City of Benicia
Wastewater Master Plan Update and Major Facility Condition Assessment

June 2020

Prepared for:
City of Benicia

Executive Summary

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TECHNICAL MEMORANDUM NO. 0 – WASTEWATER MASTER PLAN UPDATE EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY INTRODUCTION

The City of Benicia Wastewater Master Plan Update and Major Facility Condition Assessment (Wastewater Master Plan Update, Master Plan Update or Update) consists of the series of technical memoranda (TMs) listed below. This Executive Summary covers TM 1 through TM 12, as listed below.

- Wastewater Master Plan Update Introduction
- TM 0 – Wastewater Master Plan Update Executive Summary
- TM 1 – Wastewater Study Area Planning Parameters
- TM 2 – Wastewater Flows and Loads
- TM 3 – Potential Future Regulatory Requirements and Impacts on WWTP
- TM 4 – Condition Assessment Framework
- TM 5 – Condition Assessment of Wastewater Collection System
- TM 6 – Condition Assessment of Lift Stations
- TM 7 – Condition Assessment of Wastewater Treatment Plant
- TM 8 – Wastewater Collection System Model
- TM 9 – Wastewater Treatment Plant Sludge Handling and Disposal Alternatives

- TM 10 – Wastewater Sustainability and Resiliency Assessment
- TM 11 – Municipal Financing for Wastewater Systems
- TM 12 – Proposed Capital Improvement Program

Tables and Figures are retained as numbered from the original TMs. However, because some are removed for succinctness, numbering is discontinuous.

TM 1 – WASTEWATER STUDY AREA AND PLANNING PARAMETERS

The purpose of this Master Plan Update is to provide an update to the City's existing Wastewater Master Plan (2011) focused on asset condition assessments and provide a clear roadmap for the City to maintain aging infrastructure into the future. The results of the Master Plan Update provide an outline of priority and strategic projects which allow the City to operate the wastewater system efficiently and effectively under current and future development conditions. The Master Plan and Master Plan Update serve as a data baseline for future policy decisions. These documents provide professional assessments and recommendations, but project implementation decisions are reserved for policy makers.

PURPOSE AND OBJECTIVES

The objectives of the Master Plan Update are to:

- Perform site inspections, record data, and assess the condition of essential wastewater system infrastructure to provide improvement recommendations, and where applicable, identify project alternatives.
- Provide an asset management-based evaluation of the wastewater equipment and facilities using a methodology for mechanical, structural, electrical and instrumentation components of each infrastructure area.
- Develop an on-going condition assessment and monitoring schedule based on the results of the asset evaluation and discussions with City operations, maintenance, and engineering staff.
- Identify priority and strategic projects including expansion and upgrades to existing infrastructure and construction of new infrastructure to meet system demands.
- Identify capacity constraints within the existing system and use the sanitary hydraulic model to resolve areas of concern identified by the City. The whole City is not remodeled with this Update because limited growth is anticipated within the City and the 2011 Master Plan model is considered adequate.
- Provide a capital forecast for the next 20-years (up to 2040), including opinions of probable cost.

PROJECT BACKGROUND

The City of Benicia provides wastewater collection and treatment service to an area of approximately 13,512 acres within city limits. The system serves 9,297 customer accounts (as of April 2020) consisting

of 26,971 residents and 904 industrial, commercial, and other account users. The City's wastewater service system consists of wastewater collection, lift stations, treatment, and discharge facilities. The City owns and operates all aspects of the wastewater facilities. The collection system, lift stations, and WWTP are further described below.

Collection System

The City's wastewater collection system consists of approximately 150 miles of pipelines, 23 lift stations, and a 3-mile interceptor sewer that provides system capacity under peak flow conditions. Wastewater flow travels through the collection system to the southeastern part of the City. Flow enters the WWTP through a 30-inch gravity sewer conveying domestic (residential) flows, a 24-inch sewer conveying flows from the eastern industrial area, and a wet-weather screening structure receiving flows from the 36-inch wet-weather interceptor sewer.

Due to the City's topography and layout, there are 23 wastewater lift stations primarily serving relatively small sewer-shed areas. Most, but not all, of the lift stations operate at low hydraulic head and flow capacities and have short force mains that discharge to the nearest gravity sewer.

Wastewater Treatment Plant (WWTP)

The City of Benicia provides wastewater collection, treatment, and disposal services to residents and commercial/industrial/institutional customers. The City owns and operates the WWTP, which is a conventional activated sludge, secondary wastewater treatment plant permitted with an average dry weather flow of 4.5 million gallons per day (MGD) and a wet weather capacity of 11 MGD. The City's WWTP is located on the south side of the City at the intersection of East Fifth Street and East G Street in a residential area. The current plant processes include, one mechanical and one manual bar screen, grit removal, primary clarification, activated sludge, rotating biological contactors (RBC), secondary clarification, and a chlorine contact basin. The plant has stormwater holding basins that are used to divert peak influent flows, off-spec effluent, or for storage during maintenance periods.

There are three anaerobic digesters. All three digesters have the mixing and heating capabilities. However, currently, one digester is used as a primary digester, another is used for digested sludge storage and the third is not currently in service. Solids are digested to Class B criteria, dewatered through two belt filter presses (BFPs), and then hauled off-site to the Lystek operation in Fairfield Suisun where the solids are further treated to Class A standards and sold as soil amendment.

Effluent from the WWTP is discharge to the Carquinez Strait through a submerged diffuser outfall. Due to varying hydraulics influenced by fluctuating flow rates and tidal effects, the WWTP also includes an effluent lift station to the outfall. Currently, no effluent is reclaimed.

2011 Master Plan

The City of Benicia completed the existing Wastewater Master Plan in 2011. This existing Master Plan serves as the foundation of this Wastewater Master Plan Update. The 2011 Master Plan provides the foundation on which the City has based decisions regarding construction, operation, and maintenance of the wastewater collection and treatment facilities, consistent with the goals, policies, and programs of the City's General Plan.

The 2011 Master Plan outlines the key findings of the 2011 Master Planning effort and is organized into the nine sections described in **Table 1-1**.

Table 1-1 2011 Master Plan Organization and Summary

Section	Title	Description	Summary
1.0	Introduction	Overview of the purpose, organization and scope of the Master Plan.	
2.0	Study Area and Land Uses	Pertinent information on the study area, and its current and future land uses.	Limited future growth is anticipated, the City is currently approaching buildout. Specific future developments and respective land uses are identified
3.0	Existing Sanitary Sewer System	Overview of the existing system and key facilities. Summary description of the hydraulic model.	
4.0	Wastewater Flow Projections	Development of dry-weather and wet-weather wastewater flows to determine peak design flows for the system evaluation.	Land use based wastewater flow projections are determined using generation rates developed using flow monitoring data. Increase in peak wet-weather flow from 18.0 to 21.8 MGD between existing and buildout conditions (~20%). Flows above the WWTP NPDES rated 11 MGD must be diverted to the stormwater detention basin for treatment when peak flows subside.
5.0	Regulation Review	Summary of upcoming regulatory actions that may impact the City's existing collection, treatment, and/or disposal facilities.	Concluded that the City's wastewater system is generally, in a good condition from a regulatory compliance standpoint.
6.0	Collection System Analysis and Alternatives Evaluation	Analysis of collection system to identify capacity deficiencies and evaluate alternative improvements based on established hydraulic criteria.	Model produced similar results for existing and buildout. Except for Benicia Business Park which is the largest growth area.
7.0	Sustainability Approaches	General framework for integrating sustainability and green approaches with respect to the City's wastewater system.	Sustainability improvement recommendations generally include methods to minimize energy demands within treatment and conveyance facilities. Identifies recent improvements, reclaimed water potential, and concerns regarding sea level rise.
8.0	Sludge Disposal and Treatment Options	Identification of sludge disposal and treatment options for the City's WWTP.	Alternative upgrades to reduce disposal volume and/or produce higher quality solids. The 2011 Master Plan recommended consideration of co-thickening (near-term) and sludge drying (long-term). TM 9 of this Master Plan Update recommends a refined biosolids evaluation including possibly incorporating offsite organics.
9.0	Recommended Capital Improvements	Sanitary sewer collection system improvement recommendations including costs and phasing; and sludge disposal and treatment improvement recommendations at the WWTP. (2010 San Francisco ENR CCI: 8,700)	Total Capital Improvement Costs: $16.5 million • Gravity Sewer: $10.0 million (19,700 LF) • Force Main: $5.1 million (14,200 LF) • Lift Station: 1.4 million (165 HP)

PLANNING DATA

The following land use data and assumptions were extracted from the 2011 Master Plan or were developed for use in this Master Plan Update from data provided by the City. The 2011 Master Plan provides a description of existing and future land use designations. These designations were used to develop wastewater generation rates and wastewater flow projections in conjunction with new data collected with this Update. Wastewater generation rates and level of service criteria to be used in analysis of the wastewater collection system are described in TM 2 – Wastewater Flows and Loads and TM 8 - Wastewater Collection System Model.

Land uses are divided into the following designations:

- Residential
  - → Low-Density Residential (LDR)
  - → Medium-Density Residential (MDR)
  - → High-Density Residential (HDR)
- Commercial
- Industrial
- Public/Quasi-Public
- Park
- Open Space/Marsh
- Shorelines and Freeways

Land areas are also divided by development status, identified as either existing developments or large vacant parcels for future development. The City's current level of development is described as nearing buildout. The following anticipated developments were identified in the 2011 Master Plan:

Benicia Business Park:	The largest future development, located west of I-680 between Lake Herman and East Second Street, totaling 528 acres. This development is expected to consist of 150 acres of limited industrial, 35 acres of commercial, 30 acres of roadways, and 313 acres of open space.
Large Industrial Parcels:	The combined total of other vacant developable parcels are designated as industrial land use. The total area of the parcels is approximately 470 acres. Upon development assumed they will consist of approximately 50% open space and 50% developable area (240 acres of industrial land use).
Residential Infill:	There are no large vacant residential parcels designated for future development identified. Infill development was identified and described as 532 residential units, anticipated to be high density residential in the

southern part of the City. Locations were identified based on conceptual locations identified in the House Element Update.

Commercial Redevelopment: Two major commercial redevelopment areas were identified in the southeastern portion of the City. The Downtown Mixed Used Area consists of approximately 90 acres bounded by West Second Street to the west, C Street to the south, East Second Street to the east, and K Street to the north. The other anticipated major commercial redevelopment is the Historic Lower Arsenal Mixed Use Area, bounded by lands adjoining I-780 to the north, land adjoining I-680 to the east, Port of Benicia land and the Carquinez Strait on the south, and neighborhoods on the west.

The results of the land use data assessment based on the current data are used in this Wastewater Master Plan Update to develop an estimate of future conditions and wastewater flow projections. The land use data assessment is summarized in **Table 1-2** below.

Table 1-2 Land Use Data Update Assessment Summary

Land Use	Tag	2011 MP (1) Data (Acres)	GIS GP (1) Data (Acres)	Difference (Acres)
Low-Density Residential	LDR	1,828; 1,532 (4)	1,523	-9
Medium-Density Residential	MDR	437; 366 (4)	257	-109
High-Density Residential	HDR	10; 8 (4)	138	**+130**
Commercial	COM	275; 230 (4)	219	-12
Industrial	IND	2,672	2,642	-30
Public/Quasi-Public	PUB	225	249	**+24**
Parks and Recreation	PARK	339	332	-7
Open Space (2)	OS	2,117	8,153	-
Right-of-Way	ROW	1,159	0	-
Sphere of Influence (2)	SOI	~ 4,900 (2)	0	-
Total		**13,939**	**13,512**	
Total Developable Planning Area (3)		5,786	5,359	-427
Total Residential & Commercial Area (4)		2,550	2,137	-413

1. MP: master plan; GP: General Plan
2. The total area of the GIS shapefile includes the area between city limits City's SOI as OS, which was excluded from the total presented in the 2011 MP. An estimate of the SOI area excluded from the 2011 Master Plan was added to the table for purposes of comparison.
3. Total developable planning area. Total area excluding OS, ROW, and SOI.
4. Total residential and commercial development area. Approximately 15-20% of the gross area associated with residential and commercial developments is typically dedicated to public rights-of-way. Total area estimates that exclude ROW areas were developed using typical proportions of area loss seen in similar planning efforts. These estimates are presented following gross area within the table. (Gross Area; Area without ROW)

Study Period

The study period of this Master Plan Update is to year 2040 and also to identify utility need projections at buildout conditions. Buildout includes any additional future development that may occur within the City beyond 2040.

Population

The City of Benicia population data used in this Master Plan Update is presented in **Table 1-3**.

Table 1-3 Historical and Projected Population Data

2010 (1)	2015	2020	2025	2030	2035	2040	Buildout (2)
26,997	27,485	27,991	28,515	29,060	29,626	30,214	32,000

1. Actual 2010 census population data from which the remaining population data is projected at a rate of 0.355% annually.
2. It is assumed that residential infill will be limited after 2040 and the City will be near or at buildout. Total buildout population assumes the 2040 population projection plus 5%.

These data were prepared using the initial 2010 census population of approximately 26,997 people (2011 Master Plan) and a projected population growth rate of 0.355% per year provided by the City (2020). Using the 2010 census data and the growth rate provided by the City, the 2040 population is projected to be 30,214 people. Except for the 2010 data, all values are projections.

Data Summary

The proceeding data is used in this Master Plan Update to project future wastewater flow conditions and wastewater service needs within the study area. Population growth estimates, land use data, and information provided for areas of future development are used to project wastewater flows in five-year intervals from 2020 to 2040. Approximations under buildout conditions are also presented. Future developments considered in this Master Plan Update are summarized in **Table 1-4**.

Table 1-4 Future Developments

Future Development	Total Area (Acres)	Development Area (Acres)	Wastewater Generation Estimate Data Source
Benicia Business Park	528	185	Benicia Business Park Sewer Study and Environmental Impact Report
Large Industrial Parcels	470	240	2011 Master Plan industrial land use wastewater generation rate (250 gpd/acre)
Total:	**998**	**425**	

To establish flow estimates in 5-year intervals, it is assumed that the total wastewater flow estimate developed for these areas of future development will accumulate at a rate of 1% per year until buildout.

A summary of the data that is used to project wastewater flow from infill development is summarized in **Table 1-5**. Estimates of wastewater generated from infill development are based on the population growth estimate. The increase in population is converted to equivalent dwelling units (EDUs) using the average number of persons per household described in the City of Benicia Housing Element 2015 – 2023 (November 2014), equating to approximately 2.52 persons per dwelling unit.

Table 1-5 Infill Development Data

Time Period	Population	Additional EDUs (1)
2020	27,991	-
2025	28,515	208
2030	29,060	216
2035	29,626	225
2040	30,214	234
Buildout	32,000	600

1. An EDU is a unit of measure that standardizes wastewater demands to that of one-single family residential unit, i.e an Equivalent Dwelling Unit. Population data is converted to additional EDUs dividing the increase in population by the average number of persons per household in the City of Benicia (2.52 persons/EDU).

Estimates of infill wastewater contributions are estimated by applying the City's standard wastewater generation rate per EDU. Wastewater flow estimates and generation rates are further described in TM 2 – Wastewater Flows and Loads.

All results, conclusions and recommendations for the Master Plan Update are based on existing City data and visual inspections of the major wastewater assets. Visual inspection condition assessments work was completed by separate discipline experts in the areas of process, structural, mechanical, civil, electrical, corrosion and SCADA (Supervisory Control and Data Acquisition), as appropriate for each asset, and documented on inspection forms.

TM 2 – WASTEWATER FLOWS AND LOADS

The purpose of Technical Memorandum No. 2 (TM 2) is to develop projections of the influent wastewater flow quantities and characteristics through the year 2040. Data from mid-2014 through mid-2019 and projected growth established in TM1 are used to determine the current and future flows and loads, respectively. The projected flows and loads for the Master Plan Update are summarized in **Table 2-1.**

Table 2-1 Current and Future Influent Flows and Loads

Parameter	Current (Year 2020)	Future (Year 2040)	Buildout
Influent Flow, Mgal/d			
Average Dry Weather Flow (ADWF)	1.86	2.2	2.6
Annual Average Flow (AAF)	2.4	2.84	3.35
Peak Month Flow	4.3	5.09	6.01
Peak Day Flow	9.78	11.57	13.67
Peak Hour Flow	16.04	18.97	22.42
BOD Load, lb/day			
Annual Average Load	5,700	6,700	8,000
Peak Month Load	7,400	8,800	10,300
Peak Day Load	15,000	17,700	21,000
TSS Load, lb/day			
Annual Average Load	7,700	9,100	10,800
Peak Month Load	10,000	11,800	14,000
Peak Day Load	26,000	30,800	36,300

TM 3 – POTENTIAL FUTURE REGULATORY REQUIREMENTS AND IMPACTS ON WWTP

The purpose of Technical Memorandum No. 3 (TM 3) is to evaluate implications posed by current and potential future regulations on wastewater treatment processes as they relate to the City of Benicia WWTP. The objectives of the evaluations presented herein, are to identify aspects of the WWTP treatment processes and/or their operation that may cause non-compliance with current regulatory or potential future requirements.

CURRENT PERMITS

The City WWTP operates under regulation issued by the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the Bay Area Air Quality Management District (BAAQMD). Current permits that control/limit Benicia wastewater treatment processes are identified below:

- **NPDES Permit**: Benicia WWTP Waste Discharge Requirements Order No. R2-2019-0034, NPDES No. CA0038091. The order regulates 1) how and how much wastewater may be treated at Benicia WWTP from a regulatory perspective, and 2) the quality of treated wastewater (termed “effluent”) that must be produced by the WWTP.
- **Nutrient Watershed Permit**: The San Francisco Bay Waste Discharge Requirements Order No. R2-2019-0017, NPDES No. CA0038873. The Watershed Permit does not have nutrients limits but has monitoring requirements for nutrients.

- **Mercury/PCBs Watershed Permit**: The San Francisco Bay Waste Discharge Requirements Order No. R2-2017-0041, NPDES No. CA0038849. The Watershed Permit has limits on the Mercury and PCBs effluent discharge.
- **Air Quality Permit**: Potentially, atmospheric emissions from the Benicia WWTP may be regulated by the BAAQMD Plant #1791 (WWTP) and Plant #14587 (portable generator).

The foregoing documents and associated information, to the extent provided by the City, are evaluated with respect to their control/regulation of Benicia WWTP treatment processes now and in the near-term future.

NPDES Permit: Order No. R2-2019-0034

The City WWTP produces secondary effluent that is discharged to the Carquinez Strait. Conditions regulating the lawful operation and maintenance of the WWTP are specified in RWQCB Order No. R2-2019-0034 (Order). The Order 1) regulates how much wastewater can be treated by Benicia WWTP, 2) specifies what treatment processes must be used, and 3) specifies the quality of effluent to be produced. This Order was recently adopted December 11, 2019 (effective February 1, 2020) and is scheduled to expire on January 31, 2025.

The Order specifies that wastewater treatment shall be provided by specific unit processes and that the Average Dry Weather Flow (ADWF) effluent not exceed 4.5 Mgal/d. The plant has been in compliance with the current order and had no violations within the last five years, despite severe storms events that occurred throughout Northern California in January 2017.

Watershed Permit: Order No. R2-2019-0017

On May 8, 2019, the RWQCB issued a Watershed Permit: Order No. R2-2019-0017, Waste Discharge Requirements for Nutrients from Municipal Wastewater Discharges to San Francisco Bay (Bay). This permit covers 37 discharges to the Bay and its tributaries, including the City of Benicia WWTP. The purpose of the Watershed Permit is to track the amount of nutrients discharged into the Bay due to growing concern over water quality impairment due to nutrients.

Air Quality Permit

Benicia WWTP currently holds an air permit A1791 from the BAAQMD dated April 29, 2019 and expired April 1, 2020. The permit includes fourteen permitted sources and two exempt sources. The exempt sources are two industrial flares that burn biogas from the anaerobic digesters. Permitted sources include boilers, diesel and natural gas generators, and wastewater treatment processes. The permit includes limitations for the concentration of nitrogen oxides (NOx) in combustion gases, concentration of volatile organic compounds (VOCs) released from odor control systems of various wastewater treatment processes, and allowable operation of the emergency standby generator. The permit requires all digester gas to be flared before release as well as mandatory instrumentational and operational conditions. There are also requirements for the recording and reporting of source tests, startups, shutdowns, flow rates, and methane concentrations. However, there are no minimum concentration requirements for the flared gas product as long as the flare is operated according to the conditions of the permit. A summary of air permit requirements is presented in **Table 3-1**.

Table 3-1 Summary of the Air Permit Requirements

Source ID	Description	Permit Requirements	How the Permit Requirements are met / Actual Conditions
# 9	Boiler, 1150 k BTU/hr, digester gas fired	NOx in exhaust is less than 30 ppm @ 3% oxygen dry	NOx is not monitored in the exhaust but the boiler is tuned annually.
# 15	Boiler, 1575 k BTU/hr, natural gas and digester gas fired	Thermal throughput is limited to 138,000 therms during any consecutive 12 month period	This is calculated annually for BAAQMD report.
		Biogas flowmeters shall be installed and maintained	Biogas flow data to the boiler is summarized in the annual BAAQMD reports.
		Boiler tuned once a year	Permit requirements met.
		Monthly record of biogas and natural gas fed to the boiler	Permit requirements met.
		Keep record of Methane content in biogas	Permit requirements met.
		Keep record for 2 years	Permit requirements met.
# 110	Headworks (Screens and Grit Removal)	Covered and vented to air scrubbers	Permit requirements met. Headworks, primary clarifiers, aeration basins, RBCs, sludge dewatering building, and DAFT are covered - RBCs not vented to scrubber.
# 120	Primary Clarifiers	Air coming out of air scrubbers shall be routed to carbon adsorber scrubber for a second pass treatment	Permit requirements met.
# 140	Aeration Basins and RBCs	VOC from carbon adsorber exhaust shall be non-detectible (10 ppm as C1) and monitoring logs shall be kept onsite for 24 months	Permit requirements met. VOC from the carbon exhaust is measured twice a week.
# 180	Sludge Handling (Dewatering Building and DAF Thickener)	Change Carbon if VOC exceeds 10 ppm as C1	Permit requirements met. Carbon is changed when H_2S is detected from carbon tower.
# 190	Digesters	No biogas is vented to the atmosphere	Permit requirements met. All biogas is routed to either the boilers or the flares.
		Collected gas shall be abated by flare A-15 (main), flare A-1 (Backup), or S-9 Hot Water Heater (Boiler)	Permit requirements met.
		Temperature monitor shall be installed on flare A-15 and temperature logs is kept for 24 months	Permit requirements met.
		A-15 combustion temperature shall be maintained above 1400 F with a residence time of 0.6 sec in combustion chamber	Temperature is maintained above 1400. The residence time is met as long as the maximum capacity of the flare (60 cfm) is not exceeded.
		Digester gas flow to A-15 shall be measured	Permit requirements met.
		City of Benicia shall conduct a source test on Flare A-15 within 60 days of startup. Test requires monitoring number of parameters. See permit for more details	This was done when the flare was first installed. This requirement has been satisfied and now serves as a record for future engineers at the BAAQMD.
		Keep record for five years of start up and shut down dates and times, reason for shut downs, total digester gas throughput, record of digester gas methane content	Permit requirements met.
# 191	Standby Generator	Operated only to mitigate emergency conditions or for reliability-related activities	Permit requirements met.
		Unlimited operation during emergency	Permit requirements met.
		Reliability and testing operations is limited to 100 hours a year	Permit requirements met. Operate only half a day every 6 months.
		Measure hours of operation and fuel usage with a non-resettable totalizing meter	Permit requirements met.
		Catalytic converter on the engine exhaust	There is a catalytic converter. Operators use ammonia dosing system to reduce NOx emissions, even though there is not required NOx limit on the emergency generator.
		Keep record for 24 months of hours of operation (maintenance/testing and emergency), nature of each emergency condition, and fuel usage	Permit requirements met.

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The WWTP has no compliance problems with the Air Permit.

POTENTIAL FUTURE REGULATIONS

Regulatory compliance is a major objective of the Master Plan Update. Therefore, identifying future regulatory trends is a key component in developing Master Plan scenarios to allow for major design and budgeting considerations. Review of current environmental issues and regulatory trends are discussed below.

Nutrients in the San Francisco Bay

San Francisco Bay receives some of the highest nitrogen loads among estuaries worldwide yet has not historically experienced the water quality problems typical of other nutrient-enriched estuaries. It is not known whether this level of nitrogen loading, which will continue to increase in proportion to human population increase, is sustainable over the long term.

In order to determine the amount of nutrients discharged to the Bay, the RWQCB issued the first nutrient watershed permit in April 2014. This watershed permit included 37 WWTPs including Benicia. The permit did not have nutrients limit but has requirements for nutrient monitoring and reporting. The second Nutrient Watershed Permit was adopted in May 2019. Thus far, there are numerous studies being conducted to understand the impact on the San Francisco Bay. If science proves that nutrients are causing impairment to the Bay, it is expected that the RWQCB will enforce nutrient limits on the Bay discharges in the next renewal cycle.

Short-Lived Climate Pollutant Reduction Strategy: SB 1383

On September 19, 2016, the Governor signed SB 1383 to supplement the greenhouse gas (GHG) reduction strategies in the Scoping Plan to consider short-lived climate pollutants, including black carbon and methane (CH_4). The passage of SB 1383 by the California Legislature in 2016 codified the California Air Resources Board's (CARB) Short-Lived Climate Pollutant Reduction Strategy. SB 1383 established statewide targets to achieve a 40% reduction in methane emissions from 2013 levels by 2030. Additionally, SB 1383 includes a goal to reduce the level of disposal of organic waste to landfills by 50% from 2014 levels by 2020 and by 75% from 2014 levels by 2025. SB 1383 also requires the California Energy Commission and California Public Utilities Commission to incentivize the production and use of biogas. CalRecycle, is the state agency tasked with implementing SB 1383. The CalRecycle regulations will be enforced on, or after, January 1, 2022. Rule development is set to begin in late 2019 and is on-going as of the preparation of this TM. It is anticipated that this rule will be brought before the BAAQMD Board of Directors for consideration at a public hearing in the second quarter of 2020. The City does not currently accept these organic waste diversions at the WWTP.

Significant Methane Release: BAAQMD Rule 13-1

BAAQMD was planning to prohibit significant methane releases through Draft Rule 13-1. Rule 13-1 has been put on hold at this time but may go into effect in 2020. A description of Draft Rule 13-1 is provided below in the event that it is taken off hold and goes to the Board of Directors.

Under Draft Rule 13-1, any gaseous release with a methane concentration greater than 10,000 parts per million (1 percent) is considered a significant methane release. Both Type A and Type B sources would be affected by this rule with exemptions on a limited basis. Type A sources are point sources, including exhaust stacks, process vents, and components, such as valves and flanges and the emissions are tracked using traditional testing methods. Type B sources are larger area sources, such as wastewater

ponds and composting piles. Draft Rule 13-1 would require that any significant methane release be minimized to the lowest achievable level within three days and abated to below 500 ppm within 14 days, unless issued a limited exemption. Small methane releases less than 10 pounds per day for each of three consecutive days may be issued a limited exemption via a petition.

Wastewater Operations: BAAQMD Rule 13-4

The organic waste diversion targets established by SB 1383 are anticipated to increase the amount of organic material being sent to facilities with organic waste material processing. The City is not currently planning to accept these organic waste diversions at Benicia WWTP. Regardless, BAAQMD is currently planning to minimize emissions of methane, GHGs, and VOC emissions from anaerobic digesters, such as those operated at Benicia WWTP. Draft Rule 13-4 would implement portions of CARB's 2017 Clean Air Plan and mean to create a consistent regulatory framework for anaerobic digestion operation. It would include standards to ensure that biogas is produced and collected in such a way as to minimize leaks or releases of methane into the atmosphere, and that emissions of other GHGs and VOCs are minimized. These standards might include feedstock and digestate handling, leak detection and fugitive emissions minimization, flaring requirements, and recordkeeping. It would also likely include various best management practices, maintenance procedures, and require the recording and reporting of GHG emissions. BAAQMD anticipates bringing this rule before the Board of Directors for consideration at a public hearing in the second quarter of 2020.

Ocean Outfall Discharges: SB 332

Senators Hertzberg and Wiener introduced Senate Bill 332 (SB 332) on February 19, 2019. On May 16, 2019, the bill was held in committee and under submission. On February 3, 2020, the bill was returned to Secretary of Senate pursuant to Joint Rule 56. If passed, the bill would require wastewater treatment facilities that discharge through an ocean outfall to reduce the overall volume of the facility's annual flow by at least 50% by January 1, 2030 and by at least 95% by January 1, 2040, compared to the average annual dry weather discharge baseline volume through either conservation and efficiency measures or through beneficial reuse. The likelihood of this bill being taken off hold is not known. If this bill passes, the City has options for reuse, as discussed further in Technical Memorandum No. 10 Sustainability. A large non-potable reuse option in cooling tower makeup water at the Valero Refinery.

Non-Refinery Flares: SCAQMD Rule 1118.1

BAAQMD plans for a new rule by 2020 to reduce NOx from non-refinery flares by requiring biogas & non-refinery flares to meet the lowest available emissions reduction (LAER) level. It is anticipated the new rule will be similar in approach to Rule 1118.1 from the South Coast Air Quality Management District (SCAQMD). Under the SCAQMD rule, the flares at Benicia WWTP would need to meet an emission limit of 0.06 pounds of NOx per MMBtu and not exceed an annual capacity threshold of biogas treated. The planned rule from BAAQMD may differ.

Depending on the specifics of the BAAQMD, this likely means that there will be NOx monitoring requirements for the flare. If the existing flares do not comply with the BAAQMD emission limit, new flares may be required.

Nonvehicular Air Pollution: Criteria Air Pollutants and Toxic Air Contaminants: AB 617

In 2017, Governor Brown signed Assembly Bill 617 (C. Garcia, Chapter 136, Statutes of 2017) (AB 617). AB 617 intends to preserve public health by reducing the exposure to air pollutions through an effective community focused program. Specifically, the Bill aimed to protect communities disproportionally affected

by air pollution. In response, CARB developed the Community Air Protection Program (CAPP). The main components of AB 617 include:

- Community-level air monitoring,
- Improved transparency and availability of air quality and emissions data through enhanced emission reporting requirements,
- A state-wide strategy and community specific emission reduction plans,
- Accelerated implementation of best available retrofit control technology (BARCT) by December 31, 2023 at the latest on industrial sources that currently participate in the GHG Cap-and-Trade System, and
- Increased penalty fees for polluters.

To implement AB 617, BAAQMD established the Community Health Protection Program (CAPP). BAAQMD staff are working with key stakeholders including CARB, other local air districts, community groups and members, environmental organizations, and regulated industries to reduce harmful air pollutants with an emphasis on neighborhoods most impacted by air pollution. In April 2018, BAAQMD identified Benicia and Vallejo as candidate communities for the CAPP because of the large industrial facilities and health vulnerability. In year 1 of the AB 617 program, West Oakland and Richmond were selected for an Emission Reduction Plan and a Community Monitoring Plan, respectively. CARB will select the year 2-5 communities to develop Community Emission Reduction Plans and a Community Air Monitoring System. The BAAQMD must adopt community air monitoring and community emissions reduction programs for the selected communities. Vallejo has been slated for action in years 2-5. If Benicia is selected, the City will have to create an emission reduction plan or a community monitoring plan, which may include the WWTP. Benicia has not been slated at this time. Additionally, the BAAQMD must provide annual reports, including the air quality data, to CARB for publication for the following applicable facilities:

- Stationary sources that emit greater than 250 tons per year (tpy) of applicable nonattainment pollutant(s) or precursor(s)
- Facilities with at least one permit to operate with actual emissions or activity levels greater than or equal to:
  - 4 tpy of any criteria pollutant (except CO)
  - 100 tpy of CO
  - 5 MGD for open WWTP systems and 10 MGD for covered WWTP systems
- Facilities that receive an “elevated” Air Toxics Hot Spots prioritization

Considering the above stated applicable facilities, the annual reporting requirement is not applicable to the Benicia WWTP.

Attachment B of the May 2018 AB 617 Expedited BARCT Implementation Schedule Concept Paper prepared by BAAQMD identified wastewater treating as a potential source for further consideration for a potential rule development project for Local Community Emission Reduction Plans to reduce NOx emissions. However, the additional potential projects identified in Attachment B were not proposed at that time because the projects were anticipated to provide relatively small emission reductions, the anticipated

emissions will have a low impact on communities, and the emissions are not anticipated to impact achieving attainment. Therefore, it is unlikely that the expedited BARCT implementation requirement will impact the Benicia WWTP in the near future.

PFAS

Per- and polyfluoroalkyl substances (PFAS), which include PFOA, PFOS, and other chemicals, are a group of human-made chemicals that are persistent in the environment and the human body. PFAS are mobile and bioaccumulative. PFAS are commonly used to manufacture non-stick pans, cleaning products, food packaging, clothing, paints, polishes, waxes, and carpets. PFAS may enter a water system through run-off from areas where firefighting foam has often been used or from PFAS manufacturing facilities.

Under Water Code Division 7, Chapter 4, Article 4 Section 13267, the SWRCB is authorized to request technical or monitoring reports from waste dischargers if the SWRCB consults the RWQCB and determines that efforts of the RWQCBs will not be duplicated. Under section 13050(d) of the Water Code, PFAS constitutes a waste discharge. The SWRCB started investigating PFAS in March 2019. On March 20, 2019, the SWRCB notified the landfills and airports required to submit the identified information via Order WQ 2019-0006-DWQ and Order WQ 2019-0005-DWQ, respectively (Phase 1). The landfills and airports had 60 days to submit a work plan detailing the PFAS impacts assessment/investigation and had 90 days following the SWRCB's or the RWQCB's acceptance of the work plan to submit a final sampling and analysis report, including the laboratory analytical results. On October 25, 2019, the SWRCB notified the chrome plating facilities required to submit the identified information via Order WQ 2019-0045-DWQ (Phase 2). The chrome plating facilities had to submit the work plan by January 31, 2020 and had 90 days following the SWRCB's or the RWQCB's acceptance of the work plan to submit a final sampling and analysis report.

Phase 3 of this investigation will include WWTPs, which are expected to be notified via a letter. If the Benicia WWTP is notified by the SWRCB, the required information must be sent to the RWQCB within the identified time frame. Following the results of the PFAS tests, the SWRCB and the RWQCB may implement appropriate regulatory action in anticipation of future PFAS regulatory standards.

Toxic Air Containments: BAAQMD Rule 11-18

In order to address concerns regarding health impacts to local communities located near facilities like refineries, metal melting plants, Publicly Owned Treatment Works (POTWs), and stationary diesel generators, BAAQMD staff has drafted a rule, Regulation 11, Rule 18 (Rule 11-18) that targets significant reductions in emissions of toxic air contaminants (TACs) from these sources.

The Rule was adopted in November 2017 and applies to facilities whose emissions of TACs are projected to pose a significant risk to nearby residents and workers. Reductions of TACs would be achieved by setting a cap on the allowable risk for facilities across the Bay Area. BAAQMD staff is tasked with performing Health Risk Assessments (HRAs) to identify risk levels at facilities with potential to exceed the cap and then require appropriate measures to reduce risk to acceptable levels. BAAQMD staff has identified diesel particulate matter, hydrogen sulfide, cadmium, and mercury as the primary risk drivers for POTWs.

Per the Rule, BAAQMD will use toxic emissions inventories and proximity to the nearest receptor (residents or offsite workers) to conduct site-specific Health Risk Screening Analyses (HRSA). From these HRSAs, BAAQMD will determine each facility's prioritization score (PS). BAAQMD will conduct HRAs for all facilities with a cancer PS>10 or non-cancer PS>1.0. After verifying the model inputs, if the facility still has PS above that threshold, that facility would need to implement a Risk Reduction Plan that may include employing Best Available Retrofit Control Technology for Toxics (TBARCT).

POTENTIAL IMPACTS OF NEW REGULATIONS ON WWTP OPERATIONS & CAPITAL IMPROVEMENTS PROJECTS

As previously mentioned, although many of the regulations being considered are in a formative stage, they still have the potential to adversely impact operations and the capital improvement program at the Benicia WWTP.

Secondary Treatment

Currently the nature of the specific new nutrient regulations and their implementation is unclear. The Water Board is exploring additional investment from the region's POTW's in more scientific research, which would help inform any future regulations related to nutrients. The Benicia WWTP currently does not have stringent nutrient removal processes. If nutrient limits are imposed, it is anticipated that the RWQCB will probably allow nutrient trading where municipalities will be given flexibility for how they achieve their individual load limits. In essence, dischargers will be given two options: 1) upgrade the WWTP to remove nutrients, or 2) purchase the load reductions from other municipalities that reduce nutrients loads to the Bay by more than what they are required to.

For this Master Plan Update, improvements to the WWTP to comply with the potential future nutrient limits are considered. The current NPDES permit will expire on January 31, 2025 and the current watershed permits will expire on June 30, 2024. Should the RWQCB require more stringent nutrient requirements, the RWQCB will normally allow approximately ten years to finance, design and construct a project that would allow the WWTP to comply with new limits. Therefore, the soonest capital improvement project may need to be scheduled for completion in 2034. The improvements required will likely include upgrading the existing activated sludge process for biological nutrient removal (BNR) or converting to a Membrane Bioreactor (MBR) process. Comparison of both alternatives, design criteria, costs and unit process considerations are presented in TM 3.

Boilers

Stantec contacted the BAAQMD to clarify the compliance with the Toxic Air Containment Rule, and how the City may use the Best Available Control Technology (BACT) to manage pollutant emissions. Potential upgrades would be replacement of the old boilers with state-of-the-art technology that will yield higher efficiencies and lower emissions. The new boilers will need to meet the BAAQMD Regulation 9, Rule 7-300, which includes a limitation of 30 ppm NOx dry at 3% oxygen and 400 ppm CO dry at 3% oxygen. Additionally, the new boilers will need to meet the BAAQMD Regulation 9, Rule 2, which includes a limitation on ground level concentration of hydrogen sulfide of 0.06 ppm averaged over three consecutive minutes or 0.03 ppm averaged over any 60 consecutive minutes.

Biosolids Regulations and Organics Diversion

Potential impacts of Biosolids regulations and organic diversion are discussed in detail in TM 9.

Non-Refinery Flares

Depending on the specifics of the non-refinery flare rule passed by BAAQMD, this likely means that there will be NOx monitoring requirements for the flare. If the existing flares do not comply with the BAAQMD emission limit, new flares may be required.

Ocean Outfall Discharges: SB 332

If SB 332 passes, the WWTP will have to reduce the overall volume of the facility's annual flow by at least 50% and 95% by January 1, 2030 and January 1, 2040, respectively, compared to the average annual dry weather discharge baseline volume through either conservation and efficiency measures or through beneficial reuse. If this bill passes, the City has options for reuse, such as cooling tower makeup water at the Valero Refinery.

PFAS

At this time, Benicia do not have requirements for PFAS. However, if the SWRCB sends a letter to Benicia requiring PFAS testing, Benicia would have to submit a work plan detailing the PFAS impacts assessment/investigation and following the SWRCB's or the RWQCB's acceptance of the work plan, would have to submit a final sampling and analysis report, including the laboratory analytical results. Following the results of the PFAS tests, the SWRCB and the RWQCB may implement appropriate regulatory action, which may require the City to implement PFAS treatment.

TM 4 – CONDITION ASSESSMENT FRAMEWORK

Technical Memorandum No. 4 (TM 4) provides a framework for the assessment of the conditions of wastewater assets in order to:

- Determine the extent of damage of the assets (if any).
- Estimate the remaining useful life.
- Determine the risk of failure.
- Formulate remedies for the problems observed and set priorities.

CONDITION ASSESSMENT APPROACH

Except for yard piping, condition assessment included reviewing existing information (record drawings of various improvement phases, reports, operational data, permits, etc.) and field inspection of key assets by a multi-discipline engineering team (mechanical, structural, electrical/instrumentation, and corrosion engineering). The team interviewed operations personnel regarding known issues and maintenance history of major unit processes.

A systematic procedure was used to gather asset information that are specific to each discipline. Asset information such as the adequacy of the equipment/structure for the intended purpose, the condition of the

asset, any known issues were gathered and documented. To standardize the process of determining an assets condition, a tailored inspection form was developed and used.

ASSET DEFINITION AND INVENTORY DEVELOPMENT

Asset inventory of the WWTP was developed and classified by treatment process through a review of plant documents in collaboration with the City's operations staff. A detailed asset inventory for the collection system, lift stations, and the WWTP are presented in Technical Memorandum No. 5, 6, and 7, respectively.

The condition of the assets is based on visual inspection (signs of leakage, corrosion), adequacy of intended purpose, efficiency, repair history, etc. The rating scale used in the condition assessment of each asset is shown in **Table 4-1**.

Table 4-1 Asset Condition Rating

Description	Condition Rating
Excellent: Only normal maintenance required	1
Good: Minor defects (maintenance is approx. 5% of the asset value)	2
Fair: Moderate maintenance (maintenance is 10% - 20 % of the asset value)	3
Poor: Significant Deterioration (maintenance is 20% - 40 % of the asset value)	4
Unserviceable	5

The Asset rating took into consideration the asset age, observed physical condition, and operational input from City staff. The visual condition inspection results are augmented by a review of operational data and equipment maintenance history to determine performance and reliability.

ESTIMATED REMAINING USEFUL LIFE (ERUL)

Each asset has an original useful life (OUL), which is the number of years an asset is expected to be in service. The OUL values for different types of assets are presented in **Table 4-2**.

Table 4-2 Original Useful Life Values

Asset Class	Original Useful Life (Years)
Civil/Site	50 [1]
Electrical	25-35 [2]
Mechanical	25-35 [2]
Structural - concrete	50
Yard piping	50-75 [2]
Cathodic/Corrosion	25

[1] Does not include road surfaces, which require more frequent standard repair or replacement cost

[2] Depending on the type of equipment.

If assets are well maintained, their evaluated remaining useful life (ERUL) can be extended. On the other hand, if the asset is deteriorating at a faster pace than expected, then the ERUL is expected to be shortened. The ERUL will be determined based on a theoretical asset decay curve and the condition of the asset at the time of inspection. **Figure 4-1** shows an example of an asset (i.e., pump, blower, structure, etc.) that has an original life of 25 years that was installed in year 2000 and inspected in 2019. Based on the original decay curve, the asset should have condition rating of 3 and a remaining useful life of 6 years (end of useful life is 2025). If at the time of inspection, the condition rating was better than expected (i.e., 2), the modified decay curve (parallel red curve above the original decay curve) would indicate that the remaining useful life can be extended to 2029.

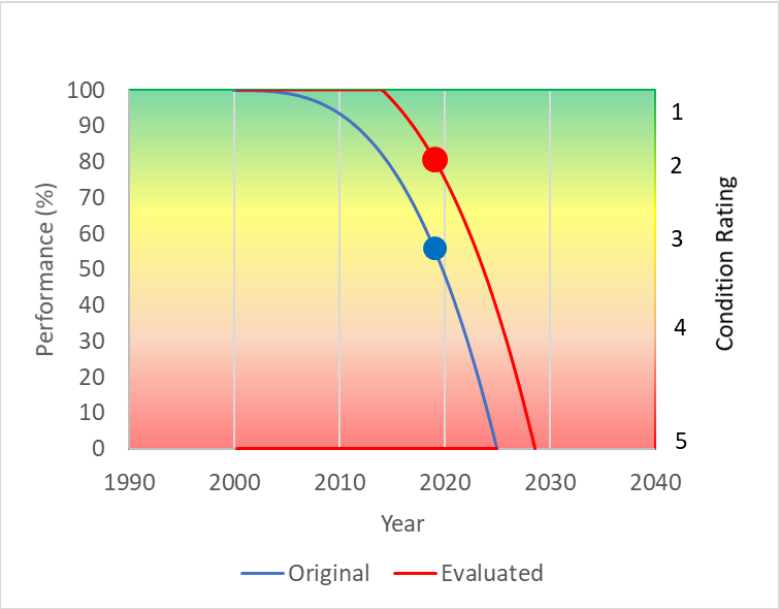

Figure 4-1 ERUL when Evaluated Condition is Better than Expected

DETERMINATION OF RISK

Risk is the mathematical product of the probability of failure and the consequence of failure. Risk is a relative number used to identify the assets, which have a high probability and/or consequence of failure. If a redundant unit is available, this risk is mitigated, and the risk is reduced. The equation used to determine the risk associated with an asset is as follows:

$$Risk = \frac{\text{Probability of Failure X Consequence of Failure X Redundancy Reduction Factor}}{25} X\ 100$$

Generally, assets with a high-risk score should be higher on the priority list for capital improvements.

Probability of Failure

The probability or likelihood of asset failure can occur due to physical failure, performance failure, or technological obsolescence. The probability of failure is inversely proportional to the ERUL, per industry standard. The probability of failure score is shown in **Table 4-3**.

Table 4-3 Probability of Failure Score

ERUL (Years)	Probability of Failure	Score
20	Very Low	1
15	Low	2
10	Moderate	3
5	High	4
Less than 5	Very High	5

Consequence of Failure

A score will be assigned based on the following four categories: Public health and safety; Reduced level of service; Regulatory compliance; Cost of repairs.

The consequence of failure scoring scale used for each asset is shown in **Table 4-4**. The score for an asset ranges from 5 points (severe consequence) to 1 point (negligible consequence).

Table 4-4 Consequence of Failure Score

Consequence of Failure	Score
Negligible	1
Low	2
Moderate	3
High	4
Severe	5

Redundancy

Redundancy is a factor that will be used to lower the risk. This factor will be assigned a value of 0.5 if there is a redundant unit and will be assigned 1.0 if there is no redundant unit.

YARD PIPING CONDITION ASSESSMENT APPROACH

Most yard piping is buried and cannot be inspected. An inventory of the buried yard piping with associated age, material, redundancy, service, diameter, and status of cathodic protection (if applicable) is developed. This information was compiled and used to develop the condition rating and risk.

YARD PIPING ASSET CONDITION RATING

Since it was not possible to visually inspect the underground piping or employ other methods of inspection (beyond the scope of this Master Plan Update), the ranking scale used in the yard piping condition assessment was based on age and status of cathodic protection as shown in **Table 4-5.**

Table 4-5 Yard Piping Condition Rating

Age and status of cathodic protection	Condition Rating
Less than 20 years old, metal cathodically protected pipe or other non-metal pipe material	Excellent (1)
Between 20 and 40 years old, metal cathodically protected pipe or other non-metal pipe material	Good (2)
Less than 20 years old, metal NOT cathodically protected pipe or non-metal pipe between 40 and 60 years old	Fair (3)
Between 20 and 40 years old, metal NOT cathodically protected pipe or non-metal pipe between 60 and 70 years old	Poor (4)
More than 40 years old, metal NOT cathodically protected pipe or non-metal pipe more than 70 years old	Possible Eminent Failure (5)

PROBABILITY OF FAILURE FOR YARD PIPING

The probability or likelihood of pipe failure will be based on the condition as shown in **Table 4-6**.

Table 4-6 Probability of Failure Score for Pipes

Condition Rating	Probability of Failure	Score
Excellent	Very Low	1
Good	Low	2
Fair	Moderate	3
Poor	High	4
Possible Eminent Failure	Very High	5

CONSEQUENCE OF FAILURE FOR YARD PIPING

For the purposes of this analysis, consequence of failure score is assigned to reflect the criticality of a yard pipe segment to the performance of the entire system. The factors considered in the development of the overall consequence of failure score are:

- **Disruption:** This factor accounts for the effect on treatment due to pipe failure.
- **Continuous service vs intermittent service:** The consequence of failure of a continuous service influent or effluent pipe will be scored the highest, whereas, a grit pipe may score lower because the grit removal system may be taken out of service intermittently.
- **Pipe Diameter:** The larger the pipe diameter, the higher the risk.

The consequence of failure factors scoring scale used for each pipe is shown in **Table 4-7**. The overall consequence of failure score will be calculated as follows:

$$Yard\ Pipe\ Consequence\ of\ Failure = \frac{Disruption\ Factor + Service\ Factor + Pipe\ Diameter\ Factor}{23}\ X\ 5$$

Table 4-7 Consequence of Failure Factors

Factor Description	Score
Disruption Factor	
Major disruption (for example, significantly reduced level of treatment, sewage on ground)	10
Moderate disruption (for example, partially affects treatment, forced bypass)	8
Minor disruption (for example, no effect on treatment but causes nuisance operation)	5
Service Factor	
Continuous service	8
Intermittent service	4
Pipe Diameter Factor	
Diameter more than 30-inch	5
Diameter between 20-inch and 30-inch	3
Diameter less than 20-inch	2

The Risk factor will be calculated based on the equations above.

TM 5 – CONDITION ASSESSMENT OF WASTEWATER COLLECTION SYSTEM

Technical Memorandum No. 5 (TM 5) documents the condition assessment of sections of the City wastewater collection system identified by the City as areas of concern. A comprehensive assessment of the whole collection system was not completed. Existing documents provided by the City were reviewed as part of this study, including drawings from previous projects, CCTV videos, and maintenance logs, as available. Interviews with operation and maintenance staff were also conducted to capture institutional knowledge related to process, function and areas of concern, followed by site visits by discipline experts to assess the condition of structures and equipment.

EXISTING WASTEWATER COLLECTION SYSTEM

The City's wastewater collection system consists of approximately 150 miles of sanitary sewer piping, a 3-mile wet weather relief pipeline, and 23 lift stations, addressed in TM 6. Piping ranges in diameter from 4-inch to 36-inch. Pipe with a diameter of 8-inch or smaller comprise about 85% of the total piping length. Wastewater is mostly conveyed to the WWTP by gravity, except for force mains from the 23 lift stations. Most force mains are relatively short and connect to the nearest gravity sewer, except for a larger force main conveyance system along Bayshore Road and Park Road that serves the industrial area and residences on the east side of the City.

TM 5 identified 24 wastewater collection CIP projects. These projects are listed in **Table 5-1.**

Table 5-1 Wastewater Collection System Projects

Project No.	Sewer Project Name / Area	Utility Map Sheet No.	Manhole Nodes	Approximate Length (ft)	Diameter (in)
WWC-001	181 East K Street	C6	056 to 054	530	12
WWC-002	El Bonito Way (force main)	E7	Highlands LS to 418	680	4
WWC-003	Hillcrest Avenue	E7	915 to 429	1,470	6 – 8
WWC-004	Elane Way	B5	730 to 230	470	6
WWC-005	255 East O Street/Wingfield Way	C/D-6	212 to 110	530	6
WWC-006	500 East H Street	B7	043 to 003	350	6
WWC-007	Jackson Street	C8	330 to 320	1,560	6 – 8
WWC-008	Polk Street	C8	336 to 324	1,040	6
WWC-009	200 Block East L Street	C7	206 to 106	610	6
WWC-010	300 Block East L Street	C7	150 to 050	520	6
WWC-011	Chelsea Hills Drive	E5	542 to 508	530	8
WWC-012	West 2nd Street/Military West	C6	483 to 105 ft DS	100	6
WWC-013	375 Military East	C7	103 to 102	160	6
WWC-014	Clocktower	C8	427 to 320	860	6 – 10
WWC-015	East 3rd Street/East S Street	D6	308 to 302	410	10
WWC-016	East Channel Road	H-6, G/H-7	721 to Park LS	5,000	12
WWC-017	I-780 Crossing @ West 7th Street	D5	343 to 342	400	8
WWC-018	Rose Drive/London Circle	E-2, D-3	831 to 804	4,100	12
WWC-019	Bayshore Road	B-7/8, C-8	120 to WWTP	2,700	12 – 24
WWC-020	East 7th Street	C-7	003 to 006	500	6 – 8
WWC-021	West H Street	B-6	211 to 221	770	24
WWC-022	El Bonito Way (gravity sewer)	E-7	418 to 412	500	8
WWC-023	Park Road Force Main	G/H-7	Park LS to Tire Shop LS discharge	3,500	12 – 14
WWC-024	Ongoing Condition Assessment	-	-	-	-

EXISTING HYDRAULIC MODEL

The existing Wastewater Master Plan (2011) includes a hydraulic model of the City's wastewater collection system using H20Map SWMM. As a result of the existing hydraulic model, six sections of the collection system were identified that had capacity deficiencies at buildout peak wet weather flows. The criteria for identifying capacity deficiencies was established as being where the surcharge level (hydraulic grade line) comes within 4 feet of the ground surface for buildout peak flows. Three of those six sections identified in the existing Wastewater Master Plan are included in TM 5 as proposed projects since they have not yet been completed. Those projects include sewer improvements in the following locations:

- East Channel Road
- I-780 Crossing at West 7th Street
- Rose Drive/London Circle

This Master Plan Update did not re-evaluate modeling criteria, levels of service, nor remodel the City's collection system as a whole. This Update incorporates the existing model, bringing deficiencies identified therein into the CIP. See TM 8 for a description of the hydraulic model.

PRIORITIZED PROPOSED SEWER COLLECTION SYSTEM PROJECTS

A priority list of wastewater collection system projects was developed incorporating City identified areas of concern and capacity limitations identified from the existing hydraulic model.

Probability of Failure Ratings were determined by reviewing CCTVs, as-built drawings, sewer logs, and communicating with Public Works staff. Consequence of Failure Ratings were determined based on the impact of sanitary sewer overflows (SSO), number of residences/businesses affected, environmental and/or public health risk due to asset location and potential construction cost of repairs. The consequences of failure ratings were determined using the failure factors adapted from the yard piping factors provided in TM 4.

CONDITION ASSESSMENT SUMMARY

Table 5-2 is a summary of the Probability of Failure Ratings, Consequence of Failure Ratings, Overall Remaining Useful Life and Risk Ratings for each of the proposed wastewater collection system projects listed in this TM.

Table 5-2 Condition Assessment Summary [1]

Project Number	Project Name	Project Condition Rating Range (1-5)	Overall Remaining Useful Life (Years)	Consequence of Failure (1-5)	Probability of Failure (1-5)	Risk of Failure Range (0-100)
WWC-001	181 East K Street	4	12	5	4	80
WWC-002	El Bonito Way (force main)	4	6	4	4	64
WWC-003	Hillcrest Avenue	3	18	3	3	36
WWC-004	Elane Way	4	11	5	4	80
WWC-005	255 East O Street/Wingfield Way	3	20	3	3	36
WWC-006	500 East H Street	4	10	4	4	64
WWC-007	Jackson Street	4	10	4	4	64
WWC-008	Polk Street	4	10	4	4	64
WWC-009	200 Block East L Street	3	20	2	3	24
WWC-010	300 Block East L Street	3	20	2	3	24
WWC-011	Chelsea Hills Drive	3	20	4	3	48
WWC-012	West 2nd Street/Military West	3	17	2	3	24
WWC-013	375 Military East	3	18	3	3	36
WWC-014	Clocktower	4	9	2	4	32
WWC-015	East 3rd Street/East S Street	3	20	4	3	48
WWC-016	East Channel Road	4	11	4	4	64
WWC-017	I-780 Crossing @ West 7th Street	3	21	4	3	48
WWC-018	Rose Drive/London Circle	3	20	4	3	48
WWC-019	Bayshore Road	4	6	4	4	64
WWC-020	East 7th Street	3	20	4	3	48
WWC-021	West H Street	2	28	4	2	32
WWC-022	El Bonito Way (gravity sewer)	3	20	3	3	36
WWC-023	Park Road Force Main	5	1	5	5	100
WWC-024	Ongoing Condition Assessment of the Wastewater Collection System	3	-	3	3	36

[1] Condition rating (1 & 2 green, 3 yellow, 4 & 5 red). Risk of failure (0-40 green, 41-59 yellow, 60-100 red).

Table 5-3 is a summary of the recommendations for each of the proposed wastewater collection system projects listed in this TM.

Table 5-3 Recommendations Sewer Collection Projects

Project No.	Project	ERUL (yr)	Pipe Mat	New Pipe (in)	Recommendations
WWC-001	181 East K Street	12	PVC & Lined	10	Re-route wastewater flow around James Lemos Swim Center to E K St and plug existing sewer. Line the existing pipe underneath James Lemos Swim Center by fold-and-form or CIPP methods.
WWC-002	El Bonito Way (force main)	6	PVC	6	City has moved forward with a design to replace the existing 4-inch AC force main with a 6-inch PVC C900 force main as part of its current CIP list.
WWC-003	Hillcrest Avenue	18	Lined	6 to 8	Line existing pipe by either a Fold-n-Form or CIPP methods.
WWC-004	Elane Way	11	Lined	6	Line existing pipe by either a Fold-n-Form or CIPP methods. Second option is to install new sewer main with on Elane Way and reconnect service laterals.
WWC-005	255 East O Street/Wingfield Way	20	PVC or Lined	6	Replace the existing pipe section with sag via open-cut method or trenchless rehabilitation compaction grouting uplifting method. Line existing pipe by either a Fold-n-Form or CIPP methods.
WWC-006	500 East H Street	10	PVC or Lined	6	Line existing pipe by either a Fold-n-Form or CIPP methods. Second option is to install a new sewer main on E. H Street up to MH #08 and reconnect two service laterals to new sewer.
WWC-007	Jackson Street	10	PVC	10	Replace and upsize the existing pipe with a minimum 10-inch by either open-cut or trenchless method of pipe bursting.
WWC-008	Polk Street	10	PVC	8	Replace and upsize the existing pipe with a minimum 8-inch by either open-cut or trenchless method of pipe bursting.
WWC-009	200 Block East L Street	20	Lined	6	Line existing pipe by either a Fold-n-Form or CIPP methods.
WWC-010	300 Block East L Street	20	PVC	8	Install a new 8” sewer main on the street via open-cut method and reconnect existing sewer laterals.
WWC-011	Chelsea Hills Drive	20	Lined	8	Line existing pipe by either a Fold-n-Form or CIPP methods.
WWC-012	West 2nd Street/Military West	17	Lined	6	Line existing pipe by either a Fold-n-Form or CIPP methods.
WWC-013	375 Military East	18	PVC	8	Upsize the existing sewer main with an 8-inch pipe using a trenchless technique such as pipe bursting.

Project No.	Project	ERUL (yr)	Pipe Mat	New Pipe (in)	Recommendations
WWC-014	Clocktower	9	PVC	6 to 10	Replace and re-route the existing line for accessibility with larger pipe diameter. Rehabilitate the pipeline between MH #422 to MH #320
WWC-015	East 3rd Street/East S Street	20	PVC	10	Replace and re-route the existing line away from the field at Robert Semple Elementary School with a 10-inch SS.
WWC-016	East Channel Road	11	PVC & Lined	15 (2,900 ft) to 18 (2,100 ft)	Replace the existing pipe section with sag via open-cut method and lined the remaining section of the pipeline. Currently it is on a CIP project list.
WWC-017	I-780 Crossing @ West 7th Street	21	PVC	12	Upsize existing pipe to a 12-inch using a trenchless method such as pipe bursting. Construct a parallel sewer main from Lori Drive up to W K Street via open-cut method. Currently it is on a CIP project list.
WWC-018	Rose Drive/London Circle	20	PVC or DIP	18	Construct a parallel sewer main for accessibility. This project is on the existing CIP list.
WWC-019	Bayshore Road	6	PVC & Lined	14 to 24	Upsize existing 12-inch to 14-inch pipe and line the existing 24-inch by either Fold-n-Form or CIPP. This project is on the existing CIP list.
WWC-020	East 7th Street	20	PVC	15 to 18	This project is on the existing CIP list.
WWC-021	West H Street	28	PVC or DIP	24	Perform a sea level rise study and slope stabilization analysis surrounding the Southampton Bay. Based on its outcome, possibly relocate the sewer main for safety and accessibility.
WWC-022	El Bonito Way (gravity sewer)	20	Lined	8	Line the existing pipe by either Fold-n-Form or CIPP.
WWC-023	Park Road Force Main	1	PVC or DIP	14	Construct a new parallel force main and line the existing force main for redundancy. Install clean-outs on the forcemain to facilitate accessibility for periodic maintenance.
WWC-024	Ongoing Condition Assessment of the Wastewater Collection System	-	-	-	Every five years, City staff review the existing CIP list and consult with operation and maintenance staff on their assessment of what requires attention, with inspections as required and a focus on re-assessing the most critical pending CIP projects. The results could be adjustments to the priority or budgets of existing CIPs and/or the addition of new CIP projects. This project is not to necessarily provide a complete condition assessment, but to update the condition assessment from the previous five-year cycle.

TM 6 – CONDITION ASSESSMENT OF LIFT STATIONS

The purpose of TM 6 is to document the condition assessment of the twenty-three existing sewer lift stations owned and operated by the City. The results of the condition assessment are used to identify projects included in the City's CIP as part of the Wastewater Master Plan Update.

SUMMARY OF EXISTING SEWER LIFT STATIONS

Out of the 23 pump stations, two are considerably large: Barn Lift Station and Park Road Lift Station have pumping capacities of 1,750 gallons per minute (gpm) and 1,250 gpm, respectively, while the remaining 21 lift stations have capacities below 500 gpm (see **Table 6-1**). Most force mains are relatively short and connect to the nearest gravity sewer, except for a larger force main conveyance system along Bayshore Road and Park Road that serves the industrial area and residences on the east side of the City.

Table 6-1 Existing Sewer Lift Stations

Name	Address	Utility Map Sheet No.	Year of Construction	Capacity[1] (gpm)
Barn	102 Panorama Drive, Benicia, CA	F5	1996	600
Bayshore	2993 Bayshore Road, Benicia, CA	F8	1987	200
Benicia Industries	1093 Jackson Street, Benicia, CA	C8	1940	394
Cambridge	949 Cambridge Drive, Benicia, CA	E2	1980	460
Carlisle	166 Carlisle Way, Benicia, CA	F5	1988	175
East 7th Street	700 East J Street, Benicia, CA	C7	1990	481
East B Street	200 East B Street, Benicia, CA	A6	1960	371
Egret	6158 Egret Court, Benicia, CA	L8	1988	253
Fleetside #1	5201 Industrial Way, Benicia, CA	J8	1988	448
Fleetside #2	5007 Industrial Way, Benicia, CA	I8	1988	448
Fleetside #3	4301 Industrial Way, Benicia, CA	I8	1988	448
Highlands	107 El Bonito Way, Benicia, CA	E7	1940	288
Industrial Way	3801 Industrial Way, Benicia, CA	H8	1988	448
Middle School	1090 Southampton Road, Benicia, CA	D5	1988	42
Park Road	3700 Park Road, Benicia, CA	G7	1993	1,250
Parkway Plaza	2055 Columbus Parkway, Benicia, CA	E2	1990	471
Sam's	706 West I Street, Benicia, CA	C5	1990	253
Teal Court	3971 Teal Court, Benicia, CA	H8	1970	160
Tire Shop	2993 Bayshore Road, Benicia, CA	F8	1967	450
Van's	856 West I Street, Benicia, CA	B5	1990	253
West 8th Street	791 West 8th Street, Benicia, CA	B5	1991	325
West 13th Street	1300 West K Street, Benicia, CA	C4	1993	325
Wharf	1100 Bayshore Road, Benicia, CA	C8	1991	150

[1]Pump capacity ratings in Table 2 and throughout this document are based on one pump in service with a second pump offline in standby position.

ASSESSMENT OF EXISTING SEWER LIFT STATIONS

Stantec developed a "Benicia Lift Station Condition Field Assessment Form" and used it for each lift station. The Assessment Form is divided into the following major areas of inspection, which are further divided into sub-areas in assessing the lift stations. The major areas of evaluation are:

- Pumps, Valves and Piping – includes evaluation for the wet/dry well suction/discharge piping, valves, pumps, motors, odor control, auxiliary equipment, safety issues and other O&M concerns.
- Wet Well – includes evaluation for top slab, wet/dry well interior walls and access hatch conditions.
- Above-Ground/Vault Piping – includes evaluation of piping and valves located above-ground or inside vaults adjacent to a lift station.
- Electrical and Instrumentation Equipment – includes evaluation of the motor control center (MCC), control panel, exposed conduits, generator, and PG&E service meter.
- Site Security – includes evaluation for site access, fencing, chemical/odor exposure and equipment clearance.
- Site Civil – includes evaluation for site paving, drainage, and accessibility.

Each assessed lift station is given a Risk Rating calculated from a Probability of Failure Rating and Consequence of Failure Rating, as described in TM 4. The Probability of Failure Ratings and Consequence of Failure Ratings are determined based on each "Benicia Lift Station Condition Field Assessment Form", closely working with the City staff and institutional knowledge of our team.

During the site visit, close inspection of submersible pumps was not performed by Stantec. According to City Staff, inspection and maintenance of each lift station is performed biannually. City Staff did not relay any concerns or problems with the operation and mechanics of the pumps. Therefore, Stantec's condition assessment of submersible pumps and auxiliary equipment is solely based on the year of installation of the pump compared to a life expectancy of twenty-five (25) years.

Additionally, Stantec performed a preliminary hydraulic analysis of each lift station, including an evaluation of pump capacities using flow data provided by the City. Wet weather calculations are based on data from January 10, 2017 and the dry weather calculations are based on data from June 4, 2019. Because the data is limited to only two days in the last three years, the flow calculations are for generalized purposes only. A more detailed hydraulic analysis using a larger data set is recommended to confirm the results. Peaking factors were calculated using the ratio of wet-weather flows to dry-weather flows.

SUMMARY OF CRITICAL FINDINGS AND RECOMMENDATIONS

Table 6-2 summarizes the most critical condition assessment findings of the existing lift stations.

Table 6-2 Condition Assessment Summary

Lift Station	Critical Findings
Barn	• Wet well discharge piping is significantly corroded • Pumps nearing the end of their expected useful life • Wet well not ventilated • Explosionproof seal-off fitting are required. • Control wire and components are installed in same panel as 480V equipment. All equipment requires 600V rating • There is no SPD installed to prevent voltage spikes in electrical system. • Large discrepancy between the stated pump capacity and hydraulic analysis calculations
Bayshore	• Wet well discharge piping is significantly corroded • Pumps are likely past their expected useful life • Access hatch is significantly corroded • Wet well is located behind parking spaces in commercial parking lot • Explosionproof seal-off fitting are required. • Control wire and components are installed in same panel as 480V equipment. All equipment requires 600V rating • There is no SPD installed to prevent voltage spikes in electrical system
Benicia Industries	• Investigate potential sources of high I/I in local collection system. • Pavement surrounding lift station is in poor condition • Interior panel shows minor signs of corrosion • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • Wet well and building require isolation. Minimum rating of equipment in the building is Class 1 Div 1 requiring explosionproof • There is no SPD installed to prevent voltage spikes in electrical system
Cambridge	• Wet well discharge piping is significantly corroded • Wet well interior wall is significantly corroded • Vault discharge piping/valves are significantly corroded • Investigate potential need to upsize the force main and sources of high I/I in local collection system. • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • UPS unit requires replacement • There is no SPD installed to prevent voltage spikes in electrical system • Poor cable management implementation • Power and control conductor labels not installed
Carlisle	• Pumps are past their expected useful life • One of the non-clog pumps runs backward and is very noisy • Wet well is in the street, dry well is next to a residential driveway • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • There is no SPD installed to prevent voltage spikes in electrical system

Lift Station	Critical Findings
East 7th Street	• Wet well does not have enough capacity • Wet well discharge piping is significantly corroded • Wet well interior wall is significantly corroded • Above ground piping is uncovered and has some corrosion • Investigate potential need to upsize the force main and sources of high I/I in local collection system. • Interior panel shows minor signs of corrosion • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • There is no SPD installed to prevent voltage spikes in electrical system
East B Street	• Wet well does not have enough capacity • Discharge piping is significantly corroded • Investigate potential need to upsize the force main and sources of high I/I in local collection system. • Interior panel shows minor signs of corrosion • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • There is no SPD installed to prevent voltage spikes in electrical system
Egret	• Pumps have exceeded their expected useful life and may be oversized • Wet well discharge piping is significantly corroded • Wet well wall is not coated • Vault discharge piping/valves are significantly corroded • Interior panel shows signs of corrosion • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • There is no SPD installed to prevent voltage spikes in electrical system
Fleetside #1	• Pumps have exceeded their expected useful life and may be oversized • Wet well discharge piping is significantly corroded • Access hatch is worn • Interior panel shows signs of corrosion • Terminal blocks and lugs show signs of H2S corrosion. Rubber isolation plugs are not effective at preventing H2S exposure • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • There is no SPD installed to prevent voltage spikes in electrical system • Communication issues were noted by operations

Lift Station	Critical Findings
Fleetside #2	• Pumps have exceeded their expected useful life and may be oversized • Wet well discharge piping is significantly corroded • Interior panel shows signs of corrosion • Terminal blocks and lugs show signs of H2S corrosion. Rubber isolation plugs are not effective at preventing H2S exposure • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • There is no SPD installed to prevent voltage spikes in electrical system • Communication issues were noted by operations
Fleetside #3	• Pumps have exceeded their expected useful life and may be oversized • Wet well discharge piping is significantly corroded • Interior panel shows signs of corrosion • Terminal blocks and lugs show signs of H2S corrosion. Rubber isolation plugs are not effective at preventing H2S exposure • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • There is no SPD installed to prevent voltage spikes in electrical system • Communication issues were noted by operations
Highlands	• Pumps have exceeded their expected useful life and may be oversized • • Top slab and access hatch have corrosion • Wet well interior wall is significantly corroded • Located in easement between two residences • Interior panel shows signs of corrosion • Terminal blocks and lugs show signs of H2S corrosion. Rubber isolation plugs are not effective at preventing H2S exposure • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • There is no SPD installed to prevent voltage spikes in electrical system • Communication issues were noted by operations • No lighting available for internal components or external panel • Loose wires need to be removed from receptacle box if not used • Existing UPS unit requires replacement
Industrial Way	• Pumps have exceeded their expected useful life and may be oversized • Force main may be undersized • Wet well discharge piping is significantly corroded • Access hatch is significantly corroded • Interior panel shows signs of corrosion • Terminal blocks and lugs show signs of H2S corrosion • The existing panel has seal-off sittings that are not used • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • There is no SPD installed to prevent voltage spikes in electrical system

Lift Station	Critical Findings
Middle School	• Wet well discharge piping is significantly corroded • Access hatch has corrosion • Wet well interior wall is significantly corroded • Vault discharge piping/valves are significantly corroded • Excessive amount of dirt in the valve vault • Interior panel shows signs of corrosion • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • No emergency power is available • There is no SPD installed to prevent voltage spikes in electrical system
Park Road	• Wet well discharge piping is significantly corroded • Pumps are past their expected useful life • Junction manhole interior wall is significantly corroded • Wet well is not ventilated • The SWBD exterior and interior panel is heavily corroded • Terminal blocks and lugs show signs of H2S corrosion • Operations noted that a PLC is replaced every year due to on-going H2S corrosion in the panel • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • No additional IR testing has occurred since May 2017 • Control wire and components are installed in same panel as 480V equipment. All equipment requires 600V rating • There is no SPD installed to prevent voltage spikes in electrical system
Parkway Plaza	• Pumps are past their expected useful life • Wet well discharge piping is significantly corroded • Access hatch is significantly corroded • Wet well interior wall has some corrosion • Located near fast-moving traffic • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • There is no SPD installed to prevent voltage spikes in electrical system • Terminal blocks and lugs show signs of H2S corrosion. Isolation compound is not effective at preventing H2S exposure
Sam's	• Wet well discharge piping flanges are corroded • Wet well discharge piping has multiple developing cracks and bulges • Wet well is located in the street • Investigate potential need to upsize the force main and sources of high I/I in local collection system. Interior panel shows signs of corrosion • Side panel conduit penetrations were not properly sealed causing water damage and corrosion to interior components • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • There is no SPD installed to prevent voltage spikes in electrical system

Lift Station	Critical Findings
Teal Court	• Lift station could potentially be decommissioned and converted to a gravity flow system • Wet well discharge piping is significantly corroded • Pumps are past their expected useful life Interior panel shows signs of corrosion • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • There is no SPD installed to prevent voltage spikes in electrical system
Tire Shop	• Wet well interior wall has some corrosion • No bollards • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • There is no SPD installed to prevent voltage spikes in electrical system
Van's	• Wet well discharge piping has some corrosion • Investigate potential need to upsize the force main and sources of high I/I in local collection system. Sealing compound used to isolate hazardous gases is not effective • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • There is no SPD installed to prevent voltage spikes in electrical system
West 8th Street	• Pumps are past their expected useful life • Wet well discharge piping is significantly corroded • Sealing compound used to isolate hazardous gases is not effective • Interior panel shows signs of corrosion • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • There is no SPD installed to prevent voltage spikes in electrical system • Operations noted communication issues
West 13th Street	• Pumps are past their expected useful life • Wet well access hatch is significantly corroded • Limited space around the lift station • Sealing compound used to isolate hazardous gases is not effective • Explosionproof seal-off fitting are required between hazardous location and unclassified equipment • There is no SPD installed to prevent voltage spikes in electrical system • Relay and electrical components should be properly mounted to back-panel • Poor cable management implementation • Power and control conductor labels not installed

Lift Station	Critical Findings
Wharf	• Pump is past the expected useful life • Wet well discharge piping is significantly corroded • Wet well access hatch is significantly corroded • Sealing compound used to isolate hazardous gases is not effective • Interior panel shows signs of corrosion • There is no SPD installed to prevent voltage spikes in electrical system • Relay and electrical components should be properly mounted to back-panel • Poor cable management implementation

RISK RATING SUMMARY

Table 6-3 summarizes Evaluated Remaining Useful Life (ERUL) and Risk Ratings for each sewer lift station.

Table 6-3 Risk Rating for Lift Stations [1]

Lift Station No	Lift Station	ERUL (yrs)	Probability of Failure (1-5)	Consequence of Failure (1-5)	Overall Risk (0-100)
1	Barn	7	4	4	64
2	Bayshore	4	4	2	32
3	Benicia Industries	6	3	3	36
4	Cambridge	4	4	3	48
5	Carlisle	7	3	3	36
6	East 7th Street	6	4	4	64
7	East B Street	6	4	4	64
8	Egret	5	4	2	32
9	Fleetside #1	5	3	3	36
10	Fleetside #2	6	3	3	36
11	Fleetside #3	8	3	3	36
12	Highlands	5	4	3	48
13	Industrial Way	5	4	3	48
14	Middle School	6	4	2	32
15	Park Road	6	4	4	64
16	Parkway Plaza	8	3	3	36
17	Sams	6	5	3	60
18	Teal	4	3	2	24
19	Tire Shop	8	2	3	24
20	Vans	7	3	3	36
21	West 8th Street	5	3	3	36

Lift Station No	Lift Station	ERUL (yrs)	Probability of Failure (1-5)	Consequence of Failure (1-5)	Overall Risk (0-100)
22	West 13 Street	6	3	3	36
23	Wharf	5	3	2	24
24	Ongoing Condition Assessment of the Sewer Lift Stations	-	3	3	36

[1] Risk of failure (0-40 green, 41-59 yellow, 60-100 red).

The above table 6-3 summarizes the risk rating for individual lift stations, although in TM 12 (Capital Improvement Program), a consolidated CIP list of six projects is presented.

RECOMMENDATIONS SUMMARY

Table 6-4 summarizes recommendations for each sewer lift station. It is recommended to update the condition assessment on a five-year cycle. An ongoing condition assessment CIP project is included in the proposed CIP (see TM12).

Table 6-4 Recommendations Summary

Lift Station	Recommendations
Barn	• Continue to monitor the pumps under the City's ongoing maintenance program as they are past the 25-year expected useful life. Replace as needed. • Replace or coat discharge piping within the wet well. • Re-coat piping and valves within the discharge piping vault. • Add ventilation and scrubber to the wet well to decrease the rate of corrosion and limit the release of odors. • Investigate the true pumping capacity of the submersible pumps and the possible need to upsize the force main. • Investigate potential sources of high I/I in the local collection system. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install isolation barriers to isolate 600V and 300V rated equipment. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings.

Lift Station	Recommendations
Bayshore	• Continue to monitor the pumps under the City's ongoing maintenance program as they are past the 25-year expected useful life. Replace as needed. • Replace or coat discharge piping within the wet well. • Replace access hatch. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install isolation barriers to isolate 600V and 300V rated equipment. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings.
Benicia Industries	• Investigate potential sources of high I/I in local collection system. • Re-pave the lift station site and provide appropriate drainage system to avoid future ponding. • Repair existing building door for proper closing. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA requirements and NEC requirements. • Install electrical surge protection device (recommended but not required) • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings. • Isolate wet well from building to declassify building rating or furnish and install explosionproof electrical panel.
Cambridge	• Replace discharge piping within the wet well. • Coat or line the wet well interior wall. • Replace piping and valves within the above-grade vault. • Investigate potential need to upsize the force main (to be verified with flow monitoring and hydraulic modeling). • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings. • Replace existing UPS unit. • Install power and control conductor labels. Properly route conductors in wireway.

Lift Station	Recommendations
Carlisle	• Continue to monitor the pumps under the City's ongoing maintenance program as they are past the 25-year expected useful life. Replace as needed. • Re-coat piping and valves within the dry well. • Re-coat the wet well. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings.
East 7th Street	• Replace or re-coat discharge piping within the wet well. • Coat or line the wet well interior wall. • Re-coat above ground discharge piping and valves and place in an underground vault for protection. • Increase the capacity of the wet well or include emergency storage capacity. • Investigate potential need to upsize the force main (to be verified with flow monitoring and hydraulic modeling). • Investigate potential sources of high I/I in localized collection system. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings.
East B Street	• Replace or re-coat discharge piping within the wet well. • Re-coat piping and valves within the vault. • Increase the capacity of the wet well or include emergency storage capacity. • Investigate potential sources of high I/I in localized sewer collection system. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings.

Lift Station	Recommendations
Egret	• Continue to monitor the pumps under the City's ongoing maintenance program as they are past the 25-year expected useful life. Replace as needed. • Replace or re-coat discharge piping within the wet well. • Coat the wet well interior wall. • Replace piping and valves within the vault. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings. • Repair panel corrosion and re-coat.
Fleetside #1	• Continue to monitor the pumps, as they are past the 25-year expected useful life, and replace as needed. • Replace or re-coat discharge piping within the wet well. • Re-coat piping and valves within the vault. • Replace wet well access hatch. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings. • Repair panel corrosion and re-coat.
Fleetside #2	• Continue to monitor the pumps, as they are past the 25-year expected useful life, and replace as needed. • Replace or re-coat discharge piping within the wet well. • Re-coat piping and valves within the vault. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommendations but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings. • Repair panel corrosion and re-coat.

Lift Station	Recommendations
Fleetside #3	• Continue to monitor the pumps, as they are past the 25-year expected useful life, and replace as needed. • Replace or re-coat discharge piping within the wet well. • Re-coat piping and valves within the vault. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings. • Repair panel corrosion and re-coat. • Install power and control conductor labels. • Properly route conductors in wireway.
Highlands	• Continue to monitor the pumps, as they are past the 25-year expected useful life, and replace as needed. • Replace or rehabilitate and coat the wet well interior wall. • Re-coat the above ground piping. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings. • Repair panel corrosion and re-coat. • Remove loose wires and properly mount relays to back panel. • Install LED strip light in interior panel to match existing. • Replace existing UPS unit.
Industrial Way	• Continue to monitor the pumps, as they are past the 25-year expected useful life, and replace as needed. • Replace or re-coat discharge piping within the wet well. • Re-coat the wet well interior wall. • Replace piping and valves within the vault. • Investigate need to upsize force main due to possible scouring. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings. • Repair panel corrosion and re-coat.

Lift Station	Recommendations
Middle School	• Re-coat discharge piping and valves in the wet well. • Replace piping and valves within the vault. • Add a wet well access hatch that can lock. • Refurbish concrete and coat the wet well interior wall. • Add more sealed access hatch to the discharge piping vault. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings. • Replace existing control panel with new.
Park Road	• Continue to monitor the pumps, as they are past the 25-year expected useful life, and replace as needed. • Replace or re-coat discharge piping and valves within the wet well. • Re-coat the wet well interior wall. • Coat or line the junction manhole. • Add ventilation and scrubber to the wet well to decrease the rate of corrosion and limit the release of odors. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings. • Recommend minimum rating of NEMA 4X for new SWBD or distribution panel. • Install isolation barriers to isolate 600V and 300V rated equipment. • Replace corroded electrical components.

Lift Station	Recommendations
Parkway Plaza	• Continue to monitor the pumps, as the pump installed in 1995 is past the 25-year expected useful life, and replace as needed. • Replace or re-coat discharge piping within the wet well. • Coat the wet well interior wall. • Re-coat piping and valves within the vault. • Investigate possible need to upsize force main due to scouring. • Replace the access hatch. • Add bollards for site protection. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings. • Replace corroded electrical components.
Sams	• Replace discharge piping within the wet well. • Investigate potential sources of high I/I in the localized sewer collection system. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings. • Repair panel corrosion and re-coat. • Provide watertight seals for all conduit penetrations to prevent interior moisture buildup.
Teal Court	• Continue to monitor the pumps, as they are past the 25-year expected useful life, and replace as needed. • Replace or re-coat discharge piping within the wet well. • Coat the wet well interior wall. • Investigate feasibility of decommissioning this lift station and converting to gravity flow. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings. • Repair panel corrosion and re-coat.

Lift Station	Recommendations
Tire Shop	• Coat or line the wet well interior wall. • Replace the Type A curb with a roll curb for easier access. • Add bollards. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings.
Vans	• Replace or re-coat discharge piping within the wet well. • Investigate potential sources of high I/I in localized sewer collection system. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings. • Repair panel corrosion and re-coat.
West 8th Street	• Continue to monitor the pumps, as they are past the 25-year expected useful life, and replace as needed. • Replace or re-coat discharge piping within the wet well. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings. • Repair panel corrosion and re-coat.

Lift Station	Recommendations
West 13th Street	• Continue to monitor the pumps, as they are past the 25-year expected useful life, and replace as needed. • Coat or line the wet well interior wall. • Investigate potential sources of high I/I in localized sewer collection system. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Replace existing ground lug with terminal ground block to properly and securely ground equipment. • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings. • Install power and control conductor labels. Properly route conductors in wireway.
Wharf	• Continue to monitor the pumps, as they are past the 25-year expected useful life, and replace as needed. • Replace or re-coat discharge piping within the wet well. • Coat the wet well interior wall. • Investigate potential sources of high I/I in localized sewer collection system. • Add explosionproof seal-off fittings for raceway transition between hazardous locations and unclassified locations to comply with NFPA and NEC requirements. • Install electrical surge protection device (recommended but not required). • Install conductor terminal box that allows operator to easily disconnect pump for service without removing seal-off fittings. • Furnish and install new motor control panel.

TM 7 – CONDITION ASSESSMENT OF WASTEWATER TREATMENT PLANT

The purpose of Technical Memorandum No. 7 (TM 7) is to conduct a condition assessment of the existing WWTP structures and equipment, leading to a prioritized and phased list of plant improvements.

The City owns and operates the WWTP, which is a conventional activated sludge secondary WWTP permitted for an average dry weather flow of 4.5 million gallons per day (MGD) and a design wet weather flow capacity of 11 MGD.

The plant was originally constructed in 1958 and has gone through major upgrades in 1978, 1989, 1998, and 2003. The current plant processes include, one mechanical and one manual bar screen, grit removal, primary clarification, activated sludge, rotating biological contactors (RBC), secondary clarification, and a chlorine contact basin. The plant has stormwater holding basins that are used to divert peak influent flows, off-spec effluent, or for storage during maintenance periods.

There are three anaerobic digesters. All three digesters have mixing and heating capabilities. However, currently, there is one digester used as a primary digester, another used for digested sludge storage and the third is currently not used. Solids are digested to Class B criteria, dewatered through two belt filter

presses (BFPs), and then hauled off-site to the Lystek operation in Fairfield Suisun. Effluent from the WWTP is discharge to the Carquinez Strait through a submerged diffuser outfall. A process flow diagram is shown in **Figure 7-1** and an aerial view of the plant is presented in **Figure 7-2**.

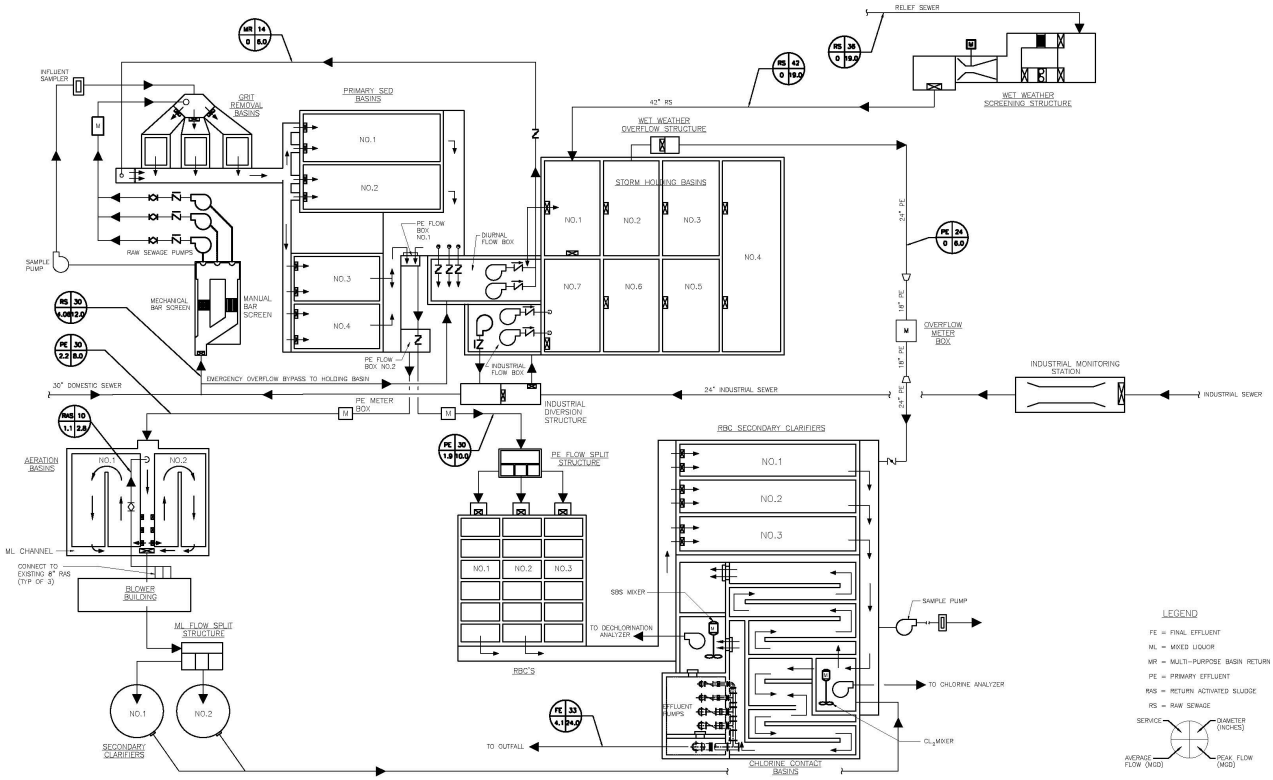

Figure 7-1 Process Flow Diagram

Figure 7-2 Aerial View of Benicia WWTP

The activated sludge process has a peak hydraulic capacity of 8.0 MGD. Influent flows greater than 8.0 MGD can be diverted to the Rotating Biological Reactor and recombined with effluent from the activated sludge process before disinfection.

As indicated in TM 2, the estimated annual average 2040 flow rate will be about 2.84 MGD, which is less than the original design capacity of the plant; therefore, this study focuses on needed improvements to existing treatment facilities related to performance or condition assessment and not expanded capacity

Existing documents provided by the City were reviewed as part of this study, including drawings from previous plant expansions and improvement projects, operation and maintenance manuals, and performance data about the plant. Stantec staff conducted a number of site visits to the WWTP to assess the condition of structures and equipment.

TM 7 is organized to provide summaries of inspection results with respect to asset category (i.e., process structure, pumps, process equipment, pumps, buildings, gates, valves, yard piping, electrical, etc.) followed by a detailed inspection of the plant unit processes (Headworks, primary treatment, secondary treatment, etc.). The condition rating (scale 1 to 5) and risk of failure (scale 0 to 100) of the assets at the WWTP are as described in TM 4 – Condition Assessment Framework.

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SUMMARY OF FINDINGS AND RECOMMENDATIONS

Summary of unit process condition assessment and identified projects proposed for the CIP are listed in **Table 7-1** and **Table 7-2,** respectively.

Table 7-1 Summary of Unit Process Inspection (Mechanical and Electrical/Instrumentation)

	Asset / Major Unit Process Area	MECHANICAL				ELECTRICAL AND INSTRUMENTATION				STRUCTURAL								ABOVE GROUND PIPING			
		Condition	Installation Year	OUL (yrs)	ERUL (yrs)	Condition	Installation Year	OUL (yrs)	ERUL (yrs)	Condition of Concrete Walls or Mats	Condition of Masonry Walls	Condition of Foundation Systems	Condition of Roof Systems	Overall Structural Condition	Installation Year	OUL (yrs)	ERUL (yrs)	Condition	Installation Year	OUL (yrs)	ERUL (yrs)
1	Industrial Monitoring Station and Building	4	1978	35	4	NA	1978	30	NA	4	1	1	3	4	1978	50	7	NA	1978	40	NA
2	Industrial Diversion Structure	2	1978	35	11	1	1978	30	11	2	NA	4	NA	4	1978	50	7	NA	1978	40	NA
3	Stormwater Holding Basins	3	1978	35	8	2	1978	30	9	3	NA	1	NA	3	1978	50	13	2	1978	40	13
4	Headworks Screens	1	2003	35	20	2	2003	30	13	3	NA	1	NA	3	1978	50	13	NA	2003	40	NA
5	Influent Pumps	4	1958	35	4	4	1998	30	4	3	NA	1	NA	3	1978	50	13	4	1978	40	5
6	Headworks Grit Pumps	3	1958	35	7	3	1978	30	6	3	NA	1	NA	3	1978	50	13	2	1978	40	13
7	Primary Clarifiers	2	1978	35	11	3	1978	30	6	3	NA	1	NA	3	1978	50	13	NA	1978	40	NA
8	Aeration Basins	2	1998	35	14	2	1998	30	11	2	NA	1	NA	2	1998	50	24	3	1998	40	12
9	Blowers	1	2009	30	19	1	2009	30	19	NA	NA	NA	NA	NA	NA	NA	NA	3	2009	40	16
10	Secondary Clarifiers - Activated Sludge	2	1998	35	14	2	1998	30	11	2	NA	1	NA	2	1998	50	24	NA	1998	40	NA
11	RAS/WAS Pump Station	1	1998	35	18	1	1998	30	14	2	1	1	1	2	1998	50	24	1	1998	40	21
12	RBCs	2	1978	35	11	2	1978	30	9	2	NA	1	NA	2	1978	50	18	NA	1978	40	NA
13	RBC Equipment Bldg - Secondary Clarifiers Sludge Pumps	2	1978	35	11	2	1978	30	9	2	2	1	2	2	1978	50	18	2	1978	40	13
14	Secondary Clarifiers - RBCs	2	1978	35	11	2	1978	30	9	2	NA	1	NA	2	1978	50	18	NA	1978	40	NA
15	Chlorine Contact Basins	2	1978	35	11	2	1978	30	9	2	NA	1	NA	2	1978	50	18	2	1978	40	13
16	Chlorination/Dechlorination Chemical Storage and Feed System	1	1998	35	18	1	1998	30	14	NA	NA	NA	NA	NA	1998	50	NA	1	1998	40	21
17	Effluent Pump Station	2	2003	35	16	2	2003	30	13	NA	NA	NA	NA	NA	NA	NA	NA	2	2003	40	19
18	Wrap Around Pipe	5	2012	35	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2012	40	NA
19	3 Water System	4	1998	35	6	3	1998	30	8	NA	NA	NA	NA	NA	NA	NA	NA	1	1998	40	21
20	Odor Control	2	1998	35	14	2	1998	30	11	NA	NA	NA	NA	NA	NA	NA	NA	2	1998	40	17
21	Odor Control - Chemical Storage and Feed System	1	1998	35	18	2	1998	30	11	NA	NA	NA	NA	NA	NA	NA	NA	1	1998	40	21
22	Dissolved Air Floatation Thickener System	3	1998	35	10	2	1998	30	11	2	NA	1	NA	2	1998	50	24	3	1998	40	12
23	Sludge Gravity Thickener	2	1989	35	12	NA	NA	NA	NA	2	NA	1	NA	2	1989	50	20	3	1989	40	10
24	Thickener Building	2	1998	35	14	2	1998	30	11	2	1	1	2	2	1989	50	20	2	1998	40	17
25.1	Digesters 1	2	1978	35	11	2	1998	30	11	2	NA	1	2	2	1978	50	18	3	1978	40	9
25.2	Digesters 2	2	1958	35	10	2	1998	30	11	2	NA	1	2	2	1958	50	16	3	1958	40	8
25.3	Digesters 3	2	1998	35	14	2	1998	30	11	2	NA	1	2	2	1998	50	24	3	1998	40	12
26	Digester building 1 and 2	2	1998	35	14	1	1998	30	14	1	1	1	1	1	1998	50	29	3	1998	40	12

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	Asset / Major Unit Process Area	MECHANICAL				ELECTRICAL AND INSTRUMENTATION				STRUCTURAL								ABOVE GROUND PIPING			
		Condition	Installation Year	OUL (yrs)	ERUL (yrs)	Condition	Installation Year	OUL (yrs)	ERUL (yrs)	Condition of Concrete Walls or Mats	Condition of Masonry Walls	Condition of Foundation Systems	Condition of Roof Systems	Overall Structural Condition	Installation Year	OUL (yrs)	ERUL (yrs)	Condition	Installation Year	OUL (yrs)	ERUL (yrs)
27	Solids Dewatering Building (BFP and Grit Classifier)	4	1989	35	4	4	1989	30	4	2	2	1	2	2	1989	50	20	3	1989	40	10
28	Boilers	2	1978	35	11	2	1978	30	9	NA	NA	NA	NA	NA	NA	NA	NA	2	1998	40	17
29	Sea Wall	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	1	1998	50	29	NA	NA	NA	NA
30	Standby Generator	2	2002	35	15	2	2002	30	12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
31.1	Old Flare	4	1958	35	4	3	1958	30	6	NA	NA	NA	NA	NA	NA	NA	NA	3	1958	40	8
31.2	New Flare	2	1998	35	14	2	1998	30	11	NA	NA	NA	NA	NA	NA	NA	NA	2	1998	40	17
32	Relief Sewer Control Structure	2	2003	35	16	2	2003	30	13	2	2	2	2	2	2003	50	26	NA	NA	NA	NA
33	Wet Weather Screening Structure	1	2003	35	20	1	2003	30	16	1	NA	1	NA	1	2003	50	32	1	2003	40	24
34	Motor Control Center - MCC-1	NA	NA	NA	NA	5	1978	30	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35	Motor Control Center - MCC-1A	NA	NA	NA	NA	4	1989	30	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
36	Motor Control Center - MCC-2	NA	NA	NA	NA	5	1978	30	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
37	Motor Control Center - MCC-3	NA	NA	NA	NA	4	1978	30	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
38	Motor Control Center - MCC-4	NA	NA	NA	NA	3	1978	30	6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
39	Motor Control Center - MCC-5	NA	NA	NA	NA	3	1978	30	6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
40	Motor Control Center - MCC-5A	NA	NA	NA	NA	3	1989	30	7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
41	Motor Control Center - MCC-6	NA	NA	NA	NA	1	1998	30	14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
42	Motor Control Center - MCC-7	NA	NA	NA	NA	1	1998	30	14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
43	Motor Control Center - MCC-8	NA	NA	NA	NA	1	1998	30	14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
44	Motor Control Center - MCC-9	NA	NA	NA	NA	1	1998	30	14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
45	Motor Control Center - MCC-10	NA	NA	NA	NA	1	2003	30	16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
46	Main Switchboard - MSB	NA	NA	NA	NA	3	1998	30	8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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Table 7-2 Summary of Improvement Projects

Project Number	Project Name	Project Condition Rating Range (1-5)	Probability of Failure (1-5)	Consequence of Failure (1-5)	Risk of Failure Range (0-100)
WWTP-001	Industrial Monitoring Station Rehabilitation	4	4	3	48
WWTP-002	Industrial Diversion Structure Rehabilitation/Replacement	4	4	3	48
WWTP-003	Stormwater Holding Basins Improvements	3	3	3	36
WWTP-004	Headworks Improvements	3	3	3	36
WWTP-005	Influent Pump Station Improvements	4	4	5	40
WWTP-006	Grit Pipes Replacement	4	4	4	64
WWTP-007	Primary Clarifiers Cross Collectors Replacement	3	3	3	18
WWTP-008	Cover and Aeration Valves Replacement at Aeration Basins	3	2	4	32
WWTP-010	Secondary Clarifier Mechanism Coating	2	2	3	12
WWTP-011	Scum Collector Replacement of RBC Clarifier 3	2	3	3	36
WWTP-012	Effluent Pumps Replacement Project	2	2	3	12
WWTP-013	Effluent Diversion (Wrap Around) Pipe Replacement	4	5	3	60
WWTP-014	3W System Improvements	4	3	3	36
WWTP-015	Chemical Storage Tanks Replacement	2	2	4	32
WWTP-016	Dissolved Air Floatation Equipment Rehabilitation	3	3	3	36
WWTP-017	Digesters Cleaning	3	3	3	36
WWTP-018	Ventilation Improvements at Dewatering Building	3	3	4	48
WWTP-019	Drainage System Rehabilitation at Dewatering Building	5	5	4	80
WWTP-020	Slude Cake Conveyor Replacement	3	3	3	36
WWTP-021	Sludge Dewatering Improvements - BFP Replacement	3	3	3	36
WWTP-022	Boiler Replacement	3	3	4	48
WWTP-023	Flare and Gas Pipes Replacement	4	4	5	80

Project Number	Project Name	Project Condition Rating Range (1-5)	Probability of Failure (1-5)	Consequence of Failure (1-5)	Risk of Failure Range (0-100)
WWTP-024	Disinfection Analyzing Room Improvements	4	4	3	48
WWTP-025	ECR-1 and ECR-2 Electrical Distribution Modification	5	5	5	100
WWTP-026	MCC Modifications and Improvements	4	4	5	80
WWTP-029	Control System Upgrade	2	3	5	60
WWTP-030	Cathodic Protection Rehabilitation	4	4	5	80
WWTP-031	Inspection of Buried Metallic Pipe	5	4	5	80
WWTP-032	Yard Pipes Replacement Project	3	3	5	60
WWTP-033	Plant Site Improvement Project	2	2	2	16
WWTP-034	Secondary Treatment Upgrade	2	2	3	24
WWTP-035	Feasibility Study of Accepting High Strength Waste	2	2	3	24
WWTP-036	Co-Processing of SSO and Energy Production	2	2	3	24
WWTP-037	Plantwide Valve Replacement Program	3	3	4	48
WWTP-038	Replace Chlorine Injection Pipe to RAS Header	4	4	3	48
WWTP-039	Effluent Pipe Replacement	4	4	5	80
WWTP-050	Plantwide Concrete Rehabilitation	3	3	5	60
WWTP-051	Ongoing Condition Assessment	3	3	3	36

* Condition rating (1&2 green, 3 yellow, 4&5 red). Risk of failure (0-40 green, 41-59 yellow, 60-100 red)

TM 8 – COLLECTION SYSTEM MODEL

The purpose of TM 8 is to present the City of Benicia's wastewater collection system model, its use in this Master Plan Update, and conclusions that can be drawn from hydraulic simulations. The collection system model was updated and utilized as part of the 2011 Wastewater System Master Plan. The hydraulic model is dynamic and can simulates system-wide flows under several flow scenarios and system configurations.

Based on the current City land use planning and buildout conditions and those conditions modeled in the 2011 Master Plan, there are no significant land use and related sewerage changes identified and therefore no new modeling efforts completed with the current Master Plan Update. The TM provides a summary of the existing collection system model and results.

2011 MASTER PLAN MODEL

The City's existing model was updated and converted to a new platform as part of the 2011 Master Planning effort. The City's sanitary sewer model was originally developed for rainfall dependent inflow and infiltration (RDI/I) analysis in an old version of EPA SWMM. Various modeling software platforms and packages were considered for the 2011 Master Plan model conversion and update. The software platform, H2OMAP SWMM, was ultimately selected based on the City's modeling needs.

The model simulates a skeletonized system with about 22 total miles of modeled pipelines. The skeletonized system includes the major trunk sewers, 10-inch diameter pipes and larger. Additional smaller diameter lines were added to the model as needed to keep tributary areas at a reasonable size.

The model was also updated to include the four lift stations and associated force mains in the eastern industrial area along Bayshore Road and Park Road that either receive flows from modeled gravity sewers or discharge directly into modeled force mains. The modeled system does not include the other smaller diameter sewers, lift stations in residential areas, lift stations that discharge to un-modeled sewers or that discharge into a modeled lift station, i.e., that do not discharge directly to a modeled force main, or small lift stations serving small residential/commercial areas.

The 2011 model was updated to include the following lift stations:

- Park Industrial Lift Station (includes Industrial Way Lift Station area)
- Tire Shop Lift Station (includes Bayshore Lift Station area)
- Benicia Industries Lift Station
- Wharf Lift Station

SEWERSHEDS (MODELED TRIBUTARY SUBAREAS)

Tributary subareas, or sewer sheds were identified and wastewater flows were allocated to the appropriate manholes within the trunk system within the model. Current and future land uses for each tributary subarea were tabulated using the land use information in Section 2 of the 2011 Master Plan. The tributary subareas from the previous model were updated to reflect the expanded 2011 Master Plan model and facilities. For existing developed areas, subarea boundaries were checked against existing sewer pipe layouts and topographic data. Information was reviewed regarding the planned sewer layout

from the Benicia Business Park Sewer Collection System Analysis (2006) to determine the discharge locations from that future development. Refer to the 2011 Wastewater Master Plan for illustrative figures.

SCENARIOS AND SIMULATED CONDITIONS

The Master Plan model contains six scenarios, three simulating existing flow conditions and three that simulate flow under buildout development conditions. Scenarios under each development condition simulate dry weather flows, wet weather flows, and the impacts of system improvements as recommended in the 2011 Master Plan. Modeled scenarios are summarized in **Table 8-1**.

Table 8-1 2011 Master Plan Hydraulic Model Scenarios

Model File Name	Scenario Description	Development Conditions	Flow Conditions	Collection System Conditions
EXST_DWF	Existing system with existing dry weather flows	Existing	Dry Weather	Existing
EXST_WWF	Existing system with existing wet weather flows	Existing	Wet Weather	Existing
EXST_IMP	Existing system with improvements, existing dry weather flows	Existing	Wet Weather	With recommended improvements
BLDT_DWF	Existing system with buildout dry weather flows	Buildout	Dry Weather	Existing
BLDT_WWF	Existing system with buildout wet weather flows	Buildout	Wet Weather	Existing
BLDT_IMP	Existing system with improvements, buildout wet weather flows	Buildout	Wet Weather	With recommended improvements

MASTER PLAN MODEL CAPACITY ANALYSIS

The following summarizes the methodology and results of the 2011 Master Plan model and results analysis. The collection system analysis is presented as Section 6 of the 2011 Master Plan and evaluates the capacity of modeled gravity sewers, lift stations, and force mains. The capacity evaluation was used to identify capacity deficiencies and evaluate alternative improvements presented in the 2011 Master Plan.

EVALUATION CRITERIA

Evaluation criteria were established to define the method by which gravity sewers, force mains, and lift stations were evaluated for capacity deficiencies using the hydraulic model. These evaluation criteria were used in the collection system hydraulic analysis and are summarized below.

Gravity Sewers

Manning's Friction Factor: The industry standard value of 0.013 for Manning's friction factor "n" was used for all gravity sewers.

Pipe Capacity: The theoretical design capacity when the pipe is flowing full is designated as full flow, QF.

Allowable Surcharge: Surcharging occurs when the hydraulic grade line within a sewer is above the crown of the pipeline. New pipe improvements, when required, must be designed to convey the required flows without surcharging. An existing pipe is considered deficient if it has both:

1. A surcharge level less than four feet below the ground surface/ manhole rim elevation; and
2. A hydraulic grade line slope steeper than the pipe invert slope indicating a capacity deficiency.

Pipe Improvement Sizing: Pipe flows should not exceed 75% of the full hydraulic capacity for pipelines 12-inches in diameter or less. Sewers larger than 12-inches in diameter should be designed to flow at full pipe capacity without surcharging.

Force Mains

Velocity: If the velocity in a modeled force main exceeded a maximum of 10 feet per second (fps) under peak flow conditions, that reach of the force main was considered deficient. Old force mains in poor condition may warrant the use of a lower velocity threshold. New or proposed improvements are designed for velocity of 5 to 7 fps to reduce head losses and lower pumping costs.

Lift Stations

Pumping Capacity: Lift stations need firm, or reliable capacity that matches or exceed the peak flows simulated in the model. The firm or reliable capacity is defined as the total pumping capacity with the largest pump in the lift station being out of service.

1.1 MASTER PLAN MODEL RESULTS SUMMARY

Table 8-2 is a summary of the recommended 2011 model improvements. This table also identifies the improvements that have been completed since 2011, and the remaining improvements that will be incorporated into the updated CIP list (TM 12).

Table 8-2 2011 Master Plan Hydraulic Model Selection Sets

2011 Master Plan Results	Description	Recommended Improvements	Projects Already Implemented By 2020	Projects to be Incorporated into the Updated CIP List
P-1 & P-2	West Fork: Capacity constraint under dry and wet weather conditions	Upsize existing 8-inch sewer to 18-inch sewer, ~4,300 LF. To serve the Benicia Business Park	X	
P-3	East Fork: Surcharged due to backwater effects	33-foot section upstream of Park LS. No recommended project, mitigated with downstream improvements	NA	NA
P-4	East Channel Road: Capacity constraint	Upsize existing 12-inch sewer to 15-inch (~2,900 LF) and 18-inch (~2,100 LF).		X
P-5	I-780 Crossing at West 7th Street: Capacity constraint Potential SSO.	Bolt down MH lid or replace 8-inch sewer with 12-inch, ~400 LF		X
P-6	W. 7th Street: Capacity constraint	Replace 8 and 10-inch pipes with 12-inch. ~1,625 LF	X	
P-7	I-780 Crossing at Southampton Rd.: Capacity constraint	Replace existing 14-inch pipe with 24-inch, ~400 LF. The manhole is bolted down, no improvements were recommended.	NA	NA
P-8	I-780 at Rose Dr.: Capacity constraint, shallow slope	Replace existing 12-inch sewer with 18-inch, ~4,000 LF		X

TM 9 – WASTEWATER TREATMENT PLANT SLUDGE HANDLING AND DISPOSAL ALTERNATIVES

The purpose of TM 9 is to review the existing sludge handling and disposition operations at the Benicia WWTP and assess alternatives to optimize future operation. The objectives of this TM are to:

- Evaluate existing sludge disposition plan.
- Evaluate the feasibility of source separated organics (SSO) addition and co-processing in the anaerobic digesters.
- Develop and assess alternative approaches to municipal solids handling and biogas management.
- Develop contingency plans for onsite solids processing.
- Develop a tactical plan for future solids handling and biogas management.

BACKGROUND

The WWTP produces an average of 2,500 wet tons per year (WT/yr) of Class B biosolids generated at about 17% dry solids concentration. Dewatered solids are hauled offsite to the Lystek facility at the Fairfield-Suisun Sanitation District (FSSD) where the biosolids are co-processed with other wastewater residuals and biosolids in the Bay Area. With a Class A biosolids product, Lystek stores and distributes the biosolids in Solano County and neighboring counties and sell the product as a soil amendment/fertilizer. Commencing in July 2018, the City is under a five (5) year contract with Republic, for hauling services from the City to FSSD, and Lystek for processing. The City pays Lystek approximately $73.53/wet tons (WT) for FY20/21 for solids treatment, and Republic about $67/WT (price increase not yet determined for FY20/21) for transportation with a combined cost of approximately $140.53/WT spent on biosolids hauling, final processing, storage, and reuse. The biogas produced from the anaerobic treatment is used for heating the anaerobic digesters and the remainder is flared.

Fundamentally, the WWTP biosolids program is effective and can be continued into the future with no foreseen issues; however, the unit cost for biosolids disposition is relatively expensive with larger utilities in the Bay Area typically paying less than $100/WT. Hence, one of the primary objectives of this TM is to develop a plan to explore biosolids disposition options including constructing facilities to achieve Class A biosolids at the WWTP. The relative size of the WWTP and the quantity of biosolids on the one hand gives the City many options for partnering with biosolids merchant facilities for further treatment, storage, and final disposition, but because the quantity is small it does not give much leverage to negotiate a better price with these third party contractors.

Because of new regulations to aggressively address greenhouse gas emissions in California, opportunities will be available to the WWTP and the City, i.e., these changes will not require changes for the WWTP (because biosolids are not disposed of in landfill), but the regulations will require changes for the City. Per California Senate Bill SB1383 and other regulatory changes, organic landfill disposal (including the organic fraction of municipal solid waste, wastewater residuals, and biosolids) will be effectively prohibited in the future. California requires 50% organics landfill diversion by 2022 and 75% organics landfill diversion by 2025). It is estimated the state will need to divert nearly half of the 43 million tons of year of material disposed of in the landfill. In order to comply with this statute, construction of new organics diversion and recovery (materials recovery facilities) are anticipated to handle the collection and processing requirements of these diverted organics for reuse. This regulation will have a significant impact on municipal solid waste systems across California, resulting in a combination of new and repurposed infrastructure to sustainably respond to these new requirements. One obvious option is to use existing available capacity at wastewater treatment plants for processing and beneficial use. Hence, one of the objectives of this TM is to examine the WWTP's ability to co-process recovered organics with the wastewater residual solids. With the anaerobic digestion process already in place, the diverted organics quantity will be significantly reduced by efficiently converting the volatile fraction to biogas. This will in turn significantly increase the amount of biogas production and thereby enhance the economic viability of beneficial use of the biogas at the WWTP. Hence, another related objective is to examine the economics of biogas utilization through combined heat and power production or renewable natural gas production.

EXISTING INFRASTRUCTURE

This section provides an overview of the existing solids handling processes and loadings. The location of existing WWTP processes are depicted in **Figure 9-1**. The following is a summary of the existing solids processes:

- Pumping and conveyance of primary sludge (PS), waste activated sludge (WAS), and thickened WAS (TWAS).
- PS is thickened in the primary clarifier (PC); WAS is thickened using a dissolved air flotation thickening (DAFT) system.
- Digestion and stabilization of TWAS and TPS (thickened PS) is stabilized in two of three anaerobic digesters. Among the three existing digesters, Digester No. 3 is operated as the primary digester (0.36 MG (million gallons)), Digester No. 2 is operated as a secondary digester (0.22 MG) and a digested sludge storage vessel, and Digester No. 1 (0.22 MG) is filled with water on standby. All reactors are connected to the biogas collection system.
- Biogas is reused to heat the anaerobic digesters as boiler fuel, and the excess biogas is flared.
- Digested solids are dewatered with two Belt Filter Presses (BFPs).
- Biosolids are hauled off-site for processing and disposition by contract.
- Foul air is treated in a two-stage chemical odor control scrubber and carbon absorber.

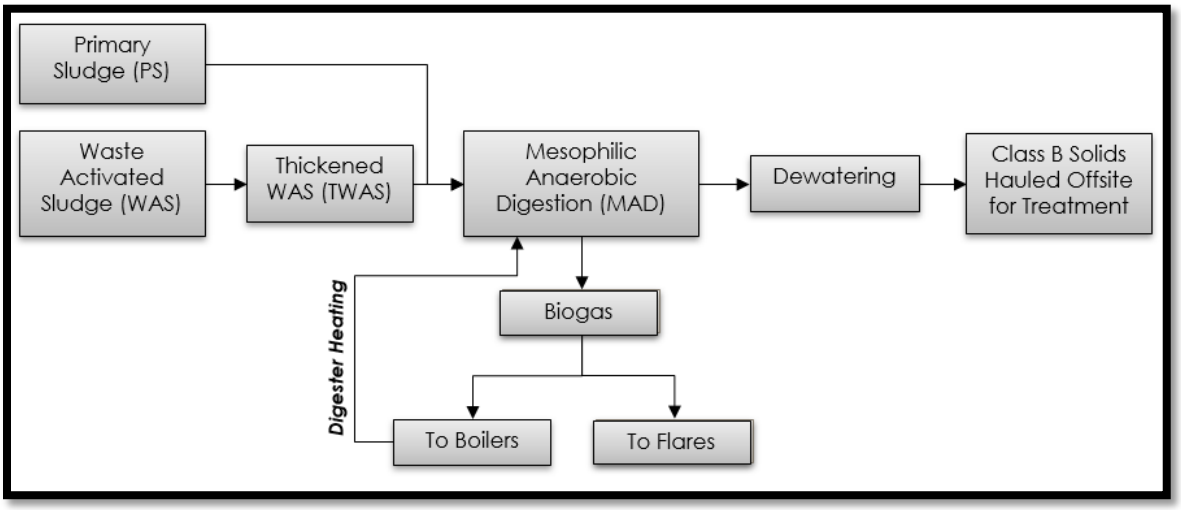

Figure 9-1 Existing Solids Process Flow Diagram

EXISTING SOLIDS LOADINGS

Existing flow rates, loading rates, and solids concentrations are presented in **Table 9-1** for annual averages (AA) and peak/maximum month (MM) conditions. These numbers are for an operating scenario employing mesophilic digestion producing Class B biosolids.

Table 9-1 Existing Solids Loadings

Solids Balance Parameter	AA		MM		Solids concentration (% dry solids)
	Flow rates, gpd	Load, dppd	Flow rates, gpd	Load, dppd	
Primary Sludge, PS	10,100	3,117	12,500	3,857	3.7%
Thickened Waste Activated Sludge, TWAS	6,000	2,252	9,400	3,528	4.5%
Digester Feed Sludge	15,951	5,368	21,692	5,881	4.0%
Digested Sludge, DS	15,991	2,903	21,692	4,078	2.3%
Dewatered Sludge	-	2,100 (8 wtpd)	-	2,970 (11 wtpd)	17.0%

BASIS OF PLANNING

Solids loading rates form the basis for capacity assessment and determination of need and size of new facilities if wastewater facilities are to provide co-processing with other municipal organics. The data presented in Table 9-1 for the existing solids loading conditions was scaled by 18 percent to account for an increase in future (2040) loadings. Evaluation of alternatives in this TM are based on 2040 solid loadings.

Future flow rates, loading rates, and solids concentrations are presented in **Table 9-2** for AA and peak/MM conditions.

Table 9-2 Future Solids Loadings

Solids Balance Parameter	AA		MM		Solids concentration (% dry solids)
	Flow rates, gpd	Load, dppd	Flow rates, gpd	Load, dppd	
Primary Sludge, PS	11,918	3,678	14,750	4,552	3.7%
Thickened Waste Activated Sludge, TWAS	7,080	2,657	11,092	4,163	4.5%
Digester Feed Sludge	18,822	6,335	25,597	8,714	4.0%
Digested Sludge, DS	18,822	3,426	25,597	4,812	2.3%
Dewatered Sludge	-	3,254 (10 wtpd)	-	4,571 (13 wtpd)	17.0%

SOURCE SEPARATED ORGANICS

The organic fraction of municipal solid waste includes food waste, yard trimmings, paper, cardboard, and a broad array of industrial solid waste such as outdated food scraps and manufacturing waste. Separating this material at the site where it is generated creates an organic waste that is less contaminated with plastics and inert material that would not be suitable for recovery and reuse. SSO generally includes

materials originates from a list of high caloric material such as food waste from generators such as restaurants, grocery stores, schools, universities, hospitals, or large institutions handling food. With separation there are less contaminants, but the SSO generally requires screening and grit separation along with dilution to meet specific requirements for co-processing anaerobically with wastewater residuals. High strength wastes (HSW) from food and beverage commercial operations often have material that is readily biodegradable in engineered reactors. Decaying SSO in a landfill produces methane, a powerful greenhouse gas contributing to climate change. California regulations are aimed at curbing greenhouse gases and the decline in available landfill space. Pursuant to SB 1383, anaerobically co-processing SSO and HSW, diverted from landfills, with wastewater residuals is expected to become more common in California.

For WWTPs with anaerobic digestion, the co-digestion of SSO will increase biogas production in anaerobic digesters and create new revenue streams. The Benicia WWTP has an existing digester capacity of 0.8 MG (combined volume of three digesters), of which 0.22 MG (only Digester No.1) is not used and therefore excess capacity. Hence, the Benicia WWTP is well positioned to accept SSO due to excess digestion capacity, though additional infrastructure is needed to make maximize the economic benefit.

For the projected future solids loading with SSO scenario, it is assumed that the quantity of the SSO the City will receive will be determined by the available digestion capacity. Flow rates, loading rates, percent solids, and VS data for the future SSO scenario are presented in **Table 9-3** for AA and MM conditions. Note that the PS and TWAS loadings rates remain same in the future.

Table 9-3 Projected SSO Loadings

SSO	AA or MM
Flow Rates, gpd	29,333
TS Load, dppd	31,803
Dry Solids, %	13%
VS fraction, %	85%
VS Load, dppd	27,033
VSr, %	75%

*Flow and Loadings will vary for alternative 3b with Thermal hydrolysis process

DESCRIPTION OF PROCESS ALTERNATIVES

Various process/technology alternatives were considered for solids handling, biogas handling, and odor control. All the alternatives are evaluated based on the future loadings (2040 loadings). Note that addition of new pre-dewatering sludge conditioning process is considered as an improvement for Alt 1b only. The intent is to simplify this analysis to illustrate the cost/benefit of implementing the pre-dewatering sludge conditioning system. All alternatives will be compared with the base alternative, Alternative 1a. Furthermore, the sizing of the DAFT system was not examined in this TM. However, it is recommended that the City considers redundancy for thickening the WAS.

ALTERNATIVE 1A- EXISTING OPERATION

This is the baseline alternative, which includes continuation of current processes and practices, handling only WWTP residual biosolids. As noted in the Condition Assessment TM 7, important upgrades within the existing solids process areas are needed and are common to all the alternatives described in TM 9.

ALTERNATIVE 1B – ADD SLUDGE CONDITIONING PRIOR TO DEWATERING

This alternative is based on making limited changes to the existing facilities and continuation of current practices. The significant difference between this Alt 1b and Alt 1a is the addition of new pre-dewatering sludge conditioning system. Sludge conditioning process is a step towards improvement in dewatering capability. For this alternative sludge conditioning through physical treatment is considered. Similar to Alt 1a, this alternative only handles WWTP residual biosolids, i.e., it does not include SSO.

ALTERNATIVES 2A AND 2B CO-PROCESSING OF SSO

The second alternative (Alt 2a and Alt 2b) considers co-processing of SSO with municipal waste (MW). In this alternative, SSO will be hauled from an offsite source separation station(s), received in the abandoned Gravity Thickener (GT) tank and transferred to the anaerobic digestion system proportionally to the TWAS and TPS. The anaerobic digestion system will be operated normally (similar to current operations) producing Class B Biosolids. Digested solids will then be dewatered and transported to Lystek (or to an alternative facility, as determined in the future) for final processing and disposition. To maximize throughput, all three existing digesters will process the TPS, TWAS, and SSO feed. BFP operation time would increase from 24 hours per week to approximately 72 hours per week with the existing BFP. A new larger BFP is proposed for both Alt 2a and 2b to limit operation time to 40 hours per week. For this alternative, daily solids production rate is increased to 43 wtpd (avg), which will be trucked and reused offsite via Lystek or Synagro or equal. On-site storage is eliminated since the daily solids production meets the minimum truck load criteria (typically 22 wtpd per truckload required).

Biogas utilization processes are distinct for Alt 2a and 2b, as described below:

- For Alt 2a, biogas generated will be used to generate electricity via Combined Heat and Power (CHP). Electricity generated will be sent to the utility grid for potential revenue generation. However, an agreement with the utility agency (PG &E) needs to be established to facilitate this arrangement. Heat recovered from Internal Combustion Engine(s) (ICE) used for electricity generation will be sent to the boilers for digester heating. Flares are used for managing tail gas (or exhaust gas from gas purification process) and for emergency situations where the CHP system is off-line. Note that biogas clean up, and air monitoring system needs to be employed for this option.

- For Alt 2b, the biogas is converted to a pipeline quality product (as RNG) and sold to a gas utility. Programs that provide renewable energy credits for the purchase of this product can make the economics of this approach attractive. Natural gas will be purchased for firing the boilers for digesters heating. Flares are used for managing tail gas and for emergency situations where the RNG system is off-line.

The overall benefit of this Alternative 2 is that the City has a greater potential for energy production via CHP/RNG and revenue generation.

ALTERNATIVES 3A AND 3B – PRODUCING CLASS A BIOSOLIDS

Alternatives 3a and 3b are intended to be contingency plans should the City be compelled to implement a Class A biosolids program in the future. Class A production will reduce the city's hauling and handling costs, and provides marketable products to farmers, businesses and local landscapers and residents. These alternatives (Alt3a Alt3b) assume the SSO program has been implemented with all the infrastructure already implemented.

Alt 3a alternative is based on producing Class A biosolids onsite with thermal drying, which will remove most of the water from the biosolids prior to transport and reuse.

ALTERNATIVES COMPARISON

Three alternatives approach to biosolids management have been developed and evaluated. Within the prior sections, information delineating each alternative is provided. This section presents the economics comparison and summarizes advantages and disadvantages.

A summary of cost estimates for Alt 1a and Alt 1b are given in **Table 9-4**.

Table 9-4 Alternative Comparison 1 - Cost Estimates

Parameter	Alt 1a (Baseline)*	Alt 1b*
Capital Cost (Avg)	$0.00M	$1.62M
Capital Cost - Low Range (-25%)	$0.00M	$1.21M
Capital Cost - High Range (+50%)	$0.00M	$2.43M
O&M Costs, $/Yr	$0.36M	$0.21M
Net Revenue, $/Yr	N/A	N/A
*Net Present Value (NPV)	$5.36M	$4.76M

*Notes:

- NPV calculated based on 20-year period, 3% interest rate, and includes capital cost (Avg), O&M cost, and revenue (when applicable).
- This is a high-level estimate; a feasibility study is required to confirm project parameters and planning budgets.

A summary of cost estimates for Alt 1a, 2a, and 2b are given in **Table 9-5**.

Table 9-5 Alternative Comparison 2 - Cost Estimates

Parameter	Alt 1a (Baseline)*	Alt 2a*	Alt 2b*
Capital Cost (Avg)	$0.00M	$20.18M	$32.11M
Capital Cost - Low Range (-25%)	$0.00M	$15.13M	$24.08M
Capital Cost - High Range (+50%)	$0.00M	$30.27M	$48.16M
Total O&M Costs, $/Yr	$0.36M	$1.10M	$1.26M
Total Revenue, $/Yr	N/A	$2.73M	$2.87M
Net Revenue $/Yr	N/A	$1.63M	$1.61M
*NPV	$5.36M	-$4.03M	$8.16M

*Notes:

- NPV calculated based on 20-year period, 3% interest rate, and includes capital cost (Avg), O&M cost, and revenue (when applicable).
- This is a high-level estimate; a feasibility study is required to confirm project parameters and planning budgets.

A summary of cost estimates for Alt 1a, 3a, and 3b are given in **Table 9-6.**

Table 9-6 Alternative Comparison 3 - Cost Estimates

Parameter	Alt 1a (Baseline)*	Alt 3a*	Alt 3b*
Capital Cost (Avg)	$0.00M	$13.46M	$22.06M
Capital Cost - Low Range (-25%)	$0.00M	$10.10M	$16.55M
Capital Cost - High Range (+50%)	$0.00M	$20.19M	$33.09M
Total O&M Cost, $/Yr	$0.36M	$0.98M	$0.85M
Total Revenue, $/Yr	N/A	$2.21M	$2.99M
Net Revenue, $/Yr	N/A	$1.23M	$2.15M
*NPV	$5.36M	-$4.84M	-$9.87M

*Notes:

- NPV calculated based on 20-year period, 3% interest rate, and includes capital costs (avg), O&M cost, and revenue (when applicable)
- This is a high-level estimate; a feasibility study is required to confirm project parameters and planning budgets.

DISCUSSIONS AND RECOMMENDATIONS

Based on the solids handling and biogas management alternatives analysis performed, accepting SSO appears to be a promising biosolids alternative for the City because of the availability of the infrastructure (abandoned gravity thickener tank and significant excess anaerobic digestion capacity). However, this conclusion is based on availability of source separation stations (offsite locations owned and operated by a third party). Before the City embarks on this project, securing contracts with such stations must be in place and a sensitivity analysis on the amount of SSO received and the cost assumptions listed in this TM

be confirmed. This can be study funded through a CIP project. Depending on the finding of the detailed study, a second and contingent project to construct an SSO and gas utilization project is also included in the CIP. The solids handling and biogas utilization CIP projects are as follows:

- WWTP-035 – SSO acceptance and biogas utilization refinement study
- WWTP-036 – SSO and Biogas Utilization Project (contingent)

Implementation of a new biogas utilization solutions with the existing condition is not worthwhile, considering high capital and O&M cost investments for the minimal energy production. It is recommended that the quantity of biogas be maximized by accepting SSO (as evaluated in Alternatives 2 and 3) for the City to consider biogas utilization alternatives.

SOLIDS DISPOSTION RELIABILITY

This project includes negotiating a long-term contract with Lystek for receipt of City biosolids and reviewing and possibly negotiating a second long-term contract with Synagro such that if one alternative becomes unavailable, the City would have a pre-negotiated alternative to use the other disposition alternative. Long term contracts will insulate the City from near term market fluctuations and competition but will likely incur additional costs for that stability. Multiple contracts, either with split sludge streams or simply with provisions to use when needed, will protect the City from disruptions to one of the disposition alternatives, even if they have a contract. The CIP does not include professional and legal services to negotiate and review contract terms with Lystek and Synagro. It is assumed that this low-cost study would be paid for by the operational and maintenance budget.

TM 10 – WASTEWATER SUSTAINABILITY AND RESILIENCY EVALUATION

The purpose of this sustainability and resiliency evaluation is to identify projects for the City that could improve the sustainability and resiliency of the City's wastewater system. This TM serves as one of the many steps the City has taken to improve its sustainability and resiliency. It is one of twelve TMs that comprise this Wastewater Master Plan Update based on condition assessment work, which resulted in a list of recommended CIP projects, addressing wastewater reliability, energy sustainability, and resiliency.

Additionally, a triple bottom line (TBL) analysis of two water reuse project options was completed to assess the feasibility of reusing treated wastewater effluent to improve water sustainability for the City. A draft Sustainability Action Plan (SAP) of the recommended water reuse project is included in **Appendix A**. The SAP includes recommended actions to be taken during three timeframes – one to five years, six to ten years, and beyond ten years.

APPROACH & METHODOLOGY

The condition assessment work completed for the Wastewater Master Plan Update resulted in a list of recommended projects to include in the City's CIP. The CIP projects are categorized as either a reliability, energy sustainability, or resiliency project and the reliability projects are discussed further in other TMs.

TM 10 also provides a TBL analysis of two water reuse project options – indirect potable reuse (IPR) and non-potable reuse (NPR). Both projects can improve the water sustainability for the City and were compared by assessing each project's respective environmental, social, and economic impacts. The two

projects were scored for each criterion on a scale of 1-7 with a higher number favoring the City's investment. A draft SAP was developed for the recommended water reuse project.

CITY'S CLIMATE ACTION PLAN AND CLIMATE CHANGE ADAPTATION PLAN

The City has completed previous work towards improving its sustainability and resiliency. The 2009 Benicia Climate Action Plan (CAP) contains a section on the water and wastewater systems. The CAP includes three objectives for the City's water and wastewater systems – 1) reduce the amount of water consumed by 20% by 2020, 2) reduce the amount of emissions resulting from pumps and lift stations, and 3) reduce the amount of emissions resulting from water and wastewater plant operations by 95% by 2020. The CAP shows that the City has been consciously working towards improving its sustainability and resiliency for years.

The City also has a Climate Change Adaptation Plan (CCAP) released in 2016 that contains several adaptation strategies to address environmental vulnerabilities and reduce risks caused by climate change. The adaptation strategies related to the wastewater system include the following:

- Increase emergency preparedness (e.g., generator rental agreements and sufficient supplies of on-site chemicals and fuel at the WWTP).
- Monitor the need to expand the WWTP's flood protection measures (e.g., sea wall).
- Sea level rise adaptation strategies (e.g., flood proof the electrical systems and reduce the vulnerability of the WWTP wastewater outfall and elsewhere along the City's coastline).

The wastewater condition assessment (TM 5, TM 6, and TM 7) resulted in recommended CIP projects (TM 12) for the wastewater system. Most CIP projects are categorized as reliability projects. However, some reliability projects also relate to energy sustainability (e.g., replacing pumps at risk of failure with higher efficiency pumps).

RECOMMENDED SUSTAINABILITY/RESILIENCY CIP PROJECTS

Below are project descriptions of the recommended wastewater CIP projects that were identified as energy sustainability or resiliency projects. These projects relate to the objectives and strategies included in the City's CAP and/or CCAP and could help improve the sustainability and/or resiliency of the wastewater system.

Resiliency CIPs:

- ***Effluent diversion (wrap around) pipe replacement (WWTP-013)* –** The effluent diversion (wrap around) pipe conveys off-specification effluent (i.e., low quality effluent that does not meet specifications due to a process upset of another reason) to the stormwater holding basins for storage until the effluent quality is restored.

Energy Sustainability CIPs:

- ***Feasibility study of accepting high strength waste (WWTP-035)* –** Currently, the dewatered solids from the WWTP are transported to the Lystek facility at the Fairfield-Suisun Sanitation District for further processing. The City has a five-year contract, which began July 2018, with Lystek for processing and with Republic for hauling services. The City currently pays a total of $140 per wet ton of sludge. The biogas produced from the anaerobic treatment is currently used

to heat the anaerobic digesters and the remainder is flared. TM 9 evaluated different alternatives for sludge management and disposal.

- ***Co-processing of source separated organics (SSO) and energy production (WWTP-036; contingent upon WWTP-035) –*** If the detailed study performed for WWTP-035 confirms that it is cost-effective for the City to accept SSO, then the City can co-process the SSO with the wastewater sludge and utilize the methane gas produced through the anaerobic processes to produce energy.
- ***Effluent pump replacement (WWTP-012) –*** The effluent pump station conveys the treated effluent from the chlorine contact basins to the outfall in Carquinez Strait and currently includes four submersible pumps (two small 8 mgd pumps and two large 12 mgd pumps). To keep a constant level in the wet well, the pumps run on a variable frequency drive (VFD) to vary the pump speed. The two large pumps operate at a high efficiency across most of their range. However, the efficiency of the two small pumps drops significantly when the pump is operated far from the best efficiency point on the pump curve. This project includes an energy efficiency study to evaluate whether it is justified to replace the effluent pumps with new pumps with higher efficiencies.

WATER REUSE TRIPLE BOTTOM LINE ANALYSIS

Water reuse could improve the City's water sustainability. Below is a triple bottom line analysis comparing the environmental, social, and economic impacts of two types of water reuse – indirect potable reuse and non-potable reuse (including industrial reuse). After a description of the two projects, the results of the TBL analysis are presented through a discussion of how each project compared for each criterion. The criteria selected include the following:

- Environmental
  - Water stress
  - Greenhouse gas (GHG) emissions
- Social
  - Potential health risks
- Economic
  - Capital costs
  - Operation and maintenance (O&M) costs
  - Institutional control over resources

NON-POTABLE REUSE (INCLUDING INDUSTRIAL REUSE) (I.E., NPR)

The June 2017 Benicia Water Reuse Study Feasibility Report by Brown and Caldwell (Water Reuse Study) studied the feasibility of implementing water reuse within the City of Benicia. The largest reuse option involved conveying recycled water to the Valero Refinery (Valero or Refinery) for cooling tower makeup water (i.e., industrial reuse). An additional reuse option studied in the Water Reuse Study involved utilizing the proposed Refinery conveyance pipeline to also convey recycled water to City customers for irrigation purposes. It was anticipated that approximately 2,000 acre-feet per year (AFY) of recycled water could be delivered to the Refinery and approximately 30-40 AFY could be utilized to offset potable water irrigation demands.

The project selected in the Water Reuse Study included treatment upgrades at the WWTP, a pump station at the WWTP, a 0.5 million gallon storage tank at the Valero Refinery, and a recycled water conveyance pipeline along City right-of-ways (ROWs). The major treatment upgrades at the WWTP included chemical addition for phosphate removal, a Modified Ludzack-Ettinger (MLE) process (nitrifying activated sludge) for ammonia removal, cloth media filtration for solids removal, and chlorination for disinfection. The NPR treatment system was sized for the Refinery's cooling tower peak month demand of 2.0 mgd. The recycled water conveyance pipeline to the refinery included approximately 14,500 linear feet of new 14-inch diameter pipe. The full Benicia Water Reuse Study Feasibility Report includes greater detail on this non-potable reuse project.

SURFACE WATER AUGMENTATION (I.E., INDIRECT POTABLE REUSE, IPR)

For the surface water augmentation project, advanced purified effluent would be sent to Lake Herman for storage before being conveyed as a raw water source to the Water Treatment Plant (WTP) for further treatment. It was assumed that the IPR system would be sized for the same flow as the NPR system (up to 2.0 mgd). Although, the IPR system may be sized differently following detailed design. Additionally, if the water elevation of Lake Herman is especially low, the amount of advanced purified effluent that may be conveyed to Lake Herman may be reduced to maintain dilution requirements with raw water volumes. The surface water regulations (California Code of Regulations Title 22, Division 4) require either a 100:1 or 10:1 dilution based on the number of log removals achieved by the treatment system. This project may require altering the City's water rights for Lake Herman per Water Right License 4900.

To achieve advanced purified effluent, upgrades would be required at the WWTP and an Advanced Water Purification Facility (AWPF) would need to be constructed. If the City chooses to pursue IPR, a detailed feasibility study should be conducted. For the purposes of this TBL analysis, it was assumed that the treatment improvements at the WWTP would include chemical addition for phosphate removal and a tertiary membrane bioreactor (TMBR). The Water Reuse Study contained a treatment alternative that included chemical addition, a TMBR, and an ultraviolet (UV) disinfection system. The chemical addition and TMBR information available for this alternative was used in this TBL analysis. It was also assumed that the AWPF would include reverse osmosis (RO) and a UV advanced oxidation process (AOP).

A recycled water pipeline from the AWPF to Lake Herman would need to be constructed. It was assumed that the AWPF would be located on or next to the WWTP. It was assumed that a portion of the 14-inch diameter pipeline alignment to the Refinery selected for the NPR project would be utilized to convey the advanced purified effluent to Lake Herman (except the portion on Valero's property) and would be extended to Lake Herman, roughly following the existing raw water pipeline alignment..

RECOMMENDATION

Figure 10-1 and **Table 10-1** are summaries of how IPR and NPR scored for each criterion with a higher score favoring the City's investment.

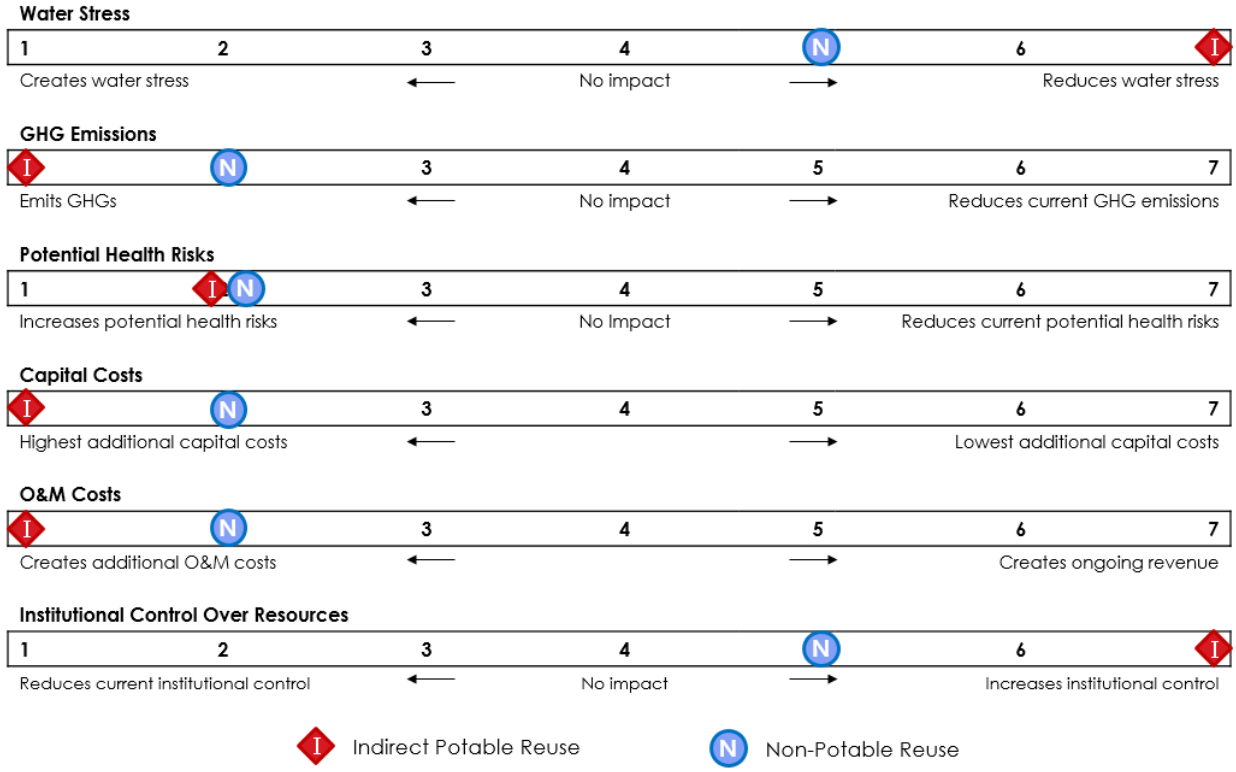

Figure 10-1 Water Reuse Project Scores

Table 10-1 Water Reuse Project Scores

Category	NPR	IPR
Water Stress	5	7
GHG Emissions	2	1
Potential Health Risks	2	2
Capital Costs	2	1
O&M Costs	2	1
Institutional Control Over Resources	5	7
Total	**18**	**19**

IPR scores higher on water stress and institutional control over resources, and NPR scores higher on GHG emissions, capital cost, and O&M costs. Overall, IPR scores higher than NPR by one point. Additionally, NPR may not provide a reliable investment for the City and offers limited flexibility as compared to IPR due to having only one potential primary recycled water user. Moreover, Valero has expressed that raw water is preferred for the cooling towers over the recycled water. While Valero may be interested in receiving the recycled water, they may not commit to receiving the recycled water continuously or in perpetuity.

A draft Action Plan for IPR was developed for discussion, completion and implementation by the City. The draft Action Plan is included in detail with the TM, with an outline as summarized below.

INDIRECT POTABLE REUSE ACTION PLAN – DRAFT

The draft action plan includes the following sections (with additional detail in the TM):

- Project Background & Description
- Project Purpose, Justification, & Relation to City Goals & Objectives
- Project Information
- Action Plan

ACTION PLAN

Table 1, 2, and **3** below show the recommended actions to take during approximate years one through five, six through ten, and beyond year ten, respectively. The due dates provided in these tables assumes that the project begins in July 2021 (the beginning of FY 2021/2022). The due dates will need to be updated depending on actual project commencement and as project development is refined.

Table 1 Recommended Actions to Be Taken During Years One Through Five

Step	Action	Responsible Party	Approximate Duration	Due Date
1	IPR Feasibility Study • Detailed mapping of permit requirements and development strategy • Detailed treatment system evaluation and siting plan • Detailed conveyance system hydraulic evaluation • Conveyance pipeline alignment alternatives evaluation • Topographic and utility survey • Geotechnical investigation • Detailed wastewater characterization • Lake Herman water balance and computational fluid dynamics modeling for mixing	City Staff & Consultant	1 year	June 2022
2	Public Outreach • Focused and deliberate campaign, with mailers, public meetings, follow-up, council presentations, etc.	City Staff & Consultant	1 year	June 2023

Step	Action	Responsible Party	Approximate Duration	Due Date
3	Coordination with Agencies (not necessarily complete nor are all necessarily applicable) • State Water Resources Control Board Division of Drinking Water Permitting • Regional Water Quality Control Board NPDES Permitting • Bay Area Air Quality Management District • Caltrans • Solano County • Benicia Building Department • California Department of Fish and Wildlife • National Marine Fisheries Service • US Army Corps of Engineers • DSOD (depending on pipe alignment)	City Staff & Consultant	Ongoing	-
4	Procure Funding	City Staff & Consultant	1 year (preliminary coordination may proceed formal funding procurement period)	June 2024
5	Preliminary Design and Funding [1] • WWTP Improvements • Conveyance Improvements	City Staff & Consultant	1 year	June 2025
6	Pilot Testing [1] • Bench test and scaled pilot for chemical addition for phosphate removal • Scaled pilot for membrane selection • Scaled pilot for RO equipment • Scaled pilot for UV advanced oxidation	City Staff & Consultant	1 month	July 2025
7	Detailed Design	City Staff & Consultant	1 year	July 2026

[1] The order of preliminary design and pilot testing may vary depending on the results of the Feasibility Study. Pilot testing will refine the design parameters prior to final equipment selection and detailed design.

Table 2 Recommended Actions to Be Taken During Years Six Through Ten

Step	Action	Responsible Party	Anticipated Duration	Due Date
8	Bid Period, Award, and Notice to Proceed	City Staff & Consultant	0.5 years	January 2027
9	Construction	City Staff, Consultant, & Contractor	2 years	January 2029
10	Project Commissioning (start-up, testing & warranty period)	City Staff, Consultant, & Contractor	1 year	January 2030

Table 3 Recommended Actions to Be Taken Beyond Year Ten

Step	Action	Responsible Party	Anticipated Duration	Due Date
-	Ongoing maintenance and monitoring	City Staff	Ongoing	-
-	Permit renewals	City Staff	Ongoing	-

TM 11 – MUNICIPAL FINANCING FOR WASTEWATER SYSTEMS

The purpose of Technical Memorandum No. 11 (TM 11) is to provide information on possible funding opportunities for the City's CIP and projects identified during development of the Wastewater Master Plan Update. These opportunities include low interest loans and grants offered through various agencies, selling municipal bonds, and others. Discussion regarding how these funding arrangements can be incorporated into the development of user rates is provided, but no progress is planned or completed towards development of funds or establishment of rates; that is left to a separate process beyond the scope of this Master Plan Update.

Rate Structure and Summary

The City bills for wastewater utility services on a bi-monthly basis (approximately every 60 days). The current bimonthly rate for a residential customer is $104.15 with a volumetric charge added based on their capped monthly water use. The final rate increase (from the FY 2017-21 5-year approved rates) will be 5% (water 3%) and is scheduled to take effect on July 1, 2020. These rates have ensured the health and safety of the community over the preceding 4 years and will ensure the City's sewer utilities remain financially solvent and operational through FY2021.

The City's last Water and Wastewater Rate Study completed in May of 2016 anticipated funding a Wastewater CIP of slightly more than $7.2 million between FY2017 and FY2021. To meet operating and CIP costs without taking on any debt, the Rate Study recommended annual rate increases of 16%, 12%, 9%, 7% and 5% between FY2017 and FY2021. On April 17, 2018, City Council reduced the FY18/19 wastewater rate increase from 9% to 0%, The Master Plan Update has determined the City will require additional money to develop the recommended CIP Projects. Cash reserves cannot fund the recommended CIP Projects. Based on financial resources currently available, the City will need to secure

additional capital to fund wastewater projects and may be required to raise rates to meet related financing obligations.

FUNDING OPTIONS OVERVIEW

Developing a strategic funding plan hinges on having a robust understanding of current funding sources, identifying and characterizing new funding sources, and evaluating the applicability and attractiveness of those funding sources. Funding sources can be tapped to support multiple or individual CIP projects. To secure adequate capital to fund the priority projects, the City may benefit from pursuing a suite of funding options.

The following provides a high-level overview of funding options for the City to consider.

CASH-FUNDED CAPITAL

The most direct form of capital funding is to pay for projects through available cash balances or revenue cash flows, often referred to as "pay-as-you-go" (PAYGO) funding. This funding source is very often the cheapest form of funding (except grant funding) as there is no interest expense to be paid off over time, nor administrative or issuance costs associated with procuring funding. Projects can be partially or entirely funded as PAYGO capital based on the funds available to meet the project funding needs. Funds may be generated to build a reserve and meet capital needs through a variety of sources. The 2016 Rate Study recommended a Sewer Fund Reserve Target of $4.3 million, to stabilize funding for operating, capital rehabilitation and replacement, and rates through accumulated PAYGO reserves.

Common sources of cash-funded capital include:

- Rate, fee, or assessment revenue collected by the City from rate payers.
- Development fees (also referred to as impact fees, capacity fees, capital facilities fees, among others)
- Assessments established to fund projects that provide a "special benefit"[1] to property owners of a clearly defined set of parcels.

Table 11-1 below is a summary of the strengths, weaknesses, opportunities and threats (SWOT) related to Cash Funded Capital.

[1] Special benefit is defined as a particular and distinct benefit over and above general benefits conferred on real property located in the district or to the public at large.

Table 11-1 Cash Funding SWOT

Strengths • Low Cost • Control • No external compliance requirements	**Weaknesses** • Must accrue adequate capital over time • Requires rate increases • Could delay delivery
Opportunities • Blend cash with government funding programs and bonds to reduce overall costs • Fund "local, near term, no-regrets" options with existing cash reserves	**Threats** • Unforeseen costs depleting capital reserves and delaying or preventing projects • Failure to implement adequate rate increases

DEBT FINANCING

Debt financing is a viable option to meet the planning, design, and construction funding needs to complete the proposed projects. Debt financing can come in various forms, most commonly revenue bonds, general obligation bonds, certificates of participation, or loans. Sources of debt financing include:

- Revenue Bonds
- General Obligation Bonds
- Certificates of Participation

Table 11-2 below is a summary of the strengths, weaknesses, opportunities and threats related to Municipal Bonds and COPs.

Table 11-2 Municipal Bonds and COPs SWOT

Strengths • Control • Minimal compliance requirements • Currently rates are low	**Weaknesses** • Typically higher rates than government financing programs • Inflexible repayment terms • Potentially high issuance costs
Opportunities • Blend bonds with government funding programs • Leverage current issuance trends to keep costs low • Issue numerous bonds over implementation of recommended CIP Projects to reduce capitalized interest prior to substantial completion	**Threats** • Interest rate risk exposure • Project risk impacting interest rate

GOVERNMENT FINANCING AND FUNDING

The recommended CIP projects may be strong contenders for competitive government funding programs but not all programs are a good fit. Evaluation criteria drives the assessment and comparison of potential funding options. These criteria weigh the qualitative risks and benefits, as well as the quantitative revenue and timing associated with each funding option. Key evaluation components include:

- Competitiveness – Provides a measure of how likely the City is to successfully compete for funding from the program
- Maximum Grant Award or Loan Amount - Determines the adequacy of the funding available to meet the needs of the City
- Funding Terms – Evaluates the attractiveness of anticipated loan interest rate and maturity compared to bonding
- Application Costs – Considers the level of effort necessary to effectively compete for funding. Outlines the application requirements
- Compliance Costs – Assesses the costs of grant or loan management after the funding has been secured
- Timing – Overlays the likely timing of funding program disbursements with the project cash flow requirements

Table 11-3 below is a summary of the strengths, weaknesses, opportunities and threats related to Government Funding and Financing Programs.

Table 11-3 Government Funding and Financing Programs SWOT Loans

Strengths • Low interest rates • Grant funding • Flexible repayment terms	**Weaknesses** • Application costs and requirements • Inadequate funding available to meet needs • Compliance and reporting costs • Government coordination and schedule impacts
Opportunities • Streamline project management and funding program application, reporting and compliance requirements • Reduce impact to rate payers through gradual rate increases that match flexible repayment terms • Utilize multiple programs with same compliance & reporting requirements to spread costs across greater capital contribution • Use a Water Infrastructure Finance and Innovation Act loan in a PPP	**Threats** • Decreases in funding available • Shifting program and political priorities • De-obligation of funds related to non-compliance

Sources of government financing and funding can include the following programs:

- California Clean Water State Revolving Fund (CWSRF)
- EPA Water Infrastructure Finance and Innovation Act (WIFIA)

GRANT FUNDING

While grant programs for the purpose of funding wastewater infrastructure projects in California do exist, they are often targeted at small disadvantaged communities or narrowly defined projects and often award limited amounts. Utilizing these programs may require some creative or out of the box type projects, solutions or collaborations. Possible grant programs include:

- CWSRF Program
- United States Bureau of Reclamation Water Reclamation and Reuse Program (Tile XVI)
- Federal Disaster Resilience and Mitigation Funding
- California Agency Grants

PUBLIC PRIVATE PARTNERSHIPS (P3)

Public Private Partnerships are an alternative means to deliver infrastructure services. P3s are rare in the US in the water sector but they do provide a real financing and project development option. This TM focuses on P3s that provide upfront capital for infrastructure projects. Design-Build-Operate (DBO), and Design-Build-Operate-Maintain (DBOM) can be considered P3s but, as those delivery approaches do not include financing (F), they are not a focus of this memo.

Typically, in a P3, a private entity assembles the delivery team and takes responsibility for project design, construction, operations and financing. A P3 project delivery approach is sometimes referred to as Design-Build-Operate-Finance, or DBOF. Private participation creates the opportunity to transfer more project risk and project responsibility from the project sponsor (City) to private partners. However, private investors will not accept regulatory, political, or disaster risk and the cost for this funding is typically paid through an operation or rate charge.

P3 financing results in higher financing costs over the life of a project compared to tax-exempt municipal debt or government financing programs. Ultimately equity returns and debt service make up a portion of the rates customers pay for their water. A P3 public sponsor must trust the design, construction, O&M savings and risk transfer, over the life of the project, will outweigh the higher financing costs.

Though newer P3 models allow for more participation from the public project sponsor, the more the City dictates development, the more the project will be built and managed like a public project, effectively minimizing the efficiencies purported to be gained through private DBOF. In order to realize those savings, the City must give up some control.

Table 11-4 below is a summary of the strengths, weaknesses, opportunities and threats associated with P3s.

Table 11-4 P3 SWOT

Strengths • Design, build, operate & maintain efficiencies resulting in cost savings • Project risk transfer • Transfer of project development and O&M responsibility • City staff directed to other projects or priorities • More flexible repayment terms	**Weaknesses** • Higher financing costs • Less control • High transaction costs • Longer project development phase
Opportunities • Leverage WIFIA • Explore ownership configurations, other options and costs during development • Identify investor-partner with lower return expectations	**Threats** • Stakeholder support • Political support • Regulatory changes • Force majeure/Disaster

CONCLUSION AND RECOMMENDATIONS

This narrative provides information on strategic funding sources for the City's CIP Projects. A critical next step is integrating the key financial characteristics of the CIP Projects with the most attractive funding scenario currently available to the City. Based on projects' characteristics and the funding options available, the City may be required to make critical financial decisions in the near term to effectively position for the impact of accruing and securing capital in the future.

Preliminary steps may be for the City to cash fund near term projects and position for loan, grant and bond issuances that can meet the significant capital needs associated with lager and long-term projects.

TM 12 – PROPOSED WASTEWATER CAPITAL IMPROVEMENT PROGRAM

The purpose of this TM is to present a proposed 20-year schedule of capital improvement projects and their associated estimated costs. Proposed projects are loosely presented chronologically to distribute costs over time in keeping with each project's criticality or other City priorities, but final project inclusion in the adopted City CIP and associated dates are approximate and adjustable. No CIP program, project or schedule is final until acted on by the City Council.

SOURCES OF PROPOSED CIP PROJECTS

The sources of the proposed CIP projects are the recommended improvement from the condition assessment evaluations or other capacity, redundancy/resiliency or value-added projects determined from the other Master Plan Update TMs and the current City five-year Capital Improvement Program (2019/2020 through 2023/2024) that was adopted on May 28, 2019. Projects and costs related to operation and maintenance or routine repair and replacement are not included with these CIP projects.

CRITERIA USED FOR PRIORITIZING PROJECTS

Each of the prospective capital projects were prioritized based on the risk posed to the community and the condition of the asset. The risk and condition rating are described in more detail in Technical Memorandum No. 4 (Condition Assessment Framework). This type of risk- based analysis aims to objectively prioritize projects and helps ensure that the most necessary projects are completed first and optimizes the CIP project schedule.

CIP COST ESTIMATING METHODOLOGY

A key element to the CIP planning process is determining budgets for each of the identified projects. The cost estimates include base/construction costs and soft costs. The engineering opinion of probable costs falls under cost estimate Classification Four (Class 4, as defined by Association for the Advancement of Cost Engineering, AACE) with an expected accuracy range of -30% to +50%. Costs include contingency and allowances for legal, admin, environmental, permitting, planning, design, construction management and inspection. All costs estimates are in 2020 dollars with an ENR construction cost index of 11392.

PROPOSED CIP SCHEDULE

A 20-year proposed schedule of the identified capital projects and their associated estimated annual costs was developed. The schedule was mostly prepared based on the risk profile or each project and smoothed projection of annual expenditures. However, in some cases, projects with lower risks are scheduled for implementation sooner than higher risk projects to address City needs. **Figure 12-1** shows the annual estimated expenditures for the three wastewater CIP categories.

PROPOSED CIP PROJECT CATEGORIES

The cost estimates developed for all capital projects are summarized by project category (WWTP, collection system and lift stations) in **Figure 12-2**. Of the total capital projects in the next twenty years, over 50% of the proposed costs are from the WWTP. A break-down of the CIP costs (base cost, soft costs, and contingency) in each category is shown in **Figure 12-3**.

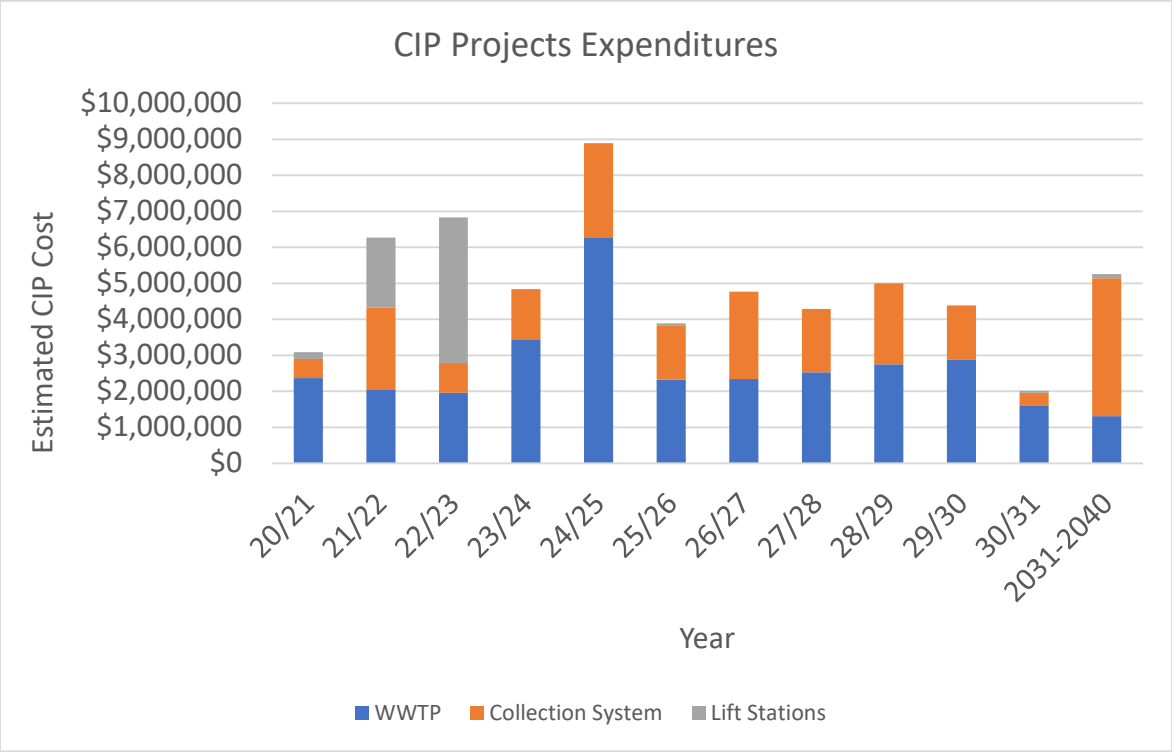

Figure 12-1 Proposed Annual Wastewater CIP Expenditures

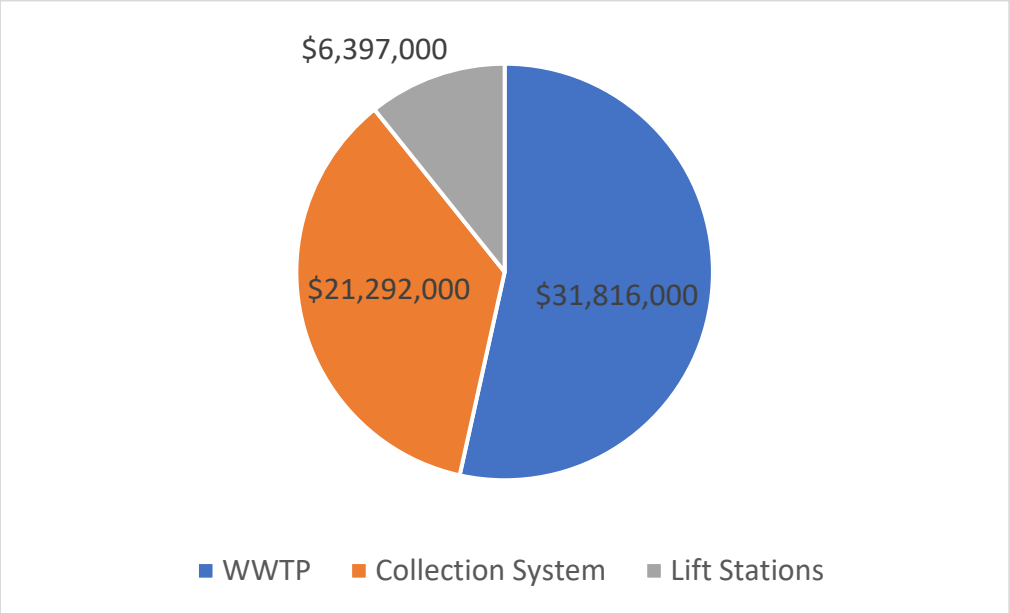

Figure 12-2 Proposed Wastewater CIP Projects Category (Not Including Contingent Projects)

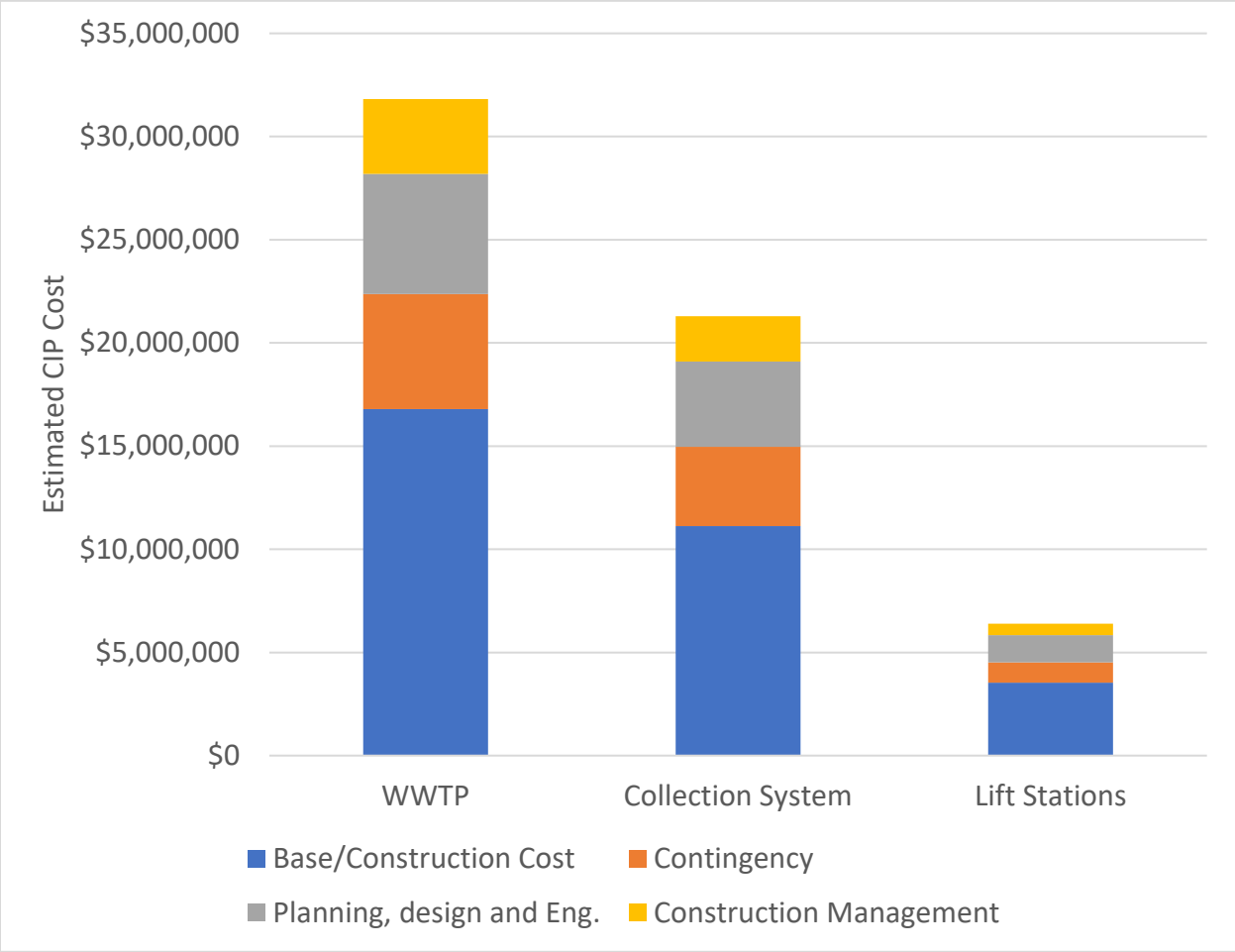

Figure 12-3 Breakdown Costs of Proposed Wastewater CIP Projects

PROPOSED WASTEWATER CIP PROJECTS

The prioritized recommended capital projects are shown in **Tables 12-1** through **12-4**. The contingent projects are listed in **Table 12-5**, representing projects that are not currently required but may become required if regulations change or studies confirm their feasibility. It is important to realize that the CIP represents a snapshot of known/observable utility conditions as of early 2020. Due to the dynamic nature of the utility operations, facility needs, and priorities may change overtime. Furthermore, several of the projects identified would require additional analysis, beyond the scope of this Master Plan Update, to determine the exact scope of necessary improvement and refine final costs. In these cases, the CIP includes budgets to further evaluate those facility needs as described in other TMs.

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Table 12-1 Proposed Wastewater Treatment Plant CIP Projects [1]

Proposed Project Name	Proposed Project #	Proposed Timeline [2]												Estimated Total	Project Condition Rating Range (1-5)	Risk of Failure Range (0-100)
		20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	2031-2040			
ECR-1 and ECR-2 Electrical Distribution Modification	WWTP-025	$623,000	$1,169,000	$1,169,000										$2,961,000	5	100
Drainage System Rehabilitation at Dewatering Building	WWTP-019	$135,000												$135,000	5	80
MCC Modifications and Improvements	WWTP-026				$1,834,000	$2,269,000	$2,269,000	$2,339,000						$8,711,000	4	80
Flare and Gas Pipes Replacement	WWTP-023								$276,000	$1,036,000				$1,312,000	4	80
Inspection of Burried Metallic Pipes	WWTP-031								$1,215,000					$1,215,000	5	80
Cathodic Protection Rehabilitation	WWTP-030	$915,000												$915,000	4	80
Effluent Piping Replacement	WWTP-039				$1,069,000	$4,009,000								$5,078,000	5	60
Grit Pipes Replacement	WWTP-006								$189,000					$189,000	4	64
Industrial Monitoring Station Rehabilitation	WWTP-001			$415,000										$415,000	4	48
Industrial Diversion Structure Rehabilitation/Replacement	WWTP-002		$552,000											$552,000	4	48
Effluent Diversion (Wrap Around) Pipe Replacement	WWTP-013		$210,000											$210,000	4	60
Disinfection Analyzing Room Improvements	WWTP-024			$99,000										$99,000	4	48
Replace Chlorine Injection Pipe to RAS Header	WWTP-038			$145,000										$145,000	4	48
Influent Pump Station Improvements	WWTP-005								$204,000	$868,000				$1,072,000	4	40
Plantwide Concrete Rehabilitation	WWTP-050									$460,000	$1,723,000			$2,183,000	3	60
3W System Improvements	WWTP-014									$300,000				$300,000	4	36
Ventilation Improvements at Dewatering Building	WWTP-018									$84,000				$84,000	3	48
Boiler Replacement	WWTP-022								$647,000					$647,000	3	48
Plantwide Valve Replacement Program	WWTP-037										$125,000			$125,000	3	48
Control System Improvements	WWTP-029										$1,025,000			$1,025,000	2	60
Stormwater Holding Basins Improvements	WWTP-003											$340,000		$340,000	3	36
Headworks Improvements	WWTP-004	$514,000												$514,000	3	36
Dissolved Air Floatation Equipment Rehabilitation	WWTP-016											$268,000		$268,000	3	36
Digesters Cleaning	WWTP-017	$180,000											$180,000	$360,000	3	36
Sludge Cake Conveyor Replacement	WWTP-020												$177,000	$177,000	3	36
Sludge Dewatering Improvements - BFP Replacement	WWTP-021												$845,000	$845,000	3	36
Ongoing Condition Assessment	WWTP-051						$55,000					$55,000	$110,000	$220,000	3	36
Cover and Aeration Valves Replacement at Aeration Basins	WWTP-008											$210,000		$210,000	3	32
Primary Clarifiers Cross Collectors Replacement	WWTP-007											$547,000		$547,000	3	18
Scum Collector Replacement of RBC Clarifier 3	WWTP-011											$91,000		$91,000	2	36
Chemical Storage Tanks Replacement	WWTP-015											$86,000		$86,000	2	32
Feasibility Study of Accepting High Strength Waste	WWTP-035		$130,000	$130,000										$260,000	2	24
Plant Site Civil Improvements	WWTP-033				$168,000									$168,000	2	16
Secondary Clarifier Mechanism Coating	WWTP-010				$357,000									$357,000	2	12
WWTP Annual Repair and Replacement [3]																
Estimated Total		$2,367,000	$2,061,000	$1,958,000	$3,428,000	$6,278,000	$2,324,000	$2,339,000	$2,531,000	$2,748,000	$2,873,000	$1,597,000	$1,312,000	$31,816,000		

[1] Condition rating (1 & 2 green, 3 yellow, 4 & 5 red). Risk of failure (0-40 green, 41-59 yellow, 60-100 red).
[2] Proposed projects are loosely presented chronologically to distribute costs over time in keeping with each project's criticality or other City priorities, but final project inclusion in the CIP and associated dates are approximate and adjustable.
[3] See repair and replacement discussion below.

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Table 12-2 Proposed Wastewater Collection System CIP Projects [1]

Proposed Project Name	Proposed Project #	Proposed Timeline [2]												Estimated Total	Project Condition Rating Range (1-5)	Risk of Failure Range (0-100)
		20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	2031-2040			
Park Road Forcemain	WWC-023	$530,000	$2,259,000											$2,789,000	5	100
Elane Way	WWC-004			$442,000										$442,000	4	80
181 East K Street	WWC-001			$390,000										$390,000	4	80
Bayshore Road	WWC-019				$613,000	$2,609,000								$3,222,000	4	64
E Channel Road Sewer Replacement	WWC-016						$569,000	$2,425,000						$2,994,000	4	64
Jackson Street	WWC-007				$798,000									$798,000	4	64
Polk Street	WWC-008						$487,000							$487,000	4	64
El Bonito Way - Forcemain	WWC-002						$395,000							$395,000	4	64
Clocktower	WWC-014											$82,000	$351,000	$433,000	4	32
Rose Drive/London Circle	WWC-018								$685,000	$2,252,000				$2,937,000	3	48
I-780 Crossing @ W 7th St	WWC-017								$1,072,000					$1,072,000	3	48
E 3rd St/E S St	WWC-015										$730,000			$730,000	3	48
Chelsea Hills Sewer Rehab	WWC-011										$511,000			$511,000	3	48
E 7th Street	WWC-020										$274,000			$274,000	3	48
Hillcrest Avenue	WWC-003											$227,000	$967,000	$1,194,000	3	36
255 E O St & Wingfield Wy	WWC-005												$416,000	$416,000	3	36
El Bonito Way - Gravity	WWC-022												$384,000	$384,000	3	36
375 Military East	WWC-013												$300,000	$300,000	3	36
500 E H St	WWC-006												$273,000	$273,000	3	36
Ongoing Condition Assessment of the Collection System	WWC-024						$55,000					$55,000	$110,000	$220,000	3	36
200 Block E L Street	WWC-009												$399,000	$399,000	3	24
300 Block E L Street	WWC-010												$328,000	$328,000	3	24
W 2nd Street/Military West	WWC-012												$132,000	$132,000	3	24
W H Street	WWC-021												$172,000	$172,000	2	32
Collection System Annual Repair and Replacement [3]																
Estimated Total		$530,000	$2,259,000	$832,000	$1,411,000	$2,609,000	$1,506,000	$2,425,000	$1,757,000	$2,252,000	$1,515,000	$364,000	$3,832,000	$21,292,000		

[1] Condition rating (1 & 2 green, 3 yellow, 4 & 5 red). Risk of failure (0-40 green, 41-59 yellow, 60-100 red).
[2] Proposed projects are loosely presented chronologically to distribute costs over time in keeping with each project's criticality or other City priorities, but final project inclusion in the CIP and associated dates are approximate and adjustable.
[3] See repair and replacement discussion below.

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Table 12-3 Proposed Wastewater Lift Stations CIP Projects [1]

Proposed Project Name	Proposed Project #	Proposed Timeline [2]												Estimated Total	Project Condition Rating Range (1-5)	Risk of Failure Range (0-100)
		20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	2031-2040			
Lift Stations I/I Studies	LS-005		$330,000	$600,000										$930,000	N/A	N/A
Lift Stations Electrical Improvements	LS-001		$370,000	$1,574,000										$1,944,000	5	80
Lift Station Improvements	LS-004		$172,000	$733,000										$905,000	5	60
Barn & Park Lift Station Improvements	LS-002		$267,000	$1,136,000										$1,403,000	4	64
E 7th Street & B St Lift Station Improvements	LS-003	$189,000	$806,000											$995,000	4	64
Ongoing Condition Assessment of the Sewer Lift Stations	LS-006						55000					$55,000	$110,000	$220,000	3	36
Wastewater Lift Station Annual Repair and Replacement [3]																
Estimated Total		$189,000	$1,945,000	$4,043,000	$0	$0	$55,000	$0	$0	$0	$0	$55,000	$110,000	$6,397,000		

[1] Condition rating (1 & 2 green, 3 yellow, 4 & 5 red). Risk of failure (0-40 green, 41-59 yellow, 60-100 red).
[2] Proposed projects are loosely presented chronologically to distribute costs over time in keeping with each project's criticality or other City priorities, but final project inclusion in the CIP and associated dates are approximate and adjustable.
[3] See repair and replacement discussion below.

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Table 12-4 All Proposed Wastewater CIP Project Budgets

CIP Project Category	Proposed Timeline [1]												Estimated Total
	20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	2031-2040	
WWTP	$2,367,000	$2,061,000	$1,958,000	$3,428,000	$6,278,000	$2,324,000	$2,339,000	$2,531,000	$2,748,000	$2,873,000	$1,597,000	$1,312,000	$31,816,000
Collection System	$530,000	$2,259,000	$832,000	$1,411,000	$2,609,000	$1,506,000	$2,425,000	$1,757,000	$2,252,000	$1,515,000	$364,000	$3,832,000	$21,292,000
Lift Stations	$189,000	$1,945,000	$4,043,000	$0	$0	$55,000	$0	$0	$0	$0	$55,000	$110,000	$6,397,000
Estimated Wastewater Total	$3,086,000	$6,265,000	$6,833,000	$4,839,000	$8,887,000	$3,885,000	$4,764,000	$4,288,000	$5,000,000	$4,388,000	$2,016,000	$5,254,000	$59,505,000

[1] Proposed projects are loosely presented chronologically to distribute costs over time in keeping with each project's criticality or other City priorities, but final project inclusion in the CIP and associated dates are approximate and adjustable.

Table 12-5 Proposed Wastewater Treatment Plant Contingent CIP Projects

Proposed Project Name	Proposed Project Description	Proposed Project #	Contingent Upon:	Estimated Cost
Effluent Pumps Replacement Project	Energy efficiency study for the effluent pump station to evaluate if new more efficient pumps are justified. If justified, replace the effluent pumps with more efficient pumps.	WWTP-012	Recommendation of the Energy Audit Study	$393,000
Yard Piping Replacement	Replace	WWTP-032	Results of yard pipes inspection	$2,758,000
Secondary Treatment Upgrade	This project includes converting the existing activated sludge plant into Membrane Bioreactor	WWTP-034	Regional Board Permit	$38,789,000 [1]
Co-Processing of SSO and Energy Production	This project includes accepting source separated organics and utilizing methane gas produced to produce energy	WWTP-036	SSO and Energy Generation Refin. Study	$21,358,000 [1]
IPR Treatment System	The advanced water treatment will include chemical addition for phosphate removal, tertiary membrane bioreactor, reverse osmosis, and an ultraviolet advanced oxidation process. Costs include required pumps, blowers, storage, and other appurtenances. Repurpose the two unused RBC Clarifiers as Tertiary Membrane Bioreactor tanks.	SUS-001	IPR Feasibility Study	$30,719,000 [1]
IPR Conveyance System	The IPR conveyance system includes a pump station at the WWTP and ~23,790 linear feet of 14-inch pipeline.	SUS-002	IPR Feasibility Study	$13,217,000 [1]

[1] This is a high-level estimate; a feasibility study is required to confirm project parameters and planning budgets.

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REPAIR AND REPLACEMENT

Repair and replacement (R&R) budgets support reserve funds for City utilities as they require rehabilitation or replacement at or near the end of their useful lives. These funds typically support significant improvements beyond routine operation and maintenance (O&M) provided during the useful life of an asset, and the boundary between O&M and R&R funds varies by agency. For example, a lift station pump replacement is an O&M funded improvement for the City of Benicia, but another City may consider that an R&R project. Alternatively, the value of the equipment may tip it from an O&M project to an R&R Project. For example, a $5,000 lift station pump may be an O&M project, but a $50,000 RAS pump improvement may be considered an R&R project.

The funds collected for R&R reserves vary significantly by agency. The City of Benicia has a policy to collect annually 3% of the utilities replacement value to support its ultimate rehabilitation or replacement. Other cities only collect a nominal amount that is not tied to the asset value and others target a specific dollar value in reserve. Many R&R budgets do not support complete utility replacement at the end of its useful life. Instead, reserves are adequate for some rehabilitation or replacement, but not for the whole utility. For the larger asset projects, it's common that new outside funding sources have to be identified specific to that project, such as loans or municipal bonds (see TM 11), which require rate adjustments at that time to cover the new funding source and debt service.

For most cities, wastewater infrastructure is among their most valuable assets. In the case of Benicia, the total wastewater asset value is estimated at near $660 million. See **Table 12-6**. Also presented in this table is the value of the City's 3% annual reserve towards these assets and the totals of the CIP projects identified in this TM. The CIP projects substantially go towards supporting infrastructure service in perpetuity and therefore directly contribute towards R&R. The term "substantially" is included here because the CIP does include new projects to improve reliability, redundancy and resiliency, but most of the CIP is related to maintaining the useful condition (repair or replacement) of existing assets. The difference between the City's 3% R&R reserve target and the proposed CIP projects is also presented as the R&R balance that the City may still need to collect. It would not be proposed to collect both the 3% R&R budget and the proposed CIP costs.

Table 12-6 Wastewater Asset Values, 3% Annual Reserves, and R&R Balance

Wastewater Infrastructure Area	Approximate Replacement Value [1]	City 3% Annual R&R Policy	CIP Average Expenditure	R&R Balance
Wastewater Collection System	$470,000,000	$14,000,000	$1,100,000	$13,000,000
Wastewater Lift Stations	$46,000,000	$1,400,000	$320,000	$1,100,000
Wastewater Treatment Plant	$140,000,000	$4,200,000	$1,600,000	$2,600,000
Total (Rounded)	**$660,000,000**	**$20,000,000**	**$3,000,000**	**$17,000,000**

[1] Replacement values are very approximate (+/- 50%) and include construction and soft costs (planning, design, environmental clearance and permitting, construction, start-up, contingency, engineering during construction, construction management and inspection). Land, easement and right of way costs are not included.

The City 3% annual reserve effectively collects 100% of the asset's value in just over 33 years, e.g. 3% per year times 33.3 years = 100%. Thirty-three years is less than the expected useful life of many of the City's wastewater assets. For example, many pipelines can be expected to have a useful life

approaching 75 years and many structures can be expected to have a useful life of approximately 50 years. These useful life terms can vary with the level of conservatism desired in City fiscal planning, but in general they have a longer useful life than 33 years. Of course, these useful life estimates are based on an industry standard of care provided as part of routine maintenance; neglect would reduce useful life projections. Also, components of every asset include elements that have shorter useful lives. For example, a lift station wet well may have a useful life of 50 years, but the pump equipment within the station only 25 years. This could mean that the pump has to be rehabilitated or replaced more frequently which may fall into the O&M funded category and the wet well itself can be included in the R&R funded category. (The approximate replacement values listed in **Table 12-8** include all components of the facility, which could allow for refinement related to the total costs that's covered through R&R reserves and the costs covered by O&M funds. That level of refinement is not discerned here, and the total costs is shown borne by R&R.)

If longer asset life spans are considered, less reserve needs to be collected each year to get to the total 100% replacement budget at the end of a useful life. See **Table 12-7.** This table reflects extended life spans and associated reduced R&R budget needed each year. **Table 12-8** is a repeat of **Table 12-6** with the alternative annual R&R reserve percentages from **Table 12-7**. It can be seen in **Table 12-8** that the R&R balance is significantly less with the extended useful life annual R&R percentages than with the City policy of 3% annually.

Table 12-7 Wastewater Asset Values, Useful Life and Alternative Annual Reserve Percentages

Wastewater Infrastructure Area	Primary Asset Useful Life (years) [1]	Alternative Annual R&R Reserve
Wastewater Collection System	75	1.3%
Wastewater Lift Stations	50	2%
Wastewater Treatment Plant	50	2%

[1] Useful life is for primary structure and pipeline infrastructure, excluding mechanical equipment and electrical gear and instrumentation.

Table 12-8 Wastewater Asset Values, Extended Useful Lives, Annual Reserve and R&R Balance

Wastewater Infrastructure Area	Approximate Replacement Value [1]	Alternative Annual R&R Reserve [2]	CIP Average Expenditure	R&R Balance
Wastewater Collection System	$470,000,000	$6,300,000	$1,100,000	$5,200,000
Wastewater Lift Stations	$46,000,000	$920,000	$320,000	$600,000
Wastewater Treatment Plant	$140,000,000	$2,800,000	$1,600,000	$1,200,000
Total (Rounded)	**$660,000,000**	**$10,000,000**	**$2,800,000**	**$7,000,000**

[1] Replacement values are very approximate (+/- 50%) and include construction and soft costs (planning, design, environmental clearance and permitting, construction, start-up, contingency, engineering during construction, construction management and inspection). Land, easement and right of way costs are not included.
[2] Reserves calculated using the percentages presented in Table 12-7.

This Repair and Replacement section is included with this CIP TM to support the City's rate process, which will have to assess and include the appropriate reserves to include for R&R in addition to supporting O&M and CIP costs.

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