise Response

Figure 1.2 Possible Impact of Climate Change

Appendix B

TM 2 FLOW RECONFIGURATION

City of Arcata
Wastewater Treatment Facilities Improvements

Technical Memorandum 2
FLOW RECONFIGURATION

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City of Arcata
Wastewater Treatment Facilities Improvements

TECHNICAL MEMORANDUM 2
FLOW RECONFIGURATION

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Abbreviations

BFE	base flood elevation
Carollo	Carollo Engineers, Inc.
CCB	chlorine contact basin
FSS	Flow Split Structure
Ft	feet
ft/s	feet per second
in	inches
MAMW	mean annual maximum water
MHW	mean high water
MHHW	mean higher high water
MLW	mean low water
MLLW	mean lower low water
MMMW	mean monthly maximum water
MSL	mean sea level
mgd	million gallons per day
PS	pump station
SLR	sea level rise
TM	technical memorandum
UV	Ultraviolet
WWTP	wastewater treatment plant

Technical Memorandum 2

FLOW RECONFIGURATION

2.1 Purpose

The purpose of this Technical Memorandum (TM) is to size the major hydraulic elements and to provide a preliminarily layout for new piping, meters, and flow control structures. These elements will include the piping to revise the dry weather and wet weather flow routing, incorporate the new ultra-violet (UV) disinfection system, and other new elements of the flow routing required to provide a single pass system for dry weather, and elements needed for recirculation and flow routing during wet weather flows. The pump station (PS) improvements will also be outlined in this TM. The size of required pumping elements for the flow reconfiguration, type of pumps (assumed to be submersible), pump size and arrangement, controls, screening configuration and size, and piping arrangement will be included.

2.2 Summary of Findings and Recommendations

The key findings and recommendations of this TM are summarized below:

- To create operational flexibility, three flow path scenarios were evaluated assuming current flows: 1) Oxidation Ponds / Treatment Wetlands First, 2) Oxidation Ditch and Secondary Clarifier First, and 3) Parallel Operations.
- To accommodate these three flow paths and future Sea Level Rise (SLR), the new headworks structure will need to be almost 6 feet higher than the current headworks structure.
- The new UV facility will be designed at a similar or slightly higher elevation than the current Chlorine Contact Tank.
- To accommodate this higher hydraulic capacity, additional weir boxes will be needed between enhancement wetlands, and weir elevations throughout the plant will need adjustment. One pipe segment will also need an increased diameter.
- To accommodate the desired operational flexibility, 13 new process pipes are needed. These pipes range in diameter from 16 to 30 inches.
- Three flow path scenarios were also evaluated for future flows. A) Gravity flow from UV to new Outfall 003 in existing pipeline, B) Gravity flow from UV to Outfall 003 in new pipeline, and C) Pumped flow from UV to Outfall 003 in existing pipeline. Of the three future flow path scenarios, only B and C would work hydraulically with the proposed system. For Scenario A, the headworks would need to be raised by an additional 3.5 feet.

2.3 Background

This section includes a brief summary of the existing flow configuration at the City of Arcata Wastewater Treatment Plant (WWTP). The flow configuration, as originally designed is shown in Figure 2.1. The City of Arcata WWTP was designed to treat a peak wet weather design flow of 5.9 mgd and a peak instantaneous flow of 16.5 mgd.

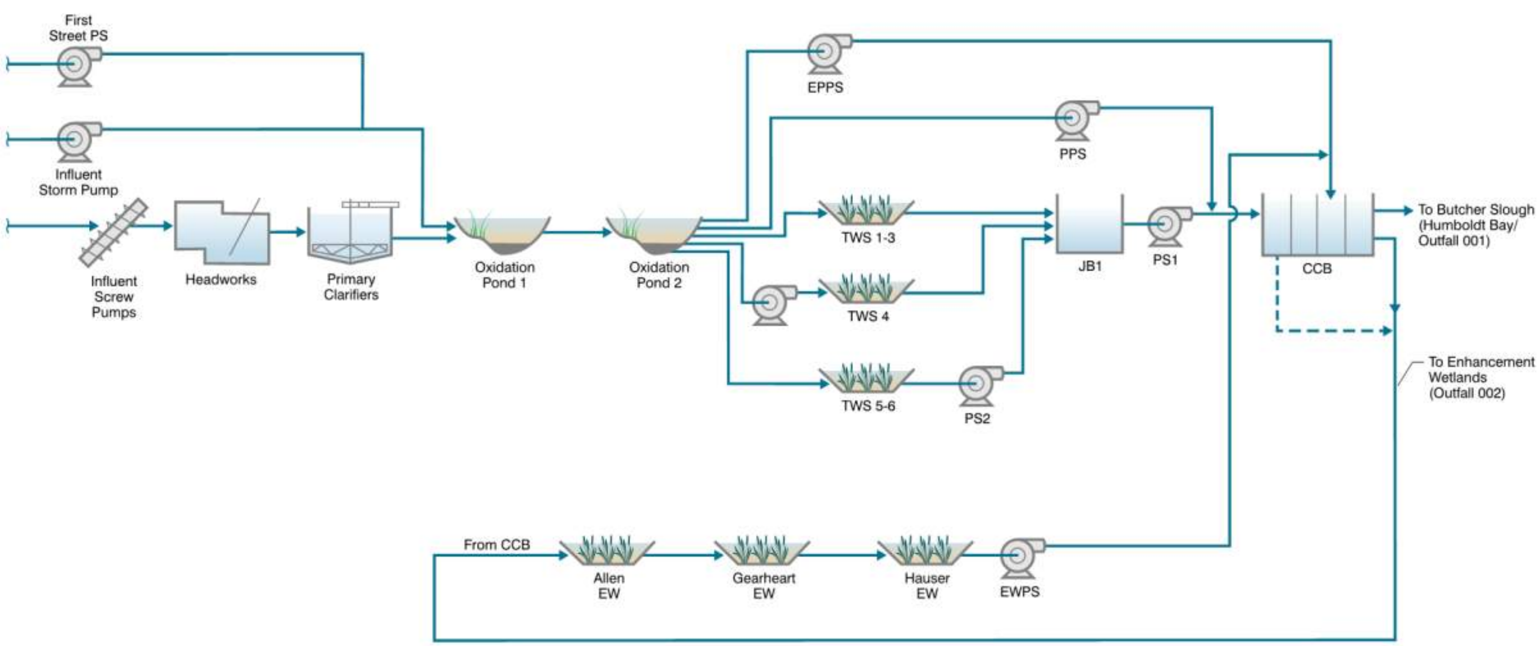

Figure 2.1 Existing Flow Schematic

Table 2.1 shows the water surface elevations through the existing system at the peak instantaneous flow rate. Note that the elevations have been converted from the elevations on the plans which are based on the NGVD 29 datum to the current NAVD 88 datum. The original elevations are converted by adding 3.35 feet to each elevation.

Table 2.1 Existing Water Surface Elevations

Existing Facilities	Water Surface Elevation at Peak Flow (ft, NAVD 29)	Water Surface Elevation at Peak Flow (ft, NAVD 88)
Influent Screw Pumps Wet Well	1.75	5.1
Bar Screens	15.07	18.42
Parshall Flume	14.99	18.34
Grit Chamber	13.87	17.22
Headworks Flow Distribution Box	13.29	16.64
Primary Clarifier	11.94	15.29
Oxidation Ponds	6.50	9.85
Treatment Wetlands	2.00	5.35
Pump Station No. 1 (PS1)	1.96	5.31
Upstream Chlorine Contact Tank (CCT) Influent Weir	10.02	13.37
CCT	8.88	12.23
Downstream CCT Effluent Weir	7.73	11.08
Allen Marsh	6.00	9.35
Gearheart Marsh	4.50	7.85
Hauser Marsh	3.50	6.85
Wetlands Effluent Pump Station (WEPS)	-2.00	1.35

The plant hydraulics are based on a series of pump stations that pump to the ponds, from treatment wetlands to chlorine contact basin (CCB), and from enhancement wetlands back to the CCB. This allows the plant to have a fairly low hydraulic profile. The highest point is the influent bar screens and flume.

2.4 Flow Design Criteria

As discussed in TM 1, the flow design criteria used for the hydraulic analysis in this predesign report are shown in Table 2.2.

Table 2.2 Flow Design Criteria

	Current Flow (mgd)	Future Flow (mgd)(1)
Minimum Flow	0.3(2)	0.3(3)
Average Dry Weather Flow	1.1(4)	1.3
Peak Dry Weather Flow	1.8(5)	2.2
Maximum Month Flow	3.0(6)	3.6
Peak Wet Weather Flow	5.9(7)	5.9(7)
Peak Instantaneous Flow	16.5(7)	16.5(7)

Notes:
(1) Future flows are based on 20 percent growth.
(2) Based on minimum minute flow recorded during 7 days in July 2017 (diurnal data received from City).
(3) As a conservative approach, it was assumed the minimum flow would not increase.
(4) Based on the 50th percentile flow during dry weather.
(5) Based on a peaking factor of 1.6. This peaking factor was calculated from the 2017 diurnal data received from the City.
(6) Based on the 91.7th percentile flow.
(7) Based on existing permitted capacity. Thus it was assumed this capacity would not increase in the future.

2.4.1 Diurnal Flow Variation

The diurnal, or change in flow over a 24-hour period, was reviewed for the Arcata WWTP, and is shown on Figure 2.2. The flow data was from July 2017, and represents the dry weather flow variation. The minimum daily, night time low flow is approximately 0.3 mgd, and the maximum daily day time flow is approximately 1.7 mgd. The average flow over this period was 1.0 mgd. The minimum flows need to be accounted for when sizing pumping facilities.

2.4.2 Sea Level Rise

Table 2.3 shows the current sea level elevations for Humboldt Bay. These elevations provide a good approximation for the water surface elevations at the new Outfall 003, located in the brackish marsh north of the enhancement wetlands. Of these sea level elevations, the highest is the Base Flood Elevation (BFE) which represents the anticipated flood water level elevation during a 100-year flood. For Humboldt Bay, the current BFE is 10.05 (NAVD 88). With sea level rise (SLR), it is anticipated that all current elevations shown in Table 2.3 will increase by 1.1 feet in 2050. SLR projections are shown in Table 2.4.

Given the City of Arcata WWTP's proximity to the bay and its low elevation, the impact of SLR was included in the evaluation of the discharge to the new Outfall 003. The design discharge elevation will be impacted by SLR and flood tide elevations. Thus the flow reconfiguration and hydraulic analysis discussed in this TM assumed the water level at the new Outfall 003 would be 11.2 (NAVD 88) to account for both the 100-year flood and the projected SLR by 2050.

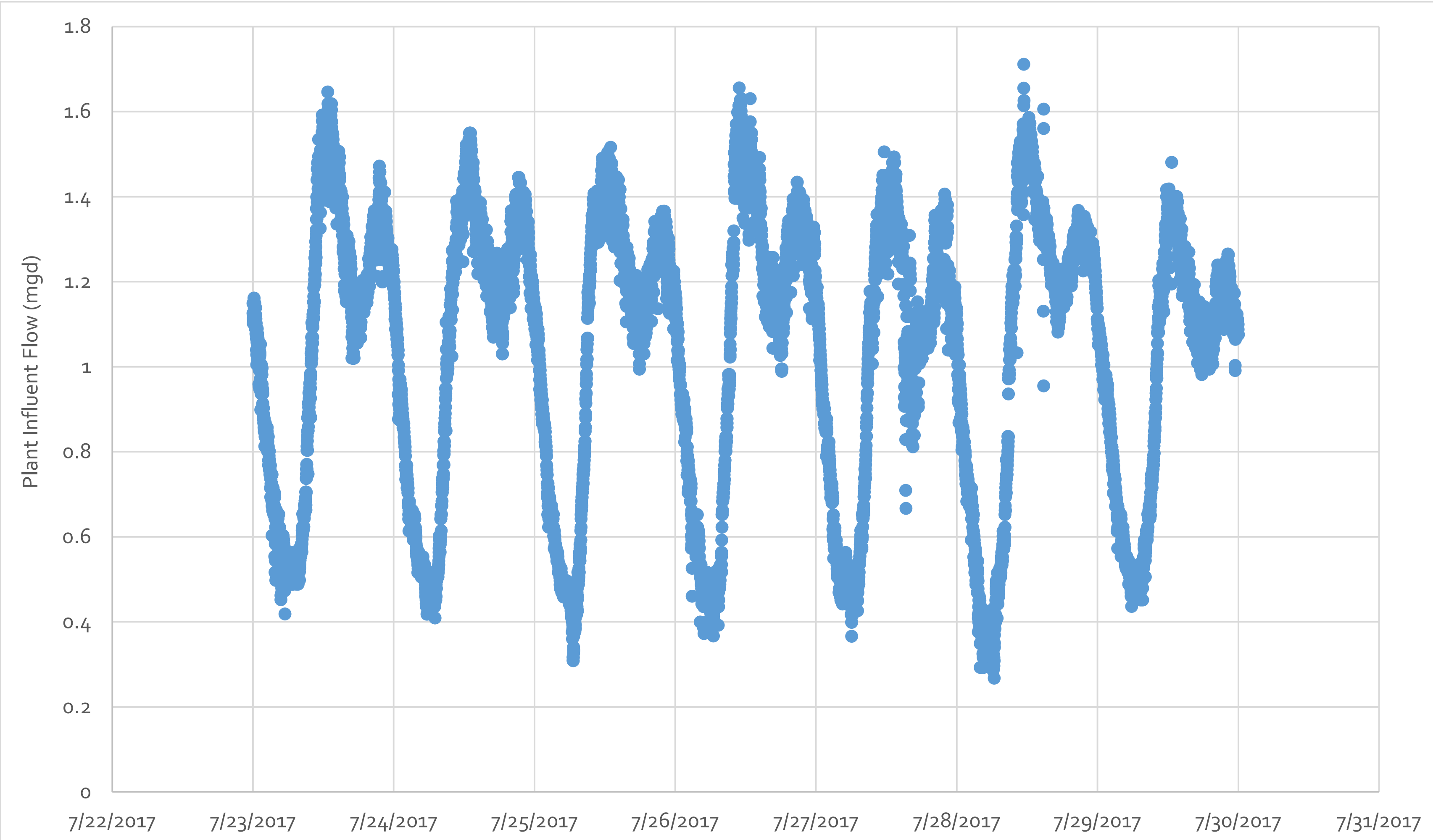

Figure 2.2 Diurnal Flow Variation

Table 2.3 Current Sea Level Elevations for Humboldt Bay

Tidal Datum	Elevation for North Spit Tide Gage (feet, NAVD 88)
Base Flood Elevation (BFE)	10.05
Mean Annual Maximum Water (MAMW)	8.78
Mean Monthly Maximum Water (MMMW)	7.74
Mean Higher High Water (MHHW)	6.85
Mean High Water (MHW)	5.80
Mean Sea Level (MSL)	3.70
Mean Low Water (MLW)	1.25
Mean Lower Low Water (MLLW)	0.00

Source: Humboldt Bay Sea Level Rise Adaptation Planning Project: Phase 2 Report, February 2015.

Table 2.4 Sea Level Rise Projections for Humboldt Bay

Year	Low Estimate (ft)	Projected (ft)	High Estimate (ft)
2030	0.4	0.6	0.9
2050	0.7	1.1	1.9
2100	2.0	3.2	5.3

Source: Humboldt Bay Sea Level Rise Adaptation Planning Project: Phase 2 Report, February 2015.

2.4.3 Updated Process Flow Diagram

The updated flow schematic is shown in Figure 2.3. This schematic is designed to provide for maximum flexibility regarding flow routing.

2.5 Flow Path Scenarios and Hydraulic Profiles

With the proposed flow schematic and hydraulic capacities, seven flow path scenarios were considered. These flow path scenarios are shown in Figure 2.4. From a hydraulic standpoint, a hydraulic profile was developed for a subset of these seven scenarios. The flow paths evaluated included:

2.5.1 Flow Path Scenarios for Hydraulic Analysis

- Dry Weather (Oxidation Ditch First) assuming 2.3 mgd through one oxidation ditch, two secondary clarifiers, and oxidation ponds.
- Dry Weather (Oxidation Pond First) assuming 2.3 mgd through oxidation ponds, one oxidation ditch, and two secondary clarifiers.
- Peak Wet Weather assuming 5.9 mgd total with 2.3 mgd through the oxidation ponds and treatment wetlands (their design capacity) and the remaining 3.6 mgd through one oxidation ditch and two secondary clarifiers.

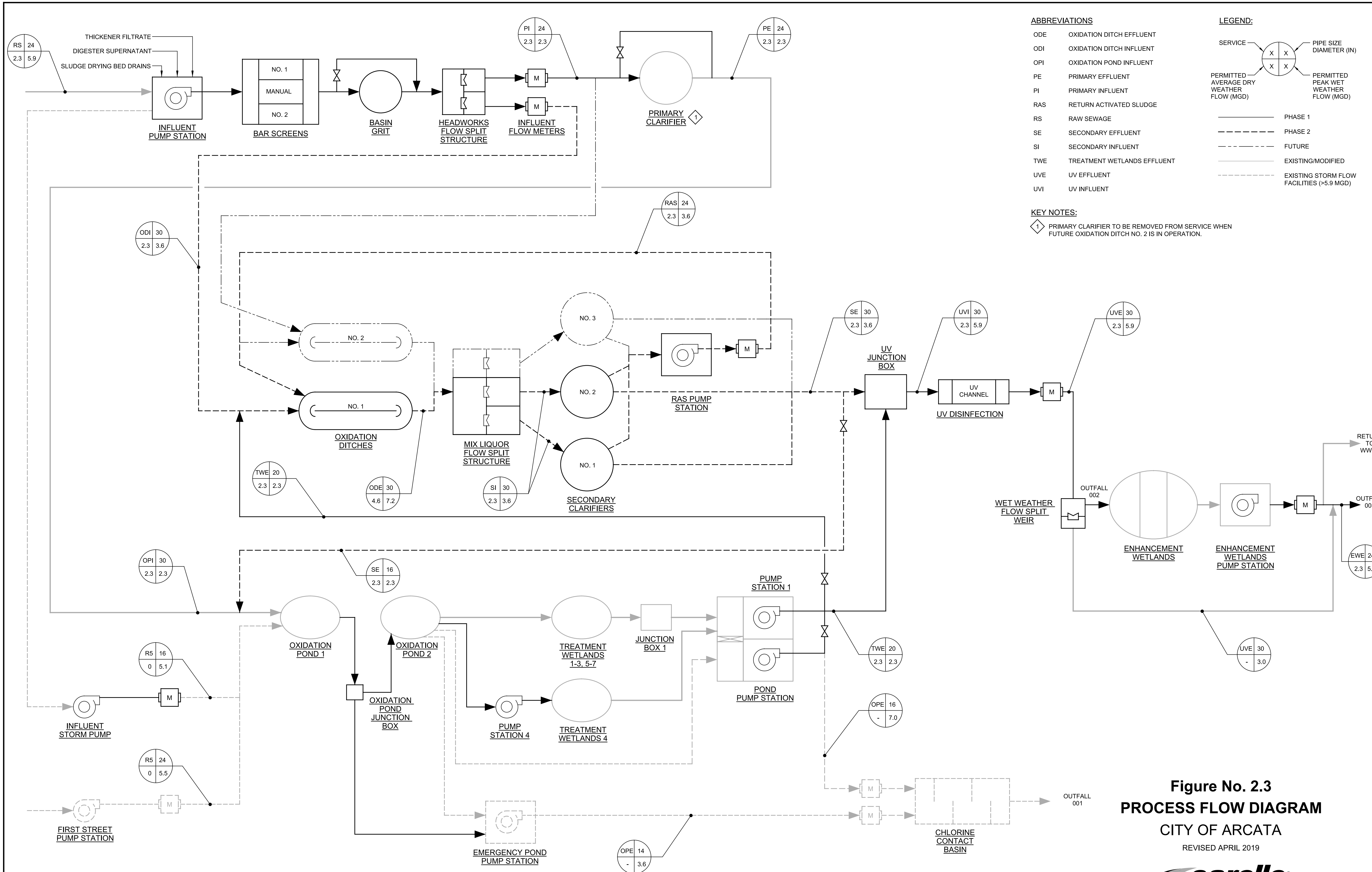

Figure No. 2.3
PROCESS FLOW DIAGRAM
CITY OF ARCATA
REVISED APRIL 2019

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2.5.2 Future Flows

In the future with SLR, it is assumed that the plant flow path is revised to address the loss of the pond and wetland system for treatment. In these scenarios, it is assumed that additional an additional conventional units are added to accommodate the peak wet weather flow. The future flow path scenarios that were evaluated include:

- Future (UV First) assuming 5.9 mgd through two oxidation ditches and three secondary clarifiers. Three variations of this alternative were considered:
  - Gravity flow from the UV structure through the existing pipeline to Outfall 003.
  - Gravity flow from the UV structure through a new pipeline to Outfall 003.
  - Pumped flow from the UV structure through the existing repurposed 30 inch pipeline to Outfall 003.

Of the scenarios modeled, Scenarios 1, 2, and 3 model possible flow paths given current flows. Of these three scenarios, Scenario 3 (Peak Wet Weather) sets the required elevation for the new facilities (Headworks, Oxidation Ditch, Secondary Clarifiers, and UV Facility). The hydraulic profile for Scenario 3 is shown in Figure 2.5. This profile raises the headworks by almost 4.5 feet from its current elevation.

Of the future flow path scenarios modeled, Scenarios 4a, 4b, and 4c model four possible ways to operate the plant. It was found that Scenario 4b or Scenario 4c could operate hydraulically given the elevation set by Scenario 3 (Peak Wet Weather). However Scenario 4a would raise the hydraulic grade line through the plant.

It is recommended that the City more forward with the elevations set by Scenarios 1, 2, 3, and either 4b or 4c to avoid the additional cost of raising the hydraulic grade line through the plant. The conclusions of this TM reflect the hydraulic profile shown in Figure 2.5.

2.6 Recommended Improvements

This section summarizes the recommended hydraulic improvements to allow for the flow path scenarios shown above in Figure 2.4.

2.6.1 Process Structures

The required weir elevations and assumed weir lengths are shown in Table 2.5. These elevations and lengths are based on the Peak Wet Weather hydraulic profile.

As shown in the table, additional weir length is needed at the outlet of Allen and Gearheart Marshes to allow for 5.9 mgd of flow. Additionally, the weir elevations for the Oxidation Pond No. 1 and 2, Allen Marsh, Gearheart Marsh, and Hauser Marsh outlet boxes will need to be adjusted to the elevations shown for high flow scenarios.

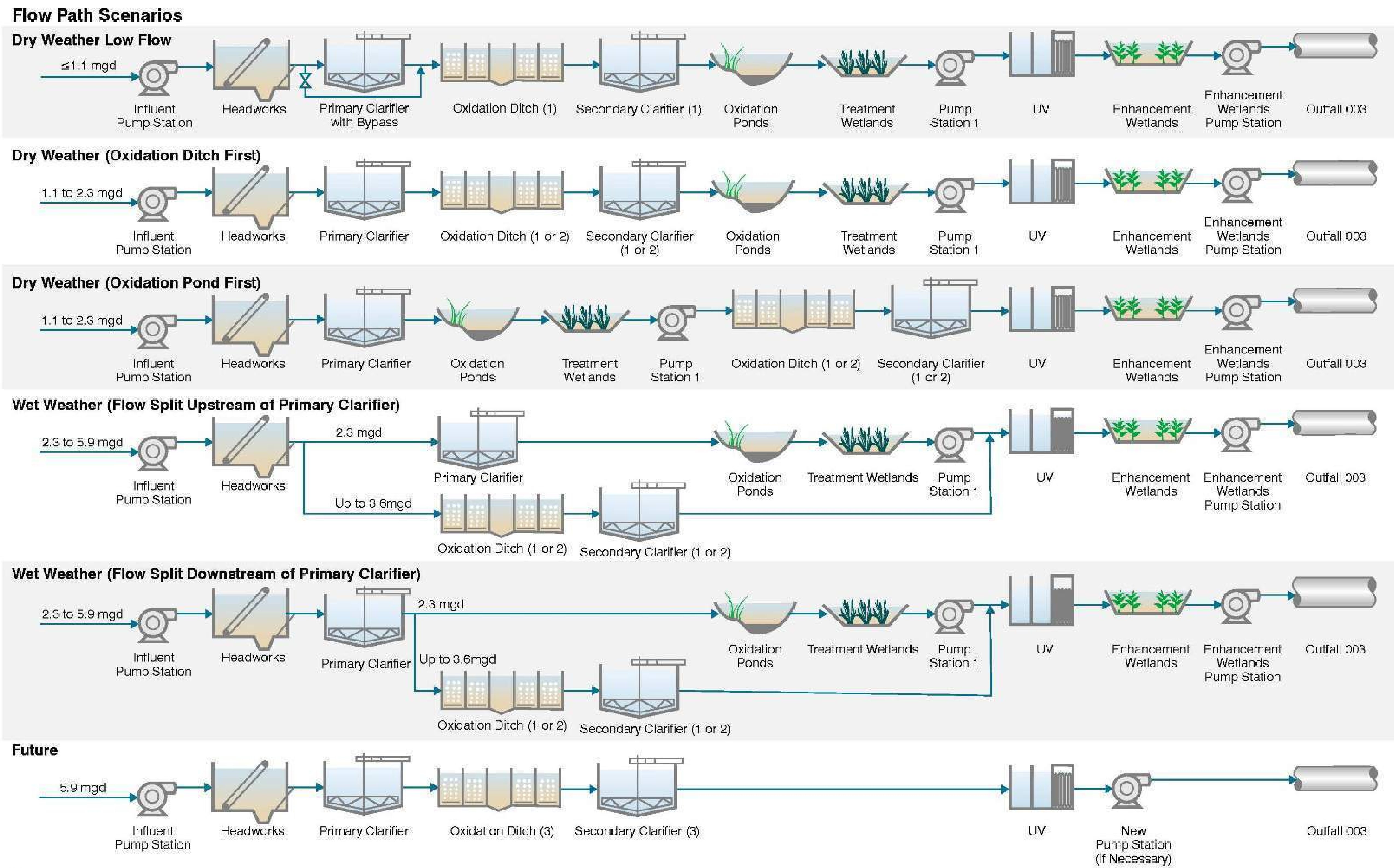
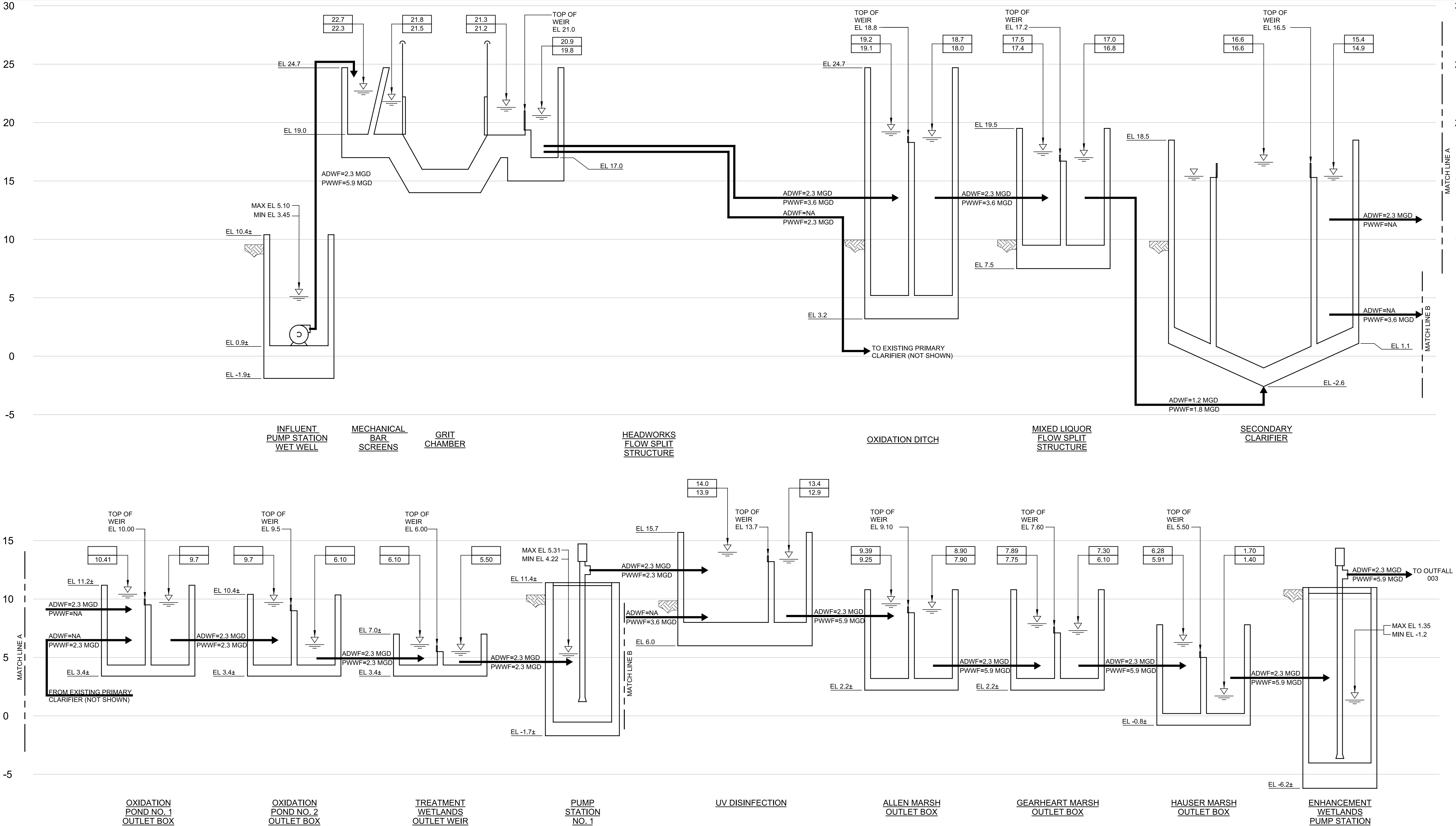


Figure 2.4 Flow Path Scenarios



LEGEND

A
B

WATER SURFACE ELEVATION AT PERMITTED PEAK WET WEATHER FLOW (PWWF)
WATER SURFACE ELEVATION AT PERMITTED AVERAGE DRY WEATHER FLOW (ADWF)

GENERAL NOTES:

1. THE EXISTING GROUND ELEVATIONS ARE APPROXIMATE.
2. THE PIPING ROUTING IS SHOWN SCHEMATICALLY. THE ELEVATIONS OF PIPES ARE NOT SHOWN TO SCALE.
3. ALL ELEVATIONS ARE BASED ON NAVD 88=NAVD 29 + 3.35

Figure No. 2.5
HYDRAULIC PROFILE
CITY OF ARCATA
carollo

Table 2.5 Proposed Weir Elevations and Lengths for Upgraded or New Facilities

Weir	Elevation (ft, NAVD 88)	Number of Weirs	Total Length (ft)
Headworks Flow Split Structure (FSS) Weir	21.0	1 New	12
Oxidation Ditch Weir	18.8	1 New per Oxidation Ditch	12
Mixed Liquor FSS Weir	17.2	1 New per Oxidation Ditch	12
Secondary Clarifier Weir	16.5	1 New per Secondary Clarifier	235(1)
Oxidation Pond No. 1 Outlet Box Weir	10.0(2)	1 Existing	4
Oxidation Pond No. 2 Outlet Box Weir	9.5(3)	1 Existing	2.5
Treatment Wetlands Outlet Box Weir	6.0(4)	3 to 4 Existing per TW	2.5(4)
UV System Finger Weir	13.7	2 New	46(5)
Allen Marsh Outlet Box Weir	9.1(6)	1 New + 1 Existing	18(7)
Gearhart Marsh Inlet Box Weir	7.6(8)	1 New + 1 Existing	18(7)
Hauser Marsh Inlet Box Weir	5.5(9)	1 Existing	4

Notes:
(1) Length based on a 75 foot secondary clarifier
(2) Existing weir is adjustable from 4.35 feet to 10.02 feet. Elevation set so Oxidation Pond 1 has a water surface elevation (WSE) of 10.41 at 2.3 mgd.
(3) Existing weir is adjustable from 7.85 feet to 10.35 feet. Elevation set so Oxidation Pond 2 has a WSE of 9.67 at 2.3 mgd.
(4) Existing weirs are set at an unknown elevation and have an unknown width. A width of 2.5 feet was assumed.
(5) Length based four finger weirs, each 11 foot long and 1 foot wide.
(6) Existing weir is adjustable from 3.35 feet to 10.35 feet. Elevation set so Allen Marsh has a WSE of 9.39 at 5.9 mgd.
(7) Currently one 6 foot weir is installed. One additional 12 foot weir will be needed in the future.
(8) Existing weir is adjustable from 3.35 feet to 10.35 feet. Elevation set so Gearhart Marsh has a WSE of 7.89 at 5.9 mgd.
(9) Existing weir is adjustable from 0.35 feet to 7.35 feet. Elevation set so Hauser Marsh has a WSE of 6.28 at 5.9 mgd.

2.6.2 Piping and Transfer Stations

The hydraulic analysis also determined the pipe diameters required for new piping as well as requirements for upsizing existing piping. Table 2.6 shows the required pipe sizing for current plant flows (new and modified piping) and Table 2.7 shows the additional required pipes for future plant flows. Future required pipes are broken down by scenario.

Table 2.6 Design Criteria for New and Modified Piping to Accommodate Current Flows

New or Modified Pipe Run	Diameter (in)	Velocity at ADWF (ft/s)	Velocity at PWWF (ft/s)
New Pipe Run			
Headworks FSS to Oxidation Ditch	20	0.8 (@1.1 mgd)	2.6 (@ 3.6 mgd)
Oxidation Ditch to ML FSS	24	1.1 (@2.2 mgd) (1)	3.6 (@ 7.2 mgd)(1)
ML FSS to Secondary Clarifiers	24	0.5 (@1.1 mgd) (1)	1.8 (@ 3.6 mgd)(1)
Secondary Clarifiers to Oxidation Pond No. 1	24(2)	0.5 (@1.1 mgd)	1.1 (@ 2.3 mgd)
Secondary Clarifiers to UV Junction Box	24(2)	0.5 (@1.1 mgd)	2.9 (@ 5.9 mgd)
UV Junction Box to UV Inlet	24	0.5 (@1.1 mgd)	2.9 (@ 5.9 mgd)
UV Outlet to Existing EW Pipeline	24	0.5 (@1.1 mgd)	2.9 (@ 5.9 mgd)
Pump Station No. 1 to UV Junction Box	24	0.5 (@1.1 mgd)	1.1 (@2.3 mgd)
Pump Station No. 1 to Oxidation Ditch	16	1.2 (@1.1 mgd)	2.6 (@ 2.3 mgd)
Oxidation Pond No. 2 to TW No. 7	18(3)	0.2 (@0.2 mgd) (4)	0.3 (@ 0.3 mgd)(4)
Oxidation Pond No. 2 to TW No. 4 (Force Main)	18(3)	0.2 (@0.2 mgd) (4)	0.3 (@ 0.3 mgd)(4)
TW No. 5, 6, and 7 to Junction Box No. 1	16	0.6 (@0.5 mgd) (4)	1.1 (@ 1.0 mgd)(4)
EWPS to Outfall 003 (Force Main)(5)	24	0.5 (@1.1 mgd)	2.9 (@ 5.9 mgd)
Modified Pipe Run			
Hauser Marsh to Sump Pump Box at Southern Edge of Hauser Marsh	24	0.5 (@1.1 mgd)	2.9 (@ 5.9 mgd)

Notes:
(1) Assumes 100 percent RAS flow.
(2) Common piping.
(3) Diameter was chosen to match existing pipes from Oxidation Pond No. 2 to other TWs.
(4) Assumes even flow split among the seven TWs.
(5) New pipe connects to the existing force main from the EWPS at the western edge of the Allen Marsh. The new pipe extends to Outfall 003 along the northern edge of Allen Marsh.

Table 2.7 Design Criteria for New Piping to Accommodate Future Flows

New Pipe Run	Diameter (in)	Velocity at Design Flow (ft/s)
Scenario 4b		
UV to Outfall 003(1)	30	1.9 (@5.9 mgd)
Scenario 4c		
UV to Existing Pipe at Outfall 002 (Force Main)(2)	24	2.8 (@5.9 mgd)

Notes:
(1) New pipe would run from the new UV structure, across the Butcher's Slough Bridge, and along the eastern edge of Allen Marsh to Outfall 003.
(2) New pipe extends from UV structure to southern edge of Allen Marsh then connects to existing re-purposed pipe running from southern edge of Allen Marsh to northern edge of Allen Marsh along the eastern edge.

Preliminary pump sizing was also determined through the hydraulic analysis and is shown in Table 2.8.

Table 2.8 Preliminary Pump Sizing

Pump Station	New/ Existing/ Replace Pumps	Design Flow (mgd)	Number of Pumps (Duty+Standby)	Firm Capacity (mgd)	Minimum Flow (mgd)	Required Head (ft)(2)	Speed Control	Pumps To	Pump Type
Liquid Process Facilities									
Influent Pump Station	New	5.9	2+1 @ 2.5 mgd 1 @ 1.0 mgd	5.9	0.5	16	Variable	Headworks	Non-clog submersible, wet pit
Treatment Wetlands 4 Pump	New	0.3	1 @ 0.3 mgd	0.0	0.3	1	Constant	Treatment Wetlands 4	Non-clog submersible, wet pit
Pump Station No. 1 (PS1)	Replace	2.3	2+1 @ 1.2 mgd	2.3	0.5	19	Variable	UV	Non-clog submersible, wet pit
Enhancement Wetland Pump Station (EWPS)	Replace	5.9	2+1 @ 2.0 mgd	4.0	1.0	35(3)	Variable	Outfall 003	Non-clog submersible, wet pit
Stormwater Facilities									
First Street Pump Station	Existing	TBD	1+1 @ 5.5 mgd	5.5	2.8	-	Variable	Oxidation Pond 1	Natural gas driven vertical turbine
Influent Storm Pump	Replace	5.0	1 @ 5.0 mgd	0.0	2.5	-	Variable	Oxidation Pond 1	Diesel driven self-priming centrifugal
Pond Pump Station (PPS)	Replace	8.4(1)	2+1 @ 3.5 mgd	7.0	1.8	18	Variable	Chlorine Contact Basin	Non-clog submersible, wet pit
Emergency Pond Pump Station (EPPS)	Existing	5.8(1)	2 @ 3.6 mgd	0.0	3.6	30	Constant	Chlorine Contact Basin	Self-priming centrifugal
Solids Handling Facilities									
Primary Sludge Pump Station	New	0.07	1+1 @ 50 gpm	50 gpm	50 gpm	20	Constant	Primary Digester	Progressive cavity, dry pit
Primary Scum Pumps	New	0.07	1+1 @ 50 gpm	50 gpm	50 gpm	20	Constant	Primary Digester	Chopper, dry pit
RAS Pump Station	New	3.6	2+1 @ 1.8 mgd	3.6	0.9	5.5	Variable	Oxidation Ditch	Non-clog horizontal centrifugal, dry pit
WAS Pump Station	New	0.14	1+1 @ 100 gpm	100 gpm	50 gpm	8	Variable	Thickener	Non-clog horizontal centrifugal, dry pit
TWAS Pump Station	New							Primary Digester	Progressive cavity, dry pit
Secondary Scum Pumps	New	0.07	1+1 @ 50 gpm per Secondary Clarifier	50 gpm	50 gpm	20	Constant	Primary Digester	Progressive cavity, dry pit

Notes:
(1) Pumping capacity for the maximum instantaneous flow of 16.5 mgd during wet weather was split between the PPS and the EPPS (excluding 2.3 mgd that is pumped from PS1). Both of these pump stations can pump directly out of Oxidation Pond No. 2.
(2) The listed required heads are preliminary and will be refined during final design.
(3) This assumes the EWPS is pumping to Outfall 003 only.

Appendix C

TM 3 HEADWORKS AND PRIMARY CLARIFIER REPLACEMENT

City of Arcata
Wastewater Treatment Facilities Improvements

Technical Memorandum 3
HEADWORKS AND PRIMARY CLARIFIER REPLACEMENT

FINAL | April 2019

City of Arcata

Wastewater Treatment Facilities Improvements

TECHNICAL MEMORANDUM 3

HEADWORKS AND PRIMARY CLARIFIER REPLACEMENT

FINAL | April 2019

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STATE OF CALIFORNIA

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Abbreviations

AWTF	Arcata Wastewater Treatment Facility
Carollo	Carollo Engineers, Inc.
CCB	chlorine contact basin
ft	feet
fps	feet per second
gpd	gallons per day
gpm	gallons per minute
in	inches
LF	linear feet
mgd	million gallons per day
ppd	pounds per day
PS	pump station
SF	square feet
TM	technical memorandum
UV	Ultraviolet
VFD	variable frequency drive
WWTP	wastewater treatment plant

Technical Memorandum 3

HEADWORKS AND PRIMARY CLARIFIER REPLACEMENT

3.1 Purpose

The purpose of this Technical Memorandum (TM) is to establish preliminary design criteria, identify main components, and develop conceptual layouts for a new headworks, influent pump station, and primary clarifier rehabilitation at the City of Arcata (City) Wastewater Treatment Facility (AWTF).

This includes selection and sizing of the new influent pumps, new bar screens, and new grit removal system for the replacement headworks and developing design criteria for all support facilities including screening conveyance, grit pumping, and screenings and grit handling. New influent flow meters will be selected, including flow meter type, size, and configuration. This TM will also outline the proposed improvements for primary clarifier rehabilitation along with primary sludge and scum pumping replacement.

3.2 Summary of Findings and Recommendations

The key findings and recommendations of this TM are summarized below:

3.2.1 Headworks

- The new influent pump station and headworks will be sized for a design peak wet weather flow of 5.9 million gallons per day (mgd), an average dry weather flow of 1.1 mgd, and a minimum hour flow of 0.3 mgd.
- The new influent pump station and headworks will be located on the site of the existing influent pump station and headworks.
- The new influent pump station will utilize four non-clog submersible pumps. Three pumps will be sized for 2.5 mgd each with two duty and one standby. One pump will be sized for 1.0 mgd for low flows.
- Influent screening will be located downstream of the influent pump station. Three channels will be provided, two channels will be equipped with mechanically cleaned bar screens, and a third bypass channel will be equipped with a manually cleaned bar screen.
- The mechanically cleaned bar screens will be multi-rake moving media screens with a bar rack spacing of 3/8-inch. A shaftless screw conveyor will convey raw screenings to washer/compactor units located above a bin for disposal.
- The grit basin will be located downstream of the screens. Mechanically induced vortex grit basins with sloped bottoms will be used for grit removal. One 12-foot diameter basin will be provided with a bypass. Two recessed impeller pumps (one duty and one standby) will be used to convey grit from the vortex grit basin to a grit dewatering unit. A cyclone/classifier will be used to dewater grit.

- A fixed weir flow split structure will be located downstream of the grit basins to split flow to the primary clarifier and the oxidation ditch. Magnetic flow meters will measure the flow rates out of the headworks to the primary clarifier and to the oxidation ditch.

3.2.2 Primary Clarifier

- Existing Primary Clarifier No. 1 will be demolished.
- Existing Primary Clarifier No. 2 will be used to settle solids upstream of the oxidation ponds, when bypassing the oxidation ditch, for flows up to 2.3 mgd.
- Primary clarifier rehabilitation will include as needed concrete repair, FRP baffle and weir repairs, and replacing the handrail. A new scum chopper pump will replace the existing scum pump and will provide mixing, decant, and scum transfer in the scum collection well.
- Primary clarifier mechanism will require further evaluation to determine if replacing the mechanism is feasible in lieu of repairing, blasting and recoating the clarifier mechanism.
- New primary sludge pumps will replace the existing sludge pumps with duty and standby progressing cavity sludge pumps to convey primary solids to the digesters or to the new thickener.

3.3 Background

This section includes a brief summary of the existing influent pumps, headworks, and primary clarifier facilities.

3.3.1 Existing Influent Pump Station and Headworks

The existing influent pump station and headworks facility provides 5.0 mgd of capacity of pumping, screening, and grit removal of raw sewage. The facility is comprised of the following:

- Two 2.5-mgd screw pumps with 10 hp motors.
- Two 5.0-mgd mechanically-cleaned bar screens that drop screenings into a single belt conveyor for transport to a roll-off bin.
- One Parshall flume for flow metering.
- One gravity tangential flow type grit removal system including a horizontal-flow grit chamber with grit pumping and grit classification.

Influent flows greater than the 5.0-mgd headworks capacity bypass both the headworks facility and primary clarifiers and are pumped, via the First Street Pump Station (located offsite) and the Influent Storm Pump (located at the Headworks), directly to the oxidation ponds. These pumps provide peak wet weather flow capacity and redundancy for the influent screw pumps.

The influent pump station and headworks were constructed in the 1984 Wastewater Treatment Plant Modifications project (CH2M HILL, 1984). Overall, the headworks is in need of a major upgrade due to the condition of the equipment, which is approximately 30 years old and rated as poor.

3.3.2 Existing Primary Clarifiers

The primary treatment facilities consist of two primary clarifiers, with a total treatment capacity of 5.0 mgd. Flow from the headworks is split to the primary clarifiers after grit removal.

- Clarifier No. 1 has a 26-foot diameter, with a side water depth of 9 feet, and a design treatment capacity of 1.0 mgd. It is fed by a 12-inch diameter influent pipeline.
- Clarifier No. 2 has a 60-foot diameter, with a side water depth of 12 feet, and a design treatment capacity of 4.0 mgd. It is fed by a 24-inch diameter influent pipeline.

The clarifiers are center-feed, peripheral-withdrawal type clarifiers. In the clarifiers, suspended solids gradually settle to the bottom of the tanks as primary sludge. Mechanical scrapers collect settled sludge and skimmer arms collect floatable scum in the primary clarifiers. Three primary sludge pumps pump solids from the bottom of the primary clarifiers to the primary anaerobic digester. Scum collected on the surface of the primary clarifiers passes through a liquid/solid separator and the scum solids are transferred to a roll-off bin for disposal.

Generally, Clarifier No. 2 is used continuously and Clarifier No. 1 is used intermittently for peak wet weather flows. The units seem sufficient for the design flows, although the peak loading rates may result in reduced performance. The Clarifier No. 1 structure appears to have been built around 1957 based on records provided by the City that indicate piles for the structure were driven around that time. Clarifier No. 2 was added later, although the date is unknown. Both units are shown in drawings dated 1971. The condition of both units is poor to very poor based on the age, concrete corrosion and cracking of the effluent launders. The walkways and handrail on Clarifier No. 1 do not meet current codes for worker safety. The interior coating on both units has failed and exposed the concrete to sulfide corrosion at the water surface.

Repairs have been made to the Primary Clarifier No. 2 clarifier mechanism and the remaining metal structure may not be able to be further repaired. The Primary Clarifier No. 2 clarifier mechanism should be further evaluated for replacement or rehabilitation.

3.4 Design Influent Flows and Loads

The influent flows used for the basis of design for the new influent pump station, headworks, and primary clarifier processes are presented in Table 3.1. The influent loads used for the basis of design are presented in Table 3.2. During wet weather, flows greater than 5.9 mgd will bypass the headworks and be pumped directly to Oxidation Pond No. 1.

Table 3.1 Design Influent Flows

	Current (mgd)	Future (mgd)	Permitted (mgd)
Minimum Flow	0.3 (1)	0.3 (1)	-
Average Dry Weather Flow	1.1 (2)	1.3 (3)	2.3 (4)
Peak Dry Weather Flow	1.8 (5)	2.2 (6)	-
Maximum Month Flow	3.0 (7)	3.6 (8)	5.0 (9)
Peak Wet Weather Flow	5.9 (4)	5.9 (4)	5.9 (4)

Notes:
(1) Based on City diurnal flow data from 7/23/17 through 7/30/17.
(2) 50th percentile flow during dry weather using City data from 2003 to 2015.
(3) Current Average Dry Weather Flow plus 20 percent growth.
(4) Existing permit capacity.
(5) Diurnal peaking factor of 1.6 multiplied by Average Dry Weather Flow. Peaking factor based on City diurnal flow data from 7/23/17 through 7/30/17.
(6) Current Peak Dry Weather Flow plus 20 percent growth.
(7) 92nd percentile flow using City data from 2003 to 2015.
(8) Current Maximum Month Flow plus 20 percent growth.
(9) Existing permitted Average Wet Weather Design Flow.

Table 3.2 Design Influent Loads

	Current (lb/d)	Future (lb/d)
BOD	4,000 (1)	4,800 (2)
TSS	5,760 (1)	6,910 (2)

Notes:
(1) 90th percentile load using City data from 2003 to 2015.
(2) 90th percentile load using City data from 2003 to 2015 plus 20 percent for growth.

3.5 Influent Pump Station Alternatives

Influent pumping is required to hydraulically lift the wastewater from the relatively deep influent gravity sewer and wet well up to the proposed screens and grit removal system in the headworks. Effluent flow from the headworks can then flows by gravity through both the primary clarifier, oxidation ponds, and treatment wetlands, and the oxidation ditch, secondary clarifiers, UV disinfection system, enhancement wetlands, and into the Enhancement Wetlands Pump Station.

There are several alternatives for the proposed influent pump station. The alternatives will be reviewed in this section. The influent pump station will be designed to pump flows of up to 5.9 mgd into the headworks. The pump station will be a wet well type, not a dry pit type, due to the space constraints and depth of the existing wet well. Screw pumps and submersible pumps were evaluated for the new influent pump station as well as the pump arrangement.

3.5.1 Screw Pumps

Screw pumps would match the existing influent pumps. An advantage of screw pumps is that they are reliable and relatively simple to maintain. They are also able to move larger solids than other types of pumps. Screw pumps can utilize a smaller wet well since screw pumps will continue to operate regardless of the water level or flow conditions in the wet well. However the screw pumps require a large footprint due to the size of the torque tube and flights and the required support structure. The larger footprint of the pumps means that likely only two screw pumps can fit on the site, which will reduce the redundant pumping capacity unless each pump can be sized for 5.9 mgd.

3.5.2 Submersible Pumps

Submersible non-clog pumps are another proven technology used in many wastewater treatment applications for pumping raw sewage. Submersible pumps offer a smaller footprint and lower capital costs than screw pumps. This low cost compared to screw pumps is due to the reduced size of the pumps and support structure required for the pumps. Their small size also allows several configurations of pump sizes and wet well layouts. Submersible pumps do require a minimum submergence that is deeper than screw pumps as well as flow conditioning to reduce turbulence into the pumps. Regular inspection and monitoring of this type of pump would require the provision of a lift or crane to pull the entire pump out of the wet well.

3.5.3 Recommendations

The two aspects of this project that are critical for equipment and process selection are footprint and capital costs. Submersible pumps are recommended because they allow for a smaller area for the influent pumping station and lower capital costs than screw pumps.

Submersible pumps can be laid out in a variety of pump capacities and configurations. The influent pump station submersible pump configuration alternatives evaluated are presented in Table 3.3.

Table 3.3 Influent Pump Station Configuration

Configuration	Firm Capacity(1) mgd	Total Capacity(2) mgd	Minimum Capacity(3) mgd	Cost	Comments
2+1 @ 2.0 mgd each	4.0	6.0	1.0	$	Lowest cost, but firm capacity less than design capacity
2+1 @ 3.0 mgd each	6.0	9.0	1.5	$$	Low cost, but not capable of low flow pumping
2+1 @ 2.5 mgd , 1 @ 1.0 mgd	6.0	8.5	0.5	$$$	Good balance of capacity range and cost
1+1 @ 4.0 mgd , 2 @ 1.0 mgd	6.0	10.0	0.5	$$$$	Highest total capacity, but highest cost

Notes:
(1) Capacity with one of the largest units out of service.
(2) Capacity with all units in service.
(3) 50 percent capacity of smallest unit.

A pump station layout utilizing three 2.5-mgd pumps and one 1.0-mgd pump is recommended. This configuration will provide full capacity during peak flows with one unit out of service and the 1.0 mgd can be used for low diurnal flows.

For the 2.5-mgd pumps, the manufacturer claims that pumps can turn down to less than 1.0 mgd, however we typically assume about 60 percent to 50 percent turndown of the rated capacity, so an expected turn down to about 1.3 mgd. Since there is only one 1.0-mgd, low flow pump and it will be used frequently for diurnal flows, an additional low flow pump can be stored on site as a standby. All the pumps are on rails and can be pulled and replaced with a davit crane/monorail crane.

The new influent pump station design will need to account for constructability of the new pump station with respect to keeping in operation the influent sewer and Influent Storm Pump Station. A portion of the existing wet well will be incorporated into the new influent pump station to minimize construction impacts to existing facilities and influent sewer pipeline. It is assumed that the Influent Storm Pump Station will be utilized to bypass the headworks during construction.

3.5.4 Pump Control

Control of the influent pumps would be based on wet well level control. Variable frequency drives (VFDs) will be utilized on the pumps to reduce the number of starts and stops for each pump and to turn down pumps during low flow. The VFDs also allow for the pumps to operate more efficiently by reducing the power demand at low flows. The VFDs and controls for the pumps will likely be installed in MCC-A located in the existing Electrical Building.

3.6 Influent Headworks Alternatives

The purpose of the headworks is to remove inorganics from the wastewater and to protect and reduce wear on the downstream process equipment. The headworks will be designed to accommodate the flows presented in Table 3.1. The facility will be designed to meet the current minimum flow conditions as well as projected average dry weather and peak wet weather flows.

There are several equipment selection alternatives for the proposed headworks facilities, including the choice of screens, washer/compactor, grit removal, grit washing and separation, and hydraulic design. The various alternatives will be reviewed in this section and the recommended alternatives presented.

3.6.1 Influent Screening

The purpose of influent screens is to remove rags, sticks, and other large objects from the influent wastewater. Effective screening will help prevent clogging of pumps and pipelines, prevent buildup of rags on mechanical equipment such as mixers and sludge collection mechanisms, reduce accumulation of materials in downstream channels, and otherwise reduce regular maintenance for processes downstream of the headworks.

3.6.1.1 Screen Opening Size

Selecting an opening size is important in establishing the design criteria for the screenings facilities. Screen opening size impacts screenings removal efficiency, dictates the size of screens, and affects plant hydraulics. In addition, screenings handling equipment needs to be sized to match the anticipated removal efficiency of the screen.

Course and fine screens are available depending on the degree of removal desired. Course screens generally have openings greater than 1/2-inch, whereas fine screens have openings less than a 1/2-inch. Course screens will allow more rags and solids to pass through. Smaller opening sizes, or closer bar spacing, will remove more solids and provide greater protection for downstream equipment. Potential reductions in maintenance provided by the screens include reduced ragging of downstream influent pumps, primary sludge pumps and digester mixing pumps. Removing inert material at the headworks reduces the buildup of this material in the digesters, reducing the frequency of digester cleaning. The removal of plastic material from the solids stream will improve the quality of biosolids for reuse.

Fine screens are recommended to remove as much of the rags and large particulates as possible to protect downstream equipment. The two most frequently utilized bar screen opening sizes used are 3/8 inch and 1/4 inch. Since the new screens are downstream of the pumps the smaller, 1/4-inch screens may work well since the pumps will create a well-mixed influent and provide come chopping of larger inorganics. However, for the new screens it is recommended that the larger, 3/8-inch bar spacing be used because this size will effectively remove most plastics and rags that can cause plugging problems but requires less headloss upstream compared to 1/4-inch bar spacing.

3.6.1.2 Channel and Clear Screen Velocity

The velocity in the channel approaching the screens should be a minimum of 2.0 feet per second (fps) at average flows. Lower velocities will cause settling in the approach channel. Channel aeration may be added to the approach channel of each screen to provide agitation and resuspend any grit that settles out. Channel aeration should be further reviewed in final design.

The velocity through openings or between bars is called the clear screen velocity and is the primary criteria used to determine the number of screens required. Recommended values range between 2.0 to 5.0 fps. For the proposed screening facility it is recommended that a clear screen velocity of 2.0 to 3.0 fps at average flows and 4.0 fps at peak hour flows be used. These velocities will provide efficient removal of screenings and limit the amount of solids that can settle. The velocity between bars at 30 percent binding should be limited to 6.0 fps.

3.6.1.3 Screening Technology Alternatives

To select the best available technology for the headworks facility, a number of screening technologies were initially evaluated including perforated plate screens, band screens, step screens, and screens that utilize bar racks. It was decided that perforated plate screens, band screens, and step screens would not be considered further because all three types of screens feature lighter duty construction than screens that utilize bar racks and have more submerged moving parts and consequently increased O&M requirements.

The three types of screens that utilize bar racks that evaluated are:

- Climber screens.
- Chain driven multi-rake screens.
- Link driven multi-rake screens.

Climber Screens

Figure 3.1 shows a typical climber bar screen. Climber screens have a reciprocating rake mechanism that maintains all drive components out of the flow stream under normal operating conditions. When a cleaning cycle is initiated, the cogwheels, housed in the frame of the bar screen, move down stationary pin racks, also housed in the frame. The drive assembly descends from its stopped position with the rake arm extended. When the cogwheels reach the bottom, they rotate around the bottom of the pin rack, engaging the rake teeth with the bar rack. As the cogwheels walk back up the pin racks, the screenings are carried out of the wastewater flow and are discharged into screenings conveyance equipment or bins located behind the bar screen. The involute gear and pin rack system is a proven and reliable system with many successful installations.

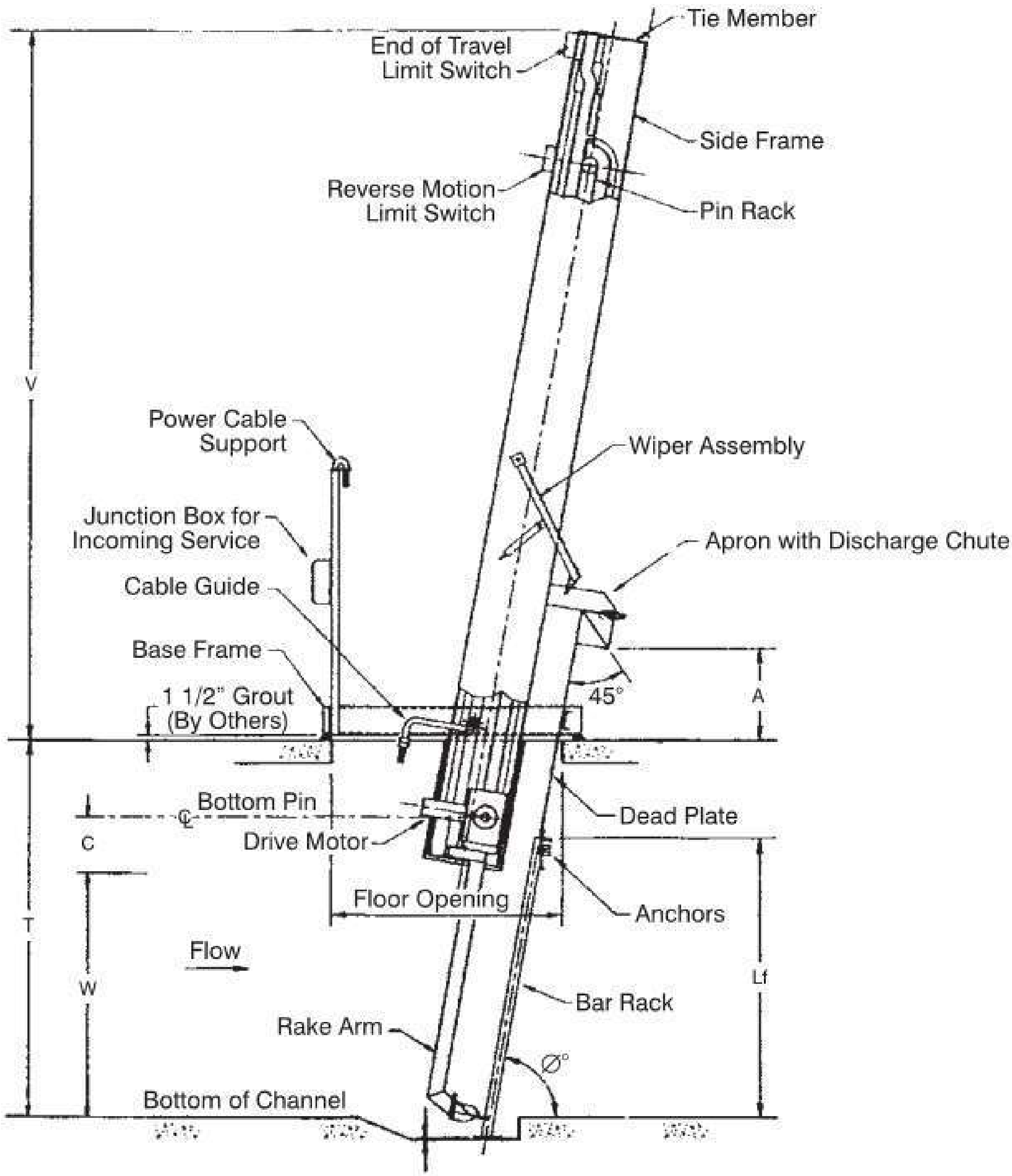
The overall height of a climber-type bar screen is determined by both the channel depth and the height of the discharge point above the operating floor. This can result in screens that are tall and more difficult to maintain. Some options to minimize the height of climber screens are to specify motors or motor housings that allow the drive to be submerged and to minimize the height of the discharge point.

The minimum recommended bar spacing for climber screens is 3/8 inch. At spacing below this dimension, the rake may experience difficulty engaging the bar rack and the rake teeth may be damaged.

Chain Driven Multi-Rake Screens

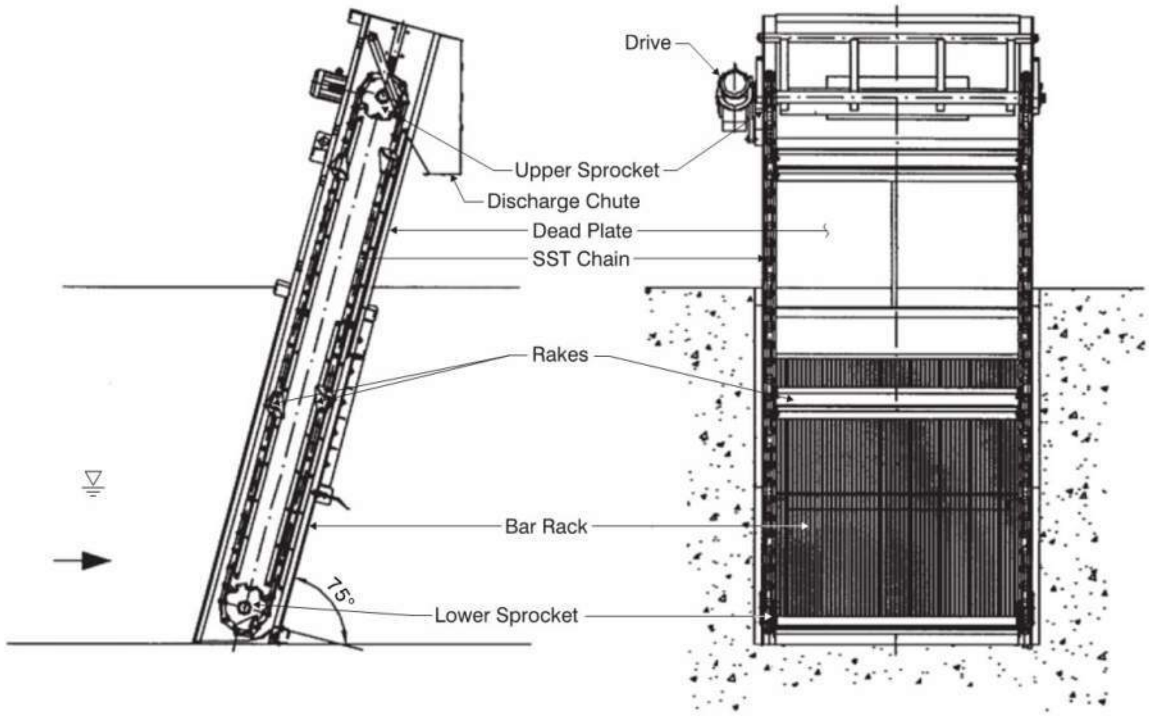
Heavy duty chain driven multi-rake screens are presented in Figure 3.2. These screens are chain-and-sprocket-type bar screens with multiple rake bars mounted onto chains on both sides of a self-contained frame. The two manufacturers we would recommend use a design with a lower sprocket assembly located in a recess at the bottom of the frame. The bearings for the lower sprockets are made of self-lubricating polyethylene material with a ceramic collar bonded onto the sprocket stub shaft. The all stainless steel chains are roller type, water lubricated, and designed for continuous submerged duty.

The screens are configured so the rakes clean and return in front of the bar rack to prevent carry over of material to the downstream channel. A two-speed drive can be provided so that raking speed can be increased to accommodate high flows or high volumes of screenings in the influent flow stream. The features of this type of screen make it capable of accommodating smaller bar rack spacing (down to 1/4 inch) than climber screens.

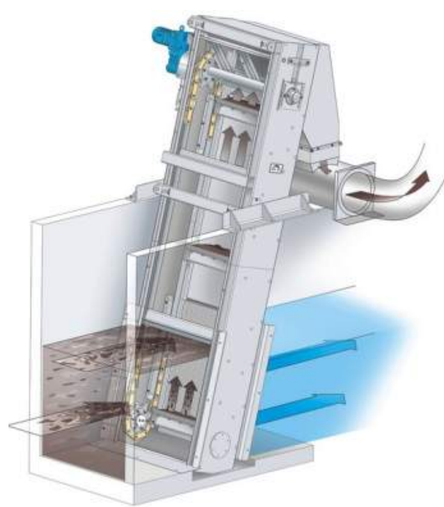


Source: Infilco Degremont

Figure 3.1 Climber Screen



Source: Headworks, Inc.

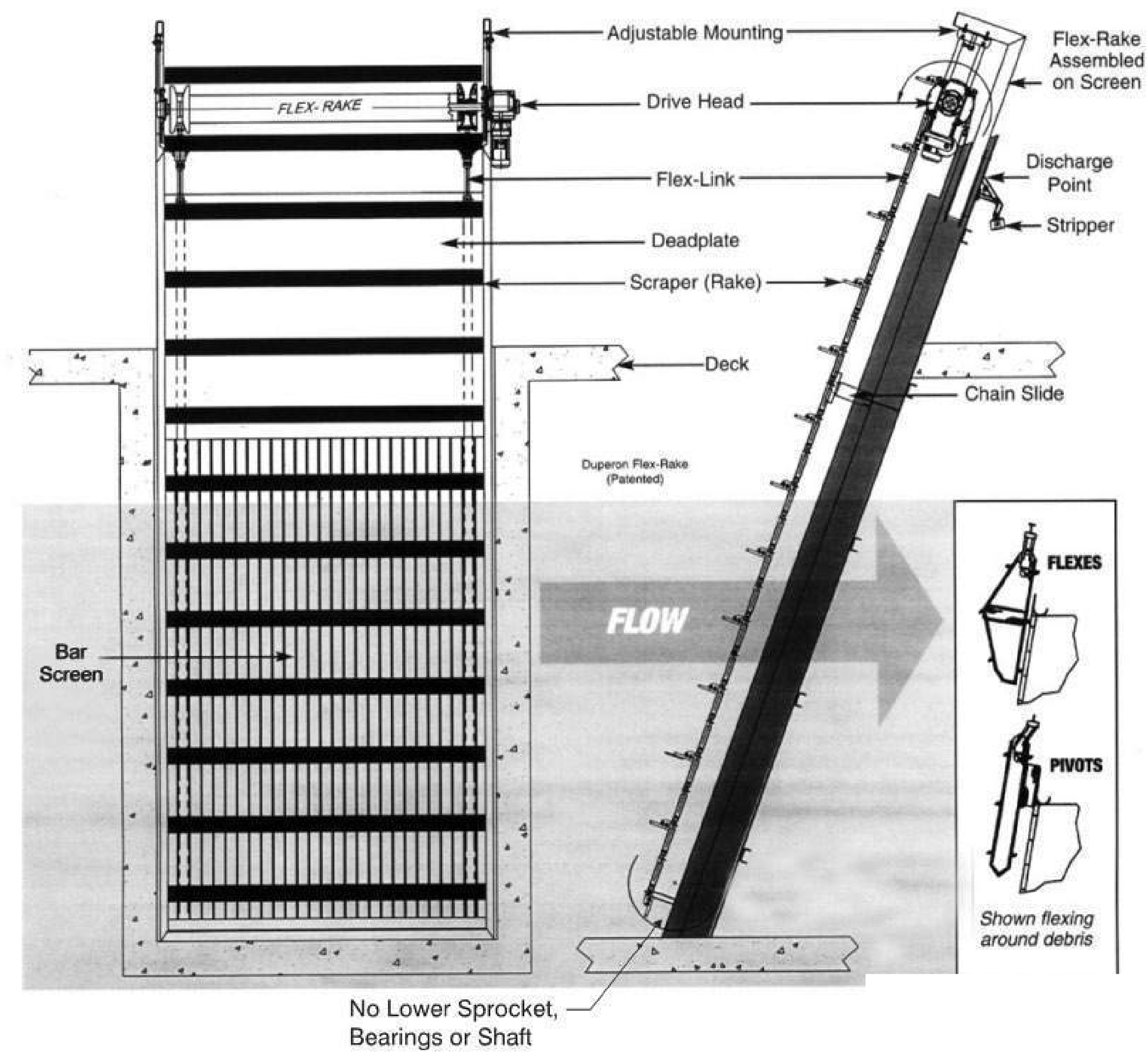


Source: Huber

Figure 3.2 Chain Driven Multi-Rake Screen

Link Driven Multi-Rake Screens

Link driven multi-rake screens considered for this project are manufactured by a single manufacturer, Duperon. Figure 3.3 shows a typical Duperon FlexRake screen. Similar to chain driven multi-rake screens, this type of screen is also a front raked, front return type screen with multiple rake bars mounted onto chains on both sides of the channel. However, there are no lower sprockets and the parallel chains serve as their own frame. The chains are constructed from 316 stainless steel castings that form a bar-like chain that bends in only one direction, providing both flexibility and rigidity.



Source: Duperon

Figure 3.3 Duperon Flex-Rake Screen

3.6.1.4 Screenings Technology Alternative Comparison

The proposed headworks layout will accommodate any of the three screening alternatives. Table 3.4 summarizes the key advantages and disadvantages associated with each screenings technology alternative. Note that at a planning level, the relative costs difference between the screenings technologies is not significant.

Table 3.4 Comparison of Screening Technology Alternatives

Alternative	Advantages	Disadvantages
Climber Screens	• No submerged moving parts. • Proven and reliable technology. • Maintenance can be performed above deck level so channel entry is not necessary.	• Height of equipment above discharge point makes maintenance more difficult. • Minimum size 3/8 inch openings.
Chain Driven Multi-Rake Screens	• Multiple rakes and continuous operation facilitate frequent cleaning passes and rapid screenings removal. • Can reverse directions several times to clear obstructions. • Reduced height of equipment above discharge point compared to climber screens. • Two-speed drive improves removal rates at peak flows.	• Permanently submerged moving parts (chains and sprockets). • Maintenance of chain and bottom sprockets requires channel access.
Link Driven Multi-Rake Screens	• No frame, underwater sprockets, bearings, or shafts. • Multiple rakes and continuous operation facilitate frequent cleaning passes and rapid screenings removal. • Reduced height of equipment above discharge point compared to climber screens. • Maintenance can be performed from deck level by pulling chains out of channel.	• Fewer number of installations compared to other screen technologies. • Sole source procurement is required.

The use of chain driven multi-rake screens for the new headworks is recommended for the following reasons:

- Multiple rakes and adjustable rake speed allow the rakes to respond more rapidly to high screening loading events than a climber screen.
- The screen can be retrofitted with relative ease to provide 1/4-inch bar screen spacing should the City decide to enhance screening removal in the future whereas the minimum recommended bar screen spacing for climber screens is 3/8 inch.
- The link driven multi-rake screen has limited operating experience in wastewater applications and can only be provided by a single manufacturer.

3.6.2 Screening Washing and Compaction

The screens will remove organic matter in addition to rags, plastic debris, and inert material. By washing the screenings, the organic matter can be separated from the inert materials before compaction and disposal and washed back into the wastewater stream. Lowering the organic content of the screenings will reduce odor generation, improve dewatering, and reduce the weight, volume, and cost of materials hauled.

Following the screenings washer, a compactor will be provided to compress and dewater the washed screenings prior to discharge to a roll-off type dumpster bin. The screen can be totally enclosed and the flow channels to and from the screens can be covered to control odors and minimize the quantity of foul air.

Screenings washing and compaction can be accomplished in a single washer/compactor unit. These units wash out the organic matter and dewater the washed screenings by compaction. Washer/compactors are available from several manufacturers and two basic types of units are available; washer/compactors with water sprays and washer/compactors with agitators. Figure 3.4 shows both typical washer/compactors with water sprays and with agitators.

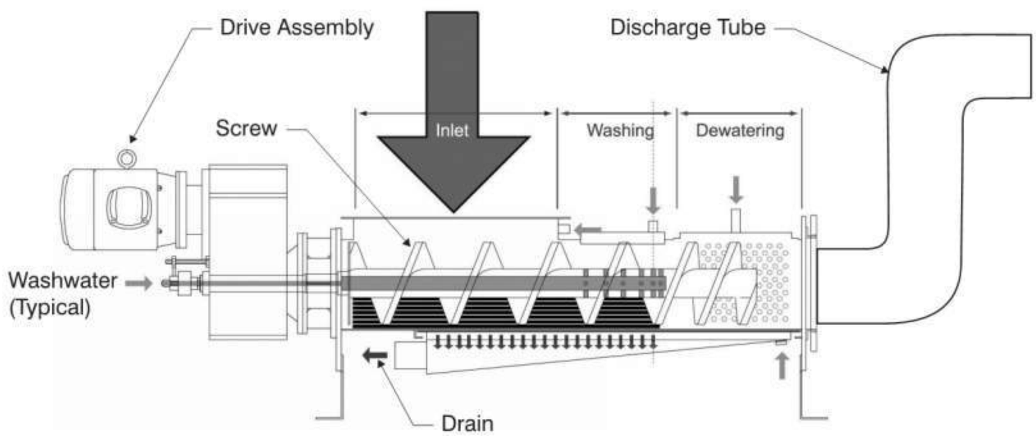
Dewatering of washed screenings in both types of units is accomplished with a screw compactor. A typical unit consists of a motor driven shafted or shaftless helical screw auger, a loading hopper, and discharge tube. Turning the auger pushes the wet screenings material from the loading hopper into the discharge tube, which is tapered for a short length. The reduction in the discharge tube diameter causes a squeezing action that removes the free water from the screenings material. The water drains out of the unit through a perforated screen in the bottom and is returned to the headworks for further treatment.

Washer/compactors that use water sprays typically apply high pressure utility water to the sides of the compactor loading hopper and to the washing zone of the compaction unit. Some units also spray water from the center shaft of the auger. Water sprays have limited success in breaking up organic matter unless the washer unit also conducts batch washing process where the auger cycles backward and forward a number of times to break the organic material apart. This type of equipment is capable of producing dewatered screenings material with a solids content of 30 to 40 percent.

Washer/compactors with in-tank agitators use mechanical agitation and a large volume of water to wash screenings. The loading hopper is first flooded with water in a batch process. The agitator breaks up the organic matter so that it can be carried out of the machine with the wash water through a fine perforated screen. The cleaned screenings material is then dewatered and discharged. Some of the more successful units are capable of reducing the weight and the volume of the raw screening by 50 to 80 percent and achieve solids content in excess of 40 percent.

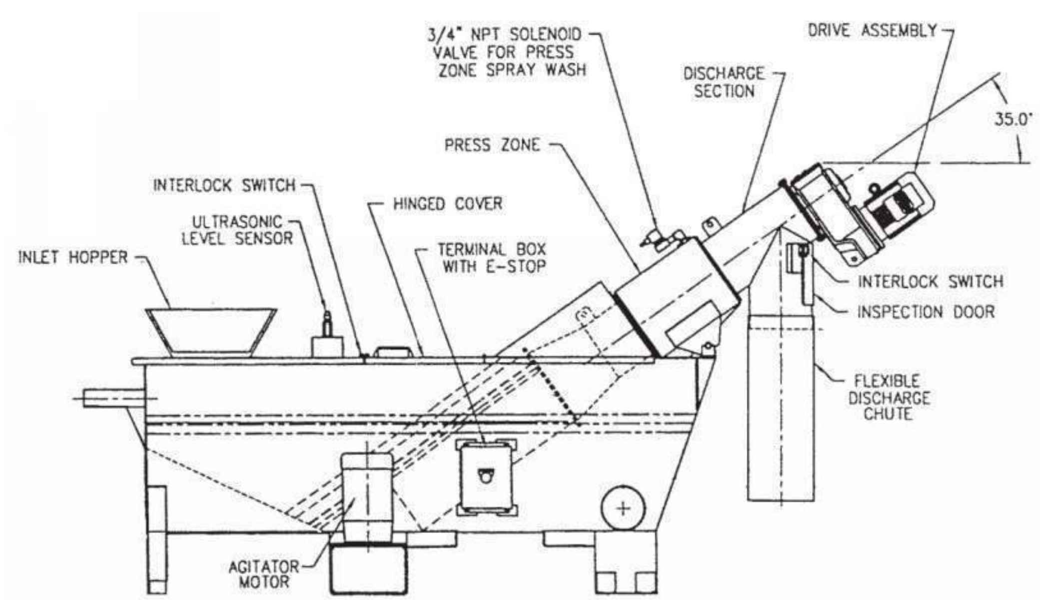
Table 3.5 summarizes the key elements, advantages, and disadvantages associated with both types of washer/compactors.

We recommend the use of a washer/compactor with water sprays that can operate in a batch washing mode. For a 3/8-inch bar screen, a unit with water sprays will provide sufficient cleaning and separation of organics from the screenings. While the washer/compactors with in-tank agitators can produce cleaner screenings materials, these units also have a higher capital cost, require more complicated control systems, and require a higher degree of operations and maintenance attention. The additional motor and ancillary equipment on the agitator system results in slightly higher overall lifetime costs.



Washer/Compactor with Water Sprays

Source: Vulcan



Washer/Compactor with Agitator

Source: Hycor

Figure 3.4 Typical Washer/Compactors

Table 3.5 Comparison of Screening Washing and Dewatering Alternatives

Alternative	Key Components	Advantages	Disadvantages
Washer Compactor with Water Sprays	• Use high pressure spray for separating organic matter from screenings • Capable of producing dewatered screening material with solids content from 30 to 40 percent	• Simple • Smaller footprint	• Not suitable for fine screening applications where large amount of organics are anticipated
Washer Compactor with Agitators	• Use hopper with mechanical agitator to separate organic matter from screenings • Capable of producing dewatered screening material with solids content over 40 percent	• Very clean product, suitable for applications with a large amount of organics	• More complex and expensive

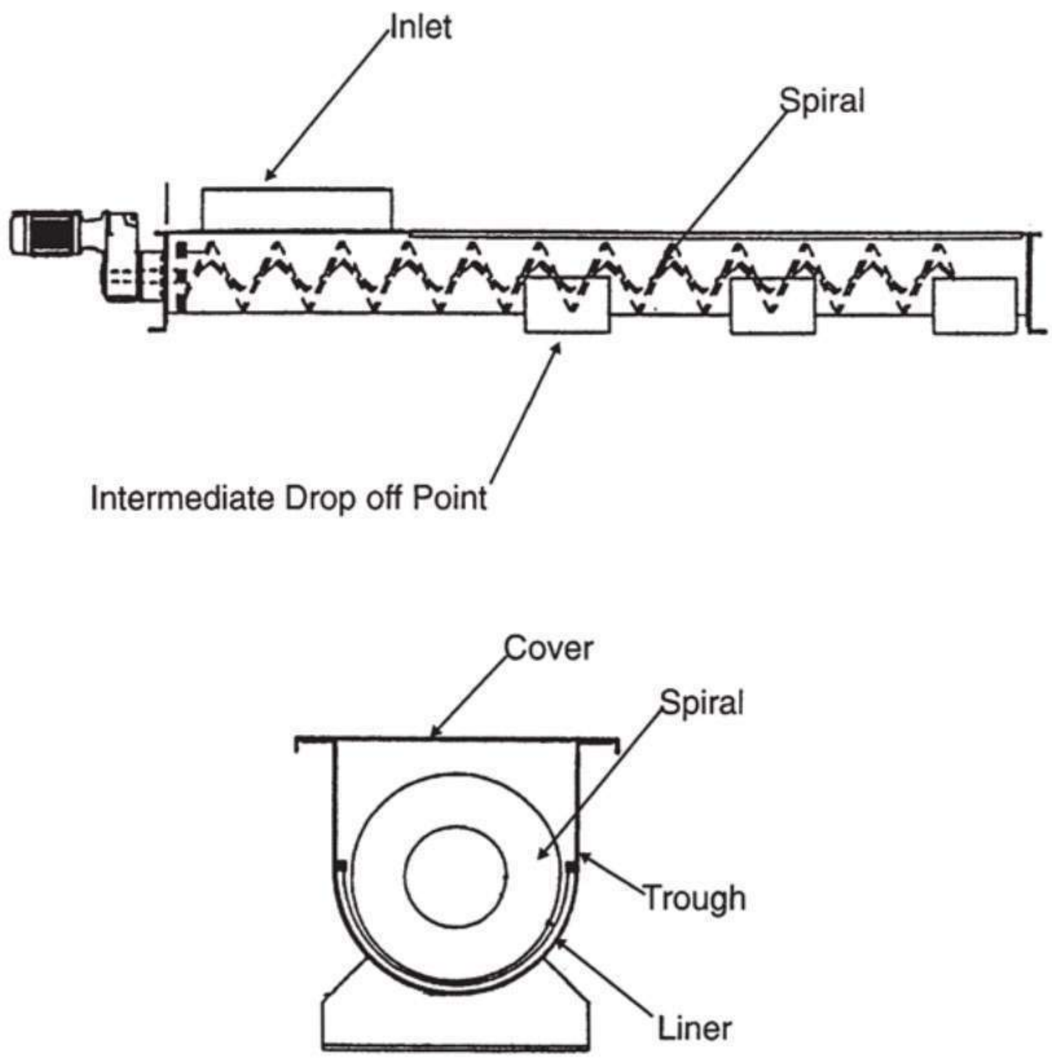
3.6.3 Screenings Conveyance

Conveyance technologies that can be used for screenings conveyance include belt conveyors, hydraulic sluiceways, and shaftless screw conveyors. We recommend the use of shaftless screw conveyors to collect screenings from the bar screens and convey them to the screenings washer/compactor for washing and dewatering.

Belt conveyors are not recommended for this application because they are messy and require more O&M attention that screw conveyors. Screenings material placed on conveyor belt is difficult to contain, will spill over the sides of the conveyor and requires frequent house-keeping.

A hydraulic sluiceway for screenings conveyance is also not recommended due the amount of flushing water required. Sluiceways typically require 300 to 400 gpm of clean, chlorinated flush water to convey screenings properly. Although this flow would be used in a screening washing process, it would then need to be returned to the influent flow stream and re-routed through the plant process at a cost. By comparison, a typical washer/compactor fed by a screw or belt conveyor would consume approximately 10 to 20 percent of the volume needed in a sluiceway application.

The recommended shaftless screw conveyors are a simple, proven, and reliable technology for screenings conveyance. The equipment consists of a hardened steel spiral installed in a stainless steel U-trough and driven by a motor and gearbox, as presented in Figure 3.5. The spiral rests on a replaceable ultra-high molecular weight polyethylene liner in the bottom of the U-trough. The screw conveyor is provided with removable stainless steel covers that completely enclose the screenings, containing the odors and preventing material from spilling out of the conveyor.



Source: American Bulk Conveying, Inc.

Figure 3.5 Shaftless Screw Conveyor

3.6.4 Screenings Facility Layout and Configuration

Three screening channels are recommend. Two channels with mechanical bar screens and one with a manual screen. Each channel will be designed for 3.0 mgd. During dry weather one mechanical bar screen may be taken out of service. The manual bar screen channel will be used to bypass a mechanical bar screen that goes out of service during wet weather.

A shaftless screw conveyor will move screenings from the bar screens to each washer compactor. Each mechanical bar screen is recommended to include a manual chute off the back side to bypass the shaftless screw convey to dump screenings directly into a bin behind the screen in the event that the shaftless screw conveyor goes out of service.

The washer compactors can be configured as duty-standby or as only a single duty washer compactor. In either configuration, it is recommended that gates on the conveyor be installed to bypass the washer compactors and discharge screenings directly to a roll-off bin in the event that the washer compactors go out of service.

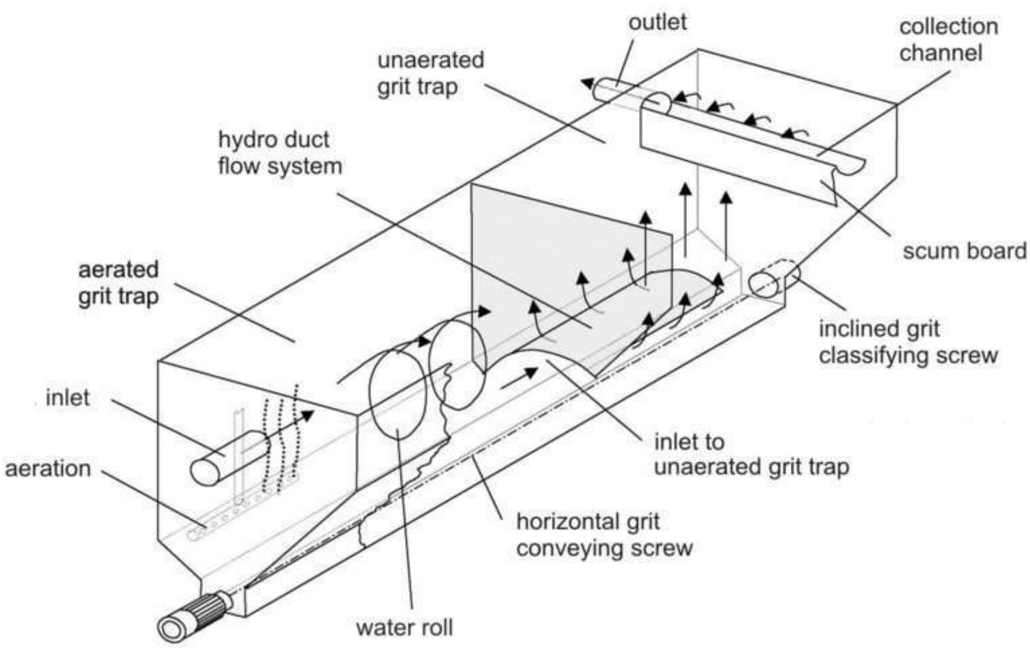
3.6.5 Grit Removal

The primary purpose of grit removal at a wastewater treatment plant is to reduce maintenance on downstream facilities. The benefits of grit removal include reducing grit accumulation in downstream channels, basins or oxidation ponds, and digesters. Effective grit removal will prolong the life of mechanical equipment and reduce wear and tear on mechanical equipment such as pumps, valves, and sludge collection mechanisms.

The two grit removal technologies most commonly installed today are aerated grit basins and mechanically induced vortex grit basins. These technologies are both proven grit separation processes and have been used in the majority of wastewater treatment plants to remove grit from the influent flow stream. The grit removal system is normally covered for odor control.

3.6.5.1 Aerated Grit Basins

The aerated grit basin uses air to create spiral roll pattern to keep the organic solids in suspension as the grit settles out by gravity. Compressed air is typically discharged into the grit chamber along the bottom of one side creating a rising air column that causes the flow to rotate. The air rate can be adjusted to create a low enough velocity near the floor to allow the grit to settle to the bottom of the basin and into collection hoppers. Since the air rate is adjustable, grit removal can be optimized. A typical aerated grist basin is presented in Figure 3.6.



Source: Huber

Figure 3.6 Typical Aerated Grit Basins

3.6.5.2 Vortex Grit Basins

The vortex type grit basin uses gravity and centrifugal action to capture grit in the center hopper of a circular tank. The influent enters at a tangent to the outside of the basin producing a spiraling doughnut-shaped flow pattern. The centrifugal action of the flow in the circular basin pushes the heavier grit particles to the outside where rotational velocities are lower, causing the grit to settle. Impellers at the center of the basins cause a lifting action that suspends and lifts the lighter organic material that is then passed out of the basin through the effluent channel. A typical vortex grit basin is presented in Figure 3.7.

Vortex grit basins can be either 270 degree layout or a 360 degree layout. In the 270 degree layout, the flow enters and exits on the same side and elevation of the grit basin, perpendicular to flow through the headworks. For the 360 degree design, flow drops beneath the effluent channel (influent channel is submerged) and rises up through the basin to the effluent channel, creating an upward velocity component, in parallel with flow through the headworks.

3.6.5.3 Comparison and Recommendation of Grit Removal Technologies

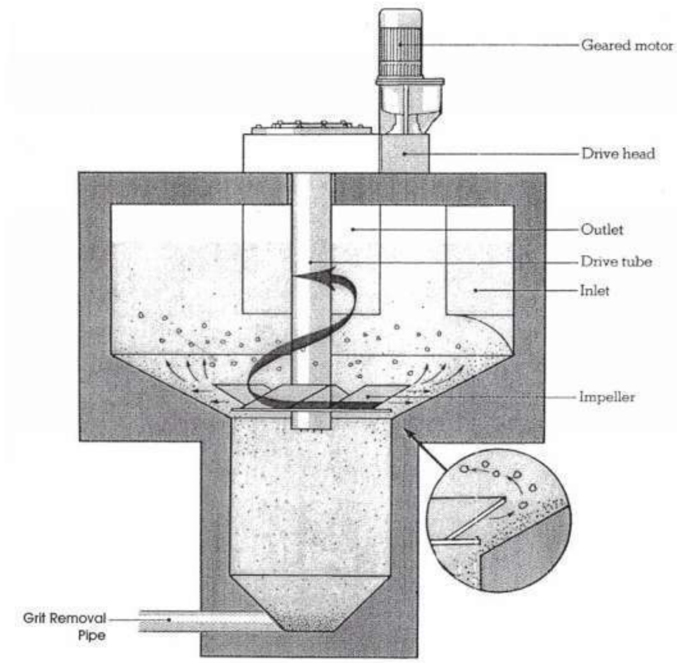
Table 3.6 presents a comparison of aerated grit basins and vortex grit basins. The use of vortex grit basins is recommended for the new headworks facility.

Table 3.6 Comparison of Grit Removal Alternatives

Alternative	Advantages	Disadvantages
Aerated Grit Basins	• Effective grit removal • Air rate can be adjusted to optimize grit removal	• Operationally more complicated • Require aeration blowers • Submerged piping and diffusers require regular maintenance and replacement • Aerated grit chamber increases potential for odors
Vortex Grit Basins	• Simple operation • Only submerged element is the impeller • Smaller footprint	• Cannot be optimized after installation • May not capture as much grit as an aerated grit basin unless the unit is oversized

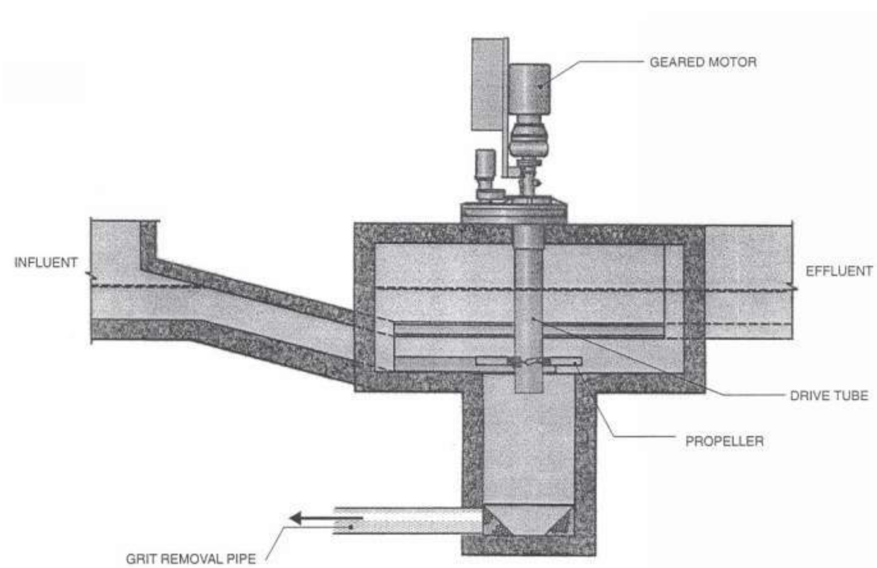
It is our experience that the manufacturer's flow rating should be de-rated by 50 percent when sizing the vortex grit process. This improves capture over the range of design flows, especially during peak flows. One 12-foot diameter vortex grit basin rated for 12 mgd is recommended. It is not anticipated that significant organics will settle out with the grit. However, organics captured with the girt will be returned to the process stream, when treated through the grit washer/classifier. It is also recommended that the grit basin include a sloped bottom to lower the potential for grit accumulation at low flows.

It is not common to take a vortex grit basin off-line. The only mechanical equipment, the impeller drive mechanism is located above the deck of the basin so regular maintenance can be accomplished without dewatering the basin. Furthermore, a vortex grit basin will continue to remove grit without an operational impeller mechanism. To address maintenance concerns, a bypass will be provided so that the basin could be taken off line and dewatered. The reliability of a single basin could also be improved by providing redundant downstream equipment such as a standby grit pump and a standby grit washer. Note that standby grit pump and grit washers are not included in the cost estimate.



Sloped Bottom Vortex Grit Basin

Source: Jones & Atwood



Flat Bottom Vortex Grit Basin

Source: Smith & Loveless

Figure 3.7 Typical Vortex Grit Basin

The equipment will be specified to include abrasion resistant materials to reduce maintenance as much as is economically possible. The final design should also carefully consider how to most easily and reliably remove the grit from the vortex grit removal system, and minimize its handling. Prior to discharging the grit to a dumpster, the grit will be washed to remove attached putrescible material.

3.6.6 Grit Pumps

Settled grit must periodically be removed from the bottom of the vortex basin grit hopper and transferred to grit dewatering equipment. This is typically accomplished by utilizing heavy-duty pumps with hardened wear components that can pass any large solids that may settle in the chamber. Two typical grit removal pump configurations were evaluated for this project; self-priming pumps positioned above the grit chamber liquid surface and recessed impeller pumps with flooded suctions.

Most vortex grit basin mechanism manufacturers also provide an option where a self-primed or vacuum primed pump is integrated with the basin impeller mechanism. The pump withdraws material from the bottom of the basin through an extended impeller drive shaft or torque tube. This type of configuration can save capital costs by eliminating the pump dry pit required to house flooded suction pumps. This savings becomes more significant the deeper the bottom vortex basin is positioned. One disadvantage of this type of system is its limited redundancy. It relies on single withdrawal point and a single pump so if there is any clogging in the suction or discharge lines or the pump requires maintenance, the grit basin would need to be bypassed.

Recessed impeller pumps are commonly used in grit handling applications and are both durable and reliable. The pump impellers are located out of the main flow path and the pump can pass solids almost as large in diameter as the inlet of the pump. Recessed impeller pumps require a flooded suction and would need to be positioned to one side of the grit basin in a pump gallery.

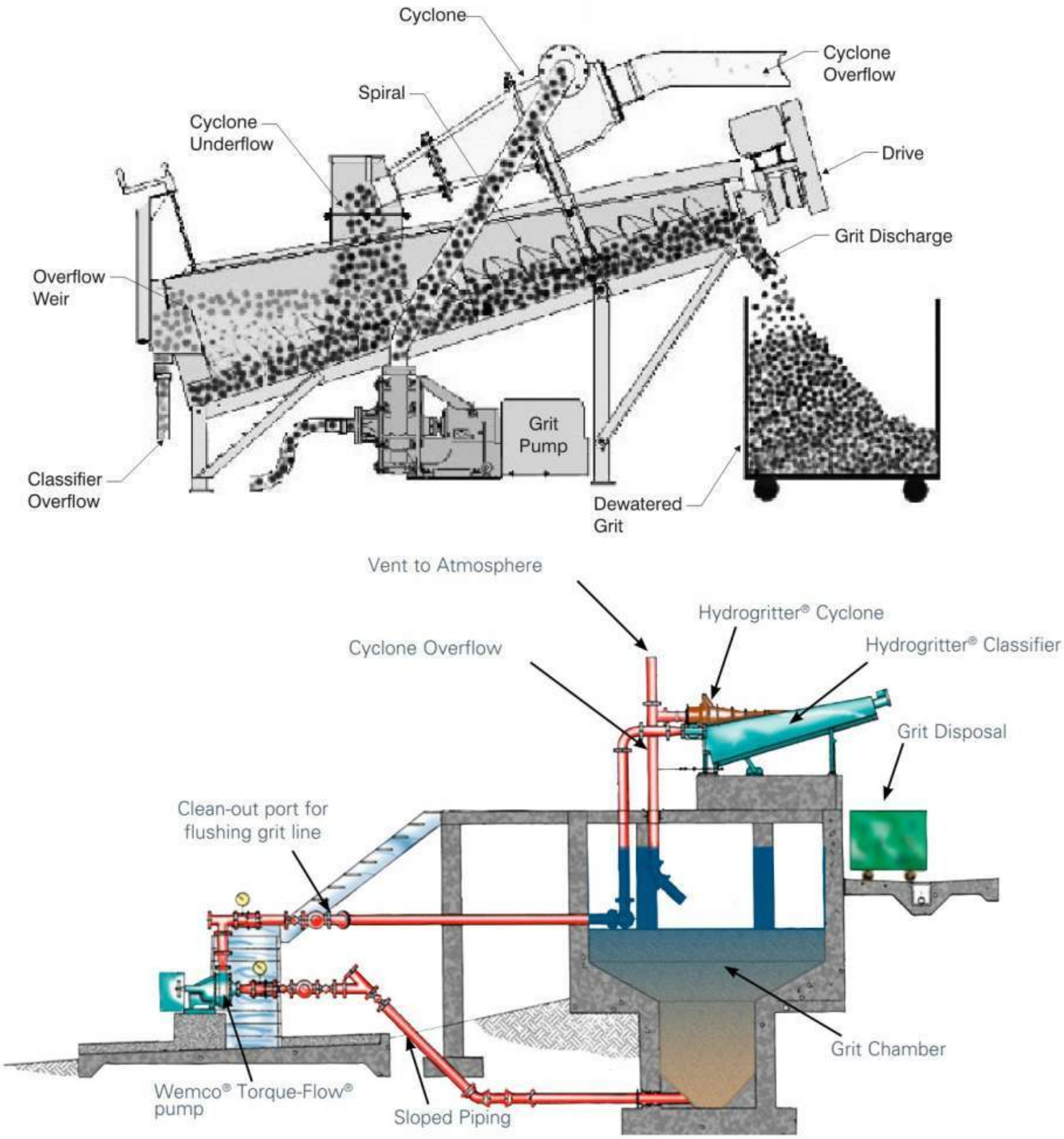
Therefore, we recommend the use of two heavy duty recessed impeller pumps in a duty standby configuration. Since the headworks and grit tanks are above grade, the grit pumps will be located at grade.

3.6.7 Grit Washing and Dewatering

Some organics will be captured in the grit removal process, with increased quantities during low flow periods, so grit washing and dewatering will be provided. Grit washing separates grit from organic solids and grit dewatering removes the free water from the washed grit. A lower organic content in the grit reduces odors and vector attraction while dewatering reduces the weight, volume, and cost of materials hauled. The additional organic material removed from the grit basin will be returned to the headworks and the quality of the dewatered grit to be hauled off-site will remain constant.

Two types of technologies for washing and dewatering grit removed from wastewater are the grit cyclone/classifiers and the proprietary Slurrycup™/Snail™ system. The Slurrycup™/Snail™ system is not recommended for further consideration due to potential intensive maintenance requirements and the possible reduced overall grit quality (higher amount of organics). On the other hand, cyclone/classifier systems can be supplied by several manufacturers and have a long history of successful operation at municipal wastewater treatment plants.

Grit slurry is withdrawn from the grit basin hopper and is pumped to a cyclone which is mounted on top of a classifier. The cyclone uses centrifugal force to concentrate the grit to as little as 5 percent of the total incoming flow, while draining the remaining water and some organic material back to the plant influent. The concentrated cyclone underflow discharges into the classifier below. Grit settles to the bottom of the classifier and is removed with a relatively short helical auger while water and suspended organics discharge over a weir at the back of the classifier. A typical grit cyclone/classifier and layout with a vortex grit basin is presented in Figure 3.8.



Source: Wemco

Figure 3.8 Typical Grit Cyclone/Classifier and Vortex Grit Basin Arrangement

One stainless steel cyclone/classifier grit dewatering unit located next to the grit pump station and discharging into disposal bins located at grade is recommended. Due to the corrosive nature of grit and because the classifier unit will be located outside, it should be fabricated from stainless steel. It is also recommend that the unit be covered to reduce splashing and to contain foul odors.

3.6.8 Headworks Materials

The recommended materials are presented in Table 3.7.

Table 3.7 Material Recommendations

Area/Equipment	Material
Influent Wet Well Interior	Concrete walls with PVC T-lock liner
Hatches	Galvanized Steel
Channels upstream of screens	Concrete walls with PVC T-lock liner
Channel Covers and Gratings	FRP
Gates	316 Stainless Steel or FRP
Stairs and Landings	Aluminum

3.6.9 Plant Influent Flow Measurement

A number of devices are available that can be used to measure flow rates in open channels and closed conduits. Important criteria that must be considered in the selection of flow metering devices include type of application, proper sizing, fluid composition, accuracy, headloss, installation requirements, operating environment, and ease of maintenance. Although all of the criteria listed are important, accuracy and repeatability are critical, especially when the units' readings are used for process control.

The three types of flow measurement devices that have been evaluated include inline magnetic flow meters, Doppler flow meters, and Parshall flumes with ultrasonic level instruments.

3.6.9.1 Inline Magnetic Flow Meters

Inline magnetic flowmeters, or mag meters, utilize Faraday's law governing the proportionality of induced voltage to velocity of a conductor passing through an electromagnetic field. The wastewater in the pipe acts as the conductor, and as electromagnetic fields are generated, electrodes sense induced voltages and converts them first to velocity, then to flow rate. Magnetic flowmeters are very accurate instruments, and are suitable for measuring the flow rate of most conductive liquids. The meters have no moving parts, and are shaped such that very little obstruction (equating to headloss) occurs within the pipe section. Typical mag meters range in size from 2-inch to 24-inch pipe diameter; however, larger sizes are available. The primary disadvantage is that full pipe flow is required for accurate flow measurement. This requires careful consideration of the piping arrangement design. The traditional, conservative "rule-of-thumb" for straight runs of piping for a magmeter location is five diameters of pipe upstream and two diameters of pipe downstream. Either a bypass piping run or dedicated spool piece can be provided so that the meter can be taken offline for maintenance, if required.

3.6.9.2 Doppler Flow Meter

Doppler flowmeters measure flow by continuously transmitting high frequency sound (>5.0 MHz) that travels through the pipe wall and into the flowing liquid. The sound is reflected back to the sensor from solids and bubbles in the flow stream, and the echoes return at an altered frequency proportional to fluid velocity. Doppler flowmeters continuously measure this frequency shift to calculate flow. The Doppler technique only works on liquids that contain solids or gas bubbles to reflect its signal. The sensor mounts on the outside of the pipe, meaning there is no obstruction to flow, and hence no pressure drop.

3.6.9.3 Parshall Flume

The Parshall flume utilizes the Venturi principle to equate flow from differential pressure measured between the flume inlet and throat. Parshall flumes provide the critical depth, and is typically coupled with some type of level instrument (i.e., ultrasonic) to measure the depth. These types of flowmeters are often used for open channel flow, and offer the advantages of low headloss and smooth hydraulic flow, which minimizes deposition. The disadvantage of the flume is that it cannot be used to measure flow in pipes under pressure. The Parshall flume offers the lowest level of accuracy of the three types of flowmeters described herein.

3.6.9.4 Recommendation

Inline electromagnetic-type flowmeters are recommended for flow measurement for the following reasons:

- Smaller footprint than a Parshall flume.
- Higher performance and reliability than Doppler and Parshall flume.
- Low capital cost.
- Low maintenance.

Manufacturers for this type of flow meter include ABB, Krohne, Rosemount, and Endress+Hauser. It is anticipated that the influent flowmeters will be located on the two pipelines out of the headworks flow split structure.

The City is required to calibrate and verify the accuracy of all flow meters. The current calibration equipment only works with Siemens mag meters. The new flow meters will need to be able to be verified on-site, not requiring being sent to the manufacturer for verification. For these reasons, Siemens flow meters are recommended to match existing.

3.6.9.5 Flow Meter Sizing and Location

Two flow meters will be provided, one upstream of the primary clarifier and one upstream of the oxidation ditch. The primary clarifier flow meter will need to be able to measure a range of flows from 0.3 mgd to 2.3 mgd and the oxidation ditch flow meter will need to be able to measure a range of flows from 0.3 mgd to 3.6 mgd. In general, solids-bearing liquids should have velocities between 3.0 to 10 feet/second for all flow ranges. Based on the flow ranges, an 8-inch nominal diameter magnetic flow meter is recommended for the primary clarifier and a 12-inch nominal diameter magnetic flow meter is recommended for the oxidation ditch. The flow meters should be pad mounted at grade and include valves for isolation. Piping should be arranged to keep the meter flooded at all times and to prevent liquid separation and the entrapment of air.

For best accuracy, a minimum of five pipe diameters upstream and two pipe diameters downstream of the flow meter are required. Complex piping arrangements should be avoided such as multiple elbows, which causes swirling flows and greatly affect the meters' accuracy and flow rate.

3.7 Primary Clarifier Facilities

The condition of both Primary Clarifier Nos. 1 and 2 is poor to very poor based on the age, concrete corrosion, and cracking of the effluent launders. The interior coating on both units has failed and exposed the concrete to sulfide corrosion at the water surface. In the Facility Plan, it was noted that the structures likely cannot be rehabilitated for use with modern clarifier mechanisms and will need to be replaced due to age. The current recommendation is to further investigate whether the Primary Clarifier No. 2 mechanism can be rehabilitated or replaced. It is recommended that Primary Clarifier No. 1 be demolished.

3.7.1 Recommended Design Parameters

The design parameters for existing Primary Clarifier No. 2 are presented in Table 3.8.

Table 3.8 Primary Clarifier Design Parameters

	Parameter	
Diameter, ft	60	
Side Water Depth, ft	12	
	Future Average Dry Weather Flow	**Peak Wet Weather Flow**
Flow Rate, mgd	1.3	2.3
Overflow Rate, gpd/SF	460	813
Typical Range, gpd/SF	800 - 1,200	2,000 - 3,000
Weir Loading Rate, gpd/LF	6,897	12,202
Typical Range, gpd/LF	10,000 - 40,000	
Solids Loading Rate, ppd/SF	1.02	1.77

The existing 60 foot diameter clarifier has center fed with peripheral drawoff sludge hoppers and scum removal and will have the following rehabilitation:

- If possible, repair the clarifier mechanism structure and blast and recoat the sludge collection mechanism, including center column, skimmer arm, and scum beach.
- Or replace the clarifier mechanism.
- New launders with fiberglass v-notch weirs, fiberglass scum baffle.
- Effluent drop-box stainless steel isolation gate.
- Repair of spalled concrete.
- A spray-on protective coating will be specified for all concrete surfaces from the top of the wall to three feet below the water surface level to provide protection for the concrete.
- At grade new primary sludge pump station with duty and standby progressing cavity sludge pumps.
- At grade new scum pump station with duty and standby chopper pumps to provide mixing, decant, and scum transfer.

3.7.2 Sludge and Scum Pumping System

The circular clarifier sludge collection mechanism moves primary sludge from the bottom of the clarifier into a central sludge hopper located near the center column. The existing primary sludge pumping system pumps 5,440 gal/day of primary sludge from the primary clarifiers to the digesters. Two new progressive cavity pumps (one duty + one standby) with a capacity of 50 gallons per minute (gpm) each will be installed at grade to pump the sludge from the hopper to the digesters via glass-lined ductile iron pipes. The pump will run intermittently though out the day. The pumps and piping may be designed to pump primary sludge to the new thickener for co-thickening with secondary solids.

Primary scum will be collected from the new primary clarifier and drain to the existing scum well adjacent to the clarifier. A chopper pump will provide mixing, decant, and scum transfer.

3.8 Recommended Facility Design Criteria

Table 3.9 summarizes design criteria for the recommended influent pump station, headworks, and primary treatment facilities.

Table 3.9 Summary of Recommended Design Criteria

	Design Criteria
Flow Criteria	
Minimum Flow	0.3 mgd
Future Average Dry Weather Flow	1.3 mgd
Future Peak Dry Weather Flow	2.2 mgd
Future Max Month Flow	3.6 mgd
Peak Wet Weather Flow	5.9 mgd
Influent Pump Station	
Capacity	8.5 mgd
Firm Capacity with Largest Unit Out of Service	6.0 mgd
Type of Pumps	Non-clog Submersible
Number Pumps	4
Pump Capacity	3 @ 2.5 mgd, 1 @ 1.0 mgd
Screenings Facilities	
Capacity, each	3.0 mgd
Number of Channels and Screens	3
Type	Two Chain Driven Multi-rake and One Manual
Screen Opening	3/8 in
Channel Width	2 ft

Table 3.9 Summary of Recommended Design Criteria (Continued)

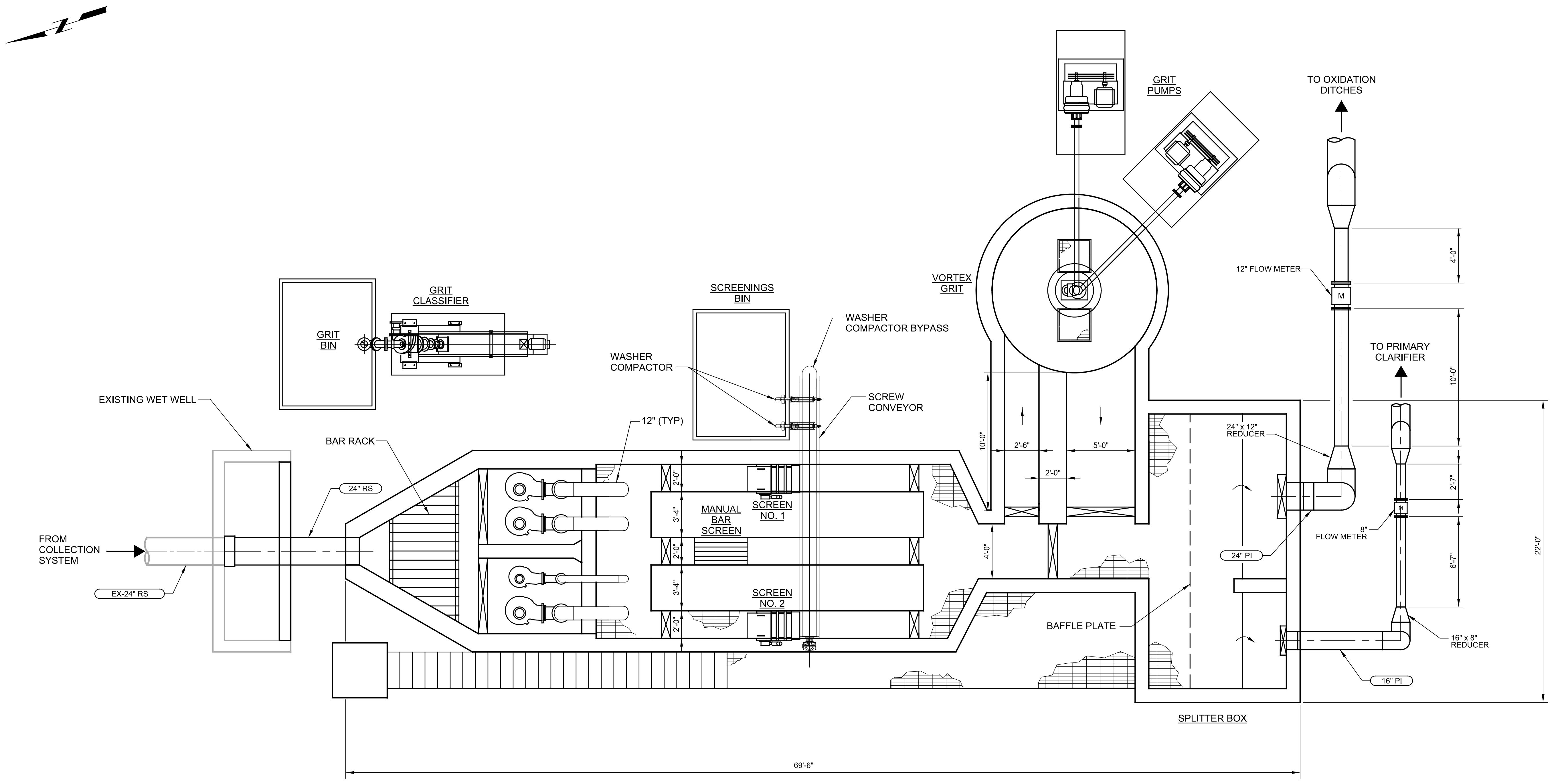
	Design Criteria
Velocity Through Screens	
Current Average Dry Weather Flow	2.0 fps
Future Average Dry Weather Flow	2.5 fps
Peak Wet Weather Flow	4.5 fps
Screenings Washer Compactor Type	Water Sprays and Dewatering Screw
Screenings Conveyor Type	Shaftless Screw
Grit Removal	
Grit Removal Basin Type	Mechanically Induced Vortex
Number of Basins	1
Size	12-foot Diameter
Floor Slope, vertical: horizontal	1:1.75
Rated Capacity, each	12 mgd
Grit Pumps	
Type	Recessed Impeller
Number of Pumps	2 (1 duty + 1 standby)
Grit Dewatering	
Type	Cyclone Classifier
Number	1
Primary Clarifier (Rehabilitated)	
Number of Units	1
Type	Circular
Diameter	60 ft
Overflow Rate	
Current Average Dry Weather Flow	389 gpd/sf
Future Average Dry Weather Flow	460 gpd/sf
Sludge Pumping	
Number of Pumps	2
Pump Type	Progressive Cavity
Capacity, each	50 gpm
Flow Metering	
Number of Units	2
Meter Type	Magnetic Flow Meter
Meter Size	12-inch and 8-inch Nominal Diameter

3.8.1 Site Layout

The proposed location of the new influent pump station and headworks facility is at the site of the existing headworks. This location is recommended since it is positioned at location of existing influent sewer and there is not space on the plant site to easily relocate the headworks. The land north of the existing headworks is not available due to limited space between the Generator Building, the fence line, and setback from the slough. In addition, the existing influent sewers and effluent pipelines below grade limit space or would have to be relocated.

For construction phasing, the intent is to bypass the headworks to Primary Clarifier No. 1 using a portion of the existing influent wet well and the Influent Storm Pump. The Primary Clarifier No. 2 upgrades and the headworks replacement construction should not be concurrent. Primary Clarifier No. 2 should be upgraded and then used to capture grit and solids while the headworks is offline. This construction activity will have to occur during dry weather. Once the new headworks is online, Primary Clarifier No. 2 can be taken out of service for girt removal.

It is possible to pump directly from the First Street Pump Station to the oxidation ponds for bypassing the headworks during construction. However it will likely be beneficial to send all flows that bypass the headworks to Primary Clarifier No. 1 to limit grit and solids sent to the ponds. The plan and section for the proposed headworks is presented in Figure 3.9 and 3.10.

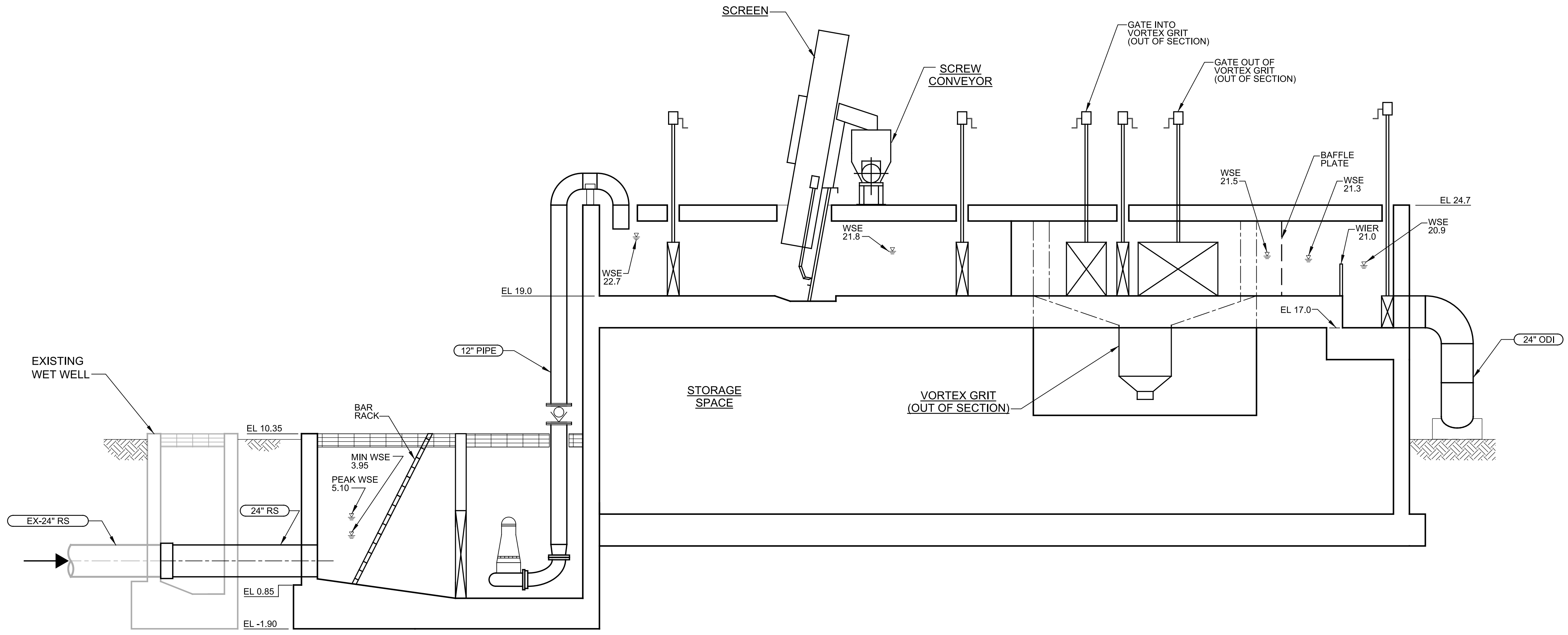


A **HEADWORKS PLAN**
SCALE: 1/8"=1'-0"
FILE: 9913B10000M110

Figure No. 3.9
HEADWORKS PLAN
CITY OF ARCATA
carollo

GENERAL NOTES:

1. WATER SURFACE ELEVATIONS AT PEAK WET WEATHER FLOW.



B 3.9 **HEADWORKS SECTION**

SCALE: 1/8"=1'-0"
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Figure No. 3.10
HEADWORKS SECTION
CITY OF ARCATA

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Appendix A

EQUIPMENT BROCHURES

Headworks Process Equipment

WesTech

Process Equipment. Process Driven.

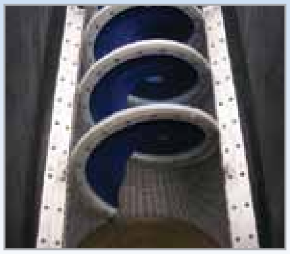
Get More Out of Your Headworks

WesTech engineers and manufactures a full line of headworks equipment. Our experience and our service-driven approach help you find the right solutions to get the most out of your headworks. The more debris and grit you can remove, the more efficient your downstream equipment and processes will become. Your wastewater treatment facility will save time and money with WesTech preliminary treatment equipment.

Getting the Job Done with Experience and Options

Since every job is unique, we take a comprehensive approach by assessing conditions and determining the particular requirements of downstream equipment and processes. The result is improved solids removal even when circumstances are less than ideal.

With multiple options in equipment selection, WesTech provides the best solution to your particular needs. With hands-on experience and hundreds of installations, we are committed to providing timely and practical consultation from initial design through project startup.



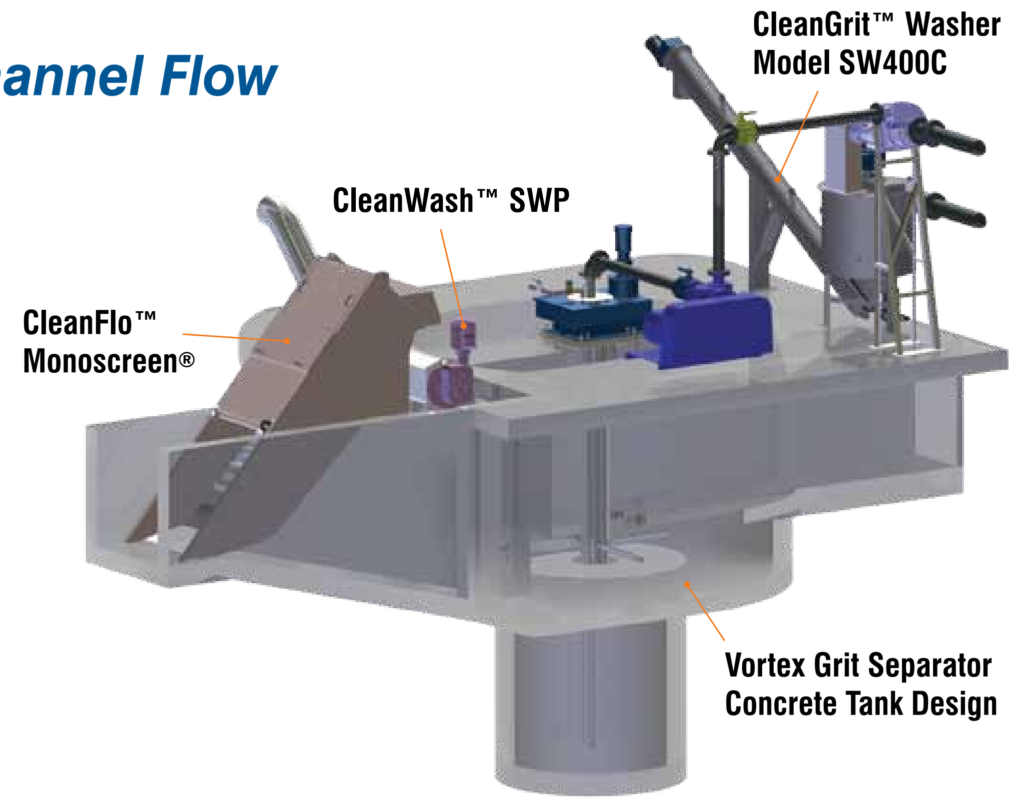
Building Upon the Past, Designing for the Future

WesTech's efficient and intelligent designs are a result of years of engineering and manufacturing within municipal and industrial markets. This experience creates the best solution — and the best value — for our customers.

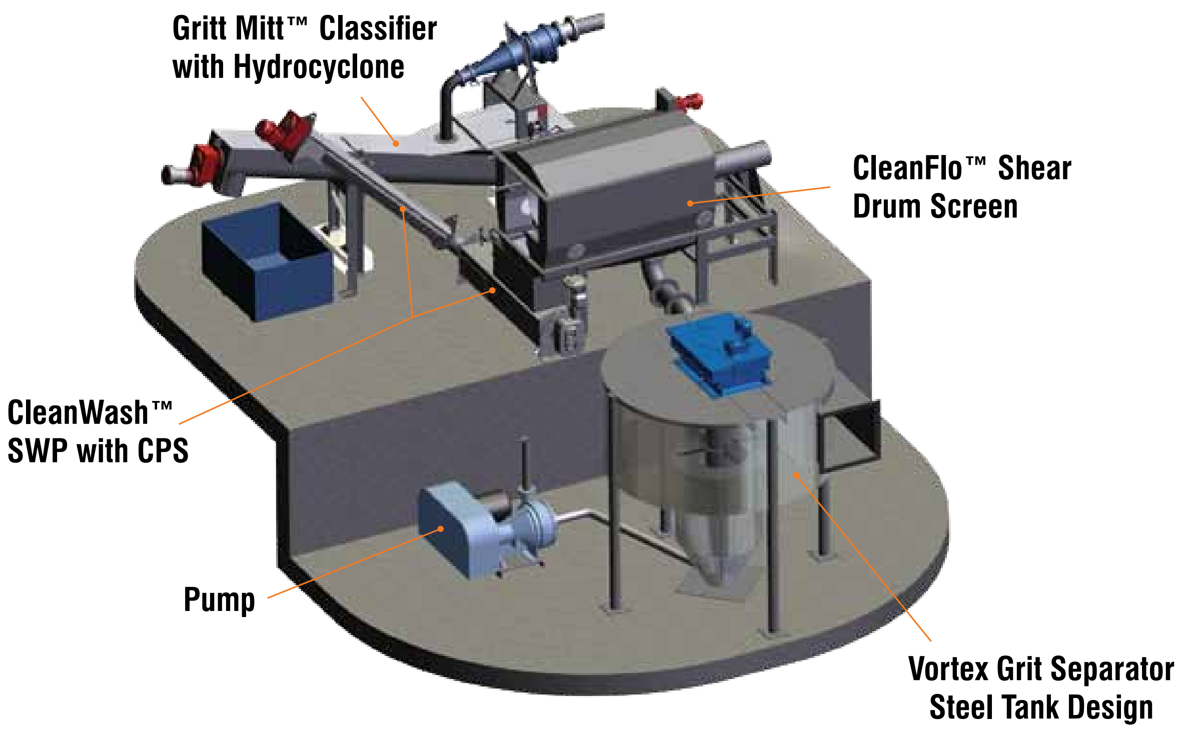
- **Shaftless spiral screens**
- **High capture filter step screens**
- **Internally fed rotary drum screens**
- **Controllable pressure for maximum screenings washing and dewatering**

WesTech provides single-source systems for your headworks specifications. Whether in-channel gravity or pumped flows, WesTech can apply the right equipment solution for both large and small installations.

In-Channel Flow



Pumped Flow



Screening

Screening is the first step in every headworks operation. The efficient removal of solids ensures proper protection to your downstream equipment and plant processes.

CleanFlo™ Spiral

For plants with flows under 10 MGD, the WesTech CleanFlo Spiral screens, conveys, and dewaters simply and economically in a single unit. The stainless steel screen basket is automatically cleaned by durable segmented brushes attached to the shaftless spiral auger. An expanded discharge zone provides unrestricted solids discharge and the hinged top mounted door allows clean and easy access.

- **Shaftless spiral operation**
- **Openings 3 – 6 mm**
- **Installed in channels or tanks**

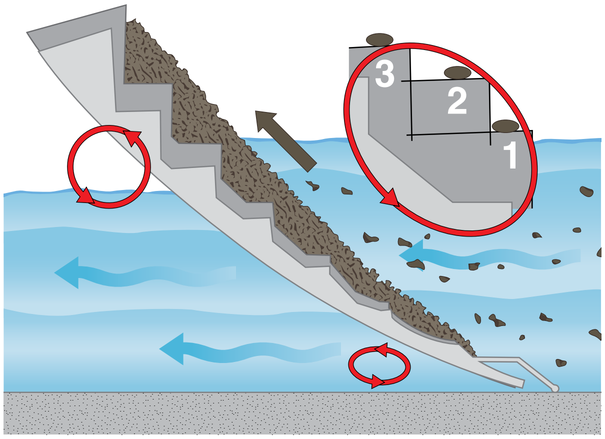
CleanFlo™ Vertical Spiral

Specifically designed in a vertical orientation, the CleanFlo Vertical Spiral is ideal for pump wetwells or confined short channels. The screen is composed of a cylindrical 3 or 6 mm perforated basket with an integral shaftless spiral and conveyor tube. The unit provides screening and conveyance of solids and can provide additional dewatering of material.

- **Vertical conveyance**
- **Optional rail support allows removal without entering wetwell**
- **Pump station screen**
- **Comminutor replacement**

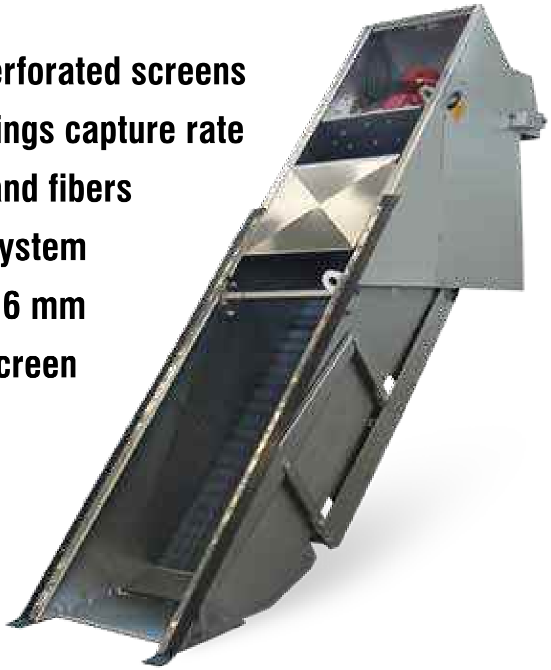
CleanFlo™ Monoscreen®

The CleanFlo Monoscreen works on the same principle as a precoat filter. The screened material forms a mat that bridges the bars. The formation of this mat efficiently captures particles smaller than the bar opening, while still allowing flow to pass. The unique motion and progressive step design of the Monoscreen minimizes the "cleaning breakthrough effect" resulting in a 50% higher capture rate than traditional step screens.



The blades in the lower part of the unit move in an elliptical horizontal motion, while the blades in the upper section move in the traditional circular motion. This progressive motion moves the captured solids (precoat solids) up the screen at a slower and more even rate.

- **Outperforms perforated screens**
- **Highest screenings capture rate**
- **Removes hair and fibers**
- **Linkage drive system**
- **Slot widths 1 – 6 mm**
- **Patented fine screen**



CleanFlo™ Rotoscreen®

Designed specifically for facilities with limited space, the CleanFlo Rotoscreen delivers powerful results while managing high flow.

- **Ideal for limited space**
- **Slot widths 1 – 6 mm**
- **Robust screen design**
- **High capacity**
- **Available with simple chain drive or linkage system**

Screening

Internally Fed Rotary Drum Screens CleanFlo™ Shear

Drum screens eliminate debris carryover. Other moving media screens experience some carryover due to inefficient cleaning, lower seals, or poor distribution. Drum screens keep all of the debris inside the rotating drum until it is discharged.

- **Rugged direct drive unit**
- **Protects debris-sensitive membranes**
- **Ease of maintenance**
- **Low operating costs**

Direct Drive for Drum Screens

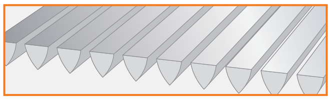
By eliminating the chain drive, WesTech removes common problems such as chain stretch, chain corrosion, chain lubrication, and tracking problems.

Maintenance is simplified and the annual or biannual expense of chain replacement is eliminated.

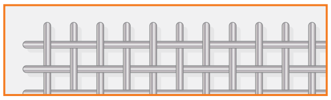
Applications:

- **Pre-MBR screening — no bypass or carryover of solids for maximum protection of membranes**
- **Preliminary treatment**
- **Sludge thickening — with chemical addition**
- **Single screen throughput up to 20 MGD**

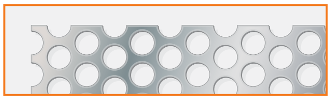
Screen Mediums



Wedge Wire
0.010 – 0.120"



Woven Mesh
0.5 – 1 mm



Perforated Plate
0.6 – 25 mm

CleanFlo™ Infloscreen

Internally fed drum screening with the convenience of in-channel installation.

- **In-channel installation**
- **Inclined and horizontal orientations**
- **Low operating costs**

Deep Channel Screens
CleanFlo™ MultiRake Bar Screen

The CleanFlo MultiRake Bar Screen is a strong, versatile, and economical fine or coarse screen with bar spacing available from 6 – 50 mm (0.25 – 2 inches). The screen is ideal for a wide range of channel sizes — up to 13 feet wide and 50 feet in depth, with installation angles from 70 – 80 degrees.

A single screen has the ability to handle flows over 150 MGD. The rake speed is available at a fixed rate or adjustable via VFD control. This ensures fast cleaning and eliminates the risk of flooding during high flow events.

- **Strong multiple rake design**
- **Eliminate upstream coarse screens**
- **High screenings load without high headloss**
- **Rake speed up to 50 ft/min**
- **Designed to automatically clear jams**
- **Variable speed operation to handle storm flows / high flow events**

CleanFlo™ Element Screen

The CleanFlo Element Screen features a unique self-cleaning action of the filter elements, making the screen suitable for a wide range of flows. The Cleanflo Element is ideal for screening of particles from 1 – 30 mm in size in deep channels.

Like most screens, the operation is intermittent and based on water level. As debris builds on the screen media and the water level rises, the screen media advances to present a clean screen surface to the incoming flow. Slowly, the debris will be lifted to the top of the screen. At this point the fingers of the screen retract within each other and are efficiently scraped clean.

- **No submerged bearings**
- **Self-cleaning elements**
- **Inclinations up to 85 degrees**

Screenings Washing and Dewatering

CleanWash™ SWP/CPS

Unlike screw wash presses in which the design of the discharge pipe creates the back pressure necessary to dewater screenings, WesTech's CleanWash Screw Wash Press and Counter Pressure Screw regulates just the right amount of back pressure to meet the highly variable influent. The positive conveyance of the screenings after each washing cycle delivers up to 70% dry solids without fear of plugging through 10, 20 or even 30 feet of discharge piping.

75% less weight per cubic foot

- **Superior dewatering**
- **Dry solids content of up to 70%**
- **Volume reduction of up to 80%**
- **No plug = No plugging**
- **Patented CPS design**

CleanWash™ SWP

Using a conventional discharge pipe, the CleanWash SWP is capable of producing light gray, relatively odorless material without using expensive, maintenance-intensive mechanical agitators.

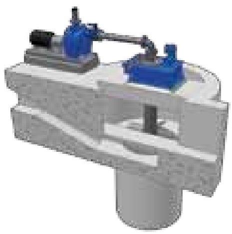
Grit Removal

Vortex Grit Separator

The WesTech Vortex Grit Separator is a forced-vortex type grit separator. The influent enters the vortex chamber tangentially and flows around the upper chamber, exiting at either 270 or 360 degrees from the influent point.

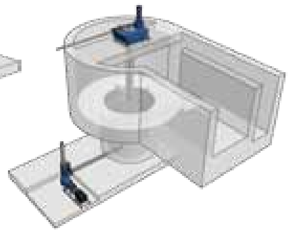
The main advantage of this type of separator is that its footprint is much less than other types of grit separators such as aerated grit chambers and detritors.

Pump Options



Self-Priming Pump

Air Lift Pump



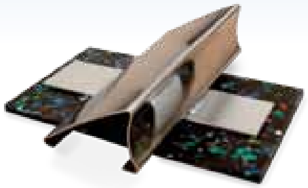
Flooded Suction Pump

ZICKERT Shark™ Grit Removal

The ZICKERT Shark bottom scraper is a proven design to continuously remove and transport grit to a hopper or sump. The Shark is based on the forward and return movement of the hydrodynamically designed scraper profiles.

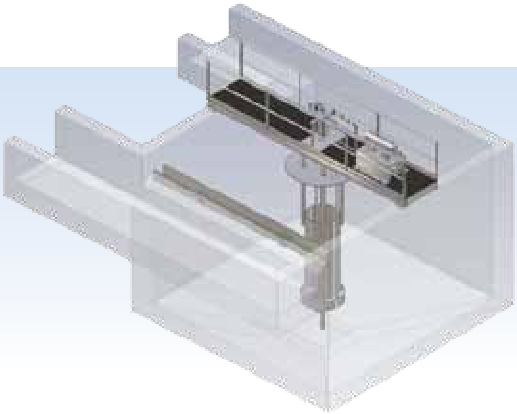
- **Few moving parts**
- **Low maintenance**
- **Optional grease removal skimmer**
- **Easy to adapt to existing tanks**
- **Replaces submerged screws or chain and flight systems**

The specially designed scrapers are welded together to form a single unit so it functions as a moving floor in the tank. The Shark is easy to install and requires very little maintenance.



Aerated Grit Chamber

This style of grit separator uses air injection to create a rolling pattern in the chamber causing heavy solids to settle to the floor and lighter organics to remain in suspension.



Grit Washing and Dewatering

CleanGrit™ Washer

WesTech CleanGrit products remove organic matter from grit collected at the headworks of a wastewater plant. Unwashed grit can consist of up to 80% organics.

Removal of the organic matter from grit will reduce disposal costs and nuisance odor complaints while improving biological plant processes. WesTech offers the largest variety of grit washing systems available in the North American market.

- **Less than 5% organics discharge**
- **Dry solids discharge greater than 85%**
- **Odor reduction**
- **Reduce grit disposal by 50%**

CleanGrit™ SW400C

The CleanGrit™ Model SW400C rinses organic matter from dewatered grit or a concentrated grit slurry by incorporating a hydrocyclone. Organic matter is loosened mechanically by an agitator and rinsed by an upcurrent backwash water process. Cleaned grit is discharged by the shaftless spiral conveyor for disposal.

The CleanGrit Model SW400C is our most compact model to wash organic material from dewatered grit.

CleanGrit™ SWA Series

The CleanGrit SWA Series is designed to dewater and wash grit from grit collection tanks, without the need for a hydrocyclone.

The SWA series features multiple sizes of washing tanks and disposal screws to meet a wide variety of flows and solids loading.

- **Flows of up to 500 gpm**
- **Solids handling capacities of up to 100 cubic feet per hour**

Gritt Mitt™ Classifiers

The WesTech grit removal system is not only available with the CleanGrit Washer but is also offered with either the WesTech Gritt Mitt Shaftless or Shafted Grit Classifier. The WesTech classifiers are designed with a range of hopper sizes, screw diameters, and screw lengths to meet any specification. The classifier system produces very good quality dewatered grit suitable for most landfills.

The WesTech classifier can be equipped with a hydrocyclone to optimize performance in systems with mechanical grit pumps.

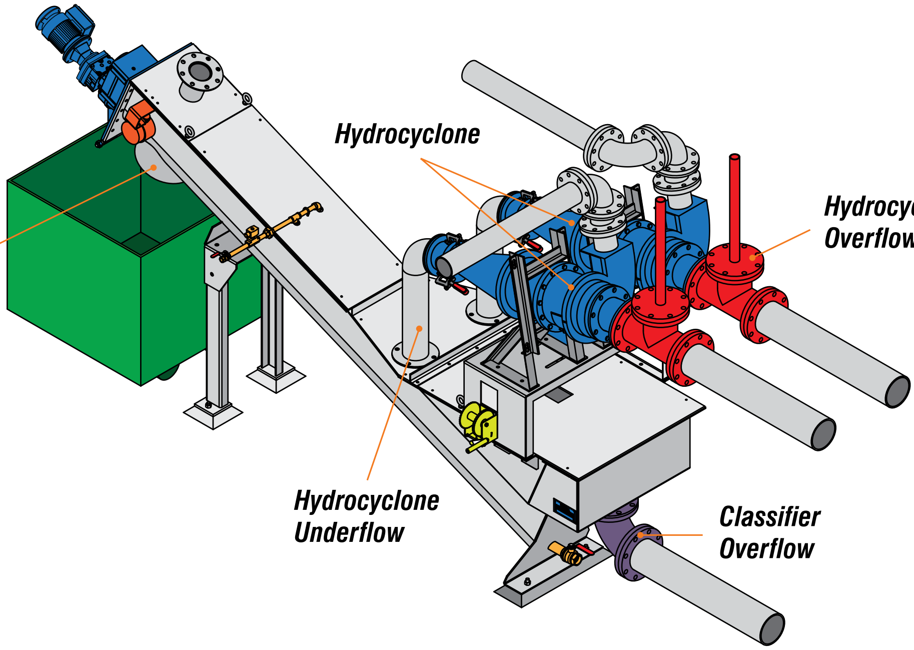
The cyclone reduces the flow entering the classifier hopper by 80 – 90% and allows a smaller footprint to be used to handle the same pumped flow.

Gritt Mitt™ Shaftless Classifier

- No submerged bearing
- Hardened carbon steel or stainless steel shaftless screw
- Screw supported by stainless steel wear bars

Gritt Mitt™ Shafted Classifier

- Heavy duty design perfect for high capacity applications
- Continuous operation allows increased solids transport
- Optional wear shoes available



Specialty Systems

CleanFlo™ All-In-One

The CleanFlo All-In-One unit combines screening, grit removal, and solids dewatering all in a single system. The CleanFlo All-In-One is suitable for indoor or outdoor installation with capacities from 0.3 – 3 MGD.

- **Integrated approach**
- **Small footprint**
- **Eliminates complex concrete structures**

Septage Receiving

WesTech supplies packaged systems specifically designed for septage receiving applications. These versatile units can be especially beneficial when haulers discharge downstream of the plant headworks, or at remote plant entry points.

Optional features include:

- **Magnetic flow meter**
- **Hauler access station**
- **Management software for full integration, tracking, billing and record keeping**
- **Automated rock removal**

See more WesTech process equipment at: westech-inc.com

Aerators
Anaerobic Digestion
Biological Treatment
Clarification
Combined Sewer Overflow
Dewatering
Dissolved Gas Flotation
Drive Units
Filtration
Flocculation
Headworks
Membranes
Oil / Water Separators
Package Plants
Residuals Handling
Septage and Receiving
Thickeners
Parts and Field Service
Systems and Turnkey
Laboratory Testing

WesTech
Process Equipment. Process Driven.

Tel: 801.265.1000
westech-inc.com
info@westech-inc.com
Salt Lake City, Utah, USA

Represented by:

Multi-Rake Bar Screen RakeMax®

Sturdy bar screen with traveling rakes:

– for coarse to fine screening
– for combined or separate sewer systems
– for deep and very deep channels
– for high screenings loads

Features

The RakeMax® is a bar screen with a spacing from $^1/_4$" to 6" (6 to 150 mm). Its bars have either a streamlined tear drop profile (spacing ≤ 12 mm) or a rectangular shape (spacing > 12 mm).

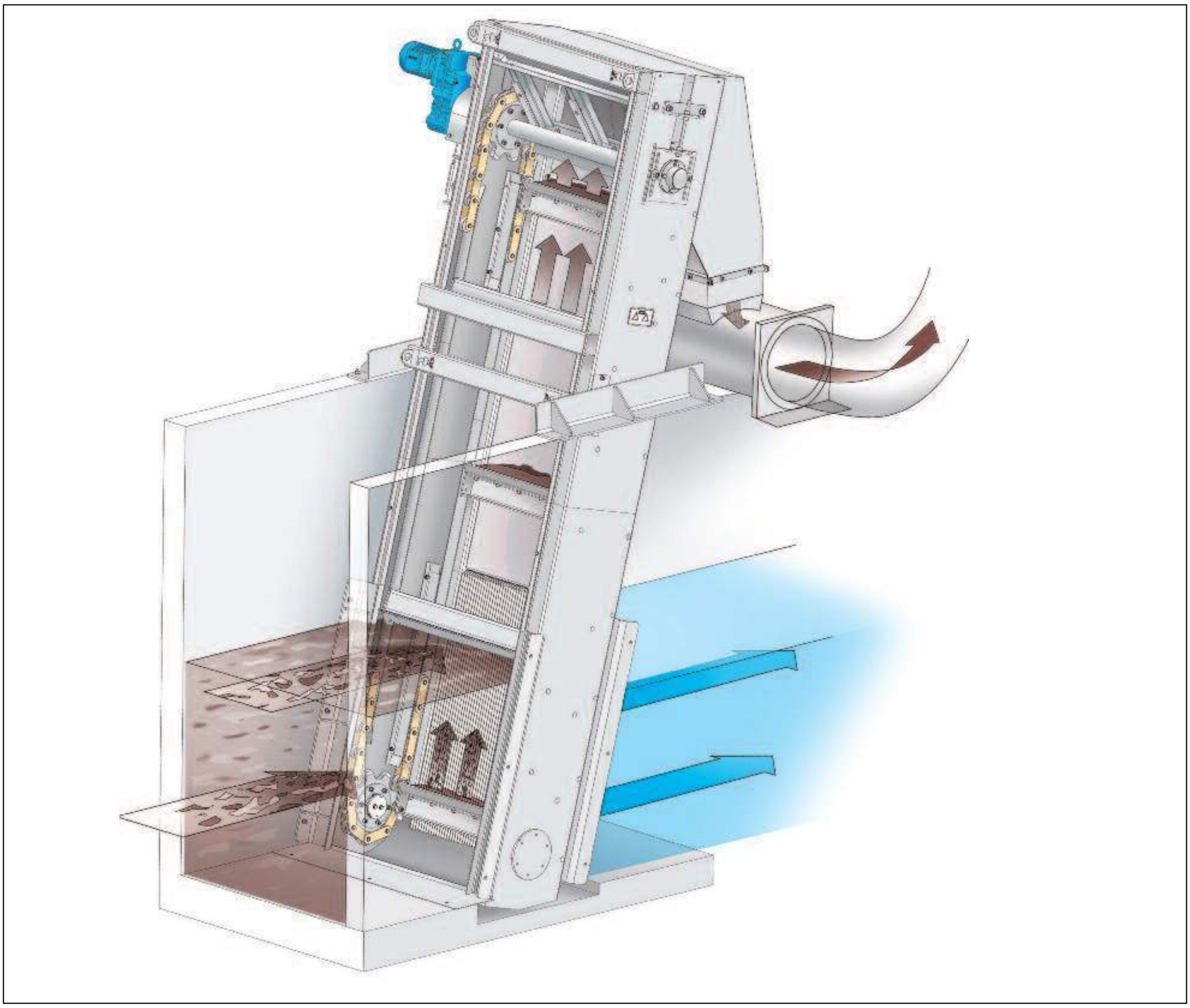
The bar rack is an integral part of the sturdy frame, which ensures perfect meshing of the rake teeth with the bar spaces. Positive and reliable cleaning is thus guaranteed.

A multitude of rake bars are bolted at selectable distances to a pair of drive chains. With short distances between its rakes, the RakeMax® is able to remove extremely high screenings loads. The rake blades are made of sections that are bolted to the rake bars, thus facilitating easy replacement of a segment in case that its teeth should become damaged or worn.

Chain rollers, made of wear-resistant polyamide, guide the chains exactly within the frame. The chains are driven by a pair of cogwheels. The plastic rollers also prevent wear between the chains and the cogwheels. The drive is connected with the frame through a spring; if the torque exceeds a certain value, due to any obstruction in the bar rack, a switch is pushed and the movement is reversed back and forth until the obstruction is loosened. Should the obstruction persist several reversals, an alarm is triggered. Self-destruction of the screen is thus prevented.

Chains and cogwheels are made of hardened, zinc galvanized and chromated steel to combine great wear-resistance with excellent corrosion-protection. They are also available in stainless steel. The maintenance-free ceramic bearings of the lower cogwheels are well-proven in thousands of ROTAMAT® installations.

The RakeMax® has a small height above the operating floor. In spite of its outstanding discharge height of up to 65 ft (20 m) above the channel floor, the RakeMax® fits into virtually any building.

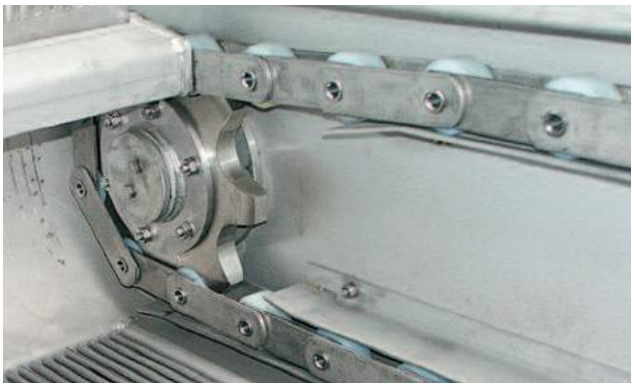


Benefits

- Fine to coarse screen with low head loss
- Removal of extremely high screenings loads
- Unimpaired by grit
- Low height above operating level
- Enclosure prevents odor nuisance
- Frame-mounted bar rack for exact rake engagement and reliable cleaning
- Mechanical overload-prevention and automatic reverse
- Easily accessible chain tensioning system
- Independently replaceable rake bars and blade sections
- Well-proven, maintenance-free lower ceramic bearings
- Sturdy design, excellent manufacturing with small tolerances
- Made of stainless steel, pickled in an acid bath for perfect finishing and corrosion protection

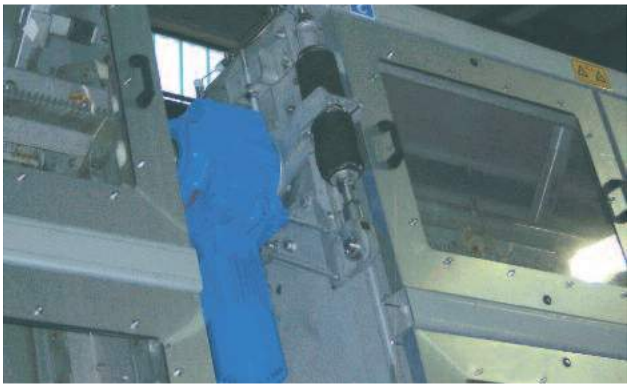
Details

Traveling rakes are bolted to the drive chains; individual sections of the rake blades can be exchanged in case that teeth should become damaged or worn; the ceramic bearings are maintenance-free (no lubrication)



Cog wheel and chain are made of hardened, wear-resistant steel that is zinc -galvanized and chromated for long-term corrosion protection; alternatively, wheels and chains can be made of stainless steel

Bar rack with a spacing of 1/4 inch (6 mm); the bars have a streamlined tear drop profile resulting in low head loss and avoiding jamming; RakeMax screens are unimpaired by grit and gravel



A torque restrictor reliably protects the screen against damage. The screen’s controls combine reliability with adjustability.

Installation Examples

60 ft long and 6 ft wide RakeMax after successful factory testing

Complete enclosure for odor control; the chain tensioning system at the side of the frame is easily accessible

Applications

The RakeMax® is the ideal screen for the following applications:

- Combined sewer systems
- Deep to very deep channels
- High screenings loads
- Combined sewer overflows (CSO) and sanitary sewer overflows (SSO)

Dimensions

Bar spacing:	≥ $^1/_4$" (≥ 6 mm)
Channel width:	Up to 13.1 ft (4 m)
Discharge height above channel floor:	Up to 65 ft (20 m)
Inclination:	70° to 85°

1/4 inch (6 mm) RakeMax feeding into a Super-Launder Washpress WAP/SL for perfect screenings washing and compaction

HUBER TECHNOLOGY, Inc.

9735 NorthCross Center Court STE A · Huntersville, NC 28078
Phone: (704) 949 - 1010 · Fax: (704) 949 - 1020
huber@hhusa.net · http://www.huber-technology.com

Subject to technical modification
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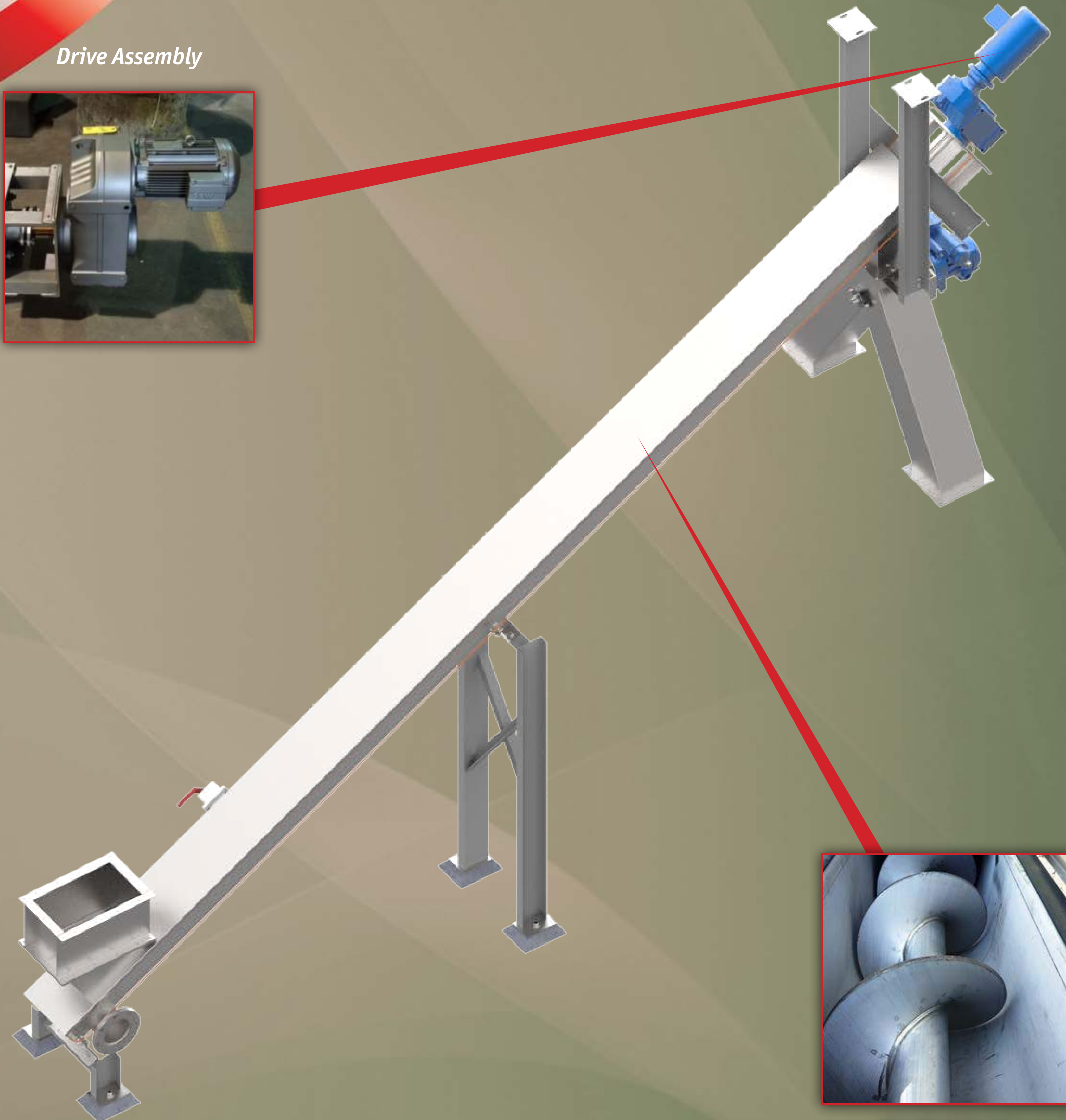
HUBER Multi-Rake Screen
RakeMax®

50 YEARS of EXCELLENCE
JMS
JIM MYERS & SONS, INC.

Bio-SCREW
Screw Conveyor System

Proven ... Process ... Performance

Drive Assembly



Shafted Screw

JIM MYERS & SONS, INC.

Since being established in 1962, Jim Myers & Sons, Inc. (JMS) has grown continually and today is recognized as one of the nation's leading designers and manufacturers of water and wastewater treatment equipment and systems. We have reached this point by incorporating equal parts innovation, quality and reliability into every component bearing the JMS name. We maintain that leadership position through one of the most comprehensive, solution-driven product offerings available.

Utilizing the latest software for BIM-compliant mechanical and structural design with commercial and proprietary analysis programs, our professional engineering staff makes concepts reality by providing solutions to complex problems.

True to our roots, our 72,000 sq. ft. Charlotte facility is the site for all fabrication, manufacturing, machining, and testing. There, the JMS commitment to excellence, a part of our DNA, manifests itself every day with the promise to continue for generations to come.

Bio-SCREW
Screw Conveyor System

Proven ... Process ... Performance

It is not possible to sum up in a few words what has taken better than half a century to achieve, but these three come the closest. Our Bio-SCREW (Screw Conveyor System) design is already proven in applications throughout the U.S. and abroad. JMS in-depth knowledge of both the water and wastewater treatment markets allows us to fully understand your process and provide solutions like the Bio-SCREW, solutions designed with operational efficiency in mind. Like all JMS products, our Bio-SCREW offers an unsurpassed level of performance geared around the longest possible component life and the lowest maintenance demands of any comparable system.

Just three words: Proven, Process, Performance, speak volumes. JMS has the answers you want, the solutions you need, and the support you deserve.

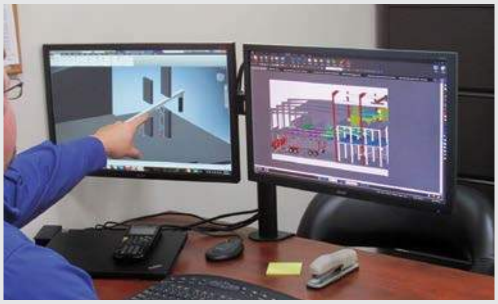
Bio-SCREW Installation in Sacramento, CA

Positive Progress

Screw technology has a long history of usefulness. Screw conveyors are currently used in many industries as they represent one of the most flexible bulk material conveyance methods available. Simple in design, the conveyor screw initiates a smooth, continuous forward movement of material. Both shafted and shaftless screw conveyors are used in the municipal water and wastewater industries to convey dewatered biosolids, sludge, screenings or grit.

Screw conveyors are compact in design, and are easily adapted to congested locations for conveyance of materials in the horizontal, inclined, or vertical directions. They offer several advantages for environmental applications such as total enclosure of materials for odor and spillage control, and the ability to handle a wide variety of materials from wet to dry, and slow-moving to free-flowing.

Screw conveyors are available in a variety of materials of construction. The ability to have multiple entry and discharge points and many options for flow control often make this type of conveyor a key component of larger material handling systems.



Conveyor Analysis Software

Why Use a Screw?

JMS is one of the largest and most established suppliers of screw conveyors for municipal and large industrial applications in North America. We use our extensive knowledge of conveyors and systems to provide custom solutions that can save dollars and maximize operational efficiency. JMS Bio-SCREW conveyors are manufactured to accepted CEMA standards, taking advantage of JMS half century of design and manufacturing experience. JMS can design shafted or shaftless conveyors in multiple configurations to meet the needs of your process, and provide heat tracing and insulation if desired. Using the latest in materials and manufacturing technology, hundreds of JMS Bio-SCREW conveyors are still in operation.

Advantages: Bio-SCREW

- Shafted and shaftless designs available in several configurations and live bottom
- Complete enclosure during conveyance eliminates spilling and odors, so less housekeeping is required
- Perfect for congested locations
- Wide range of capabilities, with multiple inlets and discharges as needed
- Can handle high temperature, abrasive, and sticky materials
- Wide capacity range, and can be used to mix or meter materials
- Special safety features

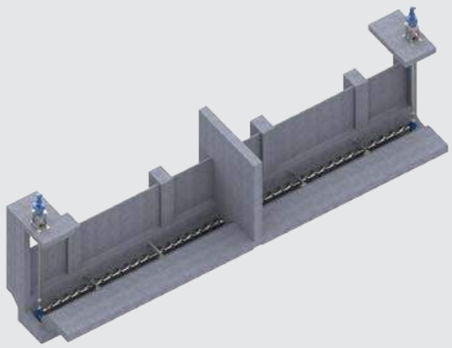
Advantages: JMS

- Professional Engineers on staff
- Integrated solutions provider
- Use of Conveyor Analysis Design Software for conveyors of most any length, geometry, or drive configuration
- CEMA manufacturer, JMS high level of CEMA involvement helps set standards for the future
- Project management expertise
- Experienced service personnel and OEM replacement parts available
- Longevity with hundreds of conveyors currently in service

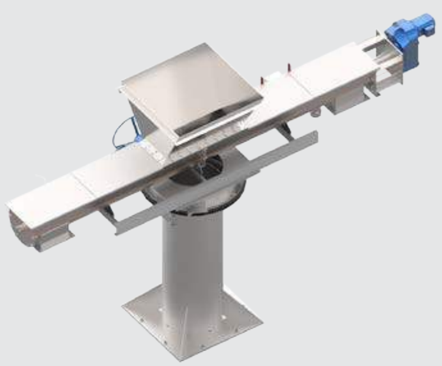
Horizontal

Inclined

Horizontal to Inclined

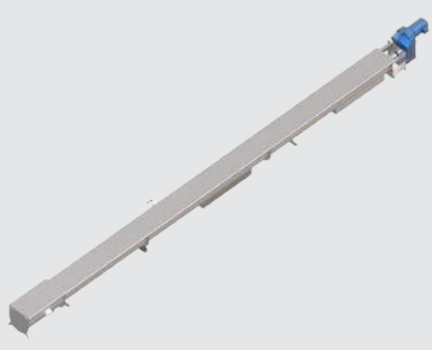


Submerged Screw



Center Pivot

Tail Pivot



Compacting Head

Truck Load-Out

Shafted Screw Conveyors

Shafted Screw

A robust versatile option that can handle a variety of highly abrasive and viscous materials. The best choice for systems that need reversing capabilities.

CEMA 226 Hanger Bearing

Designed for flush mounting inside the trough, this configuration promotes contaminant-proof operation and reduces the obstruction of material flow in high capacity conveyors.

JMS Flexible Hanger Bearing

This special JMS stainless steel flexible element accommodates misalignment of the shaft and has a longer service life than a standard CEMA 226 journal bearing.

Covers

- Numerous cover hold down mechanisms are available ranging from bolted to spring and toggle clamps
- A full range of options allows JMS to configure equipment to meet your specific needs

End Seal Assembly

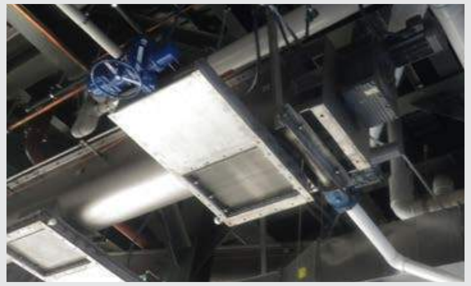
- Seal assembly prevents unwanted leakage at the shaft-trough interface
- JMS has extensive experience in leak prevention and can assist you in specifying the best seal arrangement for your application

Zero Speed Switch

- Protects equipment and process
- Contacting and non-contacting types available
- Increase process reliability, and lower maintenance costs

Drive Assembly

- Standoff bracket keeps conveyed material from entering the gearbox
- Upgraded for heavy duty operation, and suitable for wash-down duty



Bio-GATE (Slide Gate)

- Used with screw conveyors that have multiple discharge points
- Manufactured from stainless steel
- Manual handwheel or an electric, pneumatic, or hydraulic actuator

Bio-VALVE (Diverter Valve)

- Consists of 2-way or 3-way diverter valve for solid materials
- Manual chain wheel, handwheel, or an electric, pneumatic, or hydraulic actuator available

Shaftless Screw Conveyors

Shaftless Screw

This design eliminates hanger bearings. Spirals are formed from nickel-alloy steel with high hardness providing a combination of corrosion and abrasion resistance.

Liners

Specialty ultra-high molecular weight two color liners provide a visual indication of wear. Premium blends and abrasion resistant wear bars can also be used to extend working life.

End to End

Since no end bearing is required, two shaftless conveyors can be connected end to end, reducing required elevation and simplifying transfers.

Success Stories

Tallahassee, FL is nestled in the rolling hills of northwest Florida. This area is the location of the Wakulla Springs, one of the world's largest freshwater springs. The shallow aquifer is vulnerable to pollution including stormwater runoff and nitrates from wastewater treatment. The city of Tallahassee's main wastewater treatment plant, Thomas P. Smith WRF, is located near the springs.

In the early 2000s the city began a study to determine how to improve the quality of reuse water and to protect the water quality of Wakulla Springs. Under the guidance of engineering giant Hazen and Sawyer a plan was developed for upgrading the system. As a part of the process, biosolids are separated from the liquid and dried for eventual use as a Class A Biosolid.

Conveyance of biosolids within the dewatered sludge building and to the dryer building is an important part of the process. For the project, six JMS Bio-SCREW conveyors of various lengths and configurations were purchased. After three years of operation, Warren Shepherd, a long-time manager of the Biosolids area, reports that all conveyors have been running full-time without issues and that he could not be more pleased with the equipment.

System Integration

In addition to Bio-SCREW, JMS expertise extends to a host of other products and systems listed at right. Having such a broad and varied range of experience means your water and wastewater needs, whether individual component or full system, are understood. Optimized efficiency and process performance are yours for the asking. **Contact JMS today.**

Bio-HANDLING
Material Handling Systems

Bio-HANDLING
Material Handling Systems

Bio-BELT
Belt Conveyor System

Bio-SCREW
Screw Conveyor System

Bio-HOPPER
Live Bottom Hopper

Bio-VALVE
Diverter Valve

Bio-GATE
Slide Gate

Mega-TREATMENT
Water Treatment Systems

Delta-SEPARATION
Separation Systems

Eco-AIR
Low Profile Cascade Aerator

JMS
JIM MYERS & SONS, INC.

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Phone: 704-554-8397 Fax: 704-554-9113
Email: sales@jmsequipment.com
Web: www.jmsequipment.com

"Making a Difference for Generations"

Your JMS Sales Representative:

Flygt N-pump Series

SELF-CLEANING PUMPS WITH SUSTAINED HIGH EFFICIENCY

FLYGT
a xylem brand

Sustained high efficiency is priceless

Flygt N-pumps take on the toughest applications and get the job done. Every component is designed and manufactured to deliver sustained high efficiency. Thanks to the patented N-technology with its innovative self-cleaning impeller, Flygt N-pumps deliver the highest total efficiency – lowering your energy bill and reducing unplanned maintenance costs. That adds up to total peace of mind – and big savings over the long term.

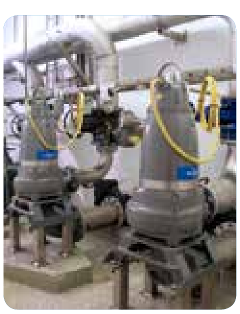
Our vast fluid handling knowledge and dedication to research and development lead to technological advances and continuous improvement.

That's why our Flygt N-pumps are at work in more than a hundred thousand installations worldwide. They have proven to be the best and most reliable choice for both dry and submersible installations far and away over our competition.

Robust and reliable

Every Flygt N-pump is tested in the factory to ensure high performance and premium quality. Flygt products deliver outstanding, cost-effective performance that has been proven in applications such as:

- Wastewater
- Stormwater
- Sludge
- Industrial effluent
- Raw water
- Cooling water



THE N-PUMP ADVANTAGE

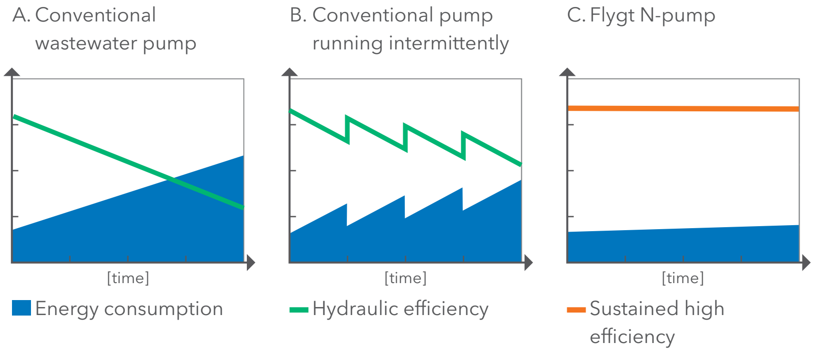
- Patented technology
- Innovative design
- Sustained high efficiency
- Self-cleaning ability
- Modular design
- Reliable
- Fewer unplanned service calls

BROAD RANGE CAPACITY

- Ratings from 2.2 hp to 870 hp
- Discharges up to 20" (500 mm)
- Flows up to 16,000 US GPM (1,000 l/s)
- Heads up to 400 ft (120 m)
- Submersible and dry installations
- Every Flygt pump is performance tested in the factory
- Can handle dry solids up to 8%

Self-cleaning N-pump saves money

Sustained high efficiency
When solid objects such as stringy fibrous material and modern trash enter the inlet of a conventional pump, they tend to get caught on the leading edges of the impeller vanes. This buildup reduces the impeller's efficiency, resulting in increased power consumption (Fig. A) and generating increased energy charges.



As solids continue to build up inside the impeller, motor thermal protection can trip causing the pump to stop and leading to costly unplanned service calls. If a conventional wastewater pump runs intermittently, the solids buildup will be removed by backflushing when the pump is shut off at the end of the operating cycle. When the next cycle begins, efficiency returns to its initial value since the impeller is free from solid objects (Fig B).

The high efficiency of the Flygt N-pump is sustained over time due to its self-cleaning ability, keeping energy costs to a minimum (Fig. C).

All Flygt N-pumps have the same self-cleaning performance regardless of duty point.

THE SELF-CLEANING CONCEPT

Stage 1. Most solid objects entering the pump will pass through the impeller between the impeller vanes. If an object gets caught on the leading edge of one of the vanes, it will slide along the backswept shape towards the perimeter of the inlet.

Stage 2. The solid object will slide along the tip of the impeller vane inside the relief groove. The guide pin in the insert ring will push all types of solids away from the center of the impeller, along the leading edge and out through the relief groove.

Broad capacity range to suit your application

Flexible and modular design
Flygt N-technology enables you to tailor the hydraulics to meet the requirements of virtually any application. Choose the hardened cast iron version for typical wastewater applications and the chopper ring version for cutting long fibers or solids. The Hard-Iron™ version should be used in abrasive applications and waters that could cause erosion corrosion due to high oxygen content.

Whatever you choose, you never sacrifice pump efficiency – and you can easily switch the module if the operating conditions change.

Cast iron

Cast iron impeller with hardened edges and insert ring for typical pumping applications.

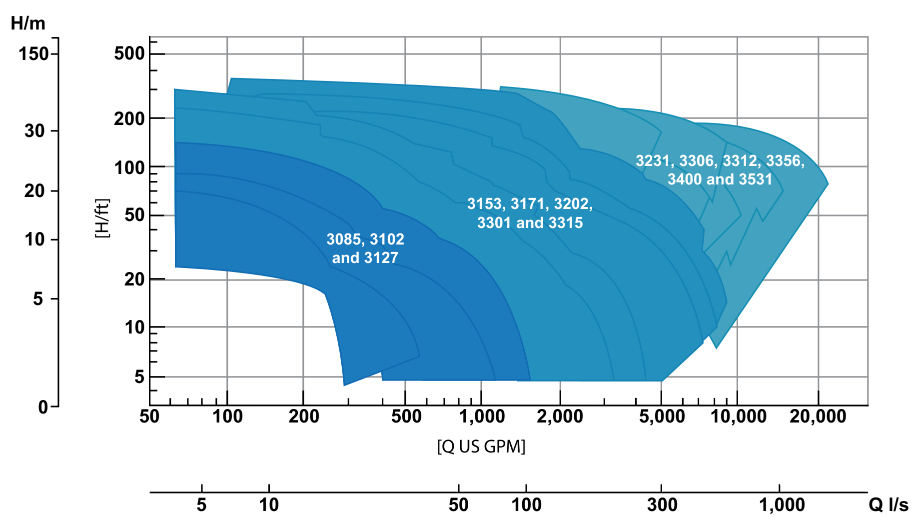
Hard-Iron™ (60 HRC)

Extra durable option for abrasive and erosion corrosion applications.

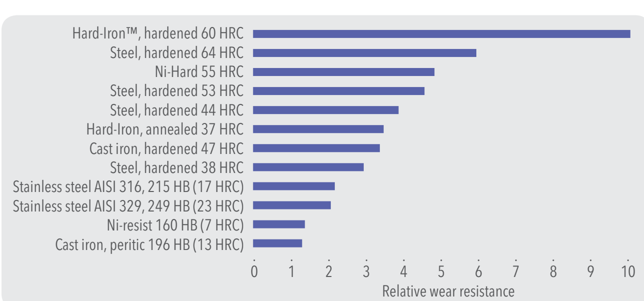
Chopper ring for cutting long fibers or solids.

Top performance with a broad capacity range

- Large capacity pumps
- Medium capacity pumps
- Low capacity pumps



Composite curves for comparison purposes only. Consult engineering data for exact flow and head capabilities.



HARD-IRON™ (60 HRC) FOR THE TOUGHEST WASTEWATER CHALLENGES

Accelerated wear tests prove that Hard-Iron™ hydraulic components keep on working efficiently with minimal wear after pumping water with a very high concentration of coarse sand (2,400 tons).

Flygt N-pumps with Hard-Iron™ components continue to deliver sustained high efficiency without clogging or erosion corrosion, prolonging lifetime by 200 percent compared to standard hardened cast iron hydraulics.

Designed and engineered for longer life

Xylem specially designs and manufactures Flygt N-pump components, such as the motor, seals and shaft, to optimize operation and prolong pump service life.

Motor

The Class H squirrel-cage induction motor delivers outstanding performance and superior heat transfer in submersible and dry installations. Heat losses are concentrated around the shrink-fitted stator, which is cooled by means of the surrounding water. The motor has a NEMA Class B maximum operating temperature rise of 80°C (176°F) to ensure long service life. All motors are capable of fully utilizing the available power while operating on a variable frequency drive.

For an even higher overall efficiency, premium efficiency motors IE3 are available.

Long-life seals

Durable tungsten carbide seals offer exceptional mechanical strength as well as superior sliding properties even when running dry. These low-friction seals withstand thousands of hours of high-pressure operation under extreme conditions without cracking, seizing up or showing signs of unacceptable wear.

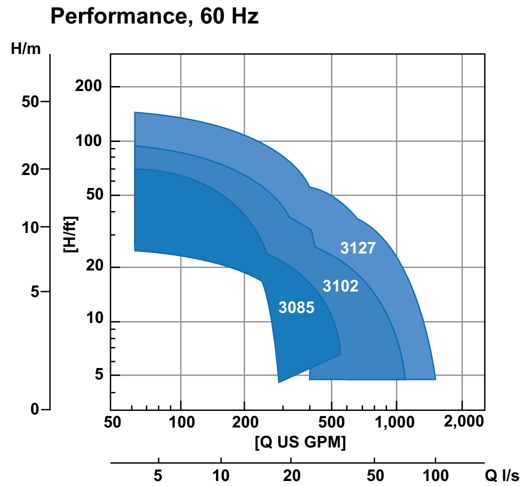
Low shaft deflection

To minimize vibration, promote quiet operation, and prolong seal and bearing life, all Flygt N-pumps feature a short shaft overhang to reduce shaft deflection.

SPIN-OUT™ SEAL PROTECTION FOR PUMPS WITH CAVITIES IN THE SEAL CHAMBER

The patented Spin-out™ design expels abrasive particles from the seal chamber, providing protection against wear of the outer seal. As an integral part of the seal chamber, Spin-out™ is as simple as it is effective.

Low capacity pumps



This series of Flygt N-pumps includes three models that handle capacities up to 1,600 US GPM (100 l/s). Like all Flygt N-pumps, these contribute to reducing the total life cycle costs of your installation.

Power ratings and size

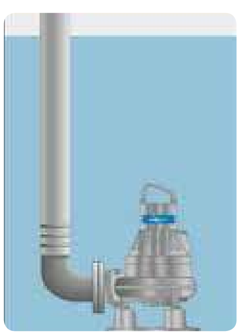
Model	3085	3102	3127
Rating, hp	2.2–4	5–6	7.5–11
Discharge, in	3" (80 mm)	3" (80 mm)	3" (80 mm)
		4" (100 mm)	4" (100 mm)
		6" (150 mm)	6" (150 mm)

Methods of installation

P

For semi-permanent wet well installations. The pump is installed with twin guide bars on a discharge connection.

S

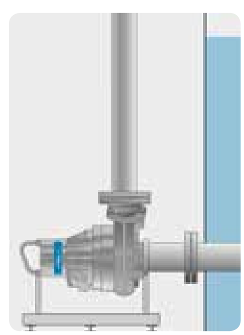


A semi-permanent freestanding installation. Transportable version with pipe or hose connection.

T

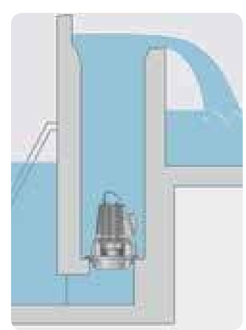
A vertically-mounted, permanent dry well or in-line installation with flange connections for suction and discharge pipework.

Z



A horizontally-mounted, permanent dry well or in-line installation with flange connections for suction and discharge pipework.

L



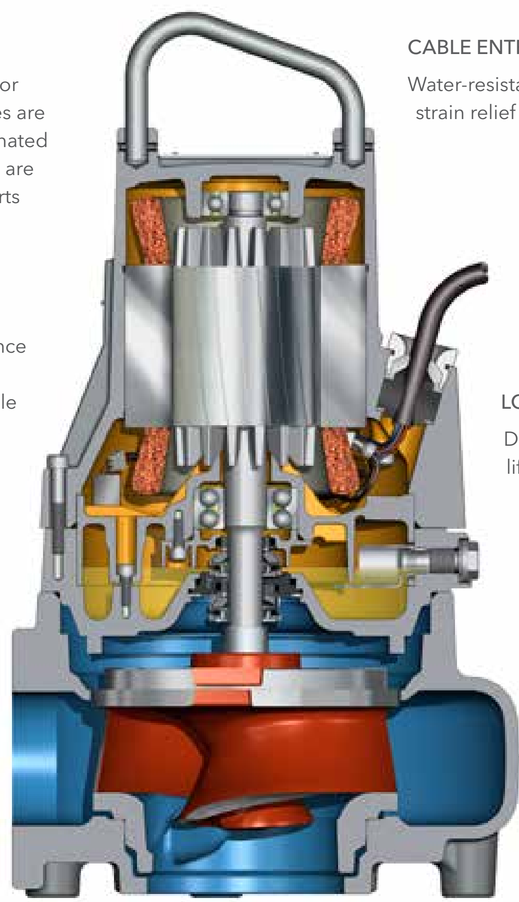
A semi-permanent installation of a pump within a vertical steel or concrete column.

BETTER HEAT TRANSFER

Our specially designed and manufactured motor provides enhanced cooling because heat losses are concentrated around the stator. Trickle impregnated in resin (Class H insulation), the stator windings are rated at 180°C (355°F) and enable up to 30 starts per hour.

COMPLIANCE

Each pump is tested and approved in accordance with national and international standards, including 60034-1 and CSA. Pumps are available in explosion-proof versions for use in hazardous environments, and are approved by the Factory Mutual, European Standard and IEC.



CABLE ENTRY

Water-resistant cable entry provides both sealing and strain relief functions to ensure a safe installation.

SENSORS

Thermal sensors embedded in the stator windings prevent overheating. Optional leakage sensors in the stator and oil housings are also available.

LONG-LIFE BEARINGS

Durable bearings provide a minimum service life of 50,000 hours.

ENDURING SEALS

The Griploc™ system consists of two sets of mechanical shaft seals that operate independently to provide double security against leakage.

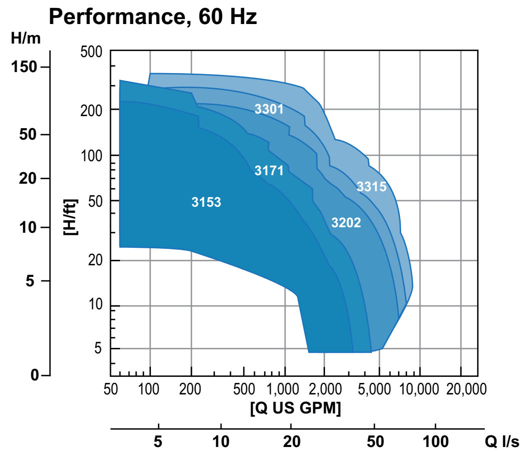
Griploc™ seal

With a robust design, Griploc™ seals offer consistent performance and trouble-free operation in challenging environments. Solid seal rings minimize leakage and the patented griplock spring, which is tightened around the shaft, provides axial fixation and torque transmission. In addition, the Griploc™ design facilitates quick and correct assembly and disassembly.

Adaptive N-impeller

The Flygt N3085 – N3127 feature an adaptive self-cleaning N-impeller that can move axially to enable easy passage of large solids through the pump.

Medium capacity pumps



For demanding pumping duties, five models handle fluid transport for capacities up to 8,000 US GPM (500 l/s). Highly efficient, these heavy-duty models provide clog-free performance in order to achieve the best overall life cycle cost.

Power ratings and size

Model	3153	3171	3202	3301	3315
Rating, hp	12-23	25-35	35-75	60-105	85-160
Discharge, in	3" (80 mm)	4" (100 mm)	4" (100 mm)	6" (150 mm)	6" (150 mm)
	4" (100 mm)	6" (150 mm)	6" (150 mm)	10" (250 mm)	10" (250 mm)
	6" (150 mm)	10" (250 mm)	8" (200 mm)	12" (300 mm)	12" (300 mm)
	8" (200 mm)			14" (350 mm)	14" (350 mm)
	10" (250 mm)				

Methods of installation

P

For semi-permanent wet well installations. The pump is installed with twin guide bars on a discharge connection.

S

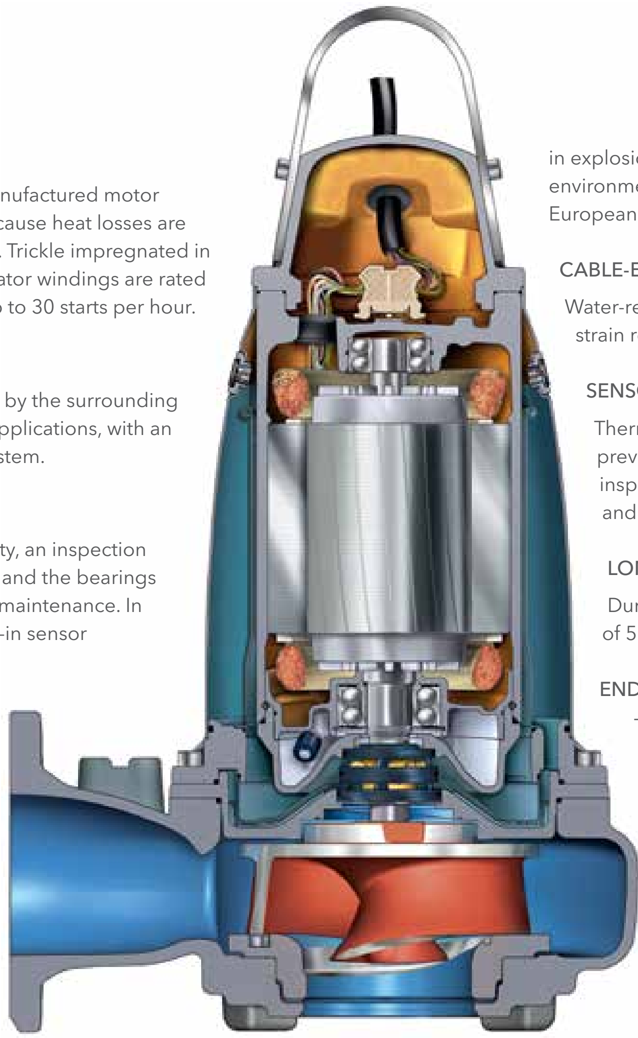
A semi-permanent freestanding installation. Transportable version with pipe or hose connection.

T

A vertically-mounted, permanent dry well or in-line installation with flange connections for suction and discharge pipework.

Z

A horizontally-mounted, permanent dry well or in-line installation with flange connections for suction and discharge pipework.



BETTER HEAT TRANSFER

Our specially designed and manufactured motor provides enhanced cooling because heat losses are concentrated around the stator. Trickle impregnated in resin (Class H insulation), the stator windings are rated at 180°C (355°F) and enable up to 30 starts per hour.

EFFICIENT COOLING

These pumps are cooled either by the surrounding liquid or, in more demanding applications, with an internal closed-loop cooling system.

INSPECTION CHAMBER

To increase operational reliability, an inspection chamber between the seal unit and the bearings enables rapid spot checks and maintenance. In the case of a seal failure, a built-in sensor provides an early warning of any fluid buildup, thus reducing the risk of expensive repair work.

COMPLIANCE

Each pump is tested and approved in accordance with national and international standards, including IEC60034-1 and CSA. Pumps are available in explosion-proof versions for use in hazardous environments, and are approved by the Factory Mutual, European Standard and IEC.

CABLE-ENTRY

Water-resistant cable entry provides both sealing and strain relief functions to ensure a safe installation.

SENSORS

Thermal sensors embedded in the stator windings prevent overheating, and a leakage sensor in the inspection chamber minimizes the risk for bearing and stator failure.

LONG-LIFE BEARINGS

Durable bearings provide a minimum service life of 50,000 hours.

ENDURING SEALS

The Flygt Plug-in™ seal with the Active Seal™ system offers increased sealing reliability and zero leakage into the motor, thereby reducing the risk of bearing and stator failure.

Flygt Plug-in™ seal with Active Seal™ system

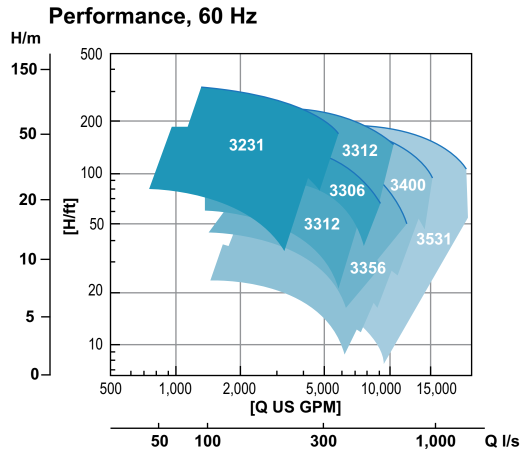
The Flygt Plug-in™ seal is a seal unit that eliminates the risks associated with incorrect installation and careless handling. It comprises the Active Seal™ system in one easy-to-handle unit.

The Active Seal™ system is a patented zero-leakage double-seal system that actively prevents liquid from entering the motor cavity, thereby reducing the risk for bearing and stator failure. It comprises a unique inner seal that acts as a micro-pump and an outer seal that prevents leakage of pumped media into the buffer chamber.

Inner seal with laser-cut spiral grooves.

Laser-cut grooves on the inner seal create a hydrodynamic pumping effect that prevents any leakage from entering the motor. This translates into enhanced sealing reliability, reduced downtime and fewer unscheduled maintenance checks. In addition, regular service inspections can be prolonged in many applications.

Large capacity pumps



When higher capacity is required, the Flygt N-pump series has five pumps to do the job. These models deliver unprecedented pumping power – reliably and efficiently.

Power ratings and size

Model	3231	3306	3312	3356	3400	3531
Rating, hp	90–335	70–280	90–470	70–280	60–470	60–870
Discharge, in	8" (200 mm)	12" (300 mm)	12" (300 mm)	14" (350 mm)	16" (400 mm)	20" (500 mm)

Methods of installation

P

For semi-permanent wet well installations. The pump is installed with twin guide bars on a discharge connection.

S

A semi-permanent freestanding installation. Transportable version with pipe or hose connection.

T

A vertically-mounted, permanent dry well or in-line installation with flange connections for suction and discharge pipework.

Z

A horizontally-mounted, permanent dry well or in-line installation with flange connections for suction and discharge pipework.

BETTER HEAT TRANSFER

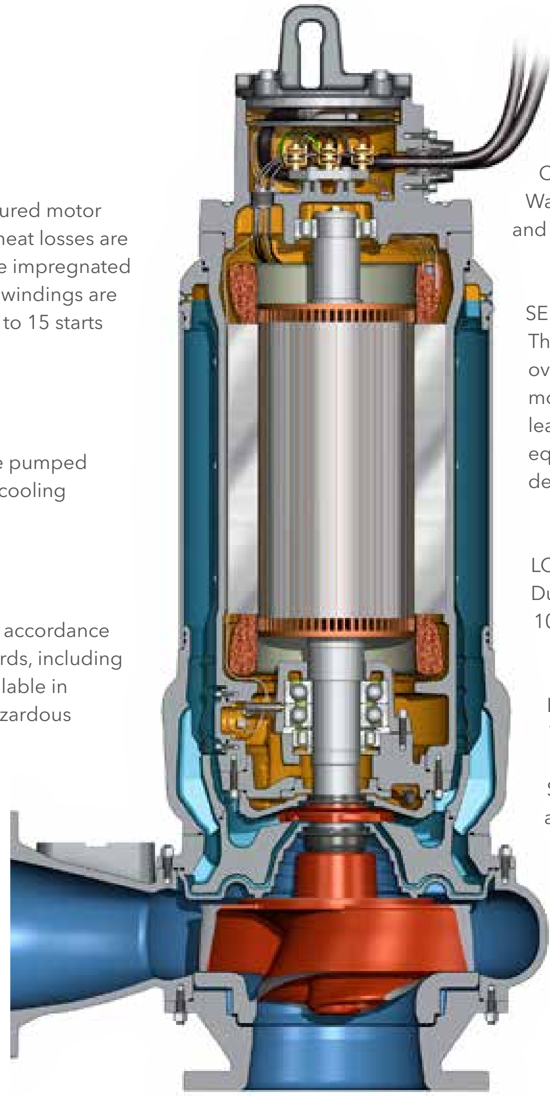
Our specially designed and manufactured motor provides enhanced cooling because heat losses are concentrated around the stator. Trickle impregnated in resin (Class H insulation), the stator windings are rated at 180°C (355°F) and enable up to 15 starts per hour.

EFFICIENT COOLING

These pumps are cooled either by the pumped liquid or with an internal closed-loop cooling system.

COMPLIANCE

Each pump is tested and approved in accordance with national and international standards, including IEC 60034-1 and CSA. Pumps are available in explosion-proof versions for use in hazardous environments, and are approved by the Factory Mutual, European Standard and IEC.



CABLE ENTRY

Water-resistant cable entry provides both sealing and strain relief functions for a safe installation.

SENSORS

Thermal sensors in the stator windings prevent overheating, and an analog temperature sensor monitors the lower bearing. The stator housing/ leakage chamber and the junction box are equipped with leakage sensors. The sensors decrease the risk of bearing and stator failure.

LONG-LIFE BEARINGS

Durable bearings provide a minimum service life of 100,000 hours.

ENDURING SEALS

Two sets of mechanical shaft seals work independently for double security. The Active Seal™ system offers increased sealing reliability and zero leakage into the motor, thereby reducing the risk of bearing and stator failure.

Zero leakage into the motor cavity

The Active Seal™ system is a patented zero-leakage double-seal system that actively prevents liquid from entering the motor cavity, thereby reducing the risk for bearing and stator failure. It comprises a unique inner seal that acts as a micro-pump and an outer seal that prevents leakage of pumped media into the buffer chamber.

Laser-cut grooves on the inner seal create a hydrodynamic pumping effect that prevents any leakage to enter the motor.

This translates into enhanced sealing reliability, reduced downtime and fewer unscheduled maintenance checks. In addition, regular service inspections can be prolonged in many applications.

Complete solutions for your needs

Ready-to-install pre-engineered, prefabricated pumping solutions

Flygt offers several packaged solutions combining our premium N-pumps with dedicated monitoring and control options and pre-fabricated pump stations designed for your needs. The prefabricated pump stations are available in a range of designs and sizes, all supplied complete with the necessary materials and equipment to allow ease and speed of installation and commissioning.

Our packaged solutions have a self-cleaning design and are tested as a system to work perfectly together to give you the ultimate performance within wastewater pumping.

Flygt SmartRun™

Flygt Multismart™

MONITORING AND CONTROL

Our state-of-the-art solutions are designed to ensure pumps work at optimum efficiency, to provide key data, to increase reliability and to prevent pump breakdown.

Our monitoring and control systems are designed for use in a variety of pumping applications. It is the specific conditions at each pump station that help you decide the best monitoring and control solution for your needs. Whether it's wastewater, stormwater, effluent, RAS, WAS, lightly contaminated water or clean water, it all demands a different solution. Naturally each system is designed to work well on its own. However, our pumps and monitoring & control systems are optimized to work even better together.

All Flygt monitoring and control equipment integrate easily into SCADA control systems for remote monitoring and control. Flygt PumpView puts you in Total Control, Your Way.

Engineered pumping solutions

Flygt's standard pump station designs are based on our long history in wastewater pumping. Our engineers work closely with you, from design and system analysis to selection of pumps, installation and monitoring & control solutions. Whether we recommend a proven Flygt standard design or develop a custom solution for you, we can offer you reliable and cost-effective pumping solutions that meet your specific requirements.

FLYGT N-PUMPS: SUBMERSIBLE AND DRY INSTALLATIONS

Flygt N-pumps are an excellent choice for handling solids in dry-pit installations. Originally designed for submersible conditions, our pumps eliminate the risk of damage to the motor due to station flooding. Submersible or dry-installed Flygt N-pumps deliver superior clog-free operation with minimal maintenance and substantial energy savings.

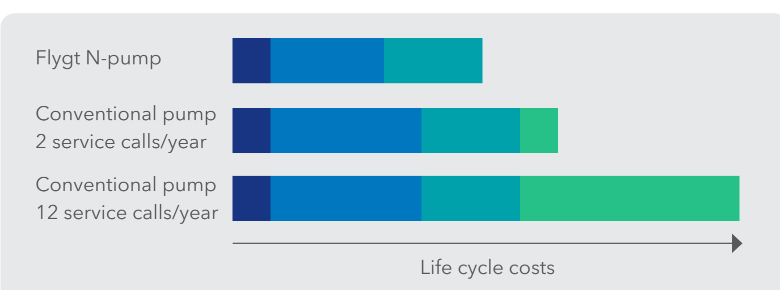
The power to adapt

Options table

Customize your Flygt N-pump with optional equipment.

Flygt N-pump model	3085	3102	3127	3153	3171	3202	3301	3315	3231	3306	3312	3356	3400	3531
Option/Product														
Motor														
Premium efficiency (IE3)	◖	◖	◖	◖	◖	◖	◖		◌	◌	◌	◌	◌	◌
Hydraulic														
Guidepin	●	●	●	◐	◐	◌								
Hard-Iron™	◐	◐	◐	◐	◐	◐	◐	○	○		○	○		○
Chopper			○	◌	◌	◌								
Adaptive N	●	●	●											
Seal system														
Griploc™ seal	●	●	●											
Plug-in™ seal				●	●	●	●	●						
Active Seal™				●	●	●	●	●	●	●	●	●	●	●
Spin-out™	●	●	●	●	●	●	●	●	◖	◖	◖	◖	◖	◖
Seal flush									○	○	○	○	○	○
Cooling system														
1. w/o cooling jacket	●	●	●	○	○	○	○	○	○	○	○	○	○	○
2. Closed Loop Cooling				●	●	●	●	●	◌	◌	◌	◌	◌	◌
3. Pump media									●	●	●	●	●	●
4. External				○	○	○	○	○	○	○	○	○	○	○
Installation														
P	●	●	●	●	●	●	●	●	●	●	●	●	●	●
S	●	●	●	●	●	●	◐	◐	●	●	●	◌	◌	◌
T	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Z	●	●	●	●	●	●	●	●	●	●	●	●	●	●
L		●	●											
Accessories														
Flush valve	○	○	○	◌	◌	◌	◌	◌						
Pump monitor *Prepared for*														
– Mini CAS	●	●	●	●	●	●	●	●						
– MAS					○	○	○	○	●	●	●	●	●	●
Pump control														
– SmartRun™	○	○	○	○	○	○	○							
– MultiSmart™				○	○	○	○	○	○	○	○	○	○	○
– FGC	○	○												

● = Standard
○ = Optional
◐ = Standard but also optional depending on model
◖ = Standard or not available depending on model
◌ = Optional or not available depending on model



SELF CLEANING SAVES MONEY

Schematic overview of calculations made on a 30kW Flygt N-pump

Purchase cost
Energy cost
Service cost
Unplanned maintenance cost

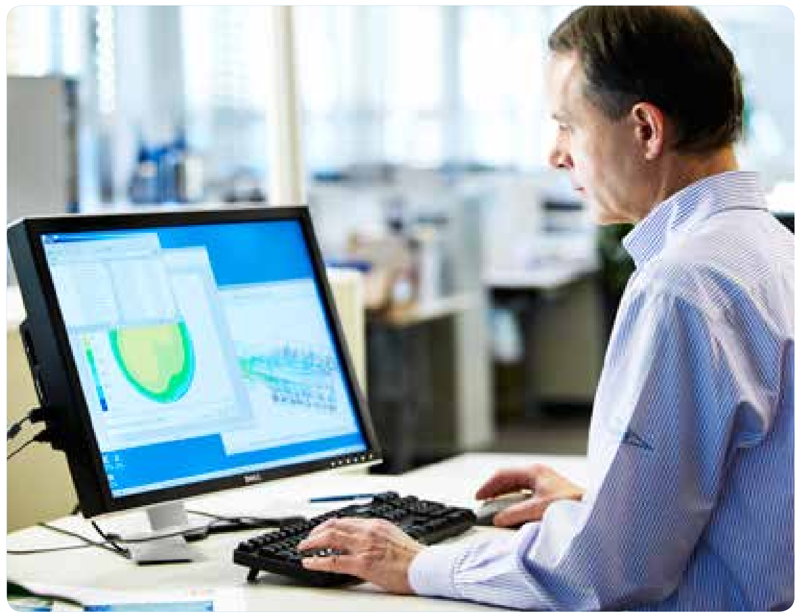
Supporting your business, every step of the way

Extensive engineering know-how
Xylem has extensive knowledge of fluid dynamics and vast practical experience in designing, operating and maintaining efficient wastewater transport systems. We provide a broad range of engineering services, including:

- System analysis and calculations
- Sump design
- Water hammer calculations
- Pump start analysis
- Transient analysis
- Computational Fluid Dynamics (CFD)
- Scale model testing

In short, we can assist you with everything you need for optimal performance and economical, energy-efficient operation.

Empower your system
With Flygt monitoring and control products, you can control and optimize the performance of every component of your system. This helps reduce stress on pumps, valves and mains, enable reliable, efficient operation, and prolong service lifetime.



Support for your Flygt pumps
Our global network of local service centers and service partners provide integrated services to support safe, efficient and reliable operation. To ensure trouble-free operation and minimal downtime, count on us for quick, professional response and quality maintenance services, using genuine Flygt spare parts.

EXTENSIVE MONITORING AND CONTROL

We supply hardware and software for complete process systems – from individual pump drives, starters, sensors and controllers to system software and scalable SCADA systems.

GENUINE FLYGT SPARE PARTS AND WARRANTY

When downtime isn't an option, rely on our global service network to deliver genuine Flygt spare parts to you – quickly and efficiently. All Flygt spare parts are backed by a solid 15-year availability guarantee. Large capacity pumps offer a 20-year availability guarantee.

Xylem ['zīləm]

1) The tissue in plants that brings water upward from the roots
2) A leading global water technology company

We're 12,000 people unified in a common purpose: creating innovative solutions to meet our world's water needs. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. We move, treat, analyze, and return water to the environment, and we help people use water efficiently, in their homes, buildings, factories and farms. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise, backed by a legacy of innovation.

For more information on how Xylem can help you, go to xyleminc.com.

FB002 • Flygt N - Pump Series Brochure • 7/2015 • NACT

Let's Solve Water

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www.xyleminc.com

HUBER Vortex Grit Chamber VORMAX

Grit separation through constant radial flow

– High grit separation through tangential feed introduction at bottom level
– High throughput capacity of up to 3,000 l/s
– Worldwide well-proven, reliable technology

Design and function

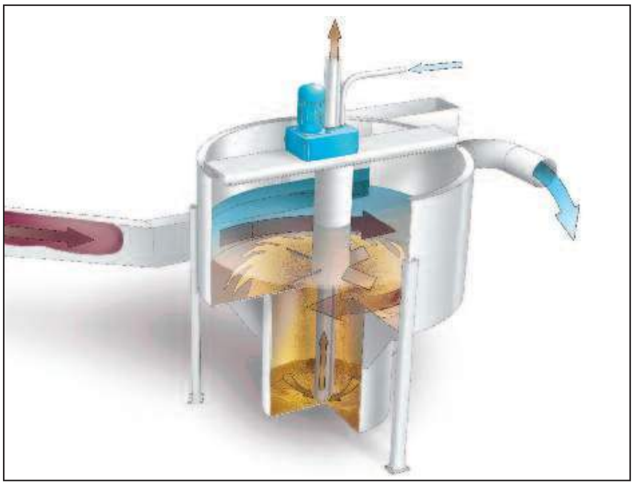
Grit separation from wastewater helps prevent operational problems such as grit sedimentation, increased wear and blockages.

Grit separation with the HUBER Vortex Grit Chamber VORMAX starts already in the inlet channel to the grit trap. Like in an unaerated longitudinal grit trap the grit sinks downs to the channel bottom from where it is transported into the circular grit trap along with the wastewater flow. A tangential rotational movement is generated due to the curved design of the (mostly concreted customer's) concrete tank. A constantly rotating stirrer helps support the wastewater circulation within the grit chamber ensuring a constant velocity of rotation within the complete grit trap system even with greatly varying hydraulic conditions. Due to the constant radial rotation, caused by a secondary flow near to the bottom, the solids are very quickly collected within the centre of the grit chamber from where thy then pass into the bottom of the grit collection tank. The grit-free wastewater then exits and flows onto the next treatment step.

Centrifugal or airlift pumps can then deliver the collected solids from the grit collection tank into a grit classifier or grit washer where the solids can then be subsequently separated and dewatered and organic particles removed.

Benefits

- Compact, space-saving design
- High grit separation efficiency
- Low energy demand
- Throughput capacity up to 3,000 l/s
- Low pressure loss
- Variable inlet and outlet arrangement
- Minimum wear, reduced maintenance
- Optional subsequent grit washing



Flow diagram of a HUBER Vortex Grit Chamber VORMAX

Installation examples

HUBER Vortex Grit Chamber VORMAX installation with HUBER Grit Classifier RoSF3

Reliable bull gear drive for the stirrer

HUBER SE

Industriepark Erasbach A1 · D-92334 Berching
Phone: + 49 - 84 62 - 201 - 0 · Fax: + 49 - 84 62 - 201 - 810
info@huber.de · Internet: www.huber.de

Subject to technical modification
0,15 / 5 – 5.2016 – 8.2005

MONSTER WASH PRESS

The Monster Wash Press is JWC Environmental's latest generation of washer compactors. The Monster Wash Press processes screenings to separate water and organics from the solids. The result is a clean, dry, light and compact discharge which reduces the amount of waste to be dumped, ultimately saving treatment facilities time and money.

The Monster Wash Press may be outfitted with a Muffin Monster® grinder to pre-condition the screenings before they enter the washer compactor. The grinder breaks open rags, plastics and trash to promote washing and removal of soft organics during the wash cycle. Additionally, pre-conditioned screenings result in superior compaction, reducing the volume of discharge that must be hauled away.

Discharge from the pre-conditioning Muffin Monster or directly from the screen enters a Pre-Wash Zone where the debris is soaked to begin the process of separating organics from the solids. An auger rotor transports the soaked debris into the Active Wash Zone of the Monster Wash Press where a paddle spiral rotor* agitates the material, enhancing wash water penetration throughout the debris. The results is the effective washing of soft organics from the solids. The soft organics pass through a screen and are returned to the plant's waste stream for treatment. The washed solids are moved to the Dewater and Compaction Zone where water is removed from the solids and the solids are compacted. The resultant discharge emerges from the Monster Wash Press as a dry, solid plug.

FEATURES AND BENEFITS

Dual Shafted Grinder (optional)

- 30K Muffin Monster grinds screenings discharge for the best washing and compacting
- Easy to retrofit grinderless Monster Wash Press with Muffin Monster

Pre-Wash Zone

- Soaks screenings to jump-start separation of organics from solids
- Brushless auger rotor to promote free movement of debris to active wash zone

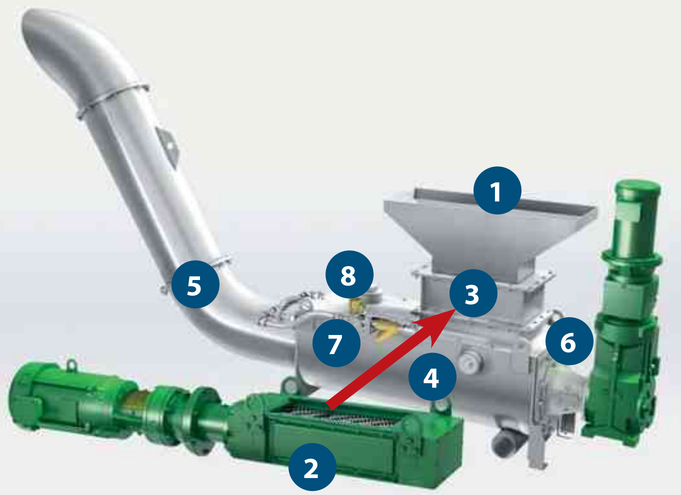
Active Wash Zone

- Paddle spiral rotor* mixes and break-ups debris in wash zone to optimize separation of soft organics from solids
- Brushed rotor keeps screen clean
- Customer defined 2, 3, or 6 mm perforated screen to separate solids from organics

Easy Maintenance

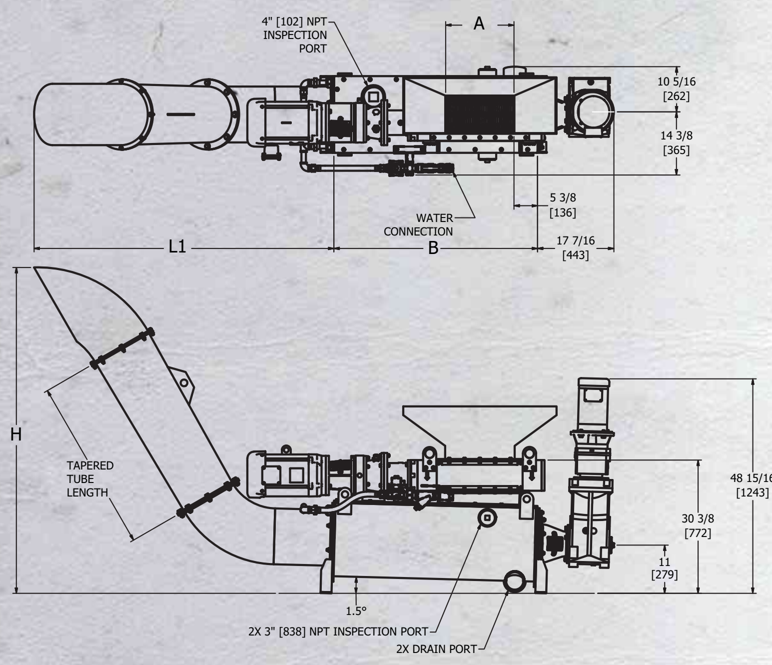
- Segmented auger rotor brush allows in situ brush replacement
- Removable top cover and drive end plate* minimizes clearance space needed to remove rotor and screen
- Field replaceable screen
- Multiple inspection ports for easy examination of equipment and operation

* Patent Pending



MONSTER WASH PRESS DETAILS

1. Hopper collect screenings
2. Muffin Monster grinds up material (optional)
3. Easy to install grinder later
4. Active Wash Zone cleans screenings
5. Cleaned discharge is dewatered and compacted
6. Removable top cover and drive end plate for easy removal of rotor and screen
7. Segmented rotor brush for in-situ brush replacement
8. Inspection ports



STANDARD CONSTRUCTION

- Hopper, Tank, Screen and Discharge Tube: 304 stainless steel
- Auger rotor: Alloy steel
- Grinder with MWP3018: Ductile iron housing, hardened alloy steel cutters

OPTIONAL EQUIPMENT

- 316 stainless steel hopper, tank, screen and discharge tube
- Stainless steel auger rotor
- Discharge bagger
- Stainless steel roller base
- Discharge tip
- Customized hopper
- Customized discharge transport assembly

MWP Model	Basic Model Dimensions - inches (mm)		Drain Port Size - inches (mm)
	A	B	
MWP0018	15-5/8 (396)	46-13/16 (1189)	4" (102) NPT
MWP3018	15-5/8 (396)	46-13/16 (1189)	4" (102) NPT

Discharge Dimensions @60º - inches (mm)		
Taper Length	H	L1
39-3/8 (1000)	74-1/4 (1886)	68-1/2 (1740)
49-1/4 (1250)	82-7/8 (212)	73-3/8 (1864)
59 (1500)	91-3/8 (2321)	78-1/4 (1988)
69 (1750)	100 (2540)	83-1/4 (2115)
78-3/4 (2000)	108-1/2 (2756)	88-1/8 (2238)

FEATURES		
	MWP0018	MWP3018
Grinder Motor, hp (kW)	N/A	7.5 (5.6)
Compaction Screw Motor, hp (kW)	3 (2.2)	3 (2.2)
Upgradable to Add Grinder	Yes	Grinder Included

PERFORMANCE		
	MWP0018	MWP3018
Continuous Throughput - ft³/hr (m³/hr)	200 (5.7)	80 (2.3)
Batch Output - ft³/hr (m³/hr)	75 (2.1)	40 (1.1)

JWC Environmental®
Trust Monster Quality™

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MONSTER INDUSTRIAL IPEC FRC

www.jwce.com

(MWP-2pg-NA-JWCE-0917)

Appendix D

TM 4 PONDS AND WETLANDS IMPROVEMENTS

City of Arcata
Wastewater Treatment Facilities Improvements

Technical Memorandum 4
PONDS AND WETLANDS IMPROVEMENTS

FINAL | April 2019

City of Arcata
Wastewater Treatment Facilities Improvements

Technical Memorandum 4
POND AND WETLANDS IMPROVEMENTS

FINAL | April 2019

This document is released for the purpose of information exchange review and planning only under the authority of
Michelle Trinh,
November 2018,
CA No. C77172
and Steven McHaney,
November 2018
CA No. C47590.

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Abbreviations

AMRI	Arcata March Research Institute
AWTF	Arcata Wastewater Treatment Facility
BOD	Biochemical Oxygen Demand
Carollo	Carollo Engineers, Inc.
CCB	chlorine contact basin
City	City of Arcata
EPPS	Emergency Pond Pump Station
EWPS	Enhancement Wetland (Hauser) Pump Station
EW	enhancement wetland
JB1	Junction Box 1
mgd	million gallons per day
mg/l	Milligrams per liter
pond	oxidation pond
PS	pump station
PPS	Pond Pump Station
PS1	Pump Station 1
PS2	Pump Station 2
RWQCB	Regional Water Quality Control Board
SCADA	supervisory control and data acquisition
TM	technical memorandum
TSS	Total Suspended Solids
TW	treatment wetland
UV	Ultraviolet
VFD	variable frequency drive
WWTP	Wastewater Treatment Plant
wetlands	enhancement and treatment wetlands

Technical Memorandum 4

PONDS AND TREATMENT WETLANDS IMPROVEMENTS

4.1 Purpose

The Arcata Wastewater and Treatment Facility (AWTF) has been using oxidation ponds and wetlands as part of the wastewater treatment system for decades.

The purpose of this Technical Memorandum (TM) is to identify maintenance and improvement projects for the Oxidation Pond (Pond) and Treatment and Enhancement Wetland (Wetland) system consistent with the findings of the previously completed and adopted Facilities Plan to improve treatment and performance, and address selected maintenance issues. The work on the oxidation ponds and wetlands is intended to be completed in concert with mechanical treatment plant upgrades addressed under separate TM's.

4.2 Summary of Findings and Recommendations

The key findings and recommendations of this TM are summarized below:

<u>Oxidation Ponds No. 1 and 2</u>

- Piping and transfer structure additions/modifications for flow equalization.
- Pond 2 Baffling.
- Pond 1 and 2 Aeration.
- Pond 1 Sludge Management.

<u>Pond Pump Station/Pump Station 1</u>

- Eliminate Pump Station 2 (PS2).
- EPPS standby pump and generator connection.
- Construct TW4 pump station (City project).
- Pond Pump Station (PPS) capacity upgrades.
- Pump Station 1 (PS1) capacity upgrades.
- New Force Main from PS1 to Ultraviolet (UV) Basin.

<u>Treatment Wetlands</u>

- Selective Excavation.
- Selective Vegetation Management.
- Selective Baffling.
- Conduits for "Blue Frogs".
- Treatment Wetland 3 Piping Repairs.
- Treatment Wetland 4 Improvements (City project).
- Treatment Wetland 7 Construction (City project).

Enhancement Wetlands

- Flow Reconfiguration and Routing.
- Flow Conveyance.
- Enhancement Wetland (EWPS or Hauser) Pump Station Upgrades.
- EWPS Conveyance Upgrades.
- Selective Excavation.
- Selective Vegetation Management.
- Selective Baffling.

The main features of the existing pond and wetland system are presented in Figure A1 and near term recommended improvements are presented in Figure A2. These oversized figures are provided in Appendix A for convenience.

4.3 Background

The oxidation ponds and wetlands have served as the main treatment system for the City of Arcata for more than 30 years. As is usually the case with wastewater regulations, they have become more stringent over time and it has become increasingly more difficult to meet all regulatory requirements at all times given the variable flow and environmental conditions, and the inherent variable performance of a natural treatment system. The natural variations in performance are often not an issue with modest discharge standards, but the ever more strict requirements are more difficult to meet at all times with the natural system. If the past is any indication of the future, regulations will become even more difficult to meet in the future with a natural system alone. Any such future system that includes pond and wetland treatment elements will need to recognize the potential seasonal variability in performance in these components and any final negotiated permit should recognize this as well.

The Facilities Plan summarizes a number of issues and opportunities at the existing wastewater treatment facility in the context of meeting anticipated regulations. Following several iterations, the City decided to develop an oxidation ditch mechanical treatment system to address what was expected to be lower discharge limits while also incorporating the value the pond and wetland system offers for wastewater management and environmental enhancement.

It is important to clarify the role of the pond and wetland system and the relationship to the planned mechanical upgrades and to identify targeted improvements to the oxidation ponds and wetlands to enhance the value they bring to the overall wastewater management strategy.

While the Regional Board has yet to release an updated permit for the facility, discussions with board staff indicate effluent limits will be more stringent. From a pond and wetland perspective, the most significant new limit being proposed is for ammonia. Although the final limits are not known at this time, indications are they are likely to be below what oxidation ponds and wetlands can typically reliably achieve on their own. This is one of the drivers for adding mechanical treatment that can be configured to meet lower limits. Therefore, the new mechanical system and the upgraded oxidation ponds and wetlands are intended to work together.

4.4 Oxidation Ponds and Wetlands Process Utilization

There is significant potential flexibility in how the overall system operates. The main roles that the oxidation ponds and wetlands are anticipated to serve include the following:

Sludge Management: The oxidation ponds have decades of accumulated sludge and the oxidation ponds with enhanced aeration can help to redistribute and digest the sludge.

Flow Equalization: The variable volume in the oxidation ponds can be used to help manage flows into the treatment wetlands and can be used to moderate overall plant flows.

Treatment: Oxidation ponds and wetlands add treatment capacity. With enhanced aeration and baffling in Pond 2, the oxidation ponds can provide more effective treatment for BOD/TSS/Ammonia removal. Moderate improvements to the treatment wetlands can help with operations and effluent polishing as well.

As discussed in TM5, the oxidation ditch system is sized to treat flows up to 3.6 million gallons per day (mgd). While this represents a majority of the flow conditions, there are times when influent flows are higher during wet weather events and additional capacity provided by the oxidation ponds and wetlands is needed for equalization and treatment. In addition, oxidation ponds and wetlands are part of a natural treatment system that can be operated at lower energy requirements than typical mechanical systems.

The goal is to provide flexibility within the entire system so that operations staff have the ability to incorporate the use of the oxidation ponds and wetlands to optimize overall system performance. This includes the ability to combine mechanical effluent and pond and wetland effluent prior to disinfection. The balance of the flow between the two systems will depend on the influent flow and load conditions, treatment objectives, and operational preferences. In addition, there will be significant periods of time when influent flow is less than the oxidation ditch capacity and piping can be provided to recirculate treatment wetland effluent into the oxidation ditch for further treatment prior to disinfection.

The purpose of the pond and wetland improvements is to complement the new mechanical system components and provide added capacity, flexibility, reliability, and options for operations. This TM focuses on pond and wetland upgrades to help achieve this purpose.

4.5 Oxidation Pond, Treatment Wetland, and Enhancement Wetland Overview

The recommended near term improvements shown in Figure A2 in the Appendix can be grouped into the following four areas:

- Pond 1 and 2.
- Treatment Pump Stations.
- Treatment Wetlands.
- Enhancement Wetlands.

These improvements to the overall pond and wetland treatment system are intended to be completed as part of the broader mechanical wastewater treatment system improvements, such as headworks, oxidation ditch, clarification, and solids management systems. These mechanical upgrades are addressed under separate TMs.

While the new oxidation ditch treatment system is intended to handle dry and wet weather flows up to 3.6 mgd and achieve treatment objectives including, BOD, TSS, and ammonia removal, the oxidation ponds and wetlands serve an important function for managing higher flows, providing effluent polishing, and providing enhancement.

Use of the Enhancement Wetlands is critical to the Arcata WWTP's ability to comply with the Enclosed Bays and Estuaries (EBE) Policy and meet Regional Board permit requirements. The Regional Board has indicated that to meet the definition of enhancement under the EBE policy, all flows up to 5.9 mgd may need to pass through the enhancement wetlands prior to discharge. Therefore, the new mechanical systems must work in concert with the upgraded oxidation ponds and wetlands systems to achieve regulatory compliance.

In prior studies (Middlebrooks, Appendix B) the anticipated effluent ammonia from treatment oxidation ponds was projected to be between 4 and 6 milligrams per liter (mg/l) after all the proposed improvements are made. These levels of effluent ammonia are typical of optimized pond systems. The treatment and enhancement wetlands can provide some additional ammonia removal, however the extent of potential removal depends on circumstances. The effluent ammonia levels are anticipated to vary depending on influent ammonia conditions, temperature, aeration, and other factors. If wastewater is introduced into the enhancement wetlands with very low ammonia (for example effluent from a highly aerobic mechanical treatment system that reduces ammonia to less than 1 mg/l), it is possible that the natural biological activities in the wetland will increase ammonia levels. This is because the influent ammonia levels are so low and natural wildlife activities contribute ammonia to the aquatic system. Ammonia levels are also expected to vary to some degree throughout the year as the influent and weather conditions vary. Achieving the overall desired treatment system performance for the entire plant will depend on the discharge requirements as they relate to dry weather and wet weather conditions, compliance point requirements, influent flow conditions, distribution of flow between natural and mechanical components and recirculation, the mixing of pond and wetland effluent with mechanical treatment system effluent, and other factors. Therefore, providing flexibility in operations allows plant staff to adjust how the oxidation ponds and wetlands contribute to meeting discharge requirements based on actual conditions.

The oxidation ponds and wetlands provide a number of important benefits to the overall system. A discussion of the near term strategies and improvements along with potential longer term adaptive management strategies and improvements is presented in the sections below.

4.6 Oxidation Ponds 1 and 2 Improvements

The oxidation ponds provide a series of treatment and flow management benefits as demonstrated through decades of service. The investments made in the oxidation ponds can continue to provide value to the City for many years to come. However, the oxidation ponds warrant both maintenance work and upgrades to improve their overall performance and utility in the overall wastewater management strategy.

Recommended Pond 1 and Pond 2 improvement items include the following:

- Piping and transfer structure additions/modifications for flow equalization.
- Pond 2 Baffling.
- Pond 1 and 2 Aeration.
- Pond 1 Sludge Management.

The overall near term improvements and longer term adaptive management strategies for Pond 1 and Pond 2 are summarized in Table 4.1 and are further discussed below.

Table 4.1 Pond 1 and 2 Improvements

Near Term Strategy/Improvements	Longer Term Adaptive Management/Improvements
Equalization	
• Provide options to equalize wet weather flow in Pond 1 and 2 under three potential strategies: – Pond 1 higher than Pond 2 – Pond 1 and Pond 2 at the same elevation – Pond 1 lower than Pond 2	Staff to determine how and when to use the three different equalization strategies based on experience with actual flow conditions and the performance of the oxidation ponds and wetlands.
Pond 1 and 2 Aeration	
• Provide conduits, mooring, spaces for starters, expandable electrical capacity, for 24 aerators in Pond 2, but install only 16 initially (or even fewer). • Temporarily install up to 8 aerators into Pond 1 to digest the sludge (or even fewer). • Allow operators flexibility to adjust aerator/blower speed and timing based on conditions. • Reuse Pond 1 aerator electrical conduits, conductors, and other equipment as appropriate to support the new temporary Pond 1 aerators.	Monitor overall treatment effectiveness in Pond 1 and Pond 2. Over time, either transfer Pond 1 aerators to empty slots in Pond 2 or install additional aerators in Pond 2 and finish out electrical as required. The overall amount of mechanical aeration and the placement of aerators can be adjusted through adaptive management decisions.
Pond 1 Sludge Management	
Digest backlogged sludge through temporary aeration of Pond 1.	Adjust aerator locations and operation over time, and/or ultimately dredge oxidation ponds if warranted.
Pond 2 Baffling	
Install baffle wall down center of Pond 2. Divide pond into "Horse Shoe" to improve hydraulics and reduce short circuiting.	None

4.6.1 Equalization

Based on the work of AMRI and Dr. Gearheart, the wetlands perform best when operating at lower flows and essentially steady state conditions (i.e. relatively constant flow of less than 2.3 mgd). This conclusion is based in part on data collected by AMRI from the TW's and findings that TW 4 has consistently shown the best performance. TW4 is fed water at essentially a constant low rate from a pump, while the gravity wetlands, TW's 1, 2, 3, 5, and 6, are fed from Pond 2 based on variable influent flows. AMRI has concluded that the higher variable flows through the gravity wetlands leads to lower treatment performance and that improving equalization of flow to reduce flow variability through the gravity wetlands will lead to better performance.

Flows greater than 5.9 mgd are bypassed directly to the Chlorine Contact Basin (CCB) using the Emergency Pond Pump Station (EPPS) and do not have the benefit of additional treatment through Treatment and Enhancement wetland systems.

Currently, weir boards are used in a box between Pond 1 and Pond 2 to manage flow and create differential elevations between the oxidation ponds to partially desync the influent flow rate from the flow rate through the gravity wetlands. This weir also causes a hydraulic restriction between the oxidation ponds and impedes peak flows. Motor operated weirs between Pond 2 and the gravity wetlands are also intended to help maintain more constant flow into the gravity wetlands, however some fine tuning of the weir operation is necessary to achieve better weir operation and flow control.

In order to provide better flow equalization in the oxidation ponds, and therefore the wetlands, it is recommended that flow control upgrades be completed to allow the operation of the oxidation ponds under the following three strategies:

1. Pond 1 higher than Pond 2.
2. Pond 1 and Pond 2 at the same elevation.
3. Pond 1 lower than Pond 2.

These operational strategies allow the oxidation ponds to better mute the peak flows and send water to the gravity treatment wetlands at a more consistent rate. It should be noted that AMRI has completed analysis of historical flows and the potential to adequately equalize future wet weather flows under Options 1 and 2 above. While AMRI has concluded that this should be sufficient, it is recommended that additional piping improvements be made to allow for Option 3 as further described below.

The recommended improvements to relieve the hydraulic restrictions and provide operational flexibility to implement these three equalization strategies are shown in Figure 4.1 below:

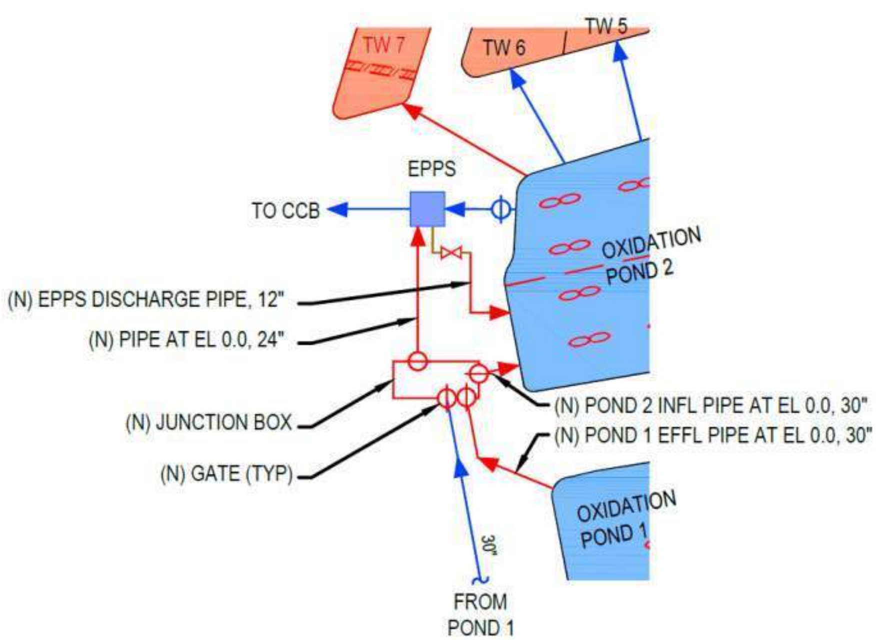

Figure 4.1 New Pond 1 and 2 Equalization Structures and Piping

The overall modifications can be summarized as follows:

- Construct a new junction box with gates to receive Pond 1 effluent.
- Install a new pipe from Pond 1 at El 0.0 to the junction box (Pond 1 effluent) and pipe from the junction box to Pond 2 (Pond 2 influent).
- Install a new pipe from the junction box to the EPPS wet well at El 0.0.
- Install a new EPPS discharge pipe to the influent end of Pond 2.
- Remove existing weir in transfer pipe between Pond 1 and 2.

The new structures and piping would allow the City to choose between the three strategies. The gates in the junction box allow operations staff to prevent water from running backwards from Pond 2 into Pond 1 when the EPPS is being used to lower the elevation of Pond 1. The Supervisory Control and Data Acquisition (SCADA) system could be used to manage the weirs between Pond 2 and the Treatment Wetlands to help maintain more constant flows into the wetlands while utilizing the equalization strategies.

4.6.2 Pond 1 and 2 Aeration

During the Facilities Planning process, an independent analysis of the oxidation ponds and recommended improvements to the system. The conclusions included recommendations to install aerators to be operated as needed depending on the flow rate, seasonal changes, and actual performance.

A proposal for aerating Pond 2 based on the recommendations is included in Appendix C. It was recommended that 24 aspirating aerators be installed in Pond 2 only and no aerators were initially planned for Pond 1. However, during the more detailed analysis in the predesign phase and further discussions with Dr. Gearheart and operations staff, it was concluded that the recommended level of aeration could be installed in a more flexible fashion and allow for more adaptive management potential, while achieving the general intent of Middlebrooks. The recommended approach is to design out Pond 2 for 24 aerators and initially install conduits and mooring posts, allowing space and capacity for the required electrical and control systems. In addition, it is recommended to design out Pond 1 for 8 aerators including conduits and mooring posts. The concept is to provide capacity for up to 24 aerators which could be distributed between Pond 1 and Pond 2, with flexibility in numbers and placement over time. This allows for significant flexibility and adaptive management capabilities. One advantage of initially installing a number of aerators in Pond 1 is this arrangement provides some aeration directly into Pond 1, which receives the influent wastewater and hence provides additional oxygen up front to aid in treatment. Another is that aeration in Pond 1 can aid in management of the sludge in Pond 1 as further discussed below. The aerators in Pond 1 could be moved to Pond 2 in the future, or additional aerators could be added to Pond 2 depending on how actual flow and load conditions and the performance of the oxidation ponds with the initial aerator configuration. This strategy provides the City with additional flexibility to implement alternative aerator configurations or add additional aerators with relatively minor effort. In addition, this concept allows the City to include the installation of various levels of aeration as additive bid items to better manage the bidding and financing process. For example, the aeration support infrastructure could be included in the base bid, while the aerators, conductors, starters, and controls, could be additive items.

4.6.3 Pond 1 Sludge Management

Sludge has accumulated in certain areas of each pond, as shown in the preliminary sludge characterization surveys conducted in 2017 by AMRI (Appendix D). The sludge is most concentrated in the corners, up to 4.2 feet high. AMRI staff estimated that 54,800-yd^3 of accumulated sludge in Pond 1 and 43,000-yd^3 of accumulated sludge in Pond 2, resulting in approximately 27 percent of the total pond volume. Pond 1 has more accumulated sludge than Pond 2 based on AMRI's research.

The AMRI GIS contour plots of the sludge accumulated in Pond 1 and Pond 2 are shown in Figures 4.2 and 4.3 respectively below.

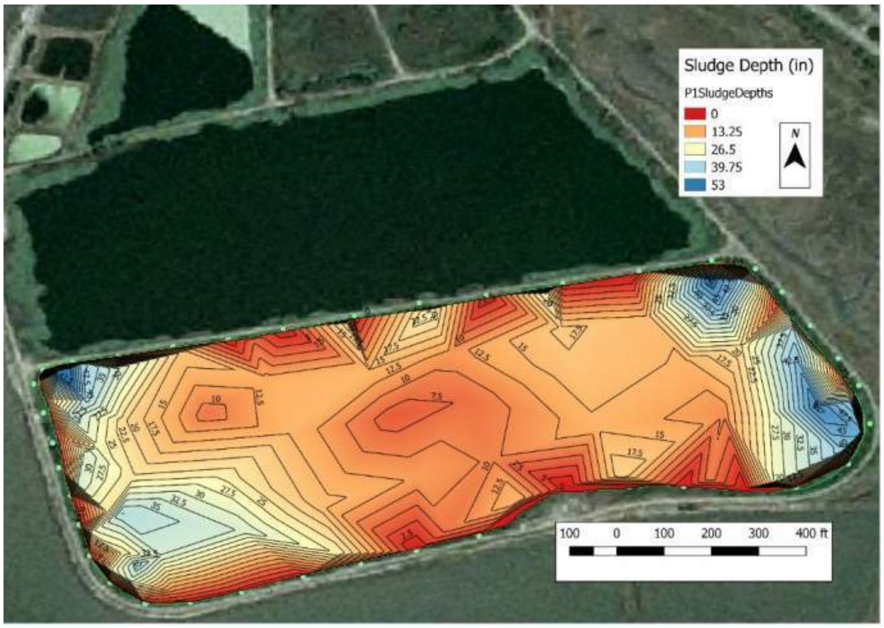

Figure 4.2 Pond 1 Sludge Accumulation (AMRI 2017)

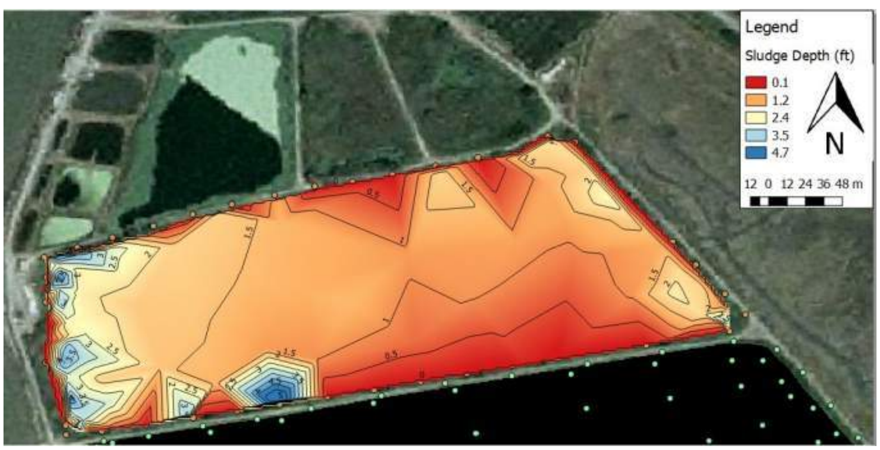

Figure 4.3 Pond 2 Sludge Accumulation (AMRI 2017)

Typical sludge removal options include using a floating dredge to pump the sludge out of the pond, dewatering the sludge onsite, and hauling the sludge offsite for disposal. The cost for removal of the sludge can be very expensive due to the low solids content from dredged sludge and the difficulty in dewatering to a manageable cake. In some applications, oxidation ponds are taken out of service and the sludge is allowed to solar dry in place. The solar drying process is typically enhanced through mixing with heavy equipment. This strategy is effective in areas of lower groundwater and high solar insolation, and with the ability to allow a pond to be out of service for months. However, given the fact that the oxidation ponds are built within the bay, there will likely be groundwater issues and the weather is typically cool and foggy in the summer, and so it may not be possible to work the sludge with heavy equipment and dry it in place. Alternatively, the sludge could be resuspended using aerators and be further digested within the oxidation ponds prior to the Treatment Wetlands (TW). This concept was originally proposed by AMRI as a practical cost savings approach.

As discussed above, the proposed strategy is to configure the improvements to allow for the installation of up to 8 aerators in Pond 1 to help manage the sludge. Operations staff could periodically adjust the location and use of the aerators as needed to achieve sludge digestion and treatment objectives. If required, dredging or other form of sludge removal could be employed in the future. However, given the anticipated reduced flow into the oxidation ponds, the rate of sludge deposition in the future is expected to be significantly less than in the past and additional sludge management tactics may not be necessary for decades.

4.6.4 Pond 2 Baffling

The work of Dr. Joe Middlebrooks as summarized in a 2016 report (Appendix B) included the concept of dividing Pond 2 into two equal cells to improve hydraulic flow through the pond and reduce short circuiting. This can be achieved by installing a baffle down the center of Pond 2 to create a horseshoe configuration as shown schematically in Figure 4.4 below:

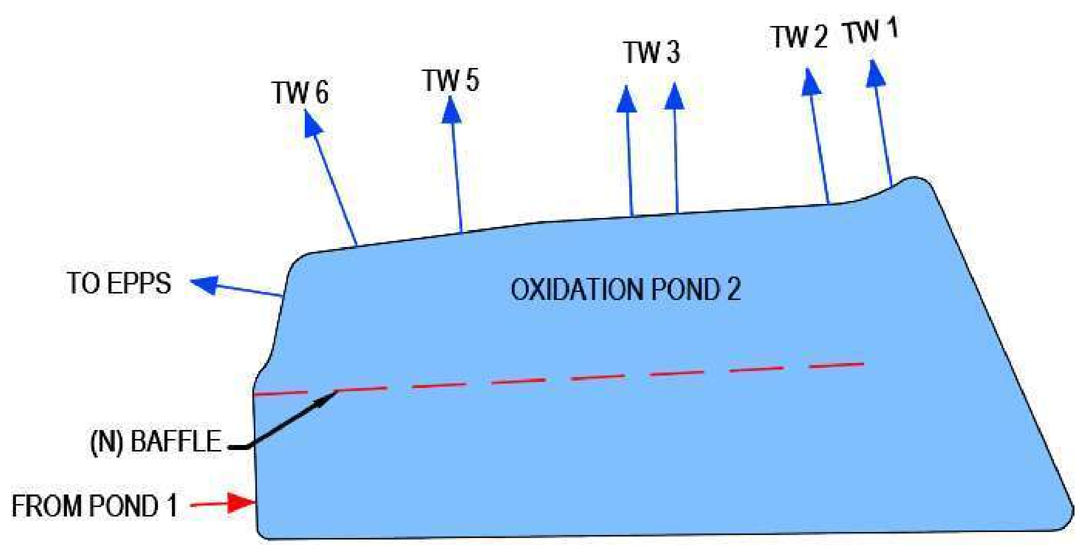

Figure 4.4 Pond 2 Baffle Layout

There are several types of baffle systems available in the market. One system use vinyl or FRP sheet piles that are pushed into the soil to form a rigid baffle. Another is to use a floating boom with a suspended curtain that is anchored to the bottom. Such baffling systems are relatively simple to install and the plastic sheet piling approach has been used in several of the Treatment Wetlands. Vinyl sheet pile baffles are more robust than floating baffle curtains and are the recommended option for the open water of Pond 2, although floating baffles could be considered further during final design as an initial cost saving measure.

4.7 Treatment Pump Station Improvements

The operation of the oxidation ponds and wetlands requires the use of a number of pump stations and pipelines for normal dry weather flow operations as well as peak wet weather operations. Based on the existing system configuration and the overall treatment system modifications, the following pond and wetland pump station improvements are recommended:

- Eliminate Pump Station 2 (PS2).
- EPPS standby pump and generator connection.
- Construct TW4 pump station.
- Pond Pump Station (PPS) capacity upgrades.
- Pump Station 1 (PS1) capacity upgrades.
- New Force Main From PS1 to Ultraviolet (UV) Basin.

The overall near term improvements and longer term adaptive management strategies for the treatment pump stations are summarized in Table 4.2 and are further discussed below.

Table 4.2 Treatment Pump Station Improvements

Near Term Strategy/Improvements	Longer Term Adaptive Management/Improvements
Eliminate PS2	
PS2 pumps TW5 and TW6 effluent to CCB. Wet well is not deep enough to flow by gravity from TW5, TW6 and Future TW7. Install new pipe from TW5 and TW6 to flow by gravity to JB1 and PS2, and then to CCB.	None
Emergency Pond Pump Station (EPPS) Standby Pump and Generator Connection	
The EPPS currently has two electric pumps with a total of 5.8 mgd capacity and a space for a third pump initially planned to be engine driven. Along with other pump stations, the capacity of EPPS is sufficient based on actual operational practice. Existing pumps have relatively low hours. No need for additional capacity at this time. As discussed above, the EPPS could also be used to lower the elevation of Pond 1 for additional equalization with completion of piping modifications.	Currently both existing electric pumps could be used to manage pond elevations during extreme wet weather events. As a separate project, the City could install a third electric pump as a standby as the existing electrical feed is sufficient only for two. Could include a manual transfer switch and generator connection to power the third pump as well from a portable generator. Also, use the EPPS for equalization as appropriate under the conditions.

Table 4.2 Treatment Pump Station Improvements (Continued)

Near Term Strategy/Improvements	Longer Term Adaptive Management/Improvements
Construct TW 4 Pump Station (TW4 PS)	
Construct minor pump station with 0.3 mgd capacity to include a small wet well with submersible pump.	None
Pond Pump Station (PPS) Capacity Upgrades	
Design PPS for 7.0 mgd firm capacity (with additional standby pump) to handle storm flows. Replace pumps with submersible rail mounted pumps.	Future modifications possible as necessitated by future conditions. Possibly install new pipe from PPS to CCB as part of a future phase instead of near term phase.
Pump Station 1 (PS1) Capacity Upgrades	
Design PS1 for 2.3 mgd firm capacity (with additional standby pump) based on upper flow capacity through the Treatment Wetlands. Replace pumps with submersible rail mounted pumps. (Integrate with the adjacent PPS improvements)	Future modifications possible as necessitated by future conditions. Pond effluent may not be high enough quality for effective UV disinfection and so consider chlorine option, which will require a new pipe from PS1 to CCB.
New Force Main From PS1 to UV Basin	
New 24" force main is needed to convey 2.3 mgd of wetland effluent from PS1 to the UV basins and to provide separate discharge lines between the PPS and PS1. A new pipe will branch off the new 30-inch force main to convey flow from the Treatment Wetland effluent to the Oxidation Ditches (alternative flow path).	None

4.7.1 Eliminate Pump Station 2

Pump Station 2 (PS2) currently pumps effluent from TW5 and TW6 to either the CCB or Junction Box 1 (JB1) using an above grade temporary pipe. Pump Station 2 is shown in Figure 4.5 on the following page. PS2 is has reached the end of its useful life and could be eliminated by the conversion to gravity flow.

For the TW5, TW6 and future TW7 effluent to flow by gravity into JB1, which eventually flows to PS1 and the CCB, it is recommended that a new buried pipe be installed between TW5/6/7 and JB1 to allow for gravity flow and eliminate the need for Pump Station 2.

Figure 4.5 Pump Station 2

Figure 4.5 above shows Pump Station 2 and Blue Frog treatment units in the background.

4.7.2 EPPS Standby Pump and Generator Connection

The EPPS is used to pump water from Pond 2 directly to the Chlorine Contact Basin when influent flows exceed 5.9 mgd. The EPPS currently has two electric pumps with a total of 5.8 mgd capacity and a space for a third pump initially planned to be engine driven. Based on discussions with staff and a review of the historical operations and near term requirements, the current capacity of the two pumps is adequate. Since the pump station is used only during high flow conditions, the two pumps have relatively few hours of run time. Therefore, the pumps appear to have additional useful life.

The EPPS building is of wood frame construction and is in need of maintenance to repair some rot in the siding. A number of other minor maintenance projects should be included as well releveling a slab outside the building.

The major recommended modification to the EPPS is the reconfiguration of the piping as previously shown in Figure 4.1 to achieve the equalization goals.

The EPPS has two installed pumps as shown below in Figure 4.6. Long term improvements could include installing a third electric pump to be used as a standby pump for peak wet weather flows, however, electrical power capacity upgrades would be required to supply power to all three pumps at once. A future third pump could also be powered by a permanent generator if a manual transfer switch and generator connection were installed or it could be powered using a portable generator. It does not appear that additional pumping capacity is currently needed and so the potential for a third pump can be considered as a future adaptive management strategy.

Figure 4.6 Emergency Pond Pump Station (EPPS)

4.7.3 Construct TW4 Pump Station

Part of the flow from Pond 2 to TW1 is routed to TW4 using a small pump. The potential to lower the elevation of TW4 and install a gravity pipe to eliminate the pump was considered, but there are grade conflicts with the existing main influent pipes and significant earthwork would be required. Instead, it is more practical and cost effective to construct a small duplex pump station with a wet to pump flow into an upgraded TW4.

4.7.4 PPS Capacity Upgrades

The PPS is used to bypass effluent from Pond 2 to the CCB during wet weather events. The PPS will be designed for 7.0 mgd firm capacity to handle wet weather events using two pumps, with an additional standby pump. The current pumps are vertical turbine pumps, and they will be replaced with submersible rail mounted pumps located in the wet well. Flow will be directed to the CCB. Additional piping modifications could also allow for treatment wetland effluent to be recirculated to the oxidation ditch under lower flow conditions if additional ammonia removal were required.

4.7.5 PS1 Capacity Upgrades

PS1 receives flow from JB1, which receives flow from all of the treatment wetlands. PS1 is located next to the PPS and shares the same wet well and it is shown in Figure 4.7 below. PS1 pumps are currently vertical turbine pumps and will be replaced with submersible rail mounted pumps. The new pumps will be rated for 2.3 mgd based on the maximum flow capacity through the treatment wetlands. Improvements at the PS1 should be coordinated with the improvements at the PPS.

Pond 2 effluent may not always be of high enough water quality for effective UV disinfection, so it may beneficial install a new pipe to the CCB for bypassing flows during wet weather. Chlorine addition has been an effective strategy for meeting permit limits through oxidation. Pond 2 effluent quality should be evaluated based on full scale performance after the proposed upgrades and the additional pipe to the CCB could be considered as part of a future adaptive management project if warranted. Alternatively, the option could be provided to pipe Pond 2 effluent to the oxidation ditch for additional treatment, which can be evaluated during final design.

Figure 4.7 PPS and PS1

4.7.6 New Force Main From PS1 to UV Basin

A new UV system will be installed to provide disinfection for the wetland and oxidation effluent. A new 24-inch force main is needed to convey 2.3 mgd of wetland effluent from PS1 to the UV basins and to provide separate discharge lines between the PPS and PS1.

In addition, a new pipe will branch off the new 24-inch force main to convey Treatment Wetland effluent to the Oxidation Ditches, if needed for additional treatment. This would be an alternate flow path to provide flexibility in system operations for treatment.

4.8 Treatment Wetlands Improvements

The Treatment Wetland recommended improvements include:

- Selective Excavation.
- Selective Vegetation Management (City project).
- Selective Baffling.
- Conduits for "Blue Frogs".
- Treatment Wetland 3 Piping Repairs.
- Treatment Wetland 4 Improvements (City project).
- Treatment Wetland 7 Construction (City project).

The main purpose of the treatment wetlands is polishing of BOD, TSS, and ammonia from the oxidation ponds. The overall near term improvements and longer term adaptive management strategies for the treatment wetlands are summarized in Table 4.3 and are further discussed below.

Table 4.3 Treatment Wetland Improvements

Near Term Strategy/Improvements	Longer Term Adaptive Management/Improvements
Selective Excavation	
Selectively excavate material near inlets and outlets of TW 1 and TW2 to eliminate current obstructions. Excavation near inlets will also help improve performance of Blue Frogs to be placed in the future. Regrade /place fill in deep area of TW1. Excavate mounds near outlets to reduce short circuiting.	Longer term solids management and regrading based on continued performance monitoring and future needs.
Selective Vegetation Management	
Selectively clear strip across TW 1 and TW 2. One Strip was cleared from TW 1 in 2017 to improve flow/treatment characteristics. This improvement could potentially be completed before other major construction as a separate project.	Longer term vegetation management based on continued performance monitoring and future needs.
Selective Baffling	
Install sheet pile or floating baffles in TW1 and TW2 to improve flow/treatment characteristics. All Baffling could be installed through adaptive management.	Possible longer term baffling improvements based on continued performance monitoring and future needs.

Table 4.3 Treatment Wetland Improvements (Continued)

Near Term Strategy/Improvements	Longer Term Adaptive Management/Improvements
Conduits for "Blue Frogs"	
The City installed Blue Frog treatment units currently in TW3. The equipment provides low energy circulation and aeration for sludge digestion in shallow oxidation ponds and wetlands. These units can be relocated when needed. Install conduits (no conductors) along inlet ends of TW 1, 2, 3, 5, 6, 7 in combination with other trenching work along the berm to allow for moving Blue Frogs every few years between TW's.	Determine when and where to move Blue Frogs based on continued monitoring and future needs and install conductors as needed.
Treatment Wetland 3	
The inlet piping of TW3 was damaged during previous vegetation clearing and needs to be repaired and reconfigured.	Same longer term vegetation and solids strategies as other TW's.
Treatment Wetland 4	
TW4 has an inefficient configuration, and less than optimum plant community. Remove plants to compost. Use excess soil to build exterior berms and submerged berms. Divide interior with three sheet pile baffles. Replant with desired species mix.	Same longer term vegetation and solids strategies as other TW's.
Treatment Wetland 7	
Construct TW 7 with earthwork, sheet pile baffles, and transfer structures within environmental constraints to increase TW capacity and overall reliability and redundancy. The configuration will in part depend on how goby mitigation is addressed.	Same longer term vegetation and solids strategies as other TW's.

4.8.1 Selective Excavation

Solids and soil material at the inlets and outlets at TW 1 and TW2 is obstructing the flow path, affecting equalization and causing short circuiting. For example, soil excavated to install the TW 1 outlet weirs was placed in front of the weirs and is obstructing the approach flow to the weirs as shown in Figure 4.8. It is recommended that soil be excavated as needed to clear the flow path to and from the weirs.

Figure 4.8 Soil Obstructing Flow at TW 1 Outlet Weirs (Photo courtesy of Gearheart, 2018)

4.8.2 Selective Vegetation Management

TW 2 has very dense vegetation across its entire area and TW1 has dense vegetation except for a recently cleared strip in the middle. Solid vegetation can cause restrictions in flow capacity. Open water areas help facilitate remixing of water and growth of algae for reoxygenation that improves treatment. It is proposed that vegetation in TW1 and TW2 be removed in several strips across the entire wetland width as shown in Figure 4.9 to allow for better flow and treatment below.

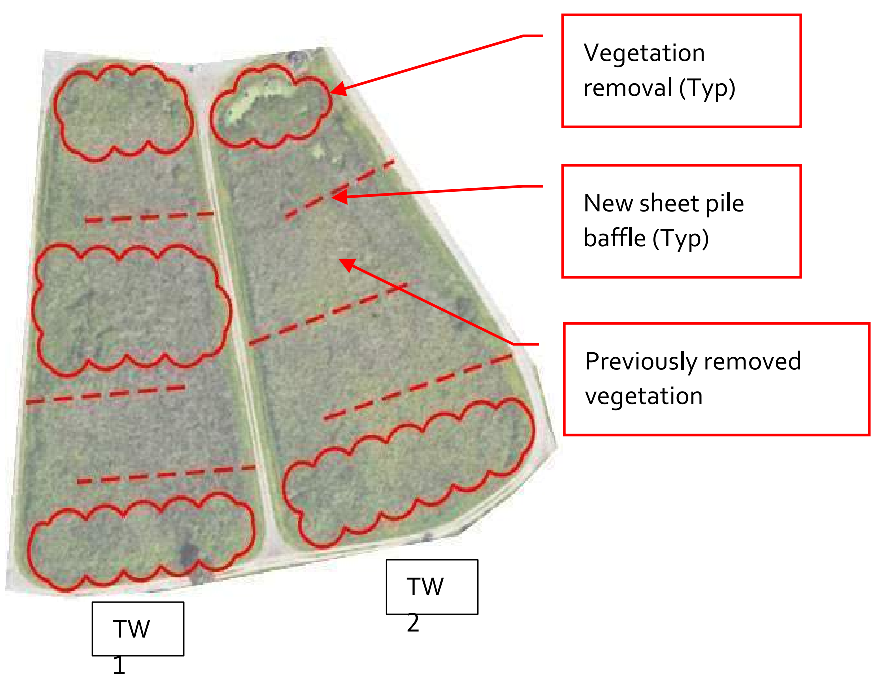

Figure 4.9 TW1 and TW2 Vegetation Removal and Baffles

4.8.3 Selective Baffling

In conjunction with the vegetation removal, it is recommended that sheet pile baffles be installed in TW1 and TW2 to facilitate improved flow and treatment through the wetlands. The proposed locations of the baffles are shown above in Figure 4.9. The baffles will create a longer flow path, prevent short circuiting and improve treatment. The performance of the wetlands should be monitored over the long term to determine if further adaptations with additional baffles is warranted.

4.8.4 Conduits for "Blue Frogs"

Blue Frog units are intended to provide low energy circulation of water and resuspension of sludge to improve mixing and treatment. Two Blue Frog units are currently located in TW3 as shown in Figure 4.10 and provide passive aeration and mixing at the influent end of the wetland in order to improve solids management and water treatment. Based on recommendations from AMRI, the City is interested in moving the Blue Frogs to different treatment wetlands every few years. The units require power and so it is recommended that conduits, without conductors, be installed at the inlet ends of TW 1, 2, 3, 5, 6, and 7 in the event that the Blue Frogs are relocated to different treatment wetlands. The conduit installation is relatively economical since other trenching work is already required for the AWTF Improvements Project. Conductors could be installed as needed when the Blue Frogs are relocated in the future.

Figure 4.10 Blue Frog Units in TW3

4.8.5 Treatment Wetland 3 Piping Repairs

The inlet piping of TW3 was damaged during vegetation clearing. The piping needs to be repaired and reconfigured as part of the overall wetland upgrades.

4.8.6 Treatment Wetland 4 Improvements

TW4 was created as a pilot wetland system with a series of small cells separated by earth berms. TW4 was modified and is operated as a full-scale treatment wetland currently, but the overall configuration and plant community is inefficient. Based on concepts developed by AMRI it is recommended that the overall wetland be reconfigured and that the existing dividing berms that take up significant surface area and volume be removed and be replaced with plastic baffle walls to provide more efficient flow and increased surface area and volume. In addition, contouring of bottom elevations and use of submerged berms will allow for a better diversity of shallow and deep areas for improved mixing and treatment. Vegetation improvements include removing the existing plants for composting and replanting the wetland with more desirable plant species. Excess soil at the bottom of the wetland can be removed to build up the exterior berms and to add new submerged berms. The overall concept for TW4 is shown in Figure 4.11 below.

Figure 4.11 TW4 Improvements

4.8.7 Treatment Wetland 7 Construction

Five small, unused wetland cells are located west of TW6. These were formerly used for wastewater purposes , but have not been in service for a number of years. It is proposed that these marshes be combined and converted into a new TW7 as shown in Figure 4.12 below. The final configuration would be determined during final design, but it is envisioned that sheet pile baffles or berms would separate areas and promote mixing.

There are potential permitting issues with the reconfiguration and reintroducing wastewater treatment uses to these small ponds formerly used as oxidation ponds and wastewater based aquaculture.. The City is currently in the permitting process for TW7.

Figure 4.12 New TW7 Construction

4.9 Enhancement Wetlands Improvements

The Enhancement Wetlands are critical for compliance with the EBE policy for meeting the enhancement definition. In the future, the NPDES permit may require all flows up to 5.9 mgd to flow through the Enhancement Wetlands prior to discharge. As pointed out by AMRI, the existing Enhancement Wetlands were not designed for plug flow and there are areas of short-circuiting and excess vegetation. In addition, the system was not designed for 5.9 mgd of flow and therefore hydraulic improvements will be required to handle these high flows. Even with hydraulic improvements, operational flexibility should be provided to bypass some flow directly to outfall 003 as might be allowed by future permits if high flows will degrade water quality. Recommended improvements include:

- Flow Reconfiguration and Routing.
- Flow Conveyance.
- Enhancement Wetland (EWPS or Hauser) Pump Station Upgrades.
- EWPS Conveyance Upgrades.
- Selective Excavation City project).
- Selective Vegetation Management (City project).
- Selective Baffling.

The overall near term improvements and longer term adaptive management strategies for the enhancement wetlands are summarized in Table 4.4 and are further discussed below.

Table 4.4 Enhancement Wetland Improvements

Near Term Strategy/Improvements	Longer Term Adaptive Management/Improvements
Flow Reconfiguration and Routing	
Provide splitter structure near 002 to allow operators the option to potentially split a portion of the 5.9 mgd peak flow directly to 003 while conveying the remainder through the enhancement wetlands. Flow split would be based on achieving water quality objectives. (This depends on approval by RWQCB, may move over to a longer term adaptive measure if it cannot be permitted in this phase of work) Install new pipe down I Street to 003.	Operation of the flow split structure could be changed over time through management of weirs etc. Flows might be increased through the enhancement wetlands as various improvements are made to the wetlands over time and as longer-term performance testing demonstrates effectiveness.
Flow Conveyance	
Add capacity for flow transfer between enhancement wetland cells, including outlet box and pipe under I Street.	N/A
Enhancement Wetland Pump Station (EWPS or Hauser Pump Station) Upgrades	
Design intake system and EWPS for 5.9 mgd peak. Will operate at lower flow for dry weather. Replace pumps with submersible rail mounted pumps. Complete intake modifications to increase capacity and reduce vegetation clogging. Upsize intake pipe to 24".	Future upgrades may include additional vegetation management strategies and features to reduce pump station operations and maintenance requirements.
EWPS Conveyance Upgrades	
Install new pipeline from I street from the existing 16" EW effluent pipe to 003 to allow conveyance of up to 5.9 mgd from the EWPS. Assess condition of existing 16" pipe.	Allow flexibility in junction with existing 16" EW effluent pipe to allow potential for flows to route back to the plant through the existing pipe for added flexibility.
Selective Excavation	
Excavation within the EW's generally not needed. Rather, use selective vegetation management approach.	Longer-term solids management and selective excavation based on continued performance monitoring and future needs.
Selective Vegetation Management	
Selectively clear areas of vegetation in EW Allen along I Street and in EW Hauser along Mt. Trashmore and cut swath in vegetation mat near outlet of EW Hauser similar to TW 1 to improve flow/treatment characteristics.	Longer-term vegetation management based on continued performance monitoring and future needs.
Selective Baffling	
Install sheet pile baffles in EW Allen, Gearheart, and Hauser to improve flow/treatment characteristics.	Possible longer term baffling improvements based on continued performance monitoring and future needs.

4.9.1 Flow Reconfiguration and Routing

Flow reconfiguration and routing is required in order to convey flows to the new Outfall 003 and to provide operational flexibility. The overall proposed configuration is shown in Figure 4.13 below.

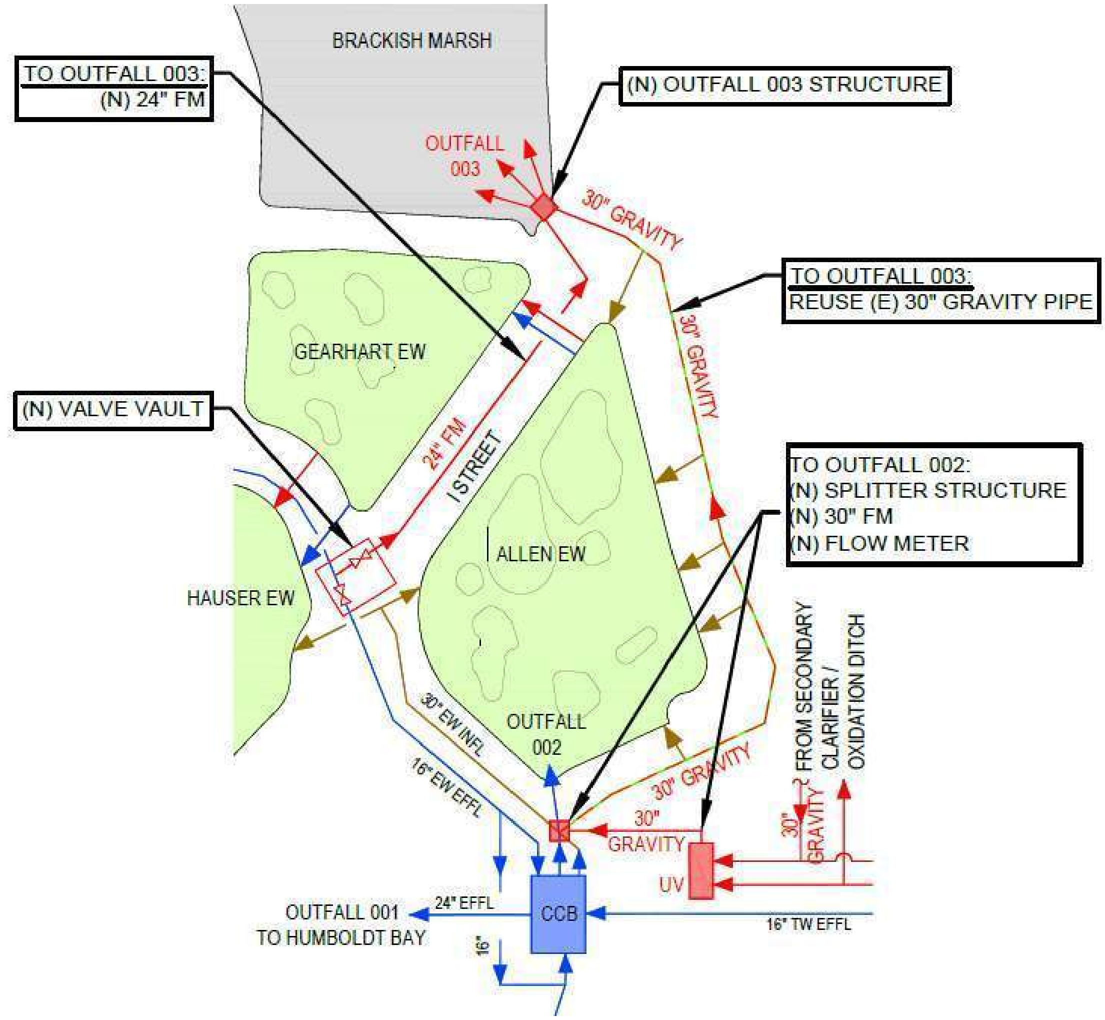

Figure 4.13 Flow Reconfiguration and Routing Improvements

The new NPDES permit (due in 2019) is expected to require conveyance of up to 5.9 mgd through the enhancement wetland system and to outfall 003. This will require an additional pipeline from the UV system to outfall 002 located in Allen EW. The hydraulics will be designed for 5.9 mgd, but the EW's were never designed for such high flows and have never been run at such high flows. Actual operational experience may show a decrease in water quality through the EW's at high flows. Therefore, it is important to provide operational flexibility in managing the 5.9 mgd flow. It is proposed that a new splitter structure be constructed at outfall 002 that allows operators to determine how much of the 5.9 mgd effluent flows through the EW's and how much is bypassed directly to outfall 003 through the existing unused 30-inch gravity line around the eastern side of Allen EW. Additional piping will be needed down I street to outfall 003. How such a bypass system would be used depends on the final permit conditions and actual operating conditions and so the use of this system is part of the overall adaptive management. In addition, permitting and approval of this approach would be required by the RWQCB. This may be considered a long term adaptive measure depending on regulatory approval.

4.9.2 Flow Conveyance

Additional capacity is needed to transfer the flow between the enhancement wetland cells to achieve the 5.9 mgd capacity target. One new transfer structure is proposed between Allen and Gearheart, and one new transfer structure is proposed between Gearheart and Hauser enhancement wetlands as shown in Figure 4.14 below.

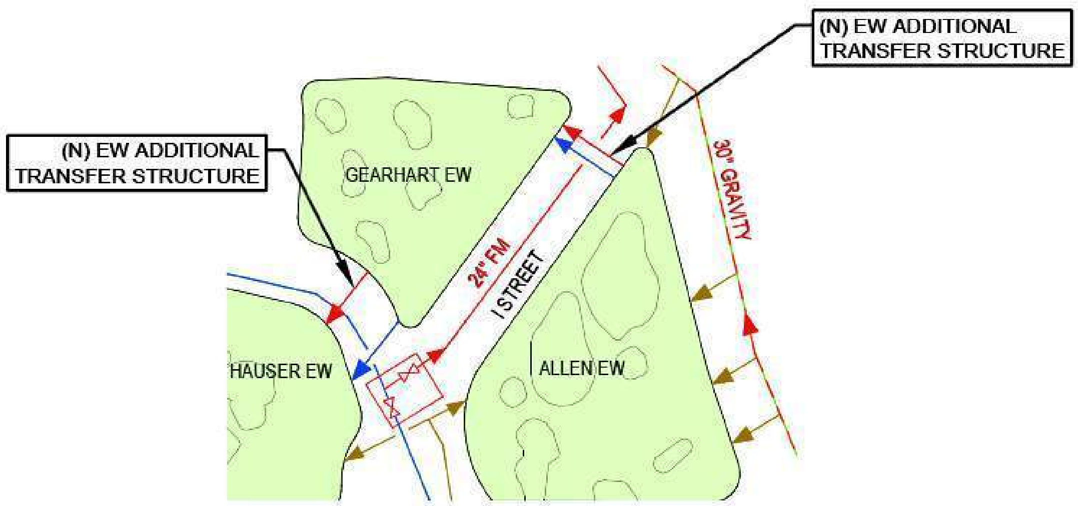

Figure 4.14 Flow Conveyance between Wetlands

4.9.3 Enhancement Wetland (EWPS or Hauser) Pump Station Upgrades

The pump station at the downstream end of the Hauser EW (EWPS) currently pumps the final effluent back to the treatment plant for discharge and ultimately will pump it to outfall 003. Conveyance upgrades to pump to outfall 003 are discussed in the following section while pump station upgrades are discussed here.

The EWPS will need to be upgraded to provide 5.9 mgd capacity. The two existing pumps will be replaced with three submersible rail mounted pumps (2 duty, 1 standby), rated nominally for 2.95 mgd each. The design capacity of the pump station will be 5.9 mgd for peak wet weather flow with two pumps running. However, the pump station will typically operate only one pump at lower flows during dry weather. The pumps will be equipped with variable frequency drives (VFDs) to adjust pumping based on overall treatment system flows.

The intake is currently overgrown with vegetation as shown in Figure 4.15 on the following page. The existing intake screens frequently clog and need regular cleaning. The overall intake system will be upgraded to provide better screening of wetland detritus and management of vegetation around the intake such as including a concrete pad leading up to the inlet.

In addition to intake screening modifications, the overall hydraulic capacity of the intake piping will be increased to a 24-inch pipe to meet the 5.9 mgd pumping capacity. The overall intake system will be replaced to provide both the increased hydraulic capacity as well as the screening capability. To improve flow characteristics, several intake locations will be constructed along the downstream end of Hauser EW.

Future improvements could include additional vegetation management strategies and operational strategies based on experience with higher peak flows.

Figure 4.15 EWPS Intake Overgrown with Vegetation

4.9.4 EWPS Conveyance Upgrades

As discussed above and as shown previously in Figure 4.14, a new segment of pipe is needed to intercept the existing force main from the EWPS and convey the EW effluent up I street and to outfall 003. It is proposed that the connection be made in a valve vault to allow for potential conveyance of EW effluent back to the treatment plant. This flexibility may be needed in the future, for example, if maintenance work is needed on outfall 003 and the City could temporarily use outfall 001.

4.9.5 Selective Excavation

Selective excavation with the enhancement wetlands is generally not required, although during the final design process some targeted areas for selective excavation may be identified. Long-term solids management and selective excavation can be determined based on continued water quality performance monitoring and wetland observations and can be undertaken under an adaptive management approach as required.

4.9.6 Selective Vegetation Management

The overall flow path and capacity through the EWs could be improved through selective vegetation management as shown in Figure 4.16 on the following page. These areas include several densely overgrown areas that cause flow restrictions. These and other areas of the EW's should be monitored over time and additional selective vegetation management should be undertaken as warranted to maintain desired flow and open water characteristics.

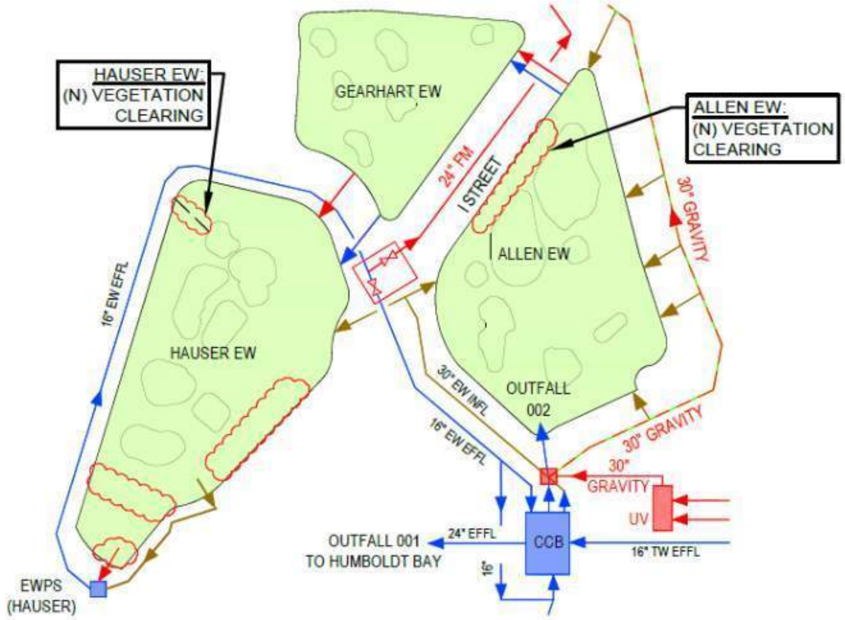

Figure 4.16 EW Vegetation Removal

4.9.7 Selective Baffling

In addition to the new transfer structures and vegetation clearing, several new baffles are recommended to be installed in Allen, Gearheart and Hauser EW to promote a better serpentine flow, reduce short-circuiting, and improve treatment performance. The baffling would be similar to what has been installed in the TW's and as proposed for Pond 2. The baffles could be sheet pile type as proposed for Pond 2, but floating curtain baffles would likely be simpler to install and less expensive for the wetlands. Proposed baffle locations are shown below in Figure 4.17.

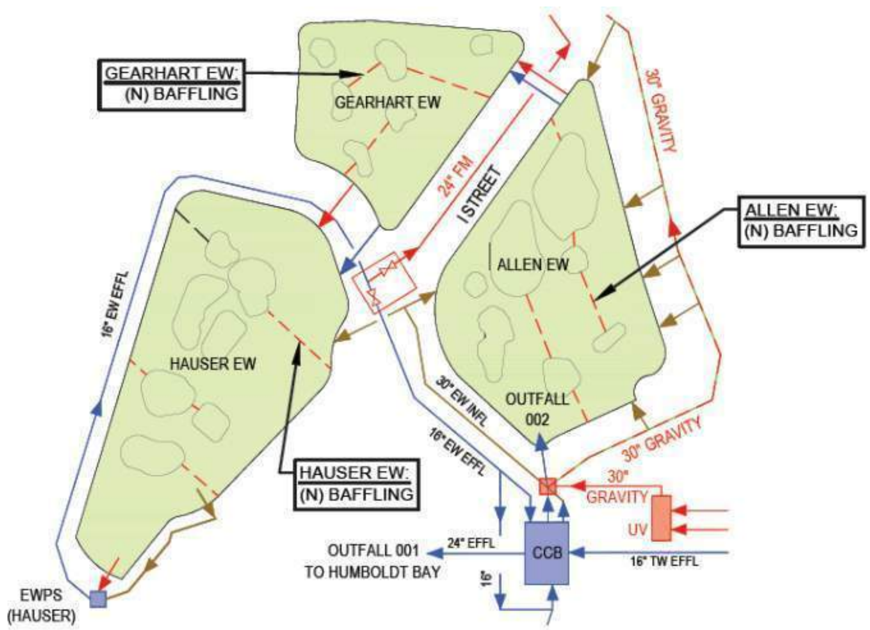

Figure 4.17 EW New Baffling

4.10 Implementation Strategies and Potential Sequencing

At the conclusion of the facility planning process, the City Council selected a project based on implementing both mechanical system upgrades and pond and wetland system upgrades with the intent of the two systems working together to ultimately achieve permit compliance objectives. This approach was confirmed with City staff through this predesign process. City staff have indicated that some of the pond and wetland improvements could be implemented separately from other mechanical system upgrades as may be logical from a timing, funding, and performance standpoint. Based on consultation with City Staff, the following elements can be implemented by the City separate from the other system upgrades:

- TW 7 construction.
- TW 4 construction.
- TW 1 and 2 selective vegetation management and excavation.
- EW selective vegetation management and excavation.

Implementation of these improvements early can provide additional treatment capacity and system robustness to help facilitate the construction of the mechanical system improvements.

The sequencing of pond and wetland components should be considered in the larger context of the sequencing of the broader treatment plant improvements considering all major components and maintaining hydraulic and performance characteristics consistent with regulatory requirements, practical operations, and site constraints.

Decisions regarding sequencing of pond and wetland improvements depends in part on Regional Board permit requirements and the sequencing and implementation requirements for the mechanical upgrades.

In addition to the improvements outlined above that the City could implement prior to mechanical upgrades, the following main elements of pond and wetland improvements should be integrated into in the overall treatment plant upgrade sequencing:

- Pond 1 and 2 Aerators.
- Pond 2 Baffle.
- Pond 1 and 2 Flow Equalization Junction Box and Piping.
- EPPS Maintenance Improvements.
- Eliminate PS2 and Install Conveyance Pipe.
- Yard Piping Improvements to Connect to UV.
- TW Baffling Improvements.
- Outfall 003 and Conveyance Pipeline Down I Street.
- TW Piping Improvements, EWPS Upgrades.

A variety of other support improvements would be needed for individual groupings including electrical, SCADA, various piping and interconnections.

Appendix A

FIGURE A1: EXISTING POND AND WETLAND PIPING

FIGURE A2: POND AND WETLAND IMPROVEMENTS

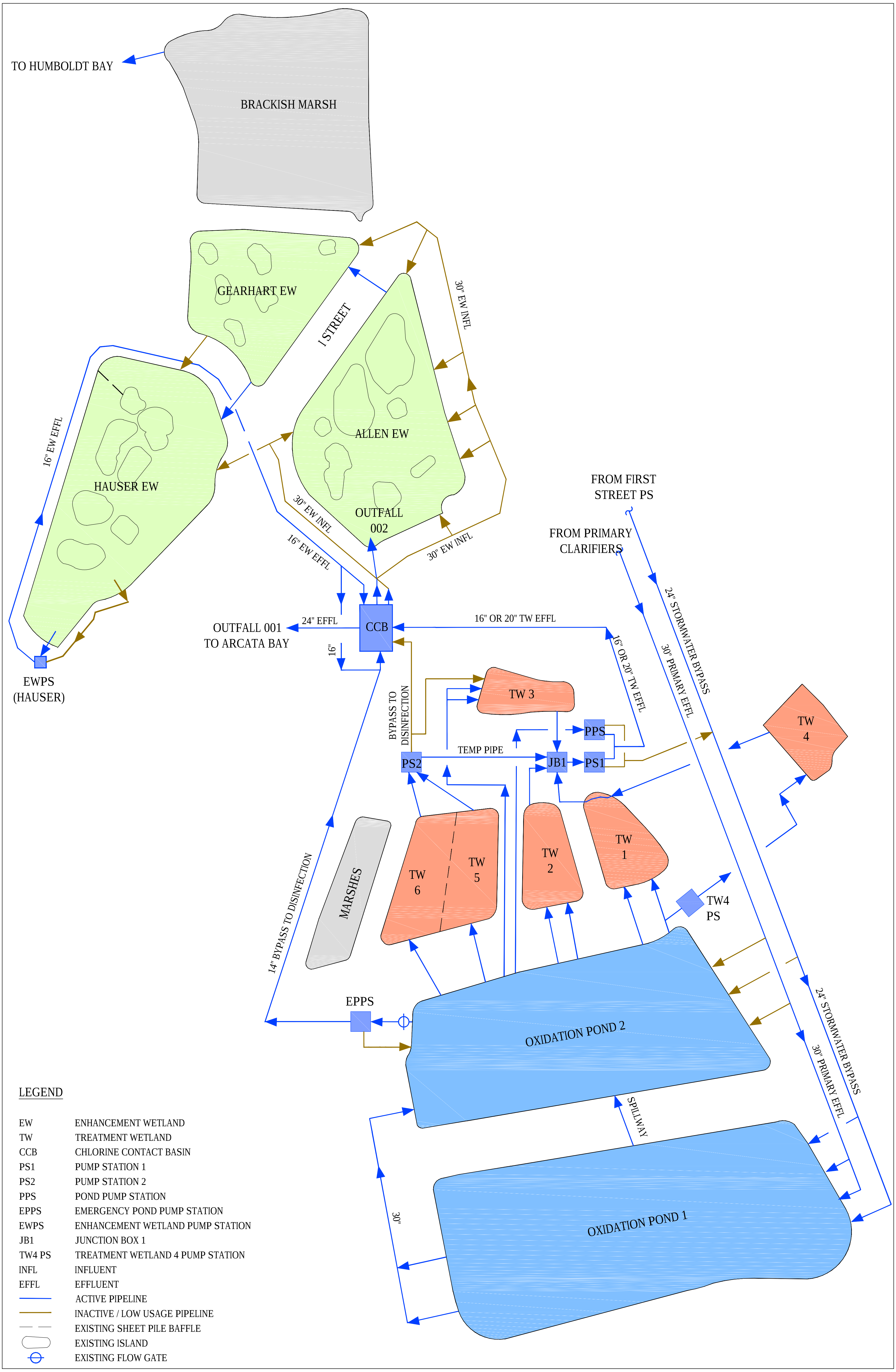

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Figure No. 1

EXISTING POND AND WETLAND PIPING

CITY OF ARCATA

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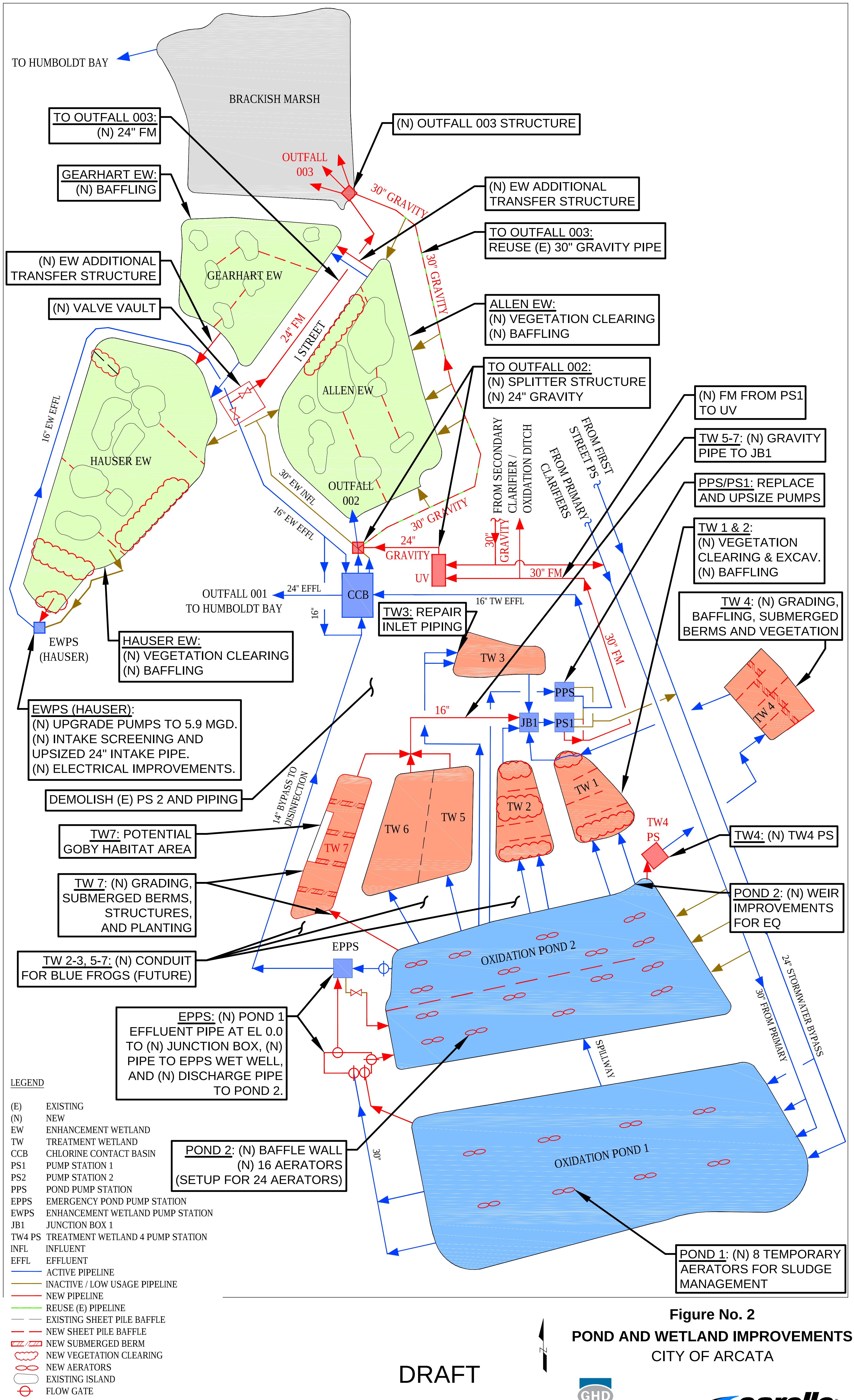

Figure No. 2
POND AND WETLAND IMPROVEMENTS
CITY OF ARCATA

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Appendix B

PERFORMANCE EXPECTED AND OPERATIONAL REQUIREMENTS FOR THE ARCATA, CA, WASTEWATER TREATMENT FACILITY

(E. JOE MIDDLEBROOKS, PE, PHD, BCEE, 2016)

Performance Expected and Operational Requirements for the

Arcata, CA, Wastewater Treatment Facility

By

E. Joe Middlebrooks, PE, PhD, BCEE

After reviewing several possible modifications to the Pond system at Arcata, CA, it was decided that the most feasible and dynamic approach is to use Pond 1 as an equalization basin and divide Pond 2 into two cells designed as partial mix aerated ponds (Ponds 2A and 2B). With control of the I/I in Pond 1, coupling the ponds with the upgraded wetlands should provide an effluent quality that will meet the proposed regulatory requirements. The system could perform well for many years at the proposed average flow rate of 2.3 mgd after the I/I problems are controlled or solved.

Following are presentations discussing the proposed design and operational requirements to make the system successful. All results are based on information and data provided by the City of Arcata and information found in the report by Carollo Engineering.

Discussions of several performance situations are presented in the following sections. A summary of the most severe controlling situation at the average design flow of 2.3 mgd will be presented first.

Worst Case Scenario

It seemed best to start with the likely severe design load that will enter Pond 2A during average design flow. The expected performance for the worst case scenario for the design of Ponds 2A and 2B receiving a flow rate of 2.3

mgd is shown in Table 1. It is assumed that Pond 1 will serve as an equalization pond, and that the equalization pond will not remove any BOD or ammonia-N, transferring the entire load from the clarifier to Pond 2A.

The greatest stress on Ponds 2A and 2B will occur when the water temperature is 6 degrees Celsius and microorganism growth rate is at its lowest. BOD removal in Pond 2A and Pond 2B should average approximately 70 and 27 mg/l, respectively. Ammonia-N conversion to NO_3-N likely will be minimal in Pond 2A, but it is expected that the effluent from Pond 2B will contain between 4 and 6 mg/L at the 2.3 mgd flow rate and an influent ammonia-N concentration of 55.2 mg/L. Theoretical calculations and experience with aerated ponds indicate that this level of ammonia conversion is feasible at 6 degrees Celsius (Gearheart, 2016).

Maximum power requirements as shown in Table 1 will be controlling in both cells during the warm months because of the lower solubility of oxygen at higher temperatures. The power requirements shown in Table 1 are produced by a design program that determines the controlling oxygen demand (Middlebrooks, 2005). The requirements during the cold months will be less because of the increase in solubility of oxygen and the reduced BOD and ammonia-N removed. Automated equipment should be installed to reduce the operating time for aerators used during the cold months and when power requirements might be lower after dilution of the influent during the rainy season.

During the summer and fall seasons when the flow rate is approximately 1.6 mgd, the aeration power requirements will be much less; therefore, it is essential that the aeration system be designed for control of each aerator. This will not only reduce the power consumption, but also provide better control of system performance. As pointed out above for Pond 1, the operators must be fully committed to good operation, be well informed and receive good training. There is no substitute for good operators.

As pointed out in Table 1, the power requirements are estimates that require refinement by equipment manufacturers; however the kg O_2/hr requirements must be provided by the equipment suppliers. The kg O_2/hr requirement is based on the environmental and microorganism requirements.

Based upon experience, it is best to install larger numbers of smaller aerators rather than fewer larger aerators. This approach provides better mixing, and when one or more are out of service, the power level is less affected.

Alkalinity Requirement

Because of the low concentration of alkalinity (approximately 60 mg/L) in the wastewater, to ensure good conversion of the ammonia-N to nitrate-N it will be necessary to add alkalinity to Ponds 2A or 2B. The calculation of the alkalinity needed is shown in Table 2. The adjustment to pH normally observed in facultative or lightly aerated ponds due to growth of algae will be much less prevalent than in facultative ponds and in partial-mix aerated ponds; therefore, there will be a need to supplement the limited supply of alkalinity in the wastewater. There will be a reduced concentration of algae in the aerated ponds that might help buffer the wastewater, but it is necessary to maintain the pH at 7 to maximize ammonia-N conversion.

During the summer and fall when the flow rate averages approximately 1.6 mgd, the needed alkalinity will be less, and the dosage will vary with the influent ammonia-N concentration and the influent flow rate. The influent alkalinity will vary significantly with the seasons; therefore, careful monitoring of the influent alkalinity will be needed to control costs for chemicals.

With an influent alkalinity of 60 to 100 mg/L there would be enough to convert approximately 8 to 14 mg NH_4/L to NO_3-N, respectively. Using all of the alkalinity would reduce the pH value below 7, the optimum for conversion.

Alkalinity also will be required with a carousel activated sludge process. If this was mentioned in the Corolla report I overlooked it.

Influence of I/I

As the flow increases during the rainy season, the performance in Ponds 2A and 2B will be significantly influenced by the control of the water transferred from Pond 1. Assuming good control of discharges from Pond 1, the pond system could produce a good quality effluent; however, the impact of solids washout into Pond 2A could be problematic with the first large surge of influent. Without diligent control of transfer of wastewater from Pond 1, the most dramatic effect on Ponds 2A and 2B will occur when a large rainfall occurs and washes the solids from Pond 1 into Pond 2A. Solids in Pond 1 are not similar or biologically active as those in Pond 2A and would dilute the active mass of organisms in Pond 2A. By controlling discharge from Pond 1 as diligently as possible, the system should function reasonably well throughout the year. It is imperative that washout of the active mass of solids be controlled constantly. It is essential that the operating staff be trained and educated about the urgency of flow control, and then monitor the system constantly.

With dilution of large inflow, the effects should not overwhelm the system provided the suspended solids in the pond ae not reduced to the point of biological inactivity. Also, the dramatic effect on the hydraulic retention time would significantly affect the efficiency of the system. Control of the depth of water in Pond 1 is critical if Ponds 2A and 2B are to function adequately during the rainy season. An automated depth control device is essential.

Storage Available

Normal operation of equalization ponds recommends that the depth of the pond not be drawn down below two feet to prevent odors. Following this advice, at a pond depth of 5.5 feet the volume in Pond 1 is approximately 45

MG, and at a depth of 2 feet the volume is approximately 16 MG. This leaves 29 MG for storage, which provides adequate room to control the discharge from Pond 1 if careful monitoring is exercised. Because the high rainfall occurs during the cool months, it is likely that odor control should not be a problem. Although redundant, it cannot be over emphasized that careful control of Pond 1 will determine how well Ponds 1, 2A and 2B perform; therefore, as stated above, automatic level control is highly recommended.

Impact of High Flow Rates

Flow Rate = 4.3 mgd

Assuming that the influent flow rate to Pond 2A is increased to 4.6 mgd and the BOD reduced by 50 percent, the effluent BOD would be less than that observed for the worst case scenario as shown in Table3. If the ammonia-N entering Pond 2B were also reduced to half of the influent to Pond 2A, the performance should also be equal to the worst case or less.   These assumptions require a serious caveat: The accuracy of these projected effluent concentrations is dependent on to what degree the suspended solids in Ponds 2A and 2B are washed out. Doubling the flow to 4.6 with the diluted wastewater by very careful introduction of wastewater from Pond 1 that did not reduce the suspended solids concentration in the aerated pond, by more than 5 to 10 %, the performance predicted in Table 3 would likely produce an effluent quality similar to that shown. However, with aerated pond suspended solids reductions beyond the 5 to 10 %, the reduction in efficiency likely will be directly proportional to the percentage that the solids are diluted in Ponds 2A and 2B. As mentioned below, the success of the proposed system is directly related to the degree of success with controlling the discharge from Pond 1.

Flow Rate = 5.9 mgd

Assuming an influent flow rate of 5.9 mgd and dilution of the pond influent BOD and ammonia-N by a ratio of 2.565 (5.9 MGD/2.3 MGD), the design concentrations for BOD and ammonia are 71 and 21.5 mg/L, respectively.

The results of this analysis are shown in Table 4. All of the concerns apply here that were expressed in the caveat in the 4.3 mgd section. Also, there are concerns about the significant increase in flow rate that would wash out an excess quantity of suspended solids in Pond 2A unless there is careful control of discharge from Pond 1.

Projected Performance

Diligently implementing the above suggestions, the total system could produce effluent concentrations as follows: BOD < 30 mg/L, TSS 30 to 40 mg/L, ammonia-N 4 to 6 mg/L, and a pH value 7.0. The system could provide an effluent that will meet the regulatory requirements for the 20% growth projected for Arcata.

Recommendations and Comments

1. **Use Pond 1 as an equalization basin and divide Pond 2 into two cells of equal volume and designed as partial mix aerated ponds as described in this report (Ponds 2A and 2B).**
2. **Practice diligent control and use the recommendations for the pond system, and the system coupled with the upgraded wetlands could satisfy the anticipated effluent standards for many years.**
3. **Correct the I/I problem and the entire treatment system will function well without the careful control of Pond 1, and will provide treatment for the projected 20% growth to an average flow rate of 2.3 mgd for many years.**
4. **Install control equipment that will provide flexibility in control of depth in Pond 1. This is essential to ensure good performance in Ponds 2A and 2B.**

5. **Install aeration equipment with controls that will provide flexibility in operation during all seasons of the year.**
6. **Install chemical feed equipment to add alkalinity to Pond 2A with controls that will provide flexibility in operation during all seasons.**
7. **Maintain a minimum pH value of 7.0 in Ponds 2A and 2B.**
8. **Provide excellent training for the operators. Careful operation is required for peak performance from the pond system and other components of the system.**

References

Gearheart, Robert and Swanson, Chuck. 2016. Facultative Oxidation Pond Aeration,

Project Description, EIT, AMRI, January 15, 2016.

Middlebrooks, E. Joe. 2005. Program for Partial-Mix Aerated Wastewater Stabilization Pond Design, With Known Temperature and Hydraulic Detention Time.

Table 1. Expected treatment in Pond 2A and 2B at design flow rate of 2.3 mgd at various water temperatures when Pond 2 is divided into two equal cells.

Assuming Pond 1 Does Not Remove any BOD or NH3-N. (Worst Case Scenario). Design based on average design flow rate of 2.3 mgd , and assuming 30% BOD removal in primary tank influent of 260 mg/L.

Water Temperature Degrees Celsius	Pond 2A Effluent BOD Flow Rate = 2.3 mgd Inf. BOD = 182 mg/L mg/L	Pond 2A Dissolved Oxygen Requirement for BOD Without Correction for Equipment Efficiency[a] kg O_2/hr[b]	kW Required In Pond 2A for BOD at 2.3 mgd kW[b]
6	69.38	153.56	80.82
10	63.41	156.95	82.61
15	56.32	160.06	84.24
20	49.68	161.98	85.25
25	43.56	162.92	85.75
30	37.97	163.12	85.85
35	32.93	162.74	85.65

[a]Excludes correction for equipment efficiencies , but Includes environmental corrections and multiplying factor of 1.5 for BOD removal.

[b]Controlled by Summer Temperature.

[c]These power req. are approximate values and are used for the preliminary selection of equipment. These values are used in conjunction with equipment manufacturers catalogs to select the proper equipment.

Table 1 Cont. Expected treatment in Pond 2A and 2B at design flow rate of 2.3 mgd at various water temperatures when Pond 2 is divided into two equal cells.

Assuming Pond 1 Does Not Remove any BOD or NH3-N. (Worst Case Scenario). Design based on average design flow rate of 2.3 mgd , and assuming 30% BOD removal in primary tank influent of 260 mg/L.

Pond 2B Effluent BOD Flow Rate = 2.3 mgd Inf. BOD = Col. B mg/L	Pond 2B Dissolved Oxygen Requirement for BOD Without Correction for Equipment Efficiency[a] kg O_2/hr[b]	kW Required In Pond 2B for BOD at 2.3 mgd kW[b]	Pond 2B Dissolved Oxygen Requirement for NH_3-N Without Correction for Equipment Efficiency[a] kg O_2/hr[b]
26.45	51.55	27.13	132.39
22.10	48.03	25.28	135.32
17.45	43.34	22.81	138.00
13.56	38.54	20.28	139.66
10.42	33.84	17.81	140.46
7.92	29.39	15.47	140.64
5.96	25.30	13.32	140.31

[a]Excludes correction for equipment efficiencies , but Includes environmental corrections and multiplying factor of 1.5 for BOD removal.

[b]Controlled by Summer Temperature.

[c]These power req. are approximate values and are used for the preliminary selection of equipment. These values are used in conjunction with equipment manufacturers catalogs to select the proper equipment.

Table 1 Cont. Expected treatment in Pond 2A and 2B at design flow rate of 2.3 mgd at various water temperatures when Pond 2 is divided into two equal cells.

Assuming Pond 1 Does Not Remove any BOD or NH3-N. (Worst Case Scenario). Design based on average design flow rate of 2.3 mgd , and assuming 30% BOD removal in primary tank influent of 260 mg/L.

kW Required In Pond 2B for NH3-N at 2.3 mgd kWb	Total Oxygen Demand for Pond 2B Flow rate = 2.3 mgd kg O2/hrb	Total kW Required for Pond 2 Flow Rate = 2.3 mgd kWb	Total hp Required for Pond 2 Flow Rate = 2.3 mgd hpb
69.68	337.5	177.63	238.20
71.22	340.3	179.11	240.19
72.63	341.4	179.68	240.95
73.50	340.18	179.03	240.08
73.93	337.22	177.49	238.01
74.02	333.15	175.34	235.13
73.65	328.35	172.62	231.48

aExcludes correction for equipment efficiencies , but Includes environmental corrections and multiplying factor of 1.5 for BOD removal.

bControlled by Summer Temperature.

cThese power req. are approximate values and are used for the preliminary selection of equipment. These values are used in conjunction with equipment manufacturers catalogs to select the proper equipment.

Table 2. Alkalinity in the wastewater is consumed during the process; therefore, must calculate needed alkalinity for 2.3 mgd.

Flow rate =	8706.5	m^3/d
Influent Alkalinity	60	mg/L
Influent Total Nitrogen =	55.2	mg/L
Assumed conversion =	0.96	
NO_3 = TN - Ne	53.0	mg/L
Influent Alkalinity	60	mg/L
Alk. used for nitrif. = (7.14 g $CaCO_3$/gNH_4-N)(NO_x) =	378	mg/L used as $CaCO_3$
Alkalinity Residual needed to maintain pH at 7 =	80	mg/L as $CaCO_3$
Alk to maintain pH at approx. 7 = Alk Used + Residual Alk. to maintain pH 7 - Inf. Alk	398.4	mg/L as $CaCO_3$
Alkalinity Needed =	3468	kg/d as $CaCO_3$

Table 3. Expected treatment in Ponds 2A and 2B at Various Temperatures and 4.6 mgd.

Water Temperature Degrees Celsius	Pond 2A Effluent BOD Flow Rate =4.6 mgd Inf. BOD = 91 mg/L mg/L	Pond 2A kg O2/hr Required at 4.6 mgd	Pond 2B Effluent BOD Flow Rate = 4.6 mgd Inf. BOD = 2A Effluent mg/L	Pond 2B kg O2/hr Required at 4.6 mgd	Pond 2B Dissolved Oxygen Requirement for NH_3-N Influent = 27.6 mg/L kg O_2/hr
6	50.23	153.55	27.73	74.65	122.04
8	48.63	155.35	25.99	73.03	123.47
10	47.03	156.95	24.30	71.24	124.74
15	43.01	160.06	20.33	66.20	127.21
20	39.03	161.98	16.74	60.55	128.74
25	35.14	162.92	13.57	54.61	129.49
30	31.41	163.12	10.84	48.64	129.65
35	27.88	162.74	8.54	42.85	129.35

Table 4. Expected treatment in Ponds 2A and 2B at Various Temperatures and 5.9 mgd.

Water Temperature Degrees Celsius	Pond 2A Effluent BOD Flow Rate = 5.9 mgd Inf. BOD = 91 mg/L mg/L	Pond 2A kg O2/hr Required at 5.9 mgd	Pond 2B Effluent BOD Flow Rate = 5.9 mgd Inf. BOD = 2A Effluent mg/L	Pond 2B kg O2/hr Required at 5.9 mgd	Pond 2B Dissolved Oxygen Requirement for NH_3-N Influent = 27.6 mg/L kg O_2/hr
6	34.69	196.95	13.22	66.12	156.4
8	33.18	199.26	12.1	63.91	156.4
10	31.71	201.31	11.05	61.61	156.4
15	28.16	205.29	8.71	55.59	156.4
20	24.84	207.76	6.78	49.43	156.4
25	21.78	208.17	5.21	47.89	156.4
30	18.98	209.22	3.96	37.70	156.4
35	16.46	208.74	2.98	32.45	156.4

Appendix C

PRELIMINARY PROCESS DESIGN REPORT AERATED LAGOON SYSTEM DESIGN # 17-3-7175 (AERATION INDUSTRIES INTERNATIONAL, 3/10/17)

CLEAN WATER OXYGEN TRANSFER TEST AIRE-O2 TRITON® TR SERIES PROCESS AERATOR/MIXER TR10 MODEL (SEPTEMBER 2015)

PRELIMINARY PROCESS DESIGN REPORT

AERATED LAGOON SYSTEM

Quote and Calcs for Pond 2 aeration

Project Name: Arcata, CA

Design # 17-3-7175

Option: AIRE-O_2 Triton®

3/10/2017

Designed by: Alan Rice, EIT, Aeration Industries International, LLC.

Aeration Industries International
AIRE-O2

1. Design Specifications

1.1 Average Flow Rates

The biological process unit has been designed for a 24 hour / 7 day flow.

The maximum hydraulic flow is assumed to be hydraulic only and does not represent an increase in the design organic load.

DESIGN PARAMETER	FLOW	UNITS
Design Flow (Annual Average)	2.3	MGD
Average Winter Flow (Maximum Hydraulic)	5.9	MGD

1.2 Influent Water Quality

The influent water quality has been provided by the engineer, and is shown in the table below.

PARAMETER	INFLUENT	UNITS
BOD_5	181	mg/L
TSS	181	mg/L
NH_3-N	55	mg/L

1.3 Effluent Water Quality

Aeration equipment was selected based on the oxygen demand required to meet the effluent values shown below.

Actual degree of treatment achieved may depend on hydraulic retention time, water temperature, settling quality, and other factors.

PARAMETER	EFFLUENT	UNITS
BOD_5	30	mg/L
TSS	30	mg/L
NH_3-N	6	mg/L

2. Design Considerations

2.1 Pre-Biological Unit Process

Neutralization is recommended / required ahead of the biological unit process if the pH is expected to fall outside of 6.5 – 8.5 for significant durations.

1/4” fine screen solids removal / reduction is recommended prior to the biological unit process (by others).

2.2 Biological Unit Process Aeration

The aeration system has been designed to provide 2.0 lbs O_2/lb BOD_5 removed and 4.6 lbs O_2/lb ammonia removed at the design flow. No surface credits, algae credits, or assimilation credits have been assumed.

The aeration system has been designed to support a process oxygen demand (AOR) of 10,155lb O_2 / day.

10155 lb O2/day / 24 hrs / 12 HP / 24 aerators = 1.47 lb O2 / HP-hr

2.3 Process Conditions

Sufficient alkalinity is required for nitrification at approximately 7.1 mg alkalinity (as $CaCO_3$) for each mg of NH_3-N nitrified. If the raw water alkalinity cannot support this consumption while maintaining a residual concentration of 50 mg/l supplemental alkalinity shall be provided (by others).

To achieve nitrification a minimum water temperature of 10°C is required. Although nitrification may occur at lower temperatures, reaction rates may be slower and ammonia removal will be unreliable.

2.4 Process Description

Aeration Industries recommends installing twenty-four (24) TR10 (12HP) Triton Aerators throughout pond 2 (cells 2a and 2b) to achieve the required oxygen transfer and mixing.

Aeration Industries has designed this lagoon aeration system to provide sufficient oxygen for BOD treatment and ammonia removal based on values provided by the engineer. Additionally, Aeration Industries has designed this system to achieve a partial mix within cell 2a and 2b.

2.5 Process Calculations

See attached.

Aeration Industries International

AIRE-O₂

3. Equipment Summary

Twenty-four (24) TR10 (12HP) AIRE-O_2 Triton® Aerators, consisting of:

- 10 HP, 230/460 volt, 3 phase, 60 Hz, 900 RPM, TEFC motor
- 2 HP regenerative blower
- Field replaceable, water lubricated lower bearing
- Field replaceable, wear-resistant sleeve
- 316 SS Dual-bladed primary PowerMix™ propeller
- 304 SS Saturn Ring diffuser
- 304 SS housing, mounting flange, & hollow shaft

  Note: Aerators shall arrive fully assembled for immediate mounting

Twenty-four (24) Universal Four-Float Assemblies, consisting of:

- Four (4) molded, low-density polyethylene, closed cell, foam filled pontoons
- Stainless steel rails and mounting hardware
- Floating vortex shield cabled to the frame

  Note: Flotation devices require field assembly

Twenty-four (24) Stainless Steel and FRP Float Walkways
Twenty-four (24) Anti-erosion Baffles

One (1) Lagoon Control System, consisting of:

- Main fuse disconnect
- 480/240-120VAC control transformer
- 480/120VAC IEC starters
- Circuit protection
- Alarm and run lights
- H-O-A selectors
- Thermal cutoff and heater protection

5000'	**1/2" SS Mooring Cable**
Fourteen (14)	**Cable End Assemblies and Turnbuckles**

Field Service (1 trip, 5 days)
Three (3) Year Warranty (see terms and conditions)
Freight FOB Jobsite ← I think freight included

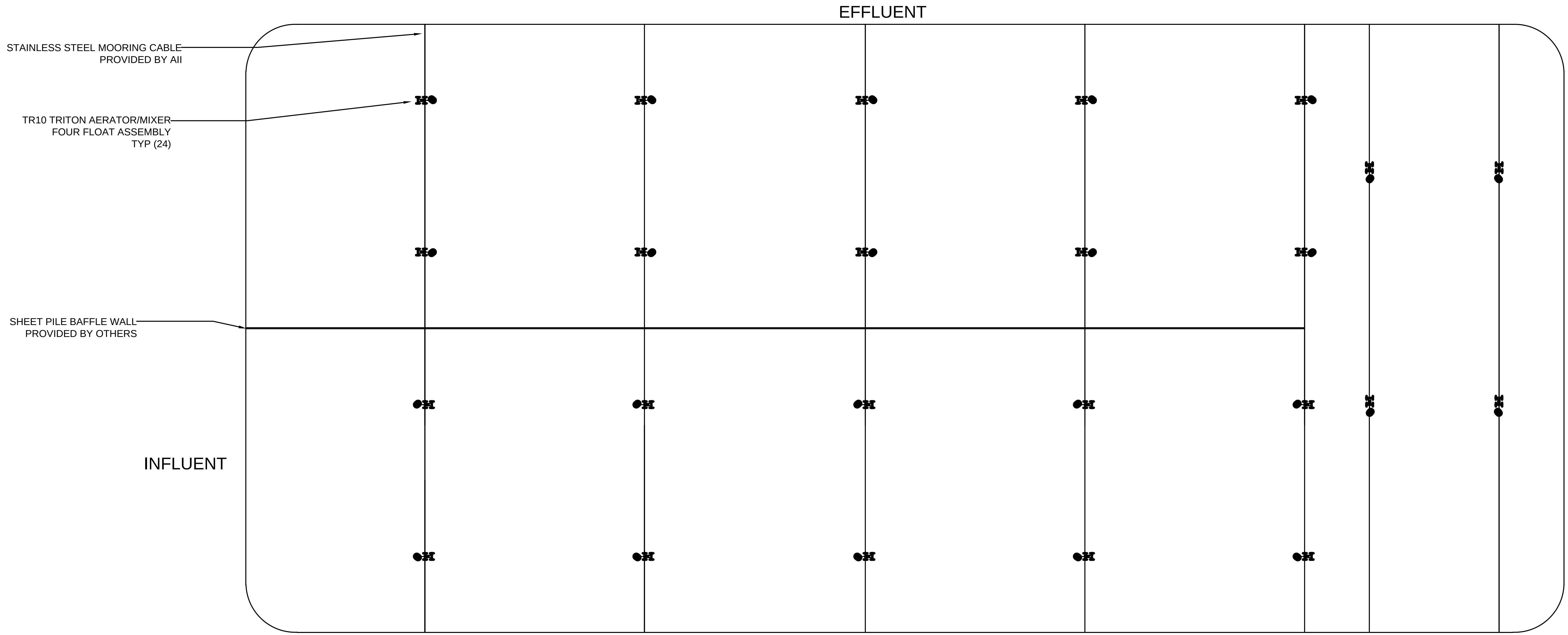
BUDGETARY PRICE: $982,200

$982200/24 = $40925 each + tax 8.5% = $44404 each

EXCLUSIONS: Installation, duties and taxes are not included. Electrical cable, DO controls and instrumentation, cord grips, baffle wall, mooring posts, and all items not specifically listed above are excluded.

NOTE: If required, submittals will be done six weeks from receipt of purchase order. Delivery is fourteen to eighteen weeks from submittal approval. Quotation valid for 30 days. Three year non prorated warranty

TERMS: General Terms and Conditions Attached (2 pages).



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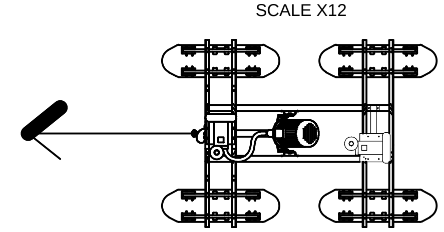


NOTES

ELECTRICAL CABLE PROVIDED BY OTHERS
JUNCTION BOXES PROVIDED BY OTHERS
SHEET BAFFLE PROVIDED BY OTHERS

UNIT LAYOUT IS DEPENDENT ON SHEET BAFFLE AS DRAWN. ALTERNATIVE CONFIGURATIONS MAY BE REQUIRED FOR DIFFERENT BAFFLE GEOMETRIES.

REV.	DATE:	BY:	DESCRIPTION:
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

Aeration Industries' International, LLC.
4100 Peavey Rd, Chaska, MN 55318•USA www.aireo2.com
Phone: +1-952-448-6789 • Fax: +1-952-448-7293
aii@aireo2.com

AIRE-O2

DRAWN BY: APR DATE: 3/10/2017
CHECKED BY: - DATE: -
SCALE: -

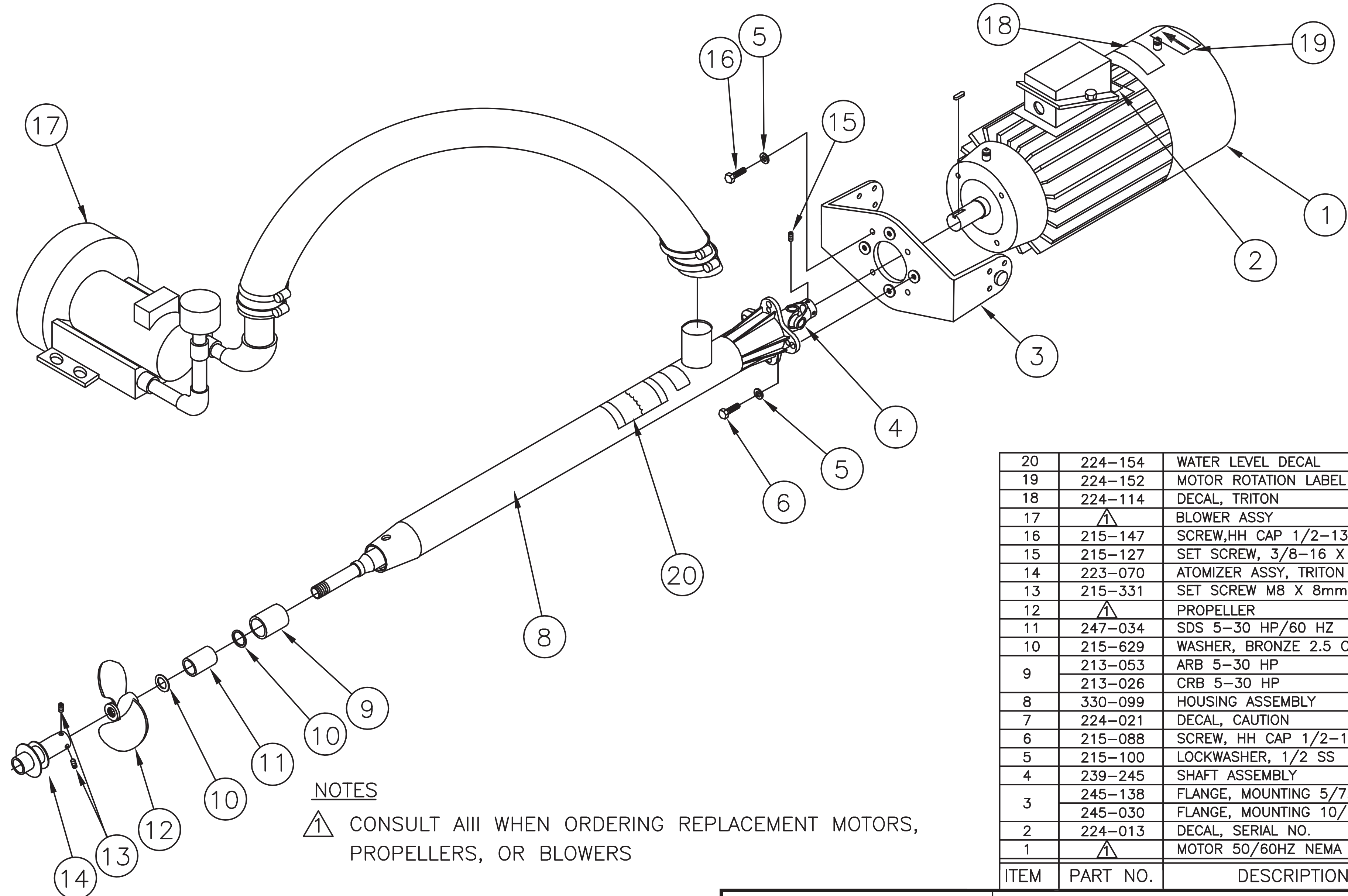
CLIENT: -
-

DRAWING STATUS:
- ☐ INFORMATION ONLY
- ☒ PRELIMINARY
- ☐ APPROVAL
- ☐ CERTIFIED FOR CONSTRUCTION
- ☐ AS-BUILT

TITLE:
ARCATA, CA
AIRE-O2 TRITONS
RECOMMENDED LAYOUT

REV: -
PROJECT NUMBER:

SHEET 1 OF 1



NOTES

⚠1 CONSULT AIII WHEN ORDERING REPLACEMENT MOTORS, PROPELLERS, OR BLOWERS

ITEM	PART NO.	DESCRIPTION	QTY.
20	224–154	WATER LEVEL DECAL	1
19	224–152	MOTOR ROTATION LABEL	1
18	224–114	DECAL, TRITON	1
17	⚠1	BLOWER ASSY	1
16	215–147	SCREW,HH CAP 1/2–13X1 1/4 SS	4
15	215–127	SET SCREW, 3/8–16 X 5/16	2
14	223–070	ATOMIZER ASSY, TRITON	1
13	215–331	SET SCREW M8 X 8mm LG S.S.	2
12	⚠1	PROPELLER	1
11	247–034	SDS 5–30 HP/60 HZ	1
10	215–629	WASHER, BRONZE 2.5 O.D.X2.0 I.D.	2
9	213–053	ARB 5–30 HP	1
	213–026	CRB 5–30 HP	
8	330–099	HOUSING ASSEMBLY	1
7	224–021	DECAL, CAUTION	1
6	215–088	SCREW, HH CAP 1/2–13X1 SS	4
5	215–100	LOCKWASHER, 1/2 SS	8
4	239–245	SHAFT ASSEMBLY	1
3	245–138	FLANGE, MOUNTING 5/7.5 HP	1
	245–030	FLANGE, MOUNTING 10/15 HP	
2	224–013	DECAL, SERIAL NO.	1
1	⚠1	MOTOR 50/60HZ NEMA	1

REV.	ECO NO.	DESCRIPTION OF CHANGE	BY	DATE
F	10-2316	ADDED 224-154	RH	2-26-10
E	10/2310	245-138 WAS 330-028	CY	1/26/10
D	09-2219	215-331 WAS 215-190	RH	4-23-09
C	07-2036	215-190 QTY. WAS 1	RH	5-16-07
B	07-2027	239-245 WAS 239-239 REMOVED 215-642	RH	3-30-07
A	06-1934	223-070 WAS 223-048, 215-190 QTY WAS 2	RH	3-28-06
–	05-1819	RELEASED FOR PRODUCTION	RH	2-25-05

Aeration Industries International, Inc.
P.O. Box 59144 Minneapolis, MN 55459 USA
Telephone: 1(612)448–6789 Telex: 9105780838 Facsimile: 1(612)448–7293

TITLE
TRITON ASSEMBLY
5-15HP 50/60HZ NEMA

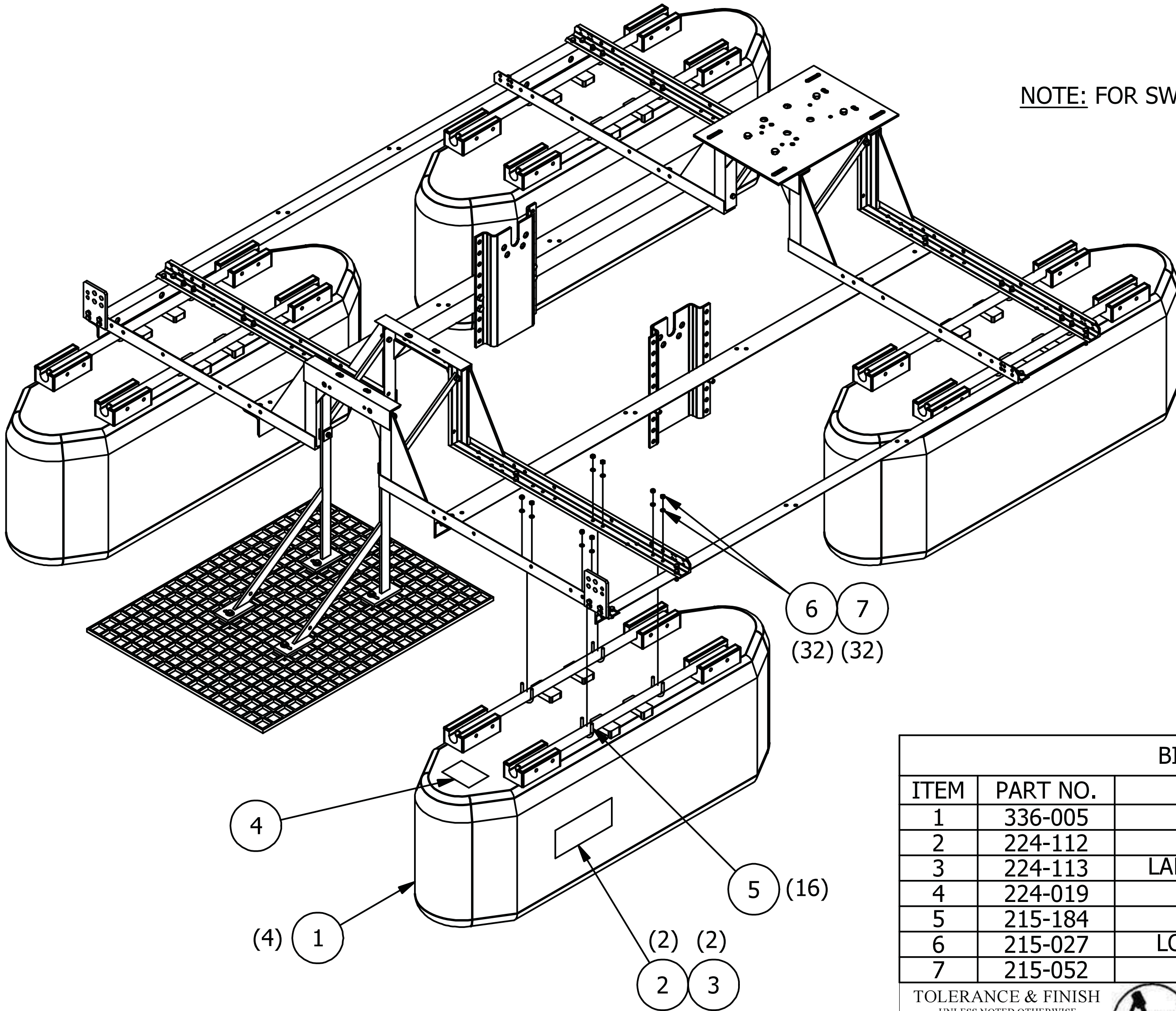
DRAWN RVH | DATE 2-25-05
APPROVED | DATE

DRAWING NO. 360-287 | PROJECT NO. | REV. F

SCALE | PLOT | SHEET 1 OF 1

REVISION HISTORY				
REV	ECO NO.	DESCRIPTION	BY	DATE
-	15-2727	RELEASED FOR PRODUCTION	JFW	11-02-15

NOTE: FOR SWING ARM OPTION SEE SHEET #3.



BILL OF MATERIAL			
ITEM	PART NO.	DESCRIPTION	QTY.
1	336-005	PONTOON ASSY. S.S.	4
2	224-112	LABEL, PHONE # DOMESTIC	2
3	224-113	LABEL, PHONE # INTERNATIONAL	2
4	224-019	LABEL, FLOATATION SAFETY	1
5	215-184	U-BOLT, 5/16-18UNC S.S.	16
6	215-027	LOCK WASHER, 5/16-18UNC S.S.	32
7	215-052	HEX NUT, 5/16-18UNC S.S.	32

DIMENSIONS AND TOLERANCES SHALL BE INTERPRETED IN ACCORDANCE WITH ANSI Y14.5-2009 STANDARDS

DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED

BREAK ALL SHARP EDGES AND REMOVE BURRS

TOLERANCE & FINISH
-UNLESS NOTED OTHERWISE-

FRACTIONS ± 1/32
ANGLE ± 1°
FINISH 125

WELDMENTS

ONE PLACE	2 PLACE	3 PLACE
± 0.06	± 0.03	± 0.015

MACHINED PARTS

ONE PLACE	2 PLACE	3 PLACE
± 0.03	± 0.01	± 0.005

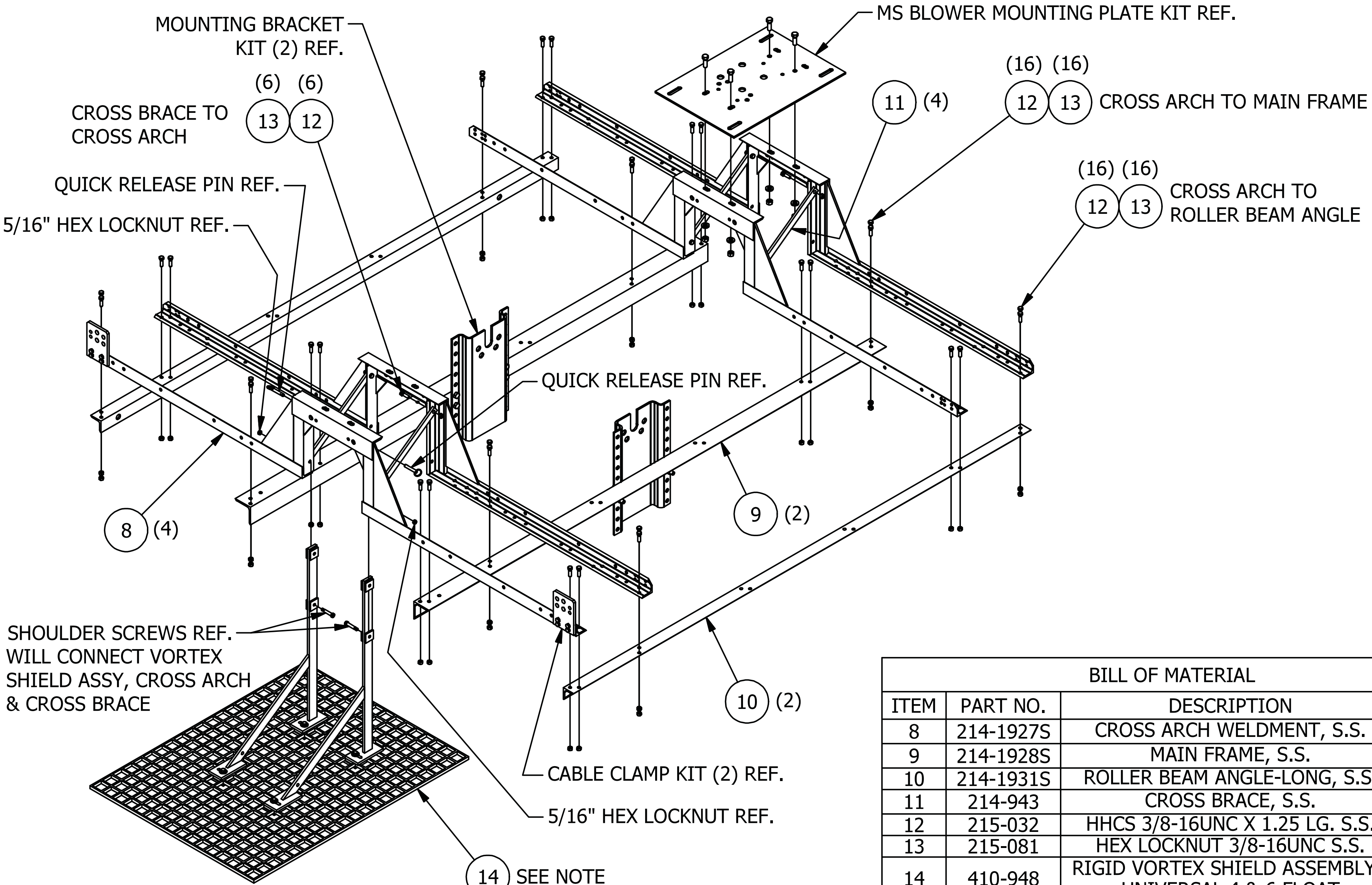
DRAWN: Joe.Widman — DATE: 12/4/2015
REVISED — DATE

Aeration Industries International, LLC.
4100 Peavey Rd, Chaska MN 55318 USA. www.aireo2.com
Phone: +1-952-448-6789. Fax: +1-952-448-7293. aii@aireo2.com

TITLE: UNIVERSAL 4-FLOAT ASSEMBLY, WITHOUT ROLLERS, S.S.

DRAWING NO.: 360-633S — REV.: -

SCALE: - — SIZE: A4 — SHEET 1 OF 3



NOTE: USE (2) QUICK RELEASE PINS, (2) SHOULDER SCREWS & (2) 5/16" HEX LOCKNUTS PROVIDED IN VORTEX SHIELD ASSEMBLY TO ATTACH TO CROSS ARCH AS SHOWN.

BILL OF MATERIAL

ITEM	PART NO.	DESCRIPTION	QTY.
8	214-1927S	CROSS ARCH WELDMENT, S.S.	4
9	214-1928S	MAIN FRAME, S.S.	2
10	214-1931S	ROLLER BEAM ANGLE-LONG, S.S.	2
11	214-943	CROSS BRACE, S.S.	4
12	215-032	HHCS 3/8-16UNC X 1.25 LG. S.S.	38
13	215-081	HEX LOCKNUT 3/8-16UNC S.S.	38
14	410-948	RIGID VORTEX SHIELD ASSEMBLY- UNIVERSAL 4 & 6 FLOAT	1

DIMENSIONS AND TOLERANCES SHALL BE INTERPRETED IN ACCORDANCE WITH ANSI Y14.5-2009 STANDARDS

DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED

BREAK ALL SHARP EDGES AND REMOVE BURRS

TOLERANCE & FINISH
-UNLESS NOTED OTHERWISE-

FRACTIONS ± 1/32
ANGLE ± 1°
FINISH 125

WELDMENTS
ONE PLACE ± 0.06 | 2 PLACE ± 0.03 | 3 PLACE ± 0.015

MACHINED PARTS
ONE PLACE ± 0.03 | 2 PLACE ± 0.01 | 3 PLACE ± 0.005

DRAWN Joe.Widman DATE 12/4/2015
REVISED DATE

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Phone: +1-952-448-6789. Fax: +1-952-448-7293. aii@aireo2.com

TITLE
UNIVERSAL 4-FLOAT ASSEMBLY, WITHOUT ROLLERS, S.S.

DRAWING NO. 360-633S | REV. -

SCALE - | SIZE A4 | SHEET 2 OF 3

AIRE-O_2®

Aeration Industries International

Volume Calculator

Basin Geometry - Rectangular, Side Slopes

Number of Basins	1			
Length	1300.0	ft	396.2	m
Width	600.0	ft	182.9	m
Water Depth	5.0	ft	1.5	m
Freeboard	1.0	ft	0.3	m
End 1 Slope (H:V)	3	*		
End 2 Slope	3	*		
Side 1 Slope	3	*		
Side 2 Slope	3	*		
Volume	27.70	MG	104,860	m^3

* indicates assumed values

Aeration Industries' calculations for determining the aeration equipment required to fulfill the oxygen and/or mixing demand of biological wastewater treatment systems

AIRE-O_2®

Note: The methods and data presented here are intended for use by the designer to estimate the power requirement for the oxygen demand using AIRE-O_2 aeration equipment. This method is not intended to cover every application. Questions can be answered by contacting AIII at 1-800-328-8287

Project Name: Arcata, CA

Project Number: 17-3-7175

Input Data (Blue Cells)

#	Parameter	Value	Unit	Description
1	Flowrate =	2.30	MGD	*Input flowrate*
2	Volume =	27.70	MG	*Input volume*
3	BOD in =	182	mg/l	*Influent BOD*
4	BOD out =	30	mg/l	*Design output BOD*
5	NH_4-N Removal =	49	mg/l	*Design ammonia or TKN removal*
6	Other =	0.00	mg/l	
7	BOD net =	152.0	mg/l	*line 7 = (line 3) - (line 4)*
8	BOD net =	2915.7	lb/day	*line 8 = (line 7) x (line 1) x 8.34*
9	NH_4-N net =	939.9	lb/day	*line 9 = (line 5) x (line 1) x 8.34*
10	Other =	0.0	lb/day	*line 10 = (line 6) x (line 1) x 8.34*

ASSUMPTIONS

#	Parameter	Value	Unit	Description
11	O_2 : BOD =	2.0	lb O_2 / lb BOD	*Typically varies between 1 and 2*
12	O_2 : NH_3-N=	4.6	lb O_2 / lb NH_4-N	*Typical value is 4.6*
13	O_2 : Other =	0	lb O_2 / lb Other	*Depends on species*

O_2 REQUIREMENT UNDER FIELD CONDITIONS (AOR)

#	Parameter	Value	Unit	Description
14	O_2 for BOD =	5831.3	lb O_2 / day	*line 14 = (line 11) x (line 8)*
15	O_2 for NH_4-N =	4323.6	lb O_2 / day	*line 15 = (line 12) x (line 9)*
16	O_2 for Other =	0.0	lb O_2 / day	*line 16 = (line 13) x (line 10)*
17	AOR =	**10155.0**	lb O_2 / day	*line 17 = (line 14) + (line 15) + (line 16)*
18	AOR =	**423.1**	lb O_2 / hour	*line 18 = (line 17) / (24)*

CORRECTION FACTORS TO DETERMINE O_2 REQUIREMENT UNDER STANDARD CONDITIONS (SOR)

#	Parameter	Value	Unit	Description
	Air Temperature =	90	°F	*Input Air temperature*
19	Basin Temperature =	90	°F	*Input Basin temperature*
20	Elevation =	0	feet above msl	*Input Basin elevation*
21	C_w =	2.0	mg/l	*Operating O_2 conc. of wastewater*
22	α =	0.85		*Correction factor for type of waste*
23	β =	0.95		*Correction factor for salinity, TDS, etc.*
24	C_{s20} =	9.09	mg/l	*O_2 saturation conc. at 68 deg F*
25	τ =	0.78		*Temperature correction factor*
26	Ω =	1.00		*Altitude correction factor*
27	C_s =	7.1	mg/l	*O_2 saturation conc. at field conditions*
28	**(Standardized) SOR =**	**709.6**	**lb O_2 / hour**	

$$SOR = \frac{(AOR) * (C_{s20})}{(\alpha)*\{\beta * C_s - C_w\} * (1.024)^{T-20}}$$

Notes:

Organic removal values are used to calculate oxygen demand. Actual performance may depend on hydraulic retention time, temperature, and other factors.

2.0lb O2 / lb BOD accounts for the complete treatment of BOD and stabilization of biomass.

Oxygen demand for BOD treatment and ammonia removal are calculated on a removed, not applied, basis.

Surface action and algae credits were not assumed in this design.

Assimilation and stripping credits were not assumed in this design.

HP REQUIREMENTS

#	Equipment	Value	Unit
32	AIRE-O_2 Triton	**266.1**	**HP**
33	AIRE-O_2 Aspirator	**354.8**	**HP**

MIXING

Process	Triton	Aspirator	
Activated Sludge	60	120	HP / MG
Complete Mix Lagoon	30	60	HP / MG
Partial Mix Lagoon	10	20	HP / MG
Facultative Lagoon	5	10	HP / MG
Chosen Process:	Partial Mix Lagoon		

	Value	Unit	
AIRE-O_2 Triton	**277.0**	**HP**	*process (HP/MG) * V*
AIRE-O_2 Aspirator	**554.0**	**HP**	*process (HP/MG) * V*
HRT	**12.04**	**Days**	*volume / flow*

RECOMMENDATIONS

Based on the information provided, this system is MIXING limited. AII recommends installing twenty four (24) TR10 (12HP) AIRE-O_2 Triton aerators to supply the oxygen and mixing required for treatment.

Aeration Industries International

Lagoons in Series Design Calculations

Project Name:	City of Arcata, CA WWTP	Date	3/10/2017
Project No.:	17-3-7175	Prepared By	APR
		Revision:	4

Design Flow =	2,300,000	gpd =	8705.5	m3/d
Lagoon Water Depth =	5.0	ft =	1.5	m

BOD Removal Zone

Total Lagoon Volume =	27.70	MG =	104845	m3
Total HRT =	12.04	days		

Suspended Growth BOD Removal Calculations

Aerated Lagoon Reactors In Series
(Metcalf & Eddy, 4th Ed., p.271)

$$S = S_o / [1 + (k_T / n) * \tau]^n$$

where
S = effluent BOD concentration, mg/l
S_o = influent BOD concentration, mg/l
τ = total retention time, days
T = wastewater temperature, C
k_T = reaction coefficient, days-1
n = number of reactors

$$k_T = k_{20} (\theta^{T-20})$$

where
k_{20} = reaction coefficient at 20 deg. C = 1.00 days^{-1} Source: Metcalf and Eddy, 4th ed., Table 8-29
θ = temperature factor = 1.036

REACTORS IN SERIES

Number of Reactors = 1

Min. Lagoon Temperature			Max. Lagoon Temperature		
T =	10	C	T =	20	C
τ =	12.04	days	τ =	12.04	days
So =	182	mg/l	So =	182	mg/l
k_T =	0.70	days^{-1}	k_T =	1.00	days^{-1}
S =	19	mg/l	S =	14	mg/l

Aeration Industries International

Lagoons in Series Design Calculations

Project Name:	City of Arcata, CA WWTP	Date	3/10/2017
Project No.:	17-3-7175	Prepared By	APR
		Revision:	4

Design Flow =	5,900,000	gpd =	22331.5	m3/d
Lagoon Water Depth =	5.0	ft =	1.5	m

BOD Removal Zone

Total Lagoon Volume =	27.70	MG =	104845	m3
Total HRT =	4.69	days		

Suspended Growth BOD Removal Calculations

Aerated Lagoon Reactors In Series
(Metcalf & Eddy, 4th Ed., p.271)

$$S = S_o / [1 + (k_T / n) * \tau]^n$$

where
S = effluent BOD concentration, mg/l
S_o = influent BOD concentration, mg/l
τ = total retention time, days
T = wastewater temperature, C
k_T = reaction coefficient, days-1
n = number of reactors

$$k_T = k_{20} (\theta^{T-20})$$

where
k_{20} = reaction coefficient at 20 deg. C = 1.00 $days^{-1}$ Source: Metcalf and Eddy, 4th ed., Table 8-29
θ = temperature factor = 1.036

REACTORS IN SERIES

Number of Reactors = 1

Min. Lagoon Temperature			Max. Lagoon Temperature		
T =	10	C	T =	20	C
τ =	4.69	days	τ =	4.69	days
So =	71	mg/l	So =	71	mg/l
k_T =	0.70	$days^{-1}$	k_T =	1.00	$days^{-1}$
S =	17	mg/l	S =	12	mg/l

Aeration Industries International

AIRE-O₂

Aire-O_2 Triton® TR Series

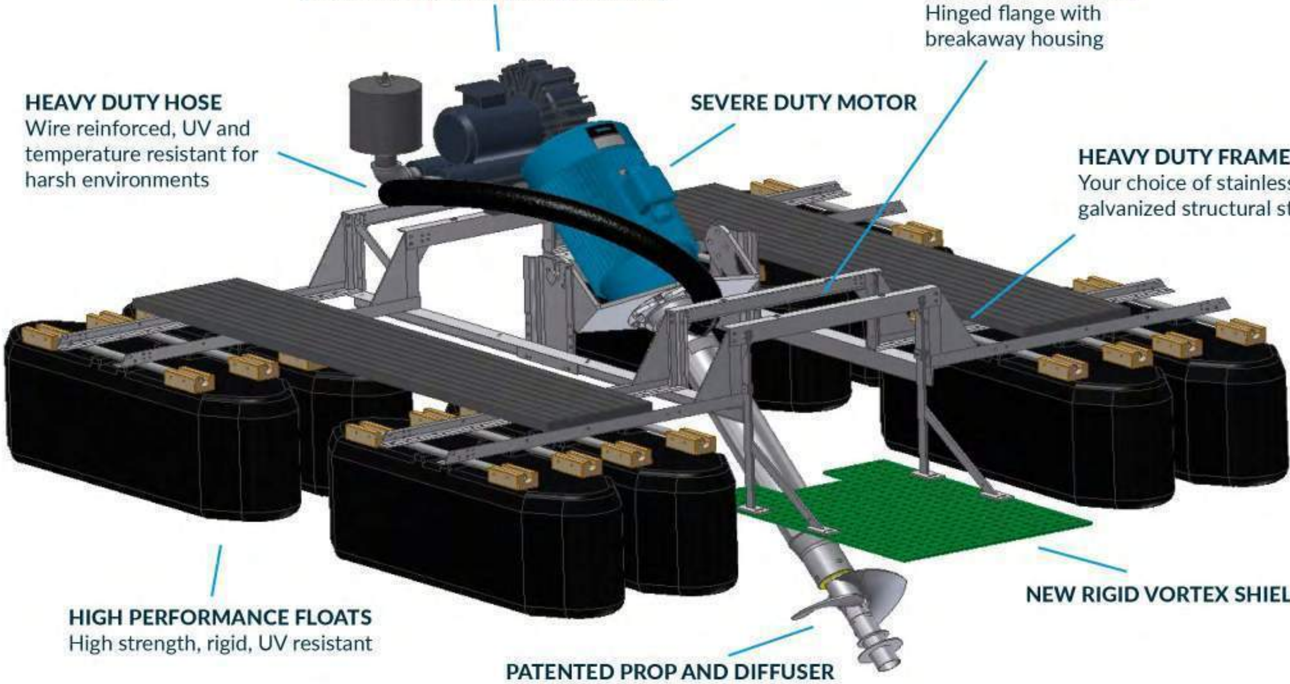
The effective, reliable solution to deliver more oxygen

Unique features allow the Triton® TR Series to perform in harsh conditions, while optimizing performance, efficiency and maximizing oxygen transfer and mixing capabilities.

WHY CHOOSE THE TRITON?

- Delivers more oxygen capacity per unit with upgraded propeller
- Trusted performance
- Maintain without removing or draining the basin
- Performs in challenging, heavy debris conditions
- Fine bubble aeration with a mixing only option for BNR applications
- Mixing capabilities
- Operates for years with minimal maintenance
- Surface mounted, horizontal mixing provides better dispersion, directional control with no splashing or aerosoling
- More than 72,000 units delivered in the US and over 93 countries since 1974

The trusted way to deliver oxygen



Universal Mounts available to fit wall or bridge geometries.

FEATURING

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- Stainless steel dual-bladed Power Mix™ propeller
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- Hoses and fittings with UV protection built in for harsh environments
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- Variable mounting angle offers flexibility

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www.aerationindustries.com

AERATION INDUSTRIES INTERNATIONAL, LLC

General Terms and Conditions

1. **Price.** Published prices are subject to change without notice and shall not be binding on Seller until reduced to writing signed by Seller. All prices are F.O.B. Chaska, MN, and do not include transportation cost or charges relating to transportation, which costs and charges shall be solely the responsibility of Purchaser. Prices quoted include standard packing according to Seller's specifications. Special packing requested by Purchaser, including packing for exports, shall be paid by the Purchaser as an additional charge.

2. **Taxes.** To the extent legally permissible, all present and future taxes, imposed by any Federal, State, Local or foreign authority, which Seller may be required to pay or collect upon or with reference to the sale, purchase, transportation, delivery, storage, use or consumption of goods or services, including taxes upon, or measured by the receipts therefrom, shall be paid by Purchaser. Amounts covered hereby shall be added to the price, or billed as a separate item as the law may require or as the Seller may determine. No offset against or reduction in price shall be allowed Purchaser by reason of taxes owed, paid or payable by Purchaser, or charged by Purchaser's account.

3. **Credit and Payment.** Credit accounts will be opened only with firms or individuals approved by Seller's Credit Department. Unless otherwise provided, in any case where delivery is made on credit, Purchaser shall have thirty (30) days from date of the invoice in which to make payment for the goods. Seller reserves the right at any time upon notice to Purchaser, to alter or suspend credit, or to change the credit terms provided herein, when in its sole opinion the financial condition of the Purchaser so warrants. In addition, the Seller may at any time, with or without notice to Purchaser, and at its option, suspend work and shipment under this contract if, in the Seller's sole opinion, the financial condition of the Purchaser so warrants. In such cases, in addition to any other remedies herein, or by law provided, cash payment or satisfactory security from the Purchaser may be required by the Seller before credit is restored or Seller continues performance. If the Purchaser fails to make payment or fails to furnish security satisfactory to Seller, then Seller shall also have the right to enforce payment of the full contract price of the work completed and in process. Upon default by Purchaser in payment when due, Purchaser shall pay immediately to Seller the entire unpaid amounts for any and all shipments made to purchaser irrespective of the terms of said shipment and whether said shipments are made pursuant to this contract or any other contract of sale between Seller and Purchased, and Seller may withhold all subsequent shipments until the full account is settled. Acceptance by the Seller of less than full payment shall not be a waiver of any or its rights hereunder. The seller reserves the right, at its discretion, to charge up to 1½% per month for amounts not paid within stated terms.

4. **Cancellation.** Cancellation of orders once placed with and accepted by us can only be made by us. Should the Purchaser, due to change in design or other good and sufficient cause, desire to effect cancellation of the order, same will be accepted on the following basis:

Purchaser shall pay in full the costs of all material, dies, tools, patterns and fixtures provided for this order, that are on hand or for which we are obligated, together with all labor and other expense incurred in connection therewith. Invoices covering said costs shall be due and payable immediately upon our acceptance of cancellation.

5. **Patents.** To the best of our knowledge, the articles purchased hereunder do not infringe any Letters Patent granted to others by the United States of America or by any country foreign thereto. We do not assume any responsibility or liability for any claim of infringement brought against the Purchaser, its successors, assigns, customers or udders of its product. The Purchaser agrees to hold us harmless against any claim of infringement which arises out of compliance by us with specifications furnished by Purchaser.

6. **Risk of Loss, Title.** The risk of loss of the goods shall pass to the Purchaser as soon as they are deposited with the carrier for shipment to the Purchaser, but title to the goods shall remain in the seller until the purchase price therefore has been paid.

7. **Shipment.** All shipments shall be F.O.B. Chaska, MN, and the date of shipment shall be contingent upon the date of acceptance of Seller's offer. Seller's obligation with respect to shipments of the goods shall not extend beyond a) putting the goods in the possession of such a carrier and making such a contract for the transportation thereof as may be reasonable having regard to the nature of the good; b) obtaining and delivering within a reasonable time such documents as may be necessary for Purchaser to obtain possession of goods; and c) notifying the Purchaser of the shipment within a reasonable time. Seller shall have the right to ship all of the goods at one time or in portions from time to time within the time of shipment. This contract shall be deemed separable as to the goods sold. Purchaser may not refuse to accept any lot or portion of the goods shipped hereunder on the grounds that there has been a failure to ship any other lot or that goods in any other lot were nonconforming. Any such default by Seller will not substantially impair the value of this contract as a whole and will not constitute a breach of the contract as a whole. The goods shall be deemed to have been tendered to Purchaser when they have been deposited with the carrier.

8. **Inspection and Acceptance.** Purchaser shall have the right to inspect the goods upon receipt of them and shall have the opportunity, at that time, to run adequate tests to determine whether the goods shipped conform to the specification of this contract.

Purchaser shall recompense Seller, at the contract price, for all goods used in testing and Purchaser shall bear any expense incurred in the inspection of the goods used in testing, whether or not the goods are non-conforming. Failure to inspect the goods or failure to notify the Seller in writing that the goods are nonconforming with ten (10) days of the receipt of the goods by Purchaser, shall constitute a waiver of Purchaser's rights of inspection and rejection for nonconformity and shall be equivalent to an irrevocable acceptance of the goods by Purchaser. Acceptance – Unless we receive notification to the contrary promptly from you, we will consider the foregoing conditions as been acceptable to you.

9. **Excuse in Seller's Performance.** This contract is subject to an the Seller shall not be responsible or liable for any delay directly or indirectly resulting from or contributed limitations on Seller's production, capabilities, prompt settlement of all details relating to the materials covered by this proposal, and to delays due to fires, explosions, acts of God, strikes or other differences with workmen, shortage of utility, facility, components or labor, delay in transportation, breakdown or accident, war and acts of war, compliance with or other action taken to carry out the intent of purposes of any law or regulation, changes, or revisions, accidents or any other causes or contingencies not caused by Seller or other which Seller had no reasonable control. In the event that any one or more deliveries hereunder is suspended or delayed by reason of any one or more of the occurrences or contingencies aforesaid, any and all deliveries so suspended or delayed shall be made after such disabilities have ceased to exist, and nothing herein contained shall be construed as lessening in any event the full amount of goods herein purchased and sold, but only as deferring delivery and payment in the events and to the extent herein provided for. Neither shall any delay in shipment be considered as a default under this contract or give rise to any liability on the part of Seller for items of incidental, special consequential damage unless such delay was directly and proximately caused by the willful and wanton act of gross negligence of Seller. Acceptance of material on delivery shall constitute a waiver of any claims against seller for damages on accounts of delay.

10. **Warranty.** Seller warrants that it will, at its option, repair or replace the goods, or return the purchase price thereof, which are found to be defective in material or workmanship or not in conformity with the contract requirements provided that, within three (3) year of shipment thereof, Purchaser gives written notice of such defect to Seller, the Purchaser returns the goods to Seller at point of original manufacture, with transportation charges prepaid by Purchaser, and an examination by Seller discloses to its satisfaction the existence of such defect or nonconformity with the contract requirements. In no event shall Seller be liable for any incidentals, special or consequential damages resulting from said effects or nonconformity. This warranty specifically excludes all labor charges that could be incurred.

THE FOREGOING DOES NOT APPLY TO COMPONENTS WHERE WERE NOT MANUFACTURED BY SELLER, AND IS EXPRESSLY IN LIEU OF OTHER WARRANTIES EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE OR USE. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE FOREGOING, NO AGENT, EMPLOYEE OR REPRESENTATIVE OF THE SELLER HAS ANY AUTHORITY TO BIND THE SELLER TO ANY AFFIRMATION, REPRESENTATION OR WARRANTY CONCERNING THE GOODS SOLD UNDER THIS SALES CONTRACT, AND UNLESS AN AFFIRMATION, REPRESENTATION OR WARRANTY MADE BY AN AGENT EMPLOYEE OR REPRESENTATIVE IS SPECIFICALLY INCLUDED WITHIN THIS WRITTEN AGREEMENT, IT SHALL NOT BE ENFORCEABLE TY THE PURCHASER.

11. **Remedies of Purchaser.** If goods are tendered which do not conform with the specifications under the sales contract and these goods are rejected by Purchaser, Seller shall have the right to cure the tender by either correcting the goods or substituting conforming goods. In the event that such substituted goods fail to conform to the contract or in the event of any other breach or repudiation of this contract by Seller, Purchaser shall not be entitled to recover any incidental or consequential damages as those terms are defined in Section 2-715 of the Minnesota Uniform Commercial Code and Purchaser's right to damages shall be limited to the difference between the contract and the market price of the goods as provided in Section 2-713 of the Minnesota Uniform Commercial Code. Purchaser shall not have the right to "cover" as provided in Section 2-712 of the Minnesota Uniform commercial code nor any rights to recover damages for any loss resulting in the ordinary course of events from nonconformity of tender as contained in Section 2-714(1) of the Minnesota Uniform Commercial Code.

12. **Assignments.** No right to interest in this contract shall be assigned by Purchaser, without the written permission of Seller, and no delegation of any obligation owned by Purchaser shall be made without permission of the Seller. Any attempted assignment of delegation shall be wholly void and totally ineffective for all purposed.

13. **Alterations, Interpretations and Definitions.** This contract shall be governed by the laws of Minnesota and is intended also as a complete and exclusive statement of the terms of their agreement. No course of prior dealings between the parties, and no usage of the trade shall be relevant to supplement or explain any term used in this contract. Acceptance or acquiescence to a course of performance rendered under this contract shall not be relevant to determine the meaning of this contract, even though the accepting or acquiescing party has knowledge of the nature of the performance and an opportunity for objection. Waiver by Seller of a breach by Purchaser of any provision of this contract shall not be deemed a waiver of future compliance therewith, and such provision shall remain in full force and effect. Any term used in this contract which is not defined herein shall have the same definition as that contained in the Minnesota Uniform Commercial Code.

Clean Water Oxygen Transfer Test

AIRE-O_2 TRITON® TR Series Process Aerator/Mixer

TR10 Model

September 2015

Certified By:

SUN-NAN HONG, PH.D., P.E.

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1. Introduction

Aeration Industries International, LLC, conducted a test and assessment of an Aire-O_2 TR10 Triton surface aerator in a test basin at its facility located in Chaska, Minnesota, USA, on September 1st, 2015.

This testing is essential to determine the oxygen transfer efficiency under clean water conditions according to the American Society of Civil Engineers (ASCE) "Measurement of Oxygen Transfer in Clean Water" [ASCE/EWRI 2-06].

2. Test Condition

Type:	AIRE-O_2 Triton		Blower
Voltage (*V*)	480		480
Frequency (*Hz*)	60		60
Motor speed (*RPM*)	900		3500
Blower Discharge Pressure (*In -WG*)	33.8		
	Run 1	Run 2	Run 3
Test Water Temperature (℃)	19.4	19.5	19.7
Barometric Pressure (*kPa*)	98.8	98.8	98.8
TDS (*mg/L*)	1014	1086	1147
Test Pool Volume (m^3)	352		

Table 1: Test Conditions

The drawings in Figure 1 illustrate the basin and probe arrangement. See Appendix A for detailed drawings.

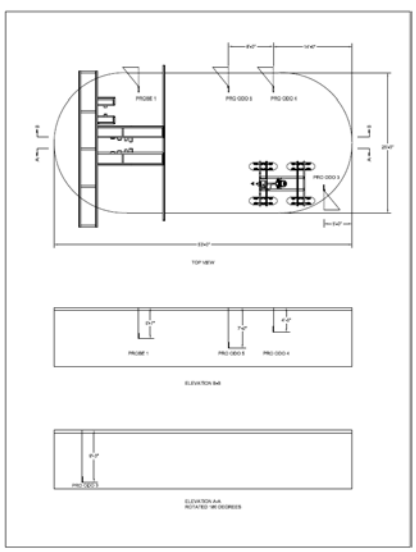


Figure 1: Plan and Profile View of Test Basin

3. Oxygen Transfer Test

3.1 O2 Transfer Test Protocol

The following test procedure follows the ASCE standard "Measurement of Oxygen Transfer in Clean Water" [ASCE/EWRI 2-06].

3.2 Preparation

1) Verify availability of required test equipment and order equipment as needed.
2) Inspect and verify all test equipment meets quality and tolerance requirements.
3) Test mechanical operation of equipment for quality and tolerance requirements.
4) Designate the appropriate mounting type and position of the equipment in a plan and profile view drawing.
5) Order required chemicals for the designated quantity of test series and runs.
   a. Technical grade sodium sulfite:
      i. 62 lbs/run at temperatures greater than 18°C.
      ii. 72 lbs/run at temperatures less than 18°C.
   b. Reagent grade cobalt chloride:
      i. 0.25 lbs/series
6) Remove all YSI probes from the basin.
   a. Verify calibration of pressure readings;
      i. Compare pressure readings from the probes to a barometer in the same area.
      ii. If the difference in readings are ≤ 1%, the pressure sensors are considered in good condition.
      iii. If there is no barometer available for pressure check, compare the readings between YSI probes.
      iv. If the difference in readings are ≤ 1%, the pressure sensors can be considered in good condition.
      v. If the difference in readings is > 1% for item i. or iii., probe(s) must be sent back to the manufacturer for pressure calibration.
      vi. Complete once for each test series.
   b. Verify calibration of temperature readings:
      i. Compare temperature reading from the probes to a thermometer in the same area.
      ii. If the difference in readings are ≤ 1%, the temperature sensors are considered in good condition.
      iii. If there is no thermometer available for temperature check, compare the readings between YSI probes.
      iv. If the difference in readings are ≤ 1%, the temperature sensors can be considered in good condition
      v. If the difference in readings are > 1% for item i. or iii., probe(s) must be sent back to the manufacturer for temperature calibration. .
      vi. Complete once for each test series.
7) Calibrate conductivity on the YSI galvanic probe. Refer to YSI ProODO Professional Series Probe manual for detail conductivity calibration instructions.

a. Use a beaker or other container capable of fully submerging the probe full of YSI conductivity calibration solution. Note: The conductivity sensor is located within the small recess at the top of the probe.
b. Fill the beaker or container with YSI conductivity calibration solution (1,000 microsiemens/cm), so that the probe will be completely submerged.
c. Insure probe is connected to the handheld controller.
d. Use the controller programming to finalize calibration.
e. Complete once for each test series.

8) Calibrate YSI Probe DO readings.
   a. Air-saturation calibration method. Refer to YSI ProODO Optical Probe manual for detail one point air-saturation calibration instructions.
      i. Designate a lead probe.
      ii. Use the sleeve including a water-saturated sponge in it to fully cover the probe
      iii. Insure the probe is connected to the handheld controller.
      iv. Use the controller programming to finalize the calibration.
      v. Match calibration of the subsequent probes to the lead probe.
   b. Winkler Titration Method
      i. Prepare the HANNA kit. Refer to HANNA Winkler kit for detail operation details.
      ii. Prepare a bucket of oxygen saturated test basin sample water.
      iii. Take DO measurement of the water sample by YSI probe.
      iv. Take DO measurement of the water sample by Winkler Titration Method.
      v. Compare the DO reading from YSI probe and Winkler Titration Method. If the difference in readings are within +/-5%, the YSI air-saturation calibration method can be used for the DO probe calibration with subsequent tests in the same series.
   c. Calibrate probes using the appropriate method each time the loggers are shut off, disconnected from the probe.
9) Calibrate YSI Probe TDS readings.
   a. Collect water sample for lab evaluation of TDS for probe verification at the beginning each test series
   b. Calibrate YSI galvanic probe cell constant of TDS based on the lab TDS result at the beginning of each test series. Refer to YSI ProODO Professional Series Probe manual for TDS cell constant setting details.
10) Calibrate Annubar differential pressure readings to 0.

3.3 Test Procedure

1) Turn off basin filter system, water inlets and outlets if any.
2) Connect Annubar and selected blower to the mixing device.
3) Position four optical YSI probes in designated locations within the testing basin.
4) Set run name/number on all loggers
5) Set salinity value on the optical probes to the salinity value recorded from the galvanic probe.
6) Initiate mixing device
7) Add 0.25 lbs Cobalt each time after the test pool is refilled. If a different test basin is used, the quantity of Cobalt should be determined by test basin volume and a target Cobalt solution concentration of 0.1mg/L ~ 0.5mg/L

8) Continue mixing for 20 minutes
9) Set time interval on all loggers
10) Start logging DO concentration at all determination points
11) Add 62lbs technical grade sodium sulfite if water temperature is above 18°C. Add 72lbs technical grade sodium sulfite if water temperature is below 18°C.
12) Keep mixing until sodium sulfite has depressed the DO concentration to less than 0.5 mg/L at all determination.
13) Keep mixing for 2~5 minutes before turning on the blower or Aerator
14) Turn on blower if it is a Triton under test. Turn off mixing device and turn on the Aerator if it is an Aspirator under test.
15) Observe and record electrical data from panel for the mixer and blower motors in 15 second intervals for two minutes after test unit is turned on for at least 10 minutes
    a. Power in kW or W.
    b. Power factor, non-dimensional.
    c. Current in Amps.
    d. Voltage.
16) Record Annubar readings, including gauge pressure, differential pressure, temperature and flow rate.
17) Record TDS readings and salinity readings from YSI galvanic probe
18) Continue test until DO reaches 98% saturation on all loggers.
19) Stop logging on all loggers.
20) Turn off blower.
21) Turn off mixer.
22) Upload data to computer.
23) The first test of the total series is considered a pool conditioning run. Only data from the second test and all consecutive tests should be used in performance evaluation.
24) Test series are considered valid under the following conditions:
    a. TDS ≤ 2,000 mg/L.
    b. Temperature of 10°C-30°C.
25) Repeat step 1) to 24) for consecutive test. At least four valid tests are required to obtain average SOTR and SAE

3.4 Data Analysis

1) Excel file 'ASCE DO PAR VERSION 3.0.1' is used for SAE, SOTR calculation
2) All four optical probe data should be processed before copying into 'ASCE DO PAR VERSION 3.0.1.'
    a. Probe data should start from the same time point.
    b. The start time point should be the time when the first probe DO value reaches 2.0 mg/L to eliminate residual sodium sulfite impact on testing.
    c. The total number of data point should not exceed 495.
3) TDS Correction
    a. A TDS correction formula developed by Aeration Industries is used for TDS correction on Kl_a.
    b. TDS is calculated throughout the duration of the test series using mass balance equations.

4) The spatial variation of average determination point Kla20 values computed in each test should be limited so that three fourth of values are within +/- 10% of the mean value of the tank.
5) Final SAE and SOTR value are required to be the average value of at least four valid repeating test. The SOTR result from repeating test are considered valid if variation in between results are less than +/- 15%
6) A +/- 5% tolerance in electrical readings is allowed in final result

3.5 Calculation Description

Calculation of Mass Transfer Rate: ($K_L a$)

The test method is based upon removal of dissolved oxygen (DO) from the water volume by sodium sulfite followed by reoxygenation to near the saturation level. The DO inventory of the water volume is monitored during the reaeration period by measuring DO concentrations at several determination points selected to best represent tank contents. These DO concentrations are sensed in situ using DO probes. The method specifies a minimum number, distribution, and range of DO measurements at each determination point. The data obtained at each determination point are then analyzed by a simplified mass transfer model to estimate the apparent volumetric mass transfer coefficient, $K_L a$ and the steady-state DO saturation concentration, C^*_∞. The basic model is described by:

$$C = C^*_\infty - (C^*_\infty - C_0)\exp(-K_l a t) \quad \text{(Eq. 1)}$$

Where:

C = DO concentration, *mg/L*

C^*_∞ = determination point value of the steady-state DO saturation concentration as time approaches infinity, *mg/L*

C_0 = DO concentration at time zero, *mg/L*

$K_L a$ = determination point value of the apparent volumetric mass transfer coefficient

Nonlinear regression is employed to fit Eq. 1 to the DO profile measured at each determination point during reoxygenation. In this way, estimates of K_La and C^*_∞ are obtained at each determination point. These estimates are adjusted to standard conditions, and the standard oxygen transfer rate (mass of oxygen dissolved per unit time at a hypothetical concentration of zero DO) is obtained as the average of the products of the adjusted determination point K_La values, the corresponding adjusted determination point C^*_∞ values, and the tank volume.

Calculation of Standard Oxygen Transfer Rate: (SOTR)

By convention, the oxygen transfer capacity of an oxygenation system is usually expressed as the rate of oxygen transfer predicted by the model at zero dissolved oxygen under standard conditions of temperature and pressure, usually 1.00 atm (101.3 kPa) and 20°C. This is termed the standard oxygen transfer rate (SOTR). The SOTR value shall be determined by correcting the values of K_La and C*.

$K_La\ 20 = K_La\theta^{(20-T)}$ (Eq. 2)

$C^*_\infty 20 = C^*_\infty\ (1/\tau\Omega)$ (Eq. 3)

Where:

K_La = determination point value of apparent mass transfer coefficient, min^{-1}.

K_La_{20} = determination point value of KLa corrected to 20°C, min^{-1}.

Θ = empirical temperature correction factor, defined by Eq. 2 shall be taken equal to 1.024 unless proven to have a different value for the aeration system and tank tested.

C^*_∞ = determination point value of steady-state DO saturation concentration estimated, *mg/L*.

$C^*_{\infty 20}$ = determination point value of steady-state DO saturation concentration corrected to 20°C and a standard barometric pressure of 1.00 atm (101.3 kPa).

τ = temperature correction factor= C^*_{st}/ $C^*_{\infty 20}$.

C^*_{st} =tabular value of dissolved oxygen surface saturation concentration at the test temperature, a standard total pressure of 1.00 atm (I 01.3 kPa) and 100% relative humidity, *mg/L*.

C^*s_{20} = tabular value of dissolved oxygen surface saturation concentration at 20°C, a standard total pressure of 1.00 atm (101.3 kPa) and 100% relative humidity, *mg/L*.

Ω = pressure correction factor = P_b/P_s for tanks under 20ft (6.1 m) [for deeper tanks or elevation changes greater than 2,000 ft (610 m).

P_b = barometric pressure at test site during test, *kPa*.

P_s = standard barometric pressure of 1.00 atm, *kPa*

T = water temperature during test, °*C*.

The average value of SOTR shall be calculated by averaging the values at each of the n determination points by:

$$SOTR = \frac{V}{n} \sum_{i=1}^{n} K_L\, a_{20i}\, C^*_{\infty 20i} \qquad \text{(Eq. 4)}$$

$$SOTR\ = 1/n \sum_{i=1}^{n} SOTR_i \qquad \text{(Eq. 5)}$$

Where:

$$SOTR_i = K_L a_{20i} \, C^*_{\infty 20i} \, V \qquad \text{(Eq. 6)}$$

V = liquid volume of water in the test tank with aerators turned off, m^3

SOTR = standard oxygen transfer rate, *kg/hr*

4. Test Results

4.1 Power Consumption

To evaluate the oxygen transfer efficiency, AII obtained wire power readings for four separate test runs using a calibrated power measurement apparatus (Schneider Electric Power Logic PM5560 Power Meter) to show the aerator power consumption. The installation and calibration of the power meter was completed within 6 months to this report date. See Appendix F for power meter installation and calibration date.

The wire power readings taken from the power measurement apparatus were used in conjunction with the equipment efficiencies to calculate delivered (shaft) horsepower. The equipment efficiencies used in delivered horsepower calculation include mixer motor efficiency, drivetrain efficiency and blower efficiency. Drivetrain efficiency was selected based on typical experience number for similar mechanism, which is 92%. Mixer motor efficiency and blower efficiency are provided by manufacturer specification. See Appendix C&D for mixer motor and blower data sheet. See Table 2 for mixer and blower power readings for each test run.

Run	MIXER			BLOWER				TOTAL	
	MIXER VOLTAGE (V)	MIXER WIRE POWER (kW)	MIXER DELIVERED POWER (kW)	ΔP (In-WG)	BLOWER VOTAGE (V)	BLOWER WIRE POWER (kW)	Blower DELIVERED POWER (kW)	WIRE POWER (kW)	DELIVERED POWER (kW)
1	480	8.7	7.1	33.8	480	1.4	0.7	9.1	7.8
2	480	8.7	7.1		480	1.4	0.7	9.1	7.8
3	480	8.7	7.1		480	1.4	0.7	9.1	7.8

Table 2: TR10 Triton Power and Pressure Reading

4.2 Oxygen Transfer

Table 3 below summarizes the results for each test run, using the output categories from ASCE DO Par Version 3.0.1. To evaluate the oxygen transfer efficiency, AII obtained DO readings for four separate test runs using a calibrated YSI optical DO Probe. The installation and calibration of the probe sensor caps were completed within 1 year to this report date. See Appendix E for installation and calibration date.

<u>Result</u>

Run	Probe	ASCE Program Outputs @ Standard Conditions								
		$K_{La,20}$ *(hr⁻¹)*	$C^*_{\infty 20}$ *(mg/L)*	SOTR *(kg/hr)*	SOTR *(lb/hr)*	Deviation from Avg. $K_{La,20}$	* Avg. SOTR *(kg/hr)*	Avg. SOTR *(lb/hr)*	** Avg. $SAE_{delivered}$ *(kg/hr-kW)*	Avg. $SAE_{delivered}$ *(lb/hr-hp)*
1	1	4.41	9.29	14.4	31.8	-1%	**14.7**	**32.4**	**1.9**	**3.1**
	2	4.45	9.40	14.7	32.5	0%				
	3	4.54	9.30	14.9	32.8	2%				
	4	4.48	9.30	14.7	32.4	0%				
2	1	4.45	9.27	14.5	32.0	2%	**14.3**	**31.5**	**1.8**	**3.0**
	2	4.25	9.40	14.1	31.0	-2%				
	3	4.29	9.31	14.1	31.0	-1%				
	4	4.41	9.29	14.4	31.8	1%				
3	1	4.46	9.47	14.9	32.8	2%	**14.6**	**32.1**	**1.9**	**3.1**
	2	4.16	9.55	14.0	30.8	-5%				
	3	4.31	9.49	14.4	31.8	-1%				
	4	4.50	9.44	15.0	33.0	3%				

Table 3: SOTR/SAE Results and Reproducibility of $K_{La,20}$

*: *The variation in between result of SOTR from repeating test are less than +/- 15%*

**: *The variation in between result of $SAE_{delivered}$ from repeating test are less than +/- 5%*

Run	ASCE Program Outputs @ Standard Conditions						
	$K_{La,20}$ (s^{-1})	$C^*_{\infty 20}$ (mg/L)	SOTR *(kg/hr)*	Average SOTR *(kg/hr)*	Average SOTR *(lb/hr)*	Average $SAE_{delivered}$ *(kg/hr-kW)*	Average $SAE_{delivered}$ *(lb/hr-hp)*
1	**4.47**	**9.32**	**10.2**	**14.5**	**32.0**	**1.9**	**3.1**
2	**4.35**	**9.32**	**10.4**				
3	**4.36**	**9.49**	**10.3**				

Table 4: Final SOTR and SAE Results

5. Certification

The undersigned certify that the following are accurate:

I. The protocol identified in Section 3 meets the minimum requirements of the ASCE "Measurement of Oxygen Transfer in Clean Water" [ASCE/EWRI 2-06].

II. The Clean Water Oxygen Transfer Test referenced in this Report, to measure and calculate the results reported in Section 4 and in item III, were conducted as specified in the protocol identified in Section 3.

III. The results summarized in Section 4 are accurate based on the data collected from the Clean Water Oxygen Transfer Test completed and reported in this Report.

Model	**AIRE-O2 TRITON® Process Aerator/Mixer**							
Parameter	Wire Power		Delivered Power		Average SOTR		Average $SAE_{delivered}$	
Unit of Measure	*kW*	*hp*	*kW*	*hp*	*(kg/hr)*	*(lb/hr)*	*(kg/hr-kW)*	*(lb/hr-hp)*
Value	9.1	12.2	7.8	10.5	14.5	32.0	1.9	3.1

Table 5: Summary of SOTR and SAE Results

Printed Name: SUN-NAN HONG, Ph.D., P.E.

Organization: Private Consultant

Title:

Signature: Sun-nan Hong

Date: Oct. 22, 2015

Appendix A: ASCE DO PAR Results

Table 6: Run 1

Iterations by Exponential method							
	Iteration	C^*_∞	C_o	K_{La}	Sum of residuals	Sum of squares	RMS
Probe 1	0	8.490	1.125	0.0656	105.8698	111.635	0.8379
	1	9.272	1.018	0.0671	3.0528	21.223	0.3653
	2	9.323	1.019	0.0671	-3.7105	20.600	0.3599
	3	9.325	1.019	0.0671	-4.0567	20.583	0.3598
	4	9.326	1.019	0.0671	-4.0761	20.582	0.3598
	5	9.326	1.019	0.0671	-4.0772	20.582	0.3598
	6	9.326	1.019	0.0671	-4.0772	20.582	0.3598
Probe 2	0	8.689	1.099	0.0657	98.4583	99.000	0.7891
	1	9.399	1.023	0.0676	2.2522	21.638	0.3689
	2	9.443	1.023	0.0677	-3.7559	21.092	0.3642
	3	9.446	1.023	0.0677	-4.0719	21.076	0.3641
	4	9.446	1.023	0.0677	-4.0892	21.075	0.3641
	5	9.446	1.023	0.0677	-4.0901	21.075	0.3641
	6	9.446	1.023	0.0677	-4.0902	21.075	0.3641
Probe 3	0	8.596	1.109	0.0663	97.1471	96.987	0.7810
	1	9.292	0.969	0.0689	2.9860	19.454	0.3498
	2	9.338	0.968	0.0691	-3.5251	18.856	0.3444
	3	9.340	0.968	0.0691	-3.8516	18.838	0.3442
	4	9.340	0.968	0.0691	-3.8697	18.837	0.3442
	5	9.340	0.968	0.0691	-3.8706	18.837	0.3442
	6	9.340	0.968	0.0691	-3.8707	18.837	0.3442
Probe 4	0	8.524	1.148	0.0661	105.1928	111.464	0.8373
	1	9.293	1.032	0.068	2.953	21.861	0.371
	2	9.342	1.032	0.068	-3.769	21.229	0.365
	3	9.345	1.032	0.0681	-4.1096	21.211	0.3652
	4	9.345	1.032	0.0681	-4.1284	21.211	0.3652
	5	9.345	1.032	0.0681	-4.1294	21.210	0.3652
	6	9.345	1.032	0.0681	-4.1294	21.210	0.3652

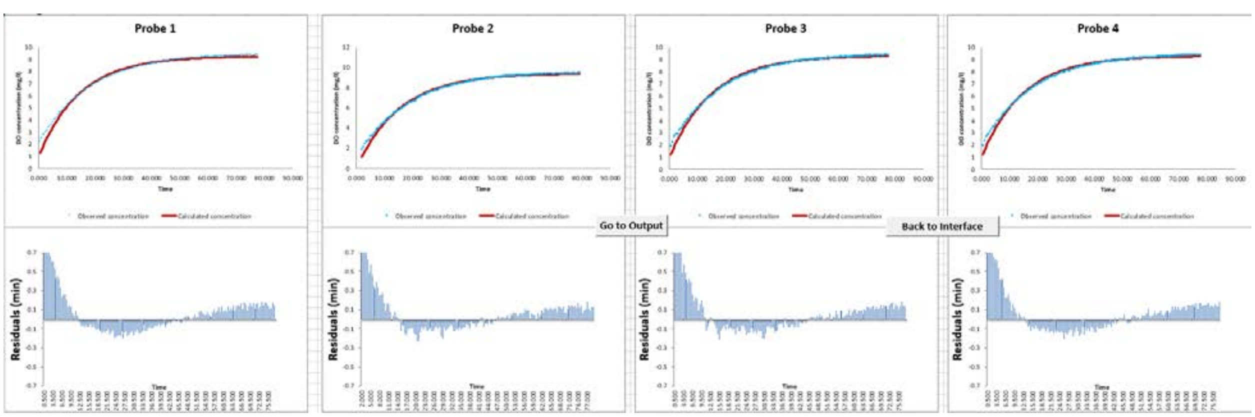


Figure 2: Run 1 Plots

Table 7: Run 2

Iterations by Exponential method

Probe	Iteration	C^*_∞	C_0	K_{La}	Sum of residuals	Sum of squares	RMS
Probe 1	0	8.490	1.125	0.0656	105.8698	111.635	0.8379
	1	9.272	1.018	0.0671	3.0528	21.223	0.3653
	2	9.323	1.019	0.0671	-3.7105	20.600	0.3599
	3	9.325	1.019	0.0671	-4.0567	20.583	0.3598
	4	9.326	1.019	0.0671	-4.0761	20.582	0.3598
	5	9.326	1.019	0.0671	-4.0772	20.582	0.3598
	6	9.326	1.019	0.0671	-4.0772	20.582	0.3598
Probe 2	0	8.689	1.099	0.0657	98.4583	99.000	0.7891
	1	9.399	1.023	0.0676	2.2522	21.638	0.3689
	2	9.443	1.023	0.0677	-3.7559	21.092	0.3642
	3	9.446	1.023	0.0677	-4.0719	21.076	0.3641
	4	9.446	1.023	0.0677	-4.0892	21.075	0.3641
	5	9.446	1.023	0.0677	-4.0901	21.075	0.3641
	6	9.446	1.023	0.0677	-4.0902	21.075	0.3641
Probe 3	0	8.596	1.109	0.0663	97.1471	96.987	0.7810
	1	9.292	0.969	0.0689	2.9860	19.454	0.3498
	2	9.338	0.968	0.0691	-3.5251	18.856	0.3444
	3	9.340	0.968	0.0691	-3.8516	18.838	0.3442
	4	9.340	0.968	0.0691	-3.8697	18.837	0.3442
	5	9.340	0.968	0.0691	-3.8706	18.837	0.3442
	6	9.340	0.968	0.0691	-3.8707	18.837	0.3442
Probe 4	0	8.524	1.148	0.0661	105.1928	111.464	0.8373
	1	9.293	1.032	0.068	2.953	21.861	0.371
	2	9.342	1.032	0.068	-3.769	21.229	0.365
	3	9.345	1.032	0.0681	-4.1096	21.211	0.3652
	4	9.345	1.032	0.0681	-4.1284	21.211	0.3652
	5	9.345	1.032	0.0681	-4.1294	21.210	0.3652
	6	9.345	1.032	0.0681	-4.1294	21.210	0.3652

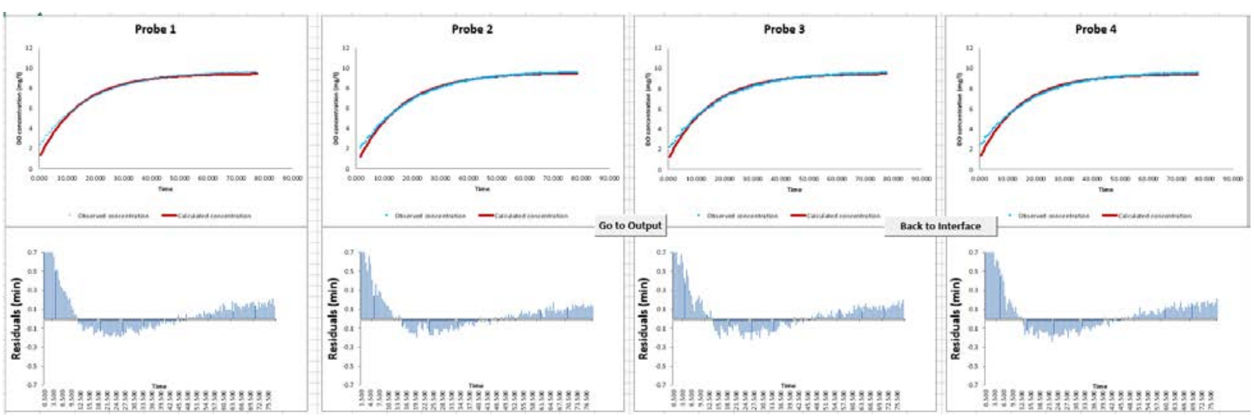


Figure 3: Run 2 Plots

Table 8: Run 3

Iterations by Exponential method							
	Iteration	C^*_∞	C_0	K_{La}	Sum of residuals	Sum of squares	RMS
Probe 1	0	8.490	1.125	0.0656	105.8698	111.635	0.8379
	1	9.272	1.018	0.0671	3.0528	21.223	0.3653
	2	9.323	1.019	0.0671	-3.7105	20.600	0.3599
	3	9.325	1.019	0.0671	-4.0567	20.583	0.3598
	4	9.326	1.019	0.0671	-4.0761	20.582	0.3598
	5	9.326	1.019	0.0671	-4.0772	20.582	0.3598
	6	9.326	1.019	0.0671	-4.0772	20.582	0.3598
Probe 2	0	8.689	1.099	0.0657	98.4583	99.000	0.7891
	1	9.399	1.023	0.0676	2.2522	21.638	0.3689
	2	9.443	1.023	0.0677	-3.7559	21.092	0.3642
	3	9.446	1.023	0.0677	-4.0719	21.076	0.3641
	4	9.446	1.023	0.0677	-4.0892	21.075	0.3641
	5	9.446	1.023	0.0677	-4.0901	21.075	0.3641
	6	9.446	1.023	0.0677	-4.0902	21.075	0.3641
Probe 3	0	8.596	1.109	0.0663	97.1471	96.987	0.7810
	1	9.292	0.969	0.0689	2.9860	19.454	0.3498
	2	9.338	0.968	0.0691	-3.5251	18.856	0.3444
	3	9.340	0.968	0.0691	-3.8516	18.838	0.3442
	4	9.340	0.968	0.0691	-3.8697	18.837	0.3442
	5	9.340	0.968	0.0691	-3.8706	18.837	0.3442
	6	9.340	0.968	0.0691	-3.8707	18.837	0.3442
Probe 4	0	8.524	1.148	0.0661	105.1928	111.464	0.8373
	1	9.293	1.032	0.068	2.953	21.861	0.371
	2	9.342	1.032	0.068	-3.769	21.229	0.365
	3	9.345	1.032	0.0681	-4.1096	21.211	0.3652
	4	9.345	1.032	0.0681	-4.1284	21.211	0.3652
	5	9.345	1.032	0.0681	-4.1294	21.210	0.3652
	6	9.345	1.032	0.0681	-4.1294	21.210	0.3652

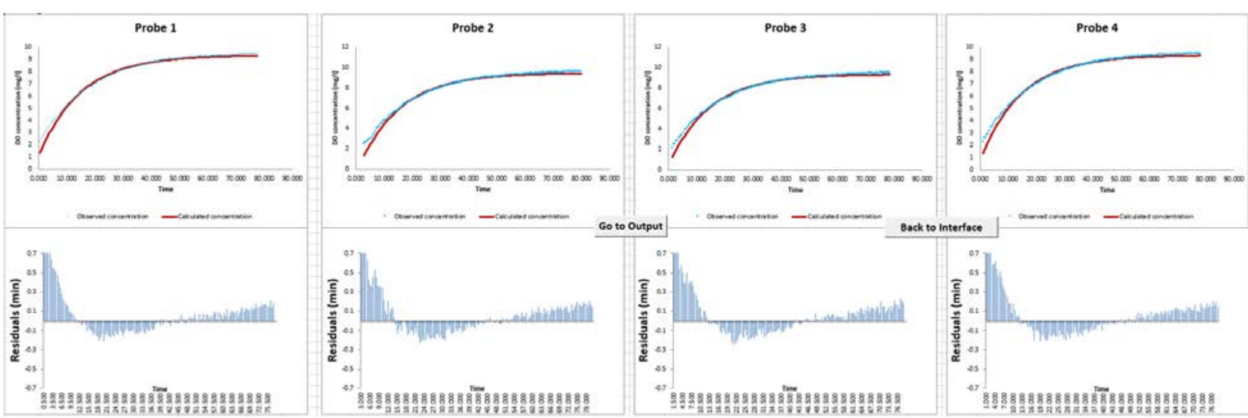
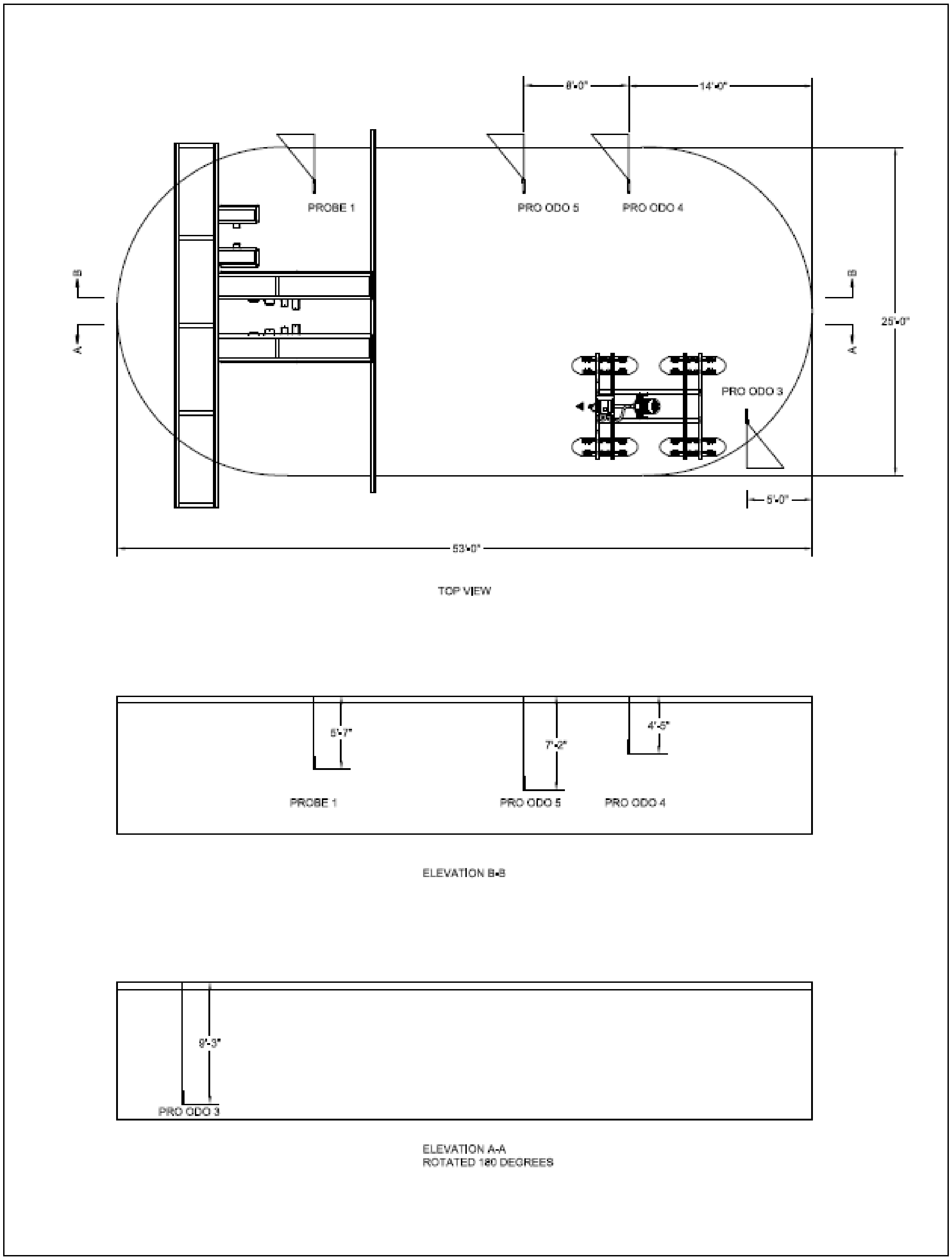


Figure 4: Run 3 Plots

Appendix B: Layout Drawings

Plan and Profile View of Test Basin



Appendix C: Blower Specifications

Data Sheet

FPZ
BLOWER TECHNOLOGY

SERIES MS – RANGE MOR
USA VERSION

PRESSURE

Model	N 3500 rpm [Hp]	N 2900 rpm [Hp]	Q max 3500 rpm [cfm]	Q max 2900 rpm [cfm]	ΔP max 3500 rpm [In WG]	ΔP max 2900 rpm [In WG]	Leq[1] 3500 rpm (Lp) [dB(A)]	Leq[1] 2900 rpm (Lp) [dB(A)]	Weight[2] max [Lbs]
K03-MS	0.75	0.75	52	43	64	60	62	60	24.3
	1	1	52	43	95	77	62.3	60.3	26.5
K04-MS	1.5	1.5	97	80	58	80	64.8	62.8	36.4
	2	2	97	80	85	100	65	63	43
	3	-	97	80	120	-	65.2	-	49.6
K05-MS	2	2	155	129	52	70	70.5	68.5	51.8
	3	3	155	129	90	110	70.8	68.8	58.4
	4	4	155	129	128	120	71.1	69.1	67.2
K06-MS	3	3	215	178	50	65	73	71	68.7
	4	4	215	178	75	95	73.3	71.3	71.65
	5.5	5.5	215	178	110	140	73.6	71.6	77.6
	6.2[*]	-	215	178	132	-	73.9	-	77.6
K07-MS	4	4	294	243	50	63	78.7	76.7	103
	5.5	5.5	294	243	75	86	79	77	107
	7.5	7.5	294	243	130	138	79.3	77.3	145.7
	10	10	294	243	181	161	79.6	77.6	154.5
K08-MS	5.5	5.5	381	315	40	52	79.7	77.7	115.7
	7.5	7.5	381	315	68	90	80	78	154.3
	10	10	381	315	115	125	80.3	78.3	163.1
	15	15	381	315	181	181	80.6	78.6	184
K09-MS	7.5	7.5	471	390	50	63	80.2	78.2	166.5
	10	10	471	390	80	95	80.5	78.5	175.1
	15	15	471	390	140	155	81	79	196.2
	20	20	471	390	181	181	81.3	79.3	269
K10-MS	7.5	7.5	556	460	36	51	80.1	78.1	170.9
	10	10	556	460	64	80	80.5	78.5	179.5
	15	15	556	460	120	135	81	79	200.6
	20	20	556	460	167	191	81.4	79.4	273.4
	25	25	556	460	211	201	81.6	79.6	298.7
K11-MS	10	10	650	538	40	53	82	80	194.9
	15	15	650	538	82	97	82.4	80.4	216
	20	20	650	538	125	141	82.7	80.7	288.8
	25	25	650	538	162	201	85.6	83.6	313.1
K12-MS	15	15	726	601	52	90	82.9	80.9	223.7
	20	20	726	601	85	130	83.2	81.2	296.5
	25	25	726	601	140	160	86.1	84.1	320.8

[*] No cURus motor.

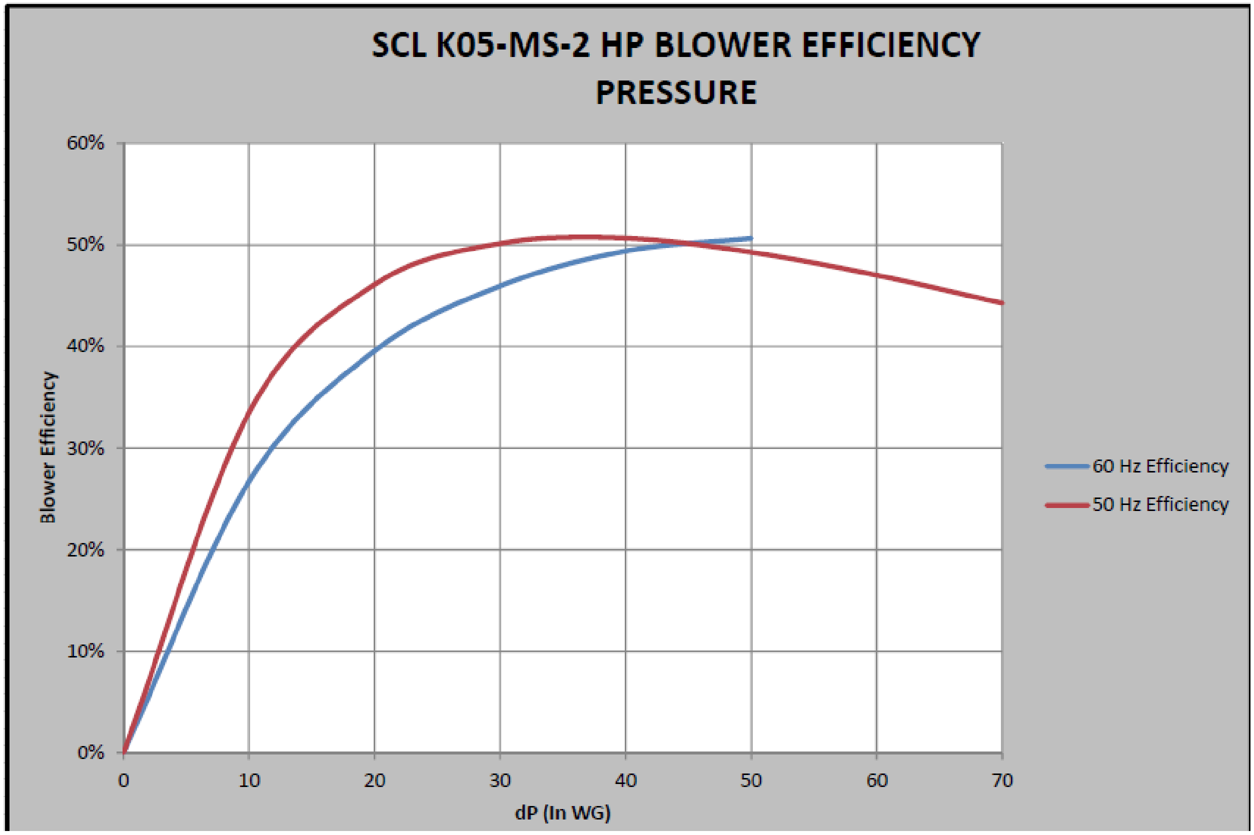
INSTALLATION

- For proper use, the blower should be equipped with Inlet FILTER and Flow Relief VALVE; other accessories available on request
- Ambient temperature from -15° to +40°C (+5° to +104° F)
- Specifications subject to change without notice
- Before installation read carefully all instructions

[1] Noise measured at 1 m distance with inlet and outlet ports piped, in accordance to ISO 3744
[2]. Value refers to the weight of the machine with 3 Phase motor if MOR range, without motor if GOR or GVR range.
N: Installed motor power Q: Flow rate ΔP: Differential pressure Leq: Sound

Pg 2

Efficiency Curve



Appendix D: Mixer Motor Specifications

Data Sheet

WEG

No.: 123

Date: 12-SEP-2014

DATA SHEET

Three-phase induction motor - Squirrel cage rotor

Customer	: Aeration Industries
Product line	: W22 High Efficiency

Frame	: 284T
Output	: 10 HP
Frequency	: 60 Hz
Poles	: 8
Full load speed	: 880
Slip	: 2.22 %
Voltage	: 230/460 V
Rated current	: 26.0/13.0 A
Locked rotor current	: 148/74.1 A
Locked rotor current (Il/In)	: 5.7
No-load current	: 11.0/5.50 A
Full load torque	: 58.9 lb.ft
Locked rotor torque	: 200 %
Breakdown torque	: 220 %
Design	: B
Insulation class	: F
Temperature rise	: 80 K
Locked rotor time	: 30 s (hot)
Service factor	: 1.25
Duty cycle	: S1
Ambient temperature	: -20°C - +40°C
Altitude	: 1000
Degree of Protection	: IP55
Approximate weight	: 373 lb
Moment of inertia	: 7.1992 sq.ft.lb
Noise level	: 54 dB(A)

	D.E.	N.D.E.
Bearings	6311 C3	6211 C3
Regreasing interval	20000 h	20000 h
Grease amount	18 g	11 g

Load	Power factor	Efficiency (%)
100%	0.82	88.6
75%	0.77	88.5
50%	0.67	87.5

Notes:

Performed by	Checked

Appendix E: YSI Optical DO Probe Sensor Cap Validation Data

Probe 2 Calibration Code

YSI® ProODO™ Sensor Cap Instruction Sheet

This instruction sheet includes the calibration coefficients specific to your Sensor Cap. New Probe/Cable assemblies are shipped with the sensor cap already installed on the sensor and the calibration coefficients preloaded into the probe at the factory. The Sensor Cap will need to be replaced about once per year, but may last longer. If you are replacing your Sensor Cap, follow the installation and setup instructions below. IMPORTANT - Be sure to save this sheet in case you need to reload the calibration coefficients.

YSI Incorporated Yellow Springs, Ohio 45387 USA
Cap Lot#: 14L100463 Position: 6
Calibration Code
K1: C01789CA K2: 41B2B0CC
K3: 40378C20 K4: 3D8D38E1
K5: B0E1886F KC: D9

AII NOTES:
Pro ODO 2 Sensor Cap
Installed: 07/06/2015
Expires: 07/06/2016

Sensor Cap Replacement

The replacement ODO™ Sensor Cap is shipped in a humidified container and the package should not be opened until immediately before sensor cap replacement. Once the sensor cap has been installed on the ODO sensor as described below, it is important to keep the sensor in a 100% humid environment. Therefore, the ODO sensor should be stored either in the grey calibration/storage sleeve with the sponge moistened or immersed in water. If the sensor dries out, refer to the manual for instructions on how to rehydrate the sensor cap.

Refer to Figures 1 and 2 below when following the instructions for replacing the cap.

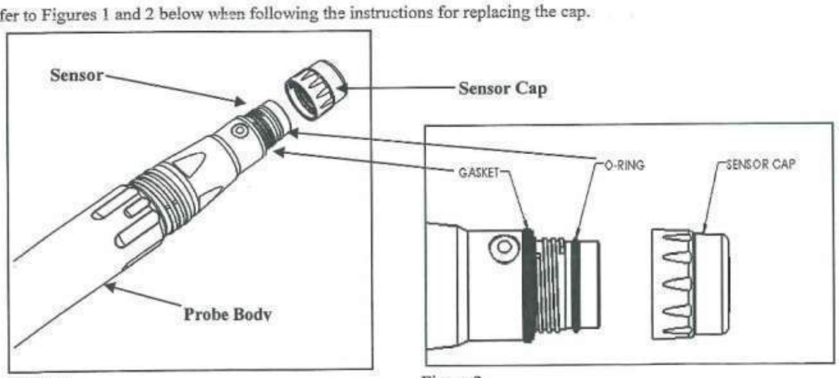


Figure 1 Figure 2

Caution: Avoid touching the sensing end of the sensor cap during the following maintenance procedures.

1. Remove the old sensor cap assembly from the probe by grasping the probe body with one hand and then rotating the sensor cap counterclockwise until it is completely free. Do not use any tools for this procedure.
2. Inspect the o-ring on the probe for damage. If there is any indication of damage, carefully remove the o-ring and replace it with the new o-ring included with the replacement Sensor Cap. Do not use any tools to remove the o-ring.
3. Ensure that the o-ring installed on the probe is clean. If necessary, wipe clean with a lint free cloth or replace the o-ring as described in the previous step.
4. Locate the o-ring lubricant included with the new Sensor Cap. Apply a thin coat of o-ring lubricant to the installed o-ring. After application, there should be a thin coat of o-ring lubricant on the o-ring only. Remove any excess o-ring lubricant from the o-ring and/or probe with a lens cleaning tissue.

YSI Inc., 1700/1725 Brannum Lane, Yellow Springs, OH 45387
800-897-4151, +1 937-767-7241, Fax: +1 937-767-9353
www.ysi.com, environmental@ysi.com

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February 2011 • Rev C
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Probe 3 Calibration Code

YSI a xylem brand **YSI ODO Sensor Cap Instruction Sheet**

This instruction sheet includes the calibration coefficients specific to your sensor cap. New probe/cable assemblies are shipped with the sensor cap already installed on the sensor and the calibration coefficients preloaded into the probe at the factory. The sensor cap will need to be replaced about once per year, but may last longer. If you are replacing your sensor cap, follow the installation and setup instructions below. IMPORTANT - Be sure to save this sheet in case you need to reload the calibration coefficients.

Cap Lot#: 15F101071

Position: 7

K1: C015C5F7	K2: 41B692E3
K3: 403624E0	K4: 3D7D12D8
K5: 60F18ACF	KC: 3B

Retain for future reference

AII NOTES:
Pro ODO 3 Sensor Cap
Installed: 07/06/2015
Expires: 07/06/2016

Sensor Cap Replacement

The replacement ODO sensor cap is shipped in a humidified container. This container should not be opened until immediately before the user replaces the old sensor cap. Once the sensor cap has been installed on the ODO sensor as described below, it is important to keep the sensor in a 100% humid environment. Therefore, the ODO sensor should be stored either in the grey calibration/storage sleeve with the sponge moistened or immersed in water. If the sensor dries out, refer to the manual for instructions on how to rehydrate the sensor cap.

Refer to Figures 1 and 2 below when replacing the sensor cap.

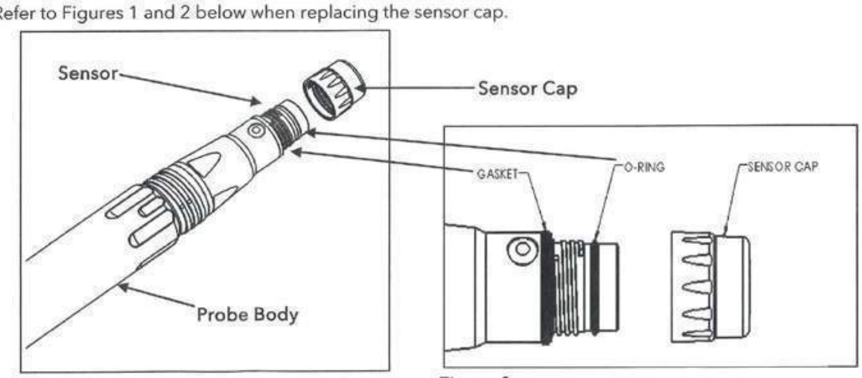

Figure 1 Figure 2

Caution: Avoid touching the sensing end of the sensor cap during the following maintenance procedures.

1. Remove the old sensor cap assembly from the probe by grasping the probe body with one hand and rotating the sensor cap counterclockwise until it is completely free. Do not use any tools for this procedure.
2. Inspect the o-ring on the probe for damage. If there is any indication of damage, carefully remove the o-ring and replace it with the new o-ring included with the replacement sensor cap. Do not use any tools to remove the o-ring.

YSI, 1700/1725 Brannum Lane, Yellow Springs, OH 45387
800-897-4151, +1 937-767-7241, Fax: +1 937-767-9353
ysi.com, info@ysi.com

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December 2014 • Rev D
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Probe 4 Calibration Code

a xylem brand **YSI ODO Sensor Cap Instruction Sheet**

This instruction sheet includes the calibration coefficients specific to your sensor cap. New probe/cable assemblies are shipped with the sensor cap already installed on the sensor and the calibration coefficients preloaded into the probe at the factory. The sensor cap will need to be replaced about once per year, but may last longer. If you are replacing your sensor cap, follow the installation and setup instructions below. IMPORTANT - Be sure to save this sheet in case you need to reload the calibration coefficients.

Probe S/N: 000000010
Cap Lot#: 15F101069

Position: 5

K1: C0198E6B	K2: 41AA8118
K3: 402B187D	K4: 3D269708
K5: 60F18ACD	KC: 00

Retain for future reference

AII NOTES:
Pro ODO 4 Sensor Cap
Installed: 07/06/2015
Expires: 07/06/2016

Sensor Cap Replacement

The replacement ODO sensor cap is shipped in a humidified container. This container should not be opened until immediately before the user replaces the old sensor cap. Once the sensor cap has been installed on the ODO sensor as described below, it is important to keep the sensor in a 100% humid environment. Therefore, the ODO sensor should be stored either in the grey calibration/storage sleeve with the sponge moistened or immersed in water. If the sensor dries out, refer to the manual for instructions on how to rehydrate the sensor cap.

Refer to Figures 1 and 2 below when replacing the sensor cap.

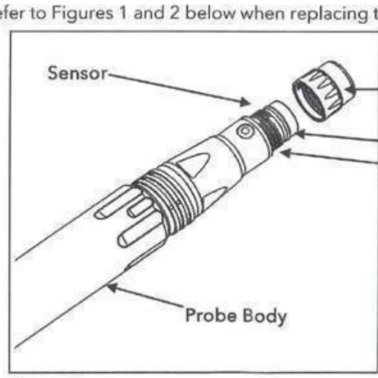

Figure 1

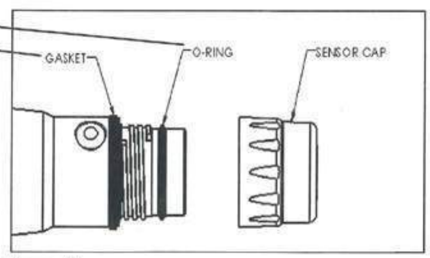

Figure 2

Caution: Avoid touching the sensing end of the sensor cap during the following maintenance procedures.

1. Remove the old sensor cap assembly from the probe by grasping the probe body with one hand and rotating the sensor cap counterclockwise until it is completely free. Do not use any tools for this procedure.
2. Inspect the o-ring on the probe for damage. If there is any indication of damage, carefully remove the o-ring and replace it with the new o-ring included with the replacement sensor cap. Do not use any tools to remove the o-ring.

YSI, 1700/1725 Brannum Lane, Yellow Springs, OH 45387
800-897-4151, +1 937-767-7241, Fax: +1 937-767-9353
ysi.com, info@ysi.com

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Probe 5 Calibration Code

a xylem brand **YSI ODO Sensor Cap Instruction Sheet**

This instruction sheet includes the calibration coefficients specific to your sensor cap. New probe/cable assemblies are shipped with the sensor cap already installed on the sensor and the calibration coefficients preloaded into the probe at the factory. The sensor cap will need to be replaced about once per year, but may last longer. If you are replacing your sensor cap, follow the installation and setup instructions below. IMPORTANT - Be sure to save this sheet in case you need to reload the calibration coefficients.

Probe S/N: 000000009
Cap S/N: 15F100205

Position: 4

K1: C021B482	K2: 41A22A2A
K3: 40287EB9	K4: 3D5205AF
K5: 60F1876D	KC: 8B

Retain for future reference

All NOTES:
Pro ODO 5 Sensor Cap
Installed: 07/06/2015
Expires: 07/06/2016

Sensor Cap Replacement

The replacement ODO sensor cap is shipped in a humidified container. This container should not be opened until immediately before the user replaces the old sensor cap. Once the sensor cap has been installed on the ODO sensor as described below, it is important to keep the sensor in a 100% humid environment. Therefore, the ODO sensor should be stored either in the grey calibration/storage sleeve with the sponge moistened or immersed in water. If the sensor dries out, refer to the manual for instructions on how to rehydrate the sensor cap.

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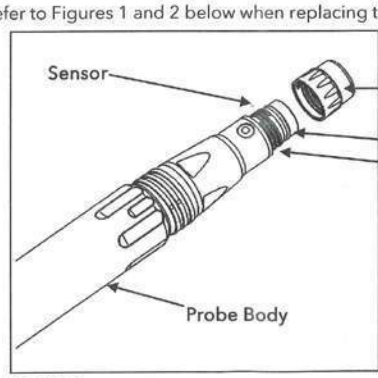

Figure 1

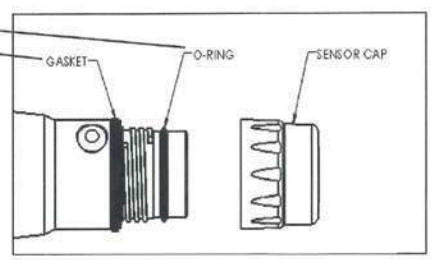

Figure 2

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ysi.com, info@ysi.com

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Appendix F: Power Meter Specification

Data Sheet

Product data sheet
Characteristics

METSEPM5560

PM5560 powermeter w 1mod2eth - upto 63th H - 1,1M 4DI/2DO 52alarms - flush mount

Main

Range of product	PowerLogic PM5000
Device short name	PM5560
Product or component type	Power meter

Complementary

Power quality analysis	Up to the 63rd harmonic
Device application	WAGES metering Power monitoring
Type of measurement	Active and reactive power Energy Power factor Frequency Voltage Current
Supply voltage	125...250 V DC 100...480 V AC (45...65 Hz)
Network frequency	45...65 Hz
Power consumption in VA	10 VA at 480 V
Display type	Backlit LCD
Display resolution	128 x 128
Sampling rate	128 samples/cycle
Measurement current	5 mA...10 A
Analogue input type	Voltage (impedance 5 MOhm) Current (impedance 0.3 mOhm)
Measurement voltage	20...400 V AC 45...65 Hz between phase and neutral 35...690 V AC 45...65 Hz between phases
Number of inputs	4 current transformer 4 digital
Measurement accuracy	+/- 0.15 °C current +/- 0.05 % power factor +/- 0.1 % voltage +/- 0.2 % active power +/- 1 % reactive energy +/- 0.2 % active energy +/- 0.05 % frequency +/- 0.5 % apparent power
Accuracy class	Class 1 (reactive energy according to IEC 62053-24) Class 0.2S (active energy according to IEC 62053-22)
Number of outputs	2 digital
Information displayed	Tariff 8
Communication port protocol	Ethernet Modbus TCP/IP daisy chain : 10/100 Mbps, insulation: 2500 V RS485 : 2 wires, 9.6, 19.2 and 38.4 kbauds, even/odd or none, insulation: 2500 V

Aug 6, 2014 Schneider Electric 1

Data recording	Data logs Event logs Min/Max of instantaneous values Time stamping Alarm logs Maintenance logs
Memory capacity	1.1 MB
Mounting mode	Flush-mounted
Mounting support	Framework
Standards	IEC 60529 IEC 61557-12 IEC 62053-22 EN 50470-1 EN 50470-3 IEC 62053-24
Product certifications	CULus conforming to UL 61010-1 CE conforming to IEC 61010-1
Width	96 mm
Depth	72 mm
Height	96 mm
Product weight	450 g

Environment

Electromagnetic compatibility	• immunity to voltage dips, conforming to IEC 61000-4-11 • surge immunity test class 4, conforming to IEC 61000-4-5 • immunity to fast transients class 4, conforming to IEC 61000-4-4 • immunity to radiated fields, conforming to IEC 61000-4-3 • electrostatic discharge class 4 (8 kV), conforming to IEC 61000-4-2 • limitation of voltage changes, voltage fluctuations and flicker in low-voltage, conforming to IEC 61000-3-3 • conducted and radiated emissions class class B, conforming to EN 55022 • immunity to magnetic fields class 4, conforming to IEC 61000-4-8 • conducted radio-frequency immunity test class 3, conforming to IEC 61000-4-6 • harmonics class class A, conforming to IEC 61000-3-2
IP degree of protection	IP30 (body) conforming to IEC 60529 IP52 (front) conforming to IEC 60529
Relative humidity	5...95 % 50 °C
Pollution degree	2
Ambient air temperature for operation	-25...70 °C
Ambient air temperature for storage	-40...85 °C
Operating altitude	3000 m

Calibration Confirmation

REVERE

Jing Huang
Mechanical Engineer - Aeration Industries International
4100 Peavey Road | Chaska, MN 55318 USA
+1 952-448-6789 Ext 735

Dear Jing,

Revere Control Systems performed commissioning and calibration on the two VFDs and a power meter on 7/28/14 and 7/29/14. The power meter and drives performed correctly.

Equipment part numbers:
25 Hp VFD – Schneider Electric

ATV71HD18N4	25HP 480V Constant Torque Drive, 41A Continuous Output, 150% Overload. Product contains an internal DC choke, inductance 2–3%.

125 Hp VFD – Schneider Electric

ATV71HD90N4	125HP 480V Constant Torque Drive, 179A Continuous Output, 150% Overload. Product contains an internal DC choke, inductance 2–3%.

Power Meter – Schneider Electric

PM5560, part number - METSEPM5560

Measurement accuracy:
- +/- 0.15 °C current
- +/- 0.05 % power factor
- +/- 0.1 % voltage
- +/- 0.2 % active power
- +/- 1 % reactive energy
- +/- 0.2 % active energy
- +/- 0.05 % frequency
- +/- 0.5 % apparent power

Thank you for allowing Revere Control Systems to participate in this project.

Thanks,

Ben Lamar, CEM, PMP
2240 Rocky Ridge Road
Birmingham, AL 35216
Office: (205) 271-9798
Cell: (205) 533-0425

Revere Control Systems, Inc. // 2240 Rocky Ridge Road // Birmingham, AL 35216 // 205.824.0004 // reverecontrol.com

Appendix G: SUN-NAN HONG'S CV

Sun-Nan Hong, Ph.D., P.E.

105 James River Road

Cary, NC 27511

(919) 469-1958 (H), (919) 677-8310 (O)

(919) 469-1958 (FAX-H), (919) 677-0082 (FAX-O)

(919) 349-7708(Cell)

PERSONAL DATA

Birthplace:	Taipei, Taiwan
Health:	Excellent
Family Status:	Married, three children

EDUCATION

B.S. in Chemical Engineering, National Taiwan University, 1963

M.S. in Chemical Engineering, Kansas State University, 1967

Ph.D. in Chemical Engineering, Kansas State University, 1970

M.S. in Environmental Engineering, University of Rhode Island, 1972

PROFESSIONAL SOCIETIES AND HONORARIES

American Institute of Chemical Engineering

Water Environmental Federation

Chinese Institute of Engineers/USA

The Greater New York Chapter, President 1985/1986

National Council, Chairman, 1989

The Friendship Award, State Council, People's Republic of China, 1996

Overseas Chinese Environmental Engineers and Scientist Association

Pollution Abatement Technical Advisor Committee, Industrial Technology Research Institute, Taiwan, ROC

PROFESSIONAL REGISTRATION

Professional Engineer - Rhode Island, No. 3364

PATENTS AND PUBLICATIONS

See Attachment.

PROFESSIONAL EXPERIENCE

Retired from Kruger on July 1, 2013.

2007 – June, 2013

Executive Vice President for Risk Assessment and Business Development

Kruger Inc/A Veolia Water Company.

Also I have been serving as an in-house consultant on various new technologies such as:

- IFAS/MBBR (Integrated Fixed-film Activated Sludge / Moving Bed Biological Reactor)
- Anammox process for high strength ammonia concentration
- OSTARA process for recovery of phosphorus in centrate from anaerobic digester

August, 1992 – September, 2007

Vice President - Engineering,

Kruger Inc./A Veolia Water Company

Originally as a US subsidiary of Kruger A/S of Denmark, Kruger Inc was established in 1989. In June of 1991, Kruger Inc purchased all wastewater treatment technologies owned by Air Products and Chemicals, Inc. and I was invited to join the then 6 person company in August, 1992. I was the only Process Engineer in the company at that time. Kruger Inc. successfully commercialized the technologies purchased from Air Products and Chemicals, Inc. and those imported from Denmark in mid 1990s. Subsequently, Kruger Inc became a part of OTV and Vivendi and now Veolia Water. During the past fifteen years, Kruger Inc has commercialized many new technologies developed by Veolia Water and grown to a 120 person company. During this period of time, I have been the Vice President in charge of overall engineering work.

Highlights of my professional responsibilities and accomplishments as VP of Engineering in Kruger, Inc. are briefly summarized below:

- ACTIFLO – High Rate Ballasted Clarification Process

  Approximately 150 plants have been installed in the US in the last 15 years. The process was originally utilized as pretreatment of surface water for turbidity removal in drinking water treatment systems. The applications of the process were expanded to include treatments of CSO/SSO (combined and sanitary sewer overflow), industrial process water supplies, tertiary phosphorus removals, chemical precipitation of metals in industrial wastewater, etc.

- BIOSTYR – Aerated Biological Filter Process

  The process is characterized with a short detention time of about 1 hour and no requirement of secondary clarifier for municipal wastewater treatment. A total of 12 systems have been installed in the US for secondary and tertiary nitrification and denitrification.

- A/O, BioDenitro and BioDenipho - Biological Treatment Systems for Municipal Wastewater Treatment

These processes have been implemented in many municipal wastewater treatment systems through out the US for BOD, TSS, nitrification, denitrification and biological phosphorus removals.

- OASES – Pure Oxygen Activated Sludge Process

  Twenty contracts during the last 15 years had been completed. The process was utilized for municipal and pulp and paper wastewater treatment. Combined with the A/O selector technology, the process was also used for phosphorus and nitrogen removals. The recent contract for Detroit, MI valued $9.7MM which is the biggest contract in Kruger's history.

- ATAD – Auto-Thermophilic Aerobic Digester Process

  The process treated municipal wasted sludge to meet Class A requirement with pathogen killed and 38% volatile solids destruction. Twenty one plants had been constructed in the US.

- Hydrotech Discfilter – A filtration device for solids removal

  Many units had been installed in the US for tertiary filtration in place of conventional sand filters. The equipment had been Title 22 certified by California Health Department for water reuse applications.

- BioCon – Sludge drying process

  This is a Danish technology with low temperature, air to air heat transfer and a slow moving belt for drying municipal waste sludge. The process has been certified as Class A process by US EPA. One system is in operation in Minnesota and 3 other systems have been contracted.

During this period of time, I continued and successfully developed A/O or OASES licenses to the following international companies:

Nippon Sanso Corporation – Japan on OASES

Hyundai Heavy Industries Co., LTD – South Korea on A/O

EuroChem, Inc – Tailand on A/O

Kaifeng Air Separation Group Co., LTD – People's Republic of China on OASES

Those license agreements provided Kruger Inc a significant income.

During the last three years, I have devoted a significant amount of effort in developing/commercializing MBR (Membrane Biological Reactor) process with flat sheet membrane manufactured by Toray in Japan, and on pilot studies of ceramic membrane manufactured by NGK in Japan for drinking water treatment.

March, 1974 – July, 1992

Senior Process Manager

Environmental/Energy Division

Air Products and Chemicals, Inc.

As Senior Process Manager, I managed a process group of eight professionals and was responsible for process design, start-up and operation of the following technology areas:

- A/O Process - Anaerobic biological selector process for nutrient removal.
- OASES Process - An oxygen activated sludge system.
- Ozone for drinking water and wastewater disinfection.
- Turn-key privatization for municipal wastewater treatment.

I was also actively involved in providing technical presentations to various clients in support of Sales' efforts.

During the period of 1984 - 1992, I directed the design of more than forty-five full-scale wastewater treatment systems using pure oxygen activated sludge process and anaerobic selector process. Applications of these systems include BOD/Nocardia control/nutrient removal of municipal wastewater, BOD/COD removal of wastewaters from pulp and paper industries, and specialty chemicals manufacturing. Also, I personally developed and delivered Technology Transfer to the A/O licensees of the following companies:

Super Max Engineering Company – Republic of China

NGK Insulators, LTD. – Japan

Japan Organo Co., LTD. – Japan

Dragados Y Construcciones, S.A. – Spain

AnperOX Viz-e szennyviztechnologiai kft. - Poland

During the period of 1974 - 1984, I was responsible for overall development work for the Environmental Products Department. I successfully directed a 1.5 million dollar project in 1979 for the construction and one-year operation demonstration of the first full-scale A/O system. I developed critical patents contributing to the improvement of the A/O process. Also, I directed pilot plant tracer studies and, subsequently, developed a Control Back Mixing System which led to the patented process of the OASES ☐ pure oxygen sludge process. I also developed a computer model for design of ozone disinfection systems.

March , 1973 – March, 1974

Assistant Project Engineer

Roy F. Weston, Inc.

Served as a member of a coordination team in the development of effluent guidelines for the organic chemical industry for the EPA. Performed conceptual and process designs of industrial wastewater treatment facilities.

February, 1972 – March, 1973

Project Engineer

Southeastern Regional Planning and Economic Development District

Tauton, Massachuset

Served as a coordinator in the development of a comprehensive regional solid wastes disposal project.

PATENTS AND PUBLICATIONS

PATENTS

US4,081,368	Activated Sludge System with Staggered Partition Basin.
US4,488,967	Treatment of Wastewater Containing Phosphorus Compounds.
US4,488,968	Removal of Phosphates and BOD from Wastewaters.
US4,552,663	Process for the Removal of Ammoniacal Nitrogen in the BOD Sorption Zone of Wastewater Treatment Plant.
US4,556,491	Avoidance of Rising Sludge in Biological Wastewater Treatment Clarifiers.
US4,650,585	Method for Minimizing Diurnal Swing in Phosphorus Content of Effluent Streams from Wastewater Treatment Plants.
US5,650,069	Dual-Stage Biological Process for Removing Nitrogen from Wastewater
US6,685,834B1	Method for Conditioning and Dewatering Thermophilic Aerobically Digested Sludge
US6,830,689B2	Process for Removing Phosphorus from Wastewater Utilizing a Triple Basin Wastewater Treatment System
US7,001,516B1	Process for Removing Phosphorus from Wastewater Utilizing a Triple Basin Wastewater Treatment System
US7,147,778B1	Method and System for Nitrifying and Denitrifying Wastewater
Pending	Method for Controlling Fouling of a Membrane Filter

PUBLICATIONS

1. "Heat Transfer to Non-Newtonian Fluids in Laminar Flow Through Concentric Annuli," Int. J. Heat Mass Transfer, 12, 1699, 1969.

2. "Distributed Discharge of Cooling Water Along Direction of Stream Flow," Water Resources, Bulletin, 8, 1031, 1972.

3. "Development Document for Proposed Effluent Limitations Guidelines and New Source Performance Standards for the Major Organic Products," EPA 440/1-73/009.

4. "Design and Operation of a Full-Scale Biological Phosphorus Removal System," WPCF Conference, Houston, TX, 1979.

5. "Controlled Back-Mixing for Activated Sludge System," Mixing Conference, Henniken, NH, 1979.

6. "Generations of Ozone from Oxygen for Drinking Water Treatment," New England Water Works association, Boston, MA, 1979.

7. "A Biological Wastewater Treatment System for Nutrient Removal," WPCF Conference, Detroit, MI, 1981.

8. "An Innovative Biological Nutrient Removal System," The Proceedings of the Conference on Environmental Engineering, ASCE, 1981.

9. "Biological Nutrient control Plant Demonstration," The Proceedings of the Specialty Conference on Water Forum, ASCE, 1981.

10. "A Biological Wastewater Treatment System for Nutrient Removal," Workshop on Biological Phosphorus Removal in Municipal Wastewater Treatment, sponsored by EPA, Indianapolis, MD, 1983.

11. "Recent Advances on Biological Nutrient Control by the A/O Process," WPCF Conference, Atlanta, GA, 1983.

12. "Biological Phosphorus and Nitrogen Removal Via the A/O Process: Recent Experience in the United States and United Kingdom," Water Science Technology, Vol. 16, pp. 151-172, 1984.

13. "The A/O Nutrient Removal Process - Theory and Operation," Post Conference, IAWPRC, Paris, France, 1984.

14. "A Year's Low Temperature Operation in Michigan of the A/O System for Nutrient Removal, " WPCF Conference, Kansas City, MO, 1985.

15. "The A/O Nutrient Removal Process - Theory and Operation," WPCF Conference, Kansas City, MO, 1985.

16. "A Comprehensive Kinetic Model for Biological Phosphorus Removal," WPCF Conference, Los Angeles, CA, 1986.

17. "Improvement in Operation of Oxygen Activated Sludge System Using Selector Technology," WPCF Conference, Dallas, TX, 1988.

18. "Upgrading Wastewater Treatment Plants with Anaerobic Selectors," IAWPRC/EWPCA, Munich, Germany, 1989.

19. "Application of Anaerobic Selector Technology in Activated Sludge Systems," WPCF Conference, San Francisco, CA, 1989.

20. "Experience on Biological Phosphorus Removal System at Titusville, Florida", Florida WPCF, 1989.

21. "Full-Scale Demonstration of the A/O Process at the Ypsilanti Community Utilities Authority Wastewater Treatment Plant," WPCF Conference, Ontario, Canada, 1991.

22. "Anaerobic Selector Technology for Wastewater Treatment," World Congress III, Beijing, China, 1993.

23. "Assessment of Activated Sludge BNR Process Configurations Utilizing Advanced Mathematical Simulation Model," WEF Conference, Anaheim, California, 1993.

24. "Converting a Single Sludge Oxygen Activated Sludge system for Nutrient Removal," WEF Conference, Anaheim, California, 1993.

25. "Sequencing Biofilm Reactor with Continuous Biological Phosphorus Removal", WEF Conference, Chicago, Illinois, 1994.

26. "Full-Scale Experience with Nutrient Removal in a Fixed Film System", Biological wastewater Treatment Fundamentals and Modeling Symposium, Roanoke, Virginia, Sept., 1996.

27. "Treatment of Combined Sewer Overflow with High Speed Microsand Settling", WEF Conference, Dallas, Texas, 1996.
28. "Enhancing Denitrification in the Secondary Anoxic Zone by RAS Addition: A Full Scale Evaluation", WEF Conference, Chicago, Illinois, 1997.

PATENTS AND PUBLICATIONS (continued)

29. "Environmental Protection through Innovative Wastewater and Sludge Treatment Strategies in Florida", WEF Conference, Orlando, Florida, 1998.

30. "Pilot and Full Scale Experience with Nutrient Removal in a Fixed Film System", WEF Conference, Orlando, Florida, 1998.

31. "The Effect of Adding Industrial Waste with High Phosphorous and Nitrogen Concentrations to a Phased BNR Treatment System: A Case Study", WEF Conference, Orlando, Florida, 1998.

32. "Evaluation of the Amount of Nitrogen Removal due to Simultaneous Nitrification and Denitrification in A/O Type BNR Processes", Proceedings of 76 th Annual Florida Water Resources Conference, Jacksonville, FL, 2001.

33. "Determination of Phase Length of BioDenipho Process Using Ammonia and Nitrate On-Line Alalyzers", CWEA Annual Conference, Ontario, CA, 2003.

34. "Demonstration of Phase Length Control of BioDenipho Process Using On-Line Ammonia and

Nitrate Analyzers at Three Full-Scale Wastewater Treatment Plants", Proceedings of WEFTEC'04, New Orleans, LA, 2004.

35. "Pilot Evaluation of Florida of Floating Media Biological Aerated Filters(BAFs) to Achieve Stringent Effluent Nutrient Discharge Requirements", Porceedings of IWA 2006, Beijing, China, 2006.

36. "Current Biological Filter Applications in Municipal Wastewater Treatment", Maryland WEF, Maryland, 2007.

37. "Improving Nitrogen Removal by RAS Addition to the Secondary Anoxic Zone: Results of Full Scale Implementation", WEFTEC, San Diego, CA, 2007.

Appendix D

SLUDGE CHARACTERIZATION PRELIMINARY INFORMATION ON BOD, COD, AND DECAY RATES-DRAFT (AMRI, 2018)

Sludge Characterization preliminary information on BOD, COD, and Decay Rates

Sludge Accumulation in the Oxidation Ponds

Oxidation Ponds 1 and 2 are facultative ponds which have been in operation for over 30-yrs. During this time, solids have accumulated on the bottoms of the ponds. They consist primarily of residual waste solids from the primary clarifier effluent which is pumped into Pond 1, and algal solids. In Pond 1 there are an estimated 54,800-yd^3 of solids, mostly in the corners of the pond (Figure 1). 43,000-yd^3 of accumulated sludge are estimated to be within Pond 2 (Figure 2). This volume accounts for 27% of the total pond volume. This sludge depth data for both ponds was collected during surveys conducted in 2017.

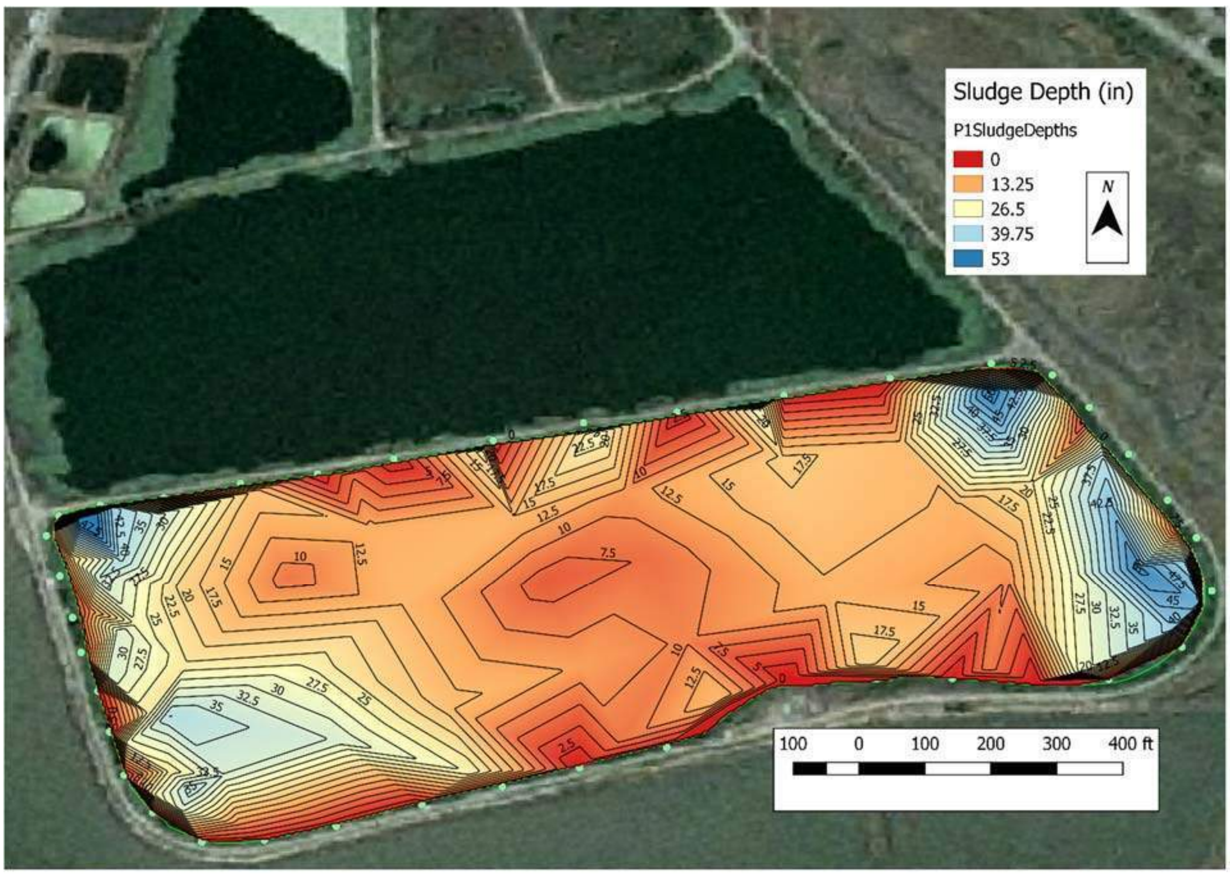

Figure 1: GIS contour plot of surveyed sludge depths in Pond 1.

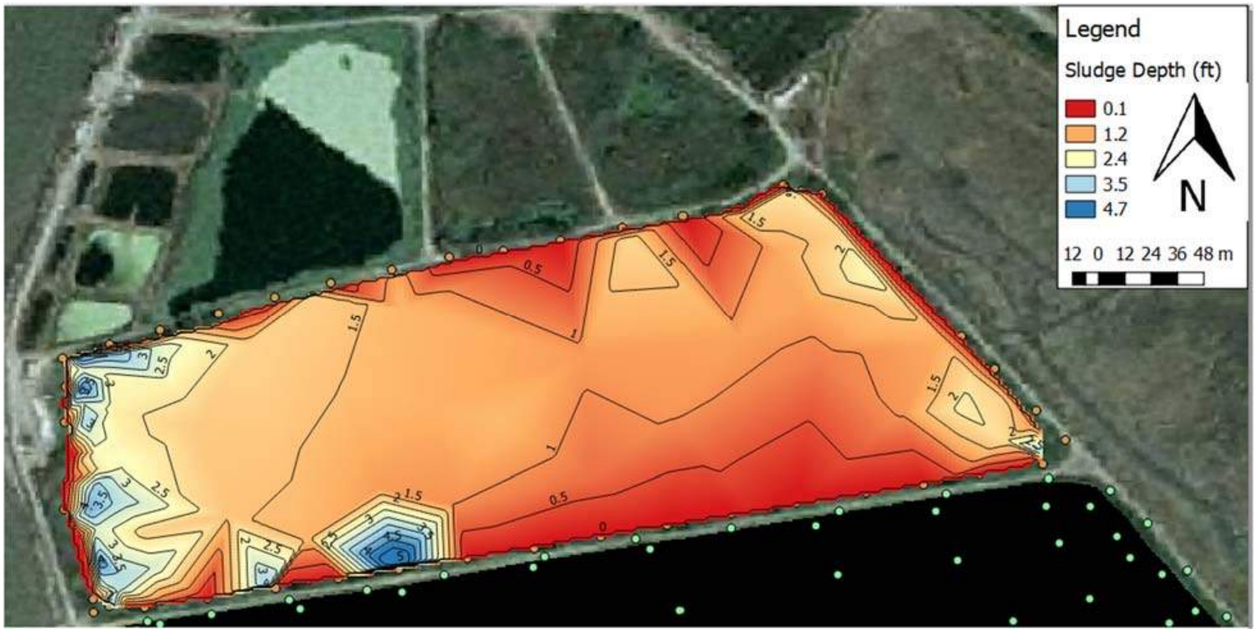

Figure 2: GIS contour plot of surveyed sludge depths in Pond 2.

Oxidation Pond Sludge Characteristics

Several studies have been performed by AMRI staff to characterize the sludge present in Pond 1 and Pond 2. Between June and July of 2016, an aeration tank was filled with a mixture of sludge and Pond 2 water to see how aeration would decrease BOD, and cause nitrification in the water column and in the sludge. The study ran from 6/1/2017 to 7/13/2016 and is therefore an ideal case due to increased summer temperatures for nitrification and reduction in BOD. Nitrification occurred within one week (Figure 3), and BOD dropped from 416-mg/L to 44-mg/L in one month.

A rate study is being conducted using Oxitop BOD testing to take daily BOD measurements on the sludge from Ponds 1 & 2. The results from two runs with triplicate samples show that the BOD in Pond 1 Sludge is approximately 3,300-mg/L, with 2,800-mg/L CBOD. The BOD decay rate is 0.1 in Pond 1. BOD is appproximately 3,500-mg/L with 2,400-mg/L CBOD in Pond two with a decay rate of 0.2. Pond 1 sludge was tested for ammonia levels using an electrode probe. Ammonia levels were between 200-400-mg/L throughout the five sample points where sludge ammonia levels were tested in Pond 1.

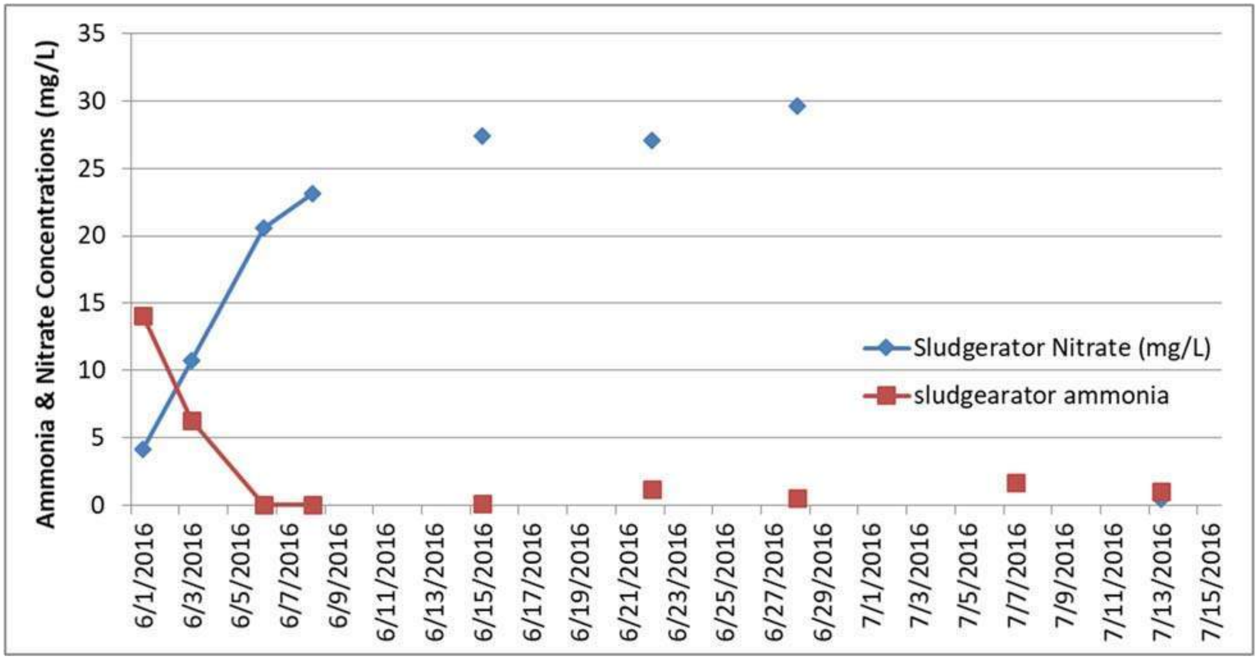

Figure 3: Ammonia and nitrate concentrations in mg/L plotted over the course of the sludge aeration study from 2016.

Appendix E

TM 5 SECONDARY TREATMENT AND ASSOCIATED FACILITIES

City of Arcata
Wastewater Treatment Facilities Improvements

Technical Memorandum 5
OXIDATION DITCHES, SECONDARY CLARIFIERS, AND ASSOCIATED FACILITIES

FINAL | April 2019

City of Arcata
Wastewater Treatment Facilities Improvements

Technical Memorandum 5

OXIDATION DITCHES, SECONDARY CLARIFIERS, AND ASSOCIATED FACILITIES

FINAL | April 2019

REGISTERED PROFESSIONAL ENGINEER
DOUGLAS W. WING
No. 38950
CIVIL
STATE OF CALIFORNIA

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Appendices

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Abbreviations

AWTF	Arcata Wastewater Treatment Facility
BOD	biological oxygen demand
Carollo	Engineers, Inc.
DO	dissolved oxygen
deg C	degrees Celsius
ft	feet
FRP	fiberglass reinforced plastic
gpd	gallons per day
hrs	hours
HRT	hydraulic retention time
MG	million gallons
mg/L	milligrams per liter
mgd	million gallons per day
NH3-N	ammonia expressed as nitrogen
ppd	pounds per day
lb	pound
RAS	return activated sludge
SRT	solids retention time
TKN	total kjeldahl nitrogen
TM	technical memorandum
TSS	total suspended solids
WAS	waste activated sludge

Technical Memorandum 5

OXIDATION DITCHES, SECONDARY CLARIFIERS, AND ASSOCIATED FACILITIES

5.1 Purpose

The purpose of this Technical Memorandum (TM) is to outline the details of the proposed oxidation ditches, secondary clarifiers, and return activated sludge (RAS) and waste activated sludge (WAS) pumping system for the City of Arcata (City) Wastewater Treatment Facility (AWTF). Design criteria were developed for all secondary treatment facilities and the recommended configuration, sizing, controls, layout, components, and features are detailed in this TM. Additionally a preliminary process model for these additional secondary treatment processes was prepared and the results of this modeling effort are included in this TM. This TM is based on the addition of one oxidation ditch and two secondary clarifiers now, with the possible addition of a second oxidation ditch and a third secondary clarifier in the future.

5.2 Summary of Findings and Recommendations

The key findings and recommendations of this TM are summarized below:

Oxidation Ditch:

- One new oxidation ditch is required for a peak flow of 3.6 million gallons per day (mgd).
- The new oxidation ditch will be constructed on the southeast part of the corporation yard at the location of the existing compost storage area. It will have volume of 1.6 million gallons (MG) and a side water depth of 14 feet.
- The oxidation ditch will be designed as a carrousel type ditch with vertical walls and two surface aerators. The oxidation ditch will be designed for both carbonaceous biochemical oxygen demand (BOD) and ammonia removal.

Secondary Clarifiers:

- Two new secondary clarifiers are required for a combined peak flow of 3.6 mgd.
- The two new 75-foot diameter circular secondary clarifiers will be constructed on the corporation yard site, near the existing bus barn location.
- The clarifier will have a 14-foot side water depth at the exterior walls and 1:12 slope toward a deep center sludge collection hopper.
- The sludge collection mechanism will include a center column, an energy dissipating inlet, a larger diameter flocculating feed well, spiral scraper sludge collectors, skimmer arm, and all epoxy coated steel construction.
- A scum collection well with a chopper pump will provide mixing, decant, and scum transfer.

Flow Split Structures:

- One new flow split structure upstream of the secondary clarifiers (mixed liquor flow split structure) will be constructed to provide an even flow distribution among the two new secondary clarifiers.
- The flow split structure will be made of concrete with a T-lock protective coating.
- The flow split structure will be located west of the new oxidation ditch.

RAS and WAS Pump Stations:

- Three new horizontal non-clog centrifugal pumps will be installed in a new RAS pump station to convey RAS to the oxidation ditch via glass-lined ductile iron pipes.
- Two new horizontal non-clog centrifugal pumps will be installed to convey WAS to the sludge thickener prior to the digesters via glass-lined ductile iron pipes.

Alkalinity Feed Facility:

- A new alkalinity feed facility may be required and would be constructed just south of the existing sludge drying beds across the entrance roadway. The need for the facility will determined in final design.
- The alkalinity feed facility will store sodium hydroxide, which is needed to provide sufficient alkalinity for the secondary treatment process.

5.3 Background

At present the AWTF uses two existing oxidation ponds run in series and six existing treatment wetlands run in parallel to provide secondary treatment. As described in TM 1 - Basis of Design, the capacity of this secondary treatment system is limited to 2.3 mgd for the oxidation ponds and 1.8 mgd for the existing treatment wetlands. With the addition of Treatment Wetland No. 7 described in TM 4 - Pond and Treatment Wetland Improvements, the capacity of the oxidation pond and treatment wetland system will be 2.3 mgd. This is not sufficient to treat peak wet weather flows of 5.9 mgd. Thus, additional secondary capacity is needed. This TM summarizes the proposed facilities needed for this additional secondary capacity.

5.4 Design Influent Flows and Loads

The influent flows used for the basis of design for the new secondary treatment processes are presented in Table 5.1. The influent loads used for the basis of design are presented in Table 5.2. The secondary effluent must be high quality and meet discharge permit requirements, with a treatment goal of less than 30 milligrams per liter (mg/L) BOD5 and TSS on an average monthly basis. Nutrient removal will be provided although the specific discharge requirements are not yet set. The treatment goal assumed for this TM is 4 mg/L NH3-N (ammonia nitrogen) on an average monthly basis.

A steady-state process model was developed for the AWTF to evaluate secondary process capacity and aeration requirements. The model was calibrated with plant operating data. See Appendix 5A for detailed calculations and model outputs for various operating conditions.

Table 5.1 Design Influent Flows

	Current (mgd)	Future (mgd)	Permitted (mgd)
Minimum Flow	0.3 (1)	0.3 (1)	-
Average Dry Weather Flow	1.1 (2)	1.3 (3)	2.3 (4)
Peak Dry Weather Flow	1.8 (5)	2.2 (6)	-
Maximum Month Flow	3.0 (7)	3.6 (8)	5.0 (9)
Peak Wet Weather Flow	5.9 (4)	5.9 (4)	5.9 (4)

Notes:
(1) Based on City diurnal flow data from 7/23/17 through 7/30/17.
(2) 50th percentile flow during dry weather using City data from 2003 to 2015.
(3) Current Average Dry Weather Flow plus 20 percent growth.
(4) Existing permit capacity.
(5) Diurnal peaking factor of 1.6 multiplied by Average Dry Weather Flow. Peaking factor based on City diurnal flow data from 7/23/17 through 7/30/17.
(6) Current Peak Dry Weather Flow plus 20 percent growth.
(7) 92nd percentile flow using City data from 2003 to 2015.
(8) Current Maximum Month Flow plus 20 percent growth.
(9) Existing permitted Average Wet Weather Design Flow.

Table 5.2 Design Influent Loads

	Current (lb/d)	Future (lb/d)
BOD	4,000 (1)	4,800 (2)
TSS (3)	5,760 (1)	6,910 (2)
NH_3	880 (4)	1,060 (5)
TKN (6)	1,330	1,610

Notes:
(1) 90th percentile load using City data from 2003 to 2015.
(2) 90th percentile load using City data from 2003 to 2015 plus 20 percent for growth.
(3) It is suspected that these values may be high.
(4) 90th percentile load using City data from 2013 to 2015.
(5) 90th percentile load using City data from 2013 to 2015 plus 20 percent for growth.
(6) Estimated based on NH_3 data.

5.5 Recommended Facilities

This section summarizes recommended facilities and design criteria for the project. Secondary treatment includes biological and physical treatment to reduce the organic content of the wastewater, typically to less than 30 mg/L BOD and suspended solids. Secondary treatment facilities include an oxidation ditch, secondary clarifiers, RAS and WAS pump stations, an alkalinity feed facility, and a mixed liquor flow split structure. The proposed system will add treatment capacity necessary to nitrify and meet low ammonia limits year-round.

In the oxidation ditch, oxygen is supplied through vertical surface aerators. Microorganisms in the oxidation ditches will provide BOD_5 reduction and nitrification (ammonia removal) of the wastewater. The secondary clarifiers will remove the biological solids and provide return of the biological solids (return activated sludge, or RAS) to the aeration process. Excess solids or waste activated sludge (WAS) will be removed and sent to the aerobic digester for further stabilization. The sections below describe each component of this process and the associated design criteria.

5.5.1 Oxidation Ditches

An oxidation ditch is an activated sludge treatment process that uses long solids retention times (SRTs) and long hydraulic retention times (HRTs) to remove organics. Typically an oxidation ditch is configured in a ring- or racetrack- shaped channel. The channel is aerated to increase the concentration of dissolved oxygen (DO) and to help circulate the wastewater and RAS around the ditch, promoting unidirectional channel flow. As the mixed liquor passes the aerator, the concentration of DO increases rapidly and then declines as biomass uptake oxygen as the flow travels through the remaining channel section. This fluctuation in DO helps promote nitrification and BOD removal. The addition of an anoxic zone can also provide denitrification.

There are two main types of advanced oxidation ditches with biological nutrient removal: 1) "Orbal type" and 2) "carrousel type". The Orbal type, shown in Figure 5.1, is designed in concentric loops that provide simultaneous nitrification and denitrification. This system is marketed by Evoqua. The "carrousel type" oxidation ditch is designed in a racetrack configuration, as shown in Figure 5.2. This type of oxidation ditch has two main vendors: Ovivo and WesTech. Because the "carrousel type" oxidation ditches have fewer aerators and drives that requiring maintenance and multiple vendors, this type is recommended.

The oxidation ditch proposed for the AWTF will be designed for both carbonaceous BOD and ammonia (nitrification) removal. The configuration will also be based on a vertical wall oxidation ditch. The preliminary configuration, including plan and section, is shown in Figures 5.3 and 5.4.

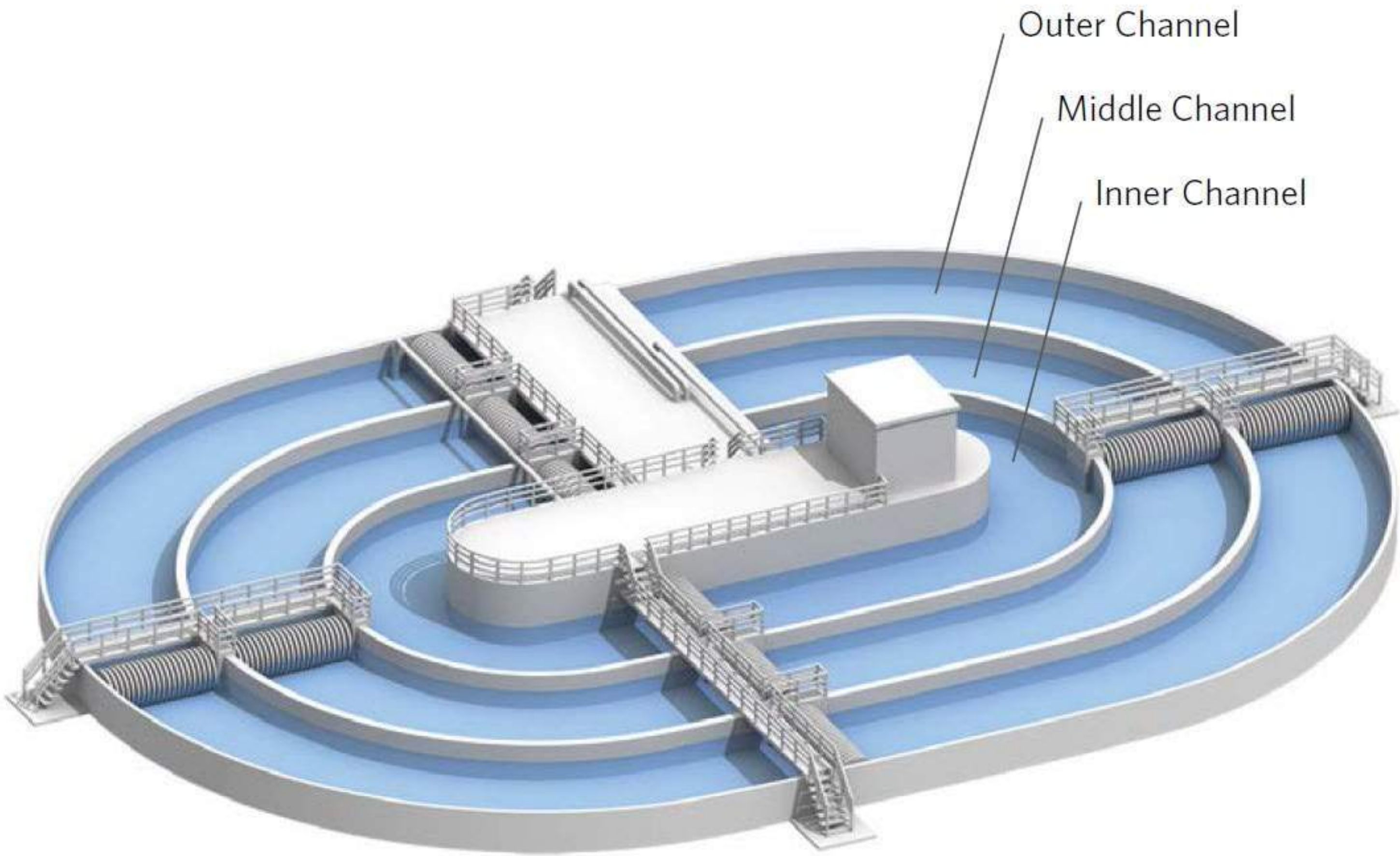
The design criteria for the oxidation ditch are shown Table 5.3. Appendix 5B provides vendor brochures and cost proposals for the proposed oxidation ditch.

5.5.1.1 Aeration

There are four main types of aeration used in oxidation ditches: surface aerators, disc aerators, draft tube aerators, or fine bubble diffusers. For the "Orbal type" oxidation ditch, described in the preceding section, aeration is provided through proprietary disk aerators, shown in Figure 5.5. The "carrousel type" oxidation ditch, meanwhile, uses vertical shaft surface aerators located at each end of the ditch. These aerators are shown in Figure 5.6.

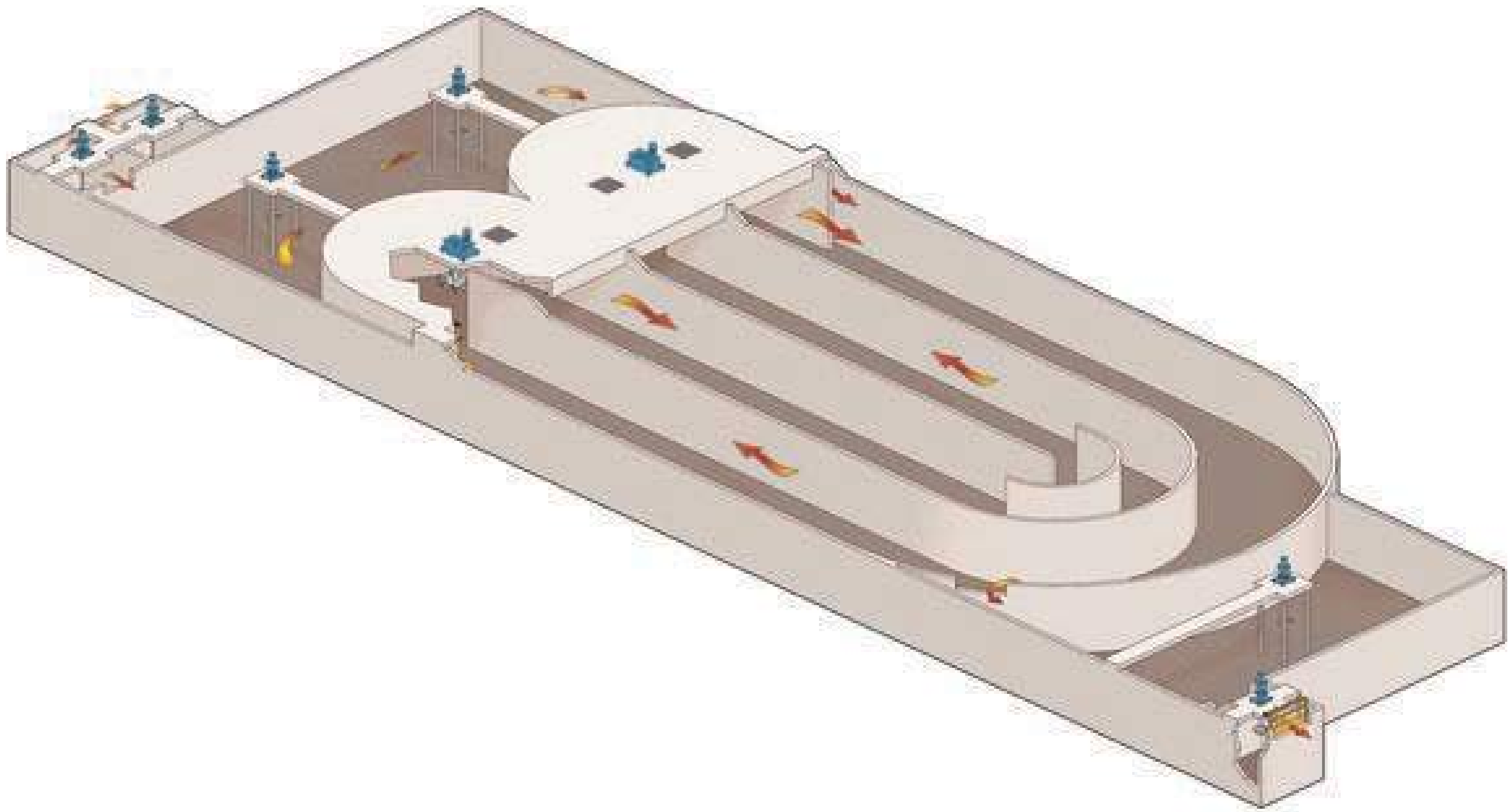
As described above, vertical shaft aerators are recommended. The aeration equipment will be sized for both the BOD loading and ammonia loading, noted above. For the proposed oxidation ditch, two vertical surface aerators are recommended, one at each end of the structure. Partial aeration redundancy would be provided, as each aerator would be designed to provide 75 percent of the total oxygen demand.

The design criteria for the aeration system design criteria are shown in Table 5.4.



Source: Envirex an Evoqua brand

Figure 5.1 Typical "Orbal Type" Oxidation Ditch Configuration



Source: WesTech

Figure 5.2 Typical "Carousel Type" Oxidation Ditch Configuration

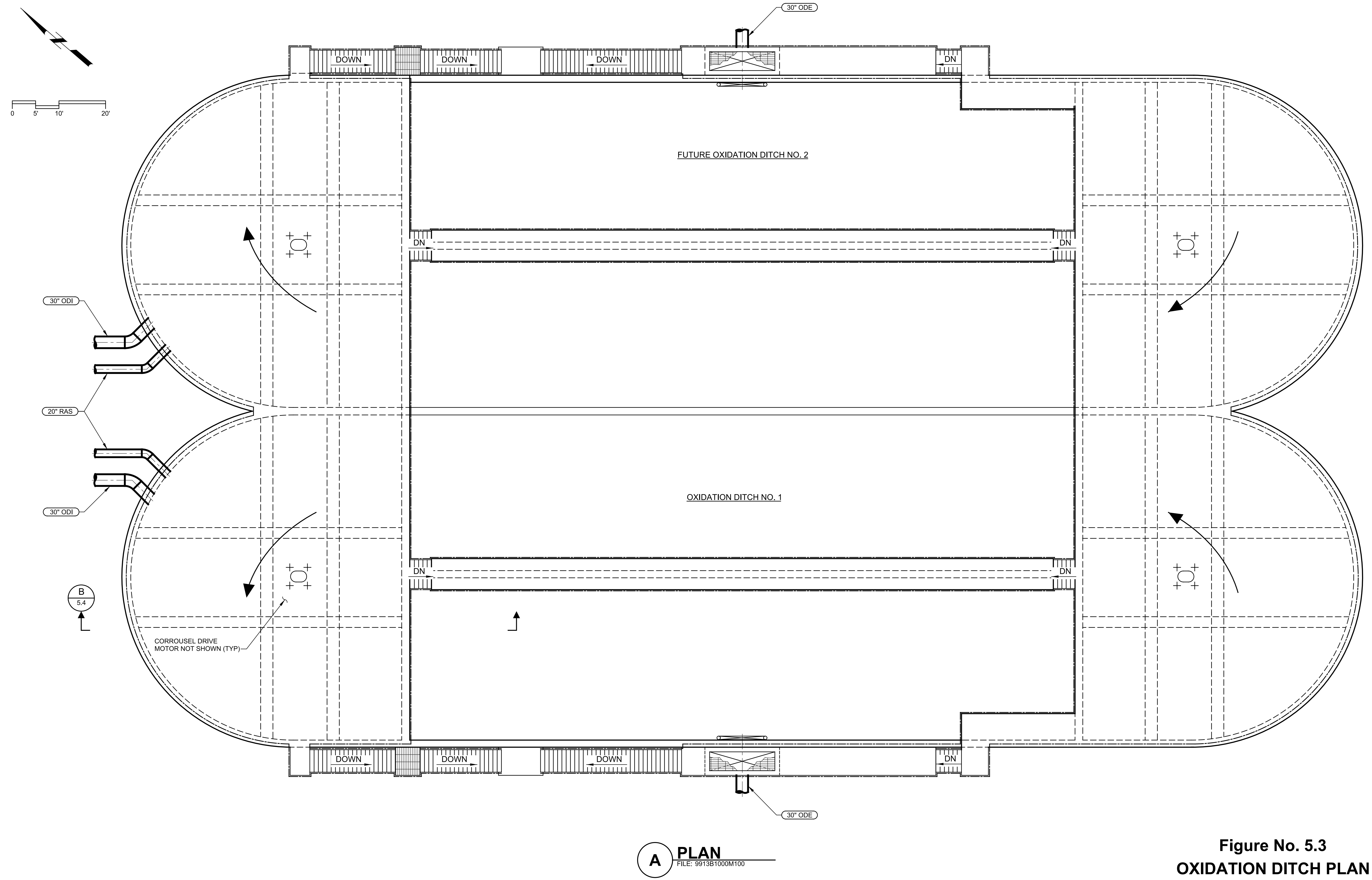


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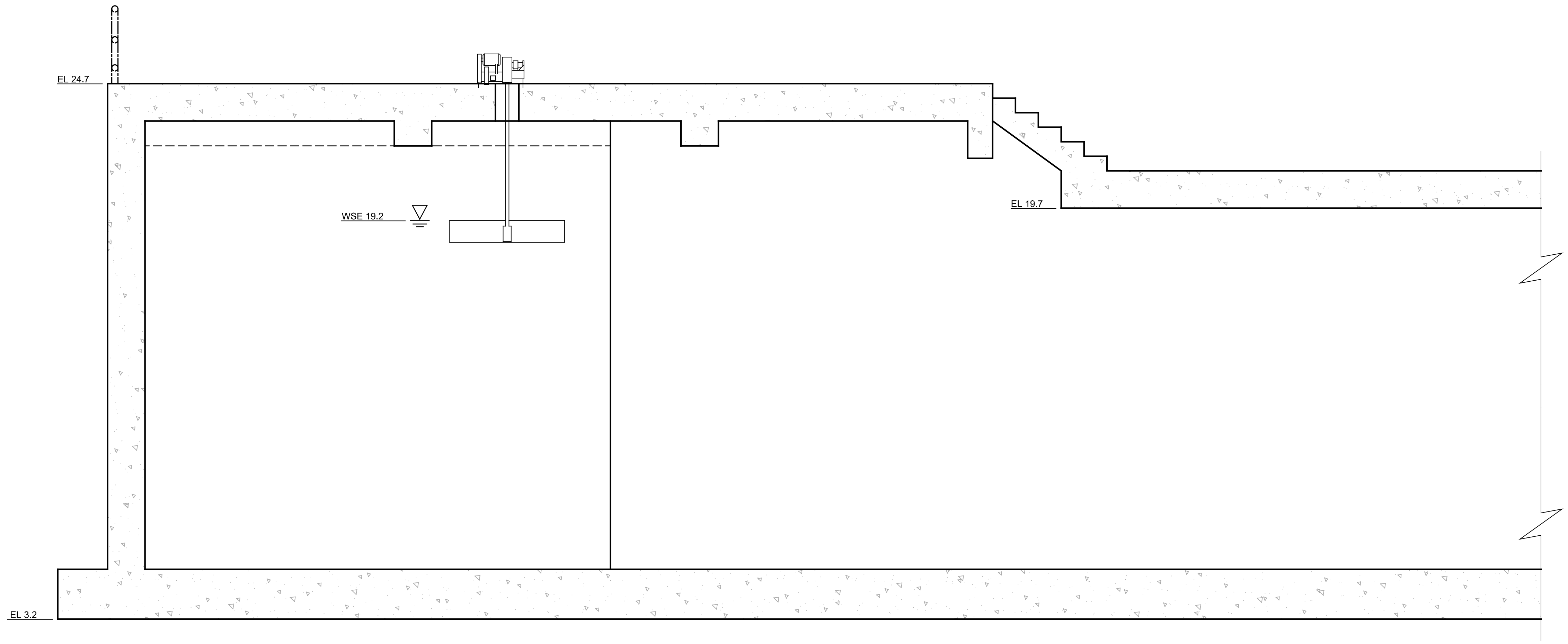
Figure No. 5.3
OXIDATION DITCH PLAN
CITY OF ARCATA
carollo



B 5.3 SECTION
SCALE: 3/8" = 1'-0"
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Figure No. 5.4
OXIDATION DITCH SECTION
CITY OF ARCATA

Table 5.3 Oxidation Ditch Design Parameters

Criteria	Unit	Value	
Number	--	1 + 1 future	
Type	--	Vertical Wall Carousel	
Temperature	deg C	10 - 20	
Volume, each	MG	1.6	
Side Water Depth	ft	14	
		Current Average Dry Weather Flow	**Current Peak Wet Weather Flow**
Flow Rate	mgd	1.1	3.6[(1)]
Hydraulic Detention Time	hrs	35	11
Typical Range [(2)]	hrs	24	
Solids Retention Time	days	16	15
Typical Range [(2)]	days	20 - 30	
MLSS	mg/L	1,800	2,900
Typical Range [(3)]	mg/L	1,500 - 5,000	
Sludge Yield	lb TSS/lb BOD	1	1
Typical Range [(3)]	lb TSS/lb BOD	0.65	

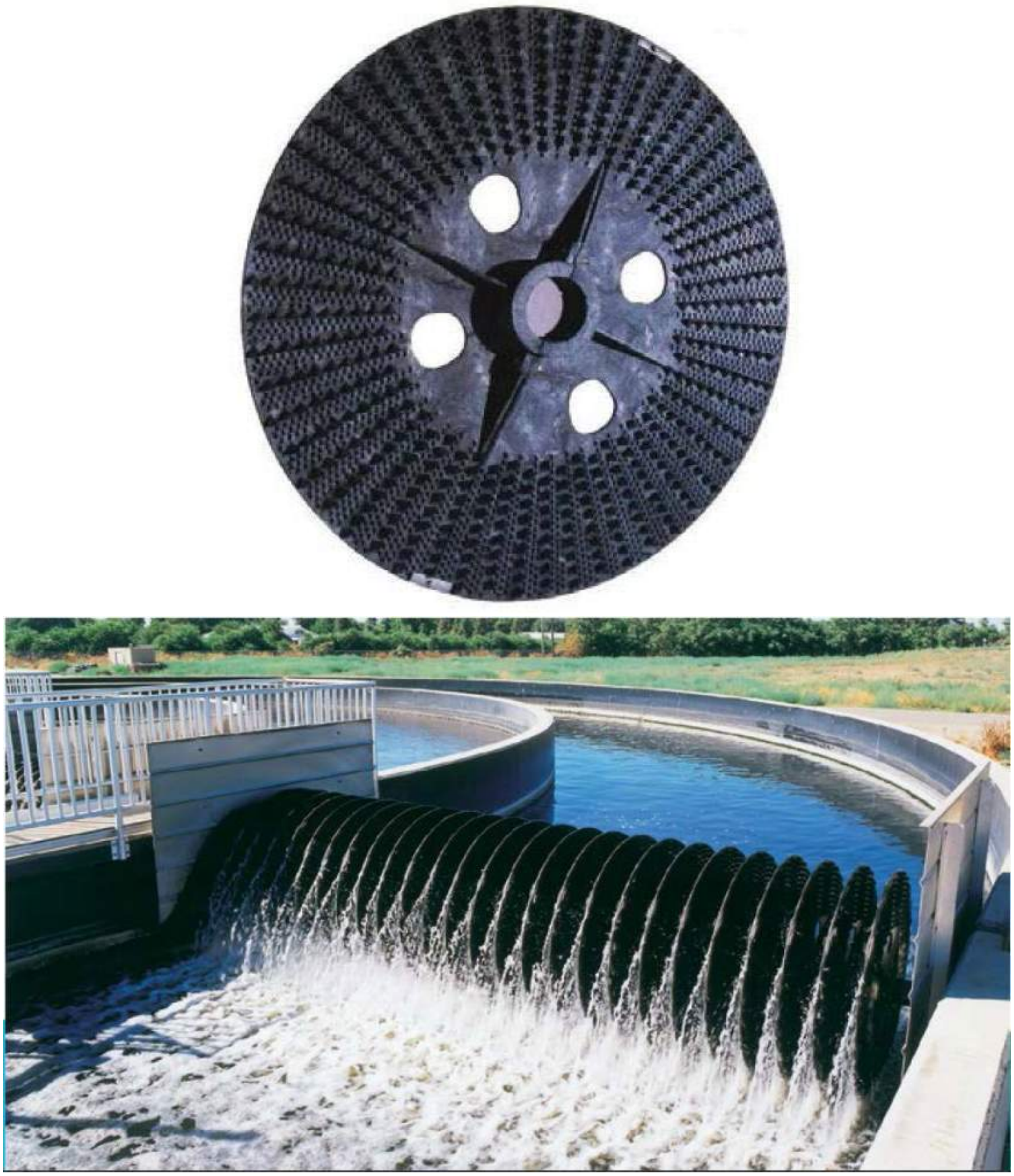
Notes:
(1) Current Peak Wet Weather Flow is 5.9 mgd; however, it is assumed that at peak flow conditions flow is split between the existing oxidation ponds and wetlands (2.3 mgd) and the new conventional secondary treatment system (3.6 mgd).
(2) MOP 8, 5th Edition.
(3) Wastewater Technology Fact Sheet: Oxidation Ditches, EPA, 2000.

Table 5.4 Oxidation Ditch Aeration System Design Parameters

Criteria	Unit	Value
Number, per ditch	--	2
Type	--	Vertical Surface Aerator
Motor Size	Hp	125
Drive Type	--	Variable Frequency

5.5.1.2 Monitoring Equipment

Oxidation ditches are typically monitored for DO concentration using DO probes. This DO concentration sets the required aerator speed, and thus the amount of oxygen added to the ditch. The concentration of DO present in the ditch indirectly monitors the nitrification and denitrification occurring.



Source: Envirex an Evoqua brand

Figure 5.5 Proprietary Disk Aerator

Source: WesTech

Figure 5.6 Surface Aerator

Alternatively, oxidation ditches can be monitored for ammonia and nitrate directly. This approach provides real-time nitrogen and ammonia removal performance, further optimizing the required aerator speed.

The desired control strategy, either oxygen-based or nitrogen-based, will be determined during final design.

5.5.1.3 Materials of Construction

The oxidation ditch structure would be made of concrete. The concrete under the aerator platform could be coated with a T-lock protective coating. Concrete surfaces from the top of the wall to three feet below the water surface level would be coated to provide protection.

The aerators would be made of high performance coated steel and the effluent weir gate would be made of aluminum.

5.5.2 Mixed Liquor Flow Split Structure

To passively split flow between the two proposed secondary clarifiers, a flow split structure is needed. The design criteria for this passive flow split structure are shown in Table 5.5. This flow split structure would be made of concrete. The concrete would be coated with a T-lock protective coating and specified for all concrete surfaces from the top of the wall to three feet below the water surface level to provided protection.

Table 5.5 Mixed Liquor Flow Split Structure Design Parameters

Criteria	Unit	Value
Design Capacity	mgd	7.2
Weir Length per Secondary Clarifier	ft	12.0

5.5.3 Secondary Clarifiers

Circular secondary clarifiers are recommended for the final secondary process to remove suspended solids. A summary of the design criteria and recommended clarifier design is listed in Table 5.6. Appendix 5B provides vendor brochures and cost proposals for the proposed secondary clarifiers.

5.5.3.1 Clarifier Inlet Design

The standard inlet design for a center feed circular clarifier typically consists of an energy dissipating inlet located around the perimeter of the center column and a larger diameter flocculating feed well that prevents short circuiting of the influent flow. The submergence and diameter of the center feed well will be established during the final design.

5.5.3.2 Sludge Collection Mechanism

The secondary activated sludge will be allowed to accumulate in the clarifier by maintaining a sludge blank level. This will compact the sludge, thereby thickening the secondary activated sludge. The floor of the clarifier will have 1:12 slope toward the deep center sludge collection hopper.

Table 5.6 Secondary Clarifier Design Parameters

Criteria	Unit	Value	
Number	--	2 + 1 future	
Type	--	Circular	
Diameter	ft	75	
Side Water Depth	ft	14	
Sludge Collector Type	--	Rapid sludge drawoff	
		Current Average Dry Weather Flow	**Current Peak Wet Weather Flow**
Flow Rate	mgd	1.1	3.6(1)
Surface Overflow Rate	gpd/sf	240	800
Typical Range (2)	gpd/sf	400 - 700	1,000 - 16,000
Solids Loading Rate	ppd/sf	6	34
Typical Range (2)	ppd/sf	20 - 30	40 - 50
Weir Loading Rate	gpd/ft	2,330	7,640
Typical Range (2)	gpd/ft	20,000 - 30,000	

Notes:
(1) Current Peak Wet Weather Flow is 5.9 mgd; however, it is assumed that at peak flow conditions flow is split between the existing oxidation ponds and wetlands (2.3 mgd) and the new conventional secondary treatment system (3.6 mgd).
(2) MOP 8, 5th Edition.

The sludge collection mechanisms typically used in secondary clarifiers are spiral scrapers. With this configuration, spiral blades are coupled with a rotating sludge collection drum at the center of the clarifier to rapidly remove settled sludge.

5.5.3.3 Materials of Construction

Circular clarifier mechanisms can be fabricated from either stainless steel or carbon steel with either a high performance coating or corrosion protection. The estimated capital cost of the stainless steel mechanism is much higher than that of the carbon steel mechanism. The carbon steel mechanism will require corrosion protection in either the form of a high performance coating or cathodic protection. Coated carbon steel mechanisms require periodic recoating and repair, while cathodic protection systems require regular testing and sacrificial anode replacement throughout the life of the mechanism. Consequently, a carbon steel mechanism has higher maintenance costs than a stainless steel mechanism. In order to reduce capital costs, a carbon steel clarifier mechanism with a high performance coating is recommended.

The peripheral weir and scum baffle will be constructed of FRP and the scum baffle supports will be fabricated from Type 316 stainless steel.

5.5.3.4 Scum Pumping System

Secondary scum will be collected from the new secondary clarifiers and drain to a new scum well adjacent to each clarifier. A chopper pump will provide mixing, decant, and scum transfer.

5.5.4 RAS Pumping System

Design criteria for the proposed RAS pump station is listed in Table 5.7. The RAS system capacity will be based on 100 percent RAS recycle at peak flow. Vertical or horizontal non-clog centrifugal pumps will be used.

Table 5.7 RAS Pumping System Design Parameters

Criteria	Unit	Value
Number and Capacity of Pumps (duty + standby)	--	--
Average Dry Weather Flow Rate	--	1 + 1 @ 1.2 mgd
Maximum Month Flow Rate	--	1 @ 3.0 mgd
Type	--	Horizontal Non-Clog Centrifugal
Discharge Head	ft	6
Motor Size	Hp	5
Drive Type	--	VFD

With the proposed design, RAS pumps would take suction directly from the secondary clarifiers. A common RAS pump station would pump RAS from both clarifiers via variable-speed driven pumps to meet the desired RAS flow rate. A standby pump would serve as the common backup for the two clarifiers. The pump speeds, and consequently flow output, would be controlled based on the RAS flow rate as measured by a flow meter located on the discharge side of the associated RAS pumps. An inline magnetic flow meter is recommended for this application due to its lower cost, smaller footprint, and higher performance than other flow measuring devices. During the first phase of the project, where only one oxidation ditch exists, the RAS pumps would discharge flow directly to the oxidation ditch, via glass-lined ductile iron pipes. In the future, if an additional ditch is constructed, the RAS pumps would discharge flow to a future RAS splitter box where RAS would then flow by gravity to each of the two oxidation ditches.

The new RAS pumps will be located in a pump pit adjacent to the secondary clarifiers. The pump suction will be located to minimize piping from the clarifiers to the pumps.

5.5.5 WAS Pumping System

Design criteria for the proposed WAS pump station is listed in Table 5.8. Based on the expected solids production, a maximum WAS withdrawal capacity of 0.05 mgd is recommended. Horizontal or vertical non-clog centrifugal pumps will be used.

Table 5.8 WAS Pumping System Design Parameters

Criteria	Unit	Value
Number of Pumps (duty + standby)	--	1 + 1
Type	--	Horizontal Non-Clog Centrifugal
Capacity, each	mgd	0.05
Discharge Head	ft	8
Motor Size	Hp	0.1
Drive Type	--	VFD

With the proposed design, two variable speed WAS pumps (one duty, one standby) would take WAS directly from the RAS pump station and pump WAS via glass-lined ductile iron pipes to the new thickener described in TM 7 - Solids Handling and Digester Improvements.

5.5.6 Alkalinity Feed Facility

The secondary process will consume alkalinity from the raw wastewater in order to nitrify (remove ammonia). Currently, raw wastewater alkalinity is not regularly measured. It is noted that some recent data indicates that alkalinity may not be necessary year-round. Additional data collection will be required to determine seasonal fluctuations, if any, in influent alkalinity. The more data collected on alkalinity loading, the more effectively the new alkalinity addition facilities can be designed, if even necessary. A wastewater alkalinity around 60 mg/L was assumed in the process modeling done in this predesign report.

With the assumption that the wastewater alkalinity is around 60 mg/L, the raw wastewater alkalinity will not provide sufficient alkalinity for the secondary treatment process, so supplemental alkalinity needs to be added to the wastewater. Commonly caustic soda, magnesium hydroxide, or hydrated lime is use to provide alkalinity and adjust wastewater effluent pH. The required chemical amount for each of these three chemicals is discussed in Appendix 5C. In each case, the dose for the alkalinity addition was modelled to maintain a neutral pH for the secondary process effluent. Recommended design criteria for a hydrated lime slurry ($Ca(OH)_2$) facility are shown in Table 5.9. The tank volume is based on approximately 14 days storage at peak use. Final chemical selection will be determined during final design.

Table 5.9 Chemical Addition Facility Design Parameters

Criteria	Unit	Value
Dose (max)	mg/L	260
Bulk Chemical Storage		
Type	--	Bulk Liquid Tank
Number	--	2
Volume, each	gal	6,000
Feed Pumps		
Type	--	Diaphragm Metering Pump
Number (duty + standby)	--	1 + 1
Capacity, each	gpd	1,000

5.6 Potential for Phasing

The system described in this predesign report assumes that at peak wet weather flows (5.9 mgd), flow can be split between the existing oxidation ponds and treatment wetlands (2.3 mgd) and the new oxidation ditch and secondary clarifiers (3.6 mgd). However, with sea level rise, it is expected that at some point in the future the existing natural system will no longer be able to provide treatment capacity. At this future time, additional treatment capacity will be needed and can be provided via a second oxidation ditch and third secondary clarifier. These additional facilities will allow the full 5.9 mgd of peak wet weather flow to be treated in the conventional secondary treatment process.

Appendix 5A

PROCESS MODEL RESULTS

	Current ADWF	Current MM (13-d SRT)	Current Peak Split	Future ADWF	Future MM (10-d SRT)	Future Peak Split	Future Peak (2 ditches)
Influent							
Flow, mgd	1.1	3	5.9	1.3	3.6	5.9	5.9
TBOD, ppd	1467	4000	4000	1733	4800	4800	4800
TSS, ppd	2112	5760	5760	2495	6910	6910	6910
NH3, ppd	323	880	880	383	1060	1060	1060
TKN, ppd	489	1333	1333	580	1606	1606	1606
TBOD, mg/L	159.9	159.9	81.3	159.9	159.9	97.5	97.5
TSS, mg/L	230.2	230.2	117.1	230.1	230.1	140.4	140.4
NH3, mg/L	35.2	35.2	17.9	35.3	35.3	21.5	21.5
TKN, mg/L	53.3	53.3	27.1	53.5	53.5	32.6	32.6
BioWin COD Input							
Flow, mgd	1.10	3.00	5.90	1.30	3.60	5.90	5.90
TCOD, mg/L	354.8	354.8	180.4	354.8	354.8	216.5	216.5
TKN, mg/L	53.3	53.3	27.1	53.5	53.5	32.6	32.6
TP, mg/L	5.0	5.0	5.0	5.0	5.0	5.0	5.0
NO3-N, mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0
pH	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Alk, mmol/L	10.0	10.0	10.0	10.0	10.0	10.0	10.0
ISS, mg/L	68.0	68.0	34.6	68.0	68.0	41.5	41.5
SCa, mg/L	80.0	80.0	80.0	80.0	80.0	80.0	80.0
SMg, mg/L	15.0	15.0	15.0	15.0	15.0	15.0	15.0
DO, mg/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BioWin Output							
Ox Ditch							
RS Flow, mgd	1.1	3.0	3.6	1.3	3.6	3.6	5.9
Flow Bypassing, mgd	0.0	0.0	2.3	0.0	0.0	2.3	0.0
TCBOD Load, ppd	1468	4003	2443	1735	4804	2931	4804
ppd / 1000 cf	6.8	18.5	11.3	8.0	22.2	13.5	11.1
TKN Load, ppd	489	1334	814	580	1607	979	1605
VSS Load, ppd	1483	4044	2468	1573	4853	2961	4853
TSS Load, ppd	2111	5758	3514	2495	6910	4217	6911
# of Ditches	1	1	1	1	1	1	2
Total Vol, mg	1.62	1.62	1.62	1.62	1.62	1.62	3.24
Vol per BioWin Reactor, mg	0.1350	0.1350	0.1350	0.1350	0.1350	0.1350	0.2700
HRT, hrs	35.3	13.0	10.8	29.9	10.8	10.8	13.2
# of Aerators per Ditch	2	3	2	2	2	2	2
# of Aerators Total	2	3	2	2	2	2	4
Power per Aerator, hp	28.5	45.1	45.8	33.6	74.2	54.2	38.2
Power per Ditch, hp	57.1	135.4	91.6	67.3	148.3	108.4	76.4
Total Aerator Power, hp	57.1	135.4	91.6	67.3	148.3	108.4	152.8
Total Aerator Power, kW	42.61	101.04	68.38	50.21	110.69	80.87	114.06
hp / ppd BOD	0.0389	0.0338	0.0375	0.0388	0.0309	0.0370	0.0318
hp / MG	35.2	83.6	56.6	41.5	91.6	66.9	47.2
Aerated Zones DO, mg/L	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Avg DO (All Zones), mg/L	1.16083	0.64917	0.95917	1.1	0.55167	0.85167	0.54
Total OTR, lb/hr	121	287	194	143	315	230	324
Total SOTR, lb/hr	183	433	293	216	475	347	489
lb O2 / hp-hr	3.20	3.20	3.19	3.21	3.20	3.20	3.20
MLSS, mg/L	1752	3990	2926	2070	4110	3517	2696
SRT, days	15.9	13	15	14.9	10	15	13.75
WAS, mgd	0.0463	0.0542	0.0412	0.0459	0.07	0.0412	0.0934
WAS TSS, mg/L	3981	9195	6816	4722	9472	8193	6220
WAS TSS, ppd	1538	4156	2341	1807	5137	2815	4849
Combined PS + WAS TSS, ppd	1538	4156	2341	1807	5137	2815	4849
Yield (TSS Produced per BOD Destroyed)	1.04768	1.03822	0.95825	1.0415	1.06932	0.96042	1.00937

Sec Clar								
Quantity	1	2	1		1	2	2	2
Diameter (ea), ft	75	75	75		75	75	75	75
Area (total), sf	4418	8836	4418		4418	8836	8836	8836
RAS %	75	75	75		75	75	75	75
RAS, mg/L	3981	9195	6816		4722	9472	8193	6220
SOR, gal/sf/d	239	333	806		284	400	403	657
SLR, lb/sf/d	6.22	19.63	34.41		8.71	24.2	20.68	26.05
State Point Analysis (outside BioWin, SN Method)								
Flow, mgd	1.1	3.0	3.6		1.3	3.6	3.6	5.9
SVI, mL/g	150	150	150		150	150	150	150
Safety Factor	1.2	1.2	1.2		1.2	1.2	1.2	1.2
Effluent								
NH3, mg/L	0.38	0.6	0.38		0.38	1.03	0.39	0.72
NO3, mg/L	32.56	19.79	14.69		32.11	11.93	16.47	7.6
NO2, mg/L	0.11	0.34	0.13		0.11	2.83	0.14	0.57
TN, mg/L	35.13	23.09	16.89		34.72	18.18	18.88	10.56
TP, mg/L	2.61	2.55	3.89		2.62	2.42	3.66	3.57
TSS, mg/L	6.25	14.07	10.24		7.36	14.5	12.3	9.5
TCBOD, mg/L	2.29	3.95	2.91		2.46	4.83	3.25	2.85
Alkalinity Addition to Ditch (outside BioWin)								
Influent Alkalinity, mg/L	60	60	60		60	60	60	60
Desired Residual, mg/L	75	75	75		75	75	75	75
Ammonia Oxidized, mg/L	*34.8*	*34.6*	*17.5*		*34.9*	*34.3*	*21.2*	*20.8*
Alkalinity Consumed, mg/L	*248*	*247*	*125*		*249*	*245*	*151*	*149*
Nitrate Reduced, mg/L	*2*	*15*	*3*		*3*	*22*	*5*	*13*
Alkalinity Recovered, mg/L	*7*	*45*	*9*		*9*	*69*	*14*	*41*
Required Dose, mg/L	*257*	*216*	*131*		*256*	*191*	*152*	*123*
Specific Gravity	1.33	1.33	1.33		1.33	1.33	1.33	1.33
Slurry Concentration, %	30%	30%	30%		30%	30%	30%	30%
Required Flow, gph	*29*	*68*	*49*		*35*	*72*	*57*	*76*
Required Flow, gpd	*707*	*1628*	*1185*		*833*	*1724*	*1368*	*1820*

Appendix 5B

VENDOR BROCHURES AND COST PROPOSALS

WESTECH OXIDATION DITCH QUOTE

Arcata WWTP

California

Engineer
Carollo Engineers

Furnished by
Adrian Williams
awilliams@westech-inc.com

Represented by
Mike Tooley
MISCOwater
Pleasanton, California
(925) 225-1900
mtooley@miscowater.com

WesTech Opportunity Number: 1860245
Thursday, June 14, 2018

Item A – Two (2) OxyStream™ Biological Oxidation Systems
WesTech Equipment Model AES2A3

Process Design

Description	Unit	Dimension/Capacity
Flow (Design)	MGD	3.0
BOD (Influent/Effluent)	mg/L	160/30
TSS (Influent)	mg/L	230
TKN (Influent)	mg/L	53
Ammonia (Effluent)	mg/L	< 4
Waste Temp (Min/Max)	°C	10/20
Site Elevation	ft. above sea level	100

Equipment

Description	Type	Quantity
Aerators	Landy7	2
Adjustable Effluent Weir	Manual	1
DO Control System	LDO	2 Probes, 1 Controller

Equipment Description (Aerators)

Description	Unit	Dimension/Capacity
Aerator		
Motor Power	HP	150
Motor Voltage	V/Ph/Hz	480/3/60
Motor Speed	rpm	1800
Motor Frame	-	TEFC, C-Face
Motor B-10 Bearing Life	hours	100,000
Motor Heater	V	120
Reducer Service Factor	-	2.5
Reducer B-10 Bearing Life	hours	100,000
Reducer B-10 Life (Output)	hours	250,000
Reducer Oil Heater	V	120
Impeller Diameter	mm	2900
Impeller Thickness	inches	3/8
Impeller Material	-	A36 Steel
Jackstuds Material	-	A307 ZP
Mounting Bars Material	-	A36 Steel

Equipment Description (Effluent Weir Gate)		
Description	**Unit**	**Dimension/Capacity**
Effluent Weir Gate		
Manual/Automated	-	Manual
Weir Gate Material	-	Aluminum
Weir Length	ft	10
Vertical Weir Travel	in	30

Equipment Description (DO Control System)		
Description	**Unit**	**Dimension/Capacity**
DO Probes		
Probe Type	-	LDO
Mounting Configuration	-	Pole Mount
Cable Length	ft	33
Range	mg/L	0 – 20.0
Accuracy	-	± 0.05 ppm below 1 ppm ± 0.1 ppm below 5 ppm ± 0.2 ppm above 5 ppm
DO Controller		
Communication Protocol	-	MODBUS 232/485 Profibus DP
4-20 mA Outputs	-	2
Display	in	1.89 x 2.67

Option A-1 – VFD and PLC Controls

Equipment		
Description	**Type**	**Quantity**
VFD	Stand Alone Panel	2
PLC-Based Control	HMI Interface	1

Equipment Description (Variable Frequency Drives)

Description	Unit	Dimension/Capacity
Variable Frequency Drives		
Power	HP	150
Power Feed	V/Ph/Hz	480/3/60
Enclosure Type	-	NEMA 12
Enclosure Cooling	-	6
VFD Rectifier	6/12/18 Pulse	6
dv/dt Filter	Y/N	N

Equipment Description (PLC Control System)

Description	Unit	Dimension/Capacity
PLC Control System		
Power Feed	V/Ph/Hz	120/1/60
Enclosure Type	-	NEMA 12
UPS	Y/N	N
HMI Size	Inches	10
HMI Manufacturer	-	Allen Bradley
PLC Manufacturer	-	Allen Bradley
PLC Model	-	1769 CompactLogix

Coatings

All steel items, with the exception of the drive mechanism, will be prepared per SSPC-SP10 and coated with one (1) coats Tnemec N140 epoxy, 3-5 mils each. The drive mechanism will be finished painted in the shop with the manufacturer's recommended paint system.

On-Site Services

WesTech Trips to the Site

Number of Trips	2
Number of Days	4

Field Service

Included field service is for installation inspection, startup, and operator training. Any additional trips that the customer may request can be purchased at the standard WesTech daily rates plus travel and living expenses.

Spare Parts	
Low Oil Cutout Switch	1
High Speed Coupling	1

Comments and Clarifications

The proposed system was designed based on the information provided and WesTech's standard equipment. The proposed equipment is backed by a 1 Year warranty.

The proposed system was designed to treat the design loadings for BOD and ammonia removal in a single basin with one (1) aerator duty, one (1) stand-by.

Option A-1 includes VFD and PLC controls.

Items Not Included in WesTech's Base Scope of Supply

- Electrical Wiring
- Conduit
- Piping
- Valves/Fittings
- Lubricating Oil/Grease
- Field Welding
- Field Erection

This proposal has been reviewed and is approved for issue by Cody Maxfield on June 14, 2018.

Budget Pricing

Proposal Name: Arcata WWTP
Proposal Number: 1860245
Thursday, June 14, 2018

1. Bidder's Contact Information

Company Name	WesTech Engineering, Inc.
Contact Name	Adrian Williams
Phone	801.265.1000
Email	awilliams@westech-inc.com
Address: Number/Street	3665 S West Temple
Address: City, State, Zip	Salt Lake City, UT 84115

2. Pricing

Currency		US Dollars
Scope of Supply		
A	(2) OxyStream™ Biological Oxidation Systems Model AES2A3	$294,600
A-1	VFD and PLC Controls	$204,700
	Taxes (sales, use, VAT, IVA, IGV, duties, import fees, etc.)	Not Included

Prices are for a period not to exceed 30 days from date of proposal.

Field Service

Daily Rate	$1,200

Prices do not include field service unless noted, but it is available at the daily rate plus expenses. The customer will be charged for a minimum of three days for time at the jobsite. Travel will be billed at the daily rate. Any canceled charges due to the customer's request will be added to the invoice. The greater of visa procurement time or a two week notice is required prior to trip departure date.

3. Payment Terms

Submittals Approved	15%
Release for Fabrication	35%
Net 30 days from Shipment	50%

All payments are net 30 days. Partial shipments are allowed. Other terms per WesTech proforma invoice.

4. Schedule

Submittals, after PO receipt	6 to 8 Weeks
Customer Review Period	2 weeks
Ready to Ship, after Submittal Approval	18 to 20 weeks
Total Weeks from PO to Shipment	**26 to 30 weeks**

Terms & Conditions: This proposal, including all terms and conditions contained herein, shall become part of any resulting contract or purchase order. Changes to any terms and conditions, including but not limited to submittal and shipment days, payment terms, and escalation clause shall be negotiated at order placement, otherwise the proposal terms and conditions contained herein shall apply.

Freight: Prices quoted are **F.O.B. shipping point** with freight allowed to a readily accessible location nearest to jobsite. All claims for damage or loss in shipment shall be initiated by purchaser.

Paint: If your equipment has paint included in the price, please take note to the following. Primer paints are designed to provide only a minimal protection from the time of application (usually for a period not to exceed 30 days). Therefore, it is imperative that the finish coat be applied within 30 days of shipment on all shop primed surfaces. Without the protection of the final coatings, primer degradation may occur after this period, which in turn may require renewed surface preparation and coating. If it is impractical or impossible to coat primed surfaces within the suggested time frame, WesTech strongly recommends the supply of bare metal, with surface preparation and coating performed in the field. All field surface preparation, field paint, touch-up, and repair to shop painted surfaces are not by WesTech.

OxyStream Layout and Concrete Estimate

WesTech

Project Information

Project Name:	Arcata, CA	Project Number:	1860245
Engineer:	Carollo	Completed by:	CTM
Date:	6/14/2018	Checked by:	Preliminary

Design Parameters

Ditch Parameters

# of Ditches	1	
Aerators/Ditch	2	
Depth	15.5	ft
Channel Width	31	ft
Straight Length	176.66	ft
Channel Freeboard	1.5	ft
Aeration Freeboard	6	ft

Assumptions

Exterior Walls	15.5	in	thick
Interior Walls	12	in	thick
Deck	12	in	thick
Floor	10	in	thick
Footings	18	in	thick
Footings	60	in	tall

Volume

Aerobic	1.62	Mgal

Footprint

	Width	Length	
Aerobic	63.00	238.66	ft
TOTAL (1 ditch)	65.58	241.24	ft

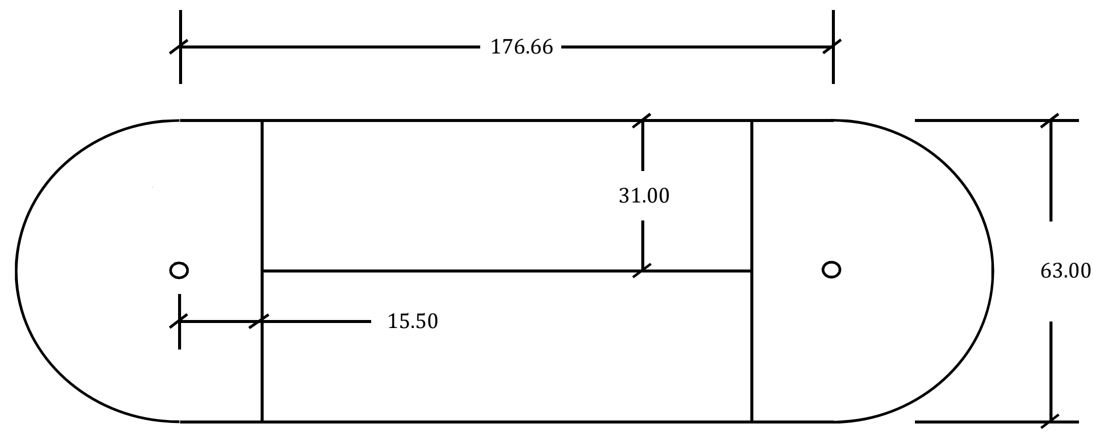
Concrete Estimate

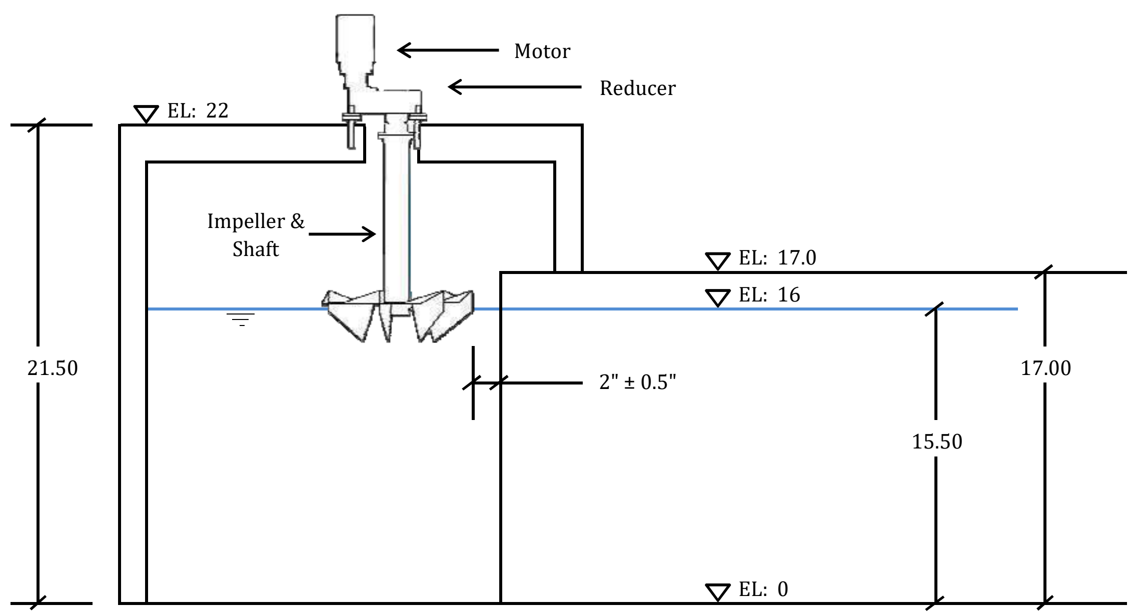
OxyStream BASIN OUTER WALLS	536	cu-yd
OxyStream BASIN INNER WALLS	135	cu-yd
OxyStream BASIN FLOOR	440	cu-yd
OxyStream BASIN FOOTINGS	201	cu-yd
Aerator Deck(s)	188	cu-yd
Total Estimated Concrete	**1499**	**cu-yd**

Ditch Layout

Drawing Not To Scale
Dimensions Given in Feet
Dimensions listed are interior dimensions

Ditches Shown: 1 of 1





OVIVO OXIDATION DITCH QUOTE

Carrousel® System Preliminary Proposal

Design Type:

Carrousel® System

For

Arcata, CA

Provided on June 19, 2018

By
Ovivo USA, LLC
4246 Riverboat Drive, Suite 300
Salt Lake City, Utah
84123
USA
www.ovivowater.com

Ovivo USA, LLC
4246 Riverboat Drive, Suite 300
Salt Lake City, Utah
84123
USA

Telephone: 801.931.3000
Facsimile: 801.931.3080

www.ovivowater.com

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Project Summary Letter

June 19, 2018

Elizabeth Charbonnet, P.E.
Carollo Engineers, Inc.
2700 Ygnacio Valley Road, Suite 300
Walnut Creek, CA 94598

Subject: Arcata, CA Carrousel® System Proposal

Dear Elizabeth

Based on the revised design criteria for Arcata WWTP, CA, we have come up with a single train design. We have provided two 125 HP VFD-controlled Excell Aerators in the basin, considering one of the aerators as a complete spare for current max. month design condition.

We have included clarifier size recommendation considering one clarifier in operation and both the clarifier in operation.

We have proposed our Oculus control system along with Water Expert App. Oculus control system shall enable operators to boost aerators based on the DO set points.

Ovivo USA provides this proposal for confidential use by you and your client. Given the ease of transferring information today, we appreciate your help in maintaining confidentiality. If you have any questions relating to this proposal, you may reach Tom at (801) 931-3242 (Mountain Time).

Very truly yours,

Mayur Chikhaliya
Product Manager
Carrousel® Systems
E: Mayur.Chikhaliya@ovivowater.com

Tom Leland, P.E.
Aeration Processes Group Manager
Carrousel® Aerostrip® Cleartec®
T : 801.931.3242
C : 801.573.6948
E : tom.leland@ovivowater.com

Scope of Supply:

Qty 2 - 125 HP Excell Aerator II w/ Excell Velocity Enhancer (EVE) made of concrete
- Single speed 1800 motor, 460 V/60Hz/3 Ph, Inverter duty, 1.15 SF on sine wave power, TEFC.
- Motor includes thermostats and space heater.
- Reducer w/ minimum 2.5 SF, Mechanical Oil Pump, Low oil Pressure switch.
- A36 Impellers, shaft, mounting, Zinc Plated Jack studs.

Qty 2 - 125 HP VFD(s), 6-pulse, 115 VAC control power transformers
- Not included: Harmonic, DV/dT filters, Bypass, Load reactor, surge Suppressor.
- Ethernet communication module and 115v for control interface.
- Configurable isolated I/O, digital Operator Interface module w/LCD digital display.

Qty 1 - Control System Type: Oculus w/ VFD, dedicated 480V/3 Ph/60 Hz feed.
- NEMA 1 MCC, installed in climate-controlled building.
- PLC is a CompactLogix.
- HMI is a 15in Windows HMI.
- (2) DO Analyzer w/ (1) Probe(s)
- (1) Water Expert App

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Design Summary (Max. Month Flow Condition)

Design Basis

The Carrousel® system described in this proposal has been designed to treat an influent wastewater flow of **3.0 MGD** with the following wastewater characteristics, in a flow sheet with no primary clarification.

Parameter	Influent	Effluent	Notes
Flow (MGD)	3.0	-	
BOD – Biochemical Oxygen Demand (mg/L)	160	5	
TSS – Total Suspended Solids (mg/L)	230	15	
TKN – Total Kjeldahl Nitrogen (mg/L)	53	2.0	
NH_3-N – Ammonia Nitrogen (mg/L)	-	1.0	

Design Criteria

Design Parameter	Design Value
Process SRT – Nitrification (days)	15.0
Minimum Wastewater Temperature (°C)	12.0
Maximum Wastewater Temperature (°C)	25.0
MLSS Concentration (mg/L)	4,000
Net Yield (lb TSS/lb $BOD_{removed}$)	0.93
Oxygen Coefficient	
lb O_2 / lb $BOD_{removed}$	1.21
lb O_2 / lb $N_{oxidized}$	4.60
Alpha (α)	0.92
Beta (β)	0.97
Elevation (feet above sea level)	23
Design Standard Oxygen Transfer Rate (lbs O2/motorHP/Hr)	3.65

Aeration Power Requirement **= 162 HP without accounting for denitrification**

Aeration Power Proposed **= 2 units at 125 HP each = 250 HP Total**

Design Summary (Average Daily Flow Condition)

Design Basis

The Carrousel system described in this proposal has been designed to treat an influent wastewater flow of **1.100 MGD** with the following wastewater characteristics, in a flow sheet with no primary clarification.

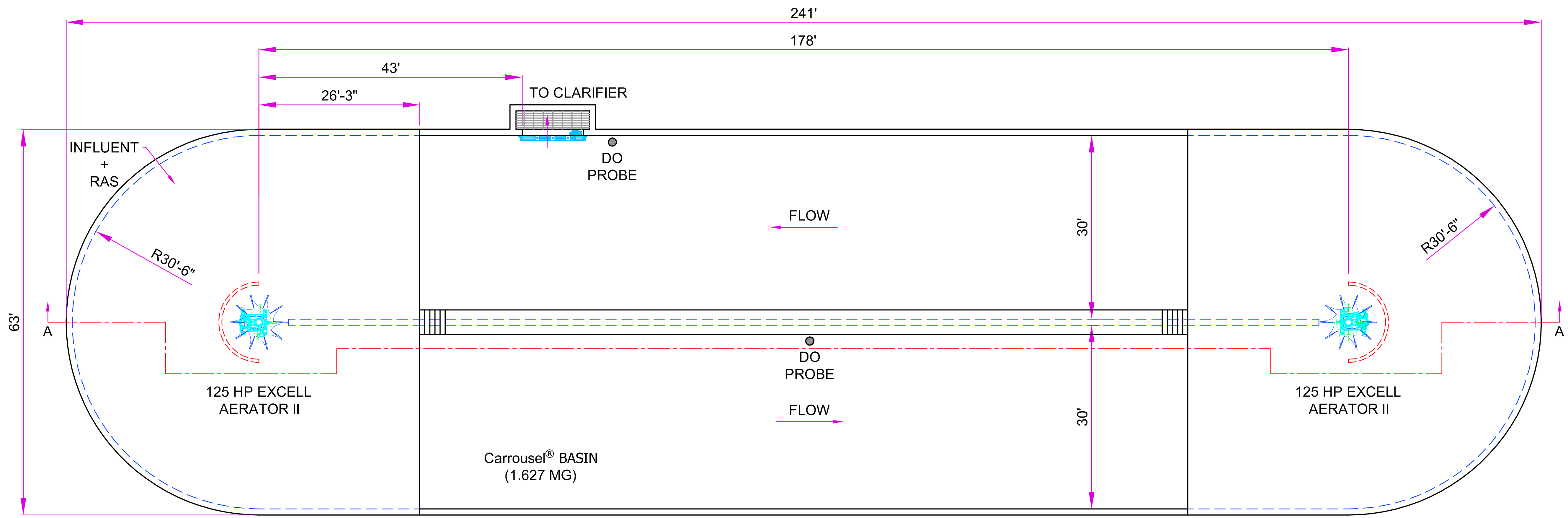
Parameter	Influent	Effluent	Notes
Flow (MGD)	1.10	-	
BOD – Biochemical Oxygen Demand (mg/L)	160	5	
TSS – Total Suspended Solids (mg/L)	230	15	
TKN – Total Kjeldahl Nitrogen (mg/L)	53	2.0	
NH_3-N – Ammonia Nitrogen (mg/L)	-	1.0	

Design Criteria

Design Parameter	Design Value
Process SRT – Nitrification (days)	29.3
Minimum Wastewater Temperature (°C)	12.0
Maximum Wastewater Temperature (°C)	25.0
MLSS Concentration (mg/L)	2,500
Net Yield (lb TSS/lb $BOD_{removed}$)	0.82
Oxygen Coefficient	
lb O_2 / lb $BOD_{removed}$	1.38
lb O_2 / lb $N_{oxidized}$	4.60
Alpha (α)	0.94
Beta (β)	0.97
Elevation (feet above sea level)	23
Design Standard Oxygen Transfer Rate (lbs O2/motorHP/Hr)	3.65

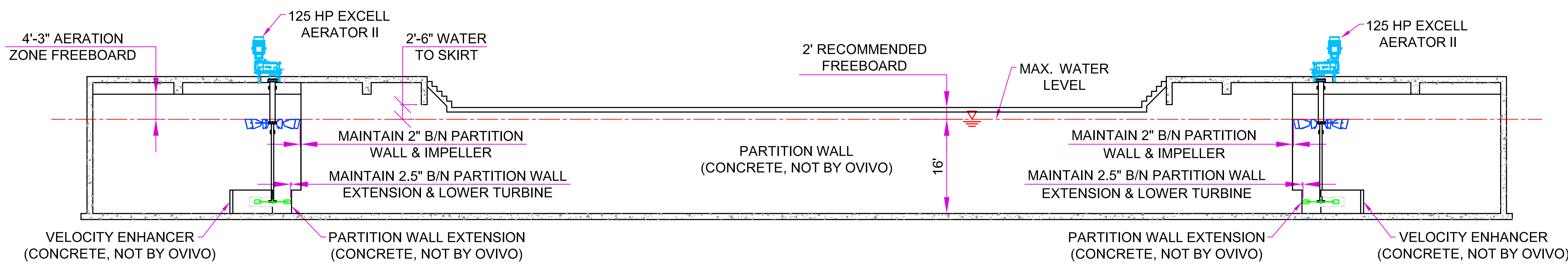
Aeration Power Requirement = 63 HP without accounting for denitrification

Aeration Power Proposed = 2 units at 125 HP each = 250 HP Total



ARCATA, CA BASIN LAYOUT

SWD = 16 FT



SECTION A-A

Carrousel®

Volumes	Carrousel® Basin
Volume Per Train	1.627 MG
No Trains	1 ea
Total Volume	1.627 MG

Concrete	Outer Wall Thickness	Inner Wall Thickness	Floor Slab Thickness	Footings	Bridges and Covers
Size of Component	12 inches	12 inches	12 inches	2.0 feet by 3.5 feet	12 inches
Concrete Volumes	425 CY	125 CY	500 CY	189 CY	211 CY
Concrete volumes are per basin.				Total Per Basin	1450 CY

						D	THIRD ANGLE PROJECTION	OVIVO Bringing water to life		
						REF. FROM: -	DO NOT SCALE PRINTS	ARCATA, CA WWTP BASIN LAYOUT -		
						DATE (mm/dd/yyyy) 06/19/2018	WORKMANSHIP STANDARD ES0001 APPLIES			
INITIAL RELEASE	-	-	-	--/--	A	DRAWN PKP	ORIGINAL S.O.	DWG. NO.	-	SHEET 1 OF 1
REVISION	EN/ECO	BY	CHECK'D	DATE		CHECK'D MAC	-			REV

Clarifier Recommendations (Two Clarifiers in Operation)

Design Parameter	Design Value
Clarifier Design Type	Spiral Blade
Average Flow (MGD)	1.1
Peak Flow (MGD)	3.6
Maximum RAS (% ADF)	250%
Maximum RAS (MGD)	2.75

Clarifiers Proposed = 2 @ 75 ft Diameter at 16 ft Side Water Depth

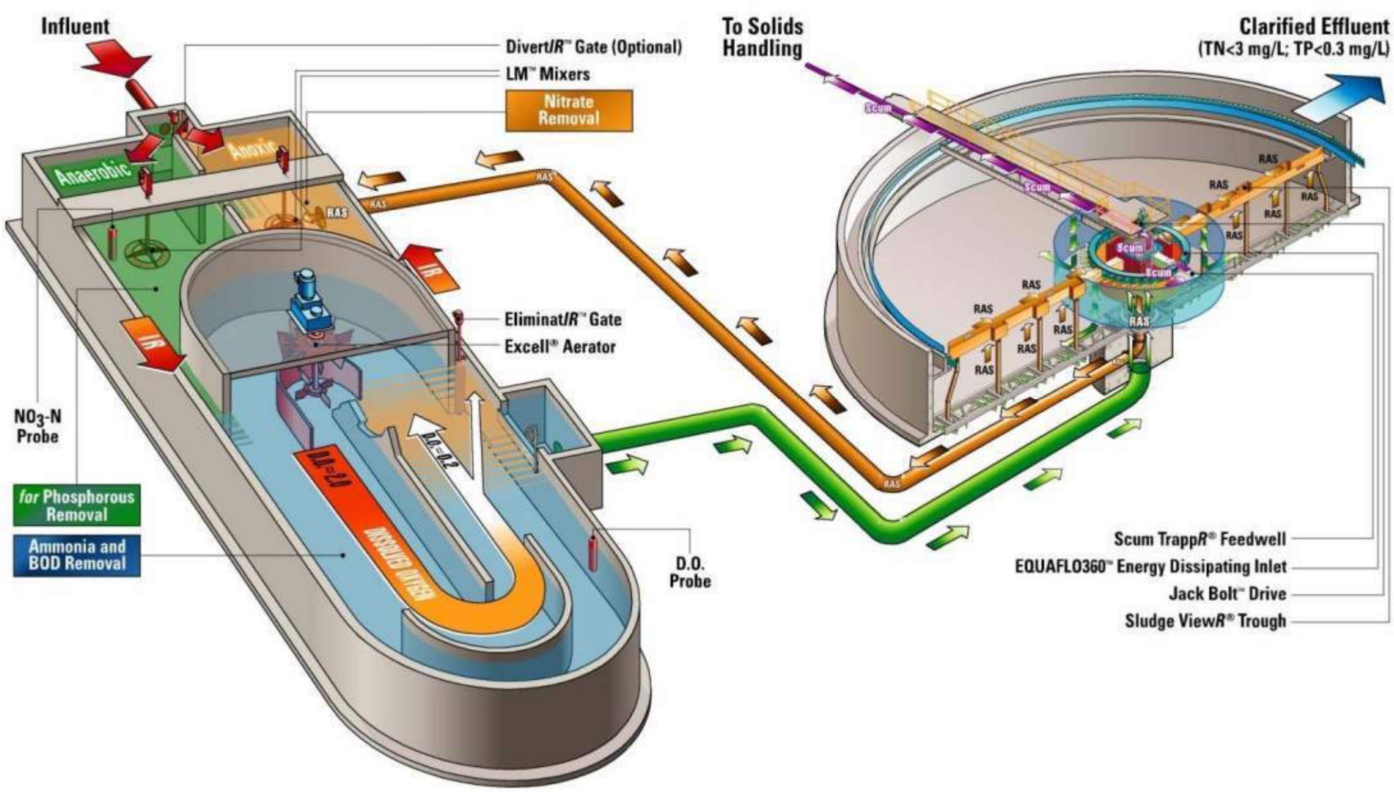


Figure: Carrousel® AlternatIR™ System and Carrousel®Proset™ Clarifier

Clarifier Recommendations (One Clarifier in Operation)

Design Parameter	Design Value
Clarifier Design Type	Spiral Blade
Average Flow (MGD)	1.1
Peak Flow (MGD)	3.6
Maximum RAS (% ADF)	150%
Maximum RAS (MGD)	1.65

Clarifiers Proposed = 1 @ 75 ft Diameter at 16 ft Side Water Depth

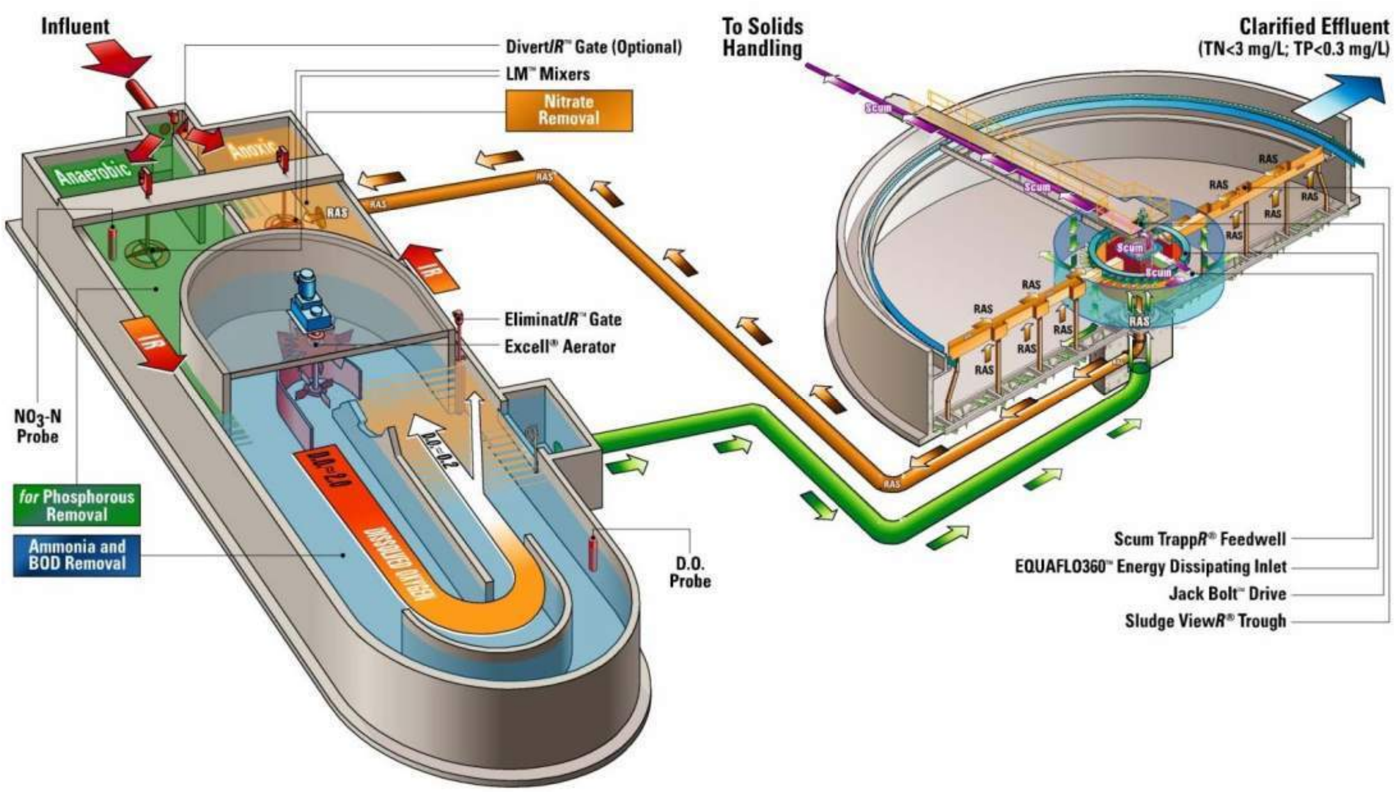


Figure: Carrousel® AlternatIR™ System and Carrousel®Proset™ Clarifier

Ovivo Experience

Ovivo Carrousel® Systems	Benefits
700 U.S. Carrousel® Installations	**Expertise in Basin Design:** • Sizing and basin layout incorporating proprietary geometry and hydraulics • Sizing of Aerator impeller size, type and speed **to maximize propulsion and oxygen transfer efficiency.**
200 U.S. Carrousel® Biological Nutrient Removal Installations	**Extensive database relating to:** • Proper Aeration and Mixing Equipment selection • Basin design and our equipment maximize N and P removal
130 U.S. Carrousel® Dual Impeller Installations	**Extensive database to design lower turbine and gear box** • **Maximize equipment longevity** • **Maximum process power turndown capability** (our equipment is proven to operate at 10-20% nameplate power and maintain mixing)
5 Full-Time Biological Process Engineers dedicated to the support of Carrousel® customers	For the past 25 years Ovivo engineers have assisted operators and engineers. • Optimization of plant effluent quality and operating costs • Free on-site and telephone support • Process support lasts a lifetime.
>40 Carrousel® Bardenpho® System Installations	Experience With Multi Stage Design To Meet 5:5:3:1: • Maintaining proper DO control • maintaining sufficient channel velocities
Nearly 2,000 Aerators Installed and Operating **>500 Aerators in Continuous Service for Over 15 Years**	A large installation base provides you with: • **proven performance** • **documented equipment longevity**

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Award Winning Plants

Almost every year, an Ovivo Carrousel® plant wins a national EPA award!

Year	Plant	Flow (MGD)
1988	Dothan Alabama (First Place)	5.00
1992	Green Forest, AR (Second Place)	2.80
1993	Vernon, NJ (Second Place)	2.50
1994	Faulkenburg Rd, FL (First Place)	6.00
1994	Denver SE, CO (First Place)	1.00
1995	Martinez, TX	2.60
1995	Little River , GA (Second Place)	1.00
1996	Wadena, MN (Second Place)	0.75
1996	So Central Brevard Co., FL (First Place)	5.50
1996	Pole Bridge Creek, GA (First Place)	20.00
1997	Fort Lupton, CO (First Place)	2.75
1998	Dyer, IN (Second Place)	1.80
1999	Edgartown, MA (first Place)	0.75
1999	Sweetwater Creek, GA (First Place)	3.00
1999	Togus, ME (Second Place)	0.20
2001	Denver SE, CO (Second Place)	1.00
2003	New Canaan, CT (Second Place)	1.20
2004	Central Davis, Kaysville, UT (First Place)	1.40
2005	North Conway, NH (First Place)	1.65
2007	Flat Creek WWTP, Gainsville, GA (Second Place)	18.00
2007	Southern Ute, Ignacio, CO (First Place)	0.80

Plus dozens of other national, state and local awards!

Calculations for Biological Basins (Max. Month Flow Condition)

1. DESIGN CONDITIONS

Design Parameter	Design Value	Design Effluent	Notes
Flow (MGD)	3.0	-	
BOD – Biochemical Oxygen Demand (mg/L)	160	5	
TSS – Total Suspended Solids (mg/L)	230	15	
TKN – Total Kjeldahl Nitrogen (mg/L)	53	2.0	
NH_3-N – Ammonia Nitrogen (mg/L)	-	1.0	

2. DESIGN ASSUMPTIONS

Design Parameter	Design Value
Process SRT – Nitrification (days)	15.0
Minimum Wastewater Temperature (°C)	12.0
Maximum Wastewater Temperature (°C)	25.0
MLSS Concentration (mg/L)	4,000
Net Yield (lb TSS/lb $BOD_{removed}$)	0.93
Oxygen Coefficient	
lb O_2 / lb $BOD_{removed}$	1.21
lb O_2 / lb $N_{oxidized}$	4.60
Alpha (α)	0.92
Beta (β)	0.97
Elevation (feet above sea level)	23

3. PROCESS CALCULATIONS (Max. Month Flow Condition)

a. AERATION VOLUME

BOD Removal $= Q \times (BOD_{in} - BOD_{eff}) \times 8.34$

$= 3.000 \times (160 - 5) \times 8.34$

$= 3{,}878\ {}^{\text{lbs BOD}}/_{\text{day}}$

Sludge Production $= Y \times Q \times (BOD_{in} - BOD_{eff}) \times 8.34$

$= 0.93 \times 3.000 \times (160 - 5) \times 8.34$

$= 3{,}619\ {}^{\text{lbs TSS}}/_{\text{day}}$

System Mass $= SRT \times Y \times Q \times (BOD_{in} - BOD_{eff}) \times 8.34$

$= 15.0 \times 0.93 \times 3.000 \times (160 - 5) \times 8.34$

$= 54{,}285$ lbs TSS

Carrousel Volume $= \dfrac{SRT \times Y \times Q \times (BOD_{in} - BOD_{eff})}{MLSS}$

$= \dfrac{15.0 \times 0.93 \times 3.000 \times (160 - 5)}{4{,}000}$

$= 1.627$ M.G.

BOD loading /kft3/day aer. $= \dfrac{Q \times BOD_{in} \times 8.34 \times 7.481 \times 1{,}000}{\text{Carrousel Volume} \times 10{,}00{,}000}$

$= \dfrac{3.0 \times 160 \times 8.34 \times 7.481 \times 1000}{1.627 \times 1000000}$

$= 18.4$ lbs BOD/kft3/day

b. AERATION POWER

Nitrogen Synthesis $= 5.6\%$ of WAS

$= 8.1 \ {}^{mg}/_{L}$

Nitrogen Oxidized (N_{ox}) $= TKN_{in} - TKN_{eff} - N_{assimilation}$

$= 53 - 2.0 - 8.1$

$= 42.9 \ {}^{mg}/_{L}$

$= 1{,}074 \ {}^{lbs \cdot N}/_{day}$

Actual Oxygen Requirement @ 1.21 ${}^{lbs\ O_2}/_{lbs\ BOD_{removed}}$ & 4.60 ${}^{lbs\ O_2}/_{lbs\ N_{oxidized}}$

AOR $= (1.21 \times 3{,}878) + (4.60 \times 1{,}074)$

$= 9{,}632 \ {}^{lbs\ O_2}/_{day}$

STD O_2Requirement $= AOR \times \dfrac{9.02}{\alpha \times (\beta \times C_{SW} - C_0)} \times 1.024^{(20-TMAX)}$

$\alpha = 0.92 \quad \beta = 0.97 \quad C_0 = 2.0$

C_{SW}at 25.0°C and 23 feet elevation $= 8.17 \ {}^{mg}/_{L} \ O_2$

SOR $= 9{,}632 \times \dfrac{9.02}{0.92 \times (0.97 \times 8.17 - 2.0)} \times 1.024^{(20-25.0)}$

$= 14{,}159 \ {}^{lbs\ O_2}/_{day}$

Power Required $= \dfrac{14{,}159}{3.65 \times 24}$

$= 162$ HP 2 @ 125.0 HP = 250 HP Installed

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Calculations for Biological Basins (Average Daily Flow Condition)

1. DESIGN CONDITIONS

Design Parameter	Design Value	Design Effluent	Notes
Flow (MGD)	1.100	-	
BOD – Biochemical Oxygen Demand (mg/L)	160	5	
TSS – Total Suspended Solids (mg/L)	230	15	
TKN – Total Kjeldahl Nitrogen (mg/L)	53	2.0	
NH_3-N – Ammonia Nitrogen (mg/L)	-	1.0	

2. DESIGN ASSUMPTIONS

Design Parameter	Design Value
Process SRT – Nitrification (days)	29.3
Minimum Wastewater Temperature (°C)	12.0
Maximum Wastewater Temperature (°C)	25.0
MLSS Concentration (mg/L)	2,500
Net Yield (lb TSS/lb $BOD_{removed}$)	0.82
Oxygen Coefficient lb O_2 / lb $BOD_{removed}$ lb O_2 / lb $N_{oxidized}$	 1.38 4.60
Alpha (α)	0.94
Beta (β)	0.97
Elevation (feet above sea level)	23

3. PROCESS CALCULATIONS (Average Daily Flow Condition)

a. AERATION VOLUME

BOD Removal $= Q \times (BOD_{in} - BOD_{eff}) \times 8.34$

$= 1.100 \times (160 - 5) \times 8.34$

$= 1{,}422\ ^{lbs\ BOD}/_{day}$

Sludge Production $= Y \times Q \times (BOD_{in} - BOD_{eff}) \times 8.34$

$= 0.82 \times 1.100 \times (160 - 5) \times 8.34$

$= 1{,}160\ ^{lbs\ TSS}/_{day}$

System Mass $= SRT \times Y \times Q \times (BOD_{in} - BOD_{eff}) \times 8.34$

$= 29.3 \times 0.82 \times 1.100 \times (160 - 5) \times 8.34$

$= 33{,}944$ lbs TSS

Carrousel Volume $= \frac{SRT \times Y \times Q \times (BOD_{in} - BOD_{eff})}{MLSS}$

$= \frac{29.3 \times 0.82 \times 1.100 \times (160 - 5)}{2{,}500}$

$= 1.628$ M. G.

BOD loading per kft3 aer. vol. $= \frac{Q \times BOD_{in} \times 8.34 \times 7.481 \times 1{,}000}{\text{Carrousel Volume} \times 10{,}00{,}000}$

$= \frac{1.10 \times 160 \times 8.34 \times 7.481 \times 1000}{1.628 \times 1000000}$

$= 6.75$ lbs BOD/kft3/day

b. AERATION POWER (Average Daily Flow Condition)

Nitrogen Synthesis $= 5.0\%$ of WAS

$= 6.3\ {}^{mg}/_{L}$

Nitrogen Oxidized (N_{ox}) $= TKN_{in} - TKN_{eff} - N_{assimilation}$

$= 53 - 2.0 - 6.3$

$= 44.7\ {}^{mg}/_{L}$

$= 410\ {}^{lbs \cdot N}/_{day}$

Actual Oxygen Requirement @ $1.38\ {}^{lbs\ O_2}/_{lbs\ BOD_{removed}}$ & $4.60\ {}^{lbs\ O_2}/_{lbs\ N_{oxidized}}$

AOR $= (1.38 \times 1{,}422) + (4.60 \times 410)$

$= 3{,}853\ {}^{lbs\ O_2}/_{day}$

$$\text{STD } O_2 \text{Requirement} = AOR \times \frac{9.02}{\alpha \times (\beta \times C_{SW} - C_0)} \times 1.024^{(20-TMAX)}$$

$\alpha = 0.94 \quad \beta = 0.97 \quad C_0 = 2.0$

C_{SW} at 25.0°C and 23 feet elevation $= 8.17\ {}^{mg}/_{L}\ O_2$

$$SOR = 3{,}853 \times \frac{9.02}{0.94 \times (0.97 \times 8.17 - 2.0)} \times 1.024^{(20-25.0)}$$

$= 5{,}543\ {}^{lbs\ O_2}/_{day}$

$$\text{Power Required} = \frac{5{,}543}{3.65 \times 24}$$

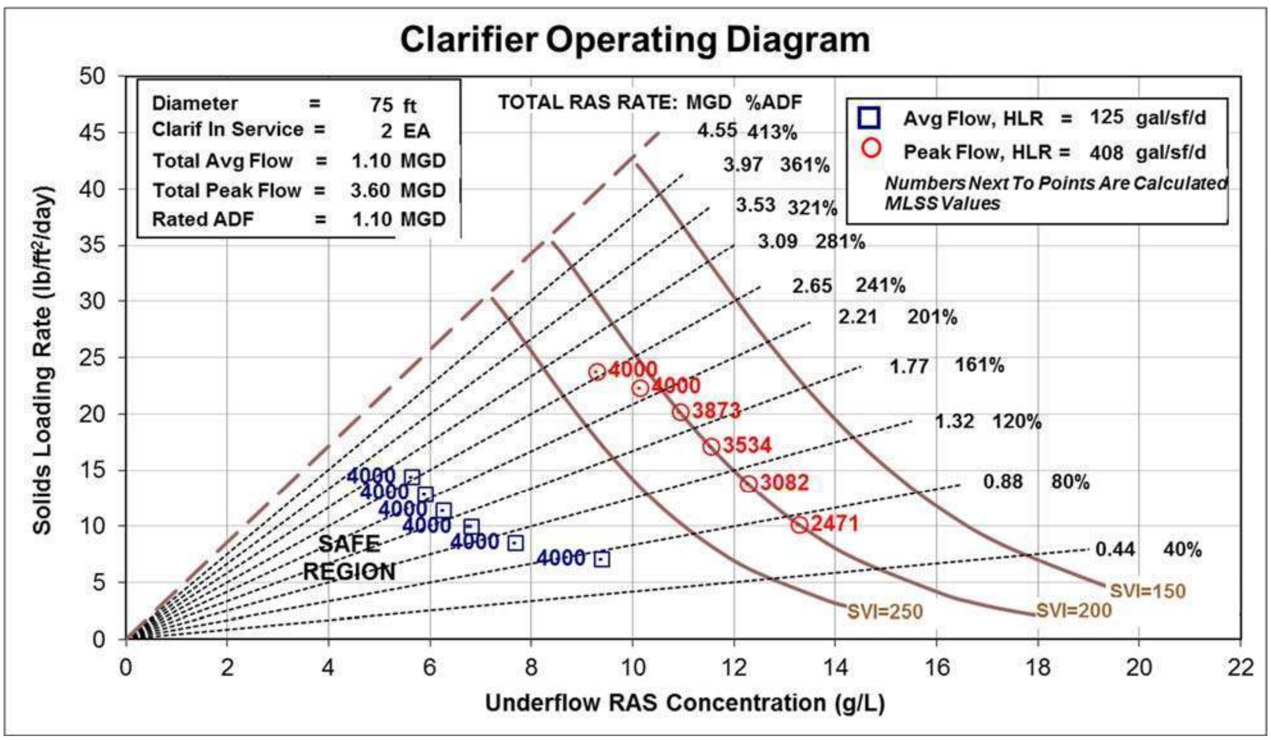
$= 63$ HP 2 @ 125.0 HP = 250 HP Installed

4. CLARIFIER CALCULATIONS (Two Clarifier in Operation)

SUMMARY OF SECONDARY CLARIFIER DESIGN RECOMMENDATION
Arcata, CA

SUMMARY OF CLARIFIER DESIGN			
Number of clarifiers operating	**2**		
Diameter, ft.	75	Biological	
Side water depth, ft.	16	Basin Vol (MG)	1.627
Average Design Flow (ADF), MGD	1.10	SVI (mL/g)	200
Mechanism type	Scraper	Target MLSS	4,000

Operating Parameters	Units	Average Flow Design RAS	Peak Flow Design RAS	Peak Flow Max RAS
Flow Used In Evaluation	MGD	1.10	3.60	3.60
RAS rate	MGD	0.83	0.83	2.75
RAS rate	%ADF	75%	75%	250%
Hydraulic loading	gal/sf-day	125	408	408
Solids loading	lb/sf-day	7.3	10.3	24.0
RAS solids	g/l	9.3	13.2	9.3
Increase in sludge blanket	ft	-	2.8	0.0
Aeration MLSS	mg/l	4,000	2,471	4,000



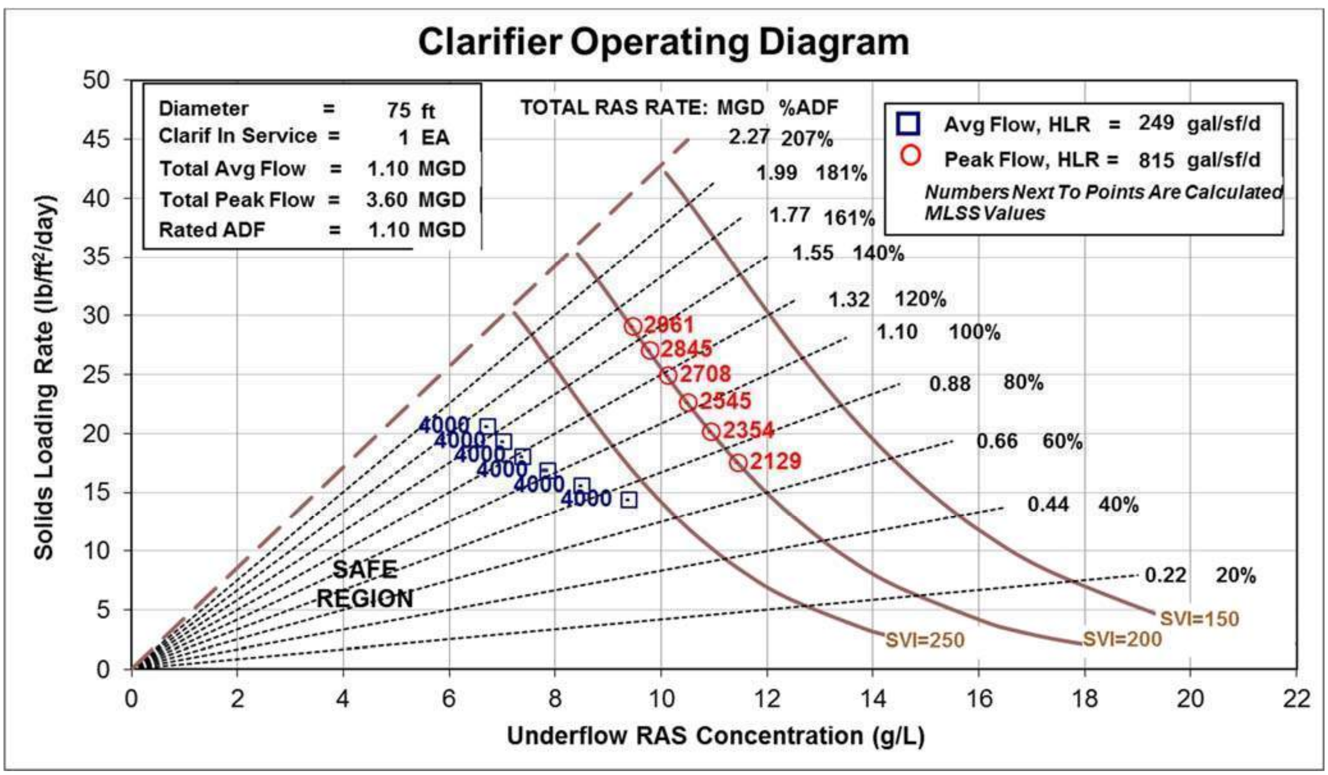
4. CLARIFIER CALCULATIONS (One Clarifier in Operation)

SUMMARY OF SECONDARY CLARIFIER DESIGN RECOMMENDATION

Arcata, CA

SUMMARY OF CLARIFIER DESIGN			
Number of clarifiers operating	**1**		
Diameter, ft.	75	Biological	
Side water depth, ft.	16	Basin Vol (MG)	1.627
Average Design Flow (ADF), MGD	1.10	SVI (mL/g)	200
Mechanism type	Scraper	Target MLSS	4,000

Operating Parameters	Units	Average Flow Design RAS	Peak Flow Design RAS	Peak Flow Max RAS
Flow Used In Evaluation	MGD	1.10	3.60	3.60
RAS rate	MGD	0.83	0.83	1.65
RAS rate	%ADF	75%	75%	150%
Hydraulic loading	gal/sf-day	249	815	815
Solids loading	lb/sf-day	14.5	17.8	29.3
RAS solids	g/l	9.3	11.4	9.4
Increase in sludge blanket	ft	-	8.1	5.4
Aeration MLSS	mg/l	4,000	2,129	2,961

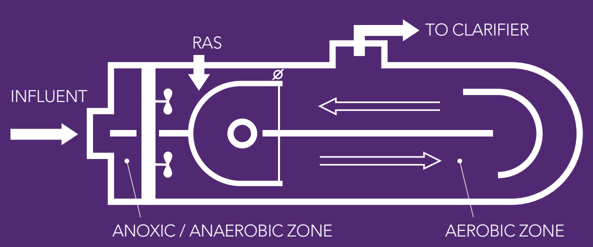


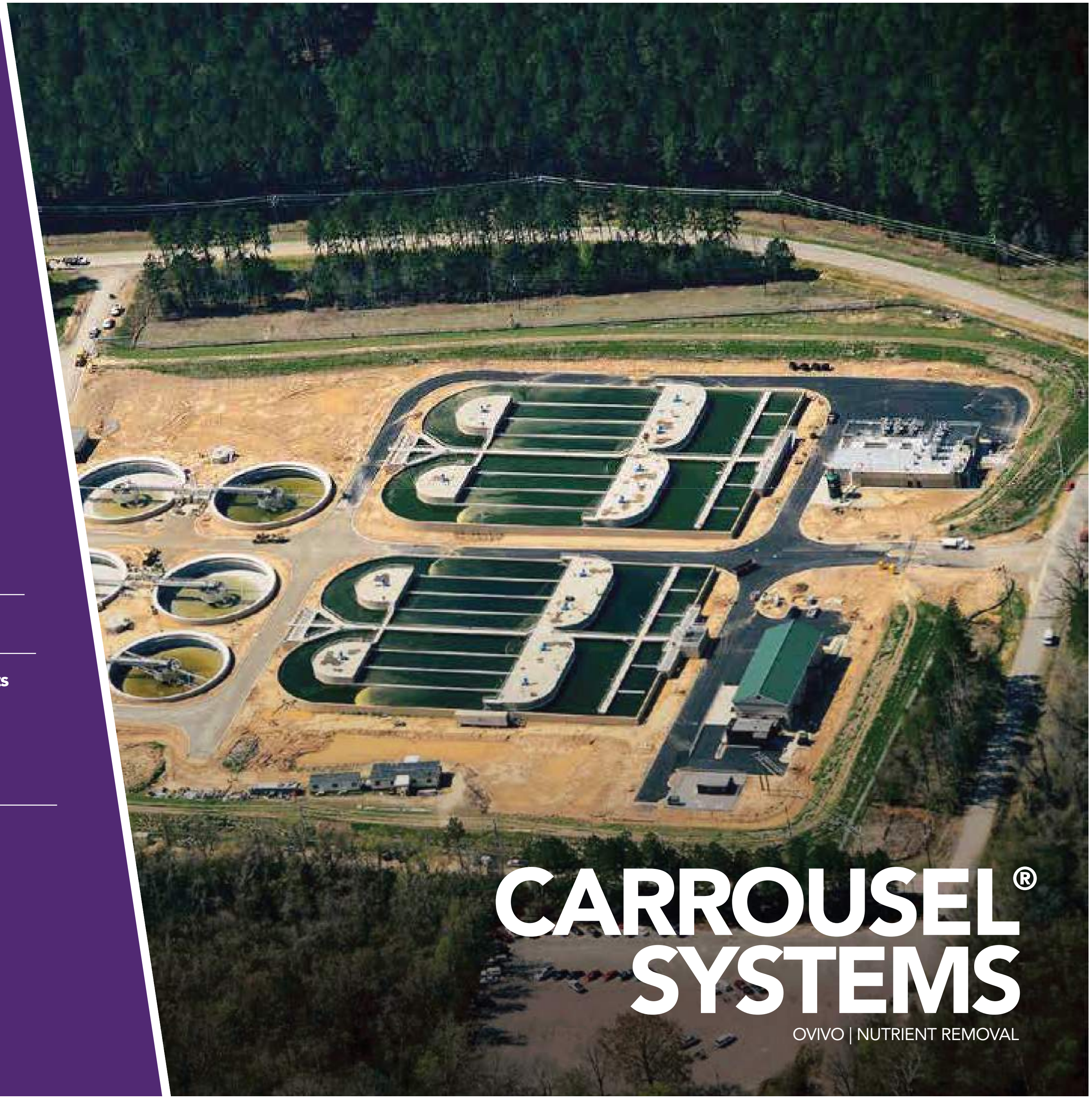
OVIVO®
Bringing water to life®

MAXIMUM TREATMENT, MINIMUM EFFORT

HOW IT CAN MEET YOUR NEEDS:

- Meets the **Most Stringent Effluent Nutrient Requirements**
- **Simple** to Operate and **Easy** to Maintain
- **Eliminate** Chemical Dependency
- **Reduce** Energy Use
- **Proven Technology** – 700+ U.S. installations

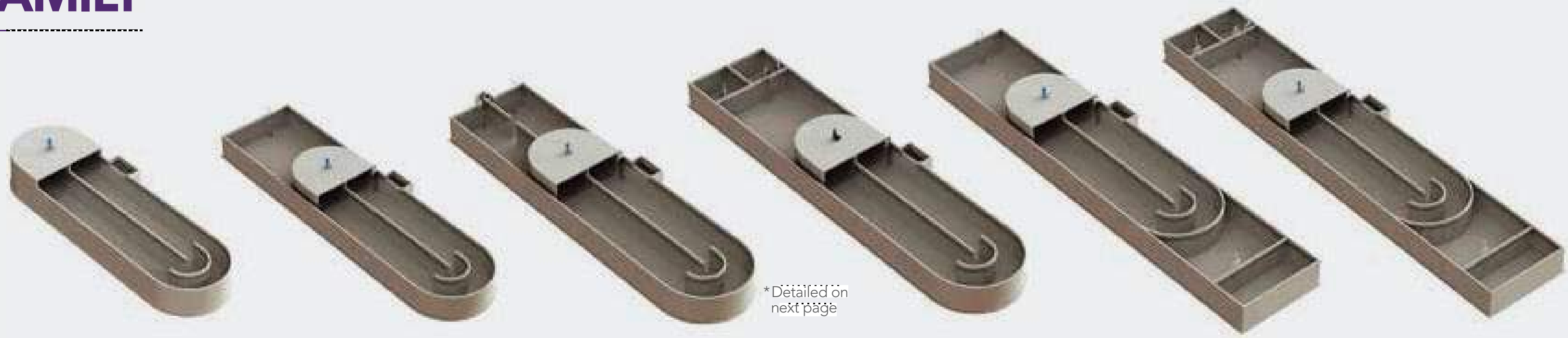




CARROUSEL® SYSTEMS

OVIVO | NUTRIENT REMOVAL

THE CARROUSEL® PROCESS FAMILY



	1-STAGE	2-STAGE	2-STAGE	3-STAGE	4-STAGE	5-STAGE
	BASIC CARROUSEL® SYSTEM	denit*IR*® CARROUSEL® SYSTEM	Alternat*IR*™ SYSTEM	A^{2}C™ SYSTEM	BARDENPHO® CARROUSEL® SYSTEM	BARDENPHO® CARROUSEL® SYSTEM
ANAEROBIC			✓	✓		✓
1ST ANOXIC		✓	✓	✓	✓	✓
AEROBIC	✓	✓	✓	✓	✓	✓
2ND ANOXIC					✓	✓
RE-AERATION					✓	✓
EFFLUENT (mg/L)	BOD≤5 NH3-N≤0.5	BOD≤5 NH3-N≤0.5 TN≤5-8	BOD≤5 NH3-N≤0.5 TN≤5-8 TP≤0.3*	BOD≤5 NH3-N≤0.5 TN≤5-8 TP≤0.3*	BOD≤5 NH3-N≤0.5 TN≤3	BOD≤5 NH3-N≤0.5 TN≤3 TP≤0.3*

*May require trim doses of metal salts

OVIVO: AN ENGINEERING PROCESS POWERHOUSE

The Ovivo Carrousel Process Team, which consists of decades of biological wastewater treatment plant design and innovation, has provided expertise and design assistance for wastewater treatment plants consisting of all shapes, sizes, and effluent permits.

CAPABILITIES:

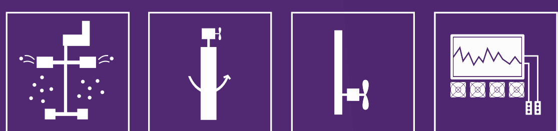
- Detail Design Support
- Process Calculations
- Equipment Sizing
- Process Guarantees
- Extended Warranties
- Retrofit Expertise
- Process Training
- Equipment Startup
- Ovivo Connect (Asset Management)

THE CARROUSEL® ALTERNAT*IR*™ SYSTEM

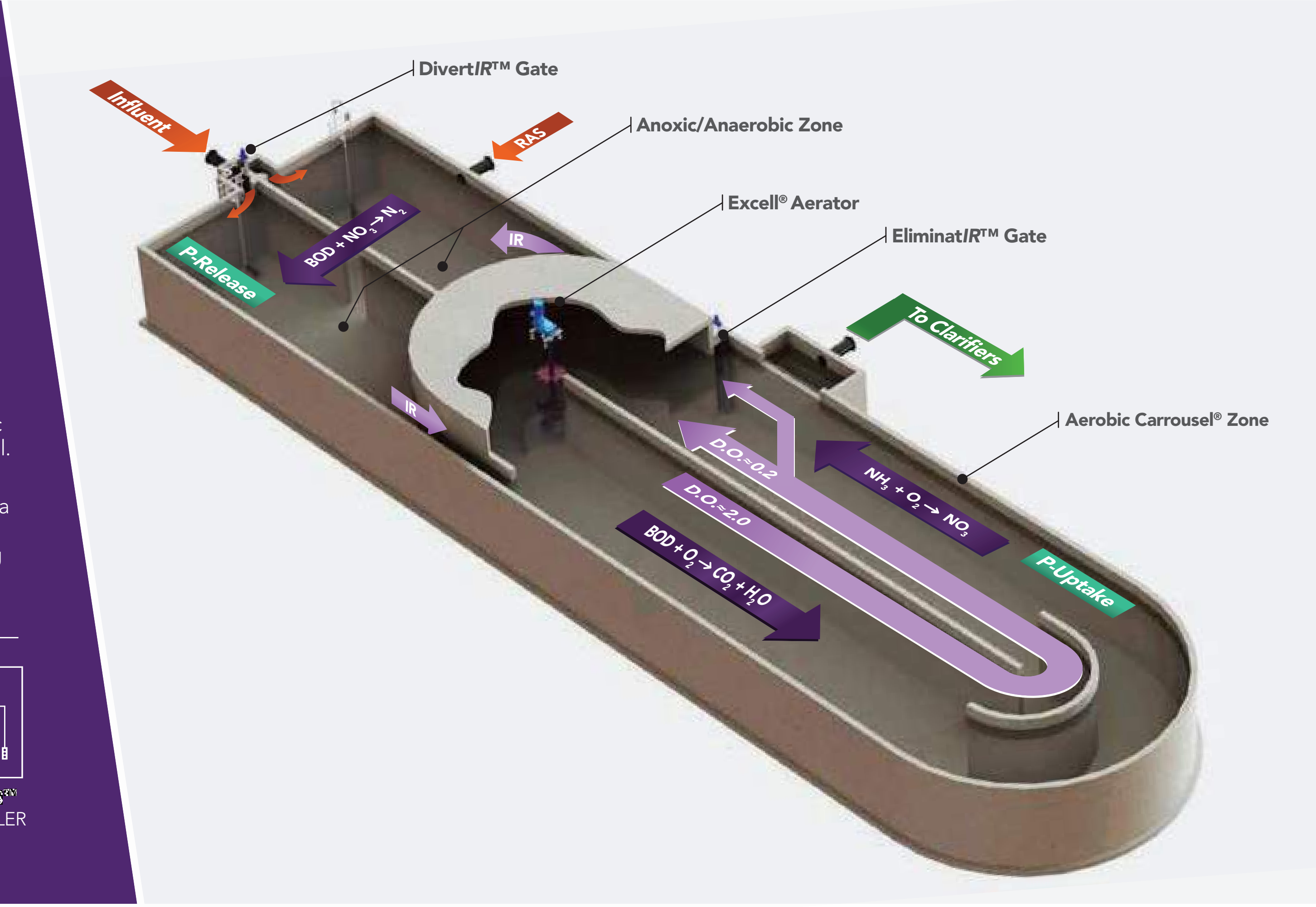
In the denit*IR*® Carrousel® System an integral anoxic basin is added for Total Nitrogen removal without supplemental carbon addition. The internal recycle (IR) is large (6-15Q) and requires no additional power, taking advantage of the propulsion generated by the Excell® Aerator.

The automatically controlled Eliminat*IR*™ Gate can be used to create anaerobic cycles in the anoxic zone in order to achieve phosphorus removal as well. This is called the Alternat*IR*™ System.

In the aerobic (Carrousel®) stage, BOD and ammonia oxidation (nitrification) proceed to completion. The Excell® Aerator provides all aeration and mixing required for the aerobic stage at all influent loading conditions.



EXCELL® AERATOR | ELIMINAT*IR*™ GATE | MIXING | OCULUS™ CONTROLLER



OVIVO:

A HISTORY OF EXCELLENCE

- **1979** — Installs 1st Carrousel® System in the USA
- **1983** — Installs 1st BNR System in the USA
- **1988** — Develops and installs 1st denitIR® Carrousel® System
- **1991** — Develops and installs 1st Dual-Impeller Aerator
- **1998** — Develops and installs 1st ACE™ Control System to conserve energy

EXCELL® AERATOR

- Efficiently provides all of the aeration and mixing required for the Carrousel Basin.
- 3.85 lb O2/HP-hr
- Power Turndown Up to 90%
- 1 man day of maintenance/year
- You Stay Clean! - No maintenance below the deck

OCULUS™ SYSTEM

- The Process "All Seeing Eye"
- User Friendly Interface
- Efficient Aeration Control
- Optimized Nutrient Removal
- Save Energy
- Reduce Chemical Dependency
- Remote Access

ELIMINATIR™ GATE

- Internal Recycle (IR) Control
- Automatically adjusts to maximize Denitrification
- IR rates between 0-12Q
- Anaerobic Cycling for Phosphorus Removal

2001 – Develops and installs 1st Deep Tank Carrousel® System: 23 ft-SWD

2006 – Installs 600th Carrousel® System in the USA

2007 – Introduces the Excell® Aerator II: Our most efficient Dual-Impeller Aerator for BNR Systems to date!

2009 – Introduces the EliminaIR™ Gate to maximize, optimize and automate BNR

2010 – Introduces the Oculus™ BNR Control System

2012 – Develops and installs the first Full BNR optimization Oculus™ MCC

2013 – Introduces Ovivo® Connect℠ Asset Management System

2014 – Introduces Carrousel® SwingIR™ System

CARROUSEL® SYSTEMS:

A FORWARD LOOKING APPROACH

A leading technology in wastewater treatment and biological nutrient removal, the Carrousel® system is universally praised for it's durability, operational simplicity, low operating and maintenance costs, and consistently high effluent quality.

Carrousel Systems offer the lowest number of aerators per basin compared to other oxidation ditch systems, such as those that use horizontal shaft aerators. This greatly simplifies installation and maintenance requirements.

At a minimum, a Carrousel System consists of a "racetrack" style reactor basin with at least one vertical shaft, low-speed mechanical aerator, the Excell® Aerator, installed in the center of one of the turns. The basic Carrousel System is capable of full BOD and Ammonia reduction. Nutrient removal is easily added to a Carrousel System via the addition of anoxic and anaerobic selector zones, or even with simple, optimized operational strategies.

The Carrousel System utilizes the Modified Lutzack-Ettinger (MLE) configuration for highly efficient denitrification. This process is known as the denitIR® System, where internal recycle (IR) flow is directed into the anoxic zone via a slip-stream channel using propulsion generated by the Excell Aerator. No additional energy for IR pumping is required. IR flowrate is varied by the EliminatIR™ Gate. The Oculus™ Control System automatically controls the aeration rate and IR flow.

Top: The Excell® Aerator is installed at one or more of the channel turns and provides all aeration and mixing required for full nitrification and BOD removal.

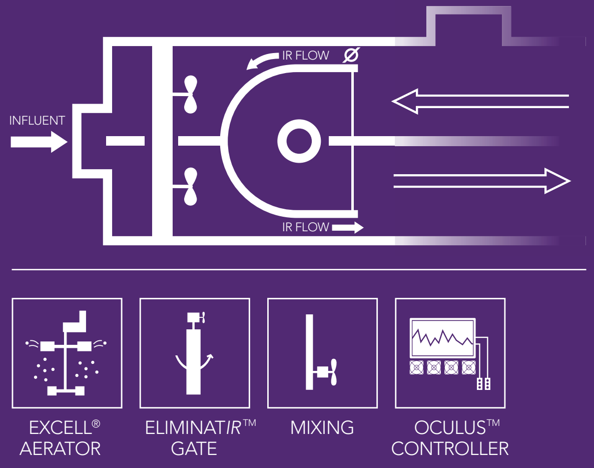
Bottom: Anoxic and anaerobic basins are easily added for Total Nitrogen and Total Phosphorus removal in Ovivo's denitIR® configuration.

ACTIVATED SLUDGE TREATMENT AND BIOLOGICAL NUTRIENT REMOVAL

35 YEARS OF CARROUSEL® SYSTEMS
1979 - present

Total Phosphorus ≤ 0.3 mg/L
Total Nitrogen ≤ 3 mg/L

- Virtually eliminates NO_3-N
- Dedicated environments maximize N and P removal
- Optimization eliminates or greatly reduces metal salt addition
- No IR pumps required
- No supplemental carbon required
- Full nitrification to NH_3-N < 0.5 mg/L in all U.S. climates



RETROFITS:

OVIVO OFFERS COMPETITIVE TURNKEY AND TRADITIONAL UPGRADE AND RETROFIT PATHWAYS FOR YOUR EXISTING SYSTEMS, EVEN IF YOU DON'T ALREADY HAVE A CARROUSEL SYSTEM.

Upgrading your existing Carrousel System has never been easier or more worthwhile. Improve your efficiency, reduce your maintenance, or automate your process.

Ovivo provides estimates for services and return on investment with a custom-made appraisal of your existing infrastructure.

You won't be disappointed you called.

ovivo® connect℠

Ovivo® Connect℠ portal is an innovative and intuitive application that allows our customers to use 'SmartTags' installed on our equipment (or a web URL) to access a personalized customer zone. Access your equipment documentation, find contract references, track service logs, manage spare parts, and plan your next maintenance to get the most out of your equipment.

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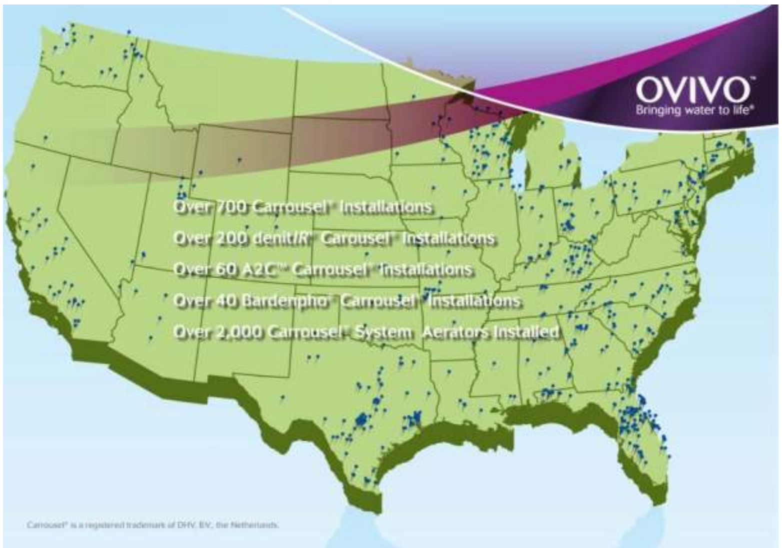
Bringing water to life

Ovivo Carrousel® Systems

Ovivo (formerly Eimco Water Technologies) has been providing Carrousel Systems since 1979. With over 700 installations, we have continuously improved the technology over the last 35 years.



We have many plants now achieving a Total Nitrogen of less than 2 mg/L and a Total Phosphorus of less than 0.2 mg/L. No supplemental carbon is ever required, and usually only sporadic trim doses of alum are required.

We have also greatly improved energy efficiency and power turndown capability with our latest aeration equipment designs.

The Oculus control System keeps a tight rein on dissolved oxygen, ORP, nitrate, and ammonia, with several operational strategies available.

Ovivo Carrousel Systems stand out in the industry due to our long history of investment, innovation and improvement

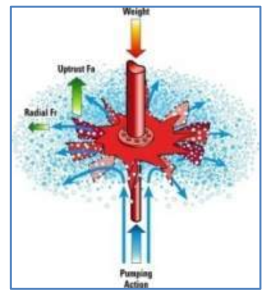
In the attached pages, we have presented several of the latest improvements available for Carrousel Systems that are included in our proposal.

Feel free to contact our Salt Lake City office at (801) 931 – 3000 and ask for anyone on the Carrousel Team.

The Excell®Aerator

Aeration and Propulsion

The Excell®Aerator, located at one or more of the channel turns in the Carrousel® Basin, uses the most efficient aerating surface impeller available. The clean water oxygen transfer efficiency is 3.8 lb O_2/ HP-hr. DHV, B.V., the inventor of Carrousel Systems and the singular authority for testing and certifying Carrousel® aerators has approved the Excell®Aerator.



The 10-bladed surface impeller acts as a pump, efficiently maintaining propulsion throughout the channel zones. The unique star plate design with integrated blades acts as a stabilizer, reducing Fa and Fr loads to the mechanical gear reducer that drives the unit, lengthening the service life of the reducer.

The lower turbine is driven by the same mechanical equipment that drives the surface impeller and requires no additional bearings. The lower turbine with the velocity enhancement baffle increases floor scouring velocity, particularly important during periods of low loading (e.g., at night, when actual influent loading is less than design). The lower turbine is connected to the surface impeller by 6 bolts. Many facilities appreciate the ease of basin draining after adding the lower turbine as solids are kept in suspension during draining.

Power Turndown

Excell®Aerator at 30Hz
(20% power; 80% turndown)

Excell®Aerator at 60Hz
(100% power; 0% turndown)

Power turndown is critical for proper operation of biological nutrient removal facilities and for cost efficiency. A properly designed Carrousel System equipped with the Excell®Aerator allows for power turndown of 80-90% *without* mixing limitations!

Successful Installations

Ovivo has recently installed ExcellAerator retrofits at Ocala, FL; Greenwood Lakes, FL; Baraboo, WI; Flagler Beach, FL; Pearsall, TX; Apopka, FL and over 100 other facilities. Each of these facilities had different reasons for choosing our dual impeller unit – better power turndown, enhanced nutrient removal, easier basin draining operations, energy savings.

OVIVO
Bringing water to life

The Eliminat*IR*™ Gate

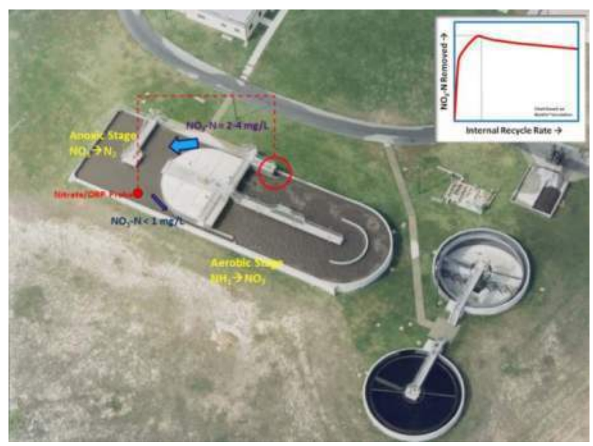
Easy Control With No Pumps

Placed at the entry to the internal recycle (IR) channel, the Eliminat***IR*** gate replaces expensive IR pumps and older manual gates. Either the center pivot or the end pivot (common for manual IR gates currently installed) designs are available.

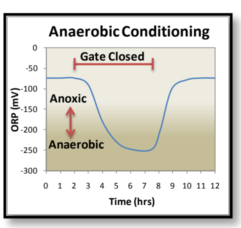
The flow through the IR channel is controlled with an electric actuator that either restricts or increases the flow through the IR channel. This is typically automated based on measured conditions in the anoxic basin (e.g., ORP, nitrate) using the Ovivo Oculus™ Control System.

The Eliminat***IR*** gate provides real time enhanced control of nitrate reduction in your facility.

Real Time Automation



The Eliminat***IR*** gate works with our Oculus control System to optimize Total Nitrogen removal. By preventing 'washout' or excessive DO from entering the anoxic zone, effluent nitrogen can be lowered by several parts per million.



Our system can also convert your existing anoxic zone into a fermentation zone by strategically closing the gate throughout the day for Total Phosphorus removal.

Successful Installations

The Eliminat***IR*** Gate can be retrofitted using existing IR gates as it was at Ocala, FL. The Eliminat***IR*** gate was added at Mt Holly Springs, NJ to provide phosphorus removal without the need to build additional fermentation basins, and at Zions Crossroads, VA; Edgewater, FL; and Spring Hill, TN in a Bardenpho® configuration.

OVIVO
Bringing water to life

The Energy Optimizer

Optimizing Impeller Submergence and Speed

For many years, surface aeration control was accomplished by raising and lowering the effluent weir to control impeller submergence. The lower the weir, the lower the submergence, and corresponding less HP was pulled by the motor and less oxygen was imparted to the water. Conversely, raising the weir increased HP and oxygen delivery. While this method was impractical in responding to diurnal variations in oxygen demand, it did allow for some operational adjustments.

Today, changing oxygen delivery is largely accomplished by variable frequency drives (VFDs). VFDs adjust the motor speed, and thus the impeller rotational speed, adjusting HP draw and oxygen delivery. This is an important component of Carrousel systems, as VFDs can allow for power turndown of 90%. With the dual impeller ExcellAerator, mixing remains sufficient at these large power turndowns, which are often required for start-up and nighttime flows in nutrient removal plants where overaeration means failure.

Ovivo now offers a system that automatically adjusts both the weir and the aerator speed, the Energy Optimizer. By adjusting both, the Energy Optimizer finds the most optimum energy usage for delivering oxygen to the wastewater, while maintaining dissolved oxygen setpoints. Not all HP is created equal: an aerator drawing 50 HP, for example, at low submergence/high speed may deliver more oxygen than the same aerator drawing 50 HP at high submergence/low speed. The Energy Optimizer continuously tracks kW usage with respect to influent loading, and optimizes submergence and speed to its most efficient point. The result is excellent treatment at the lowest possible energy costs.

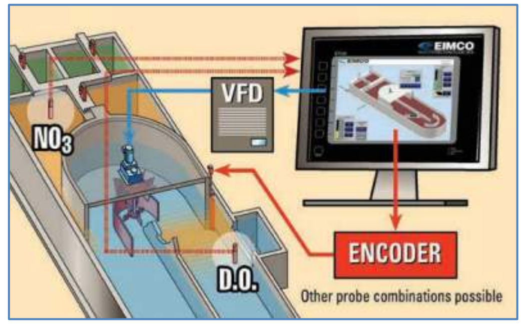
Successful Installations

The Energy Optimizer has been installed in Spring Hill, TN and Mt Holly Springs, PA with several others under construction.

The Oculus™ System

Your Carrousel SCADA

The Oculus System is the "all-seeing eye" that maximizes nutrient removal, minimizes power costs, and monitors selected process variables and equipment. The Oculus System analyzes and reports signals from a combination of dissolved oxygen (DO), oxidation-reduction-potential (ORP), ammonia (NH4-N) and nitrate (NO3-N) probes to control the Excell® Aerator power input and the EliminatIR™ gate and effluent weir position in the Carrousel® System. The probes provided are site-specific.



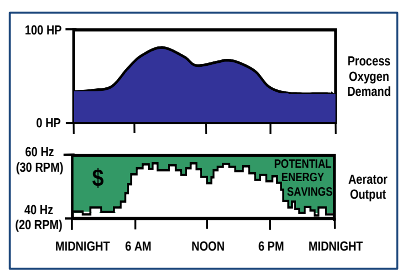
The operator can access all control functions, setpoints, and trendcharting from a custom, touch-screen interface. Each Oculus System can be equipped with a modem for on-line monitoring and quick access to our industry-leading and free process support team. The system is now available on tablets and smartphones.

Optimizes Nutrient Removal

Two key requirements for optimizing nutrient removal are, (1) providing adequate nitrate delivery to the anoxic zone and (2) protecting all anoxic and anaerobic tanks from excessive D.O. Through the use of ORP or nitrate monitoring, the Oculus System efficiently meets the first requirement by regularly adjusting the position of the EliminatIR gate. This allows for control of nitrate delivery from the aerobic zone to the anoxic zone in response to diurnal fluctuations as well as nitrate loading from other sources, such as return activated sludge (RAS) and digester decants. This is especially critical for P removal plants, which must prevent both continuous and slug loads of nitrate from entering anaerobic zones.

Minimizes Power Costs

Minimizing the aeration energy required in the activated sludge process is the most effective way to reduce power costs in a wastewater treatment plant. Using proper D.O. and effluent weir set points determined from Ovivo's extensive experience with Carrousel® nutrient removal plants, the Oculus System balances the need to minimize power consumption with the paramount need for adequate aeration capacity. Ammonia probes may also be added for continuous feedback of nitrification performance.



Successful Installations

Some of the sites where Ovivo has provided the Oculus System are Ocala, FL; Spring Hill, TN; Zion's Crossroads, VA; Mt Holly Springs, PA; Inverness, FL, and Edgewater, FL. References and site visits are available.

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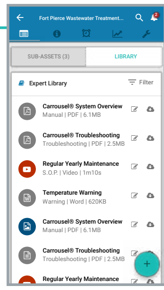
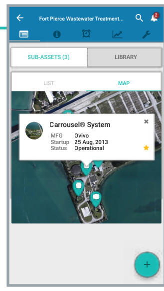


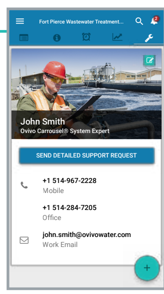
YOUR PLANT, MAPPED OUT

Never confuse your in-stalls again. Zoom in and select the right equipment on a customizable satel-lite map of your plant.



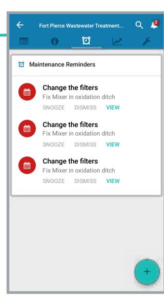
EXPERT SUPPORT IS JUST A TAP AWAY

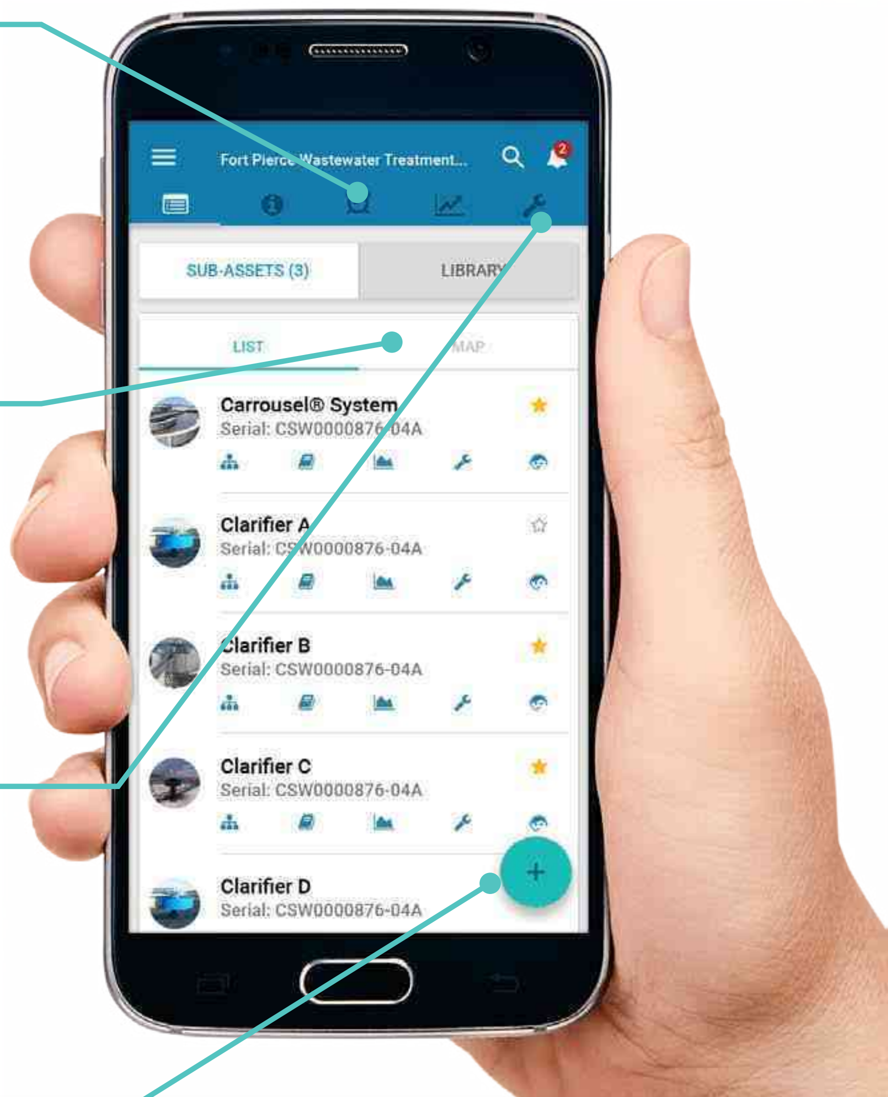
Send detailed support requests with pictures and video from your phone at any time.

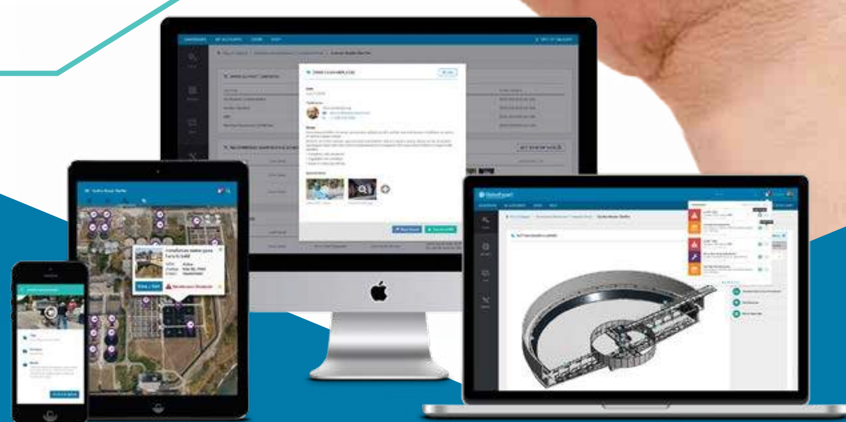


CREATE SERVICE REMINDERS & LOGS

Set your own maintenance reminders for your team to review and create ser-vice logs once completed







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Salt Lake City, Utah
84123
USA

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OVIVO Worldwide Experts in Water Treatment

To: Brad Leidecker – CHC

From: Tyson Beaman, Product Manager Sedimentation Group

Phone: 801-931-3241 Email: tyson.beaman@ovivowater.com

Date: 6/18/18

Subject: Arcata, CA -- Two (2) 75ft Diameter Spiral Bladed Secondary Clarifiers - Budget Price.

Brad,

I have prepared budget pricing for the adding new secondary clarifiers for the Arcata, CA plant. The budget pricing is based on the following parameters:

Number of Clarifiers	2 (NEW)
Clarifier Diameter:	75 ft
SWD:	14 ft
Freeboard:	2 ft
Clarifier Types:	C4D (Spiral Blade Clarifier)
Slope:	1:12

The preliminary budget pricing is as follows:

Base Price = Two (2) 75 ft Type C4D clarifier (Carbon Steel W/ Prime Paint)	$329,000
Optional add: Full Trough Skimming in lieu of the Conventional Skimming System (2 units)	$7,000
Optional add: FRP Weirs and Baffles (2 units)	$24,000
Optional add: FRP Density Current Baffles (2 units)	$37,000
Optional add: NEMA 4X Control Panel (2 units)	$21,400

Prices for mild steel mechanisms include surface preparation and one (1) manufactures standard prime coat. Finish coat not included in base price.

See Table 1 for the scope of supply for this option.

Let me know if you need any additional information.

Sincerely,

Tyson Beaman PE
Product Manager
Sedimentation Group
(801) 931-3241 (Direct)

TABLE 1

Arcata, CA WWTP
(2) 75’ diameter Secondary Clarifiers type C4D
COLUMN SUPPORTED UNITS

This budget price includes per clarifier:

- Construction materials shall be Carbon Steel unless noted otherwise.
- C40HT Clarifier Drive.
- 3ft wide steel beam supported walkway extending from the tank wall to the center operating platform decked with I-Bar grating.
- 8ft square drive platform decked with I-Bar grating.
- Aluminum 2-rail handrail around platform and walkway.
- Influent column, 24” diameter x 1/4” thick.
- Feedwell, 18ft diameter x 5’-0” submerged depth.
- Energy dissipating inlet well, 7ft diameter x 2’-7” submerged depth.
- Center cage,
- Two full radius rake arms with a tapering spiral blade on each arm.
- One sludge collection manifold
- Surface scum skimming equipment with one (1) 4ft wide scum trough and two (2) skimming mechanisms. **See Optional Adder for Full Trough Skimming**.
- Anchor bolts, 304 stainless steel.
- Assembly fasteners, 304 stainless steel.
- Drive finish painted per manufacturer standard painting scheme.
- Mechanism manufacturer prime painted only.
- Freight FCA jobsite.
- Services 3d/3t total
- O&M manuals

Items not included in the budget pricing:

- Full Trough Skimming in lieu of Conventional Skimming (Unless purchased by optional adder)
- Effluent weir plates and scum baffle (Unless purchased by optional adder)
- Density current baffles. (Unless purchased by optional adder)
- Control panel. (Unless purchased by optional adder)
- Launder covers.
- Stairways
- Spray Systems
- Demolition or installation.
- Tank or tank modifications.
- Unloading.
- Field welding.
- Finish painting.
- Lamp posts.
- VFD controller.
- Lubricants.
- Electrical controls.
- Handrail around tank.

Spiral Scraper Clarifier

Key features & benefits

- Special design developed for faster sludge removal
- Best performance on 1:12 floor slope
- Better control of sludge blanket

How we create value

- Low maintenance requirements
- Trouble-free installation
- Long lasting durable design

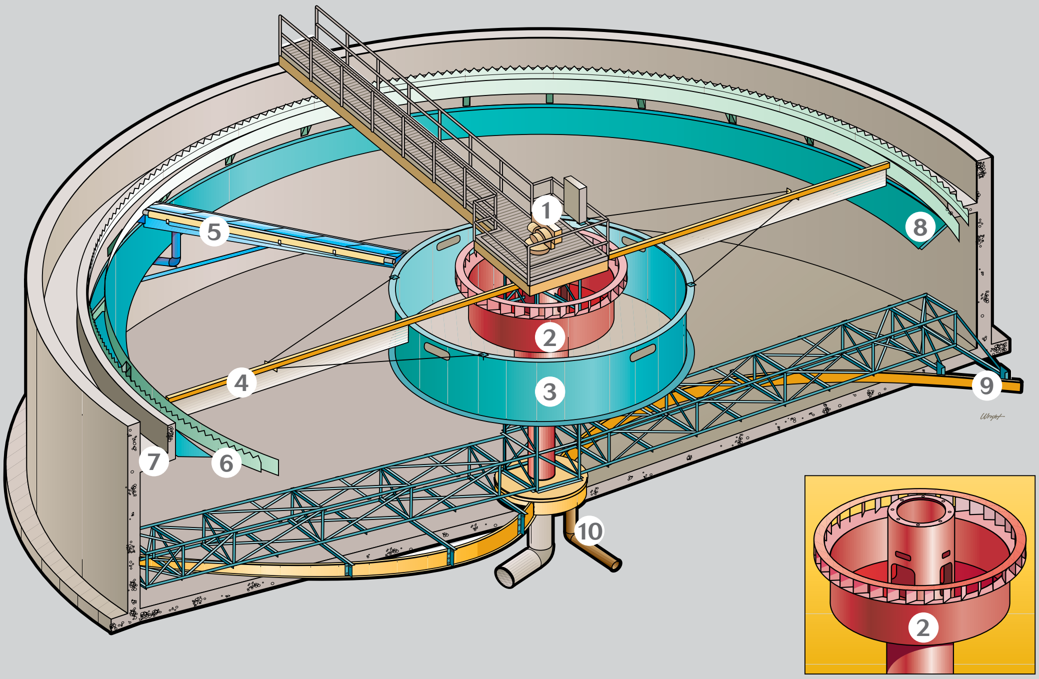
Spiral Scraper Clarifier

Features

Ovivo's Spiral Scraper Clarifier (C4-FTS) offers rapid sludge removal with spiral blades and a rotating sludge collection drum. The Spiral Scraper Clarifier offers full radius skimming and an enhanced energy dissipation well: the EquaFlo 360™.

Our clarifier design includes the most common components of the scraper clarifier as well as competitive innovations such as the EquaFlo 360™ EDI (Energy Dissipating Inlet) or the rotating sludge collection drum.

1. Drive
2. EquaFlo 360™
3. Flocculation feedwell
4. Full radius surface skimming
5. Full radius trough skimmer with radial ramp
6. Effluent weir and baffle
7. Inboard effluent launder
8. Density Current Baffle
9. Spiral rake blade
10. Rotating sludge collection drum



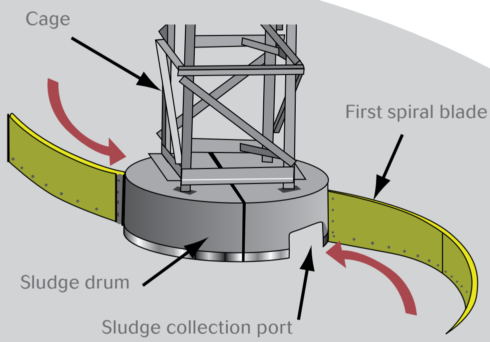
Spiral Blades and Sludge Collection Drum

The Spiral Blade Clarifier features a spiral blade design coupled to a rotating sludge collection drum. The blades are constructed to a logarithmic spiral curve with a constant 30 degree angle of attack. They are supported by two sludge removal arms of steel truss construction. Blades are equipped with adjustable 20 gauge 304 stainless steel squeegees for a better resistance to abrasion. Blade depth varies with the clarifier size and the bottom slope; the best raking performance is achieved with 1:12 floor slope.

The mechanism is designed for rapid sludge removal. Ovivo can provide an optional variable frequency drive for the adjustment of the raking speed and a better control of the sludge blanket.

The sludge drum is a circular manifold attached to the bottom end of the center cage. It is sealed around the center column and to the tank floor. The drum rotates with the cage and turns above the openings of the RAS (Returned Activated Sludge) pipe. The drum has one opening located in front of each rake blade, 180 degrees apart.

The sludge drum removes highly concentrated sludge that is brought by the spiral blades to the center of the tank. Shipped to the site in just two pieces, the sludge drum is easy to handle and install. The drum does not clog and requires little maintenance.



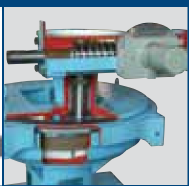
Rotating sludge drum is especially designed to remove concentrated sludge brought by the spiral blades to center of the tank

Drive Units

Ovivo provides strong, highly reliable drive mechanisms. The strength of our drives is due to their design, the materials used, full oil bath lubrication and the proper alignment of their components.

Drive

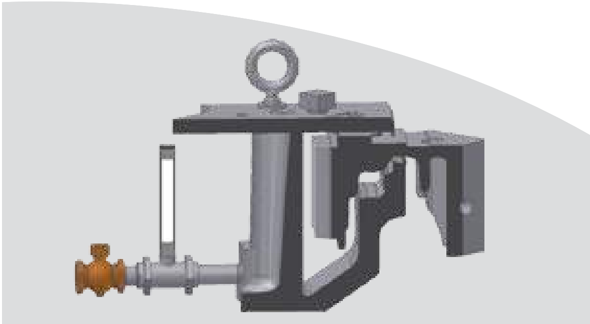
- Cast iron housing
- Oil lubrication
- Deep oil reservoir
- Strip liner bearings
- Worm gear reducer
- Single pinion
- Solid one piece main gear
- Meets latest AGMA standards



Cast Iron

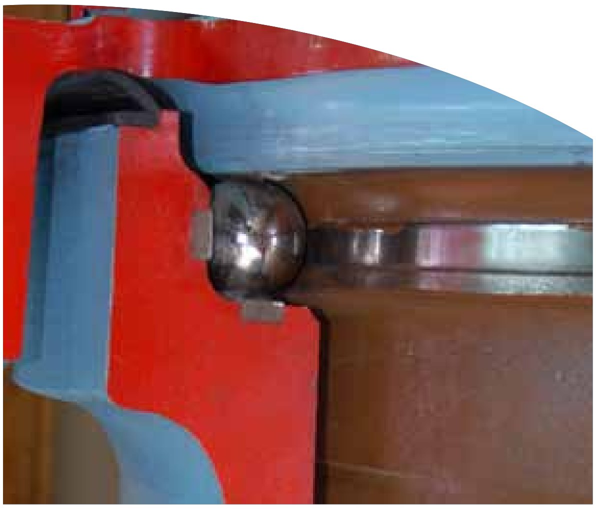
Our drives are built in cast iron per ASTM A48 Class 40A. Cast iron offers:

- Excellent corrosion protection. Cast iron has a natural resistance to corrosion and will not rust
- Resistance to heavy loads. Complex cross sections with a high degree of structural rigidity are more precisely formed than fabricated plates. Sections are easily varied to provide massive support in high load areas.
- Full inner and outer walls form a deep 'U' cross section, offering exceptional rigidity and an ample oil reservoir.
- Extra bulk under the main bearing, pinion bearing and intermediate reducer mounting surfaces ensures proper alignment under peak loads.



Oil Lubrication

Ovivo drive design includes a deep oil reservoir with full side wall. This design offers many advantages. The full sidewall avoids the possibility of oil leaking and provides good weather protection for the gear. The deep oil reservoir minimizes heat buildup, provides an area for condensate to accumulate well away from the main gear and bearings and allows complete immersion in the lubricant. The drain is located away from the main pinion gear at the lowest point to allow extraction of contaminants.



Strip Liner Bearings

Ovivo drives use strip liner bearings and the largest chrome alloy bearing balls on the market. The strip liners are specially designed for wastewater treatment applications. These high quality strips are manufactured in AISI E4140, vacuum degassed and carbon deoxidized steel and offer high strength (43-46 Rc hardness).

Quality Components

EWT drives are equipped with bearings, worms and pinion mounted on a precisely machined surface. In every drive a high quality solid pinion maintains alignment and gives better resistance to bending and deflection under loads. Mating parts are machined to precise tolerances to assure precise fit and alignment. Every drive part is fully restrained (top and bottom) with no overhung loads. Main bearings are fully restrained into base.

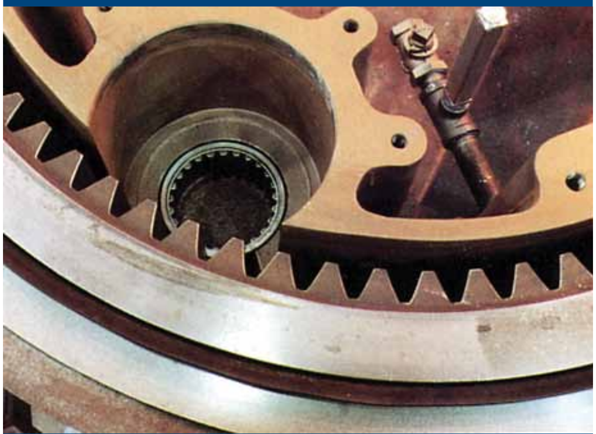
AGMA Standards

Worm gear reducer, single solid pinion, single solid worm / worm shaft and main gear all meet the latest AGMA (American Gear Manufacturers' Association) standards.

Drive Control

Each drive is equipped with an overload control device activated by thrust from the worm shaft. This drive control includes a clear plastic enclosure and a weatherproof enclosure of epoxy coated aluminum construction with electro-mechanical switches.

Drive Components Material	
Main gear housing	Cast iron ASTM A48
Worm gear housing	Cast iron ASTM A48
Main gear	Ductile iron ASTM-A536 class 100-70-03
Worm gear	Cast alloy bronze
Worm	Alloy Steel AISI 4140/42H
Pinion	Alloy steel 4150 (26-33 Rc)
Strip liners	Steel AISI E4140
Bearing ball	Chrome alloy steel
Control enclosure	Cast aluminium



EquaFlo 360™ Energy Dispersing Inlet

The EquaFlo 360 Energy Dissipating Inlet (EDI) for clarifiers differs substantially from conventional practice by using the entire EDI circumference to discharge flow rather than just a few openings in the EDI shell. The quiescent tangential flow that results provides a uniform velocity profile and promotes flocculation within the feedwell.

EDIs: uses
The influent discharges from the center column at relatively high energy levels must be dissipated to reduce the influent velocity in feedwell and provide a uniform distribution in the clarification zone.

Existing EDIs
Scoop design, baffled design or TEE outlets design dissipate energy but produce flow streams. Flow streams cause turbulences and preferential jets in the feedwell resulting in reduced clarifier performance. These designs are also associated with deep feedwells to reduce the possibility of short circuiting under the feedwell.

The EquaFlo 360™
With its extended inner rim and evenly spaced tangentially oriented vanes along the entire 360 degrees of the EDI circumference and, the new EquaFlo 360 offers the following advantages:

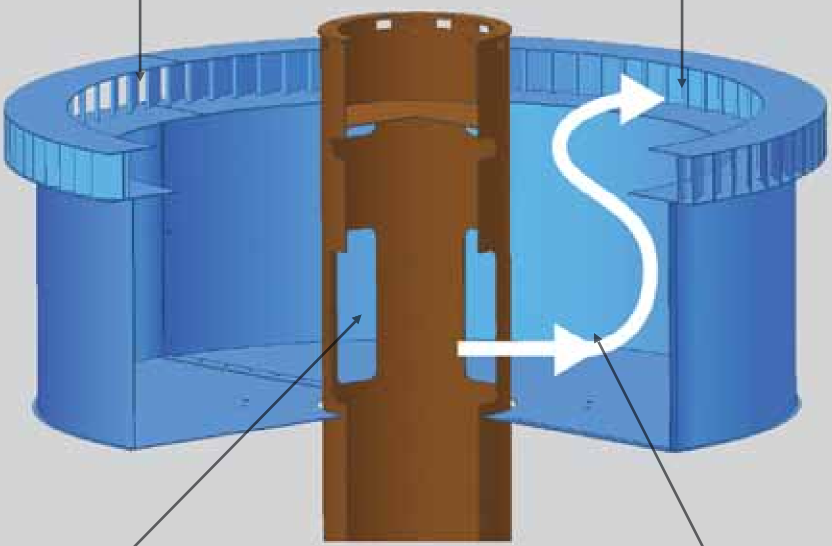
- Eliminates the distributing effects of the discrete flow streams jetting into the feedwell from the EDI
- Produces uniform flow into the feedwell around its full 360 degree circumference
- Achieves a controlled tangential flow velocity which promotes flocculation in the feedwell
- Minimizes the depth of the inlet discharge into the feedwell so the feedwell can have a minimum depth in the clarifier to avoid scouring of the sludge blanket on the clarifier floor
- Creates a tapered velocity profile for the flow that enters the clarification zone
- Increases the active clarification volume and retention efficiency of the clarifier through the use of a tangential discharge from the feedwell.

Features & benefits

- Discharge on full 360
- Evenly spaced tangentially orientated vanes
- Extended inner rim
- Double set of influent ports on influent column
- No stream jetting
- Enhanced flocculation
- Shallower feedwell
- No sludge scouring

The EquaFlo 360™ EDI discharge is ringed with evenly spaced tangentially orientated vanes along the entire 360 degree of the EDI circumference

The lower rim of the vane support ring extends back towards the column, forming a lip that provides additional flow baffling and energy dispersion



The influent column discharge ports are set below the EDI vanes, providing immediate containment and baffling of the influent via the EDI floor and cylindrical shell

Flow leaving the column ports encounters the EDI wall, then must travel around the lower support ring prior to quiescently discharging into the feedwell trough tangentially orientated vanes

Full Trough Skimmer (FTS)

Key features & benefits

- Heavy duty skimmer arms
- Increased removal rate decreases odor
- Prevents surface scum carry-over into effluent stream
- Effective removal of heavy surface scum loads in one pass
- Can be retrofitted into existing bridge and column mounted clarifiers and thickeners
- Flush valve assembly mounted at the feedwell end automatically rinses out the scum trough
- Heavy duty skimmer arms do not have pivots, hinges or springs that wear out and break
- Can be customized to fit any manufacturer's mechanism
- Eliminates the need to direct scum to the tank periphery with a hose or spray system
- Radial design enables the full length of the skimmer wiper to make simultaneous and continuous contact with the entire ramp at each revolution of the skimmer arm

The Full Trough Skimmer (FTS) mechanism is a performance enhancing skimming design that has been effectively proven and retrofitted into many existing clarifiers. This mechanism covers the entire annular space between feedwell and scum baffles and can eliminate scum quickly and effectively, at a rate faster that that of the standard scum box and skimmer design. This innovative design incorporates a radial approach ramp and an automatic flush valve. The (FTS) is an effective device that will enhance the overall performance of any clarifier of 110′ in diameter or smaller.

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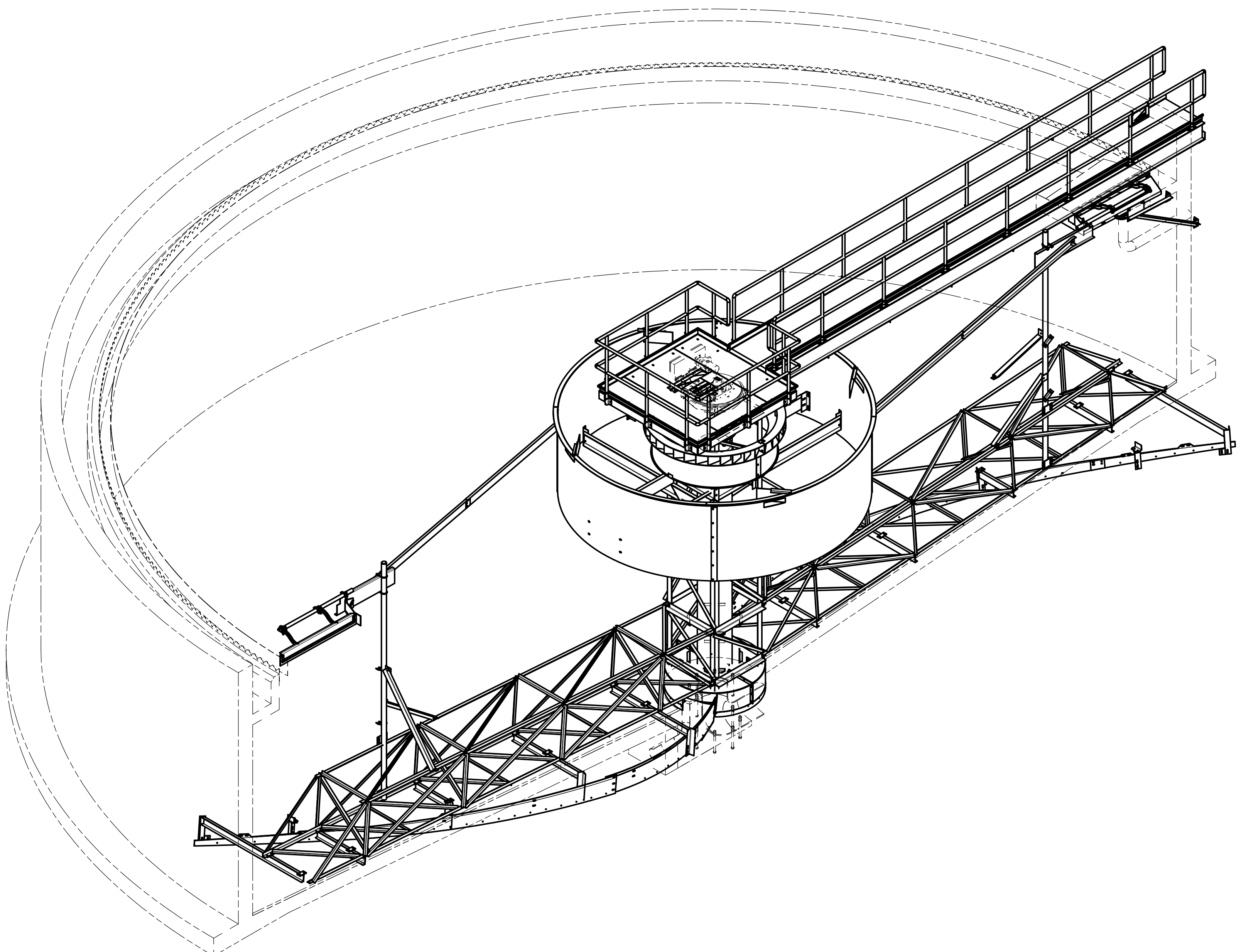
WORLDWIDE EXPERTS IN WATER TREATMENT

75'-0" DIA. C4



INITIAL RELEASE					A	
REVISION DESCRIPTION	EN/ECO	BY	CHECK'D	DATE	REV	

D

THIRD ANGLE PROJECTION

REF. FROM	CSW1045-201	DO NOT SCALE PRINTS
DATE (mm/dd/yyyy)	1/24/2017	WORKMANSHIP STANDARD ES0001 APPLIES
DRAWN	TJG	ORIGINAL S.O.
CHECK'D		SALES ASSIST

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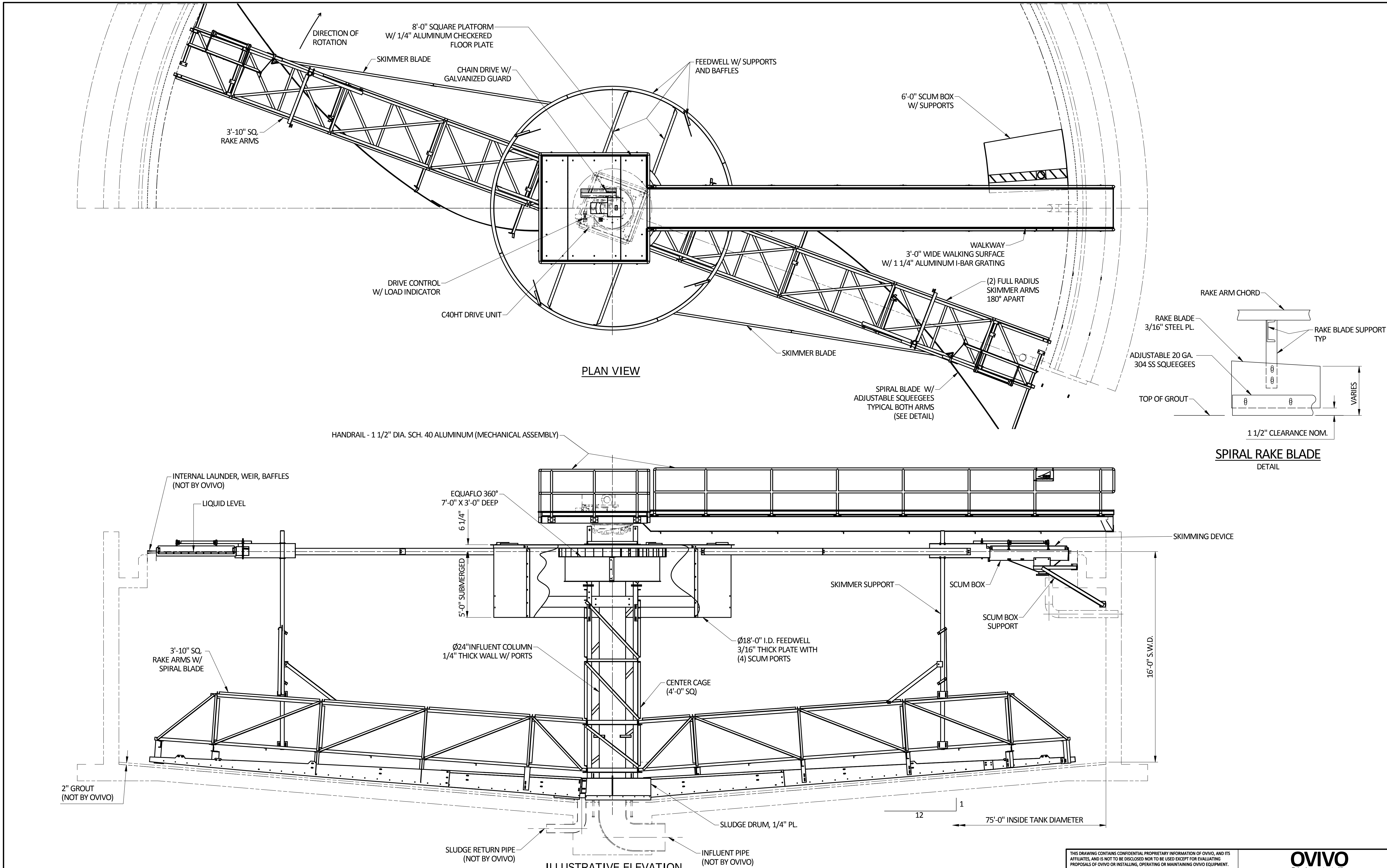
GENERAL ARRANGEMENT
75'-0" DIA. C4
W/ EQUAFLO EDI

DWG. NO.	SHEET	REV
SALES ASSIST	1 OF 2	A



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D		DO NOT SCALE PRINTS	DWG. NO.	SALES ASSIST	SHEET 2 OF 2	REV A
©COPYRIGHT 2010 BY GLV ALL RIGHTS RESERVED - REV E		WORKMANSHIP STANDARD ES0001 APPLIES				

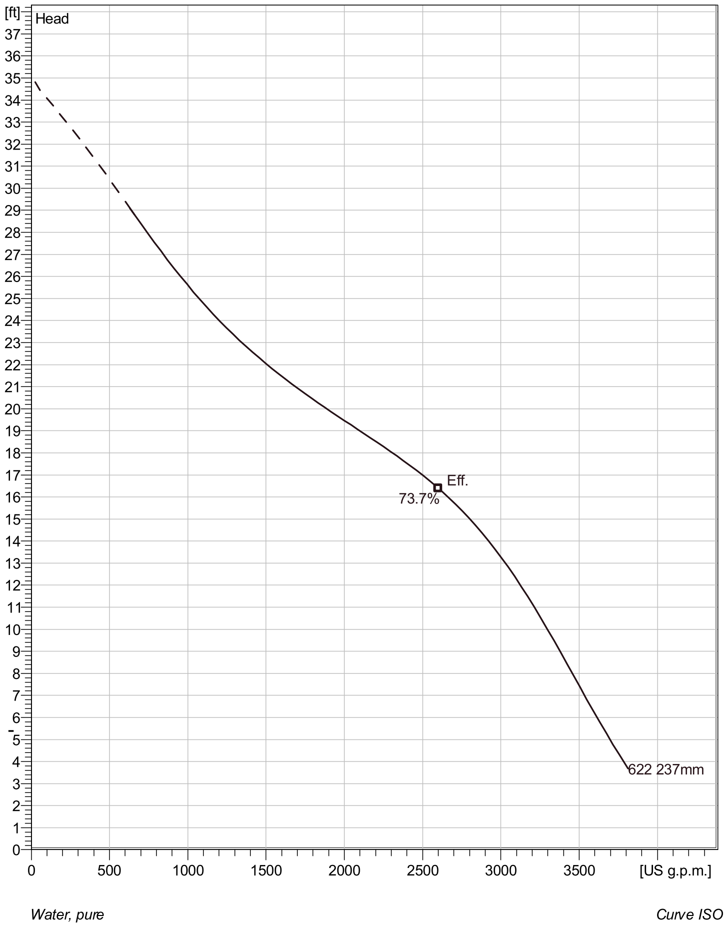
FLYGT INFLUENT PUMP QUOTE

xylem

NP 3153 LT 3~ 622

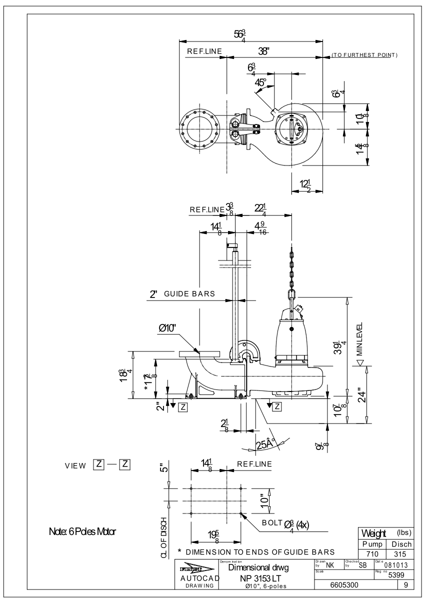
Technical specification

FLYGT



Note: Picture might not correspond to the current configuration.

Installation: P - Semi permanent, Wet



General

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

Impeller material	Hard-Iron
Discharge Flange Diameter	9 13/16 inch
Suction Flange Diameter	9 13/16 inch
Impeller diameter	237 mm
Number of blades	3

Motor

Motor #	N3153.095 21-18-6AA-W 15hp FM
Stator variant	5
Frequency	60 Hz
Rated voltage	460 V
Number of poles	6
Phases	3~
Rated power	15 hp
Rated current	22 A
Starting current	101 A
Rated speed	1155 rpm
Power factor	
1/1 Load	0.73
3/4 Load	0.67
1/2 Load	0.55
Motor efficiency	
1/1 Load	87.0 %
3/4 Load	88.0 %
1/2 Load	87.5 %

Configuration

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3153 LT 3~ 622

Performance curve

Pump

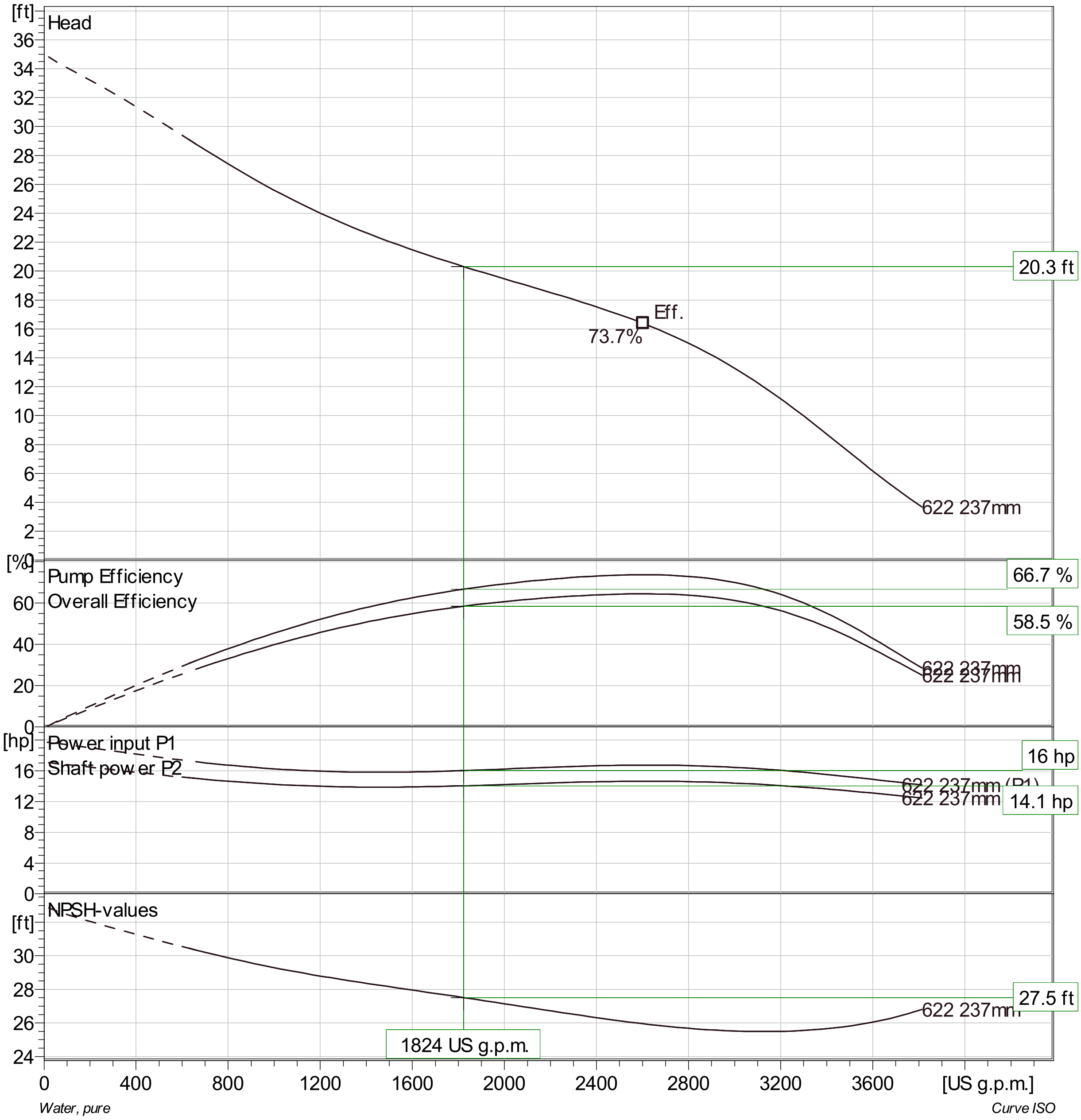
Discharge Flange Diameter	9 13/16 inch
Suction Flange Diameter	250 mm
Impeller diameter	9 5/16"
Number of blades	3

Motor

Motor #	N3153.095 21-18-6AA-W 15hp
Stator variant	5
Frequency	60 Hz
Rated voltage	460 V
Number of poles	6
Phases	3~
Rated power	15 hp
Rated current	22 A
Starting current	101 A
Rated speed	1155 rpm

Power factor	
1/1 Load	0.73
3/4 Load	0.67
1/2 Load	0.55

Motor efficiency	
1/1 Load	87.0 %
3/4 Load	88.0 %
1/2 Load	87.5 %

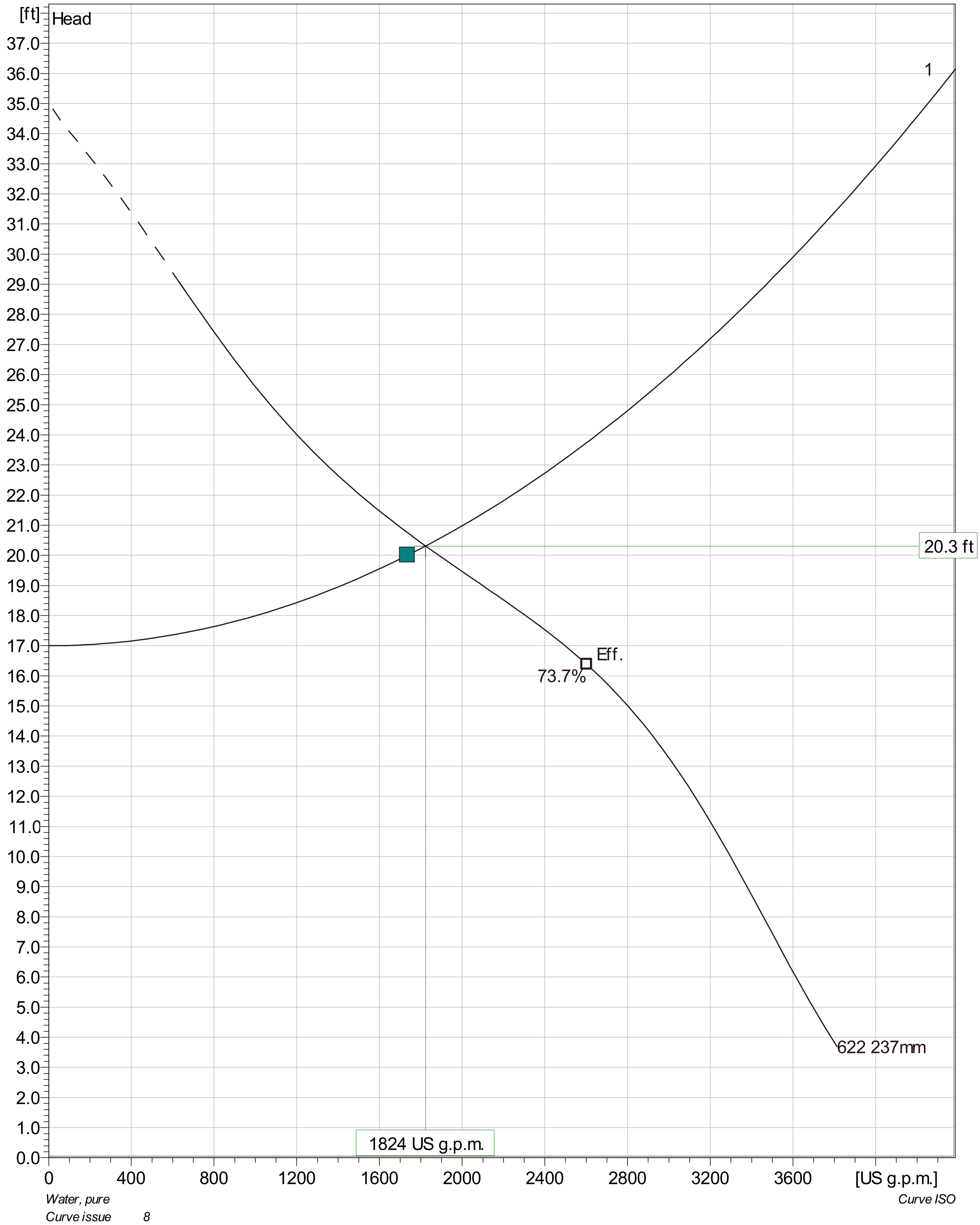


Duty point		Guarantee
Flow	**Head**	
1740 US g.p.m.	20 ft	No

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3153 LT 3~ 622

Duty Analysis

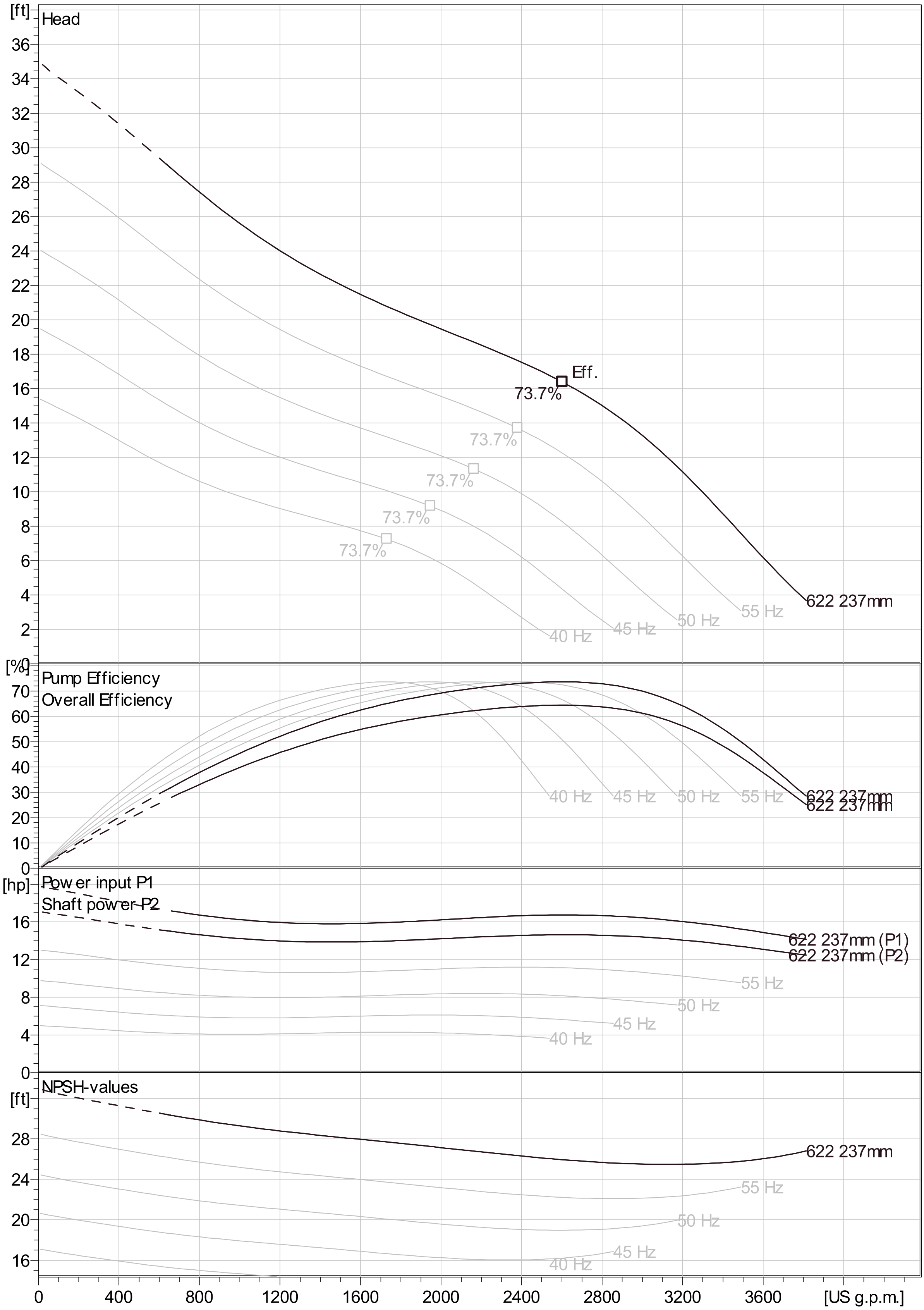


Pumps running /System	Individual pump Flow	Head	Shaft power	Total Flow	Head	Shaft power	Pump eff.	Specific energy	NPSHre
1	1820 US g.p.m.	20.3 ft	14.1 hp	1820 US g.p.m.	20.3 ft	14.1 hp	66.7 %	109 kWh/US MG	27.5 ft

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3153 LT 3~ 622

VFD Curve

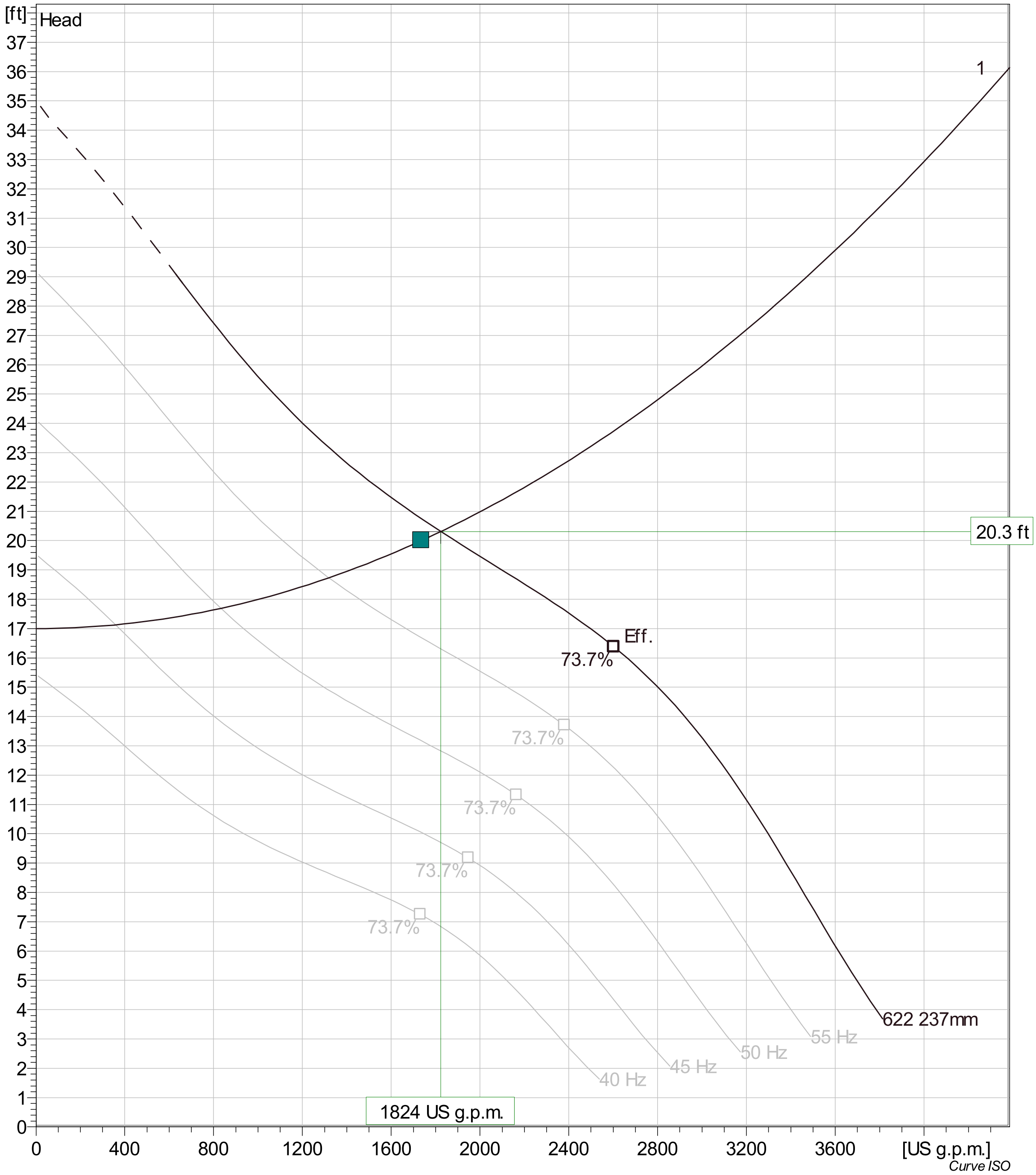


Curve ISO

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3153 LT 3~ 622

VFD Analysis

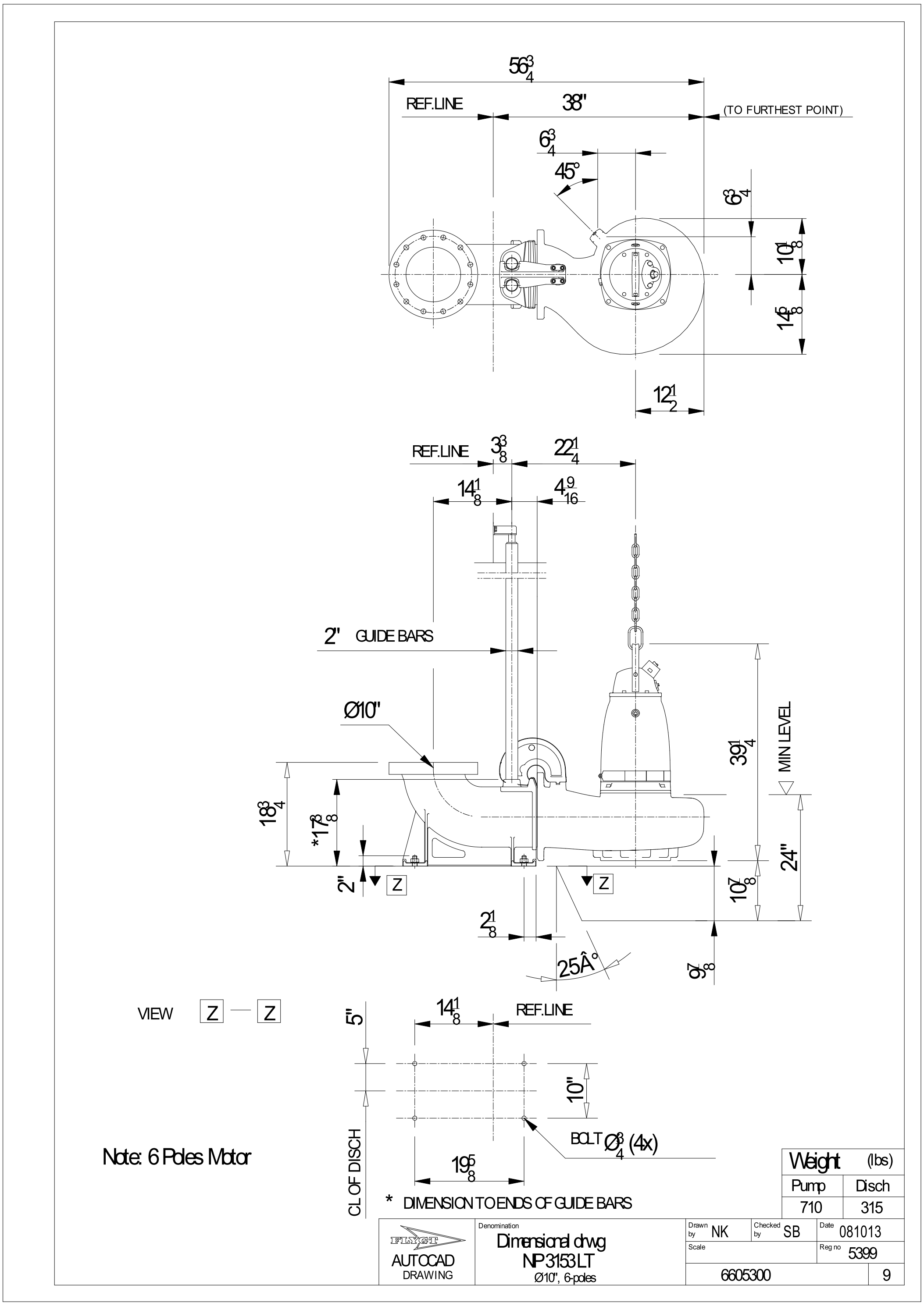


Pumps running /System	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	60 Hz	1820 US g.p.m.	20.3 ft	14.1 hp	1820 US g.p.m.	20.3 ft	14.1 hp	66.7 %	109 kWh/US MG	27.5 ft
1	55 Hz	1320 US g.p.m.	18.7 ft	10.6 hp	1320 US g.p.m.	18.7 ft	10.6 hp	58.9 %	113 kWh/US MG	24.5 ft
1	50 Hz	833 US g.p.m.	17.7 ft	8.19 hp	833 US g.p.m.	17.7 ft	8.19 hp	45.5 %	139 kWh/US MG	21.8 ft
1	45 Hz	359 US g.p.m.	17.1 ft	6.51 hp	359 US g.p.m.	17.1 ft	6.51 hp	23.9 %	259 kWh/US MG	19.5 ft
1	40 Hz									

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3153 LT 3~ 622

Dimensional drawing



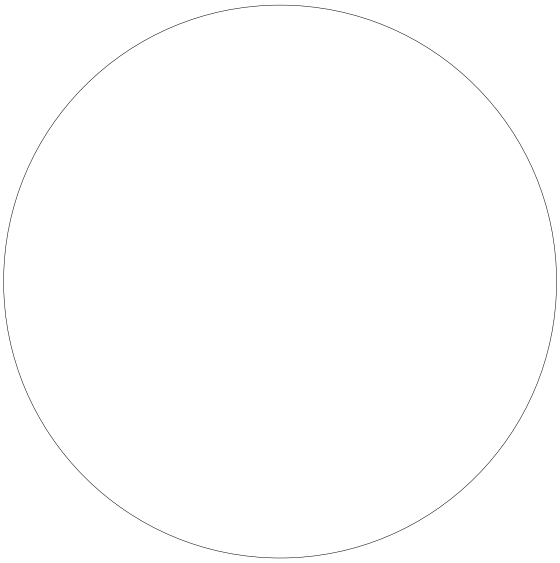
Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3153 LT 3~ 622

Life cycle costs (LCC)

Total lifetime	15	Inflation rate (rate of price increases)	2 %
Annual operating time	5600	Interest rate (for investment)	3 %
Energy cost per kWh	0.00 USD		
Power input P1			

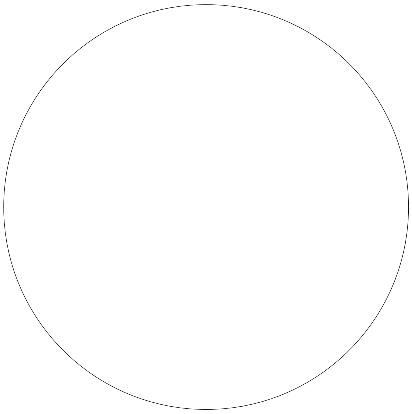
Total costs



- 0% **0.00 USD** Energy
- 0% **0.00 USD** Investment costs
- 0% **0.00 USD** Installation & commissioning
- 0% **0.00 USD** Operating cost
- 0% **0.00 USD** Maintenance & repair
- 0% **0.00 USD** Downtime
- 0% **0.00 USD** Environmental
- 0% **0.00 USD** Decommissioning

0.00 USD

First year costs



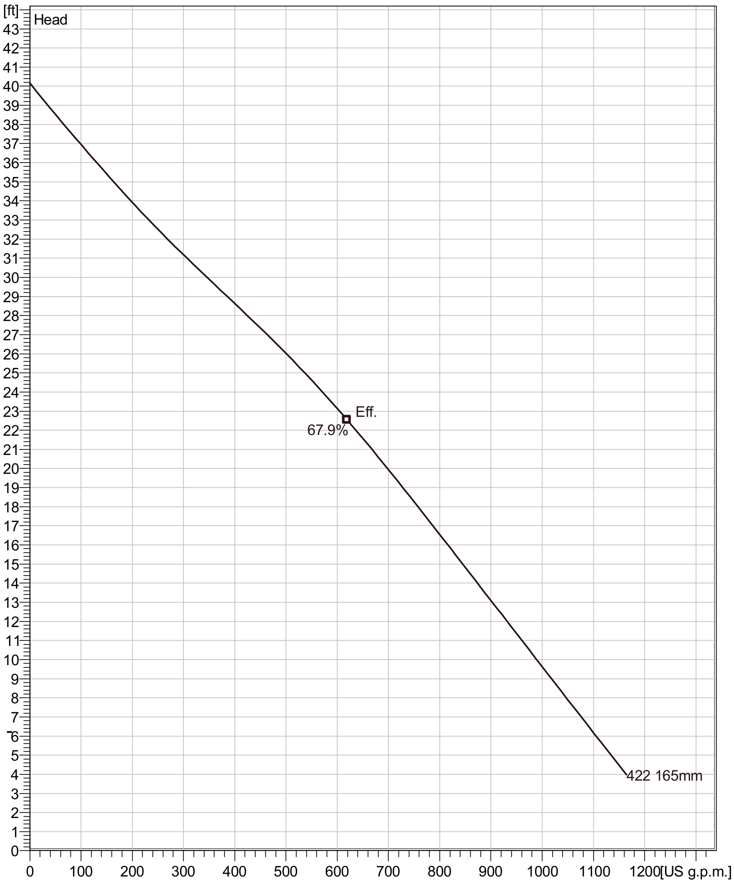
- 0% **0.00 USD** Energy (1st year)
- 0% **0.00 USD** Investment costs (1st year)
- 0% **0.00 USD** Installation & commissioning (1st year)
- 0% **0.00 USD** Operating cost (1st year)
- 0% **0.00 USD** Maintenance & repair (1st year)
- 0% **0.00 USD** Downtime (1st year)
- 0% **0.00 USD** Environmental (1st year)
- 0% **0.00 USD** Decommissioning (1st year)

0.00 USD

Disclaimer: The calculations and the results are based on user input values and general assumptions and provide only estimated costs for the input data. Xylem inc can therefore not guarantee that the estimated savings will actually occur.

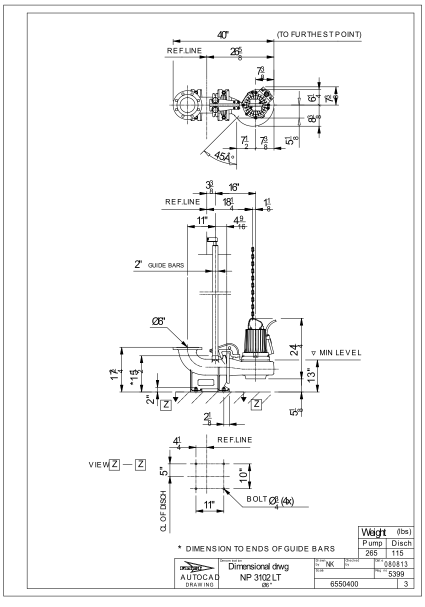
NP 3102 LT 3~ Adaptive 422

Technical specification



Water, pure *Curve ISO*

Installation: P - Semi permanent, Wet



Note: Picture might not correspond to the current configuration.

General

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

Impeller material	Hard-Iron
Discharge Flange Diameter	5 7/8 inch
Suction Flange Diameter	5 7/8 inch
Impeller diameter	165 mm
Number of blades	2

Motor

Motor #	N3102.930 18-11-4AS-W IE3 5.5hp FM
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	5.5 hp
Rated current	6.2 A
Starting current	42 A
Rated speed	1800 rpm
Power factor	
1/1 Load	0.90
3/4 Load	0.86
1/2 Load	0.75
Motor efficiency	
1/1 Load	91.9 %
3/4 Load	91.5 %
1/2 Load	90.1 %

Configuration

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3102 LT 3~ Adaptive 422

Performance curve

Pump

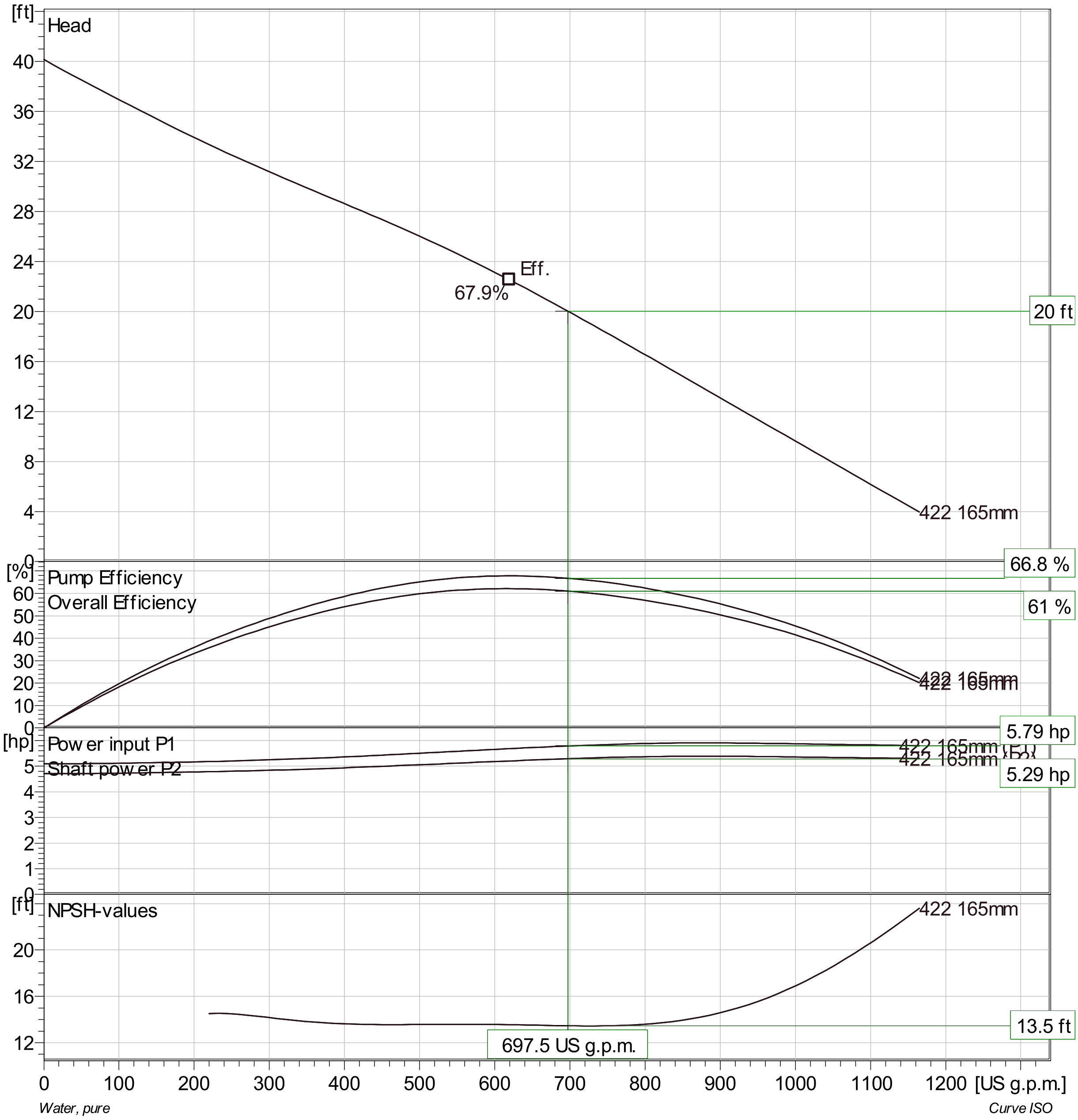
Discharge Flange Diameter	5 7/8 inch
Suction Flange Diameter	150 mm
Impeller diameter	6 1/2"
Number of blades	2

Motor

Motor #	N3102.930 18-11-4AS-W IE3 5.5hp
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	5.5 hp
Rated current	6.2 A
Starting current	42 A
Rated speed	1800 rpm

Power factor	
1/1 Load	0.90
3/4 Load	0.86
1/2 Load	0.75

Motor efficiency	
1/1 Load	91.9 %
3/4 Load	91.5 %
1/2 Load	90.1 %



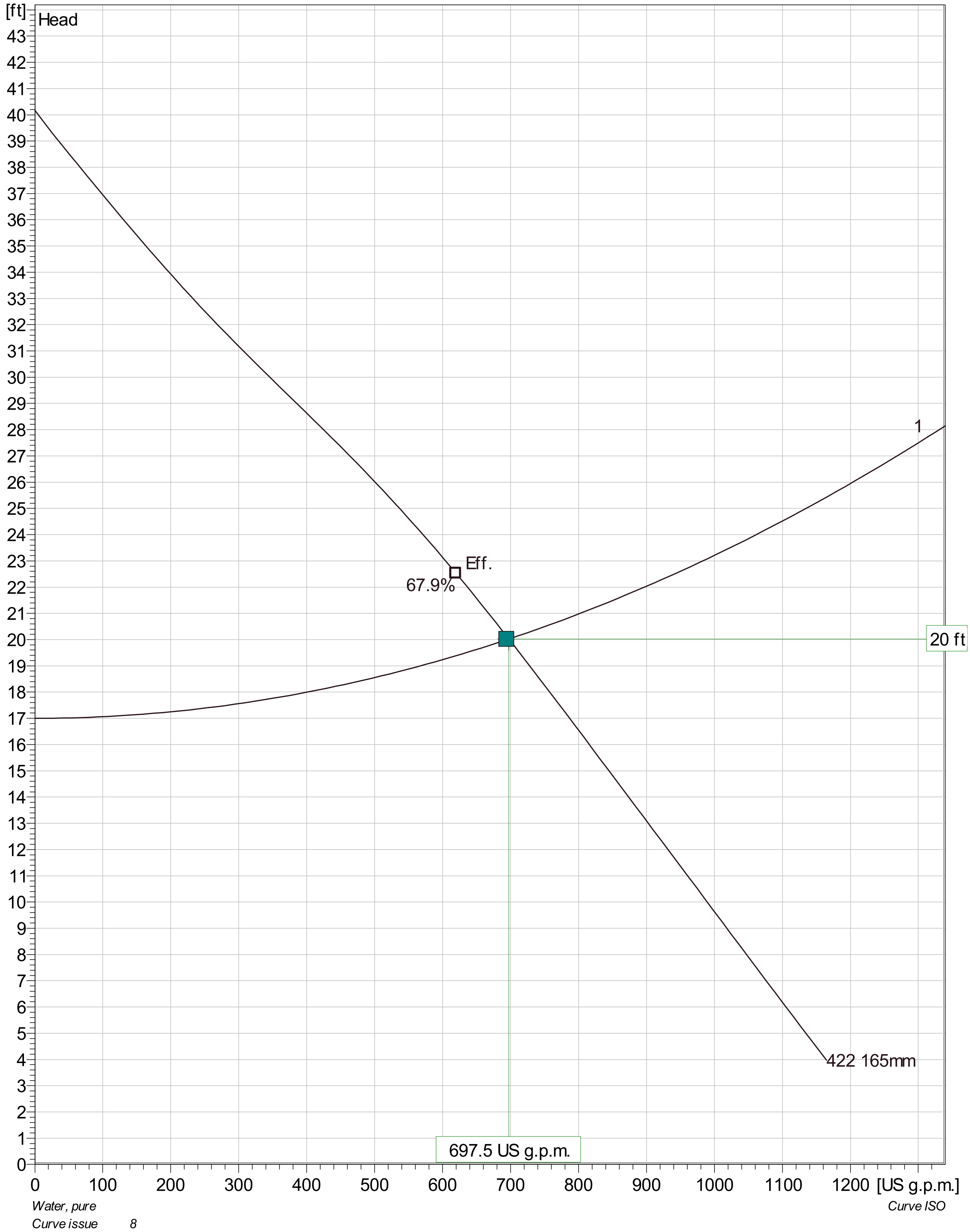
Duty point		Guarantee
Flow	**Head**	
695 US g.p.m.	20 ft	No

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

![xylem]

NP 3102 LT 3~ Adaptive 422
Duty Analysis

FLYGT

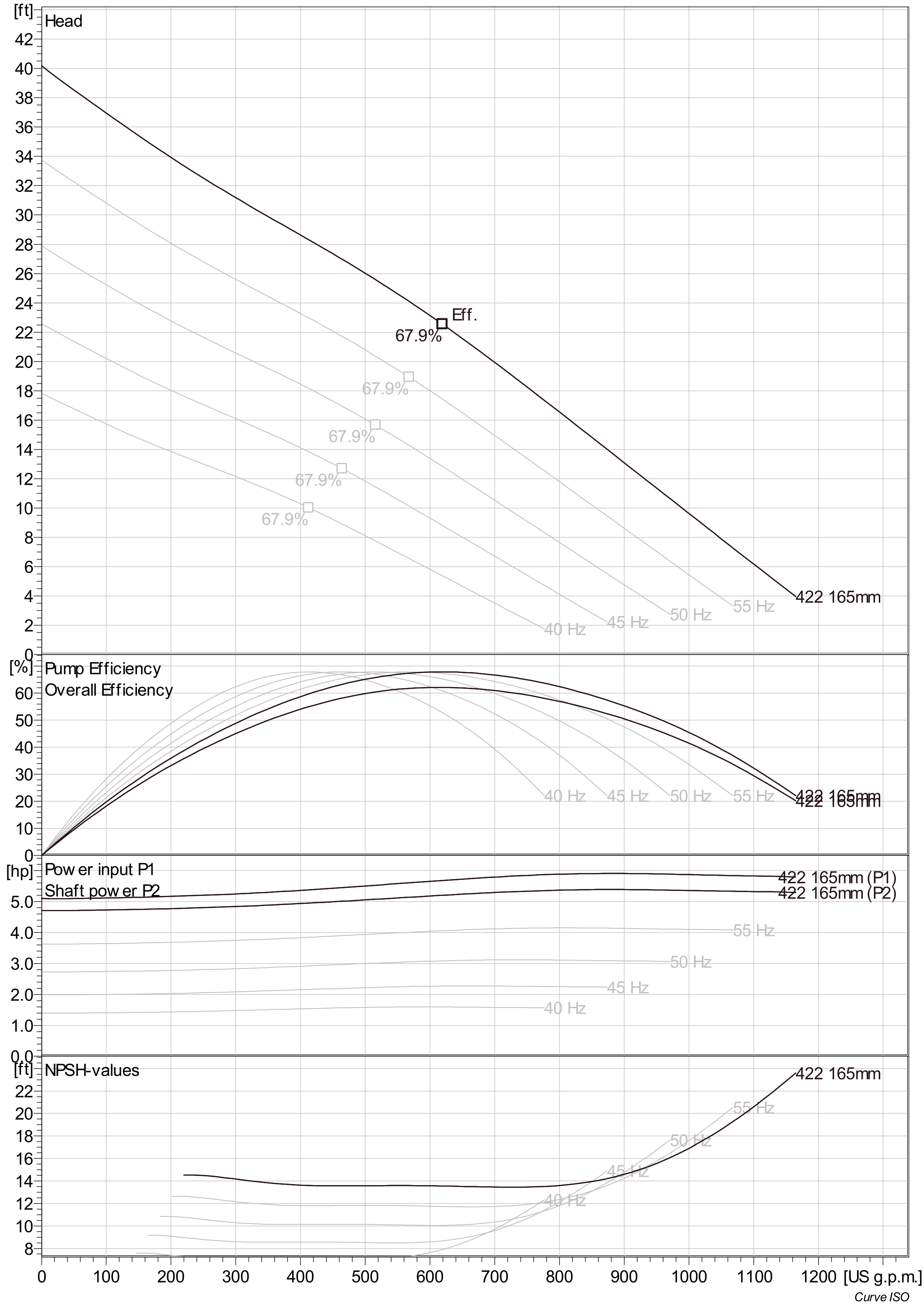


Pumps running /System	Individual pump Flow	Head	Shaft power	Total Flow	Head	Shaft power	Pump eff.	Specific energy	NPSHre
1	698 US g.p.m.	20 ft	5.29 hp	698 US g.p.m.	20 ft	5.29 hp	66.8 %	103 kWh/US MG	13.5 ft

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3102 LT 3~ Adaptive 422

VFD Curve



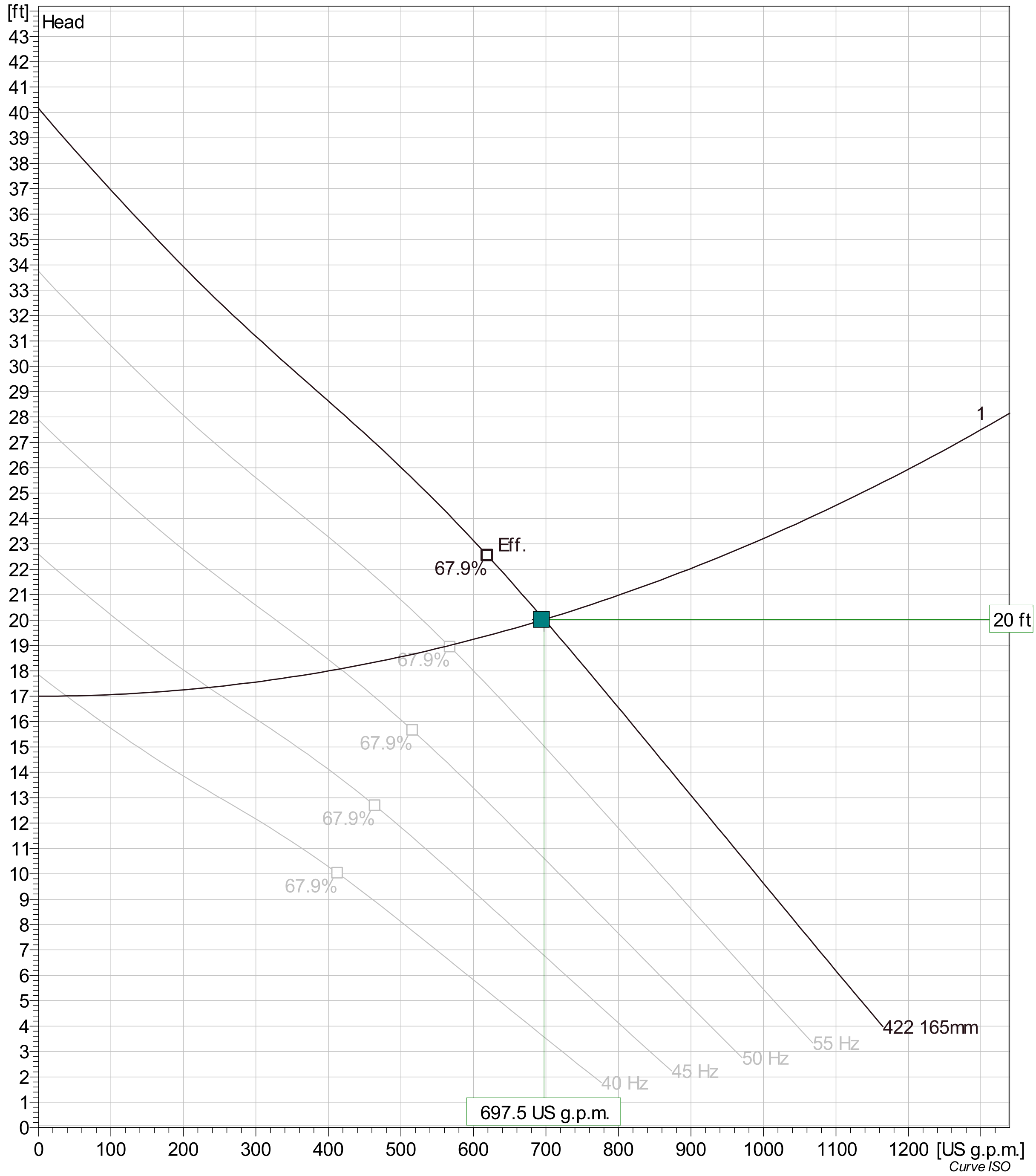
Project	Project ID	Created by	Created on	Last update
			6/23/2018	

xylem

FLYGT

NP 3102 LT 3~ Adaptive 422

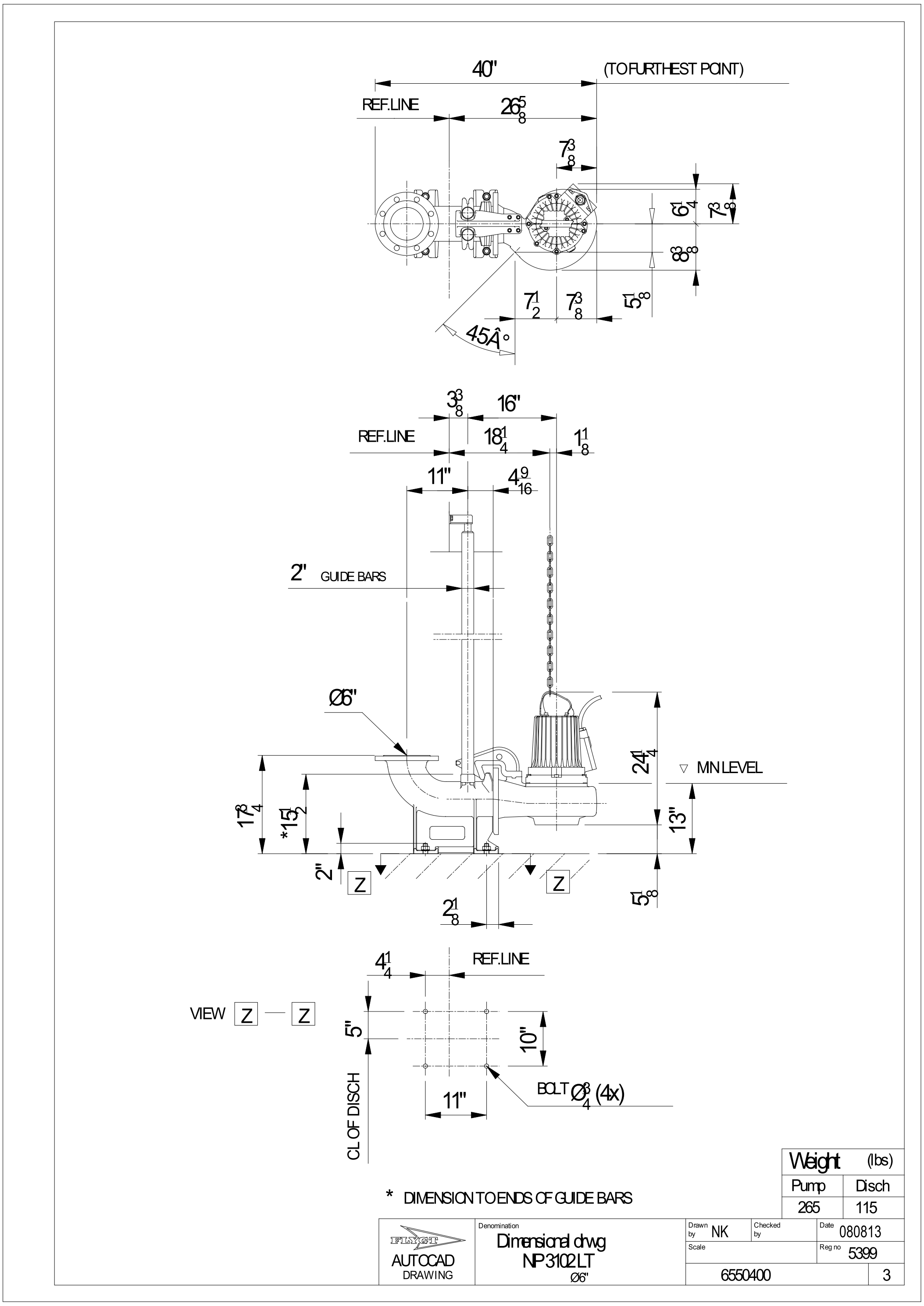
VFD Analysis



Pumps running /System	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	60 Hz	698 US g.p.m.	20 ft	5.29 hp	698 US g.p.m.	20 ft	5.29 hp	66.8 %	103 kWh/US MG	13.5 ft
1	55 Hz	566 US g.p.m.	19 ft	4.01 hp	566 US g.p.m.	19 ft	4.01 hp	67.9 %	95.1 kWh/US MG	11.8 ft
1	50 Hz	416 US g.p.m.	18.1 ft	2.92 hp	416 US g.p.m.	18.1 ft	2.92 hp	65.1 %	97.8 kWh/US MG	10.1 ft
1	45 Hz	235 US g.p.m.	17.3 ft	2.05 hp	235 US g.p.m.	17.3 ft	2.05 hp	50.4 %	124 kWh/US MG	8.88 ft
1	40 Hz	38.6 US g.p.m.	17 ft	1.4 hp	38.6 US g.p.m.	17 ft	1.4 hp	11.9 %	514 kWh/US MG	

NP 3102 LT 3~ Adaptive 422

Dimensional drawing



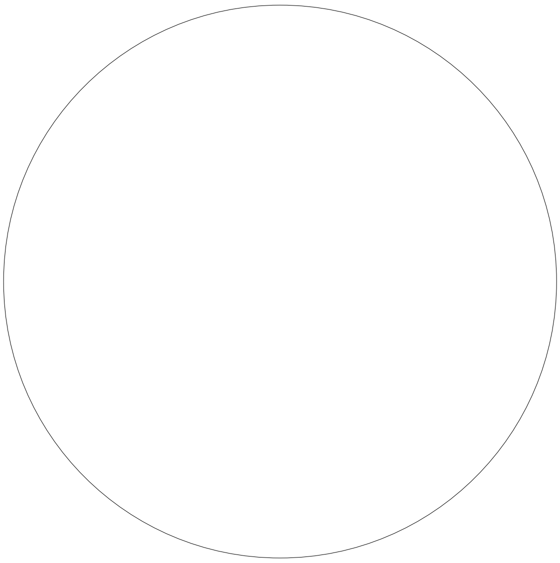
Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3102 LT 3~ Adaptive 422

Life cycle costs (LCC)

Total lifetime	15	Inflation rate (rate of price increases)	2 %
Annual operating time	5600	Interest rate (for investment)	3 %
Energy cost per kWh	0.00 USD		
Power input P1			

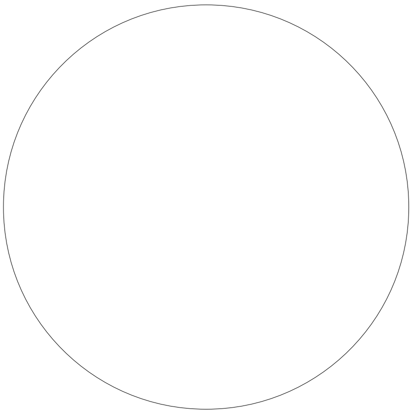
Total costs



0.00 USD

0%	**0.00 USD**	Energy
0%	**0.00 USD**	Investment costs
0%	**0.00 USD**	Installation & commissioning
0%	**0.00 USD**	Operating cost
0%	**0.00 USD**	Maintenance & repair
0%	**0.00 USD**	Downtime
0%	**0.00 USD**	Environmental
0%	**0.00 USD**	Decommissioning

First year costs



0.00 USD

0%	**0.00 USD**	Energy (1st year)
0%	**0.00 USD**	Investment costs (1st year)
0%	**0.00 USD**	Installation & commissioning (1st year)
0%	**0.00 USD**	Operating cost (1st year)
0%	**0.00 USD**	Maintenance & repair (1st year)
0%	**0.00 USD**	Downtime (1st year)
0%	**0.00 USD**	Environmental (1st year)
0%	**0.00 USD**	Decommissioning (1st year)

Disclaimer: The calculations and the results are based on user input values and general assumptions and provide only estimated costs for the input data. Xylem inc can therefore not guarantee that the estimated savings will actually occur.

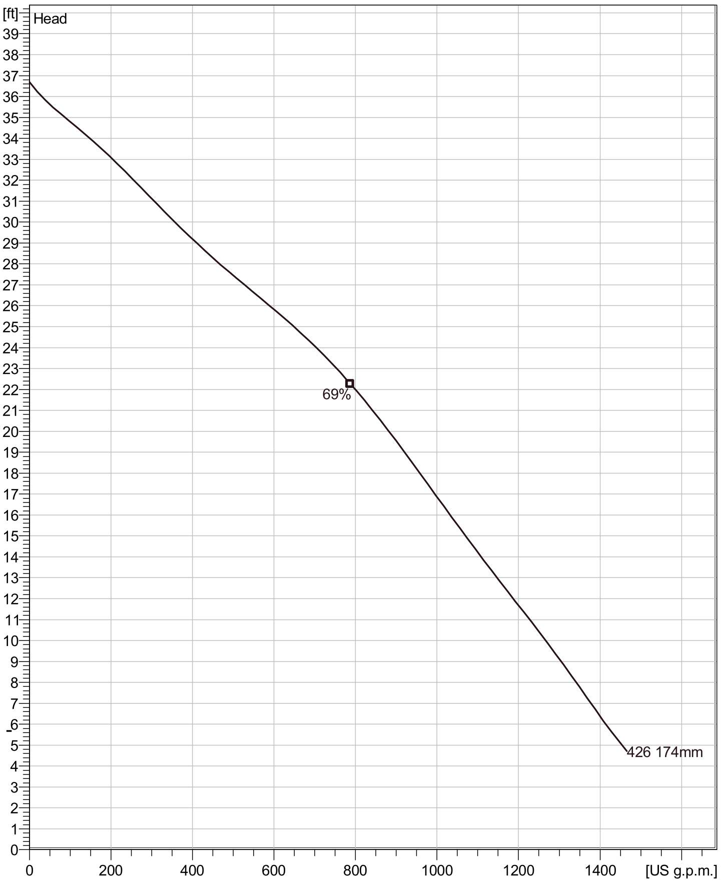
FLYGT PUMP STATION 1 QUOTE

xylem

NP 3127 LT 3~ Adaptive 426

Technical specification

FLYGT



Water, pure *Curve ISO*

Note: Picture might not correspond to the current configuration.

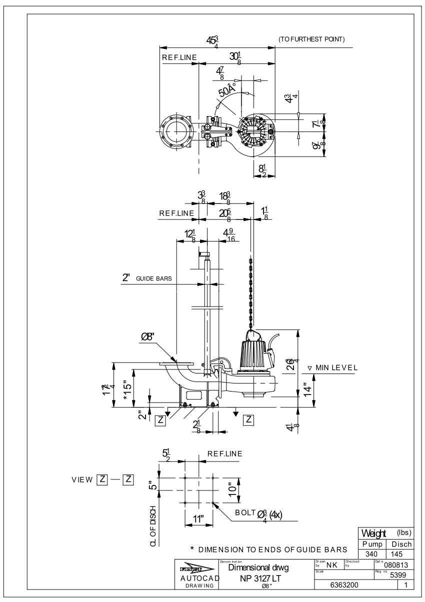
General

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

Impeller material	Hard-Iron
Discharge Flange Diameter	5 7/8 inch
Suction Flange Diameter	5 7/8 inch
Impeller diameter	174 mm
Number of blades	2

Installation: P - Semi permanent, Wet



Motor

Motor #	N3127.070 21-10-4AL-W 7.5hp FM
Stator variant	12
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	7.5 hp
Rated current	9.6 A
Starting current	52 A
Rated speed	1740 rpm
Power factor	
1/1 Load	0.88
3/4 Load	0.85
1/2 Load	0.77
Motor efficiency	
1/1 Load	83.8 %
3/4 Load	84.7 %
1/2 Load	83.7 %

Configuration

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

xylem

NP 3127 LT 3~ Adaptive 426

Performance curve

FLYGT

Pump

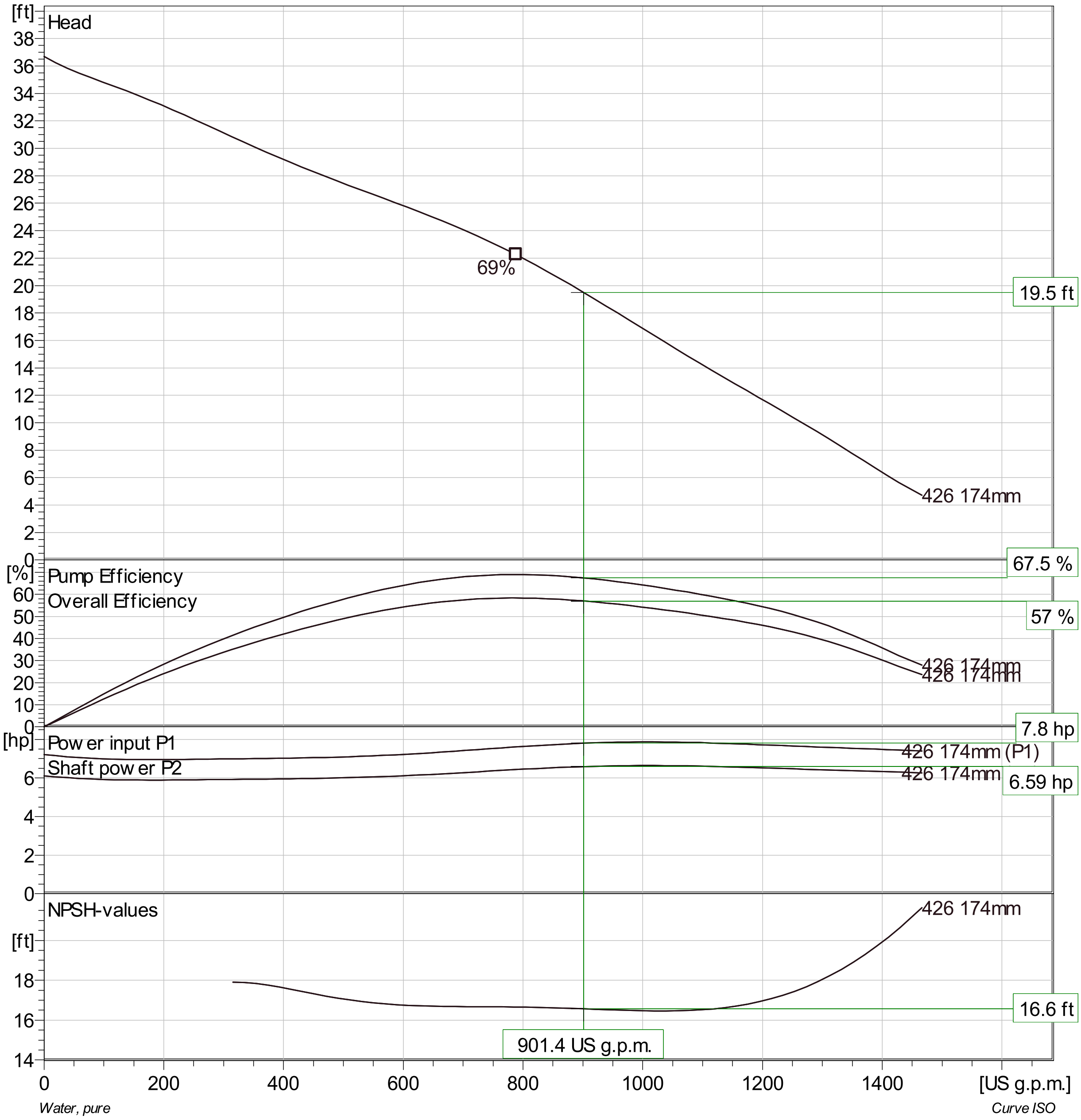
Discharge Flange Diameter	5 7/8 inch
Suction Flange Diameter	150 mm
Impeller diameter	6 7/8"
Number of blades	2

Motor

Motor #	N3127.070 21-10-4AL-W 7.5hp
Stator variant	12
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	7.5 hp
Rated current	9.6 A
Starting current	52 A
Rated speed	1740 rpm

Power factor	
1/1 Load	0.88
3/4 Load	0.85
1/2 Load	0.77

Motor efficiency	
1/1 Load	83.8 %
3/4 Load	84.7 %
1/2 Load	83.7 %



Duty point		Guarantee
Flow	**Head**	
835 US g.p.m.	19 ft	No

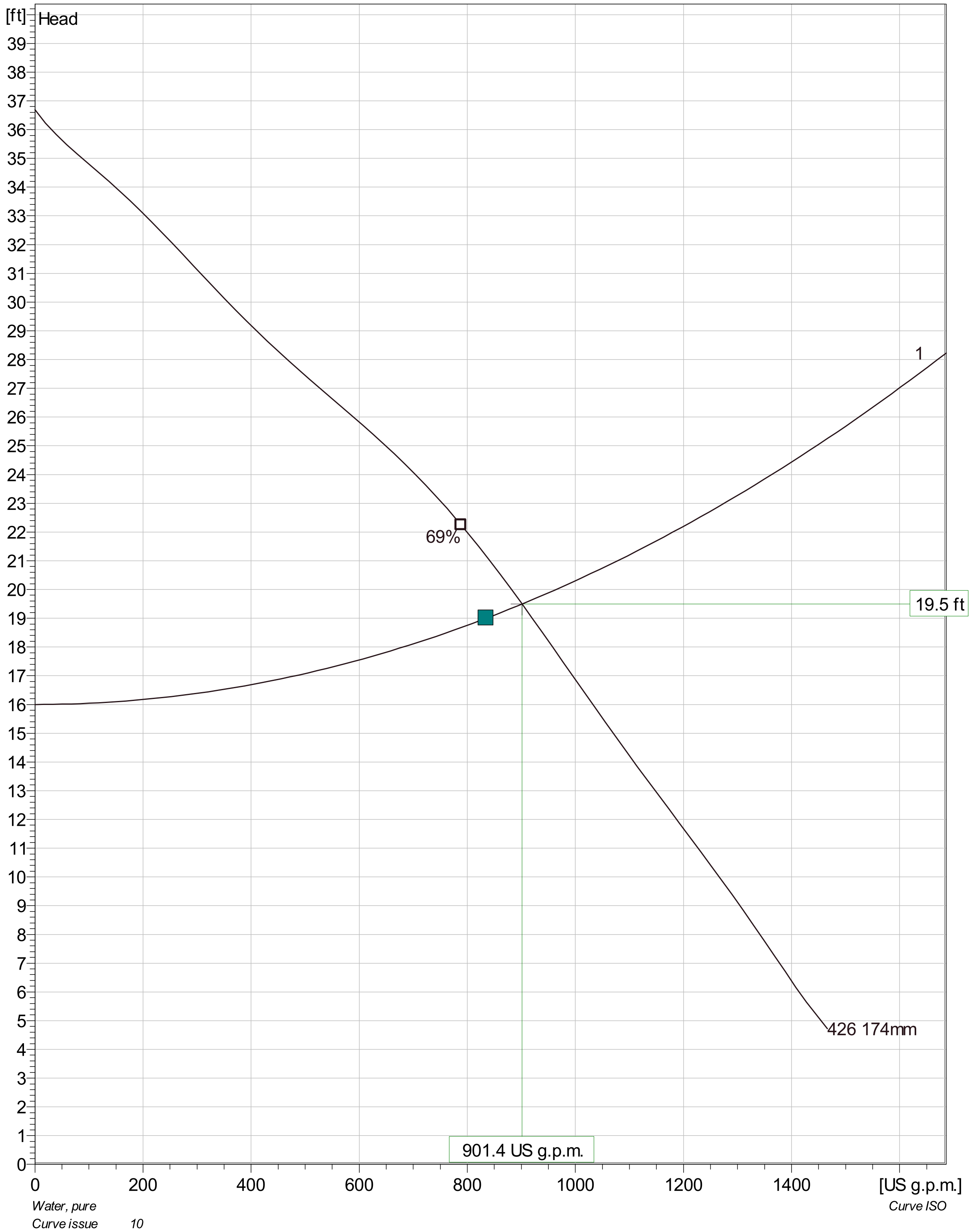
Project	Project ID	Created by	Created on	Last update
			6/23/2018	

xylem

NP 3127 LT 3~ Adaptive 426

Duty Analysis

FLYGT

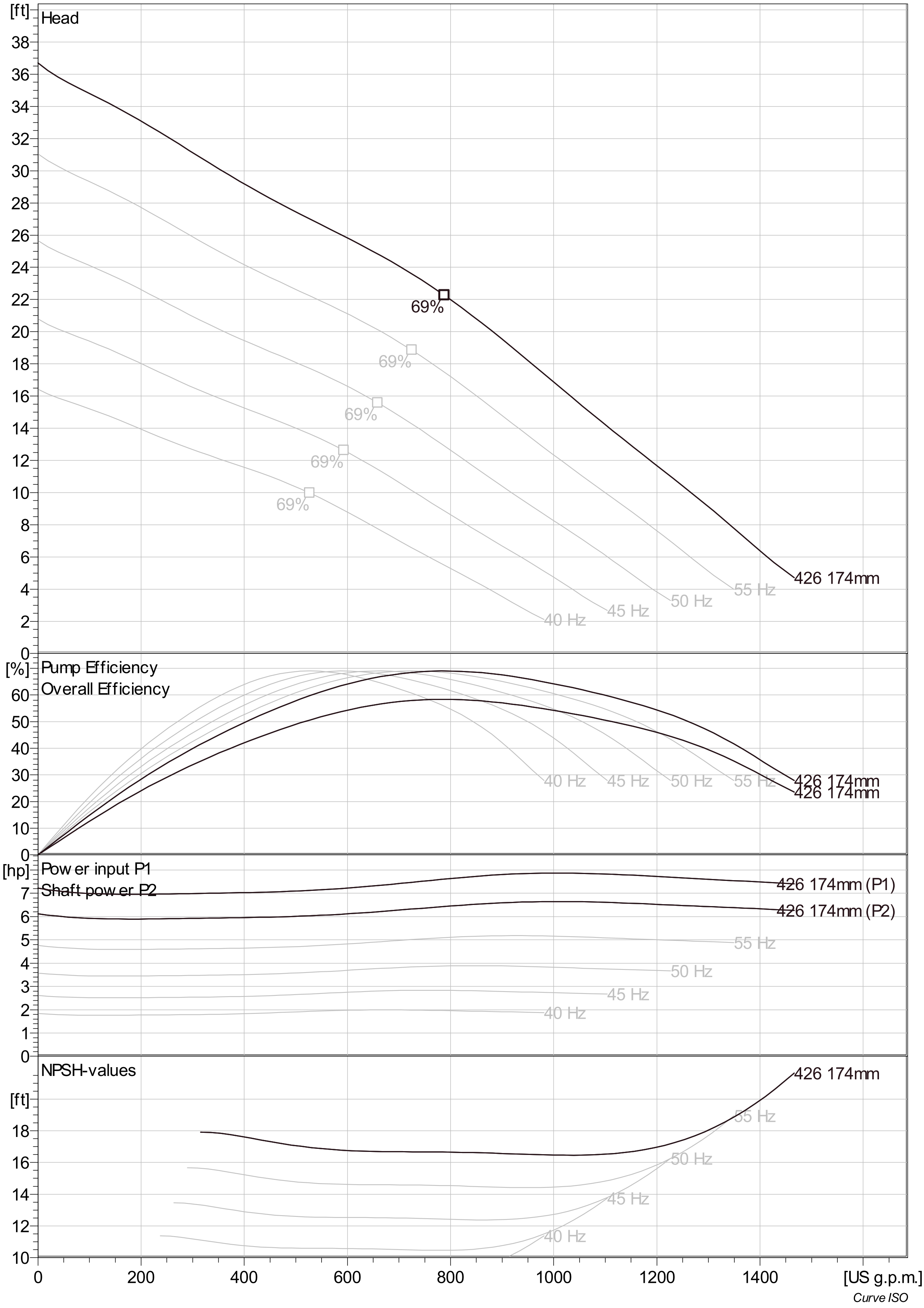


Pumps running /System	Individual pump Flow	Head	Shaft power	Total Flow	Head	Shaft power	Pump eff.	Specific energy	NPSHre
1	901 US g.p.m.	19.5 ft	6.59 hp	901 US g.p.m.	19.5 ft	6.59 hp	67.5 %	108 kWh/US MG	16.6 ft

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3127 LT 3~ Adaptive 426

VFD Curve



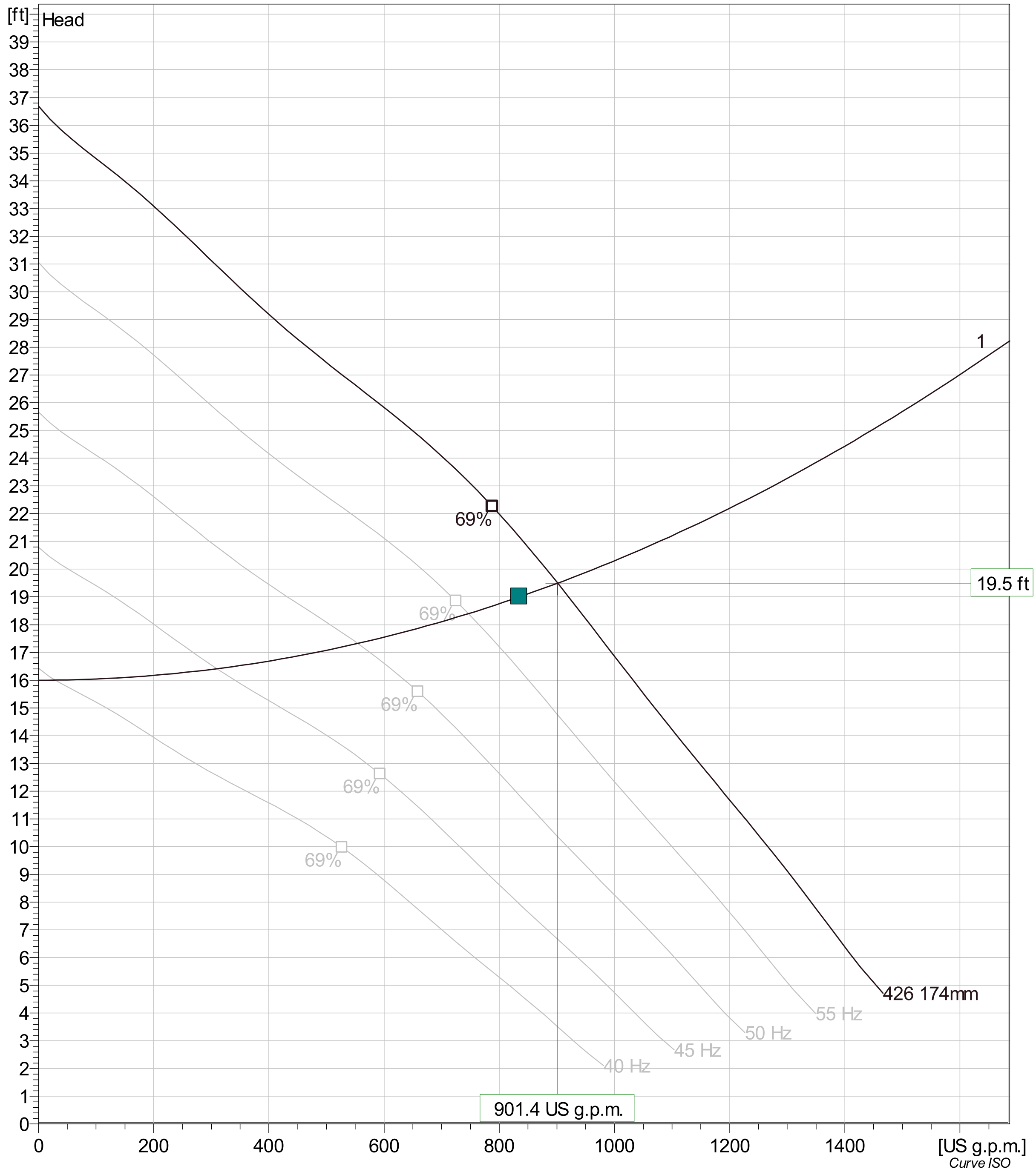
Project	Project ID	Created by	Created on	Last update
			6/23/2018	

xylem

NP 3127 LT 3~ Adaptive 426

VFD Analysis

FLYGT



Pumps running /System	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	58.4 Hz	901 US g.p.m.	19.5 ft	6.59 hp	901 US g.p.m.	19.5 ft	6.59 hp	67.5 %	108 kWh/US MG	16.6 ft
1	55 Hz	747 US g.p.m.	18.4 ft	5.04 hp	747 US g.p.m.	18.4 ft	5.04 hp	68.9 %	99 kWh/US MG	14.6 ft
1	50 Hz	554 US g.p.m.	17.3 ft	3.63 hp	554 US g.p.m.	17.3 ft	3.63 hp	66.8 %	97.3 kWh/US MG	12.5 ft
1	45 Hz	310 US g.p.m.	16.4 ft	2.54 hp	310 US g.p.m.	16.4 ft	2.54 hp	50.6 %	126 kWh/US MG	11.1 ft
1	40 Hz	28.9 US g.p.m.	16 ft	1.8 hp	28.9 US g.p.m.	16 ft	1.8 hp	6.46 %	1000 kWh/US MG	

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

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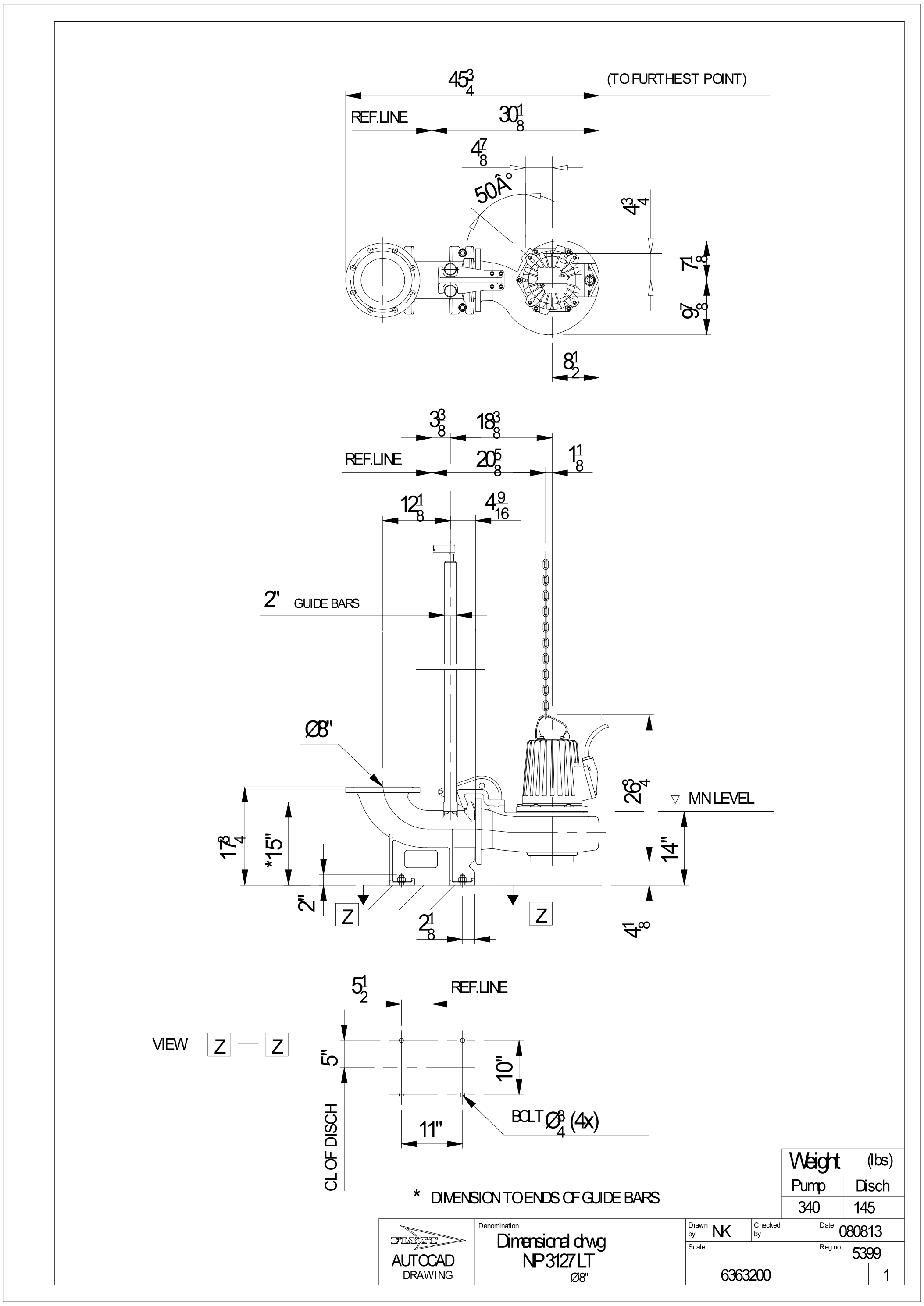
NP 3127 LT 3~ Adaptive 426

Dimensional drawing

FLYGT



Project	Project ID	Created by	Created on	Last update
			6/23/2018	

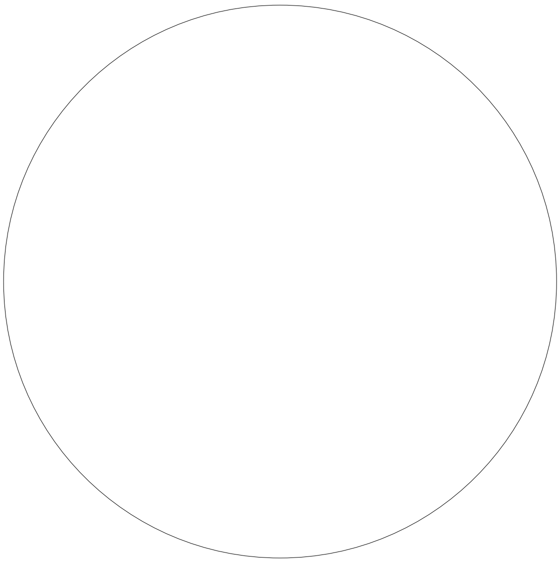
Version 10

NP 3127 LT 3~ Adaptive 426

Life cycle costs (LCC)

Total lifetime	15	Inflation rate (rate of price increases)	2 %
Annual operating time	5600	Interest rate (for investment)	3 %
Energy cost per kWh	0.00 USD		
Power input P1			

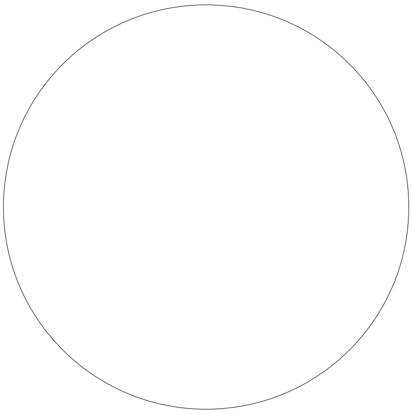
Total costs



0%	**0.00 USD**	Energy
0%	**0.00 USD**	Investment costs
0%	**0.00 USD**	Installation & commissioning
0%	**0.00 USD**	Operating cost
0%	**0.00 USD**	Maintenance & repair
0%	**0.00 USD**	Downtime
0%	**0.00 USD**	Environmental
0%	**0.00 USD**	Decommissioning

0.00 USD

First year costs



0%	**0.00 USD**	Energy (1st year)
0%	**0.00 USD**	Investment costs (1st year)
0%	**0.00 USD**	Installation & commissioning (1st year)
0%	**0.00 USD**	Operating cost (1st year)
0%	**0.00 USD**	Maintenance & repair (1st year)
0%	**0.00 USD**	Downtime (1st year)
0%	**0.00 USD**	Environmental (1st year)
0%	**0.00 USD**	Decommissioning (1st year)

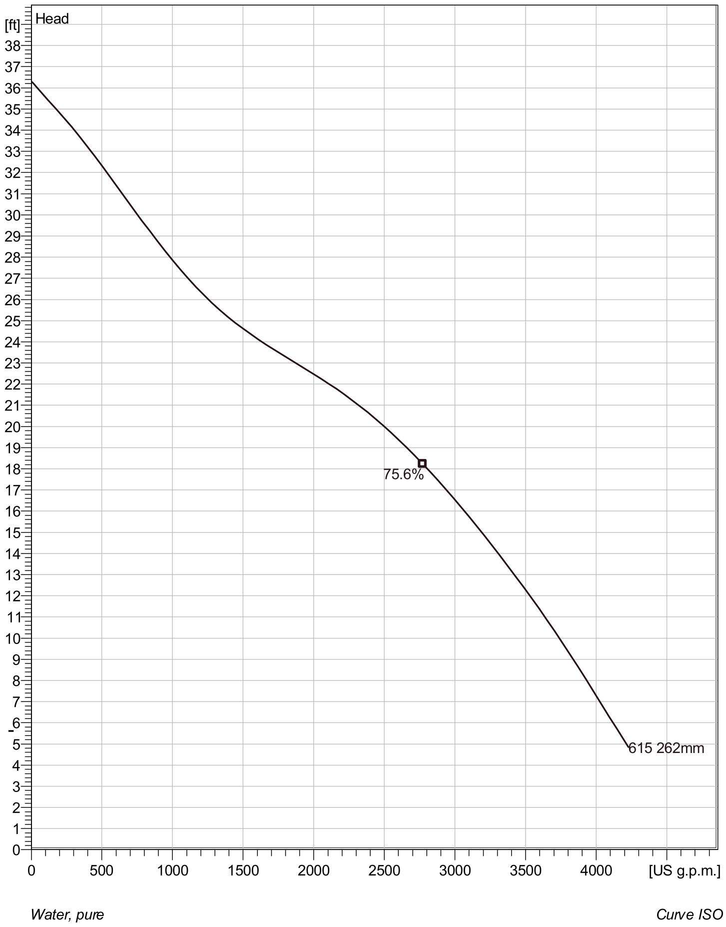
0.00 USD

Disclaimer: The calculations and the results are based on user input values and general assumptions and provide only estimated costs for the input data. Xylem inc can therefore not guarantee that the estimated savings will actually occur.

FLYGT POND PUMP STATION QUOTE

NP 3171 LT 3~ 615

Technical specification



Note: Picture might not correspond to the current configuration.

General

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

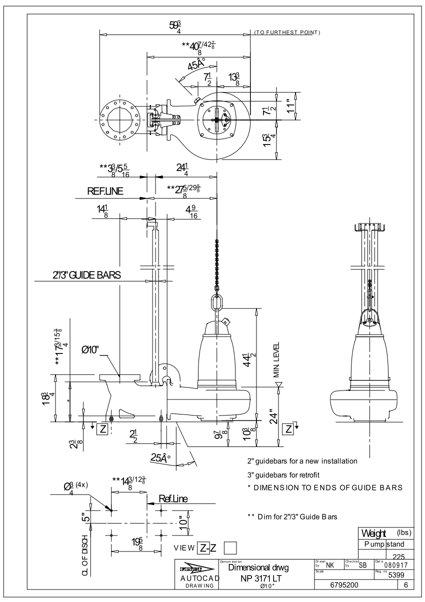
Impeller material	Hard-Iron
Discharge Flange Diameter	9 13/16 inch
Suction Flange Diameter	9 13/16 inch
Impeller diameter	262 mm
Number of blades	2

Motor

Motor #	N3171.095 25-18-6BB-W 25hp FM
Stator variant	7
Frequency	60 Hz
Rated voltage	460 V
Number of poles	6
Phases	3~
Rated power	25 hp
Rated current	32 A
Starting current	177 A
Rated speed	1160 rpm
Power factor	
1/1 Load	0.85
3/4 Load	0.80
1/2 Load	0.70
Motor efficiency	
1/1 Load	86.0 %
3/4 Load	87.5 %
1/2 Load	87.5 %

Configuration

Installation: P - Semi permanent, Wet



Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3171 LT 3~ 615

Performance curve

Pump

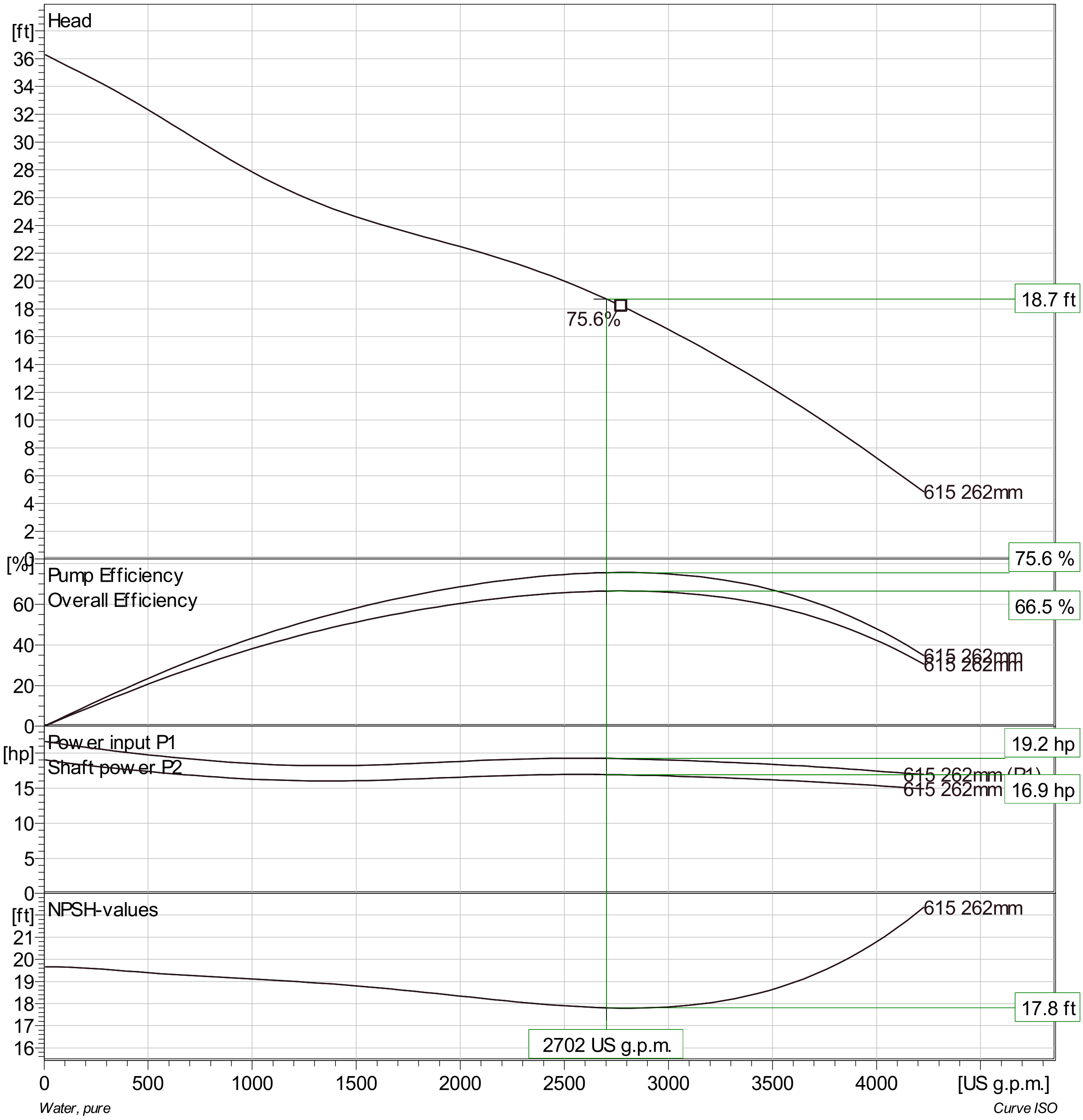
Discharge Flange Diameter	9 13/16 inch
Suction Flange Diameter	250 mm
Impeller diameter	$10^{5}/_{16}$"
Number of blades	2

Motor

Motor #	N3171.095 25-18-6BB-W 25hp
Stator variant	7
Frequency	60 Hz
Rated voltage	460 V
Number of poles	6
Phases	3~
Rated power	25 hp
Rated current	32 A
Starting current	177 A
Rated speed	1160 rpm

Power factor	
1/1 Load	0.85
3/4 Load	0.80
1/2 Load	0.70

Motor efficiency	
1/1 Load	86.0 %
3/4 Load	87.5 %
1/2 Load	87.5 %

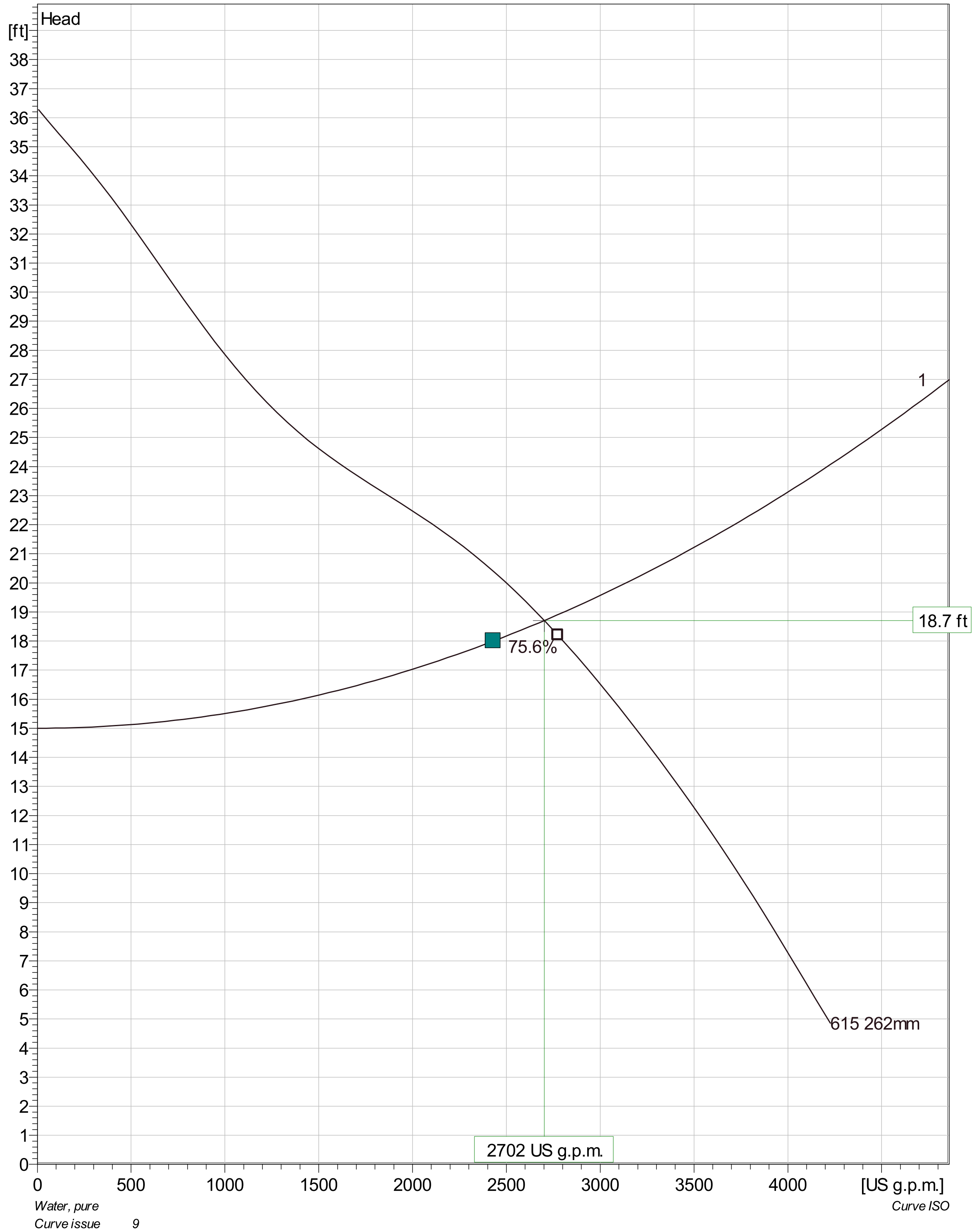


Duty point		Guarantee
Flow	**Head**	
2430 US g.p.m.	18 ft	No

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3171 LT 3~ 615

Duty Analysis

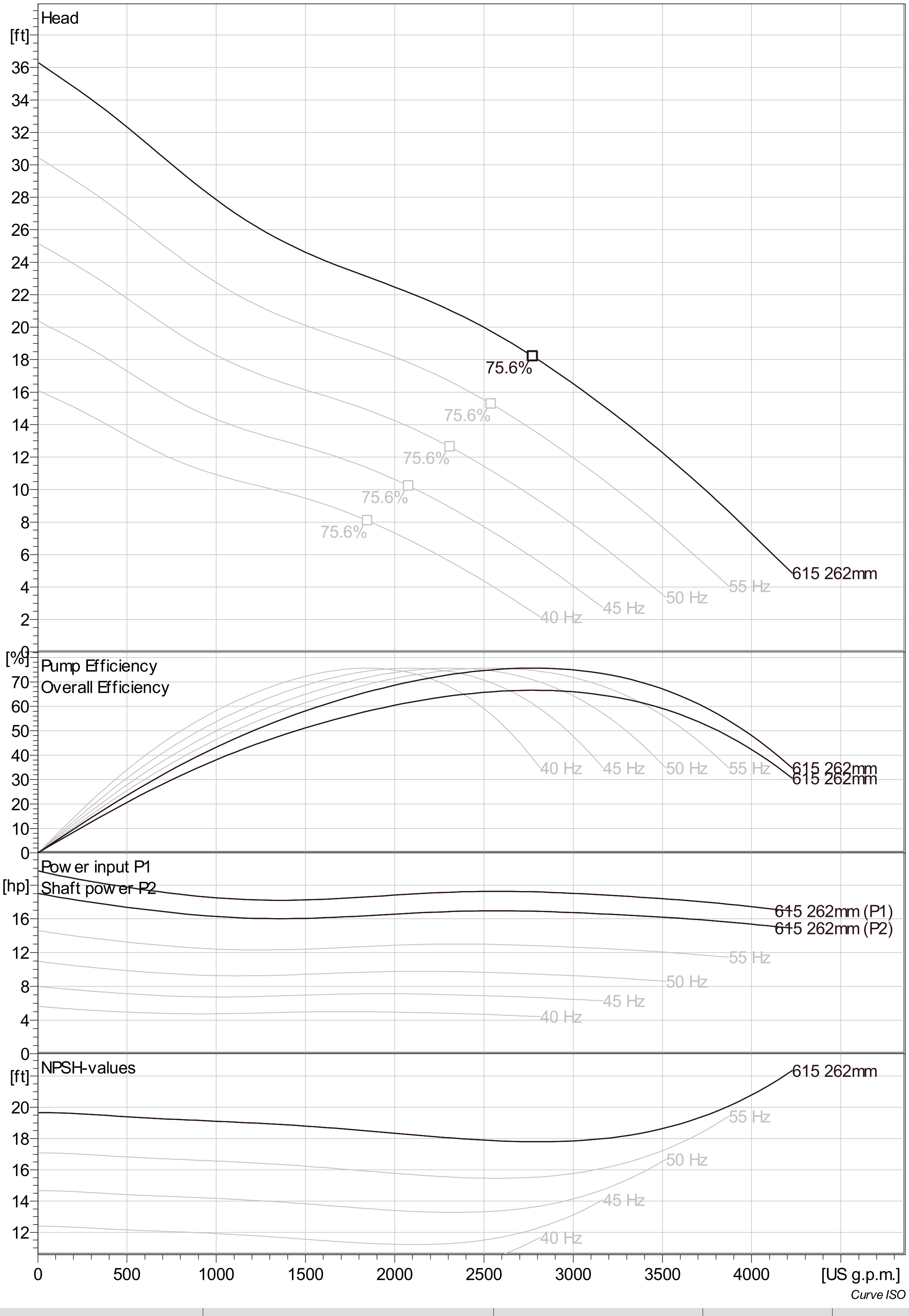


Pumps running /System	Individual pump Flow	Head	Shaft power	Total Flow	Head	Shaft power	Pump eff.	Specific energy	NPSHre
1	2700 US g.p.m.	18.7 ft	16.9 hp	2700 US g.p.m.	18.7 ft	16.9 hp	75.6 %	88.5 kWh/US MG	17.8 ft

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3171 LT 3~ 615

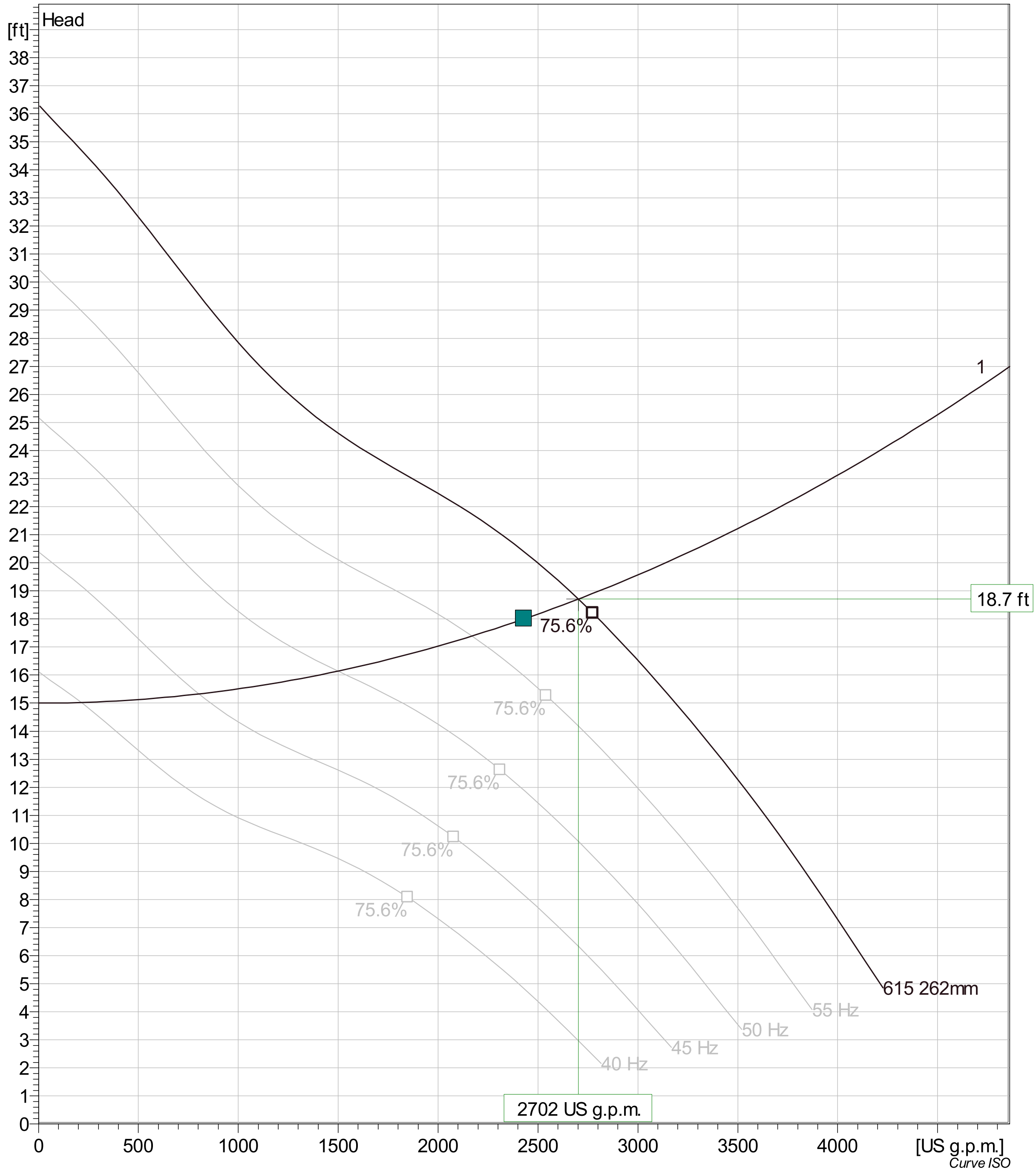
VFD Curve



Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3171 LT 3~ 615

VFD Analysis



Pumps running /System	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	60 Hz	2700 US g.p.m.	18.7 ft	16.9 hp	2700 US g.p.m.	18.7 ft	16.9 hp	75.6 %	88.5 kWh/US MG	17.8 ft
1	55 Hz	2170 US g.p.m.	17.4 ft	13 hp	2170 US g.p.m.	17.4 ft	13 hp	73.6 %	84.6 kWh/US MG	15.6 ft
1	50 Hz	1500 US g.p.m.	16.1 ft	9.42 hp	1500 US g.p.m.	16.1 ft	9.42 hp	65 %	90.2 kWh/US MG	13.8 ft
1	45 Hz	802 US g.p.m.	15.3 ft	6.81 hp	802 US g.p.m.	15.3 ft	6.81 hp	45.7 %	126 kWh/US MG	12 ft
1	40 Hz	213 US g.p.m.	15 ft	5.29 hp	213 US g.p.m.	15 ft	5.29 hp	15.4 %	380 kWh/US MG	10.2 ft

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

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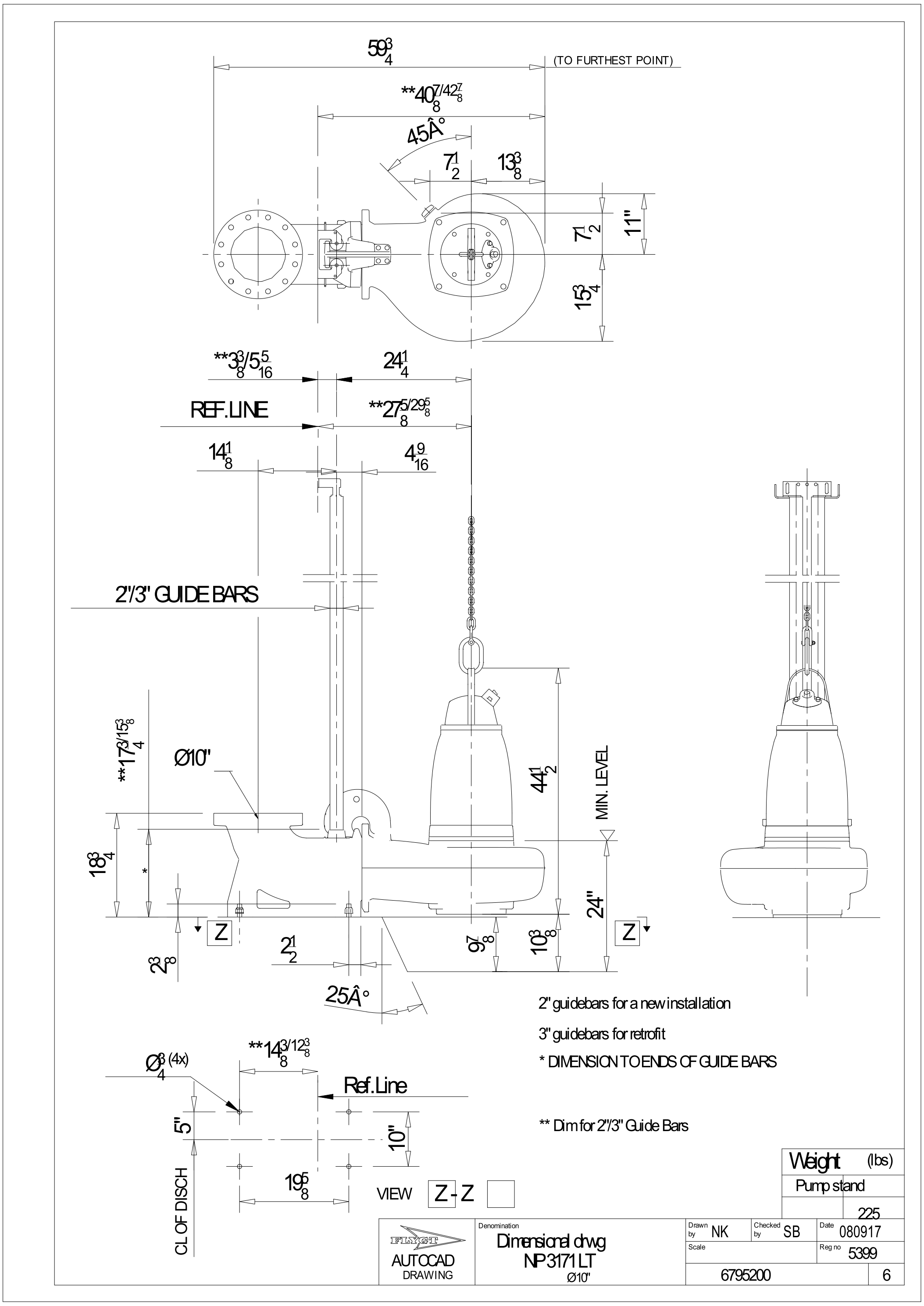
NP 3171 LT 3~ 615
Dimensional drawing

FLYGT



Project	Project ID	Created by	Created on	Last update
			6/23/2018	

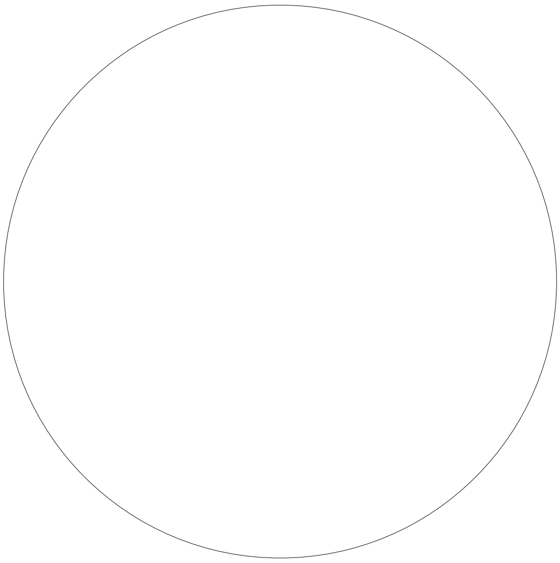
Version 10

NP 3171 LT 3~ 615

Life cycle costs (LCC)

Total lifetime	15	Inflation rate (rate of price increases)	2 %
Annual operating time	5600	Interest rate (for investment)	3 %
Energy cost per kWh	0.00 USD		
Power input P1			

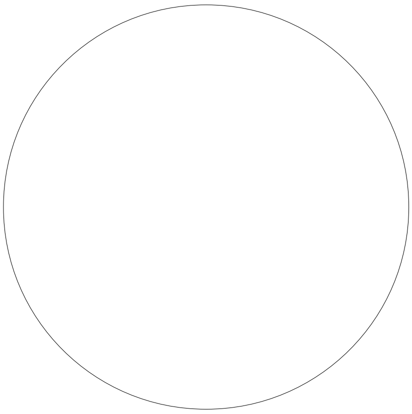
Total costs



- 0% **0.00 USD** Energy
- 0% **0.00 USD** Investment costs
- 0% **0.00 USD** Installation & commissioning
- 0% **0.00 USD** Operating cost
- 0% **0.00 USD** Maintenance & repair
- 0% **0.00 USD** Downtime
- 0% **0.00 USD** Environmental
- 0% **0.00 USD** Decommissioning

0.00 USD

First year costs



- 0% **0.00 USD** Energy (1st year)
- 0% **0.00 USD** Investment costs (1st year)
- 0% **0.00 USD** Installation & commissioning (1st year)
- 0% **0.00 USD** Operating cost (1st year)
- 0% **0.00 USD** Maintenance & repair (1st year)
- 0% **0.00 USD** Downtime (1st year)
- 0% **0.00 USD** Environmental (1st year)
- 0% **0.00 USD** Decommissioning (1st year)

0.00 USD

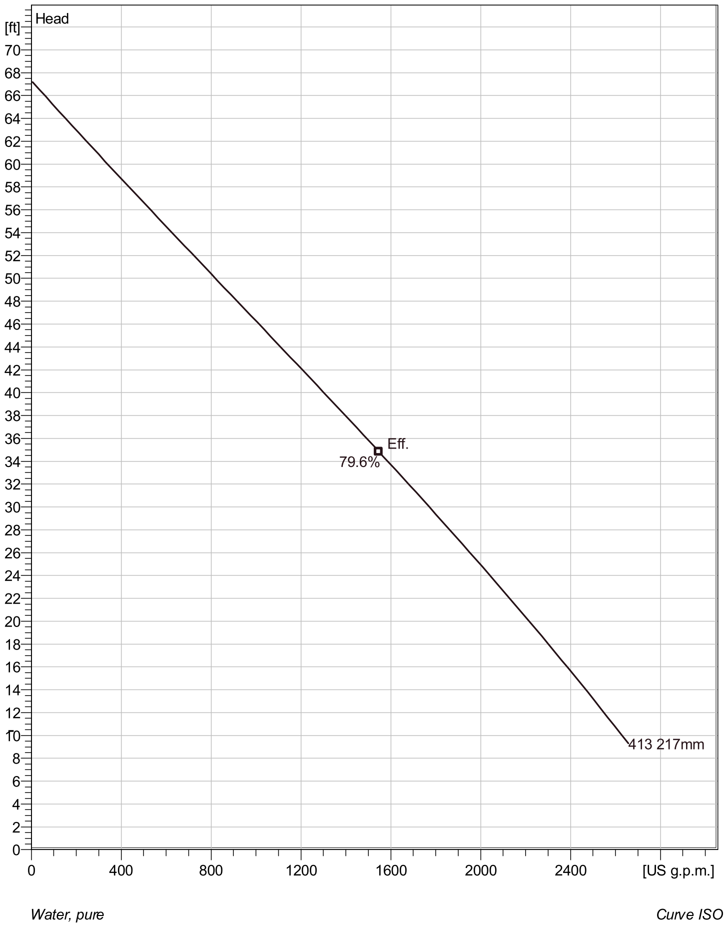
Disclaimer: The calculations and the results are based on user input values and general assumptions and provide only estimated costs for the input data. Xylem inc can therefore not guarantee that the estimated savings will actually occur.

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

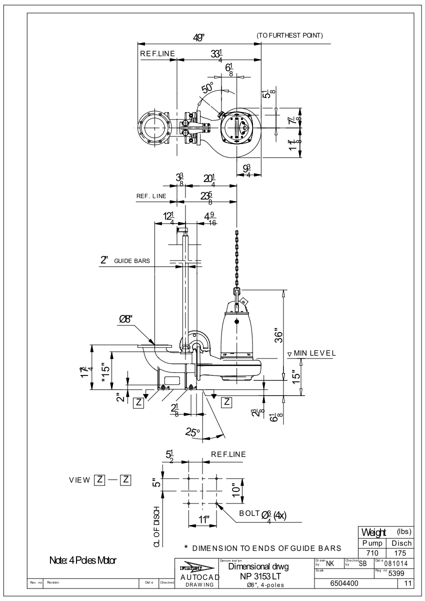
FLYGT ENHANCEMENT WETLAND PUMP STATION QUOTE

NP 3153 LT 3~ 413

Technical specification



Installation: P - Semi permanent, Wet



Note: Picture might not correspond to the current configuration.

General

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

Impeller material	Hard-Iron
Discharge Flange Diameter	7 7/8 inch
Suction Flange Diameter	7 7/8 inch
Impeller diameter	217 mm
Number of blades	2

Motor

Motor #	N3153.095 21-18-4AA-W 20hp FM
Stator variant	5
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	20 hp
Rated current	26 A
Starting current	148 A
Rated speed	1755 rpm
Power factor	
1/1 Load	0.83
3/4 Load	0.77
1/2 Load	0.66
Motor efficiency	
1/1 Load	87.5 %
3/4 Load	89.0 %
1/2 Load	89.0 %

Configuration

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3153 LT 3~ 413

Performance curve

Pump

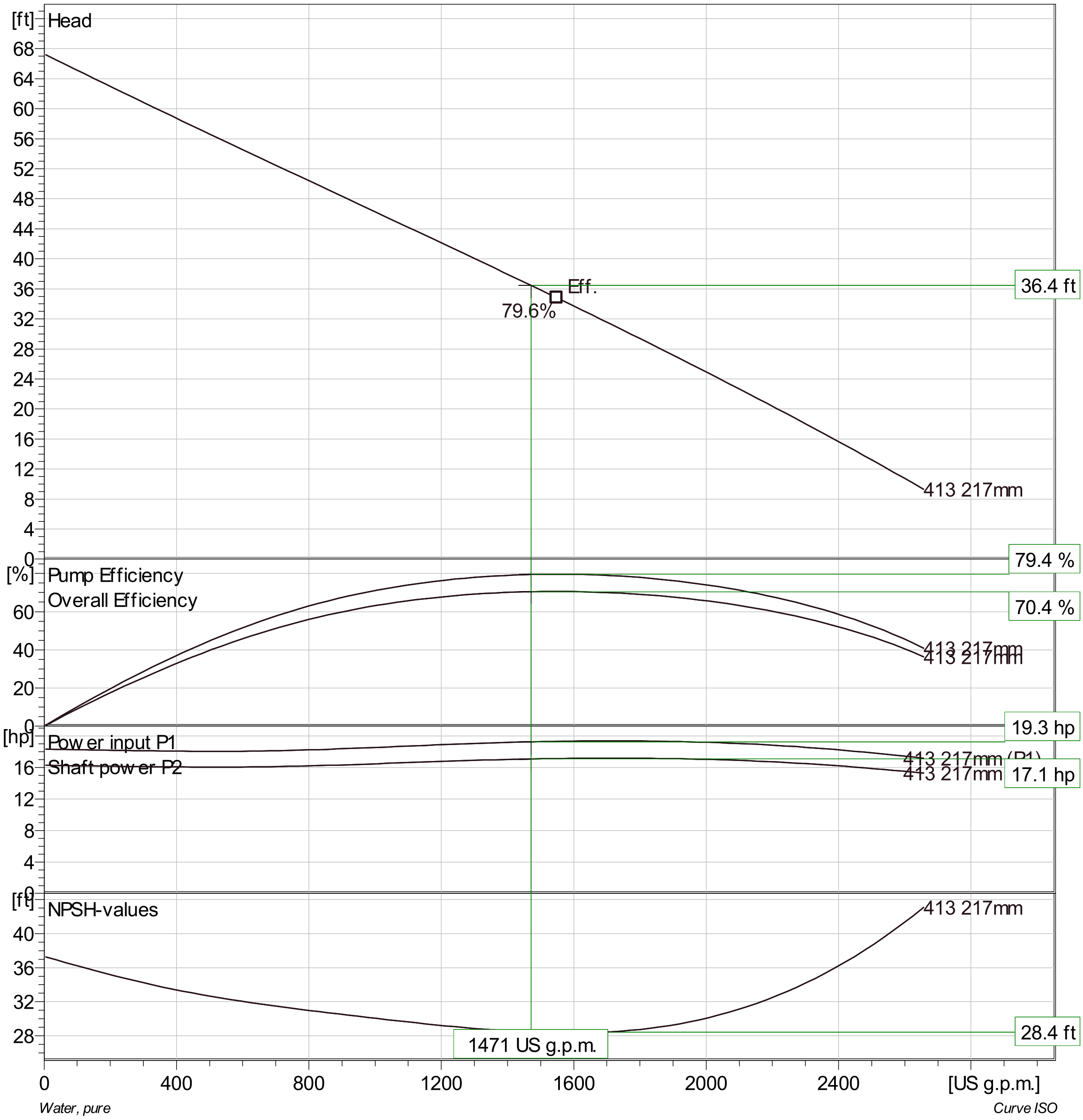
Discharge Flange Diameter	7 7/8 inch
Suction Flange Diameter	200 mm
Impeller diameter	8 9/16"
Number of blades	2

Motor

Motor #	N3153.095 21-18-4AA-W 20hp
Stator variant	5
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	20 hp
Rated current	26 A
Starting current	148 A
Rated speed	1755 rpm

Power factor	
1/1 Load	0.83
3/4 Load	0.77
1/2 Load	0.66

Motor efficiency	
1/1 Load	87.5 %
3/4 Load	89.0 %
1/2 Load	89.0 %



Duty point

Flow	Head
1390 US g.p.m.	35 ft

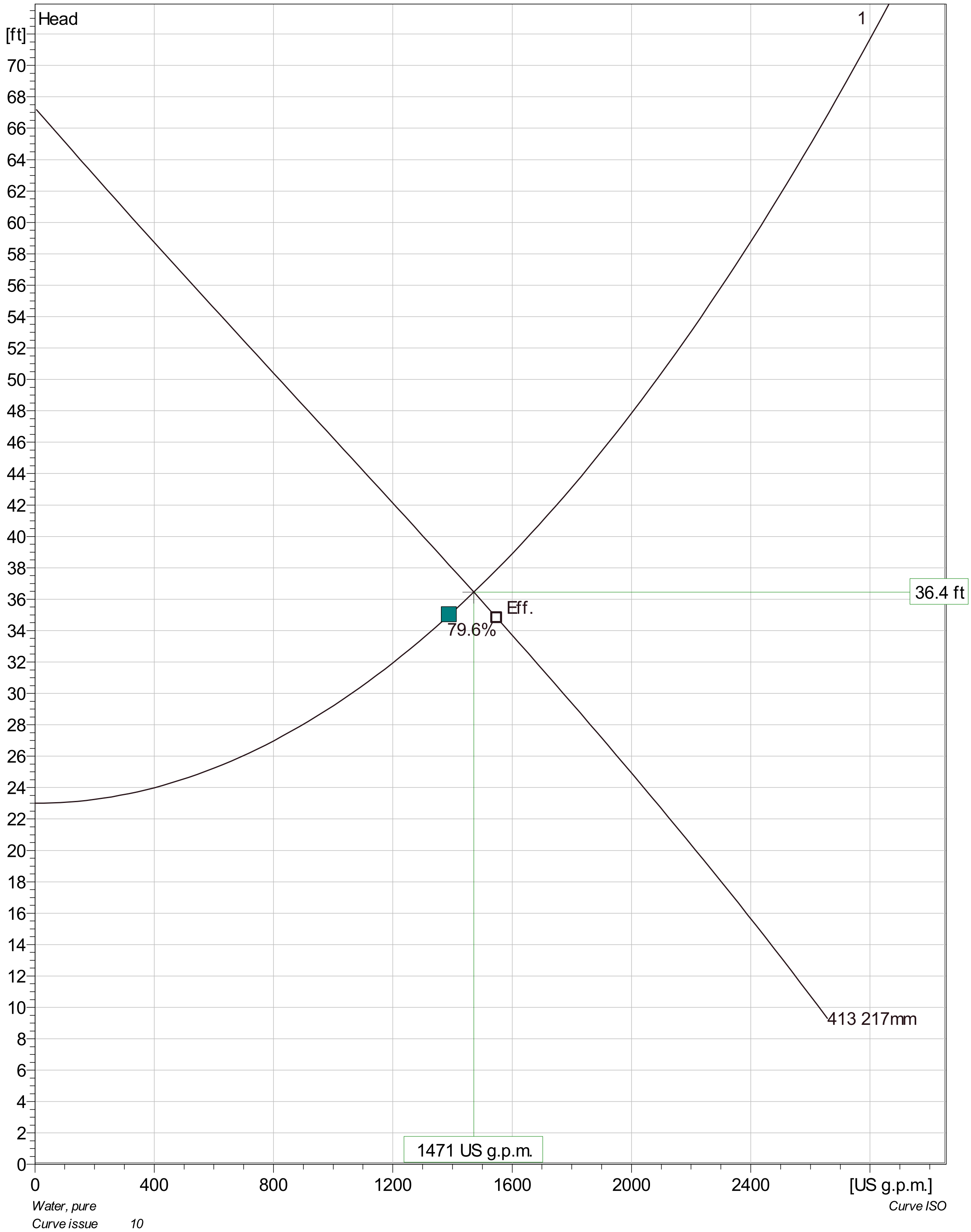
Guarantee

No

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3153 LT 3~ 413

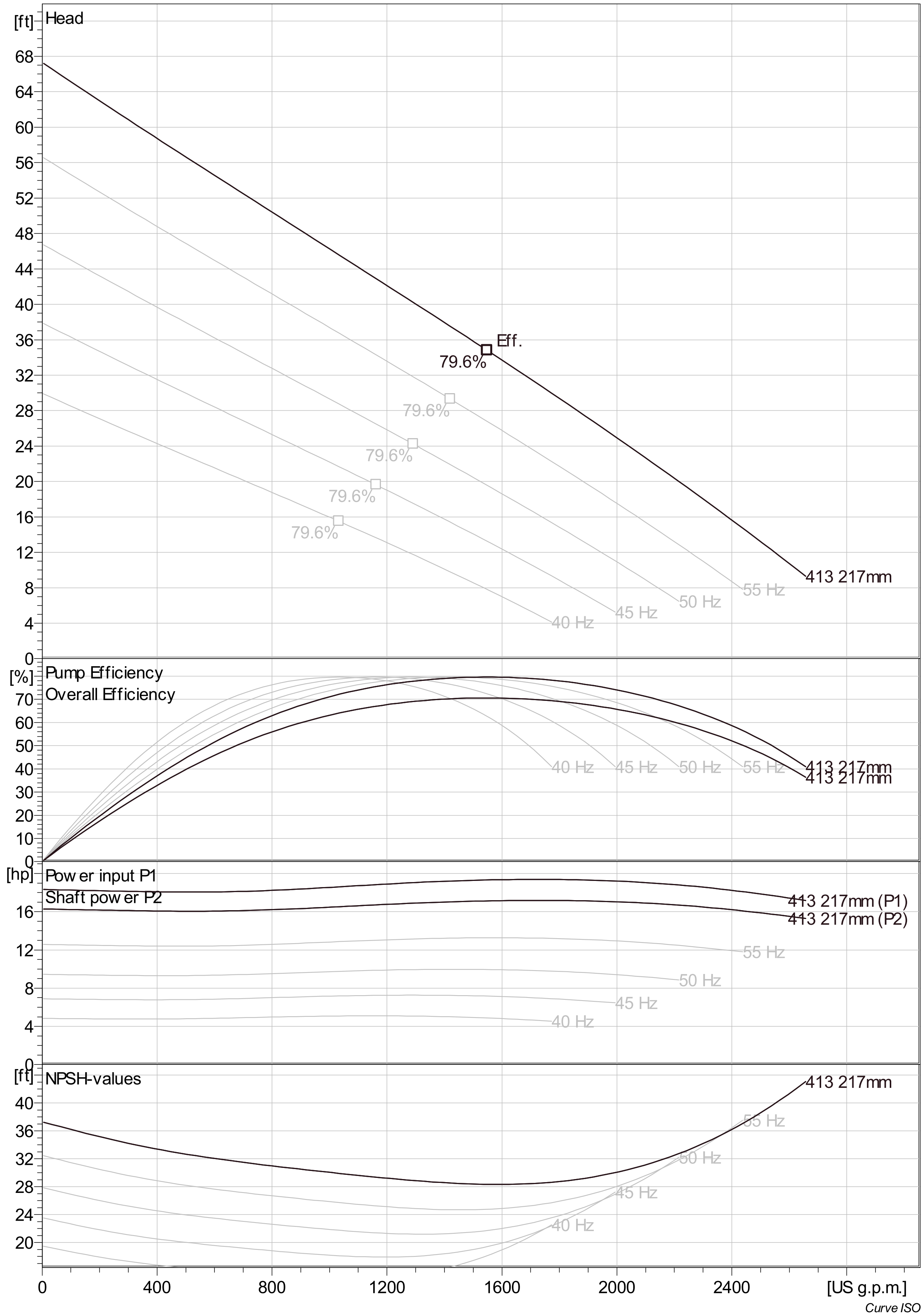
Duty Analysis



Pumps running /System	Individual pump Flow	Head	Shaft power	Total Flow	Head	Shaft power	Pump eff.	Specific energy	NPSHre
1	1470 US g.p.m.	36.4 ft	17.1 hp	1470 US g.p.m.	36.4 ft	17.1 hp	79.4 %	163 kWh/US MG	28.4 ft

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3153 LT 3~ 413
VFD Curve

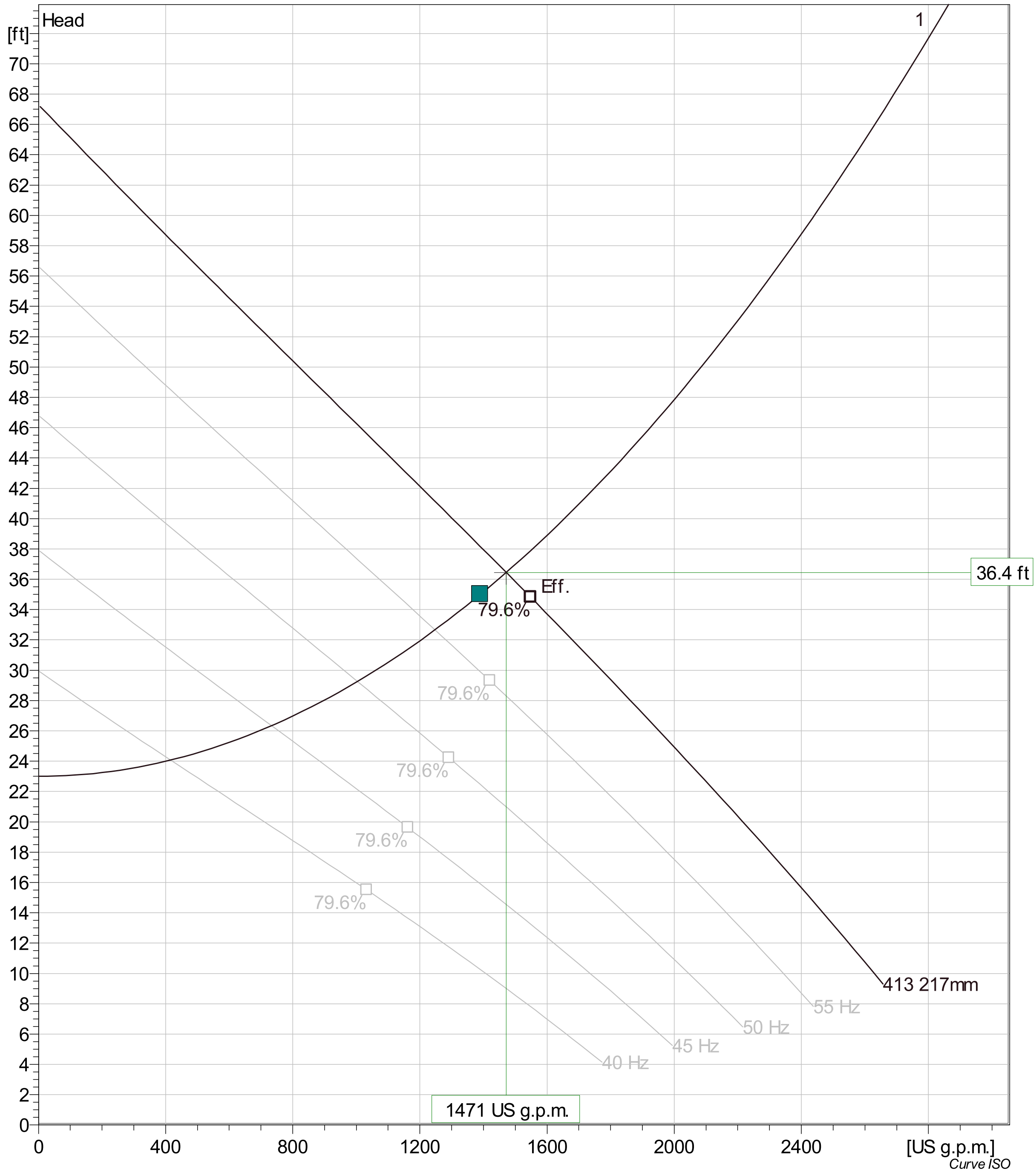


Project	Project ID	Created by	Created on	Last update
			6/23/2018	

xylem

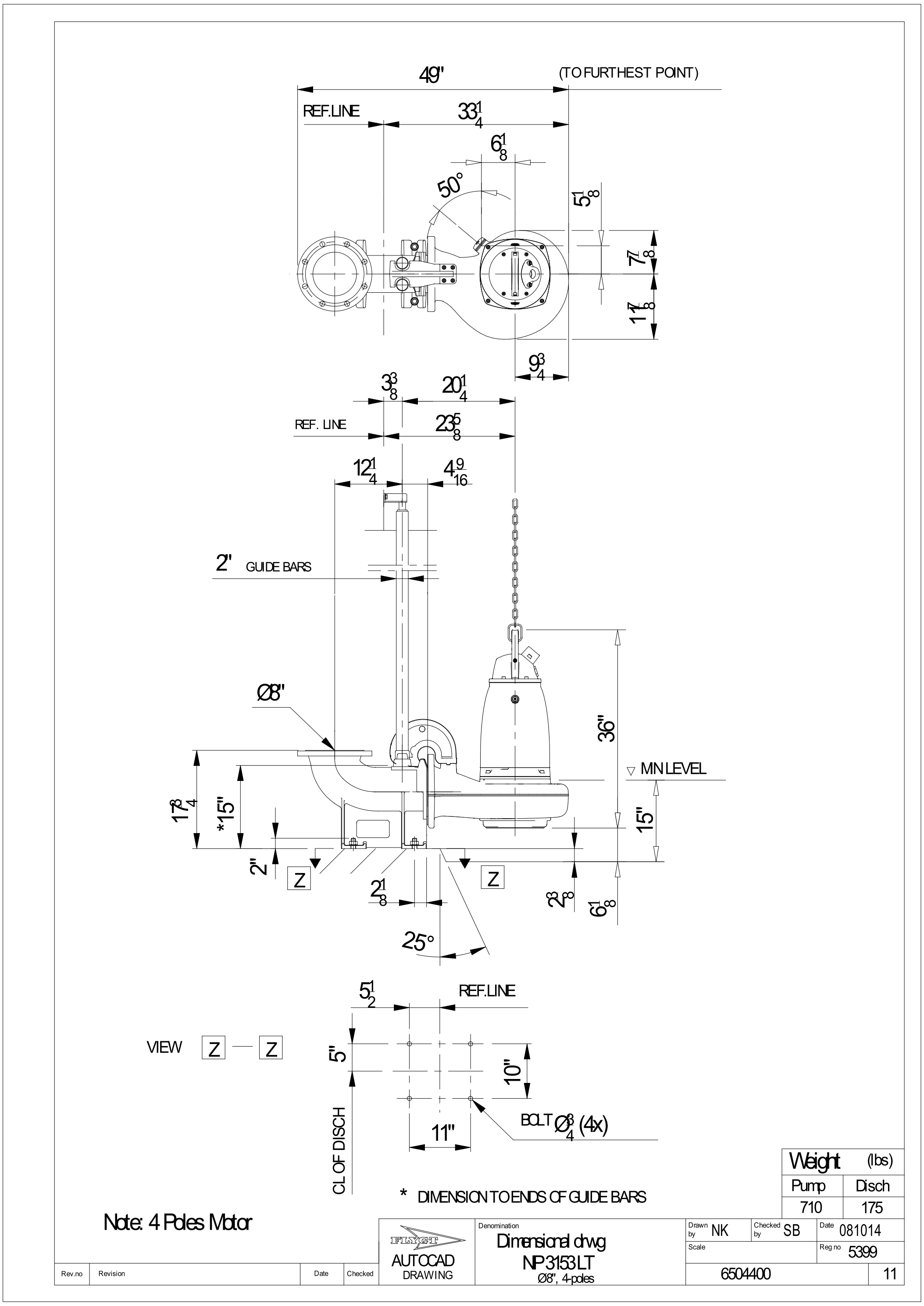
NP 3153 LT 3~ 413

VFD Analysis



Pumps running /System	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	60 Hz	1470 US g.p.m.	36.4 ft	17.1 hp	1470 US g.p.m.	36.4 ft	17.1 hp	79.4 %	163 kWh/US MG	28.4 ft
1	55 Hz	1250 US g.p.m.	32.7 ft	13.1 hp	1250 US g.p.m.	32.7 ft	13.1 hp	78.6 %	146 kWh/US MG	25 ft
1	50 Hz	1000 US g.p.m.	29.3 ft	9.73 hp	1000 US g.p.m.	29.3 ft	9.73 hp	76.3 %	135 kWh/US MG	21.9 ft
1	45 Hz	733 US g.p.m.	26.3 ft	6.95 hp	733 US g.p.m.	26.3 ft	6.95 hp	70.3 %	134 kWh/US MG	19.1 ft
1	40 Hz	416 US g.p.m.	24.1 ft	4.77 hp	416 US g.p.m.	24.1 ft	4.77 hp	53 %	169 kWh/US MG	16.7 ft

NP 3153 LT 3~ 413
Dimensional drawing



Project	Project ID	Created by	Created on	Last update
			6/23/2018	

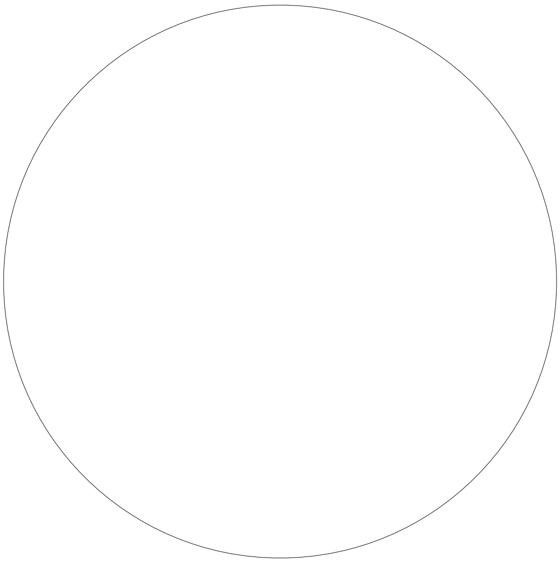
Version 10

NP 3153 LT 3~ 413

Life cycle costs (LCC)

Total lifetime	15	Inflation rate (rate of price increases)	2 %
Annual operating time	5600	Interest rate (for investment)	3 %
Energy cost per kWh	0.00 USD		
Power input P1			

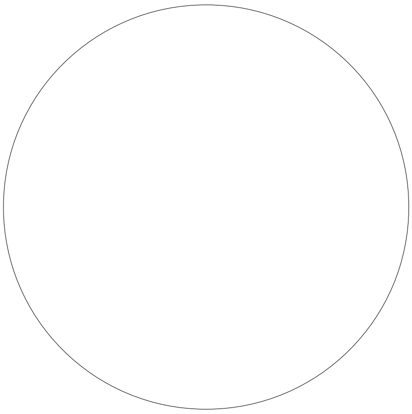
Total costs



0%	**0.00 USD**	Energy
0%	**0.00 USD**	Investment costs
0%	**0.00 USD**	Installation & commissioning
0%	**0.00 USD**	Operating cost
0%	**0.00 USD**	Maintenance & repair
0%	**0.00 USD**	Downtime
0%	**0.00 USD**	Environmental
0%	**0.00 USD**	Decommissioning

0.00 USD

First year costs



0%	**0.00 USD**	Energy (1st year)
0%	**0.00 USD**	Investment costs (1st year)
0%	**0.00 USD**	Installation & commissioning (1st year)
0%	**0.00 USD**	Operating cost (1st year)
0%	**0.00 USD**	Maintenance & repair (1st year)
0%	**0.00 USD**	Downtime (1st year)
0%	**0.00 USD**	Environmental (1st year)
0%	**0.00 USD**	Decommissioning (1st year)

0.00 USD

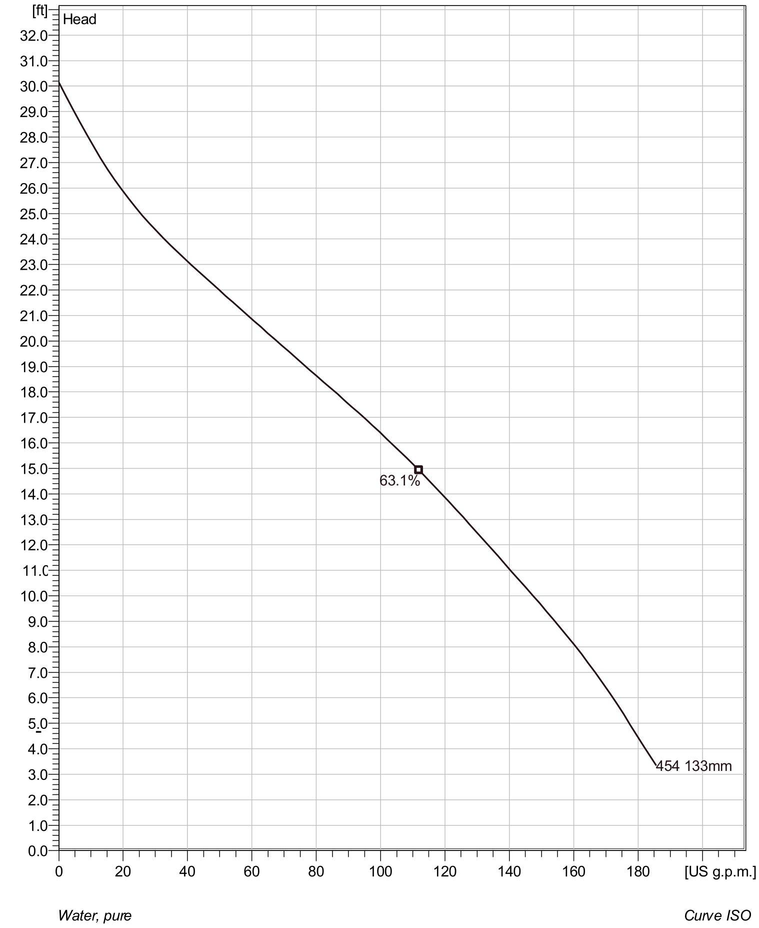
Disclaimer: The calculations and the results are based on user input values and general assumptions and provide only estimated costs for the input data. Xylem inc can therefore not guarantee that the estimated savings will actually occur.

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

FLYGT PRIMARY SCUM PUMP QUOTE

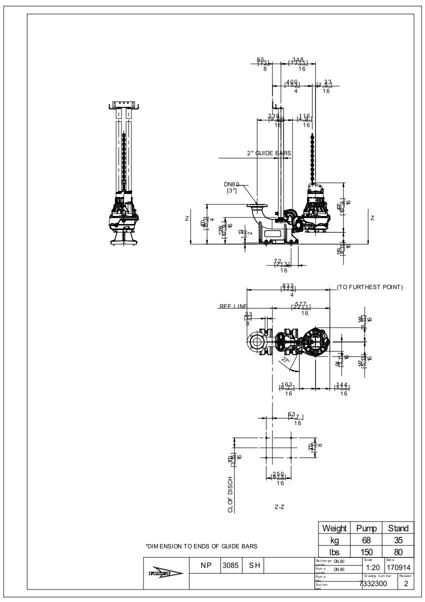
NP 3085 SH 3~ Adaptive 454

Technical specification



Note: Picture might not correspond to the current configuration.

Installation: P - Semi permanent, Wet



General

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

Impeller material	Hard-Iron
Discharge Flange Diameter	3 1/8 inch
Suction Flange Diameter	3 1/8 inch
Impeller diameter	133 mm
Number of blades	2

Motor

Motor #	N3085.070 15-10-4AL-W 2.2hp FM
Stator variant	61
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	2.2 hp
Rated current	3.6 A
Starting current	25 A
Rated speed	1735 rpm
Power factor	
1/1 Load	0.73
3/4 Load	0.65
1/2 Load	0.53
Motor efficiency	
1/1 Load	78.4 %
3/4 Load	77.0 %
1/2 Load	72.5 %

Configuration

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3085 SH 3~ Adaptive 454

Performance curve

Pump

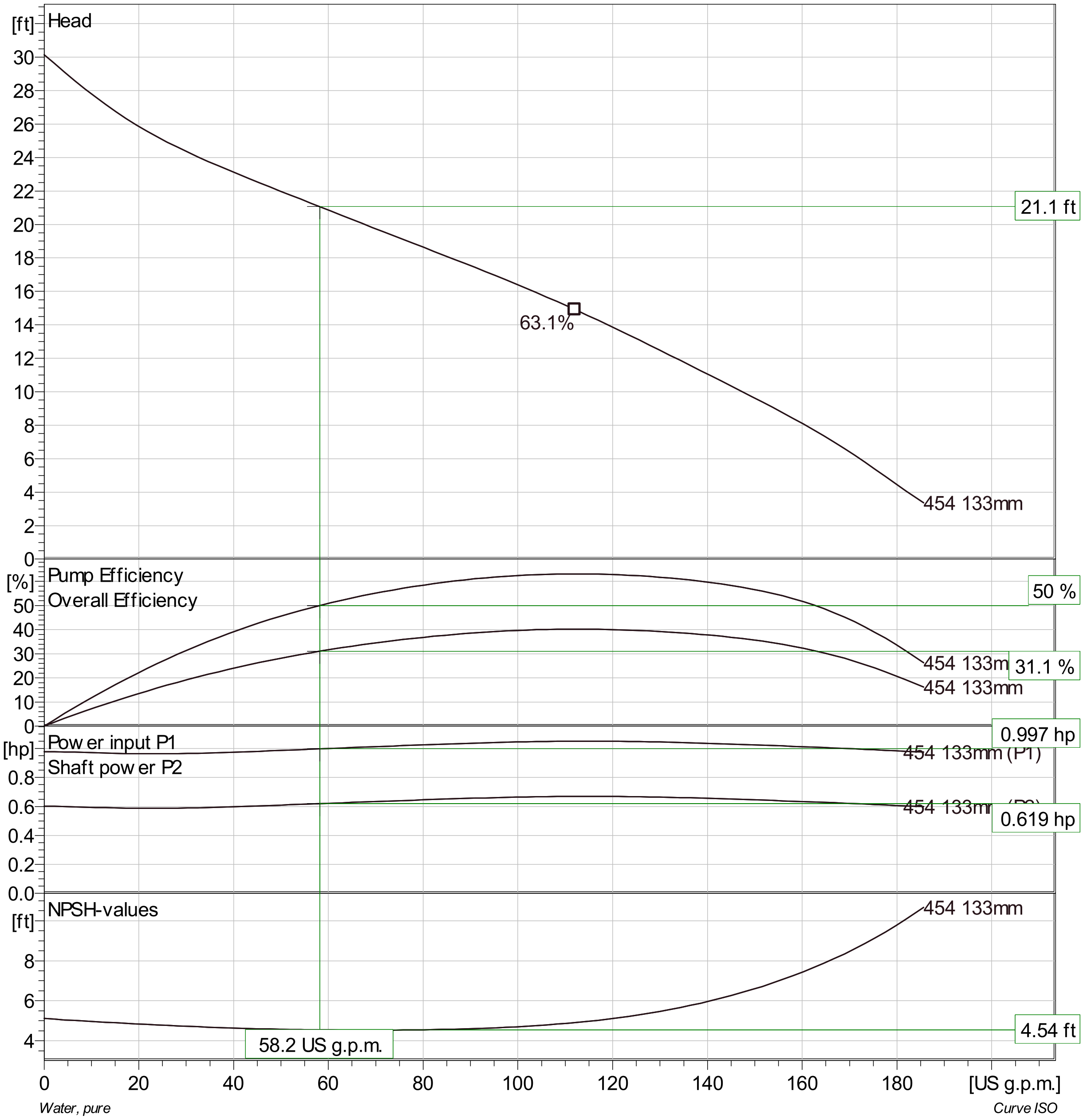
Discharge Flange Diameter	3 1/8 inch
Suction Flange Diameter	80 mm
Impeller diameter	5 1/4"
Number of blades	2

Motor

Motor #	N3085.070 15-10-4AL-W 2.2hp
Stator variant	61
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	2.2 hp
Rated current	3.6 A
Starting current	25 A
Rated speed	1735 rpm

Power factor	
1/1 Load	0.73
3/4 Load	0.65
1/2 Load	0.53

Motor efficiency	
1/1 Load	78.4 %
3/4 Load	77.0 %
1/2 Load	72.5 %

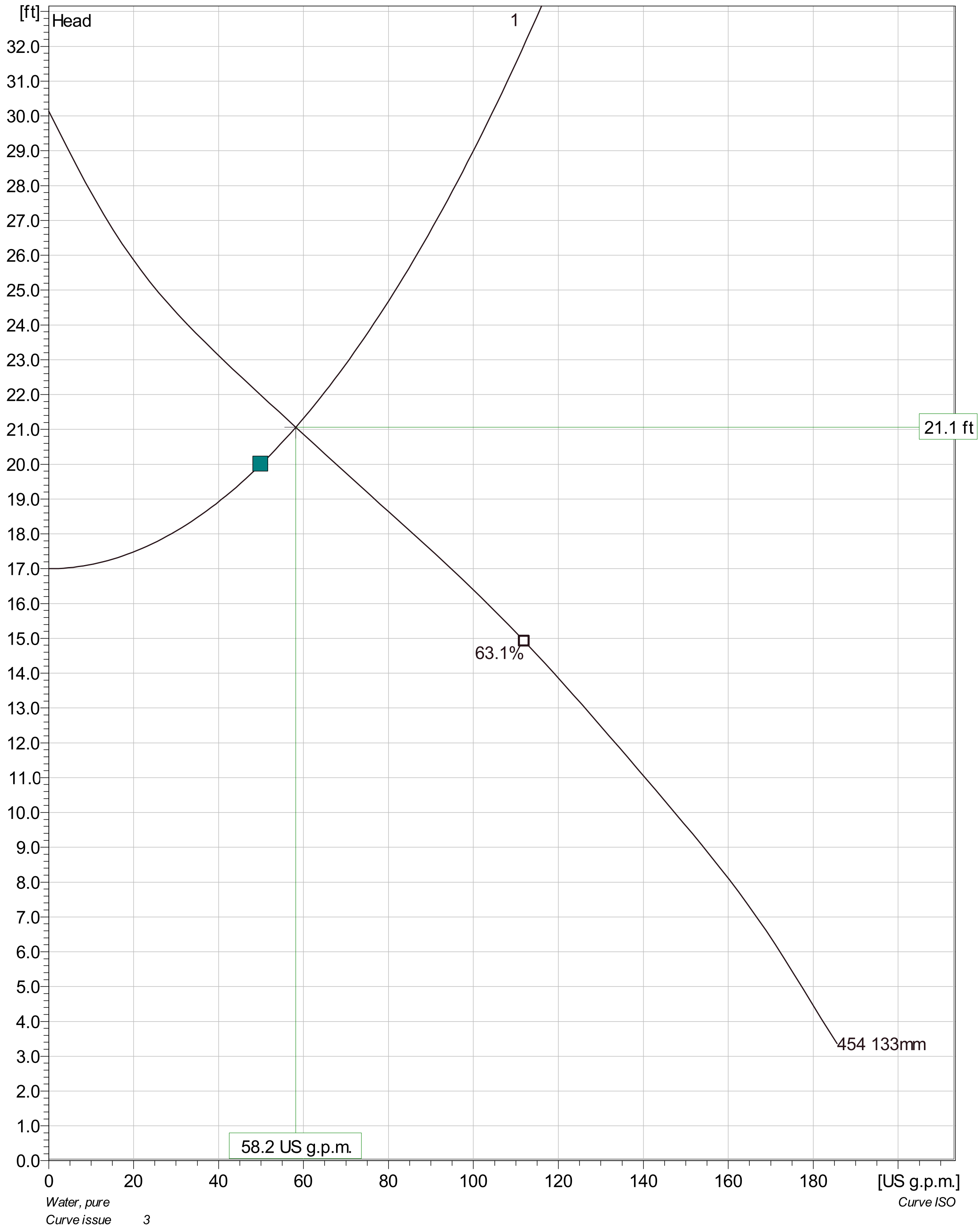


Duty point		Guarantee
Flow	Head	
50 US g.p.m.	20 ft	No

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3085 SH 3~ Adaptive 454

Duty Analysis

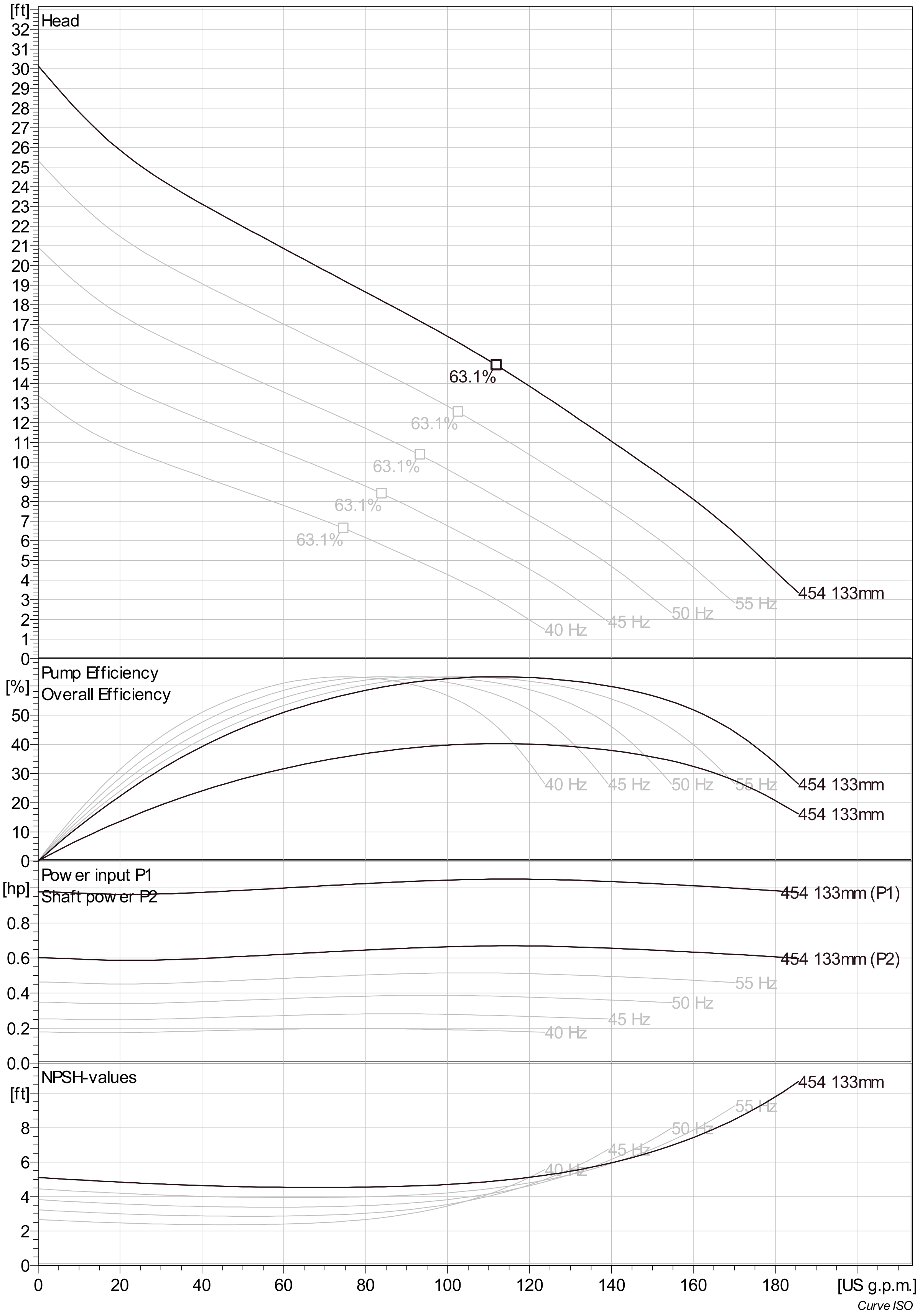


Pumps running /System	Individual pump Flow	Head	Shaft power	Total Flow	Head	Shaft power	Pump eff.	Specific energy	NPSHre
1	58.2 US g.p.m.	21.1 ft	0.619 hp	58.2 US g.p.m.	21.1 ft	0.619 hp	50 %	213 kWh/US MG	4.54 ft

Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3085 SH 3~ Adaptive 454

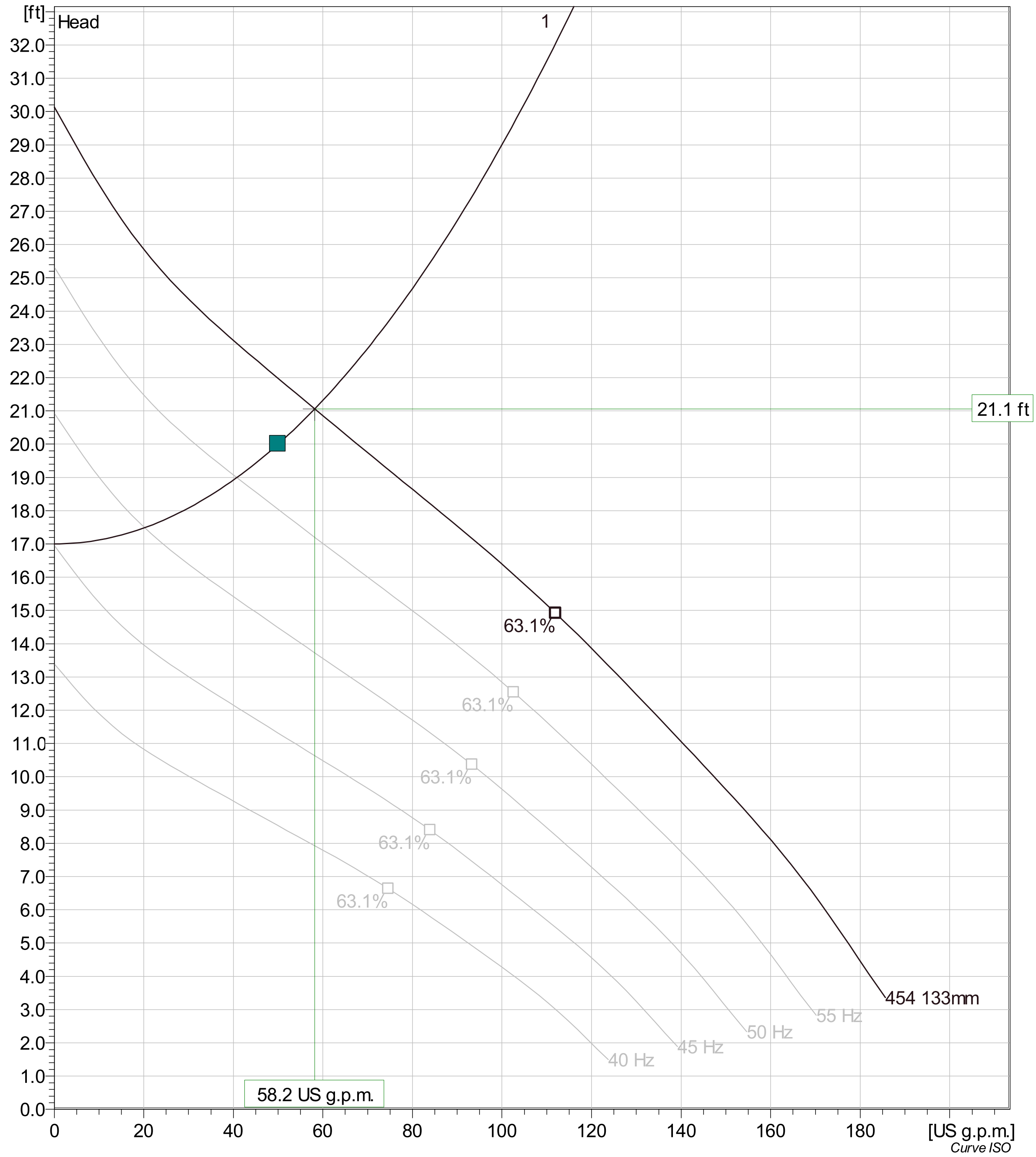
VFD Curve



Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3085 SH 3~ Adaptive 454

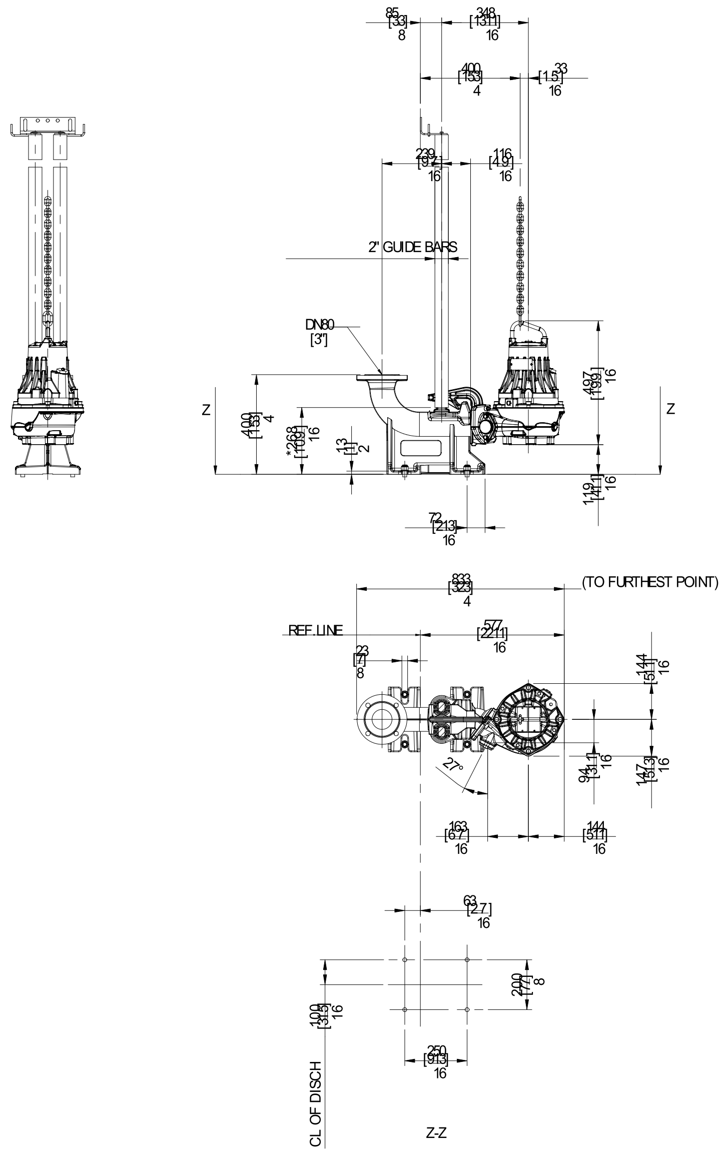
VFD Analysis



Pumps running /System	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	60 Hz	58.2 US g.p.m.	21.1 ft	0.619 hp	58.2 US g.p.m.	21.1 ft	0.619 hp	50 %	213 kWh/US MG	4.54 ft
1	55 Hz	40.8 US g.p.m.	19 ft	0.464 hp	40.8 US g.p.m.	19 ft	0.464 hp	42.2 %	254 kWh/US MG	4.01 ft
1	50 Hz	20.2 US g.p.m.	17.5 ft	0.34 hp	20.2 US g.p.m.	17.5 ft	0.34 hp	26.3 %	435 kWh/US MG	3.58 ft
1	45 Hz									
1	40 Hz									

NP 3085 SH 3~ Adaptive 454

Dimensional drawing



*DIMENSION TO ENDS OF GUIDE BARS

Weight	Pump	Stand
kg	68	35
lbs	150	80

FLYGT	NP	3085	SH	Discharge outlet DN 80 Pump outlet DN 80	Scale 1:20	Date 170914
				Pump inlet Suction inlet	Drawing number 7332300	Revision 2

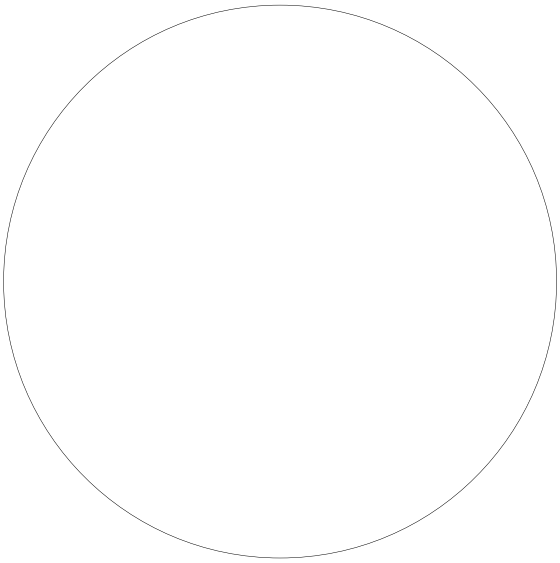
Project	Project ID	Created by	Created on	Last update
			6/23/2018	

NP 3085 SH 3~ Adaptive 454

Life cycle costs (LCC)

Total lifetime	15	Inflation rate (rate of price increases)	2 %
Annual operating time	5600	Interest rate (for investment)	3 %
Energy cost per kWh	0.00 USD		
Power input P1			

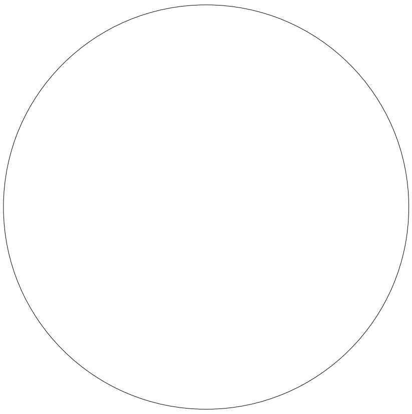
Total costs



0%	**0.00 USD**	Energy
0%	**0.00 USD**	Investment costs
0%	**0.00 USD**	Installation & commissioning
0%	**0.00 USD**	Operating cost
0%	**0.00 USD**	Maintenance & repair
0%	**0.00 USD**	Downtime
0%	**0.00 USD**	Environmental
0%	**0.00 USD**	Decommissioning

0.00 USD

First year costs



0%	**0.00 USD**	Energy (1st year)
0%	**0.00 USD**	Investment costs (1st year)
0%	**0.00 USD**	Installation & commissioning (1st year)
0%	**0.00 USD**	Operating cost (1st year)
0%	**0.00 USD**	Maintenance & repair (1st year)
0%	**0.00 USD**	Downtime (1st year)
0%	**0.00 USD**	Environmental (1st year)
0%	**0.00 USD**	Decommissioning (1st year)

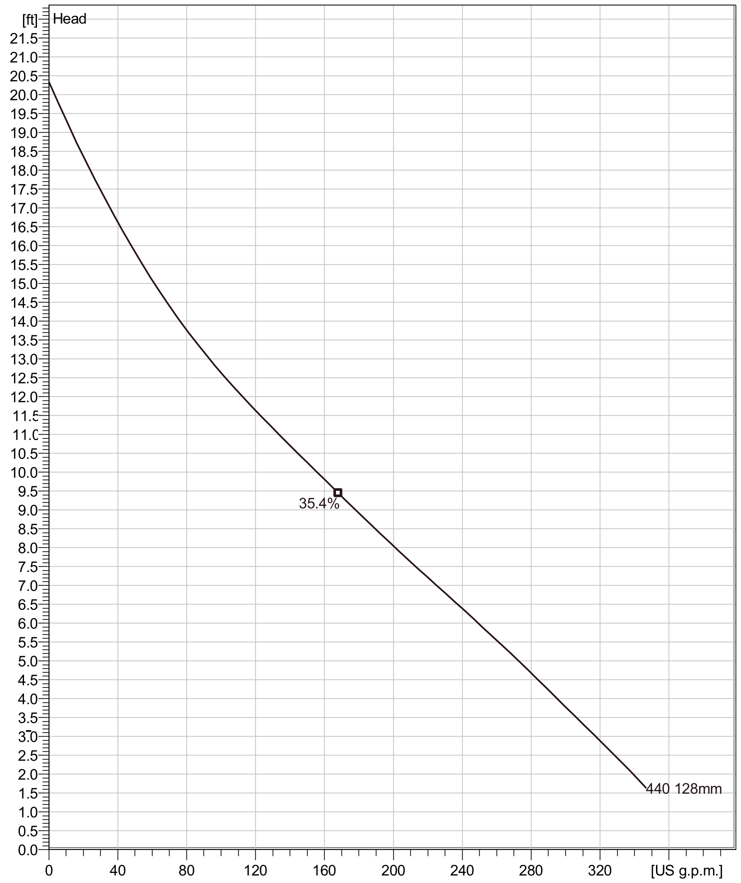
0.00 USD

Disclaimer: The calculations and the results are based on user input values and general assumptions and provide only estimated costs for the input data. Xylem inc can therefore not guarantee that the estimated savings will actually occur.

FLYGT TREATMENT WETLAND 4 PUMP

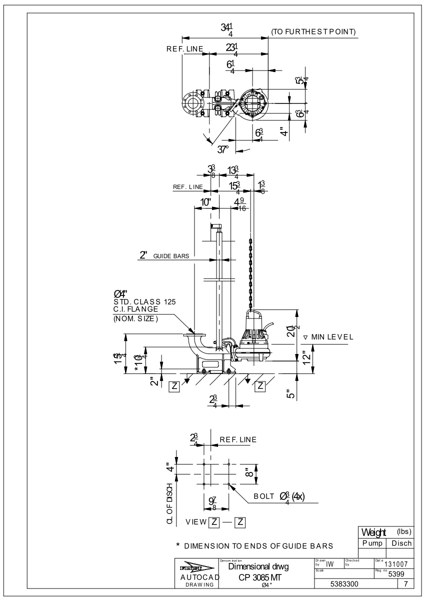
CP 3085 MT 3~ 440

Technical specification



Water, pure *Curve ISO*

Installation: P - Semi permanent, Wet



Note: Picture might not correspond to the current configuration.

General

Shrouded single or multi-channel impeller pumps with large throughlets and single volute pump casing for liquids containing solids and fibres. Cast iron design with double sealing technology. Some models available as stainless steel versions.

Impeller

Impeller material	Grey cast iron
Discharge Flange Diameter	3 1/8 inch
Suction Flange Diameter	3 1/8 inch
Impeller diameter	128 mm
Number of blades	1
Throughlet diameter	3 inch

Motor

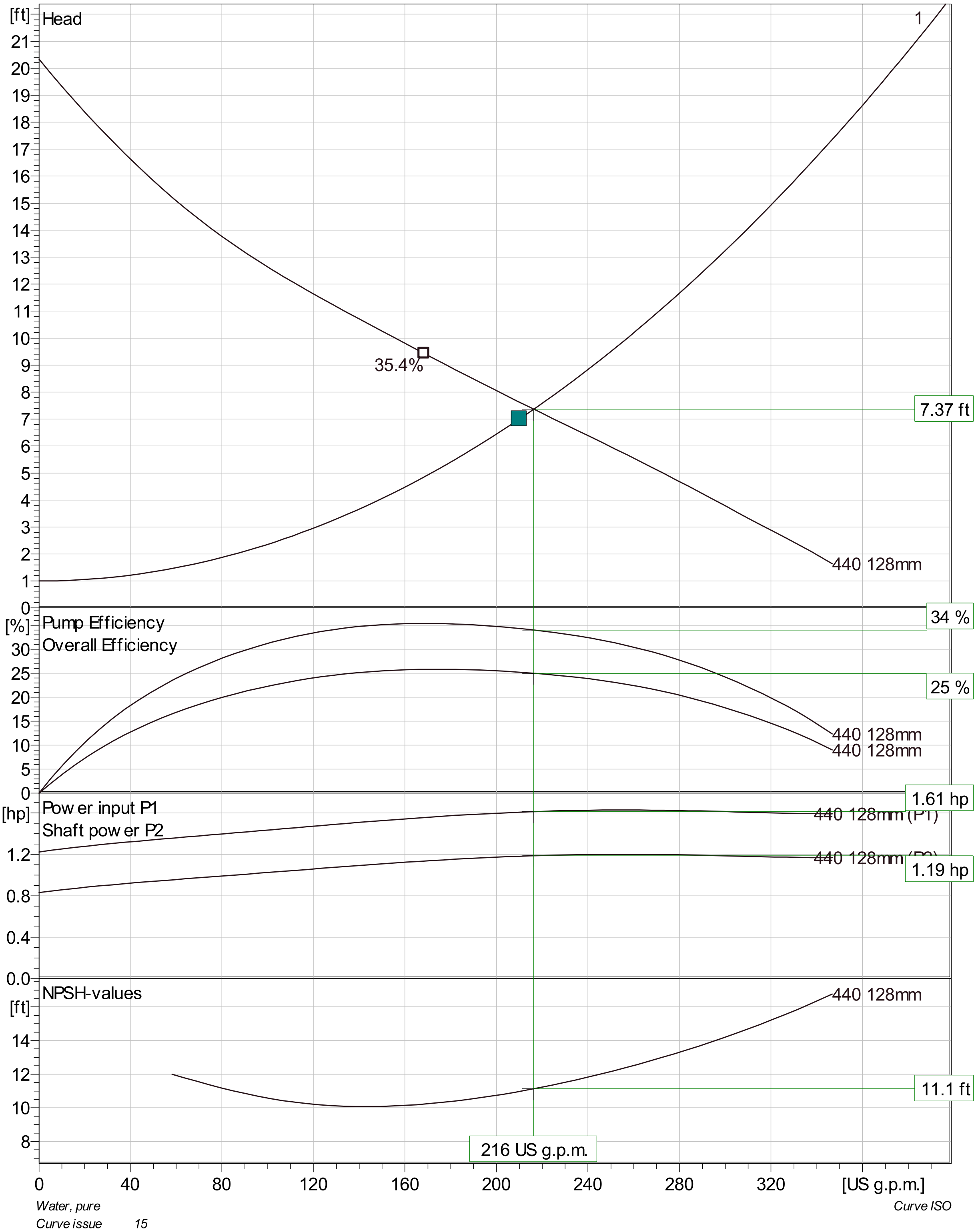
Motor #	C3085.183 15-10-4AL-W 2.2hp Standard
Stator variant	61
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	2.2 hp
Rated current	3.6 A
Starting current	25 A
Rated speed	1735 rpm
Power factor	
1/1 Load	0.73
3/4 Load	0.65
1/2 Load	0.53
Motor efficiency	
1/1 Load	78.0 %
3/4 Load	77.0 %
1/2 Load	72.5 %

Configuration

Project	Project ID	Created by	Created on	Last update
			6/8/2018	

CP 3085 MT 3~ 440

Duty Analysis



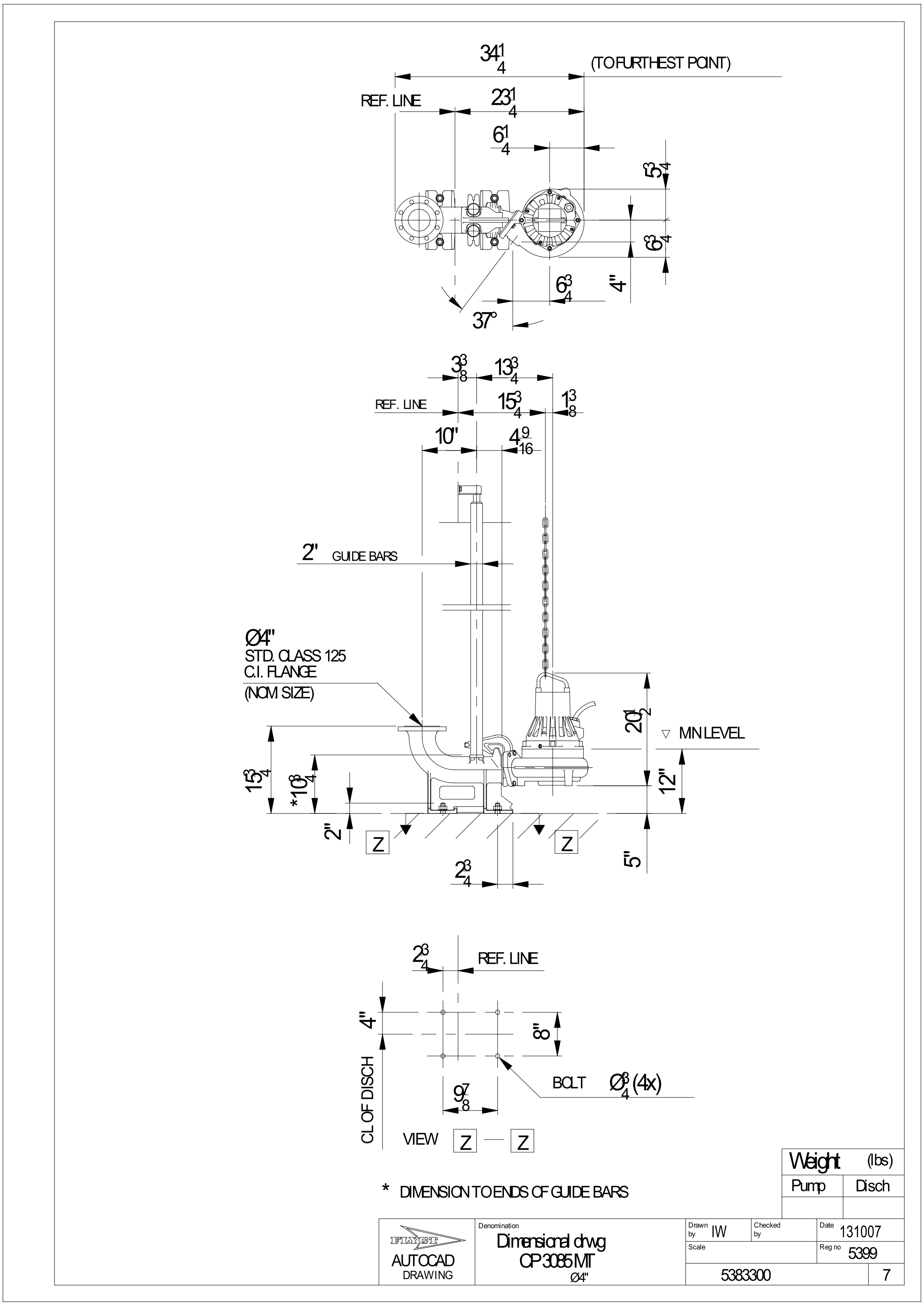
Pumps running /System	Individual pump Flow	Head	Shaft power	Total Flow	Head	Shaft power	Pump eff.	Specific energy	NPSHre
1	216 US g.p.m.	7.37 ft	1.19 hp	216 US g.p.m.	7.37 ft	1.19 hp	34 %	92.6 kWh/US MG	11.1 ft

Project	Project ID	Created by	Created on	Last update
			6/8/2018	

FLYGT
a xylem brand

CP 3085 MT 3~ 440

Dimensional drawing



Project	Project ID	Created by	Created on	Last update
			6/8/2018	

Appendix 5C

ALKALINITY FEED SYSTEM

5C.1 Chemical Alternatives for Adding Alkalinity

There is a range of chemicals available for adding alkalinity to a wastewater treatment process. This analysis focuses on caustic soda (sodium hydroxide, NaOH), magnesium hydroxide (Mg(OH)2), and hydrated lime (calcium hydroxide, Ca(OH)2).

5C.1.1 Caustic Soda

Caustic soda is a common chemical used for alkalinity addition. It is delivered and stored as a slurry, typically at 25 percent. At this concentration it is considered hazardous. Caustic soda is generally more soluble and faster acting than magnesium hydroxide, but it provides less alkalinity per unit volume than both hydrated lime and magnesium hydroxide. Therefore, larger tanks and pumps, and more frequent chemical deliveries, would be required in comparison to magnesium hydroxide or hydrated lime.

5C.1.2 Magnesium Hydroxide

Magnesium hydroxide adds alkalinity and is non-hazardous, unlike caustic soda. It is relatively safe to handle and environmentally safe, in comparison to hydrated lime. It can be delivered and stored as a slurry if it is periodically mixed to keep it in suspension. Magnesium hydroxide is slower to react than the other chemicals, such as hydrated lime and caustic soda, so mixing and retention time must be accounted for in the design and control of the injection system.

Magnesium hydroxide has limited solubility and will only raise the pH to about pH 9.5, even if significantly over-dosed. Overdosing is less likely since the excess magnesium hydroxide in solution becomes available as needed, acting as a time-release alkalinity agent. In addition, since magnesium is a divalent cation, magnesium hydroxide aids floc formation. Magnesium hydroxide provides more alkalinity per volume than hydrated lime reducing the size of the tanks and pumps, and the number of chemical deliveries, in comparison to hydrated lime.

5C.1.3 Hydrated Lime

Like magnesium hydroxide, hydrated lime can be delivered as a slurry. It is simple to feed and is typically readily available and inexpensive compared to other chemicals. Hydrated lime is generally more soluble and faster acting than magnesium hydroxide, but it provides less alkalinity per unit volume than magnesium hydroxide. Therefore, larger tanks and pumps, and more frequent chemical deliveries, would be required in comparison to magnesium hydroxide.

Hydrated lime can cause scaling at feed facilities if they are not operated and maintained properly, which means there is a higher effort for equipment operation and maintenance. In addition, hydrated lime will buffer up to a pH of 12, which will negatively impact the secondary process if is overdosed, and it is corrosive so it must be handled properly to avoid skin contact.

5C.2 Facility sizing

The estimated facility size for caustic soda, magnesium hydroxide, and hydrated lime were developed to compare tank size and pumping requirements. This will affect the footprint of the facilities as well as the associated O&M. A comparison of the tank sizes and pump rates for the alkalinity facilities for various loading conditions are presented in Table 5C.1.

Table 5C.1 Facility Sizing Comparison

Item	Current Conditions		
	ADWF	MMF	PWWF
Additional Alkalinity Required, lbs/day as $CaCO_3$	2,400	5,400	3,900
Caustic Soda (1)			
Alkalinity per Gallon, lbs $CaCO_3$ per gallon	4.0	4.0	4.0
Volume required, gal/day	592	1,356	987
Storage volume required for 14 days, gal	8,300	19,000	13,800
Feed pump rate, gal/hr	24.7	56.5	41.1
Number of Tanks	2	2	2
Tank Volume Required for 14 day Max Month Supply		10,000	
Magnesium Hydroxide Slurry (2)			
Alkalinity per Gallon, lbs $CaCO_3$ per gallon	12.5	12.5	12.5
Volume required, gal/day	189	434	316
Storage volume required for 14 days, gal	2,700	6,100	4,400
Feed pump rate, gal/hr	7.9	18.1	13.2
Number of Tanks	2	2	2
Tank Volume Required for 14 day Max Month Supply		3,000	
Hydrated Lime (3)			
Alkalinity per Gallon, lbs $CaCO_3$ per gallon	6.8	6.8	6.8
Volume required, gal/day	346	794	578
Storage volume required for 14 days, gal	4,800	11,100	8,100
Feed pump rate, gal/hr	14.4	33.1	24.1
Number of Tanks	2	2	2
Tank Volume Required for 14 day Max Month Supply		6,000	

Notes:
(1) Caustic soda is 25 percent solids.
(2) Magnesium hydroxide slurry is 60 percent solids.
(3) Hydrated lime is 45 percent solids.

Chemical bulk storage facility sizing is based on a conservative approach of chemical deliveries twice per month during maximum month conditions. The size of the chemical feed pumps is based upon the chemical flow rate required during peak loading. As shown in Table 5C.1, the smallest footprint would be needed if magnesium hydroxide slurry was used. With this chemical only two 3,000 gallon tanks would be required. However, if caustic soda was used, two 10,000 gallon tanks would be required. In between, hydrated lime would require two 6,000 gallon tanks.

For this predesign report, it was assumed that a hydrated lime slurry would be used. However, costs associated with this chemical will be evaluated during final design.

Appendix F

TM 6 SOLIDS HANDLING AND DIGESTER IMPROVEMENTS

City of Arcata
Wastewater Treatment Facilities Improvements

Technical Memorandum 6
SOLIDS HANDLING AND DIGESTER IMPROVEMENTS

FINAL | April 2019

City of Arcata
Wastewater Treatment Facilities Improvements

TECHNICAL MEMORANDUM 6

SOLIDS HANDLING AND DIGESTER IMPROVEMENTS

FINAL | April 2019

REGISTERED PROFESSIONAL ENGINEER
DOUGLAS W. WING
No. 38950
CIVIL
STATE OF CALIFORNIA

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Appendix A Key Solids Criteria Associated with 1984 Project

Appendix B Design Criteria and Process Calculations – Proposed Upgrades

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Figures

Figure 6.1 Solids Processing Schematic 6-3

Abbreviations

AC	Acre
AFY	Acre-feet per year
ADD	Average Day Demand
BOD	Biochemical Oxygen Demand
btu	British Thermal Unit
Carollo	Carollo Engineers, Inc.
cf	cubic feet
cfs	cubic feet per second
CIP	Capital Improvement Program or cast iron pipe
F	Fahrenheit
^{o}F	Degrees Fahrenheit
ft	Feet
ft-msl	feet above mean sea level
GAC	Granular Activated Carbon
gpcd	gallons per capita day
gpd	gallons per day
HGL	Hydraulic Grade Line
kW	Kilo Watts
lb/d	pounds per day
µg/L	micrograms per liter
MDD	Max Day Demand
MG	million gallons
mgd	million gallons per day
mg/L	milligrams per liter
mgd	million gallons per day
MinDD	Minimum Day Demand
MinMD	Minimum Month Demand
MMD	Maximum Month Demand
msl	Mean sea level
PHD	peak hour demand
PS	Primary Solids

psi	pounds per square inch
RO	Reverse Osmosis
SCADA	Supervisory Control and Data Acquisition
SF	Square Feet
SWP	State Water Project
TSS	Total Suspended Solids
VSS	Volatile Suspended Solids
VSR	Volatile Solids Reduction
WAS	Waste Activated Solids
WRF	Water Reclamation Facility
WWTP	Wastewater treatment plant

Technical Memorandum 6

SOLIDS HANDLING AND DIGESTER IMPROVEMENTS

6.1 Purpose

The purpose of this Technical Memorandum (TM) is to identify, evaluate, select and size proposed solids handling and digester improvements for the City of Arcata Wastewater Treatment Plant (WWTP). The need for solids handling improvements was identified in the Facilities Plan and additional analysis and recommendations are presented in this TM. Refinements and final equipment selection would be completed during the final design process. As per the scope of services, the intent of the analysis in this TM is to refine the analysis of the Facilities Plan rather than to introduce a series of new concepts and alternatives.

The solids handling and digester improvements summarized in this TM are predicated upon other system improvements including headworks screening and grit removal as well as primary and secondary clarification and sludge pumping improvements. These related improvements are addressed in separate TM's and such work is not discussed further here. This TM focuses on thickening, digestion, and dewatering assuming the other improvements are also completed.

6.2 Summary of Findings and Recommendations

The key findings and recommendations of this TM are summarized below:

- Solids Thickening:
  - Provide a new rotary drum thickener for thickening secondary solids prior to digestion.
  - Provide piping to send primary sludge to thickener for co-thickening.
- Digester Improvements:
  - Clean both the primary and secondary digesters.
  - Replace primary digester floating cover with a fixed roof type cover
  - Replace the secondary digester floating roof with a new floating roof cover.
  - Replace the existing boiler / heat exchanger with a new unit.
  - Inspect the digester mixing and heating piping and replace existing plug valves that are inoperable and mixing nozzles if worn and deteriorated.
- Sludge Dewatering: Existing drying bed system will be used for sludge dewatering.

6.3 Background

The existing solids handling and treatment facilities include primary and secondary digesters, digester mixing and heating facilities for the primary digester, sludge drying beds, compost operation, and digester gas handling. The digesters were constructed as part of the original plant in the late 1950s. The primary digester was upgraded in the 1984 project, including increasing the overall height.

Floating gas holder roofs were added at that time as well. The external condition of the digesters was rated as Fair in the Facilities Plan given the overall age of the digesters and other information known about their condition. The digesters are reported to have been cleaned in 2002 and 2014 although there are no reports available on the internal condition. For the purposes of the Facilities Plan and this TM, the overall digester structures are assumed to be usable. However, the Facilities Plan recommended rehabilitation of the covers, which is discussed in more detail later in this TM.

6.4 Overall System Configuration

The overall solids handling process flow schematic for the proposed upgraded treatment plant is presented in Figure 6.1. Much of the existing digestion Infrastructure is planned to be reused so that capital improvements are focused on maintenance and upgrades to meet the solids handling requirements of the new mechanical treatment equipment. Pertinent support information regarding design criteria from 1984 is included in Appendix A and process calculations and criteria for proposed upgrades is included in Appendix B.

6.5 Design Criteria

The key solids handling design criteria used throughout this TM are summarized in Table 6.1.

Table 6.1 Summary of Key Solids Handling Design Criteria

Criterion	Characteristic
Solids Thickening	
Solids Sources	Primary and Secondary Sludge
Solids Capture	95% Capture at 5% TSS
Thickened Sludge Loading, Maximum	16,000 gal/day
Digesters	
Primary Digester	
Type	Heated, mixed
Detention Time	21 days
Boiler Heating Capacity	1,000,000 but/hr
Secondary Digester	
Type	Unheated, Unmixed
Detention Time	Varies, depends on draw schedule & decanting
Supernatant Return	Decant and convey back to headworks
Overall` Volatile Solids Destruction	50%
Sludge Dewatering	
Type	Covered Drying Beds, air dry, periodic mixing
Size	30,000 sf, Two beds
Draw Frequency, Minimum	2 -3 times per year

See Appendix A for original 1984 system design criteria and Appendix B for more detailed design criteria and process calculations associated with recommended solids improvements.

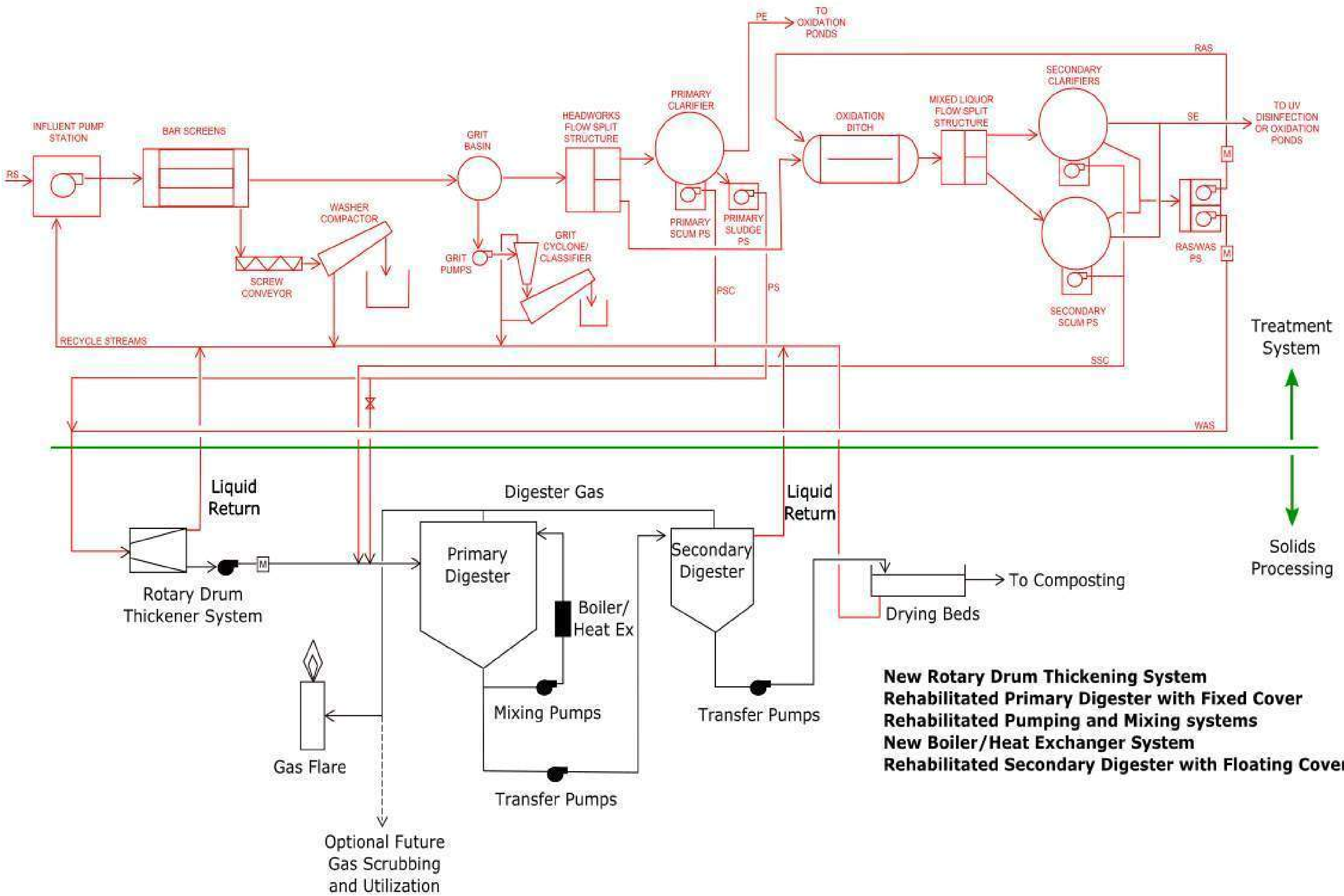

Figure 6.1 Solids Processing Schematic

6.6 Solids-Thickening Prior to Digestion

The existing solids processing system does not employ thickening prior to digestion. The existing system is based on collecting primary sludge only, which is highly digestible and tends to perform reasonably well in the digester without thickening. The digesters were originally sized to handle the additional water from unthickened primary sludge. However, the new system will have both primary and secondary sludge which introduces additional water and secondary sludge can be more difficult to digest without thickening. For the development of a new solids thickening system there are advantages to co-thickening primary and secondary sludge together such as improved thickening for secondary waste activated sludge (WAS), which is often difficult to thicken on its own, as well as reduced costs by utilizing a common process for both primary and secondary sludge.

The modified wastewater treatment process will produce mostly secondary waste activated sludge, with a small amount of primary sludge depending on how the primary clarifier is operated. The waste activated sludge is typically very dilute and it is best to thicken prior to digestion. Any primary sludge produced can be mixed with the waste activated sludge in a co-thickening process. A number of potential co-thickening technologies were considered and Rotary Drum Thickeners (RDT) were identified as the most appropriate approach. The system configuration should allow for pumping primary solids directly to digesters and thickening secondary solids in an RDT prior to pumping to digesters, or Co-thicken primary and secondary solids in an RDT prior to pumping to digesters.

How the primary and secondary solids are produced and may be mixed and thickened should be refined based on operational experience and preference. In addition, the proposed treatment upgrades and solids management strategy has a number of overall solids handling implications, including treating wastewater in the oxidation ditch with a long retention time to significantly reduce the volatile solids and hence reduce the biological load on the digesters. The implications are further discussed under the digestion and dewatering sections of this summary.

A summary of the proposed thickening process is summarized in Table 6.2.

Table 6. 2 Solids Thickening Prior to Digestion

Near Term Strategy/Improvements	Longer Term Adaptive Management/Improvements
• New RDTs. • Co-Thicken primary and secondary Solids in RDTs • Allow for pumping primary solids directly to digesters. • Always thicken secondary solids in an RDT prior to digestions.	• Treat the wastewater in the oxidation ditch with a long retention time to significantly reduce the volatile solids and the biological load on the digesters.

A cothickening process could produce 5 percent solids feed to the digesters which is important for achieving acceptable hydraulic retention time in the digesters. A new thickening system could be located in the vicinity of the existing small primary clarifier adjacent to the existing digesters. The small clarifier will no longer be needed with the treatment plant upgrades and is planned to be demolished and so thickening facilities and piping could be located in this area.

To achieve the co-thickening objective, the following five thickening technologies were evaluated:

1. Gravity Thickener.
2. Dissolved Air Flotation Thickener (DAFT).
3. Centrifuge.
4. Gravity Belt Thickener (GBT).
5. RDTs.

Each of these is briefly discussed below.

6.6.1 Gravity Thickeners

Gravity Thickeners are similar to a primary clarifier and were in common use in the past, but problems including poor settling performance, gas forming from anaerobic conditions, odors, and difficulties with control of the process has led to better options. Gravity thickening will not be considered further.

6.6.1.1 Dissolved Air Flotation Thickeners

DAFTs have been used for many years to thicken secondary WAS, which can otherwise be difficult to separate with gravity. This is accomplished by using small air bubbles to separate these solids from the liquid stream and float them to the top of the liquid surface for skimming off. While DAFT is typically an effective technology for secondary WAS, it is less than optimal performance with Primary Solids or mixed WAS/PS. For a co-thickening operation, this is not considered the best technology and will not be considered further.

6.6.2 Centrifuges

Centrifuge thickening has proven itself to be a very efficient and effective method for separating solids, either primary solids, WAS or a combination of the two. The centrifuge process is enclosed and contains odors and moisture. It is also capable of producing high concentrations of solids in the thickening process, beyond the 5 percent that is needed for digestion. Also, centrifuges are quite sophisticated and require significant operational skill as well as significant repair, maintenance and upkeep. Centrifuges also require more electrical energy than all of the thickening technologies under consideration. Centrifuges may at some point be appropriate for dewatering digested sludge, but this technology will not be considered further for thickening.

6.6.3 Gravity Belt Thickeners

GBTs utilize traveling belt filters to continuously allow water in sludge to pass through the traveling belt leaving thickened solids on the belt surface for removal. This technology can work well with both primary sludge and waste activated secondary sludge. Although waste activated sludge can be more difficult to thicken, combining it with primary sludge can enhance thickening performance and hence the strategy of co-thickening. GBTs are very energy efficient compared to centrifuges, but the units tend to be quite large. GBTs require wash water to clean the belt after the removal of thickened solids. This washing process tends to make for humid conditions that can result in odors. The GBTs can be contained in rooms or enclosures to contain the water/odors coupled with ducting to remove them from the unit and the room.

6.6.4 Rotary Drum Thickeners

RDTs utilize a rotating drum screen where sludge conditioned with polymer is introduced to the inside of the rotating drum screen. Free water drains by gravity through the screen openings and collects in a trough underdrain. Thickened sludge is conveyed through the rotatory drum and out the discharge end via continuous internal screw or angled flights. Some equipment manufacturers use a slight incline to aid with separation. Water spray/drainage is contained within the RDTs similar to GBTs but much water is needed. Power usage is one of the lowest of all choices. There are a number of experienced manufacturers of providing such equipment to the wastewater industry.

6.6.5 Recommendations

The 2017 Facility Plan identified RDTs for costing purposes and our analysis here concurs with this approach for co-thickening sludge prior to digestion for Arcata.

Based upon the anticipated flows and loads developed previously for the project and listed in the enclosed process calculations, 60 gpm of combined PS/WAS (6,361 lb/d TSS) can be processed by one RDT with 100 gpm capacity at 24/7 operation. A second RDT should be provided for standby redundancy and for processing higher flows. Production of 5 percent TSS should be the goal with 95 percent capture.

Facilities needed to support the RDTs include raw sludge blend tanks (2), thickened sludge hoppers (2), thickened sludge pumps (2), and an emulsion polymer system (sized to feed about 10 lb/dry ton) plus feed pumps (1 per RDT), duplicate mix/aging tanks, and a designated area for tote storage of emulsion polymer.

The overall thickening system described herein should be housed in a structure dedicated to the RDT process.

In addition to thickening, improvements to the digesters are recommended as further discussed below.

6.7 Digester Improvements

The primary and secondary digester structures have been in service for decades. During the upgrade of the primary digester during the 1984 project, the overall height was increased and floating gas holder roofs were added to both digesters at that time as well. Based on the Facilities Plan and confirmation through this preliminary design process, the overall condition is fair and the concrete structures appear serviceable for a number of years into the future. The covers, piping, mixing, heating, and other systems tend to require more maintenance due to corrosion and mechanical wear. The digesters need to be periodically cleaned of indigestible solids and caked on material. Also, the interior of the concrete may warrant maintenance, although the interior will not be visible for inspection until they digesters are cleaned. For the purposes of the Facilities Plan and this TM, the overall digester structures are assumed to be usable. Improvements are recommended for other solids management process as discussed below.

Historically, both digesters were operated with floating covers. It is proposed that the primary heated and mixed digester be operated with a fixed cover and that the secondary digester be operated with a floating cover. The primary digester provides the majority of the sludge treatment while the secondary digester is essentially for storage between draws to the drying beds.

As is the current practice, supernatant will need be regularly removed from the secondary digester and conveyed back to the headworks as thickened sludge is pumped to the primary digester to provide solids storage volume.

Strategies for adaptive management for digester operation relate mostly to the heating and mixing of the primary digester and the frequency of draws from the secondary digester to the drying beds. These operational parameters can be modified based on actual flow and solids characteristics and operating practices.

Following thickening, the solids are processed in the digesters and the proposed improvements are summarized in Table 6.3.

Each of these improvement areas is further discussed below.

6.7.1 Digester Configuration and Operation

The overall purpose of making improvements to the existing solids handling and digestion system is to provide maintenance and improvements to existing components and to provide additional systems for handling additional primary and secondary solids to be produced through the planned treatment plant upgrades. Additional potential enhancements to digested solids dewatering as well as digester gas scrubbing and use are also briefly considered.

Solids handling and digester Improvements begin with the gathering of Primary Solids (PS) from primary clarifiers as has been done historically and combining with secondary WAS from proposed new oxidation ditch. Given the proposed strategy to bypass the existing primary treatment system and treat influent wastewater under normal flows in the oxidation ditch, primary solids would only be produced during higher flows that are then conveyed to the treatment ponds. Therefore, the solids will predominately be secondary WAS with primary solids being created during higher flows.

The overall digester configuration and operation is based on the anticipated solids streams from the upgraded system. The configuration discussed in this section is based on the continued strategy of a primary heated and mixed digester followed by a secondary unheated and unmixed digester in which supernatant is regularly decanted and sludge is drawn down several times a year and dewatered.

Given the anticipated flows, configuration, and solids production, it has been estimated the sludge pumped from clarifiers to the primary digester will have a hydraulic retention time of approximately 23 days, which is well above a typical minimum guideline of 15 days. The volatile solids loading rate is also within typical process guidelines. Given an adequately heated and mixed digester under these loading conditions, it is estimated that 50 percent volatile solids reduction can occur through the entire digestion process. Depending on actual flows and operating conditions over time, the City should expect similar future finished sludge characteristics in terms of frequency of draws and dewatering characteristics, although draws may become more frequent. This will require optimizing primary and secondary clarification processes to maximize initial solids content and optimizing cothickening operations to maximize solids to the primary digester. A key goal is to minimize water that enters the digesters.

Table 6.3 Digester Improvements

Near Term Strategy/Improvements	Longer Term Adaptive Management/Improvements
Configuration and Operation	
• Replace the primary digester floating cover with a fixed cover. • The secondary digester will remain a floating cover.	• The operational parameters for heating and mixing of the primary digester and the frequency of draws from the secondary digester should be modified based on actual flow and solids characteristics and operating practices.
Digester Cleaning and Repairs	
• It is recommended, that as part of the overall digester modification process, that the digesters be sequentially cleaned and the interior inspected and repaired as needed.	• It is recommended the performance of the digesters continue to be evaluated over time and that they are periodically taken off line for cleaning and maintenance. • Detailed cleaning and maintenance reports should be maintained to provide a long term record of performance and to help guide operational practices and long term maintenance, improvement, or replacement planning.
Digester Covers	
• The primary digester cover should be replaced with a fixed cover. • The secondary digester cover should be replaced with a floating cover.	• Regular inspection and maintenance of the covers should take place during periodic digester cleaning and inspections.
Digester Mixing and Piping Improvements	
• Include an allowance for valve and piping replacement in the construction documents. A number of valves are frozen, pumps, and pump bases are corroded, and some piping needs replacement to maintain the overall heating and mixing loops.	• The mixing and piping system will require regular inspection and maintenance. • Piping and nozzles on the digester interior should be inspected and replaced during periodic digester cleaning. • The new mixing pumps should be equipped with VFDs to allow operators to adjust mixing characteristics ,which will provide options for addressing potential foaming issues that are more common with digestion of WAS.
Digester Boiler and Heat Exchanger	
• Replace boiler with new unit with 1,000,000 btu/hr capacity. The existing boiler and heat exchanger system is at the end of a typical service life and replacement as part of the overall treatment plant upgrades will help maintain a reliable, maintainable system.	• The heat exchanger may require periodic cleaning to maintain heat transfer efficiency. • Temperatures should be monitored and recorded over time to track possible issues and the need for cleaning.

Table 6.3 Digester Improvements (Continued)

Near Term Strategy/Improvements	Longer Term Adaptive Management/Improvements
Digester Gas Flaring/Utilization	
• Digester gas is a potential fuel source, but it is currently flared due to a number of factors including the variability in production and the high cost of scrubbing water, hydrogen sulfide, and siloxane from the gas. • Unscrubbed gas has low heating value and leaves deposits in boilers and engines. Using the gas for fuel for an engine for combined heat and power would require extensive scrubbing to increase the fuel value and clean the gas to protect the engine. • Extensive scrubbing for cogeneration adds significant capital and operations cost and is not typically done for small plants like Arcata. Such effort is not currently warranted given the relatively low cost of natural gas. • A somewhat more viable option is to consider modest condensate removal and blending with natural gas for fueling the boiler for heating the digester. However, this is not typically done for plants the size of Arcata's given the low cost of natural gas and due to a variety of operational issues including siloxane deposits in the boiler. Gas utilization could be considered further during final design. • With or without gas utilization, the flare will need to be utilized for periods when digester gas is not fully utilized. The existing flare has reached the end of its useful life and should be replaced as well.	• Gas utilization may at some point make economic sense for cogeneration if natural gas and electricity prices increase sufficiently. • The City should track actual gas production and quality after the solids improvements are made to document the available digester gas resource while monitoring natural gas and electricity pricing. • The City could in the future develop a cogeneration project when cost effective or offer the digester gas resource to a private firm to design, build, and operate a digester gas utilization system for cogeneration.

As thickened sludge is pumped into the primary digester, it will push sludge from the mixed and heated primary digester to the unheated and unmixed secondary digester. As is the practice now, an equal volume of supernatant will need to be drawn from the secondary digester as thickened sludge pumped into the primary digester. The supernatant flows through several pipes tapped into the secondary digester and is conveyed back to the headworks. Regular decanting of supernatant is necessary to separate water from solids and provide sufficient working volume in the secondary digester for stocking solids between draws.

Depending on flows, performance of the new mechanical equipment, and operational practices it will likely be necessary for the City to draw sludge from the secondary digester to the drying beds more frequently. It has been estimated the City may need to draw a minimum of three times per year rather than the current practice of two times per year. Operational characteristics should be monitored and adjusted based on adaptive management strategies as further discussed in the TM.

6.7.2 Digester Cleaning and Repairs

The digesters are reported to have been cleaned in 2002 and 2014. Although the recent cleaning is only four years ago, the proposed upgrades of the digesters will require them to be taken off line one at a time and they should be cleaned of grit and accumulated solids at that time. In addition, they should be thoroughly inspected and needed repairs made. It is anticipated as discussed below, that mixing nozzles and other internal piping is likely to need repairs during the cleaning process.

6.7.3 Digester Covers

Based on the evaluation in the Facilities Plan and as confirmed through further analysis in this preliminary design phase, the existing floating digester covers should be replaced. They have served their useful life and in fact the truss frame design of the covers makes them prone to internal corrosion that is difficult to visibly evaluate. Also, there are performance reasons to consider alternative cover approaches.

There are two strategies for replacing the digester covers. One is to provide both digesters with improved floating covers and a second strategy is to provide the Primary Digester with a fixed cover and the Secondary Digester with a floating cover.

A fixed cover typically used when the sludge level in the digester doesn't vary significantly. A fixed cover is also $50,000 to $100,000 less expensive than a floating cover and avoids the mechanical challenges associated with a floating cover. Floating covers are typically used where sludge level is variable and there isn't the need for gas storage under the digester cover.

Because the City operates one digester as a primary and a second digester as a secondary, there is no need for the primary digester to have a floating cover. The practical way to utilize a primary digester in this situation is to operate it with a fixed cover and provide an overflow pipe so that sludge pumped into the primary digester pushes digested sludge out through the overflow pipe and into the secondary digester with a floating cover. There are several advantages to this arrangement, the first being that there is a fixed volume for digestion in the primary digester. Second, the chance for short circuiting of flows through the digester can be minimized and hence overall digester performance can be improved.

Based on all of these factors, it is recommended that a fixed steel cover be used for the primary digester.

The secondary digester will need a floating cover because the volume in the digester varies throughout the year as it is being filled from the primary digester, as supernatant is being decanted, and during the periodic draws of solids for dewatering. The preferred floating cover today uses arched metal plates with a ballasted side skirt. This simple design has proven itself to be superior to the old truss style and is in fact approximately $50,000 less expensive than the old truss style.

6.7.4 Digester Mixing and Piping Improvements

The heating and mixing system for Digester No. 1 was upgraded in 2002 (Rotamix nozzles) and in 2013 (new mixing nozzles and mixing / recirculation pumps). The condition of this equipment as reported in the Facilities Plan appears to be good to fair. According to staff, many of the valves in the sludge conveyance and pumping system, much of which dates back to the original construction, are frozen and inoperable. Grit has eroded and clogged portions of the digester mixing system, nozzles, piping, etc. The pumps have been in service for a number of years and are in need of significant maintenance or replacement. The current condition will need to be assessed when the digesters have been taken out of service for upgrades, however it is recommended the pumps be replaced and an allowance be provided for other mixing and piping improvements identified when the digesters are taken off line for cleaning and other major improvements.

The planned headworks upgrades are expected to significantly reduce grit issues which should help extend the useful life of the mixing and piping systems.

6.7.5 Digester Boiler and Heat Exchanger

The existing primary digester at the plant is heated by a Walker Process Boiler from the 1994 project coupled with a tube-in-tube heat exchanger (HEX) also provided in the 1994 project. These facilities are now over 20 years old and approaching the end of their useful life. Based on making some substantial capital improvements to the digestion facilities, it is critical that the digestion process can be properly heated to accomplish the required decomposition (digestion) required by regulation.

Like the mixing piping, the heat exchanger has been subject to the erosive forces of the grit in the sludge and is anticipated to be in need of replacement.

Fortunately there are current manufacturers that can provide the size and style of boiler/heat exchanger combinations needed to fit within the existing building and still provide the expanded capacity needed for this project. Based upon the preliminary calculations developed for this TM, Heat Exchangers of up to 1,000,000 BTU/hr can provide the heating needed for this project. Boilers should be similarly matched to these capacities as minimums. By providing boiler/heat exchanger arrangements similar to the existing, modifications to the existing piping will be minimized, saving costs and time to accomplish the work. Also, a similarly sized boiler/heat exchanger will fit within the existing building.

6.7.6 Digester Gas Flaring/Utilization

The digestion process produces gas that not only contains combustible methane, but also contains significant concentrations of hydrogen sulfide, moisture and siloxane. These other constituents cause problems utilizing the digester gas for firing boilers, or fueling engine generators, and can even cause problems with flaring. The digester gas is also corrosive to gas piping, valves and instruments.

The methane in digester gas is potentially useful. The City expends approximately $20,000 per year currently on natural gas for digester heating. However, digester gas needs to be scrubbed of water and impurities to optimize its value and protect the equipment that is burning it. It is only economical to scrub and utilize digester gas if it is less costly than natural gas and currently natural gas prices are very low.

The degree of scrubbing depends on the intended use. Scrubbing for use in an internal combustion engine to generate power and heat requires extensive equipment to remove water and impurities to improve the fuel value and protect the engine and reduce emissions. The equipment for significant scrubbing is complex, and requires additional space and operations and maintenance attention and could top $200,000 alone and it is not currently economical nor practical to scrub the gas for an internal combustion engine.

The City could consider a lower level of condensate removal to fire a boiler. A simple condensate removal system is on the order of $50,000. Such gas could theoretically fire a boiler alone or be mixed with natural gas. However, the lower and variable fuel value of digester gas make it difficult to control the heating of a boiler and the remaining impurities in the gas deposit inside the boiler causing additional maintenance. It is recommended the City keep this option open and consider it further during final design process. If the City wanted to demonstrate reuse of the digester gas resource, the option could be provided and the degree to which it was used could be determined based on actual operational performance and natural gas prices over time.

The City could also consider making the digester gas available to a third party who may wish to develop a digester gas utilization project at some point in the future when technology and economics warrant it.

Even with digester gas utilization, there will be times when digester gas will continue to need to be flared if there is excess gas production or when equipment maintenance is required and so the flare should remain in operation. The existing flare has been in service for several decades and City staff report increased maintenance requirements and operational difficulties. The flare system has reached the end of its useful life and it should be replaced.

Following digestion process and gas utilization and flaring, the digested sludge is further processed through dewatering and it utilized.

6.8 Sludge Dewatering and Utilization

The City has been using covered drying beds for dewatering solids from the secondary digester. Staff report drawing sludge into the beds approximately twice a year and periodically mixing the solids to enhance drying and then loading and trucking them to the City's composting operation. The finished composted material is used on City land.

The proposed sludge dewatering and utilization improvements are summarized in Table 6.4.

These dewatering and utilization elements are discussed further below.

6.8.1 Dewatering Through Drying Beds

The condition assessment for the 2017 Facility Plan indicated the covered drying beds warranted maintenance and the City has undertaken projects to extend their useful life. The City is also considering the roof structure for holding solar panels for power generation.

Table 6.4 Sludge Dewatering and Utilization

Near Term Strategy/Improvements	Longer Term Adaptive Management/Improvements
Dewatering Through Drying Beds	
• It may be necessary to load the drying beds more frequently than currently practiced. • Current practice is to draw sludge from the digesters approximately twice a year. However, potential changes in primary and secondary solids capture and characteristics and digestion could result in an increase in the quantity of digested sludge depending on flow and operational characteristics. • The characteristics of the sludge may differ than current conditions due to the solids treatment in the oxidation ditch.	• There are a number of adaptive management strategies that could be adopted over time to accommodate the changes in the solids handling system. • Increased frequency of sludge draw from the digesters is the primary approach, which requires sufficient dewatering between draws. • Longer term strategies could include adding polymer to enhance dewatering characteristics, increasing sludge drying bed area or changing dewatering strategies such as the use of mechanical dewatering equipment such as centrifuges or belt presses. • Introduction of additional mechanical dewatering systems should be carefully considered based on actual operating experience because of the potential high capital and operational costs and added operational complexities. • There may be value in consider contracted operation of mechanical dewatering systems brought to the plant on trailers two or three times a year as needed rather than purchasing the dewatering systems.
Sludge Utilization	
• The City currently composts dewatered sludge along with green waste to produce Class B material that is used on City properties. It is anticipated the City will continue this process, which may need to be adapted to accommodate a potential increase in dewatered sludge production.	• It may be necessary for the City to adapt the ratio of green waste to digested sludge or consider covered composting areas to achieve the desired composting results. • In addition, sludge management is an issue faced by all local treatment plants and there may be long term benefit to considering a regional sludge treatment/reuse facility.

As discussed previously in this TM, it is anticipated the current drying bed method can reasonably continue into the future although actual conditions based on the sludge generated through mechanical treatment system upgrades may warrant more frequent sludge draws into the beds. In the future the City could consider an alternative dewatering approach to adapt to future conditions. Centrifuges, belt presses, and screw presses, which are commonly used dewater technologies employed at larger plants. These technologies are briefly discussed here to present context for future dewatering consideration.

Centrifuges rely on centrifugal force (≈3,000 g) to separate polymer conditioned sludge solids particles from liquid. For the Arcata plant, there are several centrifuge companies with models that operate at 35-50 gpm that would be appropriate for the Arcata plant. If two units were provided, one could be the duty unit and the other for standby or peak conditions. Because centrifuges are enclosed, odor control is greatly enhanced. Dewatered cake of 25 percent solids is possible and it is typically the highest of all common technologies. This would greatly reduce the need for onsite storage of dewatered solids and direct hauling to beneficial uses offsite or composting would be possible. Centrifuges have a high energy requirement, have high chemical use, and operate at high speed. They tend to have high operations and maintenance requirements as well.

Belt presses uses serpentine belts and rollers to squeeze water out of polymer conditioned solids. Chemical addition is needed to enhance dewatering. The equipment is not enclosed and so typically needs a building with good ventilation and potentially odor scrubbing. Belt pressed have low speed operation and so not as much bearing wear as centrifuges.

Screw presses are another option where a large slow moving screw compresses polymer conditioned sludge against metal screens to squeeze out water. A screw press operates as slow speed, but with high contact pressure. The equipment can be enclosed which leads to better odor and humidity control. Screw presses have relatively low energy use and relatively low operational requirements.

These types of mechanical sludge dewatering techniques are often used at plants that continuously produce sludge. They are impractical at this time for Arcata as the City uses a periodic draw operation and startup and shut down of such mechanical equipment would be cumbersome. Also, mechanical equipment has a high capital cost and most of the time the investment would remain idle. Private contractors install such dewatering equipment on mobile trailers and if desired the City could periodically hire a private contractor to bring equipment on site and dewater sludge as needed. Contract periodic dewatering is a good option for the City to consider in the future when additional dewatering capacity may be needed, because the City could avoid taking of very limited site space with equipment that is only occasionally requirement and the City could avoid significant capital outlay as well as associated operational costs and challenges. Therefore, it is recommended the City continue to use the drying bed method for sludge dewatering and adapt in the future as necessary.

6.8.2 Sludge Utilization

Sludge dewatered through the covered drying beds is currently mixed with green waste using a front end loader and composted in large windrow piles prior to being hauled to nearby beneficial uses on City property. The City can continue this process into the future as long as regulations allow this type of reuse and the City has area to process compost and sites to apply the compost. As a longer term adaptive management strategy the City could consider working with other Humboldt Bay area WWTP's that produce sludge and consider a regional approach to sludge management. This could be coupled with strategies to address the regional need for septage management.

6.9 Construction Considerations

The wastewater treatment plant including the solids processing facilities need to remain operational during the planned treatment plant upgrades. Digesters will need to be taken out of service for cleaning and rehabilitation and replacement of covers. The digesters have been taken out of service periodically for cleaning in the past. The rehabilitation and roof replacement is likely to take longer than a typically cleaning and so consideration needs to be given to sequencing of activities and timing as well as staging of associated construction. For example, it is desirable to have adequate space adjacent to the digesters for construction of a new roof structure at ground level and then crane it into place. Also, the timing of digester work should consider the ability to take one digester out of service while a second has sufficient capacity to allow for normal sludge flows during rehabilitation of the out of service digester. It may be necessary for the contractor to provide mobile dewatering equipment to augment the capacity of the existing drying beds. The consideration of the digester work should be included in the overall site planning, staging, and sequencing of the overall treatment plant improvements.

Appendix A

KEY SOLIDS CRITERIA ASSOCIATED WITH 1984 PROJECT

ARCATA WWTP

Source: CH2M Hill Design 1984

Design Year

Design Year		1992	
Design Population		19,056	
Wastewater Flow			
	Avg.	2.3	mgd
	Max. thru Primary	5	mgd
	Max. Month	5.9	mgd
	Peak	16.5	mgd
Wastewater Characteristics			
	BOD	4,100	lb/d
	TSS	3,400	lb/d

Primary Clarification

BOD Loading			
	Avg	4145	lb/d
	Max. Mo.	4535	lb/d
TSS Loading			
	Avg	3660	lb/d
	Max. Mo.	4145	lb/d
Number		2	No.
Diameter			
	Small	26	ft
	Large	60	ft
Side Water Depth			
	Small	9	ft
	Large	12	ft
Volume		cf	gal
	Small	4,776	35,724
	Large	33,912	253,662
	Volume, total		289,386
Overflow			
	Avg	810	gpd/sf
	Max. Mo.	1,490	gpd/sf
Detention			
	Avg	2.6	hr
	Max. Mo.	1.4	hr
Primary Sludge-TSS removal			
	Avg.	60	%
	Max.Mo.	50	%
	TSS conc - min	2.5	%
	Underflow solids Avg	7.3	gpm
	Underflow solids MaxMo	6.9	gpm

Sludge Stabilization

Primary Sludge Quantities			
	Dry Solids		
	Avg	2,200	lb/d
	Max Mo	2,075	lb/d
	Solids	2.5	%
	Flow		
	Avg	10,550	gpd
	Max Mo	9,950	gpd
	VSS	75	%
Digesters			
	No.	2	
	Diameter		
	Primary	45	ft
	Secondary	26	ft
	Depth	28	ft
	Volume	44,500	cu ft
		14,900	cu ft
	Detention	31.6	days
		33.5	days
	Loading		
	Avg	0.037	lb vss/cf/d
	Max Mo	0.035	lb vss/cf/d
Digester mixing			
	Gas reculation		
	Compressors	2	No.
	Power	10	HP
Drying Beds			
	Solids-Avg	1,115	lb/d
	Area	15,000	sf
	Annual Loading	27	lb/yr/sf
DiGas Generator			
	No.	1	
	Capacity	35	kW
Standby Generator			
	No.	1	
	Capacity	150	kW

Appendix B

DESIGN CRITERIA AND PROCESS CALCULATIONS – PROPOSED UPGRADES

Design Influent Flow and Loads - Facility Plan

	Design Criteria-Full Primary Treatment			Alternative Criteria-No Primary Treatment		
Flow						
Design	2.3	MGD	Dry Weather Flow(Maximum Month Flow)	2.3	MGD	
Peak	5.9	MGD	Peak Wet-Weather Flow	5.9	MGD	
Instantaneous Peak	16.5	MGD	Instaneous Peak Flow	16.5	MGD	
Loads			90th percentile load per city data 2003 to 2015 plus 20% growth			
BOD	4,800	lb/d		4,800	lb/d	
TSS	6,910	lb/d		6,910	lb/d	
NH3	1,060	lb/d		1,060	lb/d	
Concentrations						
BOD - Design	250	mg/l		250	mg/l	
Peak	98			98		
Instantaneous Peak	35			35		
TSS - Design	360	mg/l		360	mg/l	
Peak	140			140		
Instantaneous Peak	50			50		
Primary Sedimentation						
BOD	4,800	lb/d	90th percentile load per city data 2003 to 2015 plus :	4,800	lb/d	
BOD Removal %	40%			0%		
BOD lb/d	1,920	lb/d		-	lb/d	
TSS	6,910	lb/d		6,910	lb/d	
TSS Removal %	60%			0%		
lb/d	4,146	lb/d		-	lb/d	
Concentration %	2.5		Historical values	2.5		
Underflow gpm avg	13.81			-		
Concentration %	2.5		Concentration Chosen for Technical Memo	2.5		
Underflow gpm avg	13.8			-		
Secondary Treatment						
Flow-Design	2.3	MGD	Dry Weather Flow(Maximum Month Flow)	2.3	MGD	
Peak	5.9	MGD	Peak Wet-Weather Flow	5.9	MGD	
Instantaneous Peak	16.5	MGD		16.5	MGD	
Loads-Design			Not Captured by primary and thus into OxDitch			
BOD	2,880	lb/d	60%	4,800	lb/d	100%
TSS	2,764	lb/d	40%	6,910	lb/d	100%
WAS - generation ratio from BOD	0.6	lb VSS/lb BOD		0.6	lb VSS/lb BOD	
WAS VSS	1,728	lb vss		2,880	lb vss	
VSS/TSS	0.78	vss/tss		0.78	vss/tss	
WAS TSS	2,215	lb TSS/d		3,692	lb TSS/d	
Carry Through of NVSS in TSS						
NVSS fraction	0.22	nvss/tss		0.22	nvss/tss	
NVTSS	608	lb/d		1,520	lb/d	
WAS TSS + NVTSS through Ox Ditch	2,823	lb/d		5,213	lb/d	
Concentration	0.5	%TSS		0.5	%TSS	
volume	47.0	gpm		86.8	gpm	
Biosolids to Thickening						
Primary Solids	4146	lb/d	vs 2,200 lb/d 1984 design	0	lb/d	
WAS + NVTSS from OxDitch	2,823	lb/d	vs zero 1984 design	5,213	lb/d	
Total Solids to Co-Thickening	6,969	lb/d	vs 2,200 lb/d 1984 design ... 2.9 times more solids	5,213	lb/d	
Ratio VSS/TSS	0.78			0.78		
Total Volatile Solids to Co-Thickening	5,436	lb/d		4,066	lb/d	
Primary Solids %TSS	2.5			2.5		
PS flow	13.8	gpm		-	gpm	
WAS %TSS	0.5			0.5		
WAS Flow	47.0	gpm		86.8	gpm	
Total Flow	60.8	gpm		86.8	gpm	
	87,594	gal/day		125,000	gal/day	
RDTs Capacity	100	gpm	Parkson	100	gpm	
No.	2	1+1		2	1+1	
Biosolids Thickening - Capture	95%	SS capture		95%	SS capture	
Combined solids Thickened	6,621	lb/d		4,952	lb/d	
0.78	5,164.37	lb VSS/d		3,862	lb VSS/d	
% TSS	5.0			5.0		
Flow to digestion	15,878	gal/day		11,875	gal/day	
Recycle back to Treatment Plant	71,716	gal/day		113,125	gal/day	
Digestion						
Primary Digester - Diameter	45	ft		45	ft	
SWD	28	ft		28	ft	
Volume	44,500	CF		44,500	CF	
	332,860	Gal		332,860	Gal	
Detention Time	21.0	Days		28.0	Days	
VSS Loading Rate	0.12	lb VSS/CF/Day		0.09	lb VSS/CF/Day	
Mixing-Vaughn jet Mix						

Volatile Solids Reduction-VSR	50%			50%			
VSR	2,582	lb/d destroyed		1,931	lb/d destroyed		
Volatile Solids Remaining	2,582	lb/d remaining		1,931	lb/d remaining		
Total Solids Remaining	4,039	lb/d	24/7	3,021	lb/d		
Flow	15,878	gal/day	24/7	11,875	gal/day		
Concentration	3.05	%TSS		3.05	%TSS		
Digestion							
Heating needs	See Calculations below			See Calculations below			
Boiler(s)	for heating incoming			for heating incoming			
Heat Exchanger	Biosolids & Heat losses			Biosolids & Heat losses			
Covered Biosolids Drying Beds (2)	15,000	sf	Total paved area with central drains	15,000	sf		
Hours of operation/week	168	hr	24/7-Assumed for calculations. Actual ops 1/2 secon	168	hr		
Ratio to 24/7 flows/operation	1	ratio		1	ratio		
Adjusted Flow	15,878	gal/day	24/7	Proposed conditions		1984 Conditions	
Performance - Capture %	95%			95%		0.95 day/yr	
Production rate 24/7	3,837	lb/d		2,870	lb/d	1115 lb/day	
% solids	25.0	TSS		25.0	TSS	1059.25 lb/yr	
Dewatered Biosolids	1,840	gal/day	24/7	1,376	gal/day	1,376 sf	
	68	lb/cf		68	lb/cf	0.770 lb/yr/sf	Original Loadin
	7.48	gal/cf	Solids up by 3x	7.48	gal/cf		
	246	cf/d	Density Double 5% feed vs 2.5% feed to digestion	184	cf/d		
	9	cy/d	Net Volume diff.	7	cy/d		
	This will require the covered sludge beds be expanded by 50% or loadings to be 3 times/yr vs 2 times/yr			**This will require the covered sludge beds be expanded by 50% or loadings be 3 times/yr vs 2 times/yr**			
	of 2016 plant			of 2016 plant			
Digester Gas production	data indicates			data indicates			
Volatile Solids Reduction-VSR	50%			50%			
VSR	2,582	lb/d destroyed 24/7		1,931	lb/d destroyed 24/7		
DiGas per lb VSR	16	cu ft/lb VSR		16	cu ft/lb VSR		
	41,315	cf/d	13,200 cf/d 1984 design due to only PS digestion	30,900	cf/d		
	28.7	cfm		21.5	cfm		
	600.0	BTU/cf		600.0	BTU/cf		
	17,215	BTU/min		12,875	BTU/min		
	1,032,875	**BTU/hr**	Compare to Digester heating requirements.	**772,494**	**BTU/hr**		
			This could be close to adequate gas quantity if				
		53%	energy conversion effeciency at max conditions.		64%		
DiGas Cleaning		49%	energy conversion at 55% VSR		58%		
H_2S Removal	None now	TBD	Typical high efficiency boilers at 85%	None now	TBD		
Moisture	Some existing	TBD	There are some condensate traps now	Some existing	TBD		
Siloxane Removal	None now	TBD		None now	TBD		
DiGas Generator	35	kW	Previous unit	35	kW		
Primary Digester Heating							
Diameter	45	ft		45	ft		
Radius	22.5	ft		22.5	ft		
Side Depth	28	ft		28	ft		
Center Depth	34	ft		34	ft		
Center Drop	6	ft		6	ft		
Volume	44,500	cf		44,500	cf		
Sludge Feed - Solids	6,621	lb/d		4,952	lb/d		
Concentration	5.0	%TSS		5.0	%TSS		
Flow	15,878	gpd		11,875	gpd		
weight of flow	132,420	lb/d		99,038	lb/d		
Heat Transferr Coefficients							
Walls 12" thick conctete w/o insultation	0.85	(Btu/sf) ^{o}F H		0.85	(Btu/sf) ^{o}F H		
Floor in groundwater	0.15	(Btu/sf) ^{o}F H		0.15	(Btu/sf) ^{o}F H		
Roof exposed to air	0.2	(Btu/sf) ^{o}F H		0.2	(Btu/sf) ^{o}F H		
Temperatures							
Air	40	^{o}F	Minimum	40	^{o}F		
Feed Sludge	55	^{o}F	Minimum	55	^{o}F		
Earth below floor	45	^{o}F	Minimum	45	^{o}F		
Digester contents	95	^{o}F	Minimum	95	^{o}F		
Specific Heat of Sludge	1.0	Btu/lb ^{o}F		1.0	Btu/lb ^{o}F		
Incoming Sludge Heating	5,296,793	Btu/d	120,866 lb/d x (95^{o}F-55^{o}F)x 1.0 Btu/lb^{o}F	3,961,506	Btu/d		
	220,700	Btu/hr		165,063	Btu/hr		
Area of Digester surfaces							
wall area	3,956	SF	3.14 x Dia x Ht	3,956	SF		
Floor area	1,645	SF	3.14 x Rad x (Rad^2 + Center Drop^2)$^{1/2}$	1,645	SF		
Roof area	1,590	SF	3.14 x Rad^2	1,590	SF		
Heat loss from Digester Surfaces							
Walls	184,962	Btu/hr	0.85 x 3,956 sf x (95-35^{o}F)	184,962	Btu/hr		
Floor	12,339	Btu/hr	0.15 x 1,645 sf x (95-45^{o}F)	12,339	Btu/hr		
Roof	17,486	Btu/hr	0.2 x 1,590 sf x (95-35^{o}F)	17,486	Btu/hr		
Total heat loss from digester	214,786	Btu/hr		214,786	Btu/hr		
Total sludge heating & losses	435,486	Btu/hr	Primary Digester	379,849	Btu/hr		
Secondary Digester Heating							
Diameter	26	ft		26	ft		
Radius	13	ft		13	ft		

Flow	15,878	gpd		11,875	gpd
weight of flow	132,420	lb/d		99,038	lb/d
Heat Transferr Coefficients					
Walls 12" thick conctete w/o insultation	0.85	(Btu/sf) ^{O}F H		0.85	(Btu/sf) ^{O}F H
Floor in groundwater	0.15	(Btu/sf) ^{O}F H		0.15	(Btu/sf) ^{O}F H
Roof exposed to air	0.2	(Btu/sf) ^{O}F H		0.2	(Btu/sf) ^{O}F H
Temperatures					
Air	40	^{O}F	Minimum	40	^{O}F
Feed Sludge	95	^{O}F	Minimum	95	^{O}F
Earth below floor	45	^{O}F	Minimum	45	^{O}F
Digester contents	95	^{O}F	Minimum	95	^{O}F
Specific Heat of Sludge	1.0	Btu/lb ^{O}F		1.0	Btu/lb ^{O}F
Incoming Sludge Heating	-	Btu/d	120,866 lb/d x (95^{O}F-95^{O}F)x 1.0 Btu/lb^{O}F	-	Btu/d
	-	Btu/hr		-	Btu/hr
Area of Digester surfaces					
wall area	2,286	SF	3.14 x Dia x Ht	2,286	SF
Floor area	537	SF	3.14 x Rad x (Rad^2 + Center Drop^2)$^{1/2}$	537	SF
Roof area	531	SF	3.14 x Rad^2	531	SF
Heat loss from Digester Surfaces					
Walls	106,867	Btu/hr	0.85 x 3,956 sf x (95-35^{O}F)	106,867	Btu/hr
Floor	4,027	Btu/hr	0.15 x 1,645 sf x (95-45^{O}F)	4,027	Btu/hr
Roof	5,837	Btu/hr	0.2 x 1,590 sf x (95-35^{O}F)	5,837	Btu/hr
Total heat loss from digester	116,731	Btu/hr		116,731	Btu/hr
Total sludge heating & losses	116,731	Btu/hr	Secondary Digester	116,731	Btu/hr
Combined Heating & Losses-both Digesters	**552,217**	**Btu/hr**	**Capacity of heat exchanger required - Minimum**	**496,580**	**Btu/hr**
	Pick a boiler and heat exchanger with more than 0.5 M Btu/hr capacity			and heat exchanger with	

Appendix G

TM 7 DISINFECTION SYSTEM

City of Arcata
Wastewater Treatment Facilities Improvements

Technical Memorandum 7
DISINFECTION SYSTEM PRELIMINARY DESIGN

FINAL | April 2019

City of Arcata
Wastewater Treatment Facilities Improvements

Technical Memorandum 7

DISINFECTION SYSTEM PRELIMINARY DESIGN

FINAL | April 2019

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STATE OF CALIFORNIA

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Abbreviations

AMRI	Arcata Marsh Research Institute
AWTF	Arcata Wastewater Treatment Facility
BFE	base flood elevation
Carollo	Carollo Engineers, Inc.
CCB	chlorine contact basin
Cl_2	chlorine
FP	AWTF July 2017 Facility Plan
ft	feet
ft/s	feet per second
in	inches
kW	kilowatts
MAMW	mean annual maximum water
mgd	million gallons per day
MHW	mean high water
MHHW	mean higher high water
mJ/cm^2	millijoules per centimeter squared
mL	milliliters
MLW	mean low water
MLLW	mean lower low water
MMMW	mean monthly maximum water
MPN	most probable number
MSL	mean sea level
NFPA	National Fire Protection Association
NPDES	National Pollutant Discharge Elimination System
NWRI	National Water Research Institute
PPD	pounds per day
PS	pump station
RMPP	Risk Management Prevention Plan
RWQCB	Regional Water Quality Control Board
SLR	sea level rise
SO_2	sulfur dioxide
TM	technical memorandum
UV	ultraviolet
UVT	UV transmittance
WWTP	wastewater treatment plant

Technical Memorandum 7

DISINFECTION SYSTEM PRELIMINARY DESIGN

7.1 Purpose

The purpose of this Technical Memorandum (TM) is to provide a preliminary design for ultraviolet (UV) light effluent disinfection systems including evaluation and design criteria for the two treatment system with sizing, equipment selection, layout, construction, and operation costs, and a proposed implementation plan for the City of Arcata (City) Wastewater Treatment Facility (AWTF). The existing chlorine and sulfur dioxide disinfection/dechlorination facilities are also described, summarizing the general function and configuration, and the impact on effluent treatment is outlined. The alternative disinfection projects were originally included in the AWTF July 2017 Facility Plan (FP) and the FP capital improvements program.

7.2 Summary of Findings and Recommendations

The key findings and recommendations of this TM are summarized below:

- Ultraviolet light disinfection is recommended for flows up to the plant design flow of 5.9 million gallons per day (mgd).
- Design UVT shall be 35 percent based on wetland effluent and 55 percent based on a blended wetland and secondary effluent.
- Proposed design dose is 50 milliJoules per centimeter squared (mJ/cm^2) to provide bacterial disinfection and virus reduction.
- Design should be based on the most recent offering of the equipment that was pilot tested. The mechanical and chemical cleaning system provided sufficient cleaning and achieved required disinfection.
- Existing gaseous chlorine and sulfur dioxide system should be retrofitted with a liquid chemical system for disinfection of wet weather flows.

The overall proposed plant flow diagram is included in Appendix A.

7.3 Background

The City of Arcata operates the AWTF, which consists of headworks with screening and grit removal, primary clarification, oxidation ponds and treatment wetlands secondary treatment and polishing enhancement wetlands. Discharges from the AWTF are currently regulated by the National Pollutant Discharge Elimination System (NPDES) Order No. R1-2012-0031, which became effective on August 1, 2012, and expired on July 31, 2017. The City submitted a Report of Waste Discharge in January 2017, as required for the permit renewal. The new permit is pending and is under review by the North Coast Regional Water Quality Control Board (RWQCB).

The beneficial uses of the receiving bay include habitat for shorebirds, waterfowl, raptors, and migratory birds, oyster farming, and recreational use. The complete list of beneficial uses is included in the NPDES Permit.

The existing secondary effluent is first disinfected and then discharged to the enhancement wetlands, then returned to the plant for a second disinfection step before discharge to Humboldt Bay (Outfall 001). The discharge permit outlines a disinfection and flow configuration upgrade that is based on a once-through flow system, with UV disinfection following the enhancement wetlands, and then discharge to a new discharge point at the brackish marsh (Outfall 003).

7.4 Design Criteria

The effluent disinfection system design criteria based on the current NPDES permit are listed In Table 7.1. The effluent limitations for fecal coliform bacteria at new Outfall 003 to Humboldt Bay were retained from the previous permit. These limitations, which are described below, reflect water quality objectives for bacteria established by the Basin Plan for protection of shellfish harvesting areas. The Basin Plan criteria are based on recommendations of the National Shellfish Sanitation Program for shellfish growing areas that are affected by point source discharges.

The NPDES permit requires that treated wastewater discharged to Humboldt Bay meet the following fecal coliform bacteria criteria:

- The median fecal coliform concentration shall not exceed a Most Probable Number (MPN) of 14 organisms per 100 mL in a calendar month.
- Not more than 10 percent of samples collected in a 30-day period shall exceed an MPN of 43 organisms per 100 mL.
- The dose for a future UV system is not specified in the permit, although it is implied to be 50 mJ/cm^2, based on the reporting requirements.

Table 7.1 Effluent Disinfection System Design Criteria

	Unit	Value
Indicator Organism		
Fecal coliform	MPN/100 mL	14 (1), 43 (2)
Flow		
Average Dry Weather Flow	mgd	1.1
Maximum Month Flow (3)	mgd	3.6
Peak Wet Weather Flow (4)	mgd	5.9
Peak Instantaneous Flow (4)	mgd	16.5

Notes:
(1) Monthly Median.
(2) Not more than 10% of samples collected in a 30-day period shall exceed 43 MPN/100mL.
(3) UV effluent disinfection system capacity limit.
(4) Overall facility capacity limit including storage, UV disinfection, and wet weather discharge system.

7.5 Existing Disinfection System

Treatment equivalent to secondary treatment is accomplished using two oxidation ponds followed by six treatment wetlands. Detention time in the AWTF, prior to Allen, Gearheart and Hauser enhancement wetland, is approximately 40 days during average dry weather design flow periods when the system is well-maintained. Currently, effluent is disinfected with chlorine and dechlorinated with sulfur dioxide prior to discharge. Under the existing AWTF configuration, treated effluent from the AWTF can be combined with effluent from the AMWS, disinfected, and split, flowing by gravity either to Humboldt Bay or again through the AMWS. The result is disinfected secondary effluent, but not all effluent receives the benefit of enhanced wetland treatment through the AMWS before discharge to Humboldt Bay. In this mode of disinfection, effluent may actually be chlorinated multiple times, increasing the opportunity to form disinfection byproducts at levels above water quality objectives.

The existing disinfection system, including chlorine (Cl_2) gas disinfection followed by sulfur dioxide (SO_2) gas dechlorination, was constructed in 1984. Two banks of three one-ton Cl_2 gas cylinders are connected in parallel to provide a duty and standby supply of Cl_2 gas for disinfection. The chlorine gas feeders receive both a flow and residual signal for gas pacing and control. Gas induction units installed at the chlorine contact basin provide vacuum to transfer gas to the wastewater flow while providing mixing.

The 2003 plant evaluation (SHN, 2003) noted that the system was near its maximum capacity to handle peak wet weather flows. At that time, measures were recommended to reduce chlorine use. It was noted that any capacity increases or upgrades of the existing gas systems would trigger the need to comply with current National Fire Protection Association (NFPA) standards.

7.5.1 Chlorine Contact Basin

The existing disinfection system includes a chlorine contact basin (CCB) constructed in 1984. The basin can operate as one or two tanks, labelled the east and west basins in the plant O&M manual. The approximate volume for each basin is 185,400 gallons. The detention time at 2.3 mgd is listed as 58 minutes, while the detention time at 5.9 mgd is listed as 30 minutes.

The plant operates the basin in two modes: Split or Combined Mode, which is shown schematically in Figure 7.1.

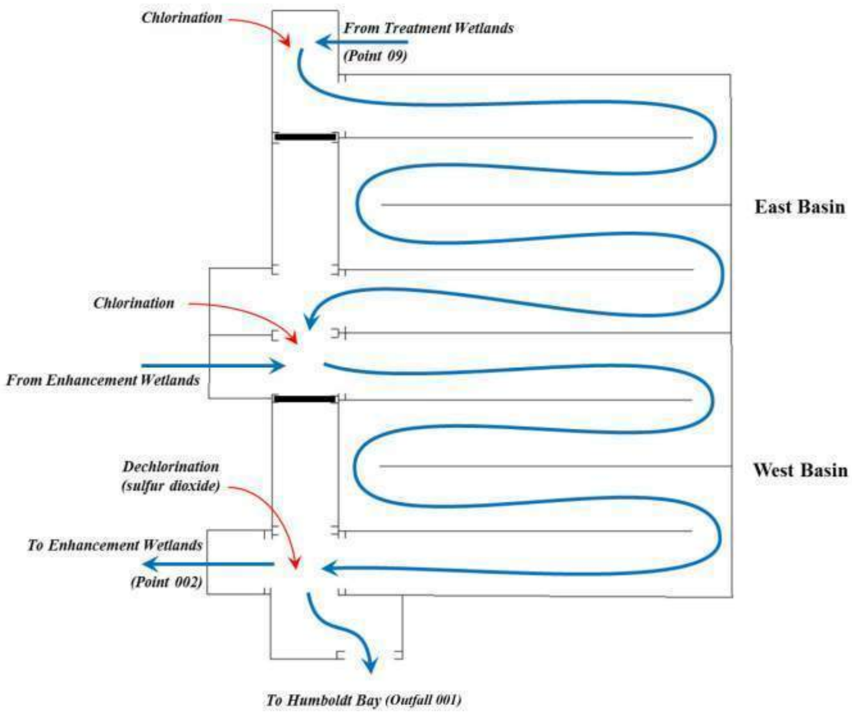
In the combined mode, flow from the treatment wetlands enter the east side, and is dosed with chlorine at the entrance to this first section. The flow then joins with the flow returned from the enhancement wetlands, mixed, and dosed a second time with chlorine. The combined flow is dechlorinated, then is split to return a portion of the flow to the enhancement wetlands, with the rest of the flow going to discharge through Outfall 001.

In split mode, flow from the treatment wetlands enters the east side, is not dosed with chlorine, and then goes to the enhancement wetlands. The return flow from the enhancement wetlands is dosed with chlorine for a first time as it enters the west basin section, then goes through the basin, is dechlorinated, and discharged to Outfall 001.

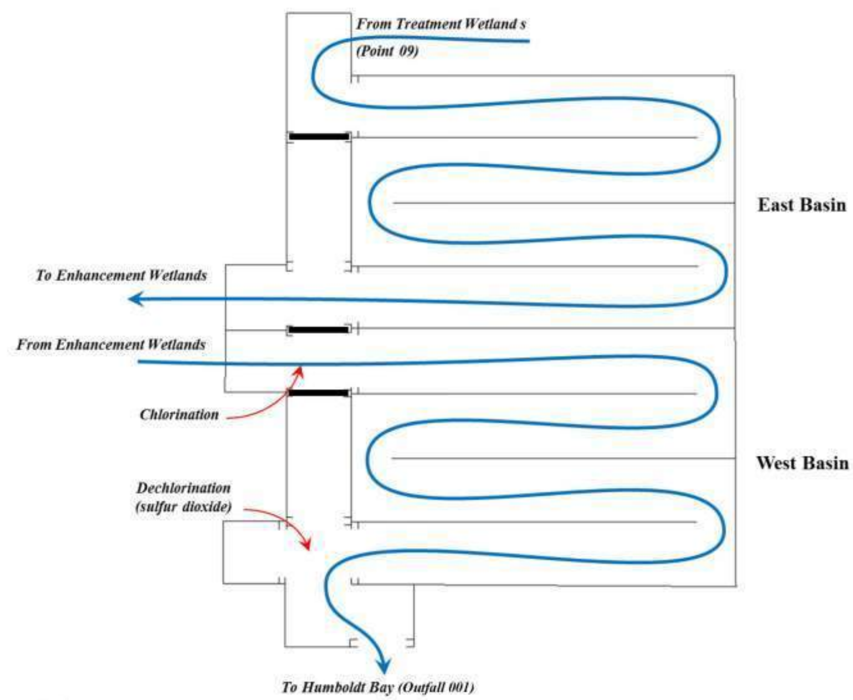
The combined mode is the normal operating mode, especially when flows exceed the capacity of the enhancement wetlands effluent pump station. This mode is especially important during wet weather flows. The split mode is used during low flows, or dry weather. It has the advantage of reducing the chlorine usage to the amount needed to disinfect the flow at Outfall 001 and reducing the potential formation of disinfection by-products.

7.5.2 Chlorine and Sulfur Dioxide Use and Impact

The AWTF currently uses approximately 225 pounds per day (ppd) of chlorine and 160 ppd of sulfur dioxide for disinfection and dechlorination, based on 2014 data. The daily average chemical use by month for the last 5 years is included in Appendix B. Chlorination also appears to impact water quality by reducing effluent BOD and suspended solids. Information from the City and Arcata Marsh Research Institute (AMRI) indicate that at times the BOD reduction can range from 700 to 1400 ppd.



COMBINED MODE



SPLIT MODE

CHLORINE CONTACT BASIN OPERATIONAL MODES

FIGURE 7.1

CITY OF ARCATA

WASTEWATER TREATMENT FACILITY IMPROVEMENTS PROJECT

carollo®

arc0915f6-9913.ai

7.6 Ultraviolet Light Disinfection Preliminary Design

UV light disinfection has been proposed for the AWTF discharge based on a series of pilot tests conducted by the City and the AMRI. The current Waste Discharge and NPDES permit provides general requirements for replacing the existing chlorination disinfection system with a UV system. The proposed UV system design requirements for the recommended project alternatives are outlined in this TM.

7.6.1 UV System Sizing Criteria

The UV system sizing criteria is listed in Table 7.2. Two alternative dose levels are outlined below, depending on the type of effluent and the final permit requirements. The basis for the dose is outlined below.

Table 7.2 UV System Sizing Design Criteria

Indicator Organism	Unit	Value
Fecal coliform (1)	MPN/100 mL	14 (2), 43 (3)
Flow		
Annual average	mgd	2.3
Maximum month (4)	mgd	5.9
UV Transmittance (UVT)		
Pond/treatment wetland effluent	%	35
Oxidation Ditch and wetland blended effluent	%	55
Dose (5)		
Alternative Dose 1 – Wetlands Effluent	mJ/cm^2	Minimum T1 dose: 17 mJ/cm^2 Minimum MS2 dose: 35 mJ/cm^2 (6)
Alternative Dose 2 – Blended Effluent	mJ/cm^2	Minimum T1 dose: N/A Minimum MS2 dose: 50 mJ/cm^2 (6)

Notes:
(1) Shellfish Harvesting Waters, EPA Quality Criteria for Water, 1986.
(2) Monthly Median.
(3) Not more than 10% of samples collected in a 30-day period shall exceed the listed value.
(4) UV facility capacity.
(5) The typical recommended test organism used for validating UV systems is MS2 coliphage (MS2) to mimic polio virus; however, using MS2 validation data for disinfection of bacteria results in potential under dosing since bacteria (coliforms) react differently to UV disinfection than MS2. Some UV manufacturers have performed validation work using proven bacteria surrogates such as T1 coliphage (T1).
(6) Additional analysis required to confirm that dose meets virus reduction concerns of RWQCB.

7.6.1.1 Design UV Transmittance

A design UVT of 35 percent was originally recommended for the UV system sizing based on a review of the available data collected to date. The original pilot UVT data is summarized in the project memorandum included in Appendix C. The UVT may seem low compared to filtered secondary effluent, but is consistent with effluent expected from other wetlands or natural systems.

Plant staff purchased a UVT meter in April 2015 and started to collect UVT data across the plant including the treatment and enhancement wetlands effluents. It was recommended that UVT sampling be continued to establish a long term history of UVT. This is especially important because it was projected that the UVT would vary seasonally. Based on the longer detention times during summer dry weather flows, it was thought that the effluent would have lower UVT levels as more organic materials decay in the wetlands and release humic type compounds. In the winter it was thought that the organic material would be diluted with rain water that falls on the system. The lower detention times due to the higher wet weather flows may also reduce the concentration of material. The data collected to date is shown in Figure 7.2. In general, the pond/wetland system UVT is fairly low, around 30 to 35 percent in the dry months, and around 45 to 55 percent in the wet months. The higher UVT may possibly be due to dilution of the soluble humic material which would raise the UVT in the wet months.

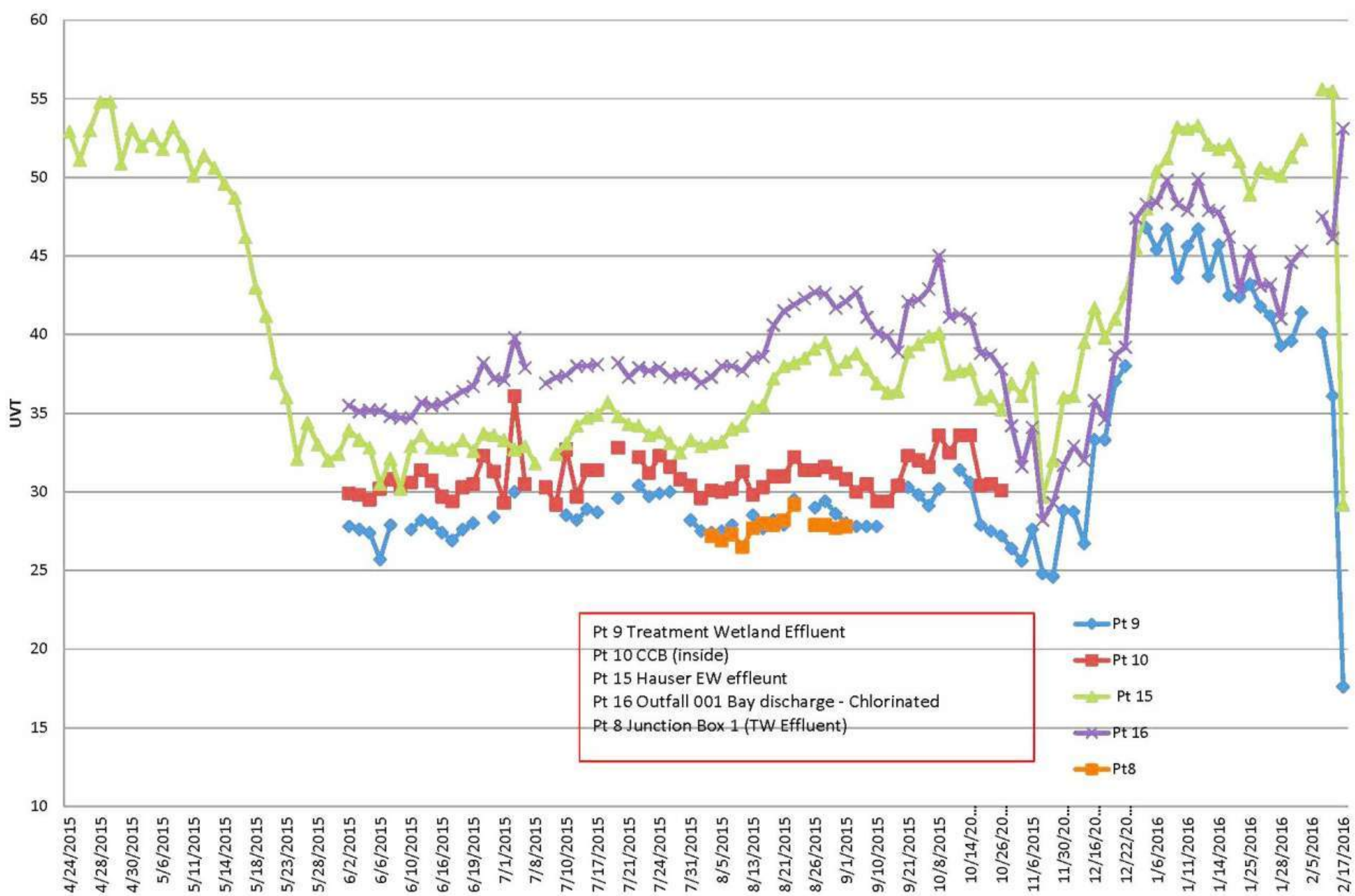
An alternative UV system design has been proposed for a blended effluent concept, where the lower wetland effluent (UVT 35 percent) would be blended with the higher oxidation ditch secondary treatment process effluent (estimated UVT of 65 percent). The blending is envisioned during the dry weather, lower flow periods of the year. The resulting blended effluent UVT is estimated at a minimum of 55 percent. The other design criteria including the peak flow of 5.9 million gallons per day (mgd), a dose of 35 millijoules per square centimeter (mJ/cm^2), with 50 percent redundancy, remain the same. The higher UVT results in a reduction in lamps from 528 to 336 and a corresponding reduction in power demand from 136 to 84 kilowatts (kW).

As noted in FP, at the June 27, 2016 meeting with the RWQCB, UV disinfection design criteria was proposed to be based on a minimum UVT of 35 percent regardless of the alternative.

7.6.1.2 Design Dose

The selection of the design UV dose is outlined below. The current permit implies the required minimum dose as 50 mJ/cm^2 which may have been based on protection of the bay oyster farming operation. The dose requirement is currently under review by the RWQCB as part of the NPDES permit update. Therefore the dose will need to be confirmed as part of the permit process for final design.

The first criterion for a design dose is that the discharge must provide bacteria reduction, specifically to meet the fecal coliform level required in the discharge permit. In an initial meeting with the RWQCB, Arcata City staff, LACO and Carollo (June 23, 2015), RWQCB staff indicated a specific concern about virus kill. The discussion focused on the disinfection of coliphage, but without any specific effluent target. In the meeting with the RWQCB on June 27, 2016, there was discussion about a future virus reduction requirement. Virus reduction would require a higher design UV dose than for bacteria reduction alone. The City will need additional input from the State (RWQCB and Division of Drinking Water) on the design dose and disinfection objectives during final design. The design dose discussion that follows is based on the current permit requirement for bacteria (fecal coliform) reduction. Design dose will need to be revised during final design when additional information is provided by the State.



UVT DATA

FIGURE 7.2

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To properly size a UV system, the dose must be determined for each target organism (bacteria and/or virus, in this case). Different organisms (e.g., bacteria, virus, and protozoa) have measurably different sensitivities to UV disinfection. For example, viruses tend to be more resistant to UV disinfection than bacteria. Much of the UV system validation work that has been completed to date has been for water reuse applications in California, where virus inactivation is the primary goal. For these applications, the ideal and recommended test organism is MS2 coliphage (MS2); however, using MS2 validation data for disinfection of bacteria results in potential under dosing since bacteria (coliforms) react differently to UV disinfection than MS2. All of the latest equipment offerings by UV manufacturers (Trojan, Calgon Carbon, Ozonia and Wedeco) considered for this project have performed validation work using T1 coliphage (T1) which is a proven bacteria surrogate. For older equipment offerings where manufacturers have not validated their system based on T1, MS2 validations can be allowed with some degree of conservatism. To account for the difference between the dose-response curves of the organisms, higher dose levels will be specified for systems validated with MS2. Based on systems that have been validated by Carollo using both MS2 and T1, the ratio between the two varies depending on the UVT and the reactor efficiency.

Figure 7.3 below shows the MS2/T1 dose ratio for two different UV reactors that range between 1.63 and 2.06 at this project's design UVT of 35 percent. For the higher MS2/T1 ratio of 2.06, a T1 dose of 1.0 mJ/cm^2 is equivalent to an MS2 dose of 2.06 mJ/cm^2.

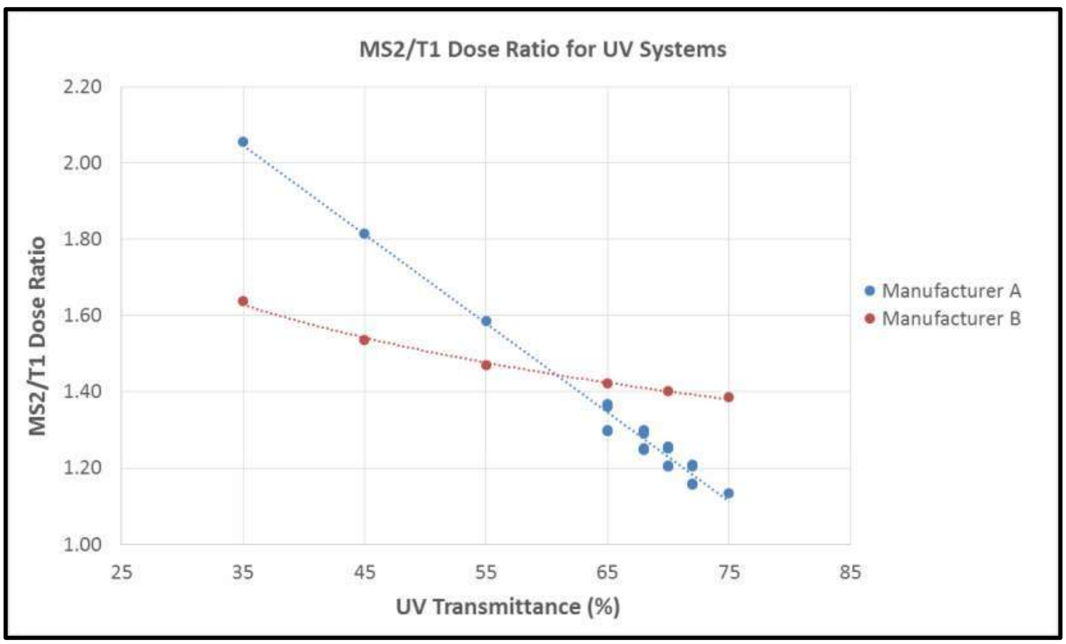


Figure 7.3 MS2/T1 Dose Ratio for UV Systems

In establishing dose criteria, the first step is to address the permit limits. The permit requirement for this project is a median fecal coliform concentration that should not exceed 14 MPN per 100 mL on a monthly basis and a daily limit that should not exceed more than 10 percent of samples exceeding 43 MPN per 100 mL. Previous UV studies by Arcata Marsh Research Institute have indicated the maximum wetland effluent fecal coliform concentration is in the 10,000 MPN per 100 mL range. Therefore, the UV system is required to provide a minimum 2.85 log reduction of fecal coliform to meet the permit limit of 14 to treat effluent from the natural system.

Typically, Carollo's recommended sizing approach is to design a UV system to disinfect fecal coliform to approximately one log below the permit limit; however, due to this project's already low permit limit, a half log will be added as a safety factor. This level of conservatism has worked well for our clients and provides plant staff greater flexibility when operating the UV system.

Using T1 as a surrogate for fecal coliform, and knowing that T1 has a similar UV sensitivity as fecal coliform, the proper dose for 2.85 log reduction of coliform can be determined. T1 has a UV sensitivity of 5 mJ/cm^2/log inactivation; a fecal coliform log inactivation of 3.35 (2.85 + 0.50 safety factor) thus represents a T1 dose of 16.75 mJ/cm^2. Converting this T1 dose to a MS2 dose using the MS2/T1 ratio of 2.06 from above, the validated MS2 dose will be 34.5 mJ/cm^2. Therefore, the specified MS2 dose for an equivalent log inactivation of fecal coliform is 35 mJ/cm^2.

For blended effluents from the natural system and the oxidation ditch/secondary clarifier treatment train, we need to look at the pathogen concentrations from each source of water. The fecal coliform concentration from the oxidation ditch/secondary clarifier effluent may be as high as 2,000,000 MPN per 100 mL range. Depending on the blending ratio, a typical fecal concentration from the blended effluents might be 1,000,000 MPN per 100 mL with a UVT of 50 to 55%. The dose analysis for this scenario results in a fecal coliform log inactivation of 5.35 (4.85 plus 0.50 safety factor) for a T1 design dose of 27.11 mJ/cm^2. However, T1 validation is generally limited to 5 log inactivation as anything above this is not reliable. Hence, for blended effluents an equivalent MS2 design dose of 50 mJ/cm^2 is specified.

The second step of the dose analysis is to address the RWQCB concerns regarding virus kill. As part of final design, the dose necessary to reduce indigenous virus (measured as coliphage) in the UV effluent should be determined. This would be done with a collimated beam test on the Arcata treatment wetland effluent, at dose values dependent on the desired test organism. There are two types of native coliphage in effluent, F-specific and somatic). F-specific (F+) coliphage has a similar UV sensitivity to MS2; therefore, recommended dose levels are 0, 5, 10, 15, 20, 30, and 50 mJ/cm^2. Somatic coliphage has a similar UV sensitivity to T1; therefore, recommended dose levels are 0, 2.5, 5, 7.5, 10, 15, and 20 mJ/cm^2.

7.6.1.3 Equipment Reliability

Equipment reliability must also be considered when designing a UV system since the regulatory standards for shellfish harvesting waters are stringent. The industry standard reference for UV is the National Water Research Institute (NWRI) Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (UV Guidelines), Third Edition. This document recommends a standby bank per channel or standby channel be installed to ensure that the specified UV dose is provided under worst-case conditions with one bank of lamps out of service. For this project we recommend one standby bank for the single channel design.

7.6.2 Initial UV Equipment Selection

Several UV manufacturers have had their equipment validated to UVT levels down to 35 percent and lower and can be used for this application. The equipment originally selected for evaluation in the design was the Trojan UV3000Plus system.

The UV3000Plus equipment was selected based successful testing in 2011 during a pilot study conducted by Trojan, AMRI, and plant staff. The Pilot Study Report is included in Appendix D, and indicated that the fecal coliform requirement could be meet with a dose as low as 20 mJ/cm^2. The method used to calculate the dose during the pilot study is proprietary and is based on a March 2012 Validation report for low UVT applications. The validation report was reviewed as part of this study.

The recommended equipment was revisited with the preferred supplier, and they now recommend that the Trojan UVSigna 2-Row model be considered. The UVSigna system utilizes higher powered UV lamps thereby requiring less lamps and a smaller footprint. In addition, the mechanical/chemical cleaning system is the same as the system that was previously pilot tested.

Equipment proposals, and details of the UV3000Plus and UVSigna 2 Row system are included in Appendix E and F, respectively.

A number of dose levels were reviewed to determine the recommended equipment configuration for this Facility Plan. A summary of the configuration is included in Table 7.3 and Table 7.4, for the two proposed systems, for dose levels of 35 mJ/cm^2 and 50 mJ/cm^2, at 35 percent and 55 percent UVT.

Table 7.3 Trojan UV3000Plus System Equipment Configurations (1)

	Design Parameters			
Minimum UV Transmittance	35%	55%	35%	55%
Minimum MS2 Dose (mJ/cm^2)	35	35	50	50
Configuration				
Number of Channels	1	2	1	2
Number of Duty Banks/Channel	2	2	3	3
Number of Standby Banks/Channel	1	1	1	1
Number of UV Modules/Bank	22	7	20	7
Number of Lamps/UV Module	8	8	8	8
Total Number of Lamps	**528**	**336**	**640**	**448**
Total Power Consumption (kW)	**136**	**87**	**165**	**116**

Notes:
(1) Design assumes an End of Lamp Life Factor of 0.86 and a Fouling Factor of 0.94.

Table 7.4 Trojan UVSigna 2-Row Equipment Configuration (1)

	Design Parameters			
Minimum UV Transmittance	35%	55%	35%	55%
Minimum MS2 Dose (mJ/cm^2)	35	35	50	50
Configuration				
Number of Channels	1	1	1	1
Number of Duty Banks/Channel	5	3	6	4
Number of Standby Banks/Channel	1	1	1	1
Number of Banks/Channel	6	4	7	5
Number of Lamps/UV Module	10	8	12	10
Total Number of Lamps	**60**	**32**	**84**	**50**
Total Power Consumption (kW)	**63.5**	**33.9**	**88.9**	**52.9**

Notes:
(1) Design assumes an End of Lamp Life Factor of 0.86 and a Fouling Factor of 0.94.

The main feature illustrated on the two configuration tables is the reduction in the number of lamps for the UVSigna 2-Row system. In addition, the total power consumption is also significantly reduced.

One other alternative was considered at the request of the City consultant from AMRI. The Enaqua UV system was recently validated and approved for use on wastewater disinfection. Preliminary sizing indicated that the Enaqua system would require eight times the number of lamps and approximately 15 percent more power consumption. Due to the higher lamp count, the Enaqua system was not included as part of this evaluation.

7.6.3 UV Flow Configuration and Layout

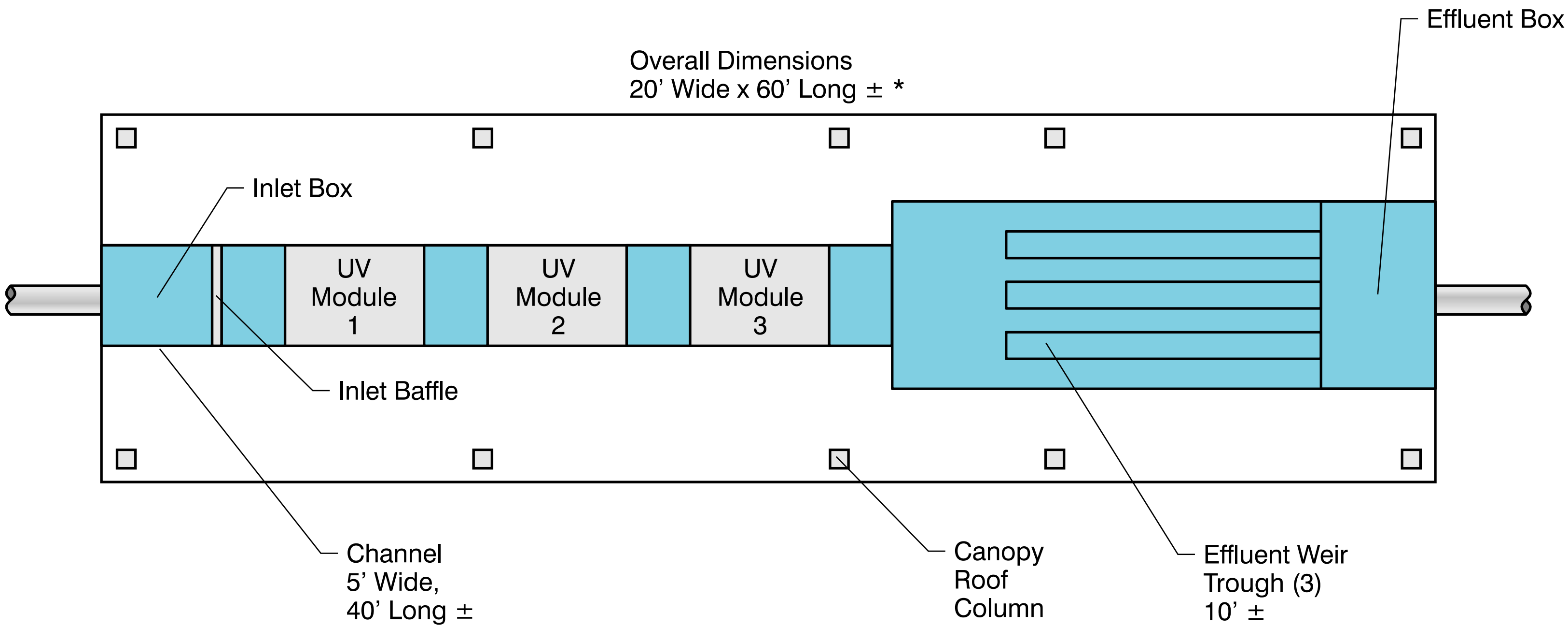
The concept envisioned by the City during the pilot testing and outlined in the NPDES permit was to disinfect the Hauser Marsh (enhancement wetland) effluent using UV disinfection, prior to discharge to the new outfall 003 at the brackish marsh. It was originally proposed that the system would be located at the outlet of the Hauser enhancement wetland. Based on the review of this location it was decided that the new UV system would be located on the plant site adjacent to the CCB. This will allow mixing of treatment wetland effluent with oxidation ditch effluent. In addition, the system can match the industrial look of the existing facilities and will provide additional security for disinfection process.

7.6.3.1 Layout for 35 Percent UVT with Trojan UV3000Plus System

The plan and section for the 35 percent UVT alternative is shown on Figures 7.4 and 7.5 to illustrate the UV system design. The plan is based on the Trojan proposal for 35 mJ/cm^2 dose with redundancy. A Trojan UV3000Plus plan and section drawing is provided in Appendix E that provides the basis for the footprint shown in these figures. If a dose of 50 mJ/cm^2 is required the facility then it will require an additional UV equipment bank, a longer overall channel, and a larger footprint.

The concept shows a single 5 feet wide channel with three banks (2 duty and 1 standby) system. The influent flow would be pumped into the channel in an inlet box, and should include a flow distribution baffle (not shown). The flow will pass the three reactor banks and flow over the effluent finger weirs. A total weir length of approximately 60 to 70 feet will be required to minimize the water surface fluctuation (1-inch maximum) during average to peak flows. The preliminary overall dimensions are shown on the plan. On each side of the channel, a walkway will be provided for access and maintenance. The Section, Figure 7.5, illustrates one concept for the protection of the facility with a sloped canopy type roof for sun and rain protection over the walkways and channel. The entire area could be enclosed with a guard rail type barrier, which would allow worker protection at a lower cost. It could also be fully enclosed in a structure at additional cost. A photograph of a similar UV system in an operating plant shows the canopy roof over UV channels on Figure 7.6. The architecture and alternatives for enclosure will be reviewed during final design.

The UV equipment maintenance would be completed using a rolling gantry type crane to lift the modules or banks from the channels. The specific Trojan reactor has an effective sleeve cleaning system, but additional cleaning of the modules and the channel is needed. Modules would be removed for cleaning on a monthly to quarterly (or longer) frequency, depending upon site-specific conditions. The major equipment maintenance, including bulb replacement, would be completed on an annual basis. Channel cleaning requires high pressure washing to remove algae and debris. Therefore, open access to the channel will be required with the equipment removed and storage adjacent to the channel.



NOTE:

* Small electrical enclosure will also be required (6' x 6' ±).

UV DISINFECTION SYSTEM CONCEPTUAL PLAN (35% UVT)

FIGURE 7.4

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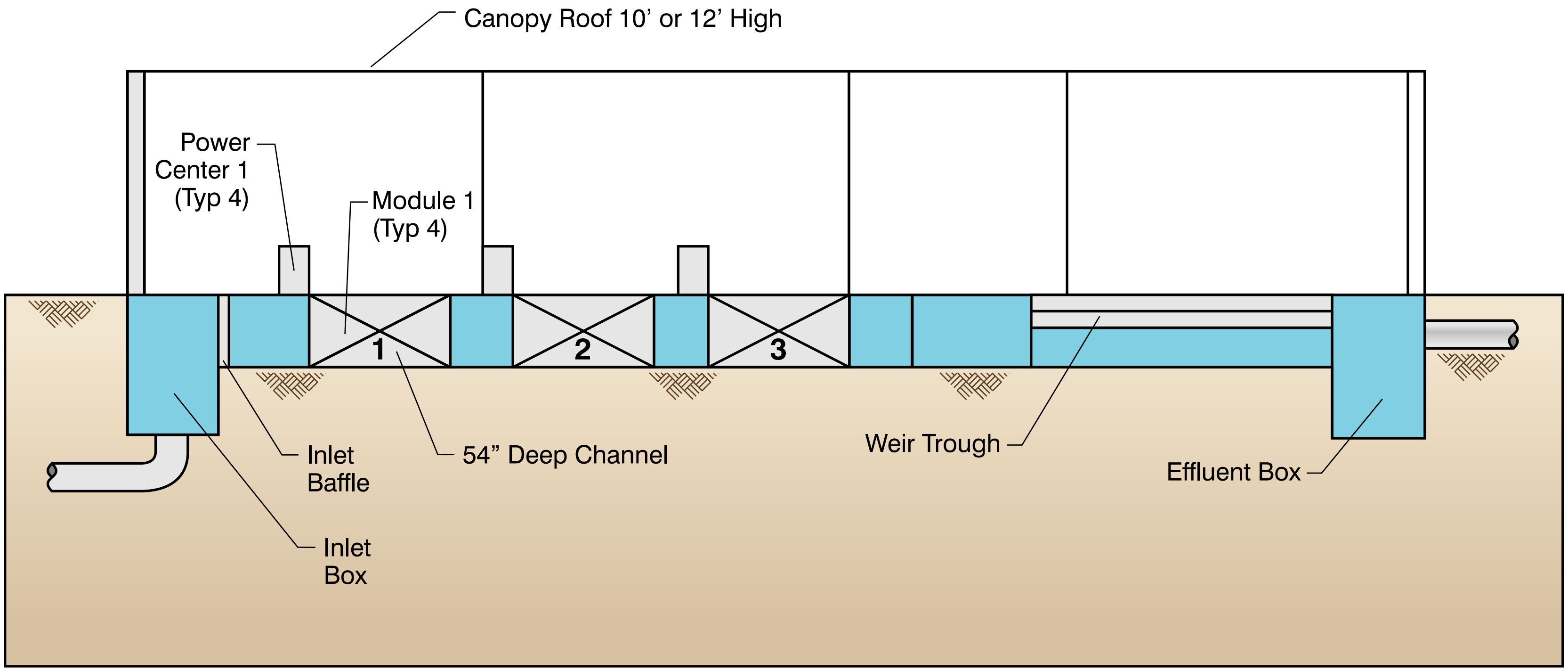

UV DISINFECTION SYSTEM CONCEPTUAL SECTION

FIGURE 7.5

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Figure 7.6 Typical Canopy Roof over UV Channels (Windsor, California)

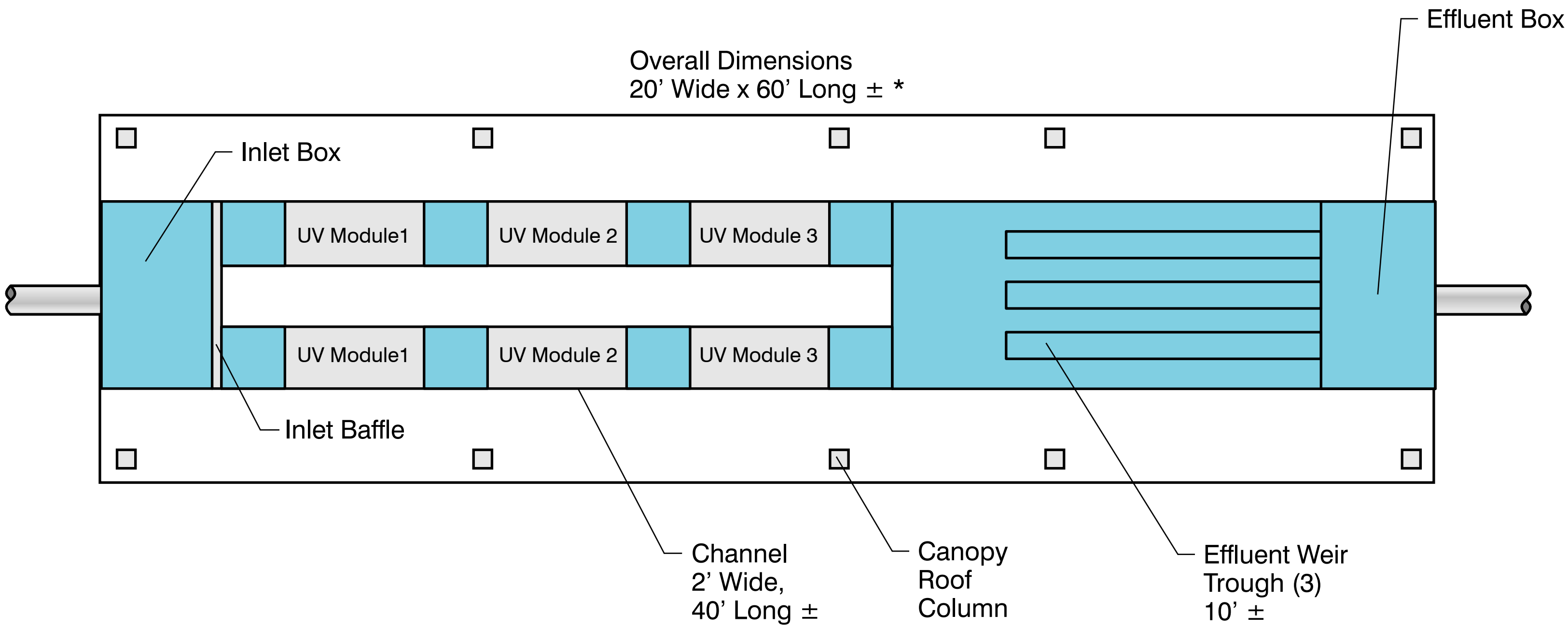
A small electrical and control building would also be required. The size for electrical enclosure might be in the range of 6 feet square. If a 150 to 180 kW standby generator is required, the size might double. The electrical and standby requirements will be finalized in final design.

7.6.3.2 Layout for 55 Percent UVT with the Trojan UV3000Plus System

The UV facility layout was updated for the projected 55 percent UVT, and will be smaller than for 35 percent due to the decrease in the number of lamps. The updated design is based on a 2 channel system. Each channel will have a capacity of up to 2.95 mgd. Therefore during most of the year, only one channel will be in service at a time. A two channel design will allow for channel and equipment maintenance. An updated layout for 55 percent UVT is shown on Figure 7.7.

7.6.3.3 Layout for 35 Percent UVT with the Trojan UVSigna 2-Row System

The Trojan UVSigna system uses a 1000 watt TrojanUV Solo Lamp™. These lamps are staggered at a 45 degree inclination that makes lamp replacement relatively easy while the UV system remains in operation. The Solo Lamp Driver enables lamp dimming from 100 to 30 percent power and can be located up to 80 feet away from the UV Modules. Additionally, the Trojan UVSigna 2-Row system can be operated based on sensor output, which means that it adjusts the power input to account for real time lamp aging and sleeve fouling. Systems that do not have the same capability continuously operate based on the assumption that the lamps are at the end of their useful life and that the sleeves are at the most fouled condition. Therefore, there can be significant savings from an O&M perspective by using a UV sensor-based control system.



NOTE:
* Small electrical enclosure will also be required (6' x 6' ±).

UV DISINFECTION SYSTEM CONCEPTUAL PLAN (55% UVT)

FIGURE 7.7

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The system is equipped with the same patented automated chemical/mechanical cleaning system as the Trojan UV3000Plus system.

The UV facility layout was updated for the Trojan UVSigna 2-Row system and the plan and section views are shown in Figures 7.8 and 7.9, respectively.

7.6.4 UV System Costs

The UV equipment cost to meet the 35 or 50 mJ/cm^2 dose at 35 or 55 percent UVT, with redundancy, is outlined in Table 7.5. The cost is based on budget proposals from Trojan for the UV3000Plus system. These costs illustrate the increasing cost with redundancy and with higher dose. The estimated construction cost is based on recent experience for standalone system projects where the costs range from 3 to 5 times the equipment cost.

Table 7.5 Trojan UV3000 Plus Equipment and Construction Cost Comparison

Item	35 mJ/cm^2 Dose With Redundancy	50 mJ/cm^2 Dose With Redundancy	35 mJ/cm^2 Dose With Redundancy	50 mJ/cm^2 Dose With Redundancy
UVT, percent	35	35	55	55
UV Disinfection Equipment Cost	$1,090,000	$1,310,000	$786,000	$923,000
Total Construction Costs				
Average range (4 times equipment)	$4,360,000	$5,240,000	$3,140,000	$3,690,000

Notes:
(1) Equipment sizing is based on an End of Lamp Life Factor of 0.90 and a Fouling Factor of 0.95.

For reference, the equipment cost for a 100 mJ/cm^2 dose is approximately 2.5 times the cost for a 50 mJ/cm^2 system with redundancy. This higher dose is normally only required for a tertiary recycled water application with high incidence of public contact.

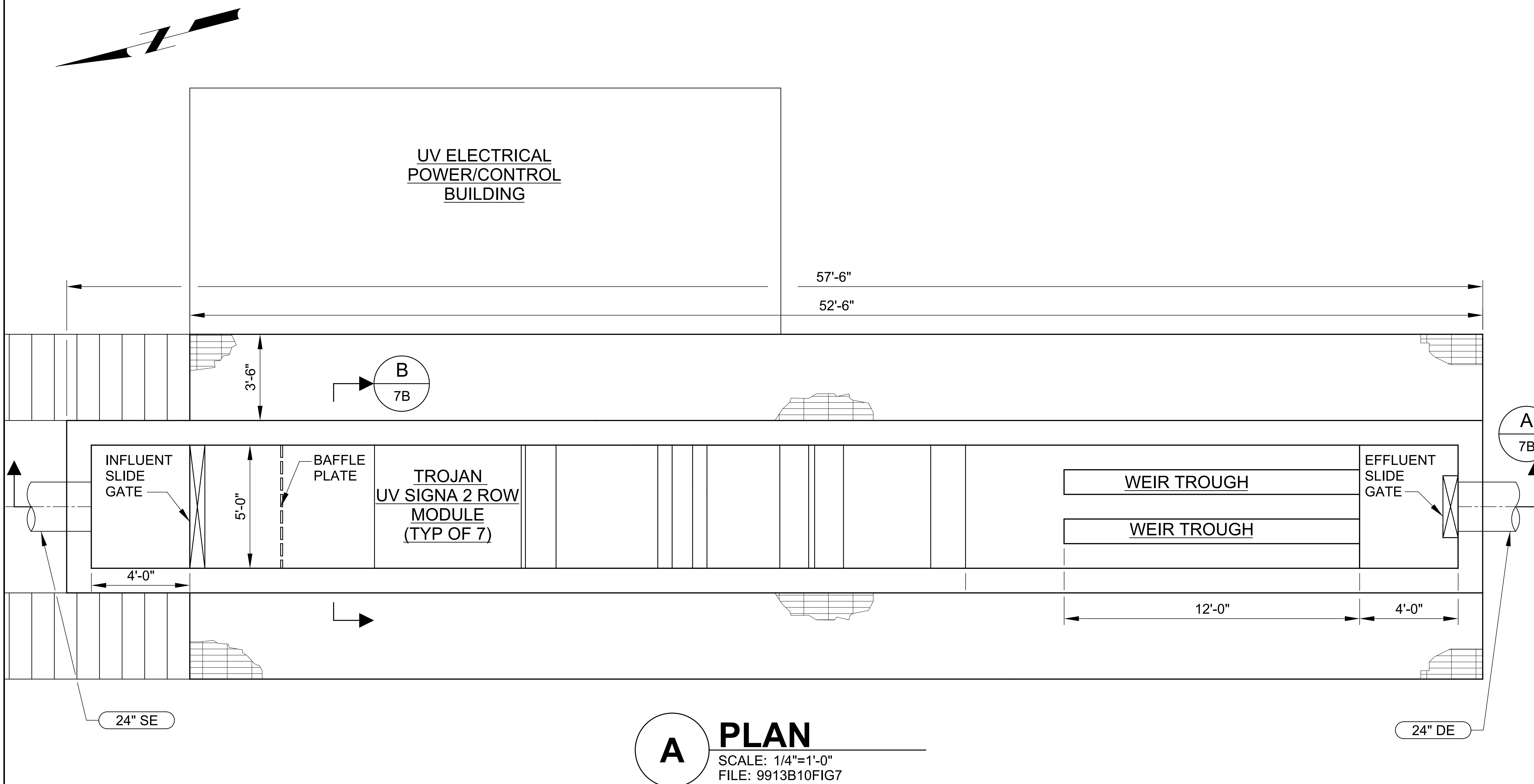
The updated Trojan proposal lists the equipment cost for a UVT of 55 percent at $785,500 with redundancy. The estimated construction cost will be 3 to 5 times the equipment cost, and range from $2,360,000 to $3,930,000 using the same installation cost factors. This reduces the cost by $910,000 to $1,520,000 for the higher UVT.

Proposals were also received from Trojan for the UVSigna 2-Row for the same conditions. Equipment and construction costs are shown in Table 7.6.

Table 7.6 Trojan UVSigna 2-Row Equipment and Construction Cost Comparison

Item	35 mJ/cm^2 Dose With Redundancy	50 mJ/cm^2 Dose With Redundancy	35 mJ/cm^2 Dose With Redundancy	50 mJ/cm^2 Dose With Redundancy
UVT, percent	35	35	55	55
UV Disinfection Equipment Cost (1)	$510,000	$640,000	$355,000	$460,000
Total Construction Costs				
Low range (4 times equipment)	$2,040,000	$2,460,000	$1,420,000	$1,840,000

Notes:
(1) Equipment sizing is based on an End of Lamp Life Factor of 0.5.



A PLAN

SCALE: 1/4"=1'-0"
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Figure No. 7.8

UV FACILITY PLAN

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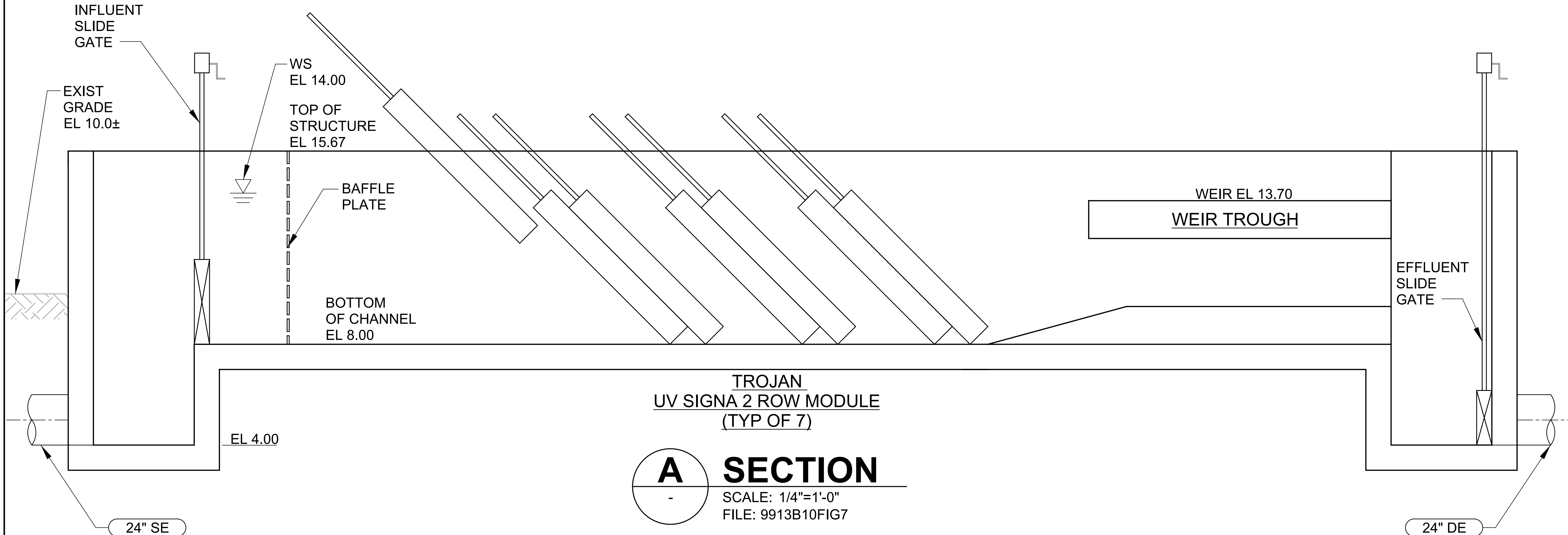
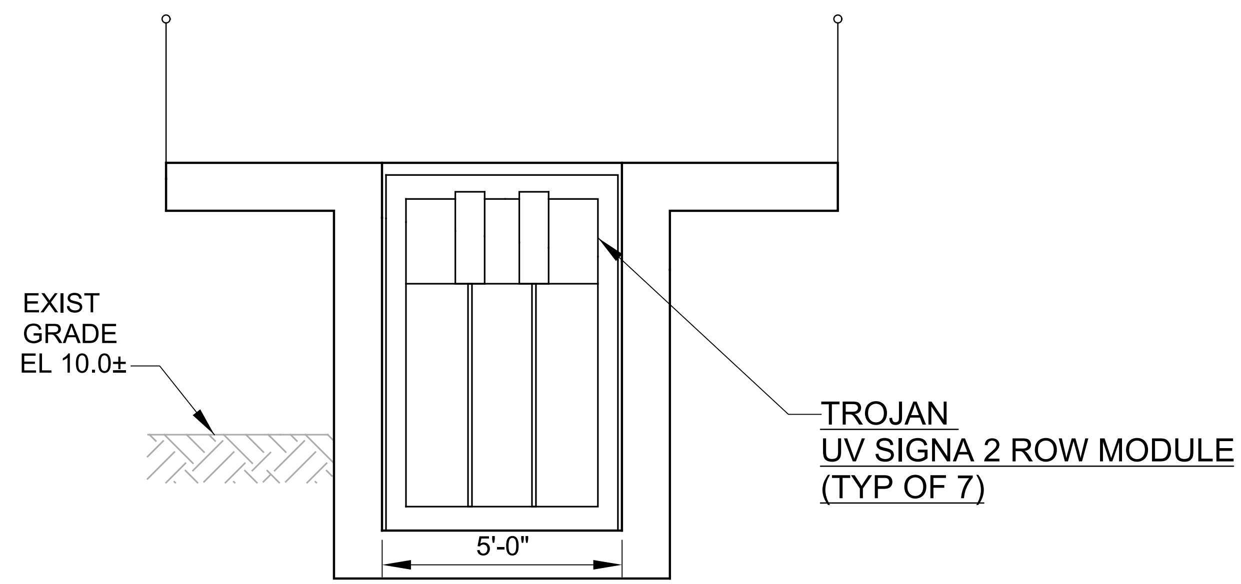


A - SECTION
SCALE: 1/4"=1'-0"
FILE: 9913B10FIG7



B - SECTION
SCALE: 1/4"=1'-0"
FILE: 9913B10FIG7

Figure No. 7.9
UV FACILITY SECTION
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Preliminary estimates of operating costs for the Trojan UV3000Plus were prepared for the 35 and 50 mJ/cm^2 dose levels with redundancy, and are outlined in Table 7.7. The assumptions for the costs are included in the table and are based on our analysis of the system and input from Trojan.

Table 7.7 Trojan UV3000 Plus Annual O&M Cost Basis and Estimate

Description	35 mJ/cm^2 Dose at 35% UVT	50 mJ/cm^2 Dose at 35% UVT	35 mJ/cm^2 Dose at 55% UVT	50 mJ/cm^2 Dose at 55% UVT
UVT, percent	35	35	55	55
Lamp Replacement	$250	$250	$250	$250
Ballast Replacement	$400	$400	$400	$400
Wiper Replacement	$15	$15	$15	$15
Quartz Sleeve Replacement	$80	$80	$80	$80
Chemical Usage	$300	$300	$300	$300
UV Sensor Replacement	$1,000	$1,000	$1,000	$1,000
Interest Rate	6.00%			
Project Life, years	15			
Electricity Rate (kWh)	$0.10			
Labor Rate (per hour)	$50.00			
Annual Parts and Replacement Cost	$112,000	$141,000	$47,300	$66,600
Annual Labor Cost	$29,600	$31,000	$25,300	$34,100
Annual Energy Cost	$50,000	$66,400	$26,000	$33,000
Total Annual Cost	**$191,600**	**$238,400**	**$98,600**	**$133,700**

Notes:
(1) All costs are based on redundant equipment.

The difference in annual O&M cost between the lower and higher dose values of 35 and 50 mJ/cm^2 is $46,800, and is predominately due to the higher energy use at the 50 mJ/cm^2 dose and the lamp count. The higher dose system has 112 more UV lamps (21 percent) compared to the 35 mJ/cm^2 system. Using the O&M cost basis in Table 7.7, the life cycle costs were calculated for both UV transmittances. The operating cost of the system at 55 percent UVT is substantially less than at 35 percent UVT, by over $104,000 per year. A comparison of the life cycle cost at the different UVTs is shown on Table 7.8. The higher UVT has a lower life cycle cost by over $2,000,000.

Table 7.8 Trojan UV3000 Plus System Net Present Worth Summary

Equipment	Equipment Cost (1)	Estimated Construction Cost (2)	Annual O&M Cost	Present Worth Life Cycle Cost (3)
35 mJ/cm^2 Dose @ 35% UVT	$1,090,000	$4,360,000	$191209,000	$6,390,000
35 mJ/cm^2 Dose @ 55% UVT	$785,000	$3,140,000	$102,200	$4.130,000
Difference	$305,000	$1,220,000	$107,800	$2,270,000
50 mJ/cm^2 Dose @ 35% UVT	$1,310,000	$5,240,000	$239,000	$7,560,000
35 mJ/cm^2 Dose @ 35% UVT	$1,090,000	$4,36,000	$133,700	$4,991,000
Difference	$387,000	$1,548,000	$104,700	$2,564,000

Notes:
(1) Based on redundant equipment and facilities.
(2) Based on 4 times the equipment cost.
(3) Life cycle based on 15 years and 6 percent interest.

The same preliminary estimates of annual operating costs for the Trojan UVSigna 2-Row were prepared for the 35 and 50 mJ/cm^2 dose levels with redundancy, and are outlined in Table 7.9. The assumptions for the costs are included in the table and are based on our analysis of the system and input from Trojan.

Table 7.9 Trojan UVSigna 2-Row Annual O&M Cost Basis and Estimate

Description	35 mJ/cm^2 Dose at 35% UVT	50 mJ/cm^2 Dose at 35% UVT	35 mJ/cm^2 Dose at 55% UVT	50 mJ/cm^2 Dose at 55% UVT
UVT, percent	35	35	55	55
Lamp Replacement	$485	$485	$485	$485
Ballast Replacement	$862	$862	$862	$862
Wiper Replacement	$20	$20	$20	$20
Quartz Sleeve Replacement	$162	$162	$162	$162
Chemical Usage	$300	$300	$300	$300
UV Sensor Replacement	$862	$862	$862	$862
Interest Rate	6.00%			
Project Life, years	15			
Electricity Rate (kWh)	$0.10			
Labor Rate (per hour)	$50.00			
Annual Parts and Replacement Cost	$18,000	$22,600	$10,200	$13,600
Annual Labor Cost	$7,600	$9,900	$4,600	$6,400
Annual Energy Cost	$19,300	$32,900	$9,900	$16,900
Total Annual Cost	**$44,900**	**$65,400**	**$24,700**	**$36,900**

Notes:
(1) All costs are based on redundant equipment.

The difference in annual O&M cost between the lower and higher dose values of 35 and 50 mJ/cm^2 is $20,500, and is predominately due to the higher energy use at the 50 mJ/cm^2 dose. The higher dose system has 24 more UV lamps (40 percent) compared to the 35 mJ/cm^2 system. Using the O&M cost basis in Table 7.9, the life cycle costs were calculated for both UV transmittances. The operating cost of the system at 55 percent UVT is less than at 35 percent UVT, by over $28,000 per year. A comparison of the life cycle cost at the different UVTs is shown on Table 7.10. The higher UVT has a lower life cycle cost by over $800,000.

The Trojan UVSigna 2-Row system offers significant annual operation and maintenance as well as present worth life cycle cost savings. For all of the scenarios, the annual O&M cost savings are greater than 70 percent compared to the UV3000Plus system. The life cycle cost savings are greater than 55 percent compared to the Trojan UV3000Plus system. The Trojan UVSigna 2Row system is the recommended disinfection system for the City of Arcata.

Table 7.10 Trojan UVSigna 2-Row System Net Present Worth Summary

Equipment	Equipment Cost (1)	Estimated Construction Cost (2)	Annual O&M Cost	Present Worth Life Cycle Cost (3)
35 mJ/cm^2 Dose @ 35% UVT	$510,000	$2,040,000	$44,900	$2,476,000
35 mJ/cm^2 Dose @ 55% UVT	$355,000	$1,420,000	$24,700	$1,660,000
Difference	$155,000	$620,000	$20,200	$816,000
50 mJ/cm^2 Dose @ 35% UVT	$640,000	$2,460,000	$65,400	$3,195,000
50 mJ/cm^2 Dose @ 55% UVT	$460,000	$1,840,000	$36,900	$2,198,000
Difference	$180,000	$720,000	$28,500	$997,000

Notes:
(1) Based on redundant equipment and facilities.
(2) Based on 4 times the equipment cost.
(3) Life cycle based on 15 years and 6 percent interest.

7.6.5 UV System Procurement

The UV system will be included in the final design for the flow reconfiguration / disinfection improvements portion of the Plant project. UV system equipment procurement can be implemented in a number of ways. The options are reviewed below at a high level for consideration by the City. The method of UV system procurement will be reviewed with the City and selected during preliminary design.

7.6.5.1 Sole Source Design and Bid

In this option, a single design is prepared and bid based on a single manufacture/supplier's product. In some cases, owners and designers have selected one supplier to provide an equipment supply bid without a competitive process. This has been done in limited cases where the supplier's equipment provides some unique feature that is critical to the project. This might include, matching existing equipment, or some patented feature that is important to the success of the project, such as the method of sleeve cleaning, or pilot results that provide critical benefits. Based on the characteristics of the Trojan equipment, with patented cleaning system, and successful pilot testing results, this could be considered by the City. Depending of the City's plan for funding, this would still need to be approved by the funding source, such as State Revolving Loan Fund (SRF).

7.6.5.2 Traditional Design and Bid

The traditional design and bid format is complicated when bidding UV disinfection equipment due to the different configurations offered by different UV equipment supplier or manufacturers. When UV equipment designs were first being considered, this was the preferred method of procurement. The designer would design the facility around one supplier, including structural, mechanical, and electrical designs. In general the UV disinfection equipment was specified based on a performance specification allowing competitive bidding. The issue with this approach was that the equipment supplied sometimes required very different structural, mechanical, and electrical designs. Even when the contractor was required to take the differences into consideration in the bid, items were sometimes missed or left out for alternative UV systems. In some cases this has resulted in disputes and change orders.

To avoid this issue, designers have prepared multiple designs around two or three suppliers, providing in some cases, two or three complete UV system designs. This was costly to the owner, since the designer had three times the effort, especially for structural, and electrical design components. In most cases the General Contractor selected the equipment based on cost alone, and the owner had no say in equipment selection.

One variation on this approach is to base bid the one manufacture that is used in the development of the bid documents. The general contractor provides a cost for installing one base bid with the pre-selected supplier's equipment, and provides the added or deductive cost for supplying other equipment. This provides the Owner with the differences in the cost of construction for different alternative suppliers. This can help to cut down on changes, but forces the contractor to determine all the extra costs for the alternative equipment, including design revisions.

7.6.5.3 Evaluated Bid for UV Equipment

One solution that designers and owners follow to avoid the issues with the traditional design and bid approach, is an evaluated bid for UV equipment. The designer and owner first issue a Request for Proposal package for bidding the UV disinfection equipment. It is based on approximately a 30 percent design, and a performance based specification. The proposal forms require not only the capital cost bid, but guaranteed power cost, lamp replacement costs, and chemical cost (if required). The proposals are used to complete a present worth analysis for each proposer. The proposer with the lowest present worth (or best overall value) would be selected. The owner would then contract with the supplier for the UV equipment supply based on this selection. In most cases the selected supply also includes an allowance for working with the owner and designer to complete the design. Then the installation could be bid to a general contractor based on the selected equipment supplier and design requirements. The equipment cost proposal is then included in the general contractors bid, and is assigned to the General Contractor by the Owner once a General Contractor is selected. Carollo has used this approach on a number of UV installations, and generally has had good experience with the overall approach. In most cases it has resulted in a good installation bid, and allows the UV supplier to be part of the design team. This approach also helps to ensure that no details are missed in the design. In addition, it provides a system that has the best value to the Owner.

In an evaluated bid format, other factors can also be used in ranking a suppliers bid. These could be addressed in a weighting process and could include the following:

- Suppliers warranty and warranty terms.
- Proximity to factory authorized service center.
- Number of installation of the type proposed for owner.
- Recent installation issues or claims against the supplier.
- Validation experience.
- Regulatory acceptance of the technology if new or improved.

7.6.6 UV System Pretreatment

The treatment wetland will require pretreatment including coarse screening and medium fine screening prior to the UV process.

The Pump Station No 1 (PS1) modifications will include a coarse screen at the inlet structure to remove larger debris and vegetation prior to pumping. This will protect both the pumps and the UV system. The type of screen and details will be reviewed during PS1 final design.

The pump station modifications should also include some type of protection for downstream UV system such as an effluent strainer to remove material especially stringy algae and other organic material. The strainer will be sized to provide 200 to 500 micron strainer with automatic cleaning. The type of strainer best suited for wetland effluent including algae and vegetation solids will be reviewed during final design.

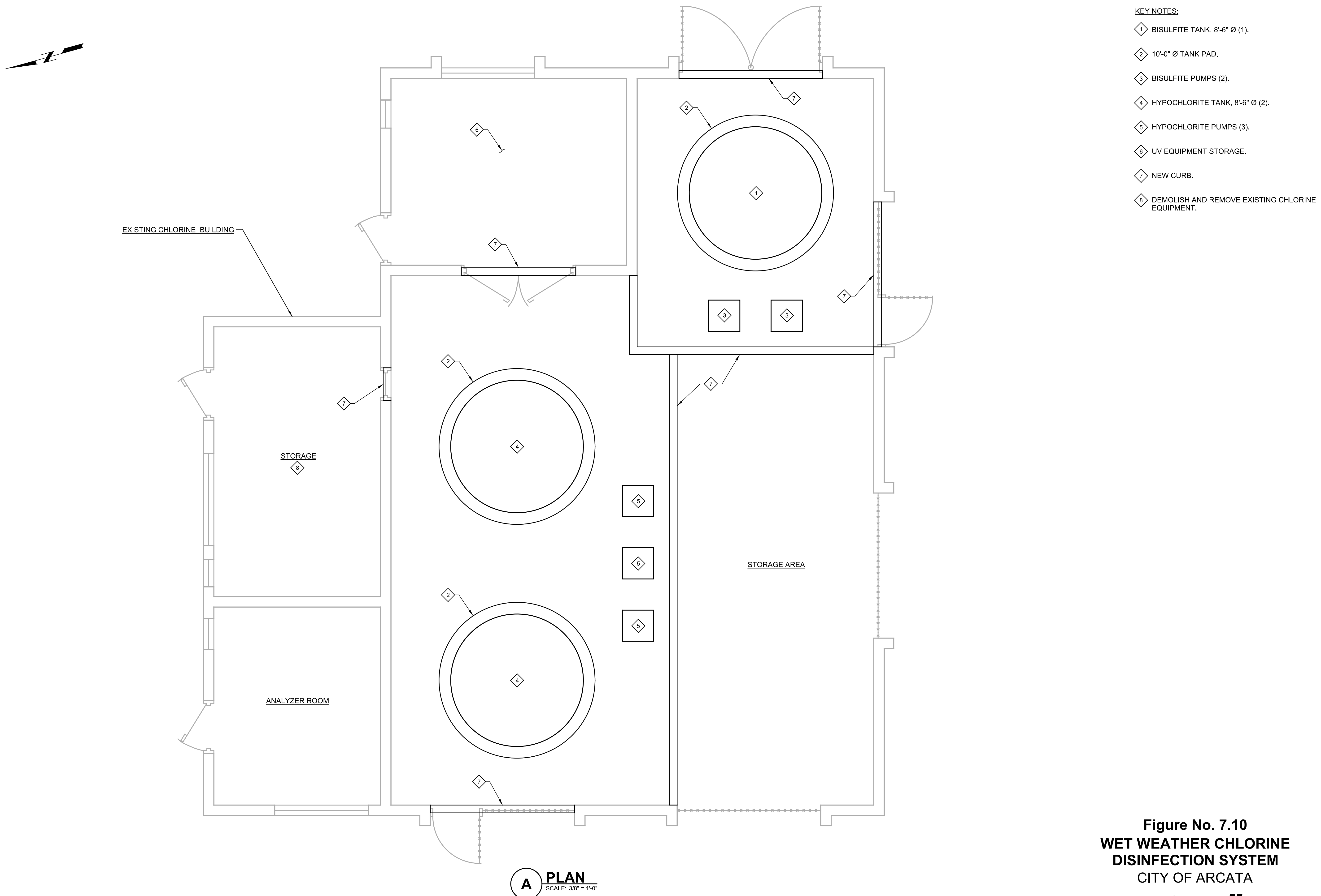
7.7 Existing Chlorine and Sulfur Dioxide System

The City of Arcata will phase out the existing chlorine and sulfur dioxide gas system as the primary disinfection process after the implementation of the new UV system. The existing system could still remain as a backup to the UV and for peak wet weather flow disinfection. This will require that the plant maintain the system and store chlorine and sulfur dioxide ton cylinders on site, especially during wet weather. It has been reported in the City's 2011 Risk Management Prevention Plan (RMPP), that the AWTF has been handling chlorine for over 25 years and has never experienced a release. As noted in the plan, the plant, on average, has fifteen (1 ton) chlorine cylinders on site. Typically six cylinders are on-line and nine are in storage. In addition, there are also six sulfur dioxide containing cylinders on-site, with two cylinders on-line and four in storage. As part of the RMPP evaluation, plant staff determined that due to an annual average chlorine consumption of 1.5 - 2.0 tons per week, chemical supplier location (500 miles away), delivery delays due to road conditions and effluent disinfection requirements, that the amount of on-site chemical was necessary. While the amount of chemical stored on-site in this scenario can be reduced once the UV system is online, chlorine and sulfur dioxide will still need to be stored on-site, and ready for use during wet weather.

The system can be retrofit to a liquid chemical system for use during wet weather or as a redundant system to the new UV system. Note that this system would only be used for disinfection for the existing Outfall 001.

The reason to retrofit the system is to reduce the overall potential risk from the ton chlorine cylinder system. Commonly sodium hypochlorite and sodium bisulfite are used to retrofit gas systems. The benefit of using the liquid chemical is lower potential for release of hazardous gas, and a fairly simple chemical dosing system. The downside is that these chemicals are less stable, and degrade over time. Typically the hypochlorite is supplied as 15 to 25 percent and bisulfite as 15 to 45 percent. These can degrade over time to less than 10 percent strength in a matter of weeks. For example, depending on the temperature a 15 percent hypochlorite solution can degrade in half in 60 to 100 days.

The chemicals would be stored in high density polyethylene tanks. The tanks could be located in the existing chlorine gas storage area, with slight modifications to provide containment. Chemical metering pumps could be installed adjacent to the tanks, and used to pump chemical solution directly to the existing CCB. The existing chemical induction units could be reused for this application. The cost of the retrofit is estimated at $350,000 to $500,000. A preliminary layout is shown on Figure 7.10.



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User: DFassbinder

Figure No. 7.10
WET WEATHER CHLORINE DISINFECTION SYSTEM
CITY OF ARCATA

7.8 Summary of Next Steps

The following items need to be reviewed or finalized during final design based on the final effluent permit requirements:

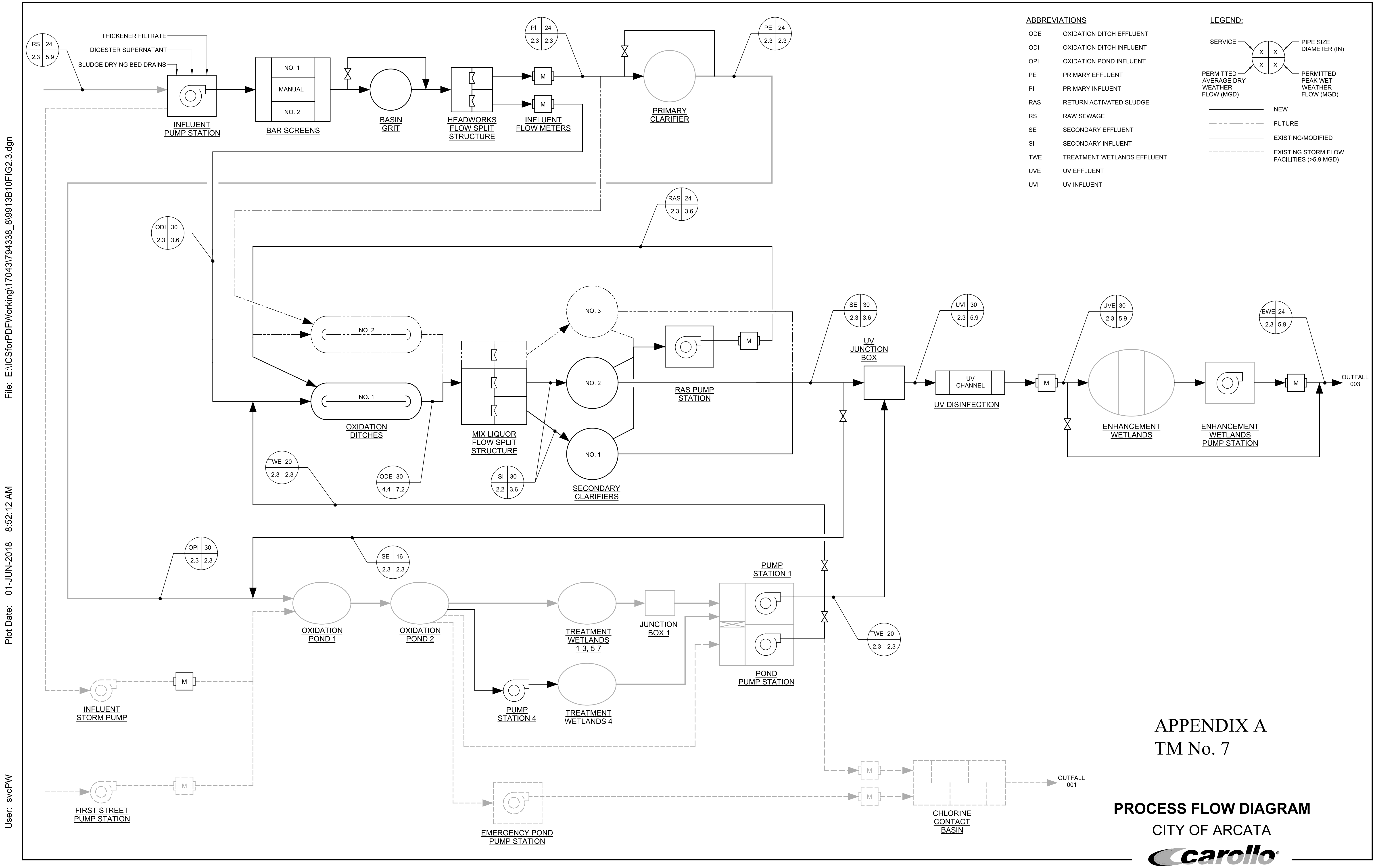
- Final system sizing based on the expected design UVT: 35 percent.
- Final design dose of 50 mJ/cm^2, to be confirmed by collimated beam test on the Arcata enhancement marsh effluent and based on feedback from State on requirements to be protective of shellfish.
- UV system facility design requirements including the need for an enclosure or other type of weather protection and architectural treatment.
- Power supply and back-up power requirements.
- Procurement method based on evaluated bid or sole source procurement.
- Chlorine system retrofit design, including demolition of existing chlorine and sulfur dioxide gas system and replacement with liquid chemical system.

7.9 References

SHN 2003 - 2000/2002 Wastewater Treatment Plant Evaluation, February 2003, SHN Consulting Engineers & Geologists Inc.

Appendix A

PLANT SCHEMATIC



APPENDIX A
TM No. 7

PROCESS FLOW DIAGRAM

CITY OF ARCATA

Appendix B

CHLORINE USE

Month/Year	Monthly Ave Flow (MGD)	Average SO_2 Use (lbs/day)	Average SO_2 Dose (mg/L)	SO_2 Peak Daily Use (lbs)	Average CL_2 Use (lbs/day)	Average CL_2 Dose (mg/L)	CL_2 Peak Daily Use (lbs)
Jun-10	2.17	186	10.28	370	220	12.16	520
Jul-10	1.32	143	12.99	210	176	15.99	270
Aug-10	1.28	160	14.99	220	230	21.55	360
Sep-10	1.37	145	12.69	200	341	29.84	530
Oct-10	1.48	221	17.90	400	347	28.11	470
Nov-10	2.47	233	11.31	390	263	12.77	470
Dec-10	3.52	270	9.20	420	275	9.37	500
AVERAGE		194		316	265		446
Jan-11	2.75	205	8.94	350	197	8.59	340
Feb-11	2.51	203	9.70	320	189	9.03	300
Mar-11	3.26	307	11.29	510	373	13.72	560
Apr-11	2.54	220	10.39	420	227	10.72	420
May-11	1.70	139	9.80	170	202	14.25	340
Jun-11	1.48	118	9.56	180	178	14.42	250
Jul-11	1.18	92	9.35	140	190	19.31	380
Aug-11	1.25	132	12.66	180	412	39.52	286
Sep-11	1.33	143	12.89	180	347	31.28	540
Oct-11	2.00	217	13.01	300	362	21.70	560
Nov-11	1.59	201	15.16	290	234	17.65	320
Dec-11	1.42	145	12.24	200	218	18.41	380
AVERAGE	.	177		270	261		390
Jan-12	2.79	213	9.15	315	271	11.65	360
Feb-12	2.03	187	11.05	290	252	14.88	380
Mar-12	2.74	241	10.55	340	256	11.20	420
Apr-12	3.16	231	8.77	400	317	12.03	580
May-12	1.67	151	10.84	220	237	17.02	320
Jun-12	1.38	132	11.47	180	163	14.16	380
Jul-12	1.19	145	14.61	200	137	13.80	200
Aug-12	1.21	134	13.28	190	225	22.30	310
Sep-12	1.31	145	13.27	190	232	21.23	320
Oct-12	1.37	154	13.48	200	199	17.42	270
Nov-12	1.72	198	13.80	310	198	13.80	420
Dec-12	3.28	238	8.70	510	282	10.31	830
AVERAGE		181		279	231		399

Month/Year	Monthly Ave Flow (MGD)	Average SO_2 Use (lbs/day)	Average SO_2 Dose (mg/L)	SO_2 Peak Daily Use (lbs)	Average CL_2 Use (lbs/day)	Average CL_2 Dose (mg/L)	CL_2 Peak Daily Use (lbs)
Jan-13	2.00	179	10.73	230	166	9.95	240
Feb-13	1.86	212	13.67	270	217	13.99	290
Mar-13	2.40	175	8.74	230	181	9.04	290
Apr-13	1.72	150	10.46	210	195	13.59	290
May-13	1.40	139	11.90	210	153	13.10	240
Jun-13	1.24	166	16.05	210	235	22.72	390
Jul-13	1.10	149	16.24	200	287	31.28	440
Aug-13	1.19	105	10.58	280	236	23.78	380
Sep-13	1.32	96	8.72	260	198	17.99	670
Oct-13	1.37	156	13.65	250	237	20.74	440
Nov-13	1.30	142	13.10	210	347	32.01	530
Dec-13	1.19	120	12.09	160	174	17.53	320
AVERAGE		149		227	219		377
Jan-14	1.32	129	11.72	180	170	15.44	240
Feb-14	2.16	213	11.82	360	266	14.77	490
Mar-14	2.28	213	11.20	380	266	13.99	520
Apr-14	1.73	194	13.45	260	167	11.57	240
May-14	1.41	156	13.27	200	170	14.46	220
Jun-14	1.16	136	14.06	190	227	23.46	500
Jul-14	1.07	75	8.40	180	187	20.96	470
Aug-14	1.18	59	6.00	90	158	16.05	200
Sep-14	1.85	94	6.09	160	190	12.31	480
Oct-14	1.57	142	10.84	300	263	20.09	770
Nov-14	1.67	211.3	15.17	240	318.3	22.85	460
Dec-14	3.19	284	10.67	420	302	11.35	460
AVERAGE		159		247	224		421
Jan-15	1.55	180	13.92	320	193	14.93	360
Feb-15	1.93	203	12.61	320	233	14.48	410
Mar-15	1.77	194	13.14	260	191	12.94	320
Apr-15	1.84	211	13.75	280	202	13.16	260
May-15	1.29	90	8.37	180	87	8.09	240
AVERAGE		176		272	181		318

Appendix C

UVT DATA

PROJECT MEMORANDUM

Project Name:	WWTP Improvements Project	**Date:**	June 4, 2015
Client:	City of Arcata (LACO)	**Project Number:**	9913A10
Prepared By:	Andrew Salveson		
Reviewed By:	Doug Wing		
Subject:	Technical Brief - UVT Data Summary and Implications		
Distribution:	LACO, City, File		

This technical brief reviews several UV transmittance (UVT) data sets, provides a graphical comparison of those data sets, and evaluates the potential implications. Recommendations for additional sampling are also provided.

1.0 UVT DATA

The Carollo team was provided with several UVT data sets:

- Sample Dates: 2008, 2011, and 2015 (current).
- Sample Locations: 8, 8-3, 9, and 15.

The sample locations are shown in Figure 1. Point 15 is the Hauser effluent, whereas Points 8, 8-3, and 9, as we interpret the locations, all represent essentially the same location in the treatment process, which is after the treatment wetlands but before the enhancement marshes. The UVT data is presented in Figures 2 to 5.

2.0 DATA ANALYSIS

Our review of this data set results in both questions and answers, and more data is needed. We propose the following items for discussion with the City:

- Points 8, 8-3, and 9 have consistently had a low UVT in the ~20% range (Figure 2 and Figure 3). The higher UVT using one UVT meter in 2011 may be the result of a calibration issue.
- Point 15 has had a UVT of ~40% to ~55%, with consistent data in 2011, but a concerning downward trend in 2015. Something has changed within the process treatment train which is driving the UVT down as part of the latest testing. It may be that flows to the enhancement marshes were chlorinated, which may have reduced increased UVT by oxidizing soluble organic matter. We are in need of feedback from the City.
- The UV system is currently considered for implementation after Point 15, and thus the UVT data from Point 15 is most relevant. If the current downward UVT trend at Point 15 continues, then the new UV system will be quite expensive to implement. Further, the UVT at Point 15 is currently well below the UVT value in the new permit.

- The increase in UVT from Points 8, 8-3, and 9 to Point 15 is substantial and must be better understood. Is the UVT increase purely a function of biological activity and filtration through the Hauser Marsh? Was there (or is there) any other type of treatment that occurs after Points 8, 8-3, and 9 but before the end of the enhancement marshes?

3.0 RECOMMENDATIONS

It is recommended that the UVT sampling at location 15 be expanded to include testing after the treatment wetlands, at either points 8 or 9, prior to the chlorine contact basin. Further, we suggest testing of UVT as it enters the Hauser Marsh.

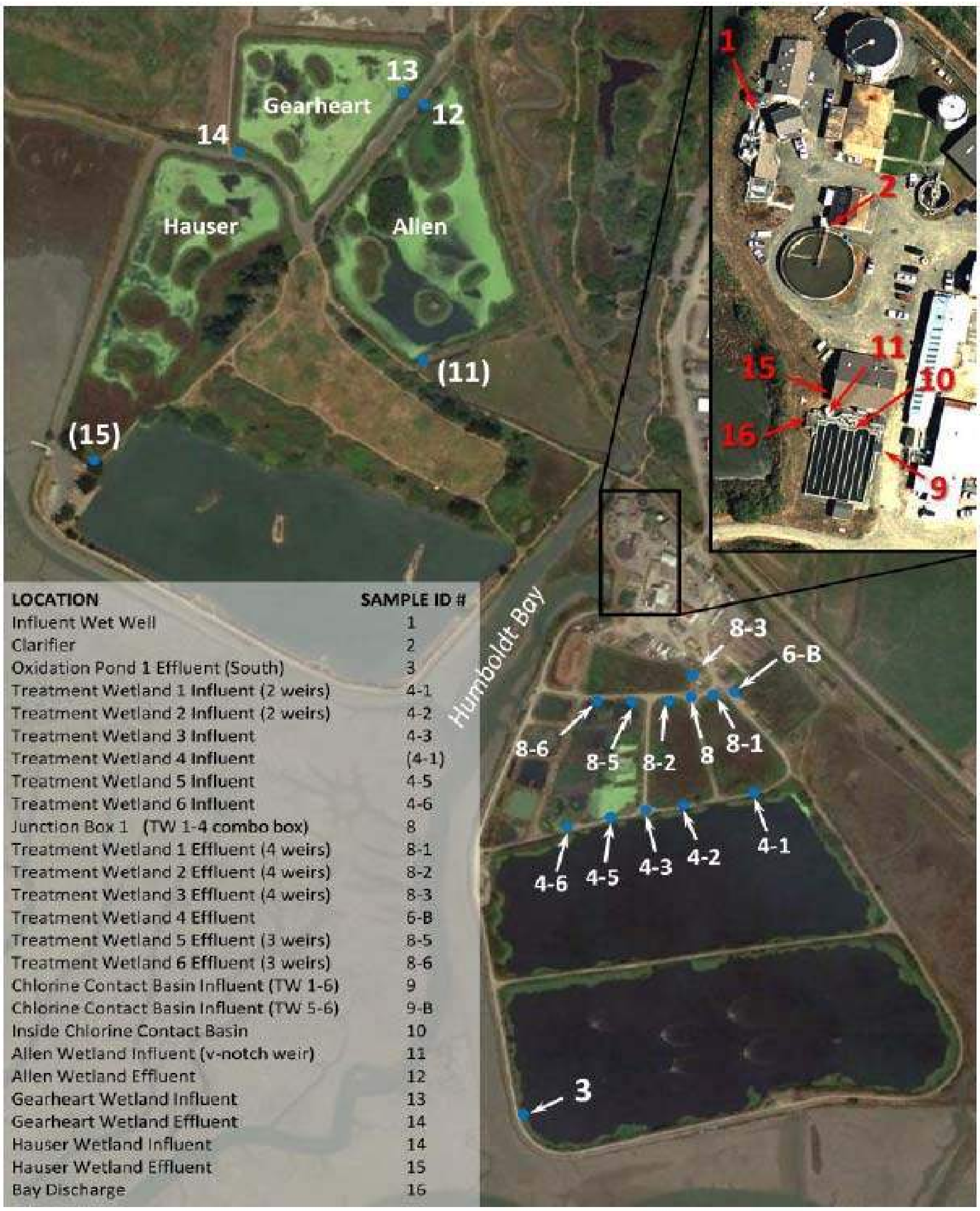


Figure III- 2. Locations and labels for sampling points through the AWTF.

Figure 1 – Sample Locations

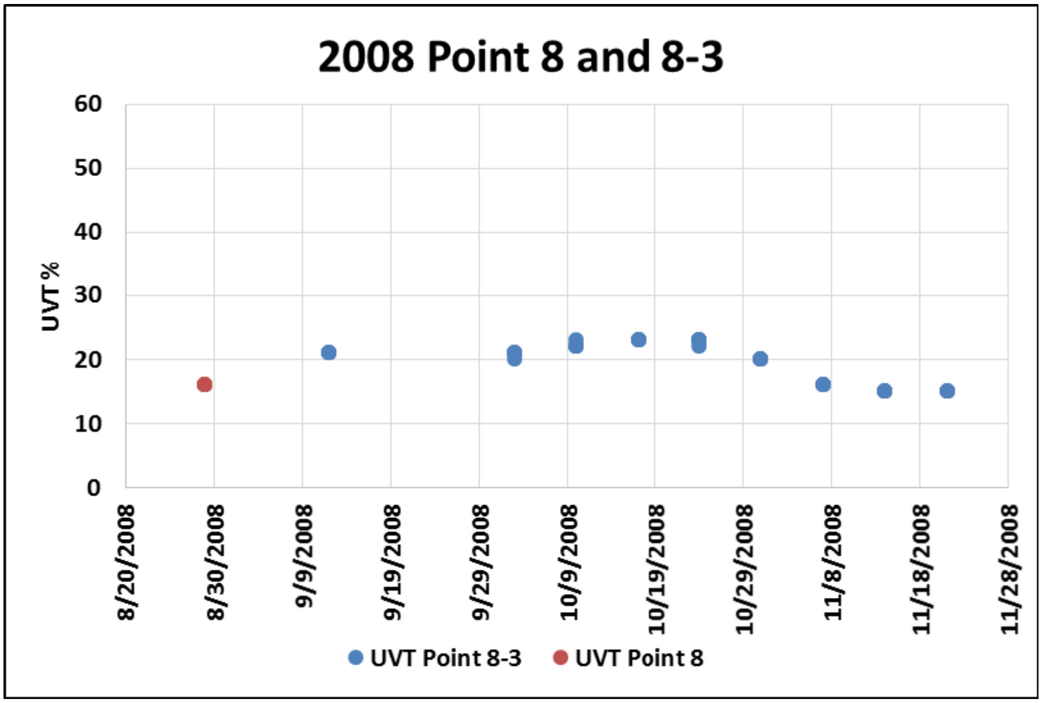


Figure 2 – 2008 Data, Points 8 and 8-3

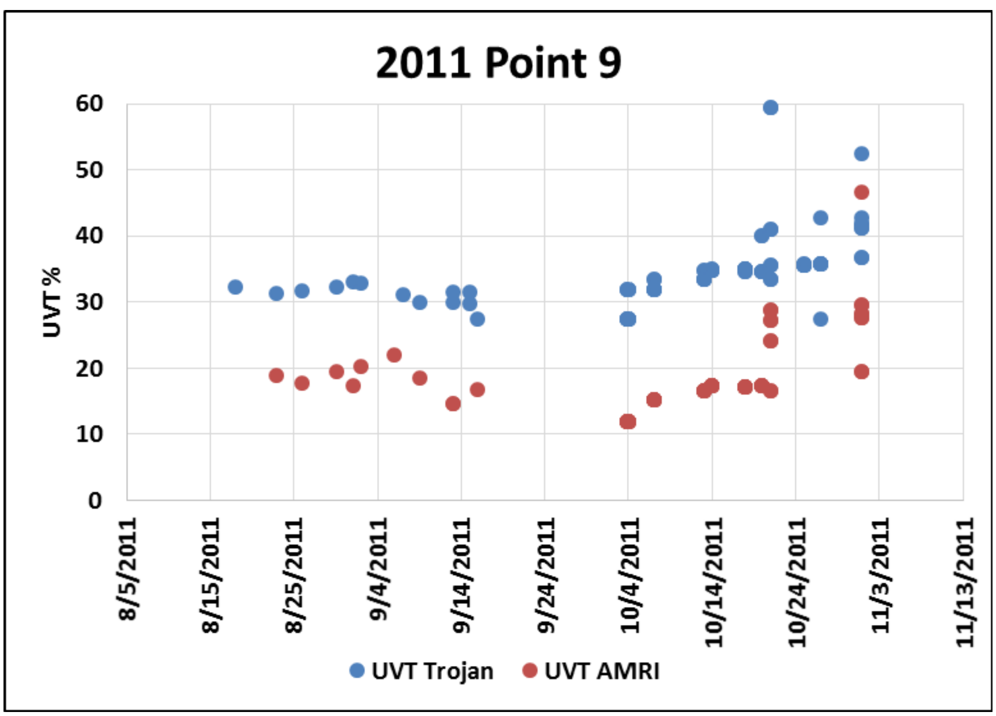


Figure 3 – 2011 Data, Point 9

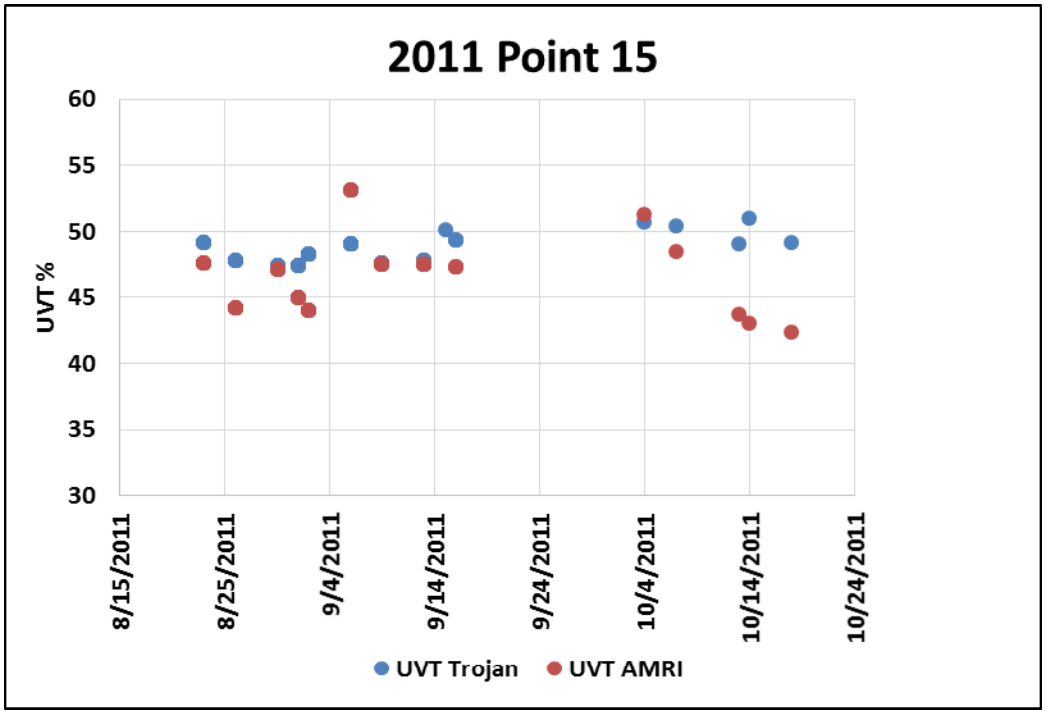


Figure 4 – 2011, Point 15

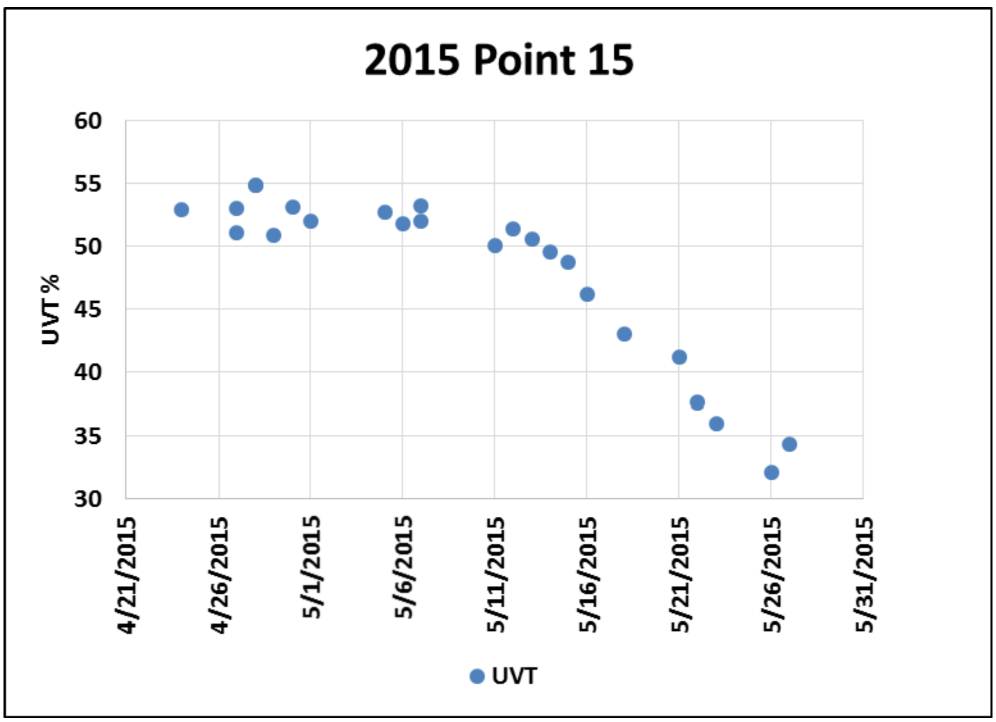


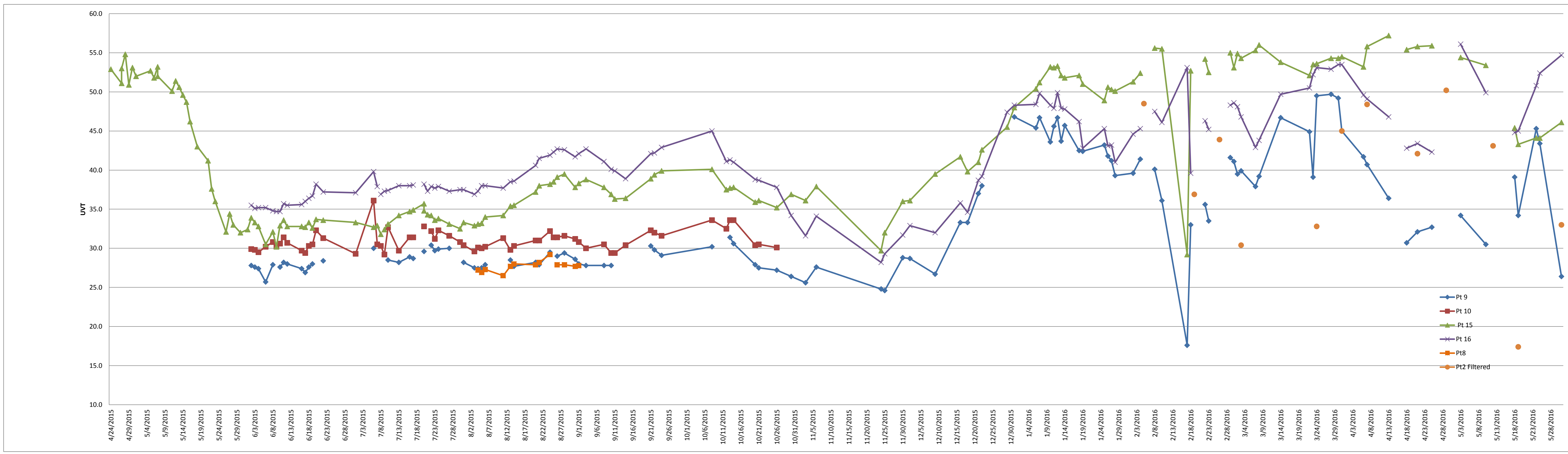
Figure 5 – 2015, Point 15

Prepared By:

Andrew Salveson

This is where the engineer digital seal will be placed.

Appendix M, UVT Data
City of Arcata
Wastewater Treatment Facility Improvements Project



c:\pw_working\projectwise\esimmons\d0388776\Arcata_UVT_Hauser Effluent_updated 6.1.2016.xlsxArcata_UVT_Hauser Effluent_updated 6.1.2016.xlsxSheet1

Appendix D

UV PILOT STUDY

MEMO

From: Arcata Marsh Research Institute

Date: November 2, 2011

UV Disinfection of the City of Arcata's treated wastewater

Purpose

Presently, UV disinfection is being considered to replace chlorine disinfection. Alternative sites for UV disinfection are being considered depending upon permitting requirements. The purpose of studying UV disinfection at multiple locations is to provide information that can be used to prove effectiveness and to design a full-system UV disinfection process. Continuing to disinfect with a chlorine-based system will produce disinfection byproducts that are not removed in the dechlorination process and are known human and ecological toxins. These disinfection byproducts have been identified in Arcata's effluent. The following list states the multipurpose goals of this UV pilot system.

- City of Arcata treats their wastewater with the lowest impact possible to meet all existing permit requirements (for disinfection permit limits see Table 1).
- Eliminating the chlorination disinfection system eliminates toxic byproducts and human hazards associated with chlorine usage.
- Options for disinfection are Point 9, a mixture of Point 9 and Point 15, and Point 15.
- Installation of UV disinfection at Point 001 is redundant when disinfection has been achieved at Point 002. Therefore, disinfection should be focused at Point 002. Additional water quality limits (BOD, TSS, Ammonia, metals etc) should be argued for and implemented at a final discharge point (Pt 001, or Pt 003 – to McDaniels Slough).
- Installation of UV disinfection at Point 001 while chlorinating at Point 002 does not eliminate the delivery of toxic byproducts to the Tertiary Constructed Wetlands (TCW). If the TCW are decided to be Waters of the State then fresh water toxicity limits from chlorination will be a difficult permit limit to meet.

Table 1: City of Arcata coliform permit limits at Outfall 001 and 002.

Permit location	Permit limit	Units	Monthly Average	Daily Maximum
Outfall 001	Fecal Coliform	MPN/100mL	14	43
Outfall 002	Total Coliform	MPN/100mL	23	230

Water Quality Objectives
The North Coast Water Quality Control Board defines water quality objectives for (1) shellfish growing areas and (2) watersheds in the ***North Coast Basin Plan*** (Plan)**.** Objectives for shellfish growing waters (applied within the Bay waters) state "*the geometric mean for fecal coliform shall not exceed 14 MPN per 100 ml and that the 90th percentile value for fecal coliform shall not exceed 43 MPN per 100 ml*." This Study applied the 90th percentile value of 43 MPN in the interpretation analyses of bay water samples.

Ultraviolet Disinfection – Background Information

The use of ultraviolet disinfection is an environmentally responsible, convenient, safe, and cost-effective way to disinfect municipal wastewater discharge. UV disinfection performance is equal to chlorine. The effluent easily meets NPDES permit requirements and is a more effective viralcide than chlorine. As a result, adequate disinfection is provided, permit requirements are met, and local aquatic life is protected. By reducing reliance on chlorine, the potential for accidental worker and/or citizen exposure is reduced.

Advantages

Safety: UV disinfection is safer than wastewater treatment systems that rely on chlorine gas. By eliminating transport and handling of large quantities of a hazardous chemical, the UV system reduces potential liability for worker/community exposure. Studies also suggest that UV disinfection controls viruses and many disease-causing bacteria better than chlorination/dechlorination.

Simplified Compliance: UV disinfection can help ease compliance with NPDES permit requirements and Fire Code regulations. Continued use of chlorine would require Arcata to build a new disinfection area incorporating secondary containment and a scrubbing/neutralization system.

Reduced Effluent Toxicity: Even at low concentrations, chlorine is toxic to aquatic organisms. Dechlorination only removes chlorine in the free residual form leaving combined forms. Aqueous chlorination practices also generate halogenated organic compounds, which may also be toxic. UV disinfection protects the aquatic habitat of the receiving waters. (Literature citation)

Operation, Maintenance and Cleaning: The operation and maintenance of UV disinfection systems is simpler than chlorination/dechlorination systems. UV process monitoring and controls relies on instrumentation that maintains optimum irradiation levels for disinfection. Automatic shutoff values exist to stop flow when conditions for target disinfections are compromised. (Literature citation)

Chemical of concern: UV has been demonstrated to reduce and remove a wide range of personal products and pharmaceutical found in domestic wastewater. There is a large body of literature showing the effectiveness of UV light on complex organic compounds in wastewater including endocrine disrupters. UV disinfection system can serve as an effective process to deal with the next group of potential NPDES parameters. (Literature citation)

Energy Consumption: The total energy requirement for UV is less than chlorination mostly due to the transportation and handling energy cost. UV has the potential to use the electricity generated from anaerobic digesters on-site. Presently Arcata does not use biogas for electrical power production.

UV Disinfection Studies

Currently, an open channel Trojan UV3000 system is being used to test disinfection of the City of Arcata's reclaimed wastewater. Previous studies (Wilson 1996, Ly 2008, Finney et al. 2009, and Garrison 2010) indicate UV disinfection is successful at both current chlorine disinfection locations (Pt 9 and Pt 15). The UV3000 model open-channel configuration believed to be the best model yet tested to handle the typical water quality seen at Pt 9 and Pt 15. Typical design range for industry norms is 20-140 mJ/cm^2.

Past UV Studies

The City of Arcata has invested in 2 previous pilot scale studies (Finney et al. 2009, and Garrison 2010), and 2 bench scale studies (Wilson 1996, and Ly 2008) to determine the efficacy of UV disinfection as a replacement for the use of chlorine.

Table 2: Summary of previous UV studies at the Arcata Marsh.

Study	**UV system (Q)**	**Study period; [# of runs]**	**Point of disinfection; Water quality**
Wilson (1996)	Lifeguard Aquatics, QL-40 (40 Watt bulb); closed vessel, (.96-5 GPM)	Oct. 1994 – Apr. 1995	Hauser effluent: Turbidity (0.9-6.1 NTU), TSS (0.3-8.2 mg/L), Transmittance (43-58%)
UV effectively disinfected all samples at all ranges below permit requirements. Dose ranged 48.4-283.63 mJ/cm^2. Note 19% of untreated samples complied with permit requirements.			
Ly (2007)	Bench-scale Double Helix UV sterilizer, closed vessel; (10 gallon samples)	Aug. – Dec. 2007 [n=15]	TM 4: TSS (17-35 mg/l), Transmittance (44.8 – 54.7%)
Influent FC ranged from 600-11,200 CFU/100ml all UV radiated samples achieved total FC kill and resulted in clean plates. UV dose is estimated to have ranged from 96-153 mW/cm^2.			

<table>
<tr><td rowspan="3">Finney et al. (2009)</td><td rowspan="3">Aquionics Inline 40+, closed vessel

(5-75 gal/min)</td><td>Aug. 2010

[n=5]</td><td>Pt 8: Turbidity (38-41 NTU), TSS (27-31 mg/l), Transmittance (16%). Water quality considered too low to achieve disinfection.</td></tr>
<tr><td>Sept. – Nov. 2010

[n=45]</td><td>TM 3: Turbidity (20-40 NTU), TSS (9-35 mg/l), Transmittance (25%).</td></tr>
<tr><td>Dec. 2010
[n=9]</td><td>Hauser: Turbidity (6 NTU), TSS (3 mg/l), Transmittance (49%).</td></tr>
<tr><td colspan="4">Increased TSS correlated with higher turbidity and lower transmittance. FC fairly easy to inactivate, TC harder, TM 3 effluent needed a dose over 200 mJ/cm^2. Hauser effluent achieved disinfection at a dose of 100 mJ/cm^2.</td></tr>
<tr><td>Garrison (2010)</td><td>Trojan Fit, model 18AL40 closed vessel

(0.11 – 1 MGD)</td><td>Sept. 2010 – Jan. 2011

[n = 107]</td><td>Pt 8: TSS (15-76 mg/L), Turbidity (10-75NTU), Transmittance @254 nm (22.5-56.3%)</td></tr>
<tr><td colspan="4">The study shows disinfection is achieved at all tested levels of TSS and UVT with varying dosages. Consistent and sufficient disinfection was achieved at 100 mJ/cm^2. There was no clear relationship between TSS and effectiveness nor between UVT and effectiveness although both TSS and UVT are considered the main parameters that affect effectiveness. Trojan was unable to provide the dosage equation that may better describe these relationships.</td></tr>
</table>

Findings:

Garrison (2010) found effective disinfection even though the closed-chamber Trojan Fit met unpredicted issues with solids build-up and flow regulation.

- Accumulated algal solids, unexpected cattail fragments, frogs, snails, and sticks.
- The UV lamps accumulated an opaque film that was described as excessive by the Trojan representative.
- The flow rate used to achieve UV disinfection was often below the designed operating parameters for the unit resulting in laminar flow rather than turbulent flow.

Recommendations

- Routine maintenance and screening at the influent pump station would reduce the amount of detrital solids entering the disinfection systems.
- Find appropriate cleaning solution for opaque film if it occurs again.
- Closed chamber UV disinfection is not appropriate

The 2011 UV Project – Testing Point 15 (Hauser) and Point 9 effluent

Pilot Study Design

A Trojan UV3000 pilot-scale UV unit for ultra-violet disinfection is being tested for effectiveness on Arcata Marsh secondary treated effluent. UV disinfection effectiveness is being determined by both the ease of operations and the ability to disinfect total and fecal coliform (TC & FC). The disinfection efficacy at different doses and ease of operations are used as design criteria and in developing operational strategies. The UV unit is located on the berm next to the chlorine contact basin to allow for multiple influent sources (Figure 1).

In order to test the disinfection effectiveness, the UV dose can be altered by changing the flow rate and therefore the residence time. The second way to change the UV dose is to alter the level of power delivered to the water.

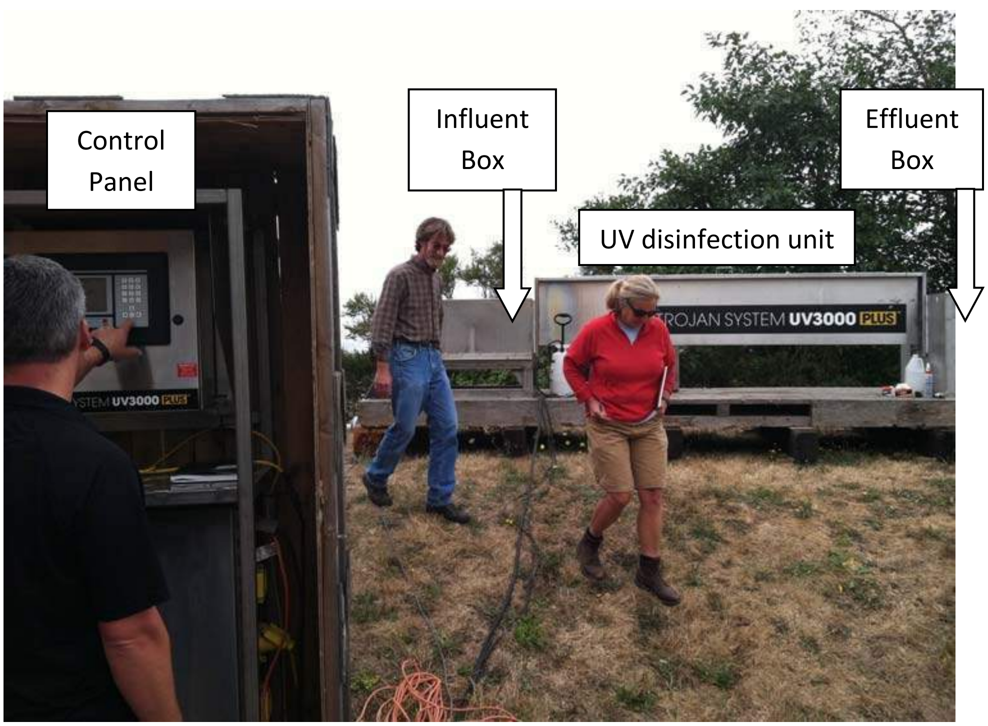


Figure 1: Trojan UV3000 control panel and disinfection unit.

The first source of water to be tested is from Hauser Wetland (Point 15). Additional sources of water to be tested are from Point 9 and a mixture from Point 9 and Hauser Wetland. The City of Arcata discharge permit has fecal coliform (FC) and total coliform (TC) limits for Outfall 001/Point 15 and Outfall 002/Point 9 (Table 3).

Table 3: City of Arcata discharge permit limits for total and fecal coliform.

Permit location	Permit limit	Units	Monthly Average	Daily Maximum
Outfall 001	Fecal Coliform	MPN/100mL	14	43
Outfall 002	Total Coliform	MPN/100mL	23	230

The different sources of water have different constituents that affect the ultra-violet transmittance (UVT). UVT is a measure of how well UV wavelengths can penetrate the source water and is effected by the turbidity, suspended and dissolved solids of the sample water. The assessment of each sampling location includes measuring UVT, turbidity, and TSS (Table 4). The Hauser Wetland effluent is typically described with a high UVT, low turbidity and TSS. Point 9 effluent is described with a lower UVT, and greater turbidity and TSS. The testing season, late summer, represents "worst-case" conditions for UVT due to high algal TSS, high turbidity, and increased humic acids (dissolved solids) from plant decomposition. Effective UV disinfection at this time of year provides design parameters that would cover poor water quality conditions.

Table 4: Water quality parameters for the influent sources to the UV system.

Source of UV influent	Dates of operation	UVT range	TSS (mg/L)	Turbidity (NTU)
Point 9	Aug 23 – Sept 16	27.5 – 34.9	54 – 77*	40 - 59
Mixture of Pt 9 and Hauser Wetland				
Hauser Wetland	Oct 4 - 13 & Oct 25 - 28	47.4 – 49.4	3 - 6	4 - 18

On October 7^{th} – 10^{th} or something – there were three days in a row of heavy rainfall. The high value for TSS reflects a spike in solids during this rainfall event.

Methods

Ease of operations is a function of how much time and effort is required by the treatment plant operators to maintain the UV unit as well as how much pre-treatment is necessary to deliver a quality of water that can be effectively disinfected.

Disinfection of coliform is being determined by the effect of UV dose on colony formation (reported in CFU/100mL) in accordance with Standard Methods for the Examination of Water and Wastewater. An alternative method for measuring coliform is the Most Probable Number (MPN) test that yields results in brackets of probable coliform abundance. The MPN test is the reporting standard for the discharge requirement.

The dose of UV light delivered to the water is described by a proprietary equation using flow rate and ultra-violet transmittance (UVT) (Figure 2). At this time of year, the effluent from Hauser Wetland is consistently about 50% UVT and Point 9 is about 30% UVT.

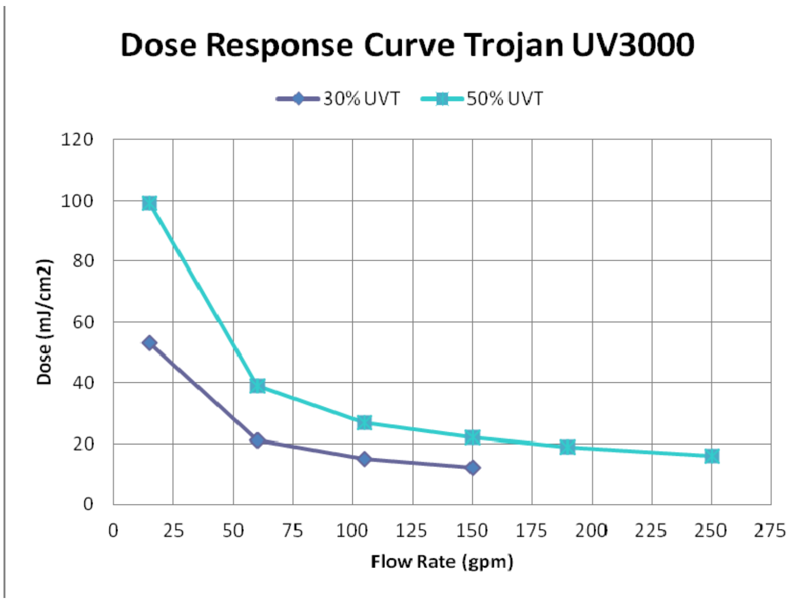


Figure 2: Dose response curve for Trojan UV3000.

Results and Discussion

Maintenance

Weekly visual inspections conducted by AMRI staff and City of Arcata wastewater treatment operators have demonstrated clean bulbs and some accumulation of solids. The clean bulbs were contrasted with the areas of grayish build-up on the bulbs that do not function as a part of the disinfection process and are not reached by the automatic cleaning mechanism (Figure 3). The accumulated solids were comprised of stringy material that may originate in the pipe between Hauser and the UV unit or may originate in Hauser Wetland itself (Figure 4). Once the influent source changed to Point 9, the influent settling basin showed pebbles and debris collecting. A simple screen was placed in front of the UV chamber to reduce the amount of large particles moving through the disinfection process. Throughout the study, the bulbs remained clean and clear of any noticeable film or build-up.

Operators have indicated that the maintenance time requirements of the UV unit are acceptable. Daily tasks are checking the UV control panel for alarms, checking the flow rate and the level of water in the unit. Additionally, when the unit is being run with Hauser influent, the operators turn off the unit and travel to the Hauser pump station to clean the effluent screen. If the screen is not cleaned daily, or if it accumulates a lot of solids there is a corresponding drop in the flow rate to the UV unit. The weekly visual inspections are demonstrating success and providing confidence in the ability of the UV unit to continue operations without a lot of maintenance.

The accumulation of stringy solids and large solids is potentially problematic, as solids can provide shielding for coliform as they move through the system. The result would be viable coliform on the effluent end of the UV unit. The solution would be a mechanical self-cleaning screen on the influent to the UV disinfection system.

Figure 3: Visual inspection demonstrating build-up of greyish coating on area of bulbs where the wiper does not reach.

Figure 4: Visual inspection demonstrating the accumulation of stringy solids on bulb apparatus and very clean bulbs.

UV Disinfection Effectiveness receiving Hauser Effluent

Doses were tested ranging from 11-44 mJ/cm^2, at flows from 48.8 to 192 gpm, and with UVT of 47-50%. Doses were reported from Trojan after supplying the conditions for flow rate and UVT. Ten sampling events were run from August 23 – September 16, 2011 to assess the disinfection of Hauser Wetland effluent. Samples were not taken at flows lower than about 50 gpm due to difficulties in setting the effluent weir in the UV unit. Each dose was analyzed for Total and Fecal Coliform (TC and FC respectively), TSS, turbidity, temperature, and UVT.

The results for TC were determined to be unreliable because of competition with muccoid colonies causing interference with the growth of TC colonies and a lack of agreement with North Coast Laboratory samples run using the MPN test. The results for FC have been verified by North Coast Laboratory samples run using the MPN test (Figure 5).

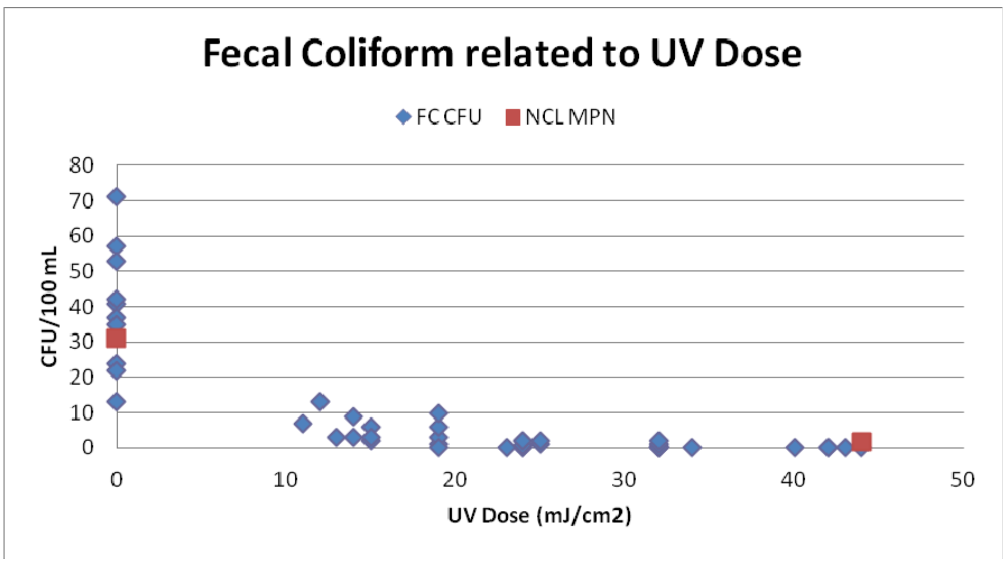


Figure 5: Fecal coliform colonies in CFU/100mL as related to applying different doses.

The lowest dose necessary to achieve permit levels for a daily maximum of 43 MPN/100mL was often achieved before disinfection, and was demonstrated by the coliform results at a dose of 0 mJ/cm^2 (Figure 5). All FC results were below 20 CFU/100mL. Results below 10 CFU/100mL were seen at doses greater than 20 mJ/cm^2.

The Trojan proprietary equation describing UV dose uses UVT and flow rate data. UVT is likely influenced by turbidity, TSS, and dissolved organics. The relationship between UVT, Turbidity, and TSS during the pilot study on Point 9 water is seen in **Error! Reference source not found.**. The distribution of turbidity data across the spectrum of UVT in Figure 6 shows a stronger correlation than that of TSS. As the turbidity of the water decreases the UVT increases.

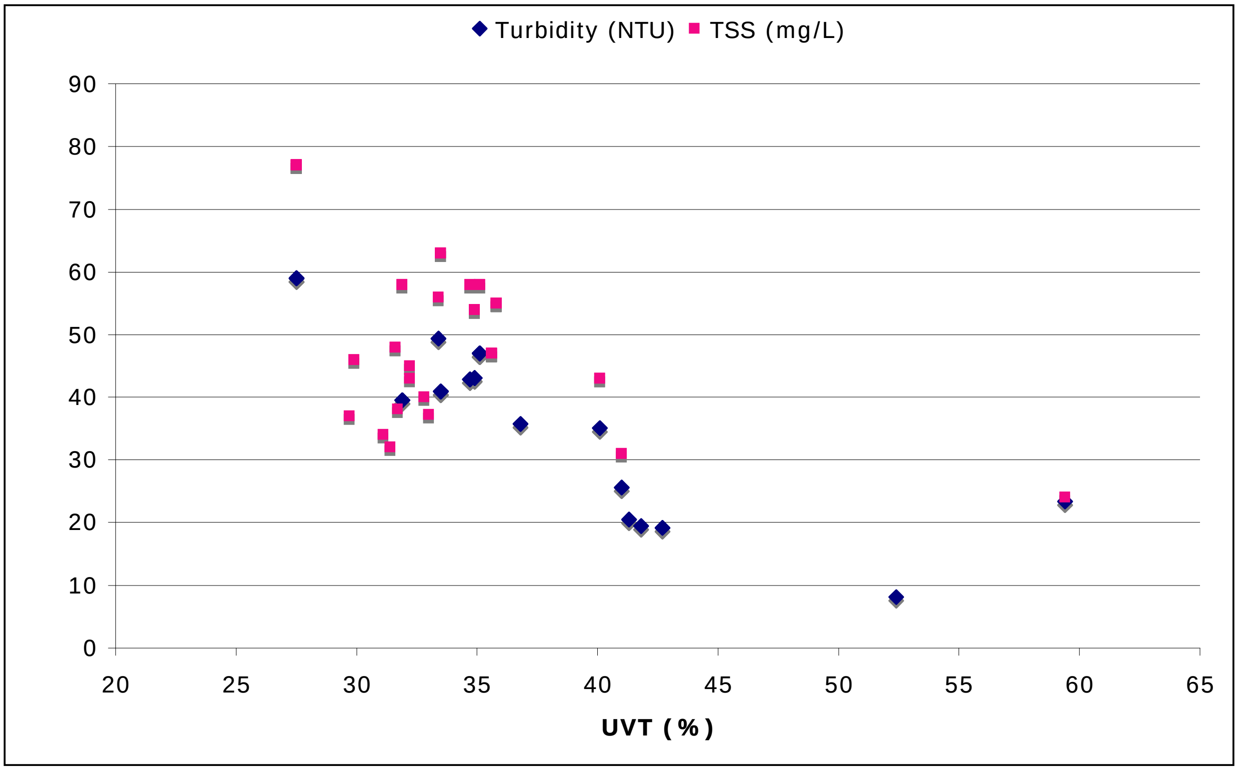


Figure 6: Ultra-violet transmittance as it relates to TSS and turbidity using Point 9 influent.

UV Disinfection Effectiveness receiving Point 9 Effluent

Doses were tested ranging from 20-42.6 mJ/cm^2, at flows from 21-132 gpm, and with UVT 27.5-59%. Doses were reported from Trojan after supplying the conditions for flow rate and UVT. Ten sampling events were run from October 4 – November 1, 2011 to assess the disinfection of Point 9 effluent. Samples were not taken at flows lower than 20.8 gpm as this is the low flow rate limit for the machine. Each dose was analyzed for Total and Fecal Coliform (TC and FC respectively), TSS, turbidity, and UVT.

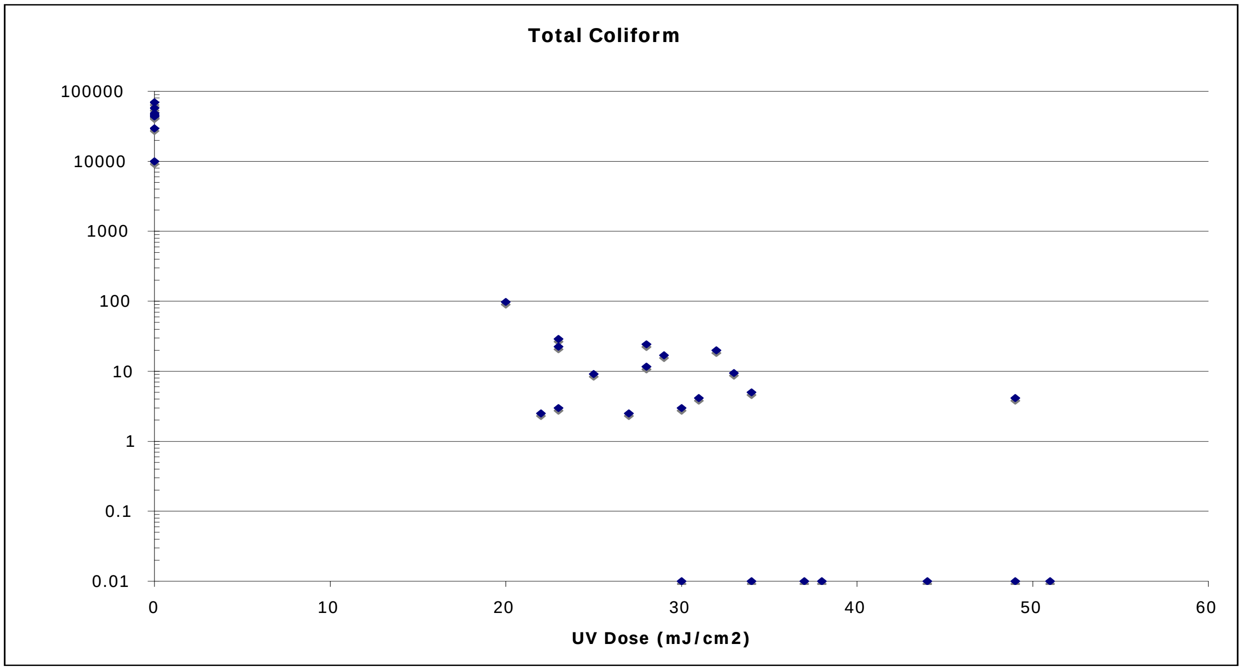


Figure 7: Total coliform in response to increasing UV dose applied to Point 9 influent. Value of 0.01 coliform is substituted for 0 coliform to use a logarithmic scale.

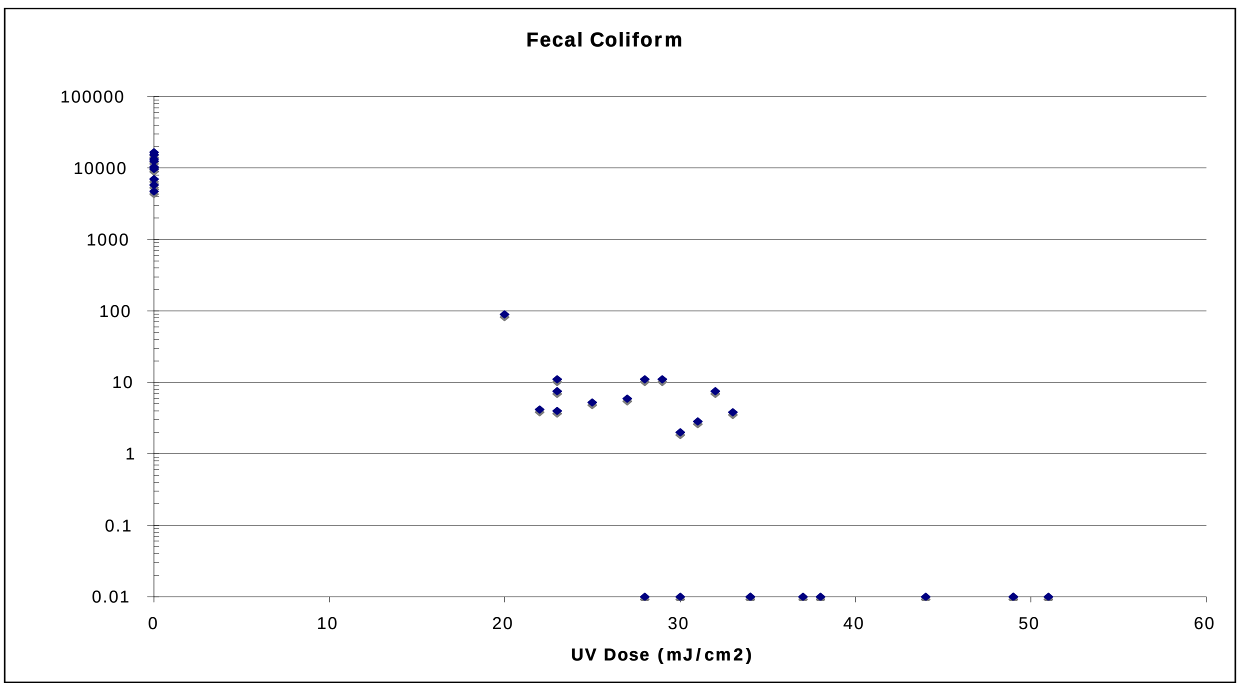


Figure 8: Fecal coliform in response to increasing UV dose applied to Point 9 influent. Value of 0.01 coliform is substituted for 0 coliform to use a logarithmic scale.

Total and fecal coliform colonies are reduced to less than 10 CFU/100mL at doses above 35 mJ/cm^2. All but one value for CFUs above 35 mJ/cm^2 are zero and are reported on the logarithmic scale as 0.01 CFU/100mL.

Conclusions

The open-channel Trojan UV3000 unit was shown to function well given the water quality and conditions of Hauser Wetland effluent (Point 15) and Treatment Marsh effluent (Point 9). Weekly visual inspections demonstrated the functionality of the wiper mechanism in keeping the bulbs clean of any build-up that could obscure the UV bulb.

The observation of stringy solids from Hauser Wetland on the UV bulb apparatus, large suspended solids from Point 9, and noticeable attached growth on the influent box for the UV unit indicates a potential problem for UV disinfection. If such large solids are allowed to pass through the unit, they may shield coliform from UV radiation and therefore not achieve disinfection. The recommendation for solving this issue is to install a mechanical self-cleaning screen to reduce influent solids and adopt a strict cleaning routine to eliminate attached growth.

Fecal coliform levels in Hauser Wetland effluent often meet permit limits without disinfection. UV disinfection of Hauser Wetland effluent at current conditions described by UVT at ~50%, TSS at 3-6 mg/L, and turbidity at 3-4 NTUs, achieves levels below 10 CFU/100mL at doses above 20 mJ/cm^2. This low dose is considered the low end of the industry standard for UV disinfection and indicates the effectiveness of UV disinfection of Hauser Wetland effluent.

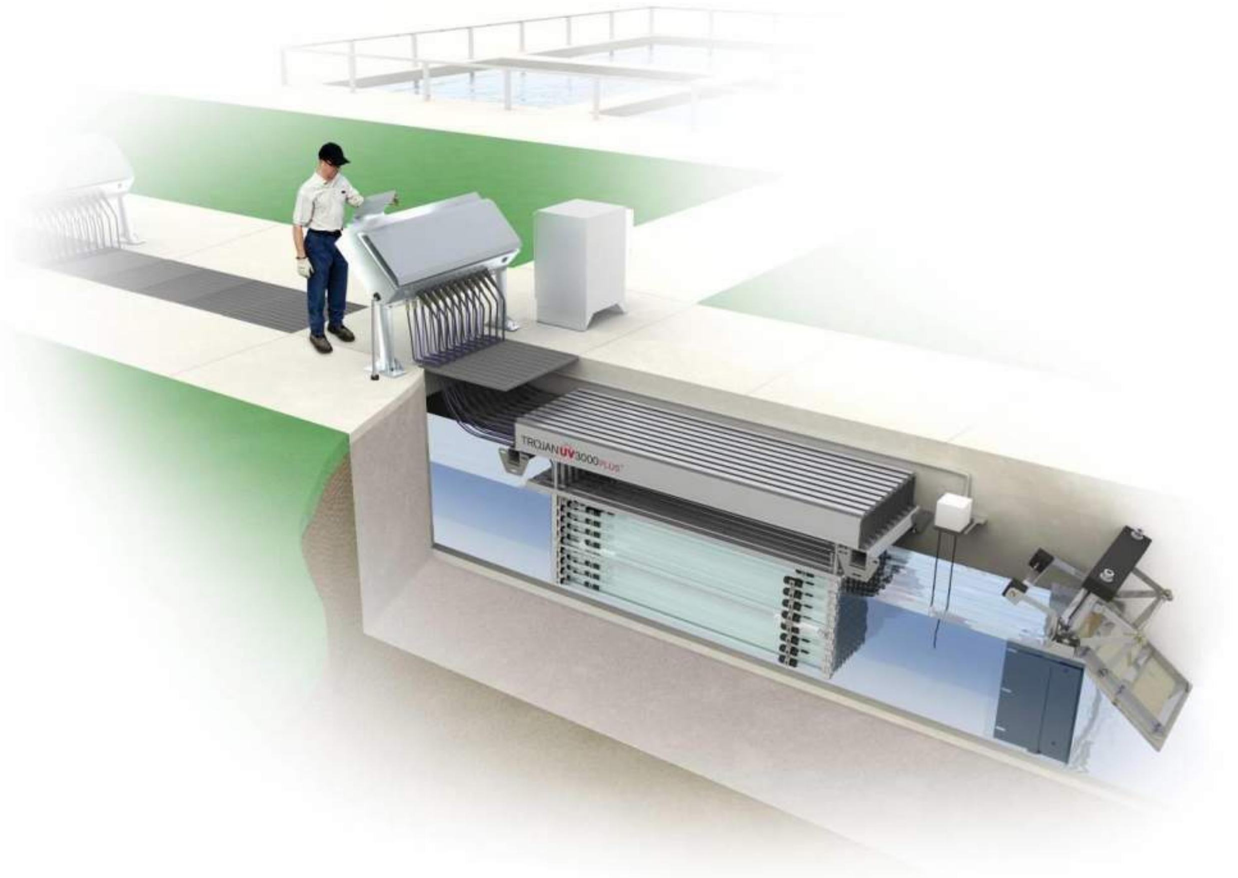
Total and fecal coliform levels in Point 9 effluent are numerous, around 10^4. UV disinfection of Point 9 effluent at current conditions described by UVT at ~34%, TSS at ~57 mg/L, and turbidity at 44 NTUs, achieves levels below 10 CFU/100mL at doses above 35 mJ/cm^2. This dose is at the low end of the industry standard for UV disinfection and indicates the effectiveness of UV disinfection of Point 9 effluent.

Appendix E

TROJAN UV3000PLUS EQUIPMENT PROPOSALS AND DRAWINGS

TROJANUV3000PLUS™

PROPOSAL FOR THE CITY OF ARCATA, CA
QUOTE: LJKR1061E
6/16/2015



The TrojanUV3000Plus™ is operating in **over 1300** municipal wastewater plants around the world. Disinfecting **over 17 billion** gallons a day, the TrojanUV3000Plus™ has become the reference standard in the industry.

June 16, 2015

In response to your request, we are pleased to provide the following TrojanUV3000Plus™ proposal for the **Arcata** project.

The TrojanUV3000Plus™ has been shown in over 1300 installations to provide dependable performance, simplified maintenance, and superior electrical efficiency. As explained in this proposal, the system incorporates innovative features to reduce O&M costs, including variable output electronic ballasts to provide dimming capability and Trojan's revolutionary ActiClean-WW™ system – the industry's only online chemical and mechanical quartz sleeve cleaning system. All Trojan installations are supported by a global network of certified Service Representatives providing local service and support.

Please do not hesitate to call us if you have any questions regarding this proposal. Thank you for the opportunity to quote the TrojanUV3000Plus™ and we look forward to working with you on this project.

With best regards,

Jordan Fournier
3020 Gore Road
London, Ontario N5V 4T7
Canada
(519) 457 – 3400 ext. 2193
jfournier@trojanuv.com

Local Representative:
David Frost
The Coombs-Hopkins Company
2855 Mitchell Drive
Suite 215, Walnut Creek, CA 94598-1609
USA
(925) 947-6733

DESIGN CRITERIA

ARCATA

Peak Design Flow:	**5.9 MGD**
UV Transmittance:	**35%** (minimum)
Total Suspended Solids:	**50 mg/l** (30 Day Average, grab sample)
Disinfection Limit:	**43 fecal coliform per 100 ml**, based on a 1 day Maximum (90%ile) of consecutive daily grab samples
Design Dose:	**35,000 μWs/cm^2**, bioassay validated
Validation Factors:	**0.90** end of lamp life factor (Low-Pressure Amalgam Lamps) **0.95** fouling factor (ActiClean-WW™ Chemical / Mechanical Cleaning System)

DESIGN SUMMARY

QUOTE: LJKR1061E

Based on the above design criteria, the TrojanUV3000Plus™ proposed consists of:

CHANNEL (Please reference Trojan layout drawings for details.)	
Number of Channels:	**1**
Approximate Channel Length Required:	**30 ft**
Channel Width Based on Number of UV Modules:	**66 in**
Channel Depth Recommended for UV Module Access:	**54 in**
UV MODULES	
Total Number of Banks:	**2**
Number of Modules per Bank:	**22**
Number of Lamps per Module:	**8**
Total Number of UV Lamps:	**352**
Maximum Power Draw:	**88 kW**
UV PANELS	
Power Distribution Center Quantity:	**2**
System Control Center Quantity:	**1**
MISCELLANEOUS EQUIPMENT	
Level Controller Quantity:	**1**
Type of Level Controller:	**Weighted Gate (ALC)**
Automatic Chemical / Mechanical Cleaning:	**Trojan ActiClean-WW™**
UV Module Lifting Device:	**Davit Crane**
On-line UVT Monitor:	**Hach UVAS sc Sensor**
Standard Spare Parts / Safety Equipment:	**Included**
Other Equipment:	

ELECTRICAL REQUIREMENTS

1. Each Power Distribution Center requires an electrical supply of one (1) 480 Volts, 3 phase, 4 wire (plus ground), 44.9 kVA.
2. The Hydraulic System Center requires an electrical supply of one (1) 480 Volts, 3 phase, 3 wire (plus ground), 2 kVA.
3. The System Control Center requires an electrical supply of one (1) 120 Volts, 1 phase, 2 wire (plus ground), 15 Amps.
4. The Online UVT Monitor requires an electrical supply of one (1) 120 Volts, 1 phase, 2 wire (plus ground), 1 Amp.
5. Electrical disconnects required per local code are not included in this proposal.

COMMERCIAL INFORMATION

Total Capital Cost: $750,000 (US$)

This price excludes any taxes that may be applicable and is valid for 90 days from the date of this letter.

OPERATING COST ESTIMATE

Operating Conditions

Average Flow: **2.0 MGD**
Yearly Usage: **8760 hours**
UV Transmittance: **35%**

Power Requirements		Lamp Replacement	
Average Power Draw:	**44 kW**	Number lamps per year:	**129**
Cost per kW hour:	**$0.10**	Price per lamp:	**$250**
Annual Power Cost:	**$38,544**	**Annual Lamp Replacement Cost:**	**$32,250**
Total Annual O&M Cost: $70,794			

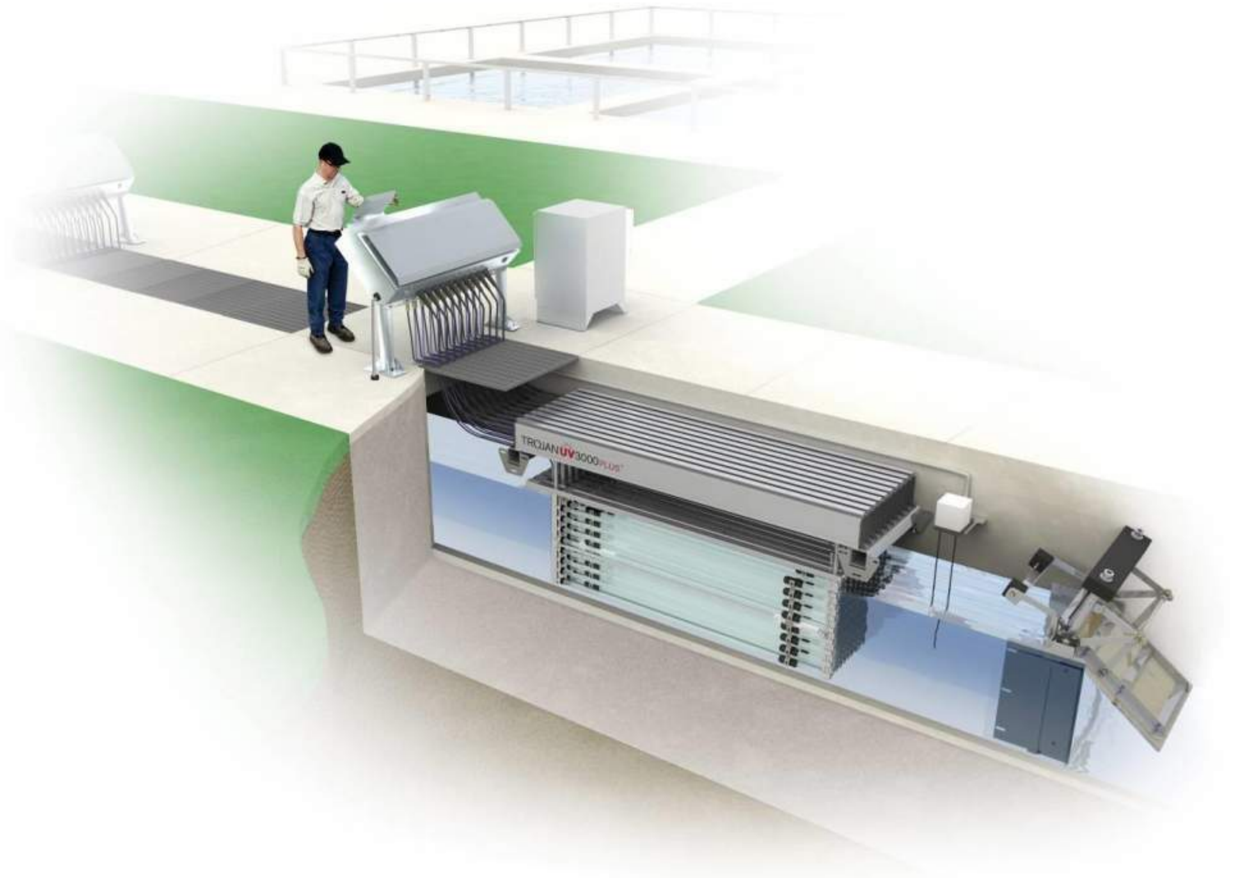
This cost estimate is based on the average flow and UV transmittance listed above. Actual operating costs may be lower due to the TrojanUV3000Plus™ automatic dose pacing control system. As UV demand decreases, by a change in operating conditions, the power level of the lamps decreases accordingly. The dose pacing system minimizes equipment power levels while the target UV dose is maintained to ensure disinfection at all times.

EQUIPMENT WARRANTEES

1. Trojan Technologies warrants all components of the system (excluding UV lamps) against faulty workmanship and materials for a period of 12 months from date of start-up or 18 months after shipment, which ever comes first.
2. UV lamps purchased are warranted for 12,000 hours of operation or 3 years from shipment, whichever comes first. The warranty is pro-rated after 9,000 hours of operation. This means that if a lamp fails prior to 9,000 hours of use, a new lamp is provided at no charge.
3. Electronic ballasts are warranted for 5 years, pro-rated after 1 year.

TROJANUV3000PLUS™

PROPOSAL FOR THE CITY OF ARCATA, CA
QUOTE: LJKR1061G
6/16/2015



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June 16, 2015

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The TrojanUV3000Plus™ has been shown in over 1300 installations to provide dependable performance, simplified maintenance, and superior electrical efficiency. As explained in this proposal, the system incorporates innovative features to reduce O&M costs, including variable output electronic ballasts to provide dimming capability and Trojan's revolutionary ActiClean-WW™ system – the industry's only online chemical and mechanical quartz sleeve cleaning system. All Trojan installations are supported by a global network of certified Service Representatives providing local service and support.

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Suite 215, Walnut Creek, CA 94598-1609
USA
(925) 947-6733

DESIGN CRITERIA

ARCATA

Peak Design Flow:	**5.9 MGD**
UV Transmittance:	**35%** (minimum)
Total Suspended Solids:	**50 mg/l** (30 Day Average, grab sample)
Disinfection Limit:	**43 fecal coliform per 100 ml**, based on a 1 day Maximum (90%ile) of consecutive daily grab samples
Design Dose:	**35,000 μWs/cm^2**, bioassay validated
Validation Factors:	**0.90** end of lamp life factor (Low-Pressure Amalgam Lamps) **0.95** fouling factor (ActiClean-WW™ Chemical / Mechanical Cleaning System)
Redundancy:	**50%**

DESIGN SUMMARY

QUOTE: LJKR1061G

Based on the above design criteria, the TrojanUV3000Plus™ proposed consists of:

CHANNEL (Please reference Trojan layout drawings for details.)	
Number of Channels:	**1**
Approximate Channel Length Required:	**42 ft**
Channel Width Based on Number of UV Modules:	**66 in**
Channel Depth Recommended for UV Module Access:	**54 in**
UV MODULES	
Total Number of Banks:	**3 (2 duty, 1 redundant)**
Number of Modules per Bank:	**22**
Number of Lamps per Module:	**8**
Total Number of UV Lamps:	**528**
Maximum Power Draw:	**132 kW**
UV PANELS	
Power Distribution Center Quantity:	**3**
System Control Center Quantity:	**1**
MISCELLANEOUS EQUIPMENT	
Level Controller Quantity:	**1**
Type of Level Controller:	**Weighted Gate (ALC)**
Automatic Chemical / Mechanical Cleaning:	**Trojan ActiClean-WW™**
UV Module Lifting Device:	**Davit Crane**
On-line UVT Monitor:	**Hach UVAS sc Sensor**
Standard Spare Parts / Safety Equipment:	**Included**
Other Equipment:	

ELECTRICAL REQUIREMENTS

1. Each Power Distribution Center requires an electrical supply of one (1) 480 Volts, 3 phase, 4 wire (plus ground), 44.9 kVA.
2. The Hydraulic System Center requires an electrical supply of one (1) 480 Volts, 3 phase, 3 wire (plus ground), 2 kVA.
3. The System Control Center requires an electrical supply of one (1) 120 Volts, 1 phase, 2 wire (plus ground), 15 Amps.
4. The Online UVT Monitor requires an electrical supply of one (1) 120 Volts, 1 phase, 2 wire (plus ground), 1 Amp.
5. Electrical disconnects required per local code are not included in this proposal.

COMMERCIAL INFORMATION

Total Capital Cost: $1,090,000 (US$)

This price excludes any taxes that may be applicable and is valid for 90 days from the date of this letter.

OPERATING COST ESTIMATE

Operating Conditions

Average Flow: **2 MGD**
Yearly Usage: **8760 hours**
UV Transmittance: **35%**

Power Requirements		Lamp Replacement	
Average Power Draw:	**44 kW**	Number lamps per year:	**129**
Cost per kW hour:	**$0.10**	Price per lamp:	**$250**
Annual Power Cost:	**$38,544**	**Annual Lamp Replacement Cost:**	**$32,250**
Total Annual O&M Cost: $70,794			

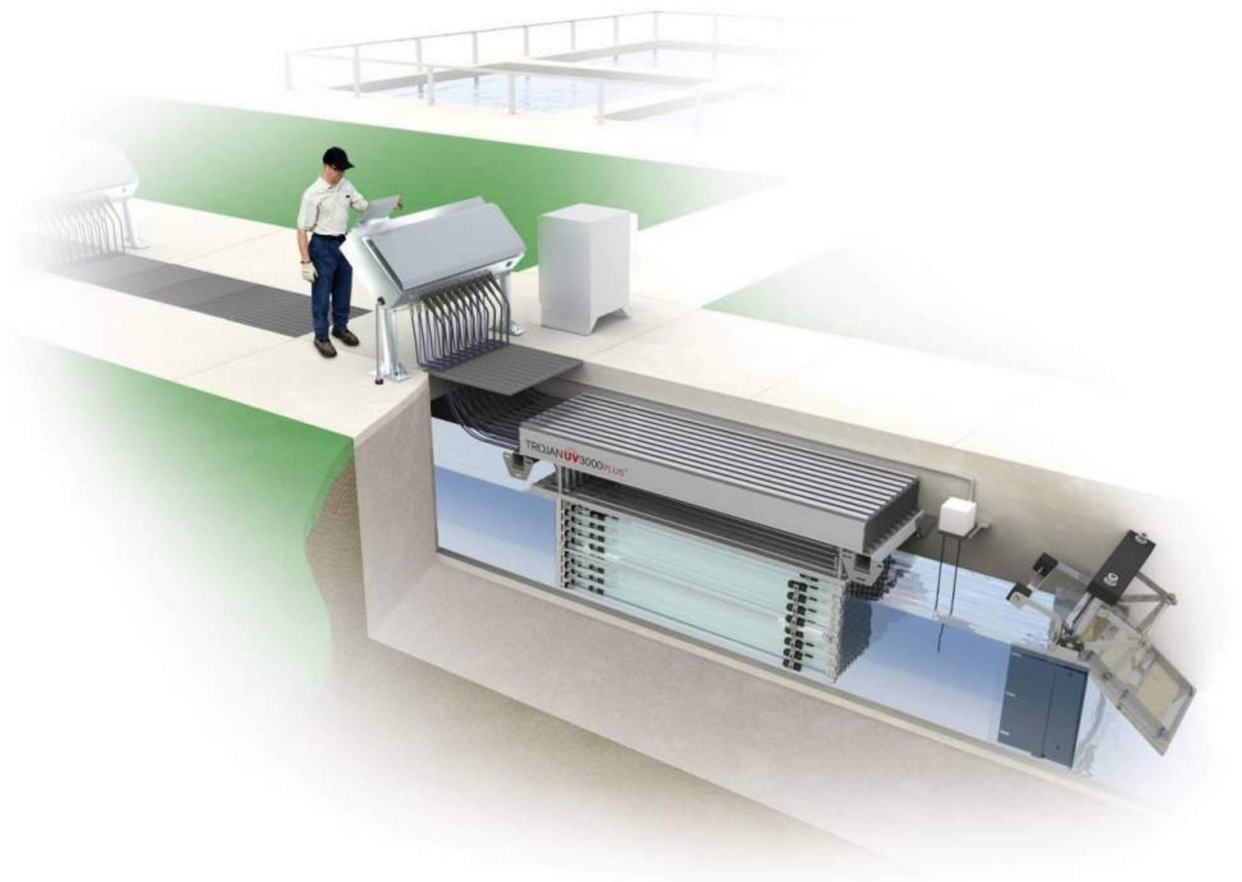
This cost estimate is based on the average flow and UV transmittance listed above. Actual operating costs may be lower due to the TrojanUV3000Plus™ automatic dose pacing control system. As UV demand decreases, by a change in operating conditions, the power level of the lamps decreases accordingly. The dose pacing system minimizes equipment power levels while the target UV dose is maintained to ensure disinfection at all times.

EQUIPMENT WARRANTEES

1. Trojan Technologies warrants all components of the system (excluding UV lamps) against faulty workmanship and materials for a period of 12 months from date of start-up or 18 months after shipment, which ever comes first.
2. UV lamps purchased are warranted for 12,000 hours of operation or 3 years from shipment, whichever comes first. The warranty is pro-rated after 9,000 hours of operation. This means that if a lamp fails prior to 9,000 hours of use, a new lamp is provided at no charge.
3. Electronic ballasts are warranted for 5 years, pro-rated after 1 year.

TROJAN UV3000 PLUS™

PROPOSAL FOR THE CITY OF ARCATA, CA
QUOTE: LJKR1061D
6/16/2015



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June 16, 2015

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Please do not hesitate to call us if you have any questions regarding this proposal. Thank you for the opportunity to quote the TrojanUV3000Plus™ and we look forward to working with you on this project.

With best regards,

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Local Representative:
David Frost
The Coombs-Hopkins Company
2855 Mitchell Drive
Suite 215, Walnut Creek, CA 94598-1609
USA
(925) 947-6733

DESIGN CRITERIA

ARCATA

Peak Design Flow:	**5.9 MGD**
UV Transmittance:	**35%** (minimum)
Total Suspended Solids:	**50 mg/l** (30 Day Average, grab sample)
Disinfection Limit:	**43 fecal coliform per 100 ml**, based on a 1 day Maximum (90%ile) of consecutive daily grab samples
Design Dose:	**50,000 μWs/cm^2**, bioassay validated
Validation Factors:	**0.90** end of lamp life factor (Low-Pressure Amalgam Lamps) **0.95** fouling factor (ActiClean-WW™ Chemical / Mechanical Cleaning System)

DESIGN SUMMARY

QUOTE: LJKR1061D

Based on the above design criteria, the TrojanUV3000Plus™ proposed consists of:

CHANNEL (Please reference Trojan layout drawings for details.)	
Number of Channels:	**1**
Approximate Channel Length Required:	**42 ft**
Channel Width Based on Number of UV Modules:	**60 in**
Channel Depth Recommended for UV Module Access:	**54 in**
UV MODULES	
Total Number of Banks:	**3**
Number of Modules per Bank:	**20**
Number of Lamps per Module:	**8**
Total Number of UV Lamps:	**480**
Maximum Power Draw:	**120 kW**
UV PANELS	
Power Distribution Center Quantity:	**3**
System Control Center Quantity:	**1**
MISCELLANEOUS EQUIPMENT	
Level Controller Quantity:	**1**
Type of Level Controller:	**Weighted Gate (ALC)**
Automatic Chemical / Mechanical Cleaning:	**Trojan ActiClean-WW™**
UV Module Lifting Device:	**Davit Crane**
On-line UVT Monitor:	**Hach UVAS sc Sensor**
Standard Spare Parts / Safety Equipment:	**Included**
Other Equipment:	

ELECTRICAL REQUIREMENTS

1. Each Power Distribution Center requires an electrical supply of one (1) 480 Volts, 3 phase, 4 wire (plus ground), 40.8 kVA.
2. The Hydraulic System Center requires an electrical power supply that is powered from the Power Distribution Center.
3. The System Control Center requires an electrical supply of one (1) 120 Volts, 1 phase, 2 wire (plus ground), 15 Amps.
4. The Online UVT Monitor requires an electrical supply of one (1) 120 Volts, 1 phase, 2 wire (plus ground), 1 Amp.
5. Electrical disconnects required per local code are not included in this proposal.

COMMERCIAL INFORMATION

Total Capital Cost: $999,000 (US$)

This price excludes any taxes that may be applicable and is valid for 90 days from the date of this letter.

OPERATING COST ESTIMATE

Operating Conditions

Average Flow: **2 MGD**
Yearly Usage: **8760 hours**
UV Transmittance: **35%**

Power Requirements		Lamp Replacement	
Average Power Draw:	**60.8 kW**	Number lamps per year:	**234**
Cost per kW hour:	**$0.10**	Price per lamp:	**$250**
Annual Power Cost:	**$53,261**	**Annual Lamp Replacement Cost:**	**$58,500**
Total Annual O&M Cost: $111,761			

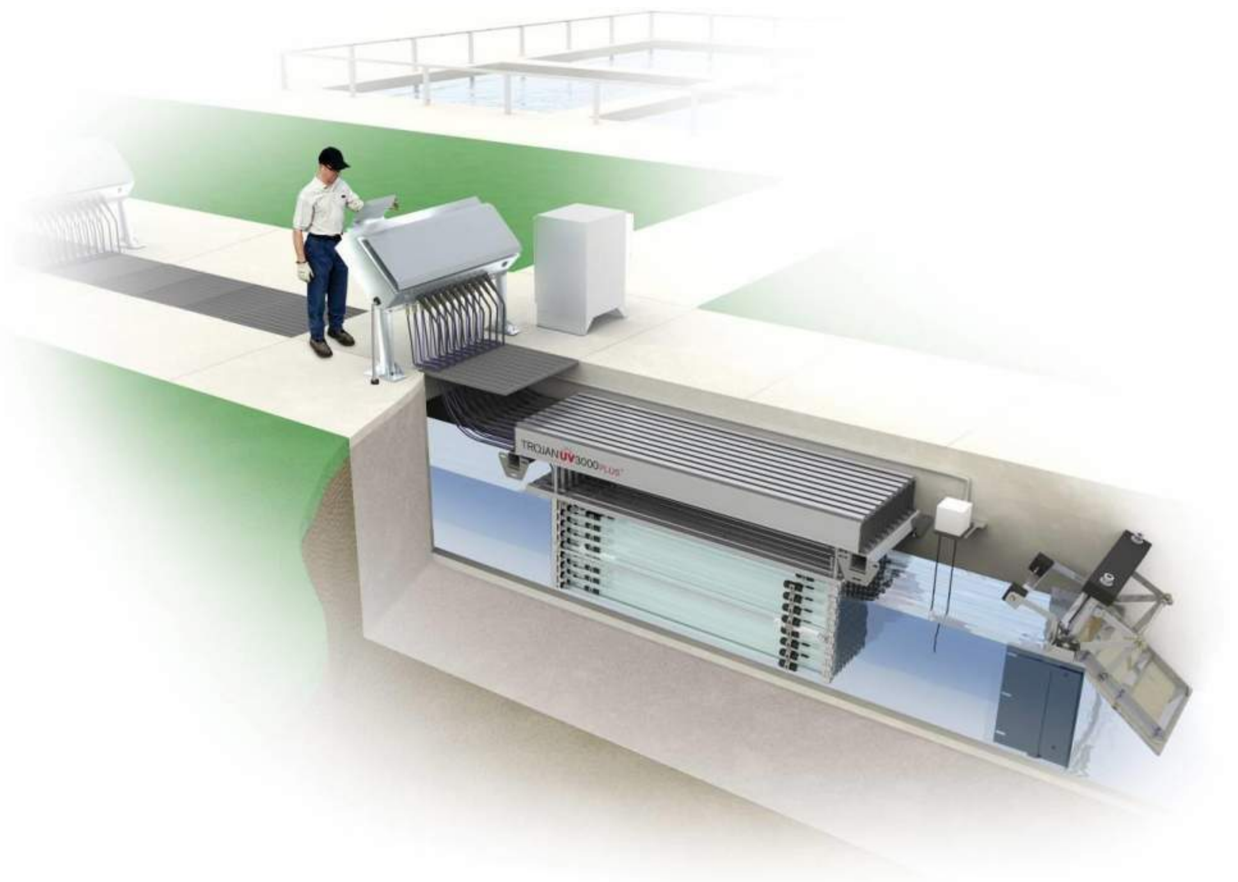
This cost estimate is based on the average flow and UV transmittance listed above. Actual operating costs may be lower due to the TrojanUV3000Plus™ automatic dose pacing control system. As UV demand decreases, by a change in operating conditions, the power level of the lamps decreases accordingly. The dose pacing system minimizes equipment power levels while the target UV dose is maintained to ensure disinfection at all times.

EQUIPMENT WARRANTEES

1. Trojan Technologies warrants all components of the system (excluding UV lamps) against faulty workmanship and materials for a period of 12 months from date of start-up or 18 months after shipment, which ever comes first.
2. UV lamps purchased are warranted for 12,000 hours of operation or 3 years from shipment, whichever comes first. The warranty is pro-rated after 9,000 hours of operation. This means that if a lamp fails prior to 9,000 hours of use, a new lamp is provided at no charge.
3. Electronic ballasts are warranted for 5 years, pro-rated after 1 year.

TROJANUV3000PLUS™

PROPOSAL FOR THE CITY OF ARCATA, CA
QUOTE: LJKR1061F
6/16/2015



The TrojanUV3000Plus™ is operating in **over 1300** municipal wastewater plants around the world. Disinfecting **over 17 billion** gallons a day, the TrojanUV3000Plus™ has become the reference standard in the industry.

June 16, 2015

In response to your request, we are pleased to provide the following TrojanUV3000Plus™ proposal for the **Arcata** project.

The TrojanUV3000Plus™ has been shown in over 1300 installations to provide dependable performance, simplified maintenance, and superior electrical efficiency. As explained in this proposal, the system incorporates innovative features to reduce O&M costs, including variable output electronic ballasts to provide dimming capability and Trojan's revolutionary ActiClean-WW™ system – the industry's only online chemical and mechanical quartz sleeve cleaning system. All Trojan installations are supported by a global network of certified Service Representatives providing local service and support.

Please do not hesitate to call us if you have any questions regarding this proposal. Thank you for the opportunity to quote the TrojanUV3000Plus™ and we look forward to working with you on this project.

With best regards,

Jordan Fournier
3020 Gore Road
London, Ontario N5V 4T7
Canada
(519) 457 – 3400 ext. 2193
jfournier@trojanuv.com

Local Representative:
David Frost
The Coombs-Hopkins Company
2855 Mitchell Drive
Suite 215, Walnut Creek, CA 94598-1609
USA
(925) 947-6733

DESIGN CRITERIA

ARCATA

Peak Design Flow:	**5.9 MGD**
UV Transmittance:	**35%** (minimum)
Total Suspended Solids:	**50 mg/l** (30 Day Average, grab sample)
Disinfection Limit:	**43 fecal coliform per 100 ml**, based on a 1 day Maximum (90%ile) of consecutive daily grab samples
Design Dose:	**50,000 μWs/cm^2**, bioassay validated
Validation Factors:	**0.90** end of lamp life factor (Low-Pressure Amalgam Lamps) **0.95** fouling factor (ActiClean-WW™ Chemical / Mechanical Cleaning System)
Redundancy:	**33%**

DESIGN SUMMARY

QUOTE: LJKR1061F

Based on the above design criteria, the TrojanUV3000Plus™ proposed consists of:

CHANNEL (Please reference Trojan layout drawings for details.)	
Number of Channels:	**1**
Approximate Channel Length Required:	**54 ft**
Channel Width Based on Number of UV Modules:	**60 in**
Channel Depth Recommended for UV Module Access:	**54 in**
UV MODULES	
Total Number of Banks:	**4 (3 duty, 1 redundant)**
Number of Modules per Bank:	**20**
Number of Lamps per Module:	**8**
Total Number of UV Lamps:	**640**
Maximum Power Draw:	**160 kW**
UV PANELS	
Power Distribution Center Quantity:	**4**
System Control Center Quantity:	**1**
MISCELLANEOUS EQUIPMENT	
Level Controller Quantity:	**1**
Type of Level Controller:	**Weighted Gate (ALC)**
Automatic Chemical / Mechanical Cleaning:	**Trojan ActiClean-WW™**
UV Module Lifting Device:	**Davit Crane**
On-line UVT Monitor:	**Hach UVAS sc Sensor**
Standard Spare Parts / Safety Equipment:	**Included**
Other Equipment:	
ELECTRICAL REQUIREMENTS	

1. Each Power Distribution Center requires an electrical supply of one (1) 480 Volts, 3 phase, 4 wire (plus ground), 40.8 kVA.
2. The Hydraulic System Center requires an electrical supply of one (1) 480 Volts, 3 phase, 3 wire (plus ground), 2 kVA.
3. The System Control Center requires an electrical supply of one (1) 120 Volts, 1 phase, 2 wire (plus ground), 15 Amps.
4. The Online UVT Monitor requires an electrical supply of one (1) 120 Volts, 1 phase, 2 wire (plus ground), 1 Amp.
5. Electrical disconnects required per local code are not included in this proposal.

COMMERCIAL INFORMATION

Total Capital Cost: $1,310,000 (US$)

This price excludes any taxes that may be applicable and is valid for 90 days from the date of this letter.

OPERATING COST ESTIMATE

Operating Conditions

Average Flow:	**2.0 MGD**
Yearly Usage:	**8760 hours**
UV Transmittance:	**35%**

Power Requirements		Lamp Replacement	
Average Power Draw:	**60.8 kW**	Number lamps per year:	**234**
Cost per kW hour:	**$0.10**	Price per lamp:	**$250**
Annual Power Cost:	**$53,261**	**Annual Lamp Replacement Cost:**	**$58,500**
Total Annual O&M Cost: $111,761			

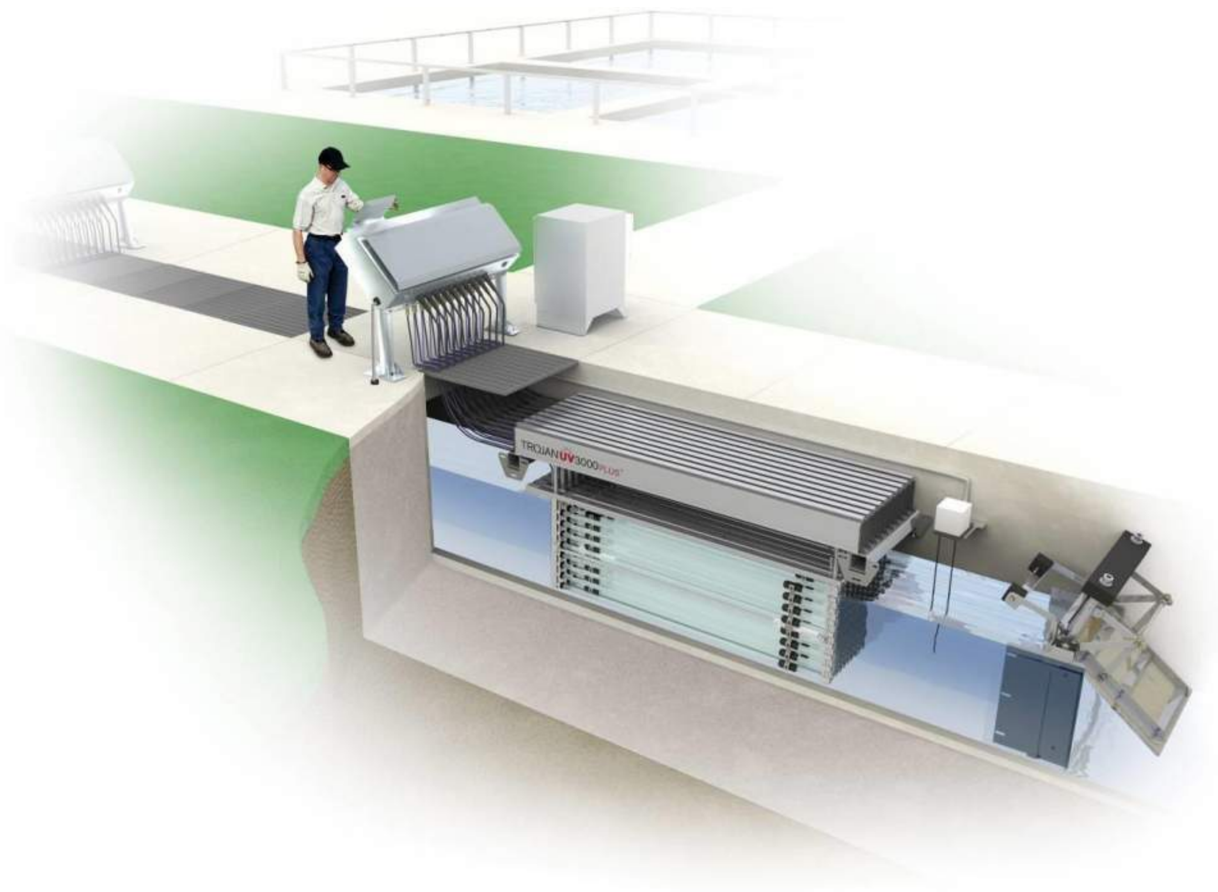
This cost estimate is based on the average flow and UV transmittance listed above. Actual operating costs may be lower due to the TrojanUV3000Plus™ automatic dose pacing control system. As UV demand decreases, by a change in operating conditions, the power level of the lamps decreases accordingly. The dose pacing system minimizes equipment power levels while the target UV dose is maintained to ensure disinfection at all times.

EQUIPMENT WARRANTEES

1. Trojan Technologies warrants all components of the system (excluding UV lamps) against faulty workmanship and materials for a period of 12 months from date of start-up or 18 months after shipment, which ever comes first.
2. UV lamps purchased are warranted for 12,000 hours of operation or 3 years from shipment, whichever comes first. The warranty is pro-rated after 9,000 hours of operation. This means that if a lamp fails prior to 9,000 hours of use, a new lamp is provided at no charge.
3. Electronic ballasts are warranted for 5 years, pro-rated after 1 year.

TROJANUV3000PLUS™

PROPOSAL FOR THE CITY OF ARCATA, CA
QUOTE: LJKR1061H
6/19/2015



The TrojanUV3000Plus™ is operating in **over 1300** municipal wastewater plants around the world. Disinfecting **over 17 billion** gallons a day, the TrojanUV3000Plus™ has become the reference standard in the industry.

June 19, 2015

In response to your request, we are pleased to provide the following TrojanUV3000Plus™ proposal for the **Arcata** project.

The TrojanUV3000Plus™ has been shown in over 1300 installations to provide dependable performance, simplified maintenance, and superior electrical efficiency. As explained in this proposal, the system incorporates innovative features to reduce O&M costs, including variable output electronic ballasts to provide dimming capability and Trojan's revolutionary ActiClean-WW™ system – the industry's only online chemical and mechanical quartz sleeve cleaning system. All Trojan installations are supported by a global network of certified Service Representatives providing local service and support.

Please do not hesitate to call us if you have any questions regarding this proposal. Thank you for the opportunity to quote the TrojanUV3000Plus™ and we look forward to working with you on this project.

With best regards,

Jordan Fournier
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London, Ontario N5V 4T7
Canada
(519) 457 – 3400 ext. 2193
jfournier@trojanuv.com

Local Representative:
David Frost
The Coombs-Hopkins Company
2855 Mitchell Drive
Suite 215, Walnut Creek, CA 94598-1609
USA
(925) 947-6733

DESIGN CRITERIA
ARCATA

Peak Design Flow:	**5.9 MGD**
UV Transmittance:	**35%** (minimum)
Total Suspended Solids:	**50 mg/l** (30 Day Average, grab sample)
Disinfection Limit:	**43 fecal coliform per 100 ml**, based on a 1 day Maximum (90%ile) of consecutive daily grab samples
Design Dose:	**100,000 μWs/cm²**, bioassay validated
Validation Factors:	**0.90** end of lamp life factor (Low-Pressure Amalgam Lamps) **0.95** fouling factor (ActiClean-WW™ Chemical / Mechanical Cleaning System)

DESIGN SUMMARY

QUOTE: LJKR1061H

Based on the above design criteria, the TrojanUV3000Plus™ proposed consists of:

CHANNEL (Please reference Trojan layout drawings for details.)	
Number of Channels:	**2**
Approximate Channel Length Required:	**54 ft**
Channel Width Based on Number of UV Modules:	**78 in**
Channel Depth Recommended for UV Module Access:	**54 in**
UV MODULES	
Total Number of Banks:	**8**
Number of Modules per Bank:	**26**
Number of Lamps per Module:	**8**
Total Number of UV Lamps:	**1664**
Maximum Power Draw:	**416 kW**
UV PANELS	
Power Distribution Center Quantity:	**8**
System Control Center Quantity:	**1**
MISCELLANEOUS EQUIPMENT	
Level Controller Quantity:	**2**
Type of Level Controller:	**Weighted Gate (ALC)**
Automatic Chemical / Mechanical Cleaning:	**Trojan ActiClean-WW™**
UV Module Lifting Device:	**Davit Crane**
On-line UVT Monitor:	**Hach UVAS sc Sensor**
Standard Spare Parts / Safety Equipment:	**Included**
Other Equipment:	
ELECTRICAL REQUIREMENTS	

1. Each Power Distribution Center requires an electrical supply of one (1) 480 Volts, 3 phase, 4 wire (plus ground), 53.1 kVA.
2. The Hydraulic System Center requires an electrical power supply that is powered from the Power Distribution Center.
3. The System Control Center requires an electrical supply of one (1) 120 Volts, 1 phase, 2 wire (plus ground), 15 Amps.
4. The Online UVT Monitor requires an electrical supply of one (1) 120 Volts, 1 phase, 2 wire (plus ground), 1 Amp.
5. Electrical disconnects required per local code are not included in this proposal.

COMMERCIAL INFORMATION

Total Capital Cost: $3,240,000 (US$)

This price excludes any taxes that may be applicable and is valid for 90 days from the date of this letter.

OPERATING COST ESTIMATE

Operating Conditions

Average Flow: **2 MGD**
Yearly Usage: **8760 hours**
UV Transmittance: **35%**

Power Requirements		Lamp Replacement	
Average Power Draw:	**125 kW**	Number lamps per year:	**456**
Cost per kW hour:	**$0.10**	Price per lamp:	**$250**
Annual Power Cost:	**$109,500**	**Annual Lamp Replacement Cost:**	**$114,000**
Total Annual O&M Cost: $223,500			

This cost estimate is based on the average flow and UV transmittance listed above. Actual operating costs may be lower due to the TrojanUV3000Plus™ automatic dose pacing control system. As UV demand decreases, by a change in operating conditions, the power level of the lamps decreases accordingly. The dose pacing system minimizes equipment power levels while the target UV dose is maintained to ensure disinfection at all times.

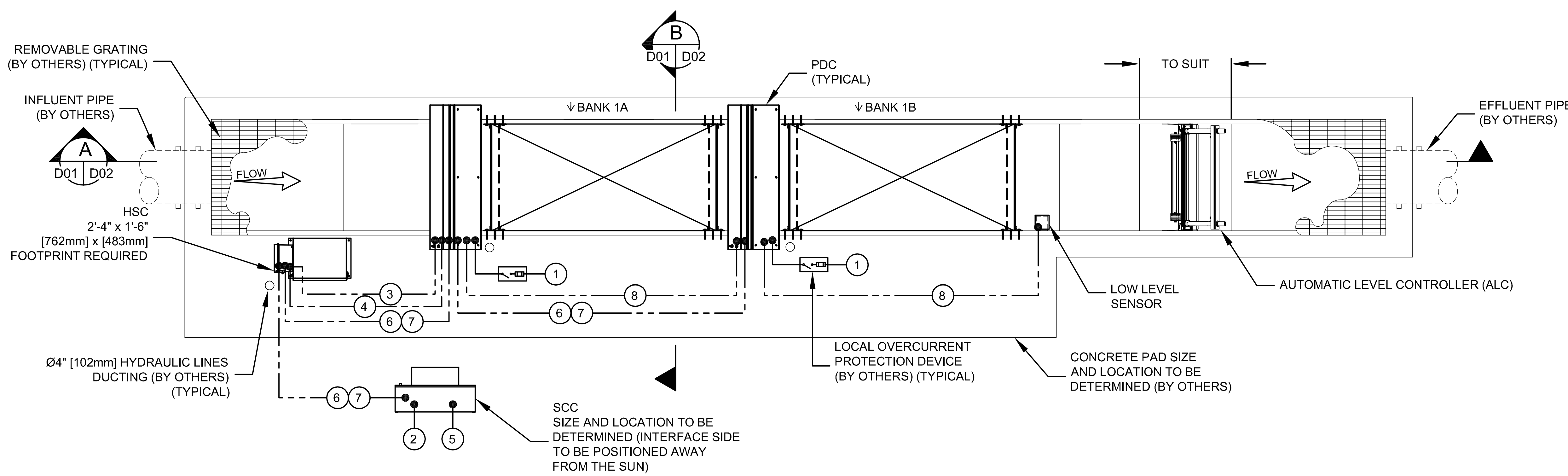
EQUIPMENT WARRANTEES

1. Trojan Technologies warrants all components of the system (excluding UV lamps) against faulty workmanship and materials for a period of 12 months from date of start-up or 18 months after shipment, which ever comes first.
2. UV lamps purchased are warranted for 12,000 hours of operation or 3 years from shipment, whichever comes first. The warranty is pro-rated after 9,000 hours of operation. This means that if a lamp fails prior to 9,000 hours of use, a new lamp is provided at no charge.
3. Electronic ballasts are warranted for 5 years, pro-rated after 1 year.

TROJAN UV3000PLUS™

EQUIPMENT INTERCONNECTIONS

No.	DESCRIPTION	FROM	TO
1	POWER DISTRIBUTION CENTER (PDC) POWER SUPPLY 480Y/277V, 3 PHASE, 4 WIRE + GROUND	DISTRIBUTION PANEL (DP) (BY OTHERS) (NOT SHOWN)	PDC
2	SYSTEM CONTROL CENTER (SCC) POWER SUPPLY 120V, 1 PHASE, 2 WIRE + GROUND, XX AMPS	DISTRIBUTION PANEL (DP) (BY OTHERS) (NOT SHOWN)	SCC
3	HYDRAULIC SYSTEMS CENTER COMPACT (HSC COMPACT) POWER SUPPLY 480V, 3 PHASE, 3 WIRE + GROUND	PDC	HSC COMPACT
4	HYDRAULIC SYSTEMS CENTER COMPACT (HSC COMPACT) 24 VDC	PDC	HSC COMPACT
5	FLOW METER 4-20 mA, DC ANALOG INPUT (BY OTHERS)	FLOW METER PANEL (NOT SHOWN) (BY OTHERS)	SCC
6	GROUND LINK 14 AWG TYPE TWH STRANDED	SCC	HSC COMPACT AND PDC(s) (DAISY CHAINED)
7	MODBUS 1 SHIELDED TWISTED PAIR	SCC	HSC COMPACT THRU PDC(s) (DAISY CHAINED)
8	LOW LEVEL SENSOR 12 VDC	LOW LEVEL SENSOR	PDC(s) (DAISY CHAINED)



PLAN VIEW

SCALE: NOT TO SCALE

NOTES:

: DO NOT SLOPE CHANNEL FLOOR.
: CHANNEL WIDTH & DEPTH MUST BE KEPT WITHIN A TOLERANCE OF + OR - ¼" [6mm].
: ANCHOR BOLTS ARE NOT SUPPLIED BY TROJAN TECHNOLOGIES.
: SYSTEM CONDUIT, WIRING, DISTRIBUTION PANELS & INTERCONNECTIONS BY OTHERS.
: ELECTRICAL REQUIREMENTS SHOWN ARE TO SUPPLY TROJAN UV EQUIPMENT ONLY. ELECTRICAL INRUSH FACTOR TO BE ADDED AS PER LOCAL CODE.
: HSC COMPACT IS SUPPLIED WITH A STANDARD 25' [7.6m] HOSE KIT.
: CHANNEL COVERING ABOVE THE MODULES MUST BE OPEN (E.G. PERFORATED GRATING). REMOVABLE GRATING SECTIONS SHALL BE EASILY REMOVED BY ONE PERSON. MAXIMUM WEIGHT OF THE SECTIONS SHALL BE IN ACCORDANCE WITH REQUIREMENTS OF THE APPLICABLE JURISDICTION.
: THE APPLICABLE INTERCONNECT IS TO BE DAISY-CHAINED BETWEEN PANELS. CONTRACTOR CAN CHOOSE THE ORDER OF CONNECTIONS THAT IS MOST APPROPRIATE.
: EFFLUENT LEVELS SHOWN REFLECT TROJAN EQUIPMENT ONLY. EFFLUENT LEVELS MAY CHANGE DUE TO CHANNEL DEBRIS OR GEOMETRY
:TOLERANCE AT ALC IS CHANNEL WIDTH +1" [25mm].

DESIGN CRITERIA		
PEAK FLOW		MGD / m³ / DAY
U.V TRANSMITTANCE AT 253.7 nm	%	
SUSPENDED SOLIDS	mg / l	
DISINFECTION STANDARD	FC / 100ml	

TROJANUV

DESCRIPTION: LAYOUT, UV3000PLUS 1 CHANNEL 2 BANK ALC WITH CLEANING (PLC)

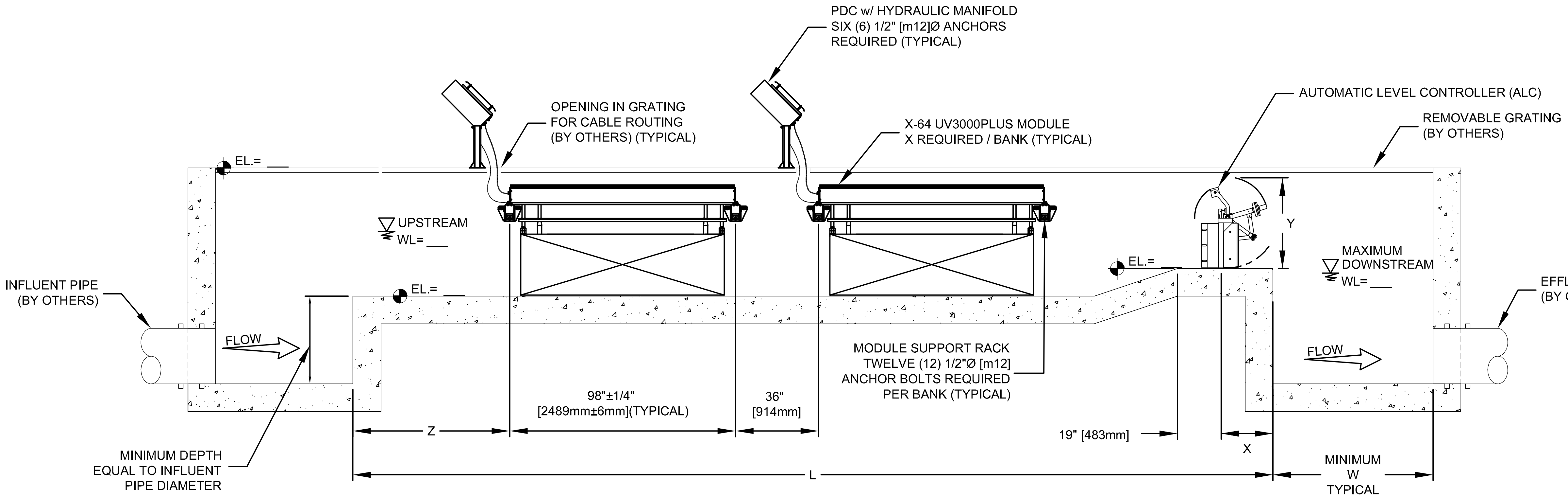
DRAWN BY :	RLM	DATE :	09DE14
CHECKED BY :	SAH	DATE :	09DE16
APPROVED BY :	LQ	DATE :	09DE16
SCALE :	NOT TO SCALE	LOG NUMBER :	N/A

QUOTE NO. 3M0670

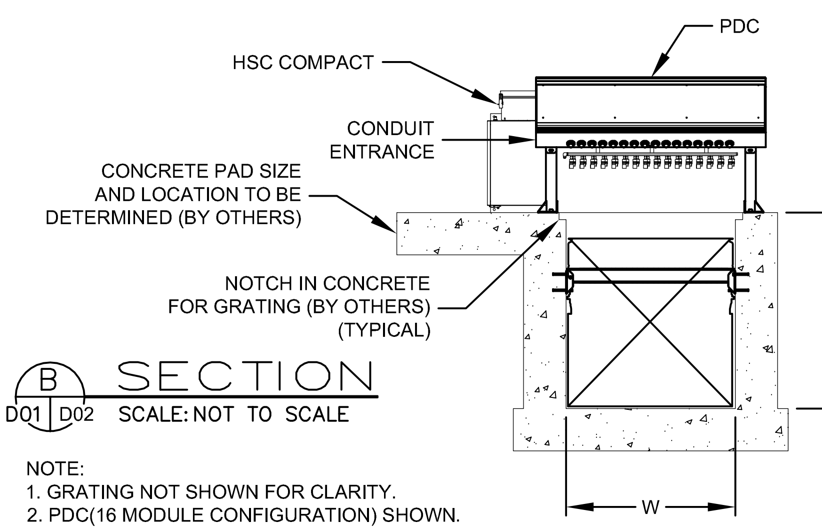
PROJECT NO. N/A

DWG NO. D01

REV. A



A SECTION
D01 | D02 SCALE: NOT TO SCALE



B SECTION
D01 | D02 SCALE: NOT TO SCALE

NOTE:
1. GRATING NOT SHOWN FOR CLARITY.
2. PDC(16 MODULE CONFIGURATION) SHOWN.

NOTES:

: DO NOT SLOPE CHANNEL FLOOR.
: CHANNEL WIDTH & DEPTH MUST BE KEPT WITHIN A TOLERANCE OF + OR - ¼" [6mm].
: ANCHOR BOLTS ARE NOT SUPPLIED BY TROJAN TECHNOLOGIES.
: SYSTEM CONDUIT, WIRING, DISTRIBUTION PANELS & INTERCONNECTIONS BY OTHERS.
: ELECTRICAL REQUIREMENTS SHOWN ARE TO SUPPLY TROJAN UV EQUIPMENT ONLY. ELECTRICAL INRUSH FACTOR TO BE ADDED AS PER LOCAL CODE.
: HSC COMPACT IS SUPPLIED WITH A STANDARD 25' [7.6m] HOSE KIT.
: CHANNEL COVERING ABOVE THE MODULES MUST BE OPEN (E.G. PERFORATED GRATING). REMOVABLE GRATING SECTIONS SHALL BE EASILY REMOVED BY ONE PERSON. MAXIMUM WEIGHT OF THE SECTIONS SHALL BE IN ACCORDANCE WITH REQUIREMENTS OF THE APPLICABLE JURISDICTION.
: THE APPLICABLE INTERCONNECT IS TO BE DAISY-CHAINED BETWEEN PANELS. CONTRACTOR CAN CHOOSE THE ORDER OF CONNECTIONS THAT IS MOST APPROPRIATE.
: EFFLUENT LEVELS SHOWN REFLECT TROJAN EQUIPMENT ONLY. EFFLUENT LEVELS MAY CHANGE DUE TO CHANNEL DEBRIS OR GEOMETRY
:TOLERANCE AT ALC IS CHANNEL WIDTH +1" [25mm].

TROJAN UV

DESCRIPTION: LAYOUT, UV3000PLUS 1 CHANNEL 2 BANK ALC WITH CLEANING (PLC)				QUOTE NO. 3M0670
DRAWN BY :	RLM	DATE :	09DE14	PROJECT NO. N/A
CHECKED BY :	SAH	DATE :	09DE16	
APPROVED BY :	LQ	DATE :	09DE16	DWG NO. D02 / REV. A
SCALE :	NOT TO SCALE	LOG NUMBER :	N/A	

Appendix F

TROJAN UVSIGNA 2ROW PROPOSAL AND DRAWINGS

PROPOSAL FOR ARCATA, CALIFORNIA
QUOTE: 216662

05/23/2018

TrojanUVSigna™ incorporates revolutionary innovations, including TrojanUV Solo Lamp™ technology, to reduce the total cost of ownership and drastically simplify operation and maintenance. It is the ideal solution for facilities wanting to upgrade their disinfection system easily and cost-effectively.

We are pleased to provide the enclosed TrojanUVSigna proposal. Please do not hesitate to contact us if you have any questions regarding this proposal. We look forward to working with you.

With best regards,

Jordan Fournier
Regional Manager
Trojan Technologies
(519) 457 – 3400 ext. 2193
jfournier@trojanuv.com

TROJANUVSIGNA™

DESIGN CRITERIA

Peak Design Flow:	**5.9 MGD**
UV Transmittance:	**35%** (minimum)
Total Suspended Solids:	**30 mg/l (30 Day Average,** grab sample)
Disinfection Limit:	**43 fecal coliform per 100 ml**, based on a 1 day Maximum (90%ile) of consecutive daily grab samples
Design Dose:	**50 mJ/cm^2**

DESIGN SUMMARY

CHANNEL (Refer to Trojan layout drawing for complete details)	
Number of Channels:	**1**
Minimum Channel Length Required:	**30'**
Channel Width at UV Banks:	**3.3'**
Channel Depth Recommended:	**7.8'**
UV BANKS	
Number of Banks per Channel:	**7 (6 duty, 1 redundant)**
Number of Lamps per Bank:	**12**
Total Number of UV Lamps:	**84 (Including 12 Redundant Lamps)**
Maximum Duty Power Draw:	**75.8 kW**
UV PANELS	
Power Distribution Center Quantity:	**2**
Hydraulic System Center Quantity:	**2**
System Control Center Quantity:	**1**
ANCILLARY EQUIPMENT	
Level Controller Quantity and Type:	**1 Fixed Weir**
Integral Bank Walls:	**Included**
On-line UVT Monitoring:	**Hach UVAS sc Sensor**
Other Equipment:	

ELECTRICAL REQUIREMENTS

1. Each Power Distribution Center requires an electrical supply of one (1) 480V, 3 phase, 4 wire + GND, 50/60 Hz, 82.1 kVA
2. Electrical supply for Hydraulic System Center will be (1) 480V, 3 phase, 3 wire + GND, 60 Hz, 2.5 kVA
3. Electrical supply for System Control Center will be (1) 120V, 1 phase, 2 wire + GND, 60 Hz, 1.8 kVA
4. The On-line UVT monitor requires (1) 120 Volts, 1 phase, 2 wire + ground, 1A
5. Electrical disconnects are not included in this proposal. Refer to local electrical codes

COMMERCIAL INFORMATION

Total Capital Cost: $ 640,000 (USD)

This price excludes any taxes or duties that may be applicable.
Standard equipment warrantees and start up by Trojan-certified technicians are included.

Operating Conditions

Average Flow:	**2.3 MGD**
UV Transmittance:	**35%**
Annual Operating Hours:	**8,760 hours**
Average Number of Lamps Online:	**36**

Power Requirements		**Lamp Replacement**	
Average Power Draw:	**31.7 kW**	Lamps Replaced per Year:	**21**
Cost per kW Hour:	**$0.10**	Price per Lamp:	**$650**
Annual Power Cost:	**$27,769**	**Annual Lamp Replacement Cost:**	**$13,650**
Total Annual Operating Cost Estimate: $41,419			

This cost estimate is based on the average flow and UV transmittance listed above. Actual operating costs may be lower with the TrojanUVSigna automatic dose pacing control system. As UV demand decreases by a change in operating conditions, the number of lamps online and power level of the lamps decreases accordingly. The dose pacing system minimizes equipment power levels while ensuring the target UV dose is maintained at all times.

Easy and Cost-Effective Maintenance

- The 1000 watt TrojanUV Solo Lamp combines the benefits of both low pressure and medium pressure lamps
- Fewer lamps, long lamp life and easy change-outs save time and money
- Lamp change-outs and cleaning solution replacement are done while the UV system is in the channel – minimizing downtime and simplifying maintenance
- Routine maintenance can be performed while banks are in the channel, but an Automatic Raising Mechanism (ARM) makes other tasks, such as winterization, simple, safe and easy
- Lamp plugs with LED status indicators and integral safety interlock prevent an operator from accidentally removing an energized lamp
- ActiClean WW™ chemical/mechanical cleaning system to keep sleeves clean during operation

SYSTEM OVERVIEW

Simple to Design and Install

- Light locks on the UV banks control water level within the channel, reducing dependence on downstream weirs and preventing short-circuiting above the lamp arc
- UV Banks include integral reactor walls to make installation easy and prevent short circuiting at the channel walls
- Stringent tolerances on concrete channel walls are not required – making retrofits simple and cost-effective

Supported by Trojan Technologies

- Trojan Technologies warrants all components of the system (excluding UV lamps) against faulty workmanship and materials for a period of 12 months from date of start-up or 18 months after shipment, whichever comes first.
- UV lamps are warranted for 15,000 hours of operation or 3 years from shipment, whichever comes first. Lamp warranty is pro-rated after 9,000 hours of operation. This means that if a lamp fails prior to 9,000 hours of use, a new lamp is provided at no charge.
- Trojan offers an unparalleled Lifetime Performance Guarantee. The spirit of this guarantee is simple: the Trojan equipment, as sized for the project, will meet the disinfection requirements for the life of the system.

Appendix H

TM 8 SITE IMPROVEMENTS

City of Arcata
Wastewater Treatment Facilities Improvements

Technical Memorandum 8
SITE IMPROVEMENTS

FINAL | April 2019

City of Arcata
Wastewater Treatment Facilities Improvements

Technical Memorandum 8
SITE IMPROVEMENTS

DRAFT | April 2019

REGISTERED PROFESSIONAL ENGINEER
DOUGLAS W. WING
No. 38950
CIVIL
STATE OF CALIFORNIA

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Abbreviations

1W	potable water
2W	non-potable water
AWTF	Arcata Wastewater Treatment Facility
BFE	base flood elevation
Carollo	Carollo Engineers, Inc.
CEQA	California Environmental Quality Act
EPPS	emergency pond pump station
kV	kilovolt
MAW	mean annual maximum water elevation
NAVD 88	North American Vertical Datum of 1988
SLR	sea level rise
TM	technical memorandum
UV	ultraviolet

Technical Memorandum 8

SITE IMPROVEMENTS

8.1 Purpose

The purpose of this Technical Memorandum (TM) is to present the overall site planning findings and recommendations for the City of Arcata (City) Wastewater Treatment Facility (AWTF). This includes planning for current and future projects, site access, construction staging and access, stormwater runoff collection, and site security options. This TM will also review, at a conceptual level, the impact of sea level rise (SLR) and the requirements for plant facilities transition with SLR. A preliminary site plan is presented for use in California Environmental Quality Act (CEQA) permitting and for preliminary discussion with resource agencies regarding project permitting.

8.2 Summary of Findings and Recommendations

The key findings and recommendations of this TM are summarized below:

- Site Plan: The central site plan for the new treatment facilities was developed to avoid as many existing corporation yard facilities as possible. However, the bus barn and maintenance shop, and biosolids composting facility will need to be relocated.
- Phased Expansion: Some new facilities will be phased in, with additional secondary treatment facilities coming on line as sea level rise impacts the natural treatment systems such that they are no longer available for use as treatment facilities.
- Site Security: Existing fencing will not be updated with this project.
- Site Access: No changes will be made to the existing plant site access.
- Facility Relocation: The existing bus barn, maintenance shop, dirt and rock storage bins, and biosolids composting facilities will need to be relocated. The bus barn, maintenance shop, and dirt and rock storage bins will be relocated just north of Treatment Wetland No. 3 while the biosolids composting facilities will be located to the west of Treatment Wetland No. 3.
- Construction Staging: Space is available for construction staging to the north and west of Treatment Wetland No. 3. There is also City owned property on South I Street that could be used for construction staging. However, these areas are limited and land nearby may need to be leased for construction staging.
- Geotechnical Considerations: A geotechnical investigation has been completed and a two part report will be issued in 2018. The report recommendations will be incorporated into final design.
- Site Utilities: The non-potable water system and stormwater drainage systems will be expanded with this project. Based on Fire Marshal input, additional fire protection facilities may also be needed, which will be determined during final design.

- Civil Design Criteria: General civil design criteria are presented in this TM for final design. In addition, the City's standard plans will also be incorporated into final design.
- Sea Level Rise: All new structures will be built at an elevation of at least 11.5 (NAVD 88), to prevent flooding during a 100-year storm with SLR and to provide an additional safety factor for process and electrical equipment. Additionally, it is recommended that all existing structures be reviewed and modified as needed to provide an elevation of at least 10.4 (NAVD 88), to prevent annual flooding at high tide with SLR.

8.3 Background

The AWTF consists of headworks with screening and grit removal, primary clarification, oxidation ponds and treatment wetlands secondary treatment, and polishing enhancement wetlands. Solids processing consists of digestion and drying in sludge drying beds. Except for the oxidation ponds and wetlands, all AWTF facilities are located on an 8.4 acre parcel off of South G Street. In addition to treatment plant facilities, this area also houses the Streets Department, corporation yard, police evidence storage facilities, as well as biosolids composing operations.

While space is limited at the AWTF, additional facilities are needed for adequate treatment of current and projected AWTF wastewater flows and future SLR.

8.4 Site Master Plan

This section describes the proposed site layout and identifies the site planning constraints including site access, site security, facility relocation, and master planning for future capacity expansion.

8.4.1 Proposed Site Layout

The facilities shown in the proposed site layouts are sized based on the discussions in process TM's developed for this project.

The proposed site layout for the oxidation ponds and treatment wetlands is shown in Figure 8.1 and the proposed site layout for the enhancement wetlands is shown in Figure 8.2.

Figure 8.3 shows the initial layout proposed for the central plant facilities. However, based on conversations with AWTF staff, it was determined that construction around the Sign Building should be kept to a minimum, as contaminated soil reportedly may be present in that area. Additionally, city staff want to keep as much of the corporation yard intact as possible. Thus, the central plant facility layout was revised, and the alternate central site plan is shown in Figure 8.4. While this alternative keeps much of the corporation yard intact, it does require the re-location of the bus barn structure and biosolids composting operation. Design will move forward with the alternate central site plan.

Figure No. 8.1

TREATMENT WETLANDS SITE PLAN

CITY OF ARCATA

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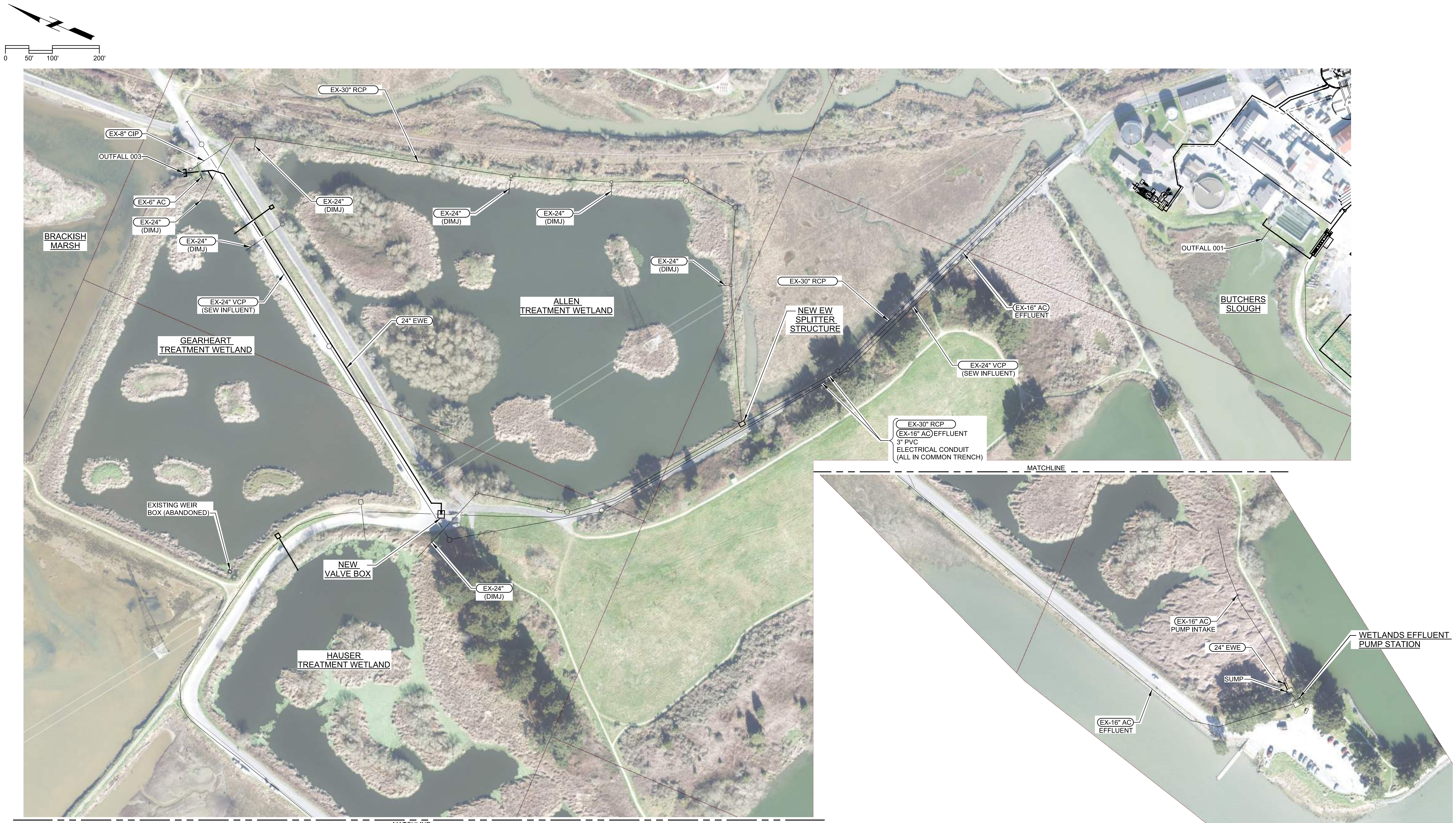
File: E:\ICSforPDFWorking\32157\794338_2019913B10FIG8.1.dgn Plot Date: 05-SEP-2018 9:36:57 AM User: svcPW



LEGEND:

EXISTING	———
NEW	———
FUTURE	- - - -

Figure No. 8.2

ENHANCEMENT WETLANDS SITE PLAN

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File: E:\ICSforPDFWorking\32155\794338_37\9913B10FIG8.2.dgn

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Figure No. 8.3

CENTRAL SITE PLAN

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File: E:\ICSforPDFWorking\32160\794338_22\9913B10FIG8.3.dgn

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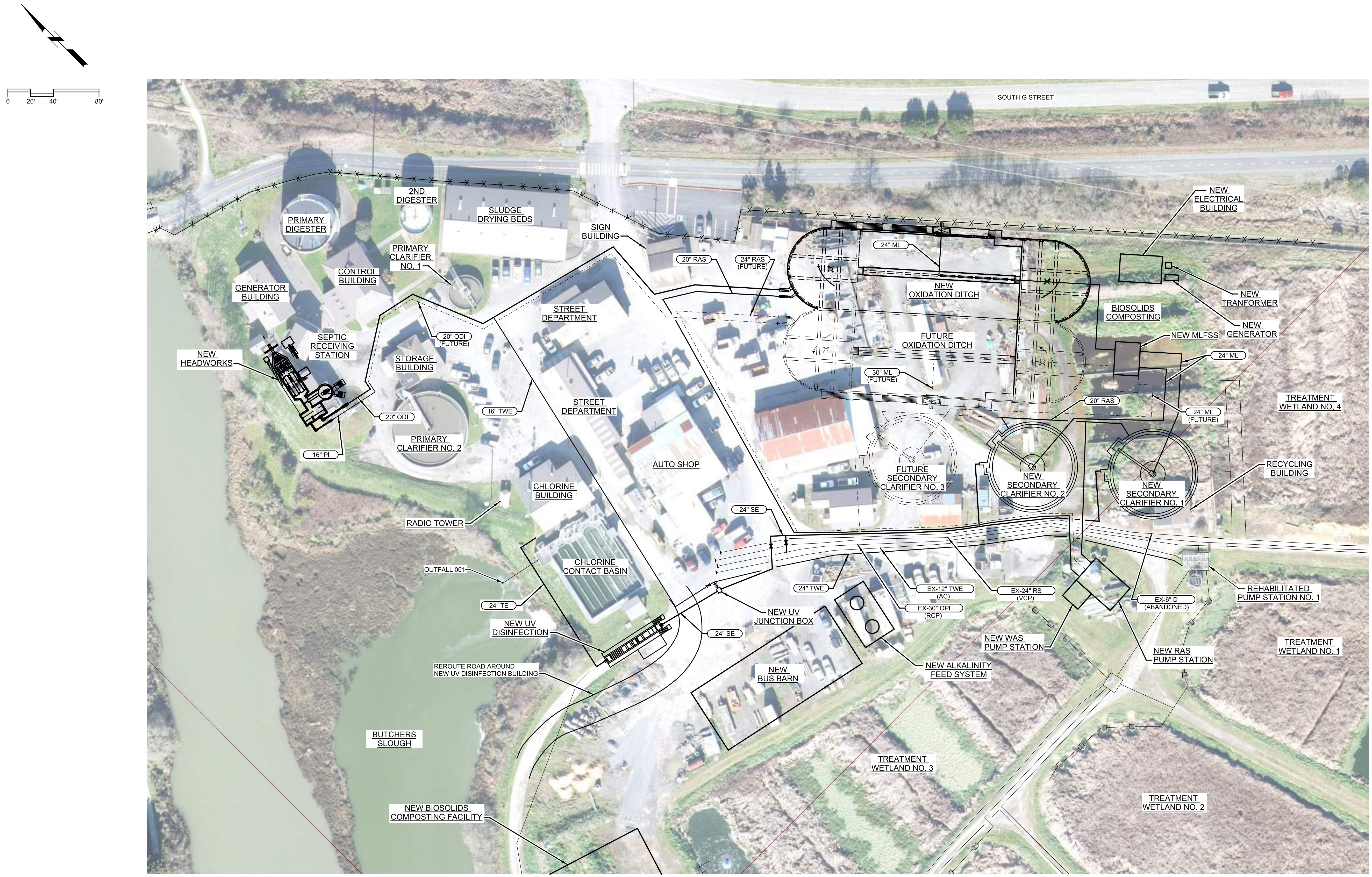

Figure No. 8.4

CENTRAL SITE PLAN ALTERNATIVE

CITY OF ARCATA

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File: E:\ICSforPDFWorking\3216\2\794338_2\3\9913B10FIG8.4.dgn

Plot Date: 05-SEP-2018 9:45:22 AM

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8.4.2 Anticipated Phased Expansion

The site layout presented is based on master planning the site to accommodate 20 percent growth. In addition, with anticipated SLR, the site layout is based on the future loss of the existing natural treatment system for treatment. Therefore, the site plans include a preliminary layout that shows future treatment units needed when the existing natural treatment system is no longer functional. These future units are not required under the current project but are shown to address the potential for future SLR. For example, the secondary process includes one oxidation ditch and two secondary clarifiers, with a second oxidation ditch and third secondary clarifier required for future expansion.

8.4.3 Perimeter Security

A chain link fence, that provides limited perimeter security, is currently installed along South G Street. The fence is continuous from the bridge north of the plant to the north eastern edge of Oxidation Pond 2. A gate is currently installed at the plant entrance off of South G Street. In discussions with AWTF staff, a new fence along the Arcata Bay side of the plant is not anticipated at this time nor is the replacement of the existing fence and gate, as they are in acceptable condition. AWTF staff have considered installing a second gate to the facility. Two potential gate locations were identified:

- The south end of the proposed oxidation ditch by the new bike trail.
- Between the proposed electrical building and oxidation ditch.

A second plant entrance was discussed for future plant improvements and was not included in the current project.

8.4.4 Site Access

As described above, there is currently one gated entrance into the AWTF. This entrance is used not only for AWTF staff access, but for police and city staff access, chemical deliveries, and sludge/screening and grit hauling. Currently, chemical deliveries arrive on a flatbed truck and loop around the street department facilities, stopping at the chlorine building. Additionally, sludge/screening and grit hauling trucks pull up to the headworks, use a front loading truck to load material for removal, and have to back out of the headworks area. These truck routes will continue with the proposed new facilities.

In addition to existing chlorine deliveries, it is anticipated that additional chemical deliveries to the new alkalinity feed system will also be needed. As shown on the site plan, this facility will be located adjacent to the relocated bus barn. Truck routing for these chemical deliveries are anticipated to be similar to current truck routing for chemical deliveries, with trucks looping around the existing street department facilities. At the south end of the street department facilities, alkalinity delivery trucks may need to back down the road leading to the oxidation ponds up to 100 feet to reach the new alkalinity feed system before continuing on their loop around the existing street department facilities.

On-site biosolids and compost hauling will also be impacted by the proposed facility changes. As described above, the alternative central site plan requires the relocation of the biosolids composting facilities offsite. Thus trucks that haul biosolids from the existing sludge drying beds to the existing composing facilities will need to drive to the new offsite location to reach the composting facilities.

8.4.5 Relocated Facilities

The following facilities will need to be relocated with the proposed new facilities:

- Bus barn used for vehicle and other material storage
- Maintenance shop
- Dirt and rock storage bins
- Biosolids composting

As shown in Figure 8.4, the bus barn will be re-located to the area just north of Treatment Wetland No. 3 and will be included with this project.

There are several potential locations for the relocated maintenance shop including incorporation into the new bus barn, at the existing chlorine facilities site (depending on the modifications to the chlorine system), or elsewhere on site as seen fit by the City. For predesign planning purposes, it is assumed that the maintenance shop will be incorporated into the bus barn. The final location of the maintenance shop will be coordinated during final design.

The dirt and rock storage bins may also be able to be relocated to this area. However, the final location of the dirt and rock storage bins is City preference and the relocation of these facilities is not included in this project.

Additionally, the biosolids composting facilities will need to be relocated. It is anticipated that these facilities can be relocated to the west of Treatment Wetland No. 3 as shown in Figure 8.4. Currently the area dedicated to biosolids composting is approximately 100 feet by 200 feet. This space allows for ten 100 foot by 20 foot non-aerated composting bays. According to AWTF staff, this area is sized sufficiently. These composting bays will be re-located with the project.

Furthermore, the road southeast of the chlorine contact basin will need to be re-routed around the proposed ultraviolet (UV) Disinfection facility. The piping from the emergency pond pump station (EPPS) and 12 kilovolt (kV) electrical feed that run along this road will also likely need to be re-routed.

In general, storage at the AWTF is quite limited and is only going to become more limited with the proposed new facilities. For this reason, expanded storage space will be accommodated with a larger bus barn. In an effort to address limited storage space, AWTF staff are currently clearing out the area around the proposed location for the relocated bus barn.

8.5 Construction Staging and Phasing

The AWTF is limited in available space so areas for construction staging onsite are minimal. Construction staging includes space for contractor parking, material and equipment storage, construction trailer, restrooms, etc. Possible construction staging locations onsite are as follows:

- Area just north of Treatment Wetland No. 3 (proposed location of relocated bus barn).
- Area just west of Treatment Wetland No. 3 (poor drainage in the winter; proposed location of the relocated biosolids composting).
- City-owned property on south I street (far from central plant).

Because the relocated bus barn and biosolids composting will be relocated to the area onsite proposed for construction staging, construction phasing is an important component of design that is discussed in TM 11 - Implementation and Schedule. If additional construction staging space is needed, the City should consider renting space along South G Street for the duration of construction.

8.6 Geotechnical Issues

A geotechnical report is currently being prepared for the project to address these issues. It will be completed in 2018 and its recommendations will be incorporated into final design. Boring locations around the central site used for the geotechnical evaluation are shown in geotechnical report.

8.7 Site Utilities

This section describes the existing and new site utilities.

8.7.1 Potable Water

Potable water (1W) is used for drinking, sanitary facilities, wash rooms, emergency shower and eyewash basins, seals for grit and sludge pumps, and chemical dilution water. Presently, potable water is split into two services outside of the AWTF gate. One service is for the corporation yard facilities on the southern end of the plant and the other service is for the plant processes on the northern half of the plant. On the plant processes side, 1W is supplied to the control building, storage building, and chlorine building from a tie in to the City's system on South G Street. On the corporation yard side, 1W is supplied to three restrooms and a car wash station. Additional 1W needs and supply upgrades are not anticipated with this project.

8.7.2 Utility Water

Non-potable water (2W) is used throughout the plant for utility station wash-down water and water supply to spray and flush lines. Presently, 2W is supplied to the generator building, headworks, control building, primary clarifiers, digesters, and chlorine building. The 2W is supplied from a tie in with a reduced pressure principle device to the City's potable system on South G Street. Initially an air gap tank was installed; however the valve in the air gap tank aged and caused a water hammer effect, so the air gap tank was replaced with a reduced pressure principal device.

It is anticipated that with the proposed facilities, the 2W system will need to be expanded. 2W would be supplied to the new oxidation ditches and secondary clarifiers for wash-down water. Additionally, a separate 2W feed from the plant's disinfected effluent could be used for spray water at the new facilities and the existing primary clarifiers. The need for this separate spray water system will be defined during final design. Alternatively a portion of the process water needs could be supplied with chlorinated plant effluent.

The distribution system would be designed to provide the supply necessary to accommodate recommended improvements. The system will be looped for reliability and have isolation capability.

8.7.3 Fire Protection

There are currently no fire hydrants on site. The closest fire hydrant is just outside the AWTF entrance gate on South G Street. According to AWTF staff, there are also no sprinkler systems in any of the buildings.

The City contacted the Fire Marshal and he had no issues with the predesign. As the design process progresses, the Fire Marshal will be updated and additional fire safety measures may be recommended, such as additional fire hydrants or sprinkler systems. A fire hydrant could be added adjacent to the new electrical building. These recommendations will be included in final design.

8.7.4 Stormwater Management

The existing on-site stormwater drainage system is designed to drain to either the headworks/influent sewer or the oxidation ponds. Currently, the northern portion of the AWTF drains by gravity to the headworks or influent sewer. The Streets Department offices, Chlorine Contact Basin, and corporation yard areas drain to the southern edge of the Chlorine Contact Basin where two 5 horsepower Gorman-Rupp pumps pump the stormwater drainage to the oxidation ponds. AWTF staff have observed that during heavy storms the corporation yard has experienced flooding, indicating that this system may be undersized.

It is anticipated that with the proposed facilities, the storm drainage facilities will need to be expanded. Stormwater drainage would be provided for the process facilities. These new drainage facilities would be designed to capture a 100-year 2-hour storm and drain to new pumps at the Chlorine Contact Basin that would pump the stormwater to the oxidation ponds.

8.7.5 Tank Drain System

Tank drain pump stations with portable submersible pumps will be considered for each major tank or process added. The pump stations could be designed to return the tank's contents to an operating tank of similar process. Quick disconnects and permanent piping would be provided at each pumping location. The need for tank drainage would be reviewed during final design, then the location and sizing of the pumps would be completed.

8.8 Civil Design Criteria

The site improvements will be designed based on the following civil design criteria:

- All new process pipelines will have a minimum depth of 4 feet below the finished subgrade.
- All new gravity pipelines will have a depth between 4 and 10 feet below the finished subgrade.
- If existing process pipe is less than 4 feet below the finished subgrade it may need to be encased or capped with concrete.
- Paving will be 4 inch AC pavement over 12 inch of ABC.
- New piping between wetland cells will have cutoff walls to prevent "piping" of water along the pipelines in berms and levees.
- Roadways will be a minimum of 24 feet wide with shoulders on each side that are a minimum of 2 foot wide.
- New duct banks will be designed for a minimum of 2 feet of cover.

In addition, the City's standard plans shall be used where applicable.

8.9 Sea Level Rise

As discussed in TM 2, Flow Reconfiguration, SLR is expected to impact plant operations in the near future by raising the water level in Humboldt Bay and thus the hydraulic grade line throughout the plant. Additionally, SLR has the potential to cause flooding of the plant site itself. This potential of plant flooding is discussed in this section.

By 2050 it is projected that sea level will rise by 1.1 feet (Humboldt Bay Sea Level Rise Adaptation Planning Project: Phase 2 Report, February 2015). The potential for flooding, given this projected SLR, was evaluated for two scenarios: (1) during a 100-year flood, and (2) during mean annual maximum tide.

Currently the Base Flood Elevation (BFE) is 10.05 feet (NAVD 88). With SLR the BFE will increase to 11.05 (NAVD 88). Thus all new structures will be built at an elevation of at least 11.5 feet, to prevent flooding during a 100-year storm with SLR and to provide an additional safety factor for process and electrical equipment.

Currently the mean annual maximum water elevation (MAMW) is 8.78 feet (NAVD 88). With SLR the MAMW will increase to 9.8. It is recommended that all existing structures have an elevation of at least 10.4 feet, to prevent annual flooding with the MAMW. Table 8.1 shows the elevation of existing structures at the AWTF that will remain with this project. As shown in the table, no structures except for the EWPS Intake Structure will flood annually during MAMW with SLR. However, a number of structures will flood during a 100-year flood with SLR. Table 8.1 does not include the elevations of the ponds and wetlands.

Table 8.1 Potential for Existing Structure Flooding with SLR

Existing Structure	Elevation (NAVD 88) (1)	Structure Will Flood during MAMW with SLR	Structure Will Flood during BFE with SLR
Chlorine Building	10.4	-	Yes
Control Building	10.4	-	Yes
Generator Building	10.4	-	Yes
First Street PS	10.4	-	Yes
Influent PS Wet Well	10.4	-	Yes
Primary Clarifier	15.6	-	-
Chlorine Contact Basin	14.9	-	-
Chlorine Contact Sump Pump	13.1	-	-
Primary Digester (top)	36.1	-	-
Secondary Digester (top)	36.1	-	-
Sludge Drying Beds	10.4 (2)	-	Yes
PS 1 / PPS	10.9	-	-
EWPS	10.4	-	Yes
EWPS Intake Structure	7.4	Yes	Yes

Notes:
(1) Elevations are based on the 1984 drawings provided by the AWTF. The conversion from NAVD 29, provided on the drawings, to NAVD 88, shown here is: NAVD 29 + 3.35 = NAVD 88.
(2) Sludge drying bed elevation was assumed, and will be confirmed in final design.

Appendix I

TM 9 ENERGY EFFICIENCY, ELECTRICAL, AND CONTROL SYSTEM

City of Arcata
Wastewater Treatment Facility Improvements

Technical Memorandum 9
ENERGY EFFICIENCY, ELECTRICAL, AND CONTROL SYSTEM

FINAL | April 2019

City of Arcata
Wastewater Treatment Facility Improvements

TECHNICAL MEMORANDUM 9
ENERGY EFFICIENCY, ELECTRICAL, AND CONTROL SYSTEM

FINAL | April 2019

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Abbreviations

A	amperes
AMRI	Arcata Marsh Research Institute
ATS	aerobic treatment system
AWTF	Arcata Wastewater Treatment Facility
Carollo	Carollo Engineers, Inc.
City	City of Arcata
CT	current transformer
EPPS	Emergency Pond Pump Station
EWPS	Enhancement Wetlands Pump Station
kV	kilovolt
kVA	kilovolt amperes
kW	kilowatt
LED	light emitting diode
MCC	motor control center
NEMA	National Electrical Manufacturer Association
PLC	programmable logic controller
PT	potential transformer
SCADA	supervisory control and data acquisition
TM	Technical Memorandum
UV	ultraviolet
V	volt

Technical Memorandum 9

ENERGY EFFICIENCY, ELECTRICAL AND CONTROL SYSTEM

9.1 Purpose

The purpose of this Technical Memorandum (TM) is to establish preliminary design criteria, identify main components, develop conceptual layouts, and recommend energy efficiency improvements for a rehabilitated and expanded power distribution system and supervisory control and data acquisition (SCADA) network at the City of Arcata (City) Wastewater Treatment Facility (AWTF).

This TM proposes modifications to the existing 12 kilovolt (kV) service to feed a new 12 kV service entrance rated switchgear, new 12 kV cable distribution throughout the facilities, new pad-mount transformers, and new 480 volt (V) motor control center (MCC) distribution equipment for new facilities and to replace the existing electrical distribution equipment. The new service and equipment would be sized to provide power to the existing AWTF facilities and the increased demand of the new process facilities. This TM also outlines the proposed improvements for networked monitoring and controls of the new and replaced equipment motor loads.

9.2 Summary of Findings and Recommendations

The key findings and recommendations of this TM are summarized below:

- A modified 12-kV service including a new protective device at the existing utility service pole is needed.
- New service-entrance rated switchgear will replace the existing 12 kV switch cabinet. New service cables will be installed from the existing service pole to the new switchgear.
- The new switchgear and new 480 V MCC will be housed in a new Electrical Building.
- The new switchgear will power the existing MCC at the existing Electrical Building and the new 480 V equipment at the new Electrical Building. The existing 12 kV switch cabinet and stepdown transformer at the existing Electrical Building will be demolished.
- New 12 kV distribution cable from new 12 kV service-entrance rated switchgear will feed new main plant pad-mount stepdown transformers and intercept exiting 12 kV cable to feed pad-mount stepdown transformers along the Treatment Wetlands and ponds.
- The Enhancement Wetlands Pumps Station (EWPS) will be fed by the new plant 12 kV cable to accommodate the new larger pumps. A new pad-mount stepdown transformer would be installed at the EWPS. Alternatively, the EWPS could be fed at 480 V from MCC-17A or with a new utility service.
- New and replaced process loads in the area of the existing Electrical Building will be fed by new MCC-17A located in the existing Electrical Building. Carollo recommends that existing loads fed by MCC-A be refed by MCC-17A. Alternatively, existing MCC-A could be maintained to power process loads that do not need modifications in the area of the existing Electrical Building.

- The existing pad-mount stepdown transformer and MCC south of Oxidation Pond No. 1 will be reused to accommodate the temporary aerators in Oxidation Pond No. 1.
- The existing pad-mount stepdown transformers at the existing Electrical Building, the Central Garage, the Emergency Pond Pump Station (EPPS), and the Arcata Marsh Research Institute (AMRI) field office, will be replaced.
- Carollo recommends the existing 250 kilowatt (kW) standby generator at the existing Electrical Building be maintained. A new standby generator will be located at the new Electrical Building to increase overall standby capacity. The new standby generator will be sized to backup critical equipment at the new facilities.
- Carollo recommends that existing lighting fixtures be replaced with light emitting diode (LED) fixtures and existing motors be surveyed for efficiency to determine if replacement could realize energy and cost savings.
- New programmable logic controllers (PLCs) will be added to the SCADA system to centralize and track equipment status information and allow quicker, more informed AWTF operation. More energy usage information will help operations make decisions to improve AWTF energy efficiency.

9.3 Background

This section includes a brief summary of the existing 12 kV service, 12 kV distribution system, and AWTF load centers.

9.3.1 Existing 12 kV Service and 12 kV Distribution System

The AWTF and the Corporation Yard receive power from the existing overhead 12 kV service located near the existing Electrical Building. Incoming overhead service cables deliver power from an offsite existing utility pole to an on-site pole owned by the AWTF. The existing utility meter potential transformer (PT) and current transformers (CTs) are located high up on the onsite pole and the meter is in a standalone enclosure at grade. 12 kV cables run down the onsite pole to an existing pad-mount switch cabinet which feeds the AWTF with two 12 kV circuits. One 12 kV circuit is stepped down to 480 V by a 225 kilovolt amperes (kVA) pad-mount stepdown transformer just north of the existing Electrical Building. This circuit powers the majority of AWTF equipment via MCC-A in the existing Electrical Building. The other 12 kV circuit powers the rest of the AWTF and Corporation Yard facilities through four pad-mount stepdown transformers distributed throughout the facility, which step down to 208 V. These transformers include a 75 kVA transformer at the Central Garage, a 75 kVA transformer at the AMRI field office, a 75 kVA transformer at the EPPS, and a 150 kVA transformer on the south side of Oxidation Pond No. 1. The 12 kV cable feeding these transformers runs down the west side of the treatment wetlands and oxidation ponds. This routing and other existing electrical facilities are shown in Figure 9.1.

The existing switch cabinet, 12 kV cable, and stepdown transformers were constructed by the Wastewater Treatment Plant Modifications project (CH2M HILL, 1984). Most of the equipment installed by that project have exceeded their useful life and should be replaced. The condition assessment of the transformers performed by Transformer Testing & Repairs, Inc. in 2009 showed that the transformers at the existing Electrical Building, the Central Garage, and Oxidation Pond No. 1 were failing and in need of replacement. AWTF staff has indicated that the transformers at the AMRI staff office and the EPPS are also in need of replacement. Carollo recommends that these transformers be replaced, with the exception of the Oxidation Pond No. 1 transformer which will not be needed beyond temporary aeration of Oxidation Pond No. 1. An overview of the existing electrical system and demolition is shown in Figure 9.2.

File: IP_PWP:d0794338\9913B10FIG9.1.dgn Plot Date: 13-AUG-2018 11:47:24 AM User: jgilkey

Figure No. 9.1

EXISTING 12KV ELECTRICAL SITE PLAN

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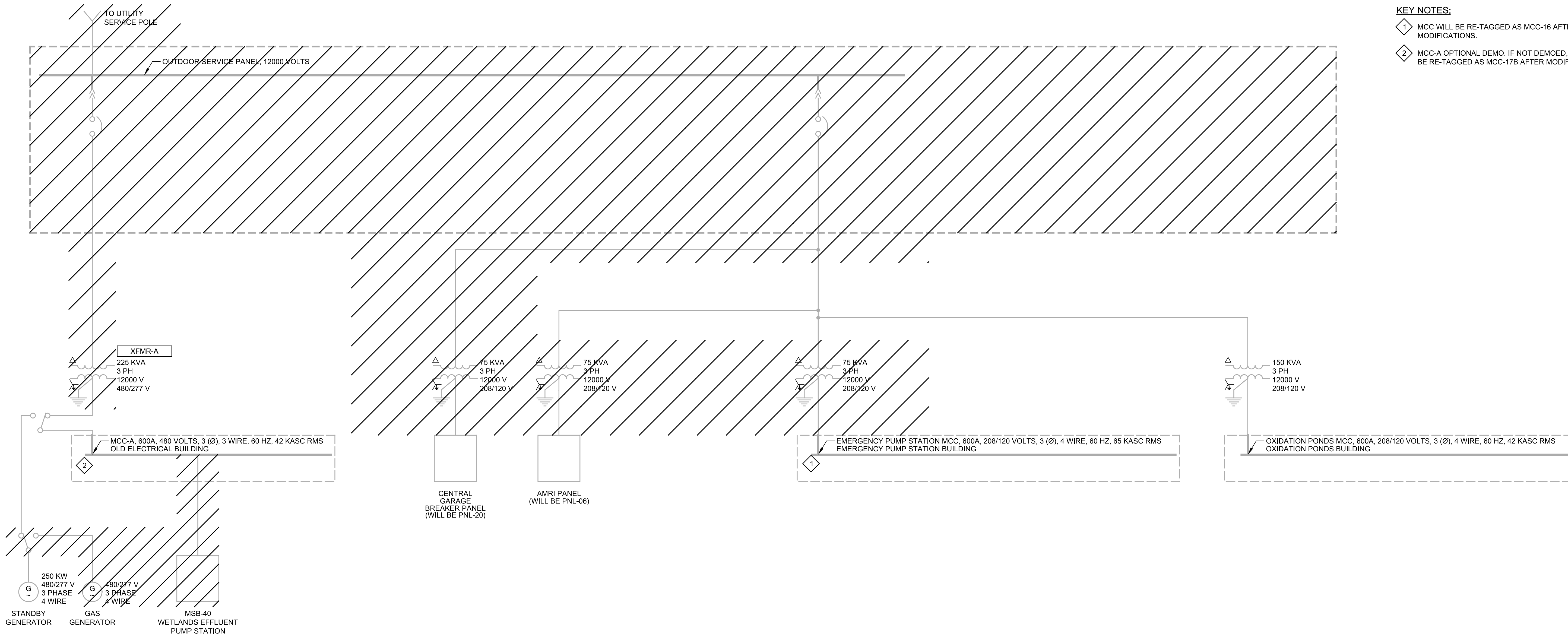

KEY NOTES:

1. MCC WILL BE RE-TAGGED AS MCC-16 AFTER MODIFICATIONS.
2. MCC-A OPTIONAL DEMO. IF NOT DEMOED, MCC-A WILL BE RE-TAGGED AS MCC-17B AFTER MODIFICATIONS.

Figure No. 9.2

EXISTING OVERALL ONE-LINE

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Most existing AWTF process loads are powered out of the existing 600 amperes (A) rated MCC-A located in the existing electrical building. MCC-A was manufactured by Klockner-Moeller, which has since merged with Eaton. Eaton no longer supports Klockner-Moeller MCCs so it will be increasingly difficult get replacement parts. Due to this and to the fact that the MCC is over 30 years old, Carollo recommends replacing MCC-A.

The existing electrical building also houses an existing 250-kW standby generator connected to MCC-A by an automatic transfer switch and an existing 150-kW natural gas generator connected upstream of the aerobic treatment system (ATS). The standby generator was replaced by the AWTF in 2008 and is in good condition. Carollo recommends that the existing standby generator be maintained to back up loads fed by MCCs at the existing electrical building. The AWTF staff has expressed that the digester gas generator is not needed and does not need to be maintained. Thus, it will be demolished to make room for other equipment.

9.3.2 Existing MCCs Serving the Emergency Pump Station and the Oxidation Ponds

An existing 600 A, 208/120 V MCC is located at the EPPS building and at the oxidation pond building. Fed through pad-mount stepdown transformers on the 12-kV system, each of these MCCs are located away from the main plant to serve remote processes. The MCC at the EPPS building is about 20 years old and has useful life remaining. The MCC at the oxidation pond building is beyond its useful life. Figure 9.2 shows the demolition of the EPPS building transformer, which will be replaced. The MCC at the EPPS building will be maintained for 208 V loads at and around Oxidation Pond No. 2; however, it will not be suitable for 480 V loads. The oxidation pond building transformer and MCC will not be demolished because they have sufficient capacity to power temporary aerators planned for installation in Oxidization Pond No. 1. The oxidation pond building transformer and MCC will be abandoned or demolished after the temporary aerators are removed.

9.3.3 Existing Power Distribution Panel at Enhancement Wetlands Pump Station

An existing 480 V feeder from MCC-A provides power to the EWPS panel. In the EWPS panel, this feeder is tapped for each pump starter and for the local power center that provides power to minor loads. The existing panel and most of the distribution equipment was installed in 1984 and is at the end of its useful life. Additionally, the existing 480 V feeder and distribution equipment is undersized for the planned new loads. Carollo recommends that the EWPS panel and the panel distribution equipment and starters be replaced together.

9.3.4 Existing Equipment at the Central Garage and the Corporation Yard

Equipment at the central garage and the Corporation Yard are fed through a pad-mount stepdown transformer on the 12 kV system. The central garage transformer was identified as failing by the 2009 transformer assessment and will be replaced. The central garage and the Corporation Yard equipment is old and may need to be replaced; however, since the only process load (Treatment Wetlands No. 4 Pump) fed by this system will be demolished by this project, Carollo recommends that replacement of any central garage and the Corporation Yard equipment be left to City discretion. At a minimum, Carollo recommends replacing any equipment identified by the AWTF to be exhibiting problematic tripping or other functional issues.

9.3.5 Existing Equipment at the AMRI Field Office

Equipment at the AMRI field office panel is fed through a pad-mount stepdown transformer on the 12 kV system. The AMRI transformer is severely corroded was identified by AWTF staff for replacement. The only process loads (Pump Station No. 2 Pond 3 Storm Pumps) fed by this system will be demolished by this project. Abandoned generator and generator transfer switch in the AMRI field office will also be demolished as instructed by AWTF staff. The rest of the equipment at the AMRI field office will be maintained.

9.4 New 12 kV System

This section summarizes the basis of design for modifications to the existing 12-kV service, provision of new 12 kV switchgear, and modifications to the existing 12 kV-distribution system.

9.4.1 New Electrical Service and Electrical Building

New 12 kV service cables will be installed from the existing utility service pole to the new service-entrance rated 12 kV switchgear at the new electrical building. This installation will be in parallel with the existing service and will allow construction of the new electrical system without significant system downtimes. The new electrical building will be located near the new process equipment loads. Figure 9.3 shows the new electrical building with the new service entrance-rated switchgear location alongside the new oxidation ditch and secondary clarifiers. A one-line diagram for the new system is shown in Figure 9.4. A new outdoor weather wrapped standby generator will be provided at the new electrical building to power critical loads during utility power outages. The new standby generator will be sized for critical equipment at the new processes, and a PLC controlled load shedding program will disable non-critical equipment when the generator is starting.

9.4.2 New 12 kV Cable System

New 12-kV duct bank will be installed to protect new 12-kV cable from the new 12-kV switchgear to the existing electrical building transformer, the central garage transformer, and to the south edge of the main plant where the new cable will intercept existing 12-kV cable in a new manhole. Existing 12-kV cable will be maintained from the south edge of the main plant to the AMRI transformer, the EPPS transformer, and the south oxidation building transformer. Keynote 4 on Figure 9.3 shows the new 12 kV duct bank routing and the proposed existing interception point of existing cables. The existing cabling will not be affected by construction and is maintained to reduce duct bank and 12 kV cable costs. New 12-kV duct bank will also be installed to the EWPS from a 12-kV manhole near the existing electrical building connection. This existing 480 V feed will be replaced with 12 kV cable to reduce cable size and cost. New pad-mount transformers will step the 12 kV down to 480 V at the new electrical building and the EWPS. Additionally, new pad-mount transformers will step the 12 kV down to 208 V/120 V at the central garage and AMRI field office.

Figure No. 9.3

MODIFIED 12KV ELECTRICAL SITE PLAN

CITY OF ARCATA

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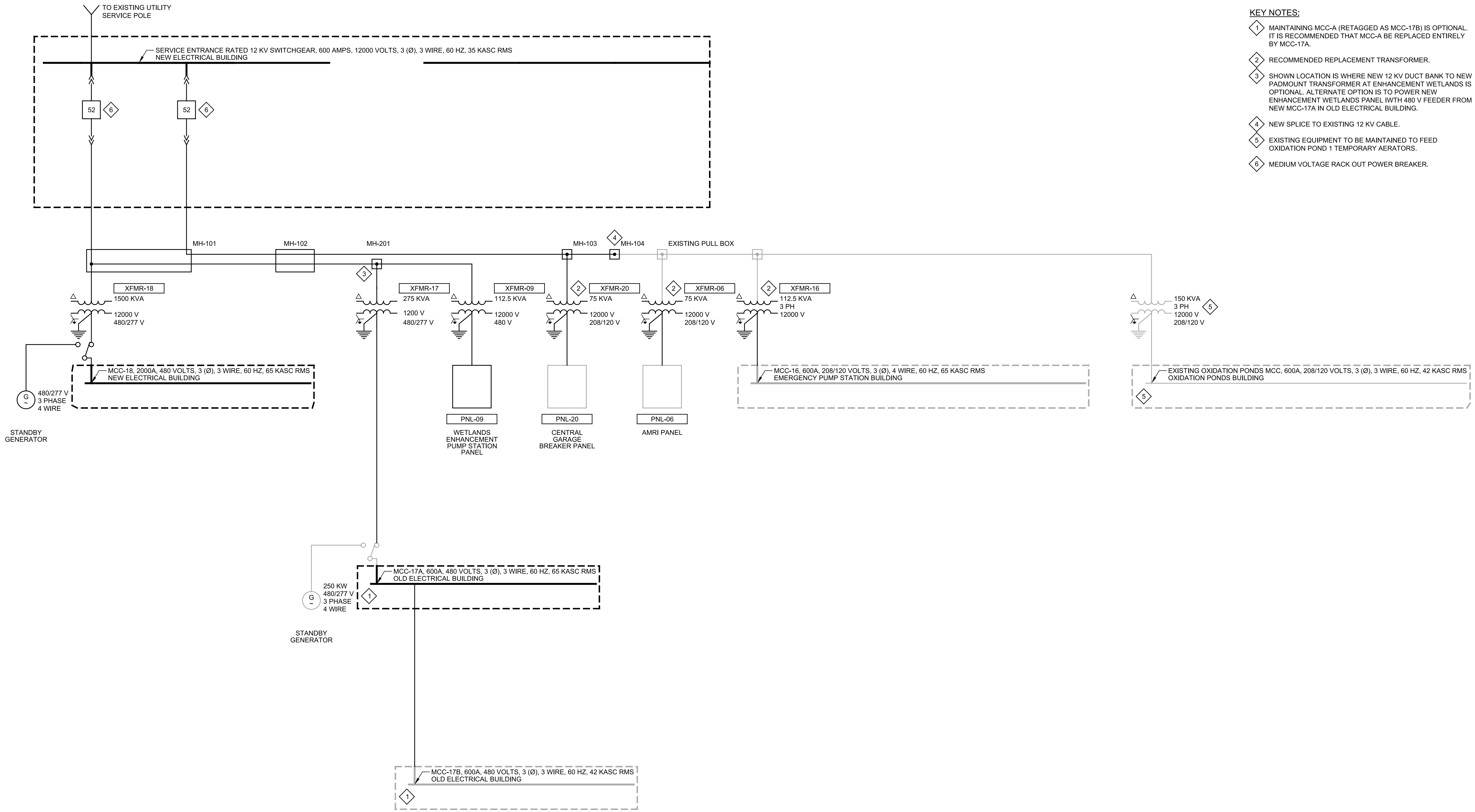

KEY NOTES:

1. MAINTAINING MCC-A (RETAGGED AS MCC-17B) IS OPTIONAL. IT IS RECOMMENDED THAT MCC-A BE REPLACED ENTIRELY BY MCC-17A.
2. RECOMMENDED REPLACEMENT TRANSFORMER.
3. SHOWN LOCATION IS WHERE NEW 12 KV DUCT BANK TO NEW PADMOUNT TRANSFORMER AT ENHANCEMENT WETLANDS IS OPTIONAL. ALTERNATE OPTION IS TO POWER NEW ENHANCEMENT WETLANDS PANEL IWTH 480 V FEEDER FROM NEW MCC-17A IN OLD ELECTRICAL BUILDING.
4. NEW SPLICE TO EXISTING 12 KV CABLE.
5. EXISTING EQUIPMENT TO BE MAINTAINED TO FEED OXIDATION POND 1 TEMPORARY AERATORS.
6. MEDIUM VOLTAGE RACK OUT POWER BREAKER.

Figure No. 9.4
MODIFIED OVERALL ONE-LINE
CITY OF ARCATA

This section summarizes the basis of design for the low voltage distribution equipment based on the existing and modified facility power requirements.

9.4.3 New Electrical Building and 480 Volt Loads at the Treatment Wetlands & Oxidation Pond No. 2

A new 1,500 kVA pad-mount transformer will serve a new 2,000 A MCC at 480 V at the new Electrical Building as shown in Figure 9.4. The new Electrical Building MCC-18 will feed new process equipment at the south end of the AWTF, MCC at the existing electrical building, new process equipment throughout the treatment wetlands, and new 480 V process equipment at Oxidation Pond No. 2. A summary of process loads fed by the new Electrical Building is shown in Table 9.1. The total operating load for all buildout loads to be powered by the new Electrical Building transformer and MCC is 1,144 kVA or 1,376 A. The transformer and MCC are sized based on the next sizes up from the minimum allowed by NEC 215, as shown in the Load Study Report in Appendix B.

Table 9.1 New Electrical Building Process Load Summary

	Existing AWTF Load(1) (kVA)	Modified AWTF Load(1) (kVA)	Buildout AWTF Load(1) (kVA)	New Power Source
Oxidation Ditches	-	260	520	MCC-18 (2)
Secondary Clarifiers	-	11	17	MCC-18 (2)
UV Disinfection	-	38	38	MCC-18 (2)
RAS Pump Station	-	6	6	MCC-18 (2)
WAS Pump Station	-	1	1	MCC-18 (2)
Thickening	-	18	18	MCC-18 (2)
Alkalinity Feed System	-	20	20	MCC-18 (2)
AWTF Water System	-	18	18	MCC-18 (2)
Treatment Wetlands Pump No. 4	9 (3)	6	6	MCC-18 (2)
Pump Station No. 1	-	23	23	MCC-18 (2)
Pond Pump Station	18(4)	57	57	MCC-18 (2)
Oxidation Pond No. 2 Aerators	-	420	420	MCC-18 (2)
Total	**27**	**878**	**1144**	

Notes:
(1) Duty loads only.
(2) MCC-18 is a new MCC located at the new electrical building.
(3) Previously fed by central garage panel.
(4) Previously fed by MCC-A.
See Appendix A for a full list of process equipment.

9.4.4 Existing Electrical Building

A new 275 kVA pad-mount transformer will serve a new 600 A MCC at 480 V at the existing Electrical Building as shown in Figure 9.4. Carollo recommends that the existing MCC-A be demolished and all existing MCC-A loads be re-fed from MCC-17A. Alternatively, existing MCC-A could be subfed from MCC-17A and retagged as MCC-17B. New and existing process loads in the north end of the AWTF will be fed by existing Electrical Building MCC(s). A summary of process loads to be fed by the existing Electrical Building is shown in Table 9.2. The total operating load for all buildout loads to be powered by the existing Electrical Building transformer and MCC is 205 kVA, or 247 A. The transformer and new MCC are sized based on the next sizes up from the minimum allowed by NEC 215, as shown in the Load Study Report in Appendix B.

Table 9.2 Existing Electrical Building Process Load Summary

	Existing AWTF Load(1) (kVA)	Modified AWTF Load(1) (kVA)	Buildout AWTF Load(1) (kVA)	New Power Source
Headworks	65 (4)	110	110	MCC-17A (2)
Primary Clarifier	11 (4)	9	9	MCC-17A/B (2) (3)
Chlorine Contact Basin	34 (4)	34	34	MCC-17B (3)
Digesters	52 (4)	52	52	MCC-17B (3)
Marsh Effluent Pumps	13 (4)	-	-	-
Pump Station No. 2 Pond No. 3 Storm Pumps	18 (5)	-	-	-
Total	**193**	**205**	**205**	

Notes:
(1) Duty loads only.
(2) MCC-17A is a new MCC located at the existing Electrical Building.
(3) MCC-17B is retagged MCC-A located at the existing Electrical Building.
(4) Previously fed by MCC-A.
(5) Previously fed by the AMRI field office panel.
See Appendix A for a full list of process equipment.

9.4.5 Emergency Pond Pump Station and Oxidation Pond Building

A new 112.5 kVA pad-mount transformer will serve the existing 600 A MCC at 208 V/120 V at the EPPS as shown in Figure 9.4. The existing EPPS MCC will be tagged as MCC-05. At the oxidation pond building, the existing 75 kVA and existing 600 A MCC at 208 V/120 V will be maintained to provide power for the temporary Oxidation Pond No. 1 aerators. The existing oxidation pond building facilities will be abandoned or demolished once these temporary aerators are removed. A summary of EPPS and oxidation pond loads is shown in Table 9.3. The total operating load for all loads on the EPPS transformer and MCC will be approximately 80 kVA, or 222 A. The transformer is sized to power these loads and other minor loads as the pump station. The equipment sizing is shown in the Load Study Report in Appendix B. The total temporary aerator operating load will be 140 kVA, or 389 A. MCC-05 and possibly MCC-18 will also need to be sourced to provide additional power to temporary aerators, as required.

9.4.6 Enhancement Wetlands Pump Station

A new 12-kV feed will be stepped down to 480 V by a new 112.5 kVA pad-mount transformer at the EWPS. This transformer will serve a new 125 A control panel at 480 V at the EWPS as shown in Figure 9.4. The new control panel will separately house both 480 V distribution equipment and 120 V controls and communication equipment for the new upsized EWPS pumps. The control panel will be mounted either behind the existing kiosk or in an electrical room in the new restroom facility. This new control panel will completely replace the control panel and distribution equipment mounted in the existing kiosk. EWPS process loads are shown in Table 9.4.

Table 9.3 Emergency Pond Pump Station and Oxidation Ponds Process Load Summary

	Existing AWTF Load(1) (kVA)	Modified AWTF Load(1) (kVA)	Buildout AWTF Load(1) (kVA)	New Power Source
Oxidation Pond No. 1 Temporary Aerators	-	~140	~140	MCC-05 (2) MCC-16 (3) MCC-18 (5)
Pond No. 1 Effluent Weirs	-	3	3	MCC-16 (3)
Pond No. 2 Effluent Weirs	3 (4)	13	14	MCC-16 (3)
Emergency Pond Pump Station (EPPS)	63 (4)	63	63	MCC-16 (3)
Total	**66**	**219**	**219**	

Notes:
(1) Duty loads only.
(2) MCC-05 is the existing MCC located at the oxidation pond building.
(3) MCC-16 is the existing MCC located at the EPPS.
(4) Previously fed by existing MCC located at the EPPS.
(5) MCC-18 is a new MCC located at the new electrical building.
See Appendix A for a full list of process equipment.

Table 9.4 Enhancement Wetlands Process Load Summary

	Existing AWTF Load(1) (kVA)	Modified AWTF Load(1) (kVA)	Buildout AWTF Load(1) (kVA)	New Power Source
Enhancement Wetlands Pump Station (EWPS)	23 (3)	57	57	PNL09 (2)
Total	**23**	**57**	**57**	

Notes:
(1) Duty loads only.
(2) PNL-09 is a new panel at the EWPS.
(3) Previously fed by MCC-A.
See Appendix A for a full list of process equipment.

9.4.7 Equipment at the Central Garage, Corporation Yard, and AMRI

New 75 kVA pad-mount transformers will replace the existing transformers at the central garage and AMRI field office. These transformers will step the 12 kV down to 208 V/120 V for the existing central garage and AMRI facilities. No other new equipment is planned for these facilities.

9.5 SCADA Network and Distributed PLCs

This section provides a brief overview of the existing AWTF SCADA system and their proposed modifications.

9.5.1 Existing SCADA Network

The exiting SCADA network block diagram is shown in Figure 9.5. Operators interface with SCADA at a workstation running a Wonderware Intouch application. The workstation communicates with a Dell Server running Wonderware Historian Server and a Wonderware remote log in software. The server communicates with two existing Siemens S7 PLCs over wireless Ethernet bridges. These PLCs and the wireless connections were installed by the AWTF SCADA technician. The PLCs are located in the Analyzer Room and the EPPS Building.

9.5.2 SCADA Network Improvements and Additions

Four additional Siemens S7 PLCs will be added to the SCADA network to increase the monitoring and remote control capabilities of AWTF staff. A preliminary network diagram of the upgraded SCADA Network is shown on Figure 9.6. A PLC will be added at the new Electrical Building, the existing Electrical Building, the EWPS control panel, and the ultraviolet (UV) facility. AWTF staff has expressed interest in replacing the existing wireless communications and new communications with fiber, but are also concerned that installing fiber to all of the remote pump stations might be too costly. A cost savings alternative would be to install additional wireless communications to match existing Ethernet bridges. Another alternative would be a hybrid system, where fiber is installed to link relatively near AWTF-located facilities and use wireless Ethernet bridges where distances to wetlands areas are relatively great. Carollo recommends that a further cost and benefit analysis be done to determine which of these approaches is best for the modified facility.

9.5.3 SCADA Server Room Requirements

A new SCADA server room is recommended for the facility. The location will be determined based on the system, although it should be centrally located. The City has requested that he room be climate controlled and have fire suppression.

9.6 Energy Efficiency

This section provides a brief overview of some options to make the existing and new AWTF processes more energy efficient.

9.6.1 New Energy Efficiency Equipment and Existing Motors

New equipment installed for new areas and processes will be energy efficient. New energy efficient equipment includes National Electrical Manufacturer Association (NEMA) premium efficiency motors and energy efficient transformers. The overall increase in motor efficiency is approximately 5 percent with premium efficiency motors. Additionally, Carollo recommends that the large existing motors to be maintained be surveyed first for efficiency to determine if replacement could realize energy and cost savings.

9.6.2 LED Lighting Efficiency

New energy efficient equipment includes LED lighting as required by the DOE and Title 24. According to a 2018 assessment completed by San Francisco State University, the AWTF has existing luminaires with high pressure sodium bulbs, incandescent bulbs, linear fluorescent tubes, compact fluorescent light bulbs, and metal halide bulbs. On a recent site visit, Carollo learned that replacement of the existing site light fixtures was completed. Carollo recommends that the existing fixtures for the rest of the facilities be replaced with LED fixtures to further improve energy savings and reduce maintenance costs.

9.6.3 Improving Efficiency through Data

Energy can be the greatest controllable cost of operating a wastewater plant if energy consumption data is available to show how and when a plant is using energy. Carollo recommends the plant introduce a procedure for periodically collecting average motor operating current and operating hours per year for all energy-intensive electrical equipment. With more detailed input, AWTF staff can create a more detailed view of energy usage and performance at the AWTF. Gathering energy consumption data by process could be automated by incorporating meter data from each MCC in to the SCADA system and displaying it on the system workstations. To accomplish this energy tracking, Smart MCCs could be installed. These Smart MCCs are able to measure the current drawn by each load supplied from the MCC. This would enable AWTF staff to monitor how much energy is used by each process as well as how much energy is used by parallel process trains.

9.6.4 Solar Photovoltaic Project

The 2018 San Francisco State University assessment recommended that a solar photovoltaic system could be installed on existing building roofs to offset utility power usage by the AWTF. It is understood that the City is currently pursuing such a system under a separate project. The size of the system will be determined by the available footprint. The preliminary size estimate is approximately 60 kW.

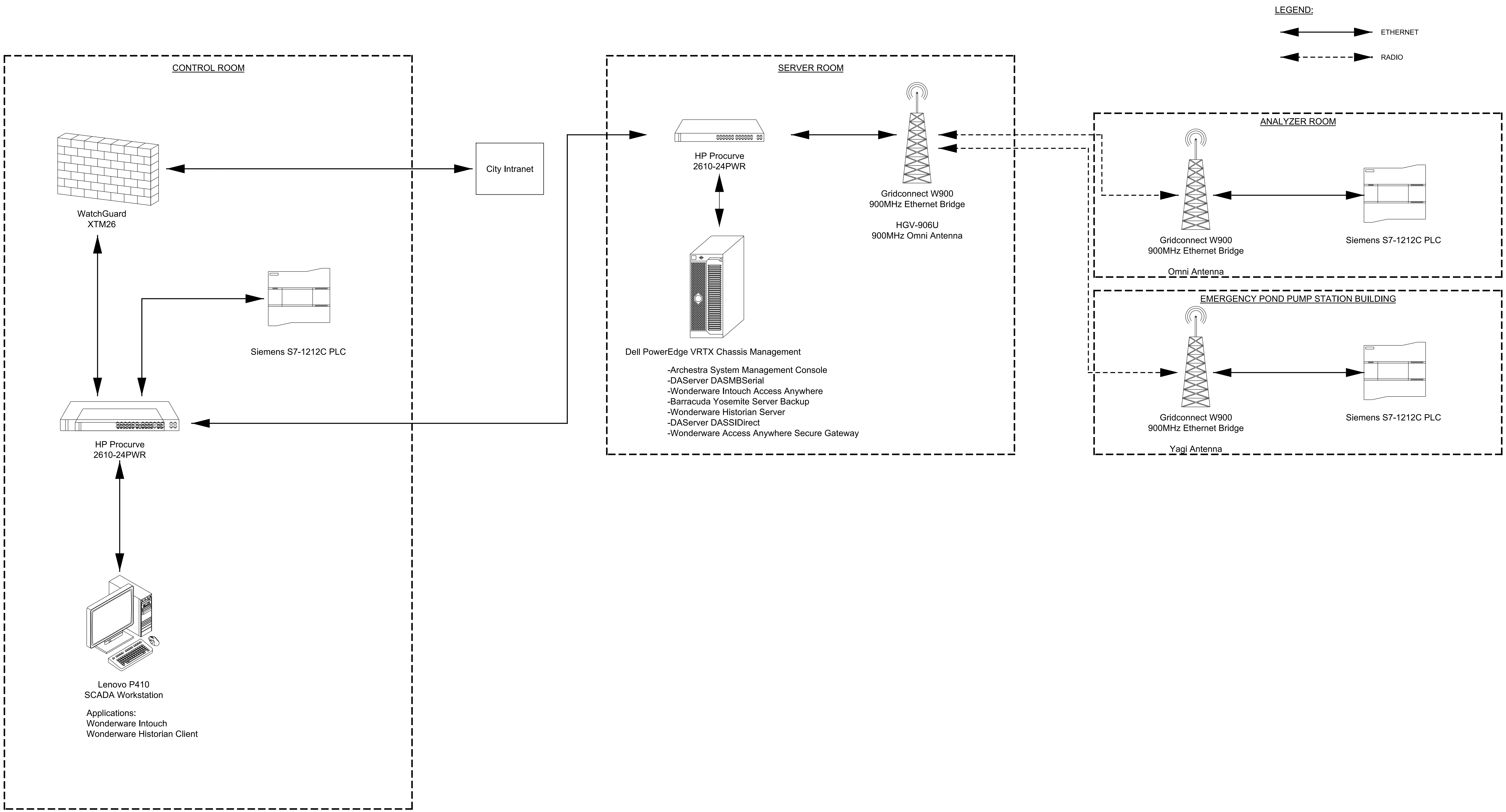

Figure No. 9.5

EXISTING WASTE WATER TREATMENT PLANT NETWORK DIAGRAM

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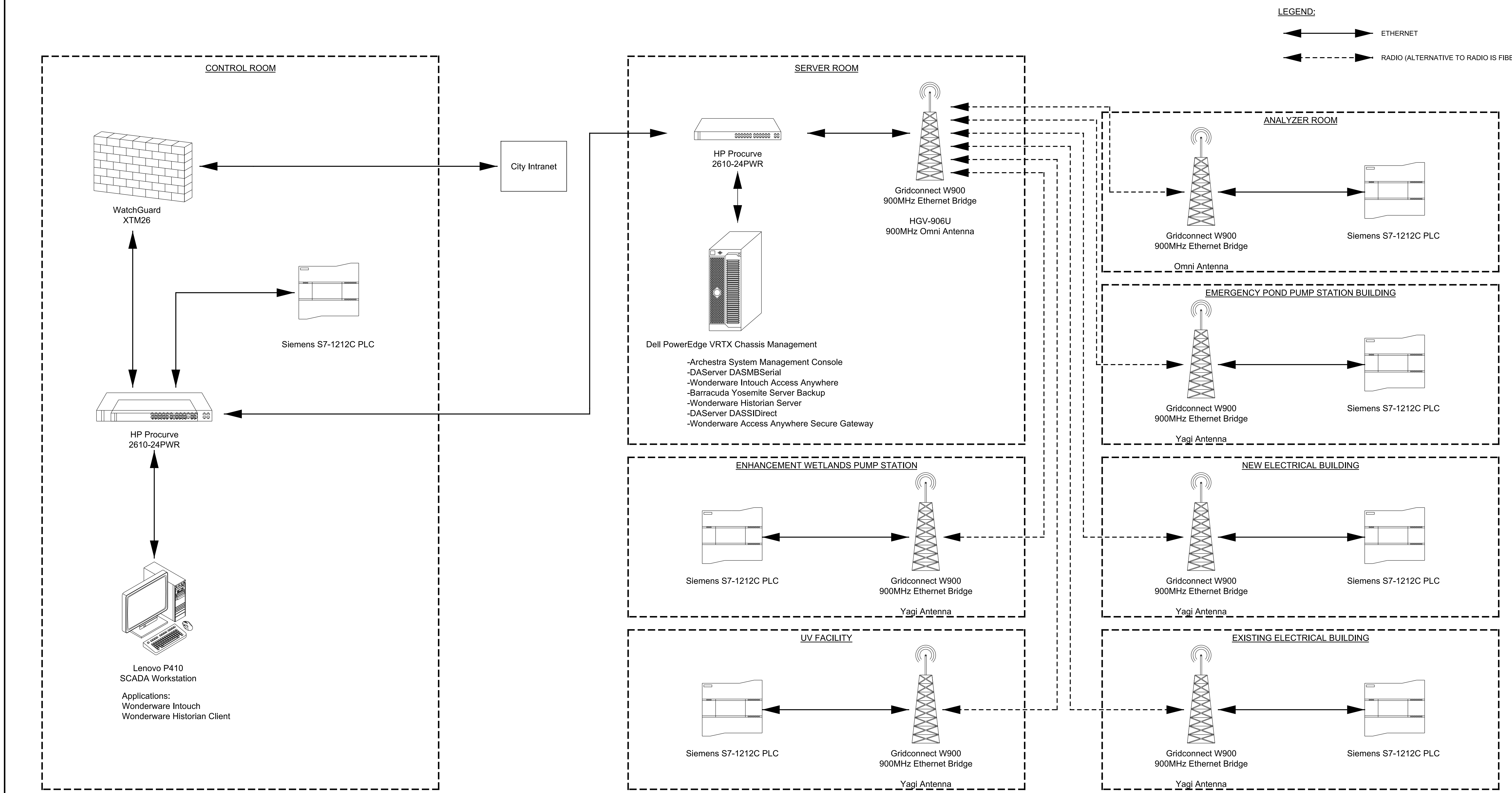

Figure No. 9.6

MODIFIED WASTE WATER TREATMENT PLANT NETWORK DIAGRAM

CITY OF ARCATA

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Appendix A

EQUIPMENT LIST REPORT

Engineers...Working Wonders With Water™

EQUIPMENT LIST REPORT

PROJECT INFORMATION

PROJECT	ARCATA WWTF IMPROVEMENTS PRELIMINARY DESIGN
CLIENT	CITY OF ARCATA
PROJECT NUMBER	9913B10
REPORT BY	ERIK BAHNEMAN
REPORT DATE	8/14/2018 4:19 PM

00 | OPERATIONS BUILDING & LAB

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
[None]	[None]											

01 | HEADWORKS

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
	COMPACTOR		DEMO	DUTY	CONSTANT SPEED	2.0	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
01-AGI-301	GRIT WASHER AGITATOR		NEW	DUTY	CONSTANT SPEED	1.0	HP	480	3	MCC-17A	N	Outdoor
01-BAR-201	SCREEN DRIVE NO. 1		NEW	DUTY	CONSTANT SPEED	1.0	HP	480	3	MCC-17A	N	Outdoor
01-BAR-202	SCREEN DRIVE NO. 2		NEW	DUTY	CONSTANT SPEED	1.0	HP	480	3	MCC-17A	N	Outdoor
01-BSR-201	SCREEN RAKE NO. 1		NEW	DUTY	CONSTANT SPEED	2.0	HP	480	3	MCC-17A	N	Outdoor
01-BSR-202	SCREEN RAKE NO. 2		NEW	DUTY	CONSTANT SPEED	2.0	HP	480	3	MCC-17A	N	Outdoor
01-CLA-301	GRIT CLASSIFIER		NEW	DUTY	CONSTANT SPEED	1.0	HP	480	3	MCC-17A	N	Outdoor
01-COL-301	GRIT COLLECTOR		NEW	DUTY	CONSTANT SPEED	1.0	HP	480	3	MCC-17A	N	Outdoor
01-CON-201	SCREW CONVEYOR		NEW	DUTY	CONSTANT SPEED	3.0	HP	480	3	MCC-17A	N	Outdoor
01-PMP-101	INFLUENT PUMP NO. 1		NEW	DUTY	VARIABLE SPEED	25.0	HP	480	3	MCC-17A	N	Outdoor
01-PMP-102	INFLUENT PUMP NO. 2		NEW	DUTY	VARIABLE SPEED	25.0	HP	480	3	MCC-17A	N	Outdoor
01-PMP-103	INFLUENT PUMP NO. 3		NEW	STANDBY	VARIABLE SPEED	25.0	HP	480	3	MCC-17A	N	Outdoor
01-PMP-104	INFLUENT PUMP NO. 4		NEW	DUTY	VARIABLE SPEED	10.0	HP	480	3	MCC-17A	N	Outdoor
01-PMP-301	GRIT PUMP NO. 1		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-17A	N	Outdoor
01-PMP-302	GRIT PUMP NO. 2		NEW	STANDBY	CONSTANT SPEED	15.0	HP	480	3	MCC-17A	N	Outdoor
01-WCO-201	SCREENINGS WASHER/COMPACTOR NO. 1		NEW	DUTY	CONSTANT SPEED	3.0	HP	480	3	MCC-17A	N	Outdoor
01-WCO-202	SCREENINGS WASHER/COMPACTOR NO. 2		NEW	STANDBY	CONSTANT SPEED	3.0	HP	480	3	MCC-17A	N	Outdoor
01-WSH-301	GRIT WASHER DRIVE		NEW	DUTY	CONSTANT SPEED	1.5	HP	480	3	MCC-17A	N	Outdoor
M-B-13-1	GRIT CHAMBER RAKE		DEMO	DUTY	CONSTANT SPEED	0.5	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
M-B-4-1	EAST SCREW PUMP		DEMO	DUTY	VARIABLE SPEED	15.0	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
M-B-4-2	WEST SCREW PUMP		DEMO	DUTY	VARIABLE SPEED	15.0	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
M-B-7-1	EAST BAR SCREEN		DEMO	DUTY	CONSTANT SPEED	0.8	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
M-B-7-2	WEST BAR SCREEN		DEMO	DUTY	CONSTANT SPEED	0.8	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
M-B-8-1	SCREENING CONVEYOR		DEMO	DUTY	CONSTANT SPEED	1.0	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
M-B-9-1	GRIT CYCLONE		DEMO	DUTY	CONSTANT SPEED	0.0	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
M-B-9-2	GRIT CLASSIFIER		DEMO	DUTY	CONSTANT SPEED	1.0	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
M-P-5-1	EAST GREASE PUMP		DEMO	DUTY	CONSTANT SPEED	0.3	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
M-P-5-2	WEST GREASE PUMP		DEMO	DUTY	CONSTANT SPEED	0.3	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
P-B-11-1	GRIT PUMP #1 - NORTH		DEMO	DUTY	CONSTANT SPEED	7.5	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
P-B-11-2	GRIT PUMP #2 - SOUTH		DEMO	DUTY	CONSTANT SPEED	7.5	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor

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EQUIPMENT LIST REPORT

PROJECT INFORMATION

PROJECT ARCATA WWTF IMPROVEMENTS
PRELIMINARY DESIGN
CLIENT CITY OF ARCATA
PROJECT NUMBER 9913B10
REPORT BY ERIK BAHNEMAN
REPORT DATE 8/14/2018 4:19 PM

02 | PRIMARY CLARIFIER

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
02-PMP-201	PRIMARY SLUDGE PUMP NO. 1		NEW	DUTY	CONSTANT SPEED	3.0	HP	480	3	MCC-17A	N	Outdoor
02-PMP-202	PRIMARY SLUDGE PUMP NO. 2		NEW	STANDBY	CONSTANT SPEED	3.0	HP	480	3	MCC-17A	N	Outdoor
02-PMP-301	PRIMARY SCUM PUMP NO. 1		NEW	DUTY	CONSTANT SPEED	3.0	HP	480	3	MCC-17A	N	Outdoor
02-PMP-302	PRIMARY SCUM PUMP NO. 2		NEW	STANDBY	CONSTANT SPEED	3.0	HP	480	3	MCC-17A	N	Outdoor
M-C-1	26' PRIMARY CLARIFIER MECHANISM		DEMO	DUTY	CONSTANT SPEED	0.8	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
M-C-2	60' PRIMARY CLARIFIER MECHANISM		EXISTING	DUTY	CONSTANT SPEED	0.8	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
P-C-3-1	PRIMARY SLUDGE PUMP #1		DEMO	DUTY	CONSTANT SPEED	3.0	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
P-C-3-2	PRIMARY SLUDGE PUMP #2		DEMO	DUTY	CONSTANT SPEED	3.0	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
P-C-3-3	PRIMARY SLUDGE PUMP #3		DEMO	STANDBY	CONSTANT SPEED	3.0	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor

03 | OXIDATION DITCHES

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
03-AER-101	AERATOR NO. 1		NEW	DUTY	VARIABLE SPEED	125.0	HP	480	3	MCC-18	N	Outdoor
03-AER-102	AERATOR NO. 2		NEW	DUTY	VARIABLE SPEED	125.0	HP	480	3	MCC-18	N	Outdoor
03-AER-103	AERATOR NO. 3		FUTURE	DUTY	VARIABLE SPEED	125.0	HP	480	3	MCC-18	N	Outdoor
03-AER-104	AERATOR NO. 4		FUTURE	DUTY	VARIABLE SPEED	125.0	HP	480	3	MCC-18	N	Outdoor

04 | SECONDARY CLARIFIER

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
04-CLR-101	SECONDARY CLARIFIER DRIVE NO. 1		NEW	DUTY	CONSTANT SPEED	1.0	HP	480	3	MCC-18	N	Outdoor
04-CLR-102	SECONDARY CLARIFIER DRIVE NO. 2		NEW	DUTY	CONSTANT SPEED	1.0	HP	480	3	MCC-18	N	Outdoor
04-CLR-103	SECONDARY CLARIFIER DRIVE NO. 3		FUTURE	DUTY	CONSTANT SPEED	1.0	HP	480	3	MCC-18	N	Outdoor
04-PMP-201	SECONDARY SCUM PUMP NO. 1		NEW	DUTY	CONSTANT SPEED	3.0	HP	480	3	MCC-18	N	Outdoor
04-PMP-202	SECONDARY SCUM PUMP NO. 2		NEW	STANDBY	CONSTANT SPEED	3.0	HP	480	3	MCC-18	N	Outdoor
04-PMP-203	SECONDARY SCUM PUMP NO. 3		NEW	DUTY	CONSTANT SPEED	3.0	HP	480	3	MCC-18	N	Outdoor
04-PMP-204	SECONDARY SCUM PUMP NO. 4		NEW	STANDBY	CONSTANT SPEED	3.0	HP	480	3	MCC-18	N	Outdoor
04-PMP-205	SECONDARY SCUM PUMP NO. 5		FUTURE	DUTY	CONSTANT SPEED	3.0	HP	480	3	MCC-18	N	Outdoor
04-PMP-206	SECONDARY SCUM PUMP NO. 6		FUTURE	STANDBY	CONSTANT SPEED	3.0	HP	480	3	MCC-18	N	Outdoor

05 | OXIDATION PONDS

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
05-AER-101	AERATOR NO. 1		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-102	AERATOR NO. 2		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-103	AERATOR NO. 3		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor

Engineers...Working Wonders With Water™

EQUIPMENT LIST REPORT

PROJECT INFORMATION

PROJECT	ARCATA WWTF IMPROVEMENTS PRELIMINARY DESIGN
CLIENT	CITY OF ARCATA
PROJECT NUMBER	9913B10
REPORT BY	ERIK BAHNEMAN
REPORT DATE	8/14/2018 4:19 PM

05 | OXIDATION PONDS

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
05-AER-104	AERATOR NO. 4		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-105	AERATOR NO. 5		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-106	AERATOR NO. 6		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-107	AERATOR NO. 7		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-108	AERATOR NO. 8		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-109	AERATOR NO. 9		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-110	AERATOR NO. 10		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-111	AERATOR NO. 11		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-112	AERATOR NO. 12		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-113	AERATOR NO. 13		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-114	AERATOR NO. 14		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-115	AERATOR NO. 15		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-116	AERATOR NO. 16		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-117	AERATOR NO. 17		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-118	AERATOR NO. 18		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-119	AERATOR NO. 19		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-120	AERATOR NO. 20		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-121	AERATOR NO. 21		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-122	AERATOR NO. 22		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-123	AERATOR NO. 23		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-AER-124	AERATOR NO. 24		NEW	DUTY	CONSTANT SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
05-GAT-401	POND 2 EFFLUENT WEIR GATE NO. 1		EXISTING	DUTY	CONSTANT SPEED	1.0	HP	208	3	MCC-16	N	Outdoor
05-GAT-402	POND 2 EFFLUENT WEIR GATE NO. 2		EXISTING	DUTY	CONSTANT SPEED	1.0	HP	208	3	MCC-16	N	Outdoor
05-GAT-403	POND 2 EFFLUENT WEIR GATE NO. 3		NEW	DUTY	CONSTANT SPEED	1.0	HP	208	3	MCC-16	N	Outdoor
05-GAT-404	POND 2 EFFLUENT WEIR GATE NO. 4		NEW	DUTY	CONSTANT SPEED	1.0	HP	208	3	MCC-16	N	Outdoor
05-GAT-405	POND 2 EFFLUENT WEIR GATE NO. 5		NEW	DUTY	CONSTANT SPEED	1.0	HP	208	3	MCC-16	N	Outdoor
05-GAT-406	POND 2 EFFLUENT WEIR GATE NO. 6		NEW	DUTY	CONSTANT SPEED	1.0	HP	208	3	MCC-16	N	Outdoor
05-GAT-407	POND 2 EFFLUENT WEIR GATE NO. 7		NEW	DUTY	CONSTANT SPEED	1.0	HP	208	3	MCC-16	N	Outdoor
05-GAT-408	POND 2 EFFLUENT WEIR GATE NO. 8		NEW	DUTY	CONSTANT SPEED	1.0	HP	208	3	MCC-16	N	Outdoor
05-GAT-409	POND 1 EFFLUENT WEIR GATE NO. 1		NEW	DUTY	CONSTANT SPEED	1.0	HP	208	3	MCC-16	N	Outdoor
05-GAT-410	POND 1 EFFLUENT WEIR GATE NO. 2		NEW	DUTY	CONSTANT SPEED	1.0	HP	208	3	MCC-16	N	Outdoor
05-PMP-201	POND PUMP STATION PUMP NO. 1		NEW	DUTY	VARIABLE SPEED	25.0	HP	480	3	MCC-18	N	Outdoor
05-PMP-202	POND PUMP STATION PUMP NO. 2		NEW	DUTY	VARIABLE SPEED	25.0	HP	480	3	MCC-18	N	Outdoor
05-PMP-203	POND PUMP STATION PUMP NO. 3		NEW	STANDBY	VARIABLE SPEED	25.0	HP	480	3	MCC-18	N	Outdoor
P-E-9-1	POND PUMP STATION PUMP #1		DEMO	DUTY	CONSTANT SPEED	7.5	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor

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PROJECT INFORMATION

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REPORT BY	ERIK BAHNEMAN
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05 | OXIDATION PONDS

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
P-E-9-2	POND PUMP STATION PUMP #2		DEMO	DUTY	CONSTANT SPEED	7.5	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
P-E-9-3	POND PUMP STATION PUMP #3		DEMO	STANDBY	CONSTANT SPEED	7.5	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor

06 | TREATMENT WETLANDS

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
	TREATMENT WETLANDS 4 PUMP		DEMO	DUTY	CONSTANT SPEED	7.5	HP	208	3	PNL-20	N	Outdoor
06-PMP-101	PUMP STATION 1 PUMP NO. 1		NEW	DUTY	VARIABLE SPEED	10.0	HP	480	3	MCC-18	N	
06-PMP-102	PUMP STATION 1 PUMP NO. 2		NEW	DUTY	VARIABLE SPEED	10.0	HP	480	3	MCC-18	N	
06-PMP-103	PUMP STATION 1 PUMP NO. 3		NEW	STANDBY	VARIABLE SPEED	10.0	HP	480	3	MCC-18	N	
06-PMP-201	TREATMENT WETLANDS 4 PUMP NO. 1		NEW	DUTY	CONSTANT SPEED	5.0	HP	480	3	MCC-18	N	
P-E-8-1	MARSH EFFLUENT PUMP #1		DEMO	DUTY	CONSTANT SPEED	5.0	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
P-E-8-2	MARSH EFFLUENT PUMP #2		DEMO	DUTY	CONSTANT SPEED	5.0	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
P-E-8-3	MARSH EFFLUENT PUMP #3		DEMO	STANDBY	CONSTANT SPEED	5.0	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor

07 | UV DISINFECTION

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
07-UVB-101	UV BANK NO. 1		NEW	DUTY		12.7	KW	480	3	MCC-18	N	Outdoor
07-UVB-102	UV BANK NO. 2		NEW	DUTY		12.7	KW	480	3	MCC-18	N	Outdoor
07-UVB-103	UV BANK NO. 3		NEW	DUTY		12.7	KW	480	3	MCC-18	N	Outdoor
07-UVB-104	UV BANK NO. 4		NEW	STANDBY		12.7	KW	480	3	MCC-18	N	Outdoor

08 | CHLORINE CONTACT BASIN

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
	WATER CHAMP #1 - EAST CL2		EXISTING	DUTY	CONSTANT SPEED	3.0	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
	WATER CHAMP #2 - MIDDLE CL2		EXISTING	DUTY	CONSTANT SPEED	3.0	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
	WATER CHAMP #3 - WEST SO2		EXISTING	DUTY	CONSTANT SPEED	3.0	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
	CHLORINE CONTACT BASIN SUMP PUMP #1 - WEST		EXISTING	DUTY	CONSTANT SPEED	5.0	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
	CHLORINE CONTACT BASIN SUMP PUMP #2 - EAST		EXISTING	DUTY	CONSTANT SPEED	5.0	HP	480	3	MCC-17B (OLD MCC-A)	N	Outdoor
P-E-1-1	SAMPLE PUMP NO. 1		EXISTING	DUTY	CONSTANT SPEED	0.8	HP	480	3	MCC-17B (OLD MCC-A)	N	
P-E-1-2	SAMPLE PUMP NO. 2		EXISTING	DUTY	CONSTANT SPEED	0.8	HP	480	3	MCC-17B (OLD MCC-A)	N	
P-E-1-3	SAMPLE PUMP NO. 3		EXISTING	DUTY	CONSTANT SPEED	0.8	HP	480	3	MCC-17B (OLD MCC-A)	N	
P-E-1-4	SAMPLE PUMP NO. 4		EXISTING	DUTY	CONSTANT SPEED	0.8	HP	480	3	MCC-17B (OLD MCC-A)	N	
P-E-1-5	SAMPLE PUMP NO. 5		EXISTING	DUTY	CONSTANT SPEED	0.8	HP	480	3	MCC-17B (OLD MCC-A)	N	

EQUIPMENT LIST REPORT

PROJECT INFORMATION

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REPORT DATE	8/14/2018 4:19 PM

09 | ENHANCEMENT WETLANDS

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
09-PMP-101	ENHANCEMENT WETLANDS PUMP NO. 1		NEW	DUTY	VARIABLE SPEED	25.0	HP	480	3	PNL-09 (OLD MSP-40)	N	Indoor
09-PMP-102	ENHANCEMENT WETLANDS PUMP NO. 2		NEW	DUTY	VARIABLE SPEED	25.0	HP	480	3	PNL-09 (OLD MSP-40)	N	Indoor
09-PMP-103	ENHANCEMENT WETLANDS PUMP NO. 3		NEW	STANDBY	VARIABLE SPEED	25.0	HP	480	3	PNL-09 (OLD MSP-40)	N	Indoor
P-E-40-1	WETLANDS PUMP #1		DEMO	DUTY	CONSTANT SPEED	10.0	HP	480	3	PNL-09 (OLD MSP-40)	N	Indoor
P-E-40-2	WETLANDS PUMP #2		DEMO	DUTY	CONSTANT SPEED	10.0	HP	480	3	PNL-09 (OLD MSP-40)	N	Indoor
P-E-40-3	WETLANDS PUMP #3		DEMO	STANDBY	CONSTANT SPEED	10.0	HP	480	3	PNL-09 (OLD MSP-40)	N	Indoor

10 | RAS PUMP STATION

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
10-PMP-101	RAS PUMP NO. 1		NEW	DUTY	VARIABLE SPEED	5.0	HP	480	3	MCC-18	N	Outdoor
10-PMP-102	RAS PUMP NO. 2		NEW	STANDBY	VARIABLE SPEED	5.0	HP	480	3	MCC-18	N	Outdoor

11 | WAS PUMP STATION

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
11-PMP-101	WAS PUMP NO. 1		NEW	DUTY	VARIABLE SPEED	0.5	HP	480	3	MCC-18	N	Outdoor
11-PMP-102	WAS PUMP NO. 2		NEW	STANDBY	VARIABLE SPEED	0.5	HP	480	3	MCC-18	N	Outdoor

12 | THICKENING

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
12-PMP-201	TWAS PUMP NO. 1		NEW	DUTY	VARIABLE SPEED	10.0	HP	480	3	MCC-18	N	Outdoor
12-PMP-202	TWAS PUMP NO. 2		NEW	STANDBY	VARIABLE SPEED	10.0	HP	480	3	MCC-18	N	Outdoor
12-THI-101	THICKENER NO. 1		NEW	DUTY	CONSTANT SPEED	5.0	HP	480	3	MCC-18	N	Outdoor
12-THI-102	THICKENER NO. 2		NEW	STANDBY	CONSTANT SPEED	5.0	HP	480	3	MCC-18	N	Outdoor

13 | DIGESTERS

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
M-F-10	DIGESTER GAS BOOSTER		EXISTING	DUTY	CONSTANT SPEED	3.0	HP	480	3	MCC-17B (OLD MCC-A)	N	
M-F-6	RADIATOR FAN		EXISTING	DUTY	CONSTANT SPEED	2.0	HP	480	3	MCC-17B (OLD MCC-A)	N	
P-F-1-1	4" CHOPPER SLUDGE RECIRCULATION PUMP		EXISTING	DUTY	CONSTANT SPEED	5.0	HP	480	3	MCC-17B (OLD MCC-A)	N	
P-F-2	SLUDGE TRANSFER PUMP		EXISTING	DUTY	CONSTANT SPEED	7.5	HP	480	3	MCC-17B (OLD MCC-A)	N	
P-F-2-2	6" CHOPPER SLUDGE RECIRCULATION PUMP		EXISTING	DUTY	CONSTANT SPEED	25.0	HP	480	3	MCC-17B (OLD MCC-A)	N	
P-F-3-2	WATER CIRCULATION PUMP		EXISTING	DUTY	CONSTANT SPEED	0.8	HP	480	3	MCC-17B (OLD MCC-A)	N	

EQUIPMENT LIST REPORT

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PROJECT INFORMATION

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CLIENT	CITY OF ARCATA
PROJECT NUMBER	9913B10
REPORT BY	ERIK BAHNEMAN
REPORT DATE	8/14/2018 4:19 PM

14 | ALKALINITY FEED SYSTEM

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
14-MIX-301	ALKALINITY TANK MIXER NO. 1		NEW	DUTY	CONSTANT SPEED	1.5	HP	480	3	MCC-18	N	Outdoor
14-MIX-302	ALKALINITY TANK MIXER NO. 2		NEW	DUTY	CONSTANT SPEED	1.5	HP	480	3	MCC-18	N	Outdoor
14-PMP-101	ALKALINITY FEED PUMP NO. 1		NEW	DUTY	VARIABLE SPEED	1.0	HP	480	3	MCC-18	N	Outdoor
14-PMP-102	ALKALINITY FEED PUMP NO. 2		NEW	STANDBY	VARIABLE SPEED	1.0	HP	480	3	MCC-18	N	Outdoor
14-PMP-201	ALKALINITY SYSTEM TRANSFER PUMP		NEW	DUTY	CONSTANT SPEED	10.0	HP	480	3	MCC-18	N	Outdoor
14-PMP-401	SUMP PUMP		NEW	DUTY	CONSTANT SPEED	0.8	HP	480	3	MCC-18	N	Outdoor

15 | PLANT WATER SYSTEM

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
15-PMP-301	3W PUMP NO. 1		NEW	DUTY	VARIABLE SPEED	15.0	HP	480	3	MCC-18	N	Outdoor
15-PMP-302	3W PUMP NO. 2		NEW	STANDBY	VARIABLE SPEED	15.0	HP	480	3	MCC-18	N	Outdoor

16 | STORMWATER SYSTEM

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
	PUMP STATION 2 POND 3 STORM PUMP #1		DEMO	DUTY	CONSTANT SPEED	7.5	HP	208	3	PNL-06	N	Indoor
	PUMP STATION 2 POND 3 STORM PUMP #2		DEMO	DUTY	CONSTANT SPEED	7.5	HP	208	3	PNL-06	N	Indoor
05-PMP-301	EMERGENCY POND PUMP STATION PUMP NO. 1		EXISTING	DUTY	CONSTANT SPEED	30.0	HP	208	3	MCC-16	N	Indoor
05-PMP-302	EMERGENCY POND PUMP STATION PUMP NO. 2		EXISTING	DUTY	CONSTANT SPEED	30.0	HP	208	3	MCC-16	N	Indoor

18 | NEW ELECTRICAL BUILDING

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
[None]	[None]											

20 | AUTO SHOP

TAG	DESCRIPTION	SPEC SECTION	STATUS	SERVICE	LOAD TYPE	LOAD VALUE	LOAD UNITS	VOLTS	PHASE	POWER SOURCE	GEN POWER	ENVIRONMENT
[None]	[None]											

Appendix B

LOAD STUDY REPORT

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PROJECT INFORMATION

PROJECT	ARCATA WWTF IMPROVEMENTS PRELIMINARY DESIGN
CLIENT	CITY OF ARCATA
PROJECT NUMBER	9913B10
REPORT BY	ERIK BAHNEMAN
REPORT DATE	8/14/2018 4:18 PM

EQUIPMENT INFORMATION

TAG	SWGR-18		
DESCRIPTION	NEW ELECTRICAL BUILDING SWITHGEAR	PHASE, WIRE, KASC	3PH, 3W, 35 KAIC KASC
LOCATION	NEW ELECTRICAL BUILDING	LARGEST MOTOR	125HP
VOLTAGE	12470	COMMENTS	
BUS AMPS	600		

LOAD TOTALS

OPERATING KVA	OPERATING AMPS
1481.1	68.6

NEC 215 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
1851.3	85.7

NEC 430 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
1523.0	70.5

DEFINITIONS

OPERATING = CONTINUOUS + INTERMITTENT

NEC 215 EQUIPMENT SIZING = 1.25 x CONTINUOUS + 1.0 x INTERMITTENT (BASED ON NEC ARTICLE 215)

NEC 430 EQUIPMENT SIZING = 1.25 x LARGEST MOTOR + 1.0 x ALL OTHER MOTORS + 1.25 x CONTINUOUS NON-MOTOR + 1.0 x INTERMITTENT NON-MOTOR (BASED ON NEC ARTICLE 430)

EQUIPMENT SIZING IS BASED ON THE LARGER OF NEC 215 AND NEC 430 CALCULATIONS (LARGER IS HIGHLIGHTED WHEN APPLICABLE)

Note: For 3-phase busses that feed single -phase loads, the amp summation under loads will not match the bus amps due to the difference in voltage.

Note: The values in this report are rounded from higher precision numbers. Manually summing the values shown may yield slightly varied results due to rounding error.

SUBFED EQUIPMENT

TAG	DESCRIPTION	EQUIPMENT SIZE	EQUIPMENT UNITS	STATUS	OPERATING KVA	OPERATING AMPS	BUS COMMENTS
XFMR-05	OXIDATION PONDS TRANSFORMER	150.0	KVA	EXISTING	0.0	0.0	
XFMR-06	AMRI FIELD OFFICE TRANSFORMER	75.0	KVA	NEW	0.0	0.0	
XFMR-09	EWPS TRANSFORMER	112.5	KVA	NEW	56.5	2.6	
XFMR-16	EMERGENCY PUMP STATION TRANSFORMER	112.5	KVA	NEW	80.0	3.7	
XFMR-17	EXISTING ELECTRICAL BUILDING NEW TRANSFORMER	275.0	KVA	NEW	202.9	9.4	
XFMR-18	NEW ELECTRICAL BUILDING TRANSFORMER	1,500.0	KVA	NEW	1141.6	52.9	
XFMR-20	CENTRAL GARAGE TRANSFORMER	75.0	KVA	NEW	0.0	0.0	
				OPERATING LOAD SUBFED SUBTOTAL	1481.1	68.6	

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EQUIPMENT INFORMATION

TAG	MCC-05		
DESCRIPTION	OXIDATION PONDS MCC	PHASE, WIRE, KASC	3PH, 4W, 42 KAIC KASC
LOCATION	OXIDATION PONDS	LARGEST MOTOR	0HP
VOLTAGE	208	COMMENTS	
BUS AMPS	600		

LOAD TOTALS

OPERATING KVA	OPERATING AMPS
0.0	0.0

NEC 215 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
0.0	0.0

NEC 430 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
0.0	0.0

DEFINITIONS

OPERATING = CONTINUOUS + INTERMITTENT

NEC 215 EQUIPMENT SIZING = 1.25 x CONTINUOUS + 1.0 x INTERMITTENT (BASED ON NEC ARTICLE 215)

NEC 430 EQUIPMENT SIZING = 1.25 x LARGEST MOTOR + 1.0 x ALL OTHER MOTORS + 1.25 x CONTINUOUS NON-MOTOR + 1.0 x INTERMITTENT NON-MOTOR (BASED ON NEC ARTICLE 430)

EQUIPMENT SIZING IS BASED ON THE LARGER OF NEC 215 AND NEC 430 CALCULATIONS (LARGER IS HIGHLIGHTED WHEN APPLICABLE)

Note: For 3-phase busses that feed single -phase loads, the amp summation under loads will not match the bus amps due to the difference in voltage.

Note: The values in this report are rounded from higher precision numbers. Manually summing the values shown may yield slightly varied results due to rounding error.

SUBFED EQUIPMENT

TAG	DESCRIPTION	EQUIPMENT SIZE	EQUIPMENT UNITS	STATUS	OPERATING KVA	OPERATING AMPS	BUS COMMENTS
PANEL "P"	LIGHTING PANEL	100.0	AMPS	EXISTING	0.0	0.0	
				OPERATING LOAD SUBFED SUBTOTAL	0.0	0.0	

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EQUIPMENT INFORMATION

TAG	PNL-06		
DESCRIPTION	AMRI FIELD OFFICE PANEL	**PHASE, WIRE, KASC**	3PH, 4W, 65 KAIC KASC
LOCATION	TREATMENT WETLANDS	**LARGEST MOTOR**	0HP
VOLTAGE	208	**COMMENTS**	
BUS AMPS	100		

LOAD TOTALS

OPERATING KVA	OPERATING AMPS
0.0	0.0

NEC 215 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
0.0	0.0

NEC 430 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
0.0	0.0

DEFINITIONS

OPERATING = CONTINUOUS + INTERMITTENT

NEC 215 EQUIPMENT SIZING = 1.25 x CONTINUOUS + 1.0 x INTERMITTENT (BASED ON NEC ARTICLE 215)

NEC 430 EQUIPMENT SIZING = 1.25 x LARGEST MOTOR + 1.0 x ALL OTHER MOTORS + 1.25 x CONTINUOUS NON-MOTOR + 1.0 x INTERMITTENT NON-MOTOR (BASED ON NEC ARTICLE 430)

EQUIPMENT SIZING IS BASED ON THE LARGER OF NEC 215 AND NEC 430 CALCULATIONS (LARGER IS HIGHLIGHTED WHEN APPLICABLE)

Note: For 3-phase busses that feed single -phase loads, the amp summation under loads will not match the bus amps due to the difference in voltage.

Note: The values in this report are rounded from higher precision numbers. Manually summing the values shown may yield slightly varied results due to rounding error.

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
	PUMP STATION 2 POND 3 STORM PUMP #1	7.50	HP	FVNR	DUTY / CONTINUOUS	DEMO		0.0	
	PUMP STATION 2 POND 3 STORM PUMP #2	7.50	HP	FVNR	DUTY / CONTINUOUS	DEMO		0.0	
					OPERATING LOAD SUBTOTAL		0.0	0.0	

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REPORT DATE	8/14/2018 4:18 PM

EQUIPMENT INFORMATION

TAG	PNL-09 (OLD MSP-40)		
DESCRIPTION	WETLANDS EFFLUENT DISTRIBUTION PANEL	PHASE, WIRE, KASC	3PH, 3W, 42 KAIC KASC
LOCATION	ENHANCEMENT WETLANDS	LARGEST MOTOR	25HP
VOLTAGE	480	COMMENTS	
BUS AMPS	100		

LOAD TOTALS

OPERATING KVA	OPERATING AMPS
56.5	68.0

NEC 215 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
70.7	85.0

NEC 430 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
63.6	76.5

DEFINITIONS

OPERATING = CONTINUOUS + INTERMITTENT

NEC 215 EQUIPMENT SIZING = 1.25 x CONTINUOUS + 1.0 x INTERMITTENT (BASED ON NEC ARTICLE 215)

NEC 430 EQUIPMENT SIZING = 1.25 x LARGEST MOTOR + 1.0 x ALL OTHER MOTORS + 1.25 x CONTINUOUS NON-MOTOR + 1.0 x INTERMITTENT NON-MOTOR (BASED ON NEC ARTICLE 430)

EQUIPMENT SIZING IS BASED ON THE LARGER OF NEC 215 AND NEC 430 CALCULATIONS (LARGER IS HIGHLIGHTED WHEN APPLICABLE)

Note: For 3-phase busses that feed single -phase loads, the amp summation under loads will not match the bus amps due to the difference in voltage.

Note: The values in this report are rounded from higher precision numbers. Manually summing the values shown may yield slightly varied results due to rounding error.

SUBFED EQUIPMENT

TAG	DESCRIPTION	EQUIPMENT SIZE	EQUIPMENT UNITS	STATUS	OPERATING KVA	OPERATING AMPS	BUS COMMENTS
MPC-XFMR-09	WETLANDS EFFLUENT MINI POWER CENTER XFMR	0.0	KVA	EXISTING	0.0	0.0	
				OPERATING LOAD SUBFED SUBTOTAL	0.0	0.0	

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
09-PMP-101	ENHANCEMENT WETLANDS PUMP NO. 1	25	HP	VFD-6	DUTY / CONTINUOUS	NEW	28.3	34.0	
09-PMP-102	ENHANCEMENT WETLANDS PUMP NO. 2	25	HP	VFD-6	DUTY / CONTINUOUS	NEW	28.3	34.0	
09-PMP-103	ENHANCEMENT WETLANDS PUMP NO. 3	25	HP	VFD-6	STANDBY	NEW	28.3	34.0	
P-E-40-1	WETLANDS PUMP #1	10	HP	FVNR	DUTY / CONTINUOUS	DEMO		14.0	
P-E-40-2	WETLANDS PUMP #2	10	HP	FVNR	DUTY / CONTINUOUS	DEMO		14.0	
P-E-40-3	WETLANDS PUMP #3	10	HP	FVNR	STANDBY	DEMO		14.0	
					OPERATING LOAD SUBTOTAL		84.8	144.0	

Date/Time displayed in this report reflect time in PST

LOAD STUDY REPORT

PROJECT INFORMATION

PROJECT	ARCATA WWTF IMPROVEMENTS PRELIMINARY DESIGN
CLIENT	CITY OF ARCATA
PROJECT NUMBER	9913B10
REPORT BY	ERIK BAHNEMAN
REPORT DATE	8/14/2018 4:18 PM

EQUIPMENT INFORMATION

TAG	MCC-16		
DESCRIPTION	EMERGENCY PUMP STATION MCC	**PHASE, WIRE, KASC**	3PH, 4W, 65 KAIC KASC
LOCATION	STORMWATER SYSTEM	**LARGEST MOTOR**	30HP
VOLTAGE	208	**COMMENTS**	
BUS AMPS	600		

LOAD TOTALS

OPERATING KVA	OPERATING AMPS
80.0	222.0

NEC 215 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
100.0	277.5

NEC 430 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
87.9	244.0

DEFINITIONS

OPERATING = CONTINUOUS + INTERMITTENT

NEC 215 EQUIPMENT SIZING = 1.25 x CONTINUOUS + 1.0 x INTERMITTENT (BASED ON NEC ARTICLE 215)

NEC 430 EQUIPMENT SIZING = 1.25 x LARGEST MOTOR + 1.0 x ALL OTHER MOTORS + 1.25 x CONTINUOUS NON-MOTOR + 1.0 x INTERMITTENT NON-MOTOR (BASED ON NEC ARTICLE 430)

EQUIPMENT SIZING IS BASED ON THE LARGER OF NEC 215 AND NEC 430 CALCULATIONS (LARGER IS HIGHLIGHTED WHEN APPLICABLE)

Note: For 3-phase busses that feed single -phase loads, the amp summation under loads will not match the bus amps due to the difference in voltage.

Note: The values in this report are rounded from higher precision numbers. Manually summing the values shown may yield slightly varied results due to rounding error.

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
05-GAT-401	POND 2 EFFLUENT WEIR GATE NO. 1	1	HP	FVNR	DUTY / CONTINUOUS	EXISTING	1.7	4.6	
05-GAT-402	POND 2 EFFLUENT WEIR GATE NO. 2	1	HP	FVNR	DUTY / CONTINUOUS	EXISTING	1.7	4.6	
05-GAT-403	POND 2 EFFLUENT WEIR GATE NO. 3	1	HP	FVNR	DUTY / CONTINUOUS	NEW	1.7	4.6	
05-GAT-404	POND 2 EFFLUENT WEIR GATE NO. 4	1	HP	FVNR	DUTY / CONTINUOUS	NEW	1.7	4.6	
05-GAT-405	POND 2 EFFLUENT WEIR GATE NO. 5	1	HP	FVNR	DUTY / CONTINUOUS	NEW	1.7	4.6	
05-GAT-406	POND 2 EFFLUENT WEIR GATE NO. 6	1	HP	FVNR	DUTY / CONTINUOUS	NEW	1.7	4.6	
05-GAT-407	POND 2 EFFLUENT WEIR GATE NO. 7	1	HP	FVNR	DUTY / CONTINUOUS	NEW	1.7	4.6	
05-GAT-408	POND 2 EFFLUENT WEIR GATE NO. 8	1	HP	FVNR	DUTY / CONTINUOUS	NEW	1.7	4.6	
05-GAT-409	POND 1 EFFLUENT WEIR GATE NO. 1	1	HP	FVNR	DUTY / CONTINUOUS	NEW	1.7	4.6	
05-GAT-410	POND 1 EFFLUENT WEIR GATE NO. 2	1	HP	FVNR	DUTY / CONTINUOUS	NEW	1.7	4.6	
05-PMP-301	EMERGENCY POND PUMP STATION PUMP NO. 1	30	HP	FVNR	DUTY / CONTINUOUS	EXISTING	31.7	88.0	
05-PMP-302	EMERGENCY POND PUMP STATION PUMP NO. 2	30	HP	FVNR	DUTY / CONTINUOUS	EXISTING	31.7	88.0	
					OPERATING LOAD SUBTOTAL		80.0	222.0	

LOAD STUDY REPORT

PROJECT INFORMATION

PROJECT	ARCATA WWTF IMPROVEMENTS PRELIMINARY DESIGN
CLIENT	CITY OF ARCATA
PROJECT NUMBER	9913B10
REPORT BY	ERIK BAHNEMAN
REPORT DATE	8/14/2018 4:18 PM

EQUIPMENT INFORMATION

TAG	MCC-17A		
DESCRIPTION	NEW MCC IN EXISTING ELECTRICAL BUILDING	PHASE, WIRE, KASC	3PH, 3W, 65 KAIC KASC
LOCATION	EXISTING ELECTRICAL BUILDING	LARGEST MOTOR	25HP
VOLTAGE	480	COMMENTS	
BUS AMPS	600		

LOAD TOTALS

OPERATING KVA	OPERATING AMPS
202.9	244.1

NEC 215 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
253.7	305.1

NEC 430 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
210.0	252.6

DEFINITIONS

OPERATING = CONTINUOUS + INTERMITTENT

NEC 215 EQUIPMENT SIZING = 1.25 x CONTINUOUS + 1.0 x INTERMITTENT (BASED ON NEC ARTICLE 215)

NEC 430 EQUIPMENT SIZING = 1.25 x LARGEST MOTOR + 1.0 x ALL OTHER MOTORS + 1.25 x CONTINUOUS NON-MOTOR + 1.0 x INTERMITTENT NON-MOTOR (BASED ON NEC ARTICLE 430)

EQUIPMENT SIZING IS BASED ON THE LARGER OF NEC 215 AND NEC 430 CALCULATIONS (LARGER IS HIGHLIGHTED WHEN APPLICABLE)

Note: For 3-phase busses that feed single -phase loads, the amp summation under loads will not match the bus amps due to the difference in voltage.

Note: The values in this report are rounded from higher precision numbers. Manually summing the values shown may yield slightly varied results due to rounding error.

SUBFED EQUIPMENT

TAG	DESCRIPTION	EQUIPMENT SIZE	EQUIPMENT UNITS	STATUS	OPERATING KVA	OPERATING AMPS	BUS COMMENTS
MCC-17B (OLD MCC-A)	GENERATOR BUILDING OLD MCC	600.0	AMPS	EXISTING	84.5	101.6	
			OPERATING LOAD SUBFED SUBTOTAL		84.5	101.6	

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
01-AGI-301	GRIT WASHER AGITATOR	1	HP	FVNR	DUTY / CONTINUOUS	NEW	1.7	2.1	
01-BAR-201	SCREEN DRIVE NO. 1	1	HP	FVNR	DUTY / CONTINUOUS	NEW	1.7	2.1	
01-BAR-202	SCREEN DRIVE NO. 2	1	HP	FVNR	DUTY / CONTINUOUS	NEW	1.7	2.1	
01-BSR-201	SCREEN RAKE NO. 1	2	HP	FVNR	DUTY / CONTINUOUS	NEW	2.8	3.4	
01-BSR-202	SCREEN RAKE NO. 2	2	HP	FVNR	DUTY / CONTINUOUS	NEW	2.8	3.4	
01-CLA-301	GRIT CLASSIFIER	1	HP	FVNR	DUTY / CONTINUOUS	NEW	1.7	2.1	
01-COL-301	GRIT COLLECTOR	1	HP	FVNR	DUTY / CONTINUOUS	NEW	1.7	2.1	
01-CON-201	SCREW CONVEYOR	3	HP	FVNR	DUTY / CONTINUOUS	NEW	4.0	4.8	
01-PMP-101	INFLUENT PUMP NO. 1	25	HP	VFD-6	DUTY / CONTINUOUS	NEW	28.3	34.0	
01-PMP-102	INFLUENT PUMP NO. 2	25	HP	VFD-6	DUTY / CONTINUOUS	NEW	28.3	34.0	
01-PMP-103	INFLUENT PUMP NO. 3	25	HP	VFD-6	STANDBY	NEW	28.3	34.0	
01-PMP-104	INFLUENT PUMP NO. 4	10	HP	VFD-6	DUTY / CONTINUOUS	NEW	11.6	14.0	

LOAD STUDY REPORT

PROJECT INFORMATION

PROJECT ARCATA WWTF IMPROVEMENTS PRELIMINARY DESIGN
CLIENT CITY OF ARCATA
PROJECT NUMBER 9913B10
REPORT BY ERIK BAHNEMAN
REPORT DATE 8/14/2018 4:18 PM

EQUIPMENT INFORMATION

TAG MCC-17A
DESCRIPTION NEW MCC IN EXISTING ELECTRICAL BUILDING
LOCATION EXISTING ELECTRICAL BUILDING
VOLTAGE 480
BUS AMPS 600
PHASE, WIRE, KASC 3PH, 3W, 65 KAIC KASC
LARGEST MOTOR 25HP
COMMENTS

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
01-PMP-301	GRIT PUMP NO. 1	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
01-PMP-302	GRIT PUMP NO. 2	15	HP	FVNR	STANDBY	NEW	17.5	21.0	
01-WCO-201	SCREENINGS WASHER/COMPACTOR NO. 1	3	HP	FVNR	DUTY / CONTINUOUS	NEW	4.0	4.8	
01-WCO-202	SCREENINGS WASHER/COMPACTOR NO. 2	3	HP	FVNR	STANDBY	NEW	4.0	4.8	
01-WSH-301	GRIT WASHER DRIVE	1.50	HP	FVNR	DUTY / CONTINUOUS	NEW	2.5	3.0	
02-PMP-201	PRIMARY SLUDGE PUMP NO. 1	3	HP	FVNR	DUTY / CONTINUOUS	NEW	4.0	4.8	
02-PMP-202	PRIMARY SLUDGE PUMP NO. 2	3	HP	FVNR	STANDBY	NEW	4.0	4.8	
02-PMP-301	PRIMARY SCUM PUMP NO. 1	3	HP	FVNR	DUTY / CONTINUOUS	NEW	4.0	4.8	
02-PMP-302	PRIMARY SCUM PUMP NO. 2	3	HP	FVNR	STANDBY	NEW	4.0	4.8	
					OPERATING LOAD SUBTOTAL		176.2	211.9	

Date/Time displayed in this report reflect time in PST

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PROJECT INFORMATION

PROJECT	ARCATA WWTF IMPROVEMENTS PRELIMINARY DESIGN
CLIENT	CITY OF ARCATA
PROJECT NUMBER	9913B10
REPORT BY	ERIK BAHNEMAN
REPORT DATE	8/14/2018 4:18 PM

EQUIPMENT INFORMATION

TAG	MCC-17B (OLD MCC-A)		
DESCRIPTION	GENERATOR BUILDING OLD MCC	PHASE, WIRE, KASC	3PH, 3W, 42 KAIC KASC
LOCATION	EXISTING ELECTRICAL BUILDING	LARGEST MOTOR	25HP
VOLTAGE	480	COMMENTS	
BUS AMPS	600		

LOAD TOTALS

OPERATING KVA	OPERATING AMPS
84.5	101.6

NEC 215 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
105.6	127.0

NEC 430 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
91.5	110.1

DEFINITIONS

OPERATING = CONTINUOUS + INTERMITTENT

NEC 215 EQUIPMENT SIZING = 1.25 x CONTINUOUS + 1.0 x INTERMITTENT (BASED ON NEC ARTICLE 215)

NEC 430 EQUIPMENT SIZING = 1.25 x LARGEST MOTOR + 1.0 x ALL OTHER MOTORS + 1.25 x CONTINUOUS NON-MOTOR + 1.0 x INTERMITTENT NON-MOTOR (BASED ON NEC ARTICLE 430)

EQUIPMENT SIZING IS BASED ON THE LARGER OF NEC 215 AND NEC 430 CALCULATIONS (LARGER IS HIGHLIGHTED WHEN APPLICABLE)

Note: For 3-phase busses that feed single -phase loads, the amp summation under loads will not match the bus amps due to the difference in voltage.

Note: The values in this report are rounded from higher precision numbers. Manually summing the values shown may yield slightly varied results due to rounding error.

SUBFED EQUIPMENT

TAG	DESCRIPTION	EQUIPMENT SIZE	EQUIPMENT UNITS	STATUS	OPERATING KVA	OPERATING AMPS	BUS COMMENTS
T-20	CHLORINE BUILDING TRANSFORMER	15.0	KVA	EXISTING	0.0	0.0	
T-26-1	CONTROL BUILDING TRANSFORMER	37.5	KVA	EXISTING	0.0	0.0	
T-29	GENERATOR BUILDING TRANSFORMER	15.0	KVA	EXISTING	0.0	0.0	
				OPERATING LOAD SUBFED SUBTOTAL	0.0	0.0	

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
	COMPACTOR	2	HP	FVNR	DUTY / CONTINUOUS	DEMO		0.0	
M-B-13-1	GRIT CHAMBER RAKE	1/2	HP	FVNR	DUTY / CONTINUOUS	DEMO		0.0	
M-B-4-1	EAST SCREW PUMP	15	HP	VFD-6	DUTY / CONTINUOUS	DEMO		0.0	
M-B-4-2	WEST SCREW PUMP	15	HP	VFD-6	DUTY / CONTINUOUS	DEMO		0.0	
M-B-7-1	EAST BAR SCREEN	3/4	HP	FVNR	DUTY / CONTINUOUS	DEMO		0.0	
M-B-7-2	WEST BAR SCREEN	3/4	HP	FVNR	DUTY / CONTINUOUS	DEMO		0.0	
M-B-8-1	SCREENING CONVEYOR	1	HP	FVNR	DUTY / CONTINUOUS	DEMO		0.0	
M-B-9-1	GRIT CYCLONE	0	HP	FVNR	DUTY / CONTINUOUS	DEMO		0.0	
M-B-9-2	GRIT CLASSIFIER	1	HP	FVNR	DUTY / CONTINUOUS	DEMO		0.0	
M-P-5-1	EAST GREASE PUMP	33333333 3/100000	HP	FVNR	DUTY / CONTINUOUS	DEMO		0.0	

LOAD STUDY REPORT

PROJECT INFORMATION

PROJECT	ARCATA WWTF IMPROVEMENTS PRELIMINARY DESIGN
CLIENT	CITY OF ARCATA
PROJECT NUMBER	9913B10
REPORT BY	ERIK BAHNEMAN
REPORT DATE	8/14/2018 4:18 PM

EQUIPMENT INFORMATION

TAG	MCC-17B (OLD MCC-A)		
DESCRIPTION	GENERATOR BUILDING OLD MCC	**PHASE, WIRE, KASC**	3PH, 3W, 42 KAIC KASC
LOCATION	EXISTING ELECTRICAL BUILDING	**LARGEST MOTOR**	25HP
VOLTAGE	480	**COMMENTS**	
BUS AMPS	600		

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
M-P-5-2	WEST GREASE PUMP	0000 33333333 3/100000 0000	HP	FVNR	DUTY / CONTINUOUS	DEMO		0.0	
P-B-11-1	GRIT PUMP #1 - NORTH	7.50	HP	FVNR	DUTY / CONTINUOUS	DEMO		0.0	
P-B-11-2	GRIT PUMP #2 - SOUTH	7.50	HP	FVNR	DUTY / CONTINUOUS	DEMO		0.0	
M-C-1	26' PRIMARY CLARIFIER MECHANISM	3/4	HP	FVNR	DUTY / CONTINUOUS	DEMO		0.0	
M-C-2	60' PRIMARY CLARIFIER MECHANISM	3/4	HP	FVNR	DUTY / CONTINUOUS	EXISTING	1.3	1.6	
P-C-3-1	PRIMARY SLUDGE PUMP #1	3	HP	FVNR	DUTY / CONTINUOUS	DEMO		4.8	
P-C-3-2	PRIMARY SLUDGE PUMP #2	3	HP	FVNR	DUTY / CONTINUOUS	DEMO		4.8	
P-C-3-3	PRIMARY SLUDGE PUMP #3	3	HP	FVNR	STANDBY	DEMO		4.8	
P-E-9-1	POND PUMP STATION PUMP #1	7.50	HP	FVNR	DUTY / CONTINUOUS	DEMO		0.0	
P-E-9-2	POND PUMP STATION PUMP #2	7.50	HP	FVNR	DUTY / CONTINUOUS	DEMO		11.0	
P-E-9-3	POND PUMP STATION PUMP #3	7.50	HP	FVNR	STANDBY	DEMO		0.0	
P-E-8-1	MARSH EFFLUENT PUMP #1	5	HP	FVNR	DUTY / CONTINUOUS	DEMO		7.6	
P-E-8-2	MARSH EFFLUENT PUMP #2	5	HP	FVNR	DUTY / CONTINUOUS	DEMO		7.6	
P-E-8-3	MARSH EFFLUENT PUMP #3	5	HP	FVNR	STANDBY	DEMO		7.6	
	WATER CHAMP #1 - EAST CL2	3	HP	FVNR	DUTY / CONTINUOUS	EXISTING	4.0	4.8	
	WATER CHAMP #2 - MIDDLE CL2	3	HP	FVNR	DUTY / CONTINUOUS	EXISTING	4.0	4.8	
	WATER CHAMP #3 - WEST SO2	3	HP	FVNR	DUTY / CONTINUOUS	EXISTING	4.0	4.8	
	CHLORINE CONTACT BASIN SUMP PUMP #1 - WEST	5	HP	FVNR	DUTY / CONTINUOUS	EXISTING	6.3	7.6	
	CHLORINE CONTACT BASIN SUMP PUMP #2 - EAST	5	HP	FVNR	DUTY / CONTINUOUS	EXISTING	6.3	7.6	
P-E-1-1	SAMPLE PUMP NO. 1	3/4	HP	FVNR	DUTY / CONTINUOUS	EXISTING	1.3	1.6	
P-E-1-2	SAMPLE PUMP NO. 2	3/4	HP	FVNR	DUTY / CONTINUOUS	EXISTING	1.3	1.6	
P-E-1-3	SAMPLE PUMP NO. 3	3/4	HP	FVNR	DUTY / CONTINUOUS	EXISTING	1.3	1.6	
P-E-1-4	SAMPLE PUMP NO. 4	3/4	HP	FVNR	DUTY / CONTINUOUS	EXISTING	1.3	1.6	
P-E-1-5	SAMPLE PUMP NO. 5	3/4	HP	FVNR	DUTY / CONTINUOUS	EXISTING	1.3	1.6	
M-F-10	DIGESTER GAS BOOSTER	3	HP	FVNR	DUTY / CONTINUOUS	EXISTING	4.0	4.8	
M-F-6	RADIATOR FAN	2	HP	FVNR	DUTY / CONTINUOUS	EXISTING	2.8	3.4	
P-F-1-1	4" CHOPPER SLUDGE RECIRCULATION PUMP	5	HP	FVNR	DUTY / CONTINUOUS	EXISTING	6.3	7.6	
P-F-2	SLUDGE TRANSFER PUMP	7.50	HP	FVNR	DUTY / CONTINUOUS	EXISTING	9.1	11.0	
P-F-2-2	6" CHOPPER SLUDGE RECIRCULATION PUMP	25	HP	FVNR	DUTY / CONTINUOUS	EXISTING	28.3	34.0	

Date/Time displayed in this report reflect time in PST

LOAD STUDY REPORT

PROJECT INFORMATION

PROJECT	ARCATA WWTF IMPROVEMENTS PRELIMINARY DESIGN
CLIENT	CITY OF ARCATA
PROJECT NUMBER	9913B10
REPORT BY	ERIK BAHNEMAN
REPORT DATE	8/14/2018 4:18 PM

EQUIPMENT INFORMATION

TAG	MCC-17B (OLD MCC-A)		
DESCRIPTION	GENERATOR BUILDING OLD MCC	**PHASE, WIRE, KASC**	3PH, 3W, 42 KAIC KASC
LOCATION	EXISTING ELECTRICAL BUILDING	**LARGEST MOTOR**	25HP
VOLTAGE	480	**COMMENTS**	
BUS AMPS	600		

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
P-F-3-2	WATER CIRCULATION PUMP	3/4	HP	FVNR	DUTY / CONTINUOUS	EXISTING	1.3	1.6	
						OPERATING LOAD SUBTOTAL	84.5	149.8	

Date/Time displayed in this report reflect time in PST

LOAD STUDY REPORT

PROJECT INFORMATION

PROJECT	ARCATA WWTF IMPROVEMENTS PRELIMINARY DESIGN
CLIENT	CITY OF ARCATA
PROJECT NUMBER	9913B10
REPORT BY	ERIK BAHNEMAN
REPORT DATE	8/14/2018 4:18 PM

EQUIPMENT INFORMATION

TAG	MCC-18		
DESCRIPTION	NEW ELECTRICAL BUILDING MCC	**PHASE, WIRE, KASC**	3PH, 3W, 65 KAIC KASC
LOCATION	NEW ELECTRICAL BUILDING	**LARGEST MOTOR**	125HP
VOLTAGE	480	**COMMENTS**	
BUS AMPS	2000		

LOAD TOTALS

OPERATING KVA	OPERATING AMPS
1141.6	1373.1

NEC 215 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
1427.0	1716.4

NEC 430 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
1183.5	1423.6

DEFINITIONS

OPERATING = CONTINUOUS + INTERMITTENT

NEC 215 EQUIPMENT SIZING = 1.25 x CONTINUOUS + 1.0 x INTERMITTENT (BASED ON NEC ARTICLE 215)

NEC 430 EQUIPMENT SIZING = 1.25 x LARGEST MOTOR + 1.0 x ALL OTHER MOTORS + 1.25 x CONTINUOUS NON-MOTOR + 1.0 x INTERMITTENT NON-MOTOR (BASED ON NEC ARTICLE 430)

EQUIPMENT SIZING IS BASED ON THE LARGER OF NEC 215 AND NEC 430 CALCULATIONS (LARGER IS HIGHLIGHTED WHEN APPLICABLE)

Note: For 3-phase busses that feed single -phase loads, the amp summation under loads will not match the bus amps due to the difference in voltage.

Note: The values in this report are rounded from higher precision numbers. Manually summing the values shown may yield slightly varied results due to rounding error.

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
03-AER-101	AERATOR NO. 1	125	HP	VFD-18	DUTY / CONTINUOUS	NEW	129.7	156.0	
03-AER-102	AERATOR NO. 2	125	HP	VFD-18	DUTY / CONTINUOUS	NEW	129.7	156.0	
03-AER-103	AERATOR NO. 3	125	HP	VFD-18	DUTY / CONTINUOUS	FUTURE	129.7	156.0	
03-AER-104	AERATOR NO. 4	125	HP	VFD-18	DUTY / CONTINUOUS	FUTURE	129.7	156.0	
04-CLR-101	SECONDARY CLARIFIER DRIVE NO. 1	1	HP	FVNR	DUTY / CONTINUOUS	NEW	1.7	2.1	
04-CLR-102	SECONDARY CLARIFIER DRIVE NO. 2	1	HP	FVNR	DUTY / CONTINUOUS	NEW	1.7	2.1	
04-CLR-103	SECONDARY CLARIFIER DRIVE NO. 3	1	HP	FVNR	DUTY / CONTINUOUS	FUTURE	1.7	2.1	
04-PMP-201	SECONDARY SCUM PUMP NO. 1	3	HP	FVNR	DUTY / CONTINUOUS	NEW	4.0	4.8	
04-PMP-202	SECONDARY SCUM PUMP NO. 2	3	HP	FVNR	STANDBY	NEW	4.0	4.8	
04-PMP-203	SECONDARY SCUM PUMP NO. 3	3	HP	FVNR	DUTY / CONTINUOUS	NEW	4.0	4.8	
04-PMP-204	SECONDARY SCUM PUMP NO. 4	3	HP	FVNR	STANDBY	NEW	4.0	4.8	
04-PMP-205	SECONDARY SCUM PUMP NO. 5	3	HP	FVNR	DUTY / CONTINUOUS	FUTURE	4.0	4.8	
04-PMP-206	SECONDARY SCUM PUMP NO. 6	3	HP	FVNR	STANDBY	FUTURE	4.0	4.8	
05-AER-101	AERATOR NO. 1	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-102	AERATOR NO. 2	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-103	AERATOR NO. 3	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-104	AERATOR NO. 4	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-105	AERATOR NO. 5	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	

LOAD STUDY REPORT

PROJECT INFORMATION

PROJECT	ARCATA WWTF IMPROVEMENTS PRELIMINARY DESIGN
CLIENT	CITY OF ARCATA
PROJECT NUMBER	9913B10
REPORT BY	ERIK BAHNEMAN
REPORT DATE	8/14/2018 4:18 PM

EQUIPMENT INFORMATION

TAG	MCC-18		
DESCRIPTION	NEW ELECTRICAL BUILDING MCC	**PHASE, WIRE, KASC**	3PH, 3W, 65 KAIC KASC
LOCATION	NEW ELECTRICAL BUILDING	**LARGEST MOTOR**	125HP
VOLTAGE	480	**COMMENTS**	
BUS AMPS	2000		

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
05-AER-106	AERATOR NO. 6	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-107	AERATOR NO. 7	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-108	AERATOR NO. 8	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-109	AERATOR NO. 9	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-110	AERATOR NO. 10	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-111	AERATOR NO. 11	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-112	AERATOR NO. 12	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-113	AERATOR NO. 13	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-114	AERATOR NO. 14	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-115	AERATOR NO. 15	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-116	AERATOR NO. 16	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-117	AERATOR NO. 17	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-118	AERATOR NO. 18	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-119	AERATOR NO. 19	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-120	AERATOR NO. 20	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-121	AERATOR NO. 21	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-122	AERATOR NO. 22	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-123	AERATOR NO. 23	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-AER-124	AERATOR NO. 24	15	HP	FVNR	DUTY / CONTINUOUS	NEW	17.5	21.0	
05-PMP-201	POND PUMP STATION PUMP NO. 1	25	HP	VFD-6	DUTY / CONTINUOUS	NEW	28.3	34.0	
05-PMP-202	POND PUMP STATION PUMP NO. 2	25	HP	VFD-6	DUTY / CONTINUOUS	NEW	28.3	34.0	
05-PMP-203	POND PUMP STATION PUMP NO. 3	25	HP	VFD-6	STANDBY	NEW	28.3	34.0	
06-PMP-101	PUMP STATION 1 PUMP NO. 1	10	HP	VFD-6	DUTY / CONTINUOUS	NEW	11.6	14.0	
06-PMP-102	PUMP STATION 1 PUMP NO. 2	10	HP	VFD-6	DUTY / CONTINUOUS	NEW	11.6	14.0	
06-PMP-103	PUMP STATION 1 PUMP NO. 3	10	HP	VFD-6	STANDBY	NEW	11.6	14.0	
06-PMP-201	TREATMENT WETLANDS 4 PUMP NO. 1	5	HP	FVNR	DUTY / CONTINUOUS	NEW	6.3	7.6	
07-UVB-101	UV BANK NO. 1	12.70	KW		DUTY / CONTINUOUS	NEW	12.7	15.3	
07-UVB-102	UV BANK NO. 2	12.70	KW		DUTY / CONTINUOUS	NEW	12.7	15.3	
07-UVB-103	UV BANK NO. 3	12.70	KW		DUTY / CONTINUOUS	NEW	12.7	15.3	
07-UVB-104	UV BANK NO. 4	12.70	KW		STANDBY	NEW	12.7	15.3	
10-PMP-101	RAS PUMP NO. 1	5	HP	VFD-6	DUTY / CONTINUOUS	NEW	6.3	7.6	
10-PMP-102	RAS PUMP NO. 2	5	HP	VFD-6	STANDBY	NEW	6.3	7.6	

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LOAD STUDY REPORT

PROJECT INFORMATION

PROJECT	ARCATA WWTF IMPROVEMENTS PRELIMINARY DESIGN
CLIENT	CITY OF ARCATA
PROJECT NUMBER	9913B10
REPORT BY	ERIK BAHNEMAN
REPORT DATE	8/14/2018 4:18 PM

EQUIPMENT INFORMATION

TAG	MCC-18		
DESCRIPTION	NEW ELECTRICAL BUILDING MCC	**PHASE, WIRE, KASC**	3PH, 3W, 65 KAIC KASC
LOCATION	NEW ELECTRICAL BUILDING	**LARGEST MOTOR**	125HP
VOLTAGE	480	**COMMENTS**	
BUS AMPS	2000		

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
11-PMP-101	WAS PUMP NO. 1	1/2	HP	VFD-6	DUTY / CONTINUOUS	NEW	0.9	1.1	
11-PMP-102	WAS PUMP NO. 2	1/2	HP	VFD-6	STANDBY	NEW	0.9	1.1	
12-PMP-201	TWAS PUMP NO. 1	10	HP	VFD-6	DUTY / CONTINUOUS	NEW	11.6	14.0	
12-PMP-202	TWAS PUMP NO. 2	10	HP	VFD-6	STANDBY	NEW	11.6	14.0	
12-THI-101	THICKENER NO. 1	5	HP	FVNR	DUTY / CONTINUOUS	NEW	6.3	7.6	
12-THI-102	THICKENER NO. 2	5	HP	FVNR	STANDBY	NEW	6.3	7.6	
14-MIX-301	ALKALINITY TANK MIXER NO. 1	1.50	HP	FVNR	DUTY / CONTINUOUS	NEW	2.5	3.0	
14-MIX-302	ALKALINITY TANK MIXER NO. 2	1.50	HP	FVNR	DUTY / CONTINUOUS	NEW	2.5	3.0	
14-PMP-101	ALKALINITY FEED PUMP NO. 1	1	HP	VFD-6	DUTY / CONTINUOUS	NEW	1.7	2.1	
14-PMP-102	ALKALINITY FEED PUMP NO. 2	1	HP	VFD-6	STANDBY	NEW	1.7	2.1	
14-PMP-201	ALKALINITY SYSTEM TRANSFER PUMP	10	HP	FVNR	DUTY / CONTINUOUS	NEW	11.6	14.0	
14-PMP-401	SUMP PUMP	3/4	HP	FVNR	DUTY / CONTINUOUS	NEW	1.3	1.6	
15-PMP-301	3W PUMP NO. 1	15	HP	VFD-6	DUTY / CONTINUOUS	NEW	17.5	21.0	
15-PMP-302	3W PUMP NO. 2	15	HP	VFD-6	STANDBY	NEW	17.5	21.0	
					OPERATING LOAD SUBTOTAL		1250.6	1504.2	

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LOAD STUDY REPORT

PROJECT INFORMATION

PROJECT	ARCATA WWTF IMPROVEMENTS PRELIMINARY DESIGN
CLIENT	CITY OF ARCATA
PROJECT NUMBER	9913B10
REPORT BY	ERIK BAHNEMAN
REPORT DATE	8/14/2018 4:18 PM

EQUIPMENT INFORMATION

TAG	PNL-20		
DESCRIPTION	CENTRAL GARAGE BREAKER	**PHASE, WIRE, KASC**	3PH, 4W, 65 KAIC KASC
LOCATION	AUTO SHOP	**LARGEST MOTOR**	0HP
VOLTAGE	208	**COMMENTS**	
BUS AMPS	100		

LOAD TOTALS

OPERATING KVA	OPERATING AMPS
0.0	0.0

NEC 215 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
0.0	0.0

NEC 430 EQUIPMENT SIZING

EQUIPMENT KVA	EQUIPMENT AMPS
0.0	0.0

DEFINITIONS

OPERATING = CONTINUOUS + INTERMITTENT

NEC 215 EQUIPMENT SIZING = 1.25 x CONTINUOUS + 1.0 x INTERMITTENT (BASED ON NEC ARTICLE 215)

NEC 430 EQUIPMENT SIZING = 1.25 x LARGEST MOTOR + 1.0 x ALL OTHER MOTORS + 1.25 x CONTINUOUS NON-MOTOR + 1.0 x INTERMITTENT NON-MOTOR (BASED ON NEC ARTICLE 430)

EQUIPMENT SIZING IS BASED ON THE LARGER OF NEC 215 AND NEC 430 CALCULATIONS (LARGER IS HIGHLIGHTED WHEN APPLICABLE)

Note: For 3-phase busses that feed single -phase loads, the amp summation under loads will not match the bus amps due to the difference in voltage.

Note: The values in this report are rounded from higher precision numbers. Manually summing the values shown may yield slightly varied results due to rounding error.

LOADS

TAG	DESCRIPTION	LOAD VALUE	LOAD UNITS	STARTING METHOD	LOAD DESIGNATION	LOAD STATUS	OPERATING KVA	OPERATING AMPS	COMMENTS
	TREATMENT WETLANDS 4 PUMP	7.50	HP	FVNR	DUTY / CONTINUOUS	DEMO		24.2	
					OPERATING LOAD SUBTOTAL		0.0	24.2	

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Appendix J

TM 10 COST ESTIMATE

City of Arcata
Wastewater Treatment Facilities Improvements

Technical Memorandum 10
COST ESTIMATE

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City of Arcata
Wastewater Treatment Facilities Improvements

TECHNICAL MEMORANDUM 10
COST ESTIMATE

FINAL | April 2019

REGISTERED PROFESSIONAL ENGINEER
DOUGLAS W. WING
No. 38950
CIVIL
STATE OF CALIFORNIA

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Abbreviations

Carollo	Carollo Engineers, Inc.
CCI	Construction Cost Indices
ENR	Engineering News Record
NPDES	National Pollutant Discharge Elimination System
SRF	State Revolving Fund
TM	Technical Memorandum

Technical Memorandum 10

COST ESTIMATE

10.1 Purpose

The purpose of this Technical Memorandum (TM) is to update the project cost estimate based on the predesign evaluations, additional input from City staff, further assessment of existing system conditions, updated cost for materials, and vendor quotes for equipment for the City of Arcata (City) Wastewater Treatment Facility (AWTF) Improvements Project. The cost presented in the memorandum should provide the application basis for the State Revolving Loan Fund (SRF) loan and grant application.

10.2 Summary of Findings and Recommendations

The key findings of this TM are summarized below:

- The estimated construction cost is $44,020,000 in current dollars, escalated to the midpoint of construction.
- The construction cost is higher than the facility plan construction cost estimate of $32,200,000.

10.3 Basis for Estimate

The project is currently in the preliminary design phase and the design has not been developed in detail. The construction cost estimates are consistent with an AACE International Class 4 budget estimate with an accuracy range of plus 50 percent to minus 30 percent of the actual project cost.

10.3.1 ENR Benchmark

Providing a cost benchmark for construction estimates is useful in documenting the time of estimate preparation and in allowing for projections and escalations to later dates using the equivalent index value.

This preliminary design cost estimate is benchmarked to the Construction Cost Indices (CCI) published by the Engineering News Record (ENR) for May 2018, which is the most current ENR. We recommend using the 20 City Average ENR, which was 11,013 for May 2018.

10.3.2 Unit Costs

Unit costs have been researched and used for the major components of the project. These major components include site work, piping, pumps, valving, structures, and appurtenances. Unit costs have also been developed using preliminary quotations received from equipment and material manufacturers supplemented with installation costs based on past experience with similar projects, available recent bid data, or cost estimating guidelines derived from estimating guides such as the 2018 RS Means Heavy Construction Data publication, the most current publication to date.

10.3.3 Contingencies

Contingencies are typically applied to a construction estimate at the design development phase to account for construction items not yet identified, and construction design unknowns. As the design is refined and finalized, the contingency, typically expressed as a percent of the raw construction cost, will trend downward. At the completion of the design, the contingency should represent only a reasonable construction change order allowance. Agencies typically retain contingency within their project budgets, even when construction contract award values are known, to cover the cost or deal with unforeseen conditions.

A 25 percent contingency, calculated based on the raw construction cost, has been included in the cost estimate. This is in alignment with the recommendations for a project at an AACE Class 4 level of development.

10.4 Cost Estimate

The total construction cost is estimated at $40,500,000 based on today's costs. This cost estimate includes a plus 50 to minus 30 percent accuracy. The estimate was escalated by 8.1 percent to $44,020,000 to match the proposed construction schedule, an annual rate of approximately 3.5 percent per year. The City's overall cost including the construction, design, construction services, permitting, administration, and start up is estimated at $59,400,000 based on adding 35 percent to the escalated construction cost.

10.4.1 Cost Estimate Breakdown

Table 10.1 summarizes the construction cost by process area and compares the updated cost estimate to the original Facility Plan cost estimate (LACO, Carollo, July 2017). While, the project components included in this preliminary design are not exactly comparable to the Facility Plan components, the comparison provided helps identify changes to required project components included in this preliminary design. A summary of the major improvements by process area as well as changes in scope since the Facility Plan is provided in the sections that follow.

10.4.1.1 Headworks

The influent pumping and headworks will be replaced with this project, and the costs for this facility went down from the initial Facility Plan estimates. Costs were lowered by reducing the size of the proposed headworks to match the existing footprint, while keeping the existing influent junction box. Planned screening, grit removal, and flow metering facilities are similar to existing facilities but upgraded versions will be provided.

10.4.1.2 Primary Clarifier

The primary clarifier will be rehabilitated instead of replaced. This lowered the cost of the recommended facilities.

10.4.1.3 Oxidation Ditch and Secondary Clarifiers

One new oxidation ditch and two new secondary clarifiers will be provided with this project. The cost of this secondary treatment system increased from the Facility Plan estimate to meet the projected ammonia limits. The volume of the ditch is larger than anticipated in the facility plan, and a second clarifier was needed for peak flows. In the future only one more oxidation ditch and a third secondary clarifier will be required to treat the full plant flow (5.9 million gallons per day

[mgd]). An alkalinity addition system was also added because additional alkalinity is needed for complete ammonia removal.

Table 10.1 Cost Estimate

Description	Construction Cost (1)	Facility Plan Cost
Headworks	$4,990,000	$6,600,000
Primary Clarifier Rehabilitation	$1,510,000	$2,050,000
Oxidation Ditch (1)	$6,980,000	$7,380,000
Secondary Clarifiers (2)	$2,800,000	Included
Oxidation Ponds (includes Pond PS and EPPS)	$3,480,000	$4,180,000
Treatment Wetlands - PS and Wetlands (No. 7 not included)	$1,060,000	$1,100,000
UV Disinfection	$2,460,000	$4,360,000
Chlorine Disinfection (DRAFT ESTIMATE)	$380,000	$150,000
Enhancement Wetlands (includes Hauser PS)	$1,830,000	$1,970,000
RAS Pump Station	$2,090,000	Included
WAS Pump Station	$280,000	Included
Thickeners	$980,000	$1,410,000
Digesters	$2,200,000	$1,200,000
Alkalinity Feed System	$650,000	New
Plant Water Systems (placeholder)	$160,000	New
Stormwater System (placeholder)	$160,000	New
Existing Electrical Building/SCADA and Controls	$1,370,000	Included
New Electrical Building/SCADA and Controls	$2,390,000	$300,000
Yard Piping & Site Improvements	$5,540,000	$1,900,000
TOTAL AWTF IMPROVEMENTS CONSTRUCTION COSTS	**$41,310,000**	**$32,100,000**
Corporation Yard Relocation	$1,550,000	$100,000
Biosolids Composting Relocation	$1,160,000	New
TOTAL CONSTRUCTION COSTS	**$44,020,000**	**$32,200,000**
Project Cost (35% added for administration, design, construction management, legal and other costs)	**$59,400,000**	

Notes:
(1) Includes 3.5 percent annual escalation to midpoint of construction.

10.4.1.4 Oxidation Ponds

Pond piping and pump station upgrades are included in the project to address wet weather flows and equipment rehabilitation. Aerators are also proposed for the ponds, although the extent of the benefit of aeration is still difficult to quantify. With just these improvements, the oxidation pond costs have gone down slightly since the Facility Plan because the accumulated solids will be left in the ponds. Deletions of the dredging and dewatering saved a significant cost that may have limited benefits.

10.4.1.5 Treatment Wetlands

The treatment wetland costs have gone up since the Facility Plan based on the addition of flow baffling, vegetation management, and treatment wetland 4 reconstruction. The included cost for the wetland pump station upgrade is similar to the Facility Plan costs.

10.4.1.6 Enhancement Wetlands

The enhancement wetland costs have gone up based on the addition of flow baffling, vegetation management, and flow conveyance between the wetland cells. The cost of the Hauser, enhancement wetland pump station upgrade is similar to the Facility Plan costs.

10.4.1.7 Disinfection

A new UV disinfection facility will be included with this project. The latest UV disinfection technology, with higher efficiency lamps, will be used. This lowers the cost of the UV disinfection system since the high efficiency lamps reduce both the capital and operating cost of the UV disinfection system. Additionally, the cost to update the existing chlorination system is included in the project. To maintain the existing system, we propose replacing the gaseous chlorine and sulfur dioxide system with a liquid bleach system that has lower risks and will meet current health and safety codes.

10.4.1.8 Digesters and Solids Thickening

A new solids thickener will be included with the project and the existing digesters will be rehabilitated. The cost of the digester rehabilitation and thickening has increased since the Facility Plan due to additional costs for the digested sludge heating and mixing system rehabilitation. A new boiler is required to replace the original unit, which is 30 years old, and was not identified in the Facility Plan. Furthermore, additional piping and valve replacement was identified during a recent assessment of the digesters.

10.4.1.9 Electrical, SCADA, Control and Utilities

The extent of the overall electrical facility rehabilitation and expansion is significantly greater than originally envisioned. The existing system was assessed during the recent site visit and is not expandable to meet the needs of the new facilities, so new facilities are proposed.

A new SCADA and control system is proposed to provide additional control and monitoring, and to modernize the existing plant controls. The system will allow for central operation, and remote operation and alarm monitoring during periods when the plant is not staffed. This will save time and operation expenses by reducing the time required if staff have to come to the plant during off times at premium labor costs.

The original Facility Plan cost estimate included electrical improvements within the cost for each area. This underestimated the full electrical investment needed for the required electrical expansion.

Plant water and drainage facilities cost have also increased to meet the needs of the new plant facilities.

10.4.1.10 Relocation of Facilities

A number of corporation yard facilities will need to be relocated with the proposed project. The cost to relocate the portion of the corporation yard impacted by the new plant construction has increased since these facilities need to be maintained onsite while also accommodating the needs of the City. Relocation of the Bus Barn, Maintenance Shop, and biosolids composting operation was not originally included in the relocation costs.

10.4.2 Cost Estimate Comparison to Facility Planning

The project components included in this preliminary design are each required to address different priorities. Some project components are needed to repair or replace aging equipment, while other project components are needed to meet permit limits. Still other projects are necessary facility relocations. Table 10.2 breaks the construction cost down by project need and compares these costs to the Facility Plan costs estimate. The projects included in this preliminary design, while more expensive than originally identified in the Facility Plan, will help ensure that the Arcata Facility will continue to be a community asset for the next 30 years and longer.

Table 10.2 Cost Estimate Breakdown by Need

Description	Construction Cost Estimate	Facility Plan Cost Estimate	Project Need
Flow Reconfiguration	$5,540,000	$3,220,000	Permit Requirements
Headworks / Primary Clarifier Rehabilitation	$6,500,000	$8,650,000	Rehabilitation
Ponds and Wetland	$6,370,000	$5,860,000	Rehabilitation
Secondary Treatment	$12,800,000	$7,380,000	Permit Requirements
Disinfection – UV and Wet weather system	$2,840,000	$4,510,000	Permit Requirements
Digesters/Solids	$3,180,000	$2,140,000	Rehabilitation
Corporation Yard Relocation	$2,710,000	$400,000	Relocation
Electrical, Controls, SCADA and Utilities	$4,080,000	Included in above costs	Permit Requirements
TOTAL CONSTRUCTION COSTS	**$44,020,000**	**$32,200,000**	
TOTAL PROJECT COSTS (35%)	**$59,430,000**		

10.4.3 Cost Estimate Inflation Factors

When construction is very active, total construction costs typically increase more rapidly than the net cost of labor and materials. In active markets overhead and profit margins also increase in response to increased demand. These factors tend to increase the actual overall inflation factor compared to the factor used in developing a cost estimate. The current estimate is based on an annual inflation factor of 3.5 percent. A review of recent construction cost inflation factors show that this may be slightly low for future estimates due to three factors:

- The general California construction market is very robust, and the backlog of construction work is higher than normal. This will put pressure to drive up costs, and may require a higher inflation factor. In addition, labor costs have been rising, especially in specialty trades such as electrical. To account for this factor, some engineers have added a flat 10 percent factor to construction cost estimates to account for the bid market climate.

- The impact of the federal tariffs is currently unknown on the public works construction, especially tariffs on steel, and stainless steel. The impact of tariffs will be to drive costs up as well.
- The overall San Francisco Engineering News construction cost index is also currently trending higher at approximately a 3.5 percent annual change, higher than the 2.5 percent factor used in the previous estimate. This index may not represent the construction market in Northern California, especially the North Coast area where Arcata is located. Therefore local construction costs need to be reviewed to see what the actual inflation rate may be.

Therefore the City should consider these factors when finalizing the construction cost estimate and the City project cost estimate used in budgeting for the project. The escalated construction cost estimate should be reviewed based on local experience and adjusted if needed to account for the current bid climate and construction cost inflation.

Appendix K

TM 11 IMPLEMENTATION PLAN

City of Arcata
Wastewater Treatment Facilities Improvements

Technical Memorandum 11
IMPLEMENTATION PLAN

FINAL | April 2019

City of Arcata
Wastewater Treatment Facilities Improvements

TECHNICAL MEMORANDUM 11

IMPLEMENTATION PLAN

FINAL | April 2019

REGISTERED PROFESSIONAL ENGINEER
DOUGLAS W. WING
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STATE OF CALIFORNIA

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Abbreviations

AWTF	City of Arcata Wastewater Treatment Facilities
Carollo	Carollo Engineers, Inc.
CEQA	California Environmental Quality Act
NPDES	National Pollutant Discharge Elimination System
NTP	Notice to proceed
RWQCB	Regional Water Quality Control Board
SRF	State Revolving Fund
TM	Technical Memorandum
UV	Ultraviolet

Technical Memorandum 11

IMPLEMENTATION PLAN

11.1 Purpose

The purpose of this Technical Memorandum (TM) is to outline implementation strategies for the City of Arcata (City) Wastewater Treatment Facilities (AWTF) project. The current project schedule will be reviewed to provide a basis for the implementation plan. The different implementation strategies and constraints will then be reviewed to see which strategy or strategies have the highest probability to meet the schedule with the least disruption to the on-going operation of the existing treatment plant and corporation yard facilities.

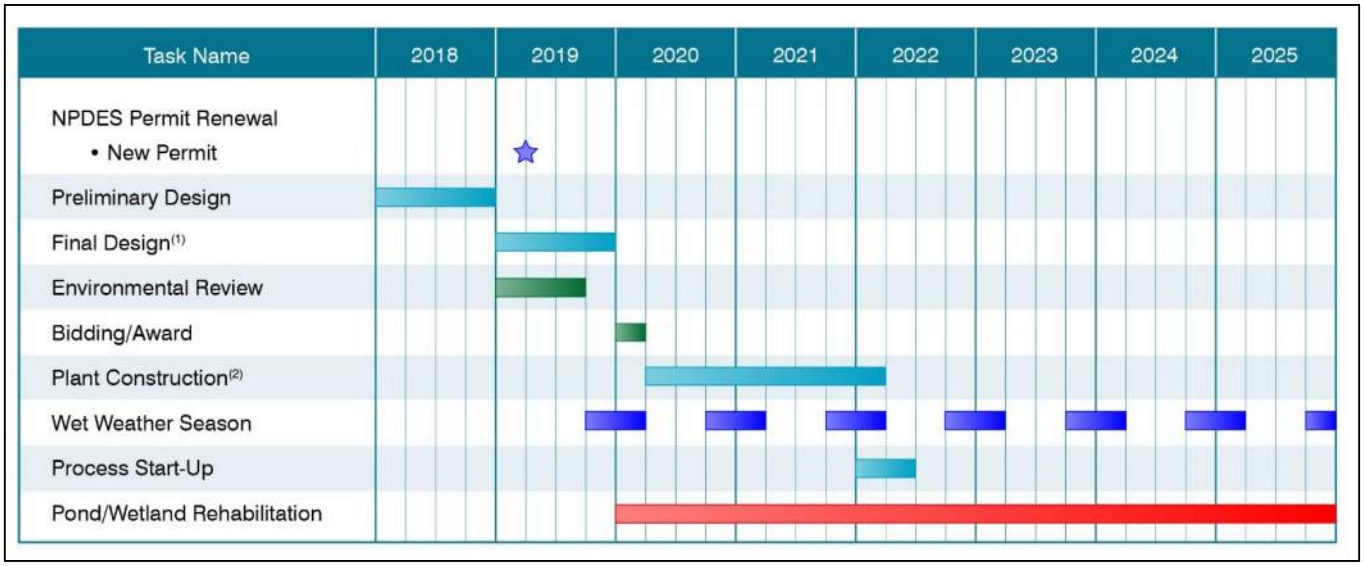
11.2 Summary of Findings and Recommendations

The key findings and recommendations of this TM are summarized below:

- The City will continue to pursue an overall project schedule based on:
  - Final design in 2019
  - Construction in 2020 and 2021
  - Startup in 2022
- Items that potentially impact schedule include:
  - National Pollutant Discharge Elimination System (NPDES) permit renewal, including new discharge limits and time schedule requirements
  - SRF funding approval and rate study
  - Environmental impact assessment, including California Environmental Quality Act (CEQA)
- A single construction project is recommended in order to capitalize on low interest loan financing and minimize administrative costs.
- Construction sequencing constraints due to limited space on site will require planning in final design and working with the contractor during construction to complete the new facilities within two years.
- City will complete rehabilitation and upgrades to treatment wetlands separately as maintenance projects.

11.3 Schedule Review

The project is currently in the preliminary design phase and final design has not started. The current schedule is shown on Figure 11.1.



Notes:
(1) To be finalized after completion of the Preliminary Design.
(2) Construction schedule is preliminary, constraints to be determined in Final Design.

Figure 11.1 Overall Schedule

The schedule is based on completion and approval of the Preliminary Design Report by September 2018 and acceptance by City Council in November 2018. Final design will start in 2019 with completion of the Final Design Bid Documents by December 2019. The project could then be bid for construction in the spring of 2020, with bids due early in 2020. A Notice to Proceed for a construction contract would be issued in early 2020, depending on the status of the funding, permitting, and other constraints. It is still envisioned that the construction would take place in 2020 and 2021 in order to make use of 2 dry weather construction seasons. Finally, process startup of the new secondary and disinfection facilities would take place through the middle of 2022.

The City has proposed completion of the wetlands improvements themselves as maintenance projects, separate from the contract for new facility construction. It is envisioned that startup of the natural system mechanical components would be completed in the same time period as the new facilities. The startup of the natural wetland components including revegetated wetlands will take longer, and may require several years to reach optimum performance.

The project timeline has been evolving since the last (NPDES) discharge permit was issued in 2012. That permit included a timeline for improvements to address several long standing issues including:

- Flow reconfiguration to a single pass flow to eliminate recirculation of wetland effluent.
- New outfall to brackish marsh identified as Outfall 003.
- Installation and startup of a new ultraviolet (UV) disinfection system.

Completion of these improvements was required by December 2016 in the 2012 permit. Due to the complexity of the overall wastewater treatment facility project, this time line was not achieved.

The City proposed an updated schedule for compliance in the Report of Waste Discharge submitted in January 2017. The proposed schedule was similar to the schedule outlined above. This project schedule was proposed to the Regional Water Quality Control Board (RWQCB) as the basis for a potential Time Schedule Order, if one was issued with the NPDES permit renewal. The City is currently working with RWQCB staff on a final project implementation schedule.

11.4 Implementation Options and Constraints

The implementation of the project will be dependent on coordination of several different activities including:

- NPDES permit renewal, especially any new discharge limits and anticipated time schedule requirements.
- Funding approval since SRF funds and grants are anticipated as the means to finance the project. Currently the City has indicated it will pursue the SRF funding once the Predesign Report is completed. The report will provide the technical basis and budget cost for the SRF loan and grant application. A new rate study and finance plan will need to be developed to demonstrate the City's ability to finance the project. These will be completed in parallel with the initial steps of final design.
- The rate study and financial plan will need to be approved by the City council for SRF funding.
- Environmental impact assessment and review including an initial study, and CEQA determination. In addition, SRF requires a CEQA Plus review that incorporates additional areas for review including cultural resources. This CEQA documentation will be provided to SRF for loan funding.
- Consultation on permitting (other than discharge permit), especially with natural resource agencies, to confirm jurisdiction and requirements for project approval.

The discharge permit is probably the most critical element affecting the project timing and configuration, since it will impact the direction the project may take based on the potential requirement for a new ammonia limit. If the limit is lower than the limit anticipated from the recent Eureka permit, the City may need to rethink the overall approach to the project, especially the upgrades to the ponds and wetlands. Early indications from the RWQCB suggest that lower ammonia limits will be required, at least on a seasonal basis, based on the receiving water data collected at the proposed Outfall 003 location.

11.4.1 Implementation Options

Implementation options considered for the predesign evaluation of project implementation include the following:

- Single large project
- Multiple smaller projects defined by work area
- Multiple smaller projects to provide early deliverables.
- Breakout of smaller pond and wetland projects.
- Phased implementation.

11.4.1.1 Single Project

The City has indicated that they prefer a single project. A large single project can potentially be financed with low interest SRF loan and grant, reducing the overall implementation costs. A single project will also reduce the city administration costs. These features provide advantages to the City from a cost and overall management perspective. The main issue with a single large project is that if any one constraint noted above is delayed it may tie up the project until each constraint is resolved.

A single project can be organized with add and deduct items that allow the City to select critical components to stay within the project budget at bid time.

11.4.1.2 Multiple Projects by Work Area

The construction could be divided up by the work area. One example is that it might work to complete the pond and wetland projects separate from the central area treatment plant work. Since the pond and wetland work is specialized, it might make sense to have a separate contractor to complete that work. In the same way, the treatment wetland work could be completed by the City (or City contractor). The main plant construction could be completed by a general contractor that regularly does treatment plant work. A treatment plant Contractor could be the most efficient with plant construction, and might be slowed down if they had to coordinate with a wetlands contractor. The disadvantage to this approach would be that the City would have to manage multiple contracts for construction.

Another option is to complete some of the repair and rehabilitation projects first, since they are not dependent upon the NPDES permit requirements.

11.4.1.3 Multiple Projects to Provide an Early Deliverable

This option could be used if the City wanted to complete items separately, especially to meet a permit requirement sooner than later. An early deliverable could be targeted for completion in the initial construction season (summer 2020). The main example is if the City wanted to complete the flow routing construction to allow the use of Outfall 003 before the remainder of the plant was constructed or on-line. Since this work is included in the current permit that will be renewed, it could be addressed before other work is started. The same thing could be done for the pond 1 and 2 flow equalization improvements. These could be implemented early to reduce the peak flows the plant might experience during subsequent construction.

11.4.1.4 Breakout of Smaller Pond and Wetland Projects

These pond and wetlands projects could be completed as either traditional design-bid-build or design-build projects. The goal of a design-build project would be to reduce to reduce the overall cost and schedule for implementation. A secondary goal might be to create work for local contractors that have worked for the City and might be able to mobilize and complete work quickly. Alternatively these projects could be completed by the City as maintenance projects. The City has indicated that they will take on some of these projects as maintenance projects.

11.4.1.5 Phased Implementation

The concept of phased implementation was discussed several times during the Facility Plan development. It had been suggested that the pond and wetlands work might be completed first, then tested to see if the secondary treatment additions were needed. In fact the opposite might make sense, to complete the secondary treatment system and see if the pond process upgrades are required to meet permit. The deferral or elimination of pond and wetland process upgrades might save money and reduce the improvements that might be lost to sea level rise.

11.4.1.6 Recommended Implementation Strategy

It is recommended that the City continue to pursue implementation of a single project.

Based on initial discussion with City staff, the City may also pursue a temporary implementation of the new discharge location, and single pass operation for dry weather flows. This may provide additional information on receiving water quality, and partially meet the current permit discharge requirements. The City has indicated that they will take on some of the wetlands rehabilitation projects as maintenance projects.

11.4.2 Implementation Sequence Constraints

A list of preliminary implementation constraints for a single project are outlined below and on Table 11.1. During final design, these constraints and the construction sequence will be further developed.

Table 11.1 Construction Implementation Constraints

Description	Predecessor	Year
Corporation Yard Relocation		
Biosolids Composting Relocation	NTP	2020
New Bus Barn	NTP	2020
Headworks	Primary Clarifier No. 2 Rehabilitation	2021
Primary Clarifier Rehabilitation	NTP	2020
Oxidation Ditch(1)	Corp Yard Relocation	2020
Alkalinity Addition Facilities	NTP	2020
Secondary Clarifiers (2)	Corp Yard Relocation	2020
RAS/WAS Pump Station	NTP	2020
ML Flow Split Structure	Corp Yard Relocation	2020
New Electrical Building	NTP	2020
Existing Electrical Building	New Electrical Building	2012
UV Disinfection	NTP	2020
Chlorine system improvements	UV disinfection	2021
Solids		
Digester No 1 cleaning/cover	NTP	2020
Digester No. 2 cleaning/cover	Digester No. 1 Rehabilitation	2021
Thickener	NTP/ Primary Clarifier No. 1 demolition	2020
Digester Heating, Boiler, and gas system	NTP	2021
Oxidation Ponds (includes Pond PS & EPPS)		
Pond Pump Station	NTP	2020
Pond Piping Improvements	NTP	2020

Table 11.1 Construction Implementation Constraints (Continued)

Description	Predecessor	Year
Pond Aerators	New Electrical Building	TBD
Treatment Wetlands - PS and Wetlands		
Pump Station 1 and yard Piping	NTP	2020
TW 1, 2 and 3	TW 4	TBD
TW 4 including PS	NTP	TBD
Enhancement Wetlands (includes Hauser PS)		
Hauser PS	Outfall 003	2021
Transfer Structures	NTP	2020
Vegetation Management	NTP	2020
Baffles and hydraulic improvements	NTP	2020
Outfall 003	NTP	202
Plant Water Systems		Ongoing
Stormwater System		Ongoing
Yard Piping & Site Improvements		Ongoing

Appendix L

ORIGINAL EXECUTIVE SUMMARY

City of Arcata
Wastewater Treatment Facilities Improvements

Executive Summary
PREDESIGN REPORT

DRAFT | November 2018

City of Arcata
Wastewater Treatment Facilities Improvements

EXECUTIVE SUMMARY

PREDESIGN REPORT

DRAFT | November 2018

Doug Wing, November 2018,
State of California, Civil,
38950

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Appendix D TM 4 Ponds and Wetlands Improvements

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Appendix F TM 6 Solids Handling and Digester Improvements

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Appendix I TM 9 Energy Efficiency, Electrical, and Control System

Appendix J TM 10 Cost Estimate

Appendix K TM 11 Implementation Plan

Abbreviations

AMWS	Arcata marsh wildlife sanctuary
AWTF	Arcata wastewater treatment facility
BOD	biological oxygen demand
Carollo	Carollo Engineers, Inc.
City	City of Arcata
NPDES	National Pollutant Discharge Elimination System
RWQCB	Regional Water Quality Control Board
TM	Technical Memorandum

Executive Summary

PREDESIGN REPORT

1.1 Purpose

The purpose of this Executive Summary is to outline the recommended improvements, new site plan and site constraints, and construction cost estimate for the improvement project. The improvement project elements are detailed in a series of Technical Memorandums (TMs), briefly described below, and included as appendices in this Predesign Report.

1.2 Background

The City of Arcata (City) Wastewater Treatment Facility (AWTF) currently discharges treated wastewater to Humboldt Bay in conjunction with enhanced treatment occurring in the Arcata Marsh Wildlife Sanctuary (AMWS). Discharges are regulated by the North Coast Regional Water Quality Control Board (RWQCB) through application of the National Pollutant Discharge Elimination System (NPDES) permit.

The AWTF operates under an NPDES permit issued in 2012 and updated in 2014, which includes requirements for disinfection, treatment processes, and outfalls. Due to compliance problems, the permit required that changes be made to improve wastewater treatment, protect beneficial uses, and reduce chemical usage. A new permit was due in 2017 and is currently expected to be issued in early 2019. It is anticipated that the new permit will introduce new lower limits for effluent ammonia. The permit will also include an updated compliance schedule, and revised requirements for the new ultraviolet light disinfection system.

1.3 Project Goals

The AWTF will be sized to meet the community needs now and for growth envisioned by the City General Plan 2020. The facility design criteria are reviewed in TM No. 1. The City currently has under taken a separate program to reduce the peak wet weather flows and volumes that must be treated at the AWTF.

The overall project goal is to improve the AWTF infrastructure with the addition of a new secondary treatment system while preserving the natural treatment system of ponds and wetlands. The objective is to optimize the existing oxidation ponds, treatment wetlands, and enhancement wetlands in conjunction with a parallel secondary treatment system to meet the anticipated treatment requirements. This project will replace, repair, or rehabilitate aging AWTF facilities to meet the community's current and future needs.

The project environmental goal is to improve water management by addressing existing and proposed NPDES requirements for wastewater treatment and by providing reliable hydraulic capacity and treatment capacity for wet weather flows.

The project will also prepare the AWTF for future infrastructure needs and will provide a resilient system that will address future concerns such as sea level rise. New facilities will be elevated above the projected flood and sea level elevations, and the project will be coordinate with the anticipated City project to raise the plant levees.

1.4 Anticipated Improvements

The project includes the anticipated improvements listed below.

1. Flow reconfiguration to single pass system, to meet permit objectives is described in TM No. 2 and includes:
    - New outfall (Outfall 003) into brackish marsh.
    - Treatment Wetlands (TW) Pump Station rehabilitation.
    - Enhancement Wetlands (EW) Pump Station replacement.
    - Piping modifications required for the flow reconfiguration.
2. Headworks replacement and Primary Clarifier No. 2 rehabilitation to replace aging facilities and provide additional treatment capacity are described in TM No. 3 and include:
    - New Influent Pump Station.
    - New bar screens and screenings treatment
    - New grit removal system and grit handling system.
    - New influent flow meters.
    - Rehabilitate Primary Clarifier No. 2, including a new mechanism.
    - Demolish Primary Clarifier No. 1.
    - New primary sludge and scum pumping system.
3. Pond and treatment wetland improvements to provide increased treatment and hydraulic capacity are discussed in TM No. 4, and also addresses wet weather flows management. The improvements include:
    - Oxidation Pond No. 1 transfer piping modification to allow for peak wet weather flow storage and attenuation.
    - Oxidation Pond No. 2 transfer structure improvements.
    - Oxidation Pond No. 2 aeration system.
    - Oxidation Pond No. 2 baffle wall.
    - Treatment Wetlands Nos. 1 to 4 regrading and revegetation. (Separate City projects)
    - Treatment Wetlands No. 7 construction. (Separate City project)
    - New Treatment Wetland No. 4 pump station. (Separate City Project)
    - Enhancement Wetlands vegetation management and excavation (Separate City Project)
    - Pump Station No. 1 and Pond Pump Station rehabilitation.
    - Emergency Pond Pump Station improvements.
4. New parallel/series secondary treatment to provide additional treatment capacity, to improve water quality and meet anticipated new permit requirements is described in TM No. 5. The proposed facilities include:
    - New oxidation ditch (design for one new and one future).
    - New secondary clarifiers (design for two new and one future).
    - RAS and WAS pumping facility.
    - Alkalinity addition facility to meet permit requirements for ammonia removal (if required).

5. Disinfection system improvements to improve water quality and meet anticipated permit requirements are described in TM No 7, and include:
    - New effluent UV disinfection facility.
    - Liquid chlorine system upgrade for peak wet weather flows.
    - New UV and EW effluent flow meters.
6. Solids handling and treatment upgrades to replace aging facilities, provide additional treatment capacity is described in TM No. 6, and includes:
    - Thickener addition for waste primary and secondary sludge.
    - Digester rehabilitation and improvements.
7. Miscellaneous site improvements to address aging infrastructure, to add all the ancillary and support facilities required for a complete treatment plant, and to accommodate corporation yard facilities impacted by new treatment plant facilities is described in TMs No. 8 and 9, and includes:
    - Bus Barn, maintenance shop, and biosolids composting relocation.
    - Electrical and instrumentation improvements.
    - Plant water system modifications.
    - Relocation and reuse of facilities for plant maintenance and parts storage facilities.

1.5 Improvement Siting and Site Constraints

The new treatment processes will be constructed within the existing plant site while maintaining operation of existing wastewater treatment processes. New facility layouts are shown in TM No. 8 Site Improvements. It is assumed that the new influent pump station and headworks will be sited in the same location as the existing influent pump station and headworks.

The City will also maintain the City Corporation Yard in conjunction with the AWTF, at the treatment plant site. As noted, the corporation yard will need to be consolidated and several areas relocated to accommodate the new plant facilities. The overall site plan with the proposed location of the new facilities is presented in Figures ES-1, ES-2, and ES-3.

1.6 Construction and Project Costs Estimate

The estimated construction cost of the recommended improvements is $40.7 M in current costs, and $44.0 M when escalated to the mid-point of construction of January 2021. A breakdown of the construction costs for the AWTF improvements is outlined in TM No. 10. The costs to meet the main project objectives are presented in Table ES-1.

Figure No. ES-1

TREATMENT WETLANDS SITE PLAN

CITY OF ARCATA

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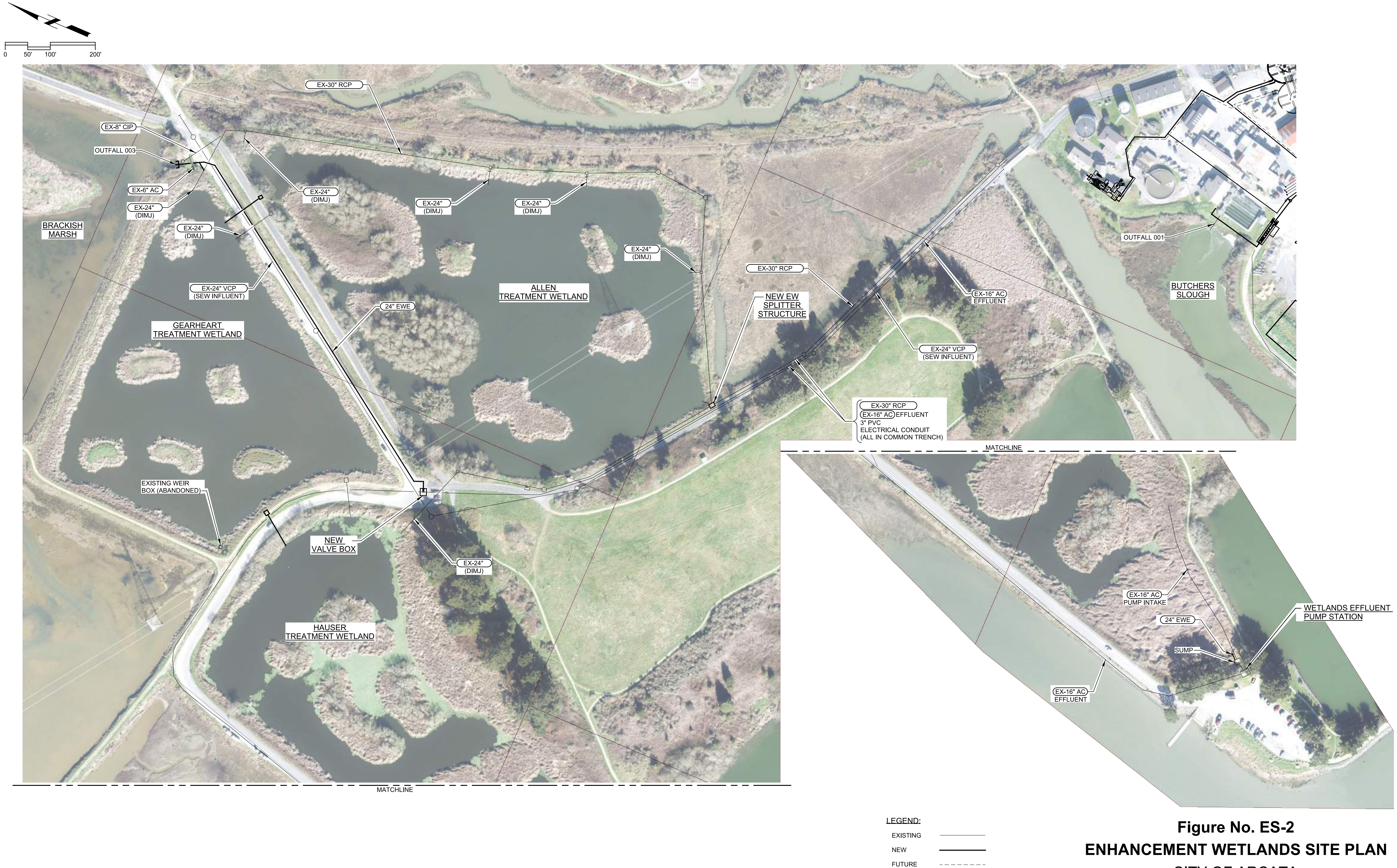

Figure No. ES-2

ENHANCEMENT WETLANDS SITE PLAN

CITY OF ARCATA

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Figure No. ES-3

CENTRAL SITE PLAN

CITY OF ARCATA

carollo

Table ES-1 Cost Estimate Breakdown by Need

Description	Construction Cost Estimate
Flow Reconfiguration improvements	$5,540,000
Headworks / Primary Clarifier replacement and rehabilitation	$6,500,000
Ponds and Wetland improvements	$6,370,000
Secondary Treatment addition	$12,800,000
Disinfection system: UV and Wet weather system upgrades	$2,840,000
Digesters/Solids improvements repair and rehabilitation	$3,180,000
Corporation Yard relocation	$2,710,000
Electrical, Controls, SCADA and Utilities additions	$4,080,000
TOTAL CONSTRUCTION COSTS (3.5% escalation)	**$44,020,000**
TOTAL PROJECT COSTS (35%)	**$59,430,000**

When construction is very active, total construction costs typically increase more rapidly than the net cost of labor and materials. In active markets overhead and profit margins also increase in response to increased demand. These factors tend to increase the actual overall inflation factor compared to the factor used in developing a cost estimate. The current estimate is based on an annual inflation factor of 3.5 percent. A review of recent construction cost inflation factors show that this may be slightly low for future estimates due to three factors:

- The general California construction market is very robust, and the backlog of construction work is higher than normal. This will put pressure to drive up costs, and may require a higher inflation factor. In addition, labor costs have been rising, especially in specialty trades such as electrical. To account for this factor, some engineers have added a flat 10 percent factor to construction cost estimates to account for the bid market climate.
- The impact of the federal tariffs is currently unknown on the public works construction, especially tariffs on steel, and stainless steel. The impact of tariffs will be to drive costs up as well.
- The overall San Francisco Engineering News construction cost index is also currently trending higher at approximately a 3.5 percent annual change, higher than the 2.5 percent factor used in the previous estimate. This index may not represent the construction market in Northern California, especially the North Coast area where Arcata is located. Therefore local construction costs need to be reviewed to see what the actual inflation rate may be.

Therefore the City should consider these factors when finalizing the construction cost estimate and the City project cost estimate used in budgeting for the project. The escalated construction cost estimate should be reviewed based on local experience and adjusted if needed to account for the current bid climate and construction cost inflation.

1.7 Implementation Plan and Schedule

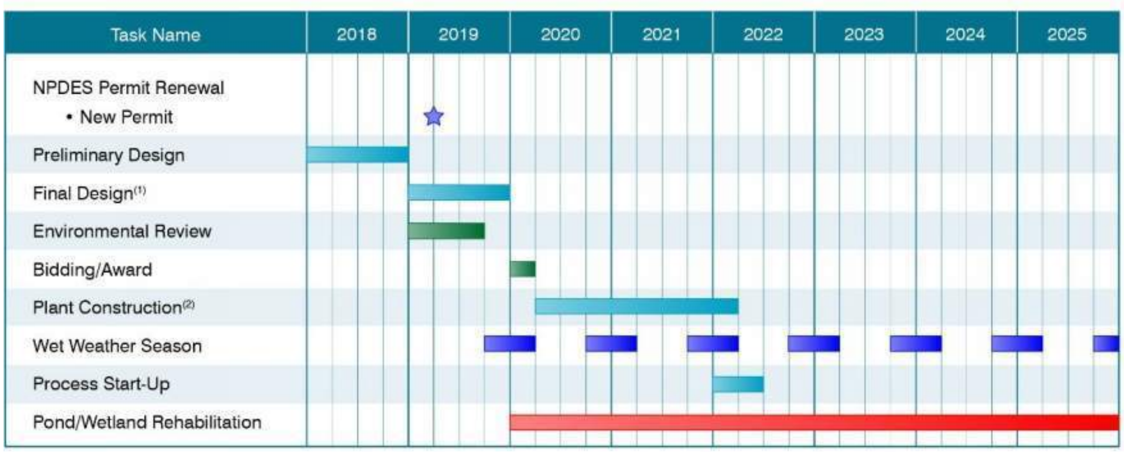
The implementation schedule is outlined below in Figure ES-4. The plan is to continue with the engineering design required to develop documents to obtain construction bids. In parallel with the design activity, environmental review for CEQA compliance will be completed, and any required permits will be identified. Then the permits will be obtained for the improvements project. A financing plan including a rate study will also be developed parallel to the design activities to ensure the City can fund the project.

It is anticipated that construction documents could be prepared in about 12 months, and a project could then be bid and awarded in three or more months. The construction, shown in 2020 and 2021, would be 24 months, or longer and cover two dry weather construction seasons. The startup would be two or three months for the mechanical portion of the plant. The startup for wetlands that might be revegetated could take up to 12 to 18 months. In addition, it is anticipated that ongoing pond and wetland rehabilitation will continue into the future, on a regular schedule.

The City has indicated that several recommended elements of the AWTF improvements would be completed by the City as separate projects. These include:

- TW 7 construction
- TW 4 construction including regrading, vegetation planting, and inlet pump station
- TW 1 and 2 vegetation management and grading/excavation
- Enhancement wetlands vegetation management and excavation

These projects can be completed as maintenance projects and do not require the same level of permit review, design and construction support as the other elements.



Notes:
(1) To be finalized after completion of the Preliminary Design.
(2) Construction schedule is preliminary, constraints to be determined in Final Design.

Figure ES-4 Overall Schedule

1.8 Conclusion

In conclusion, it is anticipated that a combination of new plant facilities and plant rehabilitation improvements can be completed within the next five year NPDES permit cycle. The new permit, which is likely to be issued in early 2019, will set new discharge criteria, and will have a compliance schedule included for meeting water quality improvements. This preliminary design report outlines the facilities needed to comply with the anticipated new standards as well as lays out an implementation schedule that is achievable within the anticipated time schedule requirements of a five year permit window.

Appendix M

HEADWORKS UPDATE

ARCATA WASTEWATER TREATMENT FACILITIES – IMPROVEMENTS PROJECT

Headworks & Screw Pump Option

February 21, 2019

Updated April 2019

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Headworks Screw Pump Alternatives

Configuration	Screw Pumps							
	Torque Tube Diameter	Screw Diameter	Number of Flights	Motor Size, hp	Firm Capacity[1] mgd	Total Capacity[2] mgd	Cost	Comments
Retrofit Existing Structure with Added Lift Pumps and Submersible Pump								
2 Screw Pumps + 1 Submersible Pump @ 2.5 mgd each	20″	36″	3	15	5.0	7.5	$	Able to reuse existing wet well but not designed for submersible pump, lowest capacity
New Structure with New Screw Pumps								
1+1 @ 6.0 mgd each	24″	54″	2	40	6.0	12.0	$$	Highest total capacity
2+1 @ 3.0 mgd each	24″	54″	1	20	6.0	9.0	$$$	Better energy efficiency versus 6.0 mgd screw pumps since only one 3.0 mgd is required most of the time

All screw pumps listed are external lift pumps with 38° inclination.

Notes:
1. Capacity with one of the largest units out of service.
2. Capacity with all units in service.

New Headworks Pump Station Alternatives

Configuration	Speed	Firm Capacity(1) mgd	Total Capacity(2) mgd	Minimum Capacity(3) mgd	Cost	Comments
Submersible Pumps						
2+1 @ 2.0 mgd each	Variable	4.0	6.0	1.0	$	Lowest cost, but firm capacity less than design capacity
2+1 @ 3.0 mgd each	Variable	6.0	9.0	1.5	$$	Low cost, but not capable of low flow pumping
2+1 @ 2.5 mgd , 1 @ 1.0 mgd	Variable	6.0	8.5	0.5	$$$	Good balance of capacity range and cost
1+1 @ 4.0 mgd , 2 @ 1.0 mgd	Variable	6.0	10.0	0.5	$$$$	Highest total capacity and highest cost for submersible pumps
Screw Pumps						
1+1 @ 6.0 mgd each	Constant	6.0	12.0	0.0	$$$$$	Highest total capacity, able to pump at lowest flows
2+1 @ 3.0 mgd each	Constant	6.0	9.0	0.0	$$$$$$	Better energy efficiency versus 6.0 mgd screw pumps since only one 3.0 mgd is required most of the time

Notes:
1. Capacity with one of the largest units out of service.
2. Capacity with all units in service.
3. 50 percent capacity of smallest unit.

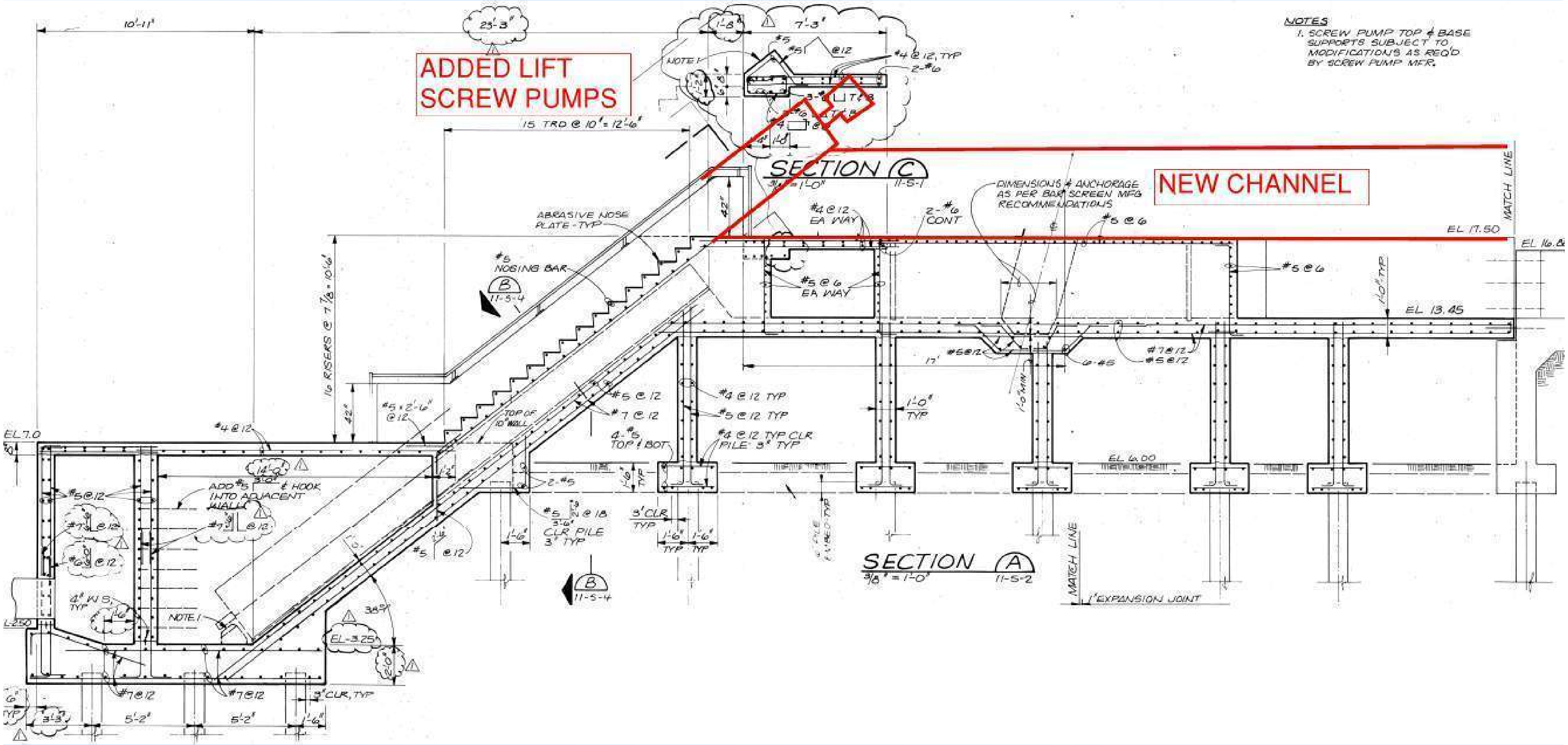
Screw Pumps

- Similar to existing influent pumps
- Reliable and relatively simple to maintain
- Able to move larger solids than other types of pumps
- Can utilize a smaller wet well
- Will continue to operate regardless of the water level or flow conditions in the wet well
- Require a large footprint due to the size of the torque tube and flights and the support structure

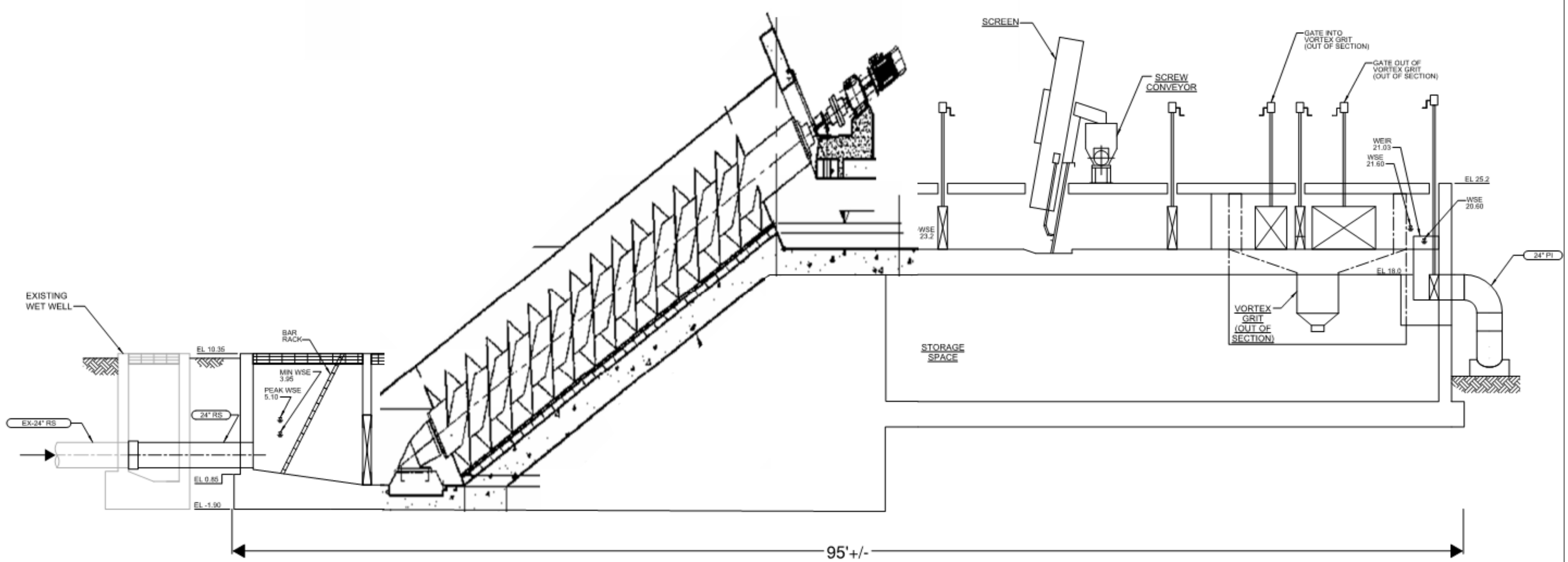
Submersible Pumps

- Smaller footprint and lower capital costs than screw pumps
- Size allows for multiple configurations of pump sizes and wet well layouts
- Require a minimum submergence that is deeper than screw pumps
- Require wet well flow conditioning to reduce turbulence into the pumps
- Require a lift or crane to pull the pump out of the wet well

Retrofit Headworks Screw Pump Section



New Headworks Screw Pump Section



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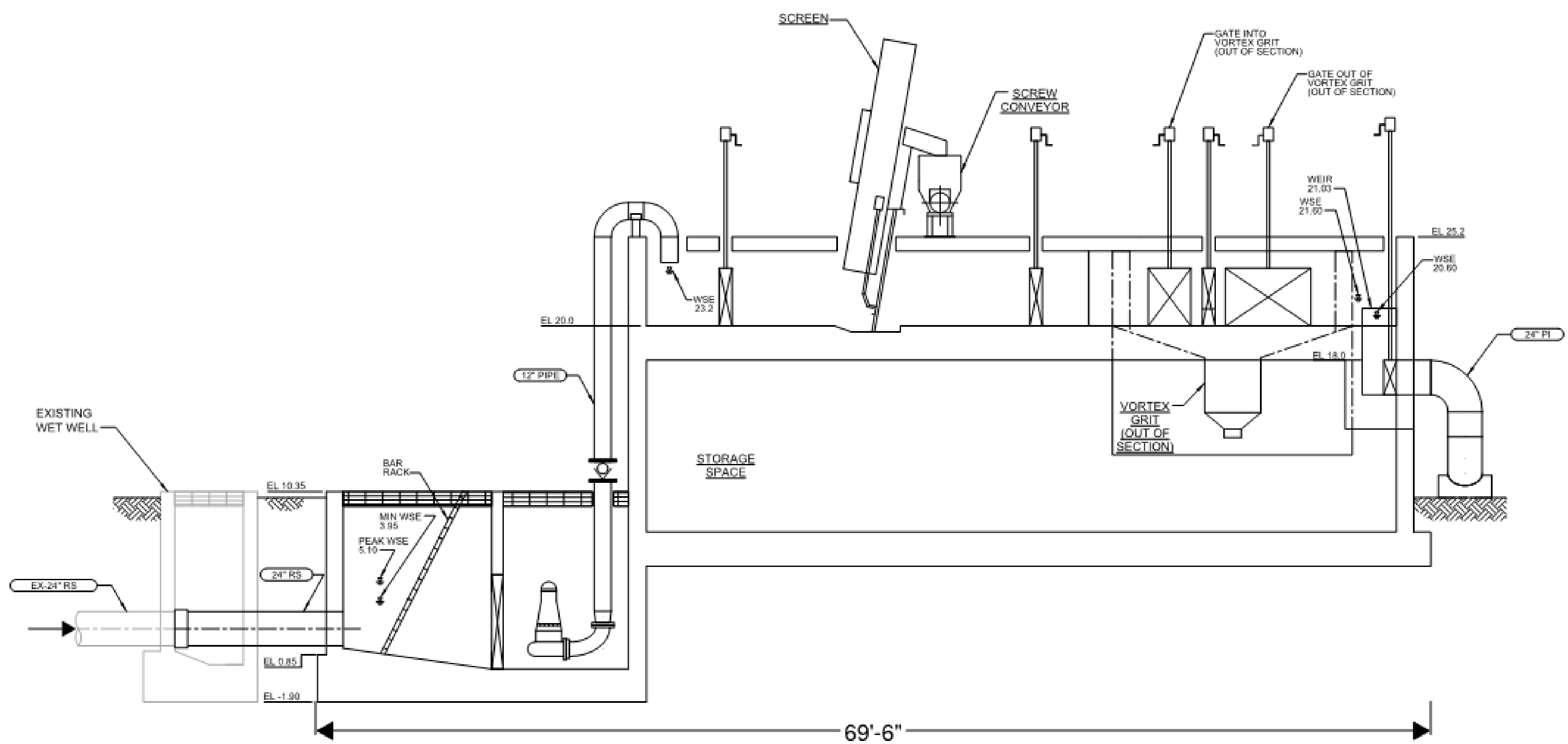
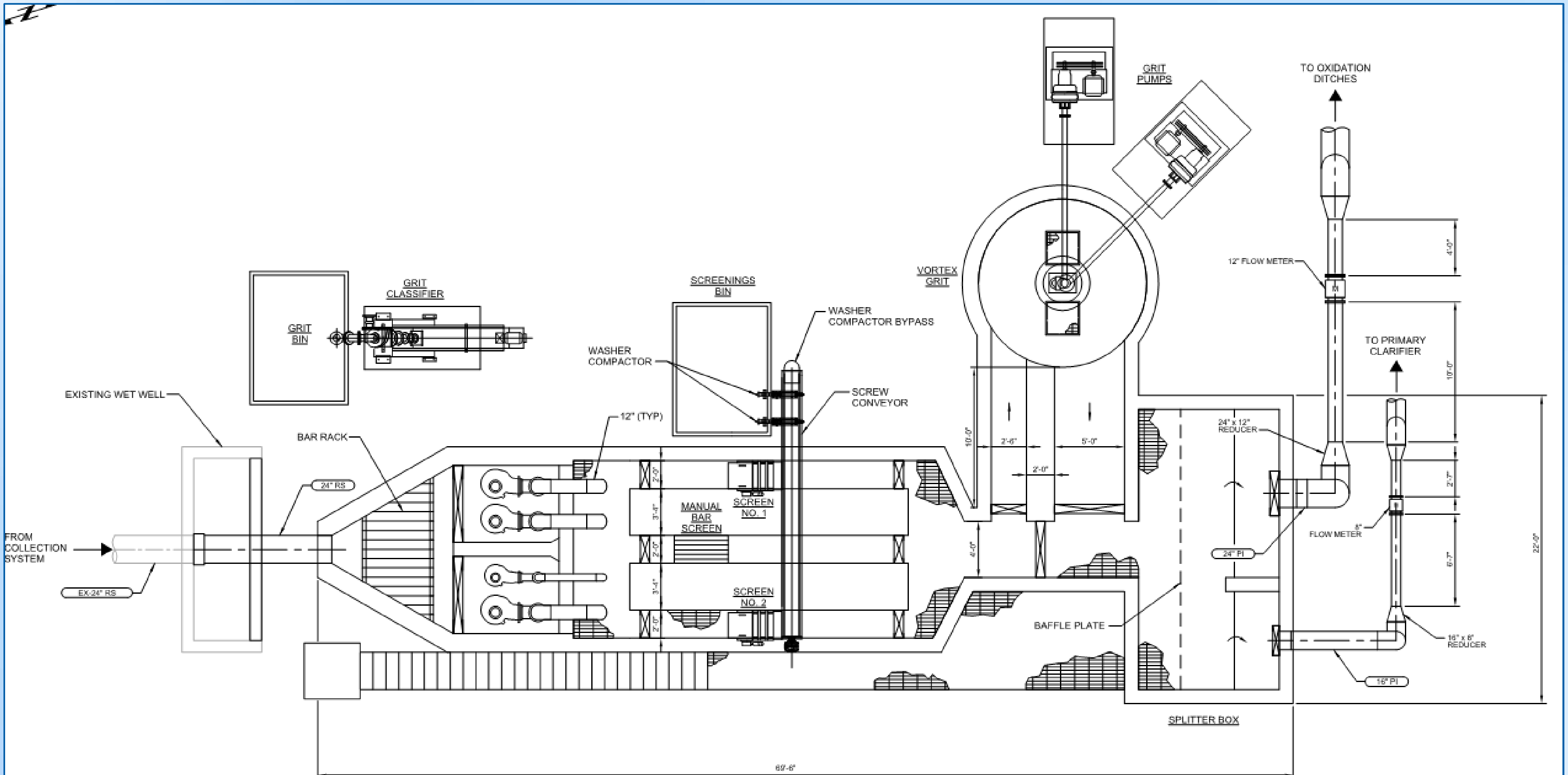
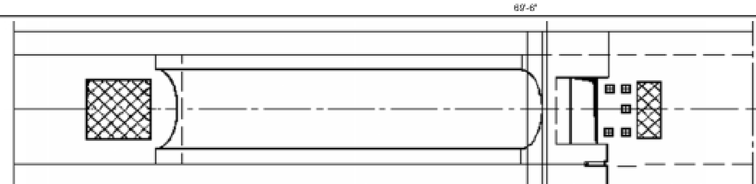
New Headworks Submersible Pump Section



Screw Pump Footprint Comparison





One Screw Pump
Approx 39’x7’

Additional Construction Costs for Screw Pumps

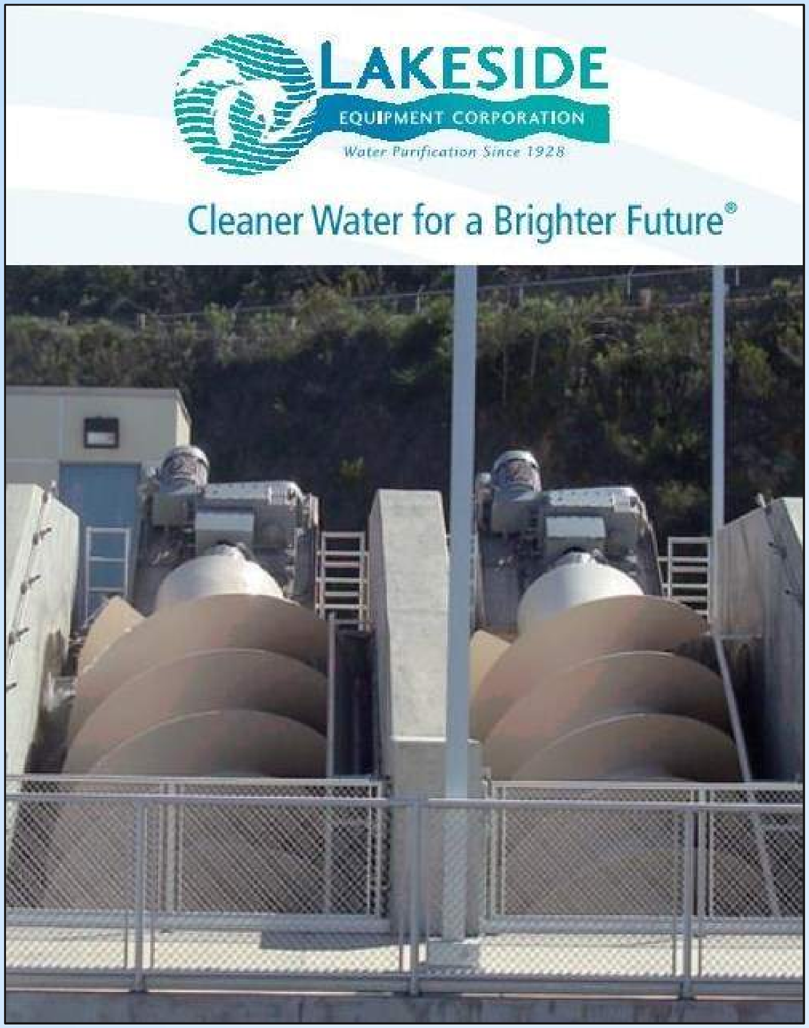
- Pump station equipment costs $400,000 to $830,000 more than submersible pump type station
- Installed costs with additional structure and piles adds $1.3 to $1.8 M to Headworks construction costs

City Review and Selection (Feb 21 Call)

- City recommended a revised influent pump option using screw pumps
  - Install 2 screw pumps with same diameter as existing, extended for the additional lift.
  - Screw Pump Capacity – 2.5 mgd each
  - Additional submersible or other auxiliary pump with 2.5 mgd capacity.
  - Firm PS capacity – 5.0 mgd (2 + 1 pumps)
  - Total capacity – 7.5 mgd

City Review and Selection (Feb 21 Call)

- City asked to retain a portion of the existing structure if possible. Carollo to review and estimate any cost savings in final design
- Carollo to prepare an updated cost estimate to confirm cost of screw pump selection in final design.



ARCATA WASTEWATER TREATMENT FACILITIES – IMPROVEMENTS PROJECT

Headworks – Screw Pump Option

January 7, 2019

Updated April 2019

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Appendix N

DISINFECTION UPDATE

ARCATA WASTEWATER TREATMENT FACILITIES – IMPROVEMENTS PROJECT

UV Disinfection – Wet Weather Options

January 7, 2019

Updated April 2019

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Purpose

- Eliminate chlorine disinfection for peak wet weather flows
- Upsize UV disinfection to account for flows greater than 5.9 MGD

Influent Flow Data

Influent Flow Condition	Probability	Influent Flow Value, MGD
Average dry weather flow		1.1 MGD
Average annual flow		1.7
Maximum month flow	91.7% (1 month in 12 months)	3.0
Peak daily average flow	99.7% (1 day in 365 days)	5.7
Maximum day flow	99.9 (1 day in 4 years)	9.1

Note: Based on 2013 to 2017 data

UV Configuration Options

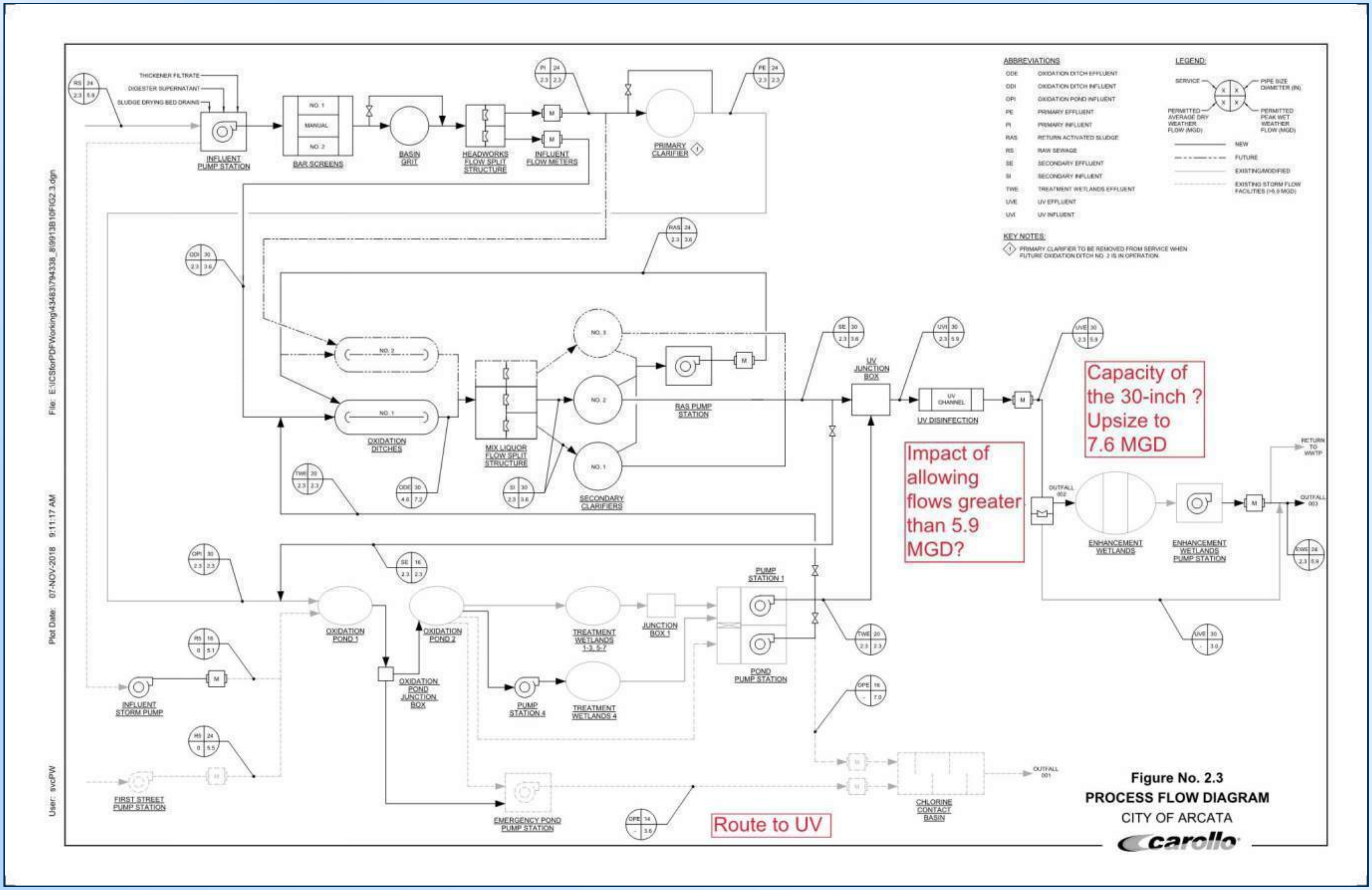
Parameters	Option 1 Trojan UVSigna 2-Row	Option 2 Trojan UVSigna 2-Row	Option 3 Trojan UVSigna 2-Row	Original Trojan UVSigna 2-Row
Peak Flow Rate (MGD)	5.9	7.6	9.8	5.9
Minimum UV Transmittance (%)	35	35	35	35
Design MS2 RED (mJ/cm2)	50.0	50.0	50.0	50.0
Configuration:				
Number of Channels	2	2	2	1
Number of Duty Banks/Channel	4	5	6	5
Total Number of Lamps	100	120	140	96
Total Power Consumption (kW)	105.8	127.0	148.1	101.6
Headloss Across UV Banks (inches)	0.8	1.4	2.3	1.3
Total Equipment Price	$825,000	$935,000	$1,090,000	$640,000
Estimated Construction Cost	$3,176,000	$3,600,000	$4,197,000	$2,464,000

Wet Weather UV Options

- Existing single channel system will handle flow 99% of the time.
- Higher flows will require a 2 channel system to address headloss.
- A 5.9 MGD 2 channel system increases equipment cost by $185,000 and construction cost by $710,000 +/-.
- Recommended option 2 channel system sized for a minimum of 7.6 MGD with 5.9 MGD equipment installed. Will increases equipment cost by $185,000 and construction cost by $1,000,000 +/-.

Note – see alternative sizing handout for additional details.

Impact on effluent conveyance. Capacity may need to be increased!



Updated UVT Data - Lower UVT during lower flows

	PT 9 Treatment Wetland (TW)	PT 10 TW in CCB	PT 15 Enhanceme nt Wetland	PT 16 Existing Discharge
Average	35.2	31.9	44.1	43.5
Min	17.6	29.2	29.2	28.2
Max	51.4	43.0	60.8	56.8
Median	33.9	30.9	42.7	43.2
Lower 10th percentile	27.5	29.7	33.0	35.2

Note: Based on data from 12/17/18 email

City Review and Selection Update (March 7 email)

- City selected the 9.8 mgd option to address wet weather flows in conjunction with pond system improvements to equalize peak flowrates.
- Will eliminate the need to rehabilitate existing chlorine system. Chlorine building can be repurposed for storage and maintenance. The CCB can be demolished and free up space for other uses.
- Will eliminate the issues with intermittent operation of the chlorine system. This will eliminate the potential of chlorine violations and disinfection byproduct issues.

City Review and Selection Update (March 7 email)

- Final design
  - Will confirm 2 channel design at higher flow
  - Proposed dose design criteria – 50 mJ/cm2
  - Confirmed UVT design criteria - 35% UVT
  - Will review impact of higher flow to EW (002) / Brackish marsh outfall (003) on effluent piping sizing/headloss
- Block grant will require open bid for equipment.

ARCATA WASTEWATER TREATMENT FACILITIES – IMPROVEMENTS PROJECT

UV Disinfection – Wet Weather Options

January 7, 2019

Updated April 2019

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Appendix O

COST UPDATE BY PHASES

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Project:	**Wastewater Treatment Facility Improvements**			
Client:	**City of Arcata**	**Location Factor:**	**1.071**	**REVISED**
Location:	**Arcata, CA**	**Estimated Midpoint of Construction:**	**April 1, 2021**	**April 7, 2019**
Zip Code:	**95521**	**Cost Estimate Preparation Date:**	**November 1, 2018**	**REV 4**
Carollo Job #	**9913B.10**	**By:**	**RRH/EAC**	
		Reviewed:	**DW**	
		Rate of Annual Inflation:	3.5%	Trending up
		Estimating Contingency:	25.0%	
		Sales Tax:	8.5%	
		General Conditions:	10.0%	Trending up
		Contractor Overhead and Profit:	10.0%	
		Bid Market Allowance:	0.0%	5% to 10%

NO.	DESCRIPTION		Original Construction Cost	Phase 1 Construction Cost	Phase 2 Construction Cost
01	Headworks	**(Placeholder)**	$5,020,000	$5,020,000	$0
02	Primary Clarifier Rehabilitation		$1,520,000	$1,520,000	$0
03	Oxidation Ditch (1)		$7,020,000	$0	$7,020,000
04	Secondary Clarifiers (2)		$2,820,000	$0	$2,820,000
05	Oxidation Ponds (includes Pond PS & EPPS))		$3,480,000	$3,480,000	$0
06	Treatment Wetlands - PS and Wetlands		$1,240,000	$1,240,000	$0
07	UV Disinfection	**(9.8 MGD Wet Weather)**	$2,474,000	$4,200,000	$0
08	Chlorine Disinfection	**(Deleted)**	$380,000	$0	$0
09	Enhancement Wetlands (includes Hauser PS)		$1,830,000	$1,830,000	$0
10	RAS Pump Station		$2,100,000	$0	$2,100,000
11	WAS Pump Station		$280,000	$0	$280,000
12	Thickeners		$980,000	$0	$980,000
13	Digesters		$2,210,000	$0	$2,210,000
14	Alkalinity Feed System		$660,000	$0	$660,000
15	Plant Water Systems		$160,000	$0	$160,000
16	Stormwater System		$160,000	$0	$160,000
17	Existing Electrical Building	**(100% split)**	$1,380,000	$1,380,000	$0
18	New Electrical Building (does not includes PV)	**(75%/25% split)**	$2,410,000	$1,808,000	$602,000
19	Yard Piping & Site Improvements	**(50% split assumption)**	$5,570,000	$2,785,000	$2,785,000
	TOTAL WWTF IMPROVEMENTS CONSTRUCTION COSTS		**$41,690,000**	**$23,263,000**	**$19,777,000**
20	Corporation Yard relocation		$1,560,000	$0	$1,560,000
21	Biosolids Composting relocation		$1,170,000	$0	$1,170,000
	TOTAL CONSTRUCTION COSTS (Includes Phase 1 Escalation)		**$44,420,000**	**$23,263,000**	**$22,507,000**
	Phase 2 Escalation Beyond Phase 1				**$1,958,000**
	TOTAL PHASE 2 CONSTRUCTION COSTS				**$24,465,000**
	Project Cost 35%		**$60,000,000**	**$31,400,000**	**$33,000,000**

Notes

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.