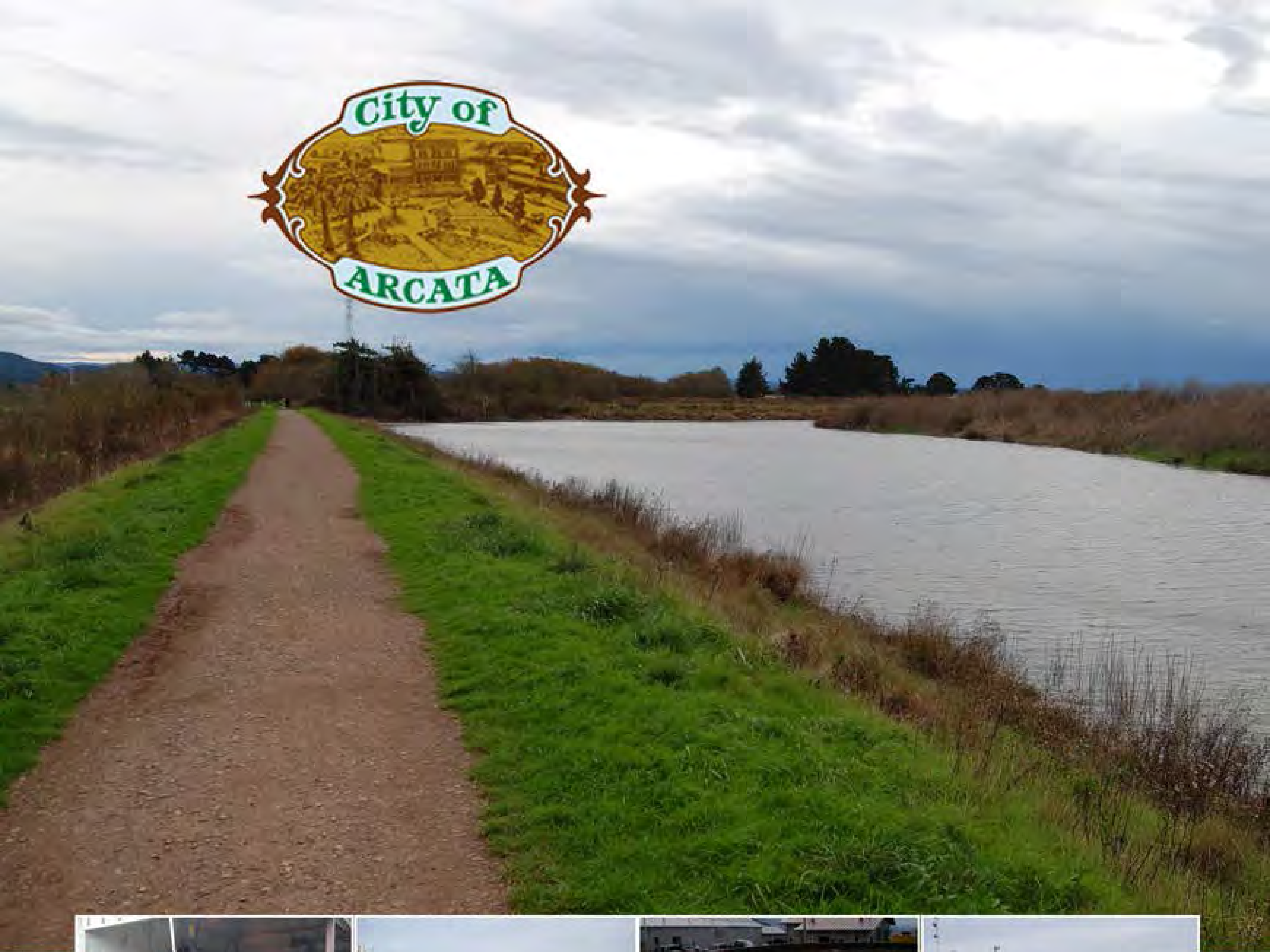

City of Arcata

Facility Plan

June 2016

LACO / carollo

CITY OF ARCATA

WASTEWATER TREATMENT FACILITY IMPROVEMENTS PROJECT

FACILITY PLAN UPDATE AND ADDENDUM

June 2016

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06/30/2016

CITY OF ARCATA

WASTEWATER TREATMENT FACILITY IMPROVEMENTS PROJECT

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Chapter 1

EXECUTIVE SUMMARY

1.1 INTRODUCTION

The Arcata Wastewater Treatment Facility (AWTF) is owned and operated by the City of Arcata (City), serving residents within the City limits and the unincorporated community of Glendale. The AWTF, shown in Figure 1.1, has been discharging to Humboldt Bay since about 1949. The AWTF currently discharges treated wastewater to Humboldt Bay in conjunction with enhanced treatment occurring in the Arcata Marsh Wildlife Sanctuary (AMWS), constructed freshwater wetlands adjacent to the treatment facility. Discharges are regulated by the North Coast Regional Water Quality Control Board (RWQCB) through application of National Pollutant Discharge Elimination System (NPDES) permits.

In 2012 the AWTF began operating under a new NPDES permit that specifically addressed several long-term issues regarding disinfection, treatment units, and outfalls. Due to past compliance problems, the new permit required changes be made to improve wastewater treatment, protect beneficial uses, increase energy efficiency, and reduce chemical usage, thereby reducing the potential for permit violations.

In response to the new permit requirements, the City initiated this Facility Plan and plant improvement project to address several issues:

- Ongoing NPDES permit violations and regulatory compliance.
- Need to repair or rehabilitate (R&R) aging infrastructure and address deferred maintenance.
- Providing reliable capacity and treatment for both wet and dry weather flows now and in the future.

This facility plan provides 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. This executive summary provides a very brief overview of key findings and recommendations of the Facility Plan. For more detailed information, the reader is directed to the individual chapters of the Plan.

This facility plan was prepared by the LACO/Carollo Engineers team as part of the Wastewater Treatment Facility Improvements Project professional services.

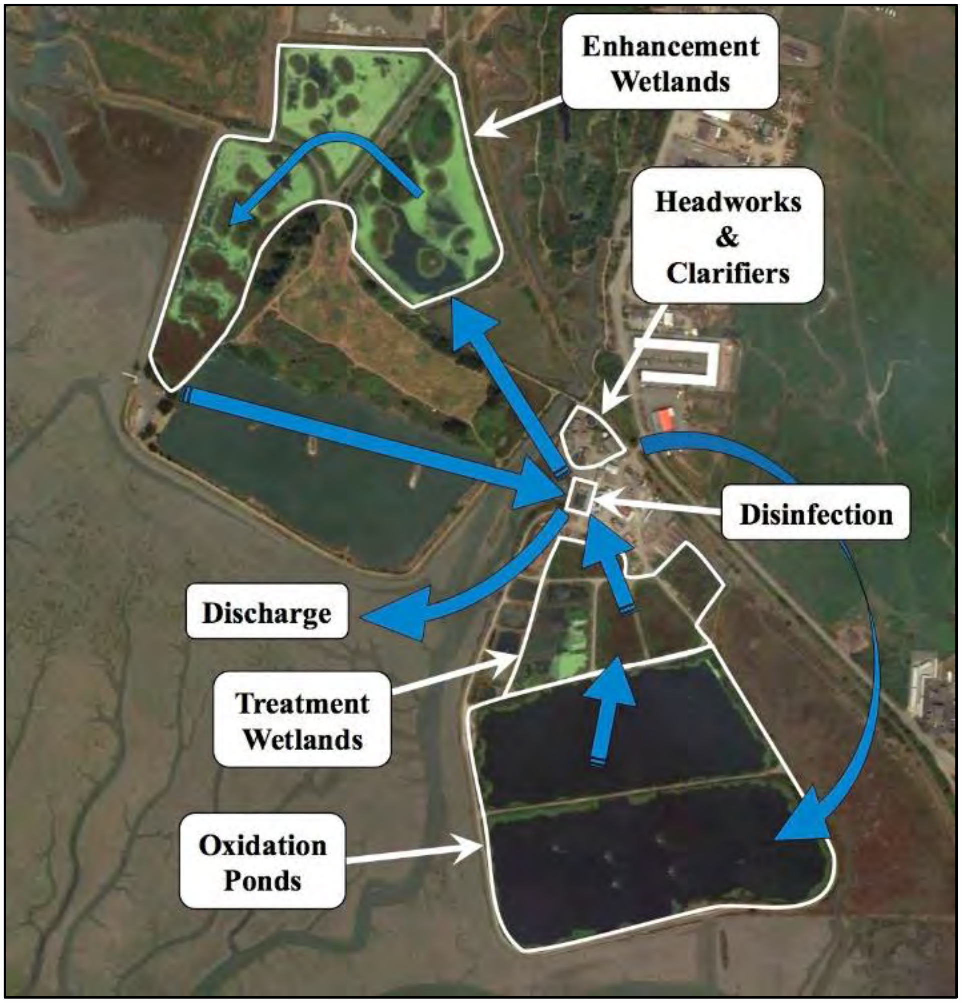


Figure 1.1 Existing AWTF Facilities

1.1.1 History of Facilities and Improvements

The original AWTF was constructed in the late 1950s. The AWTF has been upgraded throughout the years, with the last major upgrade project completed in the late 1980s. The project included a new headworks facility with screening and grit removal, a chlorine contact basin and chemical storage building, effluent pump stations and a new generator building. Since that project, smaller projects have included upgrades to the oxidation ponds, treatment and enhancement wetlands, digesters, pond aerators, chlorination/dechlorination system and the addition of a new standby generator. Generally the plant consists of these main elements:

- Influent pumps and preliminary treatment (screening and grit removal).
- Oxidation ponds, shown in Figure 1.2, and treatment wetlands that provide secondary treatment.

- Enhancement wetlands that provide polishing treatment in the AMWS.
- Chlorine contact basin that provides disinfection prior to discharge to Humboldt Bay.

Figure 1.2 AWTF Ponds Provide Secondary Treatment

The AWTF system relies heavily on land-based, natural treatment systems. This system has served the City well but has a number of drawbacks in that there is not sufficient room to further expand the natural treatment systems for additional capacity, and natural systems are inherently greatly affected by the weather (temperature and precipitation). As regulatory requirements have gotten more stringent over the years and with the initiation of mandatory minimum penalties in 2000, it has become more difficult to reliably meet permit compliance with the land-based natural system.

However, there is recognition that the facility as a whole, and the AMWS specifically, provides a tremendous community benefit. Not only do the residents of the area frequent the marsh and its five miles of trails, but visitors come from far to see the wildlife that frequents the marsh. Over 300 bird species have been observed using the marsh and it provides an important stop on the Pacific Flyway for migrating birds. A typical scene on a recreational trail is shown in Figure 1.3.

Figure 1.3 AMWS Provides a Significant Community Benefit

1.2 PLAN DEVELOPMENT AND REVIEW PROCESS

The City of Arcata, with its natural treatment system and the AMWS, are recognized as being leaders in sustainability and dedicated to being leaders in environmental progress. Established City Council goals that relate to this plan include (see 2015-16 Goals at http://www.cityofarcata.org/435/City-Council-Goals):

- Improving ***facilities and infrastructure*** to provide citizen safety and comfort.
- Providing ***environmental leadership*** to improve water resource management, increase local energy independence, strive towards zero waste and supporting ecosystem functions.
- Provide ***sustainable development*** by improving community services.
- Improve the quality of ***public services*** by improving communication with the public.
- Encourage ***citizen and community health*** by providing recreational opportunities, support essential human services, and encourage community participation.
- ***Prepare for future needs*** by providing leadership in developing adaption strategies for climate change and using best available science for future planning.

This Facility Plan strives to use these goals to help the City continue to provide wastewater services (an essential human service) in a safe manner that meets regulatory requirements and still provides the community benefits that is expected and loved.

To meet these goals for the facility plan as well as meeting Council goals, a triple bottom line approach of considering environmental, economic, and social impacts and benefits was established to use in considering alternatives and the overall direction of the plan. This is shown in Figure 1.4.

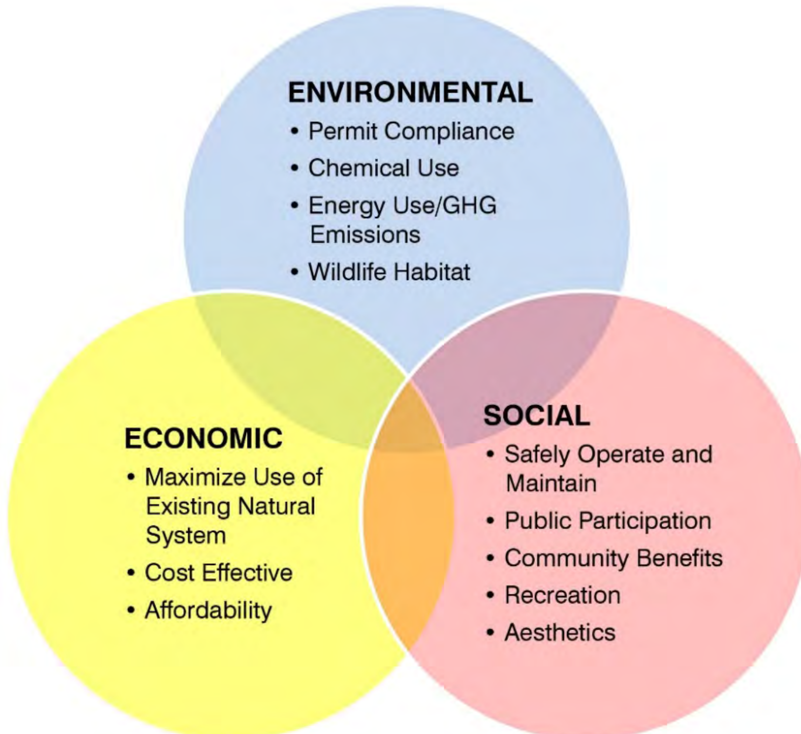


Figure 1.4 Triple Bottom Line Framework

1.2.1 Public Process and Review

Given the strong affiliation of the community and the college (Humboldt State University) with the AWTF and AMWS, it is critical that public input be provided into any proposed changes to the system. In order to get input, an Administrative Draft Facility Plan was presented to the City Staff and the Arcata Marsh Research Institute (AMRI) in September 2015. This original plan focused on needed repair and replacement, as well as permit compliance to replace the chlorination system with UV for the new outfall location in the brackish marsh. At this meeting, comments were received about concern over the process capacity being inadequate once chlorination was eliminated. At the time, process capacity was not in the scope of work. Following this input, the project team, along with the City and AMRI, did additional work and met in November 2015 to identify the capacity shortfall and alternatives to address this shortfall. Revised technical memorandums were distributed for City and AMRI review, and numerous conference calls were held to review technical work. In April 2016, a public workshop was held to present the findings and recommendations of the Draft Facility Plan, followed by a public Council Meeting on April 20th. At these meetings, significant discussion took place regarding the use of the existing natural system and investing in improving it. This Facility Plan incorporates additional alternative evaluation and development to address many of these comments. The draft Facility Plan was presented on June 6 and June 13, 2016 at City Council Workshops.

1.3 PERMIT COMPLIANCE

The AWTF must comply with regulatory requirements established by its NPDES permit. For this Facility Plan, the major regulatory requirements that affect the operation of the AWTF were reviewed along with the AWTF's compliance record. A summary of the permitting issues that affect the proposed Facility Plan is provided below:

- **Flow Reconfiguration.** The permit approves and now requires a new flow configuration and discharge point. With the new configuration, effluent flows will no longer discharge directly from the chlorine contact basin to Humboldt Bay through Outfall 001. Instead, disinfected enhancement wetlands effluent will discharge through the future Outfall 003, which will serve as the new point of compliance. Outfall 003 will be constructed in the brackish marsh at the north end of the Arcata Bay section of Humboldt Bay. Permit compliance for the flow reconfiguration is required by December 1, 2016; the City plans to request for an extension.
- **Disinfection.** Since 2013 there have been approximately 21 violations of the permit for disinfection related incidents including disinfection by-products, chlorine residual, or adequate bacteria removal. The permit includes approval for construction of a new ultraviolet light (UV) disinfection system, in place of the existing chlorine disinfection system. UV-disinfected effluent will then discharge through the future Outfall 003. Permit compliance for UV disinfection is required by December 1, 2016; the City plans to request for an extension. Additional considerations for the new UV system include:
  - Implementation of UV disinfection (see Figure 1.5) would eliminate the disinfection by products; however, the existing natural treatment system has a very low UV transmittance, which impacts the sizing of the UV needed to meet disinfection requirements.
  - The existing use of chlorine provides chemical treatment of biochemical oxygen demand (BOD) and seasonal hydrogen sulfide. Eliminating use of the chlorine will result in a shortfall of BOD removal capacity by approximately 600 to 1000 pounds per day (ppd).

Figure 1.5 Proposed UV Disinfection

- **Wet Weather Flows.** The permit does not completely define flow reconfiguration for wet weather flows. It prohibits discharge of flows greater than 5.9 million gallons per day (mgd) through Outfall 003. Therefore, by default, the difference will either need to be stored in the oxidation ponds or discharged on an emergency basis through Outfall 001. At a meeting with the RWQCB on June 27, 2016 they indicated that bypasses were an issue. Additional consideration to this issue is required.
- **Secondary Treatment.** Ongoing permit violations of plant effluent limits for BOD (at least 18 violations for Biochemical Oxygen Demand (BOD) in the last 2 years) and suspended solids (at least 20 violations for Total Suspended Solids (TSS) since 2013) indicate a need for additional secondary treatment capacity. This compliance history paired with the anticipated capacity shortfall after moving away from chlorine further supports the need for treatment beyond the capacity of the existing land-based natural system.
- **Dilution Credits.** The future Outfall 003 is currently being modelled to determine if dilution credits are justifiable for the new discharge point. If credits are allowed, the effluent toxicity testing should produce more favorable results.
- **Nutrients and Emerging Contaminants.** Nutrients such as nitrogen and phosphorus have been identified as potential issues. The North Coast RWQCB is currently reviewing limits for these constituents, and at the June 27, 2016 meeting with the RWQCB, it was made clear that the City would receive ammonia limits in its next

NPDES permit in 2017. Other permittees in the North Coast Region (e.g., City of Ferndale and City of Eureka) have also received more restrictive limits for ammonia and nutrients in recent NPDES permit renewals. RWQCB staff indicated that the City of Eureka's June 2016 permit was a good example of likely limits for the AWTF.

Constituents of Emerging Concern (CECs) include pharmaceuticals and personal care products, industrial chemicals present at low concentrations, and endocrine-disrupting chemicals. In general, these and other low-concentration contaminants have been identified as potential future issues for both effluent discharges and recycled water application. It was determined, however, that permitting around CECs would likely not take affect within the 20-year planning window for this Facility Plan.

- **Bacterial Quality of Humboldt Bay.** The bacterial quality of Humboldt Bay was noted as a particular concern in the RWQCB Water Quality Control Plan for the North Coast Region (Basin Plan) due to the location of several of California's most important commercial oyster farms in the northern lobe of the estuary known as Arcata Bay. The Basin Plan identifies stormwater runoff and point source discharges as having the greatest impact on water quality in Arcata Bay. The effluent limitations for fecal coliform bacteria for the new Outfall 003 were retained from the previous permit and reflect water quality objectives for protection of shellfish harvesting areas.

1.4 EXISTING FACILITIES OVERVIEW

The existing AWTF facilities include headworks, primary clarifiers, oxidation ponds, treatment wetlands, enhancement wetlands, and chlorine disinfection. Solids removed in the primary clarifiers are treated in anaerobic digesters and solids drying beds.

Evaluation of hydraulic and process capacity requires establishing design flow and loads. The design flows were based on the design flow. The loads were determined by using historical data sets and adding a 20 percent growth factor to the 90 percent percentile load to account for planned development under the General Plan. The City originally anticipated a 10 percent community growth which was incorporated into the Draft Facility Plan. After further discussion with the City at the Council meeting on June 13, 2016, community growth estimates have been revised to be 20 percent. Updates to incorporate this additional growth factor have been included in this Facility Plan to some extent, however, updates to sizing of the capacity projects and their cost estimates will be fully incorporated during preliminary design.

The design flows and loads are shown in Table 1.1.

Table 1.1 AWTF Design Flow and Loads Wastewater Treatment Facility Improvements Project City of Arcata	
	Flow (mgd)
Average Dry Weather Design Flow, mgd	2.3
Average Wet Weather Design Flow, mgd	5.0
Peak Wet Weather Design Flow, mgd	5.9
Peak Instantaneous Flow, mgd	16.5
Design Influent BOD_5 Load With 20% Growth, ppd	4,800
Design Influent TSS Load With 20% Growth, ppd	6,910
Design Influent Ammonia Load With 20% Growth, ppd	1,060

1.4.1 Hydraulic Capacity

In general the existing hydraulic capacity of the plant is limited and needs to be modified to meet the permit requirements for the following elements:

- Influent pumps and headworks.
- Primary clarifiers.
- Treatment wetlands and treatment wetlands pumping.
- Enhancement wetlands and enhancement wetlands pumping.

The AWTF hydraulic capacity of unit processes is shown in Figure 1.6. Note that the wetlands capacity is based on pump stations rather than the wetlands, and therefore are not rated on Figure 1.6. However, it has been noted that the treatment wetlands and enhancement wetlands perform best at steady, lower flows. For this reason, flows through the treatment and enhancement wetlands will be limited to 2.3 mgd. Hydraulic capacity upgrades including pump stations throughout the plant to provide a firm and reliable capacity up to the permitted wet weather flow of 5.9 mgd. During these peak wet flows, pond effluent is blended with wetland effluent prior to disinfection.

1.4.2 Process Capacity

Using the design flow and loads presented in Table 1.1, a review of the existing facility process capacity found that secondary treatment capacity is limited for both BOD and ammonia removal. In the existing system, the oxidation ponds convert the organic load to solids and the wetlands remove the solids. These natural systems are impacted by loading, climate (including sunlight and temperature), and pond solids accumulation. Oxidation ponds, which utilize algae to provide oxygen, generally have a lower capacity to remove organics and nitrogen in the colder winter months when the amount of sunlight is limited.

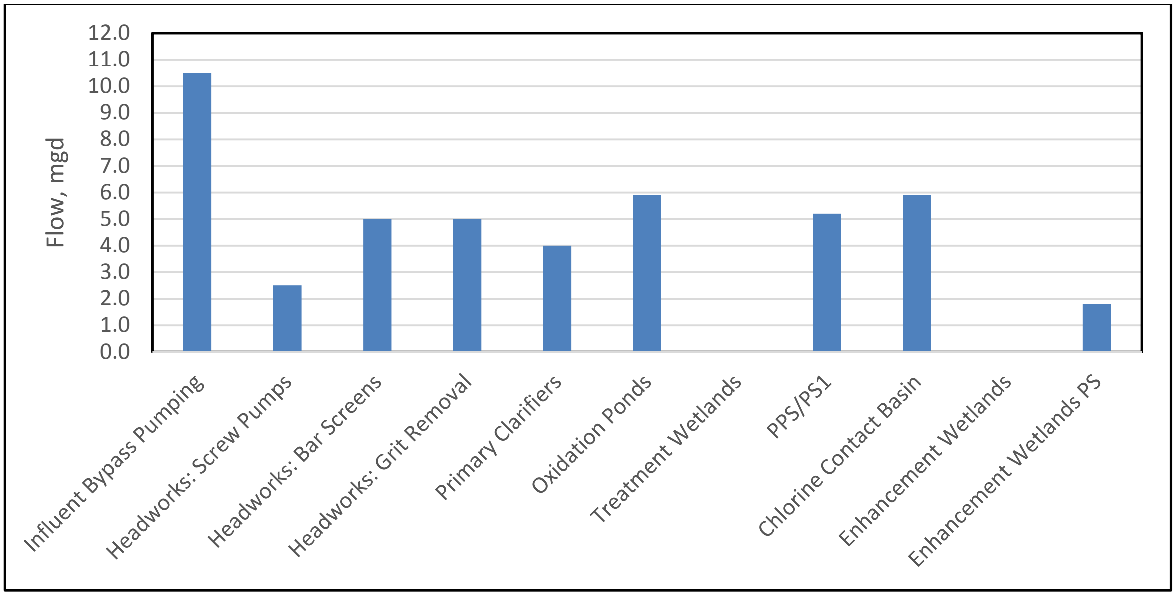


Figure 1.6 AWTF Hydraulic Capacity

Plant data confirmed that the natural system generally performed well during lower flow and warmer conditions. However, the treatment wetlands effluent regularly exceeded the permit solids level going into the AMWS enhancement wetlands, and subsequently into the chlorine contact basin prior to discharge. Plant data also showed that in higher flow, wet weather conditions, the system capacity, and permit requirements were exceeded regularly. When excess flow needs to be stored in the oxidation ponds, secondary treatment capacity within the ponds may also be diminished. In order to reduce the loading on the system and reliably meet the current permit requirements now and in the future, additional secondary treatment capacity will be required.

Using industry standards for allowable loading rates and removal rates, the capacity for BOD removal was determined for each process area, as shown in Table 1.2. The removal across each process can be added up for total removal expected. This total can be subtracted from the influent load to determine the capacity shortfall. Once the goal load for discharge is removed, the capacity shortfall is approximately 1,680 ppd of BOD as shown in Table 1.2. The allowable load for discharge is a little higher than the goal established for planning, however, the goal provides a factor of safety for reliable permit compliance.

This capacity shortfall sets the requirements for evaluating alternatives that could be used to improve or supplement treatment capacity.

Table 1.2 BOD Capacity in Existing System Wastewater Treatment Facility Improvements Project City of Arcata		
Process	**BOD load removal, (ppd)**	**BOD load (ppd) remaining**
Influent With 20% Growth		4,800
Primary Clarifiers	1,320	3,480
Oxidation Ponds	1,150	2,330
Treatment Wetlands	340	1,990
Enhancement Wetlands	120	1,870
Disinfection		none if UV
Discharge Goal at 10 mg/L	190	1,680
BOD Capacity Shortfall		**1,680**

1.5 CONDITION ASSESSMENT

As part of this Facility Plan, the AWTF facilities were evaluated for their overall condition. The purpose of the condition assessment is to document the existing facility conditions and help establish priorities for the City's wastewater treatment plant repair and rehabilitation (R&R) CIP. The findings from the condition assessment were incorporated into the CIP.

In May 2015 a condition assessment was performed to assess the current condition of existing structures and equipment and document observations made by plant staff. In general, the plant appears to have been maintained as much as the maintenance budget has allowed. However, findings from the assessment indicate that a majority of the mechanical equipment has exceeded its expected life, and that major structures are also starting to approach the end of their useful life. Finally, plant staff indicated that some capital and maintenance projects had been deferred, pending the outcome of this project. That has meant that staff has struggled to meet permit limits and keep existing equipment operational, while normally it may have been replaced.

Figure 1.7 provides a summary of the overall condition assessment rankings by unit process. Any process with a ranking greater than 3 (fair) requires some attention and rehabilitation or replacement in the near future.

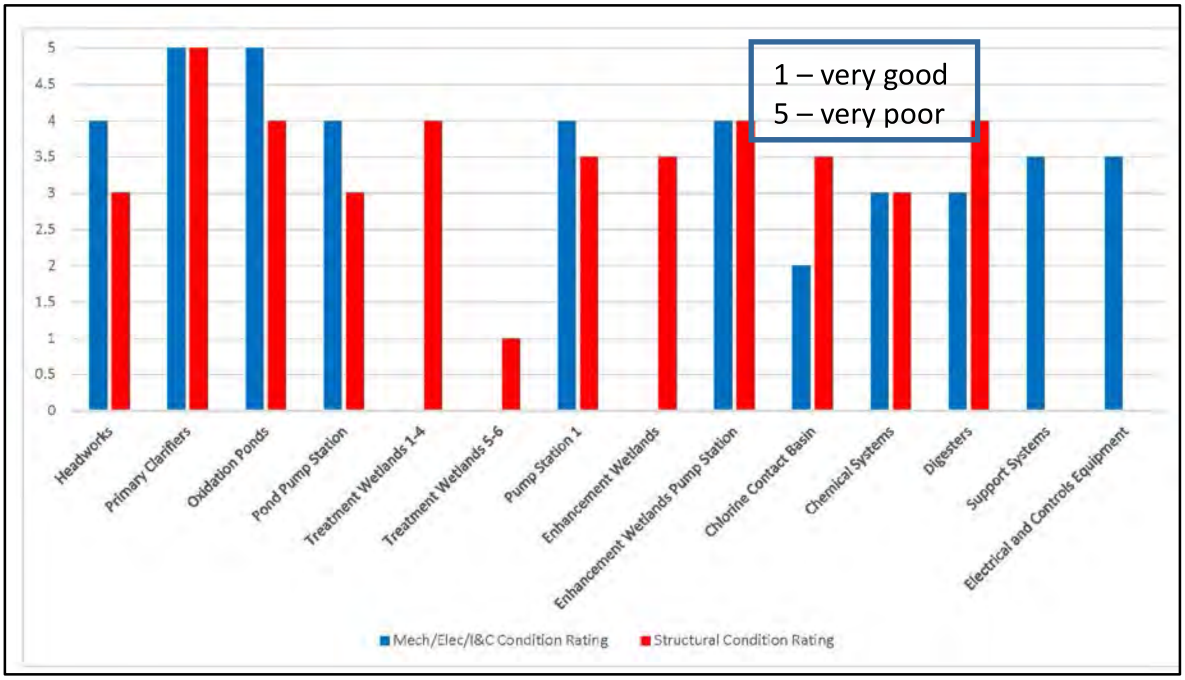


Figure 1.7 AWTF Facility Condition Rating

1.6 PHILOSOPHY IN DEVELOPING ALTERNATIVES AND CIP

Based on the findings of the existing facilities review of capacity and condition, paired with the need for permit compliance requires that the City develop a Capital Improvement Plan (CIP) to improve the system. This CIP must include a method to address the secondary capacity shortfall, which can be accomplished in a number of ways. The overall philosophy of the alternatives evaluation and CIP development can be summarized as follows:

- Achieve 100% Permit Compliance.
- Provide reliable capacity to meet current and General Plan future flow and loads.
- Maximize use of existing natural system.
- Address deferred maintenance.
- Address aging infrastructure.

1.6.1 Summary of Common Improvements Needed

Based on the condition assessment and capacity evaluations, numerous facilities will need to be improved in the next ten years based on their expected useful life and current condition. In addition, there are many common elements needed for the new flow configuration.

1.6.1.1 Permit Required Projects

The following common projects are required by the 2012 NPDES permit.

- **Outfall 003 and Flow Configuration**: The NPDES permit establishes a flow configuration to convert to a single pass disinfection system and discharge through a new outfall (Outfall 003) of 5.9 mgd. Piping, screening, pumps, and pump station modifications are required to switch to single pass flow through the system. The location of Outfall 003 is shown in Figure 1.8.

- **UV Disinfection:** A new UV disinfection system will be constructed for disinfection of secondary effluent up to 5.9 mgd. The UV process will eliminate the disinfection by-product formation and permit violations that are occurring with the use of chlorine.

Figure 1.8 New and Existing Outfall Locations

1.6.1.2 Replace/Repair Aging Infrastructure

The following projects are needed to address aging infrastructure:

- **Headworks Improvements**: The recommended headworks improvement is to replace structural and mechanical assets due to age and condition, and to upsize the capacity to handle design peak wet weather flow (PWWF) of 5.9 mgd. Replacing the headworks structure will also raise the hydraulic grade line at the start of the plant, allowing downstream facilities to flow by gravity and minimizing the need for additional pumping.

- **Primary Clarifiers**: The two primary clarifiers are currently rated at 4.0 mgd and 1.0 mgd each, and the visual condition assessment rated the average mechanical, electrical and I&C condition as very poor. The recommended improvement is to replace structural and mechanical assets due to age and condition. As part of this improvement the primary sludge and scum pumps would also be replaced.

- **Anaerobic Digesters and Sludge Heating/Mixing System**: The two anaerobic digesters are almost 60 years old. The external visual condition assessment rated the average structural condition as fair but the internal structural condition is unknown. The sludge heating and mixing system appears to be in good to fair condition. The recommended improvement is to improve structural and mechanical assets in phases.

1.6.1.3 Address Deferred Maintenance and Maximize Existing Natural System

The following projects will restore the natural treatment processes:

- **Oxidation Pond Improvements**: Solids accumulation in the oxidation ponds is affecting treatment and hydraulic capacity. Between one to two feet of solids in each pond is anticipated needing dredging, dewatering, and disposal in order to return the ponds to original design intent. Reconfiguration of the pond transfer structures is recommended for better flow distribution and improvement of storage capacity.
- **Treatment Wetland Nos. 1 through 4 Solids and Vegetation Maintenance**: Solids accumulation and heavy vegetation growth in Treatment Wetland Nos. 1 through 4 is affecting treatment and hydraulic capacity. Some solids removal, regrading of the deep and shallow water zones, and vegetation replanting is anticipated in the four older treatment wetlands in order to return them to original design intent (Figure 1.9). No maintenance project is currently planned in Treatment Wetland Nos. 5 and 6 due to their recent construction.

Figure 1.9 Treatment Wetlands will be improved

- **Treatment Wetland 7**: Construction of new Treatment Wetland No. 7 is recommended. This project would convert an existing aquaculture pond into a new 2.3 acre treatment wetland, increasing the hydraulic capacity of the treatment wetlands from 1.8 mgd to 2.3 mgd. This project may require additional permitting requirements.
- **Enhancement Wetlands Improvements:** Solids accumulation and heavy vegetation growth in the enhancement wetlands is affecting treatment and hydraulic capacity. As Waters of the State, major regrading or any activities that significantly reduce water quality or habitat will not be allowed in the enhancement wetlands. Vegetation maintenance, new baffles, and new inlet/outlet structures is anticipated in all three enhancement wetlands in order to improve treatment and hydraulic efficiency and capacity.

1.6.1.4 Provide Reliable Capacity

The following projects address capacity limitations:

- **Pump Stations Improvements**: There are numerous pump stations that need replacement due to age and insufficient capacity. These include the emergency pond pump station, which should be modified for adding suction and discharge piping to allow the pump station to pump out of Pond 1 and into Pond 2 for Pond 1 storage control. Other pump station improvements included pond pump station and pump station 1, treatment wetlands No 4 pump station, treatment wetlands pump station 2 and the enhancement wetlands pump station.

- **Secondary Capacity Augmentation:** A secondary process capacity augmentation project is required to address the capacity shortfall of the existing processes, especially without the chemical treatment removal that occurs with the chlorination process that is being retired. The alternatives for this project are discussed in the next section.

1.7 SECONDARY TREATMENT ALTERNATIVES

Identification of secondary treatment options is needed to address the BOD capacity shortfall. This task was completed in phases. The first phase consists of a preliminary screening of new secondary treatment options to be used in conjunction with the existing natural system for pretreatment, parallel treatment, or post treatment. Any of these treatment options deemed feasible were further discussed and evaluated with the City.

1.7.1 Preliminary Screening of Secondary Treatment Options

There are several treatment processes that can be used to provide additional secondary treatment capacity, either alone or in combination with other processes, in order to achieve desired effluent water quality. Table 1.3 provides a list of secondary treatment processes that are commonly considered, along with the constituents they most commonly remove. Removal of ammonia and total nitrogen was considered for future flexibility in meeting ever increasingly stringent permit requirements. Based on the June 27, 2016 meeting with the RWQCB, it is expected that ammonia removal will be required in the 2017 NPDES permit.

Table 1.3 Secondary Processes Meeting Permit Discharge Requirements
Wastewater Treatment Facility Improvements Project
City of Arcata

Process	Ability To Remove		
	Organics (BOD)[(1)]	Ammonia[(2)]	Total Nitrogen[(2)]
Suspended Growth			
Activated Sludge (oxidation ditch)	√	√	√
Attached Growth			
Trickling Filters	√		
Nitrifying Trickling Filters		√	
Denitrification Filters			√
Land Based Systems			
Ponds (Aerated or Not)	√	Summer only	
Vegetated Wetlands	√	Limited	If nitrified before
Open water wetlands	√	Some	If nitrified before

Notes:
(1) Current permit discharge requirement.
(2) Anticipated future permit discharge requirement.

While there are variations of activated sludge processed such as Oxidation Ditch, Conventional Activated Sludge, Sequencing Batch Reactors, or a Membrane Bioreactor that adds a membrane filter, the biological treatment process is the same. Similarly, there are various attached growth processes that incorporate different types of media that the biological growth attaches to, but the treatment process is essentially the same.

In addition to the secondary processes presented above, there are some physical and chemical processes that could be considered. There are several approaches that could be taken with any additional treatment process: 1) pre-secondary treatment (pretreatment) by adding processes before the existing pond/wetlands system, 2) parallel secondary treatment, and 3) post-secondary treatment (post treatment, after the pond/wetlands). Each alternative considered needs to fit with a final UV disinfection step, as the City Council has affirmed several times the decision to move away from chlorine and instead use UV. Initial options that fall into each of these categories are shown in Table 1.4.

Table 1.4 Initial Screening of Pre, Parallel and Post Treatment Options
Wastewater Treatment Facility Improvements Project
City of Arcata

	Treatment Option	Adds BOD capacity	Removes ammonia	Improves final UVT	Reliable	Move forward
Pretreatment	Chemically Enhanced Primary	< 400 ppd	No	No	Yes	No - high O&M cost
Pretreatment	Aeration	yes	limited	No	Yes	Yes
Pretreatment	Trickling Filter	yes	only if 2-stage	No	Yes	No
Pretreatment	Activated Sludge	Yes	Yes	No - TM degrades	Yes	No
Parallel	Additional Ponds/Wetlands	Yes	Summer only	No	Maybe	No - no room
Parallel	Rehabilitate Ponds/Wetlands	Yes - not enough	Summer only	No	Maybe	Yes
Parallel	Trickling Filter	Yes	only if 2-stage	No	Yes	Yes
Parallel	Activated Sludge	Yes	Yes	Yes	Yes	Yes
Post Treatment	Trickling Filter/Nitrifying Trickling filter	Yes	only if 2-stage	No	No - cold affects performance	No - not as flexible
Post Treatment	Submerged Biofilter	Not proven	Need to pilot	No	Unknown	No
Post Treatment	Ozone/Biological active Filtration	Yes	Maybe - must pilot	Not needed	Maybe - must pilot	No -Need to pilot
Post Treatment	Filtration	< 400 ppd	No	Maybe	Yes	No -Need to pilot

Of the options considered, there are only a few that Carollo recommends carrying forward for a variety of reasons. Any process that requires piloting at the AWTF was eliminated to meet the accelerated schedule for permit compliance. Any process that is not yet a proven technology with full-scale installation experience was also eliminated early in the alternatives analysis. Several processes would not provide enough capacity (such as chemically enhanced primary treatment and filtration. Attached growth processes were considered less reliable and less flexible for meeting future ammonia and nutrient removal requirements. In addition, attached growth processes do not improve UV transmittance (UVT), which makes UV disinfection more expensive. Additional pond and wetland processes require additional land and no land is available.

The options carried forward are:

- The viable pretreatment alternative to be further considered is aeration in Pond 2.
- The viable parallel treatment alternatives to be further considered are rehabilitation of the ponds/wetlands, trickling filters, and activated sludge.
- None of the post treatment alternatives will be further considered.

At the November 5 and 6, 2015 facility plan capacity workshop with the City staff and City consultant Bob Gearheart (with AMRI), a more detailed analysis of parallel secondary treatment options was discussed, including:

- Conventional activated sludge (CAS) aeration basins.
- Extended aeration activated sludge (oxidation ditch).
- Trickling filters.
- Modifying existing oxidation ponds to a Biolac system or aerated lagoons.

As discussed at the workshop, modifying the existing oxidation ponds to a Biolac system or aerated lagoons was deemed not feasible due to constructability issues with the berms and pond depths. During the November 2015 workshop, discussion of the treatment options included a number of considerations including performance, footprint, constructability, operation and maintenance requirements, and economic factors. A summary of the non-economic evaluation is outlined in Table 1.5. A summary of the economic evaluation is outlined in Table 1.6.

Table 1.5 Secondary Treatment Options Evaluation of Non-Economic Factors
Wastewater Treatment Facility Improvements Project
City of Arcata

	Criteria Scale: 1 (least favorable) to 3 (most favorable)					
Option	**Safety**	**Meets Permit**	**Ease of O&M**	**Construct-ability**	**Reliability**	**Ammonia Removal**
Conventional Activated Sludge	2	3	1	3	3	2
Extended Aeration – Oxidation Ditch	2	3	3	2	3	3
Trickling Filters	3	1	3	2	1	1

Table 1.6 Secondary Treatment Options Evaluation of Economic Factors
Wastewater Treatment Facility Improvements Project
City of Arcata

	Criteria Scale: 1 (least favorable) to 3 (most favorable)					
Option	**Construction Cost**	**Footprint**	**Operator Attention**	**Power Cost**	**Sludge Production**	**Maintenance Requirement**
Conventional Activated Sludge	3	3	1	1	1	1
Extended Aeration – Oxidation Ditch	2	1	2	2	2	3
Trickling Filters	1	2	3	3	3	2

Given the need to identify a system that is simple to operate, low maintenance and yet provides high reliability in meeting a high quality effluent, the preferred alternative was an extended aeration oxidation ditch process, shown in Figure 1.10. Compared to the oxidation ditch, conventional activated sludge requires greater operator attention and complexity; trickling filters do not provide as much reliability for treatment nor flexibility for future regulations; oxidation pond modifications have a greater risk of permit violations during long-term operation and do not allow for storage of peak wet weather flows in Pond 1.

Figure 1.10 Example of Proposed Oxidation Ditch Secondary Treatment

1.7.2 Project Alternative Development

The viable options identified in the screening process were further refined as project alternatives that address how the facility would perform as a system. Project alternatives consider facility-specific issues such as flow routing, hydraulic and treatment capacity of individual processes, and process improvement or replacement needs based on condition assessment. The goal of each project alternative is to provide a facility that maximizes use of the existing natural system while meeting treatment and permit compliance objectives.

Based on the findings of the preliminary and secondary screening as well as feedback received at presentations made to City Staff, the public and City Council in April 2016, three project alternatives were developed.

1.7.2.1 Alternative 1 - Existing System Rehabilitation

This alternative improves the existing natural treatment system with no supplemental secondary treatment process. This alternative does not provide the required capacity to meet the BOD capacity shortfall. In the past the shortfall was made up by use of chlorine for supplemental BOD removal. This alternative will not provide year-round nitrification removal, and therefore will not be able to meet the anticipated monthly average ammonia requirements. This alternative was conceptualized by AMRI and further evaluated by Carollo to meet treatment and permit compliance objectives. Pond solids would be removed, the treatment wetlands would be improved, and Treatment Wetlands No. 7 would be constructed. Aeration would be added to the ponds to provide some supplemental capacity, but a 1000 ppd BOD removal deficiency at 20 percent growth projection is still anticipated. The Alternative 1 flow schematic is shown in Figure 1.11.

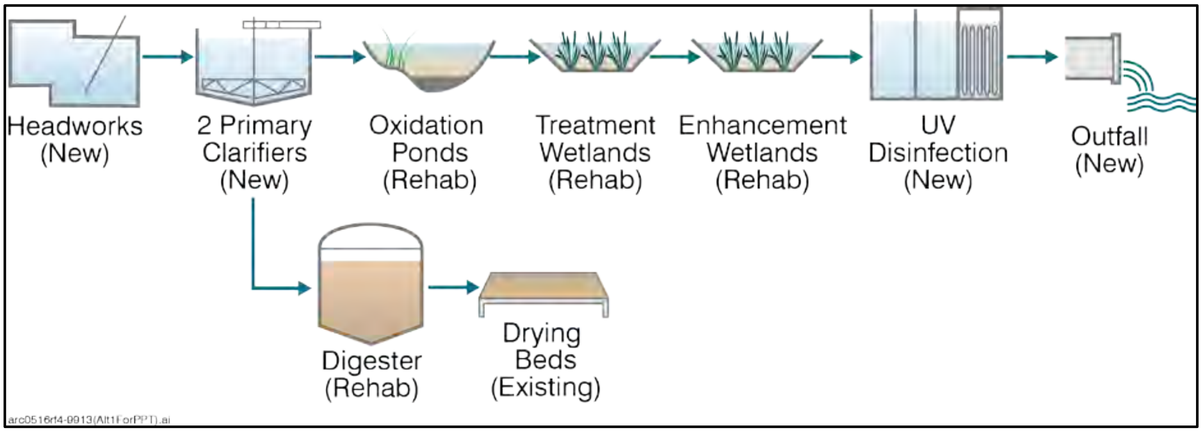


Figure 1.11 Alternative 1 - Existing System Rehabilitation

1.7.2.2 Alternative 2 - Existing System with Side-stream Treatment

This alternative provides a side-stream secondary treatment process parallel to the ponds and treatment wetlands that returns flow upstream of the enhancement wetlands. The ponds and treatment wetlands would continue treating the majority of the plant influent flow and would be improved, just as in Alternative 1. The side-stream treatment process would treat a portion of the plant influent flow as needed for supplemental BOD and year-round partial nitrification treatment capacity. An oxidation ditch is the planned side-stream treatment technology and would be operated at approximately 0.5 mgd during dry weather and able to handle additional flows during wet weather or during periods of pond turnover. Both effluents would normally blend before passing through the enhancement wetlands and UV disinfection. The Alternative 2 flow schematic is shown in Figure 1.12.

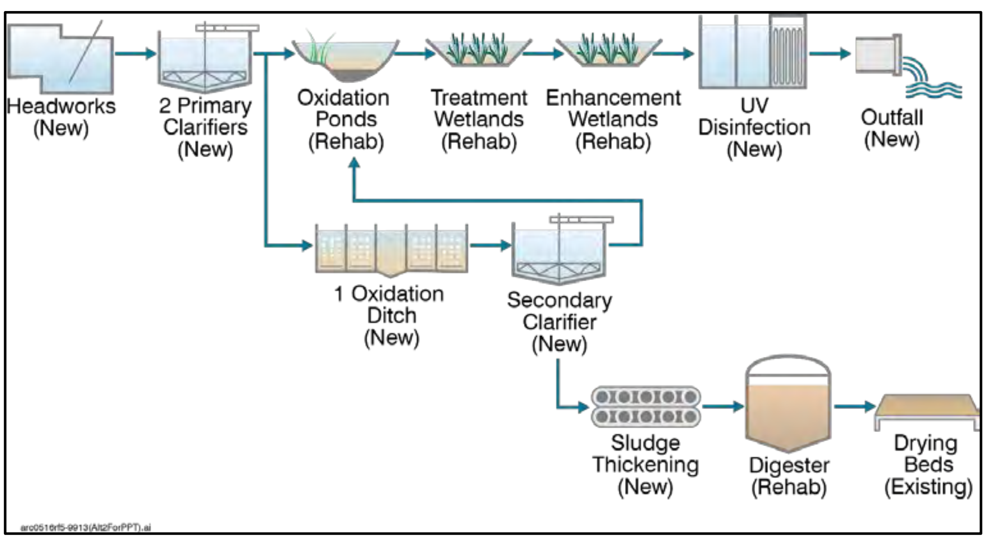


Figure 1.12 Alternative 2 - Existing System with Side Stream Treatment

1.7.2.3 Alternative 3 - Existing System with Parallel Treatment

This alternative provides a parallel secondary treatment process to the ponds, treatment wetlands, and enhancement wetlands. The natural system train and parallel process train would each treat a portion of the plant influent flow at variable percentages to provide a blended effluent meeting treatment objectives. The natural system would continue treating the majority of the plant influent flow up to available hydraulic and treatment capacity and would be improved, just as in Alternative 1 with the exception of the pond aerators, which are not necessary. The parallel process train, currently planned as oxidation ditches followed by secondary clarifiers, would provide BOD and year-round full nitrification treatment capacity to handle the remainder of the hydraulic capacity needs and to meet specific blended water quality requirements. The parallel process would be sized to turn down to 0.5 mgd in dry weather and be able to handle up to 4.1 mgd of wet weather flow. Natural system effluent and parallel process effluent would combine prior to UV disinfection. The higher quality water (higher UVT) produced by the oxidation ditch system and blended with the natural treatment system allows the UV disinfection system to be downsized. The Alternative 3 flow schematic is shown in Figure 1.13.

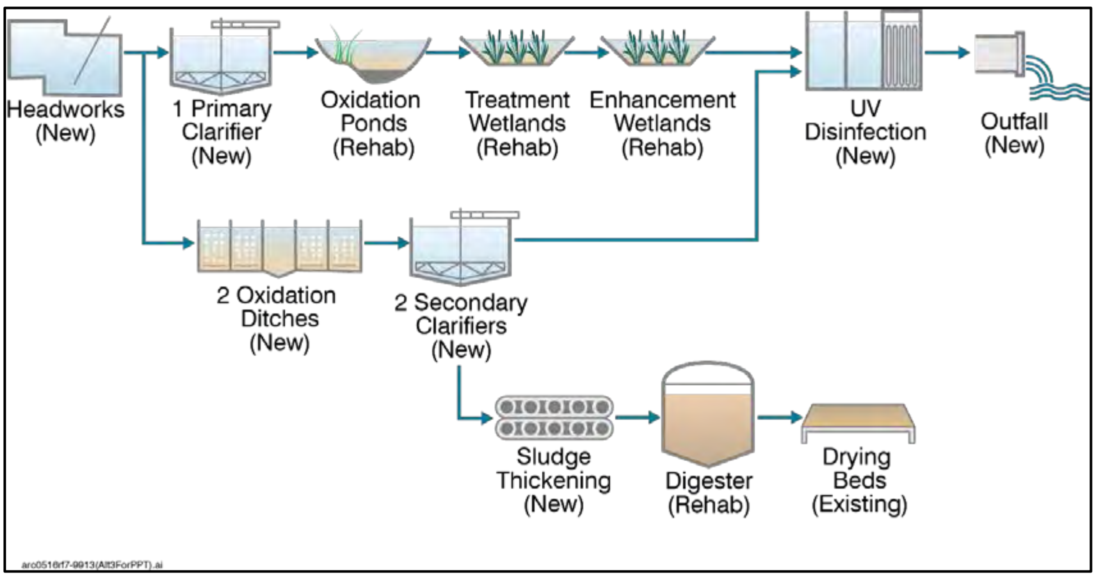


Figure 1.13 Alternative 3 - Existing System with Parallel Treatment

1.7.3 Alternative Comparison and Recommendation

A comparison of the alternatives using non-economic factors is summarized in Table 1.7.

Table 1.7 Summary of Alternative Comparison for Non-Economic Factors Wastewater Treatment Facility Improvements Project City of Arcata					
	Criteria Scale: 1 (least favorable) to 3 (most favorable)				
Alternative	**Meets Permit**	**Ease of O&M**	**Construct-ability**	**Reliability**	**Ammonia Removal**
1. Existing System Rehabilitation	1	3	1	1	1
2. Existing System with Side-stream Treatment	2	1	2	2	2
3. Existing System with Parallel Treatment	3	2	3	3	3

The alternatives are also compared based on economic criteria (project cost, operation and maintenance cost, and overall lifecycle cost) as shown in Table 1.8. Costs presented in this Facility Plan are project costs and include construction, engineering, legal, administrative, and permitting costs, as well as estimating contingencies. The costs are presented in 2016 dollars and are based on a San Francisco Engineering News Record Construction Cost Index. Costs are not escalated to future years. Cost estimates presented in the Draft Facility Plan were developed based on 10 percent community growth that was originally anticipated by the City. Cost estimate updates to reflect the 20 percent growth projection are shown with an additional 10 percent of the original secondary and solids costs.

Table 1.8 Cost Comparison of Treatment Alternatives
Wastewater Treatment Facility Improvements Project
City of Arcata

Alt.	**Description**	**Total Project Cost With 10% Growth(1)**	**Total Project Cost With 20% Growth(1,4)**	**O&M Cost**		**Lifecycle Cost(3,4)**
				Annual(2)	**Present Worth(3)**	
1	Existing System Rehabilitation	$35.1	$35.2	$0.67	$5.7	$40.9
2	Existing System Rehabilitation with Side-stream Treatment	$44.7	$45.7	$0.75	$6.4	$52.1
3	Existing System Rehabilitation with Parallel Treatment	$43.8	$45.5	$0.43	$3.7	$49.2

Notes:
(1) Costs are based on 2016 dollars, in millions, using SFENR construction cost index.
(2) Annual O&M costs include only differential O&M costs, and do not include O&M costs which are common to all alternatives (such as influent pumping).
(3) Lifecycle cost is total project cost plus present worth value of annual O&M costs. Annual O&M costs were converted to present worth value based on 3 percent inflation rate, 6 percent discount rate, and 10-year analysis period.
(4) Estimated total project cost and lifecycle cost is updated with additional anticipated growth subsequent to the June 13, 2016 Council meeting. Additional cost for 20% growth projection based on adding 10% to secondary and solids costs.

Alternative 3, rehabilitation of the existing natural system with a parallel secondary treatment process, provides the highest rankings for permit compliance, constructability, reliability and future compliance with ammonia removal (which may also help reduce effluent toxicity). Alternative 3 is anticipated to meet current permit requirements for enhancement through advanced secondary treatment with nitrification, providing full BOD treatment capacity without disinfection byproduct violations, as well as meeting future ammonia permit limits year-round. It also has the ability to provide treatment and enhancement without requiring bypass operations, meeting the requirements of the Enclosed Bays and Estuaries Policy. This alternative is anticipated to be lower in capital cost than Alternative 2 as some project elements can be eliminated or decreased. This alternative is anticipated to require the largest footprint in the treatment plant.

Alternative 1, rehabilitation of the existing natural system, fairs poorly because the BOD treatment capacity is limited in the existing natural system and therefore creates risk for permit violations. Additionally, during construction of the improvements to Alternative 1, there is a higher risk of violations due to additional stress on an already under-capacity system. Project elements to increase BOD treatment capacity include sludge removal in Ponds 1 and 2, adding aerators to Pond 2, and construction of Treatment Wetland No. 7; however, even with these improvements there will be a BOD treatment capacity shortfall with the elimination of chlorine. This would result in permit violations and mandatory minimum penalties. Increasing the growth projection from 10 to 20 percent increases the BOD treatment capacity shortfall, which will be difficult to address in Alternative 1 without an additional secondary treatment process. Furthermore, future ammonia permit limits may not be met year-round with Alternative 1 without an additional nitrification process. Per discussions with the RWQCB, effluent discharge bypassing enhancement is a violation of permit requirements. Alternative 1 currently requires up to 3.6 mgd to bypass the Enhancement Wetlands due to capacity limitations, which does not meet permit objectives.

In Alternative 2, a BOD treatment capacity shortfall would be supplemented by the side-stream secondary treatment process of one oxidation ditch and one secondary clarifier. Increasing the growth projection from 10 to 20 percent increases the BOD treatment capacity shortfall, which could be addressed in Alternative 2 by increasing capacity in the oxidation ditch. Alternative 2 is anticipated to meet current permit requirements for enhancement through advanced secondary treatment with nitrification, providing full BOD treatment capacity without disinfection byproduct violations, as well as potentially meeting future ammonia permit limits year-round. However, this alternative is anticipated to be the highest capital cost as it requires the most project elements.

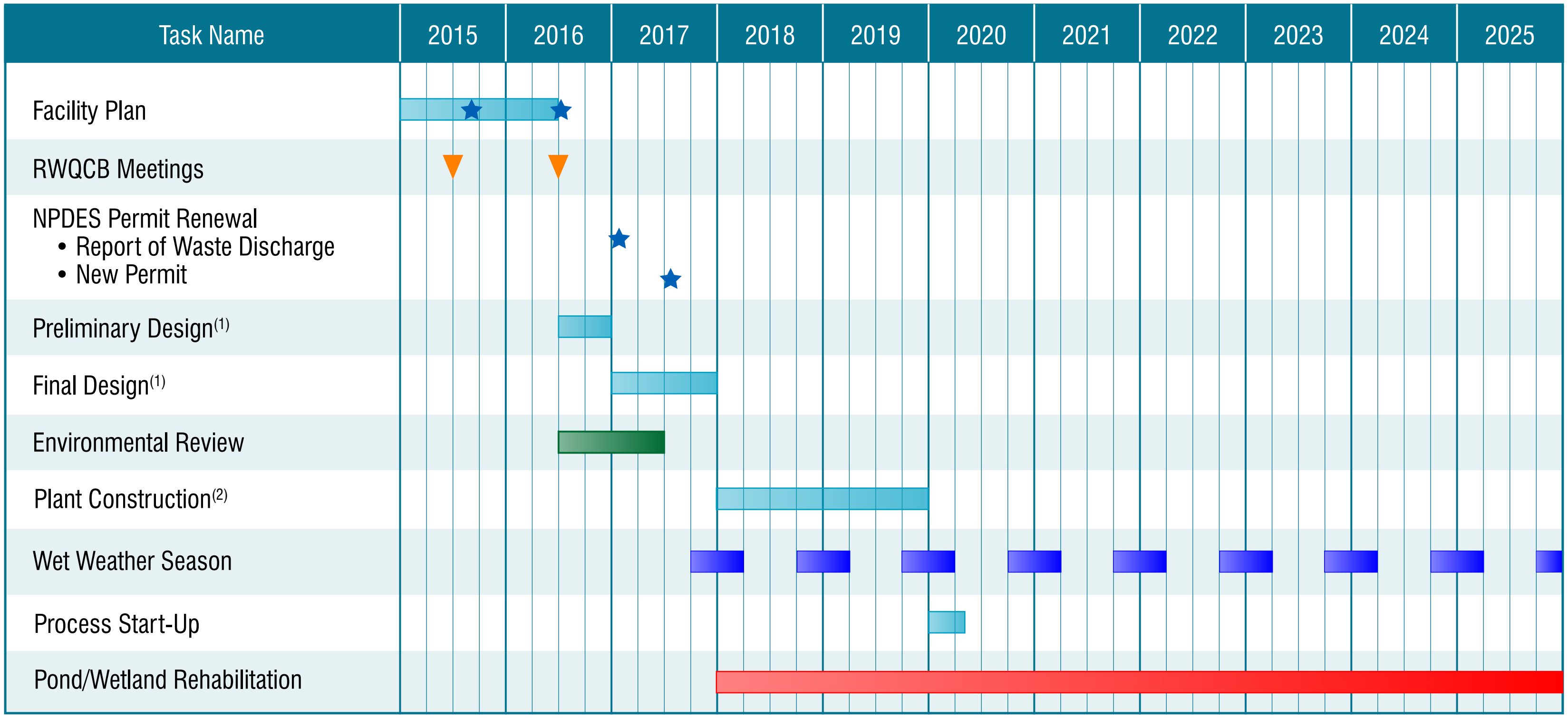
Based on these comparisons, both economic and non-economic, Carollo and LACO recommend proceeding with preliminary design of Alternative 3.

1.8 NEXT STEPS AND IMPLEMENTATION SCHEDULE

The AWTF will undergo a number of changes over the next 20 years in order to both meet permit requirements and address the ongoing needs of maintaining this vital City asset. The recommended project as outlined above will meet permit requirements, address R&R needs, and address capacity for the AWTF will including the following:

- Preliminary and final design
- Submittal of a Report of Waste Discharge to the RWQCB by January 2017 to start permit renewal. New NPDES permit expected July 2017.
- Environmental review and permitting.
- Funding Application Process for State Revolving Fund program for loans and grants.
- Bidding and award.
- Construction and start up.

A preliminary implementation schedule is shown in Figure 1.14. The schedule has been extended to account for the need to get the current facility plan approved, and then complete preliminary and final design. Construction (of the majority of the mechanical and structural elements) is shown in 2018 and 2019, with final commissioning and startup in late 2019 and early 2020. The construction will cover the dry weather periods of both 2018 and 2019, and should allow for all the work to be completed while maintaining the existing plant in operation. Wet weather periods are also shown in the schedule as construction during these periods is difficult. The Pond and Wetlands rehabilitation is shown as a separate line item as these projects may be performed by City staff as opposed to a contractor and due to the extended construction time expected. The wetlands in particular will take longer to rehabilitate due to the need to regrade during dry season, plant and let the plants get established (approximately a 2 year cycle before performing as expected).



NOTES:

(1) To be finalized after completion of the Facility Plan.

(2) Construction schedule is preliminary, constraints TBD.

UPDATED IMPLEMENTATION SCHEDULE

FIGURE 1.14

CITY OF ARCATA

WASTEWATER TREATMENT PLANT IMPROVEMENTS PROJECT

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REGULATORY REQUIREMENTS AND PERMIT COMPLIANCE

2.1 INTRODUCTION

The City of Arcata (City) owns the wastewater collection, treatment, and disposal facilities that serve approximately 16,800 residents, including 8,000 students, in the service area (City and the unincorporated community of Glendale). The Arcata Wastewater Treatment Facility (AWTF) is located at 600 South G Street in Arcata, Humboldt County, California. The AWTF in its varying forms has been discharging to Humboldt Bay since about 1949. The AWTF currently discharges treated wastewater to Humboldt Bay in conjunction with enhanced treatment occurring in the Arcata Marsh Wildlife Sanctuary (AMWS), which are constructed freshwater wetlands adjacent to the treatment facility.

The AWTF is recognized around the world for providing sustainable treatment with community and environmental benefits. Within the City's sustainability goals and initiatives that impact environmental, economic, and social realms ("triple bottom line"), National Pollutant Discharge Elimination System (NPDES) permit compliance is at the core of each category. Permit compliance protects the environment, reduces economic risk from violation penalties, and promotes a safe community.

The AWTF provides primary and secondary treatment followed by disinfection. Primary treatment facilities include influent pumping, mechanical bar screens, grit removal, and primary clarifiers. Primary solids are sent to anaerobic digesters, sludge drying beds, and sludge composting. Secondary treatment is accomplished through two oxidation ponds in series, followed by six treatment marshes operating in parallel. Currently, secondary effluent is disinfected with chlorine gas and dechlorinated with sulfur dioxide prior to discharge. Under the existing flow configuration, for about 9 months every year, a portion of the treated effluent is sent to the AMWS for enhanced treatment while the remainder is discharged to Humboldt Bay via Outfall 001. Effluent out of the AMWS is returned to the chlorine contact basin for a second step of disinfection and dechlorination. The result is disinfected secondary effluent that does not receive all the enhancement benefits of the AMWS and is chlorinated multiple times, increasing the opportunity for formation of disinfection byproducts above water quality objectives.

2.2 PURPOSE

The purpose of this chapter is to:

- Discuss compliance history of the AWTF leading up to the current NPDES permit, including review of available compliance data in the last three years to identify current permit issues.
- Review the current NPDES permit compliance requirements.

- Discuss potential future permit requirements in the State and for Humboldt Bay dischargers.

2.3 BACKGROUND

Adopted on May 16, 1974, Resolution No. 74-43, known as the Enclosed Bays and Estuaries Policy, prohibits the discharge of municipal wastewater and industrial process water to enclosed bays and estuaries “unless the discharge enhances the quality of the receiving water above that which would occur in the absence of the discharge.” The Enclosed Bays and Estuaries Policy enhancement criteria is defined as, "…(1) Full uninterrupted protection of all beneficial uses which could be made of the receiving water body in the absence of all point source discharge(s) along with (2) a demonstration by the applicant that the discharge, through the creation of new beneficial uses or fuller realization, enhances water quality for those beneficial uses which could be made of the receiving water in the absence of all point source discharges..."

In 1983, the Regional Water Board adopted Resolution No. 83-9, granting the City of Arcata a waiver, as defined in Chapter I, Paragraph A of the Bays and Estuaries Policy, permitting continued [Humboldt] Bay discharge. Resolution No. 83-9 found that the marsh disposal alternative meets the definition of enhancement set forth in State Board Order No. 79-20 because the waste would achieve secondary treatment standards, create no adverse impacts to present beneficial uses and the discharge would create new beneficial uses and wildlife habitat. As a result, the AMWS is an integral part of the AWTF and a valued part of the Arcata community providing numerous non-contact recreation and educational opportunities.

In 2012, the AWTF began operating under a new National Pollutant Discharge Elimination System (NPDES) permit that specifically addressed several long-term issues regarding disinfection, treatment units, and outfalls. The new permit enabled changes to be made to improve wastewater treatment, protect beneficial uses, increase energy efficiency, reduce chemical usage, and reduce the potential for permit violations. The NPDES Permit (No. CA0022713) and Waste Discharge Requirements Order (No. R1-2012-0031) were issued by the North Coast Regional Water Quality Control Board (RWQCB), and became effective on August 1, 2012. The permit was subsequently modified in 2015. The permit will be up for renewal on August 1, 2017.

The permit approves a new flow configuration and discharge point. Effluent flows will no longer discharge directly to Humboldt Bay (Outfall 001), but will be discharged after enhanced treatment in the AMWS. The new point of compliance and outfall (Outfall 003) will be to the brackish marsh adjacent to the AMWS, which discharges into a slough at the north end of the Arcata Bay portion of Humboldt Bay. The permit also includes approval of a new disinfection process using ultraviolet light (UV) disinfection facilities prior to Outfall 003. Until the improvements are complete, the AWTF is operating under interim effluent limits for discharge to Outfall 001, which are essentially the same as the final compliance requirements for Outfall 003. Discharge requirements for the intermediate discharge point to the AMWS (Outfall 002) are also noted in the permit. The location of the facilities and outfalls are shown in Figure 2.1. The major water quality standards established in the NPDES permit are shown in Table 2.1. The NPDES/WDR permit is included in Appendix A for a complete list of required standards.

Table 2.1 Summary of 2012 NPDES Requirements
Wastewater Treatment Facility Improvements Project
City of Arcata

Constituent	Average Monthly	Average Weekly	Max Daily
Flow, mgd	2.3 average dry weather 5.0 average wet weather 5.9 peak wet weather		
Outfall 001 - Humboldt Bay (Final/Interim limits)			
BOD_5, mg/L	45/30	65/45	
TSS, mg/L	66/30	95/45	
Fecal Coliform MPN/100 ml	14		43
Dichlorobromomethane, ug/l	0.56		1.12
Outfall 003 - Brackish Marsh			
BOD_5, mg/L	30	45	
TSS, mg/L	30	45	
Fecal Coliform MPN/100 ml	14		43
Outfall 002 - AMWS			
BOD_5, mg/L	45	65	
TSS, mg/L	66	95	

2.4 PERMIT COMPLIANCE HISTORY

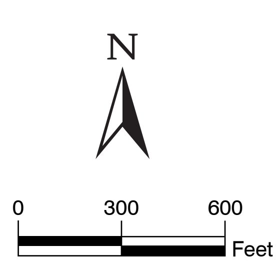
Since the original plant design, the regulatory climate and enforcement world has significantly changed. Mandatory minimum penalties were implemented by the State Water Resources Control Board (SWRCB) in 1999, and began to be enforced in 2006. Today, the

LEGEND

- Pump Station
- Existing Flow Schematic
- Proposed Flow Schematic

EXISTING PONDS

- AMWS Enhancement Marshes
- Oxidation Ponds
- Treatment Marsh
- Brackish Marsh
- Wastewater Treatment Facility



AWTF RECONFIGURATION AND OUTFALL LOCATIONS

FIGURE 2.1

CITY OF ARCATA
WASTEWATER TREATMENT FACILITY IMPROVEMENTS PROJECT

carollo

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regulatory climate is increasingly stringent. Occasional permit non-compliance is no longer acceptable to the SWRCB, environmental conservation groups, or the general public.

The mission of the SWRCB is:

> ***To preserve, enhance, and restore the quality of California's water resources and drinking water for the protection of the environment, public health, and all beneficial uses, and to ensure proper water resource allocation and efficient use, for the benefit of present and future generations.***

The SWRCB and the nine RWQCBs are charged with protecting water quality. Doing so requires regular updates to regulatory requirements based on the latest research and data. As a result, NPDES permits are consistently getting more stringent over time.

2.4.1 2004-2015 Compliance Review and Permit Violations

A review of available information from 2004 to 2015 was conducted to understand the history of permit compliance and permit violations at the AWTF.

Based on review of the 2012 permit and input from the City, a history of permit violations from 2004 to 2011 are summarized:

- On June 12, 2008, the North Coast RWQCB issued Administrative Civil Liability (ACL) Order No. R1-2008-0048 to the Permittee assessing a civil liability of $104,000 for violations of Order No. R1-2004-0036 for the period from June 22, 2004, to March 31, 2007. Most violations of waste discharge requirements in this time period were related to discharges of biochemical oxygen demand (BOD), total suspended solids (TSS), percent removal, coliform bacteria, copper, and cyanide, and for sewer system overflows. A portion of the liability is being held in abeyance pending resolution of legal matters, a portion has been paid to the State Water Pollution Cleanup and Abatement Account, and a portion was suspended pending satisfactory completion of a Supplemental Environmental Project and two collection system projects proposed by the Permittee.
- On May 19, 2010, an ACL Compliant was issued to the Permittee for five sanitary sewer overflows and copper effluent violations. ACL sought for the alleged violations totaled $83,300.
- In 2011, Mandatory Minimum Penalties (MMPs) of $9,000 were assessed for percent removal, coliform bacteria, and copper violations.

The 2013 and 2014 Annual Wastewater Treatment Reports for the AWTF were briefly reviewed to identify any potential compliance issues for Outfall 001. The 2014 report noted 27 incidences of non-compliance issues for the Outfall 001 requirements including:

- Effluent limit violations on 18 occasions, including 1 noncompliant sample for disinfection, 1 noncompliant sample for BOD removal, and several excursions of effluent TSS. It was noted that weather, and the current drought have impacted the plant operation, and may have been a contributing issue for the TSS violations.

- A brief excursion in the disinfection of the final effluent in August 2014 for up to 10 minutes resulted in incomplete disinfection. This resulted in effluent fecal coliform counts of 49 MPN/100ml.
- One chronic whole effluent toxicity test in March 2014 that appeared to indicate effluent toxicity.
- Exceedances of the plant effluent copper requirement have historically been an issue. Seven times the monthly average was exceeded and twice the daily maximum was exceeded. However, according to plant staff, these exceedances have, for the most part, been resolved due to the fact that water effects ratios (WERs) have been applied to the effluent copper limitations for Outfalls 001 and 002. It is anticipated that a WER will also be applied to Outfall 003. Therefore these have not been included in the 18 violations counted above.
- Exceedances of the Dichlorobromomethane limit twice for daily maximum and twice for monthly maximum in July and October 2014.

In 2013, there were 22 effluent limit violations for Outfall 001. Most of these were similar to the issues reported in the 2014 Annual Report.

On June 15, 2015 the State Board Office of Enforcement conducted an inspection of City wastewater facilities under the Statewide General Waste Discharge Requirements for Sanitary Sewer Systems to assist the Regional Board in enforcement action. Although the inspection was primarily conducted for compliance with the sanitary sewer system permit, the inspectors also reviewed a handful of NPDES discharge violations during the inspection and indicated that they would be reviewing violations since June 2012 for enforcement action including assessment of Mandatory Minimum Penalties (MMPs). Table 2.2 summarizes the violations by year and location from 2013 to 2015. Appendix B shows all of the violations that have occurred since the last ACL was issued.

Although MMPs are not being assessed for violations at Outfall 002 since the AMWS receiving water is not designated a water of the United States, water quality compliance at Outfall 002 is still crucial. Violations of discharge standards at Outfall 002 could be subject to discretionary penalties. A review of the 2013 and 2014 annual reports indicate 13 exceedances of discharge specifications for Outfall 002 (10 for copper and 3 for BOD).

Exceedance of the copper effluent limit was addressed in a Water Effects Ratio (WER) study submitted to the Regional Board in December of 2012, and a modified permit was issued in November 2014. The State Board has indicated that MMPs will be assessed for the period that the WER was under review.

The City projects that the pending ACL for violations since June 2012 may total greater than $200,000, with no administrative action for violations at Outfall 002.

Table 2.2 Summary of NPDES Discharge Violations From 2013 to 2015[1]
Wastewater Treatment Facility Improvements Project
City of Arcata

Year	Compliance Location	Number of Violations	Parameter	CIP Project Addressing Violation
2013	Outfall 001	3	Total Suspended Solids[2]	Secondary Treatment, Hydraulic Capacity
		5	Dichlorobromomethane	UV
		4	Chronic Toxicity	Uncertain[3]
		1	pH	UV, Secondary Treatment
2014	Outfall 001	15	Total Suspended Solids[2]	Secondary Treatment, Hydraulic Capacity
		4	Dichlorobromomethane	UV
		2	Chronic Toxicity	TBD - Mixing Zone Dilution Credit
		1	pH	UV, Secondary Treatment
		1	Chlorine	UV
		1	Fecal Coliform	UV
	Outfall 002	5	Biological Oxygen Demand[4]	Secondary Treatment
2015	Outfall 001	2	Total Suspended Solids[2]	Secondary Treatment, Hydraulic Capacity
		8	Dichlorobromomethane	UV
		2	Chronic Toxicity	Uncertain[3]
	Outfall 002	13	Biological Oxygen Demand[4]	Secondary Treatment
		2	Chlorine	UV

Notes:

(1) Summary table excludes copper violations which have been addressed by the WER and subsequent modified permit in November 2014. Non-water quality violations including deficient reporting, deficient monitoring, and order conditions are also excluded.
(2) Total Suspended Solids (TSS) violations include concentration, loading, and/or percent removal parameters.
(3) A mixing zone dilution credit (if granted) at the new outfall location or the addition of conventional secondary treatment may help with compliance.
(4) Biological Oxygen Demand (BOD) violation of concentration.

2.5 CURRENT PERMIT COMPLIANCE REQUIREMENTS

The 2012 NPDES permit outlines the approved AWTF flow reconfiguration upgrade, including the use of UV disinfection upstream of the new discharge point (Outfall 003). The new flow configuration and discharge point will replace the existing configuration which discharges directly to Humboldt Bay at Outfall 001. The new discharge point will allow for mixing and controlled discharge of freshwater into the wetlands and tidal section of Arcata Bay. The compliance schedule adopted with the permit for the new discharge point and disinfection system includes the following milestones:

- New discharge point and UV disinfection system shall be completed prior to December 1, 2016. An updated compliance schedule will be discussed later in Chapter 8, Capital Improvements Program.
- RWQCB shall be notified 30 days prior to the use of Outfall 003.
- Prior to operation of the new UV disinfection system, the City shall provide written verification of the UV disinfection system capacity based on National Water Research Institute (NWRI) validation testing.
- Prior to operation of the new UV disinfection system, the City shall provide an operation and maintenance plan detailing how the system complies with NWRI guidelines (Note that the NWRI quidelines do not apply to effluent disinfection as they were written specifically for reuse standards and further discussion with the RWQCB will be required).

2.5.1 Water Quality Standards

The current NPDES permit recognizes the transition from the current Outfall 001 to the proposed Outfall 003, but essentially requires the same effluent limits for both interim (current) conditions and final compliance. The effluent discharge requirements for final compliance are summarized in Tables 5 and 6 of the NPDES permit, and limits for the interim condition are summarized in Table 7 of the NPDES permit. For reference, the NPDES permit is provided as Appendix A. A flow reconfiguration and disinfection upgrade project is proposed in order to meet these effluent standards, as the City has indicated that permit compliance is crucial.

Since 2012 there have been approximately 20 violations of the permit for disinfection by-products (dichlorobromomethane), at least one violation for chlorine residual, and at least one violation for coliform (bacteria). Implementation of UV disinfection would eliminate the disinfection by products; however, the existing natural treatment system has a very low UV transmittance, which impacts the sizing of the UV needed to meet disinfection requirements. The main indicator of the level of disinfection will be the Fecal Coliform criteria:

- Average monthly - 14 MPN/100 ml.
- Maximum daily - 43 MPN/100 ml.

Ongoing permit violations of plant effluent limits for biological oxygen demand (BOD) (at least 12 violations for BOD in the last 2 years) and suspended solids (at least 21 violations for total suspended solids (TSS) since 2012) indicate a need for additional secondary treatment capacity beyond that of the existing natural system.

2.5.2 Flow Reconfiguration Project

As previously discussed, a portion of the of the disinfected secondary effluent is currently routed to the AMWS enhancement wetlands, returned to the chlorine contact basin (CCB) for a second step of chlorine disinfection and dechlorination, and discharged through Outfall 001. One feature of the flow reconfiguration project is that the future configuration will be based on the enhancement wetlands flows being brought back to the AWTF for blending with treatment wetlands effluent prior to disinfection and discharge. All plant flows up to 5.9 million gallons per day (mgd) will be routed to UV disinfection prior to discharge through Outfall 003.

The flow reconfiguration as described in the permit places the UV system downstream of the enhancement wetlands, right before the new discharge compliance point at the brackish marsh. A second option was initially considered for this initial planning study, which is to place the UV disinfection system after the Allen and Hauser wetlands, but upstream of the Gearheart wetland. This configuration would allow for a final buffer before discharge to the brackish marsh. This buffer in the Gearheart wetland would provide a safety factor in case of any issues with the UV system including equipment failure or power outage. Any issue with the UV system could trigger the closing of the final effluent gate to the brackish marsh outfall (003) and subsequent containment of any undisinfected effluent. Provisions could be included in the plant improvement project for a portable pump to be purchased and available to pump the contents of the Gearheart marsh back to the pond system for retreatment, if needed. This concept of a safety factor was also discussed at the initial meeting with the North Coast RWQCB. However, this alternate configuration is not recommended due the following factors:

- The original concept retains a single point of compliance downstream of all enhancement wetlands.
- The original concept provides the benefit of the longer detention time through the complete wetland system prior to discharge.
- The return of any undisinfected flow would require significant pumping to drain the Gearheart Wetland of undisinfected effluent.
- The revised flow reconfiguration concept would require modifications to the existing wetlands transfer structures, which would add cost to the project.

- The new brackish marsh discharge will provide additional protection if the existing tide gate is modified in a future project to provide isolation of the effluent discharge.

Therefore, the flow reconfiguration with UV immediately upstream of Outfall 003 is recommended.

2.6 FUTURE REGULATORY CONSIDERATIONS

The current permit will be open for renewal in 2017, and could include additional discharge requirements or other provisions. The following list outlines future regulatory issues that should be considered in planning and future design for the AWTF:

- **Nutrients.** Nutrients such as nitrogen and phosphorus have been identified as potential issues. The North Coast RWQCB is currently reviewing limits for these constituents, and they will probably be added to future discharge permits. Ammonia discharge standards in freshwater have been regulated by the EPA since 2013. North Coast dischargers are beginning to be regulated for ammonia and nitrogen discharge standards. The City of Ferndale has an ammonia limit of 1.0 milligrams per liter (mg/L) and a nitrate limit of 10 mg/L in their current permit requirement. They are however an inland stream discharger.

  The City of Eureka originally was permitted as an ocean discharge and their NPDES permit used an ammonia limit (as nitrogen) of 0.6 mg/L as the Basin Plan water quality objective. Due to the dilution credit granted Eureka, the resulting effluent limit was not prohibitive. However, Eureka just received a new permit in June 2016, which eliminated their dilution credit, and determined that they were a Humboldt Bay (estuarine) discharger and as such would be required to meet bay discharge standards. Their new permit includes effluent limits on ammonia, with an average monthly ammonia limit of 4.1 mg/L ammonia (as nitrogen), and a daily limit of 10 mg/L ammonia (as nitrogen). In addition, it was determined that the discharge was subject to the Enclosed Bays and Estuaries Policy, which requires a finding of enhancement in order to allow a bay discharge.

  Arcata's current NPDES permit requires monitoring for total ammonia and nitrate to determine the assimilative capacity of the receiving water for these nutrients and to generate background data for these constituents for a future Reasonable Potential Analysis.

- **Wet Weather Flows.** The permit does not completely define the flow reconfiguration for peak wet weather flows. It prohibits discharge of flows greater than 5.9 mgd to new Outfall 003. Therefore, flows above 5.9 mgd must be either stored in the ponds and wetlands or discharged on an emergency basis to existing Outfall 001. In the latter case, the existing chlorine and sulfur dioxide gas system would need to remain on-line and be used for disinfection of wet weather flows. Once the new UV system is on-line, additional improvements to the existing disinfection and dechlorination systems might be considered to meet any future permit requirements. Since the City has already taken significant steps to address and reduce inflow and infiltration while wet weather peak flows have persisted, handling of wet weather flow will require additional definition and potentially additional improvements to meet permit compliance.

- **Dilution Credits.** New Outfall 003 is currently being modelled to determine if any dilution credits might be justifiable for the AWTF effluent discharge. If dilution credits are allowed, then the effluent toxicity lab results might be more favorable and exhibit a lower number of failed tests.
- **pH.** The pH of the AWTF is influenced by the natural treatment system; the pH has dipped at times during "split basin" mode of operation, when the AMWS flows are returned to the chlorine contact basin. It is generally thought that the chlorination / dechlorination process is responsible for the lowered pH so this might only be a future issue for wet weather flows. The effluent pH will also impact the ammonia toxicity of the effluent. Any process changes should allow for pH control.
- **Emerging Contaminants.** Constituents of emerging concern (CECs) are pharmaceuticals and personal care products, industrial chemicals present at low concentrations, and chemicals that may affect hormone status ("endocrine disruptors.") In general these and other low concentration contaminants have been identified as potential future issues both for effluent discharges and recycled water production. Most of the research work to date has consisted of limited monitoring, especially for recycled water and drinking water supplies. The fate of these contaminants in a natural system is not clearly understood and therefore may require monitoring by the RWQCB in a future permit revision. It was determined, however, that permitting around CECs would likely not take affect within the 20-year planning window for this Facility Plan.
- **Bacterial Quality of Humboldt Bay.** The bacterial quality of Humboldt Bay was noted as a particular concern in the RWQCB Water Quality Control Plan for the North Coast Region (Basin Plan) due to the location of several of California's most important commercial oyster farms in the northern lobe of the estuary known as Arcata Bay. The shellfish harvest areas are classified by the California Department of Health Services according to several criteria, including their proximity to pollutant sources and the Department's knowledge that such areas are (or are not) of suitable sanitary quality. The Basin Plan identifies stormwater runoff and point source discharges as having the greatest impact on water quality in Arcata Bay. The Basin Plan noted that anytime there was a storm of more than a half inch of rainfall, the bacterial quality was impacted and shellfish harvesting was prohibited. The effluent limitations for fecal coliform bacteria for the new Outfall 003 were retained from the previous permit and reflect water quality objectives for protection of shellfish harvesting areas.

2.7 MEETINGS WITH NORTH COAST RWQCB

An initial meeting was held with the RWQCB staff to discuss the project in June 2015. The project objectives and NPDES permit requirements were reviewed during the meeting. A subsequent meeting took place on June 27, 2016. At that time the Wastewater Treatment Facility Improvements project draft Facility Plan was reviewed, and current NPDES permit requirements were discussed with the RWQCB.

The main points from the discussion were:

- Board staff wants to see bypass of flows greater than 5.9 mgd eliminated, including I&I reduction to reduce peak flows and reduce total volume to be stored.
- UV disinfection design criteria were discussed and it was proposed that UV disinfection will be based on a minimum UVT of 35 percent. City needs input on design dose and disinfection objectives, including coliform or virus reduction,
- Board staff indicated a requirement to have the total flow receive treatment through the enhancement wetlands. They noted that the Enclosed Bays and Estuaries Policy requires enhancement of the receiving water as a condition of discharge, including polishing of the effluent. The City and City's consultant noted that enhancement wetlands do not have the capacity for 5.9 mgd peak wet weather flow, and no land is available for additional wetland construction.
- Board staff indicated that Arcata could expect an ammonia limit in their next permit (in 2017) similar to Eureka, based on the similar Humboldt Bay discharge. The City will be required to do a Reasonable Potential Analysis (RPA) to develop the limit based on salinity, pH and other factors at the point of discharge. Board staff noted that they were no longer considering the bay a drinking water source, so nitrates (or total nitrogen) reduction was not required.

Implementation schedule was discussed, and Board staff indicated that since the NPDES permit expires in July 2017, a Report of Waste discharge should be filed at least 6 months before the permit expiration (by January 2017).

FLOW AND LOAD EVALUATION

3.1 INTRODUCTION

This chapter discusses the plant influent flow and load the Arcata Wastewater Treatment Facility (AWTF) was designed for, as well as the flow and loads that are expected over the 20- year planning horizon.

3.2 EXISTING FACILITY DESIGN FLOW AND LOADS

The AWTF currently treats municipal wastewater from the City of Arcata to meet treatment standards and discharge requirements established by the North Coast Regional Water Quality Control Board (RWQCB). These requirements are outlined in the City's National Pollutant Discharge Elimination System (NPDES) permit, which was last renewed in 2012.

Table 3.1 provides a summary of the current plant permitted influent flows in million gallons per day (mgd).

Table 3.1 AWTF Influent Permit Flow Summary
Wastewater Treatment Facility Improvements Project
City of Arcata

	Flow (mgd)
Average Dry Weather Design Flow	2.3
Average Wet Weather Design Flow	5.0
Peak Wet Weather Design Flow	5.9
Peak Instantaneous Flow	16.5

According to the 1987 "City of Arcata Wastewater Treatment Plant Modifications" record drawings, the AWTF was designed for an average annual plant influent biochemical oxygen demand (BOD) loading of 4,100 pounds per day and total suspended solids (TSS) loading of 3,400 pounds per day for a design population of 19,056 in 1992. This loading was originally designed for the existing primary treatment facility and for secondary treatment provided by "sedimentation and stabilization" Oxidation Pond Nos. 1 through 3 (total of 49 acres) and a shallow "marsh" (4 acres), followed by the enhancement wetlands (30 acres). The treatment wetlands (TWs) were constructed sometime after the 1987 modifications project in phases that occupied a portion of Oxidation Pond 3. The last phase, TW Nos. 5 and 6, were constructed in 2012 from the remainder of Oxidation Pond 3.

The 1987 design average annual plant influent flow of 2.3 mgd and design maximum month plant influent flow of 5.9 mgd correspond to the permitted average dry weather flow and permitted peak wet weather flow, respectively (see Table 3.2).

Table 3.2	**AWTF Design Flow and Loads per 1987 Drawings Wastewater Treatment Facility Improvements Project City of Arcata**
	Design criteria
Average Annual Design Flow, mgd	2.3
Maximum Month Design Flow, mgd	5.9
Influent Average Annual BOD_5, ppd	4,100
Influent Average Annual TSS, ppd	3,400
Design Population	19,056

The State Department of Finance population estimate for the City of Arcata in January 2015 is 18,085, and for January 2016 is 18,169. The influent flows and loads have changed since 1987 due to conservation efforts in recent years and changing characteristics of the community, such as the growth of food industries such as microbreweries. It is important when developing a facility plan to consider the current loading as well as the potential for future changes.

During development of the Draft Facility Plan, anticipated community growth has been a discussion item that needs to be finalized. The City originally anticipated a 10 percent growth in the community based on the General Plan's redevelopment plans and planned growth at Humboldt State University. For the purposes of the Draft Facility Plan evaluation, a 10 percent growth was originally assumed. After further discussion with the City at the Council meeting on June 13, 2016, followed by input from the City's Community Director, the community growth is anticipated to be 20 percent from now through buildout. Updates in the Final Facility Plan address this additional growth factor. Due to the conservation efforts seen in recent years, the growth is primarily anticipated to impact influent loading to the WWTP, and will not change the design flows.

3.3 INFLUENT FLOW EVALUATION

The following daily influent flow data sets were provided to Carollo by both the City and the City's consultant, Arcata Marsh Research Institute (AMRI):

- Plant Influent (Point 1) flow from January 1988 to December 2015, provided by AMRI.
- Plant Influent (Point 1) flow from January 2003 to September 2015, provided by the City.

A comparison of the two flow data sets indicated that the data was of the same origin and originally collected by the City. The flow data was plotted and the percentile flows were tabulated. For influent flow from January 1988 to December 2015, the permitted design peak wet weather flow of 5.9 mgd corresponds to between a 98th and 99th percentile, and the permitted design average dry weather flow of 2.3 mgd corresponds to a 68th percentile. For influent flow from January 2003 to September 2015, the permitted design peak wet weather flow of 5.9 mgd corresponds to a 99th percentile and the permitted design average dry weather flow of 2.3 mgd corresponds to a 77th percentile. For both data sets, the permitted design average wet weather flow of 5.0 mgd corresponds to a 97th percentile.

The data was also analyzed for duration of high influent peak flow periods. Within the period of record, the two highest peak flow durations occurred at the beginning and the end of December 1996. During each of these periods, plant influent flows higher than 5.9 mgd occurred for an average of 8 consecutive days, corresponding to about 71 to 76 million gallons (MG) of total influent flow. The flow data for these periods is included in Appendix C.

3.4 INFLUENT LOAD EVALUATION

The following influent concentration data sets were provided to Carollo by both the City and AMRI:

- Plant Influent (Point 1) BOD from January 1988 to December 2015, provided by AMRI.
- Plant Influent (Point 1) BOD from July 2003 to September 2015, provided by the City.
- Plant Influent (Point 1) TSS from January 1988 to December 2015, provided by AMRI.
- Plant Influent (Point 1) TSS from July 2003 to October 2015, provided by the City.
- Plant Influent (Point 1) Ammonia (NH_3) from February 2011 to August 2013, provided and collected by AMRI.
- Plant Influent (Point 1) NH_3 from April 2013 to December 2015, provided by the City.

A comparison of the concentration data sets provided by the City and AMRI indicated noticeable variability between the data sets. The City indicated that the data they provided is compliance data sent to the Regional Board, and directed Carollo to primarily use the City data for analysis despite a shorter period of record than for the AMRI data. Data from the entire period of record (by City and AMRI) was used for comparison with City data.

The daily influent BOD, TSS and NH3 concentration and corresponding flow data were used to calculate daily influent loads. The 90th percentile concentrations and loads were then calculated. Carollo recommends using 90th percentile loads as the basis of design for evaluating capacity of existing facilities and for sizing new secondary treatment processes. To evaluate treatment capacity of secondary treatment facilities, BOD load is the primary design parameter. BOD load was evaluated two ways: actual 90th percentile load, and a calculated equivalent load based on 90th percentile concentration at a design flow.

For City data from 2003 to 2015, the actual 90th percentile BOD load is 4,000 pounds per day (ppd), which is shown in Table 3.3. This value appears reasonable compared with the observed monthly median influent BOD load over the entire period of record, as seen in Figure 3.1. For City data from 2003 to 2015, the calculated load based on a 90th percentile BOD concentration of 280 mg/L is too conservative. At the permitted design average dry weather flow of 2.3 mgd, the calculated equivalent load would be 5370 lb/d, which is much higher than the observed monthly median influent BOD load for the entire period of record. The recommended loads for TSS and ammonia are also listed in Table 3.1 and were developed from the same actual data.

The recommended design plant influent loads are summarized in Table 3.3.

Table 3.3 Recommended Design Plant Influent Loads
Wastewater Treatment Facility Improvements Project
City of Arcata

Constituent	90th Percentile Influent Load (1), ppd	Design Influent Load With 10% Growth (2), ppd	Design Influent Load With 20% Growth (3), ppd
BOD	4,000	4,400	4,800
TSS	5,760	6,340	6,910
NH_3	880	970	1,060

Notes:
(1) Based on City daily sample data from 2003 to 2015 for BOD and TSS, and from 2013 to 2015 for NH_3.
(2) Assumed City of Arcata growth projection in Draft Facility Plan.
(3) Assumed City of Arcata growth projection in Final Facility Plan per June 13, 2016 City Council meeting.

Plots of the influent data are included in Appendix C.

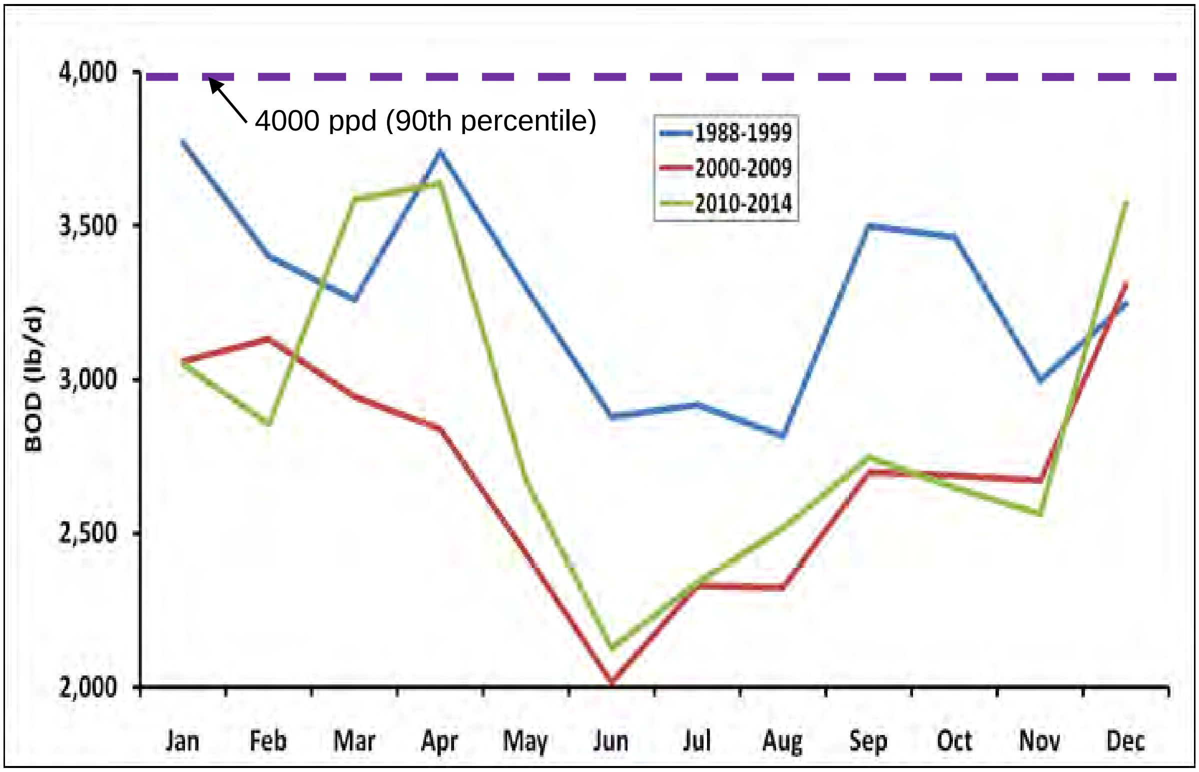

Figure 3.1 Plant Influent BOD (Monthly Median), City and AMRI Data

EXISTING FACILITIES AND CAPACITY EVALUATION

4.1 INTRODUCTION

This chapter provides an overview of the existing facilities at the Arcata Wastewater Treatment Facility (AWTF) and includes the following sections:

- An existing facilities description summarizing the general function and configuration of the treatment facilities at the AWTF.
- A capacity assessment summarizing the hydraulic and treatment capacities of the major liquid treatment unit processes at the AWTF.

4.2 FACILITY OVERVIEW

In order to maintain compliance with the discharge permit, municipal waste from the City of Arcata is treated through a series of unit processes at the AWTF. Figures 4.1 and 4.2 show the site layout and unit process flow schematic for the ATWF, respectively. Table 4.1 provides a summary of the current plant permit influent flows in million gallons per day (mgd). Appendix D includes process flow diagrams for the AWTF facilities (from *AWTF Operations and Maintenance Manual*).

Table 4.1 AWTF Influent Permit Flow Summary
Wastewater Treatment Facility Improvements Project
City of Arcata

	Flow (mgd)
Average Dry Weather Design Flow	2.3
Average Wet Weather Design Flow	5.0
Peak Wet Weather Design Flow	5.9
Peak Instantaneous Flow	16.5

4.3 EXISTING FACILITIES DESCRIPTION

The following sections provide a brief description of the existing flow configuration and hydraulic treatment capacity of the AWTF.

LEGEND

Existing Ponds
- AMWS Enhancement Wetlands
- Oxidation Ponds
- Treatment Marsh
- Brackish Marsh
- Wastewater Treatment Facility

AWTF Facilities
1. Main Office
2. Influent Storm Pump
3. Influent Screw Pumps
4. Bar Screens

AWTF Facilities (Continued)
5. Grit Chamber
6. Primary Clarifiers
7. Primary Anaerobic Digester
8. Secondary Settling Digester
9. Sludge Drying Beds
10. Generator Building
11. Boiler Room
12. Chlorine Storage Building
13. Chlorine Contact Basin

N

0 300 600 Feet

EXISTING AWTF SITE LAYOUT

FIGURE 4.1

CITY OF ARCATA
WASTEWATER TREATMENT FACILITY IMPROVEMENTS PROJECT

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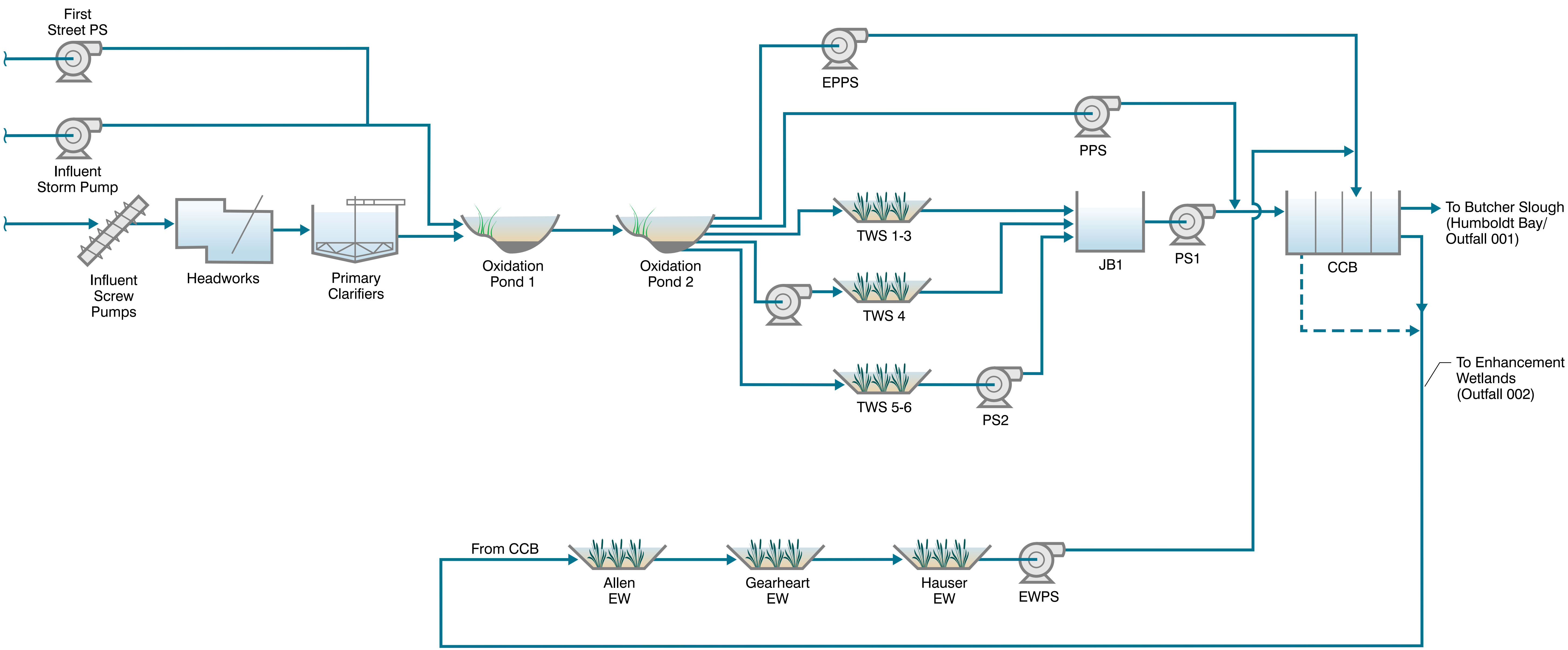


EXISTING AWTF FLOW SCHEMATIC

FIGURE 4.2

CITY OF ARCATA

WASTEWATER TREATMENT FACILITY IMPROVEMENTS PROJECT

4.3.1 Headworks

The headworks facility provides screening and grit removal of raw sewage that is pumped from the service area. The headworks facility is comprised of the following:

- Two 2.5-mgd Archimedes screw pumps.
- Two 5.0-mgd mechanically-cleaned bar screens that drop screenings into a single belt conveyor for transport to a roll-off bin.
- A parshall flume for flow metering.
- A grit removal system including a horizontal-flow grit chamber with grit pumping and grit classification.

4.3.2 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 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 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.

4.3.3 Influent Bypass Pumping

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 (at the Headworks), directly to the oxidation ponds. These pumps provide peak wet weather flow capacity and redundancy for the headworks screw pumps.

4.3.4 Oxidation Ponds and Pond Pumping

Primary effluent and influent bypass flows are conveyed by gravity to two facultative oxidation ponds for secondary treatment and stabilization. Secondary treatment is provided through a series of both biological and chemical reactions in both aerobic and anaerobic environments within the ponds. The two oxidation ponds have a total surface area of

46 acres (ac) and a total storage and treatment volume of 89 million gallons (MG). The normal mode of operation is in series, where primary effluent is routed to Oxidation Pond 1 and then flows by gravity through transfer structures to Oxidation Pond 2. Pond influent and effluent piping is also set up to operate in parallel if needed.

Dry weather effluent from Oxidation Pond 2 typically flows by gravity to the treatment wetlands for further secondary treatment. Flow in excess of the treatment wetlands capacity is piped to the wet well of the Pond Pump Station (PPS) for discharge to the chlorine contact basin (CCB). In high wet-weather flow scenarios, the Emergency Pond Pump Station (EPPS) can also be used. These pump stations are described in further detail in the capacity evaluation section of this chapter.

4.3.5 Treatment Wetlands and Effluent Pumping

Effluent from the oxidation ponds flows by gravity to Treatment Wetlands 1 through 3 and 5 through 6 for further secondary treatment. A small portion of the oxidation pond effluent is also pumped to Treatment Wetland 4, a shallow pilot wetland cell. The 9.7 acres of treatment wetlands reportedly have a capacity to treat 3.3 mgd, which is based on a minimum hydraulic retention time (HRT) of 4 days. Each treatment wetland has one or two influent distribution boxes with manually-adjustable weir gates that are set to control the flow split from the oxidation ponds. The treatment wetlands are currently operated in parallel.

Treatment wetlands effluent is pumped to the CCB for disinfection. There are two main pump stations that collect flow from the treatment wetlands for pumping to the CCB and enhancement wetlands: the wetlands Pump Station 1 (PS1), and the wetlands Pump Station 2 (PS2). These are described in further detail in the capacity evaluation section of this chapter.

4.3.6 Disinfection

Effluent from the ponds or treatment wetlands is pumped to the CCB. Disinfected effluent flows by gravity to either the enhancement wetlands or is discharge to Humboldt Bay. Currently all pond and treatment wetland flows go through the CCB, in either a split or combined mode, described in more detail in Chapter 7. The design capacity of the CCB is 5.9 mgd based on a 30 minutes of contact time.

4.3.7 Enhancement Wetlands

The Enhancement Wetlands are hydraulically limited to 1.7 mgd, which is the capacity of the Enhancement Wetlands Pump Station (EWPS). The AWTF operates three enhancement wetlands in series that have a total surface area of 33 acres and approximately 22 MG of storage. Enhancement wetlands effluent is currently pumped back to the CCB via the EWPS for disinfection and discharge.

4.4 EXISTING HYDRAULIC CAPACITY SUMMARY

This section provides a summary of the existing hydraulic capacity for the liquid treatment facilities at the AWTF. A summary of the existing process treatment capacity evaluation is discussed later in this chapter.

4.4.1 Existing Hydraulic Profile

The existing plant hydraulic profile was summarized as part of the undated AWTF Operations and Maintenance Manual project. For reference, these profiles are provided in Appendix E.

4.4.2 Influent Pumping

There are several influent pump stations serving the AWTF:

- **First Street Pumps.** The First Street Pumps are variable speed, natural-gas driven pumps that are used when influent flow to the treatment plant is greater than 5.0 mgd (capacity of headworks and primary clarifiers). Each of the pumps has a design capacity of 5.5 mgd.
- **Influent Storm Pump.** The Influent Storm Pump is a variable speed, diesel pump that diverts influent flow greater than 5.0 mgd from the headworks influent wet well directly to the oxidation ponds. The Influent Storm Pump has a capacity of 5.0 mgd.
- **Influent Screw Pumps.** The Influent Archimedes Screw Pumps each have the capacity to lift 2.5 mgd from the headworks influent wet well to the headworks bar screens.

Table 4.2 summarizes the firm influent pumping capacity.

Table 4.2 Influent Pumping Capacity Summary
Wastewater Treatment Facility Improvements Project
City of Arcata

Pump Station	Firm Capacity (mgd)
Influent Bypass Pumping(1)	10.5
Headworks Influent Screw Pumps(2)	2.5

Notes:
(1) Combined firm pumping capacity of the First Street Pumps and the Influent Storm Pump. Assumes the largest unit is out of service.
(2) Assumes the largest unit is out of service.

While it appears that there is sufficient influent pumping capacity, much of the influent flow would need to be bypassed around the headworks and primary clarifiers if one of the screw pumps is taken out of service. Upsizing the screw pumps would increase the reliability of the preliminary and primary treatment facilities. The screw pumps could either be replaced in kind or with another type of pump. Plant staff has indicated a preference for submersible pumps.

4.4.3 Headworks

With the exception of the influent screw pumps, the headworks facility appears to have sufficient hydraulic capacity to accommodate the original design flow of 5.0 mgd:

- **Bar Screens.** There are two bar screens and each screen was originally designed to handle 5.0 mgd. The actual channel hydraulic capacity was not evaluated.
- **Grit Chamber.** There is one grit chamber that was originally designed to handle flow up to 5.0 mgd. However, plant staff has indicated that the unit has difficulty handling wet weather flows, so the current capacity is less than 5.0 mgd. There is no redundancy (which is not uncommon), so channel isolation gates are used to shut off flow to the grit chamber if maintenance is required.
- **Grit Pumping.** There are two grit pumps (one duty, one standby). Each pump has the capacity to transfer 200 gallons per minute (gpm) of grit slurry from the bottom of the grit chamber to the grit classifier, which is sufficient to accommodate the original 5.0-mgd design flow.
- **Grit Classification.** There is a single grit classifier, so maintenance would require shutting down flow to the grit chamber. If this is operationally problematic, a redundant classifier could be installed as part of a headworks rehabilitation project.

4.4.4 Primary Treatment

The two primary clarifiers have a total surface area of approximately 3,400 square feet (sf). In most cases, only primary clarifier No. 2 is used. At the design flow rate of 5.0 mgd, the overflow rate through primary clarifier No. 2 was calculated to be approximately 1,770 gallons per day per square foot (gpd/sf), which is much lower than the industry-standard recommendation of 3,000 gpd/sf at peak wet weather flow. However, plant staff has indicated that removal rates and process performance drops significantly at flow rates greater than 4.2 mgd.

4.4.5 Oxidation Ponds

Effluent from the primary clarifiers flows by gravity in a 30-inch pipeline to the oxidation ponds, which are normally operated in series. Plant staff has indicated that the transfer structures between Oxidation Ponds 1 and 2 cause a hydraulic bottleneck during wet weather events. To relieve this bottleneck, the oxidation ponds are operated in a modified parallel mode when the influent bypass pumping is initiated. Additionally, as a fail-safe to mitigate the potential for overflow of Oxidation Pond 1, a spillway was constructed in the berm shared with Oxidation Pond 2. The ponds have a total volume of 89 million gallons (MG) and an average constructed depth of 5.5 feet. At the PWWF of 5.9 mgd when the ponds are empty of sludge, they have 14 days of detention time. The peak flow detention time may be insufficient depending on the plant loading, season, and weather. At the average flow of 2.3 mgd when the ponds are empty of sludge, the oxidation pond detention time is over 35 days, which should be sufficient for secondary treatment.

Due to deferred sludge maintenance over the last 30 years, current estimates of solids buildup in the ponds range from one to two feet in each pond. Assuming an average solids buildup of 1.5 feet, the peak flow detention time at 5.9 mgd is 10 days and the average flow detention time at 2.3 mgd is 26 days.

4.4.6 Treatment Wetlands

Effluent from the oxidation ponds flows by gravity to the treatment wetlands, which are operated in parallel. Per information provided in the AWTF Operations and Maintenance (O&M) Manual, the weirs in the distribution boxes are manually adjusted to maintain the desired flow split through the six treatment wetlands. These adjustments are made on a regular basis, although the flow split is difficult to maintain, since each set of treatment wetlands can treat a different flow rate.

Treatment Wetland Nos. 1 through 6 have a total volume of 13.2 MG and an average operating depth of 3.8 feet when empty of solids or vegetation. At the PWWF of 5.9 mgd, they have 2.0 days of detention time, which is reportedly considered insufficient for treatment capacity. A more typical design value for wetlands systems is on the order of four days, which is approximately 3.0 mgd.

Due to deferred sludge and vegetation maintenance over the last 30 years, operating depth is assumed to be reduced. The City and AMRI report that reliable treatment capacity of Treatment Wetland Nos. 1 through 6 is typically about 1.8 mgd. In order to manage this capacity deficiency, flows greater than 1.8 mgd to 5.9 mgd can be pumped around the treatment wetlands.

4.4.7 Secondary Effluent Pumping

The effluent pump stations pump secondary-treated effluent from the oxidation ponds, the treatment wetlands, or the enhancement wetlands for discharge into the CCB. A summary of the measured effluent pumping capacities is provided in Appendix F.

4.4.7.1 PPS and PS1

The PPS and PS1 are sited adjacent to each other, within a common structure. The pump station wet well has an interior divider wall with an isolation gate. When the gate is open, the pumps are supplied via a common wet well. During normal operation, however, the slide gate is closed and the two wet wells are hydraulically isolated from one another.

In the normal mode of operation, the PPS lifts flow from Oxidation Pond 2 to the CCB, and consists of three 1.8-mgd pumps, with a firm pumping capacity of 2.9 mgd. PS1 lifts flow from Treatment Wetlands 1 through 4 to the CCB and consists of three 1.2-mgd pumps with a firm capacity of 2.3 mgd.

4.4.7.2 EPPS

The EPPS lifts flow from Oxidation Pond 2 to the CCB. The EPPS is typically operated to supplement the capacity of the PPS during extremely high flow scenarios. The EPPS consists of two 3.6-mgd pumps, one duty, and one standby.

4.4.7.3 PS2

PS2 was originally piped to lift flow from Treatment Wetlands 5 and 6 to the CCB. However, pumping directly to the CCB has shown to disrupt the flow-paced chlorine injection system. In order to correct this problem, temporary piping was installed to re-route the discharge from the CCB to Junction Box 1, which flows by gravity into the wet well of PS1. PS2 consists of two 1.7-mgd pumps, one duty, and one standby.

4.4.7.4 EWPS

The EWPS (also known as the Hauser Pump Station) lifts effluent from the Hauser Enhancement Wetland to the CCB. The EWPS consists of three 1.5-mgd pumps and originally had a firm pumping capacity of approximately 3.0 mgd. However, the pumps are failing and the most recent testing indicated a firm pumping capacity of 1.2 mgd. Two of the pumps are controlled with variable frequency drives (VFDs) and the third is fixed speed.

The pumps are operating at the end of the pump curves, which is not ideal and may be one of the reasons for operational issues with this pump station. Additionally, the pump curve is not in alignment with measured flow values, which indicates that the pump impellers have experienced some wear and are not operating on their published curves.

4.4.7.5 Effluent Pumping Summary

Table 4.3 summarizes the effluent pumping capacity.

4.4.8 Chlorine Contact Basin

Effluent from the oxidation ponds and treatment wetlands is pumped to the CCB via the PPS and PS1. In wet weather conditions, the EPPS is also used to lift flow to the CCB. At the flow rate of 5.9 mgd, flow through the CCB has a contact time of 30 minutes, which is typically sufficient for effluent discharge.

The main points of the hydraulic analysis include the following:

- The estimated hydraulic detention time is based on combined basin mode in the CCB with no return flow from the Enhancement Wetlands.
- The CCB effluent weir sets the elevation in the basin and is not submerged at 5.9 mgd.

- There is very little head loss through the CCB.

Table 4.3 Effluent Pumping Capacity Summary
Wastewater Treatment Facility Improvements Project
City of Arcata

Pump Station	Firm Capacity[1] (mgd)
PPS	2.9
PS1	2.3
EPPS[2]	3.6
PS2[3]	1.7
EWPS	1.2

Notes:
(1) Assumes the largest unit is out of service.
(2) The EPPS is only operated during periods of peak wet weather and was not included in the overall secondary effluent pumping capacity per the City's request.
(3) PS2 does not discharge directly to the CCB, so the capacity was not included in the overall secondary effluent pumping capacity.

4.4.9 Enhancement Wetlands

Disinfected treatment wetlands effluent flows by gravity in a 30-inch pipeline from the CCB to the enhancement wetlands, which are typically operated in series. A hydraulic capacity analysis was completed by AMRI in order to better understand the feasibility of the flow reconfiguration project.

The main points of the AMRI hydraulic analysis include the following:

- Treatment wetlands effluent flows by gravity through the chlorine contact basin and the enhancement wetlands to the EWPS wet well, which serves as the downstream control point. As discussed above, the EWPS pumps effluent back to the CCB for further disinfection and discharge through Outfall 001.
- Most of the head loss in this portion of the hydraulic profile occurs at the sharp-crested weirs in the distribution boxes and junction structures. Weir elevations were taken from the 1984 drawings and should be confirmed.
- There do not appear to be any hydraulic capacity bottlenecks in between the chlorine contact basin and the EWPS wet well at the modeled PWWF of 5.9 mgd.

4.4.10 Hydraulic Capacity Summary

Table 4.4 provides a summary of the existing hydraulic capacity at the AWTF.

The main hydraulic capacity limitations or bottlenecks are the following areas:

- Headworks pumps - lack redundancy.

- The single Primary clarifier limits capacity at peak flows.
- Treatment wetlands and effluent pump stations lack capacity to accommodate permit peak flows.
- Enhancement wetland effluent pumps station lack capacity to accommodate permit peak flows.
- There is concern that the enhancement wetlands would not provide any treatment at flows greater than 2.3 mgd.

Table 4.4 Existing Flow Capacity Summary
Wastewater Treatment Facility Improvements Project
City of Arcata

Unit Process	Hydraulic Capacity (mgd)
Influent Bypass Pumping(1)	10.5
Headworks: Pumping(1)	2.5
Headworks: Bar Screens(2)	5.0
Headworks: Grit Removal(2)	5.0
Primary Clarifiers(2)(3)	4.0
Oxidation Ponds(4)	5.9
Treatment Wetlands(5)	2.3
Pond and Treatment Wetlands Effluent Pumping(6)	5.2
Chlorine Contact Basin	5.9
Enhancement Wetlands	2.3
Enhancement Wetlands Pumping(7)	1.8

Notes:
(1) Assumes largest pump is out of service.
(2) Influent flow in excess of 5.0 mgd is bypassed around the headworks facility and primary clarifiers and routed directly to the oxidation ponds.
(3) Capacity based on a single primary clarifier.
(4) Capacity is based on 15-day detention time.
(5) Flow in excess of 2.3 mgd is pumped directly from Oxidation Pond 2 to the Chlorine Contact Basin.
(6) The sum of the capacities of three PS1 pumps and two PPS pumps in parallel, which is the firm pumping capacity under the current operational arrangement. The PS2 pumping capacity was not considered because it does not discharge directly to the CCB.
(7) Flow in excess of 1.8 mgd design capacity is discharged from the CCB, through Outfall 001 and into Humboldt Bay.

4.5 NATURAL SYSTEM TREATMENT CAPACITY EVALUATION

4.5.1 Process Capacity Background

The existing treatment processes at the City of Arcata Wastewater Treatment Facility (WWTF) were constructed in 1987, with some facility improvements since then including conversion of one oxidation pond to treatment wetlands. The need for a comprehensive approach to facility improvements was first addressed during the initial development of this facility plan project in September 2015. During review with the City, it was noted that the WWTF may have a secondary treatment capacity shortfall that impacts the ability to reliably meet permit requirements. The treatment capacity shortfall was initially reviewed with City staff during a phone conference on October 29, 2015, and then addressed in a follow-up workshop on November 5 and 6, 2015. The presentation from that phone conference and the workshop presentation are included in Appendix G.

Several indications point to the need for evaluating secondary treatment capacity. As discussed in Chapter 2, the plant has experienced operational issues related with treatment capacity, including NPDES discharge violations of both BOD and TSS. Treatment capacity, as well as hydraulic capacity and detention time, have likely been impacted by 30 years of solids accumulation. Deferred vegetation maintenance in the wetland system (treatment wetlands and enhancement wetlands) has also impacted the ability for the wetlands to remove solids and maintain optimum flow capacity.

The City is planning an operational conversion of the natural system to a single-pass flow mode to pass up to 2.3 mgd through the enhancement wetlands, as well as a disinfection process change from chlorination to UV disinfection. In addition, recent UV transmittance (UVT) data collected for this project indicated that the natural system has a low UVT at certain times of the year which substantially increases the UV disinfection cost.

This section summarizes the analysis of available plant flow and constituent concentration data for evaluating current secondary treatment capacity at the WWTF. Plant data analysis was used both to confirm existing WWTF treatment capacity and to provide the basis of design for new and upgraded plant processes recommended for the WWTF Improvements Project. Conceptual design criteria recommendations for new and upgraded plant processes are discussed in Chapter 6, Alternatives.

4.5.2 BOD Loading Criteria

The basis for evaluating current treatment capacity of the existing natural system was determined by analyzing a combination of design criteria and available plant data, and confirmed by discussions with City staff and AMRI.

Typical wastewater treatment BOD loading criteria in a natural system varies depending on a variety of factors including the treatment purpose, climate (sunlight and temperature), solids accumulation, vegetation management, and short circuiting. The primary treatment purpose of oxidation ponds are to remove organic loading (BOD and ammonia), while the primary treatment purpose of treatment wetlands are to remove solids. The enhancement wetlands provide effluent polishing prior to Bay discharge, as well as additional benefits such as wildlife habitat creation and recreation.

Published values for design BOD loading in an oxidation pond can range from 35 to 125 ppd/acre due to a variety of climates and facility conditions ("Natural System for Waste Management and Treatment," Reed et al). For Northern California, Carollo recommends an oxidation pond loading criteria of 25 ppd/acre for non-aerated ponds, which has been confirmed at Napa Sanitation District and other Northern California facilities. This loading level has been confirmed to provide an effluent that can meet an average monthly effluent discharge limit of 30 milligrams per liter (mg/L) BOD_5 and 30 mg/L TSS. The AWTF Oxidation Ponds 1 and 2 have a total of 46 acres and an average depth of 5.5 ft. Aerated ponds typically have a minimum of 6.5 feet depth (2 m; Reed et al). Pond 1 has eight mechanical aerators that are in poor condition and several have not been used for a number of years; Pond 2 does not have aerators. Based on a 25 pounds per day (ppd) BOD/acre design criteria, maximum BOD loading to the oxidation ponds should be 1,150 ppd without aerators.

Published values for design BOD loading in a constructed wetland depends on whether the wetlands are fully vegetated or open water free water surface (FWS) type ("Manual - Constructed Wetlands Treatment of Municipal Wastewaters Constructed," U.S. EPA, September 2000). For a fully vegetated FWS wetland, maximum BOD loading of 35 ppd/acre (40 kg/ha-d) is recommended if a secondary effluent BOD standard of 30 mg/L is to be met. For an open water FWS wetland, maximum BOD loading ranges from 40 to 54 ppd (45 to 60 kg/ha-d). The AWTF treatment wetlands were designed primarily for solids removal and only Treatment Wetlands 1 and 2 have depths greater than 4 feet, which is typically necessary for open water surface FWS wetlands. Treatment Wetlands 1-6 have a total of 9.7 acres, not including emergent vegetation. Based on a 35 ppd BOD/acre design criteria, maximum BOD loading to Treatment Wetlands Nos. 1 through 6 should be 340 ppd. In the future, if 2.3 acres of Treatment Wetlands 7 is constructed, maximum BOD loading to Treatment Wetlands 1 through 7 should be 420 ppd.

Historically, the three Enhancement Wetlands (EWs) in conjunction with the chlorine contact basin have been providing year-round supplemental BOD and TSS treatment capacity, despite not being designed for those functions. Solids have been accumulating in the EWs for almost 30 years while percent removal of BOD has been diminishing with time. This phenomenon has been observed and analyzed by both the City and AMRI over the last 10 years. It is suspected that an internal load is increasing due to breakdown of accumulated material, reducing the treatment potential of the EWs. The EWs are designated Waters of the State which are regulated by State Water Board Resolution No. 2008-0026 to protect all waters of the State from dredge and fill activities. The City has indicated that vegetation maintenance and baffle installation will be allowed activities, which could help with treatment capacity and improvement of short circuiting issues. Current EW BOD treatment capacity is estimated by AMRI to be about 120 ppd, but may decrease in the future without solids removal.

4.5.3 Secondary Treatment Capacity Shortfall

The 10 percent growth projection developed in the Draft Facility Plan results in a design influent loading of 4,400 ppd. The design criterion for the existing primary clarifiers is 30 percent BOD removal (1987 Record Drawings). This is also a typical design criteria for new primary clarifiers. This results in an Oxidation Pond influent loading of 3,080 ppd BOD. Subtracting out the anticipated BOD removal in the Oxidation Ponds (1,150 ppd), Treatment Wetlands Nos. 1 through 6 (340 ppd), Enhancement Wetlands (120 ppd), and meeting an Outfall 002 effluent discharge limit goal of 30 mg/L (575 ppd at 2.3 mgd) results in a BOD treatment capacity shortfall of 895 ppd at Outfall 002. Meeting an Outfall 003 effluent discharge goal of 10 mg/L (192 ppd at 2.3 mgd) results in a predicted BOD treatment capacity shortfall of 1,280 ppd at Outfall 003. Note that this capacity shortfall analysis assumes the natural system is performing optimally with routine solids and vegetation maintenance conducted. With deferred maintenance of the natural system over the last 30 years, the predicted BOD treatment capacity shortfall is 1,280 ppd. Future construction of Treatment Wetland No. 7 could reduce the shortfall by 80 ppd and addition of aerators to Pond 2 could reduce the shortfall by approximately 600 ppd, leaving a BOD treatment capacity shortfall of at least 600 ppd at Outfall 003. This analysis is summarized in Table 4.5.

Following this evaluation in the Draft Facility Plan, the City revised its growth estimate to a 20 percent growth projection, which increases the BOD treatment capacity shortfall from 600 ppd to 1000 ppd even with additional Pond 2 aeration and construction of Treatment Wetland No. 7.

Independently, AMRI provided the City an analysis of a secondary treatment capacity shortfall of 1,150 to 2,017 ppd BOD during higher flow and higher BOD loading months of the year, in "AWTF Treatment Capacity Evaluation and Additional Treatment Recommendations," September 2015.

It has been documented that the plant is currently treating the BOD treatment capacity shortfall, inadvertently, by use of chlorine during combined basin operating mode (chlorinating both TW and EW effluents in the Chlorine Contact Basin), which is required about nine months every year (typically during wet weather seasons). Chlorine is a strong oxidizer and typically reduces the organics and BOD level to permit requirements. The City has the ability to increase chlorine dosage as needed. However, disinfection byproducts maybe created from the oxidation reaction, leading to violations of dichlorobromomethane. This is one reason the City has decided to limit the use of chlorine and switch to UV for disinfection.

Table 4.5	BOD Treatment Capacity Shortfall Summary Wastewater Treatment Facility Improvements Project City of Arcata		
Unit Process	**Estimated BOD Removal (ppd)**	**Remaining BOD At 10% Growth (ppd)**	**Remaining BOD At 20% Growth (ppd)**
Plant Influent	N/A	4,400	4,800
Primary Clarifiers(1)	1,320	3,080	3,480
Oxidation Ponds(2)	1,150	1,930	2,330
Treatment Wetlands Nos. 1-6(3)	340	1,590	1,990
Enhancement Wetlands(4)	120	1,470	1,870
Outfall 003 Discharge Goal @ 10 mg/L	192	1,280	1,680
BOD Shortfall		1,280	1,680
Additional Pond 2 Aeration	600	680	1,080
Adding Treatment Wetland No. 7(3)	80	600	1,000

Notes:
(1) Assumes 30% BOD removal in Primary Clarifiers.
(2) Assumes 25 ppd/acre removal in Oxidation Ponds, at 46 acres total for both ponds.
(3) Assumes 35 ppd/acre removal in Treatment Wetlands, at 9.7 acres in TW 1-6 and 2.3 acres in future TW 7.
(4) Capacity estimated by AMRI based on current removal.

Plant data confirms that the natural system without chlorine generally performs well at lower flow conditions. Figure 4.3 shows a typical example of this, that at a plant influent flow of 1.4 mgd (September 2015), BOD removal was primarily achieved in the oxidation ponds, and TSS removal was primarily achieved in the treatment wetlands. Plant influent BOD at this time was less than 3500 ppd.

Figure 4.4 shows that at plant influent flow of 1.5 mgd when operating in combined basin mode, some BOD removal occurred in the Oxidation Ponds and Treatment Wetlands No. 6, and a significant amount of BOD removal occurred due to chlorination prior to the Enhancement Wetlands. A decrease in 100 mg/L BOD corresponds to 1,250 ppd BOD removal due to chlorination. The City and AMRI analyzed the BOD and chlorine consumption data from 2009 to 2015 and confirmed that during this time while operating in combined basin mode, an average of 730 ppd of BOD removal was achieved by chlorine usage, while peak BOD removal periods could reach 1000 ppd or higher.

In comparison, influent BOD loading in the spring (typically from January through April) is generally greater than 3,500 ppd of BOD. These months also correspond to higher plant influent flows. The higher plant influent loading corresponds to a higher influent loading of the oxidation ponds beyond recommended loading criteria. As shown in Figure 4.5, Oxidation Pond 1 influent BOD loading from 2010 to 2015 is between 35 and 50 ppd/acre (monthly median). Furthermore, higher flows in the wet weather season (generally October to May) result in reduced treatment capacity in the oxidation ponds and the treatment wetlands due to decreased detention time, shifting additional loading to the enhancement wetlands. As seen in Figure 4.6, BOD loading to the Enhancement Wetlands during the wet weather season has been increasing over the last 25 years. Vegetation growth and solids accumulation in the wetland system over the last 30 years impacts the capacity shortfall.

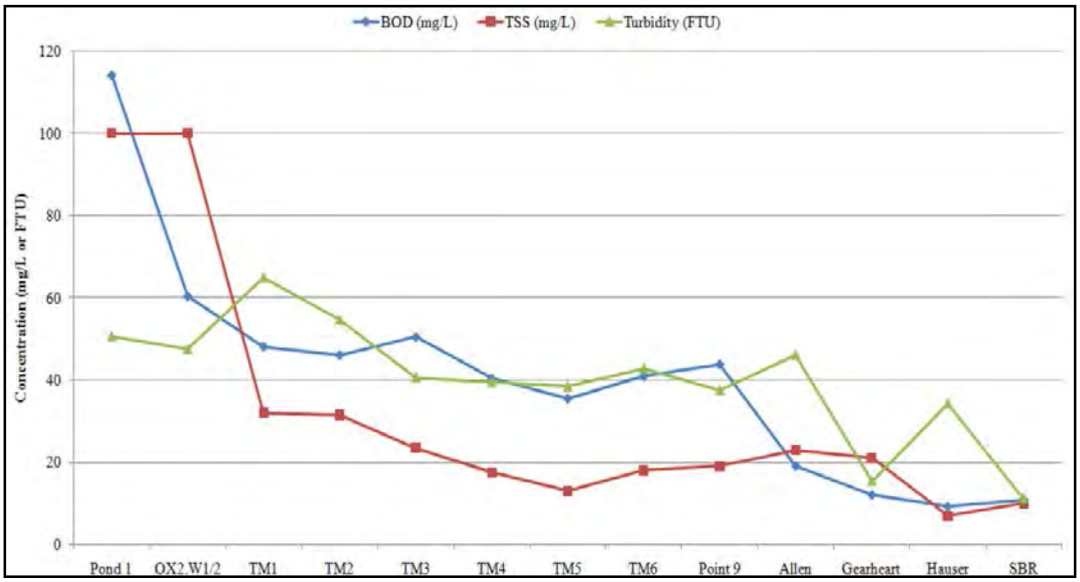


Figure 4.3 Plant Permit Performance At Lower Flows

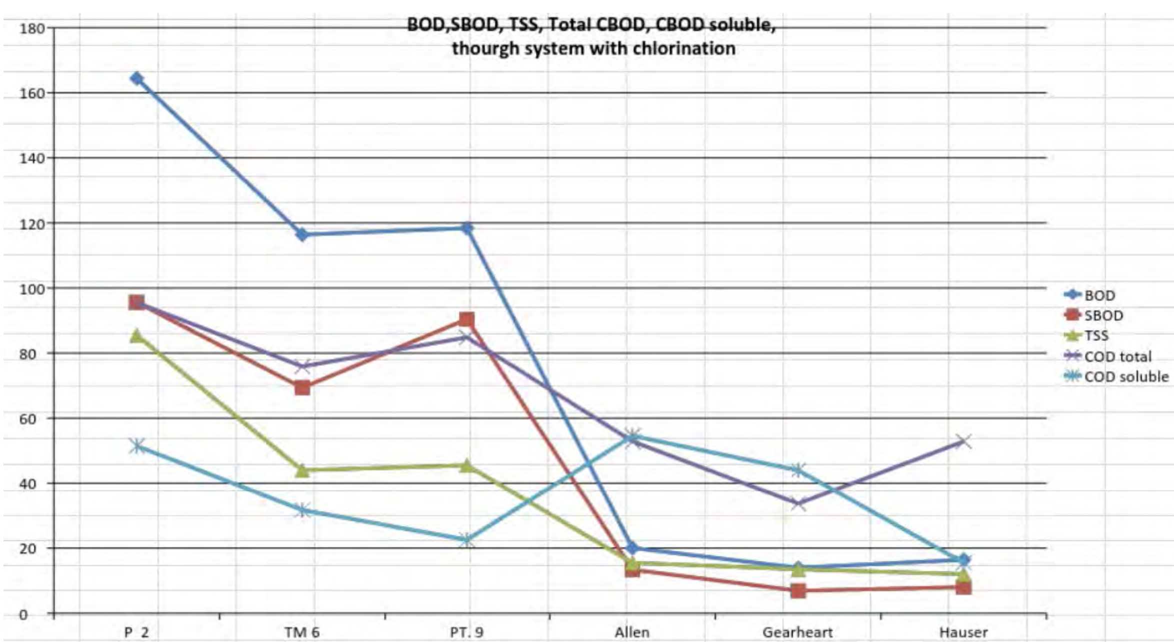


Figure 4.4 BOD Concentration (mg/L) Profile at AWTF (AMRI data, November 2015 at 1.5 mgd).

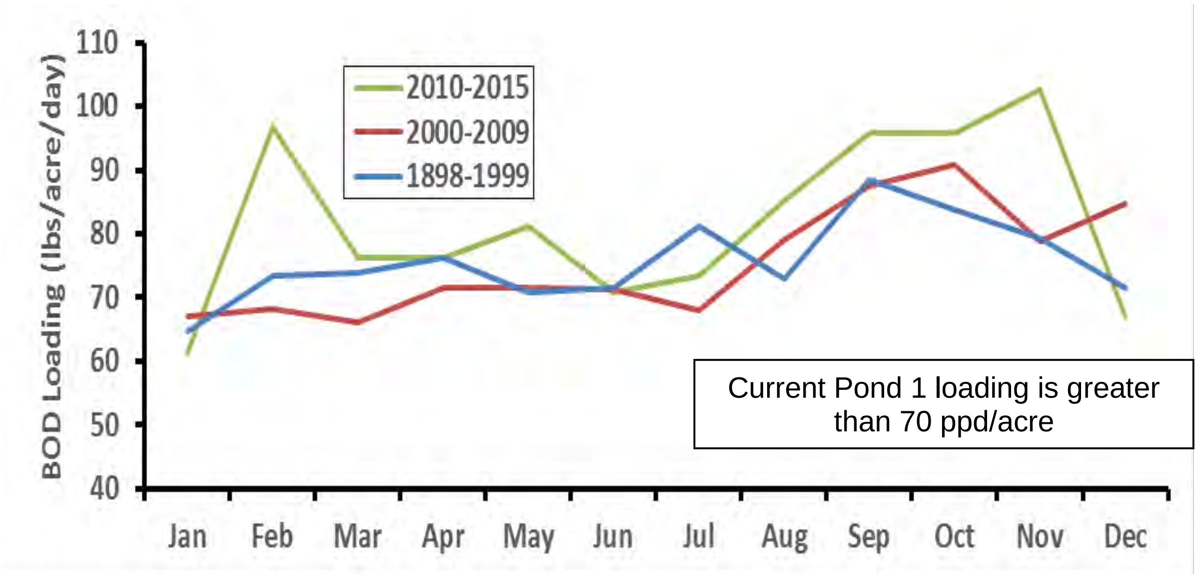


Figure 4.5 Oxidation Pond 1 Influent BOD Loading (Monthly Median)

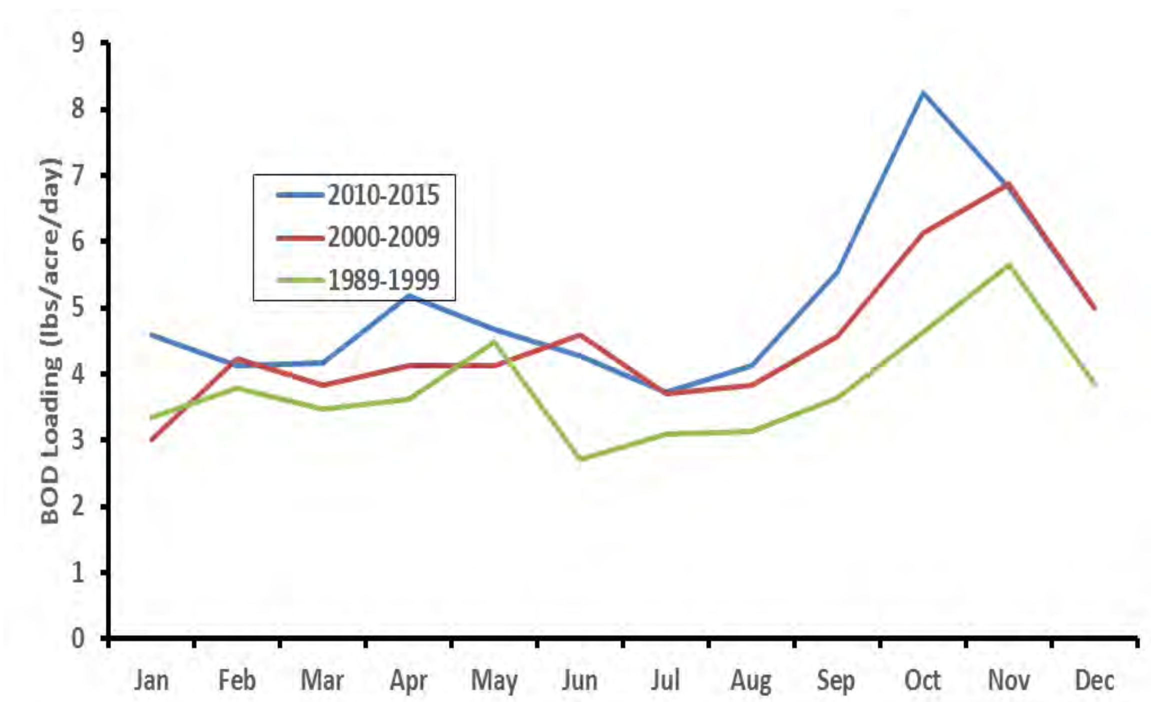


Figure 4.6 Enhancement Wetlands Influent BOD Loading (Monthly Median)

4.6 KEY FINDINGS AND RECOMMENDATIONS

The key findings and recommendations from the capacity evaluation include the following:

- **Headworks.** The reliable headworks capacity should be increased to 5.9 mgd to minimize the need to bypass preliminary and primary treatment. The following modifications would be required:
  - Replace the two existing 2.5-mgd screw pumps with two new 5.9-mgd pumps. The pumps could either be replaced in kind or replaced with submersible pumps. Pump selection should be completed during the pre-design phase of the project.
  - Evaluate replacement of the grit chamber with a new vortex grit chamber, which could handle a wider range of flows.
- **Pond and Treatment Wetlands Effluent Pump Stations.** This appears to be an operationally-intensive area of the AWTF, with multiple pump stations and changing weir elevations into and out of the treatment wetlands. Recommend that the treatment wetland pump stations be consolidated in an effort to simplify operations while adding operational flexibility. It is proposed that PS1 be upgraded to pump treatment wetlands flow to enhancement wetlands, with pond pump station remaining for peak wet weather flows.
- **Additional Secondary Treatment.** The BOD treatment capacity shortfall outlined in Table 4.5 needs to be addressed in facility planning and capital improvement program project alternatives. As noted above, addition of aerators in Pond 2 will and addition of Treatment Wetland No. 7 will improve the secondary treatment capacity of the facility, but a deficit of 1000 ppd is still anticipated with a 20 percent growth projection.

CONDITION ASSESSMENT

5.1 INTRODUCTION

The original Arcata Wastewater Treatment Facility (AWTF) was constructed in the late 1950s. A photo of the original plant is shown in Figure 5.1. The AWTF has been upgraded throughout the years, with the last major upgrade project completed in 1986 (CH2M HILL 1984). The project included a new headworks facility with screening and grit removal, a chlorine contact basin and chemical storage building, effluent pump stations and a new generator building. Since that project, smaller projects have included upgrades to the oxidation ponds, treatment and enhancement wetlands, digesters, pond aerators, and the addition of a standby generator.

Figure 5.1 Original Arcata Wastewater Treatment Plant (Circa 1958)

In May 2015, a condition assessment was performed to assess the current condition of existing structures and equipment and document observations made by plant staff. In general, the plant appears to have been maintained as much as the maintenance budget has allowed. However, findings from the assessment indicate that a majority of the mechanical equipment has exceeded its expected life, and that major structures are also starting to approach the end of their useful life. Finally, plant staff indicated that some capital and maintenance projects had been deferred, pending the outcome of this project. That has meant that staff has struggled to meet permit limits and keep as much of the existing facilities equipment operational as possible even though it should have been replaced.

5.2 PURPOSE

The purpose of the condition assessment is to document the existing facility conditions and help establish priorities for the City's wastewater treatment plant repair and rehabilitation (R&R) capital improvements program (CIP). The findings outlined in this chapter will be incorporated into the CIP presented in Chapter 6.

5.3 APPROACH

The approach used to assess the condition of the assets at the AWTF is described in the following sections.

5.3.1 Asset Inventory

An "asset" is generally defined as a complete physical component of a facility that enables service to be provided, is critical to plant operation, and/or has a value greater than $10,000. Below-ground assets (process piping) were not evaluated. Above-ground assets include structures, as well as mechanical, electrical, and instrumentation and controls (I&C) equipment and devices.

The AWTF assets were organized into a spreadsheet by unit process. The spreadsheet was configured to provide a complete summary of the asset inventory, including: asset description, design criteria, installation year (if known) and condition ranking. The ranking, estimates of remaining life and replacement costs will be used in Chapter 6 to develop the R&R CIP for the treatment facilities.

The asset inventory was developed using the 1984 CH2M HILL WWTP Modification Drawings (CH2M HILL, 1984), the 2003 Wastewater Treatment Plant Evaluation (SHN 2003) and the City's undated Operations and Maintenance (O&M) manual. The main process areas are shown on Figure 4.1 in Chapter 4.

5.3.2 Replacement Timing

5.3.2.1 <u>Original Useful Life</u>

The expected life or Original Useful Life (OUL) is the number of years an asset is expected to be in service as a function of asset type (i.e., mechanical, structural, or electrical). It is used to aid in the determination of the remaining life of an asset. The OUL estimates for different types of assets are presented in Table 5.1.

Table 5.1 Estimated OUL Based on Asset Category Wastewater Treatment Facility Improvements Project City of Arcata		
Asset Category		**Original Useful Life[1]**
Civil/Sitework		50
Structural		
	General/Other	50
	Concrete	50
	Fiberglass	25
	Steel	25
	Plastic	10
Mechanical		
	General/Other	20
	Valves	20
	Pumps - Wastewater	15
	Chemical Equipment	15
	Coolers/Air Conditioners/Fans	15
Electrical		
	General/Other	30
	Motor Control Centers	30
	Variable Frequency Drives	15
Instrumentation		**10**

Note:
(1) These values are selected based on a combination of the IIMM, Edition 2006, USEPA guides, other industry references, and Carollo experience.

These OULs were estimated based on industry standard guidelines published by the American Water Works Association (AWWA), the Water Environment Federation (WEF), and the American Society of Civil Engineers (ASCE). The International Infrastructure Management Manual (IIMM) and Carollo's internal discipline-specific experience were also referenced.

5.3.2.2 Condition Scoring System and Remaining Life

The remaining life of an asset is important because this helps determine project prioritization for the development of the R&R CIP. Two factors contributed to the determination of the remaining life of each asset:

- The year of equipment installation.
- Field notes taken during the visual condition assessment.

After the site visit, the assets were evaluated and the condition of each asset was ranked on a one-through-five ranking scale, based on the IIMM. In the IIMM, condition is expressed in terms of the amount of repair needed to bring an asset to like-new condition. The definitions for the one-through-five condition ranking system from the IIMM are shown in Table 5.2. During and after the site assessment, the Carollo/LACO team asked questions and requested additional information regarding maintenance and performance history, documented design criteria, installation date, and typical condition parameters that could be used to standardize the procedure for future assessments. The assessments were visual assessments only and did not include diagnostic testing or entry into confined spaces.

Table 5.2 Condition Ranking Scale
Wastewater Treatment Facility Improvements Project
City of Arcata

Ranking[1]	Description[1]	Percentage of Asset Requiring Rehabilitation[1][2]
1	Very good condition.	0%
2	Good, only minor defects.	10%
3	Fair to poor condition, maintenance required to return to accepted level of service.	20%
4	Poor, requires rehabilitation.	40%
5	Very poor or failed, asset unserviceable.	90%

Notes:

(1) Adapted from the International Infrastructure Management Manual. The IIMM manual is produced by a not-for-profit organization in New Zealand that develops asset management best practice publications (See http://www.nams.org.nz/).

(2) "Percentage of asset requiring rehabilitation" is that percentage of the value of the asset needed to return the asset to a condition ranking of one.

Assets that were identified to be in need of replacement within the 20-year planning horizon were incorporated into the asset inventory, which forms the backbone of the R&R CIP. Assets in good condition and that will not need to be replaced within the next 20 years will not be included in the R&R CIP.

5.4 VISUAL CONDITION ASSESSMENT RESULTS

The results of the ranking for each process area are summarized in Table 5.3 and outlined in more detail in the descriptions below. Pictures of the main process areas, including structures and equipment, are included in Appendix H, and are used to illustrate the process area ratings. An asset inventory with rankings is in included in Appendix I.

Table 5.3 Summary of Process Area Rankings
Wastewater Treatment Facility Improvements Project
City of Arcata

Process	Average Condition - Mech./Elec./I&C	Average Condition - Structural	Average Remaining Mech./ Structural Useful Life
Headworks	4 - Poor	3 - Fair	<5 / 20
Primary Clarifiers	5 - Very Poor	5 - Very Poor	<5 / <5
Oxidation Ponds	5 - Very Poor	4 - Poor	10 / 30
Pond Pump station	4- Poor	3 - Fair	<5 / 10
Treatment Wetlands 1 to 4	NA	4 - Poor	Varies
Treatment Wetlands 5 & 6	NA	1- Very Good	
Pump Station 1	4 - Poor	3 - Fair to 4 Poor	<5 / 20
Enhancement Wetlands	NA	4 - Poor	Varies
Enhancement Wetland PS	4 - Poor	4 - Poor	<5 / 10
Chlorine Contact Basin	2 - Good	3 - Fair to 4 Poor	10 / 20
Chemical System	3 - Fair	3 - Fair	<10 / 20
Digesters	3 - Fair	4 - Poor	10 / <5
Support Systems	3 - Fair	NA	<5 / 10
Electrical and Control Systems	3 - Fair to 4 - Poor	NA	<5 / NA

5.4.1 Headworks

The headworks facility consists of influent pumping, screening, flow measurement, and grit removal. The headworks were constructed in the 1984 project (CH2M HILL 1984). Overall, the headworks are in need of a major upgrade due to the condition of the equipment, which is approximately 30 years old and rated as poor.

5.4.1.1 <u>Influent Pumping</u>

The influent screw pumps were rated as poor to very poor. Although the pumps are operational, they may be close to failure, based on the age, and observed condition. The pumps are open trough, Archimedean screw type units, which have a capacity of 2.5 million gallons per day (mgd) each. Redundancy is provided by a diesel driven bypass pump that can pump from the influent raw sewage wet well directly to the oxidation ponds. In addition, the First Street Pump Station can pump wet weather flows directly to the oxidation ponds.

The influent screw pumps are near or at the end of their life, and will likely require major maintenance if they are not replaced in the near term. For the purposes of this project, it was assumed that the pumps would be replaced with similar units, although the type of pump should be evaluated during predesign. Plant staff has indicated a preference for submersible pumps, and may be interested in a retrofit for the headworks pumps with submersible units. When the pumps are replaced it is recommended that a redundant pump be provided.

5.4.1.2 Influent Bar Screens

The influent bar screens were rated as poor to very poor and are worn beyond their service life. In addition, the bar spacing is wider than current standards, and will allow stringy rag type material to pass and collect in downstream processes. Like most California facilities, the plant staff is starting to see an increase in disposable baby wipes in the influent flow, which accumulate in the primary clarifiers and digesters, leading to additional maintenance. Each bar screen is sized for the full plant flow and, therefore, has sufficient redundancy. The screening conveyor is worn and has no redundancy.

A screenings washer/compactor was previously installed in order to reduce the water and fecal matter in the screenings. The unit subsequently failed and was removed by plant staff after mechanical failure. The failed unit will need to be replaced in order to achieve the required dry solids and pass the "paint test" required for disposal of the screening material.

5.4.1.3 Flow measurement

The influent flow is measured in a parshall flume using an ultrasonic level sensor. Based on limited observations, the condition of the parshall flume insert is rated as fair. The measurement range of the flume should be verified in future predesign to confirm that it is operational for the range of dry and wet weather flows. The condition of the instrumentation was not observed. The flow measurement was reportedly upgraded prior to the 2003 Plant Evaluation.

5.4.1.4 Grit Removal

The overall grit removal system was rated as poor and the tank was rated as very poor. It consists of a flat bottom, shallow grit separation tank, grit pumps, and a grit cyclone-classifier unit. This type of grit removal tank is no longer recommended and has been replaced in most installations. It generally has poor performance and has limited functionality for plants that experience a wide range of flows, such as the AWTF. It should be replaced during any headworks rehabilitation work. The grit handling system is similar to the equipment that would be specified and provided today. In general, all components have been well maintained, but are beyond their service life, and rated poor to very poor. While the grit pumps have adequate redundancy, they should be replaced. The grit cyclone/classifier was replaced in 2003. It has had major component replacement and appears to be nearing the end of its service life (15 years).

5.4.1.5 Miscellaneous Headworks Components

The miscellaneous headworks components, including gates used for flow isolation and distribution, were rated as poor. They are original and are either at the end of useful life or have failed. Staff has noted that some gates have failed or are stuck and cannot be operated.

5.4.1.6 Headworks Structure

The headworks structure appeared to be visually in good shape based on the 30-year life and was given a fair rating. Based on review of the original construction drawings, it was noted that the structure is pile supported, and appears to have been designed based on the industry practice and code at that time for design and construction.

5.4.1.7 Headworks Electrical/Controls

The headworks electrical system is fed from a single motor control center A (MCC A) in the generator building. The controls for all equipment were designed to provide monitoring and alarms at the control panel in the operations building. The equipment condition and service life is described further in the Plant Electrical and Controls section below.

5.4.2 Primary Clarifiers

The plant has two primary clarifiers:

- Clarifier No. 1: 26-foot diameter unit.
- Clarifier No. 2: 60-foot diameter unit.

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. Overall the units are rated as poor to very poor, especially based on age.

5.4.2.1 Clarifier Mechanism

The age of the clarifier sludge collector mechanism in Clarifier No. 2 is unknown. It appears older and reportedly is in need of major rehabilitation or replacement. The clarifier sludge collector mechanism in Clarifier No. 1 appears newer, and is not used very often, and is therefore in better shape. The drive type and age of each drive is unknown. The coating for the mechanism in unit No. 2 has failed and was reportedly failing in 2002. The Clarifier No. 2 mechanism is rated as very poor. Reportedly a large crack is visible in the center column when the unit is out of service. The Clarifier No. 1 unit is rated as poor due to its observed condition. The structures are rated as very poor based on their age.

5.4.2.2 Sludge Pumping

The primary sludge pumps are progressing cavity type pumps. The age of the primary sludge pumps is unknown. Corrosion was observed on the bases. At least one pump has been rebuilt in the last 10 years. The high pressure shutoff switches on the pumps are functional, but very old. These are rated as fair to poor.

5.4.2.3 Scum Pumps and Scum System

The scum pumps and scum collector/concentrator are approximately 15 years old. They are rated as fair to poor condition.

5.4.2.4 Primary Clarifier Structure

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. The structure will need to be replaced when the mechanism is replaced due to age and requirements to meet current building codes.

5.4.3 Oxidation Ponds

The oxidation ponds have been in service since the plant was originally put in service in the 1950s. Originally there was one large pond, and later it was subdivided into Ponds 1, 2, and 3. The ponds are shown as one large pond in the 1979 Winzler and Kelly Project (WK, 1979). There is little documentation on pond construction, except that they were formed from native materials, likely using cut and fill construction methods.

The ponds have the following physical characteristics:

- **Pond No. 1.** Average operating depth is 4 to 6 feet, area is approximately 24 acres, and the total volume is 46 million gallons (MG).
- **Pond No. 2.** Average operating depth is 4 to 6 feet, area is approximately 22 acres, and the total volume is 43 MG.

With the exception of effluent pumping and aerators, there is very little equipment in the oxidation ponds. Flow enters Pond No. 1 from the primary clarifiers, and is transferred by gravity to Pond No. 2. The transfer structures are generally overflow structures with only manual weirs. Recently, the transfer structures from Pond No. 2 to treatment wetlands Nos. 5 and 6 have been upgraded with automated weirs that are controlled based on pond level. The oxidation ponds are rated as very poor for mechanical equipment and very poor for structural condition.

The ponds reportedly operate at a depth of 4 to 6 feet. The actual depth and therefore the volume is reportedly impacted by biosolids or sludge accumulation. The amount of sludge in the ponds is difficult to estimate, although the most recent survey indicates that solids range from 6-inches to 3 feet, and average about 10 to 12 inches over the area of the ponds. Since the ponds are fairly shallow, the impact of solids accumulation can be significant. Accumulated sludge in the ponds can lead to degradation of effluent quality, especially due to pond turn-over events that re-suspend solids in the water, and reduction in pond detention times.

The overall process performance of the oxidation ponds is evaluated elsewhere in this report. The main process concern has been the treatment capacity of this process once the plant is reconfigured to a one pass system. The ponds provide the secondary process for the AWTF, especially biochemical oxygen demand (BOD) removal. The pond treatment process should be evaluated together with the treatment wetlands to ensure that permit requirements can be meet with this process at the design flowrates. Reported issues include potential short circuiting in pond No. 2 from inlet to outlets, low BOD removal from ponds during certain times of the year, and variable pond outlet nitrogen concentrations. In addition, algae production in the ponds contributes to total suspended solids (TSS) increase in the pond effluent.

5.4.3.1 <u>Pond Aerators</u>

Eight mechanical pond aerators are located in Pond No. 1, based on recent satellite photography. Note that the O&M manual mistakenly indicates they are located in Pond No. 2. The aerator controls were upgraded in 2008, when dissolved oxygen control was added to save energy. The existing units are in poor condition, and several have not been used for a number of years.

The 2003 plant evaluation indicated that four aerators were located in Pond No. 1, and several additional aerators were yet to be installed. The overall purpose and use of the aerators should be clarified, since aerator installation can be costly due to the electrical improvements required to support aerator installation.

The aerators are the type with a propeller that creates vacuum and discharges air into the pond surface. These units are inefficient and generally used in ponds that require little aeration, and some mixing. The pond aerators could be replaced with horizontal type units that will improve aeration and mixing. They could be used to create flow patterns that reduce and prevent short circuiting. The location and size of the replacement units can be defined in subsequent predesign work. The condition of the aerator electrical service is not known, although some of the transformers reportedly may need replacement.

5.4.3.2 <u>Pond Pump Station (PPS)</u>

The PPS pulls from Pond No. 2 and discharges to the chlorine contact basin (CCB). It was built as part of the 1984 upgrade project and shares a common wall with Pump Station 1

(PS1), which is discussed later in this chapter. The wet well of the two pump stations can either be separated or combined via an isolation slide gate on the interior wall of the structure. The pump station structure is in fair condition, and has had some corrosion.

The vertical turbine pumps appear to be in poor to very poor condition, and are at the end of their service life. These pumps need to be replaced. The type and size of the replacement pumps should be reviewed during the next predesign phase of work.

The condition of the electrical service for these units and the controls is unknown. It has been suggested that these pumps should be retrofit with variable frequency drives (VFDs) in order to vary the pump speed and capacity and control wet well level.

5.4.3.3 Emergency Pond (2) Pump Station (EPPS)

The EPPS provides for a failsafe operation, and can pump directly from Pond No. 2 to the CCB. The pumps are self-priming centrifugal type units. Staff reported that the emergency pumps and piping were refurbished in 1996 and are rated as fair. The complete scope of the rehabilitation is unknown, but the units appear to be ready for service.

5.4.4 Treatment Wetlands

The treatment wetlands (TWs) have very little mechanical equipment or structures. Each wetland has one or two inlet structures, or in one case an inlet pump station, from Pond No. 2. The treatment wetlands were first planted and brought on line at different dates, and therefore are at different levels of maturity. The condition of each wetland is outlined below:

- TW Nos. 1 and 2 were first created by building berms in the 1984 modifications project. Average depth is approximately 4 feet. It is not known when they were planted, but the vegetation in both cells appears mature, very dense and reportedly has become so thick, that most of the vegetation is floating. In addition, these cells were never graded, or leveled, and reportedly the east side of TW No. 1 is deeper. Based on this report and visual observations, the condition is rated as poor to very poor, and is in need of a major vegetation management removal and replanting project. These cells appear to be fed from Pond No. 2 from two inlet structures per TW.
- TW No. 3 was created sometime after 1 and 2, and has fairly dense, floating vegetation. While it is not as dense or overgrown as 1 and 2, it is also rated poor due to the lack of grading and open water for reaeration. It should be scheduled for vegetation management once 1 and 2 have been graded, revegetated, and are back online. This cell is feed from a single inlet structure from Pond No. 2.
- TW No. 4 appears to have been built in the location of the sludge drying beds shown in the 1984 project. This cell is fairly shallow, less than 3 feet, and is fairly densely planted. A portion of this cell has floating plants as well. It is feed from a single pump, located in the eastern TW 1 inlet structure. It has been used as a pilot and

demonstration cell over the years. It should be deepened if it is to be used as a treatment wetland. Otherwise it can be maintained as a pilot cell. This wetland was not rated based on it use as a demonstration wetland.

TW Nos. 5 and 6 were constructed in 2012 from Pond No. 3 and brought online in 2013. These TWs were designed with a series of deep settling zones, followed by intermediate depth zones to be covered by floating wetland plants similar to the other TWs, followed by shallow zones with rooted wetland plants such as bull rush. The shallow zones help to distribute flow, while the deeper zones allow for some reaeration. The cells are divided using interlocking vinyl sheet piling. The vegetation is fairly dense, but there is some deeper, more open water, less dense areas in the beginning and middle of each cell. These cells are fed directly from Pond No. 2, from single inlet structures. The grading and planting conceptual design is shown in Appendix J, based on correspondence from Dr. Robert Gearheart. These cells are rated as fair to good and should have ongoing vegetation maintenance to maintain this rating.

Figure 5.2 Treatment Wetlands (Circa 1989)

- TW No. 7 has been planned since the creation of TW Nos. 5 and 6. It is recommended that TW No. 7 be constructed fairly soon. Once constructed, it will provide additional treatment capacity and will allow for other cells to be removed from service for replanting.

The overall process performance of the treatment wetlands is evaluated elsewhere in this report. The main process concern has been the hydraulic capacity of this process once the plant is reconfigured to a one pass system, especially at the design flowrates. The process should be evaluated together with the oxidation ponds to ensure that permit requirements can be meet with this process at the design flowrates. Reported treatment issues with the treatment wetlands include short circuiting from inlet to outlet, uneven flow distribution between treatment wetlands, and low effluent dissolved oxygen levels in conjunction with hydrogen sulfide generation. In addition, some wetland cells may be underperforming compared to others, due to the short circuiting and dense vegetation. The older treatment wetlands 1 to 4 are rated as poor due to deferred maintenance and inconsistent configuration, and treatment wetlands 5 and 6 are rated as very good based on the recent construction.

5.4.4.1 Pump Station 1

Pump Station No. 1 (PS1) receives flow from TW Nos. 1 through 4 and discharges to the CCB. It was constructed as part of the 1984 project. The equipment in the pump station was rated as poor and the structure as fair to poor. The vertical turbine type pumps are at the end of their life and need to be replaced. These could possibly be replaced with submersible type pumps, which can be evaluated during the predesign stage of the project.

The condition of the structural and electrical is unknown. Currently the pumps operate in an off/on mode, based on level, with a lead lag and standby pumps. Two of the pumps have VFDs in order to vary the pump speed and capacity to control wet well level.

5.4.4.2 Pump Station 2

Pump Station No. 2 (PS2) receives flow from TW Nos. 5 and 6 and was originally constructed to discharge directly to the CCB, but are now redirected back to Junction Box 1 which conveys flow to Pump Station 1. This pump station was originally constructed in 1990s by City staff to serve Oxidation Pond 3 storm flows and then repurposed for TW Nos. 5 and 6 in 2012. Therefore, the pumps are older and maybe at the end of their life. Pump station hydraulics should be reviewed during predesign to confirm the capacity still matches the required capacity, since the flow has been redirected. Reportedly the pump station is shallow and would need to be deeper in order to handle design gravity wet weather flows flow from the wetlands. The structure was completed by plant staff, and is not pile supported as required. The pumps are rated as poor and the structure as poor to failed.

The condition of the structural and electrical is unknown. Based on the O&M manual these pumps have VFDs and can be controlled to maintain wet well level.

5.4.4.3 Inlet and Outlet Structures

The condition of the inlet and outlet structures for the TWs was reviewed briefly during the site inspection. They appear to be in fair condition given their age.

5.4.5 Enhancement Wetlands

The enhancement wetlands are the main feature of the Arcata Marsh and Wildlife Sanctuary (AMWS). The AMWS consists of three freshwater wetlands: Allen, Gearheart, and Hauser enhancement marshes or wetlands. The wetlands receive treatment wetlands effluent that is regulated to be equivalent to a secondary treated wastewater effluent. The wetlands provide polishing of the treatment wetlands effluent while providing habitat for a diverse number of organisms, and recreation opportunities.

5.4.5.1 Enhancement Wetlands

The enhancement wetlands (EWs) were constructed from native materials in much the same manner as the TWs. They operate in series, connected by a series of effluent lines, with inlet and outlet structures. The EWs were not surveyed in detail for this report, but previous reports were reviewed to determine if there were any improvements that had been identified for the wetland operation. The main feature noted was the potential for short circuiting, based on the vegetation and construction of channels that may lead to reduced detention time. Therefore the EWs are rated as poor, and improvements that maximize the hydraulic detention time are included in the capital improvement program.

The overall process performance of the enhancement wetlands is evaluated elsewhere in this report. The main process concern has been the hydraulic capacity of this process once the plant is reconfigured to a one pass system, especially at the design flowrates. The process should be evaluated together with the treatment wetlands to ensure that permit requirements can be meet with this process at the design flowrates. Reported treatment issues with the enhancement wetlands include short circuiting from inlet to outlet and low effluent dissolved oxygen levels in conjunction with hydrogen sulfide generation. In addition, algae production in the wetlands may contribute to TSS increase in the enhancement wetland effluent. Therefore they are rated at fair to poor based on deferred maintenance, flow short circuiting, and transfer structure issues.

5.4.5.2 Enhancement Wetlands Effluent (Hauser) Pump Station

The Enhancement Wetlands Pump Station (EWPS) or Hauser PS was constructed as part of the 1984 plant modifications. It consists of three vertical turbine pumps located in a concealed wet well in the public access area of the AMWS. The pumps were rated as poor and will need to be replaced to provide the capacity for the new flow configuration. The use of the existing wet well will be further reviewed as part of the preliminary design for the UV disinfection and flow reconfiguration project.

In general the structure appears to be in fair to poor condition based on the age. The structure is pile supported, and does not appear to have any settlement issues. The way the pumps were concealed makes the PS maintenance difficult, and contributes to the poor rating. Three large hatches were placed over the vertical turbine pumps, so they could be removed, but the space is a confined space with limited access. Other types of pumps including submersible type might be considered to allow for ease of maintenance, and to reduce the access issues.

The pump station intake or inlet structure includes two inlets that draw at different elevations from the Hauser wetland. One inlet is clogged and has not worked for over a decade. These combine in an inlet box into a single inlet line into the PS wet well. The 16-inch inlet lines will need to be checked to confirm they provide the required capacity for the flow reconfiguration. The inlet structure is also pile supported. Plant staff has added a manual coarse screen in the outlet from the box to remove larger debris before it enters the wet well. The need for an automated screen will be reviewed in predesign.

The PS discharges to the existing CCB, for disinfection prior to discharge at Outfall 001. The piping will be retained for future diversion to the existing outfall if needed. New piping and valves will be added to allow discharge to the new UV disinfection facility and then gravity flow to Outfall 003.

5.4.6 Disinfection

The existing disinfection system consists of the CCB, chlorine storage and feed building and associated equipment. The system was constructed in the 1984 improvements project. The conditions of the major elements are outlined below.

5.4.6.1 CCB

The CCB consists of two 4-pass basins that can be operated in series or combined modes. The basin is a pile supported, cast in place concrete structure with concrete masonry block divider walls. The structure condition appeared to be fair to poor based on the age of construction, and the divider wall construction. The divider walls are reinforced grout filled walls that may not have structural capacity for a seismic event. The handrail was observed to be in good condition. The condition of the isolation gates and appurtenances is poor with some gates that are difficult to operate. The chemical induction mixers and mechanical equipment are nearly 20 years old and rated as fair.

5.4.6.2 Chemical Storage and Feed Facilities

The disinfection chemical storage and feed system is based on ton cylinder liquid chlorine (CL2) and sulfur dioxide (SO2) tanks. The tanks are connected in parallel to provide sufficient capacity. The condition of the system was not assessed in detail since it was assumed it would be phased out, or operated intermittently once the new UV system was implemented. It was noted that the current ton cylinder storage building was in fairly good shape, and might be repurposed for other uses once the system is off-line. It could be used for a liquid chemical system. It consists of a pile supported slab with CMU walls, and fairly tall peaked roof open building structure.

5.4.6.3 Miscellaneous Chlorine Disinfection Facilities

The miscellaneous facilities and their condition are noted below:

- Chemical residual analyzers - fair condition.
- CCB sample pumps replaced on a regular basis using disposable units - fair condition.
- CCB gates - poor condition.
- Chlorine and Sulfur dioxide induction mixers are newer and are rated as good.

5.4.7 Solids Handling and Treatment

The solids handling and treatment facilities include primary and secondary digesters; digester mixing and heating facilities; sludge drying beds and compost operation; and digester gas handling. The condition of these facilities is outlined below.

5.4.7.1 Digesters Structure

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 condition of the digester structure appears to be poor, although they have not been inspected by a structural engineer. The condition of the dome roof is unknown, but it is known that has been inspected and the exterior recoated as some point. The condition of the covers interior was not observed, although the 2003 plant evaluation also recommended an inspection and coating if required. Due to the lack of redundancy, this inspection may be difficult, and therefore has been put off by plant staff.

Staff noted that the digesters have been cleaned recently, in both 2002 and 2014. No reports were available on the condition of the digesters once they were cleaned.

5.4.7.2 Digester Mixing and Heating

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 appears to be good to fair. The boiler was reportedly replaced in 1998 or 1999. Issues with the existing digester gas piping were noted in the 2003 plant evaluation, and should be confirmed.

5.4.7.3 Sludge Drying Beds

The sludge drying beds were built as part of the 1984 project. These beds were covered with a canopy type roof. The condition of these original drying beds was rated as fair. Plant staff noted that additional drying beds could be used, or replaced with mechanical dewatering equipment.

5.4.7.4 Compost Operation

The components of the sludge and green waste compost process were not reviewed during the condition assessment and plant site walk.

5.4.8 Plant Electrical and Controls

The plant electrical and control systems are generally in fair to poor shape due the age of the equipment. Reportedly buried conduit has deteriorated in many locations, and now is just bare wire. Reportedly, the wire and cabling is need of replacement as well. The majority of the electrical equipment and control systems are the original equipment installed as part of the 1984 project.

The plant control system is outdated and does not provide some of the current labor saving features that are found in almost all systems today. These include:

- Remote operation. Currently, most equipment must be controlled at the process area only, and little if any equipment may be remotely operated.
- Remote access. This would allow alarm conditions to be reviewed by the facility manager without having to visit the plant.
- Data collection and logging. This would aid in monthly reporting and maintenance planning.
- Compatibility with new controls. Currently, new equipment with programmable logic controller (PLC) based controls cannot be integrated into the existing system.
- The system does not have the ability to integrate the collection system monitoring and control systems.

The rating of the major system components is noted below:

- Power Distribution - The MCC equipment was installed in the 1984 project, and is mostly original. The main plant MCC equipment is located in the standby generator building. The equipment including MCCs and transfer switch is in fair condition.
- Standby Generator - The plant main standby generator was replaced by staff in a recent in-house project. The installation looks good, and is reportedly working well. The unit is 250-kW. The new unit is in good condition. An older, smaller, 150-kW unit is available as a backup, although its condition is unknown.

- Plant power feed - The condition of the plant power feeder from the utility was not reviewed, although plant staff has noted the main transformer is old. Staff reportedly tests the oil in each transformer in order to anticipate transformer failure and replacement needs.

5.5 SUMMARY OF PLANT CONDITIONS

Overall the plant assets and equipment is in fair to poor condition. While this will not be a surprise to plant and City staff, it does indicate a need to complete a comprehensive update the existing capital improvement plan to bring the assets into better ratings. Therefore, in addition to the current project to meet the conditions of the discharge permit, ongoing projects will be required to rehabilitate the aging infrastructure and maintain the ability to meet permit requirements. The recommended CIP is provided as Chapter 6.

5.6 REFERENCES

- CH2M Hill 1984 - Wastewater Treatment Plant Modifications 1984.
- WK 1997 - Winzler and Kelly 1997.
- SHN 2003 - 2000/2002 Wastewater Treatment Plant Evaluation 2003.
- O&M - Arcata Wastewater Treatment Facility Operation and Maintenance Manual ND.

ALTERNATIVES

6.1 INTRODUCTION

Based on the findings of the previous chapters, there is a need to develop and evaluate alternatives that meet current and future treatment objectives and permit compliance requirements. Drivers for these alternatives include:

- Current permit requirements (new flow configuration with enhancement requirement and UV implementation).
- Ongoing permit violations.
- Need to repair/rehabilitate aging infrastructure.
- Deferred maintenance of the existing ponds and wetlands system including build-up of solids and materials causing an internal load.
- Identified shortfall in secondary treatment capacity with elimination of chlorine.
- Future regulations on ammonia/nutrients.
- Future sea level rise and flooding concerns.

This chapter describes the project options considered and the methodology for selection of recommended alternatives that best meet the multiple goals of the City.

6.2 BASIS FOR ALTERNATIVES

The design flow and loads were determined in Chapter 2 and are shown in Table 6.1. These loads include a 20 percent growth factor over existing 90th percentile loads. This allows for confidence in sizing facilities to be able to meet permit requirements in most conditions that will be seen by the Arcata Wastewater Treatment Facility (AWTF).

All alternatives should provide reliable treatment capacity for design load, provide flexibility to meet future regulatory requirements (such as ammonia removal), and must be able to fit on the existing site since additional bay fill is not permitted and additional land is not available near the AWTF. Furthermore, as discussed in the June 27, 2016 meeting with the RWQCB, the Enclosed Bays and Estuaries Policy requires effluent enhancement prior to discharge; bypassing enhancement is a violation of current permit requirements.

It is recognized that the existing natural land based system is a point of pride in the community and heralded as a model of sustainable, land-based treatment. Therefore, it is desirable to continue using the pond and wetland system to the best of their abilities and to improve them through solids removal and vegetation management to increase their reliability.

Table 6.1 Design Flow and Loads With 20% Growth Projection Wastewater Treatment Facility Improvements Project City of Arcata	
Average Dry Weather Design Flow, mgd	2.3
Peak Wet Weather Design Flow, mgd	5.9
Design Influent BOD_5 Load, ppd	4,800
Design Influent TSS Load, ppd	6,910
Design Influent Ammonia Load, ppd	1,060

6.3 SUMMARY OF COMMON IMPROVEMENTS NEEDED

Based on the findings of Chapter 5, Condition Assessment, numerous facilities will need to be improved based on their expected useful life and current condition. In addition, there are many common elements needed for the new flow configuration. Common elements include:

- **Headworks Improvements**: The headworks are currently rated at 5.0 million gallons per day (mgd) and the visual condition assessment rated the average mechanical, electrical and I&C condition as poor. The recommended headworks improvement is to replace structural and mechanical assets due to age and condition, and to upsize the capacity to handle design peak wet weather flow (PWWF) of 5.9 mgd. Replacing the headworks structure will also raise the hydraulic grade line at the start of the plant, allowing downstream facilities to flow by gravity and minimizing the need for additional pumping.

- **Primary Clarifiers**: The two primary clarifiers are currently rated at 4.0 mgd and 1.0 mgd each, and the condition assessment rated the mechanical, structural, electrical and I&C condition as very poor, especially based on their age. The recommended improvement is to replace structural and mechanical assets due to age and condition. The capacity of the primary clarifiers will vary depending on the project alternative requirements.

- **Primary Sludge and Scum Pumps**: The age of the primary sludge pumps are unknown and the scum pumps are 15 years old. Visual condition assessment rated the average mechanical, electrical and I&C condition as fair to poor. The recommended improvement is to replace the primary sludge and scum pumps due to condition along with the primary clarifiers. The capacity of the primary sludge and scum pumps will vary depending on the project alternative requirements.

- **Oxidation Pond Nos. 1 and 2 Solids Removal and Transfer Structure Reconfiguration**: Solids accumulation in the oxidation ponds is affecting treatment and hydraulic capacity. Up to one foot of solids in each pond is anticipated needing dredging, dewatering, and disposal in order to return the ponds to original design intent. Reconfiguration of the pond transfer structures is recommended for better flow distribution and improvement of storage capacity.

- **Emergency Pond Pump Station**: The existing pump station has a firm capacity of 3.6 mgd and pumps peak wet weather flows above 5.9 mgd from Oxidation Pond No. 2 to the chlorine contact basin, for discharge through Outfall 001. Plant staff reported that the pumps are older, but in good condition due to low operating hours. Recommended improvements include adding suction and discharge piping to allow the pump station to pump out of Pond 1 and into Pond 2 for Pond 1 storage control; pump rehabilitation is not anticipated to be needed.

- **Treatment Wetland Nos. 1 through 4 Solids and Vegetation Maintenance**: Solids accumulation and heavy vegetation growth in Treatment Wetland Nos. 1 through 4 is affecting treatment and hydraulic capacity. Solids and vegetation removal, regrading of the deep and shallow water zones, and vegetation replanting is anticipated in the four older treatment wetlands in order to return them to original design intent. No maintenance project is currently planned in Treatment Wetland Nos. 5 and 6 due to their recent construction. Treatment Wetland No. 4 will require substantial regrading to deepen and provide the same capacity as the other treatment wetlands.

- **Treatment Wetland No. 4 Influent Pumps and Treatment Wetlands Pump Station 2**: These pumps will need to be further evaluated during preliminary design to determine whether pump replacement is required or whether pumps can be demolished with rehabilitation of the other treatment wetlands improvements.

- **Enhancement Wetlands Improvements:** Solids accumulation and heavy vegetation growth in the enhancement wetlands is affecting treatment and hydraulic capacity. As Waters of the State, major regrading or any activities that significantly reduce water quality or habitat will not be allowed in the enhancement wetlands. Vegetation maintenance, new baffles, and new inlet/outlet structures is anticipated in all three enhancement wetlands in order to improve treatment and hydraulic efficiency and capacity.

- **Pond Pump Station/Pump Station 1**: Pond Pump Station has an existing firm capacity of 2.9 mgd and Pump Station 1 (Treatment Wetland PS) has an existing firm capacity of 2.3 mgd. The visual condition assessment of both pump stations rated the average mechanical, electrical and I&C condition as poor (score of 4), and structural condition as fair to poor (score of 3 and 4). The recommended improvement is to replace mechanical assets due to age and condition and to upgrade the combined wet well in order to improve flow by gravity upstream. The new capacity of each pump station will vary depending on the project alternative requirements.

- **Enhancement Wetlands (Hauser) Pump Station:** Enhancement Wetlands Pump Station originally had a firm capacity of 3.0 mgd, but recent pump capacity tests have derated the capacity to 1.2 mgd. The visual condition assessment of both pump stations rated the average structural, mechanical, electrical and I&C condition as poor (score of 4). The recommended improvement is to replace mechanical assets due to age and condition. The new capacity of the pump station and capacity of the discharge pipe to the new UV system will vary depending on the project alternative requirements. In general, it is agreed by the City, AMRI, and Carollo that the Enhancement Wetlands will perform best at steady lower flows. Holding their flow to 2.3 mgd for all alternatives is recommended. However this should be considered again during preliminary design given the RWQCB position (stated at the 6/27/16 meeting) that all flow must pass through the enhancement wetlands to meet the definition of enhancement. Further inspection of the existing 16-inch pump station discharge piping during Preliminary Design is also recommended to confirm condition and any rehabilitation required.

- **Anaerobic Digesters and Sludge Heating/Mixing System**: The two anaerobic digesters are almost 60 years old. The external visual condition assessment rated the average structural condition as fair but the internal structural condition is unknown. The sludge heating and mixing system appears to be in good to fair condition. The recommended improvement is to improve structural and mechanical assets in phases. The required project elements and recommended implementation schedule will vary depending on the project alternative requirements.

- **Outfall 003**: New Outfall 003 at the Brackish Marsh and effluent piping from the UV disinfection system will be sized for 5.9 mgd.

- **UV Disinfection:** A new UV disinfection system will be constructed for disinfection of secondary effluent up to 5.9 mgd. The design criteria of the UV system will vary depending on the project alternative requirements. UV disinfection will be further discussed in Chapter 7, Disinfection Alternatives.

6.4 IDENTIFICATION OF SECONDARY TREATMENT OPTIONS

Identification of secondary treatment options is needed to address the secondary treatment capacity shortfall. This task was completed in phases. The first phase consists of a preliminary screening of new secondary treatment options to be used in conjunction with the existing natural system for pretreatment, parallel treatment, or post treatment. Any of these treatment options deemed feasible were further discussed and evaluated with the City.

6.4.1 Preliminary Screening of Secondary Treatment Options

There are several treatment processes that can be used to provide additional secondary treatment capacity, either alone or in combination with other processes, in order to achieve desired effluent water quality. Table 6.2 provides a list of secondary treatment processes that are commonly considered, along with the constituents they most commonly remove.

Table 6.2 Secondary Processes Meeting Permit Discharge Requirements
Wastewater Treatment Facility Improvements Project
City of Arcata

	Ability To Remove		
Process	**Organics (BOD)[(1)]**	**Ammonia[(2)]**	**Total Nitrogen[(2)]**
Suspended Growth			
Activated Sludge	√	√	√
Attached Growth			
Trickling Filters	√		
Nitrifying Trickling Filters		√	
Denitrification Filters			√
Land Based Systems			
Ponds (Aerated or Not)	√	Summer only	
Vegetated Wetlands	√	limited	If nitrified before
Open Water Wetlands	√	Some	If nitrified before

Notes:
(1) Current permit discharge requirement.
(2) Anticipated future permit discharge requirement.

While there are variations of activated sludge processed such as oxidation ditch, conventional activated sludge, sequencing batch reactors, or a membrane bioreactor that adds a membrane filter, the biological treatment process is the same. Similarly, there are various attached growth processes that incorporate different types of media that the biological growth attaches to, but the treatment process is essentially the same.

In addition to the secondary processes presented above, there are some physical and chemical processes that could be considered. There are several approaches that could be taken with any additional treatment process: 1) pre-secondary treatment (pretreatment) by adding processes before the existing pond/wetlands system, 2) parallel secondary treatment, and 3) post-secondary treatment (post treatment, after the pond/wetlands). Each alternative considered needs to fit with a final UV disinfection step, as the City Council has affirmed several times the decision to move away from chlorine and instead use UV. Initial options that fall into each of these categories are shown in Table 6.3.

Of the options considered, there are only a few that Carollo recommends carrying forward for a variety of reasons, as discussed below. Any process that requires piloting at the AWTF was eliminated to meet the accelerated schedule for permit compliance. Any process that is not yet a proven technology with full-scale installation experience was also eliminated early in the alternatives analysis.

Table 6.3	Initial Screening of Pre, Parallel and Post Treatment Options Wastewater Treatment Facility Improvements Project City of Arcata					
	Treatment Option	**Adds BOD capacity**	**Removes ammonia**	**Improves final UVT**	**Reliable**	**Move forward**
Pretreatment	Chemically Enhanced Primary	< 400 ppd	No	No	Yes	No - high O&M cost
	Aeration	yes	limited	No	Yes	Yes
	Trickling Filter	yes	only if 2-stage	No	Yes	No
	Activated Sludge	Yes	Yes	No - TM degrades	Yes	No
Parallel	Additional Ponds/Wetlands	Yes	Summer only	No	Maybe	No - no room
	Rehabilitate Ponds/Wetlands	Yes - not enough	Summer only	No	Maybe	Yes
	Trickling Filter	Yes	only if 2-stage	No	Yes	Yes
	Activated Sludge	Yes	Yes	Yes	Yes	Yes
Post Treatment	Trickling Filter/Nitrifying Trickling filter	Yes	only if 2-stage	No	No - cold affects performance	No - not as flexible
	Submerged Biofilter	Not proven	Need to pilot	No	Unknown	No
	Ozone/Biological active Filtration	Yes	Maybe - must pilot	Not needed	Maybe - must pilot	No -Need to pilot
	Filtration	< 400 ppd	No	Maybe	Yes	No -Need to pilot

Pretreatment:

- Chemical pretreatment in the primaries would add a significant operations cost with only an additional 10 percent removal of BOD across the primaries, which does not meet the shortfall.
- The existing Pond 1 aerators could remove BOD if they were functioning and designed for the appropriate conditions (e.g. pond depth, location). In the new flow routing, Pond 1 will be used for both treatment and storage at peak wet weather flows. Therefore, the use of aerators in Pond 1 is not recommended due to variable operating depth. Pond 2 will be used for only treatment, and thus adding aerators to Pond 2 will be considered.
- Trickling filters, while a proven and effective treatment process, are poor processes upstream of UV, and do not have the flexibility to remove ammonia or nitrogen unless more than one unit is installed in series.
- Activated sludge upstream of the existing natural system would improve water quality, but to be most effective as pretreatment it would have to be sized for the full flow

which would require a high O&M cost due to aeration requirements. One disadvantage is that improved UV Transmittance (UVT) from activated sludge effluent would degrade across the existing natural system.

<u>Parallel Treatment:</u>

- Additional ponds or wetlands could provide the needed BOD treatment; however, land is not available for building new ponds or wetlands sufficient to meet the capacity shortfall. As Waters of the State, the AMWS cannot be modified to function as treatment wetlands since significant regrading would be required to create alternating deep and vegetated zones. Additional ponds or wetlands would not provide year-round ammonia or nitrogen removal, since the natural removal process is dependent on temperature and sunlight.
- Trickling filters, while a proven and effective treatment process, are poor processes upstream of UV, and do not have the flexibility to remove ammonia or nitrogen unless put in series. However they were carried through the initial screening.
- Activated Sludge processes provide both BOD and ammonia/nutrient removal and provide the most flexibility for additional treatment. As parallel treatment the process could be sized for a portion of the full flow which would reduce O&M cost due to aeration requirements.

<u>Post Treatment:</u>

- A weakness of any attached growth process (trickling filters or nitrifying trickling filters) is that they are sensitive to temperature. If the ponds and wetlands are located upstream of an attached growth process, the system will have unreliable performance in the winter months. Additionally, ammonia removal in attached growth processes has been shown to be difficult following ponds and wetlands (e.g. City of Stockton). In the summer months while ponds are reducing ammonia, the biological organisms are being starved, leading to violations in the fall when additional treatment is needed. Additionally, lightly loaded trickling filters (e.g. nitrifying trickling filters) are prone to attracting snails that strip the biological process from the media. Additional operations expenses are required to control the snails.
- A submerged biofilter is another attached growth process that was considered. However, it is our opinion that the same ammonia starving issue that happens with nitrifying trickling filters and potential poor performance in the cold months will likely happen with submerged biofilters.
- Biological active filtration paired with ozone has shown the ability to produce high quality water. However, it is unknown how such a process would perform on pond/wetland effluent. This process would require piloting. From experience at other installations, the process can be fairly expensive. In addition, the use of ozone requires special operation training and attention. Therefore, this alternative is not considered further.

- Filtration is a common process to add after secondary treatment to produce a high quality water. However, filtration following pond/wetland processes has been shown to be more difficult, requiring much lower loading rates (more filters) and high chemical (coagulant) doses in Cities of Napa, Sunnyvale, and Stockton. Additionally, it is only likely to reduce BOD by approximately 20 milligrams per liter (mg/L) or less than 400 ppd. Pilot testing would be required to determine the UVT after filtration as well as the acceptable filter loading rate and coagulant dose.

Summary of Initial Screening:

- The viable pretreatment alternative to be further considered is aeration in Pond 2.
- The viable parallel treatment alternatives to be further considered are rehabilitation of the ponds/wetlands, trickling filters, and activated sludge.
- None of the post treatment alternatives will be further considered.

6.4.2 Further Screening of Parallel Secondary Treatment Options

At the November 5 and 6, 2015 facility plan capacity workshop with the City staff and City consultant Bob Gearheart (with AMRI), a more detailed analysis of parallel secondary treatment options was discussed, including:

- Conventional activated sludge (CAS) aeration basins.
- Extended aeration activated sludge (oxidation ditch).
- Trickling filters.
- Modifying existing oxidation ponds to a Biolac system or aerated lagoons.

As discussed at the workshop, modifying the existing oxidation ponds to a Biolac system or aerated lagoons was deemed not feasible due to constructability issues with the berms and pond depths. For workshop discussion purposes, preliminary design criteria were presented for the remainder of the options in order to present comparative information. Hence, preliminary design criteria were developed based on flow design criteria shown in Table 6.4. These preliminary design criteria are outlined in Table 6.4. Note that following the November 2015 workshop, additional City flow and load data was provided to Carollo in order to further refine the load design criteria to the values presented in Table 6.4.

During the November 2015 workshop, discussion of the treatment options included a number of considerations including performance, footprint, constructability, operation and maintenance requirements, and economic factors. A summary of the non-economic evaluation is outlined in Table 6.5. A summary of the economic evaluation is outlined in Table 6.6. At the workshop, the preferred secondary treatment process selected by the City was an extended aeration oxidation ditch. The information presented in the workshop is included in Appendix G.

Table 6.4 Preliminary Design Criteria for Parallel Secondary Treatment Options
Wastewater Treatment Facility Improvements Project
City of Arcata

Item	Option		
	Conventional Activated Sludge	**Oxidation Ditch**	**Trickling Filters**
Primary Clarifiers - Quantity & Diameter(1)	2 @ 40 ft	N/A	2 @ 40 ft
Aeration Basins - Quantity & Volume	2 @ 0.23 MG	2 @ 1.44 MG	N/A
Trickling Filters - Quantity, Height & Diameter	N/A	N/A	2 @ 20 ft high, 60 ft diameter
Secondary Clarifiers - Quantity & Diameter	2 @ 70 ft	2 @ 70 ft	2 @ 70 ft
Effluent BOD (mg/L)	10	20	30
Effluent TSS (mg/L)	10	20	30
Effluent Ammonia (mg/L)	Same as influent(2)	<1	Same as influent(2)

Notes:
(1) Primary clarifiers are not a required process upstream of the oxidation ditch alternative; however, they may be recommended with project alternatives depending on flow configuration requirements.
(2) In this analysis, additional volume for nitrification was not included with CAS or trickling filters; nitrification in an oxidation ditch can be achieved without additional volume.

Table 6.5 Secondary Treatment Options Evaluation of Non-Economic Factors
Wastewater Treatment Facility Improvements Project
City of Arcata

Option	Criteria Scale: 1 (least favorable) to 3 (most favorable)					
	Safety	**Meets Permit**	**Ease of O&M**	**Construct-ability**	**Reliability**	**Ammonia Removal**
Conventional Activated Sludge	2	3	1	3	3	2
Extended Aeration – Oxidation Ditch	2	3	3	2	3	3
Trickling Filters	3	1	3	2	1	1

6.5 PROJECT ALTERNATIVE DEVELOPMENT AND COMPARISON

The most viable options identified in the screening process were further refined as project alternatives that address how the facility would perform as a system, since system performance affects the viability of any one process. Project alternatives consider facility-specific issues such as flow routing, hydraulic and treatment capacity of individual processes, and process improvement or replacement needs based on condition assessment. The goal of each project alternative is to provide a facility that maximizes use of the existing natural system while meeting treatment and permit compliance objectives.

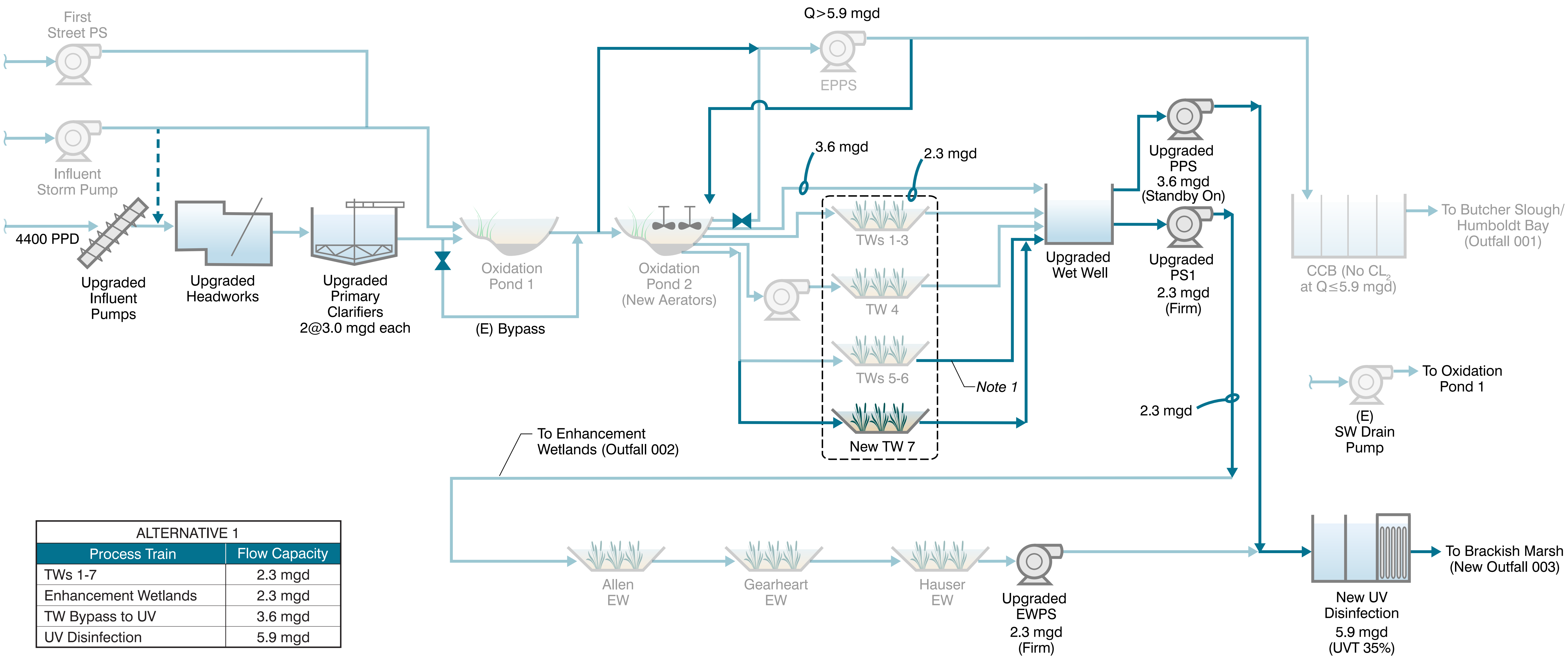
Table 6.6 Secondary Treatment Options Evaluation of Economic Factors
Wastewater Treatment Facility Improvements Project
City of Arcata

	Criteria Scale: 1 (least favorable) to 3 (most favorable)					
Option	**Construction Cost**	**Footprint**	**Operator Attention**	**Power Cost**	**Sludge Production**	**Maintenance Requirement**
Conventional Activated Sludge	3	3	1	1	1	1
Extended Aeration – Oxidation Ditch	2	1	2	2	2	3
Trickling Filters	1	2	3	3	3	2

Based on the findings of the preliminary and secondary screening as well as feedback received at presentations made to City Staff, the public and City Council in April 2016, three project alternatives were developed:

- Alternative 1, Existing System Rehabilitation. This alternative improves the existing natural treatment system with no supplemental secondary treatment process. This alternative does not provide the required capacity to meet the BOD capacity shortfall. In the past the shortfall was made up by use of chlorine for supplemental BOD removal. This alternative will not provide year-round nitrification removal. This alternative was conceptualized by AMRI and further evaluated by Carollo to meet treatment and permit compliance objectives. Aeration would be added to the ponds and Treatment Wetland No. 7 would be constructed to provide some supplemental capacity, but a 1000 ppd BOD removal deficiency at 20 percent growth projection is still anticipated. The Alternative 1 flow schematic is shown in Figure 6.1.

- Alternative 2, Existing System with Side-stream Treatment. This alternative provides a side-stream secondary treatment process parallel to the ponds and treatment wetlands that returns flow upstream of the enhancement wetlands. The ponds and treatment wetlands would continue treating the majority of the plant influent flow. The side-stream treatment process would treat a portion of the plant influent flow as needed for supplemental BOD and year-round partial nitrification treatment capacity. Both effluents would normally blend before passing through the enhancement wetlands and UV disinfection. The Alternative 2 flow schematic is shown in Figure 6.2.



ALTERNATIVE 1	
Process Train	Flow Capacity
TWs 1-7	2.3 mgd
Enhancement Wetlands	2.3 mgd
TW Bypass to UV	3.6 mgd
UV Disinfection	5.9 mgd

Notes:
1. Eliminate Pump Station 2 and upgrade PPS/PS1 Wet Well to allow flow by gravity from TWs 5-6.

LEGEND
- New Piping
- Existing Piping
- Normally Closed Valve

PROPOSED ALTERNATIVE 1
FLOW SCHEMATIC

FIGURE 6.1

CITY OF ARCATA
WASTEWATER TREATMENT FACILITY IMPROVEMENTS PROJECT

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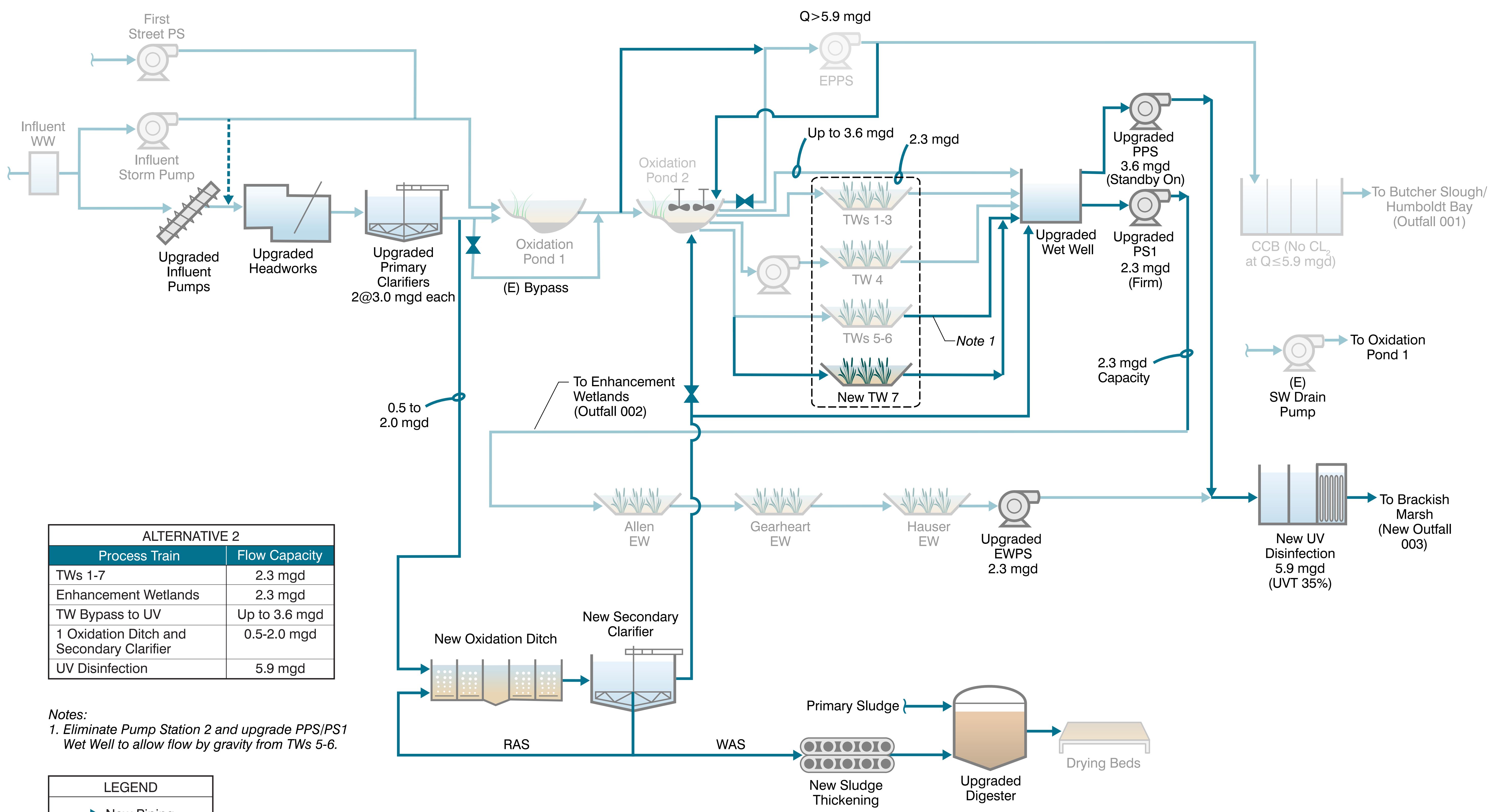

ALTERNATIVE 2	
Process Train	Flow Capacity
TWs 1-7	2.3 mgd
Enhancement Wetlands	2.3 mgd
TW Bypass to UV	Up to 3.6 mgd
1 Oxidation Ditch and Secondary Clarifier	0.5-2.0 mgd
UV Disinfection	5.9 mgd

Notes:
1. Eliminate Pump Station 2 and upgrade PPS/PS1 Wet Well to allow flow by gravity from TWs 5-6.

LEGEND
- New Piping
- Existing Piping
- Normally Closed Valve

PROPOSED ALTERNATIVE 2 FLOW SCHEMATIC

FIGURE 6.2

CITY OF ARCATA
WASTEWATER TREATMENT FACILITY IMPROVEMENTS PROJECT

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- Alternative 3, Existing System with Parallel Treatment. This alternative provides a parallel secondary treatment process to the ponds, treatment wetlands, and enhancement wetlands. The natural system train and parallel process train would each treat a portion of the plant influent flow at variable percentages to provide a blended effluent meeting treatment objectives. The natural system would continue treating the majority of the plant influent flow up to available hydraulic and treatment capacity. The parallel process train, currently planned as oxidation ditches followed by secondary clarifiers, would provide BOD and year-round full nitrification treatment capacity to handle the remainder of the hydraulic capacity needs and to meet specific blended water quality requirements. Natural system effluent and parallel process effluent would combine prior to UV disinfection. The Alternative 3 flow schematic is shown in Figure 6.3.

6.5.1 Alternative Descriptions

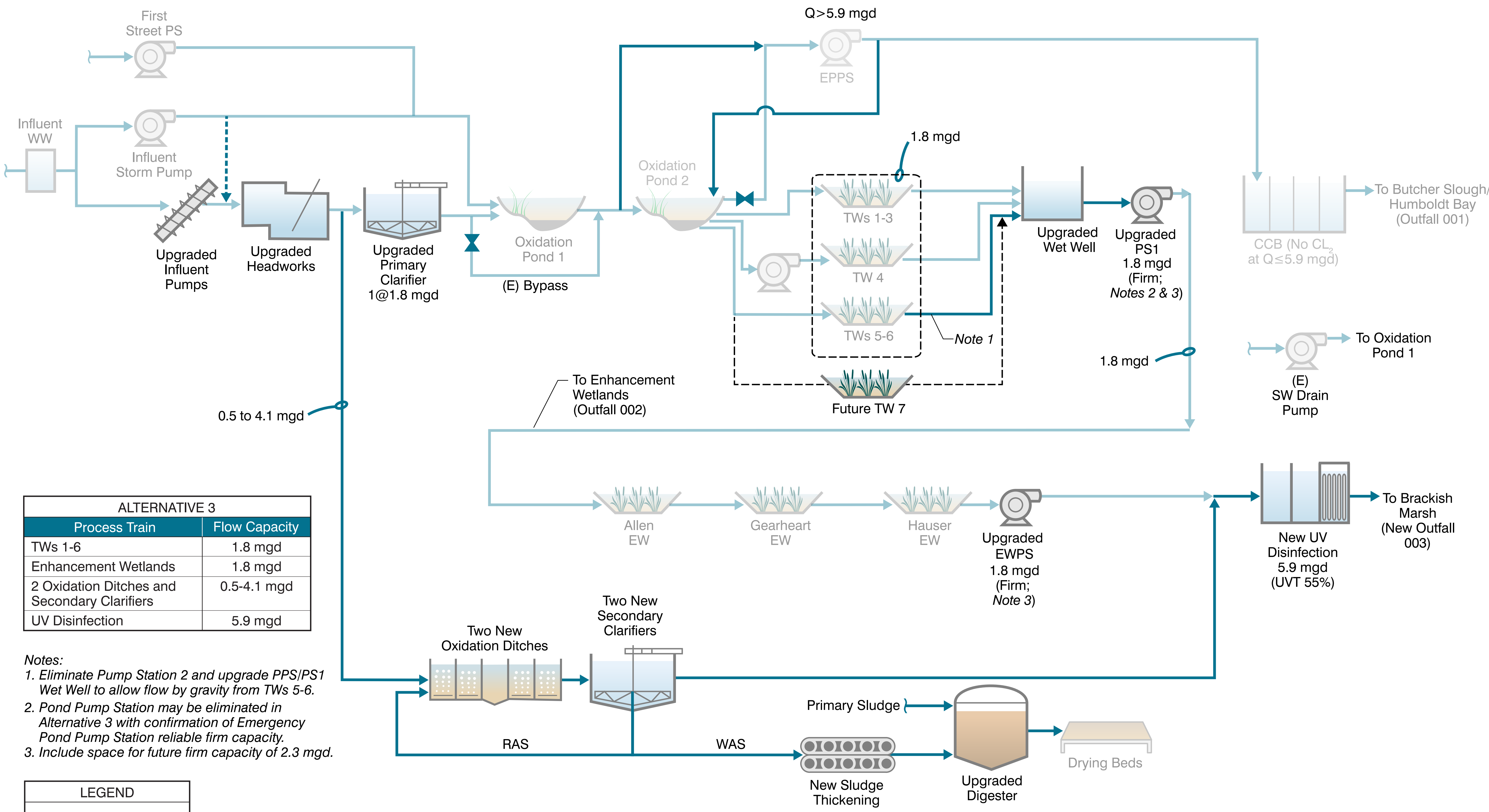
Descriptions for each project alternative are described in detail below, and a comparison of their design criteria is summarized in Appendix K.

6.5.1.1 Alternative 1, Existing System Rehabilitation

In Alternative 1, the oxidation ponds would normally handle up to 5.9 mgd, with wet weather flows greater than 5.9 mgd stored in Oxidation Pond 1, or in an emergency, sent to the existing chlorine contact basin for disinfection and discharge through existing Outfall 001. Flow to the treatment wetlands would be limited to 2.3 mgd with new Treatment Wetland No. 7 online; flows in excess of 2.3 mgd would bypass the treatment wetlands and be blended with treatment wetlands effluent prior to being sent to the enhancement wetlands. Any excess blended flows would be routed directly to the influent side of the new UV disinfection and blended with the enhanced wetlands effluent. Disinfected effluent would be discharged through new Outfall 003.

Alternative 1 includes the following elements:

- Headworks improvements rated at 5.9 mgd.
- Replace existing primary clarifiers with two new primary clarifiers rated at 3.0 mgd each. This sizing would allow process redundancy at the design average flow condition of 2.3 mgd, with overall capacity for the design PWWF condition of 5.9 mgd. Replace existing primary sludge and scum pumps with new pumps sized for two new 3.0 mgd primary clarifiers.
- Emergency Pond Pump Station improvements, oxidation ponds improvements, Treatment Wetland Nos 1 through 4 maintenance, evaluation of Treatment Wetland No. 4 influent pumps and Pump Station 2, and enhancement wetlands improvements are recommended as previously described in Section 1.3.



ALTERNATIVE 3	
Process Train	Flow Capacity
TWs 1-6	1.8 mgd
Enhancement Wetlands	1.8 mgd
2 Oxidation Ditches and Secondary Clarifiers	0.5-4.1 mgd
UV Disinfection	5.9 mgd

Notes:

1. *Eliminate Pump Station 2 and upgrade PPS/PS1 Wet Well to allow flow by gravity from TWs 5-6.*
2. *Pond Pump Station may be eliminated in Alternative 3 with confirmation of Emergency Pond Pump Station reliable firm capacity.*
3. *Include space for future firm capacity of 2.3 mgd.*

LEGEND

- New Piping
- Existing Piping
- Normally Closed Valve

PROPOSED ALTERNATIVE 3
FLOW SCHEMATIC

FIGURE 6.3

CITY OF ARCATA
WASTEWATER TREATMENT FACILITY IMPROVEMENTS PROJECT

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- New Oxidation Pond No. 2 aerators are recommended to improve aeration and mixing while preventing short circuiting. The eight existing propeller-type mechanical aerators in Pond No. 1 are in poor condition and several have not been used for a number of years. New mechanical aerators (horizontal type) are recommended to be installed in Pond No. 2 to improve pond mixing, reduce short circuiting, and provide additional BOD treatment capacity of Pond No. 2 by 600 ppd.
- Construction of new Treatment Wetland No. 7 is recommended. This project would convert an existing aquaculture pond into a new 2.3-acre treatment wetland, increasing the hydraulic capacity of the treatment wetlands from 1.8 mgd to 2.3 mgd. As discussed in Chapter 4, constructing Treatment Wetland No. 7 is anticipated to increase the BOD treatment capacity of the treatment wetlands from 340 ppd to 420 ppd.
- The recommended Treatment Wetlands Pump Station 1 improvement is to replace the existing 2.3-mgd firm capacity pumps with new 2.3-mgd firm capacity pumps due to age and condition. This sizing matches the anticipated capacity of the treatment wetlands after construction of Treatment Wetland No. 7. The recommended Pond Pump Station improvement is to replace the existing 2.9-mgd firm capacity pumps with new pumps due to age and condition so that the pump station will have 3.6 mgd capacity with the standby pump running. Improvement of the combined wet well is also recommended so that Treatment Wetland Nos. 5 and 6 can flow by gravity into the pump station, eliminating Pump Station 2.
- The recommended Enhancement Wetlands (Hauser) Pump Station improvement is to replace the existing 1.2-mgd firm capacity pumps with new 2.3-mgd firm capacity pumps to match the new flow routing capacity through the enhancement wetlands. Additional pump station improvements include adding a mechanical bar screen on the pump station inlet and strainers on the discharge line.
- Upgrade and reconfiguration of the sludge digestion system is recommended to accommodate additional primary sludge associated with increasing primary clarifier capacity. Project elements will be refined during preliminary design but may include digester cover rehabilitation and digester tank modifications.
- New UV disinfection system sized for 35 percent UVT as described in Chapter 7.

6.5.1.2 Alternative 2, Existing System with Side-stream Treatment

In Alternative 2, plant influent flow up to 5.9 mgd would be routed to the primary clarifiers before splitting to either the natural system train (oxidation ponds and treatment wetlands) or the side-stream secondary treatment train. Normally flows up to 2.3 mgd would be treated by the oxidation ponds and Treatment Wetland Nos. 1 through 7, while minimum flow (i.e. 0.5 mgd) would be treated by the side-stream secondary treatment train. Effluent from the side-stream treatment could be brought back into the treatment wetlands to take advantage of denitrification that would occur, or could be blended with treatment wetlands effluent, depending on operational needs. During pond turnover or other seasonal periods when the natural system capacity is limited, the side-stream secondary treatment train could be ramped up to handle up to 2.0 mgd. The two secondary effluents would be combined and 2.3 mgd sent to the enhancement wetlands. Any flows greater than 2.3 mgd would be blended with enhancement wetlands effluent and then disinfected with the new UV system. Disinfected effluent up to 5.9 mgd would be discharged through new Outfall 003. Wet weather flows above 5.9 mgd would be stored in Oxidation Pond 1, or in an emergency sent to the existing chlorine contact basin for disinfection and discharge through existing Outfall 001.

The facility improvements for Alternative 2 are similar to Alternative 1, with the exception of the following:

- Construct a side-stream secondary treatment process to handle the BOD treatment capacity shortfall and provide partial nitrification. Currently the recommended process for Alternative 2 is one new oxidation ditch and one new secondary clarifier sized for 2.0 mgd capacity, with the ability to turn flow down to 0.5 mgd. If Alternative 2 proceeds into Preliminary Design, the hydraulic and treatment capacity requirements can be refined.
- New Oxidation Pond No. 2 aerators are also recommended in Alternative 2 to improve aeration and mixing while preventing short circuiting, while reducing the treatment capacity required by the side-stream secondary treatment process.
- Upgrade and reconfiguration of the sludge digestion system is recommended to accommodate additional sludge associated with the new secondary treatment project. Project elements will be refined during preliminary design but may include digester cover rehabilitation, digester tank modifications, and heater/boiler upgrade.
- New secondary sludge thickening equipment will be required to accommodate additional sludge associated with the new secondary treatment project. Currently the project element includes one gravity belt thickener sized for sludge from one 2.0 mgd oxidation ditch and secondary clarifier.

6.5.1.3 Alternative 3, Existing System with Parallel Treatment

In Alternative 3, the natural system (oxidation ponds, treatment wetlands, and enhancement wetlands) would normally handle up to 1.8 mgd year-round. The basis of this capacity is maintaining reliable year-round treatment and permit compliance based on existing design criteria and operational experience. Plant influent flow above 1.8 mgd and less than 5.9 mgd would be routed to the new parallel secondary treatment train. The two secondary effluents would be blended prior to disinfection with the new UV system and discharge through new Outfall 003. Blending proportions could be adjusted to achieve desired effluent water quality. Wet weather flows above 5.9 mgd would be stored in Oxidation Pond 1, or in an emergency sent to the existing chlorine contact basin for disinfection and discharge through existing Outfall 001.

The facility improvements for Alternative 3 are similar to Alternatives 1 and 2, with the exception of the following:

- Replace existing primary clarifiers with one new primary clarifier rated at 1.8 mgd. This sizing would match the hydraulic capacity of the treatment wetlands and enhancement wetlands without providing standby capacity, though space could be provided for future addition of a second clarifier. The primary clarifier capacity in Alternative 3 is smaller than in Alternatives 1 and 2 because oxidation ditches do not require upstream treatment with primary clarifiers. This Alternative would also replace existing primary sludge and scum pumps with new pumps sized for the new 1.8 mgd primary clarifier.
- Oxidation Pond No. 2 aerators are not required with Alternative 3.
- Construction of new Treatment Wetland No. 7 is not required as part of the 10-year CIP for Alternative 3, but is a recommended future project for overall reliability.
- For Alternative 3, the recommended Pond Pump Station improvement is to replace the existing 2.9-mgd firm capacity pumps with new 1.8-mgd firm capacity pumps. Improvement of the wet well is also recommended so that Treatment Wetland Nos. 5-6 can flow by gravity into the pump station, eliminating Pump Station 2. In Alternative 3, Treatment Wetlands Pump Station 1 may be eliminated since flows above 1.8 mgd (Treatment Wetlands hydraulic and treatment capacity) would first be routed to the parallel secondary treatment train, with peak wet weather flows above 5.9 mgd routed via the Emergency Pond Pump Station.
- For Alternative 3, the recommended Enhancement Wetlands (Hauser) Pump Station improvement is to replace the existing 1.2-mgd firm capacity pumps with new 1.8-mgd firm capacity pumps to match the flow routing capacity through the enhancement wetlands. Additional pump station improvements include adding a mechanical bar screen on the pump station inlet and strainers on the discharge line.
- New UV disinfection system sized for 55 percent UVT as described in Chapter 7.
- Construct a parallel secondary treatment process to handle the design influent BOD load and provide full nitrification for up to 4.1 mgd. Currently the recommended process for Alternative 3 is two new oxidation ditches and two new secondary clarifiers, each sized for 2.0 mgd capacity with the ability to turn flow down to 0.5 mgd. If Alternative 3 proceeds into Preliminary Design, the hydraulic and treatment capacity requirements can be refined.
- Upgrade and reconfiguration of the sludge digestion system is recommended to accommodate additional sludge associated with the new larger secondary treatment project. Project elements will be refined during preliminary design but may include digester cover rehabilitation, digester tank modifications, and heater/boiler upgrade.

- New secondary sludge thickening equipment will be required to accommodate additional sludge associated with the new secondary treatment project. Currently the project element includes one gravity belt thickener sized for sludge from two 2.0 mgd oxidation ditches and two secondary clarifiers.

6.5.2 Comparison of Alternatives

The three alternatives each have advantages and disadvantages from economic and non-economic factors. The economic factors (project cost and operations/maintenance cost) and project implementation considerations will be further discussed in Chapter 8, Capital Improvements Program. Non-economic advantages and disadvantages of the three alternatives are:

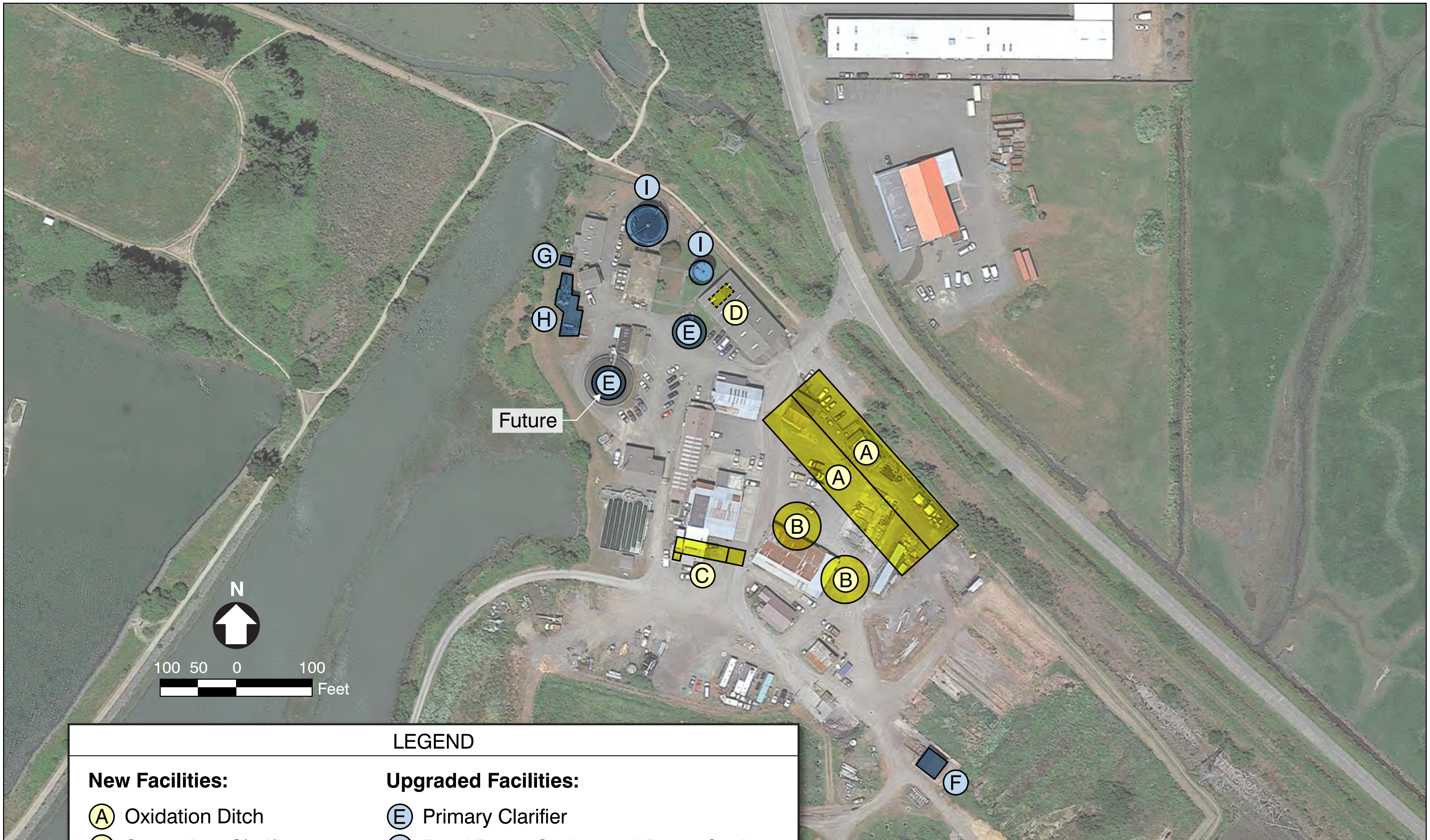
- <u>Alternative 1, Existing System Rehabilitation</u>: BOD treatment capacity is limited in the existing natural system. Project elements to increase BOD treatment capacity include sludge removal in Ponds 1 and 2, adding aerators to Pond 2, and construction of Treatment Wetland No. 7; however, even with these improvements there will be a BOD treatment capacity shortfall with the elimination of chlorine. This would result in permit violations and mandatory minimum penalties. Increasing the growth projection from 10 to 20 percent increases the BOD treatment capacity shortfall, which will be difficult to address in Alternative 1 without an additional secondary treatment process. Furthermore, future ammonia and total nitrogen permit limits may not be met year-round with Alternative 1 without an additional nitrification process. As previously discussed, effluent discharge bypassing enhancement is a violation of permit requirements. Alternative 1 currently requires up to 3.6 mgd to bypass the Enhancement Wetlands due to capacity limitations, which does not meet permit objectives.
- <u>Alternative 2, Existing System with Side-stream Treatment</u>: Like Alternative 1, project elements to increase natural system BOD treatment capacity in Alternative 2 include sludge removal in Ponds 1 and 2, adding aerators to Pond 2, and construction of Treatment Wetland No. 7; however, a BOD treatment capacity shortfall would be supplemented by the side-stream secondary treatment process of one oxidation ditch and one secondary clarifier. Increasing the growth projection from 10 to 20 percent increases the BOD treatment capacity shortfall, which could be addressed in Alternative 2 by increasing capacity in the oxidation ditch. Alternative 2 is anticipated to meet current permit requirements for enhancement through advanced secondary treatment with nitrification, providing full BOD treatment capacity without disinfection byproduct violations, as well as meeting future ammonia and total nitrogen permit limits year-round. However, this alternative is anticipated to be the highest capital cost as it requires the most project elements.
- <u>Alternative 3, Existing System with Parallel Treatment</u>: In Alternative 3, sludge removal in Ponds 1 and 2 is recommended to increase natural system hydraulic capacity and BOD treatment capacity. The natural system will still provide a baseload

secondary treatment, but the addition of the parallel secondary treatment process of two oxidation ditches and two secondary clarifiers means that Pond 2 aerators would not be needed. Treatment Wetland No. 7 is still recommended for construction in the 10-year CIP to improve reliability. Increasing the growth projection from 10 to 20 percent increases the BOD treatment capacity shortfall, which could be addressed in Alternative 3 by increasing capacity in one or both oxidation ditches. Alternative 3 is anticipated to meet current permit requirements for enhancement through advanced secondary treatment with nitrification, providing full BOD treatment capacity without disinfection byproduct violations, as well as meeting future ammonia and total nitrogen permit limits year-round. This alternative is anticipated to be lower in capital cost than Alternative 2 as some project elements can be eliminated or decreased. This alternative is anticipated to require the largest footprint in the treatment plant. A conceptual facilities site plan for this alternative is shown in Figure 6.4.

- The advantages and disadvantages of the alternatives are summarized in Table 6.7.

**Table 6.7 Summary of Alternative Comparison for Non-Economic Factors
Wastewater Treatment Facility Improvements Project
City of Arcata**

	Criteria Scale: 1 (least favorable) to 3 (most favorable)				
Alternative	**Meets Permit (Enhancement and No Bypass)**	**Ease of O&M**	**Construct-ability**	**Reliability**	**Meets Future Ammonia Removal**
1. Existing System Rehabilitation	1	3	1	1	1
2. Existing System with Side-stream Treatment	2	1	2	2	2
3. Existing System with Parallel Treatment	3	2	3	3	3



LEGEND

New Facilities:

- (A) Oxidation Ditch
- (B) Secondary Clarifier
- (C) UV System and Effluent PS
- (D) Gravity Belt Thickener

Upgraded Facilities:

- (E) Primary Clarifier
- (F) Pond Pump Station and Pump Station 1
- (G) Influent Storm Pump
- (H) Influent Pumps and Headworks
- (I) Digester and Sludge Dewatering

Note: Alternative 3 shown due to largest facility footprints required.

CONCEPTUAL FACILITIES SITE PLAN

FIGURE 6.4

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Chapter 7

DISINFECTION SYSTEM EVALUATION

7.1 INTRODUCTION

This chapter provides an overview of the existing and proposed disinfection facilities at the Arcata Wastewater Treatment Facility (AWTF) and includes the following:

- Existing facilities description summarizing the general function and configuration of the chlorine and sulfur dioxide disinfection/dechlorination facilities at the AWTF.
- Proposed ultraviolet (UV) light disinfection facility evaluation and design criteria for the two treatment system alternatives.
- Summary and recommendations for the proposed UV disinfection system.

7.2 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 will expire on July 31, 2017.

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, Appendix A Table F-3 (Facility Plan Appendix A).

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).

7.3 PURPOSE

The purpose of this evaluation is to provide a description of alternative UV effluent disinfection systems including sizing, equipment selection, conceptual layout, construction, and operation costs, and proposed implementation plan. The existing chlorine disinfection system is also described, and the impact on effluent treatment is outlined. The alternative disinfection projects are included in Chapter 6 and the capital improvements program described in Chapter 8 of this report.

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.

Table 7.1 UV Effluent Disinfection System Design Criteria
Wastewater Treatment Plant Improvements Project
City of Arcata

Indicator Organism	Unit	Value
Fecal coliform	MPN/100 ml	14[1], 43[2]
Flow		
Annual average dry weather	mgd	2.3
Average wet weather[3]	mgd	5.0
Maximum month[3]	mgd	5.9
Peak hour wet weather[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

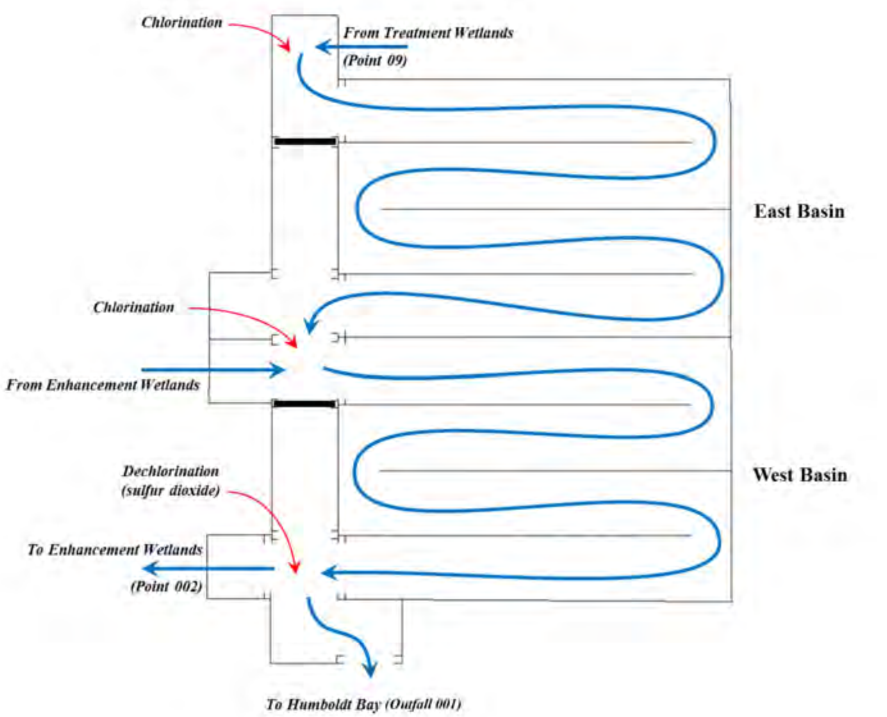
The existing disinfection system includes a chlorine contact basin (CCB) constructed in 1984. The basin can operate as one or two tanks, labelled the east and west basins in the plant O&M manual. The approximate volume for each basin is 185,400 gallons. The detention time at 2.3 million gallons per day (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.

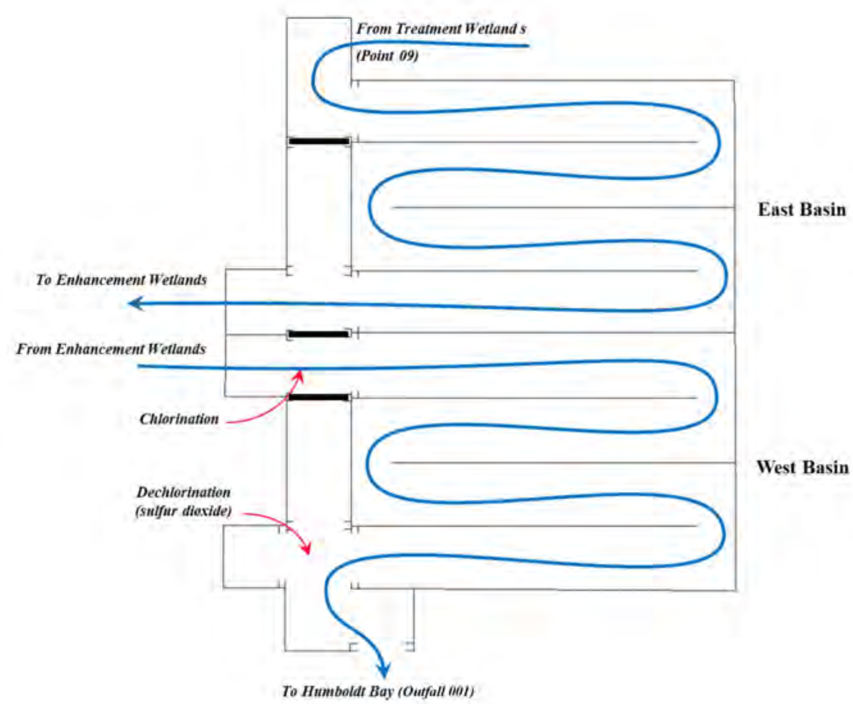
In the combined mode, flow from the treatment wetlands enter the east side, and is dosed with chlorine at the entrance to this first section. The flow then joins with the flow returned from the enhancement wetlands, mixed, and dosed a second time with chlorine. The combined flow is dechlorinated, then 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, 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



COMBINED MODE



SPLIT MODE

CHLORINE CONTACT BASIN OPERATIONAL MODES

FIGURE 7.1

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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 L. Chlorination also appears to impact water quality by reducing effluent BOD and suspended solids. Information from the City and AMRI indicate that at times the BOD reduction can range from 700 to 1400 ppd.

7.6 PROPOSED ULTRAVIOLET LIGHT DISINFECTION

Ultraviolet (UV) light disinfection has been proposed for the AWTF discharge based on a series of pilot tests conducted by the City and the Arcata Marsh Research Institute (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 three project alternatives are outlined in this Section.

7.6.1 UV System Sizing Criteria

The UV system sizing criteria is listed in Table 7.2. The basis for the dose is outlined below:

7.6.1.1 Design UVT

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 M. The UVT may seem low compared to filtered secondary effluent, but is consistent with effluent expected from other wetlands or natural systems.

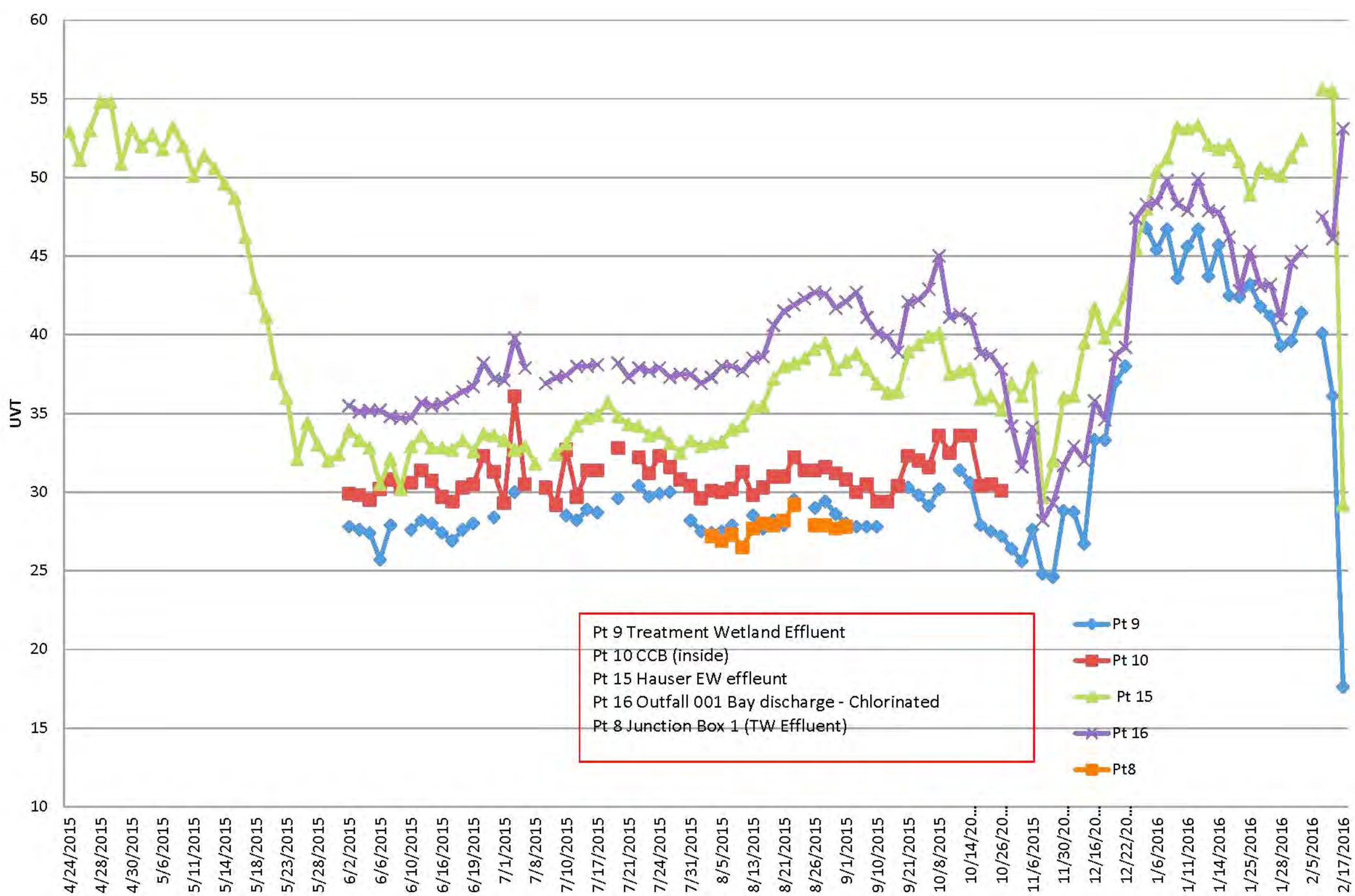
Plant staff purchased a UVT meter in April 2015 and started to collect UVT data across the plant including the treatment and enhancement wetlands effluents. It was recommended that UVT sampling be continued to establish a long term history of UVT. This is especially important because it was projected 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.

Table 7.2 UV System Sizing Design Criteria Wastewater Treatment Plant Improvements Project City of Arcata		
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)		
Alternatives 1 and 2	%	35
Alternative 3	%	55
Dose(5)		
Alternatives 1 and 2	mJ/cm^2	Minimum T1 dose: 17 mJ/cm^2. Minimum MS2 dose: 35 mJ/cm^2 (6).
Alternative 3	mJ/cm^2	Minimum T1 dose: N/A (7). 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) Fecal coliform reduction required for Alternative 3 may exceed reliable T1 validation reduction.

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 Alternative 3 based on a blended effluent concept, where the lower wetland effluent (UVT 35%) would be blended with the higher oxidation ditch secondary treatment process effluent (estimated UVT of 65%). 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 kW.



UVT DATA

FIGURE 7.2

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As noted in Chapter 2, 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 lists the required minimum dose as 50 mJ/cm^2 which was may have been based on protection of the bay oyster farming operation. 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 preliminary 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 preliminary design when additional information is provided by the State.

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. Some manufacturers (Calgon Carbon, Ozonia, and Wedeco) have performed validation work using proven bacteria surrogates such as T1 coliphage (T1). For cases 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.

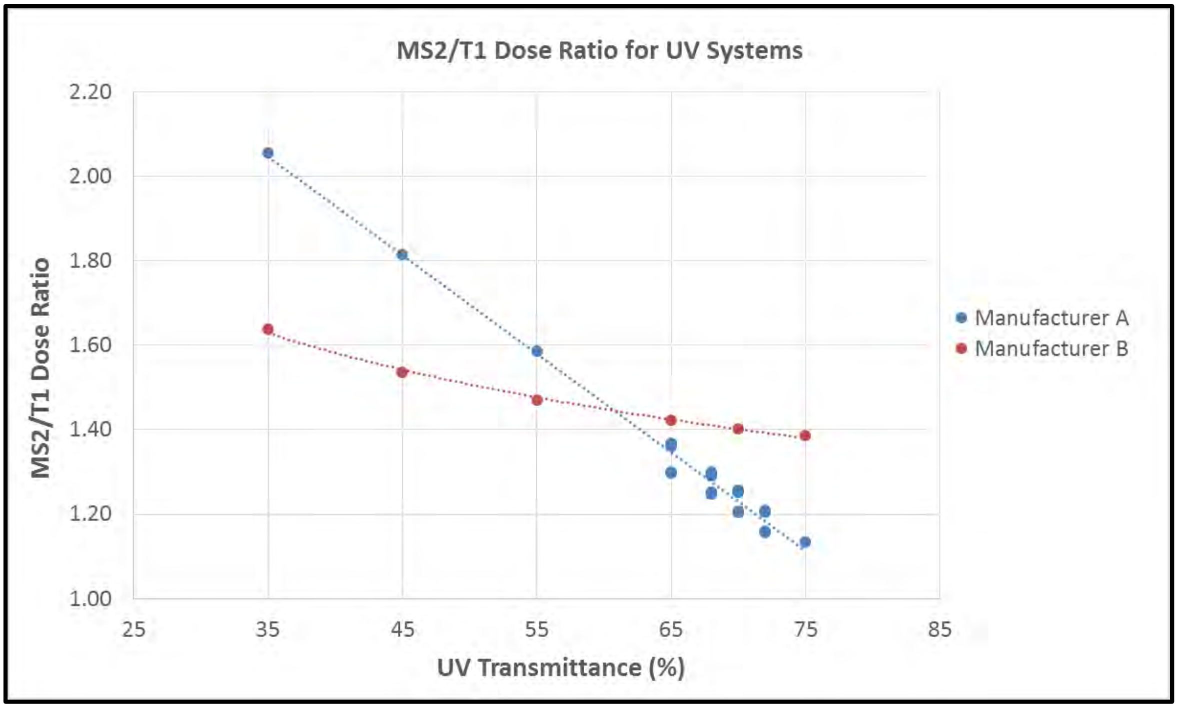


Figure 7.3 MS2/T1 Dose Ratio For UV Systems

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 of the Arcata Marsh have indicated the maximum marsh 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 (Alternatives 1 and 2). 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 Alternative 3, a similar dose analysis is required for blended effluents from the natural system and the oxidation ditch/secondary clarifier treatment train. 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 Alternative 3 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 preliminary 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 enhancement marsh 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 40 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 Proposed 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 selected for evaluation in this Facility Plan was the Trojan UV3000Plus system. It was successfully tested in 2011 during a pilot study conducted by Trojan, AMRI, and plant staff. The Pilot Study Report is included in Appendix N, 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.

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, for dose levels of 35, 50, and 100 (mJ/cm^2).

Table 7.3 Trojan UV3000Plus System Configurations[1] Wastewater Treatment Facility Improvements Project City of Arcata				
	Design Parameters			
Minimum UV Transmittance	35%	55%	35%	35%
Minimum MS2 Dose (mJ/cm^2)	35	35	50	100
Configuration:				
Number of Channels	1	2	1	2
Number of Duty Banks/Channel	2	2	3	8
Number of Standby Banks/Channel	1	1	1	0
Number of UV Modules/Bank	22	7	20	26
Number of Lamps/UV Module	8	8	8	8
Total Number of Lamps	**528**	**336**	**640**	**1664**
Total Power Consumption (kW)	**136**	**87**	**165**	**429**

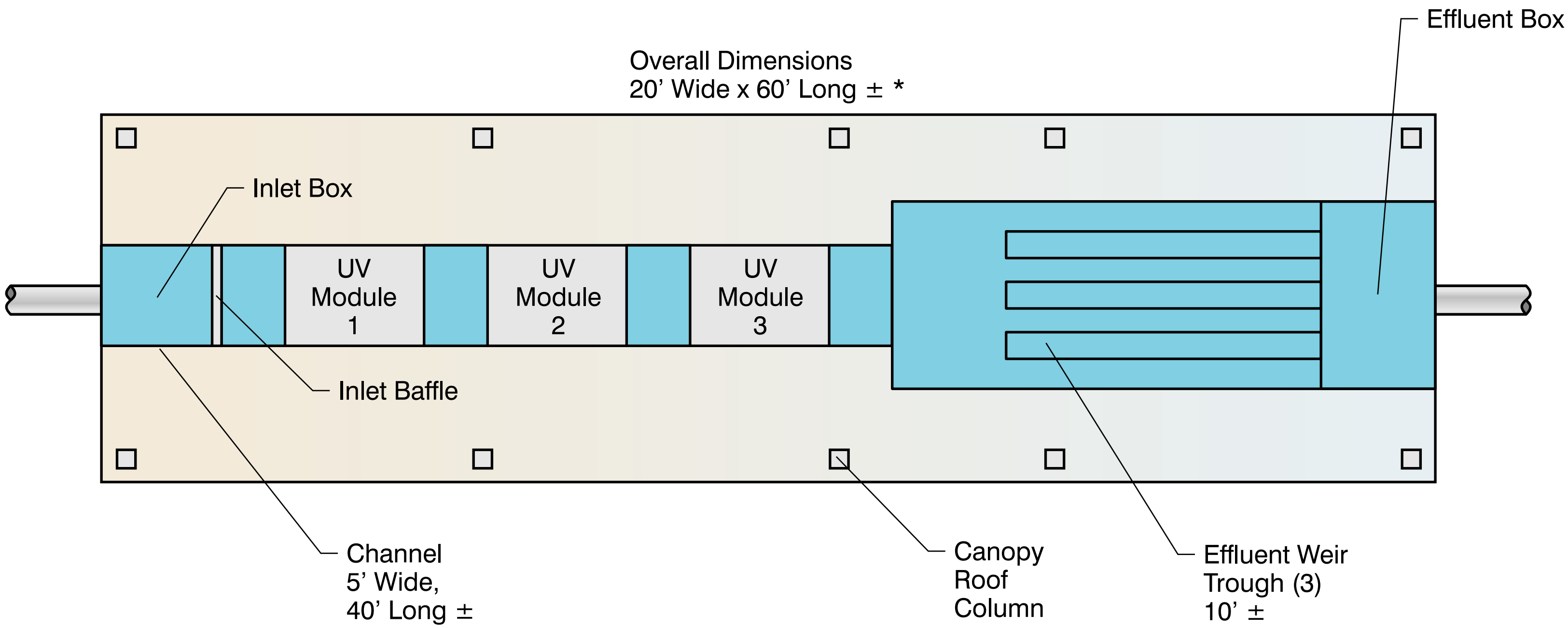
Notes:
(1) Design assumes an End of Lamp Life Factor of 0.90 and a Fouling Factor of 0.95.(

7.6.3 UV Conceptual Flow Configuration and Layout

The concept envisioned by the City during the pilot testing and outlined in the NPDES permit is to disinfect the Hauser Marsh 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 the system to match the industrial look of the existing facilities and provide additional security.

7.6.3.1 Conceptual Layout for 35% UVT

The conceptual 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 conceptual plan is based on the Trojan proposal for 35 mJ/cm^2 dose with redundancy. 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.



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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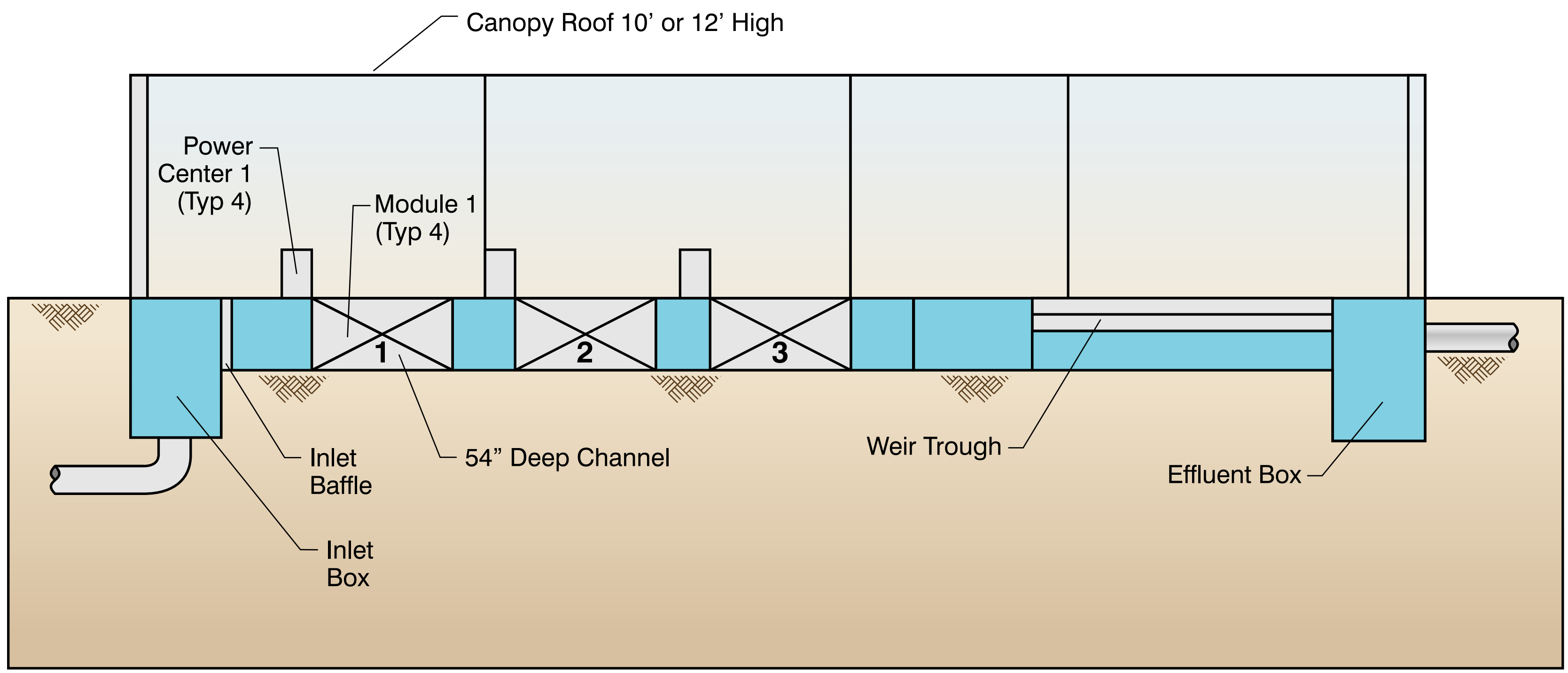

UV DISINFECTION SYSTEM CONCEPTUAL SECTION

FIGURE 7.5

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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 preliminary design.

Figure 7.6 Typical Canopy Roof Over UV Channels (Windsor, California)

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 weekly to monthly (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.

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 preliminary design.

7.6.3.2 Conceptual Layout for 55% UVT

The UV facility conceptual 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.

7.6.4 UV System Costs

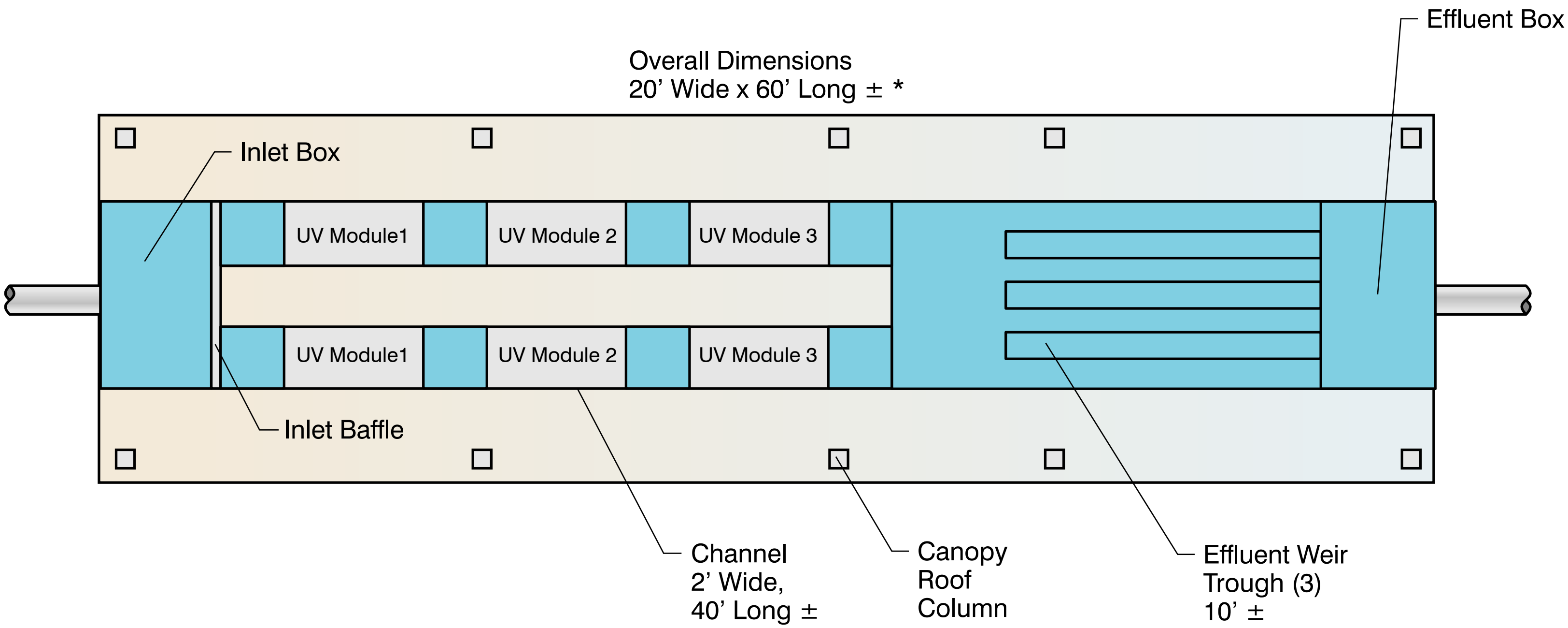
The UV equipment cost to meet the 35 or 50 mJ/cm^2 dose at 35 or 55 percent UVT, with or without redundancy, is outlined in Table 7.4. The cost is based on budget proposals from Trojan for the UV3000Plus system. These costs illustrate the increasing cost with redundancy and with higher dose. The estimated construction cost is based on recent experience for standalone system projects where the costs range from 3 to 5 times the equipment cost.

Table 7.4 Trojan UV Equipment and Construction Cost Comparison
Wastewater Treatment Facility Improvements Project
City of Arcata

Item	35 mJ/cm^2 Dose No Redundancy	35 mJ/cm^2 Dose With Redundancy	50 mJ/cm^2 Dose With Redundancy	35 mJ/cm^2 Dose With Redundancy
UVT, percent	35	35	35	55
UV Disinfection Equipment Cost	800,000	$1,090,000	$1,310,000	$786,000
Total Construction Costs:				
Low range (3 times equipment)	$2,400,0000	$3,270,000	$3,930,000	$2,360,000
High range (5 times equipment)	$4,000,000	$5,450,000	$6,550,000	$3,930,000

Note:
(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.



NOTE:

* Small electrical enclosure will also be required (6’ x 6’ ±).

UV DISINFECTION SYSTEM CONCEPTUAL PLAN (55% UVT)

FIGURE 7.7

CITY OF ARCATA

WASTEWATER TREATMENT FACILITY IMPROVEMENTS PROJECT

carollo

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The updated Trojan proposal lists the equipment cost for a UVT of 55% 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.

Preliminary estimates of operating costs were prepared for the 35 and 50 mJ/cm^2 dose levels with redundancy, and are outlined in Table 7.5. The assumptions for the costs are included in the table and are based on our analysis of the system and input from Trojan.

Table 7.5 Trojan UV O&M Cost Basis and Estimate
Wastewater Treatment Facility Improvements Project
City of Arcata

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
UVT, percent	35	35	55
Lamp Replacement	$250	$250	$250
Ballast Replacement	$400	$400	$400
Wiper Replacement	$15	$15	$15
Quartz Sleeve Replacement	$80	$80	$80
Chemical Usage	$300	$300	$300
UV Sensor Replacement	$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	$113,000	$47,700
Annual Labor Cost	$29,600	$34,100	$25,200
Annual Energy Cost	$67,800	$92,300	$29,500
Total Annual Cost	**$209,000**	**$239,000**	**$102,000**
Note: 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 only $23,100, and is predominately due to the higher energy use at the 50 mJ/cm^2 dose. 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 7.5, the life cycle costs were calculated for both systems. The operating cost of the system at 55 percent UVT is substantially less than at 35 Percent UVT, by over $107,000 per year. A comparison of the life cycle cost at the different UVTs is shown on Table 7.6. The higher UVT has a lower life cycle cost by over $2,000,000.

Table 7.6 UV System Net Present Worth Summary Wastewater Treatment Facility Improvements Project City of Arcata				
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	$209,000	**$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	$4,360,000	$209,000	**$6,390,000**
Difference	$220,000	$880,000	$30,000	**$1,170,000**

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 project. UV system equipment procurement can be can be implemented in a number of ways. The alternatives 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 now follow to avoid the issues with the traditional design approach, is an evaluated bid for UV equipment. The designer and owner first issue a package for bidding the UV disinfection equipment based on approximately a 30 percent design, and a performance based specification. The bid forms require not only the capital cost bid, but guaranteed power cost, lamp replacement costs, and chemical cost (if required). The results of the bid would then be used to complete a present worth analysis for each bidder. The bidder 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 bid 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 Hauser enhancement wetland will require pretreatment including coarse screening and medium fine screening prior to the UV process.

The Hauser pump station 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. An automatically cleaned type bar screen is proposed to facilitate operation. The type of bar screen and appropriate enclosure will be reviewed during preliminary design.

The pump station modifications should also include some type of protection for downstream UV system such as a strainer downstream of the pump station 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 preliminary 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 (6) cylinders are on-line and nine (9) are in storage. In addition, there are also six (6) sulfur dioxide containing cylinders on-site, with two (2) cylinders on-line and four (4) 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 could 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.

7.8 SUMMARY AND RECOMMENDATIONS

The proposed UV effluent disinfection system for the ATWF is outlined in this chapter.

The following items need to be reviewed or finalized during preliminary design:

- Final system sizing based on the expected design UVT: 35 or 55 percent.
- Final design dose based on 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 and basis of design for equipment (sole source or other).
- Enhancement wetland (Hauser) pump station pretreatment equipment selection.

7.9 REFERENCES

SHN 2003 - 2000/2002 Wastewater Treatment Plant Evaluation, February 2003, SHN Consulting Engineers & Geologists Inc.

Chapter 8

CAPITAL IMPROVEMENTS PROGRAM

8.1 INTRODUCTION

This chapter presents alternative capital improvements programs (CIP) for the City of Arcata Wastewater Treatment Facility (AWTF), as well as a summary of the associated project and operating costs. The 10-year CIP is a preliminary estimate of the City's required capital expenses over the next 10 years for alternative approaches to address permit and regulatory requirements, capacity limitations, rehabilitation, and repair (R&R) needs. Additional projects are identified in project elements for a second 10-year CIP (10 to 20-year CIP) that should be considered to address modernization and sea level rise requirements. It is an update to the preliminary 2014 wastewater CIP prepared by City staff, and the draft CIP presented in the original facility plan prepared in September 2015. This CIP is intended to assist the City in planning future budgets and making financial decisions for the City wastewater treatment infrastructure needs.

8.2 CIP DEVELOPMENT APPROACH

In an effort to distribute spending throughout the 20-year planning period, individual projects were identified and prioritized based on need and an acceptable approach to phasing the work. Three 10-year CIP treatment alternatives were prepared to provide the City with different options that provide different levels of risk for meeting NPDES permit requirements. The project drivers, the project prioritization approach, projects risks, and the project implementation strategy for the CIP projects are discussed below.

The three treatment alternative projects were described in Chapter 6, and include:

- Alternative 1 - Existing System Rehabilitation.
- Alternative 2 - Existing System Rehabilitation with Side-stream Treatment.
- Alternative 3 - Existing System Rehabilitation with Parallel Treatment.

8.2.1 Project Drivers and Prioritization

The AWTF CIP is comprised of five types of projects. These projects, including the methodology used for prioritization, are described in the following bullets.

- <u>Permit and Regulatory Projects.</u> The regulatory projects are those required by the current National Pollutant Discharge Elimination System (NPDES) permit and that address ongoing permit violations, including:
  - Major disinfection upgrades for conversion from chlorine gas to ultraviolet light (UV) disinfection.

- Flow reconfiguration from a two-pass to a single-pass system to handle flows up to the permitted discharge flow of 5.9 million gallons per day (mgd).
- Capacity upgrade of the Enhancement Wetlands (Hauser) Pump Station for the new discharge point.
- Construction of a new outfall (Outfall 003) for the new discharge point into the brackish marsh.

The permit requires that these upgrades be brought online prior to December 1, 2016, which will be impossible for the City to meet. A more realistic compliance schedule is that some of these projects could be brought online by the end of 2019, but full rehabilitation of the wetlands (which is proposed under every alternative) will require a longer schedule and would likely not be complete until 2022. This alternative compliance schedule will need to be approved by the Regional Water Quality Control Board (RWQCB). Initial discussions were held 6/27/16 with the RWQCB, where they acknowledged the need for additional implementation time.

- <u>Capacity Projects.</u> The capacity projects provide both hydraulic capacity in the flow reconfiguration project and secondary treatment capacity to meet capacity shortfall. The basis of design for the treatment capacity projects accommodate the projected growth expected by Arcata. As previously discussed, the City originally anticipated a 10 percent community growth which was incorporated into the Draft Facility Plan. After further discussion with the City at the Council meeting on June 13, 2016, community growth estimates have been revised to be 20 percent. Updates to incorporate this additional growth factor have been included in this Facility Plan to some extent, however, updates to sizing of the capacity projects and their cost estimates, will be fully incorporated during preliminary design.
- <u>R&R Projects.</u> The R&R projects were developed using information compiled during the condition assessment. The remaining useful life was estimated for all of the major assets at the AWTF. Replacement costs for structures and equipment with life expectancies of less than 20 years were grouped by unit process and incorporated into the CIP spreadsheet. These projects were mainly included in the 10-year CIP alternatives, although a few are spread out in the 10 to 20-year CIP timeframe to distribute spending.
- <u>Modernization Projects:</u> The modernization projects will increase energy efficiency and help to reduce labor costs by optimizing plant operations. One example is replacing the existing control system with a more modern supervisory control and data acquisition (SCADA) system. These generally have a lower priority, and are included in the 10 to 20-year CIP, given the more immediate plant needs and limited available funding.
- <u>Sea Level Rise Projects:</u> The sea level rise projects represent a placeholder for any additional projects required to address future sea level rise including additional flood protection levees or raising existing pond and wetland berm levees to protect critical

infrastructure. These projects are considered more long-term, and are included in the 10 to 20-year CIP.

8.2.2 Project Costs

Costs presented in this Facility Plan are total project costs and include construction, engineering, legal, administrative, and permitting costs, as well as estimating contingencies. The costs are presented in today's dollars. Costs are not escalated to future years.

The costs used in the CIP program for the City of Arcata are developed based on preliminary budget costs for individual equipment times a project cost factor, or cost curve information for a unit process such as a primary clarifier.

The methodology for development of the construction and project cost factors is outlined in Appendix P.

Cost estimates presented in this chapter were developed based on 10 percent community growth that was originally anticipated by the City. Cost estimate updates to reflect the additional 10 percent growth factor are shown as an additional 10 percent of the original cost estimate.

8.2.3 Project Implementation

Project implementation activities can include predesign planning, final design, environmental permitting, project funding, bidding and award, construction, and commissioning. Project duration is a function of project complexity, which generally increases as a function of project cost.

Annual CIP costs were estimated for the 10-year CIP alternatives and the 20-year planning horizon using the project drivers defined above and the project durations established for each CIP project.

8.3 10-YEAR CIP ELEMENTS AND ALTERNATIVE COSTS

As discussed in Chapter 6, three different treatment capacity alternatives were reviewed. These treatment alternatives include UV facilities of different sizing as described in Chapter 7, but does not include the potential requirement to design for lower UVT or higher dose in all alternatives as discussed at the June 27, 2016 meeting with the RWQCB. At the June 27, 2016 meeting with the RWQCB, it was made clear that the City would be getting ammonia limits in its next NPDES permit in 2017. RWQCB staff indicated that the recent City of Eureka's June 2016 permit was a good example of likely limits. While it was suspected that ammonia limits may be coming, the alternatives were not originally set up to remove ammonia to monthly average limits in the 4 milligrams per liter (mg/L) range (Eureka levels). This new information means that only Alternative 3, which was designed to provide ammonia removal for up to 4 mgd, is likely to be able to meet this future requirement year round. The existing system can meet low ammonia levels in the summer months, but not during the colder winter months. The RWQCB also indicated that bypass of flows around the treatment and enhancement wetlands did not meet the intention and definition of enhancement. The existing system relies on bypasses during wet flows to prevent degradation of effluent quality. The difference in each treatment alternative estimated capital and project cost is outlined below:

- Alternative 1 includes only additional pond aerators to address plant capacity. It does not provide adequate treatment capacity for the projected design loads and therefore has the risk of permit violations. This alternative also does not provide for additional treatment to meet future ammonia reduction requirements that are expected in the 2017 permit (per 6/27/16 meeting with RWQCB). The operations and maintenance (O&M) costs include an estimate of ongoing permit violation penalties. The common elements outlined above including the permit required flow reconfiguration are included in the alternative costs. The UV system for this alternative is sized based on the lower UVT from the wetland effluent. In addition, the primary clarifiers are sized for the total plant design flow.
- Alternative 2 include additional treatment capacity including single oxidation ditch and secondary clarifier. The side-stream treatment will address the capacity shortfall, and provide partial ammonia removal. The side stream flows are combined with the pond/treatment wetland flows prior to the enhancement wetlands for up to a total capacity of 5.9 mgd. The common elements outlined above, including the permit required flow reconfiguration, are included in the alternative costs. The UV system for this alternative is sized based on the lower UVT from the wetland effluent. In addition, the primary clarifiers are sized larger for the total plant design flow. This alternative includes additional solids handling and thickening equipment for the additional solids generated by the side-stream treatment, prior to digestion in the existing digester.
- Alternative 3 includes additional treatment capacity including two oxidation ditches and secondary clarifiers. The parallel treatment will address the capacity shortfall, and provides ammonia removal. The parallel flows are combined with the pond/treatment and enhancement wetland flows prior to the new UV disinfection system for up to a total capacity of 5.9 mgd. The common elements outlined above including the permit required flow reconfiguration are included in the alternative costs. The UV system for this alternative is sized based on the higher UVT from the blended effluent. In addition, the primary clarifiers are sized smaller for only the pond and wetland plant design flow. This alternative includes additional solids handling and thickening equipment for the additional solids generated by the parallel treatment, prior to digestion in the existing digester.

Descriptions for the major 10-year CIP projects listed in the new CIP are provided below. The 10-year CIP project, O&M and life-cycle costs are outlined in Table 8.1. A breakdown of construction and project cost estimates by project alternative for the proposed 10-year

CIP is outlined in Appendix Q. The O&M cost projections are outlined in Appendix R. Based on the revised growth projection of 20% instead of 10% used in the Draft Facility Plan, costs have been revised for an additional 10% cost added to the cost of secondary and solids costs for each alternative.

**Table 8.1 Cost Comparison of Treatment Alternatives
Wastewater Treatment Facility Improvements Project
City of Arcata**

Alt.	Description	Total Project Cost With 10% Growth(1)	Total Project Cost With 20% Growth(1,4)	O&M Cost		Lifecycle Cost(3,4)
				Annual(2)	Present Worth(3)	
1	Existing System Rehabilitation	$35.1	$35.2	$0.67	$5.7	$40.9
2	Existing System Rehabilitation with Side-stream Treatment	$44.7	$45.7	$0.75	$6.4	$52.1
3	Existing System Rehabilitation with Parallel Treatment	$43.8	$45.5	$0.43	$3.7	$49.2

Notes:
(1) Costs are based on 2016 dollars, in millions, using the SFENR construction cost index.
(2) Annual O&M costs include only differential O&M costs, and do not include O&M costs which are common to all alternatives (such as influent pumping).
(3) Lifecycle cost is total project cost plus present worth value of annual O&M costs. Annual O&M costs were converted to present worth value based on 3 percent inflation rate, 6 percent discount rate, and 10-year analysis period.
(4) Estimated total project cost and lifecycle cost is updated with additional anticipated growth subsequent to the June 13, 2016 Council meeting. Additional cost for the 20% growth projection is based on adding 10% to the secondary and solids costs.

Alternative 1 has the lowest lifecycle cost due to the lowest project cost, although it has higher projected O&M costs. Alternative 1 also has the highest risk of ongoing permit violations due to the treatment capacity shortfall, seasonal challenges in meeting future ammonia removal requirements, and the need to rely on bypass operations to meet secondary treatment standards.

Alternative 3 has the next lowest lifecycle cost, with higher project cost than Alternative 1 and the lowest O&M costs. Alternative 3 also has the lowest potential for permit violations due to its ability to meet treatment capacity and future ammonia removal requirements, as well as its ability to provide treatment/enhancement without requiring bypass operations.

Alternative 2 with the side-stream treatment alternative has the highest lifecycle costs due to the highest project and O&M costs. Alternative 2 also has a lower potential for permit violations than Alternative 1 due to its ability to meet treatment capacity and potentially meet future ammonia removal requirements (although this would need to be confirmed), as well as provide treatment/enhancement without requiring bypass operations.

8.3.1 UV Disinfection System Project

The UV disinfection system project (ID No. 1) will replace the existing chlorine gas disinfection system as the main disinfection process for the plant. The existing disinfection system will be retained for treatment of peak wet weather flows, and can also serve as a temporary back up should the UV be out of service. The project was proposed to the Regional Water Quality Control Board (RWQCB) and made a requirement of the current discharge permit, and is ranked as the highest priority project. A more complete description of this project element is included in Chapter 7. The design UVT for the new UV disinfection system will be lower for Alternatives 1 and 2 (35%) and will result in higher equipment and construction costs. The design UVT for the new UV disinfection system for Alternative 3 is projected to be higher for the blended parallel system (55%) and will result in lower equipment and construction costs. However, the design criteria for UVT and UV dose will need to be finalized during preliminary design with additional input from the State to provide adequate protection for the shellfish beneficial use.

8.3.2 Treatment Wetland No. 7 Construction Project

The construction of Treatment Wetland No. 7 (ID No. 3) is required to increase the capacity of the treatment wetland process and allow for treatment wetlands to be removed from service for revegetation. It is a priority based on achieving the permit required flow reconfiguration project. This element is common to Alternatives 1 and 2.

8.3.3 Flow Reconfiguration Project

The flow reconfiguration project (ID No. 4) will allow the plant to treat flows up to 5.9 mgd in a single pass mode of operations, with a new discharge outfall to an existing brackish marsh that flows to Arcata Bay. This project was proposed to the RWQCB to improve the overall treatment process and is included in the current permit. The project includes four main elements outlined below:

- New piping to discharge UV disinfection effluent directly to the new outfall, sized for a capacity of 5.9 mgd.
- Replacement of the existing Enhancement Wetlands (Hauser) Pump Station with a higher capacity, more reliable pump station for discharge of enhancement wetlands effluent to the new UV disinfection process that will flow by gravity to the new outfall. Note the firm capacity varies between Alternatives 1 and 2, at 2.3 mgd and Alternative 3 at 1.8 mgd.
- Construction of a new discharge or outfall (Outfall 003) to the brackish marsh, for effluent disposal to the Arcata Bay portion of Humboldt Bay.

- Upgrade of the existing treatment wetlands pump stations (PS) 001 with higher capacity at 2.3 mgd, more reliable pump station for discharge of the treatment wetlands effluent to the enhancement wetlands in Alternatives 1 and 2 (ID Nos. 17 and 18). The capacity would only be updated to a capacity of 1.8 for Alternative 3.

8.3.4 Headworks R&R Projects

The short-term R&R projects address the aging headworks infrastructure. These projects are critical because the headworks facility has the potential to fail and create multiple problems ranging from overflows in the collection system to conveyance of screening and grit to downstream process. This set of projects include new influent pumps, new screens, a new grit tank, new grit handling equipment, and all the associated facilities for a complete and reliable headworks process. Specific project elements are outlined below.

- New influent pumps sized to handle a peak capacity of 5.9 mgd to replace the existing screw pumps. The existing pumps can handle a capacity of 5.0 mgd, with an emergency diesel driven pump providing backup. The existing pumps are at the end of their useful life and could fail in the near future. It has been noted that submersible type pumps should be considered for the replacement (ID No. 10).
- New bar screens for existing headworks, with associated screenings conveyor and screening washer compactor (ID No. 11).
- New grit removal structure and associated grit handling and treatment equipment. A new vortex grit removal system is proposed to improve grit removal over the range of flows treated at the plant (ID No. 12).

8.3.5 Primary Clarifiers Replacement Project

The existing primary treatment facilities contain some of the oldest assets at the AWTF. The primary clarifier replacement project includes replacement of both the larger and smaller units with one or two identical units each sized for the design wet weather flow of 3.0 mgd (ID No. 13). The second unit will provide redundancy, as well as provide for peak hour wet weather flows up to the 5.9 mgd design flow in Alternatives 1 and 2. In Alternative 3, one 1.8-mgd primary clarifier is proposed because oxidation ditches do not require upstream treatment with primary clarifiers. New support facilities including replacement sludge pumps would be provided. (ID No. 14.)

8.3.6 Wetlands Revegetation Projects

The treatment wetlands revegetation projects (ID Nos. 26 and 27) are included in the ATWF CIP in order to recognize that the natural wetland process requires maintenance, although much different than mechanical equipment or structural maintenance. Wetlands require ongoing vegetation management, both on an annual basis and a recurring basis as the wetlands mature, especially the wetland plants. The revegetation project includes replanting and regrading of the oldest treatment wetland cells No. 1 to No 4 (ID No. 26). This work can be started once wetland cell No. 7 is created. Then, on a recurring basis, wetland cells can be removed from service and rehabilitated. Note that the concept for the rehabilitation is to remove from service, stop influent flows and dry the cell out as much as possible, remove all vegetation, regrade, then replant, slowly introducing wastewater to sustain the plant growth. It is expected that this may take up to three years per cell.

The enhancement wetlands also require vegetation management, and therefore should be included in the ongoing vegetation management program (ID No. 27), in order to maximize their service life prior to a complete revegetation. This element also includes flow improvements including baffles, and upgraded inlet/outlet structures.

In addition, vegetation management should be completed on all cells on a seasonal basis. This will include removal of trees and shrubs, or other non-wetland plants from wetlands cells.

8.3.7 Treatment Wetlands Pumping Configuration Project

The existing treatment wetland pump stations are at the end of their life for the installed mechanical equipment, and therefore require R&R. In addition, the existing pump station configuration has been based on adding pump stations as new wetland cells are added. Pump Station 1 was added when cells 1 and 2 first went into service. Then PS No. 2 was repurposed when cells 5 and 6 were added. The overall capacity of the treatment wetlands pump station would be upgraded to 2.3 mgd for alternatives 1 and 2 and only to 1.8 mgd for alternative 3.(ID Nos. 17 and 18).

8.3.8 Oxidation Pond Improvements Projects

There are three oxidation pond improvement projects included in the CIP, in addition, a significant O&M project to remove/reduce the existing solids built up in the ponds is required to maintain proper operation. Descriptions for these projects are provided in the following sections. These projects can either be combined as a single larger project or implemented separately.

8.3.8.1 Pump Station R&R Projects

The oxidation ponds provide the initial step in the secondary treatment process. Therefore these ponds are critical in meeting permit requirements. The pond pump station and the emergency pond pump station (EPPS) provide a positive means to convey flows from the ponds to the chlorine contact basin during periods of high wet weather flows. These should be rehabilitated as needed during the pond improvements projects. The pond pump station is upgraded (ID No. 19) in Alternatives 1 and 2 to 3.6 mgd capacity. The EPPS is in fairly good shape since it has not been used very often, so it will require less work than the other pump stations. In all alternatives, the EPPS piping will be modified to allow its use in pumping down Pond 1 to increase the available storage volume during peak wet-weather flows (ID No. 19).

8.3.8.2 <u>Pond Transfer Structures and Piping Project</u>

In addition, modification of the oxidation pond transfer structures and piping will be required to allow for a more controlled conveyance of flows to the treatment wetlands and to provide the flexibility to store a portion of the peak wet weather flows in the ponds (ID No. 20).

8.3.8.3 <u>Aerator Replacement Project</u>

The pond aerator replacement project element is part of Alternative 1 and 2. New horizontal aerators will be provided in Pond 2 for additional pond treatment capacity and assist in short circuit reduction in the shallow oxidation pond. Aerators may not be needed during the warmer, sunnier months from spring to fall, as the natural algae will aerate the pond content. The production of dissolved oxygen in the ponds by the algae assists natural bacteria in the ponds in breaking down the soluble and particulate wastes in the influent wastewater. During the colder, winter months, when natural sunlight is limited, aerators may be required to supplement the algae to provide dissolved oxygen (ID No. 24).

8.4 10 TO 20-YEAR CIP ELEMENTS

8.4.1 Sea Level Rise Project

Another pond project has been identified based on the projected sea level rise in the Arcata area. The pond berms and levees may need to be raised in order to avoid flooding during king (of flood) tides. This project may or may not fall within the 20-year planning window, based on current projections (ID No. 25). It is included as a long-term project in the CIP as a placeholder.

8.4.2 Plant Modernization Projects

Two main plant modernization projects were identified as part of the condition assessment.

8.4.2.1 <u>Control System / SCADA Improvements</u>

The plant control system should be upgraded to a modern SCADA system (ID No. 35N). This will allow the plant staff to maximize their effort, without having to visit any piece of equipment or pump station for normal operations and alarm troubleshooting. This project can be implemented across the entire plant in one project, or can be implemented, one process area at a time or as part of each project described above. The latter approach will require that planning for the entire system be completed so that the pieces are integrated as they are implemented individually.

8.4.2.2 <u>Lab and Control Building</u>

The lab and control buildings should be upgraded (ID No. 30) during the 20-year CIP program to allow for upgrades including the SCADA upgrade. In addition, the building may require modifications to avoid flooding by sea level rise. This project is included as a placeholder in order so that it may be updated as additional requirements are determined.

8.5 FINDINGS AND RECOMMENDATIONS

The Capital Improvements Program (CIP) alternatives presented in this chapter provide several approaches to the City CIP for the wastewater division of the Public Works Department. The alternative 10-year CIP projects and priorities are outlined to meet current permit requirements and near term R&R needs, and have different risks in reliably meeting the permit requirement. The longer term R&R needs, plant modernization requirements, and addressing sea level rise impacts would be part of a 10 to 20-year CIP program. The CIP needs to be integrated with existing capital improvements budgets and funding sources in order to meet the needs of the community and preserve this vital City asset.

The 10-year CIP should be reviewed by City staff and council and adopted by the Environmental Services and Public Works Departments. The permit-required CIP projects should be completed within the next 3 to 7 years, with the remainder of the projects implemented as soon as funds are available.

Presentations describing the CIP alternatives were made to City Council on April 20, June 6, and June 13, 2016. Presentation materials from these meetings are in Appendix S.

A meeting with the RWQCB discussing the CIP alternatives was conducted on June 27, 2016, during which the Board indicated that operational bypass of flows greater than 5.9 mgd should be eliminated. As discussed previously, the RWQCB also indicated that the City would be subject to ammonia reduction limitations in the next NPDES permit in 2017.

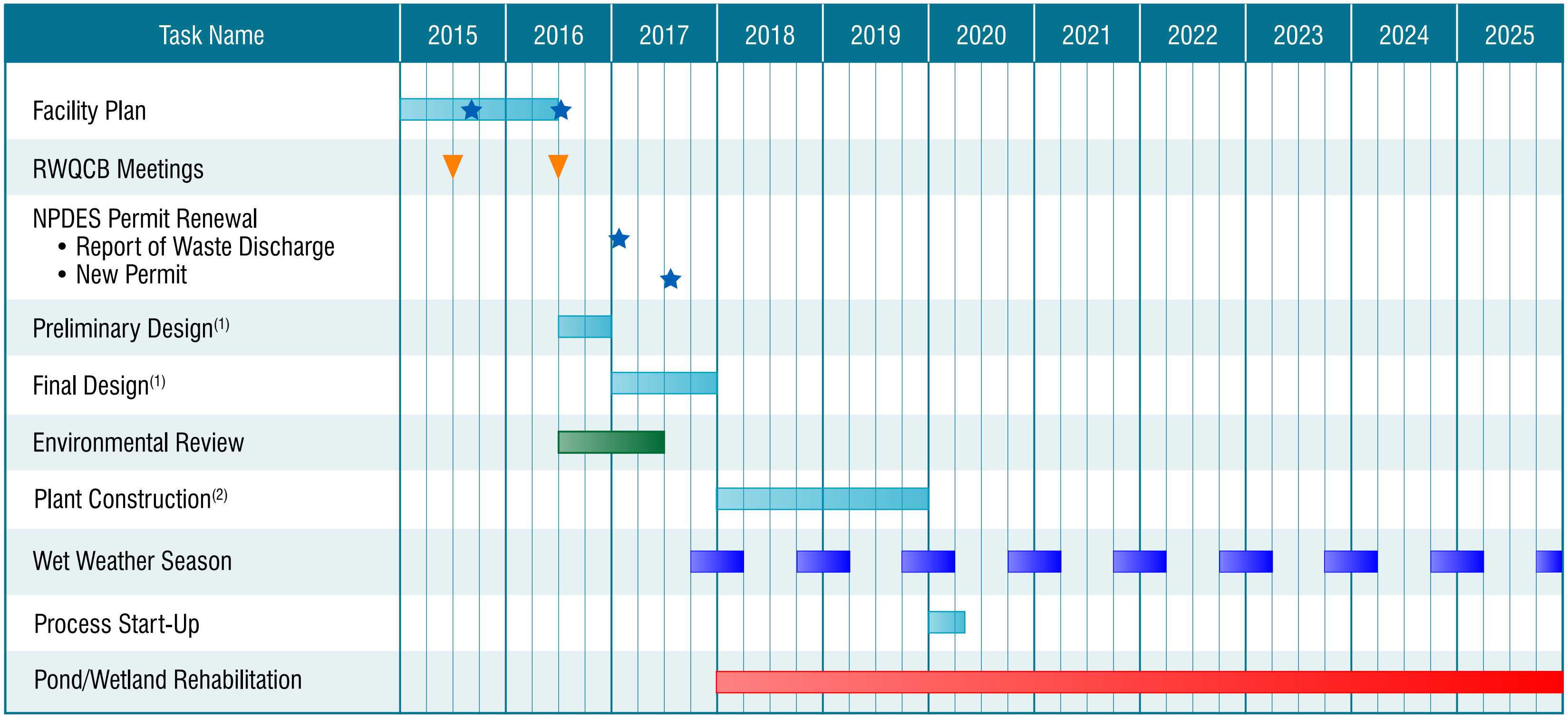
Based on economic and non-economic factors, Carollo and LACO recommend proceeding with preliminary design of Alternative 3. Alternative 3 is the only option that can reliably meet the future ammonia limit, while also providing adequate secondary treatment capacity to meet current permit requirements. Alternative 3 has the second lowest lifecycle cost, with slightly higher project cost than Alternative 1 but the lowest O&M costs. Alternative 3 has the lowest potential for permit violations of the three options due to its ability to meet treatment capacity and future ammonia removal requirements. It also could provide treatment/enhancement without requiring bypass operations, which is consistent with the Enclosed Bays and Estuaries Policy. And like all the other alternatives, the existing wetlands systems are still utilized and rehabilitated under Alternative 3.

8.6 CIP IMPLEMENTATION AND NEXT STEPS

Implementation of the recommended projects in this Facility Plan will require a significant amount of funding, time and effort for the City of Arcata. There are several key elements that should be considered in moving forward with implementation of this recommended CIP. These elements are included in the implementation schedule shown in Figure 8.1:

- CEQA / Environmental Review:
  - Approach and appropriate level of environmental review for overall plan and individual projects.
  - Proceed with CEQA for projects to be implemented in the near term.
- Funding and Financing:
  - Consider pursuing State Revolving Fund (SRF) loans to help pay for the proposed CIP improvement projects.
  - Develop a financial plan to determine the rate impacts of these projects.
  - Implement rate increases as required to fund the ongoing CIP requirements.
  - Research small and disadvantaged community funding sources for wastewater treatment project funding.
  - Proposition 1 Coastal Commission Grant - City should consider investigating obtaining grant funds to pay for sea level rise projects under the Proposition 1 Coastal Conservation Grant.
- RWQCB Discussions and NPDES Permit:
  - Submit a Report of Waste Discharge to the RWQCB by January 2017 to start permit renewal process. Confirm UV design dose and disinfection objectives, including coliform or virus reduction.
  - New NPDES permit to be issued upon current permit expiration in July 2017.

The schedule in Figure 8.1 shows preliminary design starting in mid-2016 and final design beginning in 2017. Construction (of the majority of the mechanical and structural elements) is shown in 2018 and 2019, with final commissioning and startup in late 2019 and early 2020. The construction will cover the dry weather periods of both 2018 and 2019, and should allow for all the work to be completed while maintaining the existing plant in operation. Wet weather periods are also shown in the schedule as construction during these periods is difficult. The Pond and Wetlands rehabilitation is shown as a separate line item as these projects may be performed by City staff as opposed to a contractor and due to the extended construction time expected. The wetlands in particular will take longer to rehabilitate due to the need to regrade during dry season, plant and let the plants get established (approximately a 2 year cycle before performing as expected).



NOTES:

(1) To be finalized after completion of the Facility Plan.

(2) Construction schedule is preliminary, constraints TBD.

UPDATED IMPLEMENTATION SCHEDULE

FIGURE 8.1

CITY OF ARCATA

WASTEWATER TREATMENT PLANT IMPROVEMENTS PROJECT

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