Delta Diablo Resource Recovery Facility 2022 Master Plan

Executive Summary

Project Overview and Scope

Delta Diablo (District) is a California special district that provides wastewater collection, conveyance, and treatment as well as recycled water services for customers in the cities of Antioch and Pittsburg, and the unincorporated community of Bay Point. Treatment facilities include the Wastewater Treatment Plant (WWTP; permitted average dry weather flow [ADWF] capacity of 19.5 million gallons per day [mgd]) and Recycled Water Facility (RWF; permitted capacity of 12.8 mgd), collectively referred to as the Wastewater Resource Recovery Facility (WRRF).

The District has been recognized as a **"Utility of the Future Today"** by the Water Environment Federation, the National Association of Clean Water Agencies, the Water Research Foundation, and the WateReuse Association, with the support of the Environmental Protection Agency and the Department of Energy. The recognition was earned because of the District's historical and continued focus on wastewater resource recovery in the areas of:

- Biosolids Reuse – Beneficial reuse of 100% (13,000 wet tons per month) of biosolids as fertilizer from 2018 to 2021.
- Recycled Water – Production of an average of 6 mgd (50% of influent flow) on an annual average basis.
- Energy – Generation of 54% (443 kilowatts [kW]) of the WWTP's energy demand from renewable biogas.

The District commissioned the 2022 Resource Recovery Facility Master Plan (2022 Master Plan) to:

- Guide development of a prioritized, long-term capital improvement program (CIP) that meets infrastructure needs, addresses regulatory drivers, and maintains operational effectiveness and reliability.
- Support development of the District's Asset Management Program by integrating condition assessment data from the WRRF.
- Develop a strategic, technical, and financial approach to meet future nutrient removal regulatory requirements.
- Identify and mitigate potential treatment process vulnerabilities and identify opportunities to improve process monitoring, control, and optimization.
- Develop a framework to support resource recovery, including recycled water, biosolids, biogas, and renewable energy use through identification of applicable innovative approaches, technologies, and best practices in use at peer wastewater and resource recovery agencies. This framework is intended to inform future planning efforts by the District.
- Guide the development of future capital project design assumptions by updating wastewater flow and load projections.
- Ensure that planning outcomes align with the District's Strategic Plan (2021).

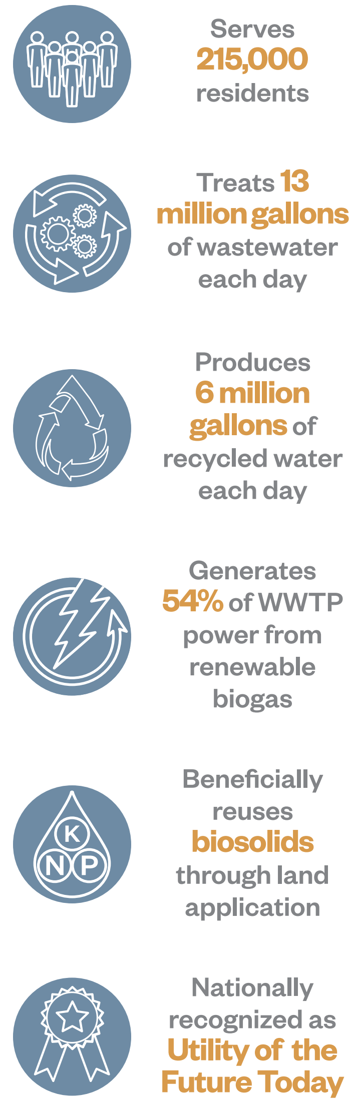


Figure ES-1. Delta Diablo at a Glance

Project Approach and Deliverables

The 2022 Master Plan considered a 20-year planning horizon (2020 to 2040). Work was performed over 10 tasks as summarized in Table ES-1. Key findings from these efforts are consolidated into six focus areas. To facilitate translation of key findings and roadmaps to actionable projects, the 2022 Master Plan includes a combination of written, graphical, and digital deliverables described in Table ES-2.

Table ES-1. 2022 Master Plan Tasks

Focus Area	Description	Applicable Tasks	Location of Detailed Documentation
1. Planning Horizon and Regulatory Outlook	This focus area addresses flow and load projections and identifies key planning triggers that may result from regulatory action. Outcomes and key findings represent the consolidation of efforts across the different focus areas and tasks.	• Task 10 - Flows and Loads • Task 3/5 - Biogas and Renewable Energy Management • Task 4 - Nutrient Management	› 2022 Master Plan Report Section 3 › Appendix 1 - Flows and Loads
2. Infrastructure Renewal and Regulatory Compliance Vulnerability	This focus area addresses asset renewal priorities due to aging infrastructure (e.g., tower trickling filters). The planning team, in consultation with the District, identified projects needed to address capacity, operational effectiveness, and reliability. As part of this focus area, the planning team and District prioritized newly identified projects into the 5-year CIP, while also helping to establish the relative priority between investing in linear versus vertical assets.	• Task 2 - Condition Assessment • Task 7 - Vulnerability Assessment, Process Control Monitoring, and Optimization • Task 12 - Outfall Hydraulics	› 2022 Master Plan Report Section 5 › Appendix 2 - Condition Assessment and Risk Analysis Methodology › Appendix 3 - Vulnerability Assessment and Process Control, Monitoring, and Optimization › Appendix 7 - Outfall Capacity Analysis
3. Nutrient Management and Advanced Treatment	This task focuses on developing a strategic, technical, and financial approach to meet future nutrient removal regulatory requirements, as well as other advanced treatment needs. As part of this work, coordination was performed across focus areas related to biosolids, biogas, renewable energy, infrastructure renewal, compliance vulnerability, and land use planning.	• Task 4 - Nutrient Management • Task 3/5 - Biogas and Renewable Energy Management • Task 7 - Vulnerability Assessment, Process Control Monitoring, and Optimization • Task 10 - Flows and Loads • Task 11 - Land Use Planning	› 2022 Master Plan Report Section 6 › Appendix 4 - Nutrient Management Analysis
4. Biosolids, Biogas and Renewable Energy	This focus area addresses biosolids treatment capacity while identifying applicable innovative approaches the District can use to achieve current and future resource recovery goals. Coordination was performed between focus areas related to nutrients, advanced treatment, infrastructure renewal, compliance vulnerability, and land use planning.	• Task 3/5 - Biogas and Renewable Energy Management • Task 6 - Biosolids Management • Task 4 - Nutrient Management • Task 7 - Vulnerability Assessment, Process Control Monitoring, and Optimization • Task 10 - Flows and Loads • Task 11 - Land Use Planning	› 2022 Master Plan Report Section 7 › Appendix 5 - Biosolids and Renewable Energy Management

Focus Area	Description	Applicable Tasks	Location of Detailed Documentation
5. Recycled Water Management	This focus area is intended to guide strategic decision-making efforts regarding long-term RWF operation and near-term capital investments by evaluating options for adding new customers and/or increasing recycled water usage and conducting a high-level review of the RWF to evaluate costs related to increased water quality requirements. Coordination was performed between focus areas related to nutrients, advanced treatment, infrastructure renewal, compliance vulnerability, and outfall hydraulics.	• Task 7 - Vulnerability Assessment, Process Control Monitoring, and Optimization • Task 8 - Recycled Water Management • Task 12 - Outfall Hydraulics	› 2022 Master Plan Report Section 8 › Appendix 6 - Recycled Water Management
6. Energy Management and Support Services	This focus area is intended to support the District's efforts to develop an Energy Management Program Guidance Document (EMPGD) outlining specific tasks and procedures to further develop the District's existing energy management program.	• Task 7 - Vulnerability Assessment, Process Control Monitoring, and Optimization • Task 9 - Energy Management	› 2022 Master Plan Report Section 9 › Appendix 8 - Energy Management

Table ES-2. 2022 Master Plan Deliverables

Deliverables	Description
Master Plan	This document provides a detailed description of project context, project approach, and key outcomes for the tasks and focus areas. The document consists of an executive summary, master plan report, and appendices. This document also includes land use planning maps that incorporate considerations from Roadmaps and the Implementation Plan.
Roadmaps	These documents provide an overarching framework of triggers and potential paths for navigating focus areas related to nutrients, biosolids, bioenergy, and biogas optimization.
Implementation Plan	This document, included in the Master Plan and the Capital Planning Tool, provides a graphical summary of projects, associated studies, and triggers as a quick reference for the key outcomes of the 2022 Master Plan.
5-Year CIP Geographic Information System (GIS) StoryMap	This digital tool provides interactive maps and text to communicate the prioritized 5-year CIP program for the WRRF.
Capital Planning Tool	This digital dashboard provides a summary of all projects identified for the planning horizon (2040) and allows the District to visualize how modifications to the selected implementation plans impact long-term financial investments.
Energy Balance Analysis Tool (EBAT)	This digital tool models the complex relationship between energy production, energy demands, and energy costs to provide accurate long term cost/benefit assessments for digester gas utilization alternatives, such as combined heat and power, vehicle fueling, and pipeline injection.
Key Outcomes from Focus Areas	This section provides a concise summary of key findings from the 2022 Master Plan organized by focus area. This summary identifies opportunities for District coordination across multiple focus areas and additional studies that are recommended for implementation.

1 PLANNING HORIZON AND REGULATORY OUTLOOK

BACKGROUND

The 2022 Master Plan considered a 20-year planning horizon (2020 to 2040) and includes consideration of flow and load projections, as well as key planning triggers that may result from regulatory action.

As the District contemplates the future, continuing evolution of federal, state, and local regulations may require changes at the WRRF to address nutrients, biosolids end use, and emerging contaminants (e.g., per and polyfluoroalkyl substances [PFAS]). Further, continued trends toward urbanization and changes to water use behavior are expected to impact flows and loads that need to be treated at the WWTP.

The two primary regulatory agencies with purview over District operations are the San Francisco Bay Regional Water Quality Control Board (Regional Water Board) for water quality and the Bay Area Air Quality Management District (BAAQMD) for air quality. Both agencies have also emphasized climate change, resiliency, and environmental justice as regulatory priorities.

Historical population data was obtained from the Department of Finance (DoF). Projected population increases were assessed based on local population projections by the Association for Bay Area Governments (ABAG) and linear extrapolation of historical DoF population data. Special considerations for development of the Master Plan approach included converting job growth to population equivalents and accounting for industrial flows and loads in benchmarking and projection analyses.

PLANNING IMPLICATIONS FOR DISTRICT

In recent years, drought conditions have spurred conservation efforts in the region which have reduced water consumption in the District's service area. As a result, influent flows to the WWTP have decreased since 2008, while population has continued to increase resulting in a more than 30% increase in biochemical oxygen demand (BOD) concentration. Correspondingly, concentrations and loads to the WWTP have continued to increase. With the Department of Water Resources (DWR) recommending lowering the water use efficiency standard from 52.5 gpd/person to 47 gpd/person by 2025, concentrations will continue to increase. The projections in the 2022 Master Plan account for recent and future conservation trends.

Water conservation efforts will continue to decouple flow and load growth at the WWTP. **Figure ES-2** and **Figure ES-3** show the historical and projected plant flow and BOD loads, respectively. For projections, a flow per capita was developed from the most recent years and coupled with various population estimates. BOD loads were projected using a similar methodology.

The impact of water conservation continues to be evident as influent flow is projected to grow from 12.8 mgd in 2020 to between 16.0 and 18.4 mgd by 2040. BOD load is projected to grow from 40,000 lb/day in 2020 to between 52,000 and 58,000 lb/day by 2040, a 30 to 45% increase.

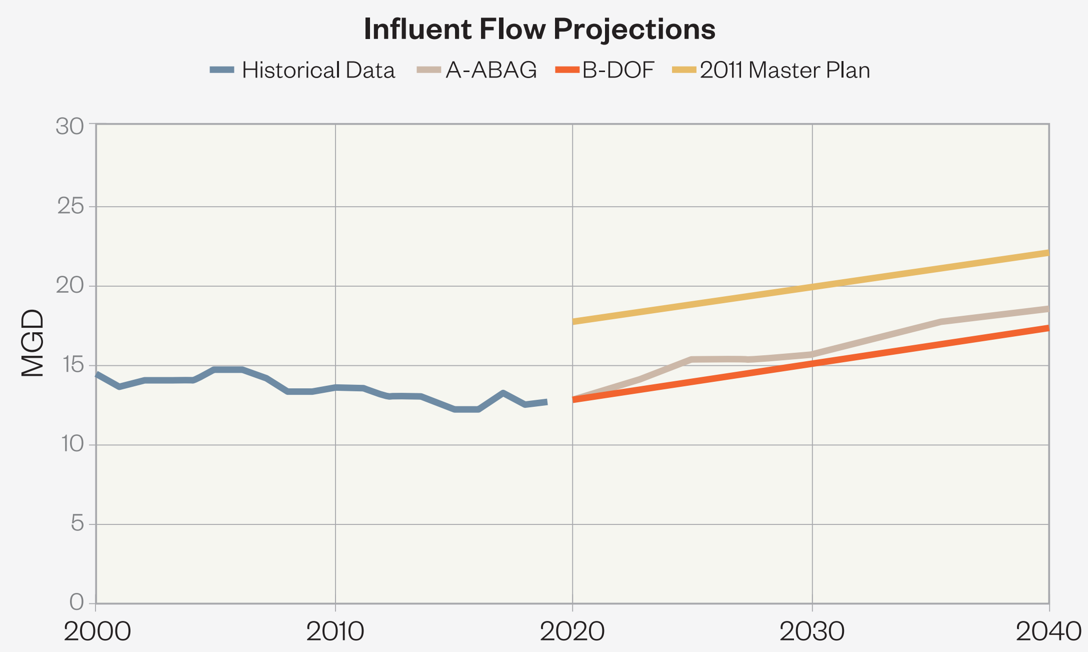


Figure ES-2 Influent Flow Projections

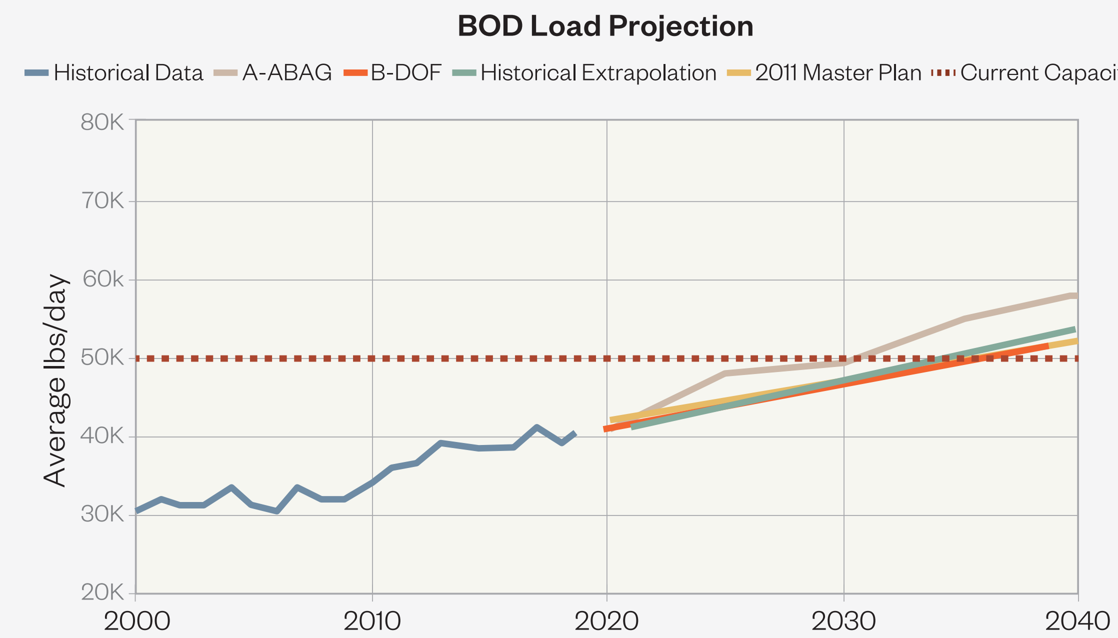


Figure ES-3 Influent BOD Load Projections

When designing and implementing future projects and studies, it is recommended that the District track both flows and loads using an equivalent flow/load concept to understand treatment needs at the WWTP. The equivalent flow concept involves:

- Maintaining the peak wet weather flow capacity of the plant (i.e., 31.1 mgd).
- Identifying the flow and/or load thresholds that limit capacity at each unit process at the WWTP.
- Calculating the equivalent average dry weather flow corresponding to the load.

The following table demonstrates how the equivalent flow concept corresponds to the WWTP's flow and load capacity.

Table ES-3 Equivalent Flow Concept

	Equivalent Average Dry Weather Flow Capacity mgd	Average BOD Annual Concentration mg/L	Average Annual BOD load lb/day
2040 Eq. Flow using 2022 Master Plan concentrations	18.3	376	57,462
2040 Eq. Flow using 2014 Capacity Assessment concentrations	22.5	305	57,462
2040 Eq. Flow using 2011 Master Plan concentrations	24.6	280	57,462

**The WWTP has a permitted average dry weather flow capacity of 19.5 mgd*

FOCUS AREA 1 PLANNING HORIZON AND REGULATORY OUTLOOK

The WWTP hydraulic flow capacity is not anticipated to be reached in the 20-year planning horizon (2040). However, BOD treatment capacity (53,200 lb/day) is projected to be exceeded between 2030 and 2037, which necessitates expansion of the WWTP. The District's discharge permit requires that planning for expansion begin when the plant is at 80% of its capacity. It should be noted that the tower trickling filters have a limitation of 200 lb BOD/1000 cf media or 46,100 lbs/day of BOD, less than the total secondary system capacity. The BOD treatment capacity limitation is corroborated by findings from the 2011 Master Plan Study and 2014 WWTP Capacity Assessment Update Study.

Evolution of nutrient regulations is anticipated in the planning horizon. The District's nutrient management strategy should continue to support:

- Monitoring of nutrients at the WWTP.
- Funding nutrient research applicable to District objectives.
- Supporting load response modeling.
- Evaluating the benefits of recycled water and natural systems.
- Establishment of nutrient trading program.
- Planning for flexible trigger-based treatment upgrades at the WWTP.

Beyond nutrients, liquids and solids treatment at the WWTP may be impacted by rapid evolution of federal and state requirements related to:

- Climate change and sea level rise.
  - Climate studies may be required as part of permit renewals and funding opportunities.
- Emerging contaminants such as PFAS, microplastics, etc.
  - The State Water Resources Control Board (SWRCB) issued order WQ 2020-0015-DWQ on July 9, 2020 that requires monitoring of PFAS at WWTPs with a capacity greater than 1 mgd.
  - The Regional Water Board and the San Francisco Estuary Institute (SFEI) have developed a strategy for tracking and monitoring for contaminants of emerging concern (CECs).
- Local landfill diversion of organics, including biosolids.
  - Senate Bill 1383 (SB 1383) requires 50% diversion of organics from landfills by 2020 and 75% diversion by 2025 relative to 2014 levels on a statewide basis.
  - Beginning in 2020, use of biosolids as alternative daily cover no longer qualifies as beneficial reuse.
- Water reuse.
- Air and greenhouse gas emissions.

CIP PROJECTS

Projects incorporated into the CIP stemming from increasing flows and loads include:

- ***Secondary Process Improvements Project*** will position the District to treat 2040 design flows and loads. These recommended improvements will allow the District to continue to meet secondary design standards as the tower trickling filters approach the end of their useful life, while also positioning for potential nutrient removal requirements. Note that with this project the tower trickling filters are not required to meet secondary design standards, but may be left in service to provide additional process capacity buffer.
  - One new 1.2-MG aeration basin with 25-ft sidewater depth (3.1 MG of total new and existing volume).
  - Retrofit existing aeration basin volume with anaerobic selectors.
  - One new 90-ft diameter secondary clarifier with 15-ft sidewater depth (6 total).
  - One new 300-hp turbo blower to provide 7,000 sfcm (3 total duty turbo blowers providing 21,000 scfm firm capacity) and blower room.
  - Tower tricking filter pump station rehabilitation.
  - New aeration basin influent distribution.

- ***Construct a New Anaerobic Digester*** to accommodate increasing BOD load to the WWTP and evolving treatment approaches in the liquid stream.
  - This project is triggered by increasing BOD load and decommissioning of the tower trickling filters.
  - Construct one new 1.1-MG digester (4.4 MG of total new and existing digester volume) to provide additional digester capacity within the next 10 to 15 years.

Projects incorporated into the CIP stemming from regulatory drivers:

- ***Sidestream treatment*** can be implemented if early adoption is pursued prior to regulations to limit nitrogen discharges. Sidestream treatment will remove 10 to 15% of the total nitrogen load at the WWTP and is compatible with the project to increase carbon capacity. Sidestream treatment will continue to provide a factor of safety if nutrient limitations (e.g., load cap) are imposed in the future and anaerobic digestion is maintained.

- ***If nutrient load caps*** are imposed, the District can achieve limits (1,700 kg/d TIN or 24 mg/L TIN for 2040 influent flows and loads) by implementing a flexible BNR strategy. A placeholder solution that builds upon the Secondary Process Improvements Project was developed as follows:*
  - Demolish the tower trickling filters by treating 100% of flow in aeration basins.
  - Construct new secondary treatment infrastructure.
    - 3.9 MG (3 basins at 1.3 MG each and 25-ft sidewater depth) of new aeration basin volume (5.1 MG of total aeration basin volume).
    - Retire existing shallow aeration basins (1.9 MG).
    - New mixed liquor distribution channels.
    - One new 90-ft secondary clarifier with 15-ft sidewater depth (7 total).
    - One new 300-hp turbo blower to provide 7,000 sfcm (4 total turbo blowers providing 28,000 scfm)
    - Intensification has the potential to reduce capital and operating costs. *

Additional phosphorus control can be achieved in the load cap configuration by leveraging anaerobic selectors to perform biological phosphorus removal, as well as addition of metal salts for chemical precipitation.

- ***If Nutrient Watershed Permit (WSP) Level 2*** standards are imposed, the District can achieve limits by implementing the flexible BNR placeholder solution with the additional components as follows:*
  - 2.6 MG (2 basins at 1.3 MG each with 25-ft sidewater depth) of new aeration basin volume (7.7 of MG total aeration basin volume).

- ***If WSP Level 3*** standards are imposed, the District can achieve limits by implementing the flexible BNR placeholder solution at the WWTP as follows.*
  - One new 1.7 MG aeration basin with 25-ft sidewater depth (9.4 MG of total aeration basin volume) of aeration basins using the flexible BNR placeholder solution.

***Intensification**
Intensification can have significant benefits to the upgrade scenarios by reducing both capital and operating costs. Options were explored during the master planning process and the potential for these technologies was incorporated into the nutrient removal trigger-based roadmap (see 2022 Master Plan Report for further discussion). It is recommended that the District pilot these technologies prior to full-scale implementation.

RECOMMENDED DISTRICT STUDIES

- ✓ Participation in regional or national studies related to PFAS source reduction and treatability.
- ✓ Climate Change/Resiliency Plan (analysis of and mitigation measures for impacts of climate change such as sea level rise, groundwater level rise, changes in weather patterns, and wildfires).

FOCUS AREA 2 INFRASTRUCTURE RENEWAL AND REGULATORY COMPLIANCE VULNERABILITY

BACKGROUND

As part of the 2021 Strategic Plan, **the District set infrastructure investment goals to ensure the long-term effectiveness and reliability of critical infrastructure** through prioritized, cost-effective investment and maintenance. Additionally, the District identified environmental stewardship goals to meet or surpass environmental and public health requirements to maintain public trust.

To achieve these goals, the District is developing a formalized Asset Management Program and performing condition assessments of linear assets within the conveyance and collection system (Delta Diablo Facility Condition Assessment Final Report, by Kennedy Jenks in 2020). To continue to support the District's infrastructure and environmental stewardship goals, the 2022 Master Plan included a focused condition assessment of vertical assets at the WWTP with a specific District-directed focus on areas related to the tower trickling filters, cogeneration engine, and buried utilities.

In addition, a vulnerability assessment of three main processes at the WWTP was performed. This assessment focused on secondary treatment (including a detailed look at the tower trickling filters), anaerobic digestion, disinfection, and an evaluation of the hydraulic capacity of the plant outfall.

Information from the condition and vulnerability assessments were used to inform development and prioritization of newly-identified CIP projects. This information was also used to help establish the relative priority between investing in linear versus vertical assets.

PLANNING IMPLICATIONS FOR DISTRICT

A desktop condition assessment was conducted for the WWTP's vertical assets.

- The approach used the age of asset and expected useful life for each asset class to determine remaining useful life (RUL), which was used as an indicator of probability of failure (PoF).
- A consequence of failure (CoF) analysis was also completed for each asset. An asset-level CoF scoring guide was used with CoF criteria and weights that were previously developed as part of the District's existing asset management risk framework.

A combination of RUL and CoF scores were used to select assets on which to conduct the focused condition assessment. The findings from the focused condition assessment were used to update the PoF for the assets and the risk model was then updated.

Major findings from the condition assessment and risk analysis showed:

- Approximately 7% (26 assets) of the WWTP's assets, within the trickling filters and the secondary clarifier area, have reached the end of their useful life and present a high CoF for the WWTP. These assets have been incorporated in the CIP as part of this 2022 Master Plan.
- Approximately 14% of the WWTP's assets are estimated to require renewal within the next 10 years and have a medium to high CoF. These assets have been incorporated in the CIP as part of this 2022 Master Plan.
- Figure ES-4 shows the projected rehabilitation and renewal (R&R) funding needs for the WWTP. To attenuate the significant capital investment in 2027, high-risk and some medium-risk assets were advanced to 2023, 2024, and 2025 during the CIP project development phase.

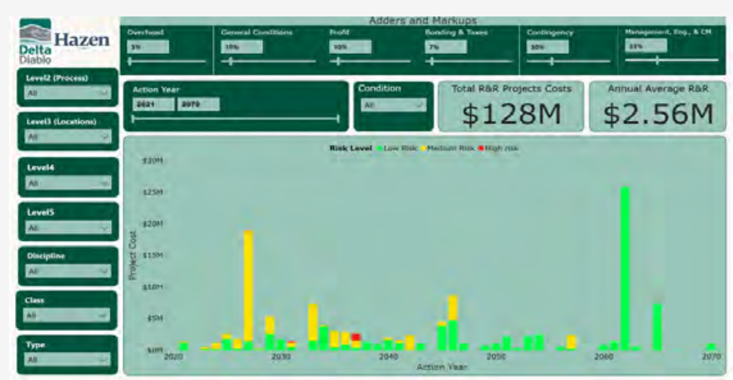


Figure ES-4 Projected 50-Year R&R Funding Needs

Major findings from the vulnerability assessments showed:

- Tower trickling filters (TTF) are approaching/at the end of their useful lives. Loss of TTF performance will reduce operational buffer and increases the risk of permit noncompliance. Investment in adequate secondary treatment capacity is necessary.
- Expansion of digester capacity was also identified as being critical to continue to serve the increasing BOD load to the WWTP and potential process changes to the liquid treatment configuration.
- Historical disinfection noncompliance events were linked to dechlorination issues due to nitrification and chemical changes by power plant recycled water customers, as well as corrosion potential from future reverse osmosis concentrate discharge.

CIP PROJECTS

Critical investment to address capacity needs are also on the planning horizon. The District will need to:

- ***Perform Secondary Process Improvements*** (i.e., additional and/or reconfigured aeration basins and secondary clarifiers) to replace the TTF's as they are beyond their useful life. These secondary process improvements should be compatible with long-term nutrient treatment needs.
  - One new 1.2-MG aeration basin with 25-ft sidewater depth (3.1 MG of total new and existing volume).
  - Retrofit existing aeration basin volume with anaerobic selectors.
  - One new 90-ft diameter secondary clarifier with 15-ft sidewater depth (6 total).
  - One new 300-hp turbo blower to provide 7,000 sfcm (3 total turbo blowers providing 21,000 scfm) and blower room.
  - TTF pump station rehabilitation.
  - New aeration basin influent distribution.
- ***Construct a New Anaerobic Digester*** to accommodate increasing BOD load to the WWTP and evolving treatment approaches in the liquid stream.
  - This project is triggered by the decommissioning of the tower trickling filters.
  - Construct one new 1.1-MG digester (4.4 MG of total new and existing digester volume) to provide additional digester capacity within the next 10 to 15 years.
- ***Clean the Outfall*** within the 2040 planning horizon.

- ***Improve Reliability and Efficiency of Treatment at the WWTP:***
  - Consider constructing an intertie to allow for the ability to treat secondary effluent at the RWF and return the flow to the WWTP for outfall discharge.
  - Install sensors in key process areas to improve process control (i.e., water quality of Calpine blowdown return stream).
  - Conduct water quality analyses in key areas to improve process control.
  - Implement improved data and energy management systems to allow for improved tracking and optimization of plant performance.
  - Incorporate best practices in process control and monitoring, as well as conduct root-cause investigations with associated preventive and corrective actions.

Projects that were identified by the risk and vulnerability analysis were bundled and incorporated into the CIP list based on discussions with the District. The 5-year CIP projects identified are listed at the right. (Note that collection system CIP projects and projects previously identified by the District are not listed here. A full CIP list can be found in Section 10 of the 2022 Master Plan Report).

Table ES- 4-Year CIP (RR and Vulnerability Projects Only)

No.	Title	Cost $K
	High Priority 12 to 24 months	
CIP-001	Secondary Process Improvements & Operational Improvements at Aeration Basins	60,000
CIP-005	CCT Analyzer Building Improvements	200
CIP-006	CCT Emergency Effluent Pump Station Replacement	450
CIP-007	CCT Sluice Gates and Chemical Mixer Improvements	1,500
CIP-008	Service Water Pumps Improvement	827
CIP-010	Dewatering Basement Polymer Equipment and Storage Area Improvements	794
CIP-012	Gravity Belt Thickeners Improvements	1,300
CIP-013	FOG Receiving Facility Improvements	50
CIP-016	WAS Pump Station Rehabilitation	50
CIP-018	Flow Equalization Basin Slide Gates Replacements	400
CIP-019	Condition Assessment of Treatment Plant Underground Piping	350
CIP-023	RAS Meter Pits and RAS Pump Station Improvements	600
CIP-025	Tower Mixing Chamber and Overflow Structure Rehabilitation	1,420
	Medium Priority 3 to 5 years	
CIP-002	Treatment Plant Structural Assessment & Rehabilitation	700
CIP-004	Improvements at Secondary Effluent Feed to RWF	150
CIP-024	Chemical Canopy Rehabilitation	750
CIP-009	Condition Assessment of Select Electrical Gear	50
CIP-014	Sanitary Drain Pump Station Improvements	600
CIP-021	Centrifuge Platform Area Improvements	3,500

RECOMMENDED DISTRICT STUDIES

- ✓ SCADA Master Plan.
- ✓ Data Management Master Plan.

FOCUS AREA 3 NUTRIENT MANAGEMENT AND ADVANCED TREATMENT

BACKGROUND

The Regional Water Board adopted the first Nutrient Watershed Permit (WSP) on April 9, 2014 in response to increased regulatory focus on the impacts of nutrient (i.e., nitrogen and phosphorus) loading on the health of San Francisco Bay. Although not currently impaired by nutrients, the resiliency of San Francisco Bay to withstand nutrient loading is uncertain. As a member of the Bay Area Clean Water Agencies (BACWA), the District continues to participate in a regional collaboration with the Regional Water Board and the scientific community to develop and implement a nutrient management strategy that uses a sound science-based approach to determine the need for future management actions.

The first Nutrient WSP required effluent monitoring to assess WWTP loading and trends, funding of scientific studies to better understand the watershed impacts, and completion of a study to evaluate treatment options at WWTPs. For the purposes of planning and estimating treatment options and costs, the following nutrient removal levels were developed for the treatment study as tabulated in Table ES-5.

ES-5 WSP Nutrient Removal Levels

Level	Ammonia	Total Nitrogen	Total Phosphorus
Level 1 (Optimization)	Varies by Facility	Varies by Facility	Varies by Facility
Level 2	2 mg N/L	15 mg N/L	1.0 mg P/L
Level 3	2 mg N/L	6 mg N/L	0.3 mg P/L

The second Nutrient WSP, adopted on May 9, 2019, required continued monitoring and reporting, additional funding of scientific studies, and implementation of studies regarding the feasibility of nutrient removal using nature-based solutions and increased recycled water production. The fact sheet of the second Nutrient WSP also outlined the Regional Water Board's intent to set load caps in the third Nutrient WSP.

Factors that will influence future District nutrient related actions are as follows:

- The results of the scientific studies that will inform the geographic and temporal requirements of nutrient reductions, if any.
- The formal adoption of load caps in the third WSP. While the second WSP fact sheet allocated a load target of 1,700 kg/day total inorganic nitrogen (TIN) based on a baseline of 1,500 kg TIN/day to the District, there is uncertainty in how and when limits will be promulgated.
- The size and number of subembayments used for monitoring and compliance. While current annual reporting on nutrient loads indicates five subembayments (of which the District is located in Suisun Bay), preliminary WSP discussions indicate that fewer subembayments will be used for compliance.

EXISTING NUTRIENT MANAGEMENT PRACTICES AT DISTRICT

The District's WWTP was not designed for nutrient removal.

Nitrogen
In 2020, influent and effluent TIN concentrations averaged 38.2 mg/L and 48.0 mg/L, respectively with an average load of 1,329 kg TIN/day discharged to the receiving water. Nitrogen removal will require modifications to the secondary biological process and/or treatment of sidestream loads generated from the solids process.

Phosphorus
In 2019, influent total phosphorus (TP) concentrations averaged 7.0 mg/L. Final effluent TP concentrations are routinely monitored twice per month. Since July 2021, effluent TP concentrations averaged 0.9 mg/L. Metal salt enriched solids from the RWF are returned to the WWTP headworks resulting in chemical phosphorus precipitation and removal. Further phosphorus control can be achieved chemically or biologically.

Beyond treatment, the District currently recycles approximately 6 mgd of the WWTP secondary effluent. Approximately 90% of the recycled water is used for cooling at two local power plants with no associated nutrient reduction; however, approximately 10% of the recycled water is used for landscape irrigation at golf courses and city parks that result in reduced nutrient loading to the receiving water.

The District facilitates beneficial recovery and reuse of 100% of the nutrients contained within the biosolids produced at the WWTP via its land application program. Sidestream nitrogen loads from the current solids processing contributes between 10 and 15% of the total nitrogen load to the WWTP.

FOCUS AREA 3

NUTRIENT MANAGEMENT AND ADVANCED TREATMENT

PLANNING IMPLICATIONS FOR THE DISTRICT

A watershed-based nutrient management approach that balances capital investment at the WWTP with regional solutions is most suitable for the District.

The District should continue to:

- Engage with regional stakeholders to develop a viable nutrient trading program.
- Support maintenance and expansion of their recycled water program to offset effluent nutrient discharge.
- Support research and development of natural and engineered systems.

If **nitrogen and additional phosphorus removal at the WWTP is required,** a trigger-based approach is recommended. A placeholder solution that provides required secondary capacity upgrades, with subsequent nutrient removal triggers was developed as follows:

- **Secondary Process Improvements Project** will position the District to treat 2040 design flows and loads to secondary standards at the WWTP with the following infrastructure. With this project the tower trickling filters (TTF) are not required to meet secondary design standards but may be left in service to provide additional process capacity buffer.
  - One new 1.2-MG aeration basin with 25-ft sidewater depth (3.1 MG of total aeration basin volume).
  - Retrofit existing aeration basin volume with anaerobic selectors.
  - One new 90-ft diameter secondary clarifier with 15-ft sidewater depth (six total).
  - One new 300-hp turbo blower to provide 7,000 sfcm (three total turbo blowers providing 21,000 scfm) and blower room.
  - TTF pump station rehabilitation.
  - New aeration basin influent distribution.
- **Sidestream treatment** can be implemented if early adoption is pursued prior to regulations to limit nitrogen discharges. Sidestream treatment will remove 10 to 15% of the total nitrogen load at the WWTP and is compatible with the project to increase carbon capacity. Sidestream treatment will continue to provide a factor of safety if nutrient limitations (e.g., load caps) are imposed in the future.
- **If nutrient load caps are imposed,** the District can achieve limits (1,700 kg/d TIN or 24 mg/L TIN for 2040 influent flows and loads) by implementing a flexible BNR strategy. A placeholder solution that builds upon the Secondary Process Improvements Project (CIP-001) was developed as follows:*
  - Demolish the TTF by treating 100% of flow in new aeration basins.
  - Construct new secondary treatment infrastructure:
    - 3.9 MG (three basins at 1.3 MG each and with 25-ft sidewater depth) of new aeration basin volume (5.1 MG of total aeration basin volume).
    - Retire existing shallow aeration basins.
    - New mixed-liquor distribution channels.
    - One new 90-ft secondary clarifier with 15-ft sidewater depth (seven total).
    - One new 300-hp turbo blower to provide 7,000 sfcm (four total turbo blowers providing 28,000 scfm).
    - Note: Intensification has the potential to reduce capital and operating costs.*

Additional **phosphorus control** can be achieved in this configuration by leveraging anaerobic selectors to perform biological phosphorus removal, as well as addition of metal salts for chemical precipitation.

- **Anaerobic Digestion**
  - This project is triggered by the decommissioning of the TTF that is a prerequisite for flexible BNR.
  - One new 1.1-MG anaerobic digester (4.4 MG of total digester volume) to increase digestion capacity.
- **If WSP Level 2** standards are imposed, the District can achieve limits by implementing the flexible BNR placeholder solution with the additional components as follows:
  - 2.6 MG (two basins at 1.3 MG each with 25-ft sidewater depth) of new aeration basin volume (7.7 MG of total aeration basin volume).
  - Intensification has the potential to reduce capital and operating costs.*
- **If WSP Level 3** standards are imposed, the District can achieve limits by adding to the WSP Level 2 configuration as follows:
  - One new 1.7-MG aeration basin with 25-ft sidewater depth (9.4 MG of total aeration basin volume).
  - Intensification has the potential to reduce capital and operating costs*

***Intensification**

Intensification can have significant benefits to the upgrade scenarios by reducing both capital and operating costs. Options were explored during the master planning process and the potential for these technologies was incorporated into the nutrient removal trigger-based roadmap (see 2022 Master Plan report for further discussion). It is recommended that the District pilot these technologies prior to full-scale implementation.

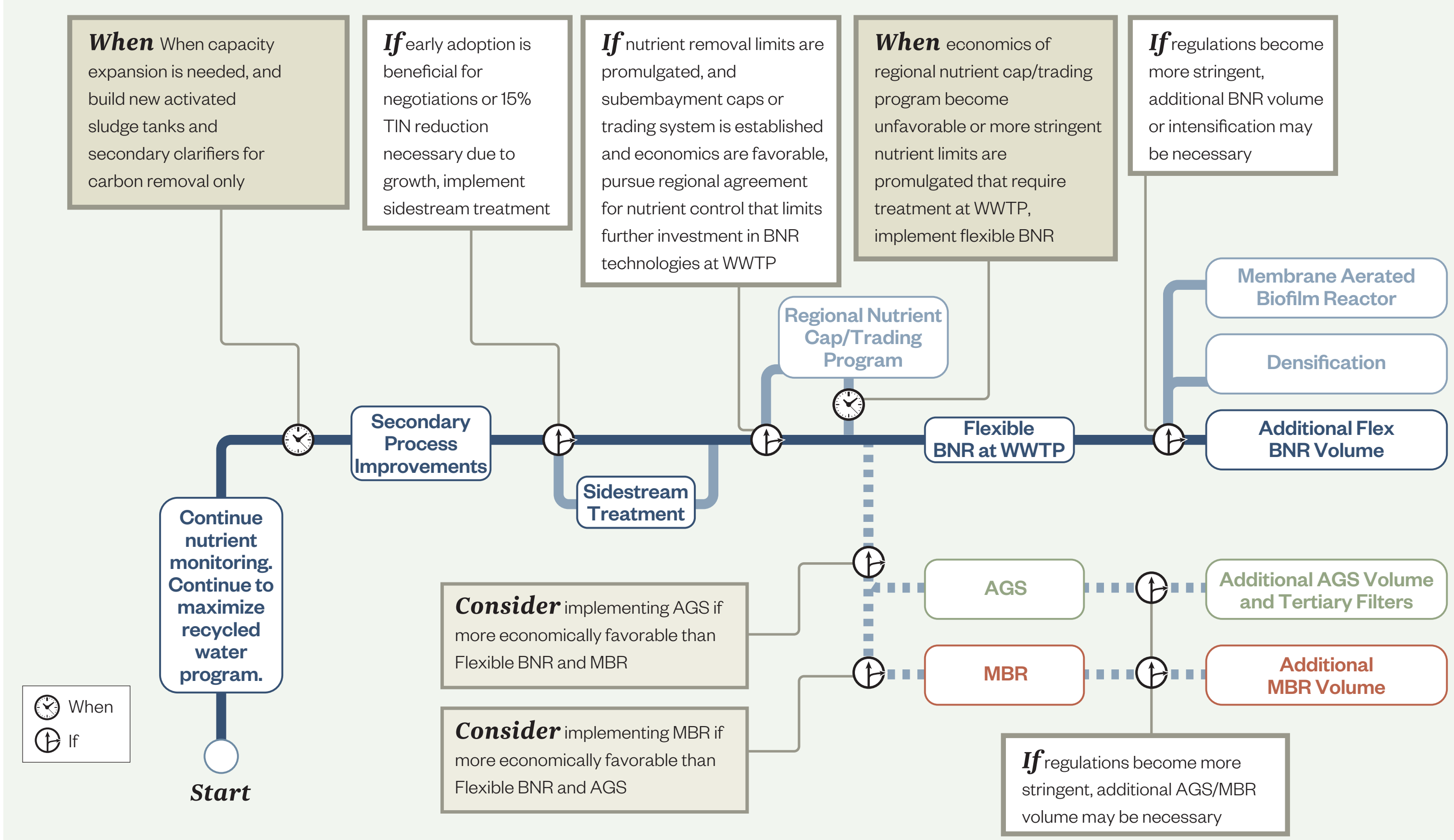
Emerging Contaminants

In addition to nutrient control, action may need to be taken to address PFAS and other emerging contaminants at the WWTP. A multi-pronged approach is recommended, which includes:

- Source control for PFAS and other emerging contaminants should be investigated.
- If treatment at WWTP is needed for effluent discharge or water reuse purposes, the District can consider granular activated carbon or ion exchange downstream of secondary clarifiers. In addition to providing control for PFAS, granular activated carbon or ion exchange can also provide some level of nitrogen and phosphorus reduction prior to effluent discharge.

NUTRIENT REMOVAL ROADMAP

The nutrient roadmap describes load and regulatory triggers that would lead to new infrastructure. Opportunities to consider intensification allow the District to reevaluate the needed process volumes.



RECOMMENDED DISTRICT STUDIES

- ✓ BNR intensification technology piloting is recommended if nutrient removal is triggered at the WWTP (e.g., densification or membrane aerated bioreactor). Information from intensification piloting can refine the flexible BNR placeholder solution described above.
- ✓ Participation in regional or national studies related to PFAS source reduction and treatability in the near-term (FY 2022). If limits appear imminent, conduct a source and treatability study to identify contributors of PFAS to the influent of the WWTP, current fate of PFAS through the existing WWTP and identify approaches for controlling PFAS at the WWTP as well as the associated impact on nutrient fate.

FOCUS AREA 4 BIOSOLIDS, BIOGAS, AND RENEWABLE ENERGY

BACKGROUND

At current influent flows (12.8 mgd) the District beneficially reuses 100% of biosolids generated at the WWTP, primarily through land application. Additionally, the District generates 54% of the WWTP's electricity demand by fueling the District's 800-kW cogeneration (cogen) engine with biogas produced from anaerobic digestion.

As part of the 2021 Strategic Plan, the District has set an environmental stewardship goal to meet or surpass environmental and public health requirements to maintain public trust. To support this goal, the District has focused on resource recovery, including the continued beneficial reuse of biosolids and maximizing energy generation by leveraging renewable biogas.

Codigestion efforts to increase biogas production include the District's fats, oil, and grease (FOG) receiving station that operated from 2015 to 2018. Efforts ended when issues with digester operation halted receiving and the hauler found an alternative receiving facility. The District also pursued a partnership with Mt. Diablo Resource Recovery (MDRR) to receive processed municipal solid waste for codigestion at the WWTP as part of the East County Bioenergy Project. The project received grant funding for planning costs and 30% design documents were produced. The project was put on hold due to favorable composting rates negotiated by MDRR in the near term.

Beginning in 2020, use of biosolids as alternative daily cover no longer qualified as beneficial reuse and instead was considered disposal for the purposes of landfill diversion. In addition, beginning in 2022, the state has a goal of diverting 50% of organics from landfill. Therefore, to continue its commitment to beneficial use of biosolids, the District continues to pursue regional solutions for biosolids management as part of the Bay Area Biosolids Coalition (BABC), which may include composting and transfer of biosolids to Lystek for further processing.

This Master Plan considered anaerobic digester capacity limitations, alternative avenues for codigestion to increase digester gas production, and advanced biosolids treatment options that may be triggered by regulatory action related to emerging contaminants (e.g., PFAS) or increased costs associated with beneficial reuse and disposal.

PLANNING IMPLICATIONS FOR DISTRICT

Digester Capacity

The District currently produces approximately 50,600 lbs/d (102 kgal/d) of sludge on an annual average (AA) basis and 56,400 lbs/d (114 kgal/d) on a maximum month (MM) basis. This sludge is digested in the existing three anaerobic digesters (1.1 MG each). With one digester offline, the District has 20 days of HRT at AA conditions and 18 days at MM conditions.

Key assumptions for the capacity analysis were confirmed with the District:

- A minimum hydraulic retention time (HRT) of 18 days with two digesters in service, one redundant digester
- A minimum HRT of 20 days with three digesters in service.

Table ES-6 Sludge Projections

		Digester Influent Annual Average		Digester Influent Maximum Month	
Year	Influent Flow	Sludge Flow (gpd)	Load (lbs/d)	Sludge Flow (gpd)	Load (lbs/d)
2030	16.3	129,800	64,000	144,600	71,300
2040	18.4	146,600	72,200	163,300	80,400

Based on the projected sludge load, existing anaerobic digestion capacity will be exceeded between 2030 and 2035 due to increasing BOD load to the WWTP and evolving treatment approaches in the liquid stream.

- Importation and codigestion of high strength waste (HSW) will further accelerate the need for capacity expansion.
- Digester capacity can be increased by construction of a **new anaerobic digester.**
  - This project is triggered by increasing loads and the decommissioning of the tower trickling filters (TTF).
  - Construct one new 1.1-MG digester (4.4 MG of total volume) to provide additional digestion capacity within the next 10 to 15 years.

High-Strength Waste

- The District can take 5,000 gpd of FOG (or HSW such as cheese whey or sugar waste with minor modifications to its existing receiving station) to increase digester gas production by 10% in the near term. However, due to the three digester capacity limitations, this practice cannot continue through the planning period.
- A detailed survey of HSW generators indicated that products like cheese whey, sugar water, and FOG are available, but tipping fees remain competitive (0.03 to 0.08 $/gal) and haulers are looking for a reliable receiving facility (i.e., not suspending receiving during maintenance periods).

Biogas Utilization

The District completed a major overhaul of the cogen engine in February of 2019, but is still experiencing challenges including unreliable controls and general maintenance downtime that is associated with operating a single engine. To support decision making regarding biogas utilization investments, an energy balance tool was used to compare biogas utilization alternatives for various levels of HSW addition (gas production).

- Expansion and/or replacement of the existing engine should be pursued if:
  - There are compatibility issues with the planned Switchgear Replacement Project.
  - The cogen system requires significant investment due to rehabilitation needs.
  - Plant loads increase, HSW is imported, and sufficient financial incentives are in place to warrant increased electricity production (i.e., BioMAT tariff).
  - Engine becomes unreliable, inoperable, or requires significant downtime to address communication or other compatibility issues.
- The economic viability of producing renewable natural gas is largely dependent on the highly variable commodity markets for renewable fuels used in the transportation sector (RINs & low carbon fuel offsets). While the value of these credits currently does not justify refining and selling biogas, the District should continue to monitor the situation in light of recent renewable natural gas procurement mandates in California.
- If thermal drying is needed to meet biosolids regulations, using surplus biogas (due to HSW addition) in the thermal dryer would be favorable.

Advanced Biosolids Processing Options

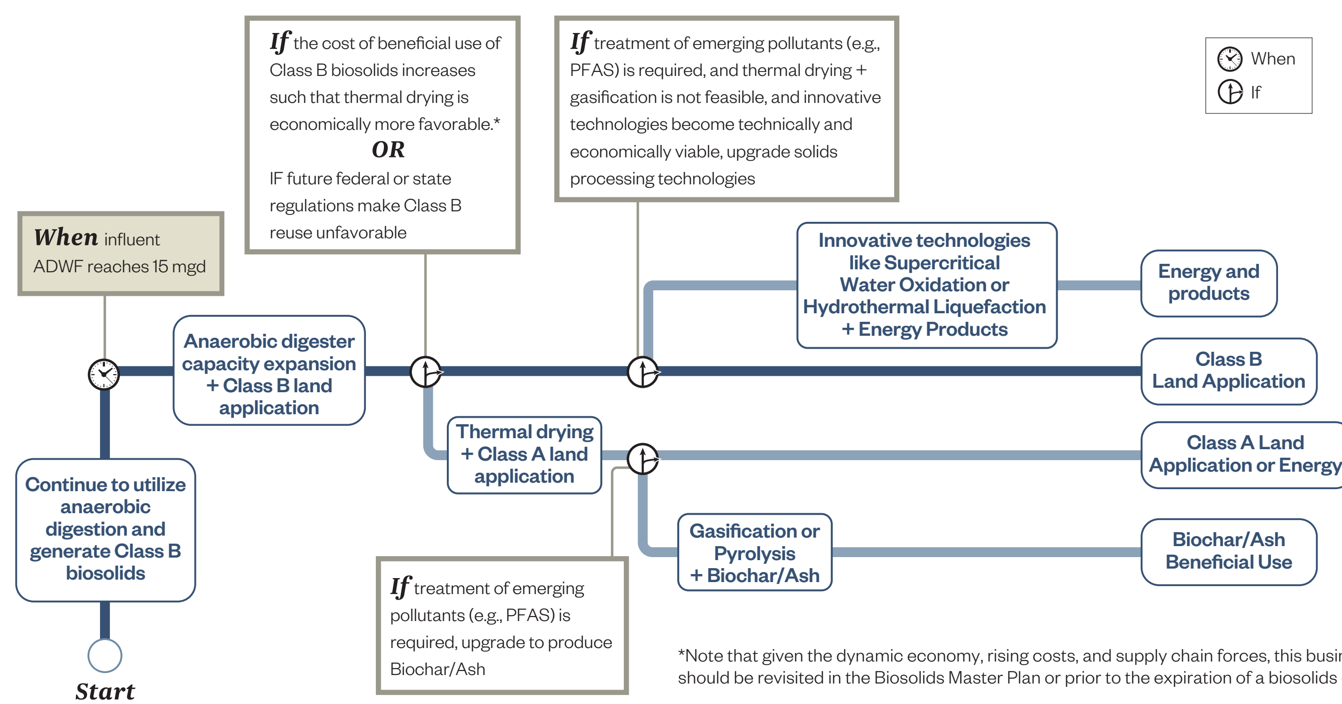
With several drivers impacting biosolids end use options, a flexible path forward will allow the District to pivot as needed. Regulatory action related to PFAS may trigger advanced thermal processing options like gasification/pyrolysis, or advanced solids treatment processes like Supercritical Water Oxidation (SCWO). Thermal drying may be triggered by increased hauling costs or regulations limiting Class B reuse and is compatible with gasification/pyrolysis.

- Compost, biochar, and dried products have the highest end user market potential.
- The District has the option of developing and managing a program or contracting with a third-party vendor to manage the biosolids product.

The District should continue to engage regional partners to explore alternative end-use solutions.

BIOSOLIDS ROADMAP

The biosolids roadmap describes load and regulatory triggers that would lead to new infrastructure for capacity or to produce new biosolids products to expand end use options.



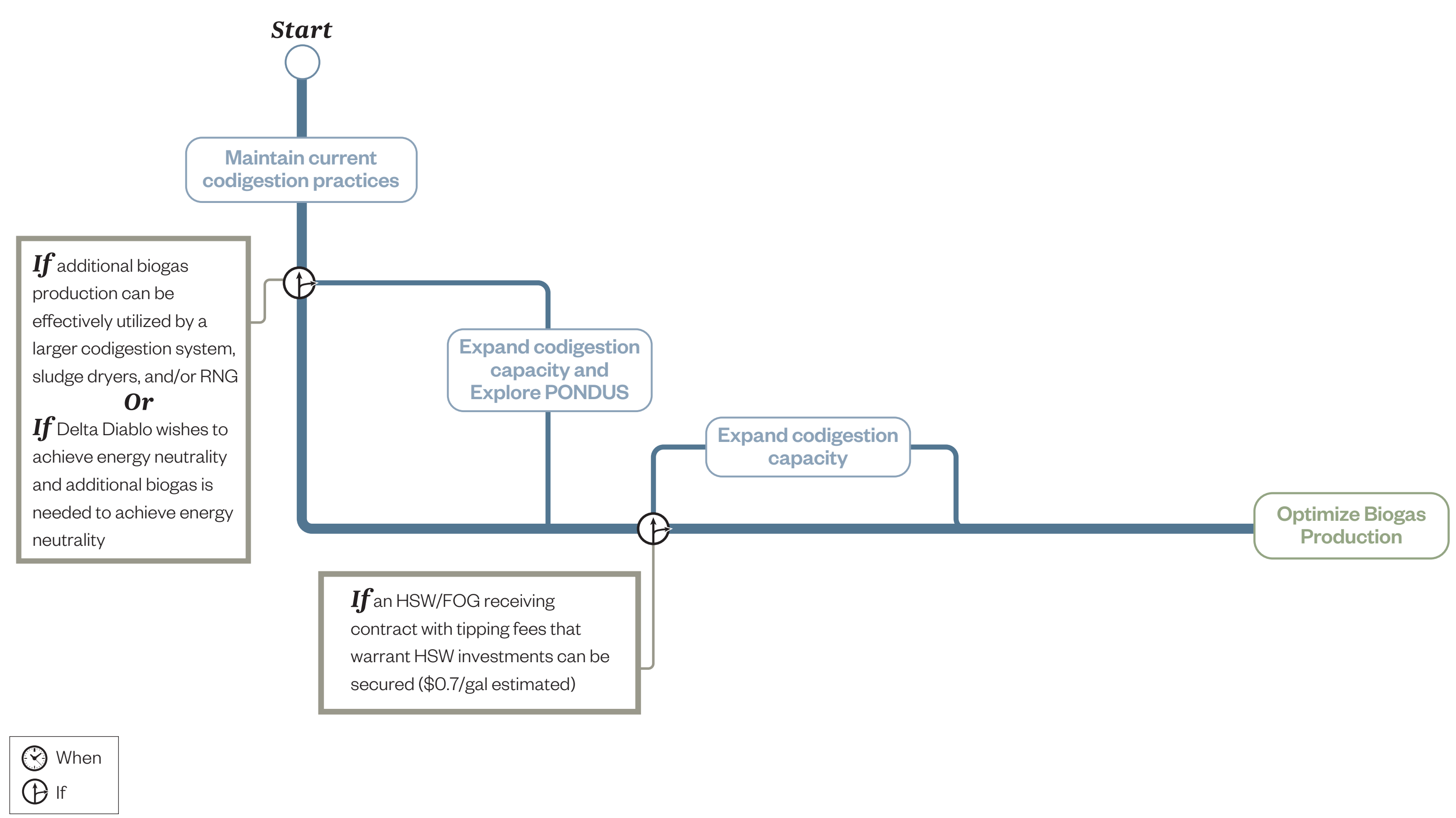
*Note that given the dynamic economy, rising costs, and supply chain forces, this business case evaluation should be revisited in the Biosolids Master Plan or prior to the expiration of a biosolids contract.

RECOMMENDED DISTRICT STUDIES

- ✓ Biosolids Master Plan.
- ✓ Biogas Utilization Study.

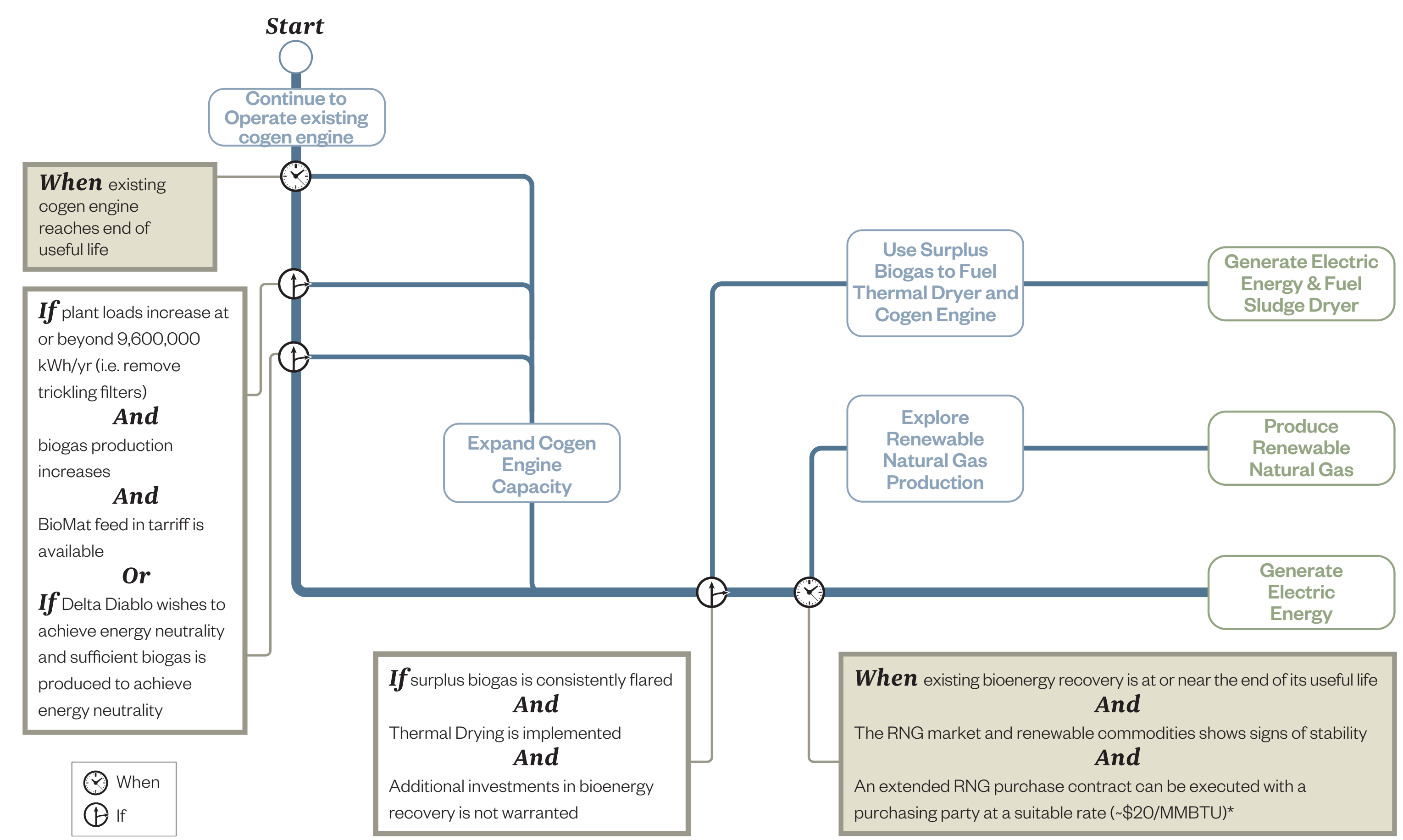
Biogas Production Optimization Roadmap

The biogas production optimization roadmap identifies triggers that change the economics of receiving and codigesting high strength waste.



Biogas Energy Recovery Roadmap

The biogas energy recovery utilization roadmap identifies triggers that change the economics of how biogas is utilized at the WWTP.



* 2020 dollars

FOCUS AREA 5 RECYCLED WATER MANAGEMENT

BACKGROUND

As part of the 2021 Strategic Plan, the District has set environmental stewardship goals to meet or surpass environmental and public health requirements to maintain public trust.

To support this goal the District currently produces approximately 6 mgd of recycled water (approximately half the influent flow (12.8 MGD) on an annual average basis), with a majority of that flow going to Calpine's Delta Energy Center (DEC) and Los Medanos Energy Center (LMEC), collectively Energy Centers, as well as irrigation users. Calpine's agreement to purchase recycled water from the District will expire in June 2031, potentially leaving the District with a significant decrease in recycled water demand.

The District must complete a Facilities Assessment to inform the decision to continue the contract with Calpine by June 2025. This 2022 Master Plan evaluated options for adding new customers and/or increasing recycled water usage by existing customers to offset the potential discontinuation of Calpine operation and conducted a high-level review of the Recycled Water Facility (RWF) to evaluate costs related to increased water quality requirements for new or existing customers. Results from this evaluation are intended to serve as a precursor to the Facilities Assessment (noted as Recycled Water Master Plan Update in CIP) planned for Fiscal Year 2023/2024.

PLANNING IMPLICATIONS FOR DISTRICT

A high-level investigation of potential users was conducted to determine the recycled water demand available to replace Calpine demand. The total estimated recycled water demand for new customers (industrial, and near- and long-term irrigation) is approximately 3,820 acre feet-per year (AFY). The estimated future recycled water demand would only replace approximately 54% of the total annual demand from LMEC and DEC. Table ES-7 lists potential users identified.

Table ES 7-Potential Future Recycled Water Users Identified

Customer	Description	Annual Average Demand (AFY)
Industrial		
Mt. Diablo Resource Recovery Park – Waste Recycle Center and Transfer Station (WRC&TS)	Recycling center and waste processing	35.3
Pittsburg Technology Park (Data Center)	Data center	2,240
Diablo Energy Storage, LLC	Advanced energy storage	-
San Francisco Bay Aggregates – Carbon Capture and Mineralization Project	Pilot facility	-
Loveridge Corridor	Zoned for future industrial use	Up to 3,266
Near-term Irrigation		
Stoneman Sports Complex	Athletic complex	110.5
Babe Ruth Fields	Athletic complex	14.7
Antioch Little League	Athletic complex	11.4
Memorial Park (Park Middle School)	Park and school	18.7
Sutter Elementary School	School	23.8
Antioch Fairgrounds (Contra Costa County Event Center)	Fairgrounds	37.6
Prosserville Park (on 6th St between M&O)	Park	2.3
City of Antioch	Park	-
Antioch Historical Society	Museum	2.7
Los Medanos Industrial Park	Office	2.1
BayWalk	Residential development	63.8
Corteva Wetlands Preserve (DOW Wetlands)	Wetlands	1.0
Long-term Irrigation		
Los Medanos College (point demand)	School	227

CIP PROJECTS

Investment in the rehabilitation and replacement (R&R) of infrastructure associated with the RWF will need to occur over the next 10 years (more than $6 million). These projects are synergistic with continuing to provide recycled water for irrigation and cooling at DEC and LMEC. These projects are listed in ES-8.

Table ES-8 RWF CIP Projects

Project	Project Priority Yrs	Project No.	Cost
Improvements at Secondary Effluent Feed to RWF	3-5	CIP-004	$150,000
Valve replacement for DEC, CCT, and DEC tank isolation	<2	TBA-2	$600,000
RWF IPS, Process Line Modification, and Blowdown	6-15	TBA-5	$1,10,000
Recycled Water Facility and Treatment Plant Intertie	<2	TBA-15	$1,70,000
Sand Filter and Filter Cover Improvements	3-5	TBA-27	$850,000
RWF Clarifier Liner Rehabilitation	No data	TBA-29	-
RWF Sand Pump Piping Replacement	<2	TBA-43	$100,000
Recycled Water Distribution System Expansion	6-15	18110	$150,000
Small RWF Capital Asset Project	6-15	19103	$250,000
Recycled Water Distribution System Improvements	6-15	19114	$500,000
Unanticipated Recycled Water Infrastructure Repairs	6-15	19104	$500,000
Recycled Water Master Plan Update	3-5	TBA-26	$300,000

Increasing the extent of recycled water production can help offset nutrient discharge from the WWTP if the reuse customer consumes the nutrients (e.g., irrigation) or if the nutrient fraction is never subject to discharge. For non-consumptive reuse (e.g., cooling water for Calpine), the District should continue to track how these nutrient loads are returned to the WWTP as they will impact nutrient treatment capacity needs, as well as effluent quality.

The future of the recycled water program has a significant impact on outfall flow. As noted in Focus Area 3, the District will need to clean the outfall in the planning period. The capacity of the outfall, with 100% of the diffusers unclogged will be 25.3 mgd. If there is no recycled water and the District must send more flow through the outfall, the District will need more outfall capacity in the planning period to accommodate wet weather as 2040 ADWF is expected to range from 16 to 18.4 mgd (wet weather peak flow 31.1 mgd).

The upcoming Recycled Water Master Plan Update (Facilities Assessment) is contractually required to be completed by June 2025 to inform the decision to renew the recycled water contract. The study will need to:

- Update recycled water user demands.
- Identify specific water quality needs for energy centers.
- Evaluate upgrades needed to continue to reliably meet energy center water quality needs in coordination with ongoing WWTP project upgrades.
- Update recycled water distribution hydraulic model and review storage requirements for new and existing customers.
- Understand the impacts to WWTP if the recycled water demand decreases, including impacts to the outfall and nutrient removal.

RECOMMENDED DISTRICT STUDIES

✓ Recycled Water Master Plan Update (Facilities Assessment), including outfall analyses.

ENERGY MANAGEMENT AND SUPPORT SERVICES

FOCUS AREA 6

BACKGROUND

The District has a long history of recognizing the importance of energy and its impact on efficient operations. In 2015, the District took steps to formalize energy management efforts by joining the Department of Energy's (DOE) Better Plants Program and joining the DOE's Water and Wastewater Pilot Project the following year. The pilot involved adopting:

- An Energy Management System Pledge
- Establishing an energy team
- Developing an Energy Manual
- Completing training on Superior Energy Performance (SEP) and ISO 50001
- Drafting plant reduction goals, administration goals (cultural awareness), and data monitoring goals
- Completing several energy audits and assessment reports.

While there is a good foundation on which to build an energy management program, implementation efforts have dropped off in recent years due to staffing changes and shortages.

As part of the 2021 Strategic Plan, the District has set organizational change goals to embrace innovation, engagement, and change to enhance service delivery, work processes, and use technology to drive sustained improvement in organizational effectiveness and efficiency. As noted previously, the District also has a strategic goal to ensure the long-term effectiveness and reliability of critical infrastructure, including electrical support system resiliency. Climate change has led to increasing wildfires causing reliability issues with electrical infrastructure throughout the industry. To increase electrical resiliency, the District has identified electrical infrastructure upgrades in addition to its energy management initiatives.

PLANNING IMPLICATIONS FOR DISTRICT

To improve reliability of energy supply and management at the WWTP, the District should:

- Complete the electrical switchgear replacement project.
- Conduct an Electrical System Master Plan.
- Reinvigorate the Energy Management System that follows ISO 50001 principles qualitatively (or quantitatively where appropriate) without pursuing certification.

Since the District has built a strong foundation for an energy management program, efforts should focus on:

- Developing a combination of qualitative and quantifiable metrics that support energy objectives relative to historical plant performance.
- Actively communicate Energy Management System Pledge to current and new employees.
- Develop an energy monitoring plan as part of the Electrical System Master Plan.

DISTRICT STUDIES NEEDED

✓ Electrical System Master Plan.

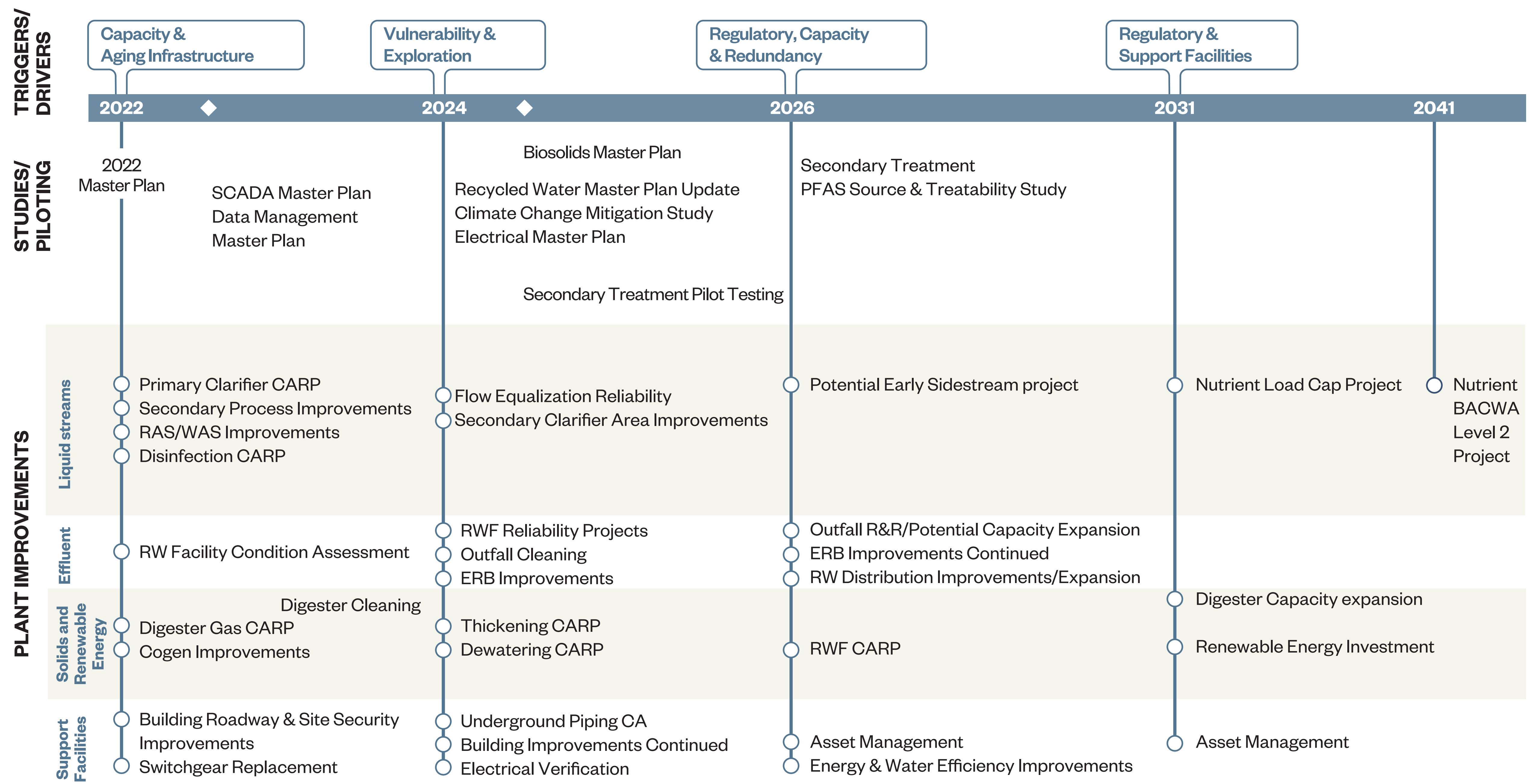
Path Forward

The path forward for the District includes CIP projects to address capacity and aging infrastructure, vulnerability, regulatory, and sustainability drivers. The implementation outlines near- and long-term projects to address these drivers. The 5-year CIP for the WWTP and RWF addresses the District's near-term goals while also setting the District up for potential future regulatory changes. The following table shows a breakdown of the WWTP and RWF 5-year CIP by process category.

Project	%
Secondary Treatment	59
Solids Treatment	7
Recycled Water Facility	7
Electrical System	6
General	6
Energy	6
Emergency Basin, Outfall, Headworks, Flow EQ	3
Building	2
Miscellaneous	4

IMPLEMENTATION

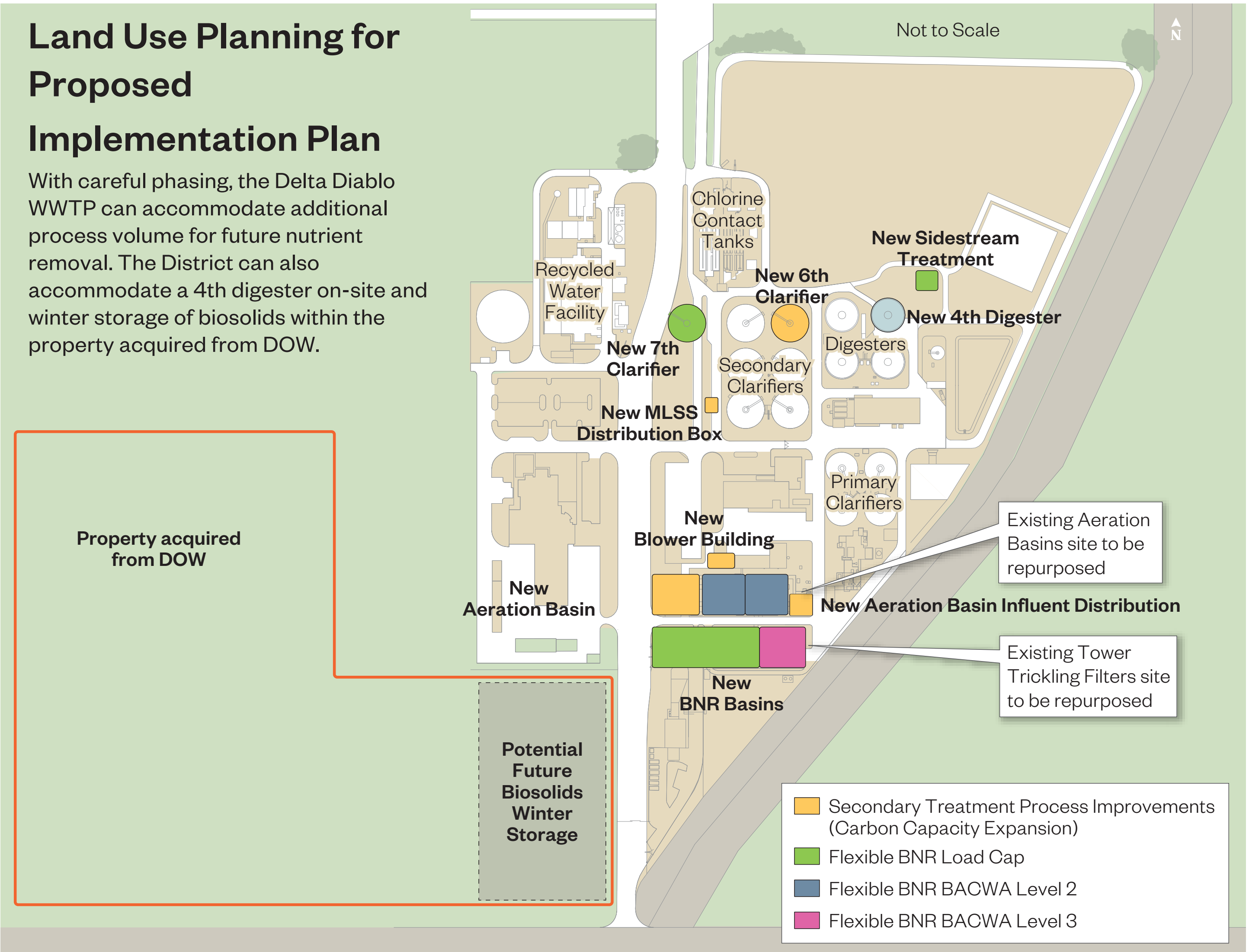
The District will need to address aging infrastructure and capacity issues while preparing for long-term drivers.



CARP: Capital Asset Replacement Program **ERB:** Emergency Retention Basin **CA:** Condition Assessment **RW:** Recycled Water

Land Use Planning for Proposed Implementation Plan

With careful phasing, the Delta Diablo WWTP can accommodate additional process volume for future nutrient removal. The District can also accommodate a 4th digester on-site and winter storage of biosolids within the property acquired from DOW.



Delta Diablo Resource Recovery Facility 2022 Master Plan

Final

Hazen

Delta Diablo

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List of Acronyms

Abbreviation	Meaning
AA	Average Annual
ABAG	Association of Bay Area Governments
ADC	Alternative Daily Cover
ADs	Anaerobic Digesters
ADWF	Average Dry Weather Flow
AFY	Acre-foot per Year
AGS	Aerobic Granular Sludge
aSRT	Aerobic Solids Retention Time
AWWA	American Water Works Association
BABC	Bay Area Biosolids Coalition
BACWA	Bay Area Clean Water Agencies
BCE	Business Case Evaluation
BFC	Binary Fission Cells
BNR	Biological Nutrient Removal
BOD	Biochemical Oxygen Demand
BOD_5	5-day Biological Chemical Demand
BRE	Business Risk Exposure
CA	Condition Assessment
CARP	Capital Asset Replacement Program
CCT	Chlorine Contact Tank
CECs	Constituents of Emerging Concern
CIP	Capital Improvement Program
CNT	Centrifuge Centrate
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CoF	Consequence of Failure
d	Day
DAF	Dissolved Air Flotation
DAS	Densification
DB	Digested Biosolids
DD	Delta Diablo
DEC	Delta Energy Center
DG	Digester Gas
DOF	Department of Finance
DWR	Department of Water Resources
ECBP	East County Bioenergy Project
EME	Emergency Retention Basin Effluent
EMPGD	Energy Management Program Guidance Document
EnMS	Energy Management System

Abbreviation	Meaning
EQ	Equalization
EQE	Flow Equalization Basin Effluent
ERB	Emergency Retention Basin
ESB	Equalization Storage Basin
FE	Final Effluent
FEB	Flow Equalization Basin
FEMA	Federal Emergency Management Agency
FOG	Fats, Oils, and Grease
ft	Foot
FT	Filtrate
ft^2	Square Foot
ft^3	Cubic Foot
gal	Gallon
GBTs	Gravity Belt Thickeners
GIS	Geographic Information System
GO	General Order
gpd	Gallons per Day
gpm	Gallons per Minute
GT	Grit
hr	Hour
HRT	Hydraulic Retention Time
HSW	High Strength Waste
HW	Headworks
IPS	Influent Pump Station
IS	Integrated Solutions
ISO	International Organization for Standardization
kg/d	Kilogram per Day
KPI	Key Performance Indicator
L	Liter
lb	Pound
lb/ft^2-day	Pounds per Square Foot per Day
lbs BOD/d	Pounds of BOD per Day
lbs BOD_5/d	Pounds of BOD_5 per Day
lbs/day	Pounds per Day
lbs/MG	Pounds per Million Gallons
LMEC	Los Medanos Energy Center
M	Million
m	Minute
MABR	Membrane Aerated Bioreactor
MBR	Membrane Bioreactor
MCCs	Motor Contol Center
MD	Maximum Day

Abbreviation	Meaning
MG	Million Gallons
mg/L	Milligram per Liter
MGD	Million Gallons per Day
ML	Mixed Liquor
MLSS	Mixed Liquor Suspended Solids
MM	Maximum 30-day
MP	Master Plan
N	Nitrogen
N/L	Total Nitrogen per Liter
NG	Natural Gas
NOAA	National Oceanic and Atmospheric Administration
NOx	Nitrogen Oxides
NPDES	National Pollutant Discharge Elimination System
NPV	Net Present Value
NRCY	Nitrified Recycle
O&M	Operations and Management
OIG	Office of Inspector General
ORP	Oxidation Reduction Potential
P	Phosphorus
P/L	Total Phosphorus per Liter
PE	Primary Effluent
PFAS	Per and Polyfluoroalkyl Substances
PI	Primary Influent
PoF	Probability of Failure
PONDUS	Thermo-chemical hydrolysis process
PPCPs	Pharmaceuticals and Personal Care Products
ppd	Pounds per Day
ppd/sf	Pounds per Day per Square Foot
PS	Primary Sludge
PSC	Primary Scum
PW	Present Worth
PWWF	Peak Wet Weather Flow
Qty	Quantity
R.E.A.L.	Resources, Efficiency, Always Improving, Legal Requirements
RAS	Return Activated Sludge
RFA	Request for Applications
RNG	Renewable Natural Gas
RO	Reverse Osmosis
RR	Rehabilitation and Replacement
RRF	Resource Recovery Facility
RTU	Recirculating Tower Underflow
RUL	Remaining Useful Life

Abbreviation	Meaning
RW	Recycled Water
RWF	Recycled Water Facility
RWF MP	Recycled Water Facility Master Plan
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SBR	Sequencing Batch Reactors
SCADA	Supervisory Control and Data Acquisition
scfm	Standard Cubic Feet per Minute
scfm/diff	Standard Cubic Feet per Minute per Diffuser
SCWO	Supercritical Water Oxidation
SE	Secondary Effluent
sf	Square Foot
SF Bay Water Board	San Francisco Bay Regional Water Quality Control Board
SFEI	San Francisco Estuary Institute
SK	Spulkraft
SLR	Solids Loading Rate
SN	Supernatant
SND	Simultaneous Nitrification Denitrification
SRT	Solids Retention Time
SSC	Secondary Scum
SWRCB	State Water Resources Control Board
TEQ	Toxic Equivalency Factor
THS	Thickened Sludge
TIN	Total Inorganic Nitrogen
TP	Total Phosphorus
TRC	Total Residual Chlorine
TS	Total Solids
TSS	Total Suspended Solids
TTF	Tower Trickling Filters
TWAS	Thickened Waste Activated Sludge
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
VSS	Volatile Suspended Solids
WAS	Waste Activated Sludge
WaterRF	The Water Research Foundation
WEF	Water Environment Federation
WGB	Waste Gas Burner
WRC&TS	Waste Recycle Center and Transfer Station
WRRF	Wastewater Resource Recovery Facility
WWTP	Wastewater Treatment Plant

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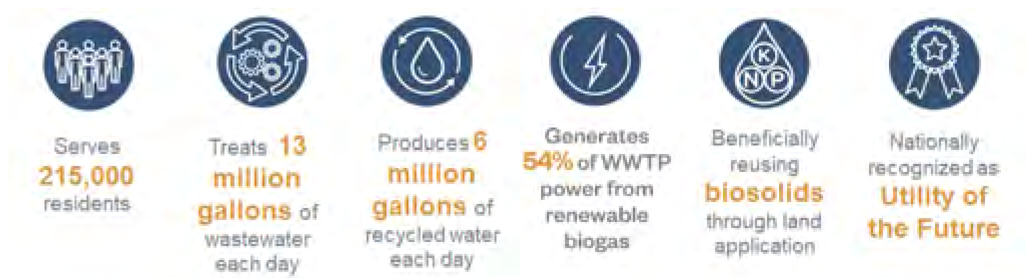
Delta Diablo

1. Introduction

Delta Diablo (District) is a California special district that provides wastewater collection, conveyance and treatment, and recycled water services for customers in the cities of Antioch and Pittsburg and the unincorporated community of Bay Point. Treatment facilities include the Wastewater Treatment Plant (WWTP; permitted average dry weather flow [ADWF] capacity of 19.5 million gallons a day [MGD]) and the Recycled Water Facility (RWF; permitted capacity of 12.8 MGD), cumulatively referred to as the Wastewater Resource Recovery Facility (WRRF). Final effluent from the WWTP is currently discharged via deep water outfall to the New York Slough. Treated effluent standards are dictated by National Pollutant Discharge Elimination System (NPDES) Permit No. CA0038547 (Order No. R2-2019-0035) issued by the San Francisco Bay Regional Water Quality Control Board (Regional Water Board).



Presently, liquid treatment at the WWTP consists of influent screening, grit removal, primary clarification, flow equalization, biological secondary treatment (trickling filters, conventional activated sludge, and secondary clarification), disinfection with sodium hypochlorite, and dechlorination with sodium bisulfite. A portion of secondary effluent from the WWTP is diverted to the RWF, where the flow is treated via flocculation, sedimentation, tertiary filtration, and disinfection with sodium hypochlorite before distribution to recycled water customers. Over 90% of the recycled water is delivered for cooling at two power plants. Return flow (blowdown) from the power plants typically ranges from 1 to 3 MGD and is reintroduced to the WWTP just upstream of the chlorine contact basins. Solids from the primary clarifiers (primary solids) and solids from the secondary clarifiers (waste activated sludge), which are subsequently thickened via gravity belt thickeners (thickened waste activated sludge), are sent for mesophilic anaerobic digestion and dewatered via centrifugation (producing Class B biosolids). Biogas that is produced from the anaerobic digestion process is used to generate power and heat that is recovered within the existing WWTP. The majority of the Class B biosolids generated at the WWTP are beneficially reused through land application.

The District is balancing several factors that can affect the near- and long-term projects in its Capital Improvement Program (CIP) for its facilities including:

- Aging infrastructure – Facilities within the WWTP (e.g., tower trickling filters [TTFs] and assets associated with the secondary clarification, etc.) are reaching the end of useful life and require proactive planning to minimize risk of failure and negative impacts to permit compliance.

- Regulatory drivers – The evolution of federal, state, and local watershed regulations may dictate changes to treatment requirements at the WWTP to address nutrients, biosolids end use, and emerging contaminants (e.g., per and polyfluoroalkyl substances, PFAS).

- Coordination of treatment capacity, regulatory compliance, and infrastructure investment – Increasing influent flows and loads to the WWTP may trigger expansion of facilities; however, coordination is needed so that expansion is compatible with evolving treatment requirements and rehabilitation and repair needs.

- Regional partnerships – regional progression towards holistic water, nutrient and biosolids management will influence investment and land use planning at the WRRF.

1.1 Master Plan Objectives

The District commissioned the 2022 Resource Recovery Facility Master Plan (2022 Master Plan) to develop an integrated, strategic planning document with analysis in key areas to guide infrastructure investment decisions in the near- and long-term. The 2022 Master Plan is intended to highlight specific measures and triggers that support decision making over the next few years, while maintaining a 20-year planning horizon for select infrastructure within the District's WRRF. With these drivers in mind, the 2022 Master Plan addresses near- and long-term drivers while embracing innovative approaches and sustainable solutions to benefit the environment, lower operating costs, increase revenues, and serve as responsible stewards of the public's resources and trust. Specific goals of the 2022 Master Plan include:

- Guide development of a prioritized, long-term Capital Improvement Program (CIP) that meets infrastructure needs, addresses regulatory drivers, and maintains operational effectiveness and reliability,
- Support development of the District's Asset Management Program by integrating condition assessment data from the WRRF,
- Develop a strategic technical and financial approach to meet future nutrient removal regulatory requirements,
- Identify and mitigate potential treatment process vulnerabilities and identify opportunities to improve process monitoring, control, and optimization,
- Develop frameworks to support resource recovery, including recycled water, biosolids, biogas and renewable energy use through identification of applicable innovative approaches, technologies, and best practices in use at peer wastewater agencies. These frameworks are intended to inform future planning efforts by the District,
- Guide the development of future capital project design assumptions by updating wastewater flow and load projections,
- Ensure that planning outcomes align with the District's strategic plan (2021).

To accomplish these objectives, work was completed per the tasks outlined in **Table 1-2** as defined in the 2022 Master Plan scope. Detailed summaries of the outcomes of each task are provided in respective appendices. As shown in Table 1-2, key findings are consolidated into six focus areas, that allow for coordination across the ten (10) tasks performed. Key deliverables from the 2022 Master Plan are summarized in **Table 1-3**.

Table 1-1 2022 Master Plan Tasks

Task No.	Task Name
1	Project Management
2	Condition Assessment
3	Biogas Utilization
4	Nutrient Management
5	Renewable Energy Production
6	Biosolids Management
7	Vulnerability Assessment and Process Control, Monitoring and Optimization
8	Recycled Water Management
9	Energy Management
10	Flows and Loads
11	Land Use Planning
12	Report Preparation

Table 1-2 2022 Master Plan Tasks and Focus Areas

Focus Area	Description	Applicable Tasks	Location of Detailed Documentation
1. Planning Horizon and Regulatory Outlook	Addresses flow and load projections and identifies key planning triggers that may result from regulatory action. Outcomes and key findings represent the consolidation of efforts across the different focus areas and tasks.	• Task 10 – Flows and Loads, • Task 3/5 – Biogas and Renewable Energy Management • Task 4 – Nutrient Management	• 2022 Master Plan Report Section 3 • Appendix 1 – Flows and Loads
2. Infrastructure Renewal and Regulatory Compliance Vulnerability	Addresses asset renewal priorities due to aging infrastructure. Projects to address capacity, operational effectiveness and reliability were identified. Newly identified projects were incorporated into the 5-year CIP, while also helping to establish the relative priority between investing in linear versus vertical assets.	• Task 2 – Condition Assessment • Task 7 – Vulnerability Assessment and Process Control, Monitoring and Optimization • Task 12 – Outfall Hydraulics	• 2022 Master Plan Section 5 • Appendix 2 – Condition Assessment and Risk Analysis Methodology • Appendix 3 – Vulnerability Assessment and Process Control, Monitoring, and Optimization • Appendix 7 – Outfall Capacity Analysis

Focus Area	Description	Applicable Tasks	Location of Detailed Documentation
3. Nutrient Management and Advanced Treatment	Development of a strategic technical, and financial approach to meet future nutrient removal regulatory requirements as well as other advanced treatment needs. Coordination was performed across focus areas related to biosolids, biogas, renewable energy, infrastructure renewal, compliance vulnerability and land use planning.	• Task 4 – Nutrient Management, • Task 3/5 – Biogas and Renewable Energy Management • Task 7 – Vulnerability Assessment and Process Control, Monitoring, and Optimization • Task 10 – Flows and Loads • Task 11 – Land Use Planning	• 2022 Master Plan Section 6 • Appendix 4 – Nutrient Management Analysis
4. Biosolids, Biogas and Renewable Energy	Addresses biosolids treatment capacity while identifying applicable innovative approaches the District can use to achieve current and future resource recovery goals. Coordination was performed between focus areas related to nutrients, advanced treatment, infrastructure renewal, compliance vulnerability and land use planning.	• Task 3/5 – Biogas and Renewable Energy Management • Task 6 – Biosolids Management • Task 4 – Nutrient Management • Task 7 – Vulnerability Assessment and Process Control, Monitoring, and Optimization • Task 10 – Flows and Loads • Task 11 – Land Use Planning	• 2022 Master Plan Section 7 • Appendix 5 – Biosolids and Renewable Energy Management
5. Recycled Water Management	Guide strategic decision-making efforts regarding long-term RWF operation and near-term capital investments by evaluating options for adding new customers and/or increasing recycled water usage. Coordination was performed between focus areas related to nutrients, advanced treatment, infrastructure renewal, compliance vulnerability and outfall hydraulics.	• Task 7 – Vulnerability Assessment and Process Control, Monitoring, and Optimization • Task 8 – Recycled Water Management • Task 12 – Outfall Evaluation	• 2022 Master Plan Section 8 • Appendix 6 – Recycled Water Management
6. Energy Management and Support Services	Support District efforts to develop an Energy Management Program Guidance Document (EMPGD) outlining specific tasks and procedures to further develop the District's existing energy management program.	• Task 7 – Vulnerability Assessment and Process Control, Monitoring, and Optimization • Task 9 – Energy Management	• 2022 Master Plan Section 9 • Appendix 8 – Energy Management

Table 1-3 2022 Master Plan Master Planning Deliverables

Deliverables	Description
Master Plan	This document provides a detailed description of project context, project approach and key outcomes for the tasks and focus areas. This document includes land use planning maps that incorporate considerations from roadmaps and the Implementation Plan.
Roadmaps	These documents, provide an overarching framework of triggers and potential paths for navigating focus areas related to nutrients, biosolids, bioenergy and biogas optimization.
Implementation Plan	This document, included in the master plan and the Capital Planning Tool, provides a graphical summary of projects, associated studies, and triggers as a quick reference for the key outcomes of the 2022 Master Plan.
5-Year CIP Geographic Information System (GIS) StoryMap	This digital tool provides interactive maps and text to communicate the prioritized 5-year CIP program for the WRRF.
Capital Planning Tool	This digital dashboard provides a summary of all projects identified for the planning horizon and allows the District to visualize how different implementation plans may impact long-term financial investments.

2. Strategic Vision for WRRF

The District's overall mission is to protect public health and the environment by safely providing wastewater conveyance, treatment, and resource recovery services in a sustainable and fiscally-responsible manner. To accomplish this, the District envisions maintaining industry leadership as a progressive "utility of the future" through active engagement of all stakeholders. Specific to the WRRF, the District has defined the strategic goals highlighted in **Figure 2-1**. This WRRF vision was used to guide activities during the planning effort to provide for compatibility with overall District mission and vision goals.

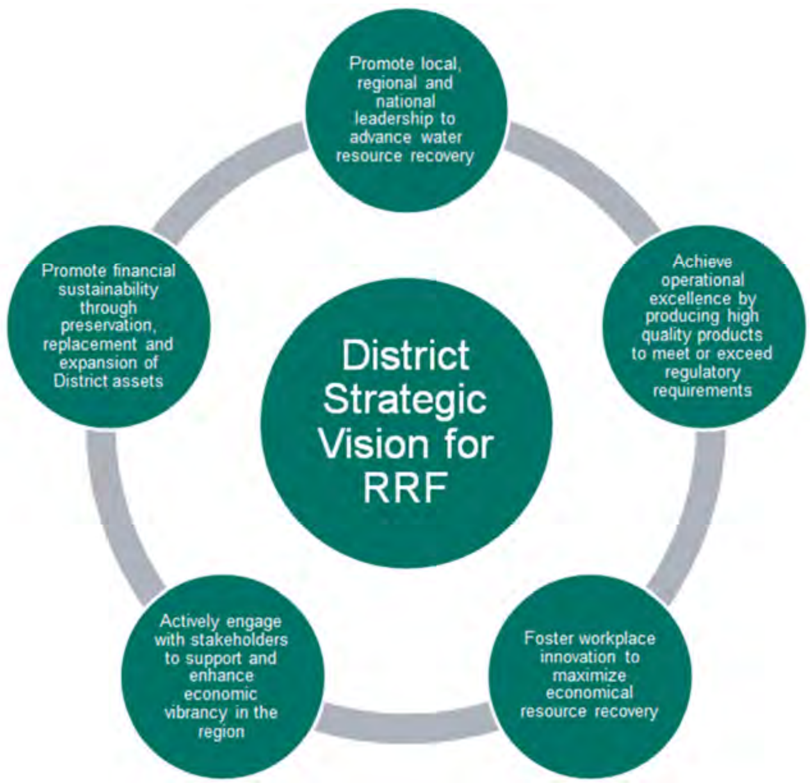


Figure 2-1. Vision for WRRF

(Adapted from Board Approved Strategic Business Plan, August 2021)

3. Focus Area 1 - Planning Horizon and Regulatory Outlook

The 2022 Master Plan considered a 20-year planning horizon (2020 to 2040). To support this effort, a regulatory outlook was performed. Flow and load projections (**Task 10**) were also developed as the underlying basis of the 2022 Master Plan and to inform when hydraulic and/or process capacity may be reached or exceeded.

3.1 Current Regulations and Performance

Flow from the WWTP that is not recycled for beneficial reuse by the RWF is discharged through a deep-water outfall and is subject to regulations by the San Francisco Bay Regional Water Quality Control Board (Regional Water Board). **Table 3-1** summarizes current discharge limitations outlined in the District's National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2019-0035) and demonstrates that the WWTP is meeting all permitted objectives.

Beyond the permitted requirements, the current nutrient watershed permit (Waste Discharge Requirements for Nutrients from Municipal Wastewater Discharges to San Francisco Bay, NPDES Permit No. CA 0038873) requires that dischargers monitor WWTP influent and effluent for nutrients. The District monitors WWTP influent for ammonia, total Kjeldahl nitrogen, nitrate-nitrite, and total phosphorus; and WWTP effluent for ammonia, nitrate-nitrite, and total phosphorus. Effluent ammonia was monitored regularly prior to the nutrient watershed permit monitoring requirements as the WWTP has a monthly ammonia limitation of 170 mg N/L. Results from monitoring indicate that the WWTP is not performing nitrification but is achieving inadvertent phosphorus removal through chemical precipitation means because of return of RWF solids to the headworks.

Table 3-1 Summary of Current Discharge Requirements and Historical Performance

		Permit or Monitoring Requirements				Historical Final Effluent (2016 to 2019)
Constituent	Unit	Average Monthly	Average Weekly	Maximum day	Instantaneous (min or max)	
Biochemical Oxygen Demand (BOD)	mg/L (% removal)	30 (85)	45	-	-	16.9 (>90%)
Total Suspended Solids (TSS)	mg/L (% removal)	30 (85)	45	-	-	12.2 (>90%)
Oil and Grease	mg/L	10	-	20	-	<2.3
pH	-	-	-	-	6.0 to 9.0	6.9 Daily Maximum 8.0 Daily Minimum
Total Residual Chlorine	mg/L	-	-	-	0.0	0.0

Constituent	Unit	Permit or Monitoring Requirements				Historical Final Effluent (2016 to 2019)
		Average Monthly	Average Weekly	Maximum day	Instantaneous (min or max)	
Total Recoverable Copper	mg/L	35	-	53	-	6.3
Total Cyanide	mg/L	18	-	39	-	2.1
Dioxin-TEQ	mg/L	1.4 x 10-8	-	2.8 x 10-8	-	0
Total Ammonia	mg/L	170	-	220	-	45.6
Enterococcus Bacteria	most probable number/100 mL	< 35 (geometric mean)	-	-	-	4.4
Nitrate + Nitrite	mg/L	monitoring only				3.3
Total Phosphorus	mg/L	monitoring only				1.6

Note that TKN is not required to be monitored in effluent, it is required to be monitored in influent only

3.2 Potential Future Regulations

A summary of regulatory drivers for the District is provided in **Table 3-2** and briefly described in subsequent sections.

Table 3-2: Summary of Regulatory Drivers for District over Planning Horizon

Regulatory Body	Process Train	Parameters Affected	Projected Time Frame	Projected Impacts	Implications for District
San Francisco Bay Regional Water Quality Control Board	Liquids, secondary, sidestream	Ammonia, total inorganic nitrogen (TIN) and phosphorus*	5 – 20 years	Potential requirement for nutrient removal at WWTP	Plan for flexible nutrient management program that incorporates: • Secondary and sidestream treatment • Nutrient trading program

Regulatory Body	Process Train	Parameters Affected	Projected Time Frame	Projected Impacts	Implications for District
US Environmental Protection Agency and State Water Resources Control Board	Liquids and Biosolids	PFAS	5 to 10 years	No specific limits at this time. However, drinking water health advisory levels may become applicable	Continue to monitor regulatory changes. Support statewide and national source control efforts such as public education and product bans. If the regulations become more likely, perform PFAS monitoring and treatability study. Plan for flexible biosolids treatment disposal
US Environmental Protection Agency	Liquids	Coliphage		No specific limits at this time	Continue to monitor for regulatory changes Changes to disinfection process may be required
California Environmental Protection Agency	Facilities	General	0 to 5 years		Understand and mitigate for potential impacts of climate change and sea level rise
State of California (Assembly Bill 341)	Biosolids	General	2020	Removes incentive for use of biosolids as alternative daily cover at landfills	Increased costs for biosolids management Increased demand for processing at Synagro composting facilities
Bay Area Air Quality Management District	Air	Flared digester gas, engine emissions	2020	Enacting limits on NOx, CO, and VOC from digester gas	Rule encourages alternative uses of digester gas (energy generation, vehicle fuel, etc.)

Regulatory Body	Process Train	Parameters Affected	Projected Time Frame	Projected Impacts	Implications for District
CalRecycle (Senate Bill 1383)	Air, Biosolids, Liquids	Biosolids end-use, Co-digestion of organics and Digester gas, Nutrient Loading	Current - 2030	40% reduction in methane emissions, increased competition for biosolids end-use options, and encouragement of codigestion at WWTPs	Increased costs for biosolids disposal. Increases quantities of HSW available for codigestion, potentially increasing tipping fees If the District increases codigestion of HSW, nutrient loading to the plant will increase

* While initially studied, the Reginal Water Board has given no indication that phosphorus removal will be required.

3.2.1 Nutrient limits

The San Francisco Regional Water Quality Control Board (Regional Water Board) is currently considering nutrient limitations for dischargers to SF Bay. Ongoing studies to determine bay and subembayment nutrient loading capacity will inform future regulations. Factors that will influence WWTP performance needs are as follows:

- The current nutrient watershed permit includes an estimate of nutrient load targets that dischargers may be expected to meet by 2024. This target was based on historical data collected between May 1, 2014 and September 30, 2017 and future population growth. The average for the District's WWTP effluent over this period was 1,500 kg/d of total inorganic nitrogen (TIN). The estimated 2024 future TIN load target for the District is 1,700 kg/d of TIN. While this type of planning level target is currently proposed, there is uncertainty in how and when limits will be promulgated.

- In addition to individual discharger targets, it is possible that effluent targets may be applied regionally to dischargers in the same subembayment. The District WWTP is part of the Suisun Bay subembayment along with Central Contra Costa Sanitary District, Fairfield-Suisun Sewer District, City of Benicia, and Mount View Sanitary District. **Figure 3-1** shows the major discharges to the bay and the subembayments. If a subembayment permit approach is developed, nutrient trading programs may provide value in helping to offset nutrient reduction needs at the District WWTP.

- The Bay Area Clean Water Agencies (BACWA) has also defined three potential effluent nutrient limitation tiers that may be applicable to SF Bay dischargers. **Table 3-3** summarizes the effluent limitations assumed in the BACWA study.

As part of the nutrient watershed permit, the District and other SF Bay discharges are required to:

- Monitor nutrients at the WWTP,
- Fund nutrient research,
- Support load response modeling,
- Evaluate the benefits of recycled water and natural systems,
- Collaborate to explore opportunities for a regional nutrient trading program,
- Plan for treatment upgrades at WWTP in the event of nutrient mass loading cap or BACWA defined treatment requirements are proposed.

Figure 3-1 Major Dischargers to the San Francisco Bay

Table 3-3 BACWA Nutrient Removal Levels

Level	Ammonia	Total Nitrogen	Total Phosphorus
Level 1 (Optimization)	Varies by Facility	Varies by Facility	Varies by Facility
Level 2	2 mg N/L	15 mg N/L	1.0 mg P/L
Level 3	2 mg N/L	6 mg N/L	0.3 mg P/L

3.2.2 Emerging Contaminants

The State Water Resources Control Board (SWRCB) issued order WQ 2020-0015-DWQ on July 9, 2020 that requires monitoring of PFAS in influent, effluent, reverse osmosis (RO) concentrates (as applicable) and biosolids (as applicable) at WWTPs with a capacity greater than 1 MGD. This state action combined with recommendations from the USEPA NPDES regional coordinators committee to include permit requirements for phased-in monitoring and best management practices, for wastewater dischargers indicates that the District should plan for potential new PFAS related regulations. The Regional Water Quality Control Board and SFEI have begun to monitor constituents of emerging concern (CECs) including microplastics, pharmaceuticals and personal care products (PPCPs), alternative flame retardants, chlorinated paraffins among others.

3.2.3 Biosolids

In California, beneficial use of biosolids products is primarily governed by the SWRCB via the General Order (GO). Recently passed California laws and regulations provide a greater opportunity for developing a beneficial use program. Factors that will influence WWTP biosolids management are as follows:

- USEPA - Office of Inspector General (OIG) Report released in 2018 has identified 352 pollutants which might pose risk. In October 2020, the USEPA issued a Request for Applications (RFA) seeking applications proposing research on pollutants in biosolids. Findings from this research may result in regulatory changes to address emerging contaminants, (i.e. PFAS, microplastics, etc.)

- Senate Bill 1383 (SB 1383) requires 50 percent diversion of organics from landfills by 2020 relative to 2014 levels and 75 percent diversion by 2025 on a statewide basis. The definition of organics includes biosolids. SB 1383 could increase codigestion of organics at wastewater treatment plants. SB 1383 also includes language that prohibits local ordinances from restricting the land application of biosolids beyond the requirements of the SWRCB General Order, thus enabling the expansion of Class B land application

- The state requires increased tracking and reporting of organic waste recycling and disposal (including sludge, biosolids, and digestate).

- Beginning in 2022, use of biosolids as Alternative Daily Cover (ADC) will not be qualified as beneficial use, it will be considered as disposal.
- Recently, several local ordinances banning or limiting land application of biosolids have been overturned (Measure E in Kern County, Measure X in Imperial County).
- Demand for beneficial end use markets (i.e., composting, land application, etc.) is anticipated to increase, increasing prices for disposal or biosolids beneficial use.

In consideration of these factors, it is recommended that the District:

- Continue to monitor federal, state, and local regulations associated with landfill diversion, beneficial use options, and emerging contaminants.
- Incorporate a multipronged approach for biosolids management that considers regional solutions as well as treatment technologies that yield a product that can be managed by a variety of markets to mitigate regulatory pressures and provide for sustainability of the District's biosolids management program.

3.3 Planning Horizon Flow and Load Projections

Future influent flows and loads (**Task 10 - Flows and Loads**) were projected for the 2040 planning horizon to frame the analysis of the Master Plan.

3.3.1 Approach

The approach used to define future flows and loads was a population-based approach that decouples flow and load growth. This differs from previous linear projections and accounts for water conservation and increasing loads from population growth.

- A statistical analysis was performed on historical influent flows and loads to understand the annual average flows and loads and peaking factors. These findings were then compared and contrasted with the 2011 Master Plan and regional planning reports.
- Commercial growth was assumed to be proportional to residential growth. I&I flows were removed from the total flow prior to determination of a per capita flow.
- Per capita flow and load benchmarks were then combined with projected population increase by various methods (linear extrapolation of historical population growth or census projection estimates) to develop flows and loads projections.
- A summary of current and future projections for flows and loads is provided in in **Figure 3-2**, **Figure 3-3**, and **Figure 3-4**, and summarized in **Table 3-6.**

3.3.2 Key Findings from Data Evaluation and Benchmarking

Key findings from the flow and load projection effort are described below. Full details are provided in Appendix 1.

- The average influent flow, 5-day biochemical oxygen demand (BOD) and total suspended solids (TSS) load to the WWTP (2016 to 2019) were 12.8 MGD, 39,300 lb BOD/day and 40,200 lb TSS/day respectively.
- Average influent flows have decreased by 10 % over the last 19 years, while influent BOD and TSS loads have increased by 30% and 25%, respectively. This finding indicates that water conservation efforts will continue to decouple flow and load growth. Moving forward, it is recommended that the District track both flows and loads to understand treatment needs at the WWTP.
- Per capita wastewater, BOD, and TSS generation rates used for the projections are summarized in **Table 3-4**. These rates fall within the range typically observed for domestic wastewaters in the United States. For flow projections, the minimum observed flow per capita of 59 gpd/person was used. For BOD and TSS load projections, the average generation per capita was used. Note that the Department of Water Resources (DWR) recommends water efficiency improvements to reach 50 gpd /person by 2030, potentially resulting in lower influent flow projections. It is recommended that the District monitor influent flow and revisit the per capita usage if these conservation goals are met.

Table 3-4 Per capita assumptions for projections

	Per capita flow (gpd/person)	Per capita BOD (ppd/person)	Per capita TSS (ppd/person)
Minimum	**59**[1]	0.18	0.17
Average	63	**0.18**[1]	**0.19**[1]
Maximum	70	0.19	0.20
Typical Range in US	52 – 74	0.11 – 0.26	0.13 – 0.33

[1] Selected per capita parameter used in projections

- Association of Bay Area Governments (ABAG) population projections and linear projection of actual California Department of Finance (DOF) population data, coupled with per capita usage, were used to develop a window of flow and load projections for the planning horizon. ABAG projections resulted in 2040 populations estimates that were approximately 10% higher than DOF population projections (**Table 3-5**).

Table 3-5 Population growth projection from ABAG and DOF

Method	2020	2030	2040
A – ABAG	0.22M	0.26M	0.31M
B – DOF	0.22M	0.24M	0.27M

- Max day peaking factors were used to develop estimates for future wet weather flows. The peaking factors determined from recent historical data were consistent with those presented in the 2011 Master Plan. Further details of peaking factors can be found in Appendix 1.

3.3.3 Flow and Load Projections

Flow and load projections for the planning horizon are shown in **Figure 3-2**, **Figure 3-3**, and **Figure 3-4**, and summarized in **Table 3-6**. Efforts from this current work indicated:

- ABAG projections were consistently higher than projections developed from historical data trends and DOF projections, representing an upper bound of flow and load projections. Loads projected using historical data trends and DOF population regression are within 2% of each other and represented the lower bound of flow and load projections. These BOD and TSS projections are similar to the projections documented in the Treatment Plant Master Plan Update (July 2011).
    - The annual growth rate associated with the ABAG projection across the 20-year planning horizon is 1.7%, whereas the annual growth rate associated with the historical data trends and DOF projections is 1.1%.
- WWTP flow capacity is not anticipated to be reached in the 20-year planning horizon. However, **BOD treatment capacity** (noted by 2014 WWTP Capacity Assessment and confirmed via modeling under this Master Plan) **is projected to be exceeded between 2030 and 2037**. As a result, an expansion of the WWTP treatment capacity is required prior to 2030.

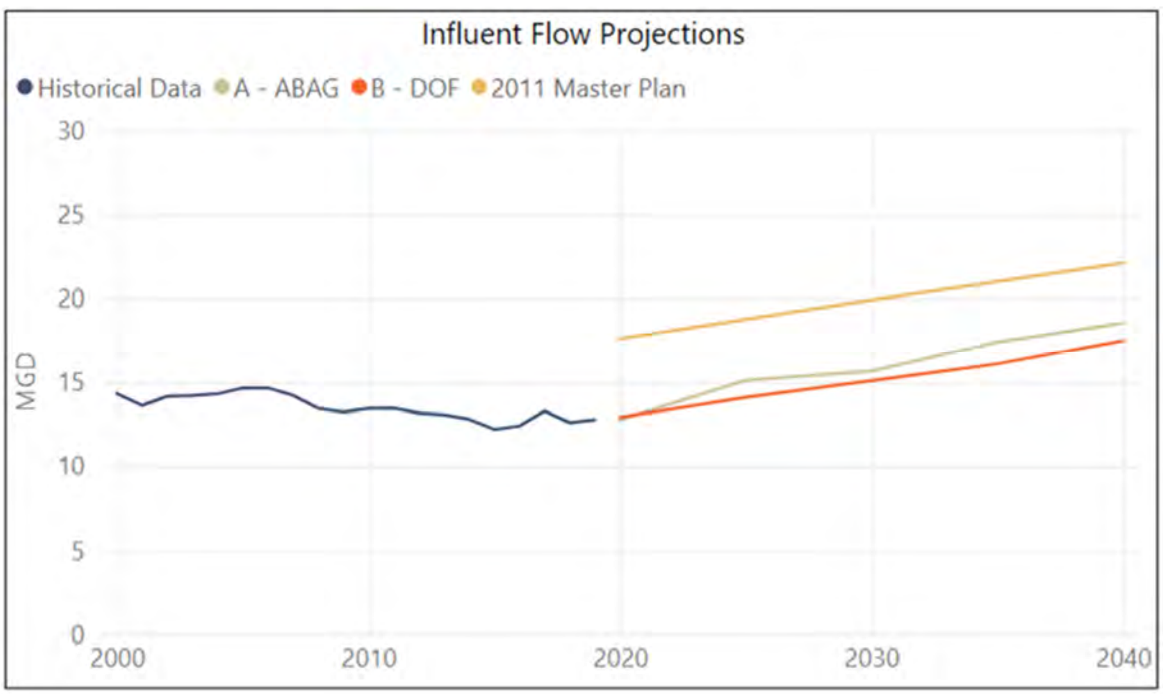


Figure 3-2: Influent Flow Projections

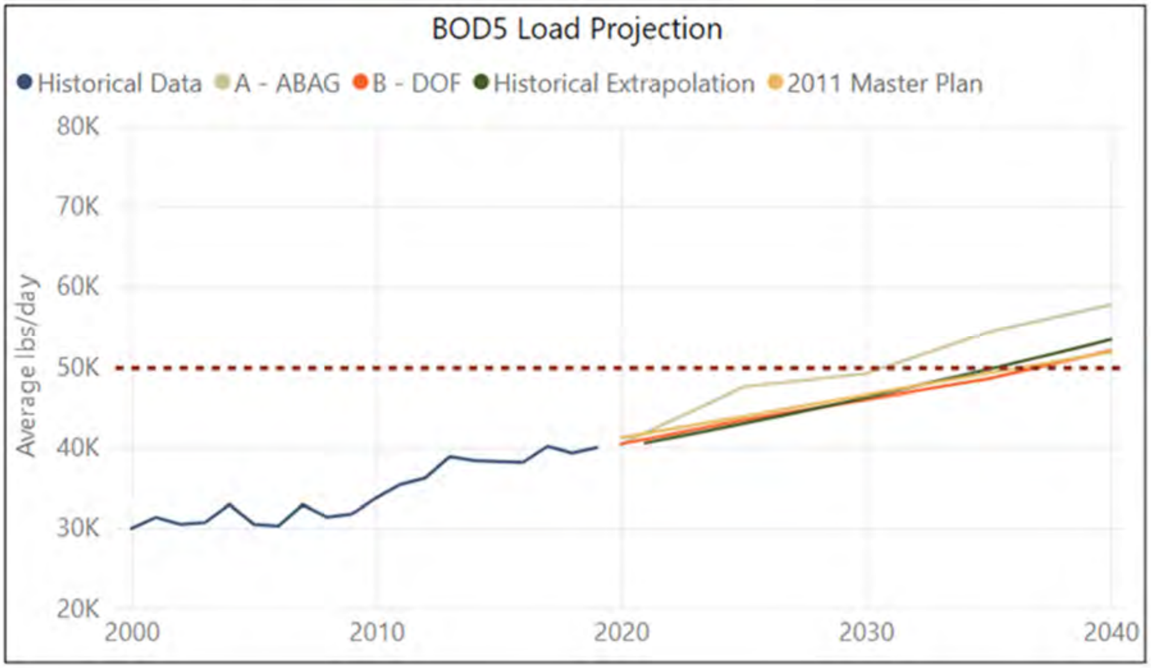


Figure 3-3: Influent BOD Load Projections

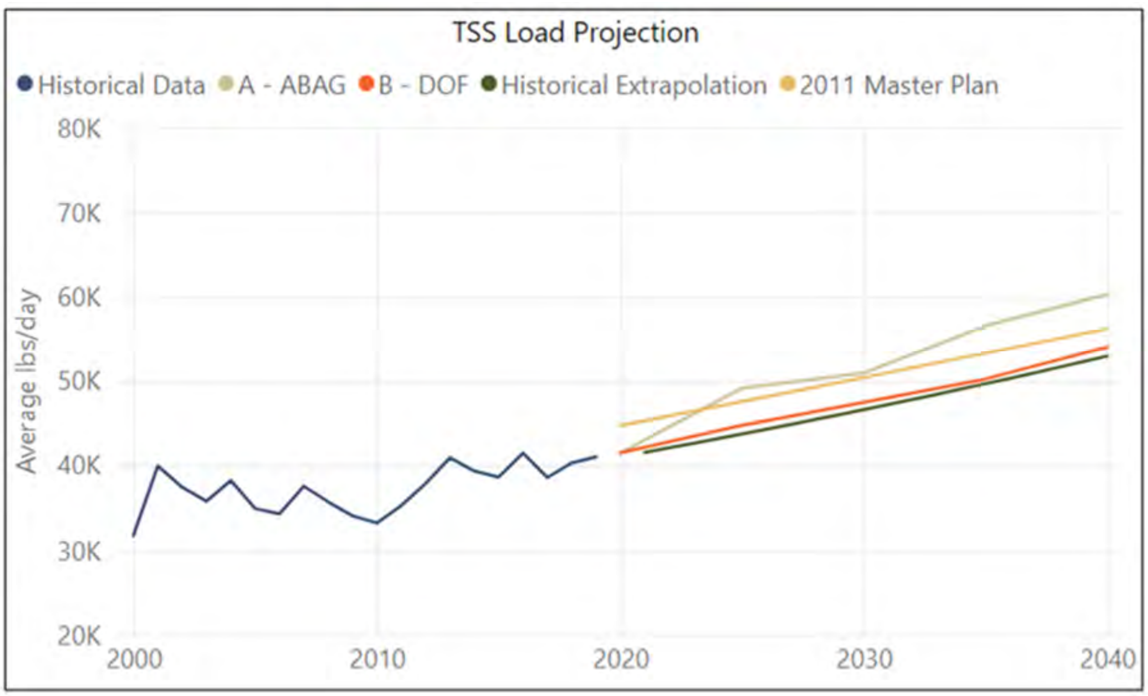


Figure 3-4: Influent TSS Load Projections

Table 3-6 Influent Flow and Load Projections

Current data	Projections			
2020		**2030**	**2040**	**Capacity Reached[1]**
Average Annual Influent Flow, MGD				
12.8 MGD	A – ABAG	16.3	18.4	2070
	B – DOF	15	16	2096
	2011 Master Plan	20	22	2057
	Wet Weather Flows (MGD)	22.5 - 24.5	24 - 27.6	
Influent BOD Load, lbs/d				
40,000 lbs/d	A – ABAG Growth	49,000	58,000	2030
	B – DOF Extrapolation	46,000	52,000	2037
	2011 Master Plan	47,000	52,000	
Influent TSS Load, lbs/d				
38,500 lbs/d	A – ABAG Growth	51,000	60,000	2036
	B – DOF Extrapolation	47,000	54,000	2040+
	2011 Master Plan	50,000	56,000	2040+

[1] Biological capacity of 53,200 lbs/d

Water conservation efforts will continue to decouple flow and load growth at the District. Moving forward, it is recommended that the District **track both flows and loads** using an equivalent flow concept to understand treatment needs at the WWTP. The equivalent flow concept involves:

- Maintaining the peak wet weather flow capacity of the plant (i.e., 31.1 MGD),
- Identifying the load threshold that limits capacity at the WWTP,
- Calculating the equivalent average dry weather flow corresponding to the load.

Table 3-7 demonstrates how the equivalent flow concept corresponds to the District's flow and load capacity. Load numbers represent the District's BOD load at the end of the planning period. For this 2022 Master Plan, all flows discussed are based on the 2022 Master Plan concentrations unless otherwise stated.

Table 3-7 Equivalent Flow Concept

	Equivalent Average Dry Weather Flow Capacity MGD	Average Annual BOD Concentration mg/L	Average Annual BOD load in 2040[1] (Table 3-6) lb/day
2040 Eq. Flow using 2022 Master Plan concentrations	18.4	376	58,000
2040 Eq. Flow using 2014 study concentrations	22.5	305	58,000
2040 Eq. Flow using 2011 study concentrations	24.6	280	58,000

[1] ABAG projection

4. Overview of Existing Facilities

The WWTP treats approximately 12.8 MGD influent wastewater through secondary treatment. **Figure 4-1** shows the process flow diagram of the WWTP. Flow is screened through mechanical bar screens (Qty. 3) installed as part of the 2019 Headworks improvement project. Grit is then removed through aerated grit chambers (Qty. 2). Flow is then treated through 70-ft diameter primary clarifiers (Qty. 4). Primary effluent can be equalized in either the Flow Equalization Basin (FEB) or the Equalization Storage Basin (ESB) during peak flow events. The Tower Pump Station pumps primary effluent to the Tower Trickling Filters (TTF) (Qty. 4). Flow from the TTF is combined with RAS and aerated in aeration basins (Qty. 5). Mixed Liquor Suspended Solids (MLSS) from the aeration basins is then clarified in circular secondary clarifiers (Qty. 5). Secondary effluent may be diverted to the RWF for recycling or be disinfected and dechlorinated prior to discharge to New York Slough.

Waste activated sludge (WAS) is thickened in gravity belt thickeners (GBTs) (Qty. 2). Thickened waste activated sludge (TWAS) is combined with primary sludge (PS) from the WWTP primary clarifies and treated in 1.1 MG anaerobic digesters (ADs) (Qty. 3). Digested sludge is then dewatered in two centrifuges. Cake from the facility is land applied. Filtrate from the GBTs and centrate from the centrifuges is returned to the main flow upstream of the TTF.

The RWF treats approximately 5.9 MGD (annual average from 2018 – 2020) of secondary effluent from the WWTP. Flow is treated in a ballasted flocculation process and then clarified in tertiary clarifiers. Flow is then filtered and disinfected prior to distribution. Recycled water, treated to Title 22 standards, is predominantly utilized for cooling by Calpine for the Delta Energy Center (DEC) and Los Medanos Energy Center (LMEC). Other recycled water customers include urban irrigation in the cities of Antioch and Pittsburg. Blowdown from LMEC and DEC is returned to the WWTP upstream of disinfection. Solids from the RWF are discharged to the WWTP upstream of the bar screens while tertiary filter backwash is returned to the RWF influent.

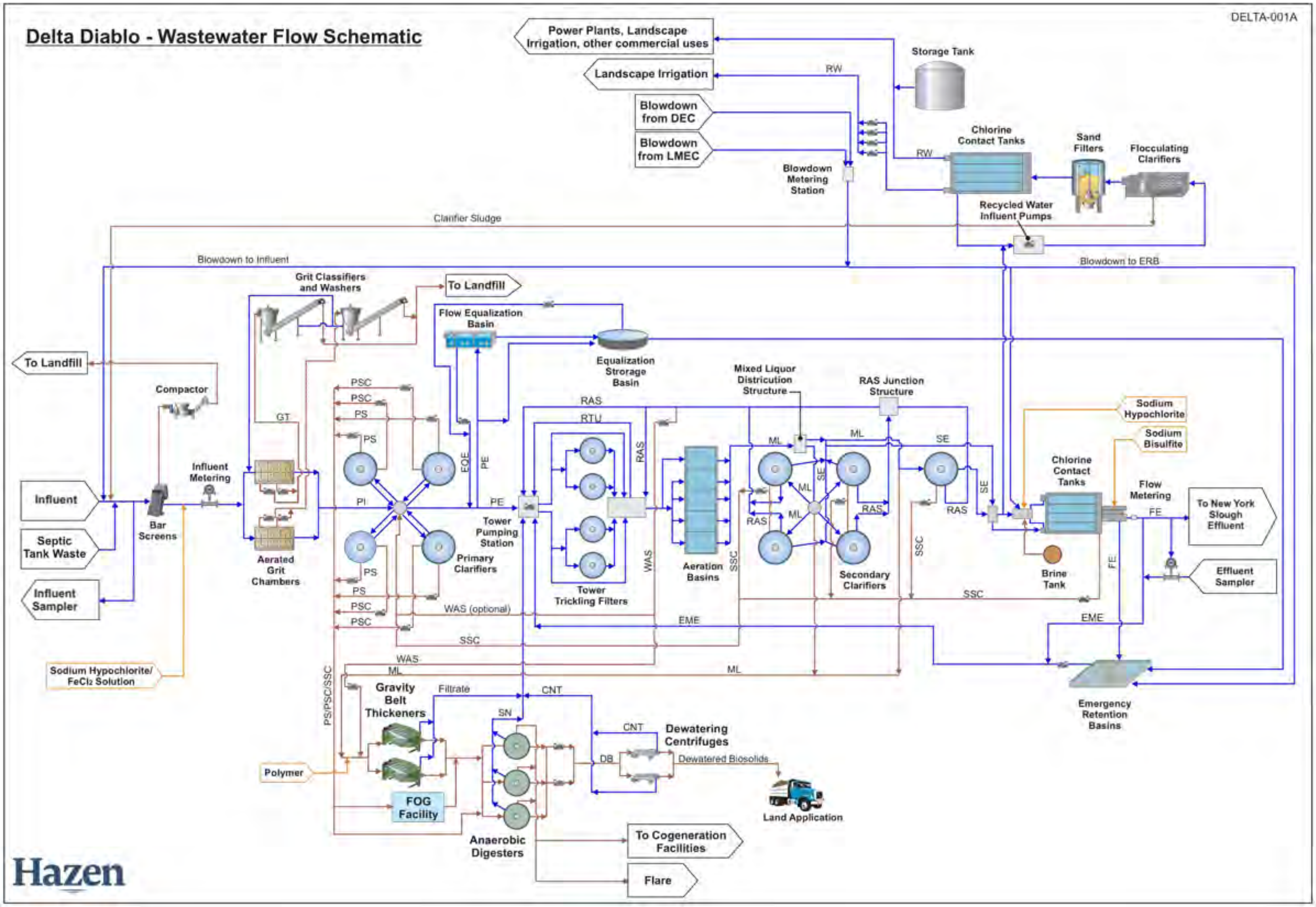


Figure 4-1 Delta Diablo RRF Process Flow Diagram

This Master Plan evaluated the secondary system biological capacity (Section 6), outfall hydraulic capacity (Section 5.3), and digester capacity (Section 7). Individual unit process capacity was not evaluated as part of this Master Plan. Process capacities are summarized in **Table 4-1** below.

Table 4-1 Delta Diablo WWTP Unit Process Capacities

Unit Process	Capacity (Hydraulic / Process)	Averaging period	Criteria	Note / Source
Screens	29.3 MGD (H)	PWWF	Design rating	2019[D]
Grit Removal	34.5 MGD (H)	PWWF	HRT = 3 min	2014[C]
Primary Clarifiers	24.9 MGD (H)	ADWF	AA HRT of 1.6 hr	1996[A]
Primary Clarifiers	57.4 MGD (H)	PWWF	SOR of 2,500 gpd/sf	1996[A]
TTF Pumping	31 MGD (H)	PWWF	5 duty, 1 standby	2014[C]
Secondary Treatment Biological Load	53,200 lbs BOD_5/d (P)	ADWF	TTF sBOD removal 40% aSRT = 1.5 d Airflow = 3 scfm/diffuser	Section 6
Secondary Clarifier	23.5 MGD (P)	ADWF	SVI = 70	2014[C]
RAS	22.1 MGD (H)	ADWF	20 MGD firm capacity 50% RAS Rate at MM condition 10 MGD / pump	2014[C]
WAS	77,300 lbs BOD_5/d; 24.6 MGD (30.4 MGD[1]) (P)	ADWF	450 gpm aSRT = 1 day	2014[C]
Chlorination	44 MGD[2] (H)	ADWF	HRT = 30 minutes	2014[C]
Chlorination	76.4 MGD[2] (H)	PWWF	HRT = 20 minutes	2014[C]
Outfall	16.6 MGD (H)	ADWF	Assuming 50% diffusers plugged	Section 5.3
Primary Sludge	160,000 lbs BOD_5/d; 51 MGD (63 MGD[1]) (H)	ADWF	3 duty/1 standby 300 gpm	2014[C]
Gravity Belt Thickener	113,000 lbs BOD_5/d; 36 MGD (44.3 MGD[1]) (H)	ADWF	240 gpm/ m 168 hrs/ week	2014[C]
Digesters	17 MGD (P)	ADWF	18-day HRT with two digesters in service	Section 7
Centrifuge	103,500 lbs BOD_5/d; 33 MGD (40.8 MGD[1,2]) (P)	ADWF	1,800 – 2,200 lb/hr (1 duty, 1 standby)	2014[C]

A-1996 Capacity Assessment
B-2011 DD Treatment Plant Master Plan Update
C-2014 WWTP Capacity Assessment
D-2019 Headworks Improvements Drawings
[1]Eqivalent flow assuming influent BOD = 305 mg/L noted in 2014 capacity assessment
[2]Buildout capacity

5. Focus Area 2 - Infrastructure Renewal and Regulatory Compliance Vulnerability

This focus area addresses asset renewal priorities due to aging infrastructure. The planning team, in consultation with the District, identified projects needed to address capacity, operational effectiveness and reliability (**Task 7 - Vulnerability and Process Control, Monitoring and Optimization** and **Task 12 - Outfall Hydraulics**). As part of this focus area, the planning team and District prioritized newly identified projects into the new 5-year CIP, while also helping to establish the relative priority between investing in linear versus vertical assets (**Task 2 - Condition Assessment**).

5.1 Condition Assessment

A major goal of this Master Plan is to develop a prioritized, long-term CIP that meets infrastructure needs, addresses regulatory drivers, and maintains operational effectiveness and reliability for the District. A **Condition Assessment and Risk Analysis** was undertaken to identify rehabilitation and replacement (RR) projects that serve as the baseline for the CIP. Long-term projects from the other technical tasks were incorporated into these findings to develop the final near- and long-term CIP (described in **Section 1**). This section describes the approach to and the key findings of the Condition Assessment and Risk Analysis task.

5.1.1 Condition Assessment Approach

- Prior to this Master Plan, the District had only performed formal condition assessments of linear assets outside the fence (undertaken by others). The condition assessment performed under this Master Plan focused on vertical assets at the WWTP. This Master Plan supports the District's asset management program by incorporating WWTP assets, further refining asset level consequence of failure, and combining analysis into one CIP list.
- A desktop condition assessment was conducted for the WWTP (vertical) assets. It used the age of asset and expected useful life for each asset class to determine remaining useful life (RUL) which was used as an indicator of Probability of Failure (PoF).
- A consequence of failure (CoF) was also determined for each asset. An asset level CoF scoring guide was used with CoF criteria and weights that were previously developed for the process level as part of the *District's Business Risk and Vulnerability* study.
- The business risk exposure (BRE) was determined for each asset based on the PoF, CoF and any mitigation strategies such as redundancy reducing CoF.
- A focused condition assessment was conducted to tailor the field inspection effort to the 2022 Master Plan budget. A risk methodology was used to identify assets for the focused condition assessment. It consisted of PoF and CoF with any mitigation such as redundancy reducing CoF as described in Figure 5-1.The focused condition assessment was conducted on 20% of the WWTPs assets and consisted of visual inspection by discipline leads and District staff. A visual inspection was conducted on the following areas: Aeration basins, secondary clarifiers, RAS meter pits, chlorine contact tanks and

effluent channels, gravity belt thickeners, digesters, blower building, FOG receiving facility, dewatering building and various MCCs. Results from the focused condition assessment were used to update the RUL and PoF of the assets inspected.

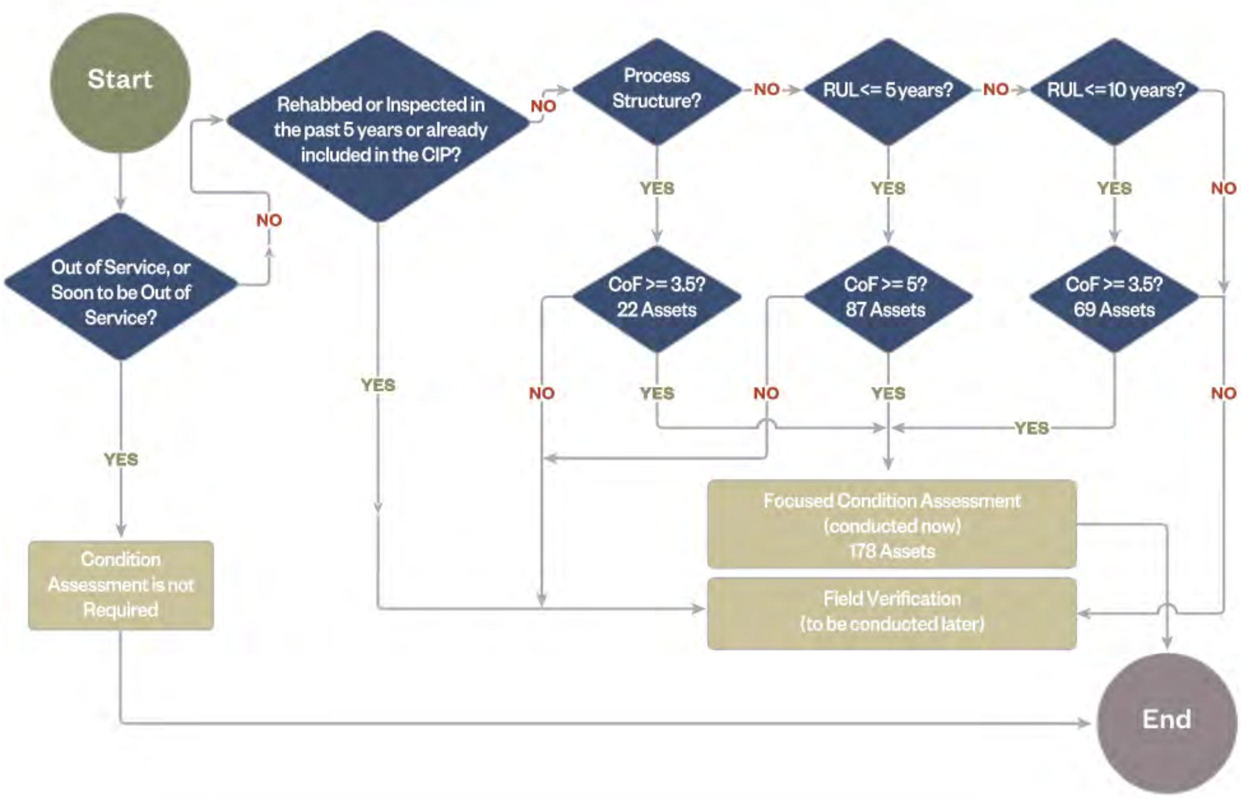


Figure 5-1 Focused Condition Assessment Selection Methodology

- The updated BRE scores were used to identify projects for the District's Capital Asset Replacement fund/program.
- A dashboard was developed to visualize results of the condition assessment and risk analysis.
- Projects identified from the vertical assets condition assessment, previously conducted linear asset condition assessment (by others) and projects identified by the District, were prioritized using the Business Case Evaluation (BCE) tool. Working with the District, Hazen guided the development of the criteria for risk, benefits and cost categories, as well as scoring and weighting criteria. The scoring and weighting criteria was used to develop scores for each project that was then used to determine the priority of projects in the near term (0-5 year) CIP.

5.1.2 Condition Assessment Key Findings and Conclusions

The results from the desktop condition assessment, focused field condition assessment and risk analysis of the WWTP found:

- Approximately 7% (26 assets) of all WWTP assets, all in the secondary clarifier area, with an estimated replacement cost of $7.3 million are approaching the end of their useful life and present a high risk for the WWTP.
- Approximately 14% of all WWTP assets with an estimated replacement costs of $15.3 million are estimated to require renewal within the next 10 years and present a medium risk.
- Approximately 79% of all WWTP assets with an estimated replacement cost of $85.2 million are estimated to require renewal beyond the next 10 years and present a low risk.

Time to Plan - The **District should begin planning for renewal of assets with a high PoF and medium CoF** risk in the areas listed in **Table 5-1**.

Table 5-1 Areas with Assets that have high PoF and Medium CoF Risk

Chlorine Contact Tanks & Effluent Channels	Digesters No. 1-3	RAS Pump Station
Dewatering Building	Aeration Basins	WAS Pump Station
Assets in Secondary Clarifiers area	South MCC Building	Gravity Thickeners

Figure 5-2 shows the projected capital outlay for assets that will need renewal. According to the projection, the District will have a spike in renewal funding needs in 2027. To attenuate this predicted spike in funding, **the District should consider advancing the renewal of high risk and some medium risk assets projected to require renewal in 2027 to years 2023, 2024 or 2025.** Alternatively, low risk and some medium risk assets could be delayed to 2028 and beyond.

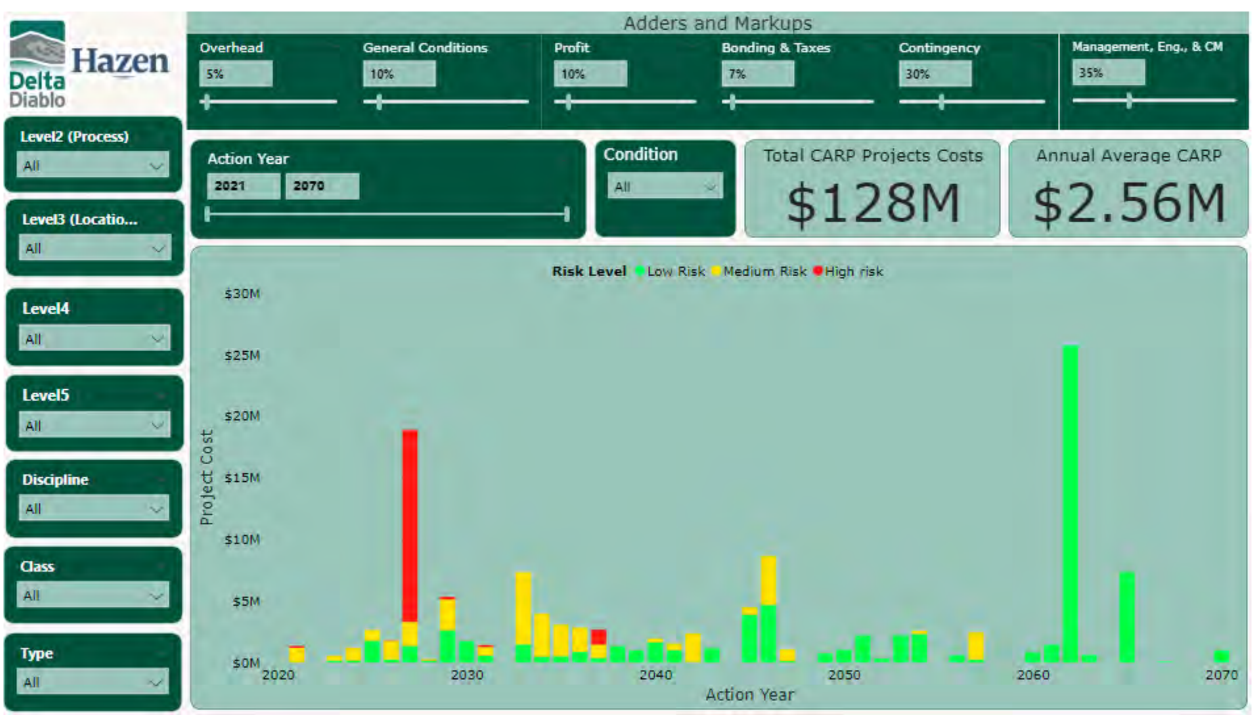


Figure 5-2 Projected 50 Year Capital Asset Replacement Fund/Program Funding Needs

The District should continue the condition assessments begun as part of this 2022 Master Plan by **focusing on areas with assets reaching the end of their useful life and high to medium CoF**, that were not already inspected by Hazen.

Assets that require renewal in the near-term, and those from 2027 that were advanced to 2023, 2024 or 2025 were bundled into projects. These projects were added to the District's 5-year CIP and are listed in **Table 5-2** below. Assets still in need of condition assessment are listed in Appendix 2

Table 5-2 5-Year CIP (Vertical Asset Condition Assessment and Vulnerability Projects Only)

No.	Title	Cost $K
Urgent Priority 12 to 24 months		
CIP-001	Secondary Process Improvements & Operational Improvements at Aeration Basins	60,000
CIP-005	CCT Analyzer Building Improvements	200
CIP-006	CCT Emergency Effluent Pump Station Replacement	450
CIP-007	CCT Sluice Gates and Chemical Mixer Improvements	1,500
CIP-008	Service Water Pumps Improvement	827
CIP-010	Dewatering Basement Polymer Equipment and Storage Area Improvements	794
CIP-012	Gravity Belt Thickeners Improvements	1,300
CIP-013	FOG Receiving Facility Improvements	50
CIP-016	WAS Pump Station Rehabilitation	50
CIP-018	Flow Equalization Basin Slide Gates Replacements	400
CIP-019	Condition Assessment of Treatment Plant Underground Piping	350
CIP-023	RAS Meter Pits and RAS Pump Station Improvements	600
CIP-025	Tower Mixing Chamber and Overflow Structure Rehabilitation	1,420
High Priority 3 to 5 years		
CIP-002	Treatment Plant Structural Assessment & Rehabilitation	700
CIP-004	Improvements at Secondary Effluent Feed to RWF	150
CIP-024	Chemical Canopy Rehabilitation	750
CIP-009	Condition Assessment of Select Electrical Gear	50
CIP-014	Sanitary Drain Pump Station Improvements	600
CIP-021	Centrifuge Platform Area Improvements	3,500

5.1.2.1 Condition Assessment Key Coordination Points

Condition assessment findings have been coordinated with several other analyses in this Master Plan. When considering alternatives for other focus areas, upgrade alternatives were compared to rehabilitation and replacement of infrastructure; i.e., new larger co-gen alternative was compared to the RUL of the existing co-gen system. Since only 20% of the WWTP assets were physically inspected as part of this focused condition assessment, any further assessment of assets should be incorporated into the District's asset registry and coordinated with the roadmaps developed as part of this Master Plan. For example, if the co-gen system becomes unreliable, inoperable, or requires significant down-time to address communication or other compatibility issues, this could trigger that it be replaced with a larger cogen that could accommodate energy neutrality.

5.2 Vulnerability Assessment and Process Control, Monitoring and Optimization

Recent events in the collection system and WWTP have prompted the District to reevaluate system vulnerabilities. This Master Plan supports the District's goal to enhance reliability and manage risk by identifying and mitigating potential treatment process vulnerabilities and finding opportunities to improve process monitoring, control, and optimization. This task answered the following questions:

- What infrastructure, equipment, and operational vulnerabilities to regulatory compliance exist and how should the District address these issues?
- What innovative, applicable, and cost-effective process monitoring, and control technologies should the District consider?

5.2.1 Vulnerability Assessment and Process Control, Monitoring and Optimization Approach

Process vulnerabilities were assessed for three major treatment areas, secondary treatment, anaerobic digestion, and disinfection; vulnerabilities in the collection system and RWF were not assessed. Physical vulnerabilities due to asset failure were identified under the Condition Assessment and Risk Analysis task (summarized in **Section 3.1**) and captured as part of CARP projects in the CIP recommended by this Master Plan. It should be noted that the District's standard operating procedures and training requirements were not reviewed as part of this task as they are periodically reviewed by staff.

- Secondary Treatment:
  - **Process modeling** was conducted to understand risk due to increased loads and with various TTF in service (and varying TTF performance). Modeled scenarios were considered risky if TTF operational targets could not be met, potentially leading deterioration of effluent quality. Key assumptions for operational targets were confirmed with staff and are summarized in **Table 5-33**. These values were selected as typical operating conditions at the plant.

Table 5-3 Secondary Treatment Vulnerability Analysis Operational Targets

Aerobic Solids Retention Time (aSRT)	Secondary Clarifier Loading	Airflow	Solids Concentrations
1.5-2 days	AA SLR: 25 ppd/sf MM SLR: 30 ppd/sf MD SLR: 40 ppd/sf	MM Airflow: 2 scfm/diff MD Airflow: 3 scfm/diff	PS: ~6% TS TWAS: ~5.5% TS Cake: ~25% TS

  - **TTF condition assessment:** TTF manufacturer was consulted for media inspection, destructive testing, and replacement costs. Improvements to the TTF to increase near-term carbon removal capacity were weighed against the need for capacity increase and future nutrient removal.

- **Anaerobic Digestion**:
    - Key assumptions based on current minimum thresholds for digester operation were used to evaluate process vulnerabilities. These include:
        - Scenario 1
            - One digester out of service
            - Minimum HRT of 18 days in service with two digesters online
        - Scenario 2
            - 20-day HRT with three digesters online.
    - Capacity was evaluated assuming two sludge production rates corresponding to liquids process with and without TTF in service. **Section 7.1** summarizes the analysis. These two scenarios represent:
        - Low sludge yield: current operation with the TTF
        - High sludge yield: future operation with only suspended growth (both for carbon removal and nutrient removal operation)
- **Disinfection**: Noted past difficulties and identified potential mitigation strategies.
- General plant wide recommendations were developed to reduce vulnerability and guide best practices. Recommendations for process monitoring and control were developed after reviewing historical process data.

5.2.2 Key Findings and Process Control, Monitoring and Optimization Recommendations

5.2.2.1 Secondary Treatment

In March 2019, the District WWTP experienced a process event that resulted in high final effluent BOD and TSS concentrations. While the WWTP did not exceed effluent limitations, the incident revealed several vulnerabilities in the secondary system including potential breakthrough of soluble BOD that can overload downstream processes. The incident and subsequent mitigation resulted in increased routine process monitoring, process training for staff, and microscopy training for early warning. This section summarizes key vulnerability findings in the secondary system.

5.2.2.1.1 Secondary System Process Modeling

Risk modeling for various scenarios (loads and number of TTF in service (varying TTF performance) **Figure 5-44**) shows increased loading, even in near-term, may not be able to achieve operational targets with a TTF out of service. The colors in the figure indicate the range of likelihood to miss operational targets from red (likely to exceed targets) to green (ability to meet targets consistently).

- As noted in **Section 3.3** and **Section 6.1.2.1,** the District is currently at 75-80% of biological capacity of the WWTP.
- As **flow and loads increase, the District will need to operate with more aeration basin and secondary clarifier units in service**.

- Loss of TTF performance reduces operational buffer (e.g., may need to operate SLR > 30 lb/ft^2-day for sufficient SRT).
- As TTF performance declines and soluble COD and soluble BOD break through the TTFs. The potential for overloading of the downstream processes increases the risk of permit noncompliance. The District will see a greater potential for increased binary fission cells (BFC) and/or filamentous growth due to soluble COD and soluble BOD breakthrough.
- **Plan for capital projects that provide additional volume/clarifier capacity.**

4 TTFs in service

	2020	2025	2030
4 ABs, 4 SCs	1.75	0.75	0.25
5 ABs, 4 SCs	2.00	1.75	1.25
5 ABs, 5 SCs	2.00	1.75	1.75

3 TTFs in service

	2020	2025	2030
4 ABs, 4 SCs	1.75	0.50	0.10
5 ABs, 4 SCs	2.00	1.50	1.00
5 ABs, 5 SCs	2.00	1.50	1.50

2 TTFs in service

	2020	2025	2030
4 ABs, 4 SCs	1.75	0.25	0.05
5 ABs, 4 SCs	2.00	1.25	0.90
5 ABs, 5 SCs	2.00	1.20	1.20

Figure 5-4 WWTP Vulnerability for Various Loadings and Units in Service

5.2.2.1.2 Tower Trickling Filter Condition Assessment

- Staff has noted that the **TTF media was sagging, indicating media failure**. There are concerns about the integrity of the bottom layers of the TTF.
- Media failure
  - Can lead to preferential flow paths for primary effluent resulting in short-circuiting and uneven buildup of biomass
  - Uneven biomass build up can lead to structural failure
  - Failure will be gradual with **performance degrading slowly over time** leading to increased soluble material breakthrough.
  - Bleed through of the TTF increases the District's vulnerability
- **Destructive testing of a media sample would require a costly disassembly** of the trickling filter to reach lower layers. Brentwood, the media manufacturer, noted that if testing was conducted, complete media replacement would be recommended rather than returning existing media back to the filter.
- Brentwood also noted that the **TTF are well beyond their useful life** and inspection would confirm this. Due to the age of the TTF, the manufacturer declined to estimate the RUL of a TTF with completely new media.
- Since TTF are not compatible with future nutrient limitations, a **costly rehabilitation including new media is not recommended**.
- **Phased decommissioning and demolition** of the Tower Trickling Filters coupled with expansion of aeration basin volume is recommended to allow for the District to achieve reliable BOD treatment as the tower trickling filter media approaches the end of its useful life.

- A project to increase liquid stream biological treatment capacity will be triggered in 2022 due to influent BOD loads reaching 80% of capacity, tower trickling filter media approaching the end of useful life as well as aeration basin and secondary clarifier capacity limitations. To be compatible with the nutrient management strategy that may require implementation of additional secondary treatment infrastructure and intensification technologies for meeting nutrient limits at the WWTP, it is recommended that the project increase aeration basin volume.

5.2.2.2 Digester

Increases in flows and loads to the WWTP will necessitate an increase in digester capacity at the WWTP. Modeling showed that process changes that occur in the liquid stream (decommissioning of the TTFs) will increase sludge production, accelerating the need for additional digester capacity. However, under both a high sludge production and low sludge production scenarios, the increase in digester capacity will be needed **within the planning period**. **Section 7.1** details the timing of these high and low sludge production scenarios and evaluates options to increase digester capacity within the planning period including an additional digester and high solids digestion. In the near-term, **allowing for digester operation at 17-day minimum HRT with two digesters online will decrease the buffer above the 15-day minimum required HRT**

5.2.2.3 Effluent Facilities

Recent disinfection incidences led to two NPDES permit exceedances related to total residual chlorine (TRC). The District's effluent limitation for TRC is 0.0 mg/L on an instantaneous basis (recorded hourly). The RWQCB will relax this standard by allowing dischargers to account for dilution at point of discharge. For the District this results in a 0.43 mg/L TRC as a one-hour average limit. While this will reduce potential vulnerabilities for the District, the dechlorination process will remain a critical process to meet discharge limitations for TRC.

District staff has also identified four critical items related to effluent facilities that impact disinfection and effluent disposal. These items and potential mitigation are summarized in **Table 5-4.**

Table 5-4 Effluent Challenges and Mitigation Strategies

Challenge	Mitigation Strategies
Nitrification at Calpine Facilities leads to increased dechlorination demand	• Install online nitrate/nitrite sensor to monitor water quality • Temporarily divert blowdown to head of plant if high nitrite observed. This will result in high TDS in recycled water and is a short-term strategy. Use data from nitrite/nitrate real-time sensor to match chlorine and SBS demand • Continue to work with Calpine to prevent nitrification (chemical addition) • Nutrient removal at the WWTP would reduce nitrification potential
Calpine changed cooling tower chemical program leading to dechlorination issues at WWTP	• Continued coordination with Calpine to identify if/when chemicals will change and when elevated doses will be utilized • Temporarily divert blowdown to head of plant when high doses expected. This will result in high TDS in recycled water and is a short-term strategy. • Explore installation of ORP or online chlorine/bromine monitoring to inform decision making
Elevated final effluent BOD when SE and blowdown BOD are low. (No cause identified / random in nature)	• District staff to deploy response plan and sampling strategy • Consider increasing frequency of CCT dredging and PM • Consider changes to autosampler tubing
Antioch RO Brine in outfall	• Perform detailed corrosion study • Reline outfall if needed • Treatment Plant Outfall Pipeline Cleaning & Inspection

5.2.2.4 Process Control and Monitoring Recommendations

Because of the age of the media in the TTFs, performance is expected to degrade over time requiring monitoring and optimization to extract value from the remaining life of the TTF until decommissioning. **Monitoring recommendations include:**

- flow to each tower,
- air flow (via portable meter),
- recirculation rate,
- TTF influent soluble BOD,
- TTF effluent soluble BOD,
- spulkraft (SK) rate,
- flushing rate,
- weekly TTF effluent microscopic analysis.

It is also recommended to increase recirculation and flushing to prevent buildup of biomass and maintain aerobic biofilm conditions. **Weekly MLSS microscopic analysis** is recommended to build a database of the suspended solids microbial population and identify early warning signs. Overall recommendations for liquids monitoring include water quality at influent, primary effluent, TTF effluent, secondary effluent and RWF effluent (generally for COD, BOD, TSS, VSS, and nutrients). More extensive monitoring will allow comprehensive key performance indicator (KPI) tracking throughout the system.

5.2.2.5 Key Coordination Points

Findings from the vulnerability assessment are coordinated with the Condition Assessment, Nutrient Management, and Biosolids Management tasks. General process monitoring and control recommendations are part of a global recommendations to reduce risk and implement District best practices. Studies recommended are:

- A Data Management Master Plan is recommended to develop a centralized data management and visualization platform that can then be extended to visualize key metrics related to plant performance, energy and chemical usage, as well as asset management (i.e., an integrated dashboard of KPIs can provide a central location for data viewing, calculations and analysis of historical data). This plan should be closely coordinated with the District's planned SCADA Master Plan.

1. SCADA Master Plan Update is pending. It will identify potential upgrades, changes, and/or replacements to enhance and increase the reliability of the District's SCADA system.
2. Electrical System Master Plan will evaluate the District's current and future electrical requirements and provide guidelines for planning the electric distribution system to serve the District in a reliable manner and potentially export power to nearby utilities.

- Recycled Water Master Plan Update will help the District chart the future of the recycled water program, RWF, and inform actions needed regarding outfall capacity improvements.
- Climate Change Study is recommended to satisfy regulatory requirements and mitigate impacts from climate change. Impacts may include site inundation, plant hydraulic throughput decrease, and changes to flows and loads.

5.3 Outfall Hydraulics

As part of the District's goal to assess the hydraulic capacities of wastewater conveyance facilities, this Master Plan included a task to estimate if and/or when a parallel WWTP outfall and pump station would be needed for discharge during high flows and tide events. This task preerorviously included evaluating alternatives to improve operation of the Bridgehead and Antioch pump stations; however, due to emergency work in the collection system in 2020, this analysis was removed the Master Plan.

5.3.1 Outfall Hydraulic Analysis Approach

- A spreadsheet-based model of the outfall was developed to estimate the outfall capacity for **various levels of diffuser clogging**: current conditions (50% of diffuser ports open); partially cleaned out condition (75% of diffuser ports open); and cleaned (100% of diffuser ports open); and for summer and winter flows.
- The capacity under these conditions was then compared to projections of future flows (**average summer and winter flows** as outlined in **Section 3.3**) to estimate if and/or when during the planning period the District should begin planning an outfall capacity project.
- Key assumptions for the outfall hydraulic modeling are summarized in **Table 5-5**.

Table 5-5 Key Assumptions for Outfall Hydraulic Modeling

Flow	Summer Value	Winter Value
Total Flow from CCT[1]	12.8 MGD	18.4 MGD
Recycled water flow to LMEC/DEC	9.7 MGD	9.7 MGD
Blowdown from LMEC/DEC	5 MGD	5 MGD
Recycled water flow for irrigation	2.8 MGD	0[2]
RO Concentrate from City of Antioch	2.0 MGD	0[2]

[1]Flows escalated per projections described in **Section 3.3.3**
[2]Assumed to be zero during winter

- The receiving water level is a controlling factor dictating the capacity of the outfall. The assumed level accounted for both sea level rise and storm conditions. The Federal Emergency Management Agency (FEMA) 100-year storm surge elevation of 11-ft was used. Sea level rise assumptions from various sources were reviewed. The intermediate-low NOAA sea level rise prediction for Port Chicago (located 12 miles downstream from the WWTP), 11.8 inches by 2070, was used. This was close to the City of Pittsburg's preliminary estimate of 7 to 10 inches. For conservatism this was assumed to be achieved by 2040.

5.3.2 Outfall Hydraulics Key Findings

- Modeling found that the outfall capacity decreases slightly (less than 0.5 MGD) over the planning period due to sea level rise and storm surge.
- Modeling also showed that cleaning the outfall (e.g., unplugging the plugged diffusers, removing debris) could increase the outfall capacity by up to 9 MGD.
- The future of the RW program has a major impact on outfall flows, assuming the local power plants stay operational. Scenarios and required actions are summarized in **Table 5-6.** The District should **incorporate an outfall analysis as part of the future Recycled Water Master Plan**.

Table 5-6 Outfall Recommendations for Various Scenarios

Scenario	Action Required
Dry Weather with Calpine	District would not need to increase outfall capacity nor clean the plugged diffusers during the planning period, as long as no more diffusers become plugged
Wet Weather with Calpine	Clean the outfall by 2022 to maintain adequate hydraulic conditions during wet weather. With 100% of the diffusers open the outfall would have adequate capacity through the planning period.
Dry Weather w/o Calpine	Clean the outfall as soon as the RW goes away because the outfall capacity would be exceeded with 50% of the diffusers open by 2025; with all diffusers open the outfall would have adequate capacity through the planning period
Wet Weather w/o Calpine	Clean the outfall as soon as RW is discontinued; with 100% of the diffusers open planning for a new outfall would need to begin around 2025

5.3.2.1 *Key Coordination Points*

- The District should revisit the outfall analysis if there are significant changes to the amount of RW produced and thus flow through the outfall. The Recycled Water Master Plan should update the analysis of the outfall capacity based on potential recycled water use.
- The analysis should also be reviewed if the climate change study changes key assumptions used in this analysis.

6. Focus Area 3 - Nutrient Management and Advanced Treatment

This task focuses on developing a strategic technical, and financial approach to meet future nutrient removal regulatory requirements as well as other advanced treatment needs (**Task 4 - Nutrient Management**). As part of this work, coordination was performed across focus areas related to biosolids, biogas, renewable energy, infrastructure renewal, compliance vulnerability and land use planning.

6.1 Nutrient Management

The District is faced with potential implementation of varied nutrient limits at the WWTP (**Section 3.1**). The SF Water Board has been developing the foundational science behind potential nutrient limits for the SF Bay. The SF Water Board has taken the following actions.

- The SF Water Board adopted the first Nutrient Watershed Permit (WSP) in 2014 in response to increased regulatory focus on the impacts of nutrient loading on the health of San Francisco Bay. The first Nutrient WSP required effluent monitoring to assess WWTP loading and trends, funding of scientific studies to better understand the watershed impacts, and completion of a study to evaluate treatment options at WWTPs.
- In 2019 the SF Water Board issued a second watershed permit that continued the requirement to monitor and report nutrient discharges. The watershed permit also identified potential planning level targets equal to the baseline nutrient load plus 15% for growth.
    - As part of the 2019 watershed permit the SF Water Board has indicated that load caps, may apply to subembayments
    - Regional nutrient trading may be accepted
    - Early adoption of nutrient removal may acknowledge by deferring further upgrades

Table 6-1 Assumed Nutrient Limits Considered for Master Plan

Interim	Future (2040 Design Horizon)	Place Holder (Beyond 2040)
Nutrient Load Caps Seasonal BNR	BACWA Level 2 TN < 15 mg/L TP < 1 mg/L (assumed monthly standard[1])	BACWA Level 3 TN < 6 mg/L TP < 0.3 mg/L (assumed monthly standard[1])

[1] Assumed a monthly average for conservatism. Actual standards may be applied seasonally or annually.

There is significant uncertainty in the timeline, standards, and application of nutrient limits. Implementation of these limits will have cascading impacts to the WWTP which include:

- Expansion of liquid stream infrastructure to provide sufficient treatment capacity at the WWTP impacts site planning and plant operations.
- Changes to liquid stream processes impact sludge production, capacity of solids treatment processes and sidestream flows and loads.

- Changes to liquid, solids, and sidestream treatment impacts the energy profile at the WWTP and RWF.
- Incorporation of nutrient removal technology at the WWTP will increase operations and maintenance needs relative to carbon only treatment.
- Water quality generated from the WWTP will change characteristics of RWF treatment needs.

While current indications are that load caps will be introduced in 2024, they will likely be imposed on the whole bay. If structured similarly to the mercury watershed permit, there will be no violations unless a discharger and the subembayment exceed their load caps. A discharger exceeding their individual load cap will likely trigger certain actions but would not be considered to be in violation. As there is significant potential for the timing of standards to change, it is in the District's best interest to continue engaging with the SF Water Board through BACWA on a regional level. These efforts could reduce the infrastructure required to comply with future nutrient requirements.

6.1.1 Nutrient Management Approach

Integrated solutions (IS) were developed to combine various technologies and approaches (i.e., modified ludzack-ettinger (MLE) and densification) into a wholistic alternative to transition the District from carbon removal to nutrient removal. To develop plant-specific integrated solutions, the following approach was taken

- Extensive sampling was performed to facilitate development, calibration, and validation of a whole plant process model.
- The calibrated process model was used to determine the **capacity** of the biological treatment process. An alternative analysis was then conducted to identify options to **increase the carbon removal capacity** of the WWTP in advance of nutrient removal technology implementation.
- Several options related to nutrient removal technologies were reviewed (26 different technologies) and screened in tandem with District staff. This resulted in the development of three (3) integrated solutions (IS) for nutrient removal implementation (**Table 6-2**).
- Integrated solutions were then **evaluated based on cost and non-cost criteria** to identify the best path forward for the District.
- A **trigger-based roadmap was developed** for helping to navigate nutrient removal considerations at the WWTP.
- **Near- and long-term CIP needs were developed** for potential paths forward.

Table 6-2 Integrated Solutions Considered for WWTP Nutrient Management

Integrated Solution 1 Flexible BNR	Integrated Solution 2 Aerobic Granular Sludge (AGS)	Integrated Solution 3 Membrane bioreactor (MBR)
Utilize conventional multi-stage BNR Potential to intensify with densification (DAS) or membrane aerated bioreactor (MBR). Potential for Next gen Nitrogen removal	Utilize AquaNereda™ for maximum densification. Eliminate clarifiers through use SBR. Potential for Next gen Nitrogen removal	Intensify with MBR Eliminate clarifiers through use of membrane cassettes
Side stream deammonification	Side stream deammonification	Side stream deammonification
Biological Phosphorus Removal with Chemical P-trim	Biological Phosphorus Removal with Chemical P-trim	Biological Phosphorus Removal with Chemical P-trim

6.1.2 Nutrient Management Key Findings

6.1.2.1 Capacity Key Findings

- The **BOD load capacity** of the facility was found using the calibrated process model, to **be 53,200 lbs/day**. This BOD load capacity will be exceeded within the planning period. Based on current raw influent BOD load, the **WWTP was found to be around 75% of BOD treatment capacity** (80% of BOD load estimated in the 2014 Capacity Analysis). A buffer of 20% is typically used to trigger planning of a capacity increase.
- Findings indicated that increasingly high BOD loads onto the TTF may result in bleed-though of soluble organics to aeration basins. This bleed-through of organics can increase the potential for selection of undesired microorganisms that can cause settling problems and impact effluent quality.
    - Bleed through of the TTF increases the District's risk of plant upsets and permit violations. As noted in **section 5**, significant investment will be required to improve TTF performance and increase capacity. As the TTF are not compatible with future nutrient removal, capacity increases focusing on expanding aeration basin volume were evaluated. Increased aeration basin volume will allow the District the flexibility in designing and constructing future nutrient removal projects.
- **Table 6-3** demonstrates how the equivalent flow concept corresponds to the District's flow and load capacity. Load numbers represent the District's BOD load at the end of the planning period in which the AA BOD load exceeds the previously mentioned facility load capacity of 53,200 lb/d.

Table 6-3 Equivalent Flow Concept for Future Conditions

	Equivalent ADWF Capacity (MGD)	AA BOD conc (projected) (mg/L)	AA BOD load (lb/d)
Master Plan 2040 Capacity High load projection (using 2020 concentrations)	**18.3**	**376**	**58,000[1]**
Master Plan 2040 Capacity High load projection (using 2014 study conc)	22.5	305	58,000
Master Plan 2040 Capacity High load projection using 2011 study conc)	24.6	280	58,000

AA = annual average
[1] BOD load in 2040 exceeds current BOD load capacity

- The Secondary Treatment Improvements Project identified to increase WWTP secondary treatment capacity (for carbon) in a manner that allows for decommissioning of the TTFs includes the following infrastructure. **Figure 6-1** shows the site plan for the Secondary Treatment Improvements Project to increase the WWTP secondary capacity with infrastructure shown in yellow (Note: the fourth digester shown is not part of the Secondary Treatment Improvements Project).
  - Rehabilitation of TTF pump station
  - New primary effluent distribution (location to be coordinated to be further coordinated)
  - One new 1.2-MG aeration basin with 25-ft sidewater depth (3.1 MG of total new and existing volume)
  - Retrofit existing aeration basin volume with anaerobic selectors
  - New secondary clarifier splitter box
  - One new 90-ft diameter secondary clarifier with15-ft sidewater depth (6 total).
  - New blower building
  - One new 300-hp turbo blower to provide 7,000 sfcm (3 total duty turbo blowers providing 21,000 scfm firm capacity) and blower room

- Improvements to the TTF pump station is needed for both near-term reliability and future BNR operations.
- The total 3.1 MG of aeration basin volume (new and existing modified with anaerobic selectors) will be sufficient to treat the entire WWTP flow to meet current secondary treatment standards. This will allow for the phased decommissioning of the TTF. The decommissioning and removal of the TTF will make space for future basin volume that will be required for nutrient removal.
- The 1.2 MG aeration basin volume will be deeper (25-ft sidewater depth), and more amenable to conversion to nutrient removal basins.
- The new turbo blower and blower building are required to aerate the deeper aeration basins.

- The additional secondary clarifier will also be reused as part of the future flexible BNR nutrient removal solution.
- The estimated project costs of for the Secondary Treatment Process Improvements Project is $52M.

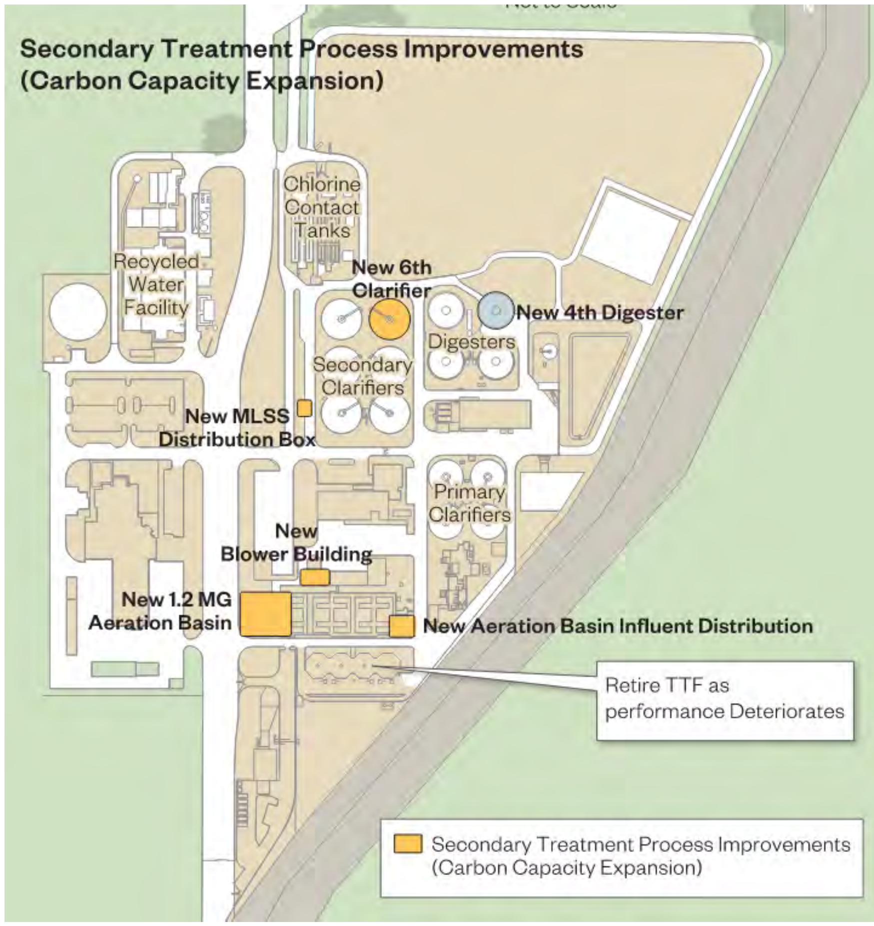


Figure 6-1 Secondary Treatment Process Improvements Project to Increase Capacity

6.1.2.2 Considerations for Implementing Nutrient Removal

The evaluation of integrated solutions yielded the following outcomes:

- Sidestream nitrogen treatment (e.g., deammonification) can remove 10 to 12% of the total nitrogen load at the WWTP regardless of the mainstream nutrient removal technology implemented.
- All integrated solutions can fit within the existing site; however, all solutions eventually require demolition of the TTFs to provide space for activated sludge tankage (**Table 6-4**). Demolition of the TTFs is possible because of the Secondary Treatment Improvements Project which is a prerequisite for all integrated solutions.

Table 6-4 Integrated Solutions Total Tankage Requirements

	IS 1 Flexible BNR	IS 2 Aerobic Granular Sludge	IS 3 Membrane Bioreactor
Nutrient Load Cap	5.1 MG	7.5 MG	4.8 MG
BACWA Level 2	7.7 MG	9.8 MG	
BACWA Level 3	9.4 MG	12.3 MG	6 MG

1. Integrated Solution 1 – Flexible BNR

As noted in **Table 6-4**, the District can achieve load cap, BACWA Level 2, and BACWA Level 3 effluent standards with additional infrastructure. **Figure 6-2** shows the process flow diagram of Flexible BNR. **Figure 6-4** through **Figure 6-6** show the site plan for the infrastructure required for each level of nutrient removal.

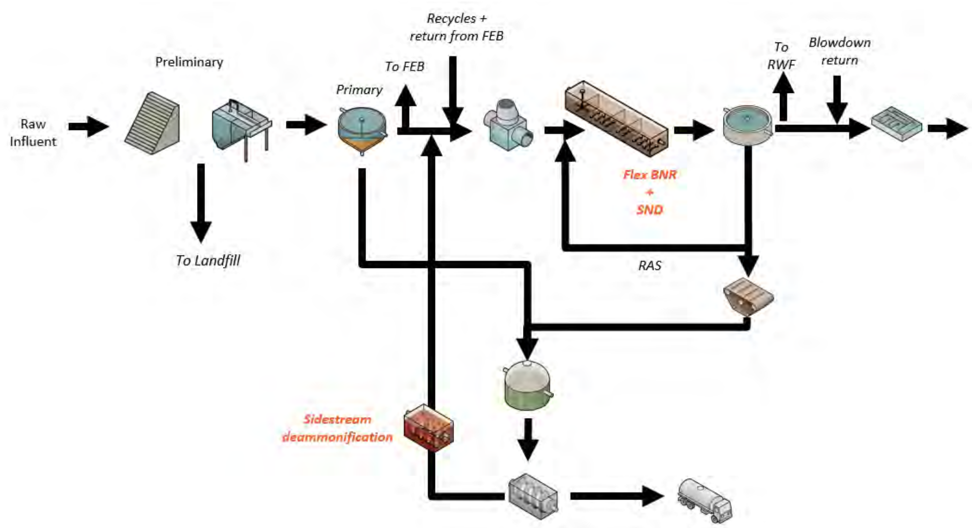


Figure 6-2 Integrated Solution 1 – Flexible BNR Process Flow Diagram

The Flexible BNR solution incorporates more aeration basin volume at a higher MLSS concentration to achieve the higher SRTs required for nutrient removal. Additional clarifier surface area will be needed to maintain effluent TSS standards. The aeration basins will be configured to have anaerobic, anoxic, and aerated zones as well as an internal nitrified recycle stream to facilitate BNR. **Figure 6-3** shows the potential configuration of the BNR basins. Selected swing zones have the flexibility to operate in different modes by changing the configuration of where primary effluent and RAS are introduced and turning off the air to the zone.

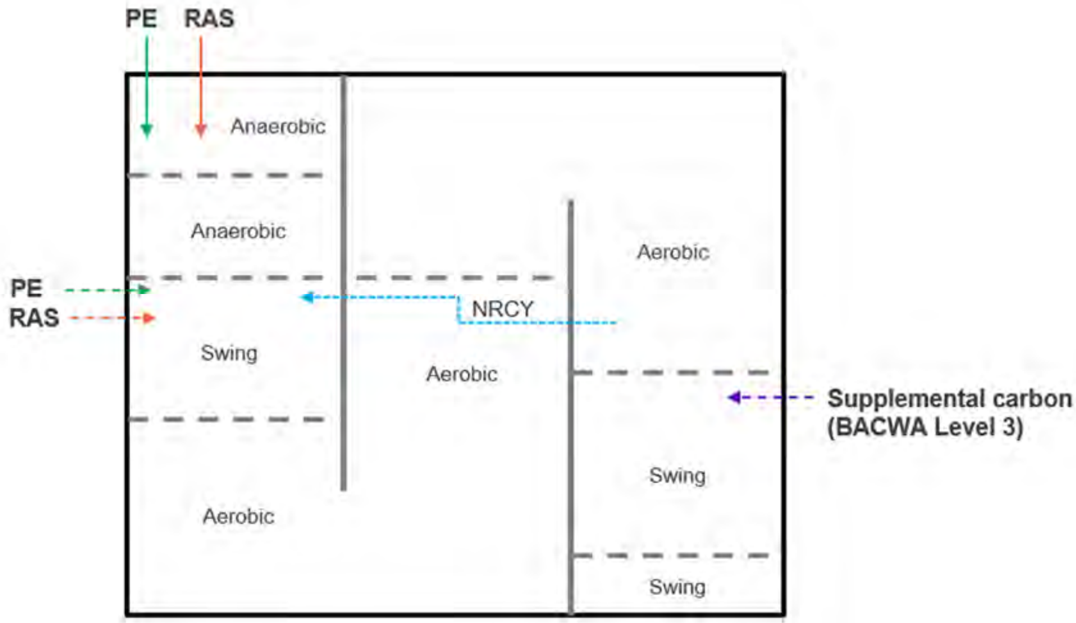


Figure 6-3 Integrated Solution 1 Flexible BNR Potential Basin Configuration

Flexible BNR allows for integration of other burgeoning intensification technologies including densification and membrane aerated bioreactor (MABR). These technologies can be explored as they become more viable and cost effective.

a. IS 1 – Flexible BNR required infrastructure for load cap standards

The additional infrastructure required to achieve load cap standards is shown in **Figure 6-4** and includes:

- Demolish the Tower Trickling Filters by treating 100% of flow in the new aeration basins.
- Construct new secondary treatment infrastructure:
  - New primary effluent distribution channel.
  - 3.9 MG (3 basins at 1.3 MG each and 25-ft deep) of new aeration basin volume (5.1 MG of total existing and new aeration basin volume with 25-ft sidewater depth).
  - Retire existing shallow aeration basins.
  - New mixed liquor distribution channels.
  - One new 90-ft secondary clarifier with 15-ft sidewater depth (7 total).
  - One new 300-hp turbo blower to provide 7,000 sfcm (4 total duty turbo blowers providing 28,000 scfm firm capacity)
  - Note: Intensification has the potential to reduce capital and operating costs.*

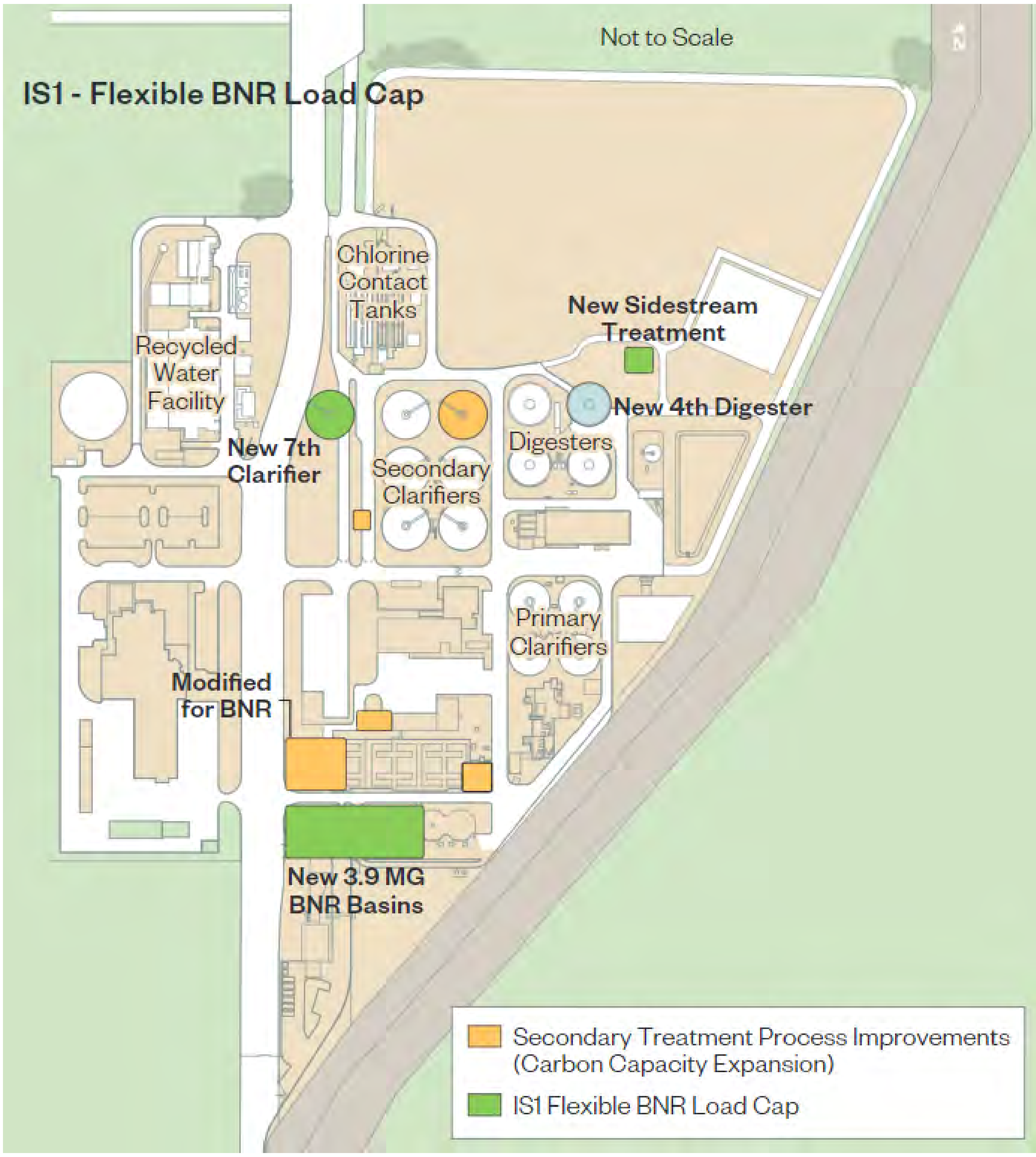


Figure 6-4 Integrated Solution 1 Flexible BNR Load Cap Required Infrastructure

b. IS 1 – Flexible BNR required infrastructure for BACWA Level 2 standards

To achieve nutrient removal BACWA Level 2 standards, aeration basin volume will need to increase by 2.6 MG (7.7 MG total BNR volume). This volume will be constructed in the footprint of the decommissioned aeration basins as shown in **Figure 6-5**.

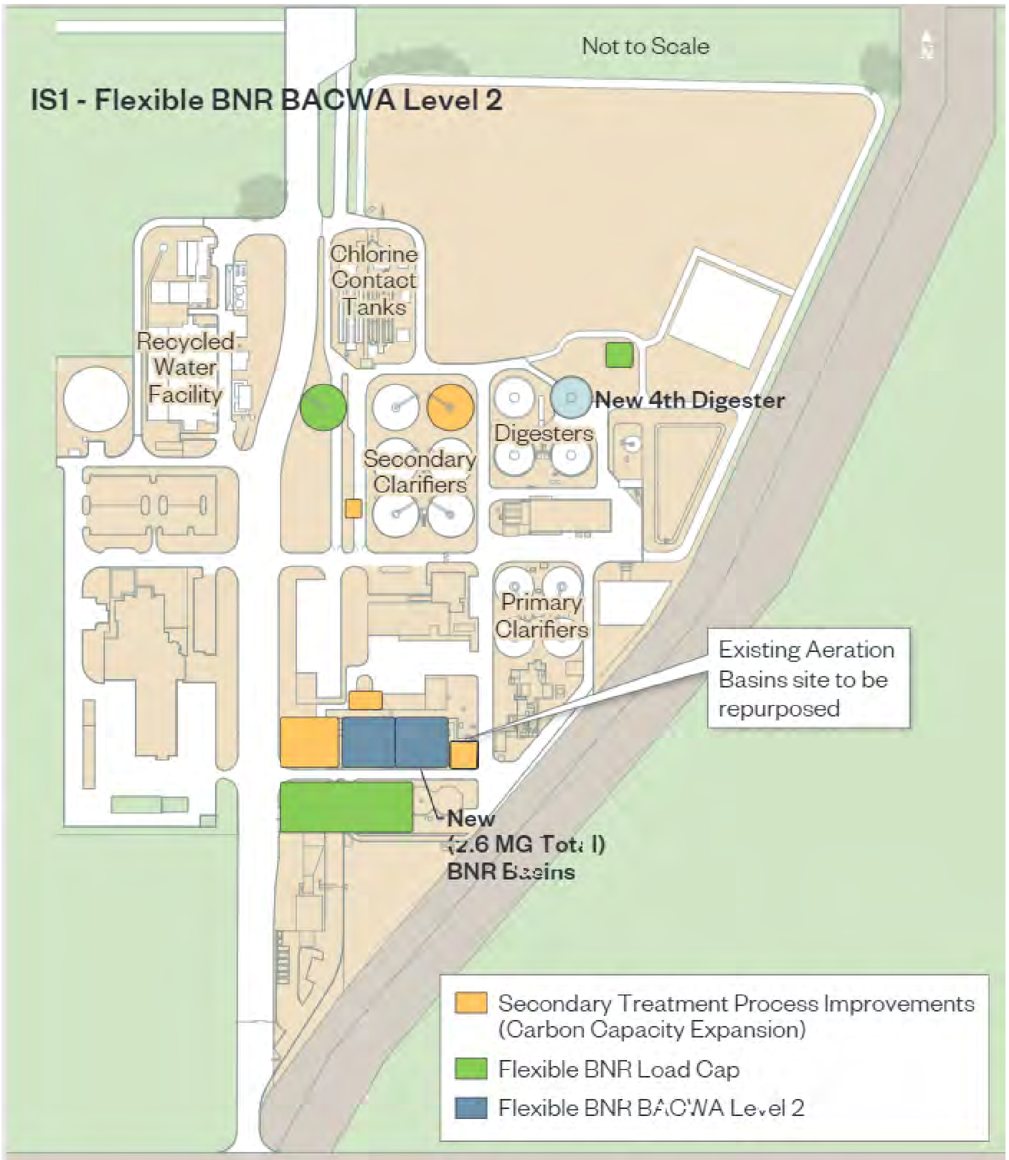


Figure 6-5 Integrated Solution 1 Flexible BNR BACWA Level 2 Required Infrastructure

c. IS 1 – Flexible BNR Required Infrastructure for BACWA Level 3 standards

To achieve nutrient removal BACWA Level 3 standards, aeration basin volume will need to increase by 1.7 MG (9.4 MG total BNR volume). This volume will be constructed in the footprint of the decommissioned TTF as shown in **Figure 6-6**.

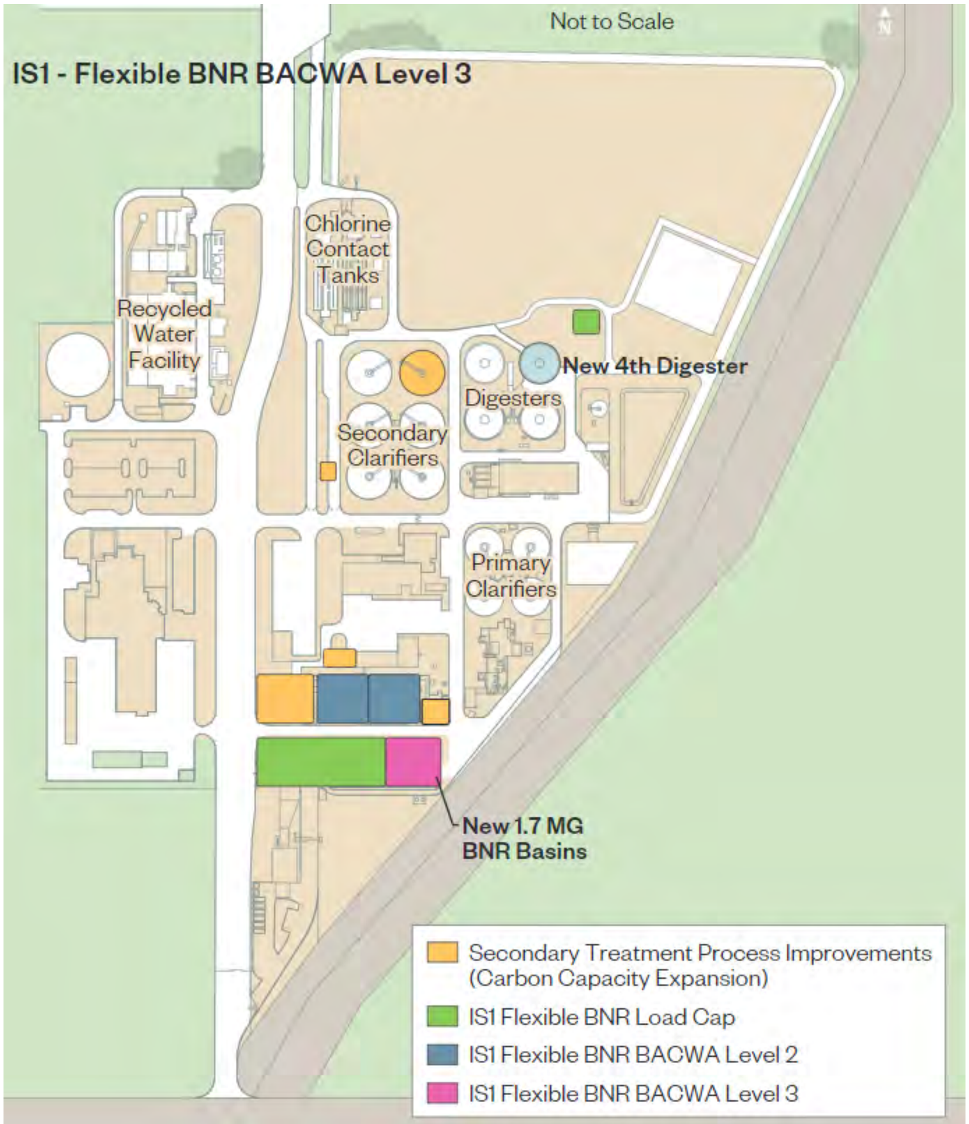


Figure 6-6 Integrated Solution 1 Flexible BNR BACWA Level 3 Required Infrastructure

2. Integrated Solution 2 – Aerobic Granular Sludge

As noted in **Table 6-4**, the District can achieve load cap, BACWA Level 2, and BACWA Level 3 effluent standards with Aerobic Granular Sludge (AGS)**. Figure 6-7** shows the process flow diagram of Integrated Solution 2 Aerobic Granular Sludge. **Figure 6-8** through **Figure 6-10** show the site plan for the infrastructure required for each level of nutrient removal.

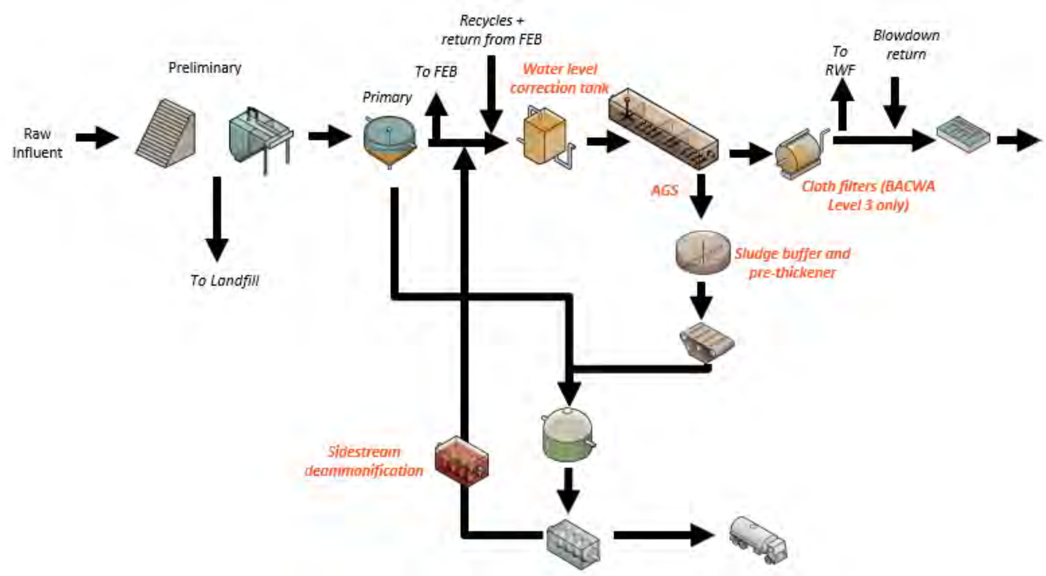


Figure 6-7 Integrated Solution 2 - Aerobic Granular Sludge Process Flow Diagram

The AGS technology is implemented in sequencing batch reactors (SBRs) that cycle through fill, aeration, settling, and decant phases. Since settling is done within the SBR, secondary clarifiers and RAS systems are not required for implementation of this technology. Because SBRs cycle through fill stages, multiple SBRs operating out of phase and flow equalization will be required to treat influent flow. Since the SBRs will operate as separate sludges the District will need to monitor each SBRs for process control.

a. IS 2 – Aerobic Granular Sludge required infrastructure for load cap standards

The additional infrastructure required to achieve load cap standards is shown in **Figure 6-8** and includes:

- Demolition the TTF to make space for future BNR basins.
- New primary effluent distribution
- Construction of two 2.5 MG sequencing batch reactors.
- Addition of 1.2 MG SBR
- Modification of the 1.2MG deep aeration basin (installed under the Secondary Treatment Process Improvements Project) to operate as an SBR
- One new 80,000-gal water level correction tank
- Conversion of two existing secondary clarifiers to sludge buffer / pre thickening tanks
- New effluent channel
- New blowers
- Sidestream treatment

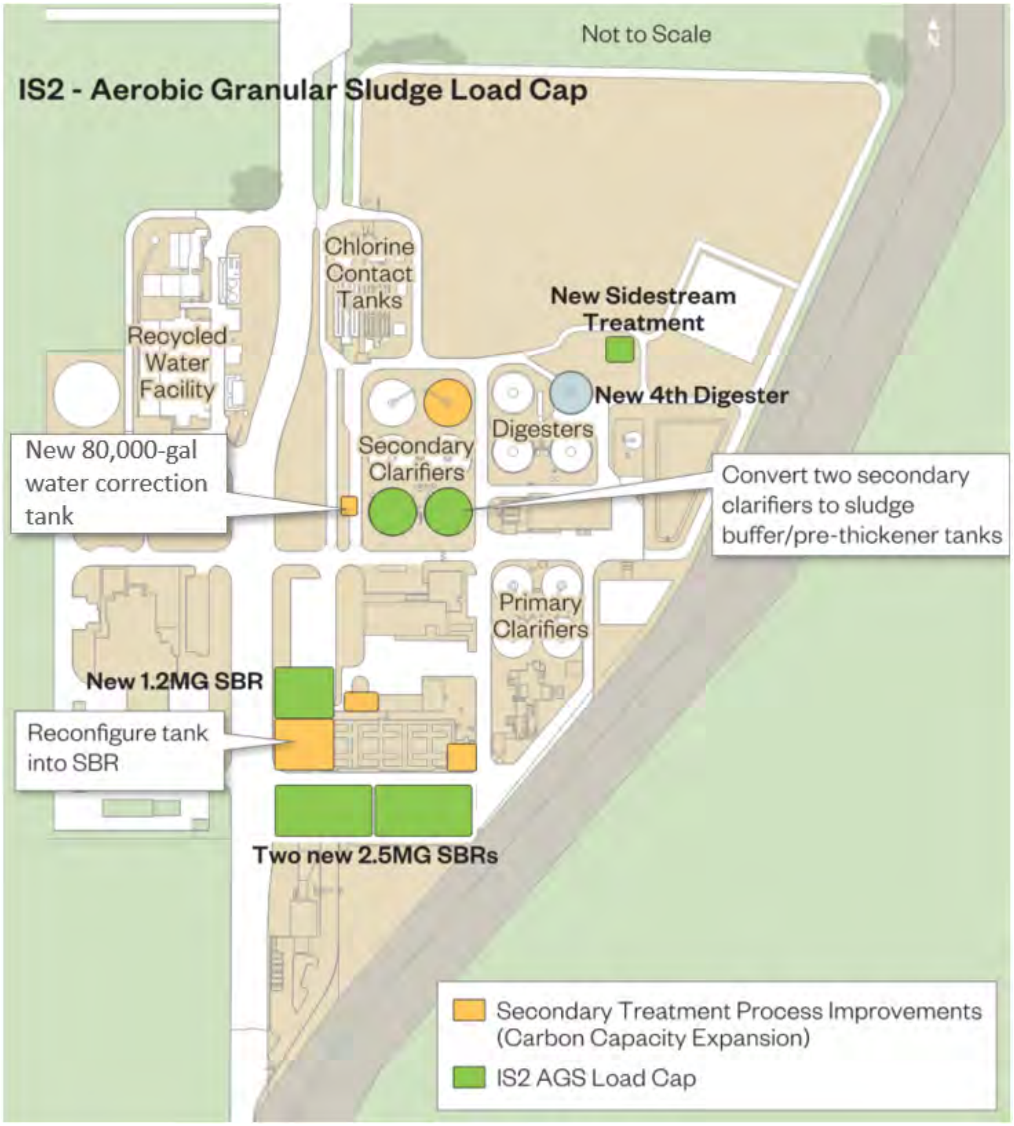


Figure 6-8 Integrated Solution 2 AGS Load Cap Required Infrastructure

b. IS 2 – Aerobic Granular Sludge required infrastructure for BACWA Level 2 standards

To achieve nutrient removal BACWA Level 2 standards, an additional 2.5 MG SBR will need to be constructed (9.9 MG total SBR volume). This volume will be constructed in the footprint of the decommissioned aeration basins as shown in **Figure 6-9**.

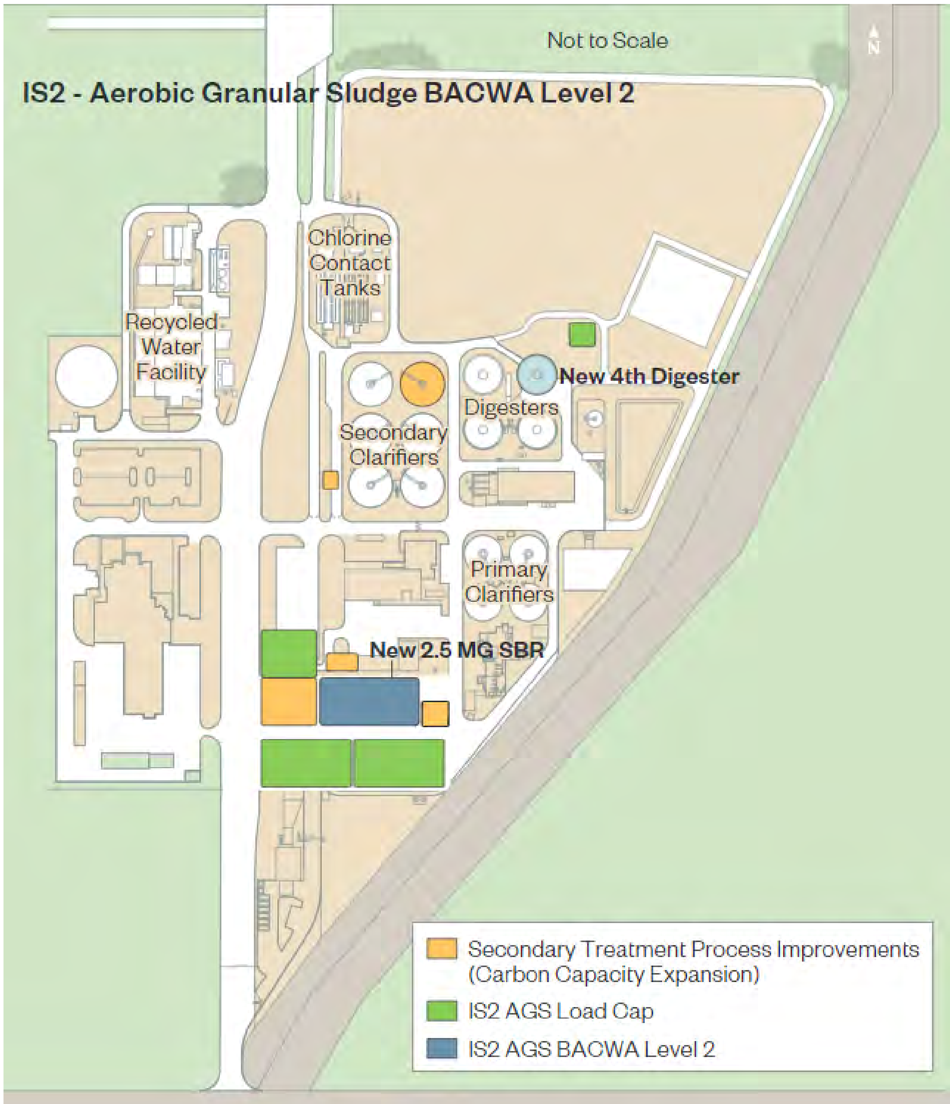


Figure 6-9 Integrated Solution 2 AGS BACWA Level 2 Required Infrastructure

c. IS 2 – Aerobic Granular Sludge Required Infrastructure for BACWA Level 3 standards

To achieve nutrient removal BACWA Level 3 standards, a 2.5 MG SBR will need to be constructed (12.4 MG total SBR volume). This volume will be constructed in the space just east of the roadway. Tertiary cloth filters will need to be implemented to increase solids removal and meet BACWA level 3 standards.

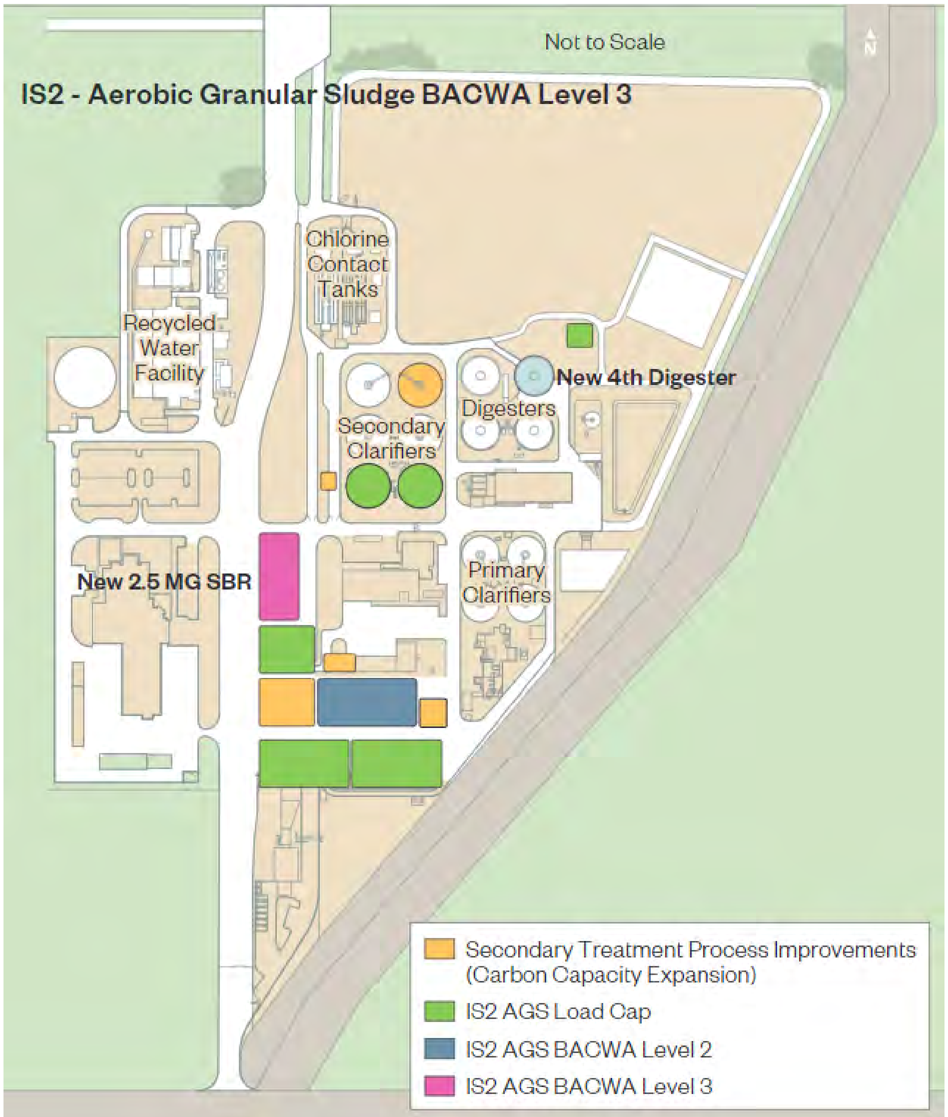


Figure 6-10 Integrated Solution 2 AGS BACWA Level 3 Required Infrastructure

3. <u>Integrated Solution 3 – Membrane Bioreactor</u>

As noted in **Table 6-4**, the District can achieve load cap, BACWA Level 2, and BACWA Level 3 effluent standards with a membrane bioreactor process (MBR)**. Figure 6-7** shows the process flow diagram of Integrated Solution 3. **Figure 6-8** through **Figure 6-10** show the site plan for the infrastructure required for each level of nutrient removal.

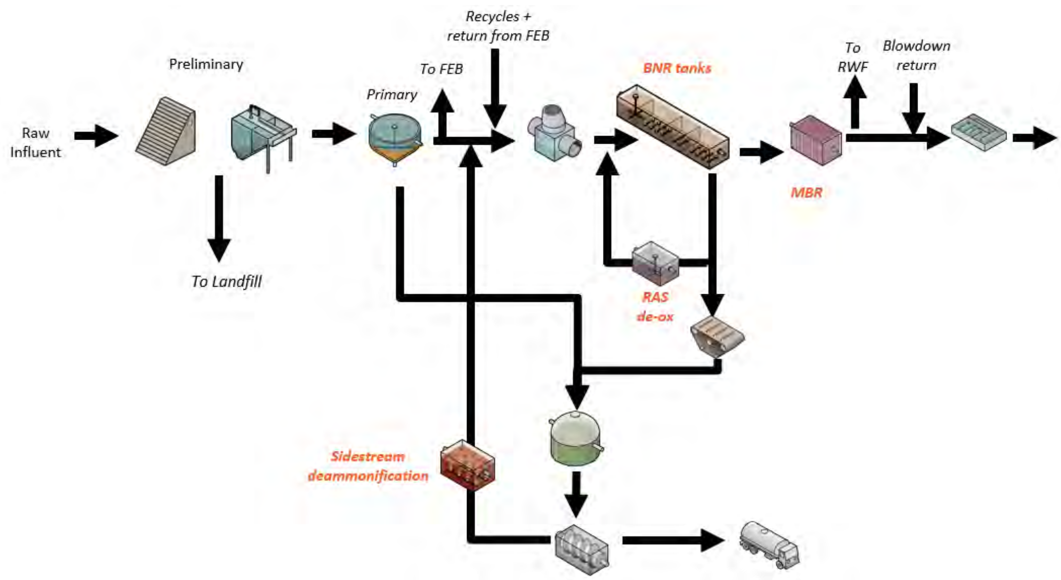


Figure 6-11 Integrated Solution 3 – Membrane Bioreactor Process Flow Diagram

The MBR system uses membranes for solids separation instead of secondary clarifiers. This physical barrier, allows for the aeration basins to operate at a higher MLSS, intensifying the biological process. Because the membranes can be fouled, fine screens upstream of the BNR basins are required to protect the membranes. To limit high flux rates across the membranes, flow equalization is required during wet weather.

a. IS 3 – Membrane Bioreactor required infrastructure for load cap/BACWA Level 2 standards

Due to the level of intensification inherent in the MBR process, the additional infrastructure required to achieve load cap standards is the same as the infrastructure to achieve BACWA Level 2 standards. This is shown in **Figure 6-12** and includes:

- Demolition the TTF to make space for future BNR basins.
- Decommissioning of the existing shallow aeration basins
- Construction of fine screens
- Construction of primary effluent distribution
- Construction of 3.6 MG aeration basin volume (4.8 MG total aeration basin volume).
- New membrane tank
- New Blowers
- New RAS De-oxygenation tank
- Sidestream treatment

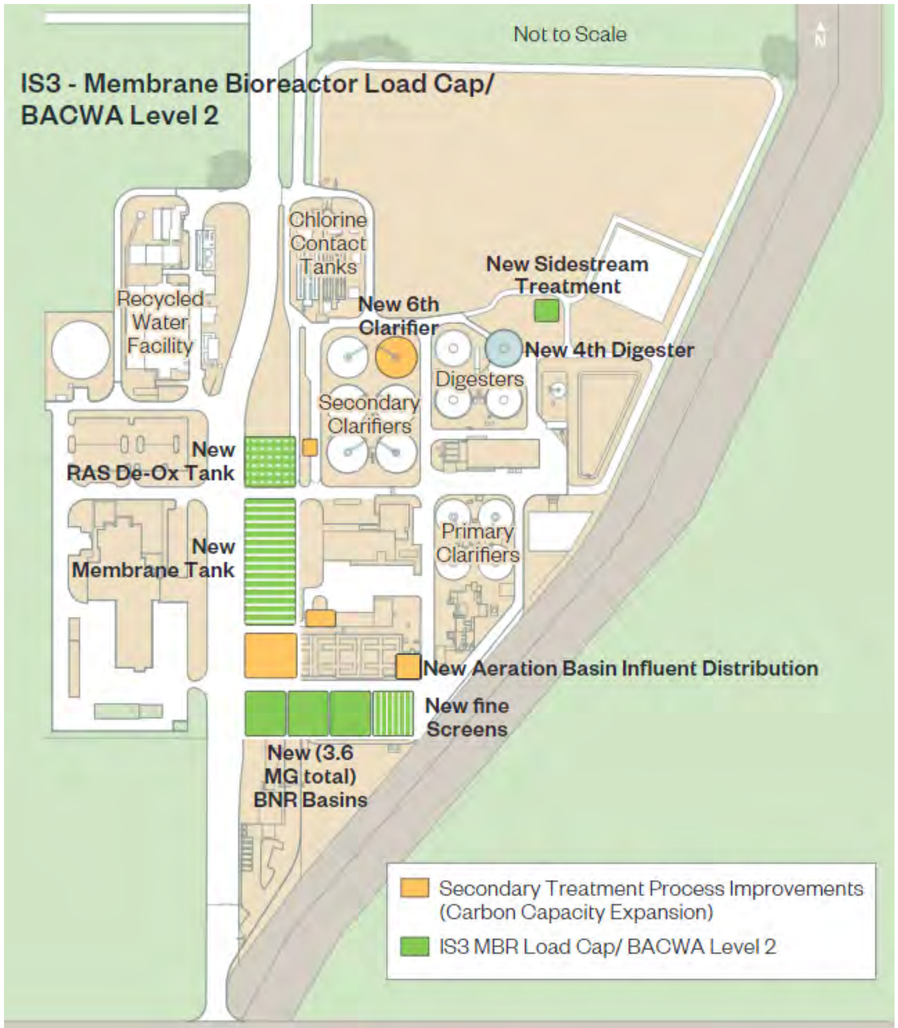


Figure 6-12 Integrated Solution 3 MBR Load Cap Required Infrastructure

b. IS 2 – 3 Membrane Bioreactor Required Infrastructure for BACWA Level 3 standards

To achieve nutrient removal BACWA Level 3 standards, an additional 1.2 MG BNR tank will need to be constructed (6.0 MG total volume). This volume will be constructed footprint of the decommissioned shallow basins. Additional blowers and cassettes will be required to meet BACWA level 3 standards.

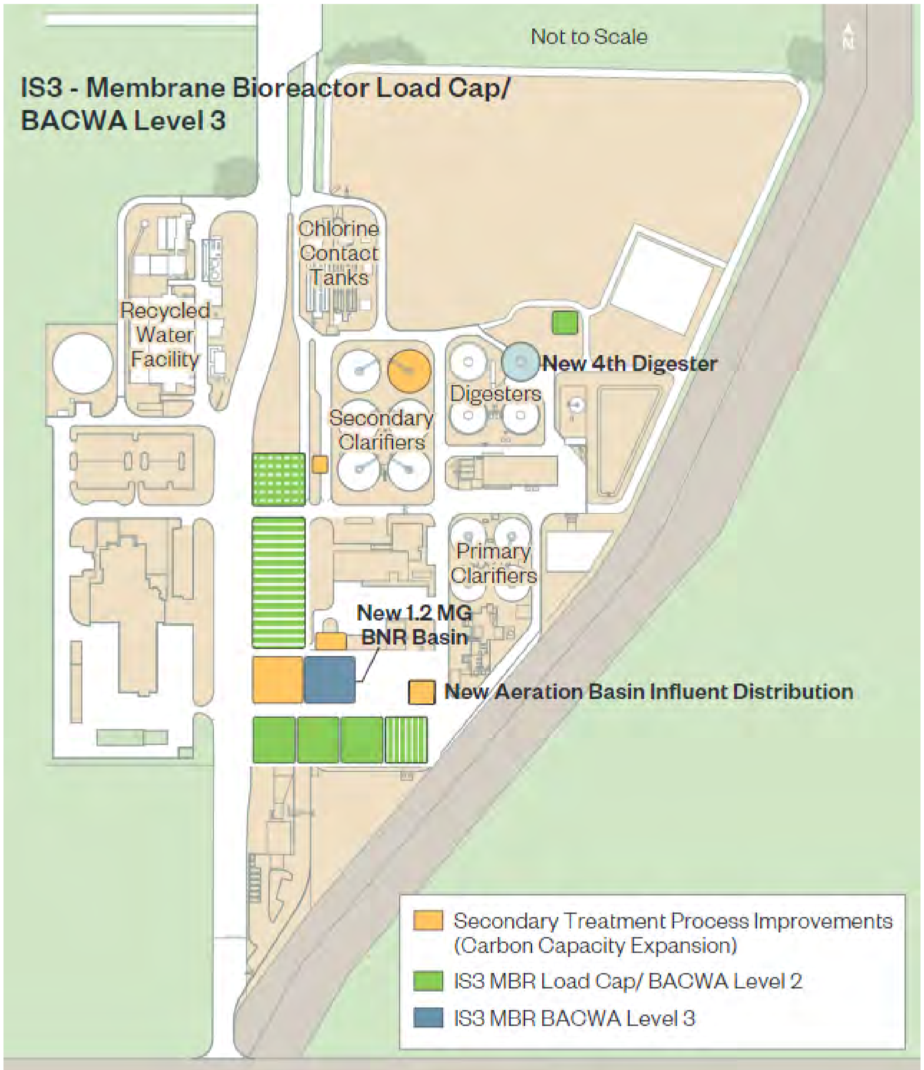


Figure 6-13 Integrated Solution 3 MBR BACWA Level 3 Required Infrastructure

4. <u>Comparison of Integrated Solutions</u>

- Costs were developed for the three integrated solutions for infrastructure to meet load cap and BACWA Level 2 standards. Costs were not developed for BACWA Level 3 infrastructure as this was identified to confirm the infrastructure could fit on the site.

Table 6-5 Project Costs for Integrated Solutions

	IS 1 Flexible BNR	IS 2 Aerobic Granular Sludge	IS 3 Membrane Bioreactor
Load Cap	$76M	$112M	$204M
BACWA Level 2	$29M	$28M	
Add O&M cost			

- Despite having the smallest activated sludge tank volume needed, IS3 - MBR requires construction of a membrane facility to fully replace secondary clarifiers and process all of the plant flow to maintain plant operation.
- Flexible BNR and AGS have similar expected water quality relative to reuse needs and as a result, it would be expected that the RWF would need to remain in operation. For MBR, water quality is expected to be highest due to the membrane separation step and it is possible that the RWF may not be needed (depending on evolution of reuse regulations).
- AGS has the highest labor requirement (32 Full-time equivalents (FTEs)) of the alternatives (30 FTEs for flexible BNR and 29 FTEs for MBR) due to the number of separate sludge systems and individual tank instrumentation.
- MBR requires 35% and 49% more energy than Flexible BNR and AGS options.
- IS1 – Flexible BNR was estimated to have the lowest capital and 10-year life cycle cost (2030 to 2040), followed by AGS and MBR.
- Given the uncertainty associated with timelines for nutrient standard promulgation, the potential for nutrient trading, and cost, the current **recommended baseline for nutrient removal at the WWTP is IS1 – Flexible BNR**. However, the District should re-evaluate the economics of the integrated solutions prior to further implementation.

6.1.2.3 Trigger Based Approach for Carbon and BNR Projects

To accommodate treatment needs at the WWTP (capacity expansion and variable nutrient removal), a trigger based nutrient roadmap was developed (Figure 6-14):

- Trigger 1 – **Carbon removal capacity expansion:** This project is triggered to provide construction of additional aeration basins (1.2 MG additional volume, 3.1 MG total aeration basin volume), clarifiers (one 90-ft diameter), and associated equipment to **provide sufficient BOD treatment capacity through 2040 projections**. This project was developed to be compatible with any future BNR technology.
- Trigger 2 – **Sidestream treatment**: This project would be triggered based on a need for proactive implementation of sidestream nitrogen removal to **achieve 10 to 15% reduction in effluent TIN** without committing to a large nutrient removal capital project for the mainstream liquids process. As sidestream treatment will achieve a 10-15% reduction in effluent TIN, implementing sidestream treatment will delay trigger 4. If the District does not choose early adoption and chooses to implement nutrient removal when mandated by the regional board, this trigger is not satisfied and sidestream treatment is not

implemented. This project was developed to be compatible with any future BNR technology.

- Trigger 3 – **Pursue regional partnership**: This is triggered when **nutrient trading becomes feasible and economically viable as a means for addressing nutrient removal required**. If/when the economics of regional partnerships are no longer favorable, the fourth trigger would be implemented.
- Trigger 4– Mainstream BNR treatment at WWTP: This is triggered when nutrient trading (if available) becomes infeasible and economically non-viable as a means for addressing nutrient removal. At the present time, Flexible BNR is shown as the primary backbone of the mainstream BNR technology; however, since technologies are expected to mature and economics will change, it is recommended that the District re-evaluate (including pilot testing of intensification technologies) nutrient removal technologies prior to implementing a large capital project in the future. These intensification technologies are compatible with Flexible BNR.

6.1.2.4 Key Coordination Points

The nutrient roadmap (**Figure 6-14**) is both impacted by and impacts other strategic decisions made by the District. Future coordination efforts that the District incorporate into subsequent studies include:

- Piloting – As noted, the District should pilot intensification technologies as they mature and potentially become more economically favorable. Piloting should occur prior to Trigger 4.
- Recycled Water – The District should quantify impact future recycled water users will have on the discharged effluent nutrient load from the WWTP (i.e., a smaller recycled water program may increase effluent loading from the plant). Currently the future (both make up of users and quantity of RW distributed) depends largely on the fate of the agreement with Calpine which will be evaluated after the Recycled Water Master Plan is completed.
- Biosolids and Renewable Energy –
  - The shift to BNR operations (and away from TTF) will increase sludge production and necessitate digester capacity increase (earlier than when operating TTF for carbon removal). This is analyzed in **Section 7**.
  - The Biosolids Master Plan will be completed in the mid-term (3-5 years) and may explore advanced digestion options. The impact of these advanced digestion options on sidestream nutrient load should be noted. Any impacts should be incorporated into an update of this Master Plan Implementation Plan.
  - A shift to BNR will also increase the electrical consumption of the WWTP. Energy neutrality analysis should be updated with information of BNR operations.

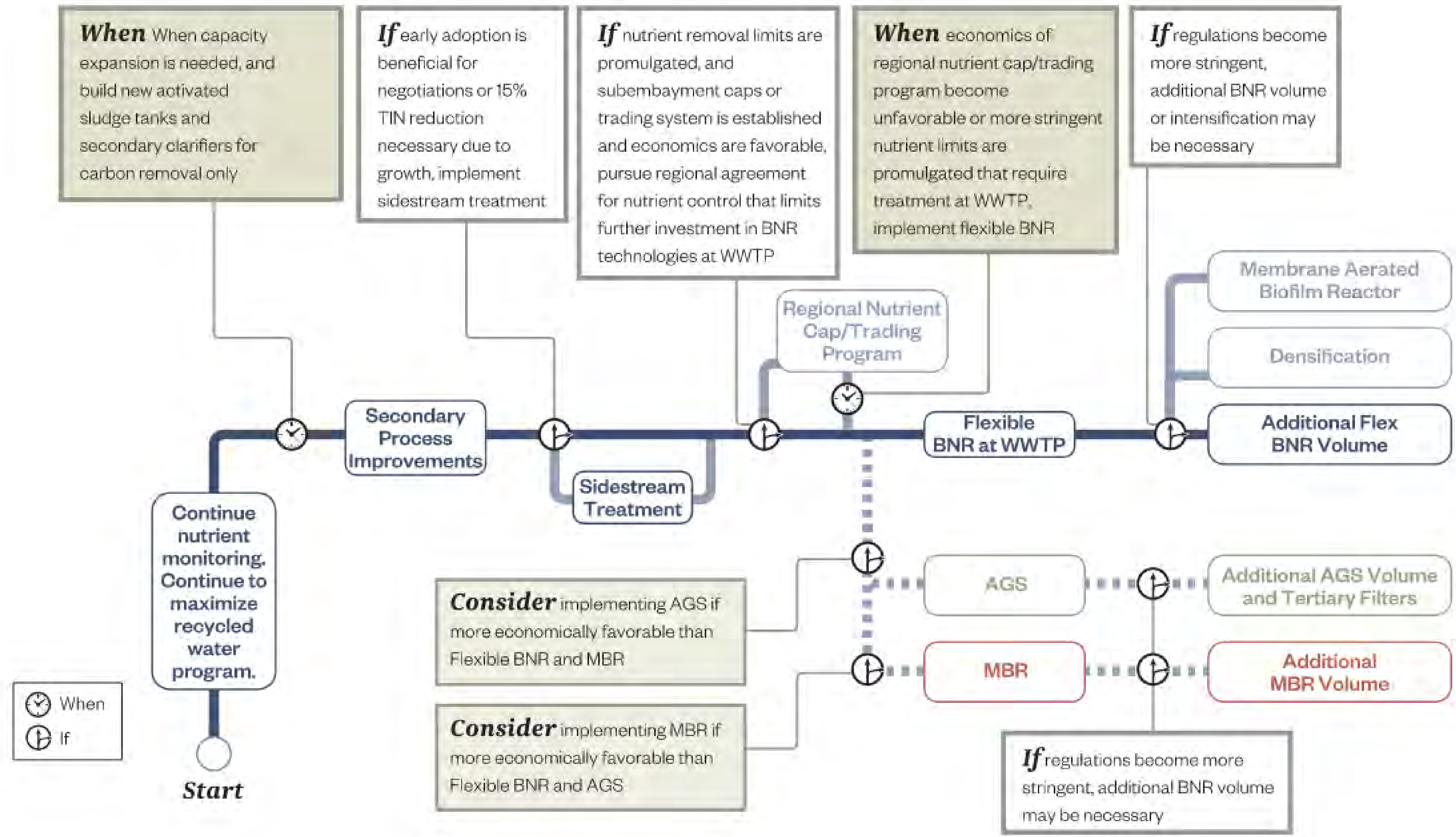


Figure 6-14 Nutrient Management Roadmap for WWTP

7. Focus Area 4 - Biosolids, Biogas and Renewable Energy

This focus area addresses biosolids treatment capacity while identifying applicable innovative approaches the District can use to achieve current and future resource recovery goals (**Task 3/5 - Biogas and Renewable Energy Management** and **Task 6 - Biosolids Management**). Coordination was performed between focus areas related to nutrients, advanced treatment, infrastructure renewal, compliance vulnerability and land use planning.

7.1 Biosolids Management

The District is facing uncertainty in its biosolids management program due various drivers including:

- **Increasing regulations further limiting end use options for biosolids.** Senate Bill 1383 will limit the quantity of biosolids diversion to landfills. Beginning in 2022 use of biosolids as Alternative Daily Cover (ADC) will not be qualified as beneficial use, it will be considered disposal. Competition on beneficial end use markets (i.e., composting, land application, etc.) is anticipated to increase, increasing prices for the District.
- Potential regulations for emerging contaminants (i.e., **PFAS**): If stringent PFAS concentration limits are established for biosolids, this could limit land application.
- **Digester capacity limitations.** Process changes to the WWTP liquid stream and increased loads to the WWTP will impact digester capacity.

The District has actively pursued regional solutions for biosolids management as part of the Bay Area Biosolids Coalition (BABC) in order to support its goal of 100% reuse of biosolids. Current practices include land application, composting and transfer of biosolids to Lystek for further processing. The goal of this analysis is to identify and understand long-term, cost-effective alternatives when current practices (land application) are no longer available. This analysis has been conducted with the understanding that the District will be conducting a Biosolids Master Plan in 2023/2024.

7.1.1 Biosolids Management Approach

- An analysis was conducted to determine the **capacity** of the existing digester system. An alternative analysis was conducted to compare **options to increase the anaerobic digestion capacity** of the WWTP.
- A **biosolids end-use market assessment** was conducted to provide information on potential opportunities associated with applicable technologies and corresponding products.
- **Regional solutions** to biosolids end-use to help the District achieve it's 100% reuse goal were explored.
- A **review of advanced processing options** to produce other biosolids products (Class A/EQ dried product, biochar, etc.) that were found to be favorable, was conducted.
- A **biosolids management road map** was developed to guide the District through the changing regulatory landscape and capacity stressors in the planning period.

7.1.2 Biosolids Management Key Findings

7.1.2.1 Capacity Key Findings

The capacity analysis was performed assuming the high growth assumption for influent load as defined in **Section 1**. Key assumptions for the capacity analysis were confirmed with the District:

- A minimum hydraulic retention time (HRT) of 18 days with two digesters in service (one redundant digester).
- A minimum HRT of 20 days with three digesters in service.

The analysis was done for two different liquid stream processes (tracks), low sludge yield (current operation with TTF) and high sludge yield (biological nutrient removal – no TTF).

Table 7-1 Sludge Yield for current and future liquid stream operation

	Primary Sludge		Waste Activated Sludge	
	Annual Average (AA)	Maximum Month (MM)	Annual Average (AA)	Maximum Month (MM)
Low Sludge Yield (Current operation)	1,500 lbs/MG	1,600 lbs/MG	1,800 lbs/MG	2,000 lbs/MG
High Sludge Yield[1] (Future operation w/o TTF)	1,900 lbs/MG	2,100 lbs/MG	2,200 lbs/MG	2,500 lbs/MG

[1] When TTF are decommissioned, a higher sludge yield will be used

The capacity analysis found that for either the high or low sludge yield tracks, the **District will need to increase digester capacity within the planning period**. This capacity increase is necessitated earlier in the high sludge yield track, **2030**. Relaxation of the minimum HRT requirement could extend digester capacity in the near-term.

Table 7-2 Digester Influent Sludge Production Projections for Low and High Yield Operation

Year	Flow[1] (MGD)	Digester Influent Annual Average		Digester Influent Maximum Month	
		Flow (gpd)	Load (lbs/d)	Flow (gpd)	Load (lbs/d)
2020	12.9	83,100	41,000	91,400	44,800
Low Sludge Yield (continuing current operation with TTF)					
2030	16.3	105,000	52,000	115,000	56,500
2040	18.4	118,600	58,200	130,300	64,000
High Sludge Yield (Future operation without TTF)					
2030	16.3	129,800	64,000	144,600	71,300
2040	18.4	146,600	72,200	163,300	80,400

[1]Based on 2020 concentration

The three options to increase digester capacity that were evaluated including:

- A fourth digester
- Recuperative thickening
- High solids digestion

Recuperative thickening did not increase capacity enough to meet 2040 loads while maintaining the minimum HRT with two digesters and one out of service; both the high solids digestion and a fourth digester options increased firm capacity sufficiently; **Figure 7-1** and **Figure 7-2** Show the process flow diagram for these alternatives respectively.

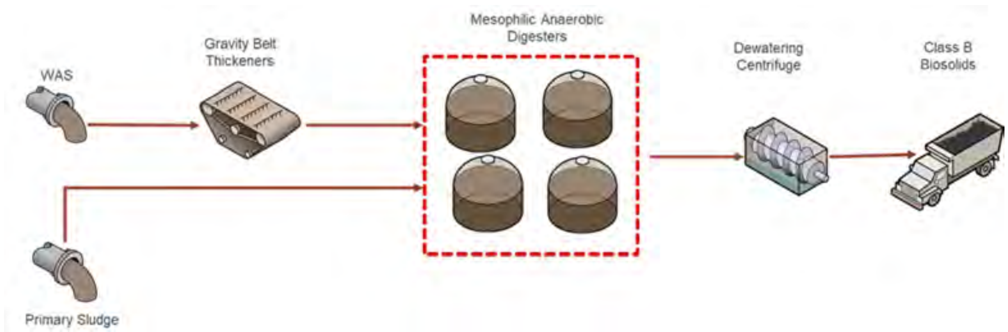


Figure 7-1 Additional Digester Process Flow Diagram

A fourth digester can be incorporated into the WWTP to increase digestion capacity. Infrastructure would include the fourth digester and ancillary piping to connect to the upstream and downstream processes. The fourth digester would be similar to the existing three digesters and does not represent an increase in complexity for solids handling.

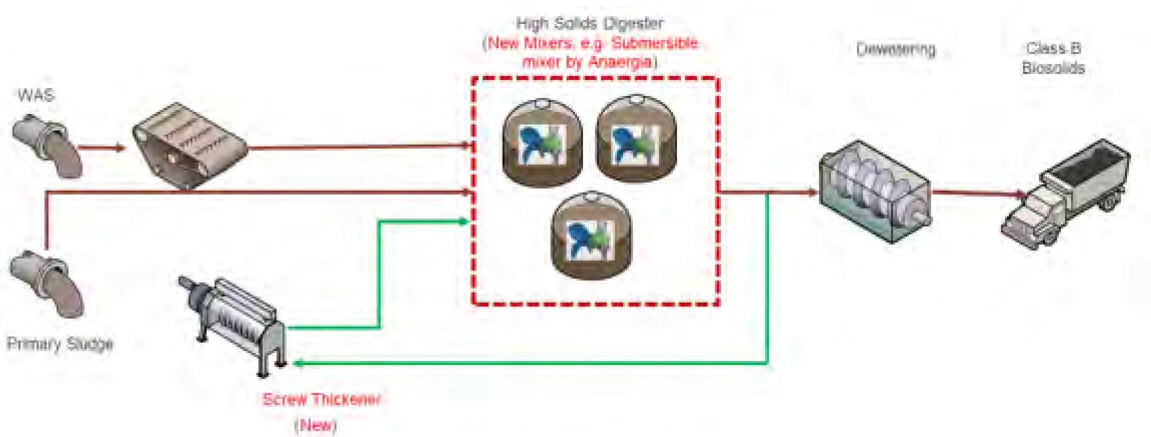


Figure 7-2 High Solids Digestion Process Flow Diagram

High solids digestion will increase capacity by allowing the digester to operate a higher solids content. Implementation of a high solids digestion process would require a screw thickener to thicken and recycle digester contents. Operation at a higher solids concentration would also require new mixers to be installed in the existing digester to mix the high solids contents. This process would increase the complexity of the solids handling processes. **Table 7-3** Summarizes construction and O&M costs for the two alternatives in 2020 dollars.

Table 7-3 Digester Capacity Alternatives Costs

	New Digester ($M)	High Solids Digestion ($M)
Probable Construction Cost	$8.6	$10.3
O&M Cost *PW at 20 Years 2% Rate*	$1.6	$1.7

High solids digestion was found to be more expensive from both a capital and O&M perspective. A non-economic analysis found these options to be similar from a technical, compatibility, environmental and logistical perspective. Ultimately **a fourth digester was found to increase capacity most economically while providing the same benefits**.

7.1.2.2 Biosolids End-use Market Assessment

Technologies and corresponding products considered in the end-use market assessment are summarized in **Table 7-4.** End-use markets evaluated for biosolids included bulk agriculture, land reclamation, energy, and specialty markets. **Compost, biochar, and dried products are most desirable products in the end-use market with the lowest cost.** All three products have potential for management by the District (i.e., a "self-managed" program). Biochar may provide an opportunity for the vendor to manage the product.

Table 7-4 Technology and Products Considered for End-use Market Assessment

Technology	Product
Mesophilic Anerobic Digestion	Class B Cake
Thermal Hydrolysis Pretreatment	Class A/EQ Cake
Thermo-Chemical Hydrolysis	Class A Liquid
Gasification and Pyrolysis	Class A/EQ **Biochar**
Thermal Drying	Class A/EQ **Dried Granule**
Composting	Class A/EQ **Compost**

7.1.2.3 Wet Weather Biosolids Storage

Regional solutions include use of the property obtained from DOW for winter storage. Initial review showed on-site storage of biosolids could provide some benefits considering the seasonal variation of biosolids land application. If the District aims to store 6 months of biosolids on-site (generally no biosolids application between November to April), 300,000 – 500,000 ft^3 of on-site storage will be necessary. The required space for biosolids storage facility is estimated to be 50,000 - 80,000 ft^2 and there is **sufficient space to store biosolids on-site for 6 months**. However, several factors including odor potential, climate conditions, stability, topography and proximity to water should be considered carefully in future evaluations.

7.1.2.4 Advanced Processing Options

Advanced processing options to produce biosolids products found to be favorable in the end-use market were reviewed. Options included thermal drying (both direct and indirect), gasification/pyrolysis, hydrothermal liquefaction, and supercritical water oxidation (SCWO). While a more detailed business case evaluation is recommended, **Table 7-5** summarizes the high-level review. **Thermal drying** would generate significantly **lower volume end-product** (Class A /EQ dried product) with potential to be successfully distributed into a **variety of markets**. It also sets the stage for the District to meeting potential **regulatory changes through addition of gasification or pyrolysis**.

Table 7-5 High Level Summary of Advanced Processing Options

Criteria	Thermal Drying	Gasification/ Pyrolysis	Hydrothermal Liquefaction	SCWO
Energy Consumption (NG and Electricity)	High	Medium	Not Available	Not Available
Footprint	Compact	Compact	Compact	Compact
PFAS and Emerging Pollutants	No	Yes	Yes	Yes
Development Status	Established	Emerging	Demonstration stage	Demonstration stage
Regional Solutions	Yes	Yes	Yes	Yes
District Only	Yes	Yes	Not commercially feasible	Yes
Digestion	Prefers digestion	Prefers no digestion	Prefers no digestion	Prefers no digestion

7.1.2.5 Biosolids road map

A roadmap was developed to summarize biosolids management options for the District.

- Advanced processing options, especially thermal drying and gasification/pyrolysis processes should be evaluated further in District's next Biosolids and Energy Master Plan.
    - Consider thermal drying to reduce volume when biosolids disposal increase and thermal drying becomes more economically favorable.
- Digester capacity should be increased around 2030.
- The main triggers for advanced processing options are future regulatory considerations and high competition for available disposal/beneficial use sites and alternative markets.
- Alternative markets for end products are developing and variety of markets will help to mitigate regulatory pressures.

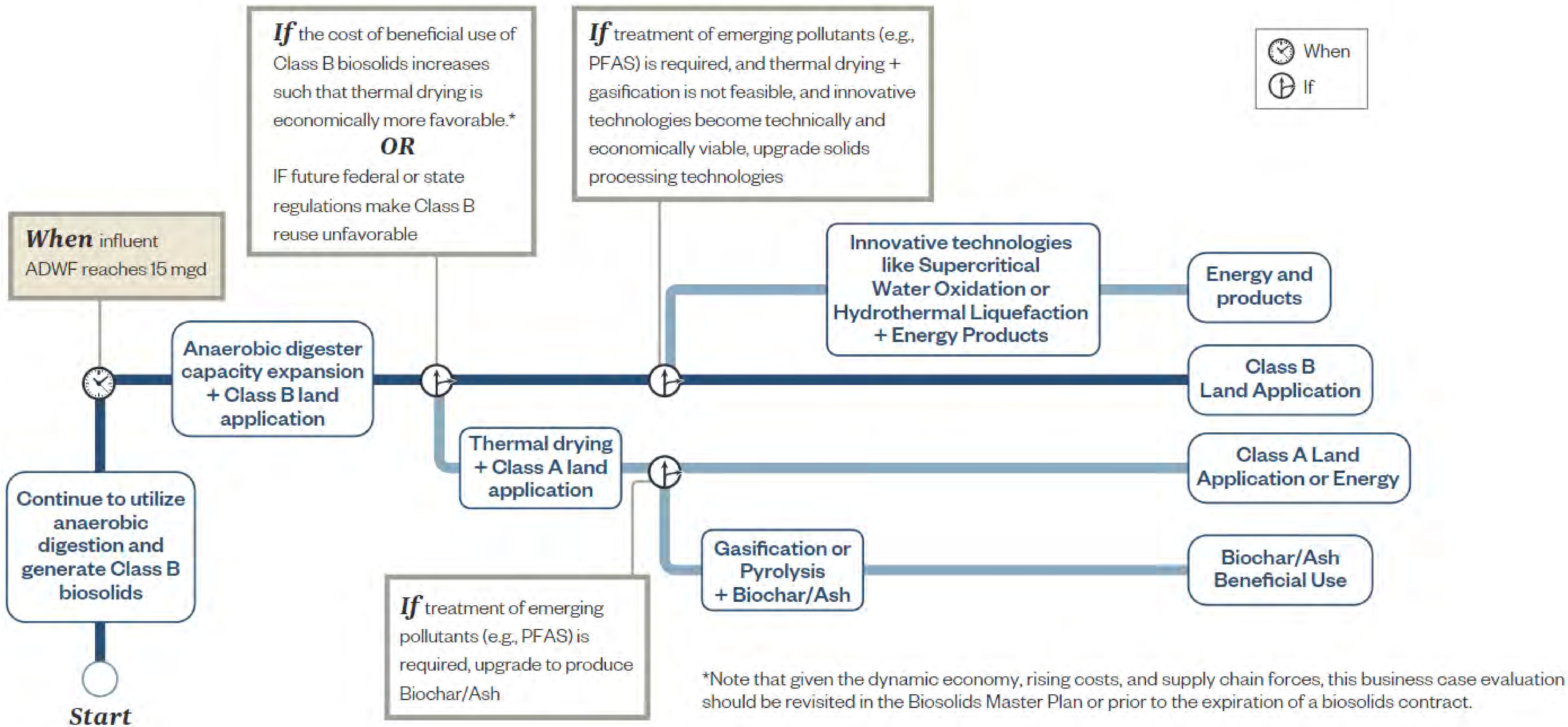


Figure 7-3 Biosolids Management Roadmap

7.1.2.6 Key Coordination Points

The biosolids roadmap (**Figure 7-3**) is both impacted by and impacts other strategic decisions made by the District. Future coordination efforts that the District incorporate into subsequent studies include:

- The Biosolids Master Plan should include an analysis of advanced processing options on sidestream nutrient loading. Any changes should be used to check the District's progress along the Nutrient Management Roadmap (**Figure 6-14**) and timing of triggers.
- The Biosolids Master Plan should consider any increased phosphorus captured as a result of the anaerobic selector installed as part of Secondary Treatment Improvements. This may impact potential land application options.
- As the Biosolids Master Plan further considers advanced processing options (i.e., thermal drying), the District should revisit its renewable energy program as discussed in **Section7.2**.

7.2 Biogas and Renewable Energy Management

To support the District's commitment to resource recovery and the goal of becoming energy self-sufficient, this Master Plan explored biogas utilization alternatives and renewable energy production. When available, the District enhances biogas production with codigestion of FOG however, recently, the District's FOG program has ceased operation as regular haulers have found other outlets.

Recent regulations (SB 1383) have mandated that 75% of organic waste be diverted from landfills by 2025, increasing the potential for HSW codigestion at WWTPs. The District recently explored the option of partnering with Mt. Diablo Resource Recovery (a local waste hauler) and Anaergia to co-digest organic waste of as part of the East County Bioenergy Project (ECBP). Since the future of the ECBP is uncertain, and the District is still interested in maximizing biogas utilization, original Master Plan tasks related to the ECBP have been shifted to analyzing the Districts system without ECBP. This task explores diverting organic waste to the District's digesters through a trucked waste program similar to the existing system.

7.2.1 Biogas and Renewable Energy Management Approach

- A **high strength waste (HSW) market assessment** was conducted to identify potential trucked wastes that could enhance biogas production at the WWTP.
- **Biogas production** was estimated for three tiers of HSW addition: 5,000 gpd (rehab of existing receiving station), 10,000 gpd (double receiving capacity) and maximum amount of HSW that can be co-digested.
- Four **biogas utilization options** were explored: existing cogeneration (cogen) system, new cogen system, renewable natural gas (RNG), and gas for thermal drying.
    - The existing cogen system was recently rebuilt in 2019 but still experiences significant challenges and is undersized to achieve energy neutrality. Challenges with the current cogen system include unreliable controls and general maintenance downtime that is associated with operating a single engine.

- An energy balance tool was developed and calibrated for the District to analyze the business case scenario for these options. A **roadmap** was developed to outline triggers for when the District should consider certain actions.

7.2.2 Biogas and Renewable Energy Management Key Findings

7.2.2.1 HSW Market Assessment

The HSW market assessment study identified that **Cheese whey, sugar water and FOG** were found to be readily available in large volumes within a 50-mile radius of the WWTP, while winery waste, food waste, DAF and soy whey were not found to be abundant. Sugar water and whey are generally cleaner than FOG and would require relatively less processing. However, these sources have higher seasonal variation than FOG. **Competitive tipping fees would be needed to incentivize** haulers to transfer HSW to the WWTP as most haulers indicated they would not be willing to pay higher than current pricing, summarized in **Table 7-6.**

Table 7-6 Typical Bay Area Tipping Fees for HSW Haulers

	FOG	Cheese Whey	Sugar Water
Tipping Fee ($/gal)	0.03 - 0.08	0.03 – 0.05	0.05 – 0.08

7.2.2.2 Biogas Production

As noted in **section 7.1**, the District will need to increase digester capacity by 2030 to accommodate increased loads to the WWTP and changes in the liquid stream process. Addition of HSW will necessitate that this digester capacity expansion occurs even earlier. This analysis assumes that capacity has been expanded and three digesters are in operation (one digester standby). **Table 7-7** shows the available digester capacity with and without HSW.

Table 7-7 Digester Capacity with HSW

	Digester Capacity	HSW Flow
No HSW	185,000 gpd	0 gpd
Tier 1	180,000 gpd	5,000 gpd
Tier 2	175,000 gpd	10,000 gpd
Tier 3	163,000 gpd	22,000 gpd

Digester gas production was estimated for three tiers of HSW addition for low and high sludge yield scenarios, track 1 and 2 respectively. The impact of PONDUS, a thermo-chemical hydrolysis process, on digester gas production was also considered. The analysis showed:

- ✓ Converting to a high sludge yield process will increase digester gas production.
- ✓ Adding HSW will increase digester gas production.
- ✓ PONDUS will increase digester gas production significantly.

- **The existing cogen system will become undersized with the addition of HSW or when the District implements a high sludge yield process**.

7.2.2.3 Biogas Utilization Alternatives

The energy balance tool was used to determine NPV of biogas utilization alternatives. Key findings include:

Existing cogen system:

- Keeping the existing 800kW cogen system provides the highest value. **Continue using existing 800kW cogen system until it inoperable.**
- The additional biogas from the PONDUS exceeds the fuel demand from the existing 800kW cogen engine and therefore does not increase the revenue generated.

New cogen system:

- In most cases, the new cogen alternatives returned a lower 20-year NPV compared to the existing 800kW cogen system. **The incremental benefit of a new cogen does not cover the additional capital costs**.
- Energy generated by the new cogen alternatives exceed the plant energy usage in some cases, reducing the overall value.
- The **BioMAT tariff improves the 20-year NPV for the new cogen alternatives**, however it does not exceed the 20-year NPV for the existing cogen alternatives (with the exception of PONDUS)
- The new cogen alternatives under the PONDUS biosolids alternative provides a maximum of ~$2,000,000 (20-year NPV) which will not underwrite the cost of the PONDUS process.

Renewable Natural Gas Alternative:

- Under the current market conditions for renewable fuel commodities, **RNG production has a lower overall 20-year NPV** for all biosolids and FOG/HSW alternatives. RNG should not be considered unless commodity prices/economics change significantly. The RNG market is continuously changing and this evaluation should revisited when the District is considering a change to biogas utilization.

Thermal Drying:

- Energy recovery revenue will not finance the cost of a sludge drying system.
- Thermal drying is a good way to utilize excess biogas if a drying system is needed to meet biosolids regulations

FOG/HSW Benefit:

- The additional energy generation from **expanding the FOG/HSW receiving capacity** to 10,000 gal/day **does not support investment of** $1,300,000 in **capital costs** to expand the FOG/HSW system.

7.2.2.4 Biogas Utilization Roadmap

Two roadmaps were developed to illustrate the options for biogas utilization and optimization at the WWTP. The Bioenergy Recovery Roadmap **(Figure 7-4**) focuses on the triggers to increase cogen capacity, utilize biogas for thermal drying or pursue RNG production. The current baseline strategy identified as part of this Master Plan is maintaining and operating the existing cogen system. The Biogas Optimization Roadmap (**Figure 7-5**) illustrates options to increase biogas production. These options are impacted greatly by the District's ability to receive HSW, process HSW in digesters, and utilize biogas.

1. Bioenergy Recovery Roadmaps Key Findings
   - The cogen system should be expanded if the existing cogen needs replacement, the District wishes to pursue energy neutrality, or the energy needs of the plant increase significantly.
   - If the District is flaring digester gas and implements thermal drying to reduce hauling costs or find more biosolids -end users, the District should divert excess gas to the thermal dryer.
   - Renewable Natural Gas (RNG) is not economically favorable unless market conditions change (value of credits increases) significantly.
2. Biogas Optimization Roadmap Key findings
   - Codigestion capacity should be expanded if the District wishes to pursue energy neutrality and has expanded the cogen capacity.
   - Alternatively, if tipping fees become lucrative, codigestion capacity can be expanded. Given the market conditions for HSW, tipping fees are not likely to be high enough to justify cost of expansion of the codigestion receiving facilities.

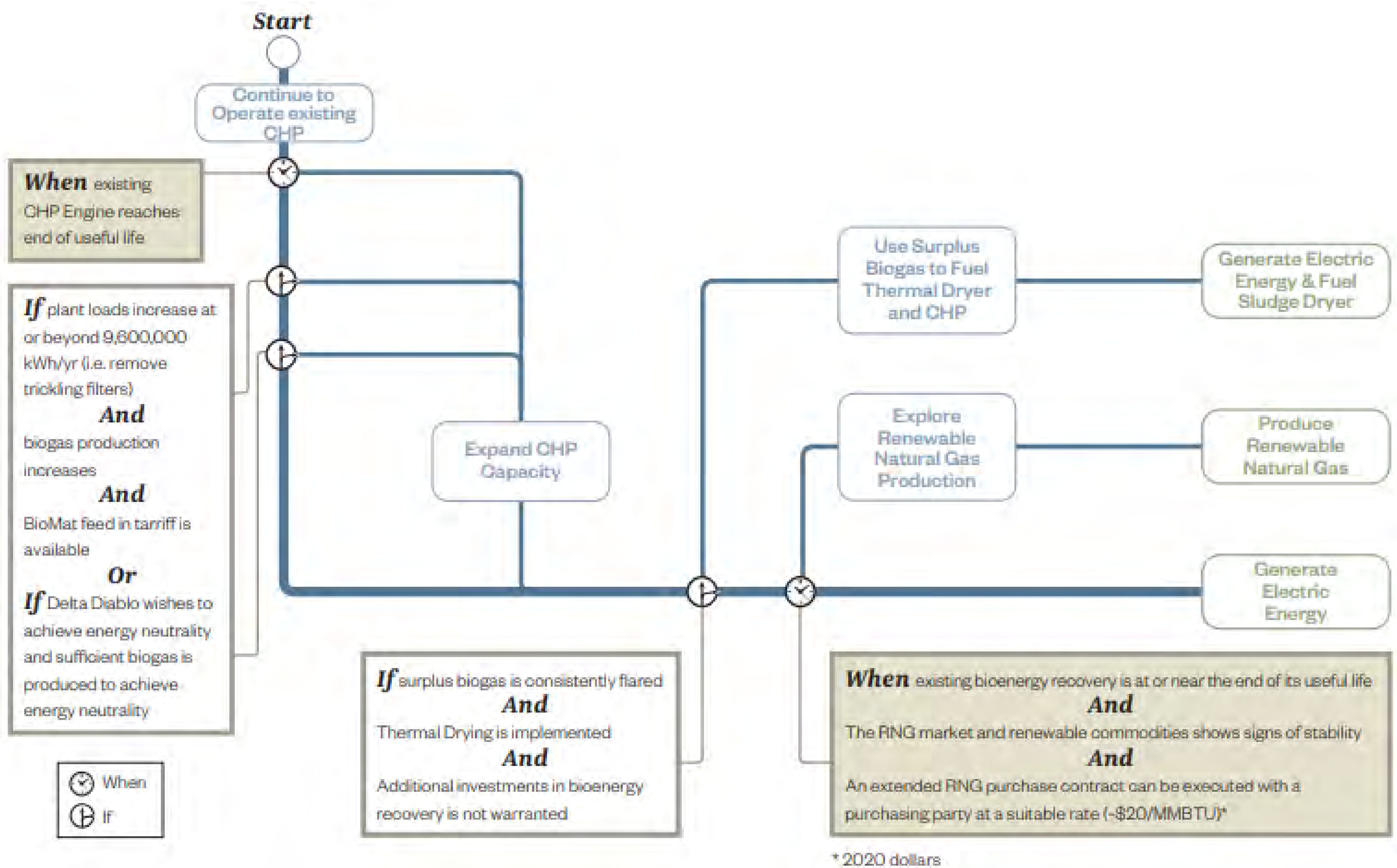


Figure 7-4 Bioenergy Recovery Roadmap

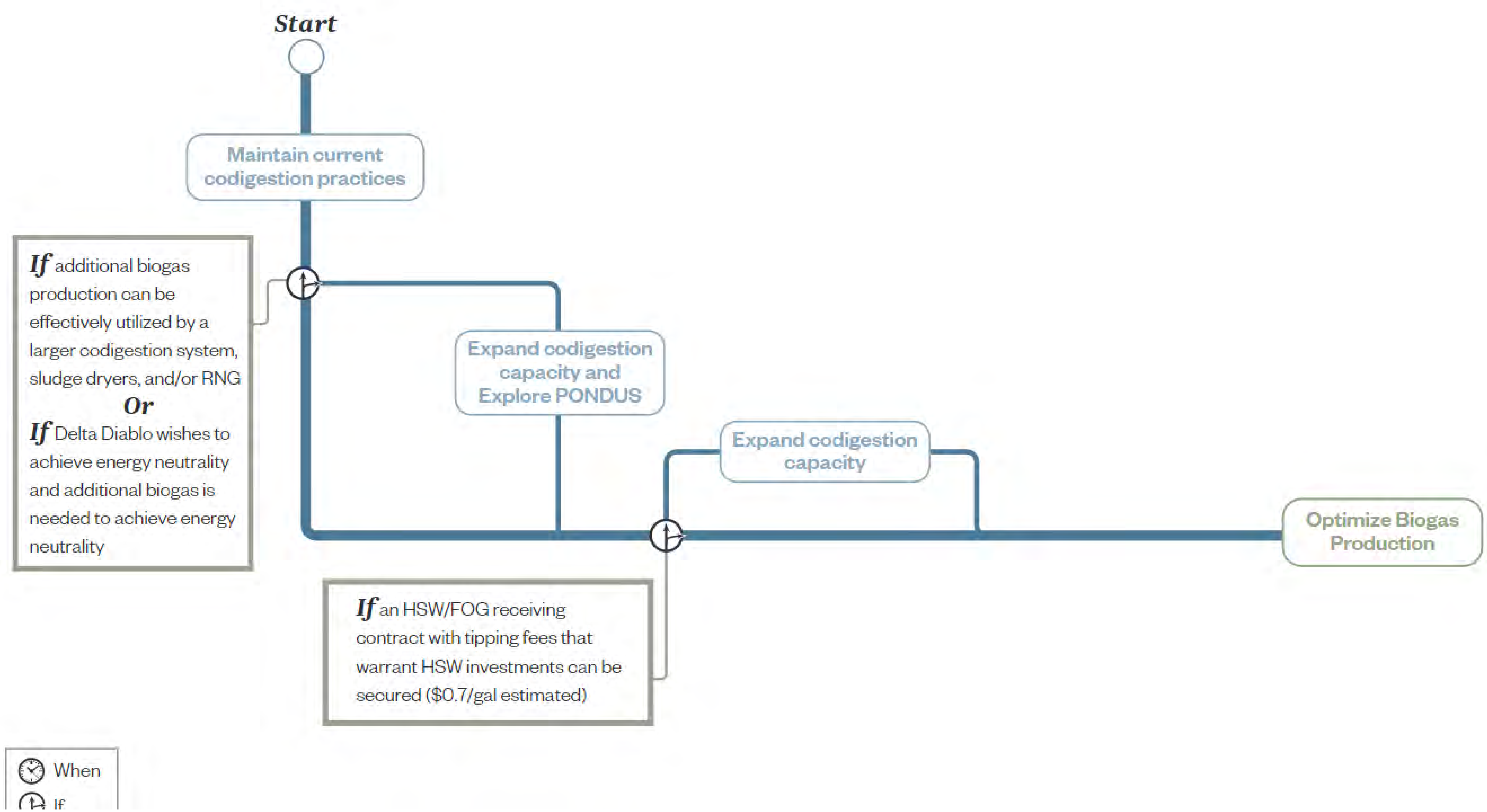


Figure 7-5 Biogas Optimization Roadmap

7.2.2.5 Key Coordination Points

The Bioenergy Recovery and Biogas Optimization Roadmaps are both impacted by, and impact other strategic decisions made by the District. Future coordination efforts that the District should incorporate into subsequent studies include:

- As the Biosolids Master Plan further considers advanced processing options (i.e., thermal drying) the District should revisit its renewable energy triggers.
- The District should revisit renewable energy triggers when planning BNR upgrades. A larger energy demand may increase the financial payback period of a cogen upgrade.

7.2.3 Biosolids Management and Biogas and Renewable Energy Management Coordination

Biosolids management and biogas and renewable energy management decisions are inextricably connected. At minimum the District must increase digester gas capacity. This is the baseline implementation in this Master Plan. The District may also choose to pursue energy neutrality; this will require implementation of capital improvements as outlined in **Table 7-8**.

Table 7-8 Implementation options for Biosolids and Renewable Energy Management

Implementation Option	Activities
Baseline Implementation – Keep cogen as is	• District constructs a new digester to increase digester capacity before 2030
Energy Neutrality Implementation	• District constructs a new digester to increase digester capacity before 2030 • The District chooses to increase the capacity of the cogen system to pursue energy neutrality • The District can expand HSW program because of available digester capacity and gas can be utilized in cogen system
Advanced Processing Implementation	• District constructs a new digester to increase digester capacity before 2030 • The District chooses thermal drying to produce a dried product to reduce hauling costs or as regulations require • The District expands HSW program because of available digester capacity and gas can be utilized for thermal drying • District may choose to further advanced processing options to address emerging contaminants

As the District will further investigate options as part of the Biosolids Master Plan, the baseline implementation option carried forward will be to increase digester capacity with a 4^{th} digester being installed before 2030. Energy neutrality and advanced processing may be executed if the District pursues energy neutrality or advanced processing options to improve biosolids end-use options. Note that energy neutrality or advanced processing options may be implemented together and are not mutually exclusive, however, both plans include expanding HSW to provide biogas for either electricity generation or thermal drying. If the District chooses to implement both options, the HSW receiving facility should be expanded to accommodate both.

8. Focus Area 5 - Recycled Water Management

This focus area is intended to guide strategic decision-making efforts regarding long-term RWF operation and near-term capital investments by evaluating options for adding new customers and/or increasing recycled water usage and conducting a high-level review of the RWF to evaluate costs related to increased water quality requirements (**Task 8 - Recycled Water Management**). Coordination was performed between focus areas related to nutrients, advanced treatment, infrastructure renewal, compliance vulnerability and outfall hydraulics.

8.1 Recycled Water

The District provides recycled water to industrial, commercial, and irrigation customers via the RWF. The District's long-term contract to provide Calpine with recycled water will expire in 2030. There is a significant potential for Calpine to cease operation of their two local facilities, LMEC and DEC. This purpose of this task is to guide strategic decision-making efforts regarding long-term RWF operation and near-term capital investments by:

- Evaluating options for adding new customers and/or increasing recycled water usage by existing customers to offset potential of Calpine discontinuing operation.
- Conducting a high-level review of the RWF to evaluate costs related to increased water quality requirements for new or existing customers.

This Master Plan task will serve as a precursor to the Recycled Water Facility Master Plan Update (Facilities Assessment) planned for 2023/2024. The Update will be provided to Calpine for review and budgeting and will be used by Calpine to inform their decision whether or not to renew the recycled water agreement in 2030. There are several implications if the agreement with Calpine is not renewed, including a significant reduction in funding for operation, maintenance, and improvements to the RWF, potential impact on nutrient load cap estimation, and increased flows to the outfall potentially triggering the need to start planning for a second outfall. These impacts are identified and explored here and recommended to be further quantified in the RWF MP.

8.1.1 Recycled Water Approach

- To evaluate the potential demand for recycled water without Calpine, a **high-level investigation of potential users** was performed. The investigation was confined to the cities of Pittsburg and Antioch, where recycled water is currently provided.
- A high-level review of the RWF was conducted to evaluate how the District should manage **near-term capital investments** (planned CIP projects):
  - To cost effectively maintain operations for current level of treatment
  - Confirm that the near-term CIP is synergistic with long-term projects if the District decides to improve water quality for other potential recycled water users.
- **Key focus areas to consider in the future Recycled Water Facility Master Plan Update** (Facilities Assessment) were developed based on these initial findings.

8.1.2 Recycled Water Key Findings

8.1.2.1 Potential Recycle Water Users

Existing and potential recycled water users were identified in the 2013 Recycled Water Master Plan. Based on discussions with District staff:

- The following users identified in 2013 are not currently using recycled water: Praxair, Dow Chemical, United Spiral Pipe, K2 Pure Solutions, and PG&E Gateway Generation Station.
- The following users were identified in 2013 as potential users and are now using recycled water: Pittsburg High School, Parkside Elementary School, and Rancho Medanos Junior High School. Mt. Diablo Resource is currently using recycled water and the average annual demand is expected to increase over the next few years.

Staff from the cities of Antioch and Pittsburg were contacted to obtain their input on potential new recycled water users. Table 8-1 lists the potential new users identified by these two cities. **The total of these potential demands is estimated to be 3,800 AFY (an average of 3.4 mgd).**

Table 8-1 Potential Future Recycled Water Customers

Customer	Description	AA Demand (AFY)
Industrial		
Mt. Diablo Resource Recovery Park – Waste Recycle Center and Transfer Station (WRC&TS) [a]	Recycling center and waste processing	35.3
Pittsburg Technology Park (Data Center)	Data center	-
Diablo Energy Storage LLC	Advanced energy storage	-
San Francisco Bay Aggregates – Carbon Capture and Mineralization Project	Pilot facility	-
Loveridge Corridor	Zoned for future industrial use	Up to 3,266
Near-term Irrigation		
Stoneman Sports Complex	Athletic complex	110.5
Babe Ruth Fields	Athletic complex	14.7
Antioch Little League	Athletic complex	11.4
Memorial Park (Park Middle School)	Park and school	18.7
Sutter Elementary School	School	23.8
Antioch Fairgrounds (Contra Costa County Event Center)	Fairgrounds	37.6
Prosserville Park (on 6th St between M&O)	Park	2.3
City of Antioch [b]	Park	-
Antioch Historical Society	Museum	2.7
Los Medanos Industrial Park	Office	2.1
BayWalk	Residential development	63.8
Corteva Wetlands Preserve (DOW Wetlands)	Wetlands	1.0
Long-term Irrigation		
Los Medanos College (point demand)	School	227

8.1.2.2 Review of CIP

The near-term CIP includes the projects listed in **Table 8-2**. These projects were evaluated for synergy with potential future irrigation users and the data center needs. Water quality requirements for the Pittsburg Technology Park (data center) were not specified, requirements were assumed based on similar projects.

Table 8-2 RWF near-term CIP

Project	Timeline (Years)	Synergistic with future needs for:	
		Irrigation	Data Center
Improvements at Secondary Effluent Feed to RWF	3 – 5	Yes	Yes
Valve replacement for DEC, CCT, and DEC tank isolation	<2	Yes	Yes
RWF IPS, Process Line Modification, and Blowdown	6-15	Blowdown improvements may not be needed	
Recycled Water Facility and Treatment Plant Intertie	<2	Yes	Yes
Sand Filter and Filter Cover Improvements	3-5	Yes	Unknown
RWF Clarifier Liner Rehabilitation	No data	Yes	Yes
RWF Sand Pump Piping Replacement	<2	Yes	Yes

The 2013 Recycled Water Master Plan included a table of Proposed Title XVI Program improvements. Most of these are related to LMEC/DEC and so, other than re-rating the chlorine contact basin, should be postponed until a decision by Calpine is made whether or not to continue using recycled water.

A high-level evaluation of the existing distribution system was conducted to estimate the feasibility of servicing new recycled water customers. Of the 17 potential new users, seven users could be served without major modifications to the existing distribution system, and 10 users would require onsite recycled water storage tanks or additional pipes to connect into the existing distribution line. The distribution system itself could serve these potential customers if LMEC/DEC discontinued recycled water use. However, some of these new users would require recycled water storage to allow them to receive recycled water at a relatively constant flow while using recycled water at peak flows (e.g., irrigation for 2 hours every other day).

8.1.2.3 Key Coordination Points

It is recommended that the future Recycled Water Facility Master Plan Update (Facilities Assessment)in 2023 include:

- An evaluation of existing recycled water users to determine if they plan to continue using recycled water and/or if they would be interested in expanding their use.
- An update of potential new recycled water user demands.
- An evaluation of potential upgrades to meet data center needs once known.
- An update of RW distribution hydraulic model and review storage requirements for new and existing customers.
- An evaluation of impacts associated with any return or concentrate streams including nutrient loads.

9. Focus Area 6 - Energy Management and Support Services

This focus area is intended to support District efforts to develop an Energy Management Program Guidance Document (EMPGD) by providing specific recommendations to further tailor the District's existing program (**Task 9-Energy Management**)..

9.1 Energy Management

As part of the Master Plan, the District is interested in developing an EMPGD outlining specific tasks and procedures to further develop their existing energy management program. It is recognized the District strives to develop an energy management program that is not time or resource intensive and integrates easily with ongoing projects, procedures, operations, and enterprise systems.

9.1.1 Energy Management Approach

The purpose of this EMPGD is to examine the District's current energy management program and practices and provide recommendations based on industry best practices and standards (i.e., ISO 50001, WEF, WaterRF, US DOE Better Plants, AWWA) for the District's consideration to further develop their energy management program.

The EMPGD focuses on the following five (5) key energy management program areas (**Figure 9-1**).

Energy Policy, Objectives and Targets
- Build on previous work to express the intentions, direction, and commitments for improving energy efficiency, resiliency, energy awareness, and existing practices.

Organizational Readiness and Planning
- Basic guidelines to incorporate energy management into core business practices.

Tools and Strategies for Continual Improvement
- Communication and recognition of energy improvements via simple systems integrated into ongoing efforts.

Monitoring and Visualization Considerations
- Information to enable plant staff to understand energy performance and inspire ideas for improvement.

Monitoring Infrastructure and Visualization Platform Recommendations
- Plan infrastructure needed to communicate information to all levels of the organization.

Figure 9-1 Energy Management Program Areas

9.1.2 Energy Management Key Findings

Based on the work to date, the District is already an industry leader in energy management. The District has implemented many industry best practices and key elements of industry standards, such as those outlined in ISO 50001, WEF, WaterRF, US DOE Better Plants, and AWWA guidance documents. Of particular note is the Board approved Energy Management System Pledge which meets all the requirements of an ISO 50001 energy policy. It is a strong foundation for further developing the District's energy management program.

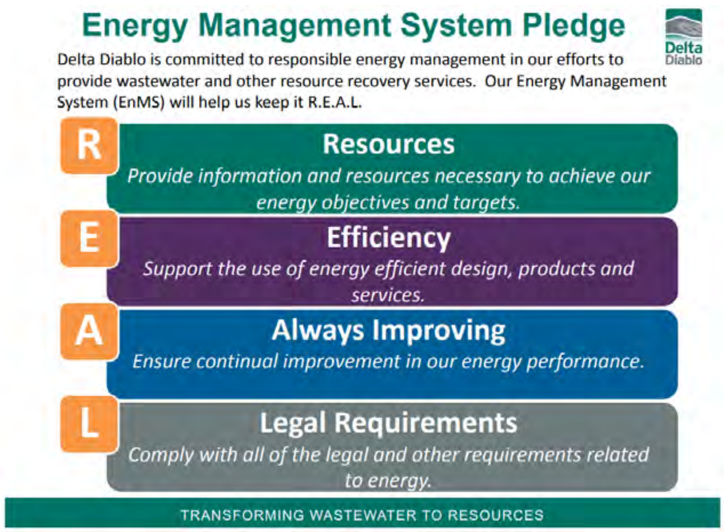


Figure 9-2 Delta Diablo Energy Management System Pledge

9.1.2.1 Recommendations Summary

- Further develop quantitative and qualitative metrics that measures progress towards the District's energy policy and goals (R.E.A.L) to communicate progress to stakeholders and promote an "energy awareness culture".
- Further develop training and orientation programs for new and existing staff to promote energy awareness and support energy integration into the District's core business practices.
- Document and communicate operational procedures and practices that integrate energy management into the District's core business practices. Core business practices include Capital Planning, Engineering and Design, Procurement, Operations and Asset Management.
- Develop a strategic power monitoring implementation program that prioritizes energy monitoring on loads that provide valuable and actionable optimization information. Power monitoring implementation plan should be aligned with planned equipment upgrades and replacements. Power monitoring implementation plan should also be aligned with the energy data visualization strategy.
- Develop an energy data visualization strategy in alignment with the District's existing IT and SCADA plans. The energy data visualization strategy should develop specific metrics and key performance indicator visualizations that facilitate staff driven optimization as well as measure and communicate progress towards the District's energy policy and goals (R.E.A.L.).

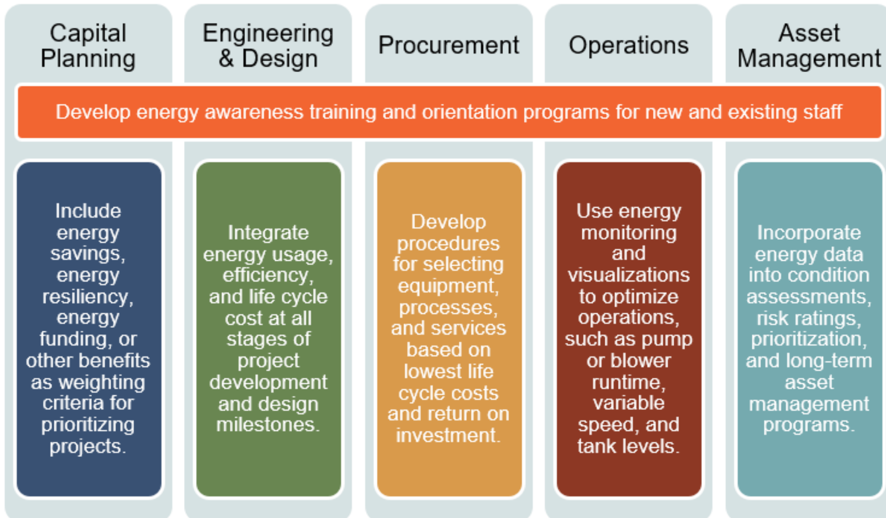


Figure 9-3 Energy Management Recommendations

9.1.2.2 Key Coordination Points

The Energy Management recommendation to increase awareness of energy efficiency can be coordinated with District capital projects by prompting staff to consider energy management and life cycle costs in the planning and design phases. An energy monitoring strategic plan is recommended to be incorporated into the District's Electrical Master Plan to identify key select locations for energy monitoring.

10. Conclusions and Look ahead

The District is balancing several drivers including capacity, aging infrastructure, reliability and vulnerability, and regulations. This RRFM addresses these drivers and explores questions related to asset management, flows and loads, nutrient management, biosolids and renewable energy management, recycled water, vulnerability and risk mitigation and energy management. The key findings from the Master Plan have been distilled to a 20-year Implementation Plan shown in **Figure 10-1**. The Implementation Plan outlines key CIP projects (or groups of CIP projects) and studies to strategically address the District drivers and achieve its goals. The Implementation Plan is divided into the following categories:

- Piloting and Studies – Describes future studies and piloting to confirm or optimize performance
- Liquids Treatment – Includes liquid treatment processes from headworks to disinfection
- Effluent Management – Includes emergency retention basin, outfall facilities, RWF, and RW distribution system
- Solids and Renewable Energy – Includes solids handling, HSW and energy generation facilities.
- General and Support Facilities – Includes electrical infrastructure, buildings, roadwork

Note that timing shown in the Implementation Plan corresponds to approximate year of project initiation. A detailed description of costs and project components is provided in the Capital Planning Tool (available as electronic deliverable).

10.1 Liquids Treatment

Near-term (less than 2 years)

- Flows and loads confirmed that the WWTP is currently at 75% of its biological treatment capacity. As a result, it is recommended that the District invest in adding aeration basin volume at a depth compatible with nutrient removal options. This project includes Capital Asset Replacement Program projects in the secondary clarifier system, primary effluent pumping, and distribution system.
- Analysis concluded that the TTF are not compatible with the District's nutrient management future. Vulnerability analysis noted that the TTF are beyond their useful life and would require significant investment for future service. The District should not invest in near-term improvements of the TTF. As TTF media fails performance will degrade gradually over time. The District should continue to operate the TTF until significant deterioration is observed.
- The District will also invest in aging infrastructure with repairs to the Primary Clarifiers, Flow Equalization and Disinfection processes.

Mid-term (2-5 years)

- While it is not expected that potential nutrient effluent load caps will be exceeded within 5 years, the District should monitor regulatory developments including the subembayment load caps and nutrient trading market developments. Nutrient trading may impact long-term nutrient management strategies.
- The District should participate in regional or national studies related to PFAS source reduction and treatability. If the regulations become more likely, perform PFAS monitoring and treatability study.
- Plan for flexible biosolids treatment disposal.

Long-term (5-10 years)

- After improvements to the secondary system, the District can explore demonstrating densification. Densification may further unlock secondary capacity.
- Load caps will likely be implemented in this time frame. The District should monitor regulatory developments including the subembayment load caps and nutrient trading market developments.
- Sidestream treatment, may be implemented in this period if early nutrient removal adoption is beneficial or if significant HSW is accepted for codigestion
- The District may investigate nutrient removal technologies that can be implemented as part of the nutrient load cap solution (i.e., Aerobic Granular Sludge, MABR). The baseline alternative is Flexible BNR.
- Decommission TTF as performance degrades.

Long-term (10 – 20 years)

- If mainstream treatment to achieve nutrient limits are necessary (e.g., BACWA Level 2), the District will need to implement additional capital projects. The baseline alternative is Flexible BNR, a nutrient management strategy that involves construction of new aeration basins and clarifiers.

Long-term (Beyond 20 years)

- If further nutrient limits are implemented (e.g., BACWA Level 3), the District will need to implement additional capital projects. The baseline alternative is Flexible BNR which provides flexibility to expand to meet these stringent standards.

10.2 Biosolids and Renewable Energy

Near-term (less than 2 years)

- Near-term activities related to Biosolid and Renewable Energy infrastructure, focus on reliability of the existing system. General areas that will be affected include:
    - Sludge thickening improvements
    - Digester Cleaning
    - Digester Gas handling improvements

    - Cogen signal improvements

Mid-term (2-5 years)

- A Biosolids Master Plan to explore advanced digestion options.
- The District should participate in regional or national studies related to PFAS source reduction and treatability. Capital projects during this time will focus on dewatering including improvements to the polymer equipment, dry polymer feed pumps, mixers, air dryer, flow meters and storage tanks.

Long-term (10-20 years)

- Flows and loads, along with process changes in the secondary system (TTF retirement) will necessitate a digester capacity increase. The baseline alternative is the addition of a 4^{th} digester.
- Additional digestion capacity will also allow the District to continue development of the renewable energy program. Current place holder activities include
    - Improvements to HSW receiving
    - Cogen engine capacity expansion or upgrade (may be sooner if organics codigestion is implemented)

10.3 Effluent Management

Near-term (less than 2 years)

- Near-term activities related to effluent management include RWF facility reliability improvements

Mid-term (2-5 years)

- As the Calpine agreement expires in 2030, the District must prepare a **Recycled Water Facility** Master Plan to determine the:
    - necessary investment in the RWF to continue providing RW to Calpine
    - options should the Calpine cease operation

- Capital projects during this time frame include
    - Cleaning the outfall to increase capacity
    - Emergency Retention Basin improvements including return pumps rehabilitation and optimization assessment

Long-term (5-10 years)

- During this time period Calpine will review the **Recycled Water Facility** Master Plan Update (Facilities Assessment) and determine if it will renew the agreement with the District.

- Projects in this period depend largely on whether the District will continue to provide RW to Calpine. The following projects will be impacted by this decision.
  - Outfall capacity – If the District does not continue to provide RW to Calpine and does not acquire new users, the increased flow to the outfall will necessitate an outfall capacity expansion project
  - RWF CARP projects may be impacted if the Recycled Water Facility Master Plan Update (Facilities Assessment) identifies other users such as the Pittsburg Technology Park (data center) that might necessitate process changes to the RWF
  - RW distribution improvements – If the District expands its customers, it may necessitate changes to the RW distribution system.
- The District has additional improvements to the ESB identified for this time period including installation of sump pumps on a float control system in the emergency storage basin.

10.4 Support Facilities

Near-term (less than 2 years)

- General improvements to buildings, site security and roadways
- CIP projects in this period include on-going electrical switch gear replacement

Mid-term (2-5 years)

- The District will conduct an Electrical Master Plan. It is recommended that this includes energy monitoring strategic planning.

Long-term (5-10 years)

- The District may implement water and energy efficiency improvements during this period. This may be informed by strategic energy monitoring suggested in the mid-term.
- The District will also continue to invest in its asset management program to reduce vulnerability and mitigate risks.

10.5 Piloting and Studies

Through the 2022 Master Plan, several additional studies and piloting projects were identified to inform long-term projects (**Table 10-1**). These studies are intended to build upon the analysis of this Master Plan.

Table 10-1 Additional District Studies Needed

Study	Description	Timeframe
SCADA Master Plan	This study will update the 2011 Supervisory Control and Data Acquisition (SCADA) Master Plan to identify potential upgrades, changes, and/or replacements to enhance and increase the reliability of the District's SCADA system.	2022 to 2023

Study	Description	Timeframe
Data Management Master Plan	This study will facilitate development of a centralized data management and visualization platform that can be extended to visualize key metrics related to plant performance, energy and chemical usage, as well as asset management. This effort directly supports District objectives to achieve operational excellence. Close coordination will be needed with teams performing the SCADA and Electrical Master Plans.	2022 to 2023
PFAS source and treatability study	The District should continue to support statewide and national source control efforts such as public education and product bans. If the regulations become more likely, perform PFAS monitoring and treatability study. This study will allow the District to identify contributors of PFAS to the influent of the WWTP, current fate of PFAS through the existing WWTP and identify approaches (e.g., source control or treatment at WWTP) for controlling PFAS at the WWTP.	2023 to 2026
Climate Change Mitigation study	This study will focus on quantifying the impacts due to impacts of climate change such as sea level rise, changes in rainfall volume and intensity, associated site inundation, plant hydraulic throughput decrease, and changes to flows and loads that may occur.	2023 to 2026
Electrical Master Plan	This study will evaluate the District's current and future electrical requirements and provide guidelines for planning the electric distribution system to serve the District in a reliable manner while providing flexibility to potentially export power to nearby utilities.	2023 to 2026
Biosolids Master Plan	This study will help the District navigate the diversity of advanced processing technologies and renewable energy pathways. Additionally, this study will address regional solids management solutions that may become available to the District.	2023 to 2026
Recycled Water Master Plan	This project will help the District chart the future of the recycled water program, RWF and inform actions needed regarding outfall capacity improvements.	2023 to 2026
Intensification technology piloting (if nutrient removal is triggered at WWTP)	This piloting project is included as a placeholder to allow the District to pilot test intensified BNR technologies prior to informing capital investment for nutrient removal at the WWTP.	Post 2026 (timeline will be revised based on evolution of nutrient regulations)

10.6 Outcomes from Land Use planning

Land use planning was conducted as part of nutrient management, biosolids management, and renewable energy management where new infrastructure was considered. Key outcomes from land use planning include:

- Near-term (0-5 years) Land use planning is visualized dynamically on the story map tool. This tool can be shared internally with District staff or board members, or externally with the public.
- Long-term (5-20 years) Land use planning can be visualized on the build out site map. Note that several unit processes are planned to be constructed in the footprint of existing facilities. This will require phased construction to implement. This is further detailed in **Appendix 5 – Nutrient Management**.

As shown in **Figure 10-2** the District has adequate space for Flexible BNR alternative for nutrient management and the baseline implementation for biosolids management.

10.7 Updates to the Implementation Plan

The Implementation Plan is intended to be a living document. The District has several plans and studies that will affect the long-term projects currently planned for. The District should update the Implementation Plan and road maps developed as part of this Master Plan with key findings from these future studies. This Master Plan can be updated using the dynamic digital tools or by revisiting key trigger points on the road maps.

10.8 Digital Tools

This Master Plan is accompanied by digital tools to effectively communicate the Master Plan outcomes. The digital tool developed for the District for this Master Plan include the Capital Timing Tool and story map. These web-based tools are described below.

10.8.1 Capital Planning Tool

The capital timing tool outlines the baseline Implementation Plan with an assumed regulatory timeline. The tool summarizes timing and capital investment over time. The tool is also programmed with mutually exclusive alternative implementation plans, i.e., implementation of MBR for nutrient management. The tool is intended to help the District understand the implications of various alternatives.

10.8.2 Story Map

The Story Map fulfills the District's goal to improve communications by graphically displaying the near-term capital improvement projects at the WWTP. The story map is linked to CIP sheets for each project identified in the 0-5 year range. The tool can be used to communicate to the District Board of Directors or to public customers.

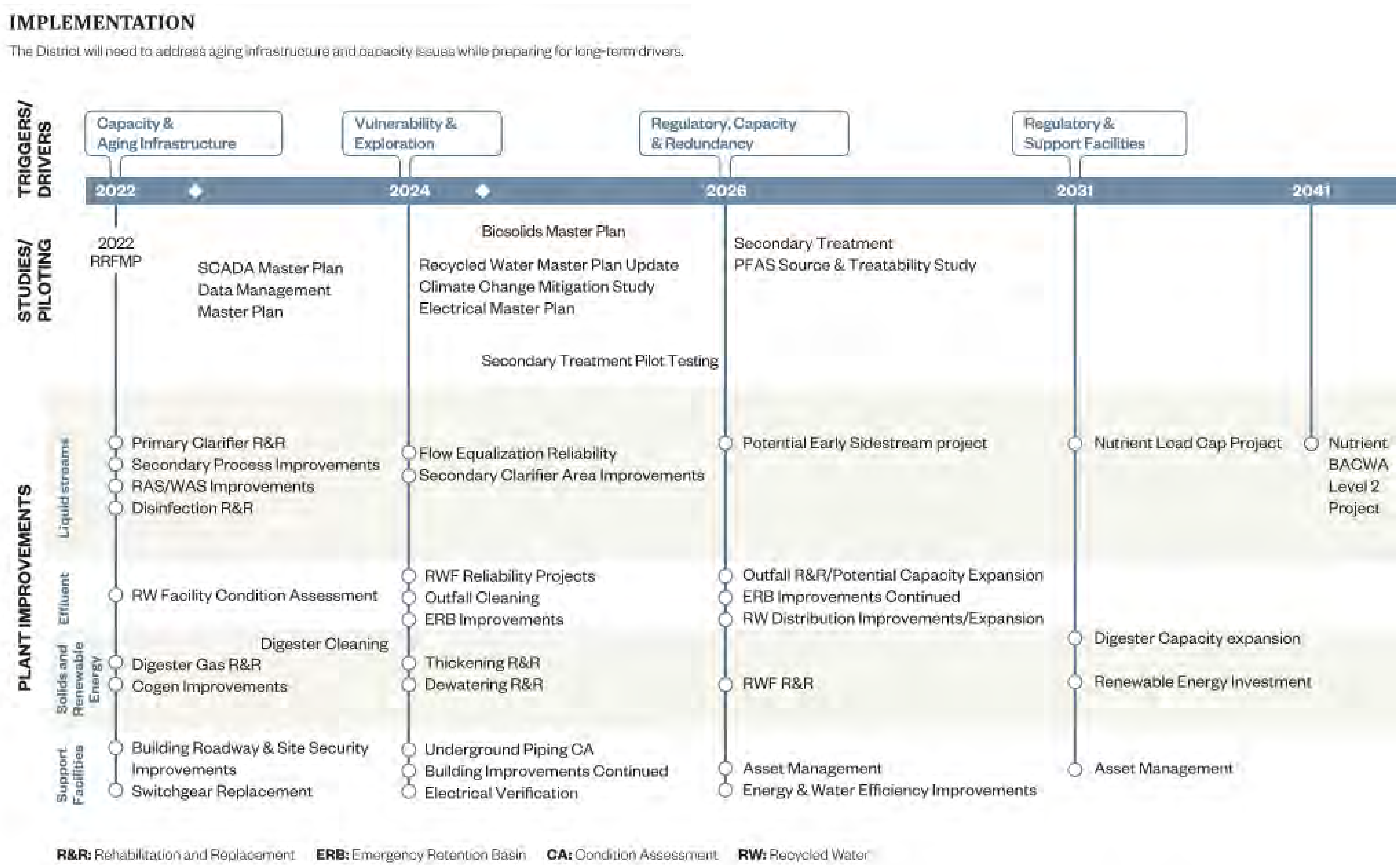


Figure 10-1 2022 Master Plan Implementation Plan

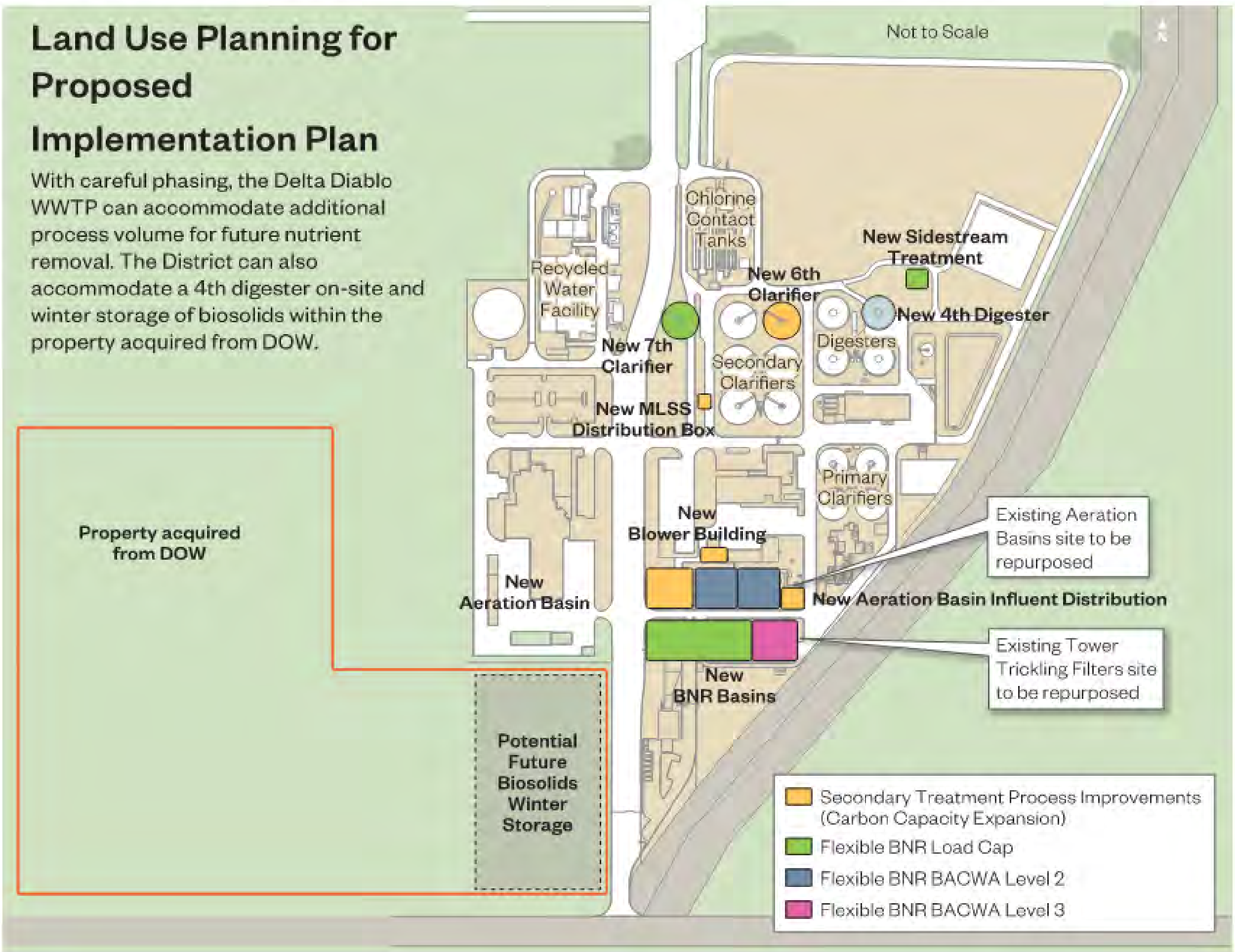


Figure 10-2 Site Planning for Implementation Plan from 2022 Master Plan

Appendix 1

TM – 01 Flow and Loads

November 1, 2021

To: Brian Thomas, Delta Diablo

From: Irene Chu, Justin Irving, Hazen

Reviewed by: Paul Pitt, Hazen

Re: Master Plan – Flows and Load Projections

TM - 01 Flow and Load Projections

Final

Revision No.	Date	Description	Author	Reviewed
0	March 2020	Flow and Loads	Chu, Irving	Pitt
1	August 2022	Flow and Loads	Chu	District

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1. Introduction

For the Delta Diablo (District) Resource Recovery Facilities Master Plan (Master Plan), flows and loads were projected to the planning horizon, 2040. These projections were an update of the previous master planning projections since drought conditions have caused flows and loads to deviate greatly from the predictions made in 2011. While flows are decreasing or remaining relatively flat due to drought conditions (e.g., mandatory water conservation in new homes, incentives to decrease water use), loads have been increasing due to population and business growth in the area. For this reason, the predictions for flows and loads must be decoupled. As such, within this Master Plan, the process capacity of the plant and the flow capacity were assessed separately. Projections assuming a high and low growth rate were developed to provide a range of future conditions. This range of future flows and loads provided a window of when hydraulics or process capacity could be reached and set the boundary conditions for the analysis in this Master Plan. This Technical Memorandum describes the methodology and summarizes the projected flows and loads.

1.1 Background Information / Previous Studies

This Master Plan referred to three studies where plant flows, projections, and capacity were determined previously by others. These include the Conveyance System Master Plan Update (April 2010), the Treatment Plant Master Plan Update (July 2011), and the Treatment Plant Capacity Assessment Update (March 2014). Key findings from these reports are outlined in the sections below and referenced throughout this report.

1.1.1 Conveyance System Master Plan Update (April 2010)

The buildout average dry weather flow (ADWF) for the District system was estimated to be 25.1 MGD. This equates to 25.3 MGD when incorporating 0.2 MGD sludge return from the Recycled Water Facility (RWF). This buildout flow of 25.3 MGD was used to understand when the plant reaches flow capacity. Peak wet weather flow (PWWF) was defined as 32.5 MGD.

1.1.2 Treatment Plant Master Plan Update (July 2011)

Future flow projections were based on a linear extrapolation of historical flow data from 1991 to 2009. As shown by the solid blue line on **Figure 1-1**, using this growth assumption, the buildout flow of 25.3 MGD would be reached in 2057. Water conservation efforts became apparent beginning in 2008. The green dashed line on **Figure 1-1** represents the adjusted projections accounting for water conservation efforts.

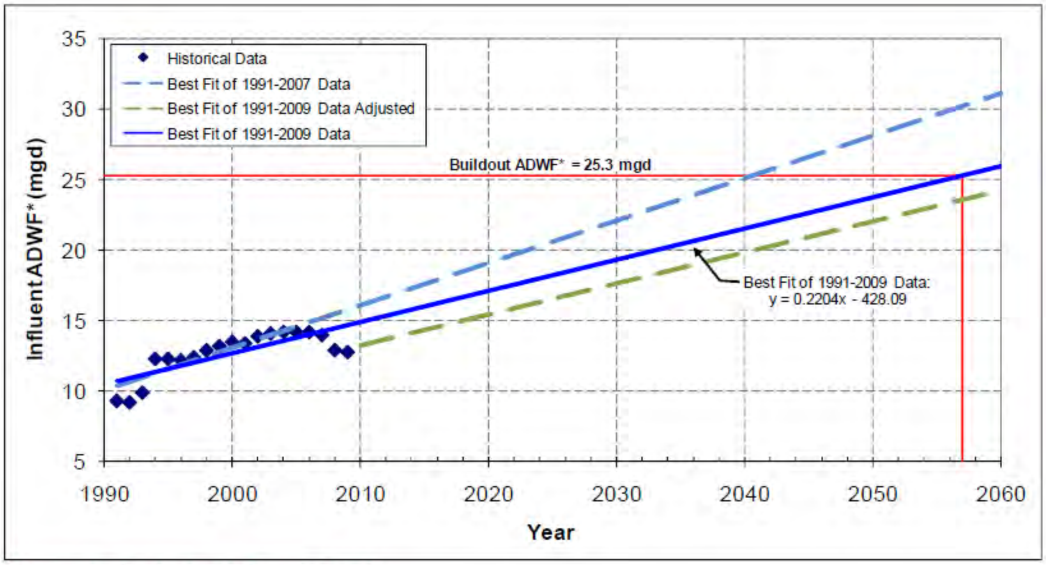


Figure 1-1: Projected Influent ADWF from Treatment Plant Master Plan Update (July 2011)

Table 1-1 presents historical average flow data from 2007 to 2009 and flow projections through buildout. Future loads were developed based on these projected flows, as well as historical concentrations and peaking factors. Projected influent BOD loads are presented in **Figure 1-2**.

Table 1-1: Projected Influent Flows from Treatment Plant Master Plan Update (July 2011)

Condition	Influent Flow (MGD)						
	Current (2007 – 2009)	Peaking Factors	2020	2030	2040	2050	Buildout
Average Dry Weather	13.2	0.97	17.1	19.3	21.5	23.7	25.3
Average Annual	13.6	1.00	17.6	19.9	22.1	24.4	26.0
Maximum Month	14.7	1.09	19.0	21.5	23.9	26.4	28.1
Maximum Day	18.6	1.53	24.1	27.2	30.3	33.4	35.6
Peak Wet Weather	32.5	2.46	35.6	38.7	41.8	44.9	47.1

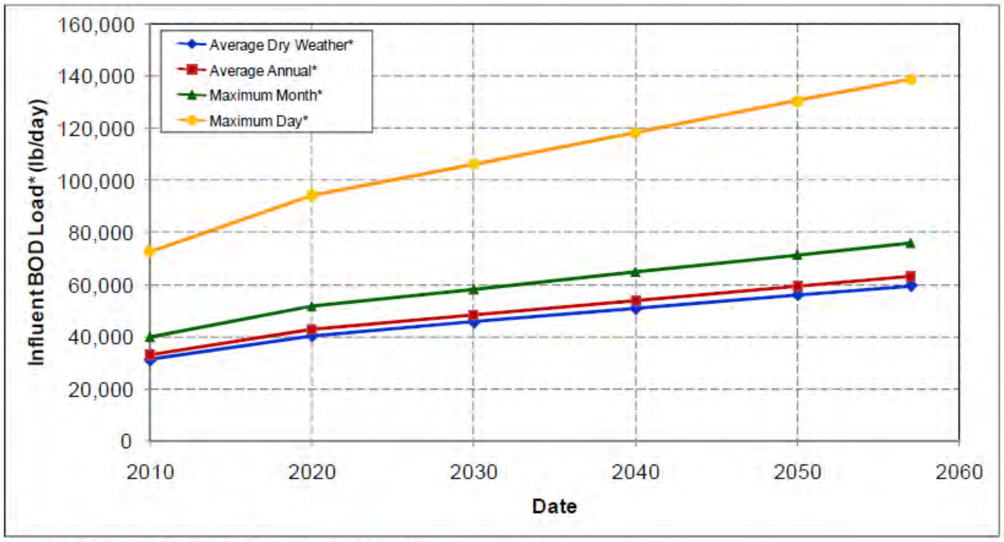


Figure 12. Projected Influent BOD Loads

* Includes raw influent BOD loads and 720 lb/day of BOD from RWF return sludge.

Figure 1-2: Projected Influent BOD Loads from Treatment Plant Master Plan Update (July 2011)

1.1.3 Treatment Plant Capacity Assessment Update (March 2014)

Aeration improvements resulted in an increase in ADWF capacity from 16.5 MGD to 21.3 MGD with the limiting unit processes being the aeration basins and the trickling filters, as shown on **Figure 1-3**. Using the specified influent concentrations in the study, an ADWF of 21.3 MGD equates to a secondary treatment process capacity of 49,500 lbs/d for BOD. For this initial analysis, a BOD load of 49,500 lbs/d was used to understand when the plant would reach biological loading capacity. The maximum loading for the trickling filters was defined as 200 lbs BOD/1,000ft^3-day per filter. Once this limit is reached, the plant typically bypasses flow to the aeration tanks. Process capacity is further evaluated under this Master Plan in the TM 04 Nutrient Management Analysis

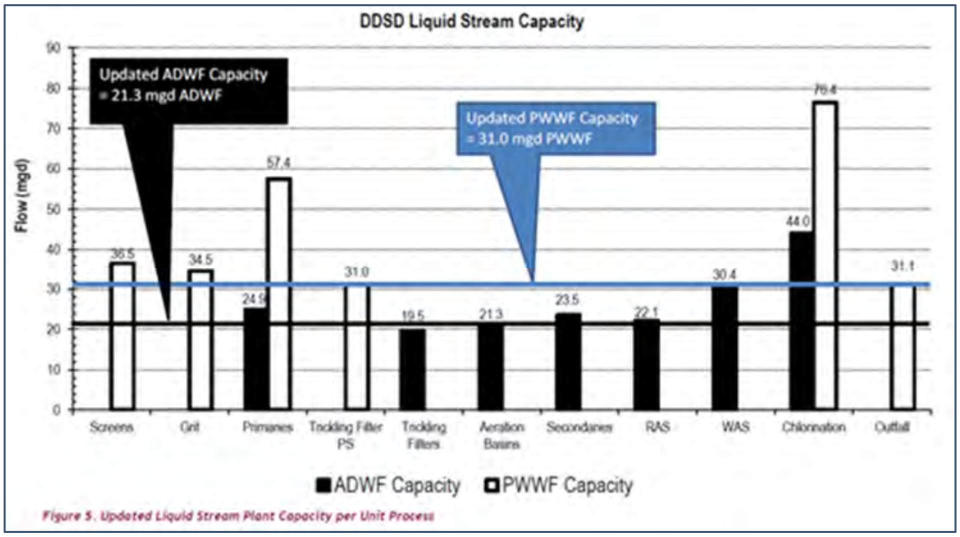


Figure 1-3: Updated Liquid Stream Plant Capacity per Unit Process from the Treatment Plant Capacity Assessment Update (March 2014)

1.2 Approach to Master Plan

The approach used to define future flows and loads for this Master Plan effort is a population-based approach that decouples flow and load growth. As such, it can account for water conservation and increasing loads from population growth. The four-step approach is outlined in **Figure 1-4**.

Figure 1-4: Approach to Master Plan Flows and Loads

For this project, a statistical analysis was performed on historical influent loads to understand the annual average flows and loads and peaking factors. These findings were then compared and contrasted with past planning efforts to build consensus on per capita flow and load benchmarks for the District for the 2022 Master Plan projections. Per capita flow and load benchmarks were then combined with projected population increase by various methods (linear extrapolation of historical population growth or census projection estimates) to develop flows and loads projections.

Historical population data was obtained from the Department of Finance (DoF). Projected population increases were assessed based on local population projections by the Association for Bay Area Governments (ABAG) and linear extrapolation of historical DoF population data. Special considerations for development of the Master Plan approach included converting job growth to population equivalents and accounting for industrial flows and loads in benchmarking and projection analyses.

2. Historical Data

Historical data from 2000 to 2019 was analyzed to develop per capita metrics for influent flow, BOD, TSS, and ammonia loads. Key findings from the historical data evaluation are outlined in the sections below.

2.1 Influent Flow

As shown in **Figure 2-1**, average annual influent flow rates have decreased by approximately 10% over the last 19 years. This confirms that water conservation trends observed in the Treatment Plant Master Plan Update (July 2011) analysis have continued.

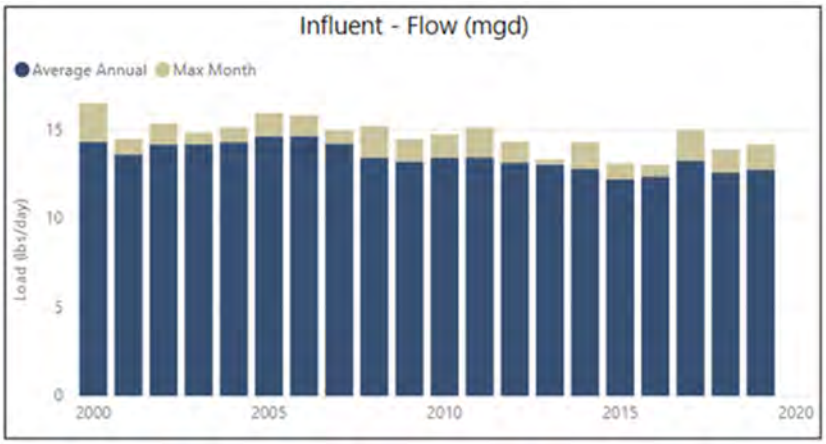


Figure 2-1: Influent Flow

2.2 Influent BOD

Figure 2-2 presents influent BOD loads and concentrations from 2000 to 2019. Average influent BOD loads have increased by 26% over the last 10 years or 2.3% per year. Current loads are approximately 40,000 lbs/d or 20% below the ADWF capacity described in the Treatment Plant Capacity Assessment Update (March 2014).

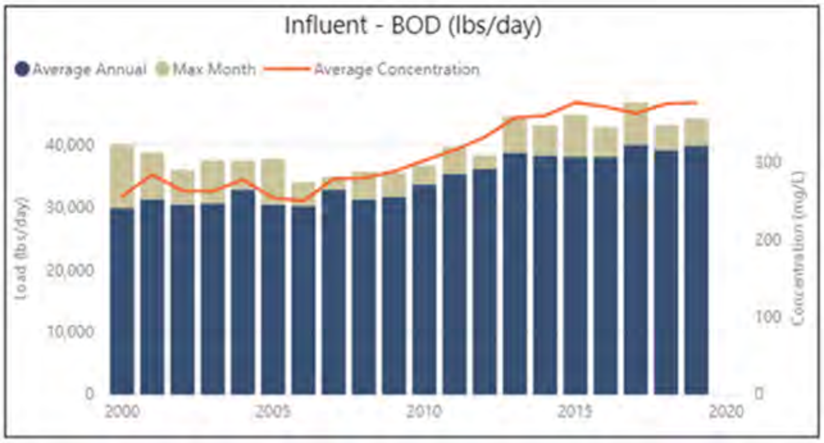


Figure 2-2: Influent BOD

2.3 Influent TSS

Figure 2-3 presents the historical influent TSS data from 2000 to 2019. Average influent TSS loads have increased by 18% over the last 10 years or 1.6% per year. In general, TSS loads showed more variability than BOD loads over the historical time range, with more recent data (last 10 years) being more consistent.

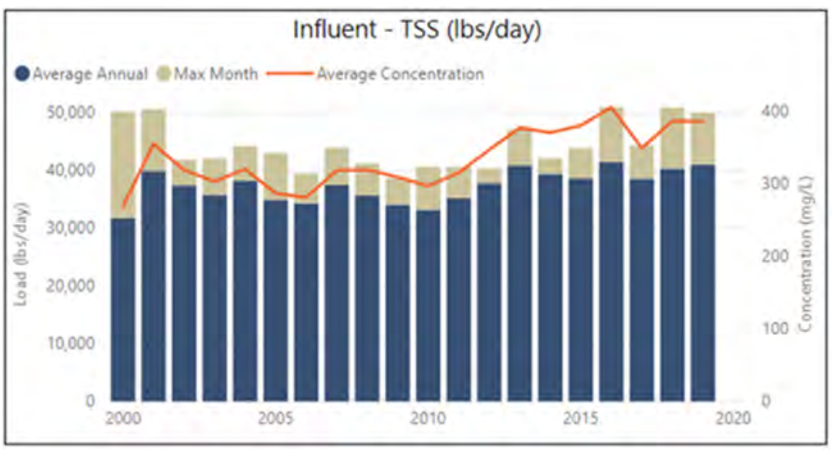


Figure 2-3: Influent TSS

2.4 Influent Ammonia

The influent ammonia load has increased by 14% over the last 7 years or 1.9% per year. Ammonia data was collected less frequently and over a shorter historical time frame and thus may reflect a period of more rapid growth in the District.

2.5 Peaking Factors

Peaking factors calculated from the historical dataset discussed above are presented in **Table 2-1**. Outliers were filtered out to avoid skewing the calculations. The resulting peaking factors are within typical ranges, indicating that the data is reliable. **Table 2-2** lists the peaking factors determined in the Treatment Plant Master Plan Update (July 2011), which are similar to those calculated for this analysis. This indicates that while influent loads to the plant have increased, load variability has not changed significantly in the last 10 years. The 2022 Master Plan peaking factors will be used with projections for alternative analyses. Ammonia, TKN, Ortho-P, and TP will be estimated based on historical and special sampling ratios to BOD and TSS.

Table 2-1: Peaking Factors Calculated for 2022 Master Plan

Peaking Factor	Influent Flow	Influent BOD Load	Influent TSS Load
Maximum 30-Day	1.1	1.1	1.2
Maximum 7-Day	1.2	1.3	1.4
Maximum Day	1.5	1.4	1.7

Table 2-2: Peaking Factors from Treatment Plant Master Plan Update (July 2011)

Peaking Factor	Influent Flow	Influent BOD Load	Influent TSS Load
Maximum 30-Day	1.08	1.18	1.24
Maximum 7-Day	-	-	-
Maximum Day	1.37	1.70	1.99

3. Per Capita Flow and Load Benchmarking

3.1 Historical Population

Available historical population data was mined from several sources, including the Census, the American Community Survey, and the DoF, as described in **Table 3-1**. Ultimately, the historical DoF data was used for the per capita benchmarking due to the fact that yearly data was available, and the boundaries could be aligned with the District's service area. The DoF data is sourced from the Demographic Research Unit, which was created as subset of the DoF in 1951 and is nationally recognized. The Demographic Research Unit serves as a single official source for demographic data used for planning and budgeting at the local and state level.

Table 3-1: Summary of Available Sources for Historical Population Data

Source	Census	American Community Survey (ACS)	Department of Finance
Years Available	2000 and 2010	2015	Yearly data from 2000 to 2019 (for this analysis)
Boundaries	By census tract Tract boundaries do no overlap perfectly with District service area	By census tract Tract boundaries do no overlap perfectly with District service area	District's service area
Notes	Has projections of population growth	Less accurate than census	Chosen for developing per capita flows and loads

Analysis of the DoF dataset indicated that the District's service area population has increased 24% over the last 19 years or 1.12% per year. While the data shows that population growth slowed during the great recession (between 2007 and 2009), an average over the whole dataset dampens this temporary perturbation.

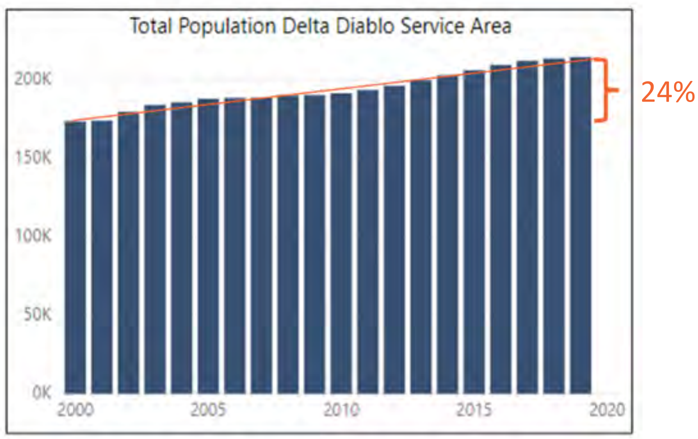


Figure 3-1: Population Data from DoF Dataset

3.2 Influent Flow per Capita

Annual average flows were coupled with yearly population data to determine a per capita influent flow for each year, as shown in **Figure 3-2**. The influent flow per capita has decreased significantly since 2008, concurrent with the drought conditions in California. Only the last 10 years of per capita estimates were used for benchmarking. **Table 3-2** shows the minimum flow per capita for this period was 59 gpd/person while the average was 63 gpd/person. Based on California Department of Water Resources (DWR) goals to achieve 55 gpd/person[1], the minimum flow per capita of 59 gpd/person (shown in orange in **Table 3-2)** was used for future flow projections.

[1] On May 11, 2021, the DWR formally released recommendations in a draft *Report to the Legislature on the Results of the Indoor Residential Water Use Study (IRWUS)*, which were set in 2018 by previous water conservation legislation (AB 1668 and SB 606). In the draft report, DWR calls for revised targets for per capita use of 47 gpd/person by 2025 and 42 gpd/person by 2030. The current statutory targets are 55 gpd/person by 2020, 52.5 gpd/person by 2025, and 50 gpd/person by 2030 (Water Code § 10609.4(b)(1)). However, the revised draft standards are based on a qualitative study and concerns have been expressed about its reliability for basing such stark revisions to the already low targets in statute.

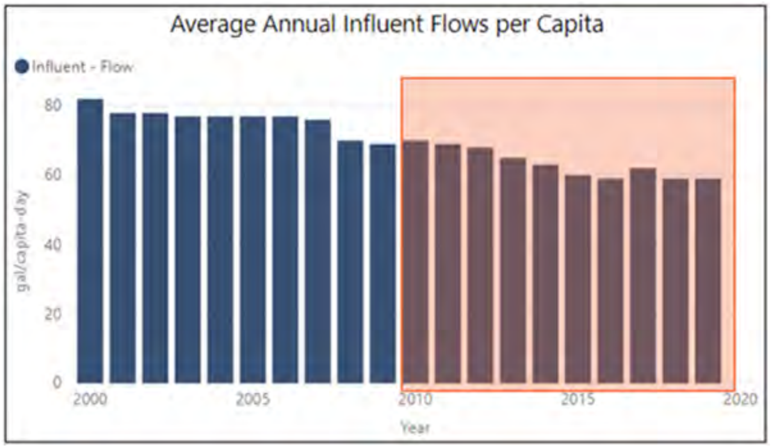


Figure 3-2: Influent Flows per Capita

Table 3-2: Per Capita Flow Benchmark

	2010 – 2019 Per Capita Flow (gpd/person)
Minimum	59
Average	63
Maximum	70
Typical Range	52 – 74

3.3 Influent BOD and TSS Loads per Capita

Annual average loads for BOD and TSS were coupled with yearly population data to determine a per capita influent BOD and TSS load for each year. BOD and TSS per capita loads were very consistent over the last 10 years and within typical ranges. This indicates very reliable dataset that give load projections confidence. As shown in **Table 3-3**, minimum and maximum per capita loads were very close to the average per capita loads. The average per capita loads for BOD and TSS (shown in orange) will be used for per capita benchmarking.

Table 3-3: Per Capita Flows and Loads

	2010 – 2019 Per Capita BOD (ppd/person)	2010 – 2019 Per Capita TSS (ppd/person)
Minimum	0.18	0.17
Average	0.18	0.19
Maximum	0.19	0.20
Typical Range	0.11 – 0.26	0.13 – 0.33

4. Projected Population Increase

Growth rates for population were estimated using two methods, Method A: Population projection by the ABAG and Method B: Extrapolation of historical DoF population data, which are further described below.

4.1 Method A: ABAG Data

The ABAG uses census growth projections for each census track to estimate population growth. The District's service area is comprised of several census tracks including some census tracks that are partially in the District's service area (see **Figure 4-1**). These tracks were prorated by a percentage to estimate the projected growth in the District's service area. The prorated percentage was determined based on comparing census track historical population data to the DoF historical population data for the District's service area. Census predictions for job growth in the District's service area were also included in the projections. This job count was multiplied by a factor of 0.35 to estimate contribution to the District's wastewater flow and load. As described in **Table 4-1** below, the adjusted ABAG population growth is estimated to be 90,000 by 2040 (40% increase in population). Most of this growth is related to single-family focused in the Los Medanos College area.

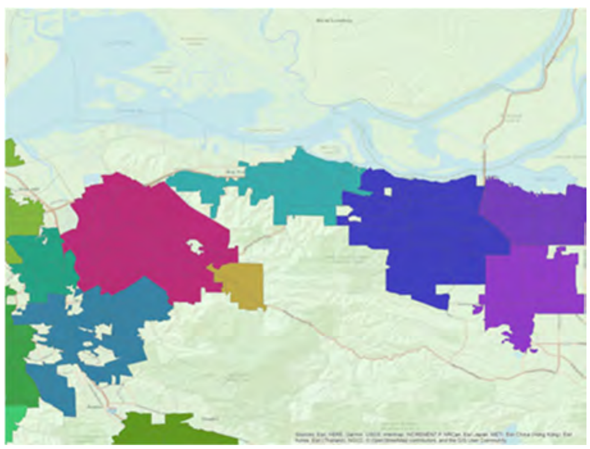


Figure 4-1: Census Tracts in the District's Service Area

4.2 Method B: DoF Extrapolation

A second method to determine projected population growth was developed based on extrapolation of the DoF historical population data. The observed average annual population growth from 2000 to 2019 was 1.12% per year. This rate was then used to project population increases through 2040, the planning horizon.

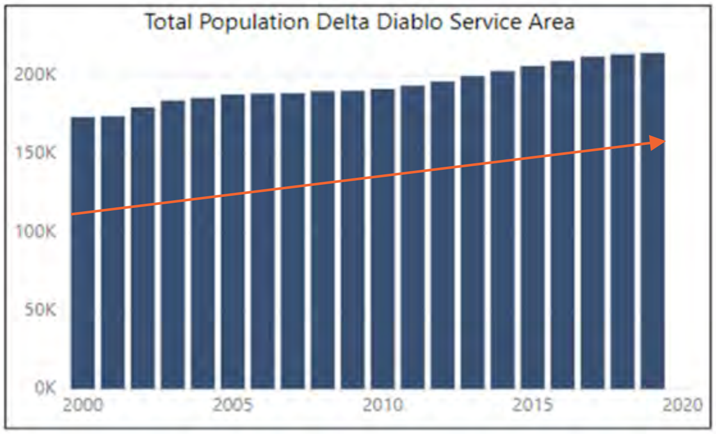


Figure 4-2: Population Growth from Historical DoF Data

4.3 Results of Population Estimation Methods

The year 2020 was considered a common starting point for both methods; the 2020 population was estimated to be 1.12% of 2019 population. Population projections using each method are outlined in **Table 4-1**. Overall, the ABAG projections were found to be 10% higher than DoF extrapolation projections, as shown graphically in **Figure 4-3**. As such, Method A (ABAG data) was considered to be more conservative for use in the Master Plan.

Table 4-1: Population Projections

Method	2020	2030	2040
A (ABAG)	0.22M	0.26M	0.31M
B (DoF)	0.22M	0.24M	0.27M

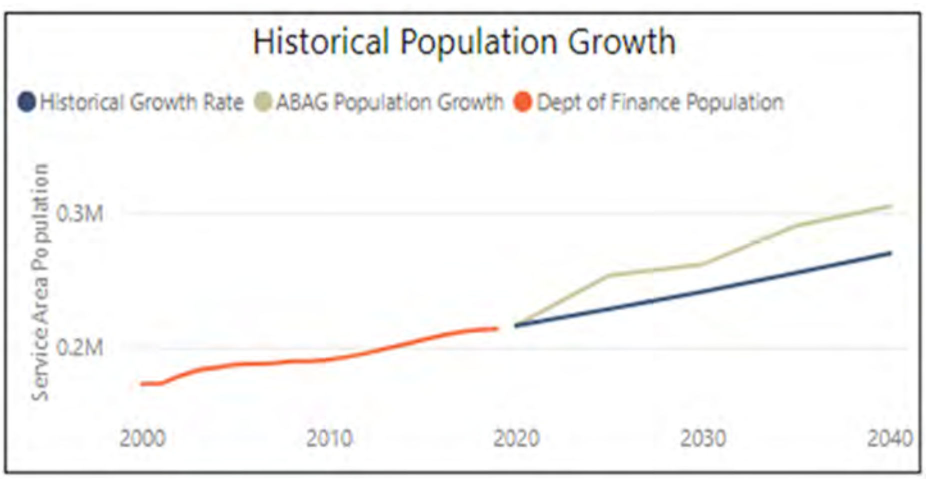


Figure 4-3: Projected Population Growth using Methods A and B

5. Flow and Load Projections

5.1 Flow Projections

Population projection methods were multiplied by per capita flows to develop flow projections. Both Methods A and B, described above, project influent flows significantly lower than the flow projections in the Treatment Plant Master Plan Update (July 2011). However, this is expected since water conservation efforts continued after the initial analysis in 2011, resulting in declining per capita flows. The two methods result in similar flows, with Method A projecting slightly higher flows than Method B; the difference between 2040 projections is 2.4 mgd or 15%. These projections estimate that the District will reach buildout in approximately 2070 (Method A) or 2096 (Method B), well beyond the planning period of this Master Plan. The projections are show in **Figure 5-1** and summarized in **Table 5-1**.

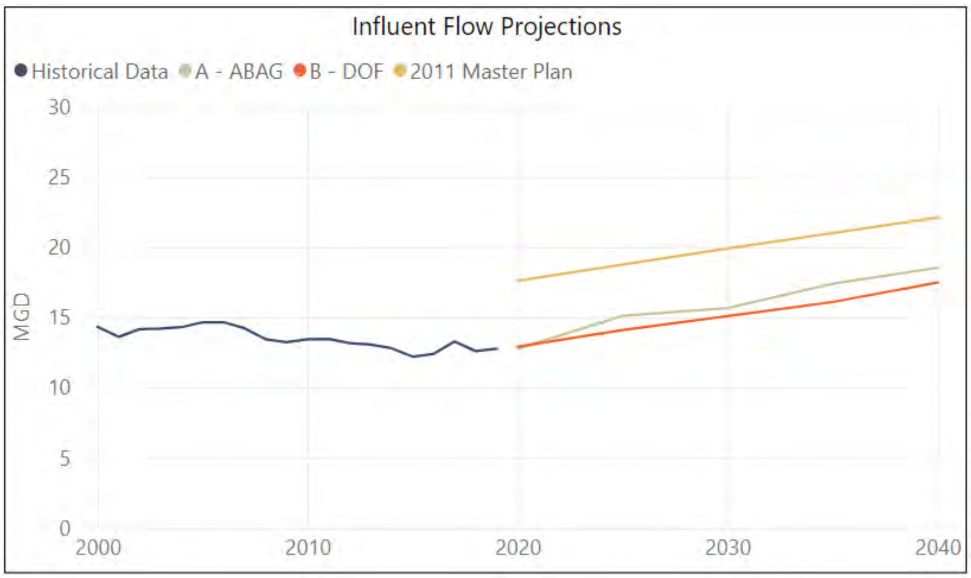


Figure 5-1: Influent Flow Projections

Table 5-1: Summary of Influent Flow Projections

Projection	2030 Flow (MGD)	2040 Flow (MGD)	25.3 MGD Capacity Reached
Method A – ABAG	16.3	18.4	2070
Method B – DOF	15	16	2096
2011 Master Plan	20	22	2057

5.2 Load Projections

Population projection methods were coupled with per capita loads to develop load projections. A third method (Method C) was also used. Method C used extrapolation of historical loads for the purposes of comparison. The load extrapolation method (Method C) and the projection based on the DoF population extrapolation (Method B) produced similar estimates for future BOD loads; these are 53,000 lbs/d and 52,000 lbs/d respectively and represent a difference of 2%. These estimates are also similar to BOD projections from the Treatment Plant Master Plan Update (July 2011). The BOD projections based on ABAG growth (Method A) are approximately 12% higher than Methods B and C. BOD load projections are presented in **Figure 5-2** and summarized in **Table 5-2**. Based on the capacity defined by the Treatment Plant Capacity Assessment report (March 2014), all three methods predict that the District will reach process capacity (represented by the dashed line on **Figure 5-2**) sometime between 2030 and 2047, which is within the Master Plan planning period ending in 2040.

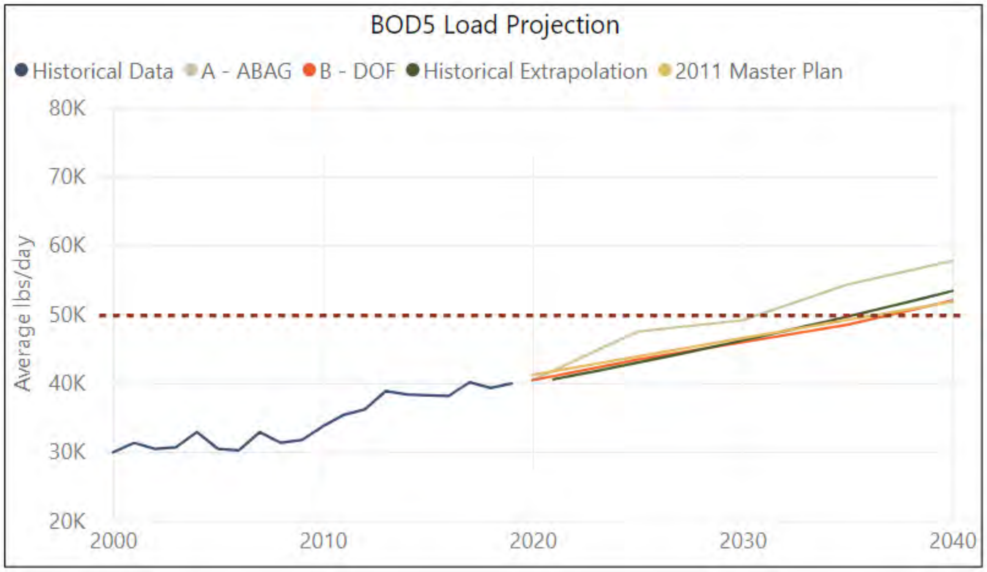


Figure 5-2: BOD Load Projections

Table 5-2: Summary of BOD Load Projections

Projection	2030 Load (lbs/d)	2040 Load (lbs/d)	Capacity Reached
Method A – ABAG	49,000	58,000	2030
Method B – DOF	46,000	52,000	2037
Method C – Load Extrapolation	46,000	53,000	2035
2011 Master Plan	47,000	52,000	-

The TSS projections based on load extrapolation (Method C) and DoF population (Method B) yield similar results with a difference of approximately 2%. The TSS load predictions from the Treatment Plant Master Plan Update (July 2011) are slightly higher than Methods B and C, while projections based on ABAG growth (Method A) yields loads that are approximately 13% higher than Methods B and C. TSS load projections are presented in **Figure 5-3** and summarized in **Table 5-3**. The WWTP influent TSS load capacity is determined from digester capacity. The digesters will reach capacity when influent flow is 17.5 mgd and influent TSS is 57,000 lbs/d (TM 05 Biosolids Management and Renewable Energy Management).

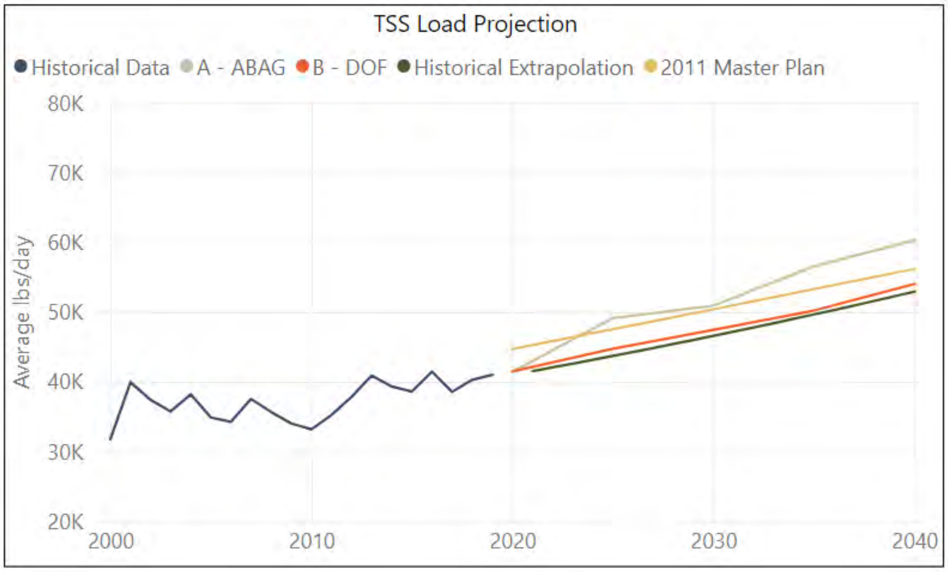


Figure 5-3: TSS Load Projections

Table 5-3: Summary of TSS Load Projections

Projection	2030 Load (lbs/d)	2040 Load (lbs/d)	Capacity reached
Method A – ABAG	51,000	60,000	2036
Method B – DOF	47,000	54,000	2040+
Method C – Load Extrapolation	47,000	53,000	2040+
2011 Master Plan	50,000	56,000	2040+

6. Conclusions

Key findings from the flow and load projection analysis are described below. A summary of flow and load projections is provided in **Table 6-1**.

- The Delta Diablo WWTP will reach biological capacity within 10 to 15 years.
- The District should begin planning for capacity improvements to ensure upgrades are in place in a timely fashion.
- It is recommended that the District evaluate unit process capacities based on the upper and lower boundary conditions to develop a capacity window to compare to the planning horizon of this Master Plan.

Table 6-1: Summary of Flow and Load Projections

Parameter	Current Average	Previous MP Average (2040)	2040 Average	2040 High	2040 Low
Flow, MGD	12.8	22.1	18.5	21.0	16.8
Peak Day Flow, MGD	19.2	33.2	27.8	31.5	25.2
BOD, lbs/d	40,000	51,800	55,100	59,400	50,800
TSS, lbs/d	41,000	56,200	58,400	64,000	52,800
NH_3-N[1], lbs/d	5,900	7,600	8,100	8,730	7,500
TKN[2], lbs/d	4,000	5,180	5,510	5,940	5,080
TP[3], lbs/d	1,150	-	1,570	1,700	1,450

[1] Assumes NH_3-N:BOD ratio of 0.1
[2] Assumes NH_3-N:TKN ratio of 0.68
[3] Assumes BOD:TP ratio of 35

- Water conservation efforts will continue to decouple flow and load growth at the District. Moving forward, it is recommended that the District track both flows and loads using an equivalent flow concept to understand treatment needs at the WWTP. The equivalent flow concept involves:
    - Maintaining the peak wet weather flow capacity of the plant (i.e., 31.1 MGD),
    - Identifying the load threshold that limits capacity at the WWTP,
    - Calculating the equivalent average dry weather flow corresponding to the load.

Table 6-2 demonstrates how the equivalent flow concept corresponds to the District's flow and load capacity. Load numbers represent the District's BOD load at the end of the planning period.

Table 6-2 Equivalent Flow Concept

	Equivalent Average Dry Weather Flow Capacity MGD	Average Annual Concentration mg/L	Average Annual BOD load in 2040 (Table 3-6) lb/day
2040 Eq. Flow using 2022 Master Plan concentrations	18.4	376	58,000
2040 Eq. Flow using 2014 study concentrations	22.5	305	58,000
2040 Eq. Flow using 2020 concentrations using 2011 study concentrations	24.6	280	58,000

Appendix 2

TM – 02 Condition Assessment and Risk Analysis Methodology

Hazen

Delta Diablo

May 25, 2021

To: Brian Thomas, Delta Diablo

From: Allan Briggs, Dawn Guendert, Sean Pour, Irene Chu, Hazen

Re: Master Plan - Condition Assessment and Risk Analysis Methodology

TM - 02 Condition Assessment and Risk Analysis Methodology

Final

Job no

Revision No.	Date	Description	Author	Reviewed
1	5/25/2021	Draft	Briggs, Guendert, Pour, Chu	M. Solomon
2	8/29/2022	Draft	Chu	District

Table of Contents

1. Condition Assessment and Risk Analysis

As part of the 2022 Master Plan, a condition assessment was conducted for the Delta Diablo (District) Wastewater Treatment Plant (WWTP) and the risk assessment methodology was evaluated.

1.1 Objective

The objective of this condition assessment is to acquire a more accurate knowledge of the timing of asset failure, or the rate of deterioration of an asset, and adjust asset management plans accordingly. The objective of risk analysis is to identify the District's business risk exposure based on determining the probability of failure (PoF) and consequence of failure (CoF). Hazen has modified the traditional approach to condition and risk assessment to accommodate the constraints of the Master Plan as in **Figure 1-1**.

Figure 1-1 Condition Assessment Approach for Master Plan

The condition assessment for this project included three components: 1) desktop evaluation of each asset; 2) desktop evaluation of underground assets; and 3) a focused field condition assessment of assets identified as high risk.

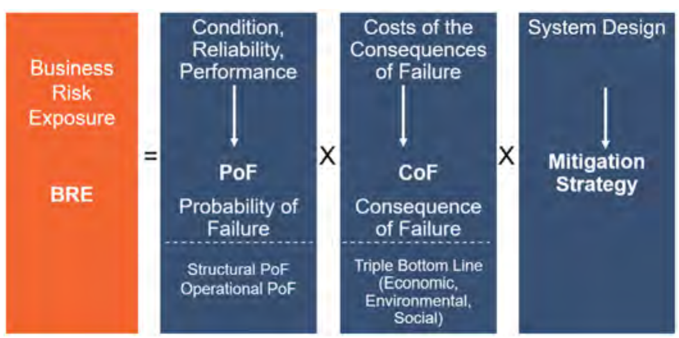


Figure 1-2 Business Risk Exposure

The desktop condition assessment used the age of asset and expected useful life for each asset class to determine remaining useful life (RUL) which was used as an indicator of PoF. The CoF criteria and weights for the process level (**Figure 1-3**) and asset level (**Figure 1-4)** align with the District's *Business Risk and Vulnerability Assessment Study.*

Process Level CoF Description	CoF Weight (%)
Safety	30
Environmental/Regulatory Impact	25
Quality of Service and Delivery	20
Public Perception	10
Fiscal Impact	15

Figure 1-3 Process Level Criteria and Weights

CoF Level	Description	Examples
5 - Highest	Catastrophic impact	Automatic Transfer Switch, Blowers, Flame Arrester, Gas Detector, Emergency Generator, MCC, Eyewash Station
4 – Major	Critical impact on the main functionality of the process/facility	Flow Meter, Pumps, Mixer, Belt Press, Gas Meters, Grinder, Motor, Conveyors, Valves
3 – Moderate	Marginal impact on the main functionality of the process/facility	Air Compressor, Air Dryer, Boiler, Crane Assembly, Fuel Tank, Sampler, Skimmer, Process Structure, Ventilation Fan, Weir Structure
2 – Minor	Minor impact on the main functionality of the process/facility	Access Cover, Louver, Spray System, Air Receiver, Water Softener
1 - Negligible	Lowest impact on the main functionality of the process/facility	Concrete Pad, Exhauster, Paving, Fence, Roof, Trailer, Walkway

Figure 1-4 Asset Level Scoring Guide

A preliminary risk assessment was an age-based assessment. Assets from the asset registry were selected for a focused condition assessment as described in **Section 2**. The risk model was then updated based on information discovered from the focused condition assessment as described in **Section 3**; i.e. it is discovered that pumps have been replaced in kind are not as old the desktop condition assessment has noted them to be.

2. Focused Field Condition Assessment

A methodology consisting of a combination of RUL and CoF scores was used to determine the assets on which to conduct the Focused Field Condition Assessment and the assets on which to conduct Field Verification later. This is illustrated in **Figure 2-1.** Assets identified by the District to be abandoned or already planned to be rehabilitated or replaced within the next 5 years were not considered for the field condition assessment.

Of the 1,248 assets in the preliminary asset register, **approximately 20% of assets were determined to be reaching the end of their useful life within the next 10 years** and had a CoF score of 3 or higher. It was this 20% of the asset inventory that comprised the Focused Field Condition Assessment.

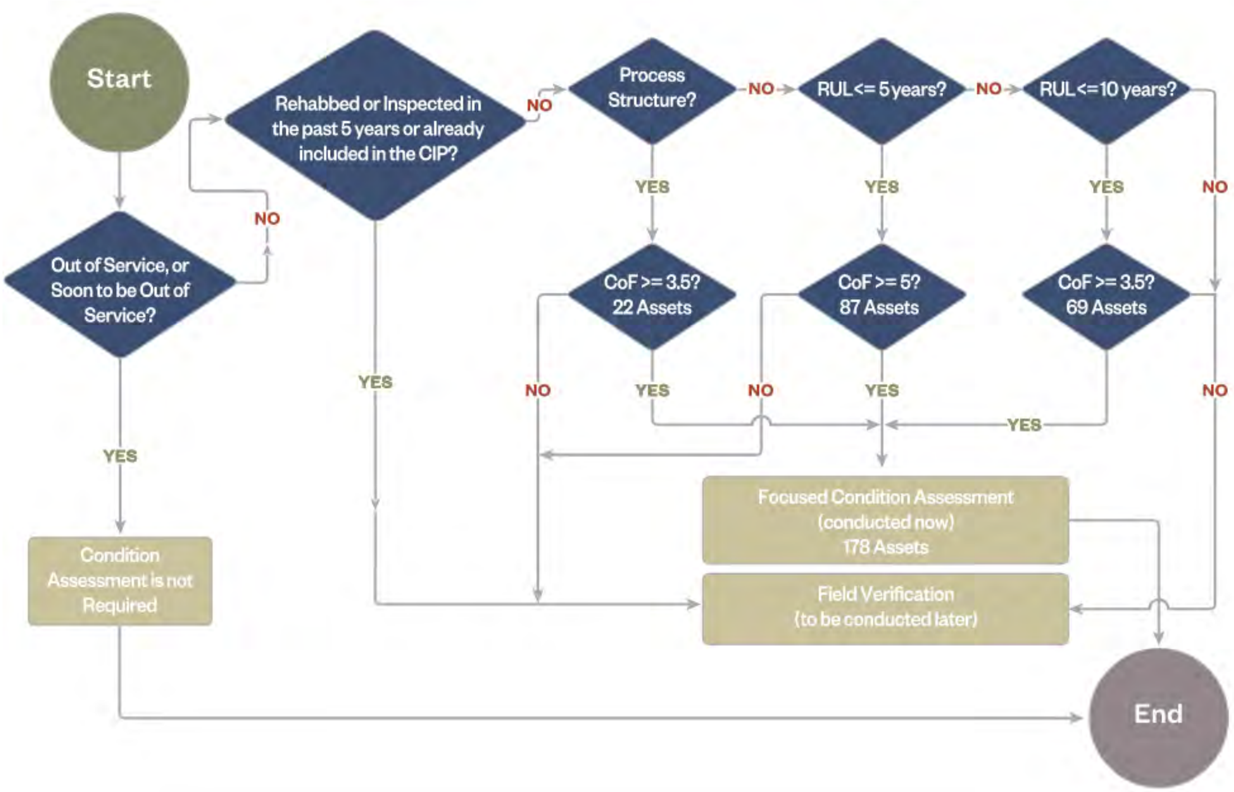


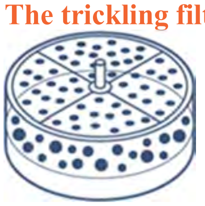
Figure 2-1 Focused Condition Assessment Methodology

2.1 Field Condition Assessment Focus Areas

The assets identified for the Focused Field Condition Assessment included the following assets. These assets and their relative risk are shown in **Figure 2-2.**

- Aeration Basins, No. 1-5
- Secondary Clarifiers, No. 1-5
- Secondary Clarifiers: RAS
- Meter Pits 1-3
- Chlorine Contact Tanks & Effluent Channels
- Dewatering Building: Polymer and Sludge feed pumps and mixers and Centrifuges
- Gravity Belt Thickeners
- Digesters 1 – 3
- Blower Building
- FOG Receiving Facility
- MCCs throughout the WWTP

Figure 2-2 Initial Risk Model of Delta Diablo WWTP



The trickling filters 1 – 4 were also identified as high risk but due to other considerations regarding potential termination, it was determined that only the MCC and structure would be visually inspected. A more comprehensive assessment would be conducted at a later date if this process is determined to be needed in the long term.

The findings from the focused field condition assessment were used to update the RUL and PoF of the assets inspected. The results of the desktop and field condition assessment (**Figure 2-3**) found **11 assets,** primarily located in the area of the chlorine contact tanks, secondary clarifiers, headworks, and secondary effluent diversion structure had **reached the end of their useful life** and another **53 assets were approaching the end of their useful life.**

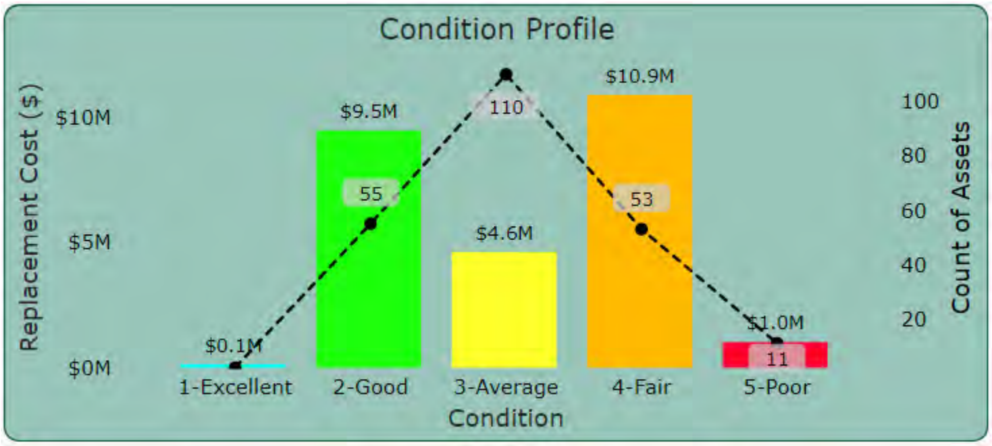


Figure 2-3 Delta Diablo Asset Condition Profile

3. Updated Risk Analysis Results

The findings from the Focused Field Condition Assessment were used to update the PoF for the assets that were visually inspected and the risk model was then updated (**Figure 3-1**). The updated risk analysis results found that a **total of 26 assets, with an estimated replacement value of $7.3 million, within the trickling filters and the secondary clarifier area, are approaching the end of their useful life and present a high risk**. Assets associated with the trickling filter were found to have reached the end of their useful life also, but the CoF was not as high as the secondary clarifier assets.

Time to Plan – The District should begin planning for renewal of assets with a high PoF and medium CoF risk in the following areas:

- Chlorine contact tanks and effluent channel
- Dewatering building
- Gravity belt thickeners
- Aeration basins
- South MCC building
- Secondary clarifiers
- Digesters 1 – 3
- RAS Pumps (valves)
- WAS Pumps (valves)

Figure 3-1 Updated Delta Diablo Risk Model

3.1 Key take-aways

Key take-aways from the field condition assessment and risk analysis are summarized in **Figure 3-2** below:

- Approximately 7% (26 assets) of the WTTP assets, within the trickling filters and secondary clarifier area, with an estimated replacement cost of $7.3 million are approaching the end of their useful life and present a high risk.
- Approximately 14% of the WTTP assets with an estimated replacement costs of $15.3 million are estimated to require renewal within the next 10 years and present a medium risk.
- Approximately 79% of the WTTP assets with an estimated replacement cost of $85.2 million are estimated to require renewal beyond the next 10 years and present a low risk.

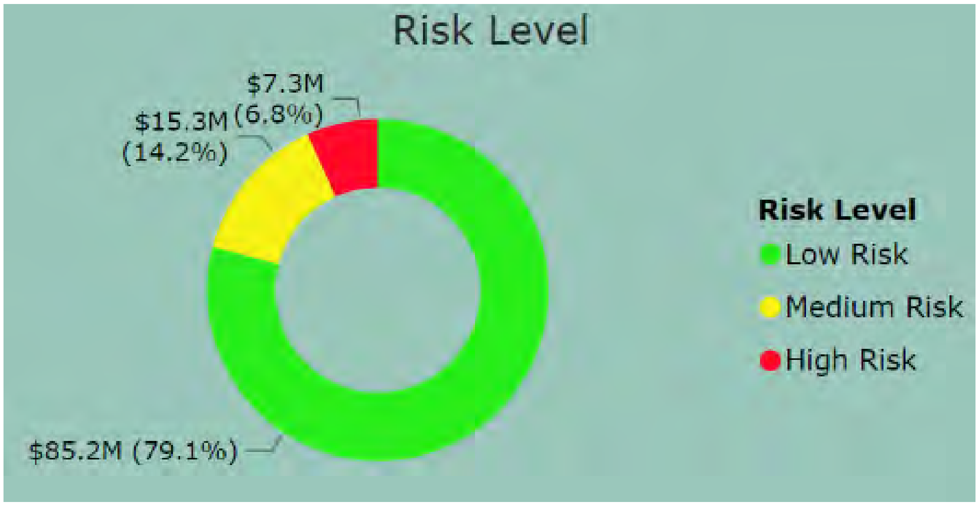


Figure 3-2 Asset Risk Summary

4. Recommendations

According to the asset registry projection, the District has a spike in renewal funding needs in 2027. The renewal of high risk and some medium risk assets projected to require renewal in 2027 should be advanced to years 2023, 2024 or 2025. Alternatively, low risk and some medium risk assets could be delayed to 2028.

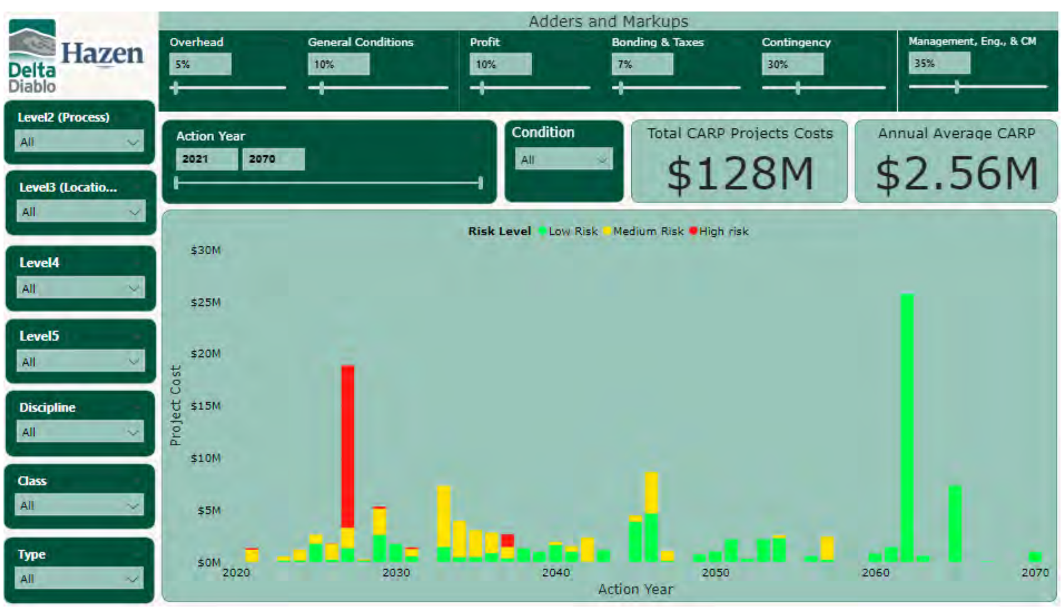


Figure 4-1 Capital Asset Replacement Program Projection

The District should continue the condition assessments begun by Hazen by focusing on areas with assets reaching the end of their useful life and high to medium CoF, that were not already inspected by Hazen.

Assets identified as urgent and high priority were reviewed with the District and bundled into projects. Additionally selected assets requiring renewal in 2007 were advanced years 2023, 2024 or 2025 to attenuate the spike in capital needs in 2007. These projects were incorporated into the District's CIP and are presented in **Table 4-1** along with along with projects related to capacity and vulnerability. Projects identified by others as part of the collection system asset management study and District identified projects are not listed in the table below.

Table 4-1 5-Year CIP (Capital Asset and Replacement Program and Vulnerability Projects Only)

Title	Cost[1] $K
Urgent Priority 12 to 24 months	
Secondary Process Improvements & Operational Improvements at Aeration Basins	60,000
CCT Analyzer Building Improvements	200
CCT Emergency Effluent Pump Station Replacement	450
CCT Sluice Gates and Chemical Mixer Improvements	1,500
Service Water Pumps Improvement	827
Dewatering Basement Polymer Equipment and Storage Area Improvements	794
Gravity Belt Thickeners Improvements	1,300
FOG Receiving Facility Improvements	50
WAS Pump Station Rehabilitation	50
Flow Equalization Basin Slide Gates Replacements	400
Condition Assessment of Treatment Plant Underground Piping	350
RAS Meter Pits and RAS Pump Station Improvements	600
Tower Mixing Chamber and Overflow Structure Rehabilitation	1,420
High Priority 3 to 5 years	
Treatment Plant Structural Assessment & Rehabilitation	700
Improvements at Secondary Effluent Feed to RWF	150
Chemical Canopy Rehabilitation	750
Condition Assessment of Select Electrical Gear	50
Sanitary Drain Pump Station Improvements	600
Centrifuge Platform Area Improvements	3,500

[1]Costs presented in 2021 dollars

CIP sheets (Appendix A) were developed for each project in **Table 4-1.** as well as District identified projects and projects identified for the collection system. These sheets were then linked to a GIS based website to communicate the near-term CIP by year.

2022 Master Plan

TM 02 – Condition Assessment and Risk Analysis Methodology

Appendix A
CIP Sheets

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

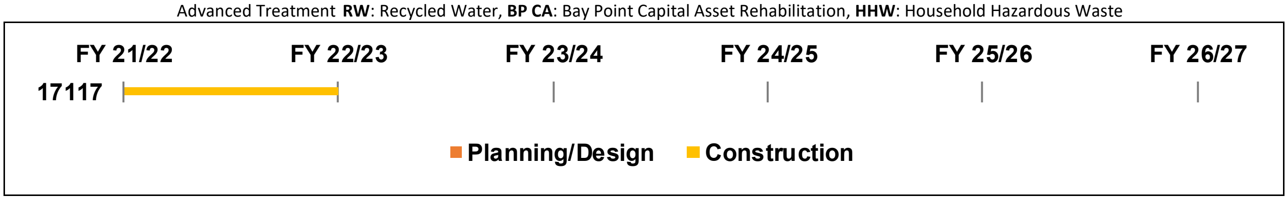
Project Name: Headworks Improvements | **Project Number: 17117**

Description/Justification:
The existing headworks, which provides the initial screening and grit removal of wastewater, is near its full operating capacity and components of the facility are nearing the end of their service lives. This project includes design and construction to rehabilitate the headworks structure and replace major equipment to provide effective and efficient screening and grit removal at the District's Wastewater Treatment Plant.

Project Assessment:
This project addresses the assets at the headworks facility which are nearing the end of their useful lives. It is identified as a high risk because a failure in any of the headworks components could stress the downstream treatment processes and put critical pumps at risk of accelerated wear or failure. Replacement and rehabilitation of various components at the headworks structure will improve efficiency of the screening and grit removal process.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $14,100,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	**$13,183,094**
FY 21/22 Budget	**$916,906**
Future Fiscal Year(s) Budget	
Estimated Total Project Cost	**$14,100,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$916,906					**$916,906**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$916,906					**$916,906**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

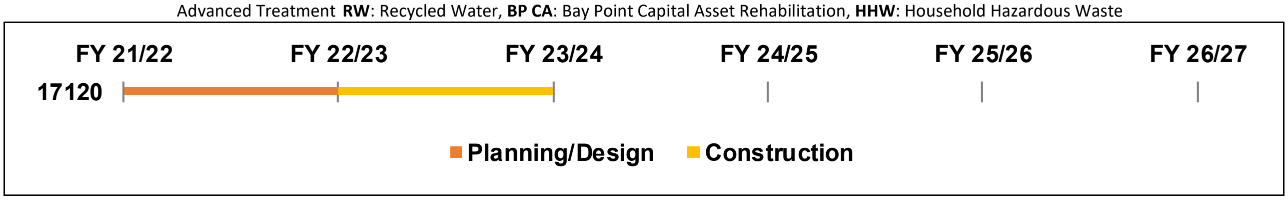
Project Name: Treatment Plant Electrical Switchgear Replacement | **Project Number: 17120**

Description/Justification:
This project will replace the existing switchgear to ensure continuous, reliable power and treatment operations. This is a critical component of the treatment plant electrical power feed system.

Project Assessment:
A failure in the main switchgear would cause a loss of power for the entire treatment plant, which would severely impact treatment plant processes. This project may affect the District's ability to operate the existing cogeneration system. The CIP includes a project to upgrade the cogeneration system immediately after completion of this project.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $9,441,406**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$4,441,406**
Future Fiscal Year(s) Budget	**$5,000,000**
Estimated Total Project Cost	**$9,441,406**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget	$4,441,406	$5,000,000				**$9,441,406**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds	$4,441,406	$5,000,000				**$9,441,406**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

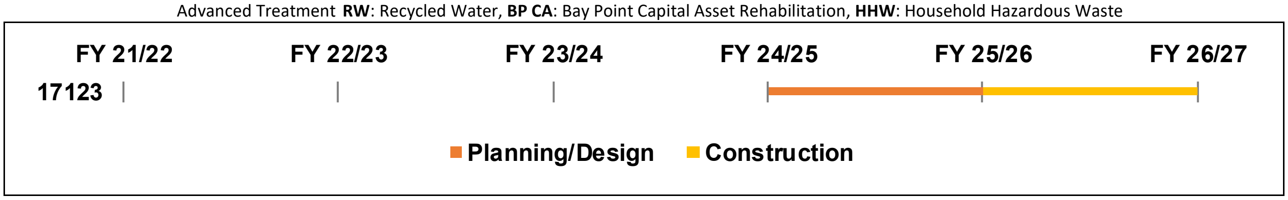
Project Name: Nutrient Technology Research and Innovation **Project Number: 17123**

Description/Justification:
This project will allow the District to explore various nutrient removal technologies and options through studies, pilot testing, and collaboration. The District may participate in various regional activities related to nutrients, with particular emphasis on developing emerging and innovative technologies for treatment.

Project Assessment:
This project addresses the need to explore various nutrient removal technologies and develop innovative technologies for the treatment plant. This is low risk because the current regulatory requirements do not necessitate that nutrient removal be added to our processes. The Resource Recovery Facility Master Plan may recommend technologies to be researched.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**AT - 100%**
Funding Amount:	**AT - $500,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$500,000**
Estimated Total Project Cost	**$500,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste

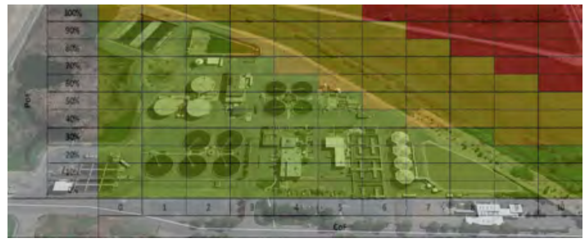


Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget				$250,000	$250,000	**$500,000**
Funding Source: AT						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds				$250,000	$250,000	**$500,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

Project Name: Conveyance and Treatment Systems Reliability Improvements — **Project Number: 18107**

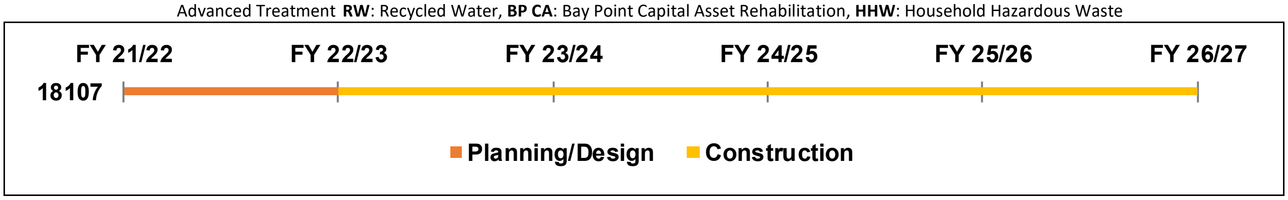
Description/Justification:
This project will evaluate, design, and perform activities to increase the reliability of the District's pumping and conveyance system, as outlined in the Sewer System Management Plan (SSMP). Project activities include risk assessment, improved inspection, testing, and response protocol and system enhancement, and expanded mapping for use in development and implementation of an asset management program. A new appropriation is established each fiscal year



Project Assessment:
This project addresses the need for a systematic approach to increase reliability of the District's pumping and conveyance system. This project will identify potential risks and deficiencies in the conveyance and treatment systems and activities to increase reliability, however, because there are not immediate drivers for these improvements this project is considered low risk.

Priority:	**3- Medium Priority (6 – 15 years)**
Funding Type*:	**WW CA - 100%**
Funding Amount:	**WW CA - $175,000**
Lead Department:	**RRS***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$25,000**
Future Fiscal Year(s) Budget	**$150,000**
Estimated Total Project Cost	**$175,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$25,000	$25,000	$25,000	$50,000	$50,000	**$175,000**

Funding Source: WW CA

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$25,000	$25,000	$25,000	$50,000	$50,000	**$175,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

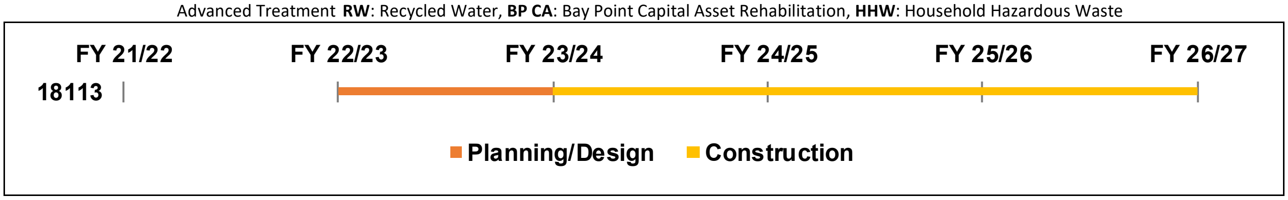
Project Name: District Office Building Rehabilitation | **Project Number: 18113**

Description/Justification:
In 2016, the District completed a condition assessment effort for the Plant Operations Center and Treatment Plant (TP) office buildings. The report concluded that many of the building systems, including mechanical, plumbing, electrical, and interior finishes were nearing the end of their useful lives. This project will consist of predesign, design, and construction of identified essential building upgrades required to properly maintain the building functions.

Project Assessment:
This project addresses operational issues with multiple assets at the TP office buildings. This project is identified as a medium risk because the buildings systems, such as mechanical, plumbing, electrical, etc., are nearing the end of their useful lives and their failures could result in work spaces that are not safe, functional, or fit for human occupancy. Rehabilitation of the office buildings is required for maintaining the building functions.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $5,482,837**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	**$1,245,981**
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$5,482,837**
Estimated Total Project Cost	**$6,728,818**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget		$400,000	$1,000,000	$2,000,000	$2,082,837	**$5,482,837**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds		$400,000	$1,000,000	$2,000,000	$2,082,837	**$5,482,837**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

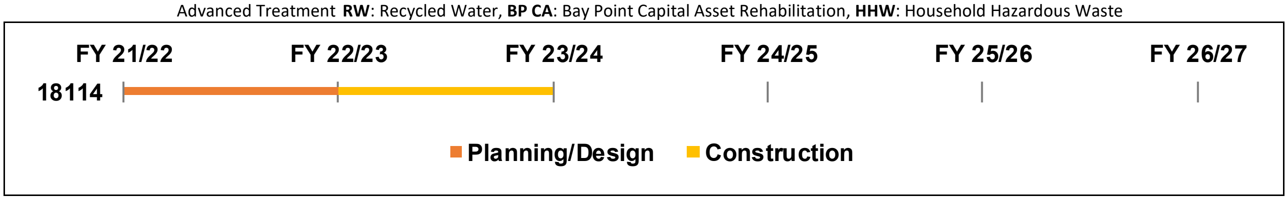
Project Name: SCADA Communication Network/PLC Processor Upgrade | **Project Number: 18114**

Description/Justification:
The SCADA system is the District's automated system for monitoring and reporting the ongoing status of the District's resource recovery operations onsite and remotely. The upgraded communication network, in combination with the planned PLC processor replacements is required to provide improved performance and reliability to the District. This project consists of replacing the Programmable Logic Controllers (PLC) and upgrading the current Supervisory Control and Data Acquisition (SCADA) communication network protocol.

Project Assessment:
This project addresses the immediate need to upgrade the District's SCADA system and replace the PLC processors. This project is identified as medium risk as the SCADA and PLC's are currently functional. However, these systems provide critical functionality and control the treatment plant and pumps station equipment and instrumentation. A failure of these systems could result in a loss of automation and/or monitoring of the processes required for successful conveyance and treatment of wastewater.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 90%, RW CAR - 10%**
Funding Amount:	**WW CAR - $672,170, RW CAR - $74,685**
Lead Department:	**RRS***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	**$72,772**
FY 21/22 Budget	**$474,083**
Future Fiscal Year(s) Budget	**$200,000**
Estimated Total Project Cost	**$746,855**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$474,083	$200,000				**$674,083**

Funding Source: WW CAR, RW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$474,083	$200,000				**$674,083**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

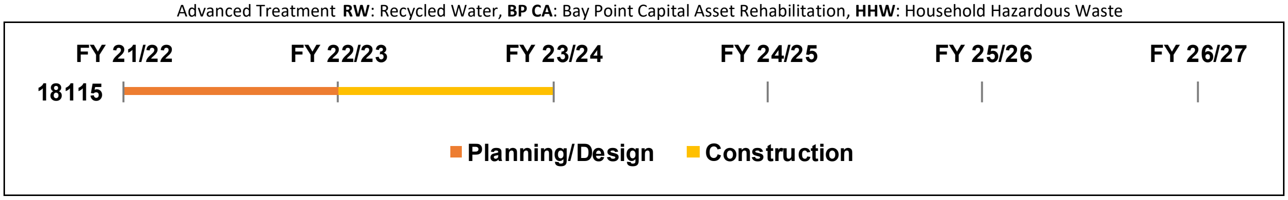
Project Name: Treatment Plant Roadway Maintenance Project | **Project Number: 18115**

Description/Justification:
The treatment plant roadway and parking lot asphalt is showing signs of aging and is in need of rehabilitation. This project will include condition assessment, analysis of current/future traffic patterns and loading, geotechnical engineering recommendations, design, reconstruction of failed areas, improvements to roadway geometry, rehabilitation of the asphalt surface, and striping.

Project Assessment:
This project addresses the need to improve and maintain the treatment plant's roadway and parking lot as it has started to show signs of aging. It is considered low risk because the existing roadway surfaces are currently functional. Although some areas show signs of failure, the repairs to these areas can be deferred for some time.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $1,000,000**
Lead Department:	**BS***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$250,000**
Future Fiscal Year(s) Budget	**$750,000**
Estimated Total Project Cost	**$1,000,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget	$250,000	$750,000				**$1,000,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds	$250,000	$750,000				**$1,000,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

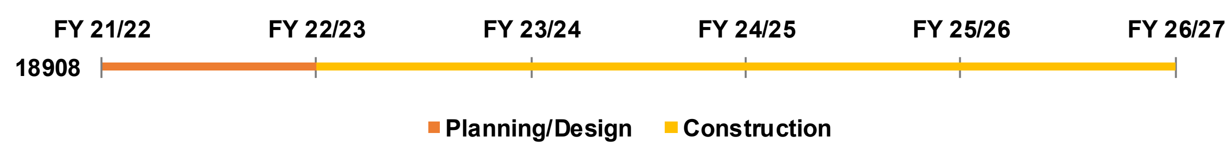
Project Name: Energy and Water Efficiency Improvements | **Project Number: 18908**

Description/Justification:
The Energy and Water Efficiency Improvements project will allow for the implementation of various energy and water efficiency measures that will improve the District's environmental performance and lead to long-term energy and water savings. In its effort to be a leader in environmental stewardship, the District is continually looking for ways to improve energy and water efficiency.

Project Assessment:
This project addresses District's goal to improve the environmental performance throughout the various plant operations which leads to cost savings. This project is low risk because it does not impact or improve the functionality of existing infrastructure but will better manage the resources needed to support the conveyance and treatment processes.

Priority:	**3- Medium Priority (6 – 15 years)**
Funding Type*:	**WW CA - 50%, WW CAR - 50%**
Funding Amount:	**WW CA - $87,500, WW CAR - $87,500**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$25,000**
Future Fiscal Year(s) Budget	**$150,000**
Estimated Total Project Cost	**$175,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$25,000	$25,000	$25,000	$50,000	$50,000	**$175,000**

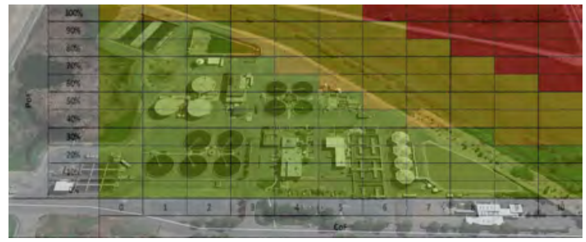
Funding Source: WW CA, WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$25,000	$25,000	$25,000	$50,000	$50,000	**$175,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

Project Name: Small District Capital Asset Project | **Project Number: 19100**

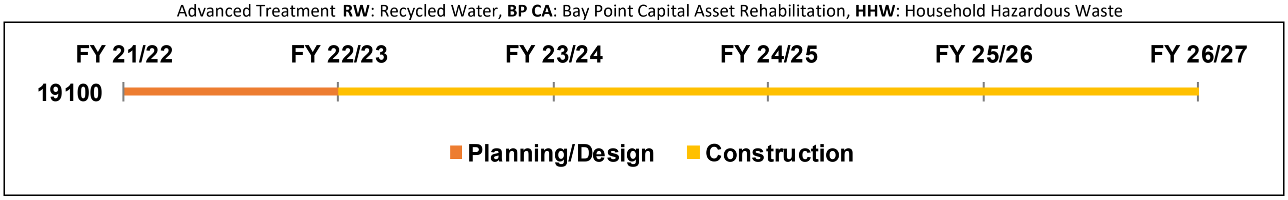
Description/Justification:
The Small District Capital Asset Project will allow the implementation of conveyance system and treatment plant improvements which are identified during the course of a particular fiscal year, but not included as a separate line item in the Capital Asset Fund budget. This project also includes a comprehensive safety inspection and assessment of existing facilities to evaluate compliance with all applicable safety regulations and requirements.



Project Assessment:
This project will identify upgrades/improvements required in the conveyance system and treatment plant that are in addition to those already listed under the Capital Asset Fund budget. This project places an emphasis on safety and regulatory compliance throughout the plant. Depending on the specific improvement identified, they could hold a high, medium, or low risk.

Priority:	**3- Medium Priority (6 – 15 years)**
Funding Type*:	**WW CA - 50%, WW CAR - 50%**
Funding Amount:	**WW CA - $175,000, WW CAR - $175,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$50,000**
Future Fiscal Year(s) Budget	**$300,000**
Estimated Total Project Cost	**$350,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$50,000	$50,000	$50,000	$100,000	$100,000	**$350,000**

Funding Source: WW CA, WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$50,000	$50,000	$50,000	$100,000	$100,000	**$350,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

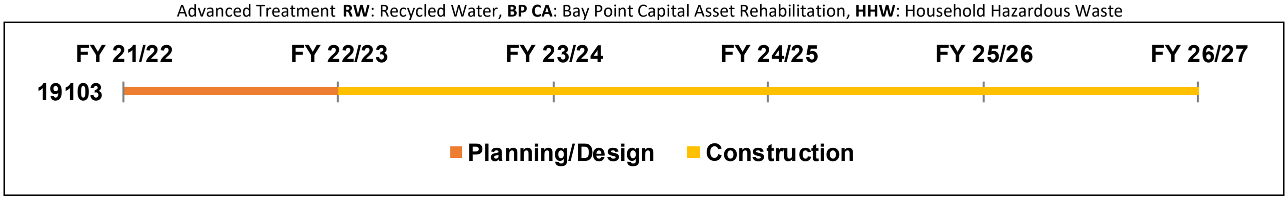
Project Name: Small Recycled Water Facility Capital Asset Project | **Project Number: 19103**

Description/Justification:
The Small Recycled Water Facility Capital Asset Project will allow the implementation of the District's Recycled Water Facility (RWF) improvements which are identified during the course of a particular fiscal year, but not included as a separate line item in the Recycled Water Capital Asset Fund budget.

Project Assessment:
This project will identify upgrades/improvements required at District's Recycled Water Facility (RWF) that are in addition to those already listed under the Recycled Water Capital Asset Fund budget Depending on the specific improvement identified, they could hold a high, medium, or low risk.

Priority:	**3- Medium Priority (6 – 15 years)**
Funding Type*:	**RW CA - 100%**
Funding Amount:	**RW CA - $250,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$50,000**
Future Fiscal Year(s) Budget	**$200,000**
Estimated Total Project Cost	**$250,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$50,000	$50,000	$50,000	$50,000	$50,000	**$250,000**

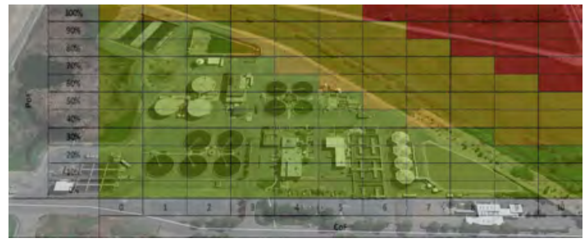
Funding Source: RW CA

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$50,000	$50,000	$50,000	$50,000	$50,000	**$250,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

Project Name: Asset Management Program | **Project Number: 19109**

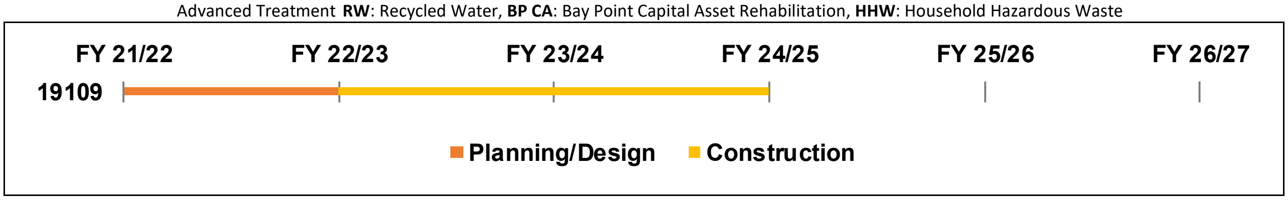
Description/Justification:
The project includes planning, evaluation, design, and implementation of a new Asset Management (AM) system for the District. The new AM system will replace the existing Mainsaver software. The AM system will detail all the District's assets, along with age and condition, ongoing maintenance and issues, risk of failure, and consequence of failure. The existing system is limited and does not support the District's needs for rate modeling and long-term forecasting, resource planning, and risk analysis.



Project Assessment:
This project addresses the need to replace the existing AM system which has become outdated and does not support the current needs of the District. This is a low risk project as the existing system provides adequate functionality to track assets and their maintenance to support the treatment process.

Priority:	**3- Medium Priority (6 – 15 years)**
Funding Type*:	**WW CA - 100%**
Funding Amount:	**WW CA - $750,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	**$60,039**
FY 21/22 Budget	**$189,961**
Future Fiscal Year(s) Budget	**$500,000**
Estimated Total Project Cost	**$750,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$189,961	$250,000	$250,000			**$689,961**

Funding Source: WW CA

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$189,961	$250,000	$250,000			**$689,961**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

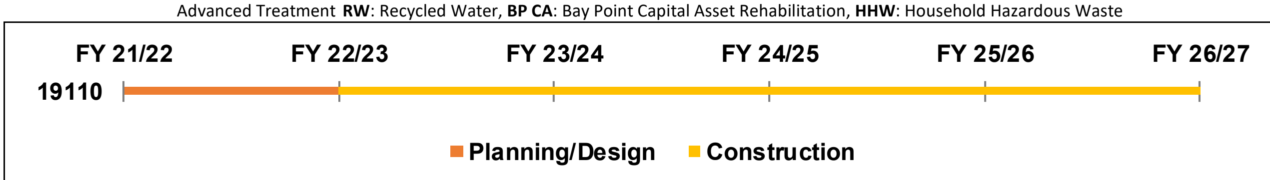
Project Name: Emergency Retention Basin Improvements | **Project Number: 19110**

Description/Justification:
Assess alternatives to manage the maintenance flows that routinely enter the Emergency Retention Basin (ERB). The ERB experiences daily flows from various maintenance and operational activities. These flows result in increased vegetation inside the ERB. This evaluation will look at alternatives on how to better manage these types of flows, optimize the available storage volume, and reduce the vegetation growth within the basin.

Project Assessment:
This project addresses concerns with the vegetation growth inside the basin. This is a low risk project. The ERB capacity is currently maintained through periodic vegetation removal and excavation of deposited sediment. However, improvements can significantly reduced the workload and costs associated with the maintenance of the ERB.

Priority:	**2- High Priority (3 – 5 years)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $1,050,000**
Lead Department:	**RRS***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$850,000**
Future Fiscal Year(s) Budget	**$200,000**
Estimated Total Project Cost	**$1,050,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$850,000	$50,000	$50,000	$50,000	$50,000	**$1,050,000**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$850,000	$50,000	$50,000	$50,000	$50,000	**$1,050,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

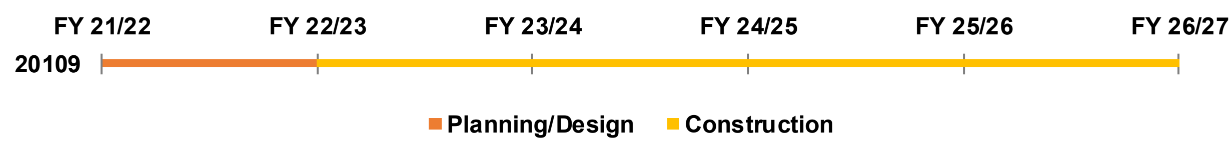
Project Name: Unanticipated WW Treatment & Conveyance Infrastructure Repairs — **Project Number: 20109**

Description/Justification:
The Unanticipated Replacement Project will allow the repair/replacement/improvement of treatment plant equipment that is not functioning properly, or has early service life failure during the course of a particular fiscal year.

Project Assessment:
This project provides a proactive approach to address any unanticipated repair/replacement needs at the WW treatment plant. This programmatic project is necessary to ensure that repairs or replacement equipment is available when needed and that discretionary funds are available.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $1,180,000**
Lead Department:	**RRS***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$260,000**
Future Fiscal Year(s) Budget	**$920,000**
Estimated Total Project Cost	**$1,180,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$260,000	$260,000	$260,000	$200,000	$200,000	**$1,180,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds	$260,000	$260,000	$260,000	$200,000	$200,000	**$1,180,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

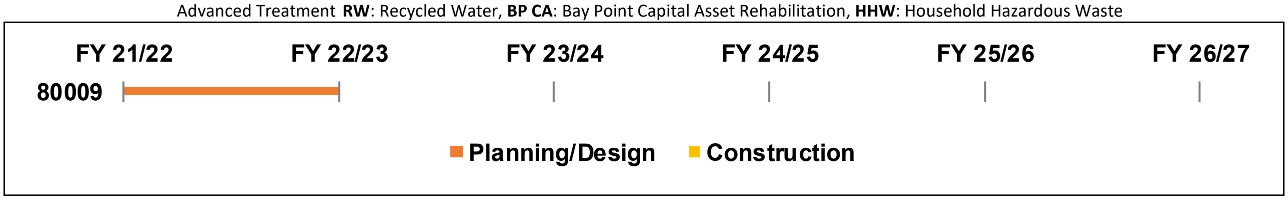
Project Name: Resource Recovery Facility Master Plan | **Project Number: 80009**

Description/Justification:
This project includes identification and evaluation of key long-term strategic planning issues associated with the District's Resource Recovery Facility (i.e., the Wastewater Treatment Plant and Recycled Water Facility (RWF). Significant focus areas would include investigating biogas utilization options for the East County Bioenergy Project, assessing plant expansion and upgrade needs to meet future nutrient management regulatory requirements, evaluating long-term RWF operating scenarios and costs, identifying potential treatment process regulatory compliance vulnerabilities and enhanced process monitoring and control tools, updating future growth projections, supporting development of the Asset Management Program, evaluating biosolids management options, and developing a prioritized CIP to reflect FCA findings. The project would also include recommendations for additional, more detailed master planning activities in subsequent years for specific focus areas.

Project Assessment:
This project is an example of District's proactive approach to develop CIP to address near term infrastructure needs, mitigate operational vulnerabilities and meet any future regulatory requirements. This is a medium risk project. Long-term planning is desirable but not critical to the existing treatment and operation of the plant.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CA - 35%, WW CAR - 50%, AT - 10%, RW Exp - 5%**
Funding Amount:	**WW CA - $560,000, WW CAR - $800,000, AT - $160,000, RW Exp - $80,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	**$930,550**
FY 21/22 Budget	**$669,450**
Future Fiscal Year(s) Budget	
Estimated Total Project Cost	**$1,600,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$669,450					**$669,450**

Funding Source: WW CA, WW CAR, AT, RW Exp

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$669,450					**$669,450**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

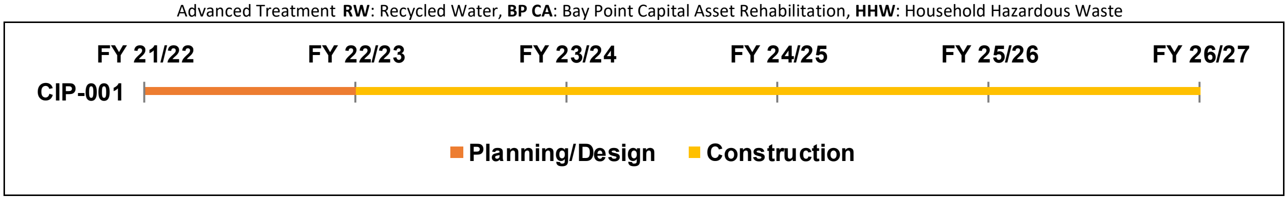
Project Name: Secondary Process Improvements & Operational Improvements at Aeration Basins | **Project Number: CIP-001**

Description/Justification:
The project includes planning, design, and construction of I) new primary effluent pumps, ii) new aeration basins, iii) retrofit of existing aeration basins to include anaerobic selectors, iv) new blower, headers and associated building, v) new mixed liquor distribution box, and vi) new secondary clarifier. The project components are needed to allow the RRF to perform carbon only treatment using activated sludge only (after existing tower trickling filters are retired) through 2040 projected flows and loads. Planning/Design is scheduled to start in FY22/23 with construction to commence in FY 23/24. The project also includes replacement of actuators on sluice gates of the aeration basins to make them easier to operate. Consider addition of basin dewatering pump to facilitate the operations.

Project Assessment:
This project not only addresses the aging infrastructure associated with the secondary process, but also includes modifications to result in operational efficiency. The secondary process is considered high risk and therefore the failure of this process will result in major operational issues in the future. The project takes into account projected loads in the future and hence the modifications are needed for operational efficiency of the secondary process.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 78%, WW Exp - 16%, AT - 6%**
Funding Amount:	**WW CAR - $46,800,000, WW Exp - $9,600,000, AT - $3,600,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$500,000**
Future Fiscal Year(s) Budget	**$59,500,000**
Estimated Total Project Cost	**$60,000,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget	$500,000	$1,500,000	$8,000,000	$25,000,000	$25,000,000	**$60,000,000**
Funding Source: WW CAR, WW Exp, AT						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds	$500,000	$1,500,000	$8,000,000	$25,000,000	$25,000,000	**$60,000,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

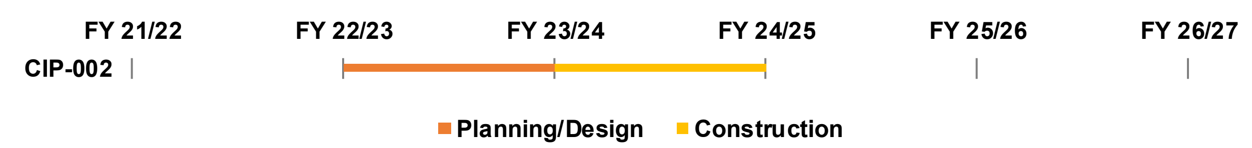
Project Name: Treatment Plant Structural Assessment & Rehabilitation | **Project Number: CIP-002**

Description/Justification:
Non-Destructive Testing (NDT) of structures at Aeration Basins, CCTs and RAS Pump Station, based on level 1 visual condition assessment and structural investigation of Blower Building, Flow Equalization Storage Basin, Plant Operation Center, CCT Analyzer Building and Warehouse based on their age or staff recommendations. Addition of hose bibs to facilitate cleaning of basins at Aeration Basins and CCTs.

Project Assessment:
This project addresses structural issues observed at the Aeration Basins, CCTs and RAS Pump Station during the field condition assessment. Although considered a low to medium risk project, conducting NDT will provide an in-depth assessment of the properties and strength of the material of these existing structures and help make better decisions on future rehabilitation needs.

Priority:	**2- High Priority (3 – 5 years)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $700,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$700,000**
Estimated Total Project Cost	**$700,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget		$250,000	$450,000			**$700,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds		$250,000	$450,000			**$700,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

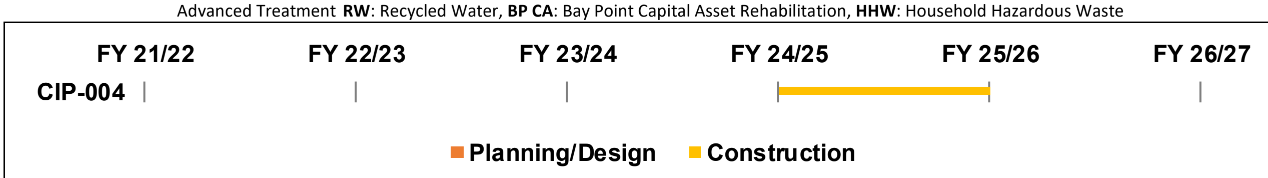
Project Name: Improvements at Secondary Effluent Feed to RWF | **Project Number: CIP-004**

Description/Justification:
Replace butterfly valve and perform condition assessment of pipeline feeding RWF

Project Assessment:
This project addresses the operational issues observed at the pipeline feeding RWF and the butterfly valve located on this pipeline. This pipeline currently does not have any redundancy and is operated manually. Internal leakage was observed at the butterfly valve. Conducting further condition assessment will help evaluate the extent of pipe failure and the cause of leaks inside this pipeline.

Priority:	**2- High Priority (3 – 5 years)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $150,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$150,000**
Estimated Total Project Cost	**$150,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget				$150,000		**$150,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds				$150,000		**$150,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

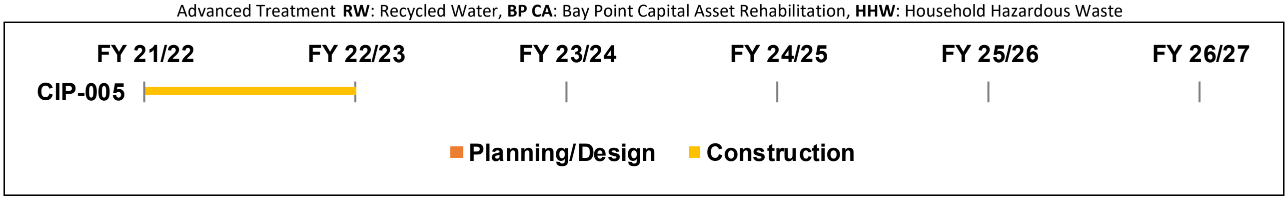
Project Name: CCT Analyzer Bldg. Improvements **Project Number: CIP-005**

Description/Justification:
Replace Mechanical and I&C equipment including Analyzers, Control Panels and Pumps and HVAC improvement at CCT Analyzer Building.

Project Assessment:
This project addresses the Mechanical and I&C assets at the CCT Analyzer Building that are approaching the end of their useful lives. Temperature control is an issue inside the building causing it to affect the performance of the analyzers and the control panels. The piping assembly is showing signs of corrosion. Replacement of these assets was recommended by the District staff and can have a significant impact on the overall secondary process.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $200,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$200,000**
Future Fiscal Year(s) Budget	
Estimated Total Project Cost	**$200,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$200,000					**$200,000**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$200,000					**$200,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

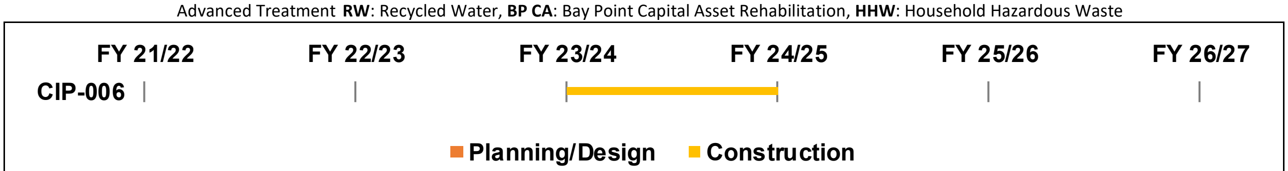
Project Name: CCT Emergency Effluent Pump Station Replacement | **Project Number: CIP-006**

Description/Justification:
Replace Mechanical and Electrical equipment including Pumps, Valves, Motors and Flow Meter at Emergency Effluent Pump Station.

Project Assessment:
This project addresses the mechanical and electrical assets at the Emergency Effluent Pump Station. These assets are approaching the end of their useful lives and need replacement to support proper operation of the pump station.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $450,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$450,000**
Estimated Total Project Cost	**$450,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget			$450,000			**$450,000**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds			$450,000			**$450,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

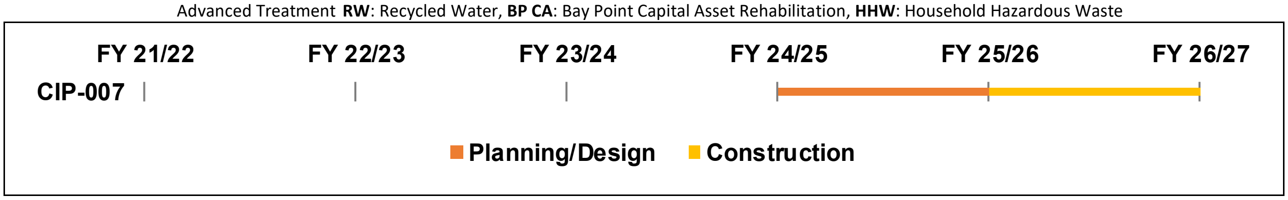
Project Name: CCT Sluice Gates & Chemical Mixer Improvements | **Project Number: CIP-007**

Description/Justification:
Replace sluice gates, drain mud valves, chlorine flash mixers, bisulfate diffuser assembly, and surface sprayer assemblies at CCT. Consider turning manual sluice gates to MOVs for gates that are operated more frequently.

Project Assessment:
This project addresses sluice gates that are showing signs of corrosion and currently being operated manually. The sluice gates and chemical mixers are approaching the end of their useful lives and need replacement to support proper operation and to avoid failures.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $1,500,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$1,500,000**
Estimated Total Project Cost	**$1,500,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget				$400,000	$1,100,000	**$1,500,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds				$400,000	$1,100,000	**$1,500,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

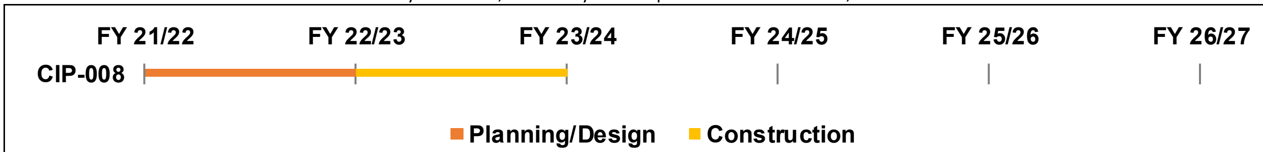
Project Name: Service Water Pumps Improvement | **Project Number: CIP-008**

Description/Justification:
Replace the two influent sluice gates and other Mechanical, Electrical, and I&C equipment at Service Water Pumps area. Consider using recycled water.

Project Assessment:
This project addresses operational issues with multiple assets at the Service Water Pumps Area. The sluice gates are showing signs of corrosion and are difficult to operate. The pumps, flow meters, valves and strainers are approaching the end of their useful lives. Replacing these assets will ensure operational reliability of the Service Water Pumps area and avoid any failures in the future.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $827,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$413,500**
Future Fiscal Year(s) Budget	**$413,500**
Estimated Total Project Cost	**$827,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget	$413,500	$413,500				**$827,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds	$413,500	$413,500				**$827,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

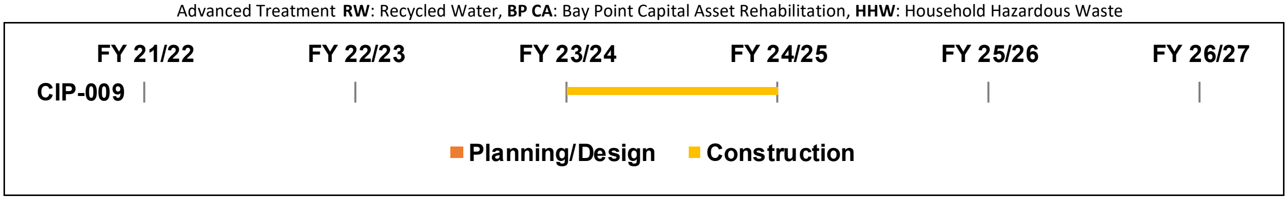
Project Name: Condition Assessment of Select Electrical Gear — **Project Number: CIP-009**

Description/Justification:
Integrity verification of select electrical gear including VFD's, MCC Cabinets, Generators, Load Bank and Transformers identified through the Level 1 Condition Assessment.

Project Assessment:
This project addresses select electrical assets at multiple locations around the plant that are approaching the end of their useful lives. MCC cabinets are showing signs of corrosion. VFDs do not have proper enclosure and are subject to overheating in the rooms they are located in. An integrity verification of these assets can provide more in-depth analysis on the actual condition of these assets and identify those assets that in need of immediate replacement or rehabilitation.

Priority:	**2- High Priority (3 – 5 years)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $50,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$50,000**
Estimated Total Project Cost	**$50,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget			$50,000			**$50,000**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds			$50,000			**$50,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

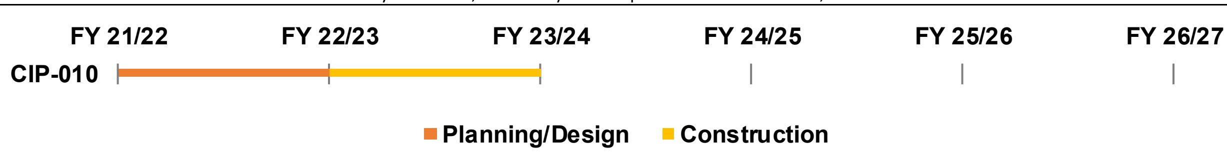
Project Name: Dewatering Basement Polymer Equipment and Storage Area Improvements | **Project Number: CIP-010**

Description/Justification:
Replace Air Dryer, Flow Meter, Mixers, Dry Polymer Feed, Pumps, Tanks at Dewatering Basement

Project Assessment:
This project addresses the mechanical assets located at the basement of the Dewatering Building. The Centrifuge Polymer Feed Assembly had recently failed and has been since replaced. Other mechanical assets are approaching their useful lives. Replacing these assets will ensure operational reliability and avoid any future failures at the Polymer Equipment and Storage areas.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $794,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$397,000**
Future Fiscal Year(s) Budget	**$397,000**
Estimated Total Project Cost	**$794,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$397,000	$397,000				**$794,000**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$397,000	$397,000				**$794,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

Project Name: Gravity Belt Thickeners Improvements — **Project Number: CIP-012**

Description/Justification:
Improve reliability of gravity belt thickeners. Rework the control panel to fix operational control issues.

Project Assessment:
This project addresses reliability issues with gravity belt thickener 2. There are operational concerns with the mechanical and I&C portion of this thickener that result in multiple false alarms. Reworking some of the components such as the control panel, belt and hopper is required for proper operation of the thickener, including adding the ability for the thickeners to operate simultaneously as needed.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $1,300,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$1,300,000**
Estimated Total Project Cost	**$1,300,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	FY 26/27
CIP-012		Planning/Design	Construction			

■ **Planning/Design** ■ **Construction**

Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget		$300,000	$1,000,000			**$1,300,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds		$300,000	$1,000,000			**$1,300,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

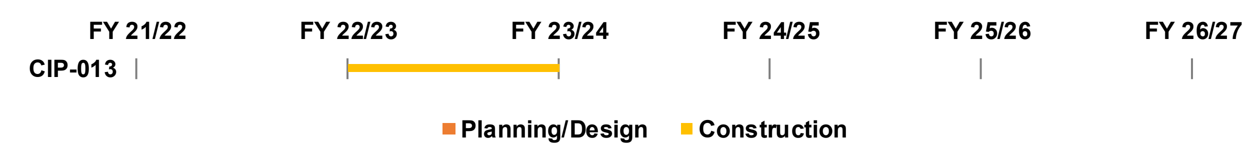
Project Name: FOG Receiving Facility Improvements | **Project Number: CIP-013**

Description/Justification:
Replace FOG Receiving Station sump pumps.

Project Assessment:
This project addresses the corrosion issues observed on the sump pumps located at the FOG Receiving Facility. Severe corrosion was observed on the discharge piping inside the vault along with exposed cable wires. These sump pumps are approaching the end of their useful lives and replacing these pumps will improve the operations at the FOG Receiving Facility.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $50,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$50,000**
Estimated Total Project Cost	**$50,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget		$50,000				**$50,000**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds		$50,000				**$50,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

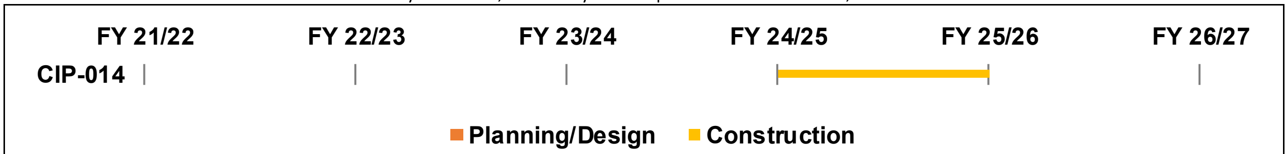
Project Name: Sanitary Drain Pump Station Improvements | **Project Number: CIP-014**

Description/Justification:
Rehabilitation of Sanitary Drain Pumps Assemblies

Project Assessment:
This project addresses pump assemblies at the Sanitary Drain Pump Station. These assets have reached the end of their useful lives. Rehabilitation of these assets will ensure continuous operation at the pump station.

Priority:	**2- High Priority (3 – 5 years)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $600,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$600,000**
Estimated Total Project Cost	**$600,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget				$600,000		**$600,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds				$600,000		**$600,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

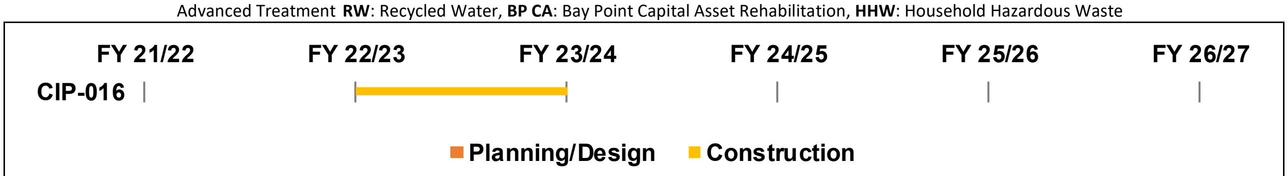
Project Name: WAS Pump Station Rehabilitation **Project Number: CIP-016**

Description/Justification:
Replace or rehabilitate pump assemblies and valves at WAS Pump Station.

Project Assessment:
This project addresses the mechanical assets at the WAS Pump Station. These assets have reached the end of their useful lives which makes it critical to replace or rehabilitate them in order to ensure operational reliability at the pump station.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $50,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$50,000**
Estimated Total Project Cost	**$50,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget		$50,000				**$50,000**

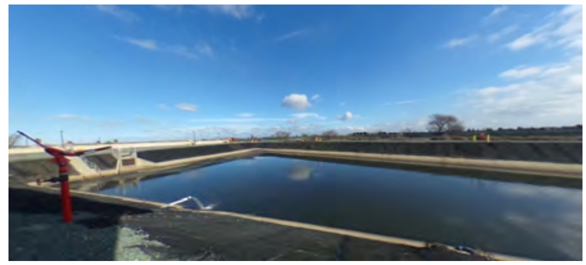
Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds		$50,000				**$50,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

Project Name: Flow Equalization Basin Slide Gates Replacements — **Project Number: CIP-018**

Description/Justification:
Flow Equalization Basin Slide Gates Replacements. Replace slide gates MSG-7201, MSG-7202 and MSG-1612 that are at the end of their useful lives.



Project Assessment:
This project addressed the slide gates at the Flow Equalization Basins that have reached the end of their useful lives. Replacing these slide gates will ensure proper operation and avoid any future failures.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $400,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$400,000**
Estimated Total Project Cost	**$400,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	FY 26/27
CIP-018			Construction	Construction		

Planning/Design **Construction**

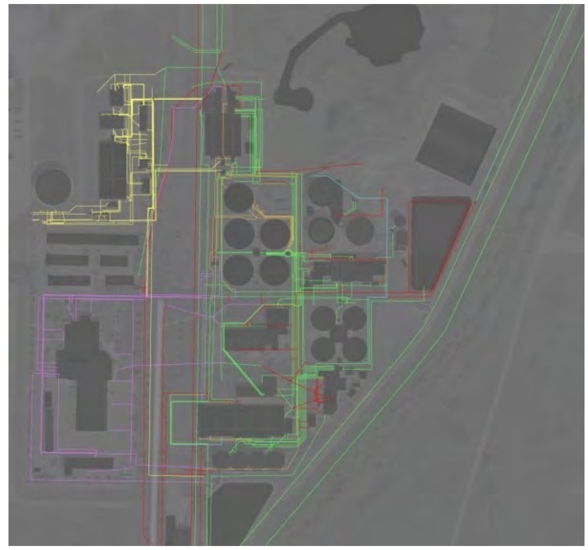
Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget			$400,000			**$400,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds			$400,000			**$400,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

Project Name: Condition Assessment of Treatment Plant Underground Piping | **Project Number: CIP-019**

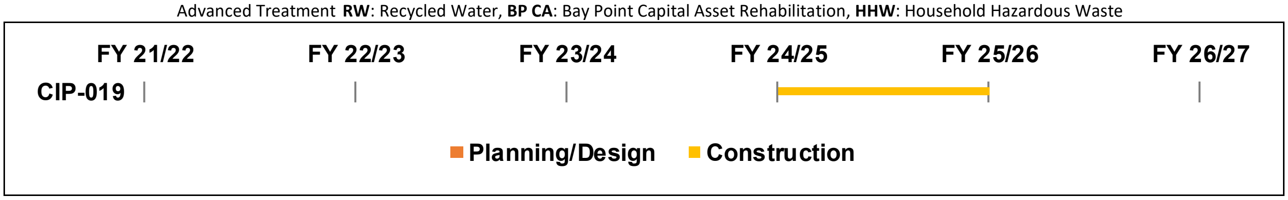
Description/Justification:
Field condition assessment of pipelines associated with RAS, Mixed Liquor, Primary Effluent and Secondary Effluent Lines

Project Assessment:
The project addresses the pipelines associated with the RAS, Mixed Liquor, Primary Effluent and Secondary Effluent Lines. Conducting a condition assessment of these pipelines will determine pipeline replacement and rehabilitation needs that may significantly affect the overall operation of the different processes inside the treatment plant.



Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $350,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$350,000**
Estimated Total Project Cost	**$350,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget				$350,000		**$350,000**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds				$350,000		**$350,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

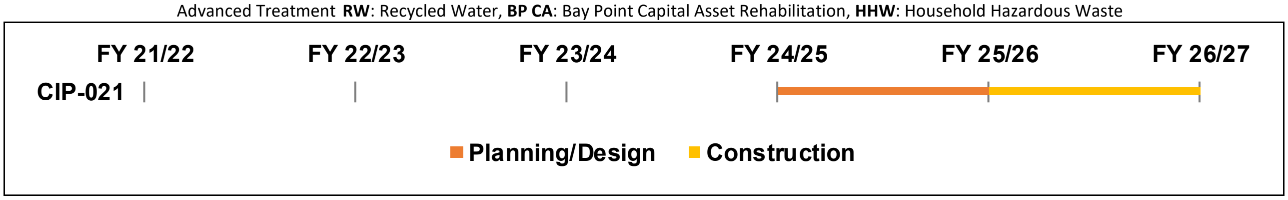
Project Name: Centrifuge Platform Area Improvements | **Project Number: CIP-021**

Description/Justification:
Replacement or rehabilitation of sludge conveyors, centrifuge feed grinders and feed switching valve. The project also includes overhaul of the centrifuges.

Project Assessment:
This project addresses mechanical assets supporting the operations of the centrifuges that are approaching the end of their useful lives and other operational issues. Currently both the centrifuges are on an alternating schedule for preventative maintenance and overhaul. Replacing components of the centrifuge platform and overhauling the centrifuges will fix the operational issues and increase reliability.

Priority:	**2- High Priority (3 – 5 years)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $3,500,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$3,500,000**
Estimated Total Project Cost	**$3,500,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget				$1,500,000	$2,000,000	**$3,500,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds				$1,500,000	$2,000,000	**$3,500,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

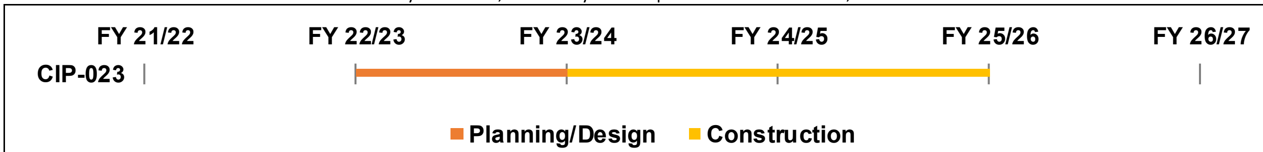
Project Name: RAS Meter Pits & RAS Pump Station Improvements | **Project Number: CIP-023**

Description/Justification:
Replace RAS actuated flow control valves, isolation valves, sump pumps and covers at Pits No. 1 and No. 2. Replace or rehabilitation of scum ejectors and addition of redundancies to Scum Ejector Assemblies to be able to divert the flow and allow for replacement of valves. Rehabilitation of RAS Pump No. 3 improvements.

Project Assessment:
This project addresses operational issues observed with multiple mechanical assets at the RAS Meter Pits and RAS Pump Station. The actuated flow control valves were last replaced in 2004 and are not operating properly at the moment. The sump pump assembly poses significant fall hazard due to severe corrosion on sump covers which need immediate replacement. The scum ejectors have reached the end of their useful lives and the scum ejector assembly does not have any redundancies present currently. Adding redundancies will allow diversion of the flow and replacement of valves, in case of an emergency. RAS Pump Station No. 3 Assembly has reached the end of it's useful life and replacing the assembly will ensure proper operation and avoid failures at the pump station.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $600,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$600,000**
Estimated Total Project Cost	**$600,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget		$100,000	$200,000	$300,000		**$600,000**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds		$100,000	$200,000	$300,000		**$600,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

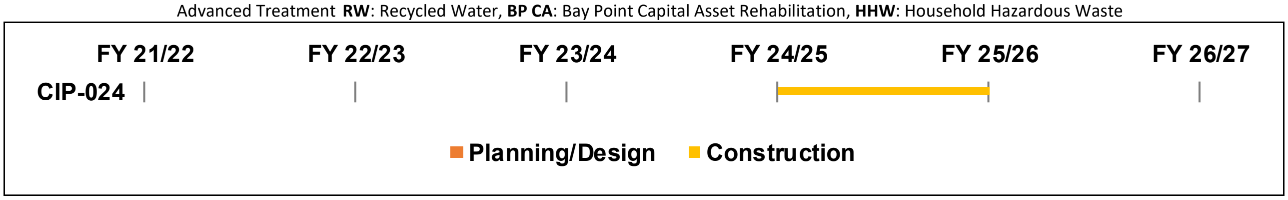
Project Name: Chemical Canopy Rehabilitation | **Project Number: CIP-024**

Description/Justification:
Replacement and Rehabilitations at Chemical Storage facility - Sodium Bisulfite and Sodium Hypochlorite Assemblies.

Project Assessment:
This project addresses the aging infrastructure associated with the Sodium Bisulfite and Sodium Hypochlorite chemical storage facitilies.

Priority:	**2- High Priority (3 – 5 years)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $750,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$750,000**
Estimated Total Project Cost	**$750,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget				$750,000		**$750,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds				$750,000		**$750,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

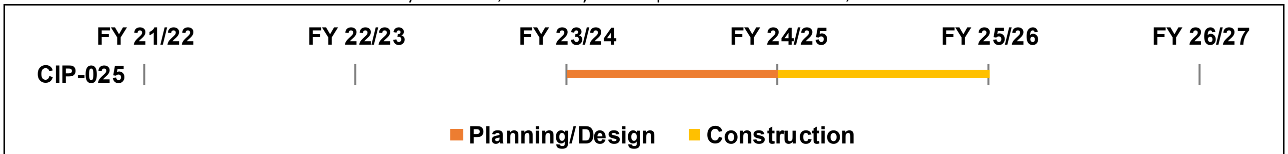
Project Name: Tower Mixing Chamber & Overflow Structure Rehabilitation | **Project Number: CIP-025**

Description/Justification:
In 2018, the District completed a condition assessment and performance evaluation of the Tower Mixing Chamber (TMC) and Diversion Overflow Structure (DOS) (including slide gate MSG-1612). These structures are past their useful lives due to corrosion from normal sulfide gases generated in raw sewage. The project will involve planning, design and construction of the concrete structures and slide gate rehabilitation and replacement work including a major temporary bypass system to allow the District to continue its normal treatment operations

Project Assessment:
This project addresses the failures within the structures and will eliminate significant safety hazards and NPDES permit violations due to flooding and improper treatment.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $1,420,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$1,420,000**
Estimated Total Project Cost	**$1,420,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget			$550,000	$870,000		**$1,420,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds			$550,000	$870,000		**$1,420,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

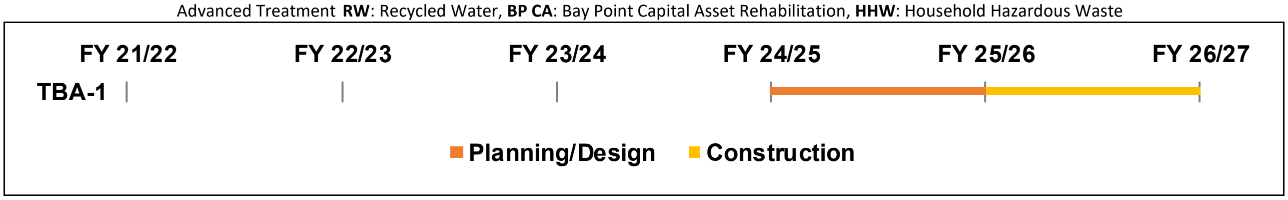
Project Name: Secondary Clarifier Area Improvements | **Project Number: TBA-1**

Description/Justification:
This project includes additional structural evaluation and coating of the secondary clarifiers and miscellaneous mechanical repairs.

Project Assessment:
This project addresses the structurual and mechanical issues observed at the secondary clarifiers. Minor repairs are required to maintain the operational efficiency of the secondary process.

Priority:	**2- High Priority (3 – 5 years)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $1,000,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$1,000,000**
Estimated Total Project Cost	**$1,000,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget				$350,000	$650,000	**$1,000,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds				$350,000	$650,000	**$1,000,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

Project Name: Treatment Plant Flow Equalization Improvements - Emergency Storage Basin **Project Number: TBA-10**

Description/Justification:
Install sump pumps on a float-control system in the Emergency Storage Basin (ESB) at the District's Wastewater Treatment Plant to allow for automatic draining of the ESB after use.

Project Assessment:
This project addresses the need to install sump pumps with an automatic float-control system to ease the process of draining of the ESB after it's use. This project is low risk as the ESB is currently configured to be manually drained. An automated system will reduce staff time required to monitor and operate the manually controlled drain pumps.

Priority:	**3- Medium Priority (6 – 15 years)**
Funding Type*:	**RW CA - 100%**
Funding Amount:	**RW CA - $125,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$125,000**
Estimated Total Project Cost	**$125,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste

Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget					$125,000	**$125,000**

Funding Source: RW CA

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds					$125,000	**$125,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

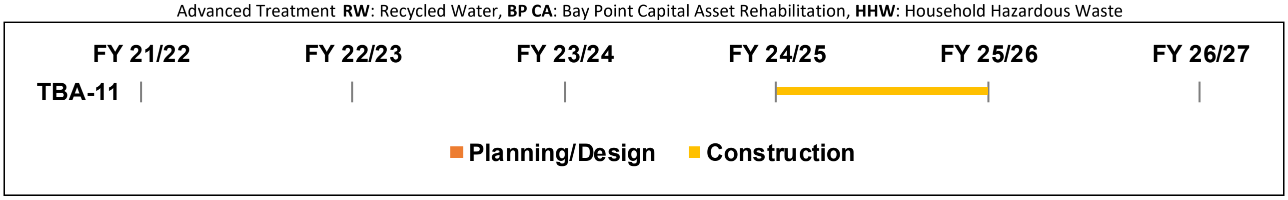
Project Name: RAS Pump Rehabilitation | **Project Number: TBA-11**

Description/Justification:
This project includes planning, design, and construction of rehabilitation and replacement measures for the Return Activated Sludge (RAS) Pumps. The work consists of replacing worn lower bearings, replacing failed coatings, and repairing concrete and grout. The RAS Pumps are the only mechanism for conveying needed RAS to the aeration basins to ensure crucial biological treatment. RAS pump failures will impair the District's biological treatment and lead to a catastrophic plant failure.

Project Assessment:
This project addresses the operational issues observed at the RAS pumps. RAS pumps are crucial components of the biological treatment process that have started showing signs of aging. This is a medium risk project. The pumps are currently in fair condition but will need rehabilitation in the near future.

Priority:	**2- High Priority (3 – 5 years)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $300,000**
Lead Department:	**RRS***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$300,000**
Estimated Total Project Cost	**$300,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget				$300,000		**$300,000**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds				$300,000		**$300,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

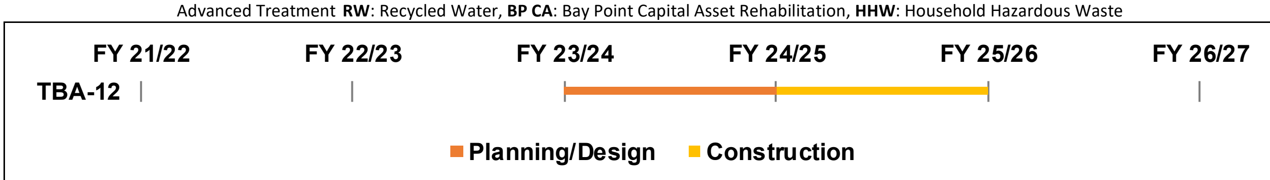
Project Name: Chlorine Contact Influent Gates Replacement — **Project Number: TBA-12**

Description/Justification:
The project includes planning, design, and construction of new influent control gates for the Treatment Plant Chlorine Contact Tanks (CCTs). The influent gates of the distribution structure and the individual CCTs are nearing the end of their useful life and do not adequately seal when in the closed position.

Project Assessment:
This project addresses the operational issues of the influent control gates at CCTs that do not adequately shut and remain partially open. This project is identified as medium risk as the current condition of the gates does allow for partial isolation of the CCTs and their function is currently acceptable under normal operating conditions. However, complete isolation is required for proper maintenance and operation.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $2,000,000**
Lead Department:	**RRS***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$2,000,000**
Estimated Total Project Cost	**$2,000,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget			$500,000	$1,500,000		**$2,000,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds			$500,000	$1,500,000		**$2,000,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

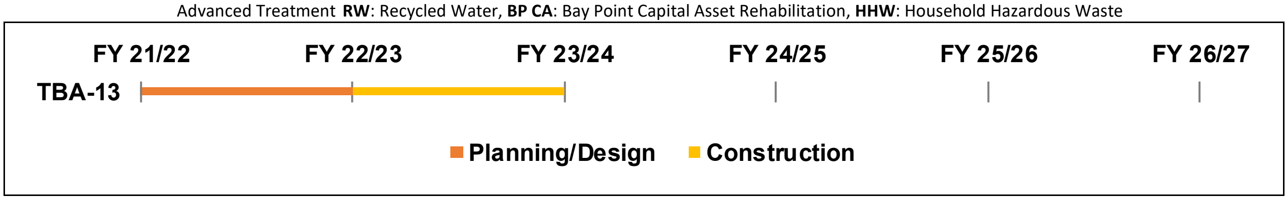
Project Name: Emergency Retention Basin Pump Rebuilds | **Project Number: TBA-13**

Description/Justification:
The return pumps that move water from the Emergency Retention Basin to the plant Headworks for treatment have shown signs of excessive wear and have been in operation past their service life. This project is to remove, inspect, and rebuild the pumps, including their oiling systems, to extend their useful life.

Project Assessment:
This project addresses the operational issues of the return pumps that convey water from ERB to the headworks. These pumps have started are showing signs of aging. This is a medium risk project because the pumps are currently functional but require preventative maintenance to extend their useful life and improve their efficiency.

Priority:	**2- High Priority (3 – 5 years)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $160,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$80,000**
Future Fiscal Year(s) Budget	**$80,000**
Estimated Total Project Cost	**$160,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$80,000	$80,000				**$160,000**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$80,000	$80,000				**$160,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

Project Name: DEC Storage Tank Rehabilitation — **Project Number: TBA-14**

Description/Justification:
This project consists of evaluating coating options and recoating of the Delta Energy Center (DEC) storage tank exterior and interior. This includes looking at the existing interior coating and evaluating options for a more resilient coating, to handle the corrosive environment within the tanks interior head space. Past inspections have shown a significant amount of corrosion in the head space of the storage tank as well as the beginnings of exterior corrosion. This corrosion has the potential to compromise the integrity of the tank if not addressed.

Project Assessment:
This project addresses the structural defects observed on the interior and exterior portion of the DEC Storage tank. This project is medium risk as no significant structural defects to the tank have been identified to date, however, routine evaluations and rehabilitation work are required to maintain the tank's optimal service life.

Priority:	**2- High Priority (3 – 5 years)**
Funding Type*:	**RW CAR - 100%**
Funding Amount:	**RW CAR - $1,000,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$1,000,000**
Estimated Total Project Cost	**$1,000,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	FY 26/27
TBA-14				Planning/Design	Construction	

■ **Planning/Design** ■ **Construction**

Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget				$250,000	$750,000	**$1,000,000**
Funding Source: RW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds				$250,000	$750,000	**$1,000,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

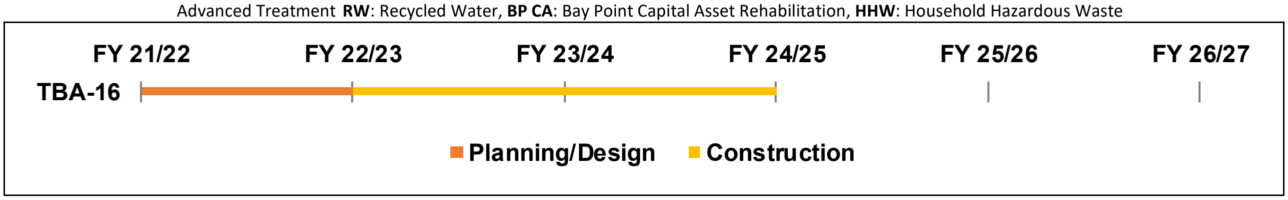
Project Name: Cogen System Improvements **Project Number: TBA-16**

Description/Justification:
This project will replace the existing Cogen engine, controls, and paralleling gear to ensure compatibility with the new switchgear, which is a critical component of the treatment plant electrical power feed system.

Project Assessment:
This project may affect the District's ability to operate the new switchgear. The CIP includes a project to replace the existing switchgear prior to the start this project.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $5,000,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$250,000**
Future Fiscal Year(s) Budget	**$4,750,000**
Estimated Total Project Cost	**$5,000,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget	$250,000	$750,000	$4,000,000			**$5,000,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds	$250,000	$750,000	$4,000,000			**$5,000,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

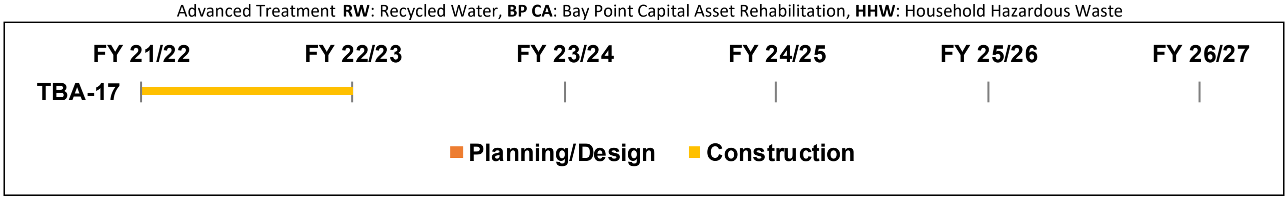
Project Name: Aboveground Fuel Storage Tank Rehabilitation | **Project Number: TBA-17**

Description/Justification:
An inspection and assessment of ten above ground diesel/oil storage tanks at the treatment plant and pump stations identified deficiencies which includes secondary containment failures on multiple tanks, and possible primary containment failure of the tank at the Pittsburg Pump Station. This project will repair and/or replace the tanks as needed and will ensure that the tanks meet current codes and standards.

Project Assessment:
This project addresses the primary and secondary containment failures of multiple aboveground fuel storage tanks. This is a high risk project because a complete failure of these tanks would result in costly environmental cleanup and would leave the various generator engines without a fuel/oil supply which is needed to operate these facilities during a power outage. Repair and/or replacement of these tanks as needed will avoid any major failures in the future.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $300,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	**$71,481**
FY 21/22 Budget	**$228,519**
Future Fiscal Year(s) Budget	
Estimated Total Project Cost	**$300,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$228,519					**$228,519**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$228,519					**$228,519**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

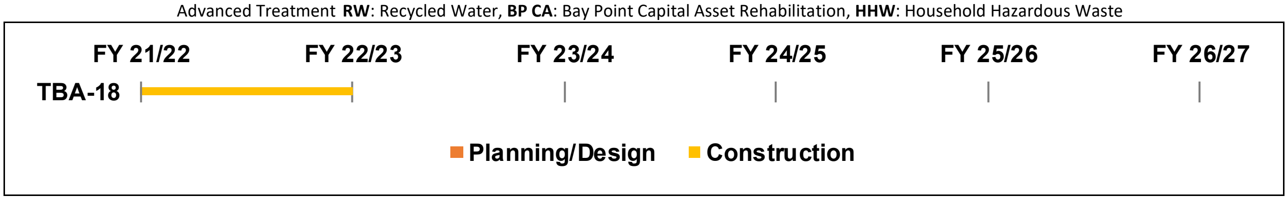
Project Name: Site Security Improvements | **Project Number: TBA-18**

Description/Justification:
This multiphase project will address recent security concerns at the District's Wastewater Treatment Plant. The initial phase will upgrade office building doors to control access into the POC and TP buildings. The future phases will evaluate and install perimeter barriers and video surveillance system to ensure long-term security and safety of staff and the general public.

Project Assessment:
Ongoing security breaches can result in potential safety concerns for staff and the general public as well in loss of properties, which could severely impact treatment plant processes or staff's ability to respond to maintenance needs. The CIP includes a project to upgrade the data network infrastructure via a third-party provider to support video and other access control measures at the remote pump station sites and treatment plant.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $365,025**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	**$300,000**
FY 21/22 Budget	**$65,025**
Future Fiscal Year(s) Budget	
Estimated Total Project Cost	**$365,025**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$65,025					**$65,025**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$65,025					**$65,025**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

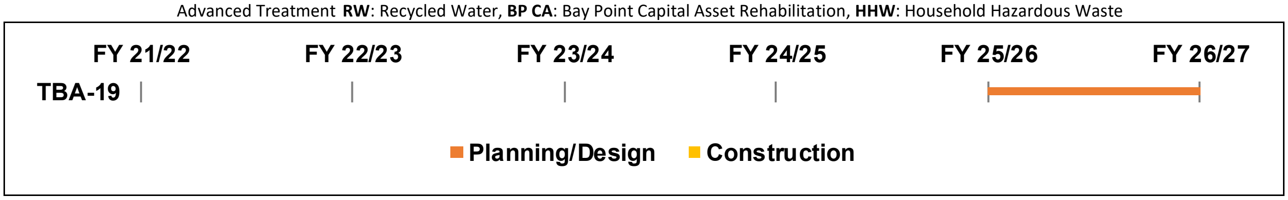
Project Name: Biosolids Management Master Plan **Project Number: TBA-19**

Description/Justification:
This project will establish long-term strategies for the disposal, distribution, and potential marketing of the District's biosolids to ensure strict compliance with future regulatory requirements.

Project Assessment:
While there are no regulatory requirements that immediate changes to the District's existing biosolids management practices, it is possible that future regulatory changes could significantly impact available biosolids end use options. The Resource Recovery Facility Master Plan includes a preliminary assessment of existing biosolids and practices, threats, and opportunities.

Priority:	**2- High Priority (3 – 5 years)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $400,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$400,000**
Estimated Total Project Cost	**$400,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget					$400,000	**$400,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds					$400,000	**$400,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

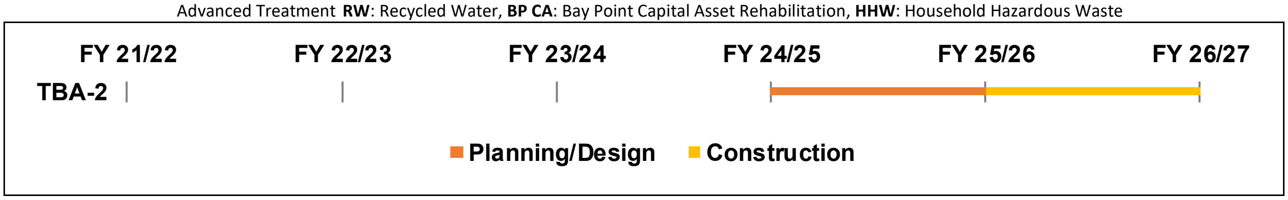
Project Name: DEC and CCT Valves Replacement & DEC Tank Isolation Valves Replacement | **Project Number: TBA-2**

Description/Justification:
This project consists of planning, design, and construction of various components at the RWF. The work to be performed under this project will include the RWF Backwash Valve Installation, RWF DEC Drain Valve Automation, RWF Polymer Blending Unit Replacement, RWF Sand Filter Backwash Optimization, RWF CCT Influent Valves and Lamella Tube Replacement. Planning and design are anticipated to begin in FY22/23 with construction to commence in FY23/24.

Project Assessment:
This project addresses the mechanical assets at RWF. These assets have reached the end of their useful life and replacement of these assets is necessary to maintain the operational reliability at RWF.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**RW CAR - 100%**
Funding Amount:	**RW CAR - $700,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$700,000**
Estimated Total Project Cost	**$700,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget				$225,000	$475,000	**$700,000**

Funding Source: RW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds				$225,000	$475,000	**$700,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

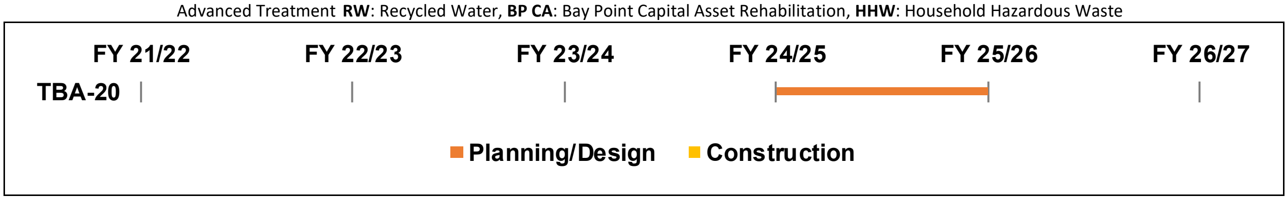
Project Name: Electrical System Master Plan | **Project Number: TBA-20**

Description/Justification:
This project will evaluate the District's current and future electrical requirements and provide guidelines for planning the electric distribution system to serve the District in a reliable manner and potentially export power to nearby utilities.

Project Assessment:
The existing electric distribution system has adequate capacity for the existing infrastructure and appears to have limited capacity to serve additional power demands from new infrastructure. This project will consider future projects in the CIP and Resource Recovery Facility Master Plan.

Priority:	**2- High Priority (3 – 5 years)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $300,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$300,000**
Estimated Total Project Cost	**$300,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget				$300,000		**$300,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds				$300,000		**$300,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

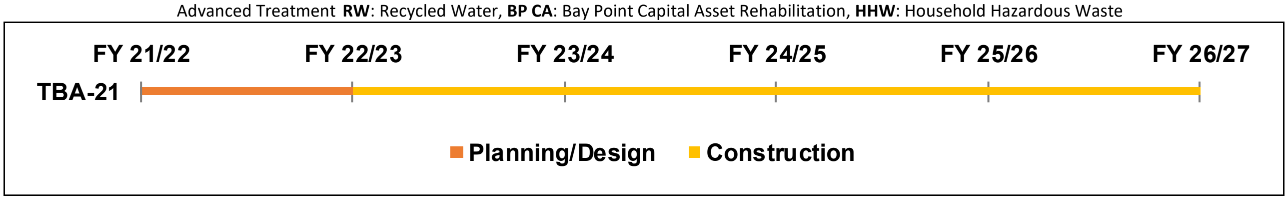
Project Name: IT Equipment Replacement **Project Number: TBA-21**

Description/Justification:
This Unanticipated Replacement Project will allow the repair/replacement/improvement of IT equipment that is not functioning properly, or has early service life failure during the course of a particular fiscal year.

Project Assessment:
This project provides a proactive approach to address any unanticipated repair/replacement needs of the IT equipment throughout the plant. This programmatic project is necessary to ensure that repairs or replacement equipment is available when needed and that discretionary funds are available. Depending on the specific improvement identified, they could hold a high, medium, or low risk.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $600,000**
Lead Department:	**IT***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$50,000**
Future Fiscal Year(s) Budget	**$550,000**
Estimated Total Project Cost	**$600,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget	$50,000	$50,000	$50,000	$400,000	$50,000	**$600,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds	$50,000	$50,000	$50,000	$400,000	$50,000	**$600,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

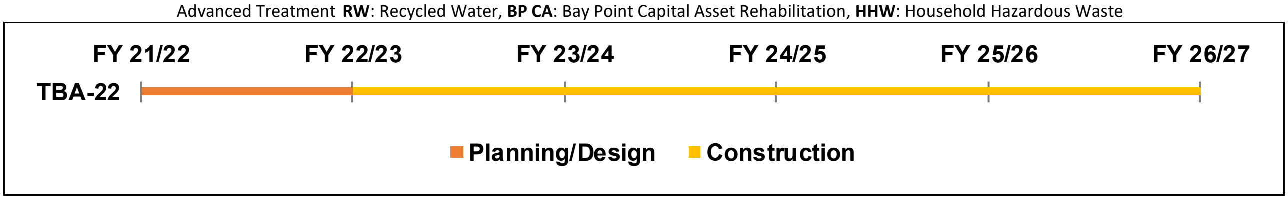
Project Name: Lab Equipment Replacement | **Project Number: TBA-22**

Description/Justification:
The Unanticipated Replacement Project will allow the repair/replacement/improvement of lab equipment that is not functioning properly, or has early service life failure during the course of a particular fiscal year.

Project Assessment:
This project provides a proactive approach to address any unanticipated repair/replacement needs of the lab equipment. This programmatic project is necessary to ensure that repairs or replacement equipment is available when needed and that discretionary funds are available. Depending on the specific improvement identified, they could hold a high, medium, or low risk.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $125,000**
Lead Department:	**RRS***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$25,000**
Future Fiscal Year(s) Budget	**$100,000**
Estimated Total Project Cost	**$125,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget	$25,000	$25,000	$25,000	$25,000	$25,000	**$125,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds	$25,000	$25,000	$25,000	$25,000	$25,000	**$125,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

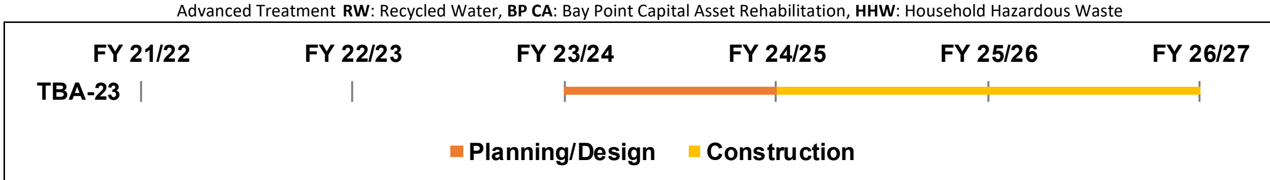
Project Name: Primary Clarifier Nos. 1 - 4 Coating | **Project Number: TBA-23**

Description/Justification:
The coatings on the primary clarifier sludge collectors has failed and are not protecting the structures effectively, reducing the useful life of the clarifier mechanisms. This project includes planning, design, and application of new protective coatings for Primary Clarifier Nos. 1 – 4. Design will get underway in FY21/22 with construction to commence in FY22/23 and FY23/24.

Project Assessment:
This project addresses the structural failure observed on the coatings on the primary clarifier sludge collectors. This project is identified as a low risk because the corrosion observed on the collectors has not indicated that a failure will occur in the near term, and there is a level of redundancy in the primary clarifier system in the event of a failure.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $1,400,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$1,400,000**
Estimated Total Project Cost	**$1,400,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget			$400,000	$500,000	$500,000	**$1,400,000**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds			$400,000	$500,000	$500,000	**$1,400,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

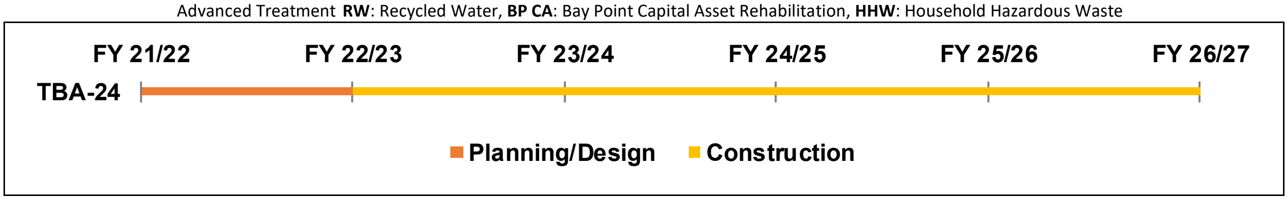
Project Name: Vehicle Replacements | **Project Number: TBA-24**

Description/Justification:
An increase in needed repairs for both function and safety, along with the age of the vehicles, are contributing to excessive expenses to maintain vehicles in the fleet. This project is for the replacement of Vehicle 40, 47, 56, 57, and 65.

Project Assessment:
This project addresses the immediate need to replace vehicles in the fleet that are showing signs of aging and are in constant need of repair. This is a low priority project because these vehicles are operational and maintainable, but cost to keep them safe and running is becoming excessive.

Priority:	**2- High Priority (3 – 5 years)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $945,000**
Lead Department:	**RRS***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	**$145,000**
FY 21/22 Budget	**$100,000**
Future Fiscal Year(s) Budget	**$700,000**
Estimated Total Project Cost	**$945,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget	$100,000	$400,000	$100,000	$100,000	$100,000	**$800,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds	$100,000	$400,000	$100,000	$100,000	$100,000	**$800,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

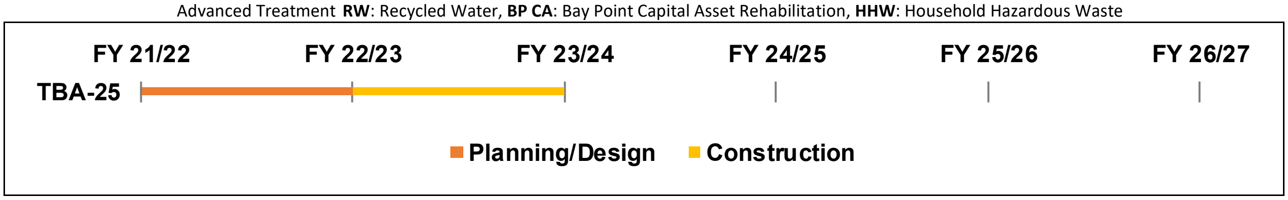
Project Name: Primary Clarifiers Area Improvements - Phase 2 **Project Number: TBA-25**

Description/Justification:
This project will complete the primary clarifier and scum pit control system upgrades by replacing upgrading local control panels, replacing the portions of the original relay control systems not upgraded with the Phase 1 project, improve pump fault alarm reliability, replacement of suction pressure switch assemblies, and the installation of motor soft starters or VFDs on the sludge and scum pump. Work will also include removal and abandonment on unused components in MCC Relay Control Panels E & F, Local Control Panel X-2001, and RTU-2000.

Project Assessment:
This project includes control system upgrades that were not addressed during phase 1 of the project. The control system at the primary clarifier and scum pit has been experiencing multiple operational issues. These issues can have significant impact on the primary treatment process. Upgrading the control system and removing the unused components will ensure operational reliability.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $500,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$150,000**
Future Fiscal Year(s) Budget	**$350,000**
Estimated Total Project Cost	**$500,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget	$150,000	$350,000				**$500,000**
Funding Source: RW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds	$150,000	$350,000				**$500,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

Project Name: Recycled Water Master Plan Update | **Project Number: TBA-26**

Description/Justification:
The District's Recycled Water Supply Agreement with Calpine expires in 2030. In accordance with the Agreement terms, the District is obligated to notify the District of its intent to continue receiving recycled water beyond 2030 by April 2025. This project will access the capital infrastructure needs to operate the RWF beyond 2030 and evaluate the potential to provide recycled water to other users.

Project Assessment:
The District must complete the project to comply with the Recycled Water Supply Agreement. The Resource Recovery Facility Master Plan will assess recycled water distribution alternatives if Calpine does not receive recycled water beyond 2030 and identify near-term facility investment(s) needed to maintain reliability.

Priority:	**2- High Priority (3 – 5 years)**
Funding Type*:	**AT - 100%, RW CA - 100%**
Funding Amount:	**AT - $150,000, RW CA - $150,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$300,000**
Estimated Total Project Cost	**$300,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	FY 26/27
TBA-26			Planning/Design ———	———		

Planning/Design   Construction

Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget			$300,000			**$300,000**
Funding Source: AT, RW CA						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds			$300,000			**$300,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

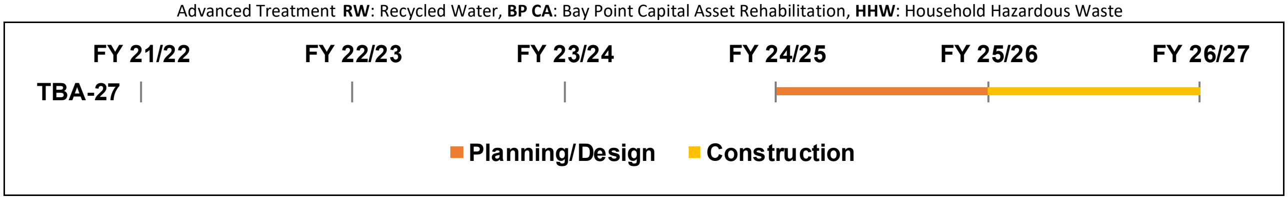
Project Name: Sand Filter and Filter Cover Improvements | **Project Number: TBA-27**

Description/Justification:
This project consists of an assessment of alternatives and implementation of improvements at the RWF. The work to be performed under this project will include the Microsand System Rehabilitation, RWF Sand Filter Media Replacement, and RWF Filter Cover Improvements Phase II. Planning and design are anticipated to begin in FY22/23 with construction to commence in FY23/24.

Project Assessment:
This project addresses the operational issues observed at RWF due to deteriorating performance of the sand filter media, filter cover and Microsand system. This project is considered low risk. These existing components are functional. Repair and/or replacement of these existing components will facilitate long-term maintenance.

Priority:	**2- High Priority (3 – 5 years)**
Funding Type*:	**RW CAR - 100%**
Funding Amount:	**RW CAR - $1,082,000**
Lead Department:	**RRS***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$1,082,000**
Estimated Total Project Cost	**$1,082,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget				$500,000	$582,000	**$1,082,000**
Funding Source: RW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds				$500,000	$582,000	**$1,082,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

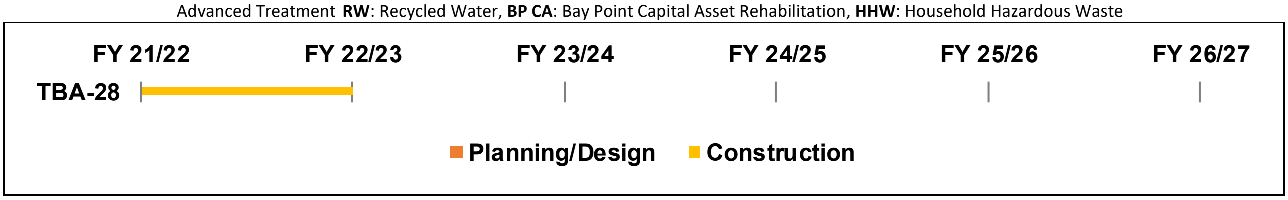
Project Name: Sand Filter Intermittent Backwash System | **Project Number: TBA-28**

Description/Justification:
This project will replace the existing air lift module, which are facing obsolescence, add isolation valves, and control system for the backwash function of the filters.

Project Assessment:
This project addresses the various components of the Sand Filter Intermittent Backwash System that are nearing the end of their useful lives. Replacing this components will improve the functionality of the filter system.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**RW CAR - 100%**
Funding Amount:	**RW CAR - $750,000**
Lead Department:	**RRS***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	**$150,000**
FY 21/22 Budget	**$600,000**
Future Fiscal Year(s) Budget	
Estimated Total Project Cost	**$750,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget	$600,000					**$600,000**
Funding Source: RW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds	$600,000					**$600,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

Project Name: RWF Clarifier Liner Rehabilitation **Project Number: TBA-29**

Description/Justification:
This project will repair the RWF clarifier liner.

Project Assessment:
This project addressed the damage associated with the RWF clarifier liner to protect the structural components from corrosion.

Priority:	**2- High Priority (3 – 5 years)**
Funding Type*:	**RW CA - 100%**
Funding Amount:	**RW CA - $50,000**
Lead Department:	**RRS***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$50,000**
Estimated Total Project Cost	**$50,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	FY 26/27
TBA-29					Construction	

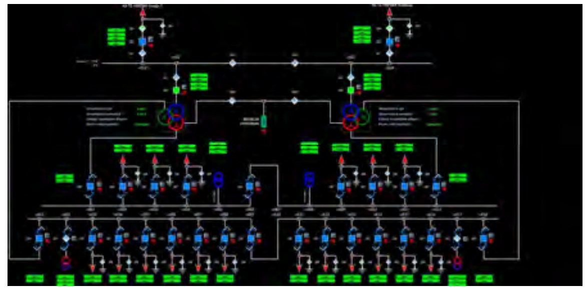
Planning/Design Construction

Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget					$50,000	**$50,000**
Funding Source: RW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds					$50,000	**$50,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

Project Name: SCADA Master Plan Update | **Project Number: TBA-32**

Description/Justification:
This project will update the 2011 Supervisory Control and Data Acquisition (SCADA) Master Plan to identify potential upgrades, changes, and/or replacements to enhance and increase the reliability of the District's SCADA system.



Project Assessment:
The District's SCADA system is essential for the operation of District facilities because it performs plant monitoring, alarming, and remote control and its functionality and capabilities should be evaluated periodically. This project is considered low risk because there are no immediate drivers for this analysis.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $500,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$500,000**
Estimated Total Project Cost	**$500,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	FY 26/27
TBA-32			Planning/Design			

Planning/Design **Construction**

Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget			$500,000			**$500,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds			$500,000			**$500,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

Project Name: Primary Service Water Filter Replacement | **Project Number: TBA-35**

Description/Justification:
This project will replace the existing water filters in the primary clarifier distribution area.

Project Assessment:
This project addresses the operational issues with the water filters at the primary clarifier distribution area. These filters have reached the end of their useful life and their replacement is necessary to improve the operation in the primary clarifier distribution area.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $300,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$150,000**
Future Fiscal Year(s) Budget	**$150,000**
Estimated Total Project Cost	**$300,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste

Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$150,000	$150,000				**$300,000**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$150,000	$150,000				**$300,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

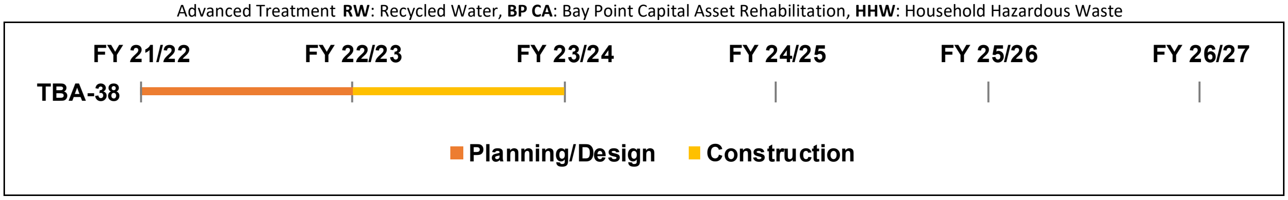
Project Name: CCT Service Water Pumps Replacement — **Project Number: TBA-38**

Description/Justification:
This project will replace the existing four water service pumps in the Treatment Plant chlorine contact tank area.

Project Assessment:
The water service pumps have reached the end of their useful lives. Replacing these pumps will improve the operational reliability of the secondary process.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $300,000**
Lead Department:	**RRS***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$150,000**
Future Fiscal Year(s) Budget	**$150,000**
Estimated Total Project Cost	**$300,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$150,000	$150,000				**$300,000**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$150,000	$150,000				**$300,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

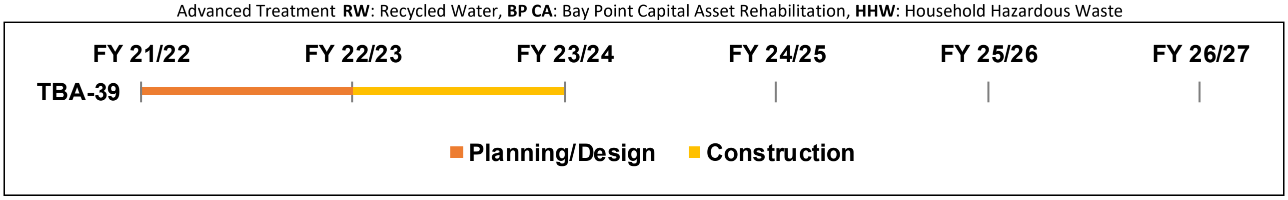
Project Name: TTF Odor Control Rehabilitation | **Project Number: TBA-39**

Description/Justification:
This project will replace the existing fans and modifications to the floor will allow proper drainage underneath the fan assemblies to facilitate future maintenance.

Project Assessment:
The existing fans at the TTF have reached the end of their useful lives and require immediate replacement along with the modifications underneath the fan assemblies to assist in future maintenance activities.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $200,000**
Lead Department:	**RRS***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$100,000**
Future Fiscal Year(s) Budget	**$100,000**
Estimated Total Project Cost	**$200,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget	$100,000	$100,000				**$200,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds	$100,000	$100,000				**$200,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

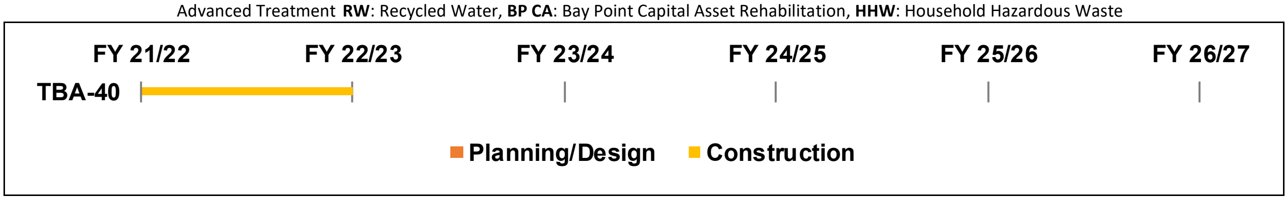
Project Name: Dewat Boiler Replacement | **Project Number: TBA-40**

Description/Justification:
This project will replace the existing boiler in the Dewater Building.

Project Assessment:
The boiler at the Dewater building has reached the end of their useful lives. Replacing the boiler will improve the operational reliability at the building.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $300,000**
Lead Department:	**RRS***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$300,000**
Future Fiscal Year(s) Budget	
Estimated Total Project Cost	**$300,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste

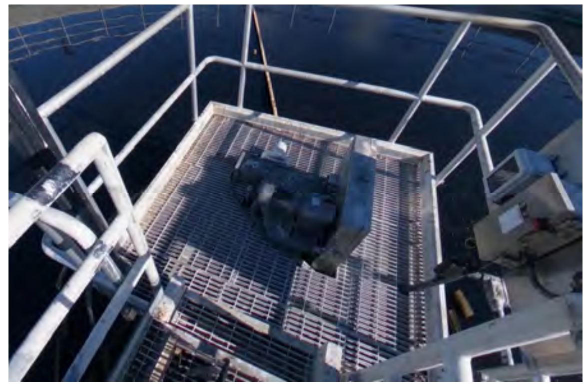


Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget	$300,000					**$300,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds	$300,000					**$300,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

Project Name: Primary Clarifiers 1 & 4 Drive Unit Replacement | **Project Number: TBA-41**

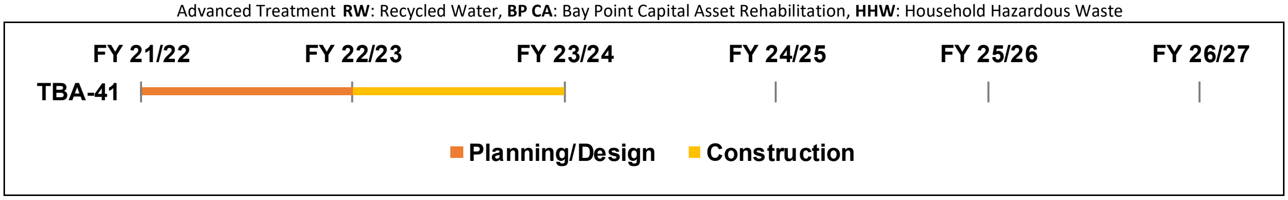
Description/Justification:
This project will replace the existing water filters in the primary clarifier distribution area that are nearing the end of their useful life.



Project Assessment:
Since the existing water filters at the primary clarifier distribution area have reached the end of their useful life, replacing these filters is essential to maintain the operational functionality in this area.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $200,000**
Lead Department:	**RRS***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$100,000**
Future Fiscal Year(s) Budget	**$100,000**
Estimated Total Project Cost	**$200,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget	$100,000	$100,000				**$200,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds	$100,000	$100,000				**$200,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

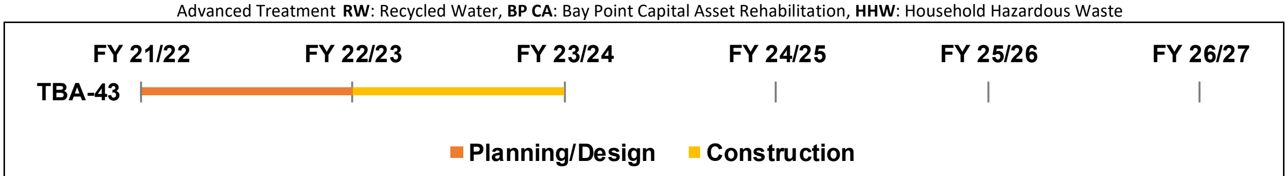
Project Name: Vactor Decant Facility | **Project Number: TBA-43**

Description/Justification:
This project will include design and construction of a decant facility for disposal of debris removed from treatment process and conveyance/collection system.

Project Assessment:
This project address the immediate need to provide a solution to the mounting debris from the treatment process and collection/conveyance system. The Vactor Decant Facility is an environmentally safe process that allows proper disposal of the debris collected.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $500,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$200,000**
Future Fiscal Year(s) Budget	**$300,000**
Estimated Total Project Cost	**$500,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget	$200,000	$300,000				**$500,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds	$200,000	$300,000				**$500,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

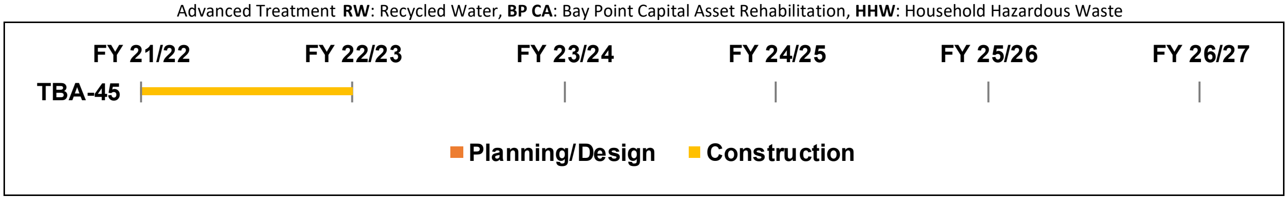
Project Name: RWF Sand Pump Piping Replacement | **Project Number: TBA-45**

Description/Justification:
This project will replace the existing sand piping within the RWF filtration area due to severe corrosion concerns.

Project Assessment:
The existing sand piping within the RWF filtration area has reached the end of it's useful life causing severe corrosion concerns. Replacement of the sand piping will ensure operational reliability at the facility.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**RW CAR - 100%**
Funding Amount:	**RW CAR - $100,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$100,000**
Future Fiscal Year(s) Budget	
Estimated Total Project Cost	**$100,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$100,000					**$100,000**

Funding Source: RW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$100,000					**$100,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

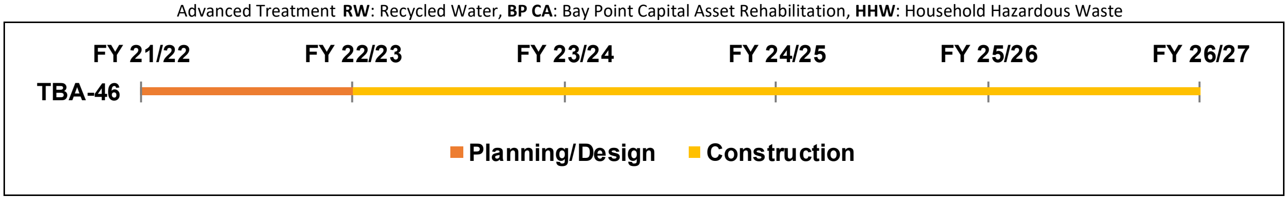
Project Name: Household Hazardous Waste Improvements | **Project Number: TBA-46**

Description/Justification:
This project allowance is for minor projects or equipment repair/replacement at the HHW Facility.

Project Assessment:
The HHW facility that is need of minor improvements and repair/replacement of some equipment at the facility. These equipment are nearing the end of their useful life. This project will ensure smooth operations at the HHW facility

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**HHW - 100%**
Funding Amount:	**HHW - $400,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$25,000**
Future Fiscal Year(s) Budget	**$375,000**
Estimated Total Project Cost	**$400,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$25,000	$25,000	$25,000	$25,000	$300,000	**$400,000**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$25,000	$25,000	$25,000	$25,000	$300,000	**$400,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

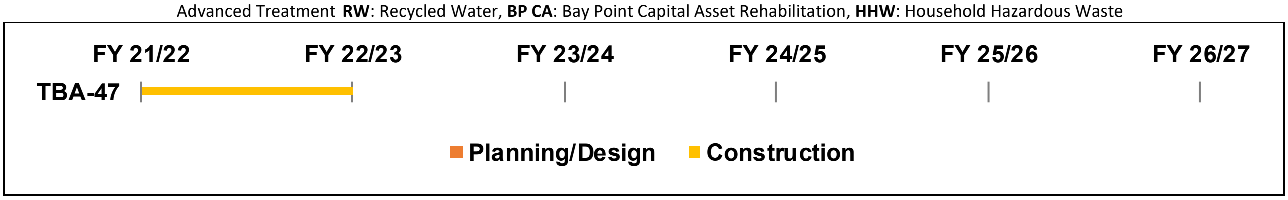
Project Name: On-Site Fueling Station Replacement — **Project Number: TBA-47**

Description/Justification:
This project will replace the On-site Fueling Station

Project Assessment:
The on-site fueling station is reaching the end of it's useful life and needs replacement. This project will ensure that the on-site fueling station does not cause any operational concerns in the future.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $550,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	**$248,075**
FY 21/22 Budget	**$301,925**
Future Fiscal Year(s) Budget	
Estimated Total Project Cost	**$550,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget	$301,925					**$301,925**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds	$301,925					**$301,925**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

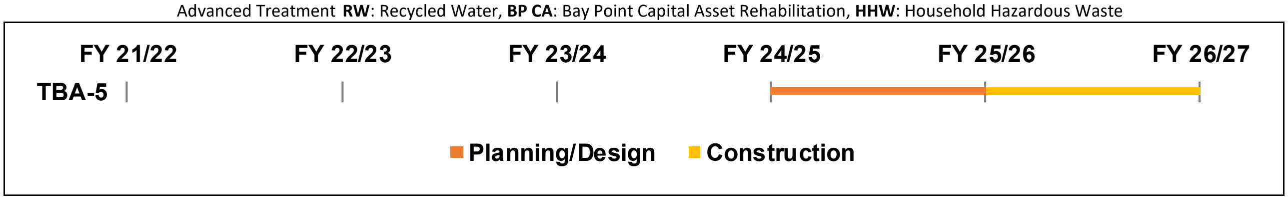
Project Name: RWF IPS, Process Line Modification, and Blowdown — **Project Number: TBA-5**

Description/Justification:
This project consists of planning, including best replacement/rehabilitation alternatives, design, and construction of the identified processes at the RWF. The identified processes include the Influent Pump Station Improvements, Power Plant Blowdown Re-routing, Process Drain Line Modifications, and FEB Diversion Gate & Control Replacement. Planning and design is anticipated to start in FY24/25 with construction to commence in FY25/26.

Project Assessment:
This project addresses the replacement/rehabilitation needs at the identified processes at the RWF and is considered medium risk. The identified work will facilitate maintenance of the RWF but it is not critical to the immediate needs of the facility as these existing components are functional.

Priority:	**3- Medium Priority (6 – 15 years)**
Funding Type*:	**RW CA - 100%**
Funding Amount:	**RW CA - $1,100,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$1,100,000**
Estimated Total Project Cost	**$1,100,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget				$250,000	$850,000	**$1,100,000**
Funding Source: RW CA						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds				$250,000	$850,000	**$1,100,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

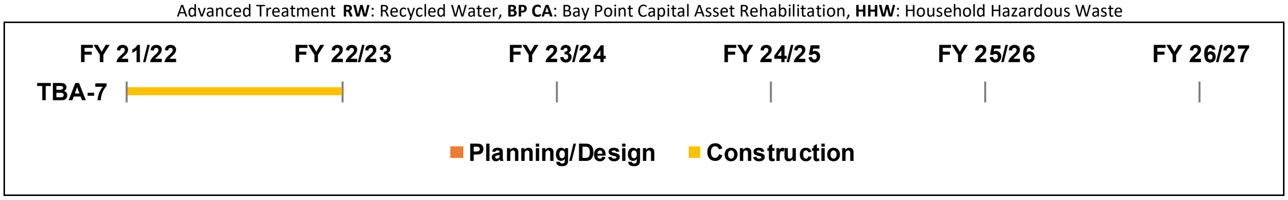
Project Name: Digester No. 1 Cleaning & Repair — **Project Number: TBA-7**

Description/Justification:
This project consists of removing debris to correct any deficiencies, evaluating the interior condition of the structure and piping, and performing the necessary corrective work.

Project Assessment:
This project addresses the cleaning and repair needs of the Digestor No. 1. This project will ensure operational reliability of the digestor and avoid any future issues.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $400,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$400,000**
Future Fiscal Year(s) Budget	
Estimated Total Project Cost	**$400,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$400,000					**$400,000**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$400,000					**$400,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

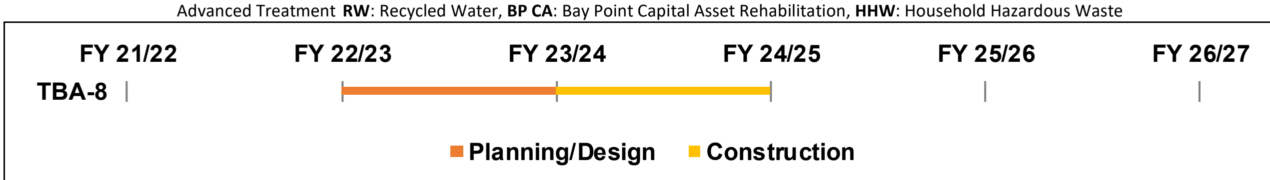
Project Name: Digester No. 3 Cleaning & Repair | **Project Number: TBA-8**

Description/Justification:
This project consists of removing debris to correct any deficiencies, evaluating the interior condition of the structure and piping, and performing the necessary corrective work.

Project Assessment:
This project addresses the cleaning and repair needs of the Digestor No. 3. This project will ensure operational reliability of the digestor and avoid any future issues.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $400,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	
Future Fiscal Year(s) Budget	**$400,000**
Estimated Total Project Cost	**$400,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
Budget		$200,000	$200,000			**$400,000**
Funding Source: WW CAR						
	FY 21/22	**FY 22/23**	**FY 23/24**	**FY 24/25**	**FY 25/26**	**5-Year Total**
District Funds		$200,000	$200,000			**$400,000**
Debt Issuance						
Grant Proceeds						

Capital Improvement Program
Fiscal Year 2020/2021 to Fiscal Year FY 2024/2025
CAPITAL PROJECT

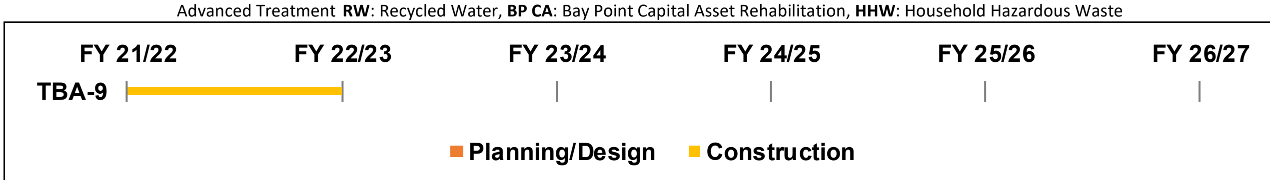
Project Name: Digester Gas Handling and Compressors Replacement | **Project Number: TBA-9**

Description/Justification:
This project will upgrade the existing digester gas handling system and replaced the associated gas compressors.

Project Assessment:
This project addresses the operational issues of the gas compressors at the existing digester gas handling system at Digestor No. 3. This project will improve operational reliability of the digestor.

Priority:	**1- Urgent Priority (12-24 months)**
Funding Type*:	**WW CAR - 100%**
Funding Amount:	**WW CAR - $600,000**
Lead Department:	**ES***
Project Budget Estimate	
Prior Fiscal Year(s) Approved Budget	
FY 21/22 Budget	**$600,000**
Future Fiscal Year(s) Budget	
Estimated Total Project Cost	**$600,000**

*Note: **ES**: Engineering Services; **RRS**: Resource Recovery Services; **WW**: Wastewater; **CA**: Capital Asset, **CAR**: Capital Asset Replacement, **Exp**: Expansion, **AT**: Advanced Treatment **RW**: Recycled Water, **BP CA**: Bay Point Capital Asset Rehabilitation, **HHW**: Household Hazardous Waste



Anticipated Project Budget Schedule:

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
Budget	$600,000					**$600,000**

Funding Source: WW CAR

	FY 21/22	FY 22/23	FY 23/24	FY 24/25	FY 25/26	5-Year Total
District Funds	$600,000					**$600,000**
Debt Issuance						
Grant Proceeds						

Appendix 3

TM – 03 Vulnerability Assessment and Process Control, Monitoring, and Optimization

November 15, 2022

To: Brian Thomas, Delta Diablo Brian Thomas

From: Irene Chu; Wendell Khunjar; Paul Pitt, Hazen

Re: Master Plan – Vulnerability Assessment

TM - 03 Vulnerability Assessment and Process Control, Monitoring, and Optimization

Final

Job no

Revision No.	Date	Description	Author	Reviewed
0	November 2021	Vulnerability TM	Chu	Pitt
1	November 2022	Vulnerability TM	Chu	District

Table of Contents

1. Introduction

Recent events in the collection and conveyance system and the WWTP have prompted the District to reevaluate system vulnerabilities as part of this infrastructure renewal focus area of the 2022 Master Plan. This analysis supports the District's goal to enhance reliability and manage risk by identifying and mitigating potential treatment process vulnerabilities and finding opportunities to improve process monitoring, control, and optimization.

1.1 Recent events

The District provides a high level of service for its customers. Recent events, however, have caused excursions from normal operation and have put the District at increased risk for interruption of service and permit violations. While the District has successfully abated these situations, they create emergencies that require substantial staff and financial resources. Two such events are summarized below and were resolved by District staff prior to the 2022 Master Plan. This analysis references the events described below.

1. March 2019 process upset: In March 2019, the District WWTP experienced a process event that resulted in high final effluent TSS concentrations. The WWTP did not exceed permit requirements, however the incident revealed several vulnerabilities in the secondary system including potential breakthrough of soluble BOD that can overload downstream processes. Subsequent mitigation resulted in increased routine process monitoring, process training for staff, and microscopy training.
2. Chlorine discharge: During routine maintenance on the chlorine analyzer, redundant analyzers were both removed from service resulting in discharge with residual chlorine greater than the permitted limit of 0.0 mg/L. It was found that the standard operating procedure (SOP) for this routine maintenance adequately outlined the proper procedure and that user error led to the violation. The District will provide additional training for staff on this procedure.

1.2 General Approach

As part of the District's commitment to identifying vulnerabilities and minimizing the associated risks, the District:

1. Continues to train staff and periodically review and update the District's SOPs. This work, by District staff, is ongoing and SOPs were not reviewed as part of this 2022 Master Plan.
2. Has identified physical vulnerabilities due to asset failure as part of the Condition Assessment and Risk Analysis task (summarized in **TM 02 Condition Assessment and Risk Analysis Methodology**) and captured as part of replacement and rehabilitation projects in the CIP recommended by the 2022 Master Plan.
3. Has undertaken this analysis to understand process vulnerabilities at the WWTP. This task answered the following questions:
   - What infrastructure, equipment, and operational vulnerabilities to regulatory compliance exist and how should the District address these issues?

- What innovative, applicable, and cost-effective process monitoring, and control technologies should the District consider?

Process vulnerabilities were assessed for three major treatment areas as listed below; vulnerabilities in the collection system and RWF were not assessed. Vulnerabilities associated with underground piping that cannot be accessed or evaluated were deferred to the Condition Assessment of Treatment Plant Underground Piping project that is slated for fiscal year 2024 / 2025.

- Secondary treatment.
- Anaerobic digestion.
- Disinfection.

2. Secondary System Vulnerabilities

2.1 Secondary System - Tower Trickling Filter Vulnerabilities

2.1.1 Approach

2.1.1.1 Detailed Condition Assessment

The Tower Trickling Filters (TTFs) are a critical part of the WWTP secondary system. While the top three layers of media were replaced recently, these units are over 30 years old. Photos from staff showed media sagging, indicating failure. **Figure 2-1** shows the District TTF media. Media failure can lead to preferential flow paths for primary effluent resulting in uneven buildup of biomass. Uneven buildup of biomass can lead to structural failure. Staff also noted concern with the bottom structural layers of media. **Figure 2-2** shows typical modes of failure for trickling filters. While failure will be gradual, performance degradation will lead to increased soluble BOD breakthrough. As described in the risk modeling in **Section 2.2.2.2** this will significantly increase the District's risk of noncompliance.

Figure 2-1 Delta Diablo Tower Trickling Filter Media

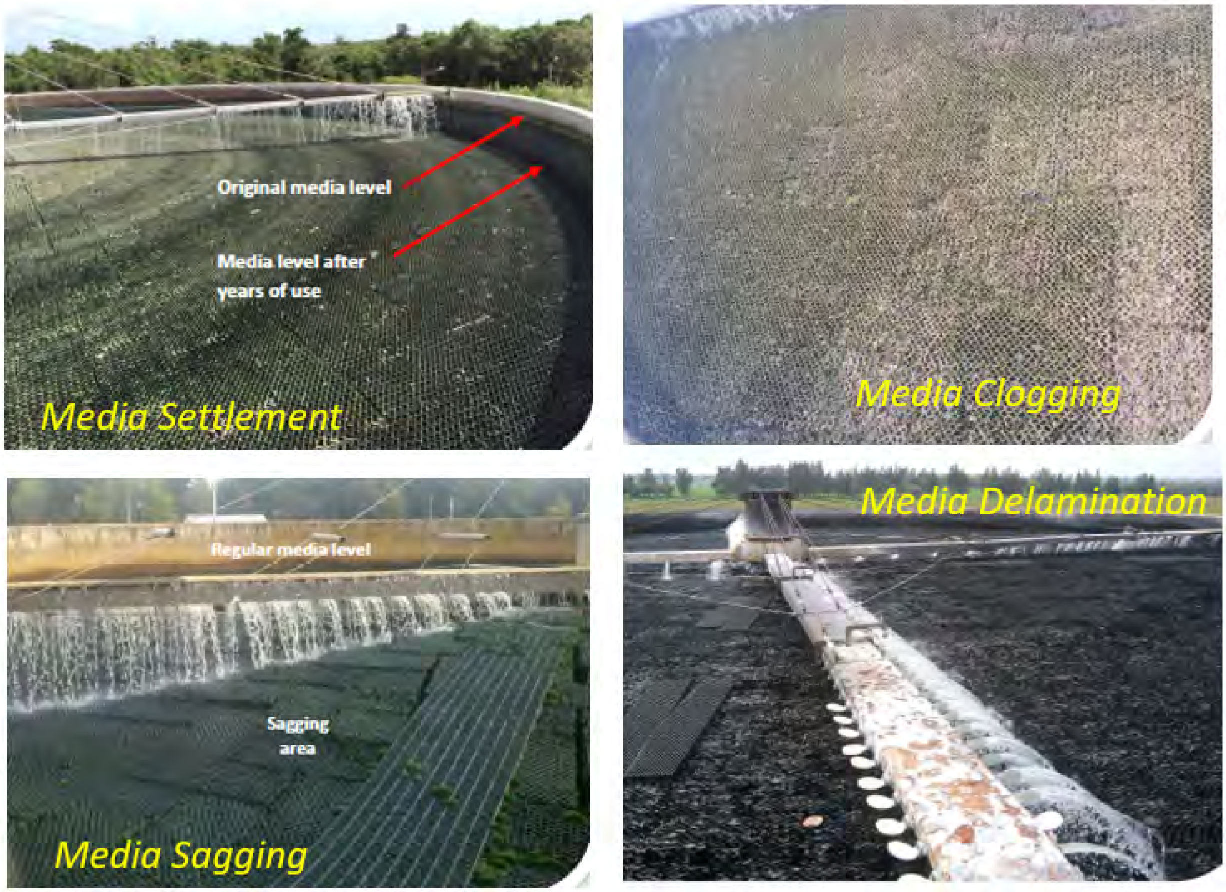


Figure 2-2 Trickling Filter Media Failure Modes

Given the criticality of the TTFs, a detailed condition assessment was planned to accurately determine the remaining useful life of the TTFs. The TTF manufacturer, Brentwood, was consulted for media inspection, destructive testing, and replacement costs. Improvements to the TTFs to increase near-term carbon removal capacity were weighed against the need for capacity increase and future nutrient removal.

2.1.1.2 Process Data Review

A high-level review of available plant process data was conducted to provide context for the condition assessment of the media. Routine operation and periodic flushing of the media impact the amount of attached growth in the media. The weight on the media can impact the media condition and eventually trickling filter condition and performance.

2.1.2 Findings

2.1.2.1 Detailed Condition Assessment Findings

Destructive testing of the media, a crush test, was proposed to understand the decrease in material strength of the media. Discussions with the manufacturer indicated that crush tests are typically undertaken on a block of filter material, not a core sample. Review of the TTF drawings and structural components indicated that removal of a block of media would require a costly disassembly of the trickling filter. This includes roof removal by crane and removal of top layers to reach lower structural layers. Furthermore, the manufacturer noted media failure may be highly localized and therefore multiple samples would likely be required from one tower, increasing the cost of media inspection. Due to the cost of opening a TTF for media inspection, the manufacturer suggested complete media replacement of the inspected TTF.

Brentwood also noted that the **TTFs are well beyond their useful life** and inspection would confirm this. Due to the age of the TTFs, the manufacturer declined to estimate the remaining useful life (RUL) of a TTF with completely new media. A costly and time-consuming process of media inspection and replacement is not recommended:

- The manufacturer would not estimate RUL of a rehabilitated TTF with new media.
- The inability of the manufacturer to guarantee performance of a TTF with new media for any amount of time, indicated that rehabilitation of the TTFs would not significantly reduce the risks of impaired performance of the secondary system.

Since the rehabilitation of the TTF could not reliably reduce risks of the secondary system, a **costly rehabilitation including new media is not recommended**. Further assessment of the TTFs to determine scope of the required upgrades was not pursued. Moreover, as the TTFs are not compatible with future nutrient limitations, improvements to increase secondary system capacity should not focus on the TTFs. Infrastructure required to increase carbon removal capacity at the plant is described in **TM 05 Nutrient Management Analysis**.

A project to increase liquid stream biological treatment capacity will be triggered by 2030-2035 due to a combination of flow and load increases, tower trickling filter media approaching the end of useful life, as well as aeration basin and secondary clarifier capacity limitations. To be compatible with the nutrient management strategy that may require implementation of additional secondary treatment infrastructure and intensification technologies for meeting nutrient limits at the WWTP, it is recommended that the project increase aeration basin volume. To meet carbon removal standards through 2040 loads without the TTFs, the following process volume is needed:

- A total of 3.1 MG (1.2 MG new) of aeration basin
- A new secondary clarifier to maintain process capacity

TM 05 Nutrient Management discusses aeration basin volume required as part of this capacity expansion, the configuration of the basin, the flexibility for the planned future nutrient removal options, and required the ancillary structures.

2.1.2.2 *Process Data Review Findings*

The District does not currently have the means to monitor or has not historically monitored the following parameters of the Tower Trickling Filters:

- flow to each tower,
- air flow to each tower (via portable meter),
- recirculation rate,
- TTF influent soluble BOD,
- effluent soluble BOD,
- spulkraft (SK) rate, (shear or flushing intensity defined as the depth (in millimeters) of water deposited in the passage of one distributor arm (SK, mm/pass of arm),
- flushing rate.

These parameters provide valuable information about the operation of the trickling filters. The District aims to achieve a distributor arm rotation of once per ninety seconds and is not currently recirculating flow. Based on this speed, the operating SK rates for the TTFs was found to be around 15 mm/pass.

$$SK\ Rate = \frac{wetting\ rate\ \left[\frac{m}{hr}\right] x\ 1000\frac{mm}{m}}{\#\ of\ arms\ x\ Distributor\ rpm\ x\ 60\ minutes}$$

$$= \frac{\left(\frac{12.8\ mgd}{9{,}090\ sf}\ x\ 1000\frac{mm}{m}\right)}{4\ x\ 0.66\ rpm\ x\ 60\ min} = 15\frac{mm}{pass}$$

An operating SK rate of 15 mm/pass is below recommended operating values (50-120 mm per pass) for this level of organic loading. Low operating SK rates can lead to build up of organic matter that can cause preferential flow patterns. The additional weight from material build up will stress layers including the structural lower layers. Preferential flow paths will cause short circuiting and performance deterioration. Breakthrough of soluble carbon can significantly impact downstream processes. SK rates during flushing, or flushing SK rates, are typically 200 – 500 mm/pass depending on frequency of flushing (daily vs weekly) to waste excess biofilm.

Water quality before and after the trickling filters would help assess TTF performance, test and optimize TTF operations, and understand loading to the downstream aeration basins. It is recommended that the District continue to sample before and after the tricking filters and analyze for BOD and sBOD as part of its sampling routine.

2.2 Secondary Treatment – Suspended System Vulnerabilities

2.2.1 Approach

A process model was developed and calibrated to simulate the WWTP processes at the plant (see **TM 05 Nutrient Management** for process model development documentation). This calibrated model was used to understand risk due to increased loads and with various secondary process units in service. **Figure 2-3** describes the approach used to model the various scenarios and their inputs.

Figure 2-3 Secondary Treatment Vulnerability Assessment Approach

Loads considered for modeling corresponded annual average projections for 2020, 2025, and 2030 as summarized in **Table 2-1**.

Table 2-1 Process Vulnerability Load Scenarios

Year	BOD	TSS
2020	40,000 lbs/d	41,000 lbs/d
2025	43,000 - 44,500 lbs/d	47,500 - 50,500 lbs/d
2030	46,000 - 49,000 lbs/d	54,000 - 60,000 lbs/d

Scenarios were also undertaken for all TTFs online (4), three TTFs online, and two TTFs online. The resulting increase in loading per cubic foot of TTF media was coupled with a decrease in soluble COD removal.

Scenarios were also run for four or five aeration basins in service. A decrease in aeration volume decreases the aerobic SRT of the system, a parameter that the District maintains above a preferred target of 1.5 days. These were paired with scenarios of four or five secondary clarifiers in service. A decrease in clarifier surface area increases the surface overflow rate and solids loading rate. These are parameters that the District tracks carefully and maintains below a preferred limit.

Modeled scenarios were considered high risk if operational targets could not be met. Key assumptions for operational targets were selected as typical operating conditions at the plant and were confirmed with staff. These operational targets are summarized in **Table 2-2**.

Table 2-2: Assumptions for Capacity Evaluation

Parameter	Maximum Month	Maximum Day
PC TSS removal, %	60	60
Temperature, °C	16	20
Basins in service	All ABs in service 1 SC OOS service	All ABs and SCs in service
Min aerobic SRT, day	1.5	1.5
Min DO in basin, mg/L	1.0	0.5
Max diffuser airflow, scfm/diffuser	2.0	3.0
SVI, mL/g	90 (95th percentile)	63 (50th percentile)
Max RAS rate, mgd[1]	30	30
Max SC SLR, lbs/ft^2-day	30	40

Notes:
PC – Primary Clarifier
AB – Aeration Basin
OOS – Out of Service
SC – Secondary Clarifier
SRT – Solids Retention Time
DO – Dissolved Oxygen
scfm – Standard Cubic Feet per Minute
SVI – Sludge Volume Index
RAS – Return Activated Sludge
SLR – Solids Loading Rate

[1] Per O&M screw pump maximum capacity

2.2.2 Findings

2.2.2.1 Capacity

For this analysis biological capacity of the secondary system was defined as the maximum BOD influent load to the WWTP that would maintain the operational parameters listed in **Table 2-2** with four TTFs and a primary clarifier TSS removal rate of 60%. This analysis confirmed biological capacity of WWTP secondary system to be approximately 53,000 lbs/d. This is similar to the secondary system capacity noted in **2014 Capacity Analysis** (by others). As noted in **TM 01 Flow and Load Projections**, projections indicate that the District is currently at 75-80% of biological capacity and will exceed biological capacity in 10 to 15 years (2030 – 2034). **Figure 2-4** shows the influent BOD load projections for the planning period.

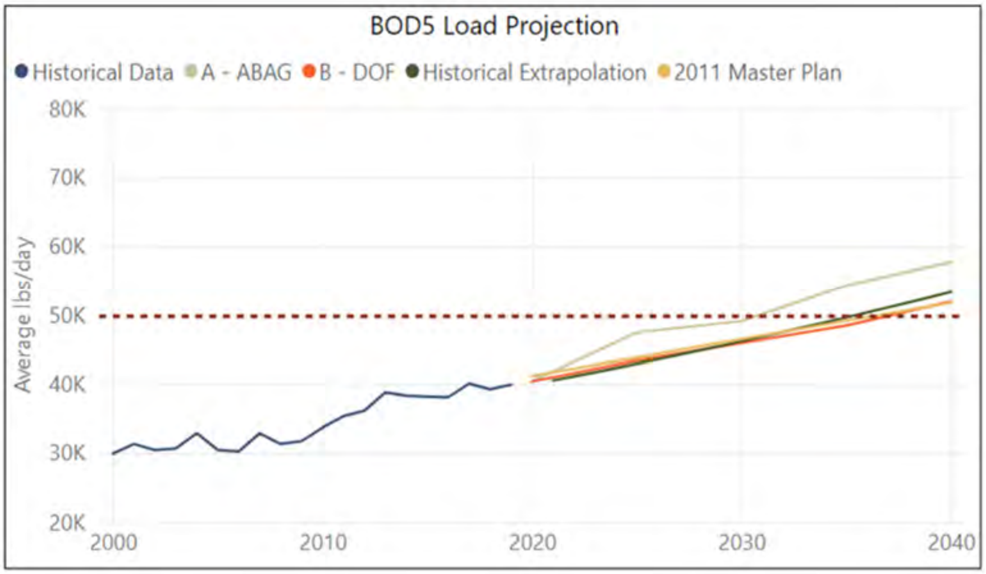


Figure 2-4: BOD Load Projections

Analysis also showed that the District would have difficulty meeting multiple operational targets at influent BOD loads of around 53,000 lb/d. This indicates that the secondary system is not limited by one unit process but by multiple aspects of the secondary system. These include the TTFs, aeration basin volume, and airflow. As such, any secondary process improvements will need to expand the aeration basin volume and provide additional blower capacity.

2.2.2.2 Risk Scenarios

Risk modeling was conducted to indicate secondary capacity for various loads and units in service (number of TTFs, aeration basins, and secondary clarifiers). A scenario was considered high risk when operational targets will be difficult to meet as indicated by red in in **Figure 2-5**. Results show that as **flow and loads increase, the District will need to operate with more aeration basin and secondary clarifier units in service**. The colors in the figure indicate the range of likelihood to miss operational targets from red (likely to exceed targets) to green (ability to meet targets consistently).

Results show an increased loading (per process volume online) due to a TTF out of service or loss of removal efficiency even in near-term, increases risk to maintain plant compliance. A TTF out of service will increase the lbs BOD/cf load on the remaining TTFs resulting in lower soluble COD removal and increased loading on the aeration basins. There is a much greater potential for increased binary fission cells (BFC) and/or filamentous growth in the aeration basins due to soluble COD breakthrough. Therefore, as TTF performance declines and soluble COD breaks through the TTFs, the potential for overloading of the downstream processes increases the risk of permit noncompliance.

To compensate for loss of TTF performance, the District may need to operate at a higher MLSS to maintain aerobic SRT. This reduces operational buffer as it results in higher solids loading rates than has been historically maintained.

4 TTFs in service

	2020	2025	2030
4 ABs, 4 SCs	1.25	0.75	0.25
5 ABs, 4 SCs	2.00	1.75	1.25
5 ABs, 5 SCs	2.00	1.75	1.75

3 TTFs in service

	2020	2025	2030
4 ABs, 4 SCs	[illegible]	0.50	0.10
5 ABs, 4 SCs	2.00	[illegible]	1.00
5 ABs, 5 SCs	2.00	[illegible]	[illegible]

2 TTFs in service

	2020	2025	2030
4 ABs, 4 SCs	[illegible]	0.25	0.05
5 ABs, 4 SCs	2.00	1.25	0.90
5 ABs, 5 SCs	2.00	1.20	1.20

Figure 2-5 WWTP Vulnerability for Various Loadings and Units in Service

To mitigate this capacity vulnerability and minimize risk, the District will need to **plan for capital projects that provide additional volume/clarifier capacity.**

3. Anaerobic Digestion

3.1.1 Approach

The capacity of the anaerobic digester was determined for various future operating scenarios, including changes to the liquid stream to accommodate secondary capacity expansion and nutrient removal. This capacity analysis was used to understand the risk of not meeting the required 15-day hydraulic retention time (HRT) required for class B solids. **Figure 3-1** shows approach to assessing the process vulnerability of anaerobic digestion at the WWTP.

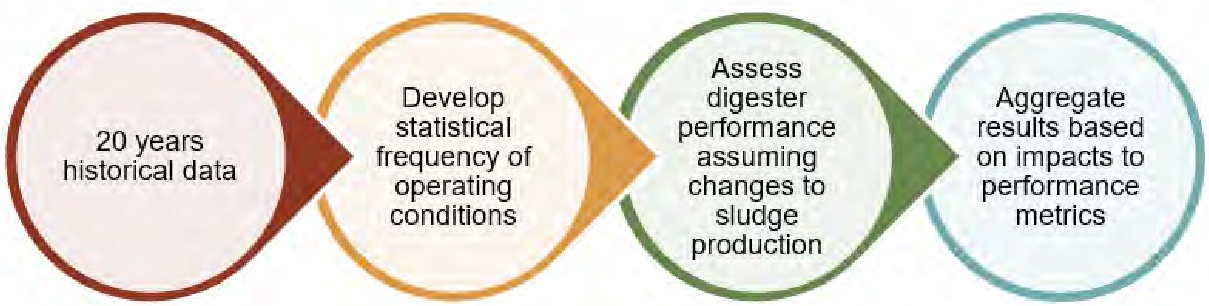


Figure 3-1 Anaerobic Digestion Vulnerability Assessment Approach

Target operating conditions were reviewed with staff. To maintain an appropriate factor of safety over the minimum regulatory requirement for HRT and to ensure the District can adequately service and clean digesters, the following operational targets were developed as outlined in **Table 3-1**. These targets, summarized below, were discussed with staff and agreed upon for this analysis.

Table 3-1 Anaerobic Digestion Vulnerability Analysis Operational Targets

Parameter	Value
Minimum number of Digesters in Service	2
Minimum HRT with Two Digesters in Service	18 days
Minimum HRT with Three Digesters in Service	20 days

Capacity was evaluated assuming two sludge production rates (tracks) corresponding to liquids process with and without the TTFs in service. These two scenarios are low sludge yield (current operation with the TTFs) and high sludge yield (future operation with only suspended growth without trickling filters).

These were coupled with flow and load projections summarized in **TM 01 Flow and Load Projections.** The digesters were considered over capacity when the operational targets could not be met on a maximum month basis.

Table 3-2 Sludge Yield for current and future liquid stream operation

	Primary Sludge		Waste Activated Sludge	
	AA	MM	AA	MM
Low Sludge Yield (Current operation)	1,500 lbs/MG	1,600 lbs/MG	1,800 lbs/MG	2,000 lbs/MG
High Sludge Yield (Future operation w/o TTF)	1,900 lbs/MG	2,100 lbs/MG	2,200 lbs/MG	2,500 lbs/MG

AA = Annual Average; MM = Maximum Month

3.1.2 Findings

Total digester feed in gpd, was determined for a range of influent flows for both high and low sludge yield scenarios and compared to the maximum digester loading that can meet the operational targets detailed in **Table 3-1**. **Figure 3-2** shows the digester influent maximum month sludge projections compared to the limit for two digesters online.

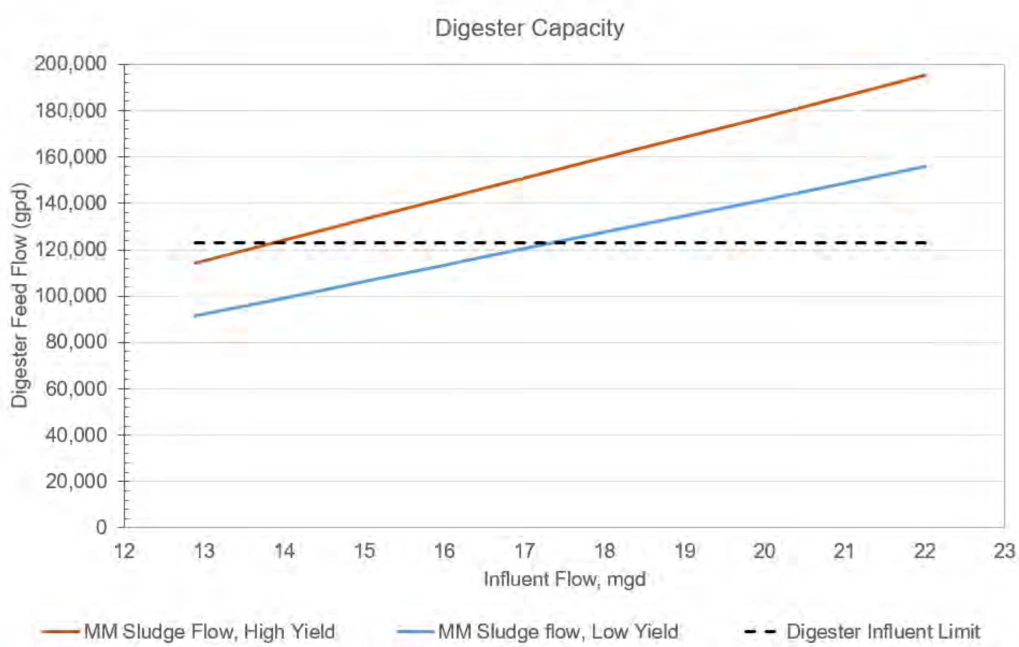


Figure 3-2 Digester Capacity with Two Digesters Online for High and Low Sludge Yields

As expected, digester influent flow increases as plant influent flow increases for either the high or low sludge yield scenarios. Both scenarios show that the sludge production will surpass the capacity for two digesters online within the planning period. For two digesters in service, the plant will reach digestion capacity as outlined in **Table 3-3:**

Table 3-3 Influent Flow Capacity for Low and High Sludge Yield Scenarios

	Influent Flow when Digesters Reach Capacity
Low Sludge Yield (Current operation)	17.5 mgd
High Sludge Yield (Future operation w/o TTF)	14 mgd

The flow projection window for 2040 is 16 mgd to 18.4 mgd as described in **TM 01 Flow and Load Projections**. **Increases in flows and loads to the WWTP will necessitate an increase in digester capacity at the WWTP** **(Table 3-3)**. Required process changes that occur in the liquid stream (decommissioning of the TTFs, as described in **TM 04 Nutrient Management Analysis**) will increase sludge production, accelerating the need for additional digester capacity. However, under both a high sludge production and low sludge production scenarios, the increase in digester capacity will be needed **within the planning period**. **TM 05 Biosolids and Renewable Energy,** details the timing of these high and low sludge production scenarios and evaluates options to increase digester capacity within the planning period. These include an additional digester, recuperative thickening and high solids digestion. In the near-term, **allowing for digester operation at 17-day minimum HRT will provide some process buffer.**

4. Disinfection

Recent disinfection incidences led to two NPDES permit exceedances related to total residual chlorine (TRC). The District's effluent limitation for TRC is 0.0 mg/L on an instantaneous basis (reported hourly). The Regional Water Board will relax this standard allowing for non-zero TRC in discharges depending on the dilution at the point of discharge. For the District this results in a 0.43 mg/L TRC as a one-hour average limit. While this would reduce potential vulnerabilities for dischargers, the dechlorination process will remain a critical process to meet discharge limitations for TRC.

4.1.1 Approach

The approach to disinfection and effluent facilities vulnerabilities centered around challenges as discussed in workshops with staff. Mitigation strategies, including increased monitoring and infrastructure to provide operational flexibility has been discussed with staff and are documented in this section.

- **Disinfection**: Noted past difficulties and identified potential mitigation strategies.
- General plant wide recommendations were developed to reduce vulnerability and guide best practices. Recommendations for process monitoring and control were developed with staff through workshops.

4.1.2 Findings

District staff identified four critical items related to effluent facilities that impact disinfection and effluent disposal. The effluent facility challenges for the WWTP increase when the blowdown from Calpine varies due to process changes at the Calpine facilities. These changes and the water quality of the blowdown is not within the control of the WWTP. These items and potential mitigation measures are summarized in **Table 4-1.** District staff has mitigated these challenges in the past, however additional mitigation and monitoring identified through workshops with the District are listed below:

Table 4-1 Effluent Challenges and Mitigation Strategies

Challenge	Mitigation Strategies
Nitrification at Calpine facilities leads to increased dechlorination demand	• Install online nitrate/nitrite sensor to monitor blowdown water quality • Temporarily divert blowdown to head of plant if high nitrite observed. This will result in high TDS in recycled water and is a short-term strategy. Use data from nitrite/nitrate real-time sensor to match chlorine and sodium bisulfite (SBS) demand • Continue to work with Calpine to prevent nitrification (chemical addition) • If nutrient removal were implemented at the WWTP this would reduce the potential for nitrification at the Calpine facilities
Changes in cooling tower chemical program leading to dechlorination issues at WWTP	• Continued coordination with Calpine to identify if/when chemicals will change and when elevated doses will be utilized • Temporarily divert blowdown to head of plant when high doses expected. This will result in high TDS in recycled water and is a short-term strategy. • Explore installation of oxidation reduction potential (ORP) or online chlorine/bromine monitoring to inform decision making
Elevated final effluent BOD when SE and blowdown BOD are low (no cause identified / random in nature)	• District staff to deploy response plan and sampling strategy • Consider increasing frequency of CCT cleaning and preventive maintenance • Consider changes to autosampler tubing
Antioch RO Brine in outfall	• Perform detailed corrosion study • Reline outfall if needed • Outfall Pipeline Cleaning & Inspection

Other issues noted by staff included challenges with sampling locations or set up. These included lack of adequate mixing prior to sample collection, sampling system delay or sample stratification causing unrepresentative samples, the impact of blowdown and chlorine addition on sampling locations. In general, the samplers should be located near liquid process stream being sampled with short suction lines that are replaced routinely. Samplers should also collect samples from well mixed areas such as pump discharge piping or a well-mixed channel. Staff has also explored the concept of moving the SBS dosing point as well as the desire for an analyzer (or dual analyzers) to read bromine the chlorine simultaneously.

5. Conclusions and Recommendations

5.1 Secondary System

5.1.1 Infrastructure Recommendations

Phased decommissioning and demolition of the tower trickling filters coupled with expansion of aeration basin volume is recommended to allow the District to achieve reliable BOD treatment as the tower trickling filter media approaches the end of its useful life. To minimize stranded assets, this expansion should be synergistic with future options for nutrient removal and the upcoming Recycled Water Master Plan. **TM 04 Nutrient Management Analysis** further details aeration basin configuration and site layouts for this option. A minimum of 1.2 MG of new aeration basin volume and a secondary clarifier will need to be constructed. As noted in **Section 2**, the existing secondary system is at 75-80% capacity and the TTFs are beyond its useful life.

5.1.2 Optimization and Monitoring Recommendations

The TTFs are beyond their useful life and performance is expected to degrade over time requiring monitoring and optimization to extract value from the remaining life of the TTFs until decommissioning. **Monitoring recommendations include:**

- Flow to each tower.
- Air flow (via portable meter).
- Recirculation rate.
- TTF influent soluble BOD.
- Effluent soluble BOD.
- Spulkraft (SK) rate.
- Flushing rate.
- Weekly TTF effluent microscopic analysis.

It is also recommended to increase recirculation and flushing to prevent buildup of biomass and maintain aerobic biofilm conditions. **Weekly MLSS microscopic analysis** is recommended to build a database of the suspended solids microbial population and identify early warning signs. Overall recommendations for liquids monitoring include water quality (COD, BOD, TSS, VSS, and nutrients) at the:

- Influent.
- Primary effluent.
- TTF effluent.
- Secondary effluent.
- RWF effluent.

More extensive monitoring will allow comprehensive key performance indicator (KPI) tracking throughout the system.

5.2 Anaerobic Digestion Recommendations

The District will need to implement a capacity expansion and eventually decommission the TTFs. This will cause an increase in sludge production, putting the District on the high sludge yield track. The capacity analysis found that for either the high or low sludge yield tracks, the **District will need to increase digester capacity within the planning period**. This capacity increase is necessitated earlier with the high sludge yield track, **2030**. The District will likely decommission the TTFs and be on the high sludge yield trach by 2030. **TM 05 Biosolids and Renewable Energy** analyzes options to increase anaerobic digestion capacity. In the near-term, relaxation of the minimum HRT requirement could extend digester capacity in the near-term.

5.3 Effluent Facilities

Recommendations to reduce risk associated with the effluent facilities center on monitoring of the blowdown coming from the Calpine facilities. These include the installation of nitrate/nitrite probes to understand if nitrification has occurred at the Calpine facilities and installation of ORP or chlorine probes to understand when Calpine has changed chemical protocols that may affect dechlorination.

At times the District has observed an elevated final effluent BOD when blowdown and secondary effluent BOD are low. While there is no known cause of this, it has been recommended that sampling points be inspected and cleaning of the CCT occur more frequently to prevent build up. The District currently dewaters and hoses the CCT every two weeks to remove build up that can cause this issue.

The District has concerns with the potential addition of reverse osmosis concentrate to the outfall when there is little to no effluent flow. To mitigate these vulnerabilities, it is recommended that a corrosion study be completed. As part of the outfall capacity study summarized in **TM 07 Outfall Capacity Analysis**, outfall cleaning and inspection is recommended. Should the corrosion study recommend relining the outfall, this work can be coordinated with the cleaning and inspection already recommended.

5.4 Key Coordination Points

Findings from the vulnerability assessment are coordinated with recommendations from the condition assessment, nutrient management, and biosolids management focus areas. General process monitoring and control recommendations are part of a global recommendations to reduce risk and implement District best practices. Studies recommended are:

- It is recommended that KPIs used be monitored via integrated dashboards. These tools can provide a central location for data viewing, calculations, and analysis of historical data. A Data Management Master Plan is recommended to develop a centralized data management and visualization platform that can then be extended to visualize key metrics related to plant performance, energy, and chemical usage, as well as asset management. This plan should be closely coordinated with the District's planned SCADA Master Plan.
- SCADA Master Plan is recommended to identify potential upgrades, changes, and/or replacements to enhance and increase the reliability of the District's SCADA system.

- An Electrical System Master Plan is recommended to evaluate the District's current and future electrical requirements and provide guidelines for planning the electric distribution system to serve the District in a reliable manner and potentially export power to nearby utilities.
- To satisfy regulatory requirements and mitigate impacts from climate change, it is recommended that a Climate Change Study be conducted. Impacts may include site inundation, pant hydraulic throughput decrease, and changes to flows and loads.

Appendix 4

TM – 04 Nutrient Management Analysis

November 21, 2022

To: Brian Thomas, Delta Diablo

From: Irene Chu, Wendell Khunjar, Paul Pitt, Hazen

Re: Master Plan – Nutrient Management Analysis Technical Memorandum

TM - 04 Nutrient Management Analysis

Final

Revision No.	Date	Description	Author	Reviewed
0	8/31/2021		McGovern/Chu	WK
1	7/5/2022		Chu	WK
2	9/5/2022		Chu	District

Job no

Table of Contents

1. Introduction

The San Francisco Bay Regional Water Quality Control Board (Regional Water Board) adopted the first Nutrient Watershed Permit (WSP) on April 9, 2014, in response to increased regulatory focus on the impacts of nutrient (i.e., nitrogen and phosphorus) loading on the health of San Francisco Bay. Although not currently impaired by nutrients, the resiliency of San Francisco Bay to withstand nutrient loading is uncertain. As a member of the Bay Area Clean Water Agencies (BACWA), the District continues to participate in a regional collaboration with the Regional Water Board and the scientific community to develop and implement a nutrient management strategy that uses a sound science-based approach to determine the need for future management actions.

- The 2014 WSP had the following requirements:
  - Effluent monitoring for nutrients. The data collected during the first WSP was used to establish a baseline and develop load targets in the second WSP.
  - Funding of regional scientific studies.
  - Annual reporting of nutrient loading and trends.
  - A regional evaluation of optimization and upgrade projects at existing wastewater treatment plants. BACWA agencies worked with a consultant to satisfy this permit requirement and submitted a final report titled, *Potential Nutrient Reduction by Treatment Optimization, Sidestream Treatment, Treatment Upgrades, and Other Means* (Nutrient Reduction Study) in 2018.
- In 2019, the Regional Water Board issued the second WSP that required continued monitoring and reporting of nutrient discharges, continued funding of scientific studies, and the implementation of additional evaluation of nutrient reduction options (recycled water and natural systems). The Fact Sheet of the second WSP also indicated that load caps would be implemented in the third WSP.
  - Data from the first WSP was used to calculate a performance-based baseline (max dry season month from 2014-2017). A 15% buffer was added for growth to establish a load target, called a Planning Level Target (PLT). The District's PLT was 1,700 kg/day.
  - Regional nutrient trading may be accepted.
  - Early adoption of nutrient removal may be acknowledged by deferring further upgrades.

While there is significant uncertainty in the limits, and how they will be applied (i.e., load limit for subembayment or individual dischargers) or averaged (i.e., annually, seasonally, or monthly) in the third WSP, the BACWA Nutrient Reduction Study levels and second WSP PLT were used for this analysis. **Table 1-1** summarizes the assumed nutrient limits for the interim, 2040, and beyond 2040 timeframes.

Table 1-1: Assumed Nutrient Limits Considered for 2022

Interim	Future[1] (2040 Design Horizon)	Place Holder[1] (Beyond 2040)
Nutrient Load Caps Seasonal BNR	BACWA Level 2 TN < 15mg/L TP < 1 mg/L	BACWA Level 3 TN < 6 mg/L TP < 0.3 mg/L

[1] Assumed a monthly average for conservatism. Actual standards may be applied seasonally or annually.

There is significant uncertainty in the timeline, standards, and application of nutrient limits. Implementation of these limits will have cascading impacts to the WWTP. For example:

- Expansion of liquid stream infrastructure to provide sufficient treatment capacity at the WWTP impacts site planning and plant operations.
- Changes to liquid stream processes impact sludge production, capacity of solids treatment processes, and sidestream flows and loads.
- Changes to liquid, solids, and sidestream treatment impacts the energy profile at the WWTP and Recycled Water Facility (RWF).
- Incorporation of nutrient removal technology at the WWTP will increase operations and maintenance (O&M) needs relative to carbon only treatment.
- Water quality generated from the WWTP will change characteristics of RWF treatment needs.

While current indications are that load caps will be introduced in 2024, they will likely be enforced on a whole bay basis. If structured similarly to the mercury watershed permit, there will be no violations unless both the individual and whole bay load caps are exceeded. A discharger exceeding their individual load cap will likely trigger certain actions but would not be considered to be in violation, unless the whole bay load cap was also exceeded.

As there is significant potential for the timing of standards to change, it is in the District's best interest to remain engaged in the regional nutrient management discussions. These efforts could reduce the infrastructure required to maintain nutrient removal compliance.

2. Nutrient Management Approach

The approach used for the nutrient management analysis consisted of a Comprehend, Explore, and Converge phase, as outlined in **Figure 2-1**. For the Comprehend Phase, existing plant operations, conditions, and constraints were assessed, and site-specific tools were built to accurately represent current conditions at the plant. For the Explore Phase, technologies for achieving nutrient removal at the WWTP were reviewed with the District. The site-specific tools developed during the Comprehend Phase were then used to analyze the short-listed options for nutrient removal. Finally, during the Converge Phase, technology and site-specific trigger-based implementation plans were developed, as well as a roadmap for a flexible future.

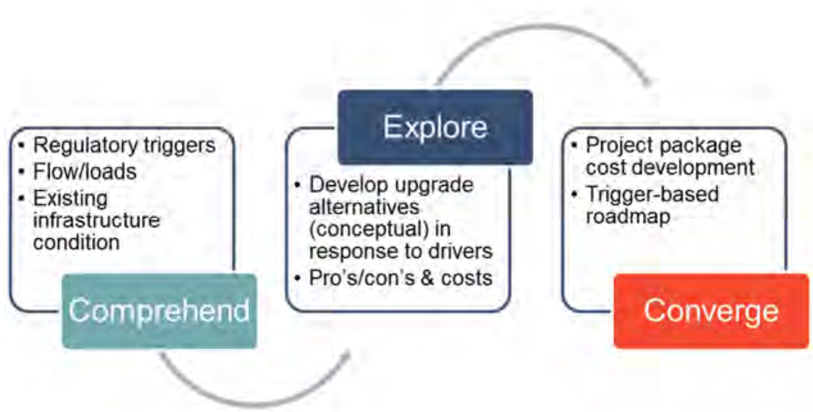


Figure 2-1: Three-Phase Approach for Nutrient Management Analysis

3. Historical Data Review

Historical data was reviewed to build consensus on understanding of current operations, identify trends in performance, and establish periods for model calibration and validation. **Figure 3-1** shows a decrease in influent flow over the last 20 years. From **Figure 3-2** and **Figure 3-3**, it can be seen that influent biological oxygen demand (BOD) and total suspended solids (TSS) concentrations and loads to the plant have increased slightly.

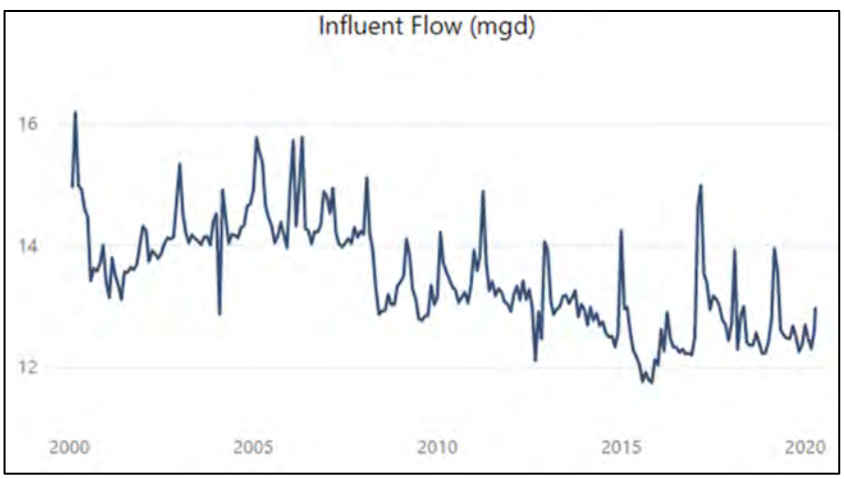


Figure 3-1: Influent Flow

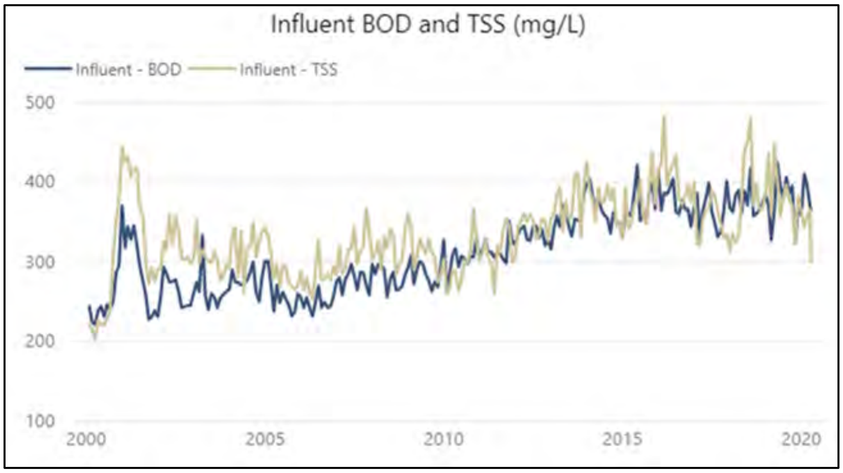


Figure 3-2: Influent BOD and TSS Concentrations

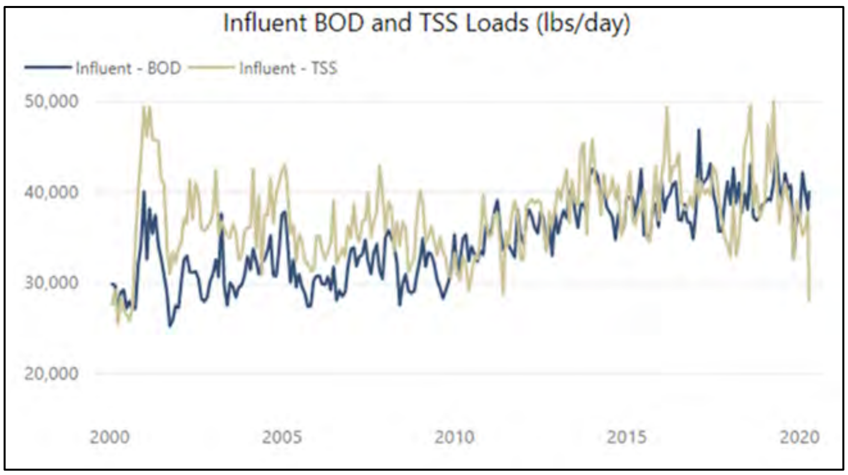


Figure 3-3: Influent BOD and TSS Loads

Figure 3-4 and **Figure 3-5** show BOD and TSS removal in the primary clarifiers from 2019 to 2020. The TSS removal performance ranges from 40% to 60%, and the BOD removal performance ranges from 20% to 30%. This is typical for primary clarifier removals in the industry. At times the District may experience higher than typical removals due to the addition of ferrous chloride in the collection system and discharge of RWF sludge to the headworks. This addition can result in periods of enhanced primary removals.

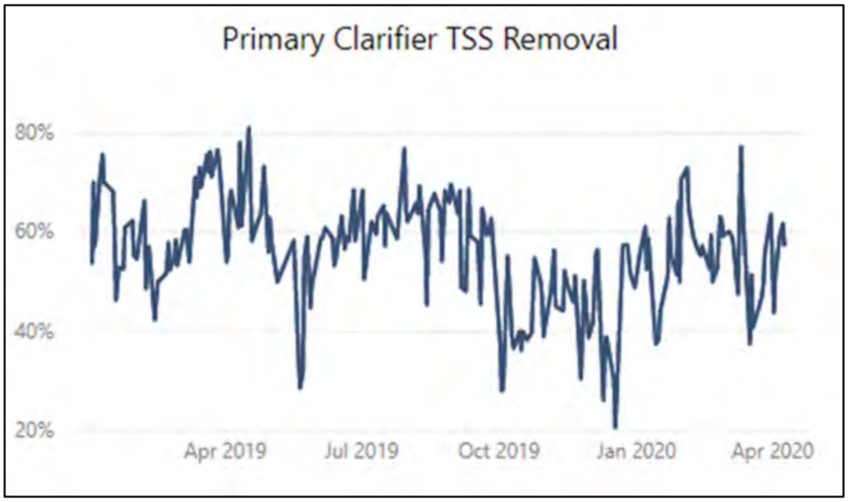


Figure 3-4: Primary Clarifier TSS Removal

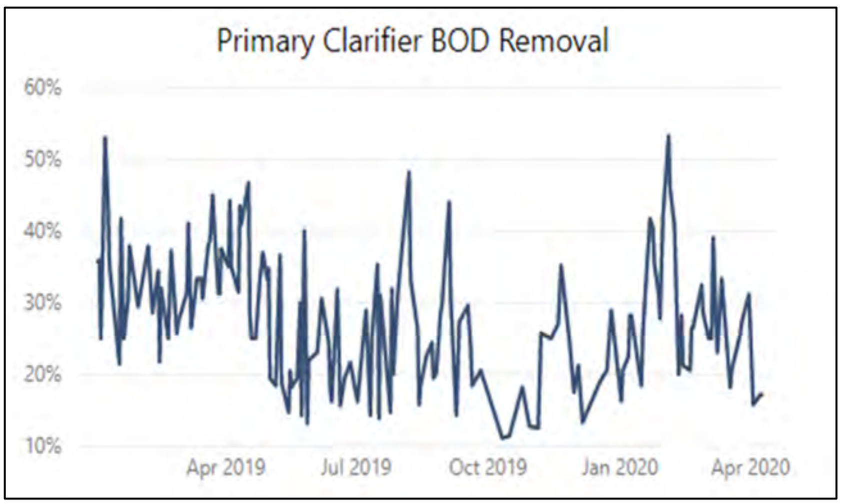


Figure 3-5: Primary Clarifier BOD Removal

As shown in **Figure 3-6**, the solids retention time (SRT) varied between 1.5 days and 3 days between 2019 and early 2020. The average over this period was approximately 2 days. District staff prefer to maintain an SRT greater than 1.5 days for BOD removal.

Figure 3-7 shows the sludge volume index (SVI) over the course of 2019 and early 2020. The SVI was consistently below 100 milliliters per gram (mL/g). This District has historically maintained SVI's lower than 100 mL/g and does not typically experience bulking.

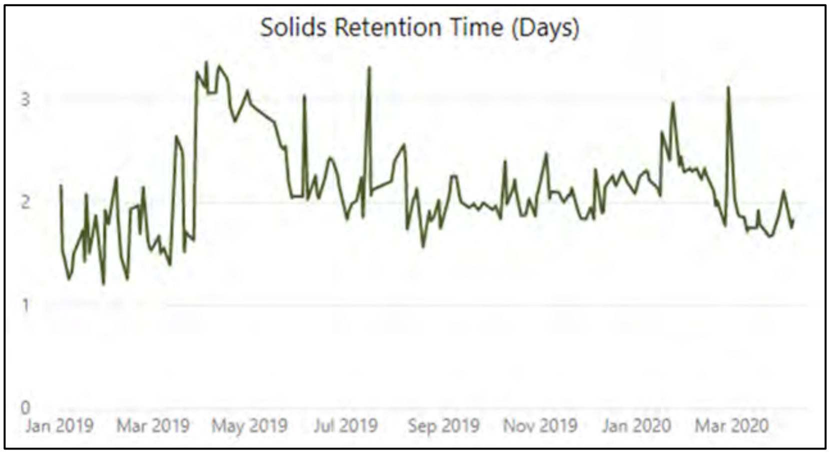


Figure 3-6: Solids Retention Time

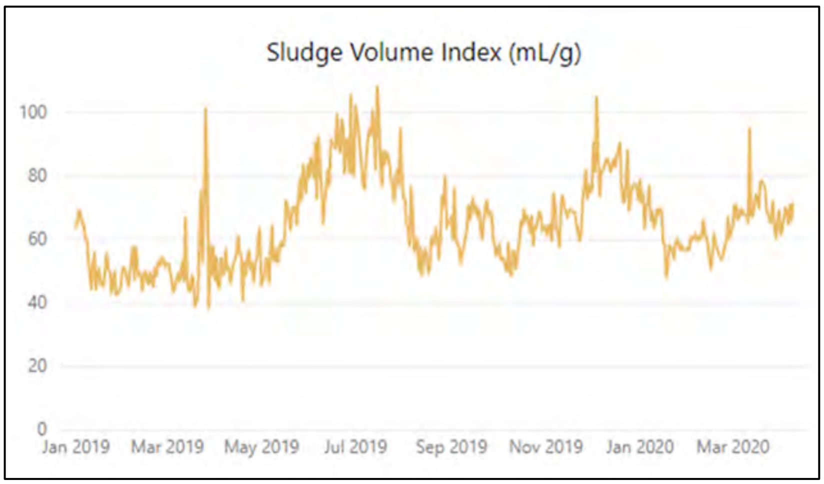


Figure 3-7: Sludge Volume Index

Figure 3-8 presents the total airflow and dissolved oxygen (DO) in the aeration basins between 2019 and early 2020. DO in the aeration basins has varied from 1 mg/L to 2 mg/L, with recent levels averaging below 1.5 mg/L. The District typically targets a 1.5 mg/L DO but can have difficulty achieving this if there is significant soluble BOD breakthrough from the Tower Trickling Filters (TTFs).

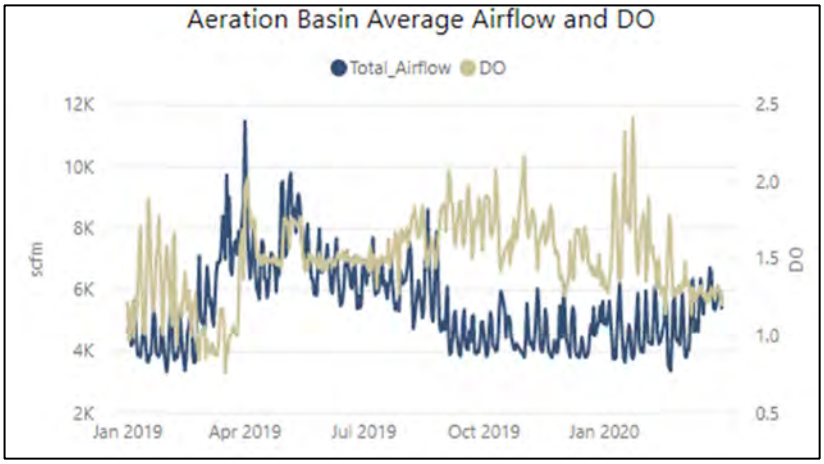


Figure 3-8: Airflow and DO

The District has maintained effluent BOD and TSS below the permit limitations as summarized in **Table 3-1**. **Figure 3-9** and **Figure 3-10** show the BOD and TSS concentrations in the final plant effluent over the last 20 years. Effluent BOD ranges from 10 to 25 milligrams per liter (mg/L), and effluent TSS ranges from 5 to 25 mg/L.

Table 3-1: Final Effluent Limitations

Parameter	Unit	Average Monthly	Average Weekly
BOD	mg/L (% removal)	30 (85)	45
TSS	mg/L (% removal)	30 (85)	45

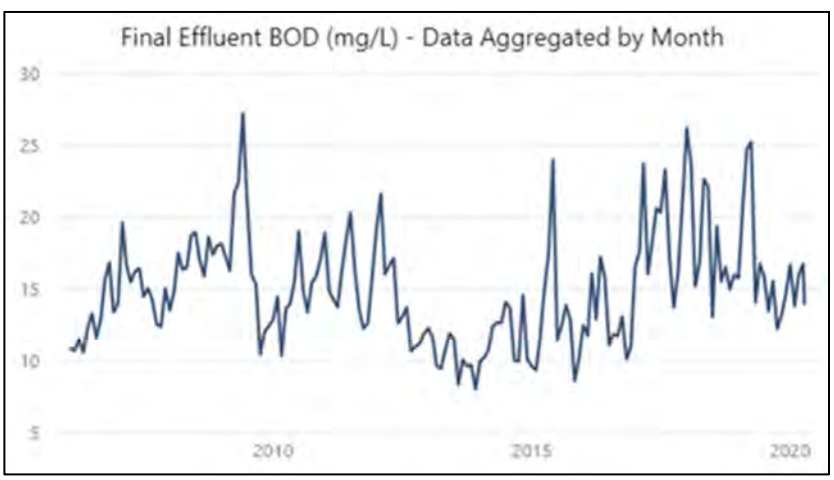


Figure 3-9: Final Effluent BOD

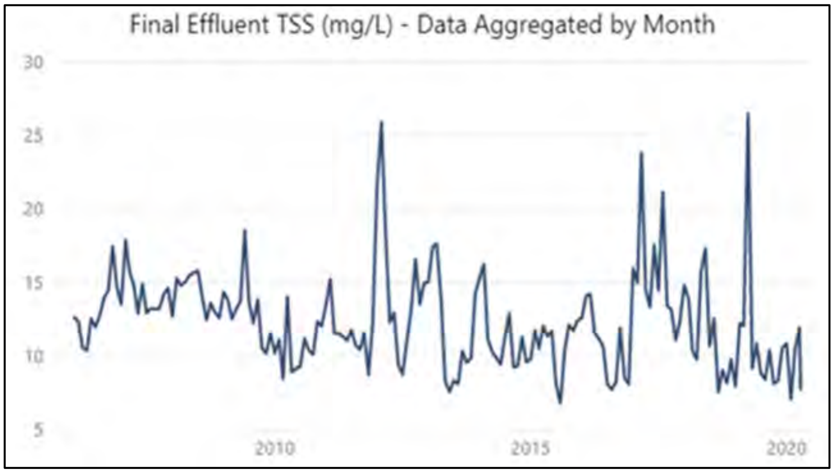


Figure 3-10: Final Effluent TSS

3.1 Historical Data Summary

Key takeaways from the historical data review are summarized below:

- The WWTP has consistent TSS removal in the primary clarifiers.
- Settleability is excellent with an SVI below 100 mL/g.
- Aside from a brief period from January to March 2019 when the aeration basin SRT was < 1.5 days, the aeration basin SRT was consistent with an average around 2 days.
- DO in the aeration basins varied between approximately 1.0 and 2.5 mg/L during 2019.
- The District has consistently met secondary effluent standard with no permit violations reported over the period analyzed.

4. Special Sampling

To support site-specific model development, the District, in collaboration with Hazen, performed special sampling in February 2020 to detail the plant processes for model calibration. Composite samples were collected for the influent, primary clarifier effluent, trickling filter influent and effluent, and secondary effluent.

Figure 4-1 shows average composite sampling results for TSS and volatile suspended solids (VSS) throughout the plant. Influent VSS to TSS ratio were found to be approximately 85%, typical of municipal influent wastewater. TSS Removal across the primary clarifiers was observed to be 58% during the special sampling period as summarized in **Table 4-1**. TSS increases from the primary clarifier effluent to TTF influent due to recycle streams and RAS addition upstream of the TTF. As expected TSS increases across the TTF from biomass that is sloughed off the TTF media. While the TTF effluent, aeration basin influent, TSS averaged over 450 mg/L, the secondary effluent was observed to average 10 mg/L during special sampling. This represents a TSS removal 98% across the aeration basin and secondary clarifiers.

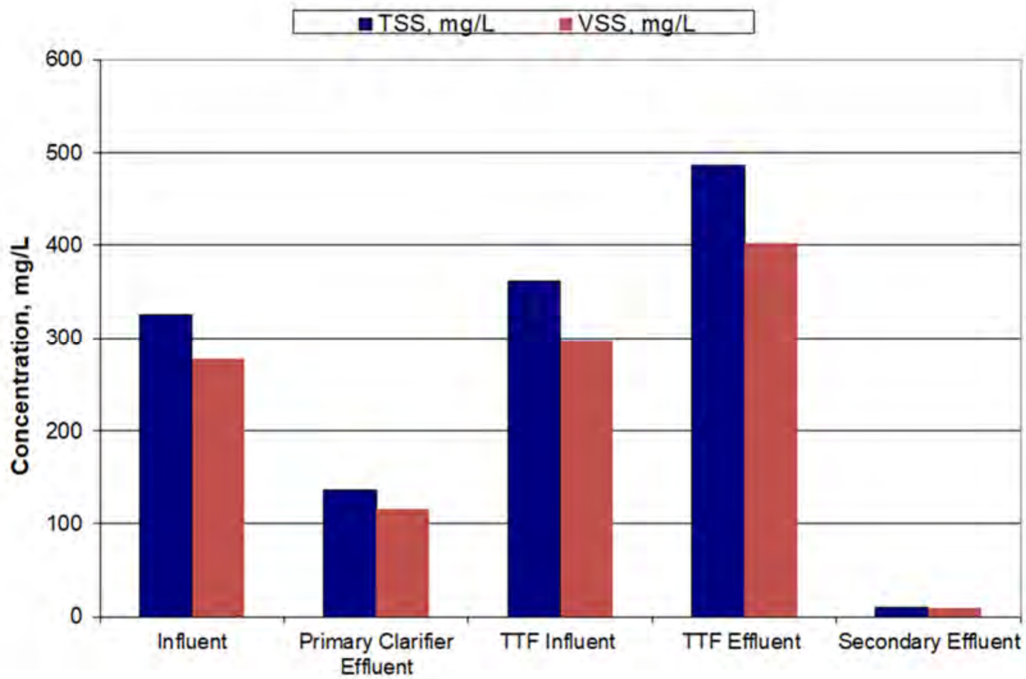


Figure 4-1: TSS and VSS Special Sampling Results

Table 4-1: TSS and VSS Removal

Unit Process	% Removal	
	TSS	VSS
Primary Clarifiers	58.0	58.2
Aeration Basins	98.0	97.9

BOD and chemical oxygen demand (COD) composite sampling results are shown in **Figure 4-2**, and removal across the primary clarifiers and trickling filters is summarized in **Table 4-2**. COD removal across the primary clarifiers was consistent with chemically enhanced primary treatment (CEPT). As noted, while the District does not intentionally perform CEPT in the primary clarifiers, ferrous chloride is added upstream in the collection system and RWF sludge containing coagulant and polymer is discharged to the WWTP headworks. This chemical addition can increase soluble COD and BOD removal in the primary clarifiers similarly to CEPT.

An increase in BOD and COD was observed between the primary clarifier effluent and trickling filter influent due to the influence of the return activated sludge (RAS) recycle and sidestream loads entering at this point. While there was little to no COD and BOD removal across the TTF, soluble BOD removal across the trickling filters was observed to be approximately 50%.

Secondary effluent was observed to have a COD of 70 mg/L representing an overall removal greater than 90% compared to raw influent.

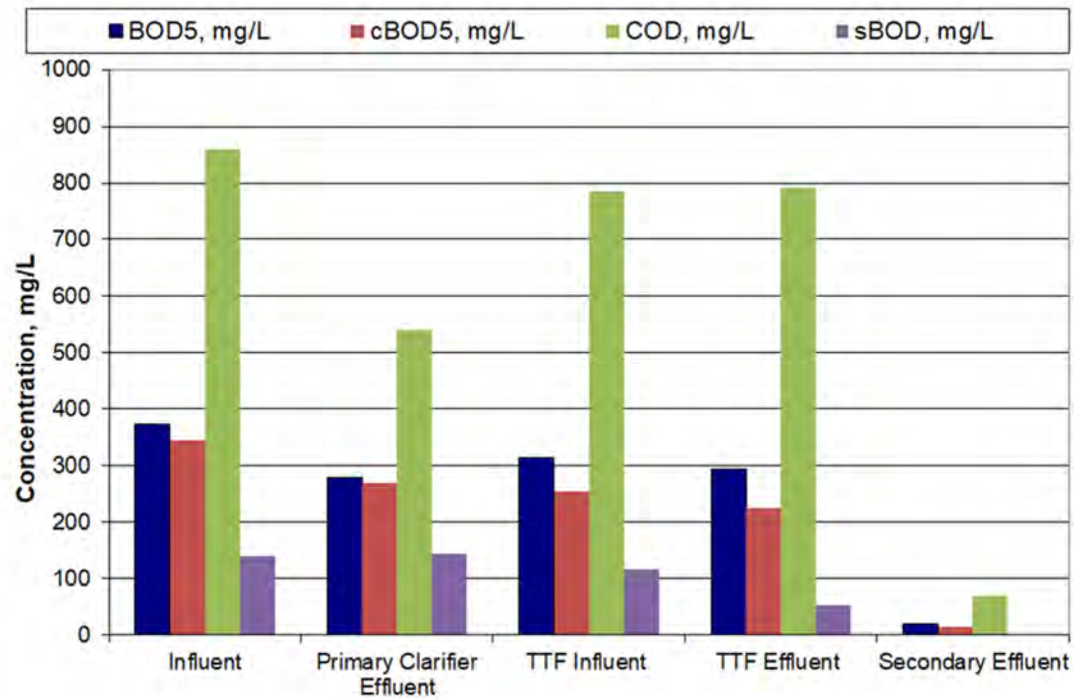


Figure 4-2: BOD and COD Special Sampling Results

Table 4-2: BOD and COD Removal

Unit Process	% Removal			
	BOD_5	$cBOD_5$	COD	sBOD
Primary Clarifiers	25.0	21.6	37.3	3.4
Tower Trickling Filters	-	-	-	54.7

Composite sampling results for nitrogen and phosphorus are shown in **Figure 4-3** and **Figure 4-4** respectively. Sidestream nutrient loads can be observed as the increase in ammonia and orthophosphate between the primary clarifiers and the trickling filters. For nitrogen, the sidestream load represents approximately 15 to 20% of the total nitrogen load to the secondary process (between 5 and 10 mg/L). For phosphorus, the sidestream load is between 10 and 25% of the total phosphorus load to the secondary process (between 1 and 3 mg/L).

Minor ammonia removal was observed across the aeration basin (TTF effluent ammonia was observed 49 mg/L and secondary effluent ammonia was observed to be 46 mg/L). Nitrification was not expected and not observed due to the short SRTs at the WWTP. The short SRTs at the WWTP do not allow for ammonia oxidizing bacteria population to grow significantly.

Phosphorus removal across the secondary system was observed to be 75% (Primary effluent phosphorus was observed to be 5.5 mg/L and secondary effluent phosphorus was observed to be 1.4 mg/L). Orthophosphate removal across the secondary system was observed to be approximately 50% (TTF effluent phosphorus was observed to be 3 mg/L and secondary effluent phosphorus removal was observed to be 1 mg/L). This removal is consistent with heterotrophic biomass growth. Enhanced biological phosphorus removal due to phosphorus accumulating organisms was not observed during the special sampling with effluent orthophosphate of 1 mg/L.

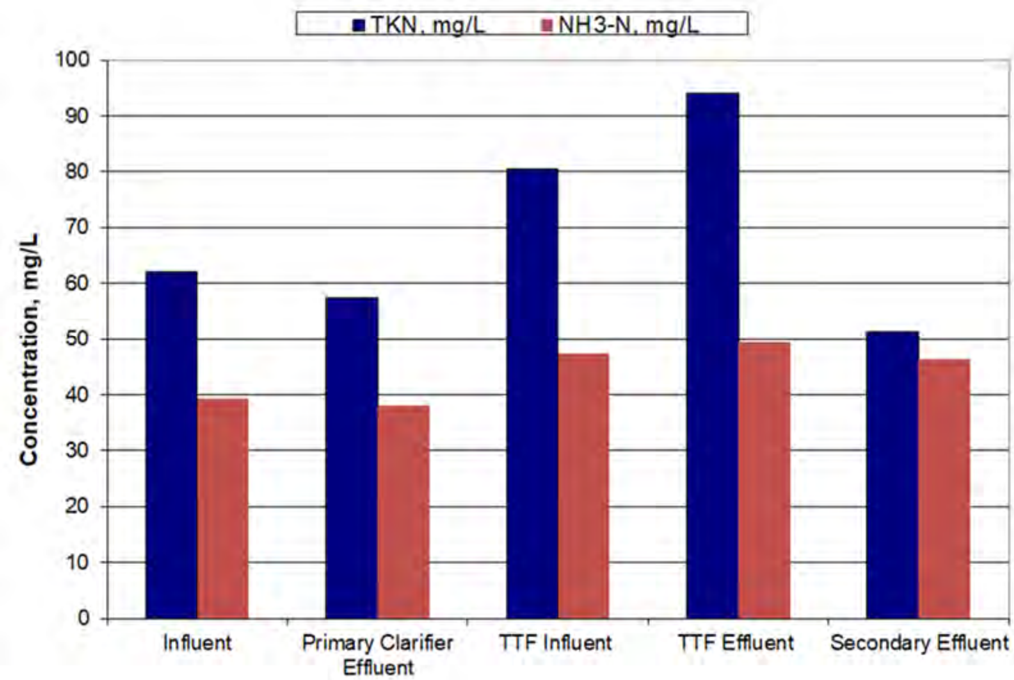


Figure 4-3: Nitrogen Special Sampling Results

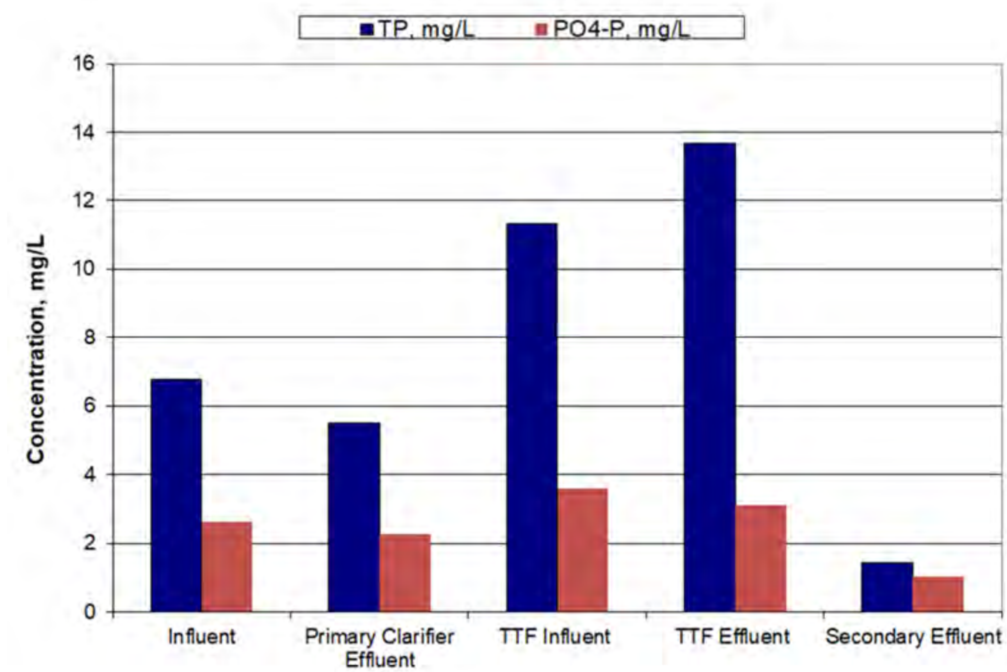


Figure 4-4: Phosphorus Special Sampling Results

In addition to composite samples, pH and DO profiles were also collected at various locations throughout the plant, as detailed on **Figure 4-5** and **Figure 4-6**. The pH profile indicated stable pH in the biological systems at the plant. Alkalinity consuming processes such as nitrification were not occurring, allowing the pH to remain relatively stable.

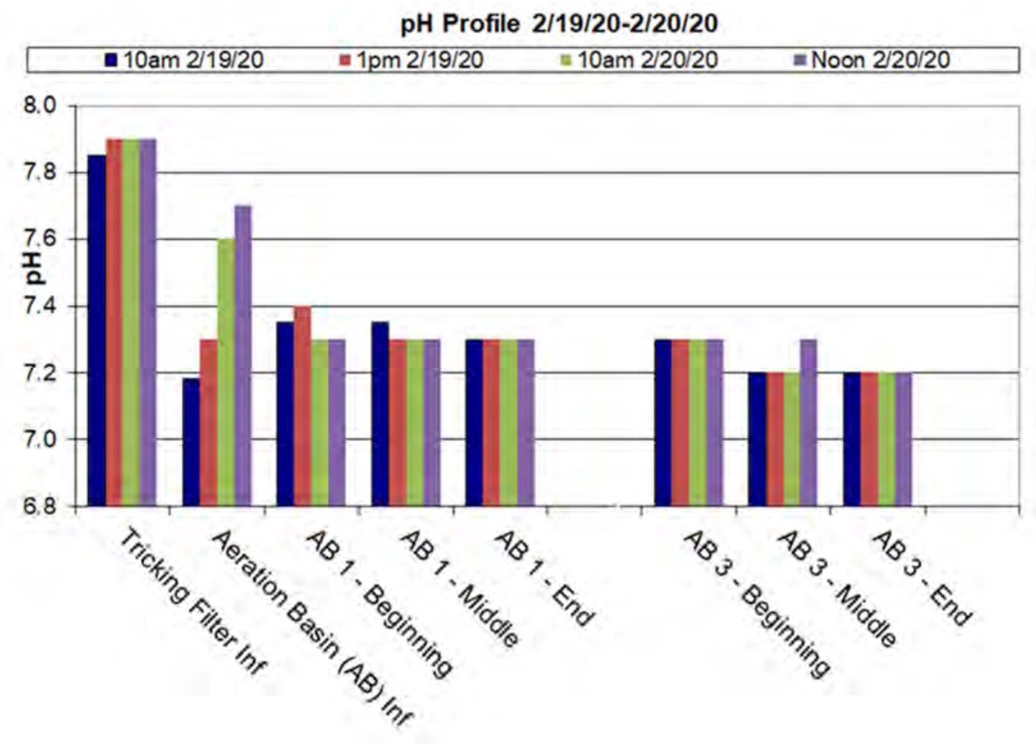


Figure 4-5: pH Profile Results

DO for the tower trickling filter influent, was measured from the tower mixing chamber and was observed to be 6 mg/L, likely due to air entrainment. Dissolved oxygen at the in the aeration basins was observed to average between 1 mg/L and 3 mg/L during the special sampling period. Generally, aeration basin 1 was found to have relatively stable DO. Aeration basin 3 was found to have lower DO values on average as compared to aeration basin 1.

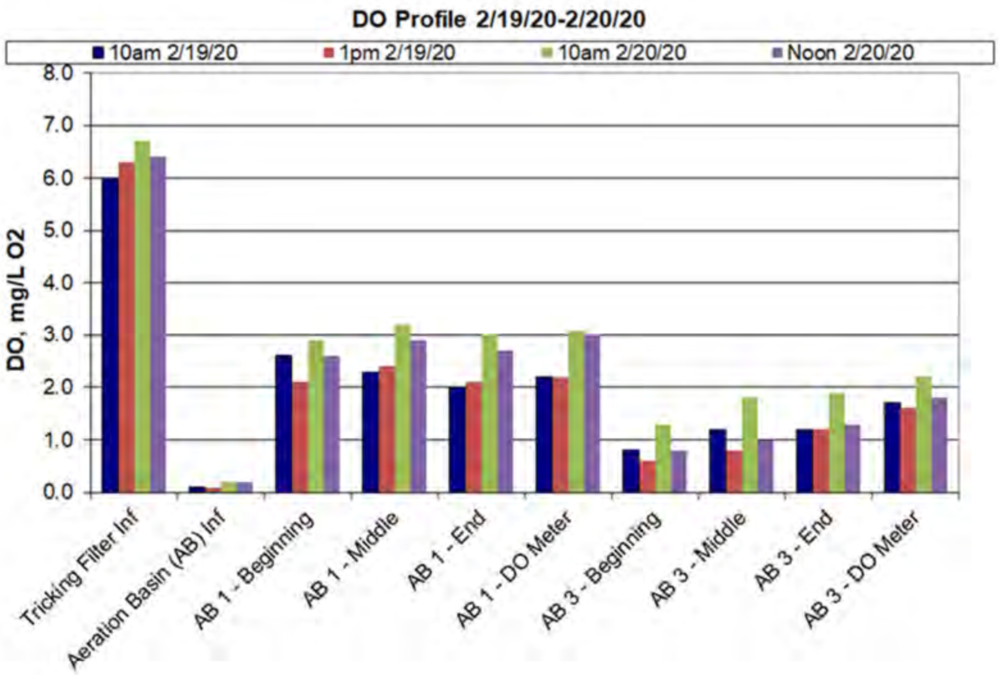


Figure 4-6: DO Profile Results

Diurnal samples were also taken from raw influent, primary effluent, TTF influent, and TTF effluent. These were used with the hourly influent flow to determine the diurnal load peaking factors. **Figure 4-7** shows the diurnal flow pattern observed during special sampling and the pattern from historical data. Low flows at the plant typically occur around 5:00 AM and are approximately 0.45 to 0.5 of the average daily influent flow. Typically flow rises to about noon and remains elevated until 9:00 PM with peaking factors ranging from 1.1-1.45 during this time. This pattern is typical for municipalities dominated by residential flows.

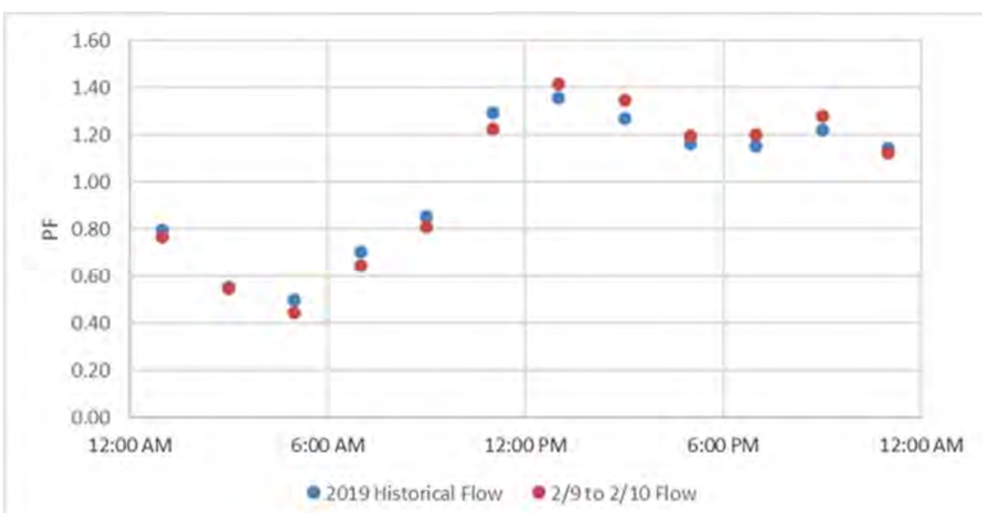


Figure 4-7 Diurnal Influent Flow

Raw influent and primary effluent diurnal loads are shown in **Figure 4-8** and **Figure 4-9** respectively. For both locations, the diurnal peaking factor ranges from 1.5 to 1.8. Peak loading to the plant occurs around noon while low loads occur around 5:00 AM. This is consistent with flows at the plant.

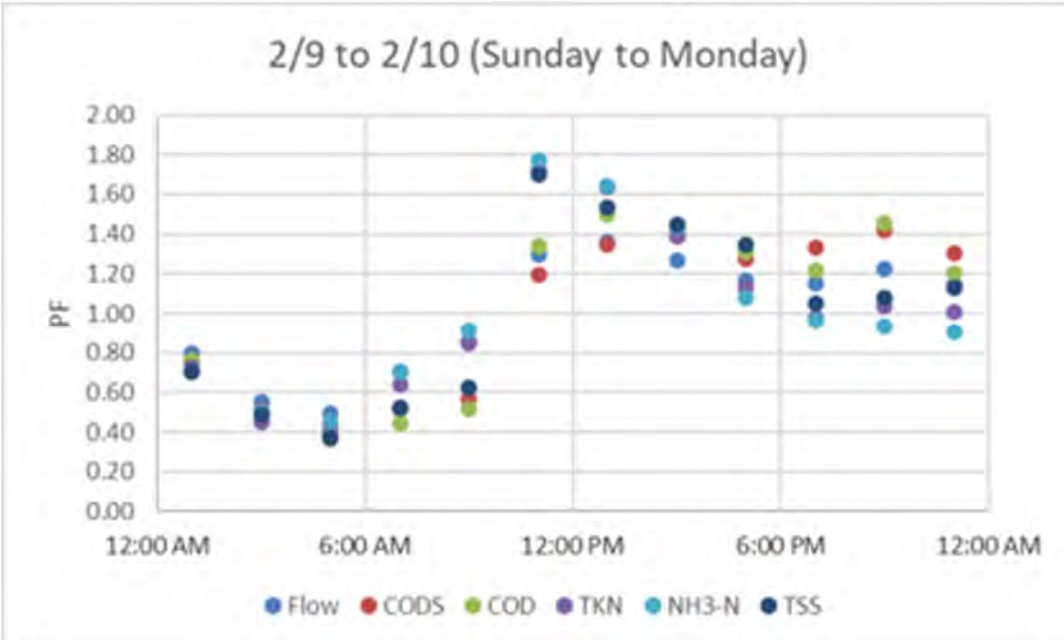


Figure 4-8 Raw Influent Peaking Factors

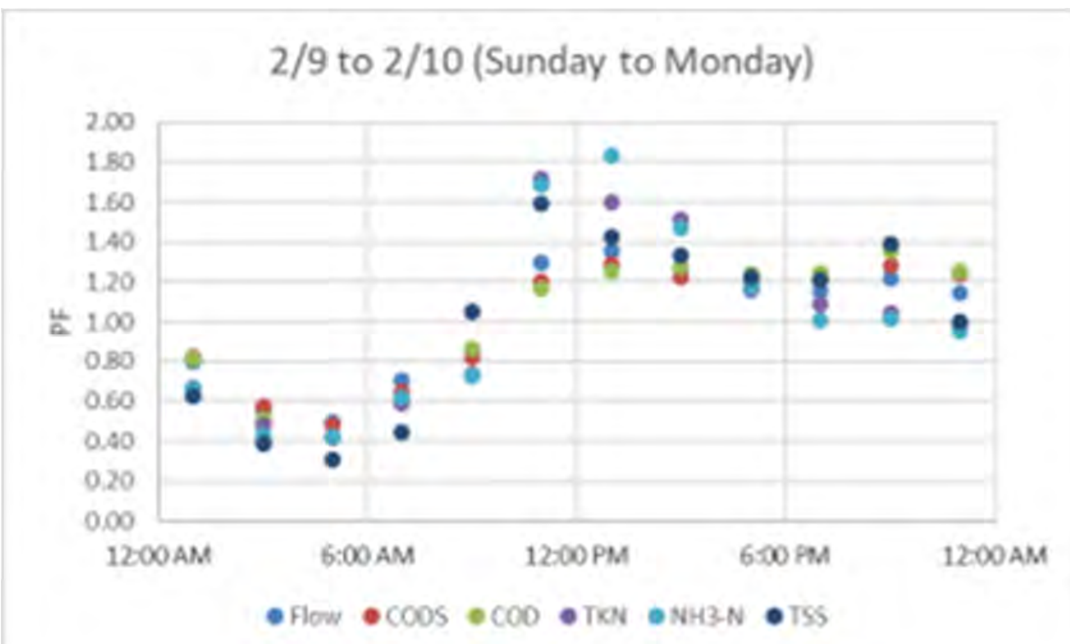


Figure 4-9 Primary Effluent Peaking Factors

On March 16, 2020, California issued a shelter in place order in response to the COVID-19 pandemic. Initial comparisons were made to understand what impact, if any, the order had on plant loading. **Figure 4-10** and **Figure 4-11** show the comparison before (2019) and after (March 16, 2020 – April 9 2020) the shelter in place. Neither the flow nor the BOD loading showed significant difference after the order was issued.

Figure 4-10 WWTP Influent Flow Before and After Shelter In Place

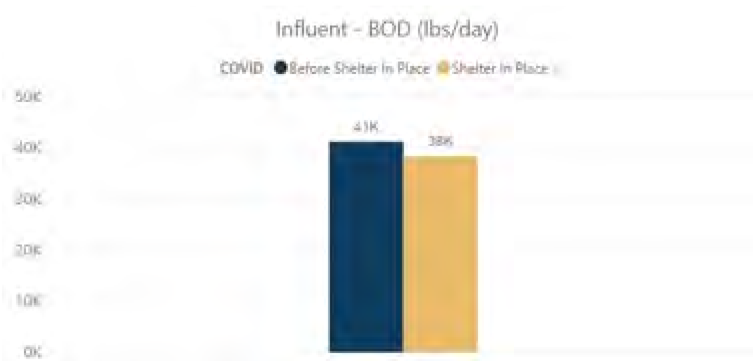


Figure 4-11 WWTP Influent BOD Before and After Shelter In Place

4.1 Key take-aways from special sampling

A summary of key take-aways from the special sampling event is provided below:

- Wastewater at the WWTP is typical of medium to high strength wastewater.
- Diurnal sampling showed a correlation between flows and loads, which is typical of facilities with a large residential fraction.
- TSS removal across the primary clarifiers is approximately 60%, which is consistent with historical performance.
- Soluble BOD removal in the tower trickling filters ranges from 40% to 50% at the current loading rate.

- The WWTP currently has limited nitrogen control, and phosphorus removal is primarily through chemical sludge return from the Recycled Water Facility and ferrous chloride addition in the conveyance system.
- Diurnal peaking factors for flows and loads to the secondary treatment process are approximately 1.5.
- The regional Stay-At-Home order did not increase loads, but resulted in sustained loads for longer periods (i.e., the difference between weekday and weekend profiles are less pronounced).

5. Process Modeling

A whole plant process model was developed to evaluate the capacity of the system and size and analyze future configurations. The modeling approach used for the Master Plan is illustrated in **Figure 5-1** and includes steady-state calibration and validation, dynamic validation, and finally application of the model for capacity evaluations, optimization, planning, and training purposes.

Figure 5-1: Modeling Approach for Master Plan

5.1 Model Development

A schematic of the whole plant model developed for this Master Plan is presented in **Figure 5-2**. Assumptions and model parameters are described below:

- Influent COD fractions were developed based on the special sampling event (see fractionation information below).
- Primary clarifier performance was defined by historical and special sampling data.
- Tower trickling filter performance was cross-checked with stress testing data from 1996, as well as sampling data from 2020.
- A single element was assumed for all aeration basins and the secondary clarifiers.
- Digester influent was assumed to be equivalent to primary sludge and waste activated sludge (WAS) minus losses during thickening.
- In the absence of an extensive recent dataset, dewatering centrate quality was cross-checked based on Hazen's professional experience.

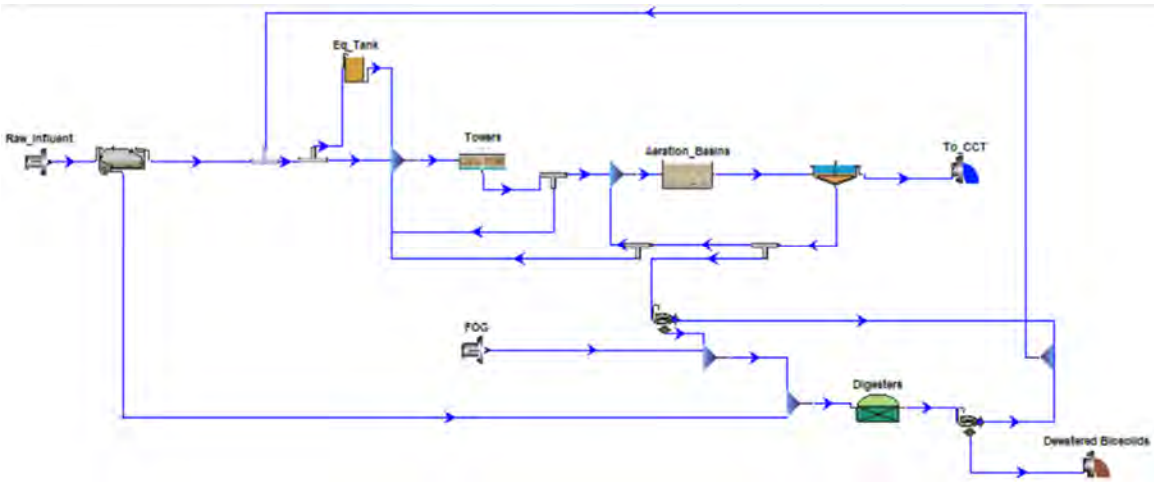


Figure 5-2: WWTP Whole Plant Model

Historical data was used to develop an inert suspended solids (ISS) balance for the whole plant and a TSS balance around the primary and secondary clarifiers. When the raw influent ISS:TSS ratio was adjusted to 0.18, the ISS balance and the primary clarifier balance closes within 20%. The secondary clarifier also closes within 20%.

The COD fractionation is summarized in **Figure 5-3**. For this modeling effort, COD fractions were developed based on special sampling data. Results from the fractionation sampling are shown in **Table 5-1** while, **Table 5-2** presents the final COD fractions that were used for the WWTP process model compared to the default values from the modeling software.

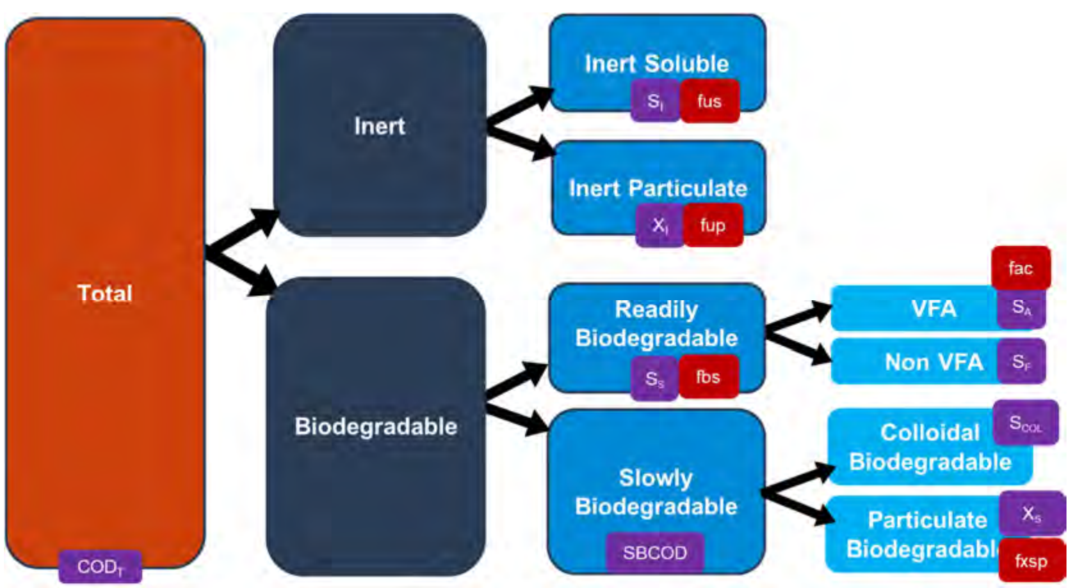


Figure 5-3: COD Fractionation

Table 5-1: Measured COD Fractionation Results

Average	Influent	Secondary Effluent
BOD_{XX}	373	-
COD_{XX}	790	70
COD_{XG}	320	52
COD_{XM}	236	55
COD_{XF}	164	49

Notes:
XX – not filtered unless specified in Standard Methods
XG – filtered with glass fiber filter (1.5 μm)
XM – filtered with 0.45 μm membrane filter
XF – flocculated and filtered with 0.45 μm membrane filter

Table 5-2: COD Fractions for Process Model

Model Parameter	Default	WWTP Model
Fbs – Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.16	0.143
Fac – Acetate [g/COD/g of readily biodegradable COD]	0.15	0.106
Fxsp – Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.75	0.692
Fus – Unbiodegradable soluble [gCOD/g of total COD]	0.05	0.065
Fup – Unbiodegradable particulate [gCOD/g of total COD]	0.13	0.130
Fcel – Cellulose fraction of unbiodegradable particulate [gCOD/gCOD]	0.5	0.500
Fna – Ammonia [gNH3-N/gTKN]	0.66	0.629
Fnox – Particulate organic nitrogen [gN/g Organic N]	0.5	0.500
Fnus – Soluble unbiodegradable TKN [gN/gTKN]	0.02	0.020
FupN – N:COD ratio for unbiodegradable particulate COD [gN/gCOD]	0.035	0.070
Fpo4 – Phosphate [gPO4-P/gTP]	0.5	0.382
FupP – P:COD ration for unbiodegradable particulate COD [gP/gCOD]	0.011	0.022

The readily biodegradable portion of the influent COD, f_{bs}, was measured to be approximately 14% of the influent COD, this is less than the BioWin™ default but not atypical for municipal wastewater. The higher the rbCOD fraction, the easier it is to denitrify when performing nutrient removal.

The soluble unbiodegradable portion of the influent COD, f_{us}, was measured to be 6.5% of influent COD. This is slightly higher than the BioWin™ default but not atypical for municipal wastewater. The higher the Fus, the more COD will be present in the final effluent.

Other COD fractions, non-colloidal slowly biodegradable (f_{xsp}) and unbiodegradable particulate (fup) cannot be measured and were adjusted through the calibration process to align model predictions with historical data.

The ammonia portion of influent Total Kjeldahl Nitrogen (TKN) was measured to be approximately 63%. This is typically for municipal wastewater. The orthophosphate portion of influent total phosphorus (TP) was found to be 38%. While this is lower than typical values, it is consistent with the District's addition of ferrous chloride to the collection system and the discharge of RWF sludge to the headworks, as it precipitates orthophosphate out of solution, upstream of the influent sampler.

5.2 Model Validation and Calibration

Steady state and yearly dynamic models were developed to calibrate and validate the process model to current conditions. First, results from the special sampling period in February 2020 were used for steady-state calibration of the model. Historical data from a similar period in 2019 was then used for validation of the steady-state model. **Table 5-3** shows the steady-state calibration and validation results.

Table 5-3: Steady-State Model Calibration

Unit Process	Parameter	February 2020 Data	Model	Model/Hist	2019 Data	Model	Model/Hist
Primary Effluent	PE BOD, mg/L	263	251	95%	255	261	102%
	PE TSS, mg/L	142	131	92%	163	142	87%
Aeration Basins	MLSS, mg/L	3,441	3,422	99%	3,160	3,636	115%
	Airflow, scfm	5,915	6,069	103%	6,536	6,650	102%

Daily dynamic validation was then performed on the model using a longer period of historical date from June to December 2018. **Figure 5-4** and **Figure 5-5** show the influent BOD and TSS concentrations predicted by the model, which match well with historical concentrations. Primary sludge production and cake production from the model, shown in **Figure 5-6** and **Figure 5-7**, both match the historical loads within 20%. Trickling filter performance in the model agreed with historical performance, special sampling data, and 1996 stress testing data.

Figure 5-8 and **Figure 5-9** show WAS production and mixer liquor suspended solids (MLSS) from the aeration basins, which also match the historical data within 20%. Finally, the secondary effluent TSS predicted by the model, presented in **Figure 5-10**, matches reasonably well with the historical data.

Overall, the predicted values for solids production showed good agreement with historical sludge production, and predicated secondary effluent showed good agreement with historical plant performance.

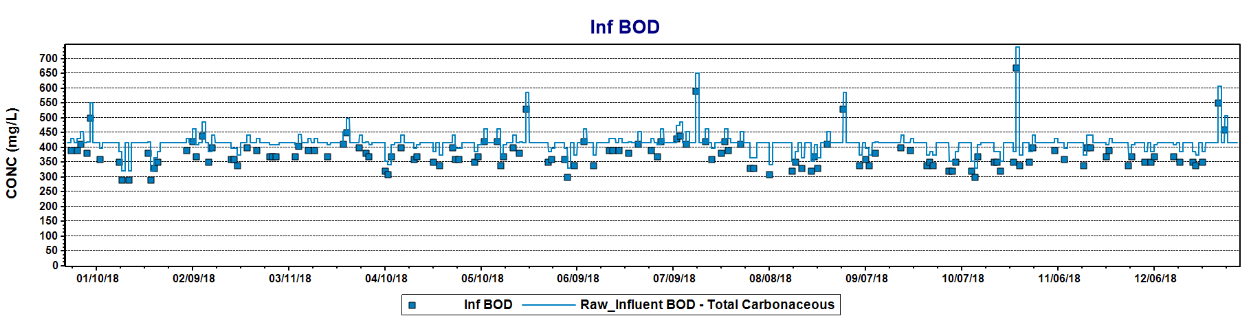


Figure 5-4: Influent BOD for Daily Dynamic Model Validation

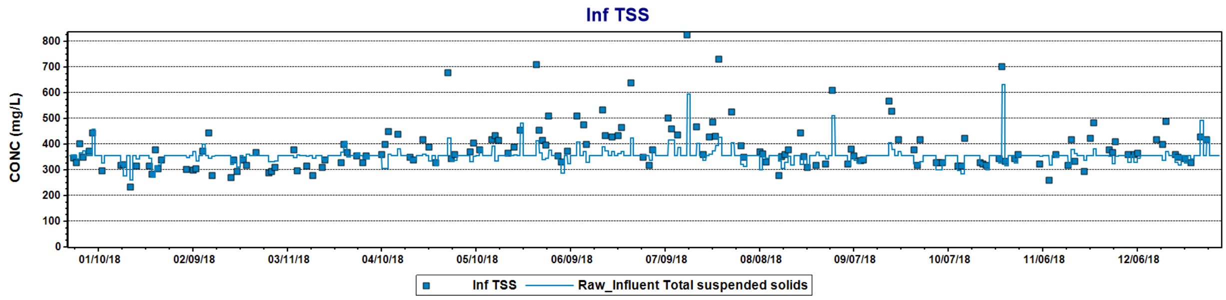


Figure 5-5: Influent TSS for Daily Dynamic Model Validation

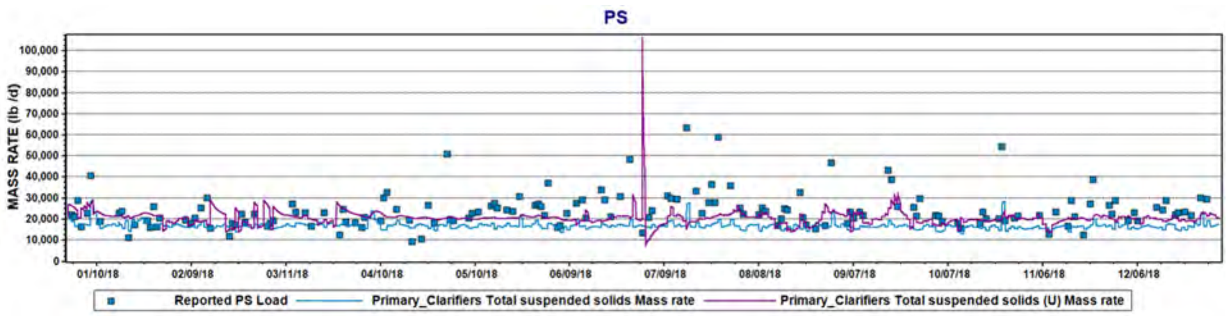


Figure 5-6: Primary Sludge Load for Daily Dynamic Model Validation

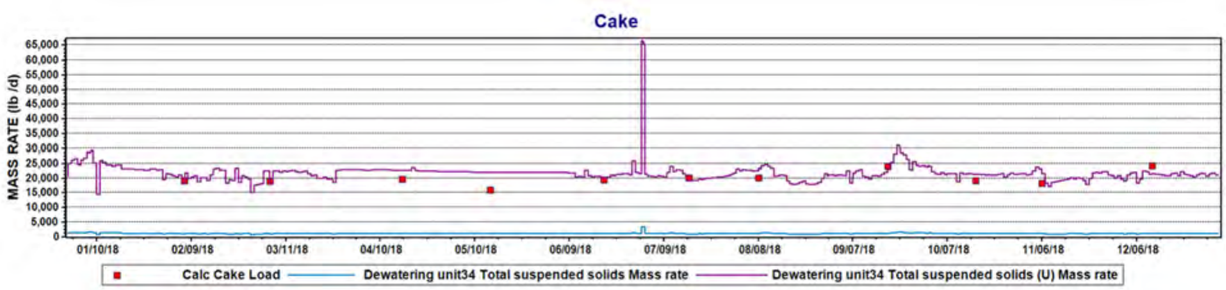


Figure 5-7: Cake Load for Daily Dynamic Model Validation

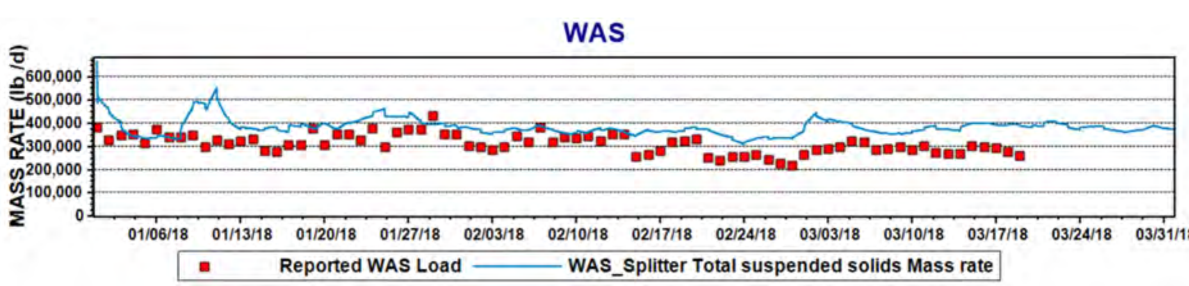


Figure 5-8: WAS Load for Daily Dynamic Model Validation

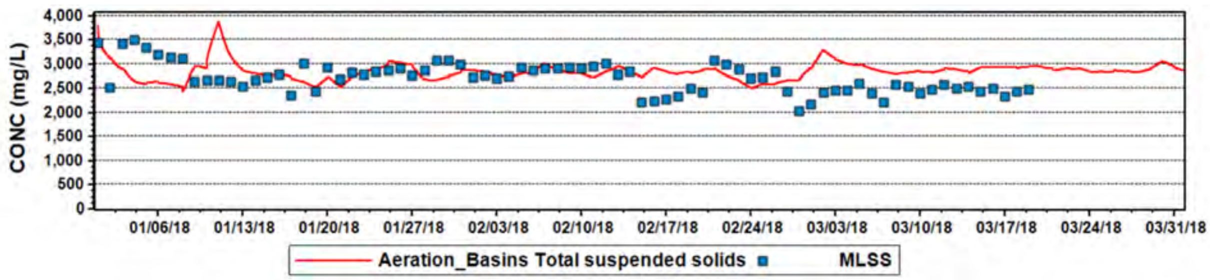


Figure 5-9: MLSS for Daily Dynamic Model Validation

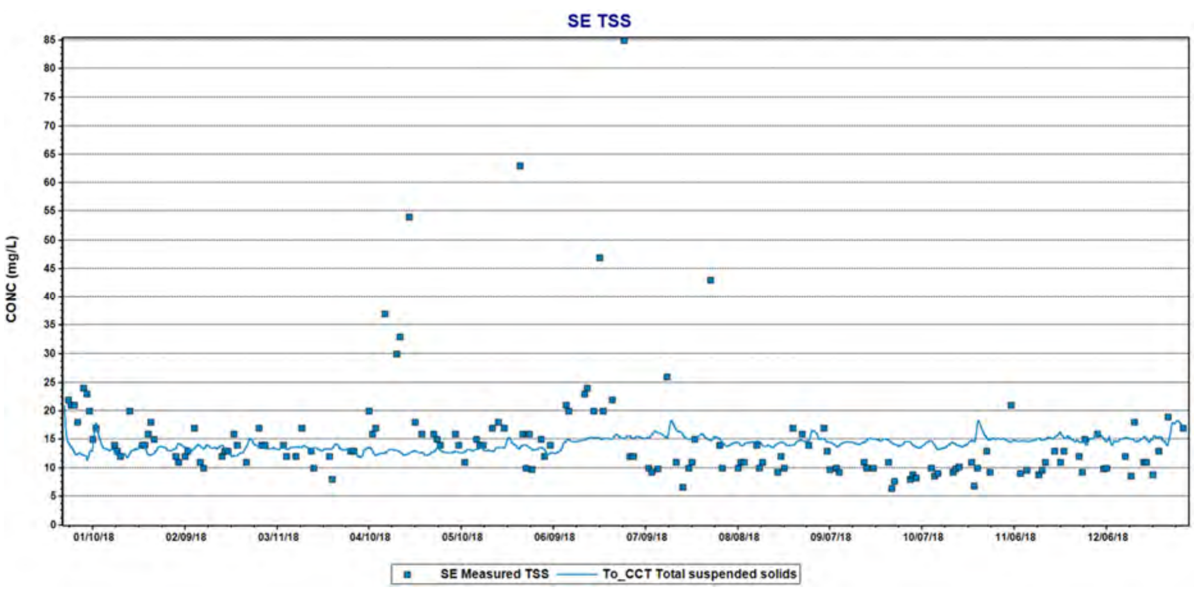


Figure 5-10: Secondary Effluent TSS for Daily Dynamic Model Validation

6. Capacity Analysis

After calibrating the model, the BOD load capacity of the secondary system was assessed. The capacity analysis focused on five main unit processes, including the primary clarifiers, tower trickling filters, aeration basins, aeration system, and secondary clarifiers. **TM 03 Vulnerability Assessment and Process Control, Monitoring and Optimization** summarizes the assumptions and results of the assessment. Key findings include:

- The BOD load capacity of the facility was assessed using the calibrated process model to be 53,200 pounds per day (lbs/day). This BOD load capacity will be exceeded within the planning period. Based on the current raw influent BOD load, the WWTP was found to be within 75% of BOD treatment capacity. A buffer of 20% is typically used to trigger planning of a capacity increase.
- **Figure 6-1** shows the load projections detailed in the Master Plan Flows and Loads Technical Memorandum as well as the estimated BOD load capacity of the WWTP. According to the figure, the WWTP has approximately 10 to 15 years before the BOD

capacity of the plant is reached. If growth within the District slows, the timing of reaching maximum capacity may be pushed out, however, nutrients may trigger capital improvement projects within the Master Plan planning timeframe (2040).

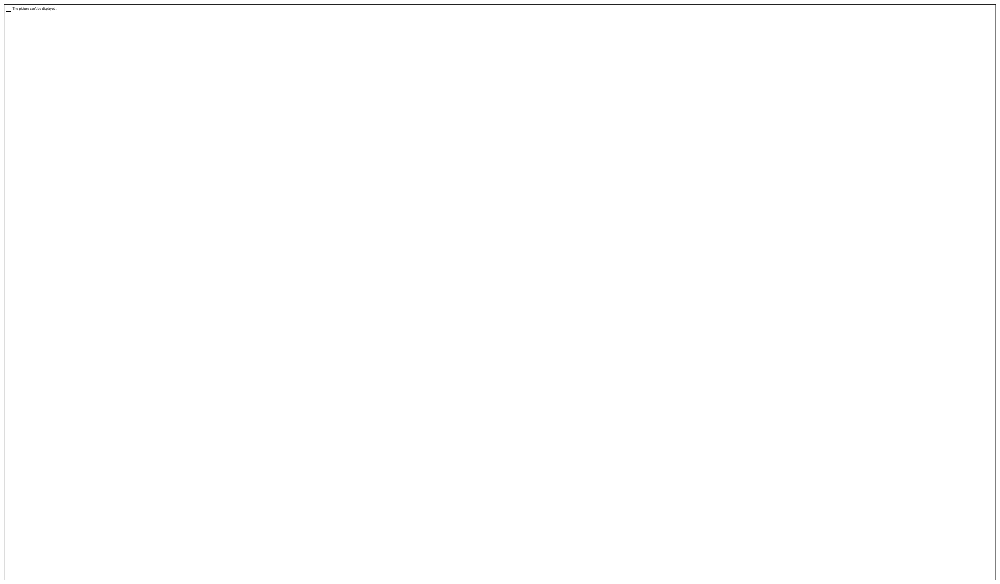


Figure 6-1: BOD Load Projections

- Increasingly high BOD loads on the tower trickling filters will result in bleed-through of soluble organics to the aeration basins and increased potential for selection of unwanted microorganisms that can cause settling problems and impact effluent quality. Bleed-through of the trickling filters increases the District's vulnerability.
- In addition to bleed through of the TTF, the current aeration system and aeration basins (total existing volume 1.9MG) limit capacity of the secondary system.
- Diminishing performance in the trickling filters may negatively impact the secondary process capacity, resulting in high MLSS and high solids loading rate (SLR) or standard oxygen requirement (SOR) in the secondary clarifiers.

6.1 Secondary Treatment Process Improvements (Capacity Expansion)

The District can leverage the existing infrastructure by continuing to operate the tower trickling filters and existing aeration basins and secondary clarifiers until the capacity of the trickling filters is exceeded. Once performance in the trickling filters deteriorates, flows would bypass the trickling filters to the aeration basins. Additional basin volume would be added to allow for 100% treatment of 2040 flows and loads. Both the new and existing basins would be reconfigured with a selector zone to maintain superior settleability. This strategy builds only what is required for carbon removal and achieves secondary standards effluent quality. A list of new infrastructure associated with this carbon expansion is provided below, and a proposed site layout is shown in **Figure 6-2**. (Note: the fourth digester shown is not part of the Secondary Treatment Improvement Project.)

- One new 1.2-MG aeration basin with 25-ft sidewater depth (3.1 MG of total new and existing volume).
- Retrofit existing aeration basin volume with anaerobic selector
- Construct new MLSS splitter box
- One new 90-ft diameter secondary clarifier with 15-ft sidewater depth (6 total)
- One new 300-hp turbo blower to provide 7,000 sfcm (3 total duty turbo blowers providing 21,000 scfm firm capacity) and blower room
- Tower trickling filter pump station rehabilitation
- Construct new aeration basin influent distribution (location and impact to RAS pumping to be coordinated)

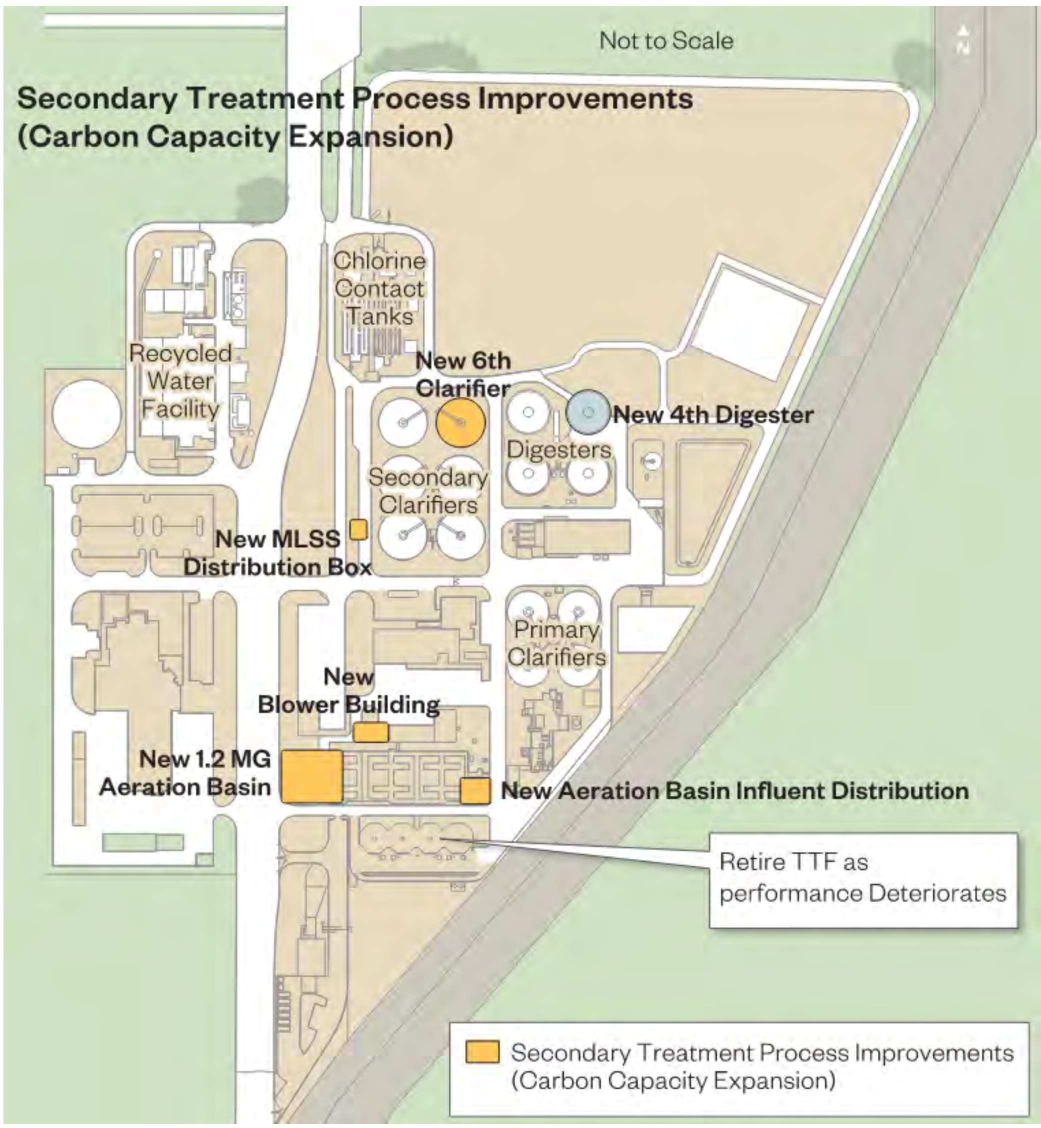


Figure 6-2: Site Layout for Carbon Expansion

7. Nutrient Removal Alternatives

Both conventional and emerging technologies were considered for nutrient removal as part of the Explore phase of the nutrient management analysis. These technologies were reviewed at a high level with staff and initially screened for feasibility and fatal flaws. Integrated solutions (IS) were developed to combine various short-listed technologies (i.e. modified ludzack-ettinger (MLE) and densification) into a wholistic alternative to transition the District from carbon removal to nutrient removal. These integrated solutions were sized and coordinated with the Secondary Treatment Process Improvement Project described in **Section 6.**

7.1 Assumptions

The nutrient removal alternatives analysis was based on the site-specific assumptions including operational targets, available area, and levels of redundancy. These assumptions were discussed with District staff and are described in this section.

7.1.1 Nutrient Targets

Table 7-1 outlines the nutrient effluent limitations used to frame the nutrient management analysis. While load sharing with other dischargers in the District's subembayment may be an acceptable way of achieving nutrient loading standards, the market for nutrient trading has not been established. This tool for achieving nutrient removal standards was not relied upon for this analysis; this analysis assumes that nutrient removal is achieved through treatment at the WWTP.

Table 7-1: Assumptions for Nutrient Limits

Interim	Future[1] (2040 Design Horizon)	Place Holder[1] (Beyond 2040)
Optimize existing infrastructure Goal is to reduce nutrients as much as possible with low CAPEX projects Nutrient load caps Seasonal BNR	BACWA Level 2 TN < 15 mg/L TP < 1 mg/L	BACWA Level 3 TN < 6 mg/L TP < 0.3 mg/L

[1] Assumed a monthly average for conservatism. Actual standards may be applied seasonally or annually.

Based on these assumptions, the Master Plan analysis sized facilities based on the BACWA Level 2 monthly standard. This approach provides flexibility in determining final solutions and adapting to changing regulations. A modular implementation system was used to gradually transition from the current treatment levels to future conditions, while aligning with interim standards. Possible interim triggers include:

- Nutrient load caps
- Nutrient trading

7.1.2 Siting

Available land for nutrient management projects was identified in two primary areas:

- West of the existing secondary clarifiers and aeration basins
- Recently purchased DOW property

Operations building located between the aeration tanks and the clarifiers was initially considered but ultimately the cost of relocation resulted in this location being dropped from consideration. A layout of proposed expansion areas at the WWTP is provided in **Figure 7-1**.

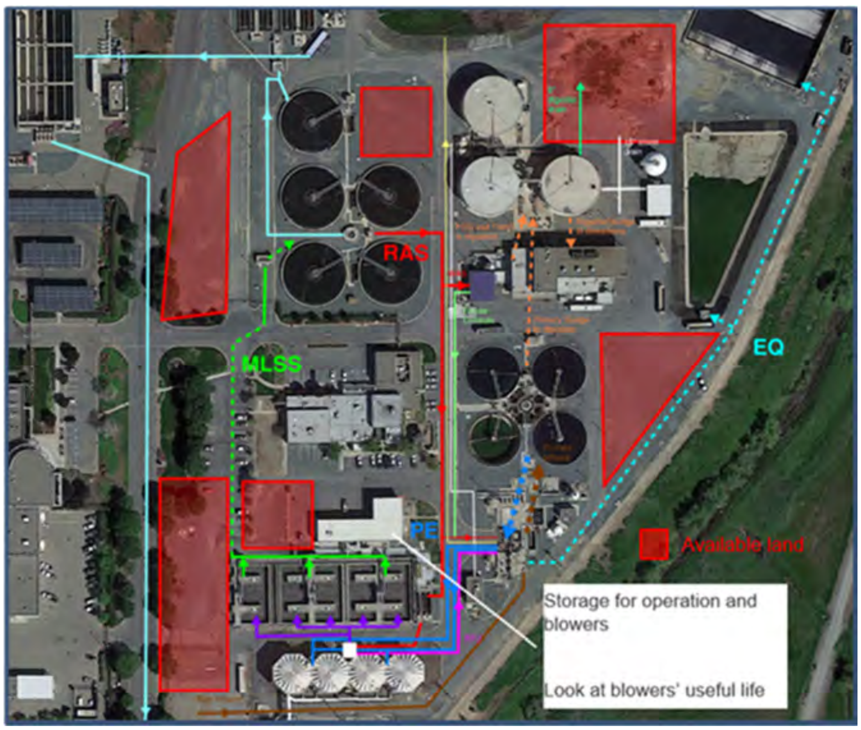


Figure 7-1: Proposed Expansion Areas at the WWTP

7.1.3 Hydraulics

Table 7-2 outlines the hydraulic assumptions used for this Master Plan. This was based on future flow predictions and peaking factors from historical data.

Table 7-2: Hydraulic Assumptions

Flows	2022 Master Plan (MGD)
Average Annual	16.3 to 18.4
Max 30-day	17.9 to 20.2
Max Day	23.6 to 26.7

7.1.4 Redundancy Requirements

Table 7-3 describes the maximum 30-day and daily redundancy Level of Service (LOS) requirements considered for each unit process.

Table 7-3: Redundancy Requirements

Unit Process	Redundancy LOS at Max 30-day	Redundancy LOS at Max Day
Primary Clarifiers	One unit out of service	All units in service
Trickling Filters	One unit out of service	All units in service
Aeration Basins	One unit out of service	All units in service
Secondary Clarifiers	One unit out of service	All units in service

7.1.5 Operational Assumptions from Initial Nutrients Analysis

Table 7-4 lists the minimum and average temperature assumptions and **Table 7-5** lists the activated sludge assumptions considered for this nutrient analysis. The assumed primary clarifier removal is consistent with historical data.

Table 7-4: Temperature Assumptions

	Temperature °C
Minimum Week	16
Average	22
Summer Average	25

Table 7-5: Activated Sludge Assumptions

Parameter	Annual Average	Maximum Month	Maximum Day
PC TSS Removal (%)	60	60	60
SVI (mL/g)	100 (95th percentile)	100 (95th percentile)	90 (50th percentile)

7.2 Technology Options

As noted, a review of 18 established and emerging technologies for achieving nutrient removal was performed as part of the Explore Phase. Both sidestream and mainstream treatment options were considered, as described in the sections below. The technologies were initially screened using four main criteria to develop a short-list for further consideration. Criteria for the short-listing process included the following:

- Technology maturity
- Compatibility with nutrient limits
- Excessive energy demands
- Excessive hydraulic demands

7.2.1 Sidestream Treatment

Sidestream treatment involves the manipulation of either the solids or the liquids stream. Treatment is typically focused on nutrient removal or recovery. Sidestream treatment can increase treatment capacity, reliability, and overall flexibility by intercepting and treating between 10% and 30% of the nutrient load in a compact footprint. This helps to reduce the load impacts on the mainstream biological process by decreasing the intensity and duration of recycle nutrient loads. Sidestream treatment may also benefit disinfection stability. Typically, the high temperature, low flow, and high concentrations associated with this type of treatment allow for a compact footprint that costs between 50% and 70% less than treating a similar nutrient load in the mainstream. Additionally, nitrifiers or Annamox bacteria can seed the main process, aligning with next generation nitrogen removal goals. For the Master Plan, several sidestream technologies for nitrogen and phosphorus removal were considered.

Nitrogen removal technologies considered for sidestream treatment at the WWTP included nitrification/denitrification, nitrification/denitritation, and deammonification. **Table 7-6** summarizes the technology options and short-list selections for nitrogen removal.

- Nitrification/denitrification uses conventional BNR processes to treat sidestream. This process requires full nitrification of the sidestream and therefore consumes significant amounts of energy and alkalinity. It also requires a significant amount carbon for denitrification. As such this process can be chemically intensive and is not recommended.
- Nitritation/denitrification processes such as the SHARON process, use oxygen to convert ammonia to nitrite via nitritation and nitrite to nitrogen gas through denitritation. While this uses less oxygen and carbon than full nitrification/denitrification, it still consumes significant energy and carbon.
- Deammonification is a proven technology for sidestream treatment with mature technologies such as DEAMON™, ANITA™ Mox (both fixed film and moving bed bioreactor), and AnammoPAQ®. This process, partial nitritation followed by anaerobic ammonia oxidation, requires growth of anammox bacteria and uses significantly less oxygen and carbon than either nitritation/denitritation or nitrification/denitrification. Due to its significant energy and chemical savings, deammonification has become the industry standard for sidestream nitrogen removal.

Table 7-6: Sidestream Treatment Options

Technology Option	Benefits	Considerations	Pass/Fail
Deammonification	- Mature concept - Costs effective for nitrogen removal (1/3 CAPEX cost for main plant BNR)	- Vendor specific application	Pass
Nitrification/ Denitrification	- Mature concept - Large experience base	- Energy and chemically intensive	Fail
Nitritation/ Denitritation	- Mature concept - Few installations remain	- Energy and chemically intensive	Fail

Phosphorus removal technologies considered for sidestream treatment at the WWTP included chemical addition and phosphorus recovery. **Table 7-7** outlines the technology options and short-list selections for phosphorus removal. Chemical precipitation has been used for sidestream phosphorus removal at WWTPs for decades. It involves metal salt addition to form phosphate containing precipitates that are ultimately settled and removed from the WWTP via sludge hauling. Phosphorus recovery is also a mature concept that involves precipitation of phosphorus in a form than can be beneficially reused. This typically requires chemical addition in a separate tank and a separation process to remove the phosphorus product. Due to the capital investment of a tank, pumping and chemicals, this technology is typically more economically favorable in plants performing biological phosphorus removal (bio-P) with stringent phosphorus standards. As such, planning for phosphorus recovery should be contingent upon the main plant approach for phosphorus removal.

Table 7-7: Sidestream Phosphorus Treatment Options

Technology Option	Benefits	Considerations	Pass/Fail
Chemical Precipitation	- Mature technology - Low CAPEX cost - Large experience base	- High OPEX - Increases sludge production	Pass
Phosphorus Recovery	- Mature concept - Growing experience base - Potential for resource recovery	- Higher CAPEX - More favorable with Bio-P in main plant	Pass*

* Contingent on main plant approach for P

7.2.2 Mainstream Treatment

A number of technology options were considered for mainstream nutrient removal. These options can be grouped into four categories, Conventional BNR, Intensified BNR, Next Generation Nitrogen Removal, and Tertiary Denitrification. These categories are explored in the following section.

7.2.2.1 Conventional BNR

Conventional BNR involves nitrification and denitrification using either suspended or attached growth in configurations typical for municipal wastewater treatment. These technologies have many similarities with technology typically used for carbon removal at WWTPs. **Table 7-8** summarizes the technology options and short-list selections for main plant conventional BNR.

- Multi-stage BNR uses different zones in an activated sludge tank to perform nitrification (aerobic zones) and denitrification (anoxic zones). Internal pumping is used to bring nitrified recycle (NRCY) flow to denitrified zones. Multi-stage BNR configurations include Modified Ludzack-Ettinger (MLE), Anaerobic-Anoxic-Oxic (A2O), and Bardenpho process.
- Step-feed BNR can be used during dry weather to introduce primary effluent to anoxic zones at different locations in the aeration basin. This carbon addition to subsequent stages can increase denitrification of the system and reduce reliance on outside carbon sources.

Wet weather step-feed can be a critical operational tool to manage solids inventory during high flows, a necessity for maintain BNR operations through the wet weather season.

- Two-sludge systems consist of two sets (A and B stages respectively) of aeration and settling in series. The A stage, a short SRT system, is used to redirect carbon to the digesters. The B stage is used to provide nutrient removal. This would increase digester gas production but could require supplemental carbon for future limits.
- Nitrification trickling filters are similar to the TTF currently at the WWTP. Loading to the existing TTF would need to be reduced (additional TTF to be constructed) to promote nitrification in the TTF. Chemically intensive denitrification filters would need to be installed to perform nutrient removal. Optimization of the TTF for N removal is challenging.

Table 7-8 Main Plant Conventional BNR Options

Technology Option	Benefits	Considerations	Pass/Fail
Multi-stage BNR	- High compatibility with TN and TP goals - High level of performance	- Transition to 5-stage for lower TN	Pass*
Step-feed BNR	- Improved mixed liquor inventory management	- Reduced EBPR potential	Pass*
Two-sludge	- Biogas recovery potential - Smaller B stage	- Supplemental carbon demand for future limits - 2 separate sludges; more complexity - Siting and hydraulic constraints	Fail
Nitrification Trickling Filters	- Similar technology to existing WWTP	- Optimization for N removal more challenging than activated sludge - Not compatible with low TN limits; need denite filter	Fail

* Combine multi-stage and step-feed into single Flexible BNR concept

Ultimately two-sludge systems and Nitrification trickling filters were not considered further. Two-sludge systems were both operationally complicated and not compatible with the hydraulics of the WWTP. Nitrification filters were eliminated as they were difficult to optimize for nitrogen removal and would require denitrification filters and more pumping.

7.2.2.2 Intensified BNR

Intensified BNR includes established and emerging technologies that concentrate biological activity to achieve the same nutrient removal in a smaller space with either suspended or fixed growth. **Table 7-9** summarizes the technology options and short-list selections for main plant intensified BNR.

- Integrated fixed film activated sludge (IFAS) grows biofilm on suspended media in an IFAS basin for nitrification. NRCY brings flow back to an anoxic zone for denitrification. Screening is required to keep media in the aeration basin, impacting hydraulics of the existing WWTP.
- Membrane aerated bioreactor (MABR) uses membranes to transfer oxygen to biofilm grown on the membrane to nitrify wastewater flow. Denitrification can occur simultaneously in the bulk solution surrounding the membrane.
- Membrane bioreactor (MBR) systems replace secondary clarifiers with membranes. The physical separation process achieves secondary effluent TSS < 2mg/L and allows the mixed liquor suspended solids (MLSS) concentration in the BNR basin to increase to approximately 8,000 mg/L, intensifying the BNR process.
- Aerobic Granular Sludge (AGS) systems use dense suspended growth in the form of granules (0.5 mm up to 3 mm in size) that settle well. The excellent setting allows for higher MLSS concentrations (approximately 8,000 mg/L) thereby intensifying the BNR process. The granules have anaerobic, anoxic, and aerobic zones that promote nutrient removal. The proprietary granular sludge system is provided by AquaNereda™ and requires the secondary system to be configured as sequencing batch reactors (SBRs).
- Densified activated sludge (DAS) utilizes similar principals as AGS systems, but the suspended biomass is only partially granularized. This technology can be used in a flow through system with secondary clarifiers. The excellent settling sludge can allow the BNR basins to achieve MLSS concentrations 5,000 mg/L to 6,000 mg/L.
- BioMag™ systems are rely on the introduction of reusable iron oxide ballast to produce high density flocs with faster settling rates. These higher settling rates intensify the system by allowing the BNR basins to operate at higher MLSS. While the ballast is reusable, there will be losses, and continuous addition of iron oxides will be required.
- Biological combined systems (BIOCOS®) is a continuous flow SBR concept that reduces energy consumption by using the same equipment for aeration, mixing, and recycling.

Ultimately BioMag™ and BIOCOS® were not considered further as there were limited large scale installations in the United States. BioMag presented further costs and operational issues with the addition of iron oxides. IFAS was also not considered further due screening and media requirements, the hydraulic impacts associated with screening, and the energy associated with keeping media in suspension. DAS and MABR technologies were promising but relatively new. These were suggested for further evaluation and/or piloting as the technologies mature. Both options are compatible and can be retrofitted in a more conventional BNR system as described in **Section 7.2.2.1**.

Table 7-9 Main Plant Intensified BNR Options

Technology Option	Benefits	Considerations	Pass/Fail
MABR	- Compatible with conventional BNR configurations - Increases SRT without additional volume	- Fine screening requirements - High CAPEX relative to SRT benefits	Pass*
Aerobic Granular Sludge	- Fast settling sludge - No clarifiers needed - Simultaneous nitrification/ denitrification (SND) possible	- Proprietary (AquaNereda™) - SBR operation to sustain granular sludge - Multiple sludges - Need filtration for lower nutrient limits	Pass
MBR	- High quality effluent for BOD, TSS, nutrients, and turbidity - Makes effluent more amendable to potable reuse - Simplified operation by eliminating settleability considerations	- High CAPEX and OPEX - Modular installation challenging	Pass*
Densified Activated Sludge	- Fast settling sludge - Compatible with conventional BNR configurations - SND possible	- Pilot necessary to verify degree of benefits	Monitor Progress**
IFAS	- Compatible with conventional BNR configurations	- Screening and media requirements - Hydraulic impacts - Higher energy/mixing demand	Fail
BioMag™	- Compatible with conventional BNR configurations	- Increased inert fraction to digestion - Limited installations at large scale - High O&M in long term	Fail
BIOCOS®	- Fast settling sludge - SND possible	- Limited installation at large scale	Fail

* Combine with Flexible BNR option

** Candidate for piloting

7.2.2.3 Next Generation Nitrogen Removal

Next generation nitrogen removal (NGN) includes alternatives to full nitrification and denitrification. Some of these processes are established technologies for sidestream treatment but have yet to be applied to more dilute main plant conditions. **Table 7-10** summarizes the technology options and short-list selections for main plant NGN removal.

- Simultaneous nitrification and denitrification (SND) achieve nitrification and denitrification in the same volume at the same time. It couples monitoring of ammonia with DO control to balance the two processes and save energy and chemical costs.
- Nitritation/denitritation, use oxygen to convert ammonia to nitrite via nitritation and nitrite and nitrogen gas through denitritation. This process has not been successfully implemented in main plant flows of WWTPs at large scale.
- Deammonification uses partial nitritation followed by anaerobic ammonia oxidation. It requires growth of anammox bacteria organisms which have yet to grow in the main plant flows of WWTPs.
- Partial Nitrification Denitritation Anammox (PANDA) uses both full nitrification and nitritation and deammonification processes. While it is more stable process than deammonification in main plant processes, there have yet to be full scale applications of this technology.

Table 7-10 Main Plant Next Generation Nitrogen Removal Options

Technology Option	Benefits	Considerations	Pass/Fail
SND	- Compatible with conventional intensified BNR	- Reliance on instrumentation	Pass*
PANDA/PdNA	- No NOB repression required - Operating cost savings	- Risk of NH_3 in effluent - Limited full-scale experience	Monitor Progress**
Nitritation/ Denitritation	- Operating cost savings	- Limited success with NOB repression - Risk of NO_2 and NH_3 in effluent - Complexity of operation	Fail
Mainstream Deammonification	- Operating cost savings	- Limited success with NOB repression - Risk of NO_2 and NH_3 in effluent - Annamox retention	Fail

* Combine with Flexible BNR concept

** Candidate for piloting

Ultimately main plant nitritation/denitritation and mainstream deammonification were eliminated due to the complexity and limited success in applying it to dilute conditions found in main plant flows. While PANDA processes appear more stable, there is limited full-scale experience. It is recommended that the development of this technology be tracked and considered in the future if it becomes a more viable solution. SND is recommended to be incorporated if a more conventional BNR solution is chosen.

7.2.2.4 Tertiary Denitrification

Tertiary denitrification can achieve nutrient removal beyond BACWA Level 2 standards. These are considered here at a high level for potential BACWA Level 3 standards (not currently anticipated in the planning period). **Table 7-11** summarizes the technology options and short-list selections for tertiary denitrification.

- Moving bed bioreactor (MBBR) grows biofilm on media similar to IFAS but without a return sludge. MBBR can be implemented downstream of the secondary clarifiers as a denitrification step if supplemental carbon is added.
- Biologically active filtration (denitrification filters) uses carbon addition and attached growth in filter media to denitrify flow. It can be combined with phosphorus removal.
- Microbial Encapsulated Media Reactors (Biocatalysts) use a high density of single, highly efficient organisms that are controlled and protected in the versatile form of a biocatalyst composite.

Table 7-11 Tertiary Denitrification Options

Technology Option	Benefits	Considerations	Pass/Fail
MBBR	- Mature technology for polishing NO_3 - Compatible with PANDA/PdNA	- Media management - Solids separation before effluent discharge - High operating cost	Pass*
Denitrification Filters	- Mature technology for polishing NO_3 - Compatible with PANDA/PdNA - Additional solids removal step	- Potential large footprint - High operating costs	Pass*
Microbe Encapsulated Media Reactors (Biocatalysts)	- Compact footprint - Polishing potential	- New technology - No full-scale facilities in the US - Requires piloting, demonstration, and validation	Monitor Progress**

* Consider for Level 3, if needed

** Candidate for piloting if more stringent limits arise

As noted, tertiary denitrification is not required for the District to achieve BACWA Level 2 standards. These technologies are not expected to be needed within the planning period. Both MBBR and denitrification filters can be integrated into the WWTP for tertiary denitrification when needed. The biocatalysts technology should be monitored and potentially piloted when further nutrient removal is required.

7.2.2.5 *Summary of short-listed technologies*

Table 7-12 summarizes the short-listed nutrient removal technologies considered for the District. These technologies were combined to form integrated solutions to fit the District's current and future nutrient removal needs.

Table 7-12 Short-listed Nutrient Removal Technologies

Sidestream		Mainstream BNR for BACWA Level 2			BACWA Level 3[2]
Nitrogen Removal	**Phosphorus Removal**	**Conventional BNR**	**Intensified BNR**	**Next Generation Nitrogen Removal**	**Tertiary Denitrification**
Deammonification	Chemical precipitation	Multi-stage BNR	Granular activated sludge[1]	Simultaneous nitrification and denitrification	MBBR
-	Phosphorus recovery	Step-Feed BNR	Densified activated sludge	-	Denitrification
-	-	-	Membrane bioreactor	-	Biocatalysts
-	-	-	Membrane aerated bioreactor[1]	-	-

[1] Piloting would be recommended for these technologies.
[2] This category is considered a place holder for BACWA Level 3 nutrient removal

7.3 Integrated Solutions

The short-listed technologies described above were combined into three integrated solutions. These integrated solutions represent three different paths for nutrient removal. All integrated solutions were developed to be compatible with the Secondary Process Improvements Project described in **Section 6.** The infrastructure described in this section assumes that the Secondary Process Improvements Project has been implemented.

- Integrated Solution 1 (IS 1) – Flexible BNR
- Integrated Solution 2 (IS 2) – Aerobic Granular Sludge
- Integrated Solution 3 (IS 3) – MBR

For each integrated solution, proposed infrastructure and process upgrades are provided for three planning scenarios:

- *Load cap* – No specific nutrient limit. Goal is to reduce nutrient as much as possible with low CAPEX projects.
- *BACWA Level 2 (2040 planning horizon*) – TN < 15 mg/L and TP < 1 mg/L
- *BACWA Level 3 (beyond 2040)* – TN < 6 mg/L and TP < 0.3 mg/L

7.3.1 Integrated Solution 1 – Flexible BNR

Flexible BNR combines the conventional multi-stage and step-feed BNR processes. With this option, the District has future flexibility to intensify with MABR or DAS in the future. There is also potential for next generation nitrogen removal via SND. Sidestream nitrogen removal is achieved with deammonification, and biological phosphorus removal is employed with chemical P-trim. An overall process schematic for Flexible BNR is provided in **Figure 7-2**. An example of a Flexible BNR basin layout is show in **Figure 7-3**.

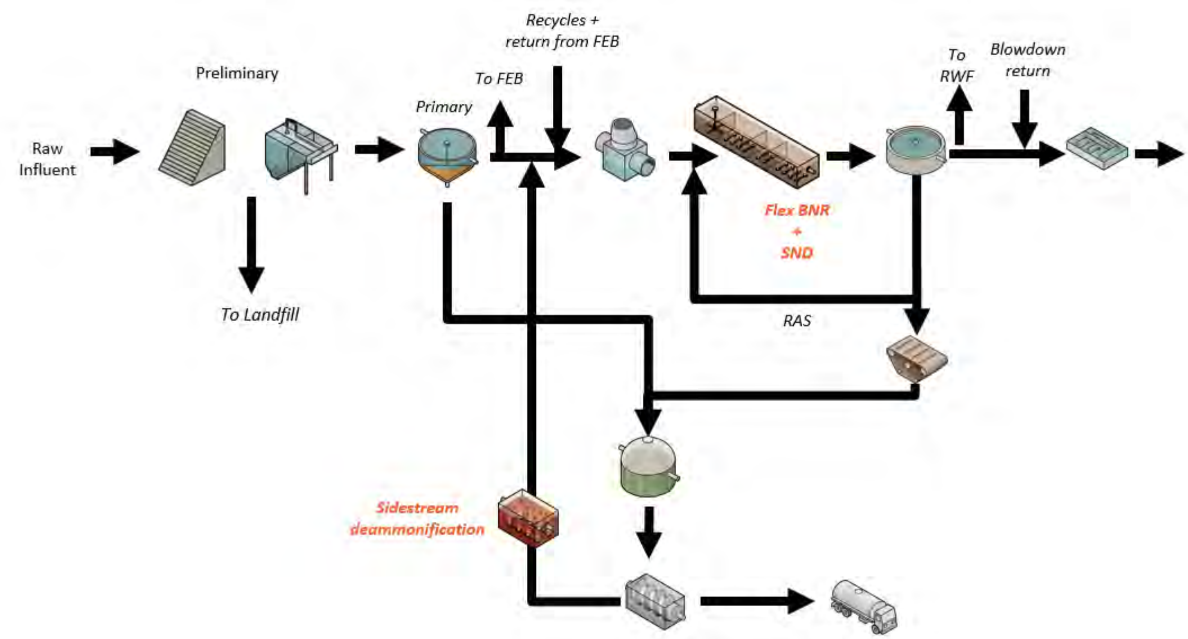


Figure 7-2: Integrated Solution 1 Flexible BNR Process Flow Diagram

The Flexible BNR solution incorporates additional aeration basin volume that will operate at higher MLSS concentrations (compared to carbon removal) to achieve the higher SRTs required for nutrient removal. Additional clarifier surface area will be needed to maintain effluent TSS standards. The aeration basins will be configured to have anaerobic, anoxic, and aerated zones as well as an internal nitrified recycle to facilitate BNR. **3** shows the potential configuration of the BNR basins. Selected swing zones have the flexibility to operate in different modes by changing the configuration of where primary effluent and RAS are introduced and turning off the air to the zone. The following sections describe the additional infrastructure required for the load cap, BACWA Level 2, and BACWA Level 3 planning scenarios.

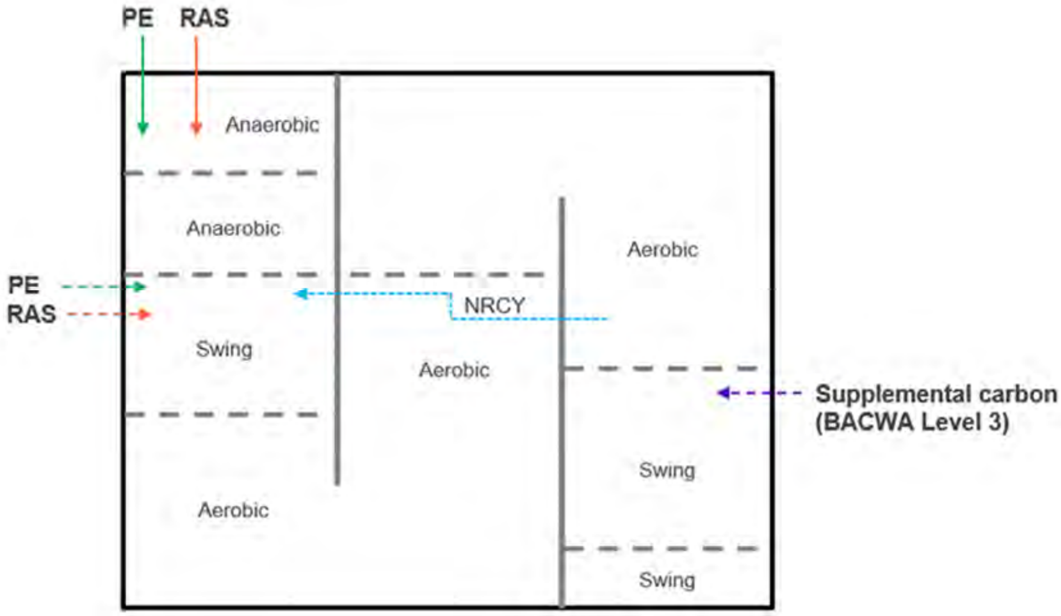


Figure 7-3: Integrated Solution 1 Flexible BNR Potential Basin Configuration

7.3.1.1 Load Cap

In order to meet the projected nutrient load cap for the plant (1,700 kg/d), the following new infrastructure improvements are anticipated for Flexible BNR:

- Demolish decommissioned Tower Trickling Filters
- 3.9 MG (3 basins at 1.3 MG each and 25-ft deep) of new aeration basin volume (5.1 MG of total existing and new aeration basin volume with 25-ft sidewater depth).
- Retire existing shallow aeration basins.
- New mixed liquor distribution channels.
- One new 90-ft secondary clarifier with 15-ft sidewater depth (7 total).
- One new 300-hp turbo blower to provide 7,000 sfcm (4 total duty turbo blowers providing firm capacity of 28,000 scfm)

This upgrade includes 3.9 MG of new deep aeration basins over the decommissioned TTF and decommissioning of the existing shallow aeration basins. The deeper basins will provide more oxygen transfer and volume to maintain nitrification. Aeration basins will have a maximum SRT of 4 days. The additional secondary clarifier will provide redundancy for future peak flow conditions. The secondary clarifiers will have a maximum 30-day SLR of 31 lb/ft^2-day. A proposed layout for infrastructure improvements to meet the future load cap requirements is provided in **Figure 7-4**.

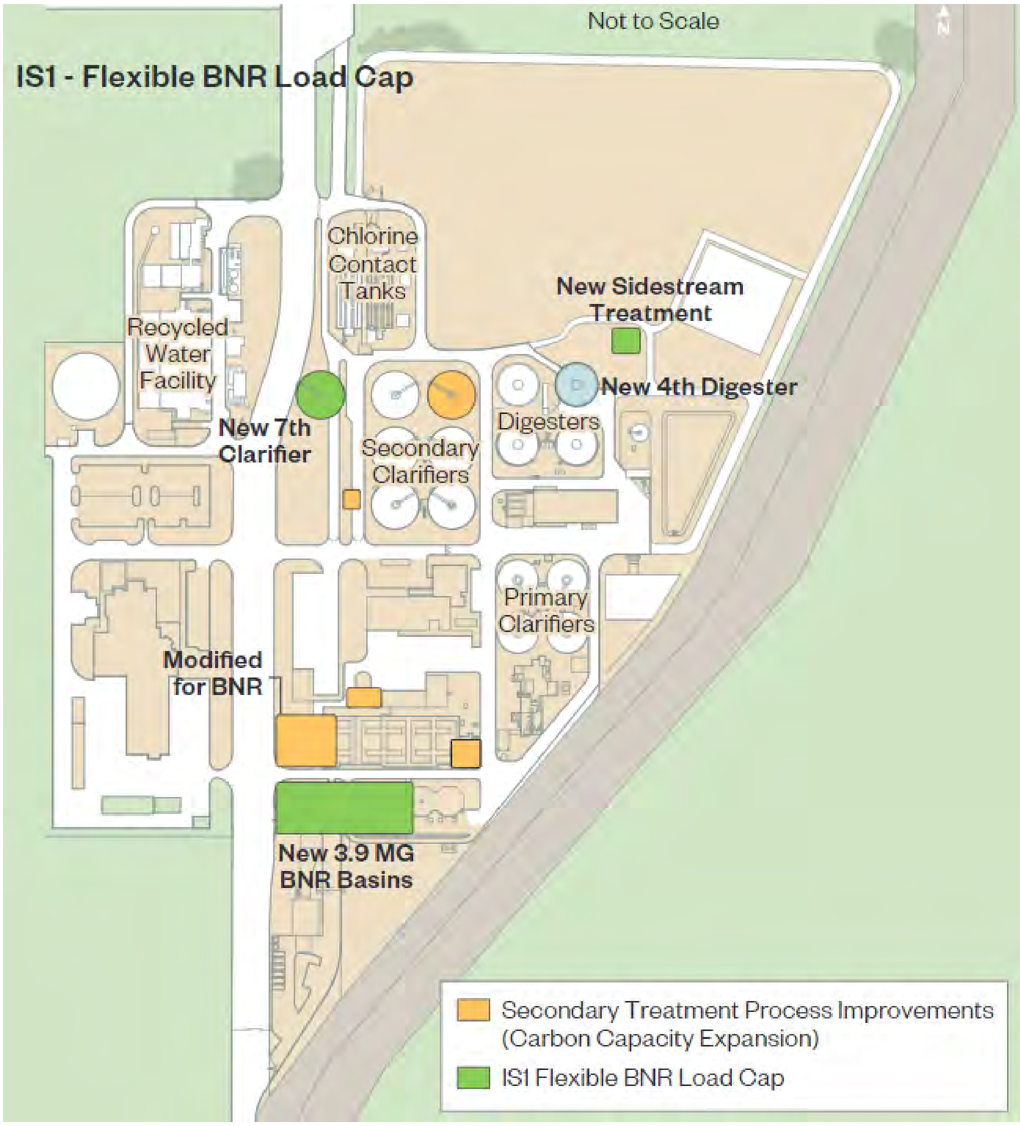


Figure 7-4: Site Layout for Load Cap (IS 1 - Flexible BNR)

7.3.1.2 BACWA Level 2

To meet BACWA Level 2 monthly effluent limits (TN < 15 mg/L and TP < 1 mg/L) with Flexible BNR, the following additional infrastructure improvements would be required:

- Demolish existing shallow aeration basins
- 2.6-MG (2 basins at 1.3 MG each with 25-ft sidewater depth) new aeration basin volume (7.7 MG of total aeration basin volume)

This option utilizes infrastructure from the carbon expansion and load cap projects, specifically by tapping into the new MLSS channel and primary effluent distribution network. The additional aeration basin volume will increase the maximum SRT to 5 days. A proposed layout for infrastructure improvements to meet BACWA Level 2 effluent limits is provided in **Figure 7-5**.

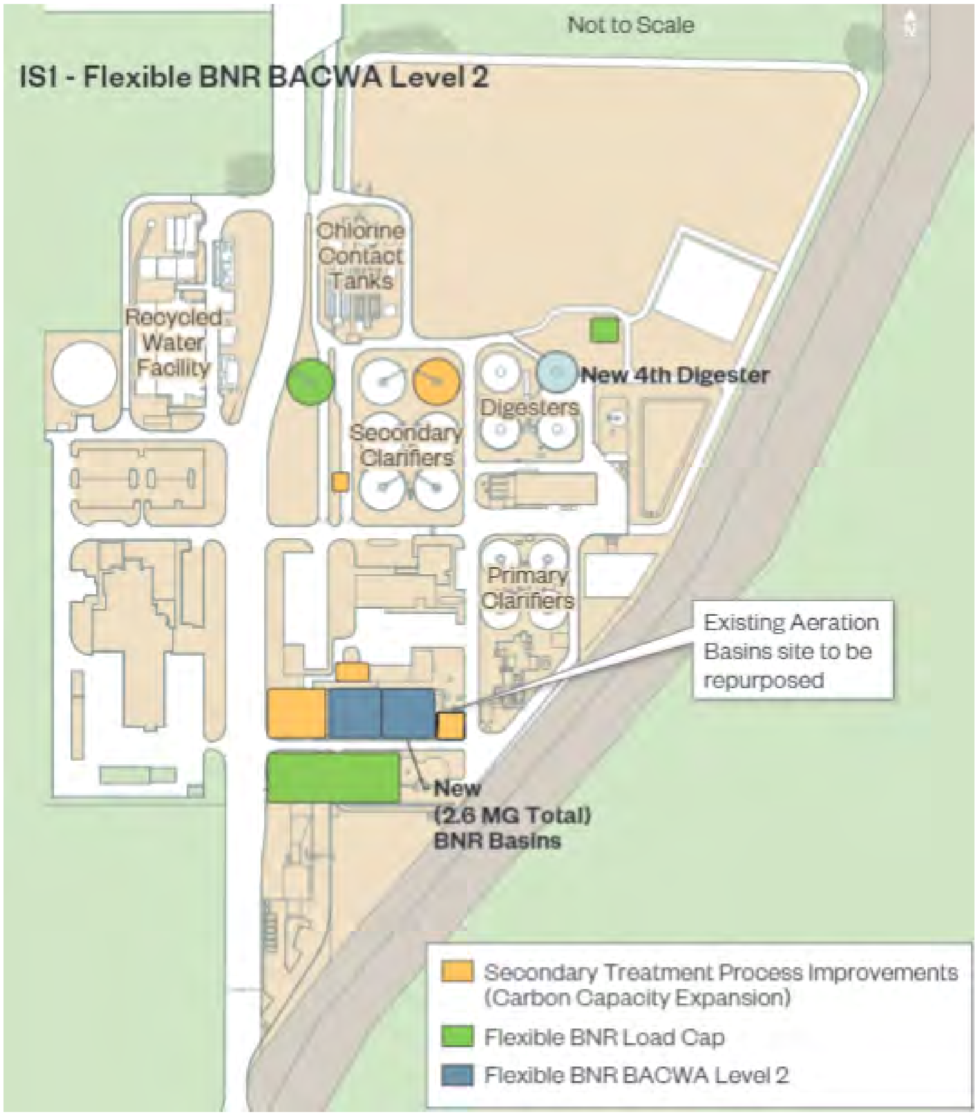


Figure 7-5: Site Layout for BACWA Level 2 (IS 1 - Flexible BNR)

7.3.1.3 BACWA Level 3 (Beyond 2040)

To meet BACWA Level 3 monthly effluent limits (TN < 6 mg/L and TP < 0.3 mg/L) under Flexible BNR, the following additional infrastructure improvements would be required:

- One new 1.7-MG aeration basin with 25-ft sidewater depth (9.4 MG of total aeration basin volume)

This option also utilizes infrastructure from the previous projects, specifically by tapping into the new MLSS channel and primary effluent distribution network. The additional aeration basin volume will increase the maximum SRT to 6 days. A proposed layout for infrastructure improvements to meet BACWA Level 3 effluent limits is provided in **Figure 7-6**.

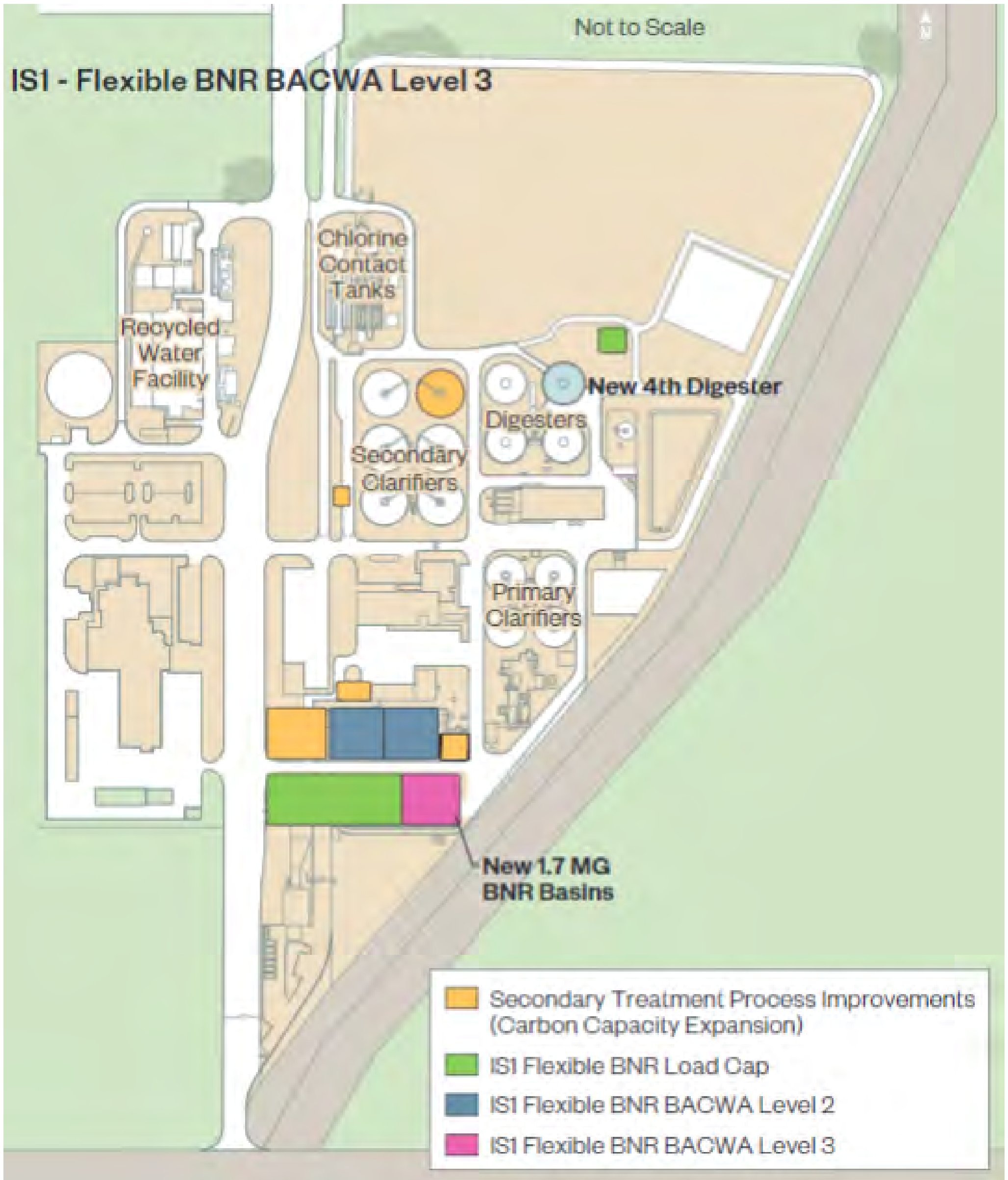


Figure 7-6: Site Layout for BACWA Level 3 (IS 1 - Flexible BNR)

7.3.2 Integrated Solution 2 – Aerobic Granular Sludge

Aerobic granular sludge utilizes AquaNereda™ aerobic granular sludge technology to achieve nutrient removal in an SBR configuration. The secondary clarifiers are not used as settling is conducted in the SBR tanks. A water correction level tank and sludge buffer and pre-thickener tanks are required for this option. Sidestream nitrogen removal is achieved with deammonification, and biological phosphorus removal is employed with chemical P-trim. An overall process schematic for Aerobic Granular Sludge is provided in **Figure 7-7**.

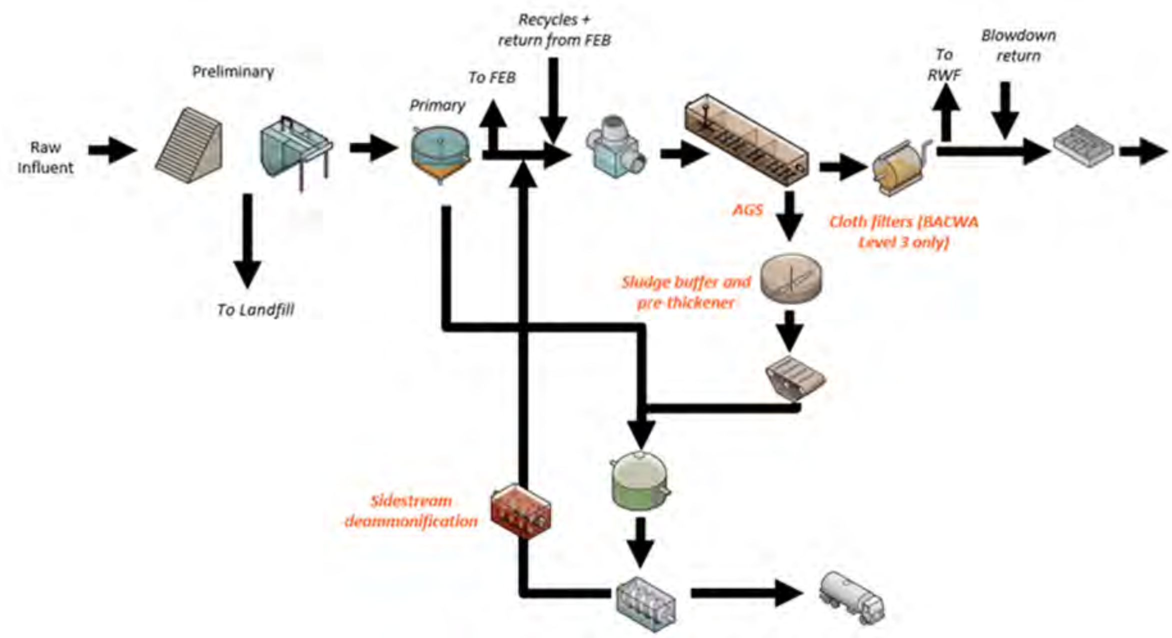


Figure 7-7: Aerobic Granular Sludge Process (IS 2- Aerobic Granular Sludge)

7.3.2.1 Load Cap

To meet the projected future loads of the plant under Aerobic Granular Sludge, the following new infrastructure improvements are anticipated:

- Decommission and demolish the trickling filters to make space for future BNR basins
  - 100% treatment flow to the aeration basins for carbon removal
- Construct new water level correction tank and associated pumps
- Install new primary effluent pumps
- Reconfigure 1.2-MG aeration basin (constructed for carbon expansion) into SBR tank
- Construct three new SBR tanks (one at 1.2 MG and two at 2.5 MG)
- Relocate existing NX300 blowers
- Add two new NX300 blowers
- Repurpose two secondary clarifiers as sludge buffer and pre-thickener tanks
- Construct new effluent channel to chlorine contact tank
- Implement sidestream treatment (deammonification)

This option utilizes the new basin volume and blowers constructed for the carbon expansion. After conversion of the existing 1.2-MG basin to an SBR tank and construction of three new SBR tanks, total basin volume is increased to 7.5 MG. However, due to the process change associated with AGS, this option may result in four of the secondary clarifiers and the MLSS splitter box becoming stranded assets.

A proposed layout for infrastructure improvements to meet the future load cap requirements is provided in **Figure 7-8.**

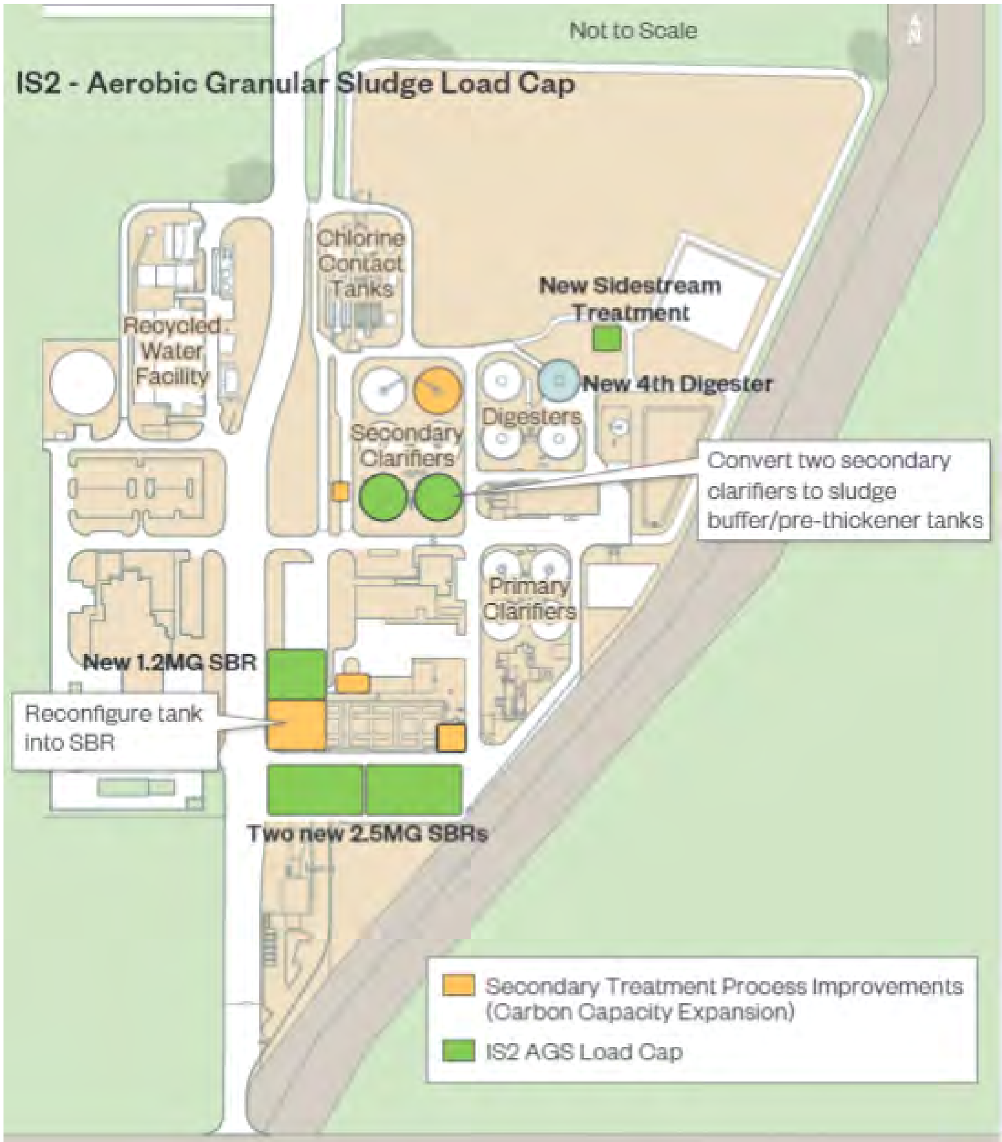


Figure 7-8: Site Layout for Load Cap (IS 2 - Aerobic Granular Sludge)

7.3.2.2 BACWA Level 2

For the plant to meet BACWA Level 2 monthly effluent limits (TN < 15 mg/L and TP < 1 mg/L) with Aerobic Granular Sludge, the following additional infrastructure improvements would be required:

- Construct one new 2.5-MG SBR tank (9.8 MG total basin volume)

This option utilizes infrastructure from the carbon expansion and load cap projects, specifically by tapping into the new primary effluent distribution network and the secondary effluent channel. A proposed layout for infrastructure improvements to meet BACWA Level 2 effluent limits is provided in **Figure 7-9**.

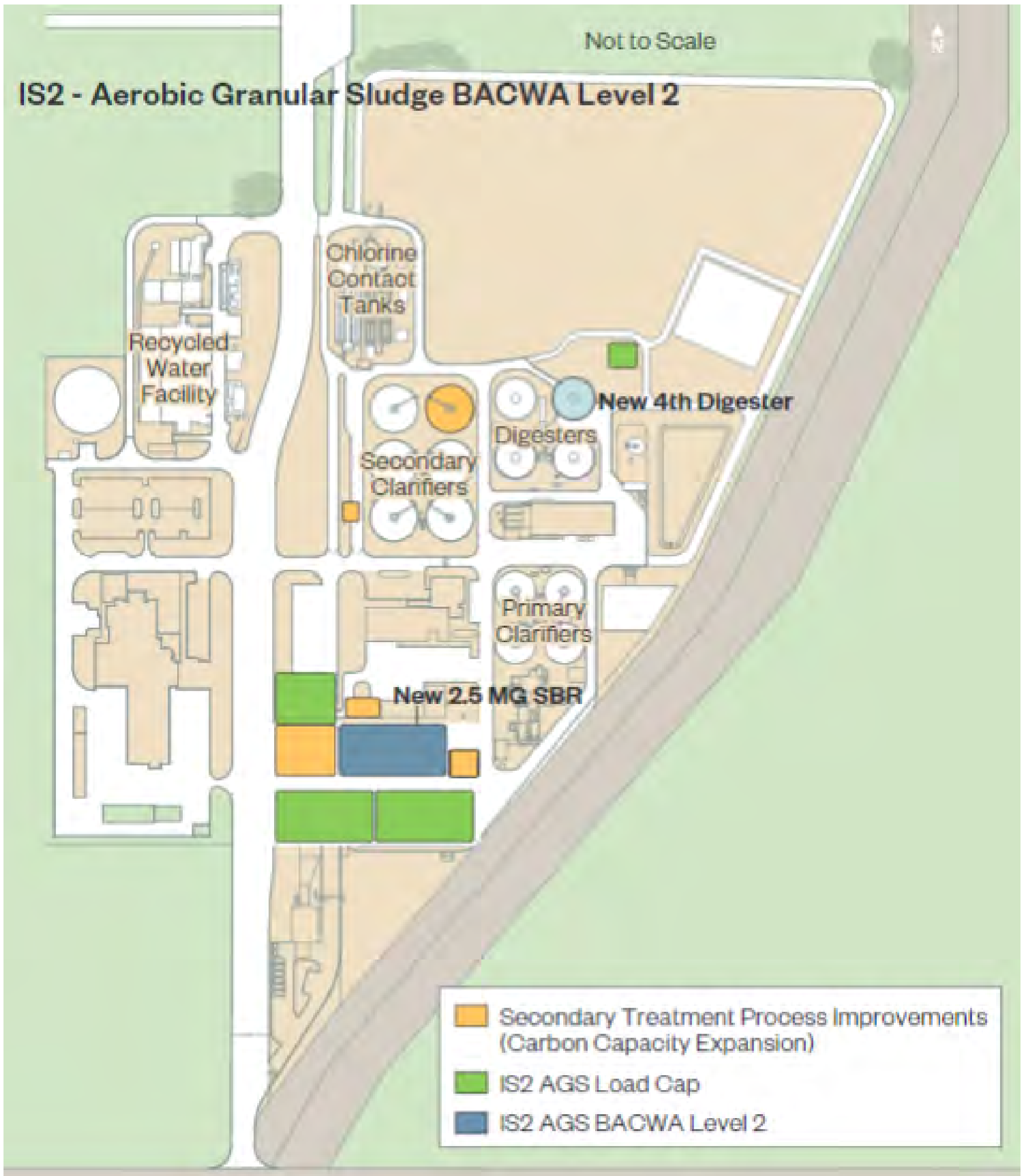


Figure 7-9: Site Layout for BACWA Level 2 (IS 2 - Aerobic Granular Sludge)

7.3.2.3 BACWA Level 3 (Beyond 2040)

For the plant to meet BACWA Level 3 monthly effluent limits (TN < 6 mg/L and TP < 0.3 mg/L) with Aerobic Granular Sludge, the following additional infrastructure improvements would be required:

- Construct one new 2.5-MG SBR tank (12.3 MG total basin volume)
- Build tertiary cloth filters

This option also utilizes infrastructure from the previous projects, specifically by tapping into the new primary effluent distribution network and secondary effluent channel. Tertiary cloth filters are added to increase solids removal and meet BACWA Level 3 effluent limits. A proposed layout for infrastructure improvements to meet BACWA Level 3 is provided in **Figure 7-10**.

Figure 7-10: Site Layout for BACWA Level 3 (IS 2 - Aerobic Granular Sludge)

7.3.3 Integrated Solution 3 – Membrane Bioreactors

Integrated Solution 3 achieves full intensification trough the installation of MBRs. Similar to Aerobic Granular Sludge, the secondary clarifiers are eliminated, but through the use of membrane cassettes. Sidestream nitrogen removal is achieved with deammonification, and biological phosphorus removal is employed with chemical P-trim. An overall process schematic for an MBR solution is provided in **Figure 7-11**.

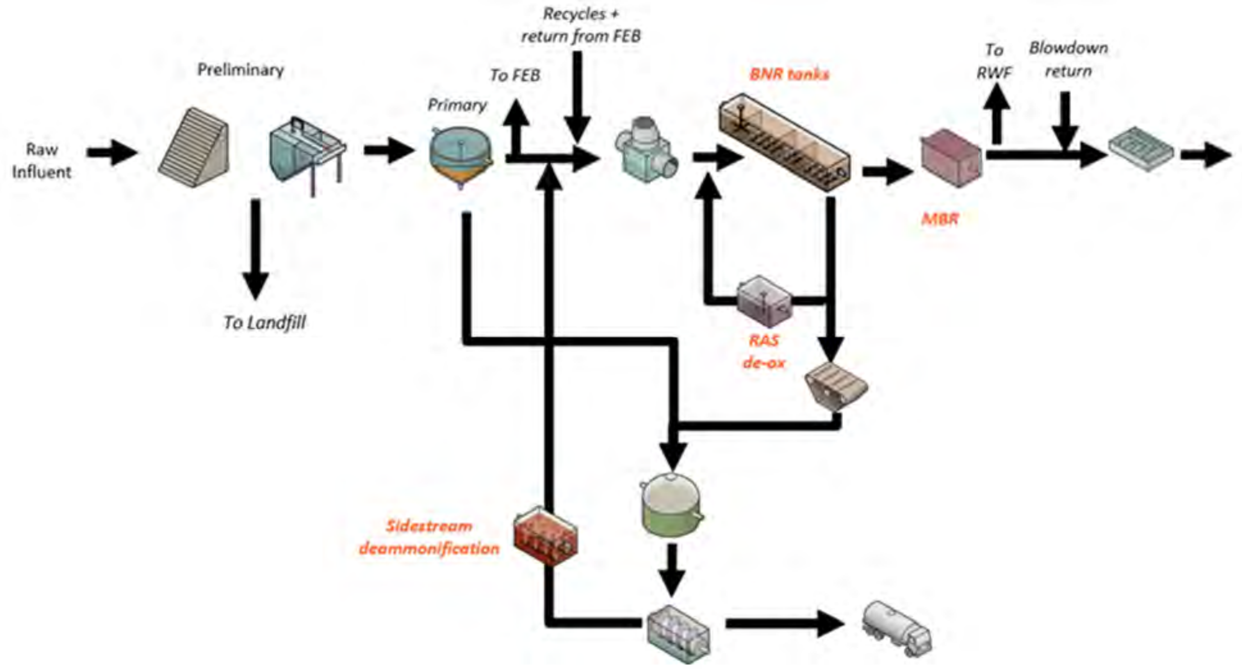


Figure 7-11: MBR Process

7.3.3.1 *Load Cap/ BACWA Level 2*

For the MBR option, the volumes required to meet load cap requirements can also support meeting BACWA Level 2 effluent limits (TN < 15 mg/L and TP < 1 mg/L). Therefore, these two scenarios are combined for the MBR solution. The following new infrastructure improvements are anticipated for MBR solution:

- Decommission and demolish the trickling filters to make space for future BNR basins
    - 100% treatment flow to the aeration basins for carbon removal
- Construct fine screening facility
- Construct new primary effluent distribution network to convey flow to aeration basins
- Reconfigure 1.2-MG tank constructed during the carbon expansion to be compatible with MBR operations
- Construct new 3.6-MG aeration basin (4.8 MG total basin volume)
- Construct new MLSS distribution system
- Construct MBR tanks with space for future cassettes
- Construct new RAS De-ox box with associated pumping and piping
- Construct new internal MLSS pumping system
- New Blowers

This option utilizes the new basin volume and blowers constructed for the carbon expansion. The increased aeration basin volume will have a maximum SRT of 6 days. However, due to the process change associated with MBRs, this option may result in all of the secondary clarifiers and the MLSS splitter box becoming stranded assets. A proposed layout for infrastructure improvements to meet the future load caps and BACWA Level 2 requirements is provided in **Figure 7-12**.

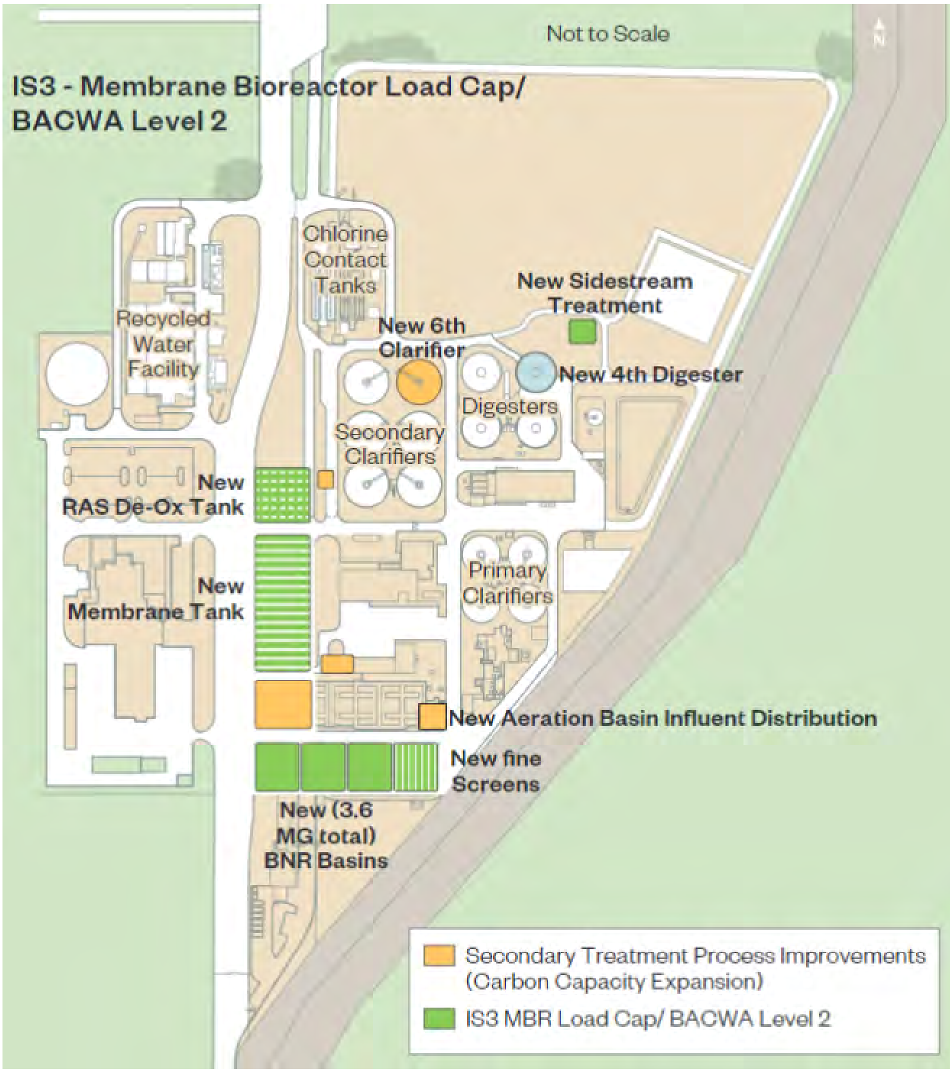


Figure 7-12: Site Layout for Load Cap / BACWA Level 2 (IS 3 - MBR)

7.3.3.2 BACWA Level 3 (Beyond 2040)

To meet BACWA Level 3 monthly effluent limits (TN < 6 mg/L and TP < 0.3 mg/L) under the MBR solution, the following additional infrastructure improvements would be required:

- Demolish decommissioned shallow aeration basins
- Construct one new 1.2-MG tank (6 MG total basin volume)
- New blowers
- Additional membrane cassettes

This option utilizes infrastructure from the previous projects, specifically by tapping into the new primary effluent distribution network and MLSS channel. New tank volume, one blower, and additional cassettes are added. The maximum SRT for the process is maintained at 6 days. A proposed layout for infrastructure improvements to meet BACWA Level 3 is provided in **Figure 7-13**.

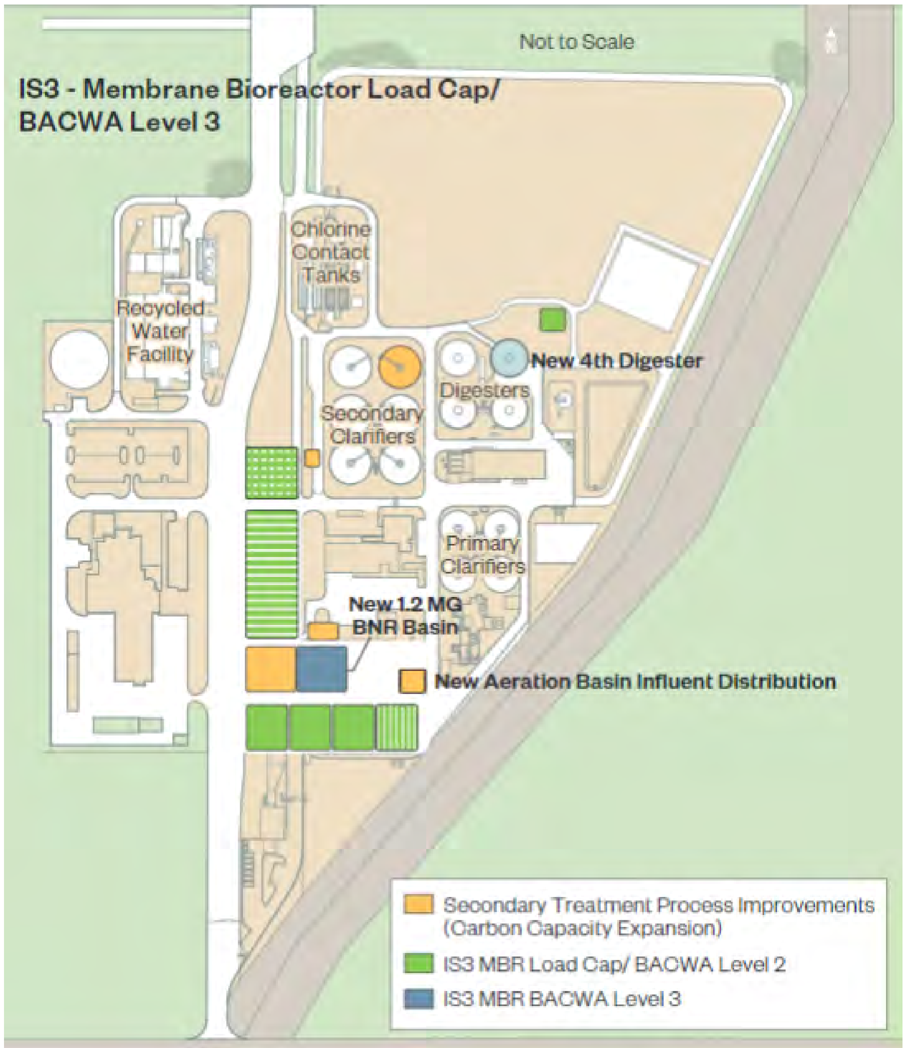


Figure 7-13: IS3 – Membrane Bioreactor BACWA Level 3

7.4 Comparison of Alternatives

Each alternative solution was evaluated based on a variety of criteria, including both economic and non-economic factors. The following sections present the findings of the comparison evaluation.

7.4.1 Capital Costs

Capital costs (2021 dollars) were estimated for each integrated solution. Assumptions for project adders are listed in **14**. Class 4 estimates were used to assess capital costs, as described in **Table 7-1415**.

Table 7-13: Project Adders

Project Adders	%
Engineering and Environmental	12%
Engineering Services during Construction	3%
Construction Management	15%
Administrative and Legal	5%
Other	5%
Subtotal, Project Adders	**40%**

Table 7-14: Summary of Cost Estimate Classes

Estimate Level	Project Level	Basis	Accuracy
Class 5 – Factored Estimate	Conceptual / Screening	Similar	-50% to +100%
Class 4 – Equipment Factored Estimate	Study / Feasibility	Parametric Model / Major Equipment	-30% to +50%
Class 3 – Budgetary Cost Estimate	Budget Authorization	Semi-detailed Unit Costs	-20% to + 30%
Class 2 – Control Budget Estimate	Budget / Bid Estimate	Detailed Take-offs	-15% to + 20%
Class 1 – Detailed Estimate	Definitive Estimate	Material Take-offs	-10% to +15%

Estimates for overall project costs for each IS are outlined in **Table 7-15**. The carbon expansion and additional digester are common to all three options. Costs for digester capacity expansion are included as it will be required within in the planning period. The Flexible BNR option has the lowest associated costs, while the MBR option has the highest.

Table 7-15: Project Cost Summary

<table>
<tr><th>Phase</th><th>IS 1
Flexible BNR</th><th>IS 2
Aerobic Granular Sludge</th><th>IS 3
Membrane Bioreactor</th></tr>
<tr><td>Carbon Expansion</td><td colspan="3">$52M</td></tr>
<tr><td>Digester Expansion</td><td colspan="3">$9M</td></tr>
<tr><td>Load Cap</td><td>$76M
($137M)</td><td>$112M
($173M)</td><td rowspan="2">$204M
($265M)</td></tr>
<tr><td>BACWA Level 2</td><td>$29M
($166M)</td><td>$28M
($201M)</td></tr>
</table>

* Incremental costs are listed with cumulative costs listed in brackets, assuming implementation.

7.4.2 Labor Requirements

A model was developed to estimate differences in labor requirements for each of the alternatives. This model was calibrated to existing plant staffing. Estimates for total labor requirements for each of the alternatives, under the load cap scenario are outlined in **Table 7-167**.

Table 7-16: Comparison of Labor Requirements

Full-Time Equivalent (FTE)	IS 1 Flexible BNR	IS 2 Aerobic Granular Sludge	IS 3 Membrane Bioreactor
Operations	15	15	14
Maintenance	10	10	10
I&C	5	7	5
Total	**30**	**32**	**29**

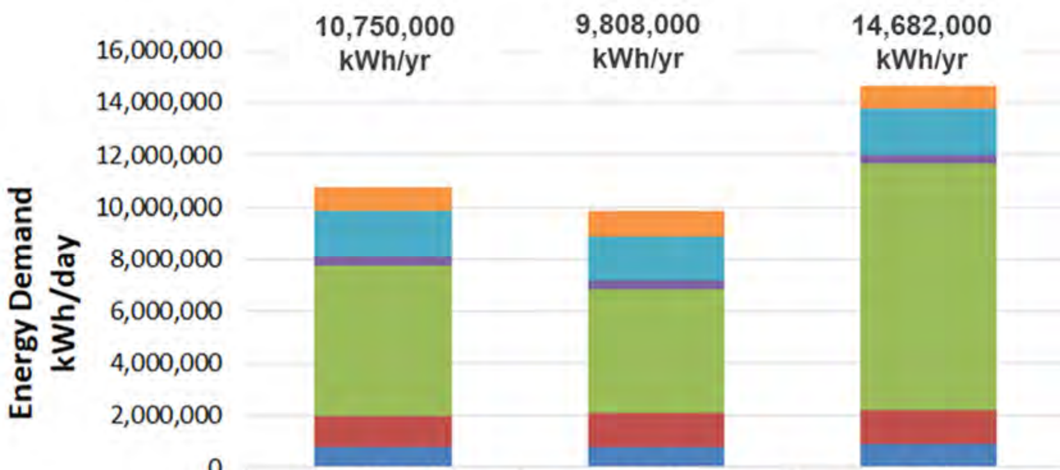
* Load cap scenario used as a reference for labor estimates.

7.4.3 Energy Demand

Energy demands associated with each integrated solution were also evaluated, using the load cap scenario for reference. Energy requirements for six major processes were included in the estimate, as outlined below:

- Odor control
- Solids processing
- Disinfection
- Secondary process
- Equalization and pumping
- Preliminary and primary processes

Figure 7-14 compares the estimated energy demands for each integrated solution in a graphical format. As shown, Aerobic Granular Sludge has the lowest energy requirements due to lower pumping demand and reduced aeration demand. Membrane bioreactors have has the highest energy requirements, which is largely driven by the secondary processes.



	IS1 - Flex BNR	IS2 - AGS	IS3 - MBR
Odor Control	915,000	915,000	915,000
Solids Processing	1,752,000	1,752,000	1,752,000
Disinfection	332,000	332,000	332,000
Secondary	5,739,000	4,719,000	9,490,000
EQ + Pumping	1,202,000	1,280,000	1,280,000
Prelim + Primary	810,000	810,000	913,000

Figure 7-14: Comparison of Energy Demand

7.4.4 Impacts to Recycled Water Program

Table 7-178 outlines the impacts each integrated solution would have on the recycled water program at the RWF. To assess impacts to the recycled water program, a variety of recycled water quality parameters were identified. For each integrated solution, benefits to a given recycled water quality parameter were assessed on a five-point scale, ranging from negative benefits to high benefits. Again, the load cap scenario is used as a reference. From the table, it can be seen that the MBR solution has the highest beneficial impacts to the recycled water program with respect to nitrogen, phosphorus, suspended solids/turbidity, pathogens, and reliability. However, all three alternatives had low to negative benefits regarding PFAS, CECs, TDS, and alkalinity.

Table 7-17: Summary of Impacts to Recycled Water Program

Beneficial Impact	IS 1 Flexible BNR	IS 2 Aerobic Granular Sludge	IS 3 Membrane Bioreactor
NH_3	+++	++++	++++
NO_3	+++	+++	++++
TIN	+++	+++	++++
TP	+++	++++	++++
Suspended Solids/Turbidity	++++	++	+++++
Pathogens	+++	++	++++
PFAS	+	+	+
CECs	+	+	+
TDS	-	-	-
Alkalinity	+	+	+
Reliability of System	+++	+++	++++

+++++: high benefits
+++: medium benefits
+: low benefits
- : negative benefits

7.4.5 Impacts to Solids Capacity

Impacts to solids capacity were evaluated assuming two digesters are in service. **Figure 7-15** shows the estimated digester hydraulic retention time (HRT) for each alternative throughout the planning horizon. For each of the options, it was assumed that nutrient load cap infrastructure is in place by 2035. The figure shows carbon removal only scenario would require operation of a third digester by 2030. Redundancy would then need to be provided by an additional digester. On the other hand, BNR operation reduces sludge production and can allow for a 15 to 18-day SRT at 2040 with two digesters in operation.

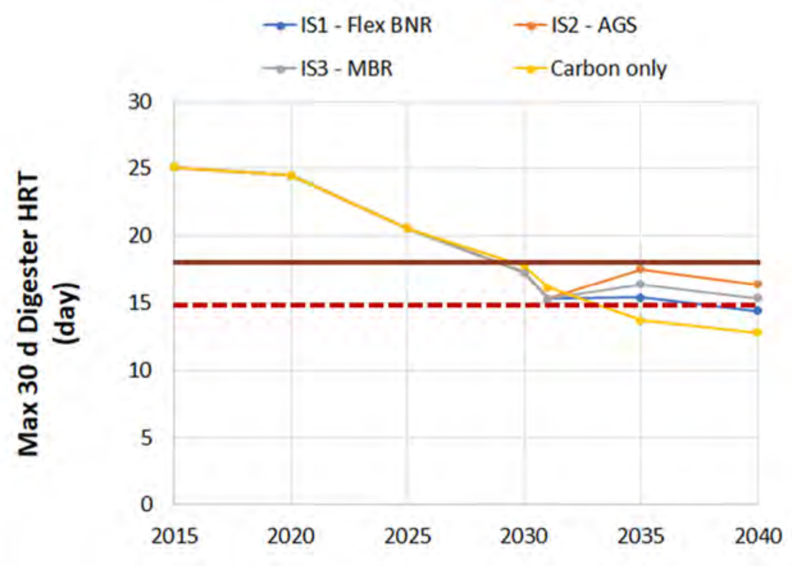


Figure 7-15: Summary of Solids Capacity

7.4.6 Net Present Value (NPV) Cost Summary

Table 7-18 presents the NPV cost summary for each alternative using the load cap scenario for reference. As shown, Flexible BNR has the lowest costs in all three categories and MBR has the highest estimated costs.

Table 7-18: NPV Cost Summary

Phase	IS 1 Flexible BNR	IS 2 Aerobic Granular Sludge	IS 3 Membrane Bioreactor
Total Project Cost (Load Cap)	$137M	$173M	$265M
Average Yearly O&M	$9.9M	$10.3M	$11.0M
10-year NPV (2030 to 2040)	$241M	$281M	$380M

* Assumed 2% discount rate

7.5 Apparent Best Alternative

The apparent best alternative is Flexible BNR. This is mainly due to the lower capital and O&M costs as well as the flexibility to incorporate intensification processes such as densified activated sludge and membrane aerated bioreactors if and when these processes become viable. The modularity of Flexible BNR allows the District to build only what is necessary for the standards that are in place. This alternative also makes best use of the assets installed under the Secondary Process Improvements Project for capacity expansion, minimizing stranded assets.

8. Summary

To accommodate treatment needs at the WWTP (capacity expansion and variable nutrient removal), a trigger based nutrient roadmap was developed (**Figure 8-1**):

- Trigger 1 – **Carbon removal enhancement:** This project is triggered to provide construction of additional aeration basins (1.2 MG additional volume, 3.1 MG total aeration basin volume), clarifiers (one 90-ft diameter) and associated equipment to **provide sufficient BOD treatment capacity through 2040 projections**. This project was developed to be compatible with any future BNR technology.
- Trigger 2 – **Sidestream treatment**: This project would be triggered based on a need for proactive implementation of sidestream nitrogen removal to **achieve 10 to 15% reduction in effluent TIN without committing to a large nutrient removal capital project for the mainstream liquids process.** This project was developed to be compatible with any future BNR technology.
- Trigger 3 – **Pursue regional partnership**: This is triggered when **nutrient trading becomes feasible and economically viable** as a means for addressing nutrient removal required. If/when the economics of regional partnerships are no longer favorable, the fourth trigger would be implemented.
- Trigger 4– **Mainstream BNR treatment at WWTP**: This is triggered when nutrient trading becomes infeasible and economically non-viable as a means for addressing nutrient removal. At the present time, Flexible BNR is likely to remain the most economical, but due to the potential changes in the technology and marketplace, a re-assessment of available nutrient removal technologies (including pilot testing of intensification technologies) should take place.

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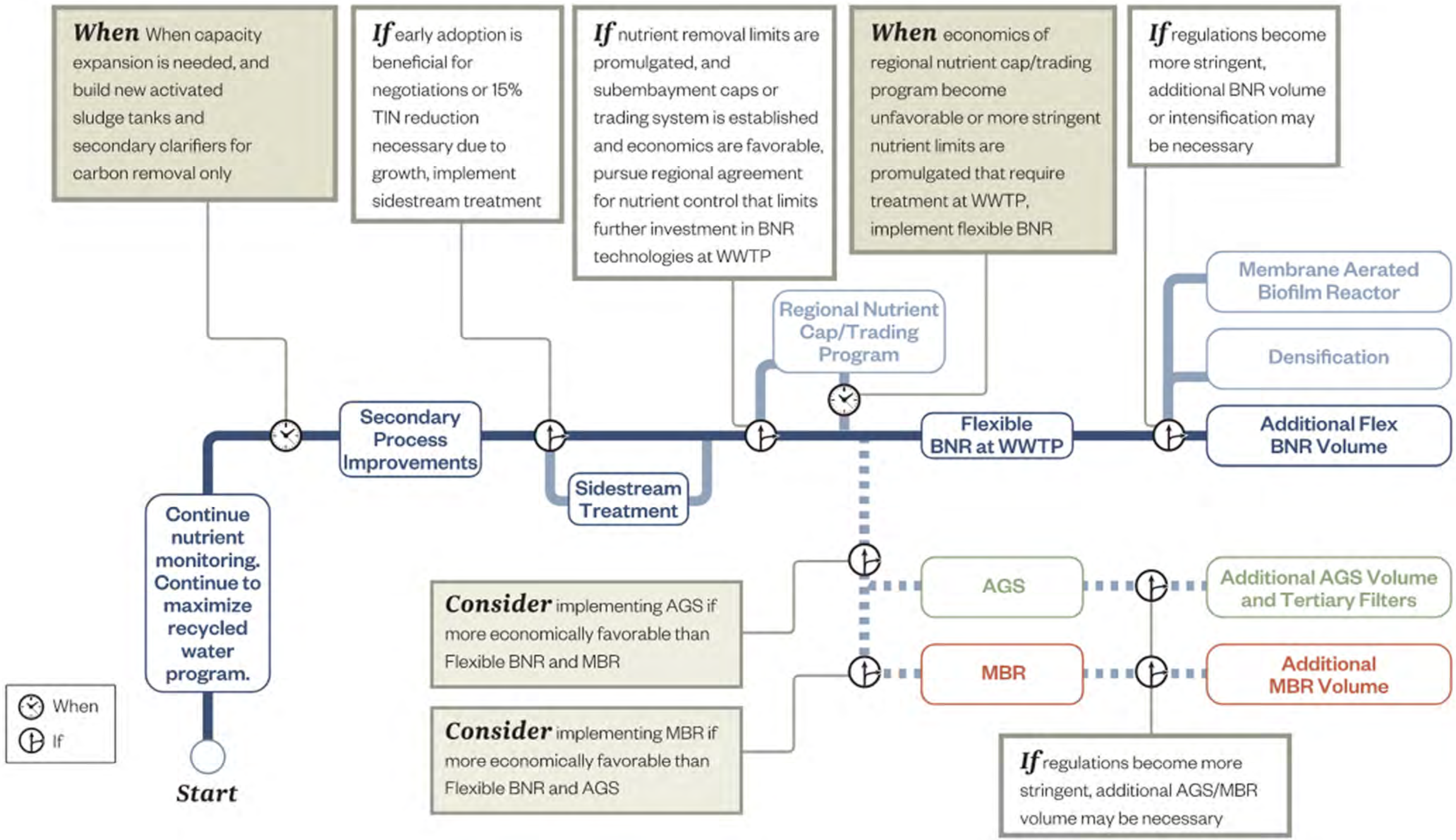


Figure 8-1: Nutrient Roadmap

Appendix 5

TM - 05 Biosolids and Renewable Energy Management

October 18, 2022

To: Brian Thomas, Delta Diablo

From: Derya Dursun, Bryan Lisk, Hazen

Re: Master Plan – Biosolids and Renewable Energy Management

TM - 05 Biosolids and Renewable Energy Management

Final

Revision No.	Date	Description	Author	Reviewed
0	3/25/2021	Biosolids and Renewable Energy	D. Dursun, B. Lisk, H. Enriquez	M. Abu-orf, I. Chu
1	10/31/2022	Biosolids and Renewable Energy	I. Chu	District

Table of Contents

1. Introduction

As part of 2022 Master Plan, renewable energy production and biosolids management options for the District's wastewater treatment plant (WWTP) were evaluated. The evaluation was aimed at identifying biosolids management and bioenergy recovery strategies for the next 20-year period. The main objectives of this Technical Memorandum (TM) are:

- Identify capacity improvements to accommodate increased flows and loads and future liquid stream process changes.
- Evaluate regional High Strength Waste (HSW) market
- Explore renewable energy production
- Investigate biogas utilization alternatives
- Identify alternative beneficial use outlets for biosolids
- Assess alternative biosolids management options

2. Regulatory Landscape for Biosolids Management

In California, beneficial use of biosolids products is primarily governed by the State Water Resources Control Board (SWRCB) via the General Order (GO). Recently passed state laws and regulations provide a greater opportunity for developing a beneficial use program. However, there are other developing regulations that have potential to limit the beneficial use of some products and/or markets. Local regulations, generally at the county level, have significantly limited beneficial use of biosolids. The following regulatory considerations could trigger and shape the future biosolids and energy management for the District.

2.1 Future Regulatory Considerations

- Federal: USEPA – Office of Inspector General (OIG) Report released in 2018 has identified 352 pollutants in beneficially reused biosolids which might pose risk. While decades of research and experience demonstrate the safety of beneficial reuse of biosolids, the EPA concurred that additional research on emerging contaminants would be advantageous. In October 2020, the USEPA issued a Request for Applications (RFA) seeking applications proposing research on pollutants in biosolids. Findings from this research may result in regulatory changes to address emerging contaminants (i.e., PFAS, microplastics, etc.).
- State:
    - PFAS limits may be established based on findings from the SWRCB sampling and analyses. If stringent PFAS concentration limits are established for biosolids, this could

limit land application. Implementing advanced thermal processing and emerging technologies could be viable options.

- Senate Bill 1383 (SB 1383) requires 50 percent diversion of organics (including WWTP solids and biosolids) from landfills by 2020 relative to 2014 levels and 75 percent diversion by 2025. This could increase codigestion of organics at WWTPs. Regulations recently adopted under SB 1383 prevent county ordinances from unduly restricting the land application of biosolids. In turn, enabling the expansion of Class B land application.
- The state requires increased tracking and reporting of organic waste recycling and disposal (including sludge, biosolids, and digestate).
- Beginning in 2020, use of biosolids as Alternative Daily Cover (ADC) no longer qualified as beneficial use, it is considered disposal.
- Recently, several local ordinances banning or limiting land application of biosolids have been overturned (Measure E in Kern County, Measure X in Imperial County).
- Competition on beneficial end-use markets (i.e., composting, land application, etc.) is anticipated to increase, which would increase prices for disposal or biosolids beneficial use.

Given the dynamic regulatory landscape, the District should keep a close eye on federal, state, and local regulations associated with landfill diversion, beneficial use options, and emerging contaminants. The District should choose biosolids processes which allow for the greatest flexibility of product that can be managed in a variety of markets to help to mitigate regulatory pressures and ensure the sustainability of the District's biosolids management program.

3. Biosolid End-Use Market Assessment

To provide information on potential biosolids end-use market opportunities associated with applicable technologies and corresponding products, an end-use market assessment was conducted. Technologies and products evaluated are shown in **Table 3-1**:

Table 3-1 Biosolids End-Use Technologies and Products Evaluated

Technology	Product
Mesophilic Anerobic Digestion	Class B Cake
Thermal Hydrolysis Pretreatment	Class A/EQ Cake
Thermo-Chemical Hydrolysis	Class A Liquid
Gasification and Pyrolysis	Class A/EQ Biochar
Thermal Drying	Class A/EQ Dried Granule
Composting	Class A/EQ Compost

Markets evaluated for biosolids end-use include bulk agriculture (feed/forage crops, food crops, and rangeland), land reclamation (fire-ravaged land and mined land), energy (cement kilns), and specialty markets (soil blenders, landscape supply companies, nurseries, and golf courses).

Compost, biochar, and dried products showed the highest potential to be beneficially used a variety of markets including feed/forage crops, food crops, nursery, and golf course markets if adequate public outreach and demonstration efforts are completed. All three products have potential for management by the District (i.e., a "self-managed" program). Notably, biochar may provide an opportunity for the technology vendor to manage the product.

Product	Management Method	Low Outside the Gate Cost ($/WT)	High Outside the Gate Cost ($/WT)	Low Annual Outside-the-Gate Costs or Revenues	High Annual Outside-the-Gate Costs or Revenues
Class B Cake	TPC	($35)	($40)	($462,000)	($528,000)
Class A/EQ Cake	TPC	($35)	($40)	($364,000)	($416,000)
Class A Liquid	TPC	($25)	($35)	($550,000)	($770,000)
Class A/EQ Dried	SMP	$10	($5)	($35,000)	($87,500)
Class A/EQ Compost	SMP	$10	($5)	$83,000	($146,500)
Class A/EQ Biochar	TPC or SMP	$5	$0	$11,500	$0

TPC = Third-party contractor; SMP = Self-managed program

Parentheses indicate negative $ (cost) values. Absence of parentheses indicate positive $ revenue.

All costs are shown in 2020 dollars.

The end-use market assessment shows that compost, biochar, and dried products are most desirable products in the end-use market with the lowest cost for disposal.

4. Existing Biosolids Management and Disposal Methods

The District's WWTP currently processes solids produced from primary and secondary clarification onsite as illustrated in **Figure 4-1**. Primary sludge and scum are directly pumped to the digesters. Gravity belt thickeners thicken waste activated sludge (WAS) before feeding the mesophilic anaerobic digesters. The digested biosolids meets Class B requirements and are currently dewatered using centrifuges. Currently, the digester gas from the digesters is conveyed to a combined heat and power system to offset purchased electric energy and provide digester heating. The District's solids handling system has been operating with two (2) digesters in service since August 2017 and rehabilitation of the third digester is currently in progress.

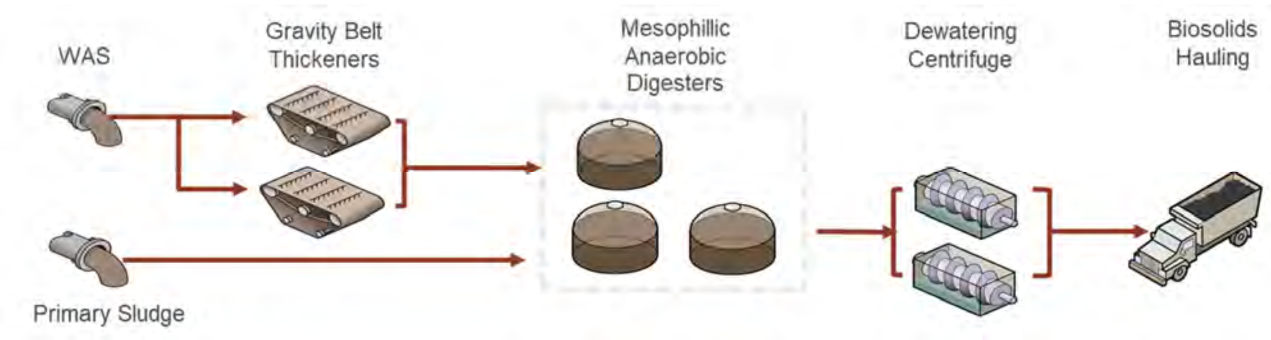


Figure 4-1 Existing Solids System Process Flow Diagram

The District currently has a contract with Synagro to handle biosolids hauling, disposal, and beneficial use. The current Synagro contract is based on 20-70 wet tons/day. The District generates approximately 35 wet tons/day of Class B biosolids. The 2020 costs by Synagro are provided in **Table 4-1.**

Table 4-1 2020 Synagro Hauling Costs

Objectives	Targets
Class B Beneficial Use	$50.00
Class A Beneficial Use	$80.00
Class B Disposal	$67.85
Off-spec Disposal	$71.25
Transportation to Lystek	$17.00

5. Anaerobic Digestion Capacity

The capacity of the anaerobic digesters was determined for various future operating scenarios, including changes to the liquid stream to accommodate secondary capacity expansion and nutrient removal. This capacity analysis was used to understand the risk of not meeting the required 15-day hydraulic retention time required for class B solids. **Figure 5-1** shows approach to assessing the process vulnerability of anaerobic digestion at the WWTP.

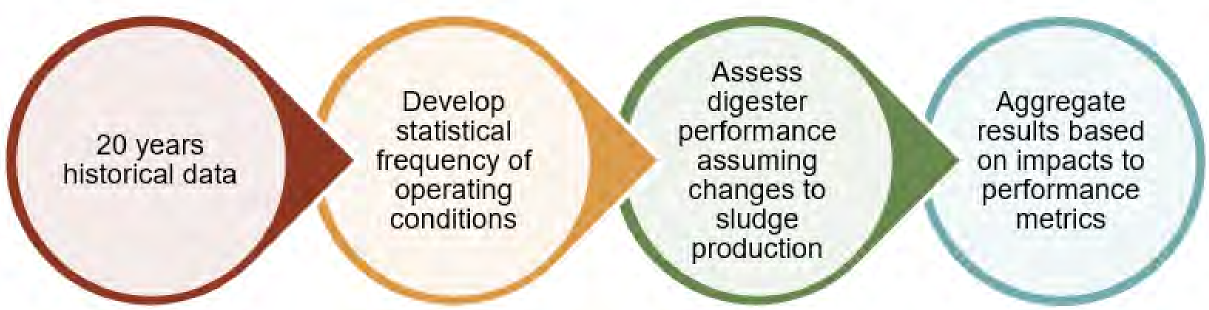


Figure 5-1 Anaerobic Digestion Vulnerability Assessment Approach

Target operating conditions were reviewed with staff. To maintain an appropriate factor of safety over the minimum regulatory requirement for HRT and to ensure the District can adequately service and clean digesters, the operational targets were developed as outlined in Table 5-1. These targets, summarized below, were discussed with staff and agreed upon for this analysis.

Table 5-1 Anaerobic Digestion Vulnerability Analysis Operational Targets

Parameter	Value
Minimum number of Digesters in Service	2
Minimum HRT with Two Digesters in Service	18 days
Minimum HRT with Three Digesters in Service	20 days

Capacity was evaluated assuming two sludge production rates (tracks) corresponding to liquids process with and without the TTFs in service. These two scenarios are low sludge yield (current operation with the TTFs) and high sludge yield (future operation with suspended growth and no TTFs).

These were coupled with flow and load projections summarized in **TM 01 Flows and Loads.** As noted in **Figure 5-1** the digesters were considered over capacity when the operational targets could not be met on a maximum month basis.

Table 5-2 Sludge Yield for current and future liquid stream operation

	Primary Sludge		Waste Activated Sludge	
	AA	MM	AA	MM
Low Sludge Yield (Current operation)	1,500 lbs/MG	1,600 lbs/MG	1,800 lbs/MG	2,000 lbs/MG
High Sludge Yield (Future operation w/o TTF)	1,900 lbs/MG	2,100 lbs/MG	2,200 lbs/MG	2,500 lbs/MG

Total digester feed in gpd was determined for a range of influent flows for both high and low sludge yield scenarios and compared to the maximum digester loading that can meet the operational targets detailed in **Table 5-1Figure 5-2** shows the digester influent maximum month sludge projections compared to the limit for two digesters online.

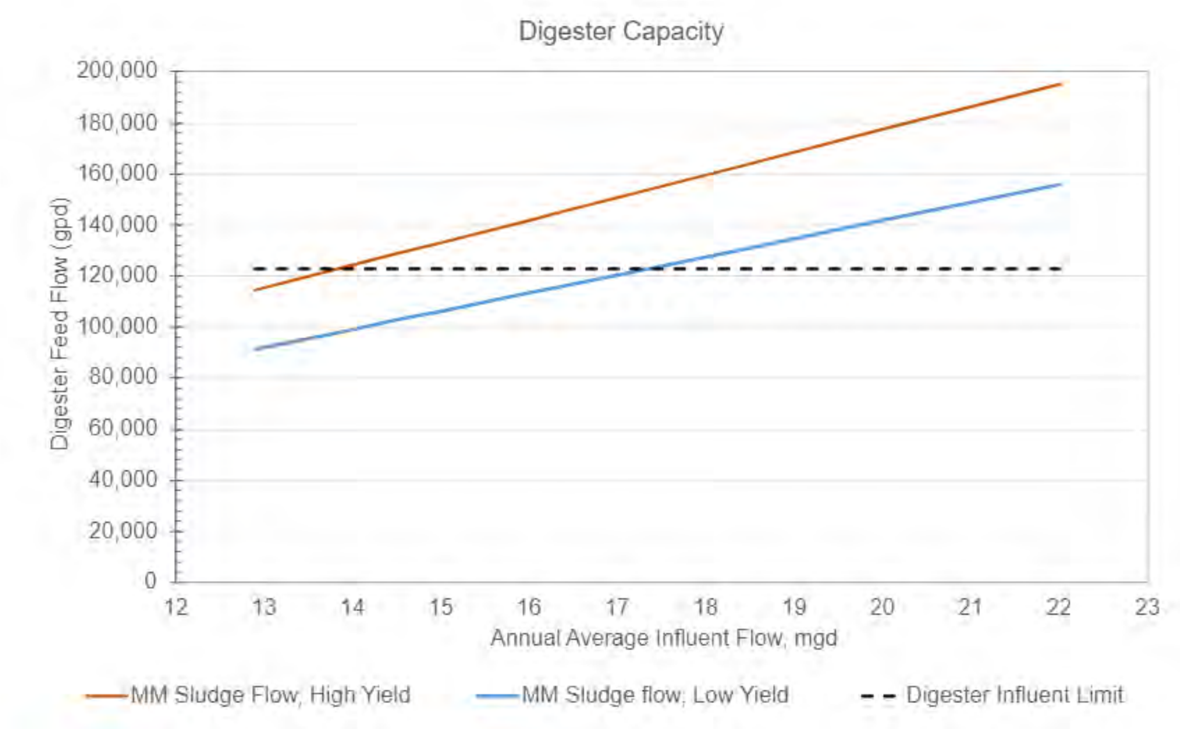


Figure 5-2 Digester Capacity with Two Digesters Online for High and Low Sludge Yields

As expected, digester influent flow increases as plant influent flow increases for either the high or low sludge yield scenarios. Both scenarios show that the sludge production will surpass the capacity for two digesters online. For two digesters in service, the plant will reach anaerobic digestion capacity as outlined in **Table 5-3**:

Table 5-3 Anaerobic Digestion Capacity

Scenario	annual Average Influent Flow (mgd)
Low sludge yield scenario	17.5
High sludge yield scenario	14

The flow projection window for 2040 is 16 mgd to 18.4 mgd as described in **TM 01 Flows and Loads**. **Increases in flows and loads to the WWTP will necessitate an increase in digester capacity at the WWTP** as indicated by **Figure 5-2** and **Table 5-3**. Required process changes that occur in the liquid stream (decommissioning of the TTFs, as described in **TM 04 Nutrient Management**) will increase sludge production, accelerating the need for additional digester capacity. However, under both a high sludge production and low sludge production scenarios, the increase in digester capacity will be needed within the planning period. In the near-term, **allowing for digester operation at 17-day minimum HRT will provide some process buffer.**

6. Biosolids Management Alternatives Analysis

6.1 Objectives

As indicated in **TM 03 Vulnerability Assessment and Process Control Monitoring and Optimization**, the existing digesters will not have the capacity to treat anticipated future flow of 18.4 mgd due to load increases and process changes in the liquid stream. It will therefore also not have capacity to accept HSW to enhance biogas and bioenergy production within the planning period. In addition, as concluded in **Section 2** there is uncertainty surrounding Class B biosolids disposal or beneficial use in the state of California. In this evaluation, Hazen aims to identify alternative biosolids management options to achieve the following:

- **Increase Digester Capacity**. Preliminary evaluation of options to increase the digestion capacity that would allow the District to pursue HSW co-digestion and generate Class B product.
- **Evaluate Advanced Processing Options.** Review options to produce other biosolids products (**Class A/EQ dried product, biochar, etc.)** which was found favorable as a result of the end-use market assessment (**Section 3**).
- **Investigate Other Biosolids Management Options**. To include winter storage of biosolids.

6.2 Alternatives to Increase Anaerobic Digestion Capacity

6.2.1 Approach

The approach to analyzing options to increase anaerobic digestion capacity at the WWTP included technical assessment and economic and non-economic evaluations. The step-by-step approach adopted to evaluate alternatives to increase anaerobic digestion capacity is outlined in **Figure 6-1**.

Figure 6-1 Approach for Analyzing Anaerobic Digester Capacity Options

The District's planning horizon for the 2022 Master Plan is 2040. The flows and loads analysis predicted the following range of digestion feed flows and loads at Annual Average (AA) and Maximum Month

(MM) Conditions. Although projected influent flows range between 16-18.4 mgd for 2040, the more conservative 18.4 mgd was selected for this evaluation. **Table 6-1** outlines the sludge projections for various methods.

Table 6-1 Sludge Projection by Various Methods

Influent Flow	Projection Method	Year	Digester Influent Annual Average (AA)		Digester Influent Maximum Month (MM)	
mgd	Current	2020	gpd	lbs/day	gpd	lbs/day
12.9		2020- Current	102,700	50,600	114,400	56,400
15.0	Method B - DOF	2030	119,500	58,900	133,000	65,600
16.0		2040	127,500	62,800	142,000	69,900
16.3	Method A - ABAG	2030	129,800	64,000	144,600	71,300
18.4		**2040**	**146,600**	**72,200**	**163,300**	**80,400**
20.0	2011 Master Plan	2030	159,300	78,500	177,400	87,400
22.0		2040	175,300	86,400	195,200	96,200

Assumptions: 6% TS, 81% VS/TS ratio (based on historical data)

6.2.2 Alternatives Considered to Increase Anaerobic Digestion Capacity

Three alternatives were considered to increase anaerobic digestion capacity as shown in **Figure 6-2.** These were determined after discussion with the District.

Alternative 1. Adding a New Digester

Alternative 2. Recuperative Thickening

Alternative 3. High Solids Digestion

Figure 6-2 Alternatives Considered to Increase Anaerobic Digestion Capacity

The alternatives to increase anaerobic digestion capacity are evaluated based on **Volatile Solids Loading (VSL)** limit and **Hydraulic Retention Time (HRT)** to maintain firm and total capacity. These are outlined in:

- **Firm Capacity**: Digestion capacity to maintain required HRT with one digester out of service.

- **Total Capacity**: Digestion capacity to maintain required HRT with all units in service.

Table 6-2 Evaluation Criteria

Evaluation Criteria	Value
Hydraulic Retention Time (HRT)	
Capacity at AA condition (Firm/Total)	20 days/ 25 days
Capacity at MM condition (Firm/Total)	18 days /20 days
Volatile Solids Loading (VSL)	
Anaerobic Digestion - Max	0.20 lbs VS/CF
High Solids Digestion - Max	0.30 lbs VS/CF

Each alternative was evaluated in two tracks corresponding to a high and a low sludge yield scenarios.

- Track 1 - Current operation mode with Trickling Filters (TTFs), low sludge yield scenario
- Track 2 - Future changes in liquid stream processes without TTFs for biological nutrient removal, higher sludge yield scenario.

6.2.3 Alternative 1 - Fourth Anaerobic Digester

Alternative 1 evaluated construction of an additional digester (1.1 MG) to restore redundancy in the digestion process as show in **Figure 6-3**. The existing digester volume would have adequate capacity to meet requirements of an 18-day HRT under MM flow conditions with all three units in service. However, in 2040, the expected HRT at under MM flows and loads condition is 17 days with two units in service which is less than 18 days. A higher sludge yield is estimated with Track 2 (**Figure 6-5**), and therefore the digester capacity would need to be increased earlier compared to Track 1(**Figure 6-4**).

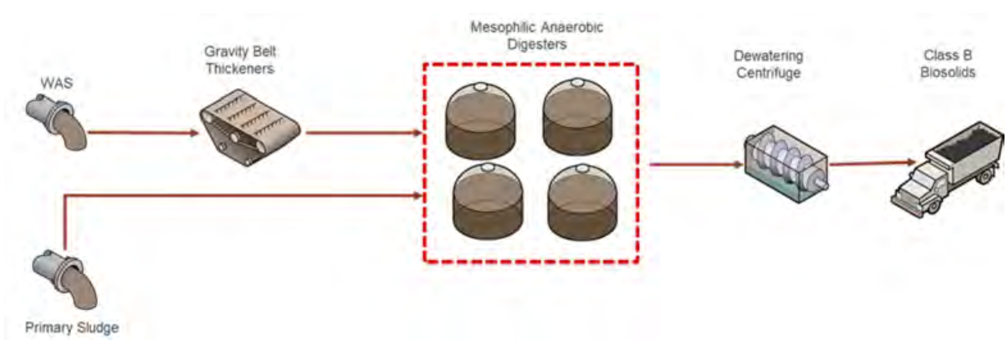


Figure 6-3 Alternative 1 - Fourth Anaerobic Digester Process Flow Diagram

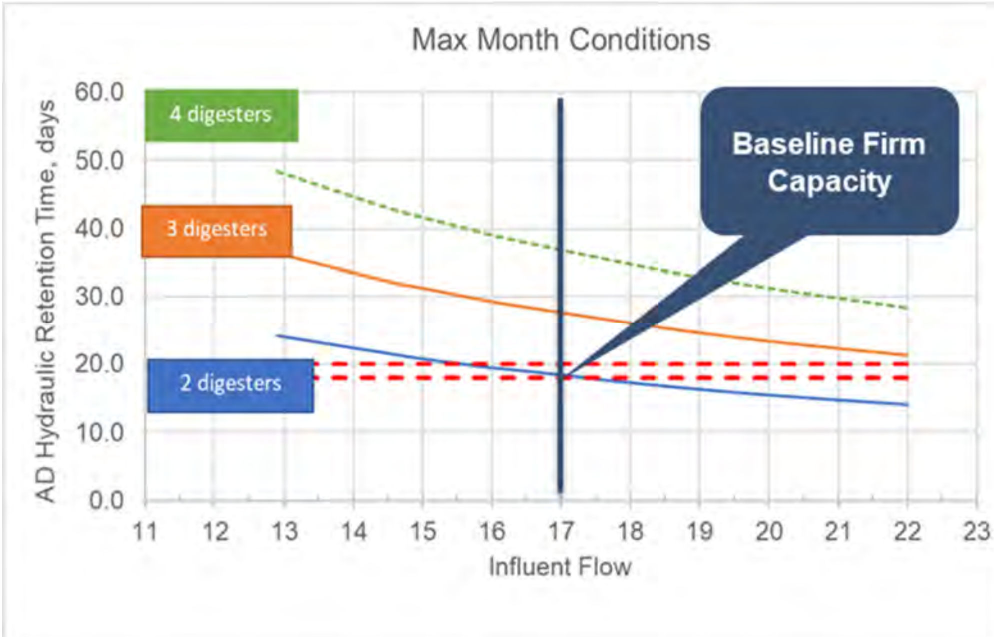


Figure 6-4 Fourth Digester with Low Sludge Yield Scenario

Under the low sludge yield scenario, the digestion baseline firm capacity is 17 mgd, with two digesters in operation. Each digester can provide approximately 8.5 mgd capacity to maintain the 20-day HRT at AA condition and 18-days HRT at MM condition. With a fourth digester, the firm capacity is increased to **25.5 mgd** with three digesters in operation.

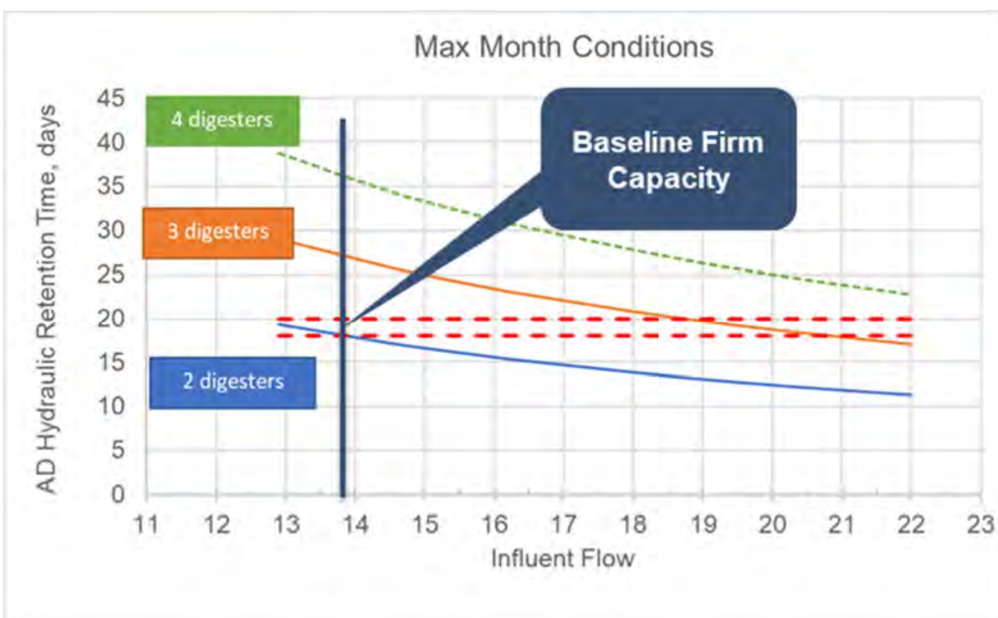


Figure 6-5 Fourth Digester with High Sludge Yield Scenario

Under the high sludge yield scenario, the digestion baseline firm capacity is 14 mgd, with two digesters in operation. Each digester can provide approximately 7 mgd capacity to maintain the 20-day HRT at AA condition and 18-days HRT at MM condition. With a fourth digester, the firm capacity is increased to **21 mgd** with three digesters in operation.

6.2.4 Alternative 2 - Recuperative Thickening

Alternative 2 evaluated recuperative thickening to increase digestion capacity without constructing a new digester. In this alternative, installation of a new thickener to thicken the digested biosolids to approximately 7% prior to re-feeding to the digesters is required.

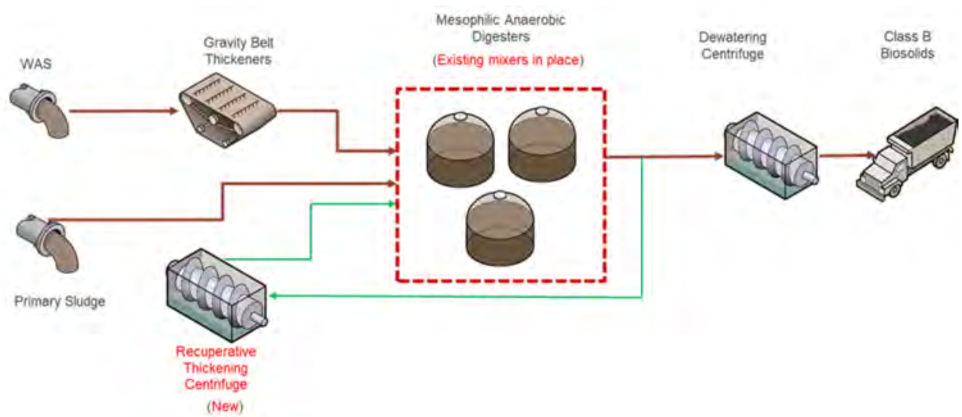


Figure 6-6 Alternative 2 - Recuperative Thickening Process Flow Diagram

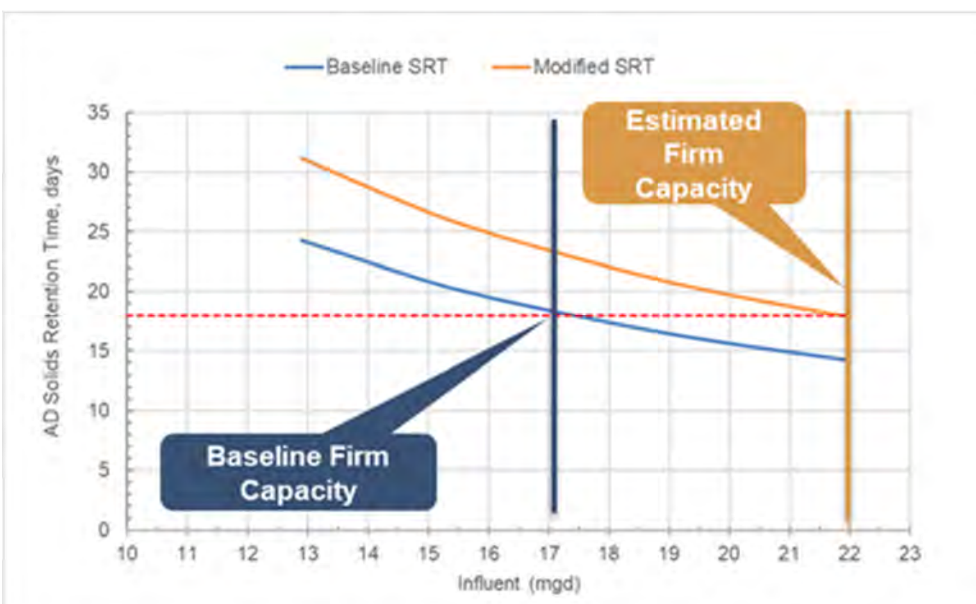


Figure 6-7 Recuperative Thickening with Low Sludge Yield Scenario

Under the low sludge yield scenario, with recuperative thickening, each digester could handle up to 11 mgd influent flow. With two digesters in service and one standby digester, recuperative thickening can provide a firm capacity up to 22 mgd.

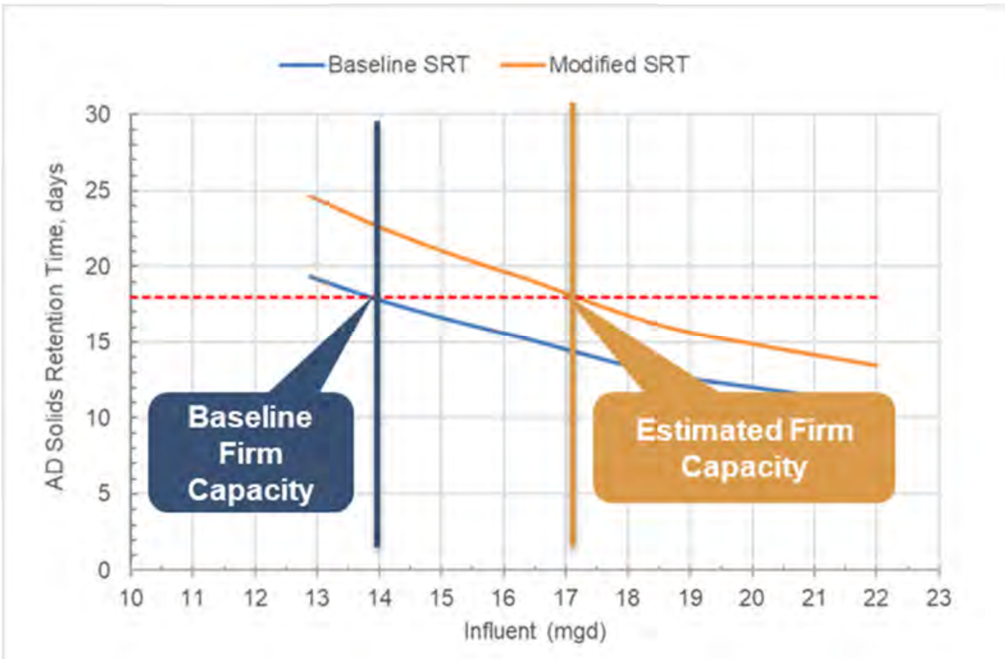


Figure 6-8 Recuperative Thickening with High Sludge Yield Scenario

Under the high sludge yield scenario, with recuperative thickening, each digester could handle up to 8.5 mgd influent flow. With two digesters in service and one standby digester, recuperative thickening can provide a firm capacity up to 17 mgd. This option does not provide adequate capacity to meet the 2040 planning horizon.

6.2.5 Alternative 3 – High Solids Digestion

Alternative 3 evaluated recuperative thickening at higher solid concentration to increase digestion capacity without constructing a new digester. In this alternative, installation of a new thickener will thicken the digested sludge between 10% and 12% TS prior to re-feeding the digesters. New mixing systems must be installed in each digester to handle high solids mixing for this alternative.

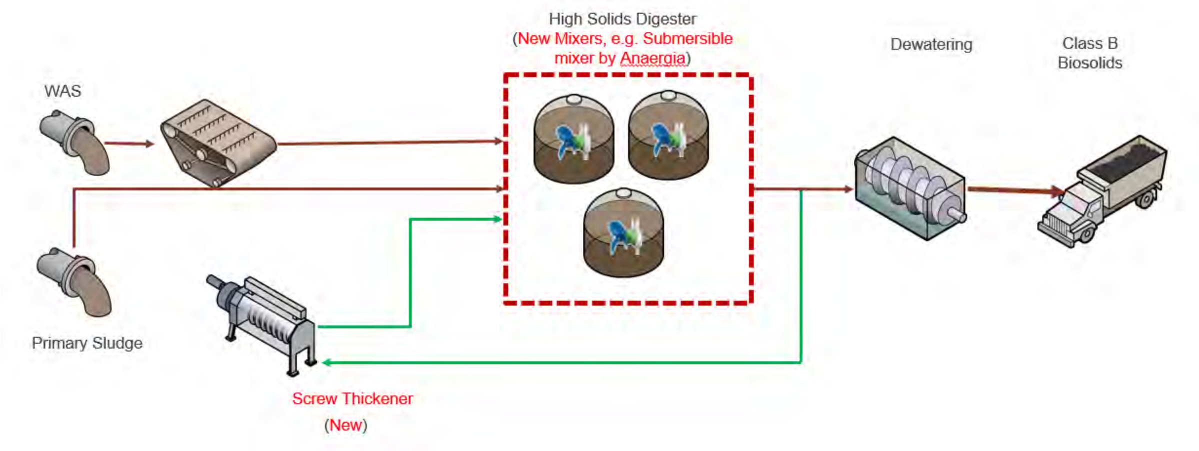


Figure 6-9 Alternative 3 – High Solids Digestion Process Flow Diagram

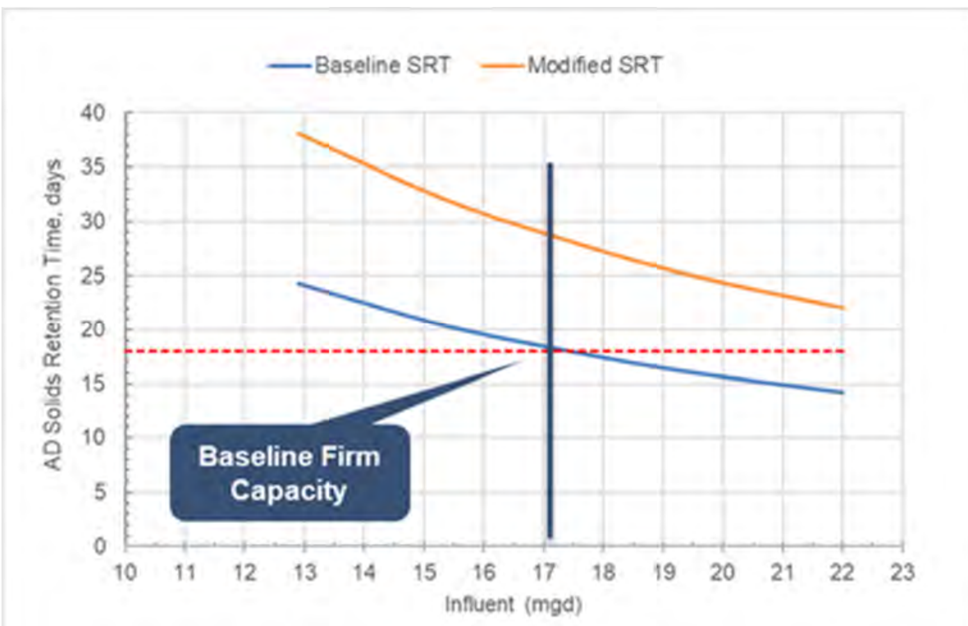


Figure 6-10 High Solids Digestion with Low Sludge Yield Scenario

Under the low sludge yield scenario, with high solids digestion, each digester would treat **over 11 mgd** influent flow. High Solids Digestion can provide firm capacity **beyond 22 mgd** influent flow.

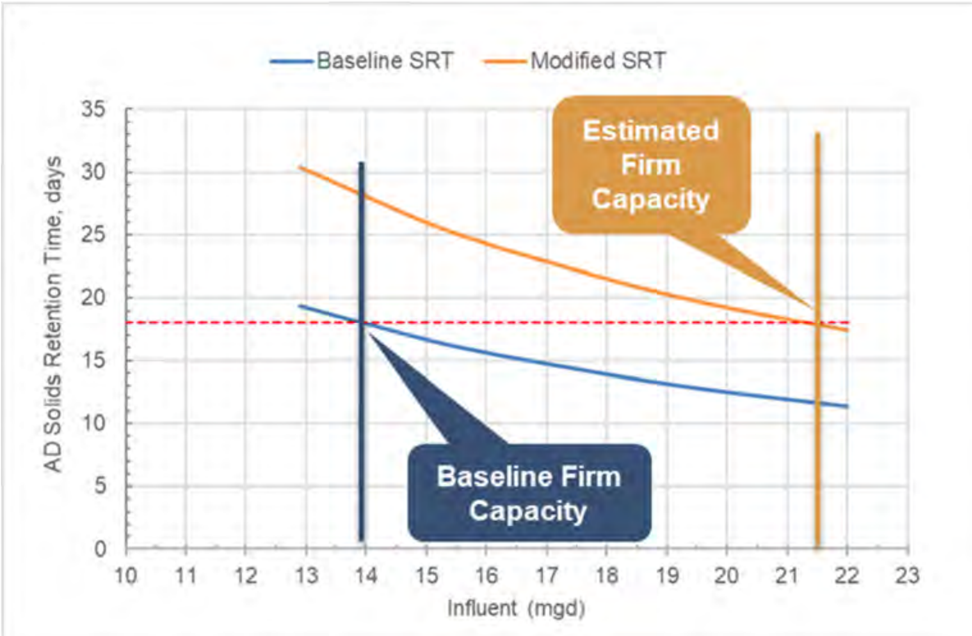


Figure 6-11 High Solids Digestion with High Sludge Yield Scenario

Under the high sludge yield scenario, with high solids digestion, each digester would treat **11 mgd** influent flow. High Solids Digestion can provide firm capacity **up to 21.5 mgd** influent flow.

6.2.6 Alternative Comparison

Each alternative will increase digestion capacity at the WWTP. **Table 6-3** summarizes the increase in capacity from each alternative. However Alternative 2 – Recuperative Thickening will not provide enough of capacity increase to accommodate the high sludge yield scenario for 2040 loading conditions. Both Alternative 1 – New Digester and Alternative 3 – High Solids Digestion will provide an increase in firm capacity to accommodate future loading scenarios through 2040.

Table 6-3 Capacity Alternatives Summary

Alternative	Firm Capacity Increase	Total Capacity Increase
New Digester	50%	30%
Recuperative thickening	20%	20%
High Solids Digestion	>50%	>50%

Capital and operating and maintenance (O&M) costs were developed for the three alternatives as presented in **Table 6-4**.

Table 6-4 Capacity Alternatives Capital and O&M Costs

Alternative	New Digester ($M)	Recuperative Thickening ($M)	High Solids Digestion ($M)
Probable Construction Cost	$8.6	$2.5	$10.3
O&M Cost *PW at 20 Years 2% Rate*	$1.6[1]	$2.3	$1.7

[1]O&M includes pump mixing

Recuperative Thickening appears to be the most cost-effective alternative to increase digester capacity. Considering the operations change in the future (Track 1 vs Track 2), recuperative thickening would buy time until influent flow reaches 17 mgd however would not provide capacity for anticipated 2040 flow (18.4 mgd).

New Digester addition significantly increases digestion capacity and provides sufficient capacity for 2040. It is a reliable, proven way to increase capacity. Considering economic factors, new digester addition is a preferred option.

High Solids Digestion provides the highest capacity increase without the need to construct a new digester. However, retrofitting existing process would be complex and not be financially favorable.

6.2.6.1 Non-economic evaluation

A non-economic comparison was performed to weigh additional factors in determining a preferred alternative. Four main categories and 11 subcategories were identified with the District for non-economic evaluation of alternatives. Weighting and scoring of each criterion were also discussed. The categories and the questions asked for each category are presented in Table 6-5.

Table 6-5 Non-economic Evaluation Criteria

Criterion	Weight	Questions
Technical	30%	• How much improvement does this technology provide on digester capacity? • Does the technology provide flexibility in operation? • Is this considered as a reliable technology with proven successful operating records for long period of time?
Compatibility with Existing Process	40%	• How easily can the technology be integrated with existing infrastructure? • Will this alternative change the quantity and quality of the sidestreams? • Can this technology contribute to long-term biosolids management objectives? • Does this alternative contribute phasing options to the overall program?
Environmental	10%	• Will this alternative need a permit or any modifications to existing permit? • Will this alternative reduce the greenhouse gas emissions and carbon footprint?
Logistical	20%	• What will be the process footprint? • What level of technical expertise and level of effort will be required by staff to operate and maintain the process?

Non-economic comparison of alternatives includes unweighted and weighted criteria evaluation. The non-economic evaluation marginally favors high solids digestion (Alternative 3) due to its flexibility and the ability to provide the highest increase in capacity. However, constructing new digester is not far behind in scoring.

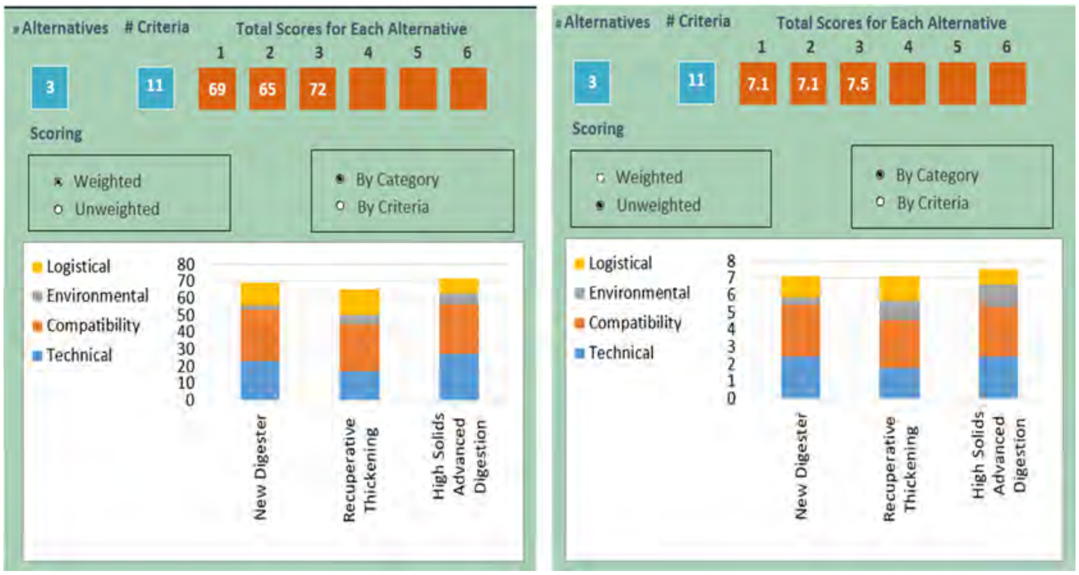


Figure 6-12 Capacity Alternative Non-economic Evaluation Summary

The addition of a new digester significantly increases digestion capacity and provides sufficient capacity for both Track 1 and Track 2. It is a reliable method to increase capacity. Considering economic factors, and relatively close non-economic factors, a new digester addition is the preferred option.

6.2.7 Impact of Digester Capacity Improvements on HSW Co-digestion

The District currently has a HSW program that has the capacity to accept 5,000 gpd of FOG. With proposed capacity enhancements, the District could have sufficient capacity to expand their existing HSW program.

Adding a new digester will increase digestion capacity to accept HSW significantly. In 2040, which has an equivalent flow of 18.4 mgd, the District could accept over 10,000 gpd of HSW. Although recuperative thickening increases capacity to certain extent, the high solids in the digester could provide operational issues of the existing pump mixing system in the digesters. Therefore, the benefit of this alternative would be limited for HSW co-digestion. On the other hand, high solids digestion and the mixing would be compatible with HSW co-digestion and with enhanced capacity, the District could expand existing HSW program beyond 10,000 gpd.

6.3 Review of Advanced Processing Options

The options assessed to increase anaerobic digester capacity continue to produce Class B cake, similar to the product the District currently produces. This section reviews options to produce other biosolids products (Class A/EQ dried product, biochar, etc.) which was found favorable as presented in **Section 3**. These end products provide flexibility of end-use with more adaptability to changes in market/regulations. The following sections evaluate advanced treatment processes that might be applicable to the District. These options are thermal drying, gasification/pyrolysis, supercritical water oxidation, and hydrothermal liquefaction.

6.3.1 Thermal Drying

Thermal drying generates Class A/EQ dried product with greater than 90% dry solids and thus significantly reduces the hauling costs and the volume of the final product to be managed (disposed or beneficially used). The final product could be beneficially used for land application, as an energy source in cement kilns, or in a gasification process. Excess biogas that is not used for anaerobic digester heating can be used by dryers. Thermal drying is a well-established technology that could diversify the District's biosolids management portfolio and can be coupled with gasification/pyrolysis technologies in the future. The quality of dried products varies depending on drying technology and should be considered as an important factor when selecting a drying technology.

Types of Thermal Dyers

1. **Direct dryers** that have been successfully used for drying municipal wastewater solids include rotary drum dryers and belt dryers.

    - **Rotary drum dryers** should not be considered due to size of facility, can be considered for regional opportunities.
    - **Belt dryers** operate at relatively low temperatures that range from 130-177℃ (265-350°F). Sludge is placed on porous conveyor belt, and the heated gas is blown or drawn through the

Figure 6-13 Thermal Dryer Products

layer of solids on the belt. Belt dryers are typically more suitable for small to medium facilities.

2. **Indirect dryers** that have been successfully used for drying municipal sludge include tray dryers, paddle dryers, disc dryers, and rotary chamber dryers.

    - **Paddle dryers** and **disc dryers** are types of hollow flight dryers. Both paddle dryers and disc dryers consist of a stationary horizontal jacketed vessel containing two intermeshing, counter rotating agitator shafts with paddles.
    - **Rotary chamber dryers** are like paddle and disc dryers, except they have a hollow rotor and agitators, through which the heat transfer medium circulates. Heat is transferred to the biosolids by conduction through the surfaces of the paddles. This type of thermal dryer operates at relative low temperature drying (350°F -450°F).
    - **Tray dryers** are similar to disc dryers except they are configured vertically and mix recycled granules with dewatered solids before feeding them to the dryer. Tray dryers have limited installations in the US.

6.3.2 Gasification/Pyrolysis

Advanced thermal processes including gasification and pyrolysis are promising technologies that are also capable of removing PFAS compounds, providing additional resilience to the District to changes in regulations. The byproducts from these processes can be used in different markets.

Table 6-6 Gasification/Pyrolysis Comparison

Parameter	Incineration	Gasification	Pyrolysis
Temperature (°F)	1,650-2,000	1,100-1,800	390-1,100
O_2 Supplied	> Stoichiometric (Excess Air)	< Stoichiometric (Limited Air)	None
By-Products	Flue Gas (CO_2, H_2O) and Ash	Syngas (CO, H_2) and Ash	Pyrolysis Gas, Oils, Tars and Char

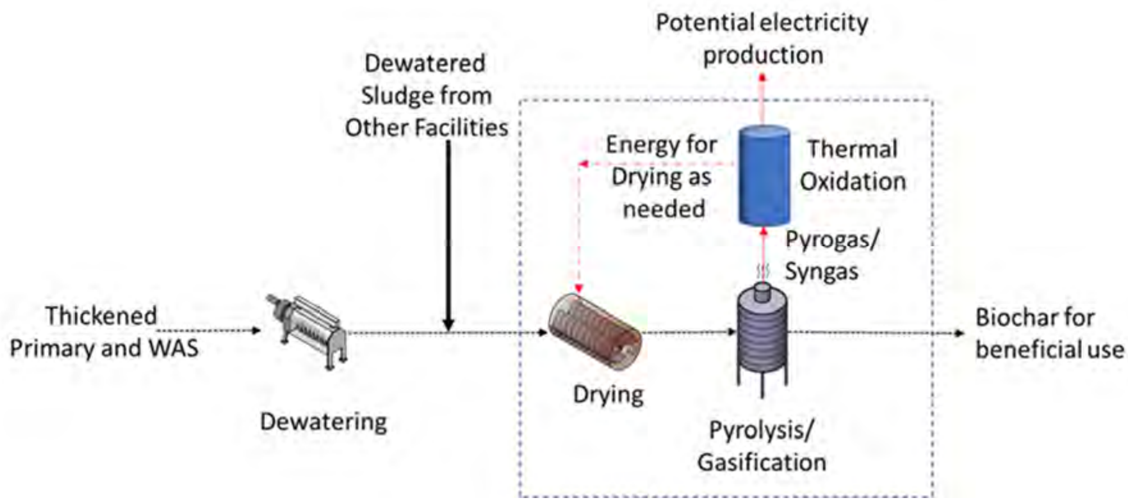


Figure 6-14 Typical Gasification/Pyrolysis Process Flow Diagram

Both gasification and pyrolysis processes require drying of the feed biosolids to generally more than 80% solids. The processes produce syngas or pryogas. It is speculated that this low temperature helps to de-sorb PFAS compounds from the solids and transfer it to the syngas. The syngas is then thermally oxidized at high temperature (~2000 ºF) which destroys the PFAS compounds. The energy generated from the thermal oxidation of the syngas can be used to provide energy for drying. **Gasification/ Pyrolysis technologies are emerging and reaching commercial scale.**

There are currently five gasification/pyrolysis facilities from different vendors being constructed in the U.S. in the last two years.

Table 6-7 Recent Gasification/Pyrolysis Installations

Facility and Location	Vendor	Drying/Thermal process	Size (wet tons/day)	Status
Silicon Valley Clean Water, CA	Bioforcetech	Biodry/Pyrolysis	20	Operating since 2017
Morrisville, PA	Ecoremedy, LLC	Thermal drying/ Gasification	70	Operating since 2021
Linden Roselle Sewage Authority, NJ	Aries Clean Energy	Thermal drying/ Gasification	430	Operating since 2022
Schenectady, NY	Biowaste Pyrolysis Solutions	Dual thermal drying/Pyrolysis	100	Commissioning 2Q 2021
Rialto, CA	Anaergia	Thermal dryer / Pyrolysis	300	Commissioning 3Q 2021

6.3.3 Hydrothermal Liquefaction

Production of fuel via hydrothermal liquefaction (HTL) could provide an economically favorable alternative to anaerobic digestion and other existing sludge management practices. HTL uses temperature and pressure to convert wet organic matter to biocrude oil and methane gas (**Figure 6-15**) in less than an hour. Key features of this process include:

- T = 360°C; P = 200 bar (20 MPa)
- Captures >85% of feedstock energy
- Uses <14% of fuel energy produced to run the system
- After mechanical dewatering, solids at 15-25% solids could be diverted to HTL process.
- The process does not require installation of drying or even digestion processes.

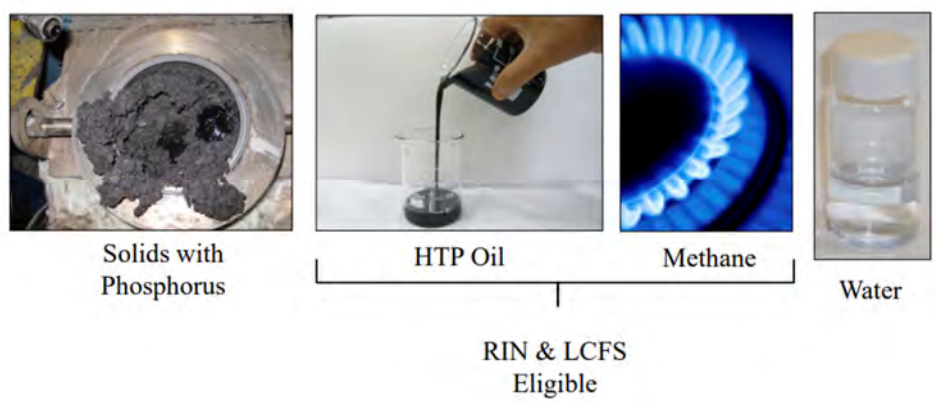


Figure 6-15 Hydrothermal Liquefaction End Products

RIN: Renewable Identification Number; LCFS: Low Carbon Fuel Standard
Photo Credit: Genifuel

The process was initially developed over 30 years ago by Department of Energy (DOE) at Pacific Northwest National Lab (PNNL). HTL was recently supported by Water Research Foundation as HYPOWERS Demonstration Project at Central Contra Costa Sanitary District. The process is still in demonstration stage and is not well established.

6.3.4 Supercritical Water Oxidation

Supercritical water oxidation (SCWO) refers to the oxidation of organics in water in supercritical phase of water. These conditions represent the most aggressive, in terms of temperature and pressure, of all thermal oxidation processes. ‘Supercritical’ refers to the state of water within a specific region of pressure (>250 bar) and temperature (>374 °C). The physical properties of water, specifically its density, viscosity, diffusivity, dielectric constant, and its subsequent solubilization of organic and inorganic compounds, change significantly in the supercritical region. **SCWO converts organic waste into clean water, heat, electricity, and CO_2 in seconds (Figure 6-16).**

Figure 6-16 Super Critical Water Oxidation Process Concept

SCWO was originally commercialized in the 1980s but was subject to a number of operational challenges. These challenges led to the decline in implementation of the technology. Most of the SWCO plants installed in the 1990s and early 2000s, have been shut down. Recently, it has been successfully demonstrated by a research team from Duke University with funding from the Gates Foundation for municipal wastewater sludge feed. The process is still in the demonstration phase.

6.3.5 Advanced Processing Summary

A summary of the high-level review of advanced processing is provided in **Table 6-8**. It compares the options for various criteria including energy consumption, footprint, ability to treat emerging contaminants such as PFAS, developmental status, ability to be a regional solution, ability to be a process for District use only, and compatibility with anaerobic digestion. More detailed Business Case Evaluations (BCE) are recommended for the future Biosolids Master Plan.

Table 6-8 Summary of Advanced Processing Options Review

Criteria	Thermal Drying	Gasification/ Pyrolysis	Hydrothermal Liquefaction	Supercritical Water Oxidation
Energy Consumption (NG and Electricity)	High	Medium	Not Available	Not Available
Footprint	Compact	Compact	Compact	Compact
PFAS and Emerging Pollutants Destruction	No	Yes	Yes	Yes
Development Status	Established	Emerging	Demonstration stage	Demonstration stage
Regional Solutions	Yes	Yes	Yes	Yes
District Only	Yes	Yes	Not commercially feasible	Yes
Digestion	Prefers digestion	Prefers no digestion	Prefers no digestion	Prefers no digestion

6.4 Winter Storage of Biosolids

The District purchased approximately 28.1 acres of property located adjacent to the WWTP from the Dow Chemical Company. Onsite storage of biosolids could provide some benefits considering the seasonal variation of biosolids land application. The use of the new property for biosolids storage was evaluated.

Figure 6-17 Property Acquired From Dow Chemical Company

The evaluation was based on 6 months of onsite biosolids storage (generally biosolids land application during the wet season between November to April can be challenging). The District would require holding 300,000 – 500,000 ft^3 of biosolids onsite. The required space for biosolids storage facility is 50,000 - 80,000 ft^2.

Based on preliminary assessments, the District has sufficient space to store biosolids onsite. However, several factors including odor potential, climate conditions, stability, topography, and proximity to water should be considered carefully in further evaluations.

7. Biosolids Path Forward

A roadmap (**Figure 7-1**) was developed to show the biosolids management options for the District and the associated trigger points to evaluate a change in operation. Advanced processing options, especially thermal drying and gasification/pyrolysis processes should be evaluated further in District's next Biosolids Master Plan as a near-term solution.

Long-term trigger points include:

- Digester capacity should be increased around 2030. A new digester would provide a cost effective and reliable solution, whereas the high solids digestion option provides non-economic benefits.
- The main triggers for advanced processing options are future regulatory considerations and high competition for available disposal/beneficial use sites and alternative markets.
- Alternative markets for end products are developing and variety of markets will help to mitigate regulatory pressures.

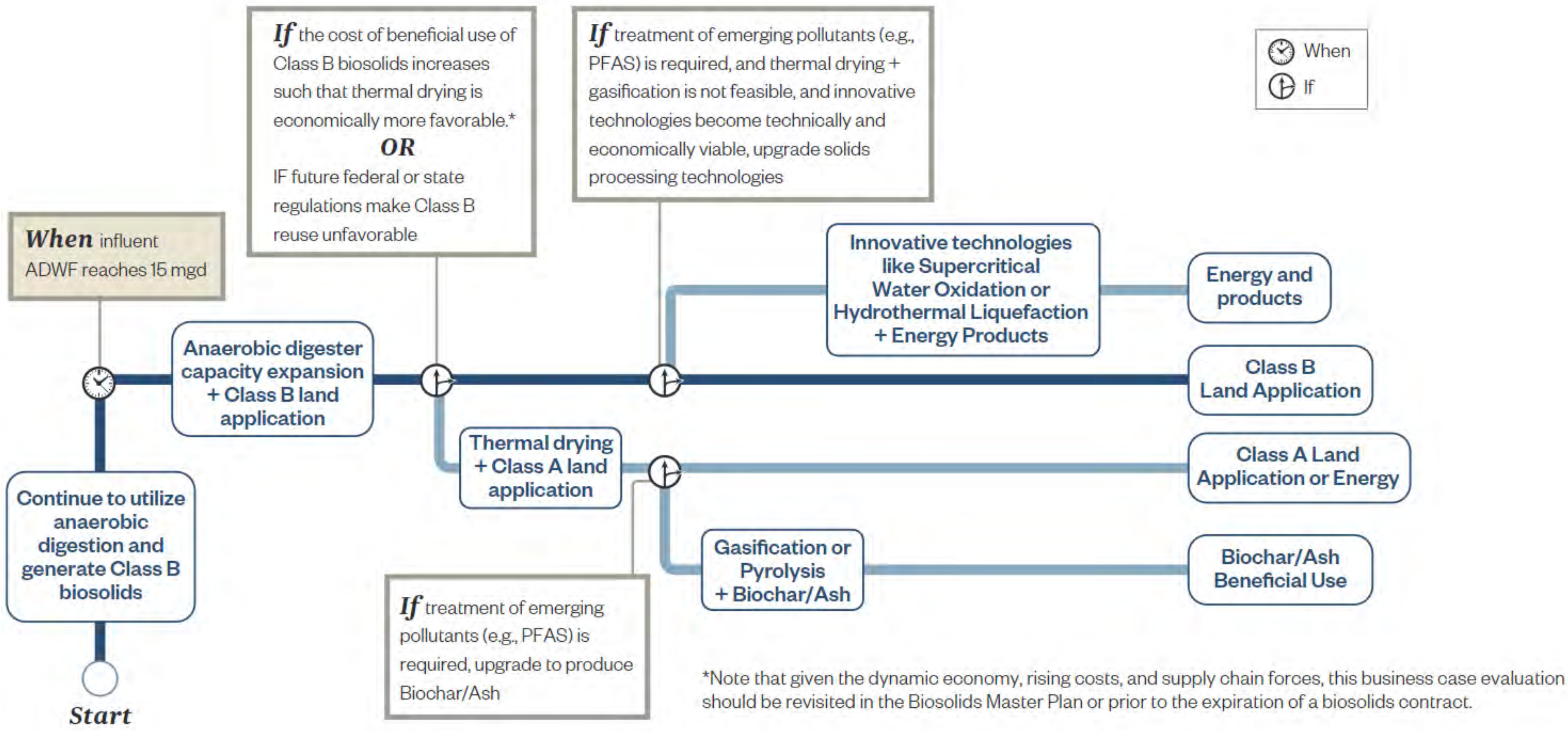


Figure 7-1 Biosolids Roadmap

8. Codigestion of High Strength Waste (HSW)

At current influent flows (12.8 mgd) the District beneficially reuses 100% of biosolids generated at the WWTP, primarily through land application. Additionally, the District generates 54% of the WWTP's electricity demand by fueling the District's 800-kW cogeneration (cogen) engine with biogas produced from anaerobic digestion.

As part of the 2021 Strategic Plan, the District has set an environmental stewardship goal to meet or surpass environmental and public health requirements to maintain public trust. To support this goal, the District has focused on resource recovery, including the continued beneficial reuse of biosolids and maximizing energy generation by leveraging renewable biogas.

Codigestion efforts to increase biogas production include the District's fats, oil, and grease (FOG) receiving station that operated from 2015 to 2018. Efforts ended when issues with digester operation halted receiving and the hauler found an alternative receiving facility. The District also pursued a partnership with Mt. Diablo Resource Recovery (MDRR) to receive organics extracted from processed municipal solid waste for codigestion at the WWTP as part of the East County Bioenergy Project. The project received grant funding for planning costs and 30% design documents were produced. The project was put on hold due to favorable composting rates negotiated by MDRR in the near-term.

8.1 High Strength Waste Market Assessment

The District engaged the Hazen/Material Matters team to conduct a high strength waste (HSW) market assessment to evaluate the availability of regional HSW to accept as feedstocks to the WWTP's anaerobic digesters (ADs). The goal is to assess the viability of an expanded hauled-in waste program to optimize use of digester capacity, increase energy production, and potentially increase revenues. The market assessment study identified sources of HSW within the 50-mile radius of the District.

The results (**Figure 8-1**) show that a large volume of Fat, Oil, Grease (FOG) is generated within the 50-mile radius of the District. Over 92,500 gallons per week of FOG and 0.60 million gallons of other HSW sources were identified. Beyond FOG, availability of other HSW sources were explored.

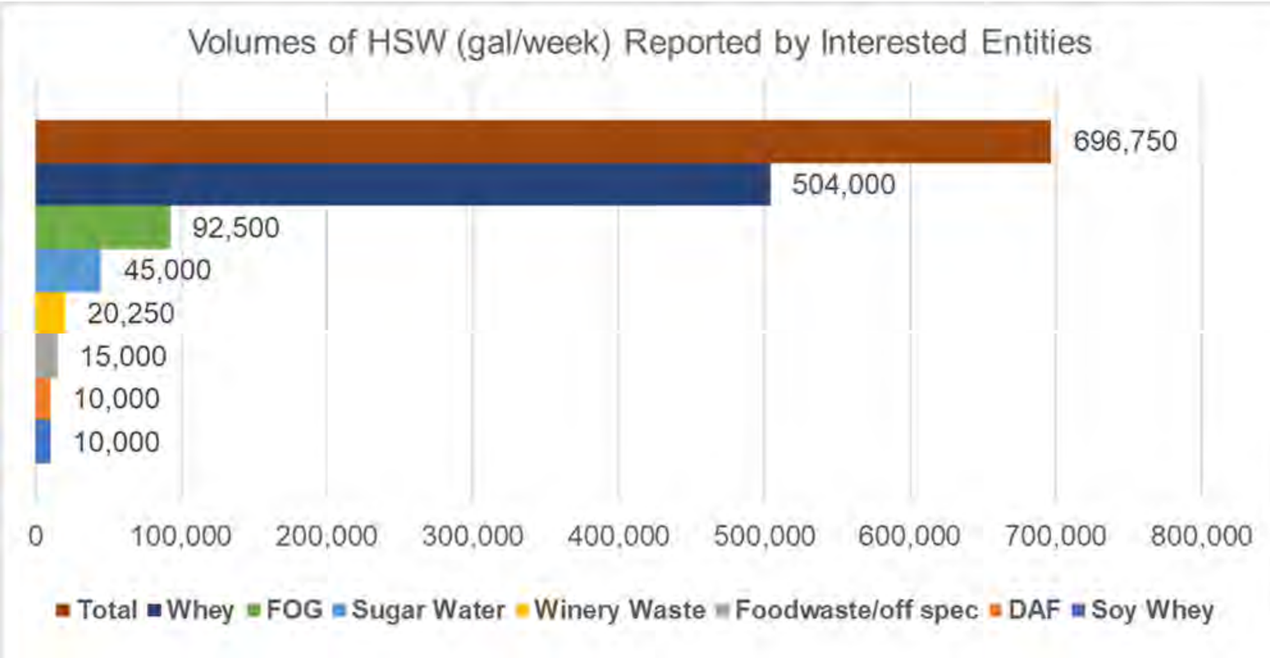


Figure 8-1 High Strength Waste Market Assessment Results

Whey and sugar water were identified as the most reliable sources of HSW for the District because of their availability. Sugar water and whey are generally cleaner compared to FOG and would require relatively less processing before feeding to the digesters for codigestion. **Table 8-1** summarizes key features and considerations of sugar water and whey. The main challenge for these alternative HSW sources would be the seasonal variation from the industries.

Table 8-1 Comparison of Sugar Water and Cheese Whey

Sugar Water	Whey
Seasonal variation, relatively lower volume is available	Consistently higher amount available
Simple sugars, easy to digest, gas increase in short period of time	Molecules are more complex, more difficult to digest
Generally, does not include many solids, mainly soluble material	It can include solids, which might increase overall biosolids generation
Higher tipping fees	Lower tipping fees
O&M is generally simple, may not need complex pretreatment (grinder etc.) or heating	May need additional units for screening due to higher solid content

Viable competitive tipping fees for different HSW categories and the range of fees haulers reported paying are summarized in **Table 8-2**. Most haulers indicated they would not be willing to pay higher than current pricing.

Table 8-2 Tipping Fees Associated with Various HSW types

High Strength Waste Type	Tipping Fee
Dissolved Air Floatation (DAF) Solids	$0.04 - $0.05
FOG	$0.03 - $0.08
Winery Waste	$0.04 - $0.07
Sugar Water	$0.05- $0.08
Food Waste/ Off Spec	$0.04 - $0.07
Whey/Soy Whey	$0.03 - $0.05

To restart codigestion at the WWTP the District will need to consider what type of material the District is willing to process including the capital costs associated with changes to the existing receiving and storage stations, abundance of material, tipping fees, and the competitive market for feedstocks. Key insights from the HSW market assessment include:

- Large volume of high strength waste is available within the District's 50-mile radius.
- Beyond FOG, whey and sugar water are identified as alternative feedstocks
- Competitive tipping fees are needed to incentivize haulers to transfer HSW to the District's facility.

8.2 High Strength Waste Codigestion Evaluation

Evaluating the impact of HSW addition on digester capacity includes the following steps:

1. **Organic waste market assessment** – The results from HSW market assessment were used to identify three (3) tiers for evaluations.
2. **Evaluate capacity** – Current flows and loads to the plant and the solids production from primary and secondary treatment processes were evaluated to determine the existing digestion capacity for the 3 tiers.

The estimated gas production from this section is used as an input for **Section 10** to develop the overall energy balance and evaluate biogas utilization alternatives by using Energy Balance Analysis Tool (EBAT). The three tiers used for the HSW codigestion assessments are:

- **Tier 1:** Limit HSW to the existing FOG receiving infrastructure (5,000 gpd HSW)
- **Tier 2:** Double the existing receiving capacity (10,000 gpd HSW)
- **Tier 3:** Codigest the maximum amount of HSW without exceeding digester capacity

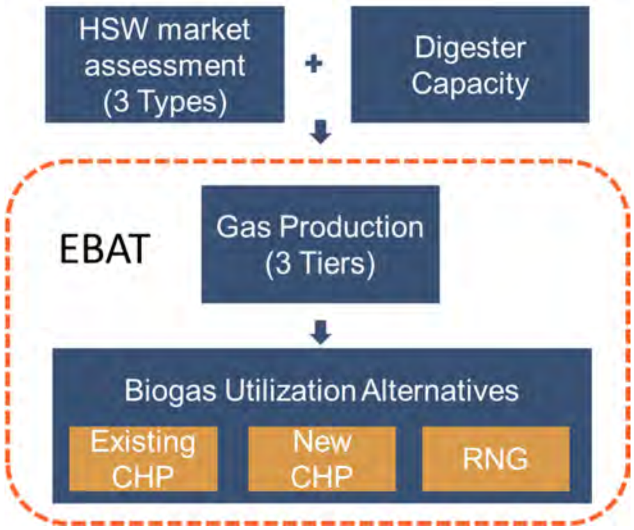


Figure 8-2 Approach to HSW Codigestion Evaluation

8.2.1 Tier 1 - Limit HSW to the existing FOG receiving infrastructure

As noted in **Section 5**, increased flows and loads will require that the District expand anaerobic digester capacity to maintain the desired redundancy and HRT for either high or low sludge yield operation. Addition of FOG/HSW at the existing receiving infrastructure (5,000 gpd) will further reduce the digester capacity and necessitate digester capacity improvements earlier in the planning period. Figure 8-3 illustrates the impact of codigesting 5,000 gpd of FOG or HSW on digester HRT.

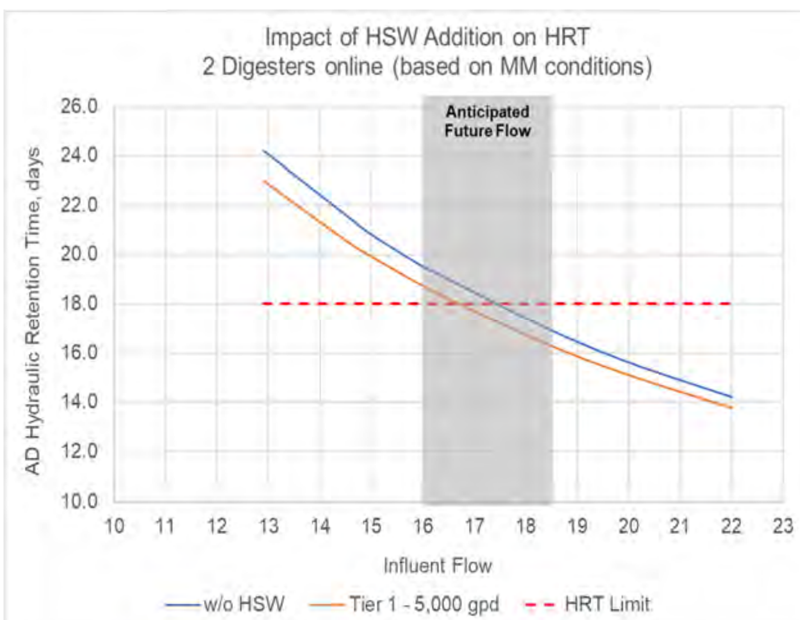


Figure 8-3 Impact of HSW Addition (Tier 1) on Digester HRT

8.2.2 Tier 2 - Doubling Existing Storage Capacity

Addition of FOG/HSW at double the existing receiving infrastructure (10,000 gpd) will further reduce the digester capacity and necessitate digester capacity improvements even earlier in the planning period. **Figure 8-4** illustrates the impact of codigesting 10,000 gpd of FOG or HSW on digester HRT.

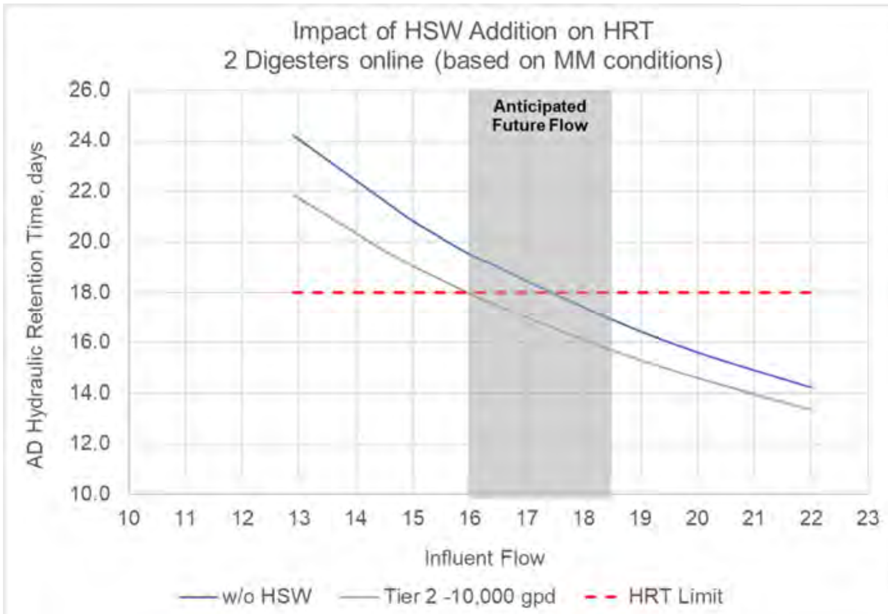


Figure 8-4 Impact of HSW Addition (Tier 1) on Digester HRT

8.2.3 Tier 3 - Maximum Allowable HSW Volume

The Tier 3 evaluation approach used the range of flow projections, 16.3 mgd to 18.4 mgd (as summarized in **TM 01- Flows and Loads**), to provide a range of maximum allowable HSW volume that the District can accept in the existing digesters.

Figure 8-5 shows the District will **not have the digester capacity to accept HSW by 2040** if influent flow reaches 18.4 mgd since 18 days MM HRT requirements cannot be maintained with two digesters in service. If influent flows are on the low end of future projections, the District will **only have the digester capacity to accept less than 9,500 gpd HSW by 2040** and maintain redundancy and operational HRT targets.

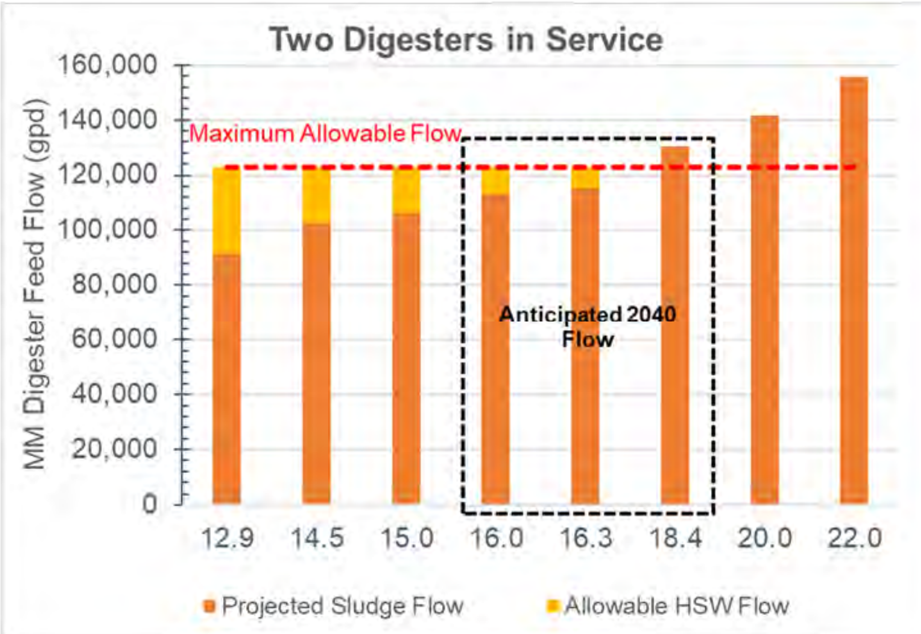


Figure 8-5 Maximum Allowable HSW with Two Digesters in Service

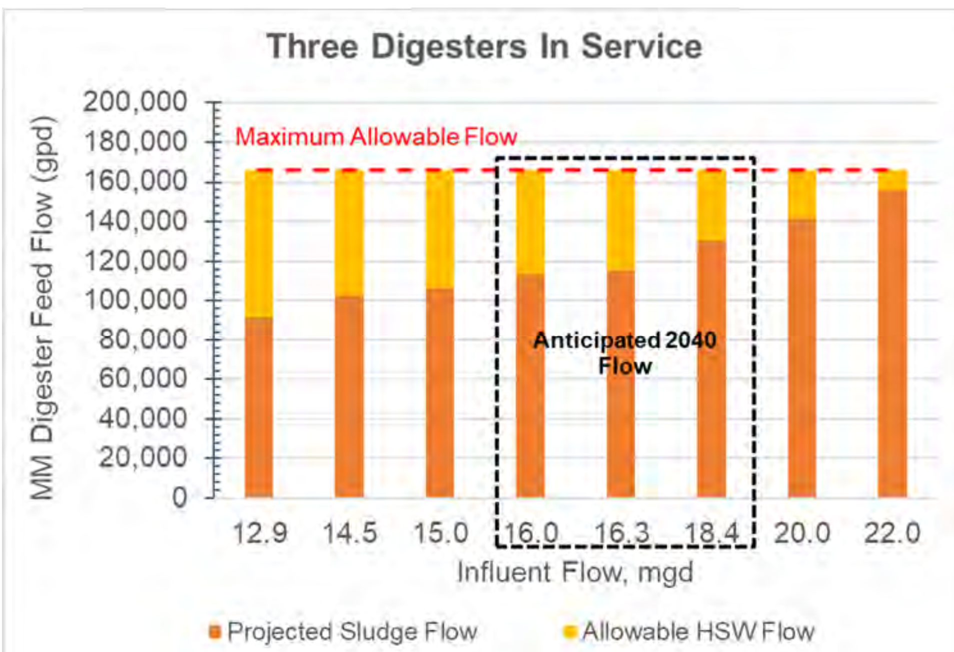


Figure 8-6 Maximum Allowable HSW with Three Digesters in Service

Figure 8-6 shows that with three digesters in service, there will be capacity to accept **over 20,000 gpd HSW** in 2040 (influent flow of 18.4 mgd) while meeting the MM HRT requirement of 20 days. If influent flows are on the low end of future projections, the District can receive **over 50,000 gpd** HSW by year 2040 (influent flow 16 mgd) at MM condition with three digesters in service.

Operation of three digesters will provide significant capacity for HSW codigestion, however solids loading should be monitored carefully. The volatile solids loadings to digesters with HSW addition was also evaluated to ensure stable digester operation. The results indicated that the HRT of the digesters will be limited when two digesters are in service.

Analysis of all three HSW addition tiers indicate that the capacity of existing digesters should be increased in the future to enhance biogas and renewable energy production by accepting higher volumes of HSW.

9. Alternatives to Enhance Biogas Production

HSW codigestion was evaluated as a main option to enhance biogas production. However, thermo-chemical hydrolysis (TCH) processes were also reviewed and included in energy evaluations presented in Section 10. PONDUS is a TCH process that is offered by Centrisys/CNP (CNP). A process flow diagram of a typical integration into the solids stream is shown in **Figure 9-1**. It uses heat (60°C - 70 °C) and alkali addition for sludge hydrolysis as PONDUS is a TCH process that is offered by Centrisys/CNP (CNP) and uses heat (60°C - 70 °C) and alkali addition for sludge hydrolysis as an anaerobic pretreatment process. The process is specifically applicable to TWAS and uses increased pH and heat to hydrolyze the TWAS. The process breaks down the cell membranes of the TWAS, thus releasing organic acids which are consumed quicker in the anaerobic digestion process. The process also results in a significant amount of soluble COD and volatile fatty acids. This process offers the benefits of reduced sludge viscosity and increased volatile solids reduction (VSR), thus increasing biogas production.

The benefits of the PONDUS technology are listed below and typical performance is noted in **Table 9-1**:

- Enhanced biogas production
- Improved VSR
- Improved rheology of feed solids thus potentially requiring less energy to heat, pump, and mix the sludge in the digester
- Drier cake – The hydrolyzed sludge could generate dryer cake thus lowering polymer consumption

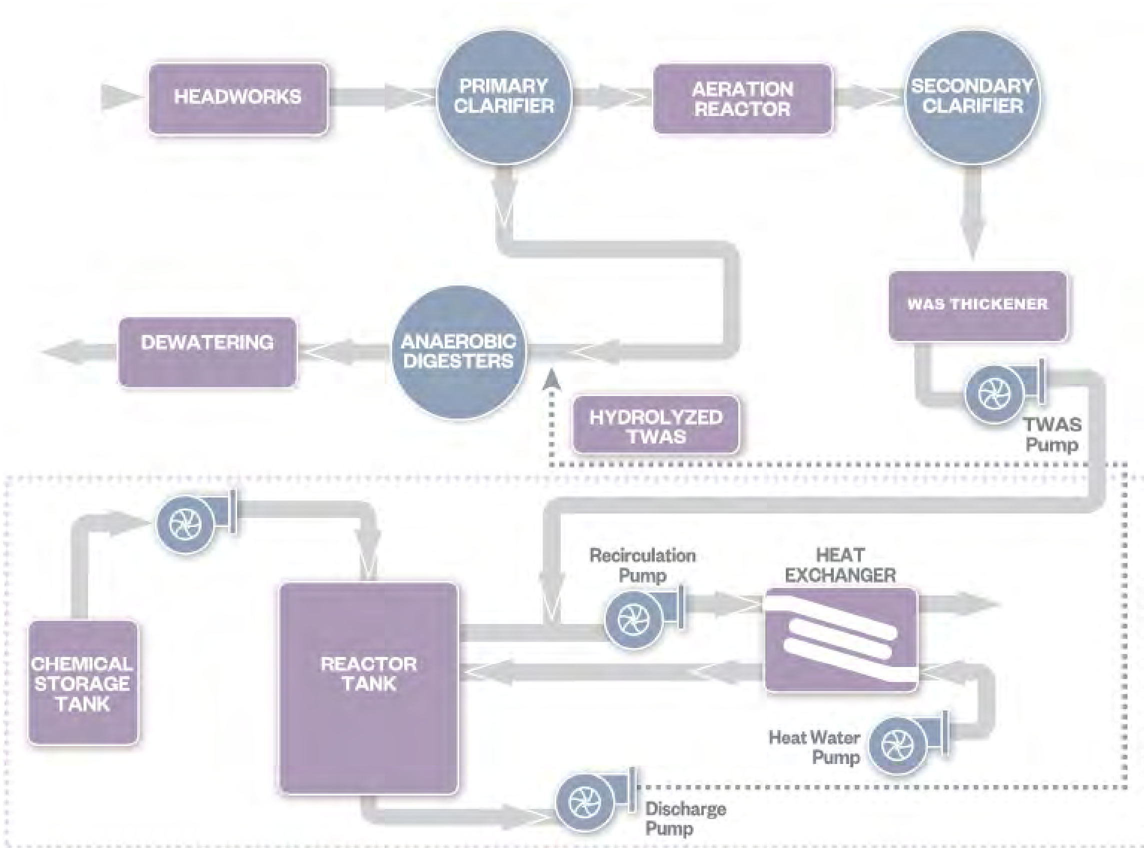


Figure 9-1 Typical PONDUS Integration in Solids Handling

The reactor tank, the chemical feed system, heat exchanger, pumps, and controls are the equipment required to install the PONDUS process.

Table 9-1 Typical PONDUS Performance

Parameter	Performance
Reduce TWAS Viscosity	Up to 80%
Enhance Biogas Production	Up to 30%
Improve VSR ratio	Up to 6-point increase
Improved digested biosolids dewaterability	3% to 6%

10. Biogas Production & Existing Biogas Utilization Capacity

The biogas production for current influent flow conditions (12.8 mgd) with various scenarios for digester capacity and liquid stream configurations (high and low sludge yield) is summarized in the **Table 10-1**. A scenario for current flow conditions and PONDUS was also considered. The baseline scenario is considered to be current flow conditions with high sludge yield as the District will transition away from the Tower Trickling Filters, resulting in a higher sludge yield.

Table 10-1 Gas Production at Current Flows for Various Digester Capacity and Sludge Yields Scenarios

Sludge Yield	Digester Configuration	Biogas Production	Note
Low	Existing	~165 SCFM	
High	Existing	~230 SCFM	Baseline Condition
High	Fourth Digester	~246 SCFM	
High	Recuperative Thickening	~242 SCFM	
High	High Solids Digestion	~249 SCFM	
High	Existing with PONDUS	~290 SCFM	

The results show that the scenarios, with the exception of PONDUS, do not have a significant impact on biogas production compared to the baseline scenario. Therefore, biogas production will not be the primary driver for implementing a particular digester expansion alternative.

Biogas production was determined for the various FOG/HSW tiers and sludge yields. The biogas production estimates were based on modeling calibrated to current conditions (low sludge yield without HSW addition or PONDUS to increase gas production). The model was then used to estimate future biogas production based on the sludge yield, HSW amount and type, and whether PONDUS was installed. The associated ideal cogeneration system ratings for these scenarios was determined and is summarized in **Table 10-2**. The Ideal cogeneration system rating assumes ideal operation of the digester, no loss of digester gas, and minimal downtime. The analysis below assumes there is enough capacity to accept various tiers of HSW volumes.

Table 10-2 Gas Production at Current Flows for Various HSW Tiers and Sludge Yield Scenarios

Scenario				Biogas Production	Ideal Cogeneration System Rating
Sludge Yield	HSW amount	HSW Type	PONDUS		
Low	None	NA	None	~165 SCFM	800KW (Existing system rating)
Low	Tier 1	FOG	None	~183 SCFM	950KW
Low	Tier 2	FOG	None	~205 SCFM	1,050KW
High	None	NA	None	~230 SCFM	1,150KW
High	Tier 1	FOG	None	~250 SCFM	1,300KW
High	Tier 2	FOG	None	~270 SCFM	1,400KW

Scenario				Biogas Production	Ideal Cogeneration System Rating
Sludge Yield	HSW amount	HSW Type	PONDUS		
High	None	NA	PONDUS	~290 SCFM	1,450KW
High	Tier 1	FOG	PONDUS	~310 SCFM	1,600KW
High	Tier 2	FOG	PONDUS	~330 SCFM	1,700KW

Analysis of the biogas production for various scenarios showed that biogas will increase with the higher sludge yield resulting from taking the trickling filters out of service. It will also increase with the addition of FOG or HSW. The existing cogeneration system will be slightly undersized for the scenarios with high sludge yield production without the PONDUS technology. For all scenarios adding PONDUS technology will increase digester gas production.

10.1 Biogas Utilization Alternatives

Based on the biogas production scenarios, several biogas utilization alternatives were evaluated as summarized in **Table 10-3**.

Table 10-3 Biogas Utilization Alternatives

	Description
Alternative 1	Keep existing 800kW cogen system in service
Alternative 2	Replace existing cogen engine with a larger unit sized to utilize all of the projected produced biogas
Alternative 3	Replace existing cogen engine with a renewable natural gas (RNG) production system and inject RNG into the natural gas network for sales as a transportation fuel
Alternative 4	Utilize biogas as fuel for a sludge dryer

Several considerations and assumptions were noted when comparing cogen, renewable natural gas, and sludge drying systems. These include:

Cogeneration System

- Familiar technology
- Existing heat recovery infrastructure can be reused
- Energy independence

- Energy used within the plant provides ~$0.12/KWH of savings. Net metering limits revenue of surplus energy to $0.04/KWH. If demand charges can be reduced, savings/revenue increase significantly.
- Bioenergy Market Adjusting Tariff (BioMAT) could net ~$0.12/KWH for all KWH produced by the cogen system

Renewable Natural Gas

- "Upgrading" gas conditioning system to clean biogas to natural gas pipeline quality.
- Revenue comes mainly from commodity markets for renewable fuels used in the transportation sector (RINs & low carbon fuel offsets). These are regulatory driven markets that have a high potential for volatility.
- Requires a natural gas pipeline extension and interconnection study.
- FOG/HSW can increase the volume but also reduce the value of the RNG produced.
- Revenue not constrained by the net metering or BioMAT terms.

Sludge Drying

- Energy recovery revenue will not underwrite the cost of a sludge drying system
- Good way to utilize excess biogas and cogen heat if drying system is needed to meet biosolids regulations

10.2 Biogas Utilization Alternatives Economic Evaluations

The table below summarizes the 20-year net present value (NPV) for the biogas utilization alternatives. The cogen alternatives have the potential for the WWTP to achieve or exceed energy neutrality. The plant energy consumption is estimated to be approximately 10,000,000 KWH per year after the trickling filters are decommissioned and the WWTP operates in a high sludge yield condition in 2040. At the time of the analysis, it was assumed that all surplus energy generated will be exported back to PG&E at $0.025/KWH All energy used by the plant will generate ~ $0.12/KWH of savings. Under this assumption, the cogen system revenue will begin to diminish if the cogen system generates more energy than the plant is consuming. Currently the District is not compensated for export of electricity to PG&E, further disincentivizing net production of energy.

The limitations of the current net metering agreement can be eliminated if the energy generated by the cogen system can be sold directly to PG&E under the BioMAT program. Currently, the BioMAT program will purchase energy derived form a biomass source (i.e., biogas) for ~$0.127/KWH for all KWH generated. The BioMAT tariff will increase the value of the electric energy generated, however the future viability of the program is unknown at this time. The table below shows the revenues for net metering and BioMAT scenarios.

Table 10-4 Biogas Utilization Scenarios (Assumes Baseline Conditions of High sludge yield)

	Estimated Capital Costs[6]	20 Year NPV[1]	20 Year NPV [1]	20 Year NPV[1] With PONDUS[5]	20 Year NPV[1] With PONDUS[5]
			Net Metering		BioMAT
Existing 800kW Cogen (No FOG/HSW)	($1,000,000)[2]	$8,600,000	$9,400,000	$8,600,000	$9,400,000
Existing 800kW Cogen (5,000 gpd FOG/HSW)	($1,000,000)[2]	$9,000,000	$9,800,000	$9,000,000	$9,800,000
Existing 800kW Cogen (10,000 gpd FOG/HSW)	($2,330,000)	$8,100,000	$8,900,000	$8,100,000	$8,900,000
New Cogen (No FOG/HSW)	($3,900,000)	$6,900,000	$8,300,000	$6,600,000	$10,800,000
New Cogen (5,000 gpd FOG/HSW)	($4,250,000)	$7,000,000	$9,300,000	$6,700,000	$11,800,000
New Cogen (10,000 gpd FOG/HSW)	($5,830,000)	$6,000,000	$9,100,000	$5,700,000	$11,600,000
RNG (No FOG/HSW)	($7,500,000)[4]	$1,100,000[3]		$3,500,000	
RNG (5,000 gpd FOG/HSW)	($7,500,000)[4]	$2,400,000[3]		$4,800,000	
RNG (10,000 gpd FOG/HSW)	($8,830,000)[4]	$2,280,000[3]		$4,700,000	

1. Assumes $1,300,000 capital cost to expand FOG/HSW from 5,000 gpd to 10,000 gpd. Includes all O&M costs, energy revenue, and $0.05/gal FOG/HSW tipping fee
2. Includes $1,000,000 for misc. existing cogen system rehab
3. Assumes RIN and LCFS credit of $12.00/MMBTU of RNG produced. Assumes RNG production efficiency of 85%.
4. Capital costs for pipeline extension are estimated. Pipeline interconnection study must be completed to finalize RNG system costs
5. The cost to implement PONDUS is not included in the NPV calculations
6. Costs are in 2020 dollars

Key findings from the energy balance analysis include:

Existing cogen system:

- Keeping the existing 800kW cogen system provides the highest value. **Continue using existing 800kW cogen system until it inoperable.**
- The additional biogas from the PONDUS exceeds the fuel demand from the existing 800kW cogen engine and therefore does not increase the revenue generated.

New CHP system:

- In most cases, the new cogen alternatives returned a lower 20-year NPV compared to the existing 800kW cogen system. **The incremental benefit of a new cogen engine is outweighed by the additional capital costs**. As shown with lower NPV for new cogen systems vs the existing cogen system.
- Energy generated by the new cogen system alternatives exceed the plant energy usage in some cases, reducing the overall value.
- The **BioMAT tariff improves the 20-year NPV for the new cogne alternatives**, however it does not exceed the 20-year NPV for the existing cogen alternatives (with the exception of PONDUS)
- The new cogen alternatives under the PONDUS biosolids alternative provides a maximum of ~$2,000,000 (20-year NPV) which will not underwrite the cost of the PONDUS process.

Renewable Natural Gas Alternative:

- Under the current market conditions for renewable fuel commodities, **RNG production has a lower overall 20-year NPV** for all biosolids and FOG/HSW alternatives. RNG should not be considered unless commodity prices/economics change significantly. The RNG market is continuously changing and this evaluation should revisited when the District is considering a change to biogas utilization.

Thermal Drying:

- Energy recovery revenue will not finance the cost of a sludge drying system.
- Thermal drying is a good way to utilize excess biogas if a drying system is needed to meet biosolids regulations

FOG/HSW Benefit:

- The additional energy generation from **expanding the FOG/HSW receiving capacity** to 10,000 gpd **does not support investment of** $1,300,000 in **capital costs** to expand the FOG/HSW system.

10.3 Biogas Utilization Roadmaps and Implementation Strategies

Two roadmaps were developed to illustrate the options for biogas utilization and optimization at the WWTP. The Bioenergy Recovery Roadmap **(Figure 10-1**) focuses on the triggers to increase cogen system capacity, utilize biogas for thermal drying, or pursue RNG production. The current baseline strategy identified as part of this Master Plan is maintaining and operating the existing cogen system. The Biogas Optimization Roadmap (**Figure 10-2**) illustrates options to increase biogas production. These options are impacted greatly by the District's ability to receive HSW, process HSW in digesters, and utilize biogas.

1. Bioenergy Recovery Roadmaps Key Findings
    - The cogen system should be expanded if the existing cogen needs replacement, the District wishes to pursue energy neutrality, or the energy needs of the plant increase significantly.
    - If the District is flaring digester gas and implements thermal drying to reduce hauling costs or find more biosolids end users, the District should divert excess gas to the thermal dryer.
    - Renewable Natural Gas (RNG) is not economically favorable unless market conditions change (value of credits increases) significantly.
2. Biogas Optimization Roadmap Key findings
    - Codigestion capacity should be expanded if the District wishes to pursue energy neutrality and has expanded the cogen capacity.

Alternatively, if tipping fees become lucrative, codigestion capacity can be expanded. Given the market conditions for HSW, tipping fees are not likely to be high enough to justify cost of expansion of the codigestion receiving facilities.

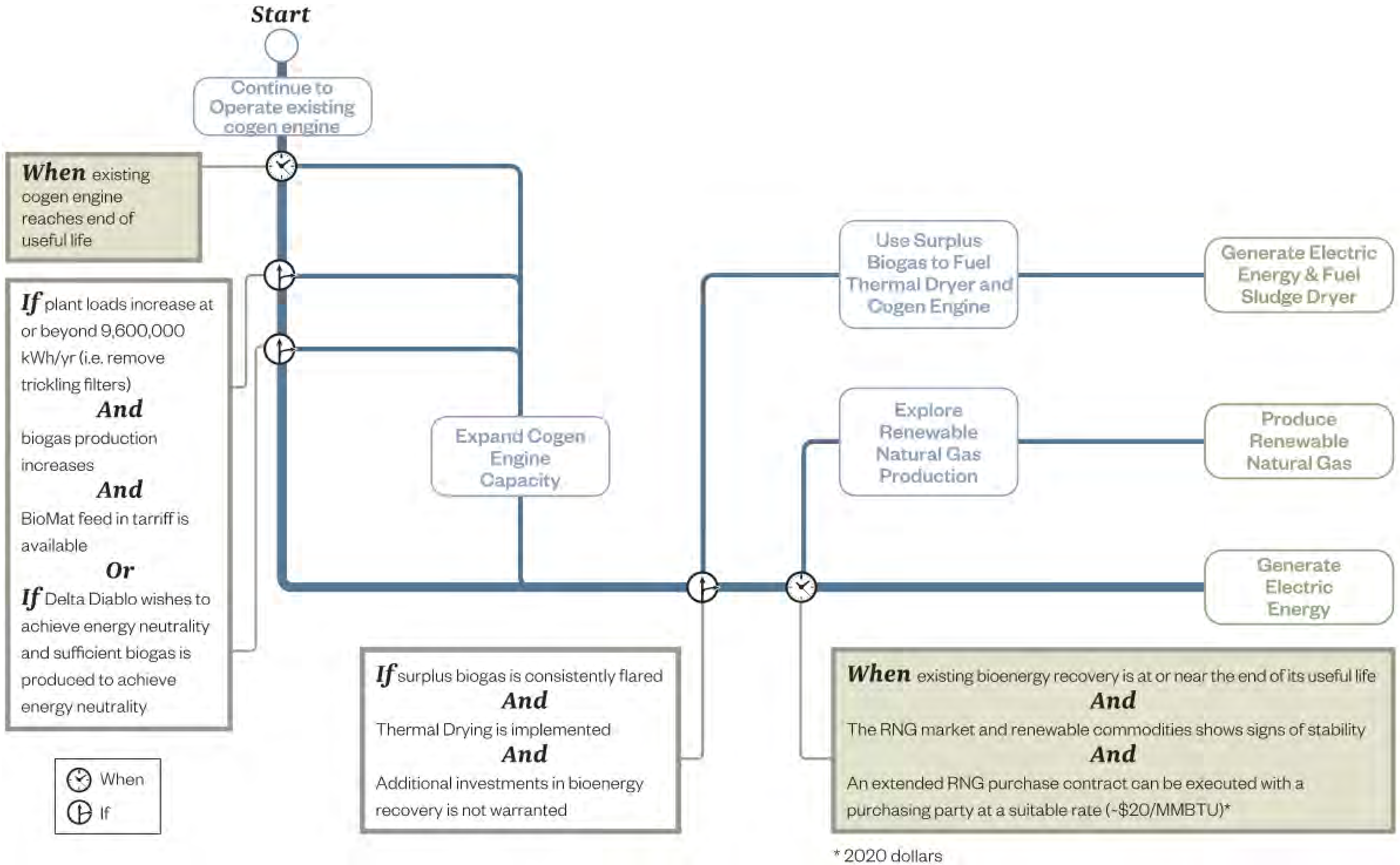


Figure 10-1 Bioenergy Recovery Roadmap

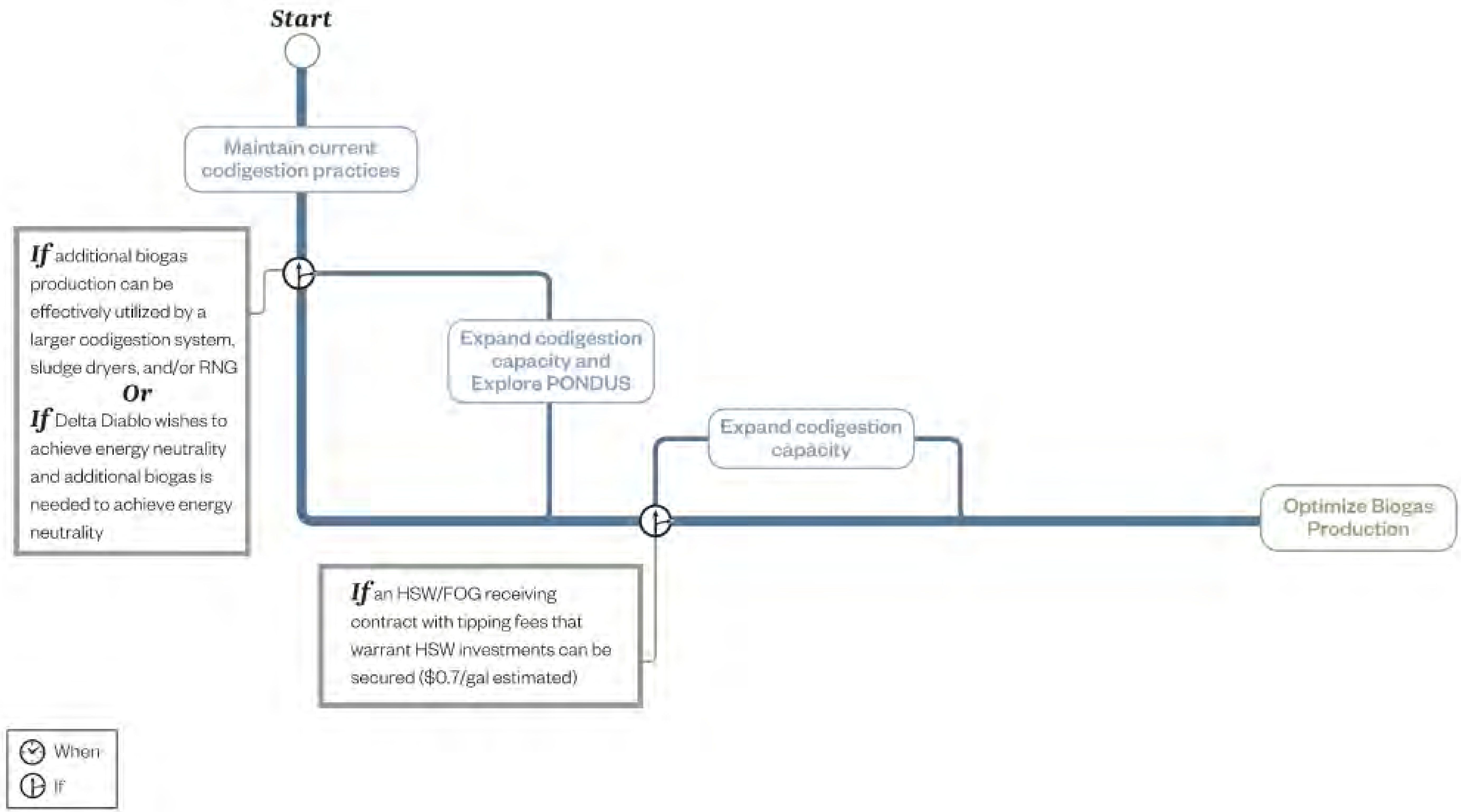


Figure 10-2 Biogas Optimization Roadmap

Biosolids management and biogas and renewable energy management decisions are inextricably connected. At minimum the District must increase digestion capacity. This is the baseline implementation in this Master Plan. The District may also choose to pursue energy neutrality; this will require implementation of capital improvements as outlined in **Table 10-5**.

Table 10-5 Implementation options for Biosolid and Biogas/Renewable Energy

Implementation Option	Activities
Baseline Implementation – Keep cogen system as is	• District constructs a new digester to increase digestion capacity before 2030
Energy Neutrality Implementation	• District constructs a new digester to increase digestion capacity before 2030 • The District chooses to increase the capacity of the cogen system and HSW receiving station to pursue energy neutrality • The District can expand HSW program because of available digestion capacity and gas can be utilized in the expanded cogen system
Advanced Processing Implementation	• District constructs a new digester to increase digestion capacity before 2030 • The District chooses thermal drying to produce a dried product to reduce hauling costs or as regulations require • The District expands HSW program because of available digestion capacity and gas can be utilized for thermal drying • District may choose to further advanced processing options to address emerging contaminants

As the District will further investigate options as part of the Biosolids Master Plan, the baseline implementation option carried forward will be to increase digester capacity with a fourth digester being installed before 2030. Energy neutrality and advanced processing may be implemented if the District pursues energy neutrality or advanced processing options to improve biosolids end-use options. Note that energy neutrality or advanced processing options may be implemented together and are not mutually exclusive, however, both plans include expanding HSW to provide biogas for either electricity generation or thermal drying. If the District chooses to implement both options, the HSW receiving facility should be expanded to accommodate both.

Appendix 6

TM – 06 Recycled Water Management

Hazen

Delta Diablo

November 5, 2022

To: Brian Thomas, Delta Diablo

From: Gregg Cummings, Audrey Gozali, Hazen

Re: Master Plan – Recycled Water Management

TM - 06 Recycled Water Distribution Alternatives and Near-Term Capital Improvement Program

Final

Revision No.	Date	Description	Author	Reviewed
1	11/5/2021	Internal Draft	A.Gozali, G. Cummings	I Chu, M. Solomon
2	11/5/2022	Draft	Chu	District

Table of Contents

1. Introduction

The District provides recycled water to industrial, commercial, and irrigation customers via the Recycled Water Facility (RWF) of which Calpine is the largest customer. The District's long-term contract to provide Calpine with recycled water will expire in 2030. There is a significant potential for Calpine to cease operation of their two local facilities, LMEC and DEC. This purpose of this task is to guide strategic decision-making efforts regarding long-term RWF operation and near-term capital investments by:

- Evaluating options for adding new customers and/or increasing recycled water usage by existing customers to offset potential of Calpine discontinuing operation.
- Conducting a high-level review of the RWF to evaluate costs related to increased water quality requirements for new or existing customers.

This Master Plan task will serve as a precursor to the Recycled Water Facility Master Plan Update (Facilities Assessment) planned for 2023/2024. The Update will be provided to Calpine for review and budgeting and will be used by Calpine to inform their decision whether or not to renew the recycled water agreement in 2030. There are several implications if the agreement with Calpine is not renewed, including a significant reduction in funding for operation, maintenance, and improvements to the RWF, potential impact on nutrient load cap estimation, and increased flows to the outfall potentially triggering the need to start planning for a second outfall. These impacts are identified and explored here and recommended to be further quantified in the RWF MP.

1.1 Objectives

This Technical Memorandum 6 summarizes the review of Delta Diablo's RWF. The objective of this review is to:

- Develop and evaluate, at a high-level, up to two recycled water distribution alternatives to determine if there are cost-effective operating scenarios for the RWF if Calpine does not continue operation after 2030 (or sooner). The alternatives may include customers to make up for potential loss of Calpine as a recycled water customer and alternative uses. The Consultant will hold a recycled water alternatives workshop to present findings.

- Conduct a high-level review of the RWF to determine how the District should manage near-term capital investments and highlight key focus areas to consider in a future Recycled Water Master Plan, including:

    - Recommendations to cost effectively maintain operations for current level of treatment
    - Recommendations for a near-term Capital Improvement Program (CIP) that is synergistic with long-term projects if the District decides to improve water quality

2. Background

2.1 Wastewater Treatment Plant and Recycled Water Facility

Major treatment processes at the District's Wastewater Treatment Plant (WWTP) include screening, grit removal, primary clarification, tower trickling filters, aeration, secondary clarification, disinfection, and dechlorination, as shown on Figure 2-1. Secondary effluent is discharged to the New York Slough in the San Joaquin Delta or diverted to the RWF prior to chlorination/dechlorination for further treatment and distribution to local recycled water customers. The WWTP has a rated average dry weather flow (ADWF) capacity of 19.5 million gallons per day (mgd) and a peak wet weather flow capacity of 31.1 mgd.

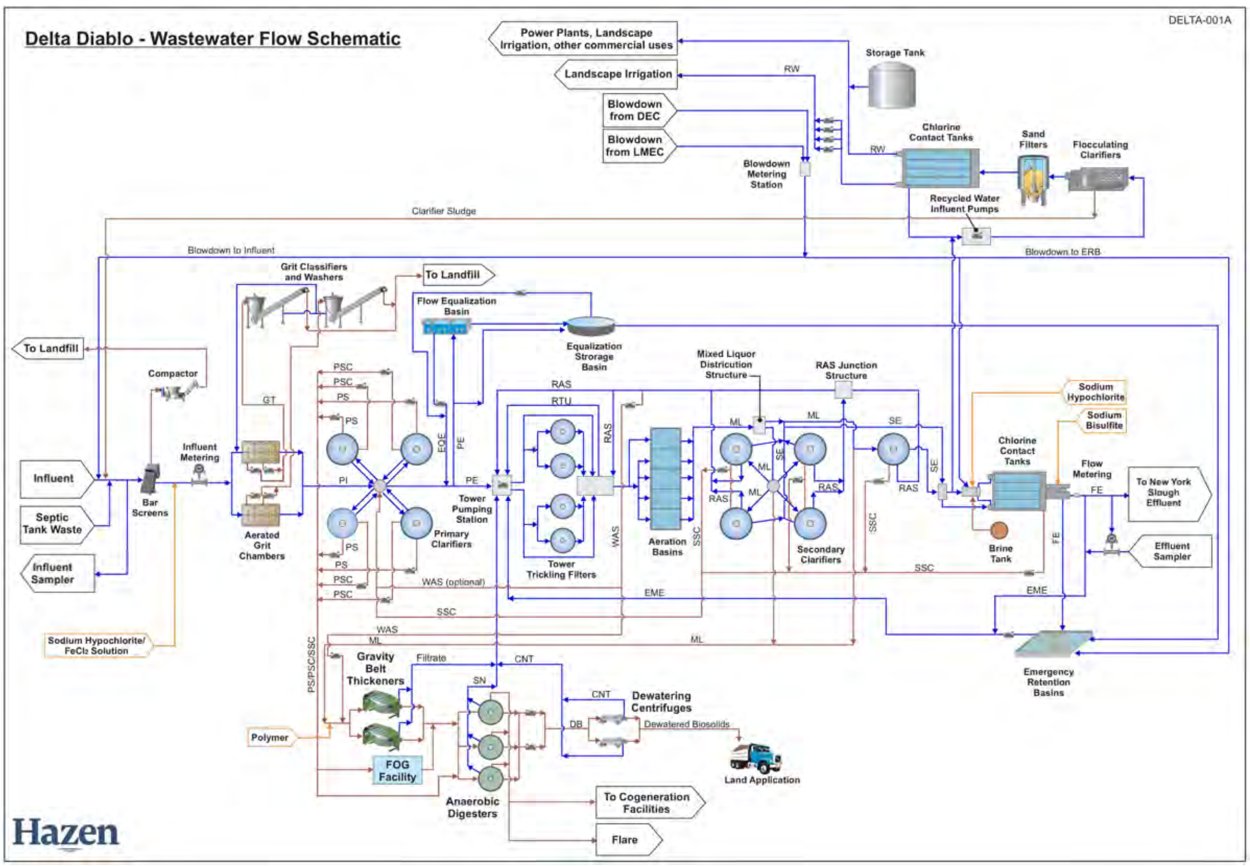


Figure 2-1. WWTP and RWF Process Flow Diagram

The RWF treatment processes include flocculating clarification, continuous backwash sand media filtration, and chlorine contact basins, as shown on Figure 2-2. The permitted capacity of the chlorine contact basins is currently 12.8 mgd, which is the limiting capacity of the three RWF treatment processes. As noted in the 2013 Recycled Water Master Plan, during permitting, the chlorine contact basins were assumed to have a 75% baffling efficiency, resulting in the 12.8 mgd capacity, however, subsequent operational testing at the RWF during start-up indicated that the actual baffling efficiency was 95%, equating to a capacity of 16.2 mgd

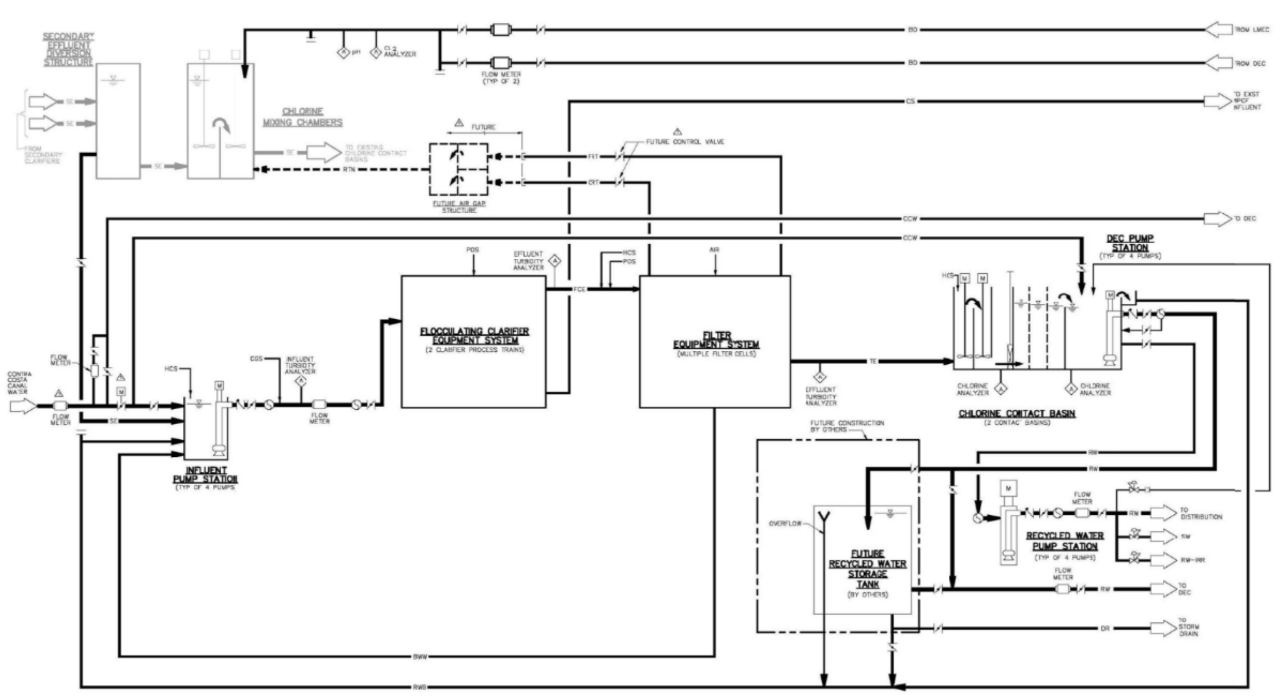


Figure 2-2. RWF Process Flow Diagram from 2013 Recycled Water Master Plan

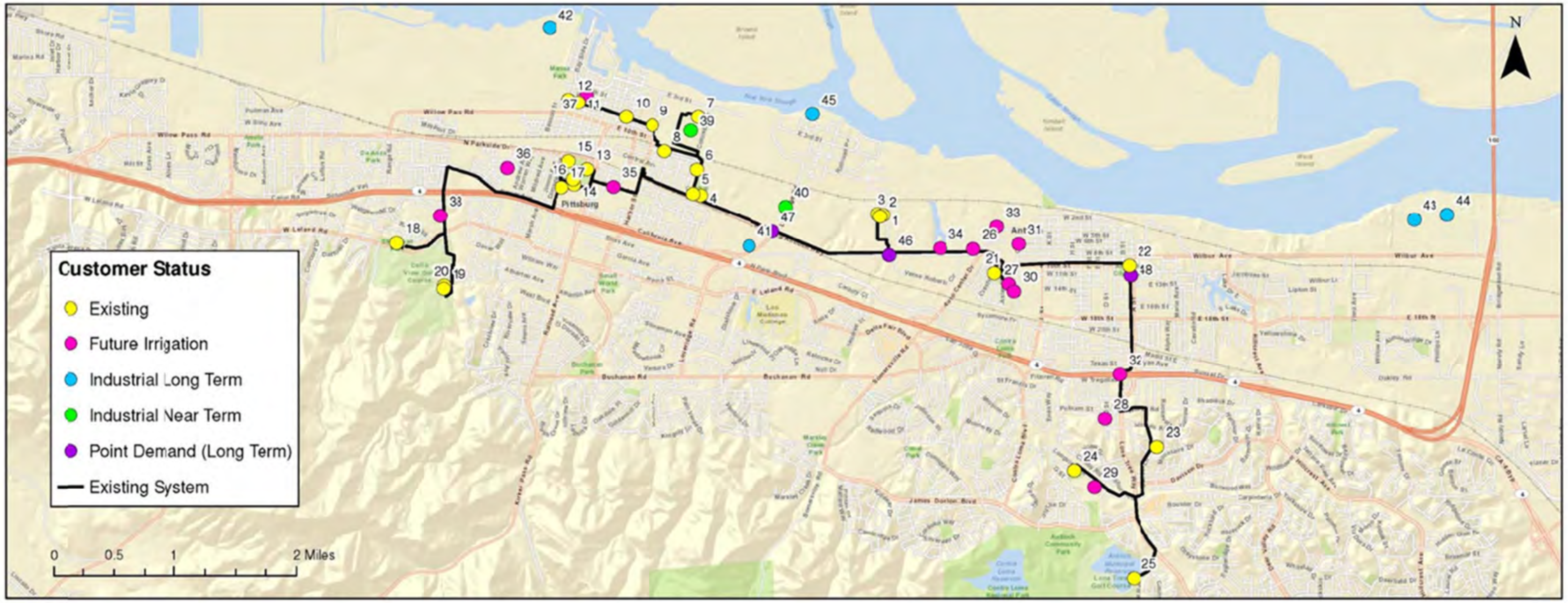
2.2 List of Information Reviewed

For this task, the following information was reviewed:

1. RMC/HDR, Delta Diablo Recycled Water Master Plan, Final Draft, July 2013
2. V.W. Housen, Recycled Delta Diablo Recycled Water System Planning TM, March 2017

3. Recycled Water Users

As part of the 2013 Recycled Water Master Plan, several options were identified to maximize the use of recycled water by adding more users. **Figure 3-1** shows the locations of existing and potential future recycled water users identified in the 2013 Recycled Water Master Plan, shown by location number listed in Tables 3-1 and 3-2. The sections below provide a discussion of existing and potential future recycled water users.



Customer List

1. RWF Service Water (3W)
2. WWTP Irrigation (Before flow meter)
3. WWTP Irrigation (After flow meter)
4. Central Park Soccer Field (RW Meter #8 - Soccer Field)
5. Central Park Irrigation (RW meter #1 - Baseball Park)
6. Columbia Linear Park (RW meter #2 - by the bend Linear Park)
7. Los Medanos Energy Center (LMEC) (Industrial)
8. East Santa Fe Linear Park (RW meter #3 - NW Linear Park)
9. 8th Street Linear Park (RW meter #4 - Harbor & 8th)
10. East 8th Street (RW meter #5 - 8th & Los Medanos)
11. W. Eighth St (RW meter #6 - 8th & West)
12. Mariner Park (RW meter #7 - PPS)
13. City Park - Booster Station and Railroad & Civic (Pittsburg RW Meter #9)
14. City Park (North) - Community Center at Civic (Pittsburg RW Meter #10)
15. City Park (West) - Baseball Field at Davi (RW Pittsburg Meter #11)
16. City Hall - City Hall at Civic (Pittsburg RW Meter #12)
17. City Hall (West) - Police Station at Davi (Pittsburg RW Meter #13)
18. Stoneman Park (Demand at Irrig. Booster PS) - (Pittsburg RW Meter #14)
19. Delta View Golf Course (DVGCR) Reservoir (Pittsburg RW Meter #15)
20. GC Tank Jockey Pump (Pittsburg RW Meter #17)
21. Fairview Park
22. Antioch City Park
23. Mountaire Park
24. Chichibu Park
25. LTGC Outlet (Lone Tree Golf Course) Reservoir
26. Babe Ruth Fields (Antioch Phase 2)
27. Antioch Little League (Antioch Phase 2)
28. Memorial Park (Antioch Phase 2)
29. Sutter Elementary School (Antioch Phase 2)
30. Antioch Fairgrounds (Antioch Phase 2)
31. Prosserville Park (On 6th St between M&O)
32. Caltrans (Hwy 4 at RW pipeline crossing)
33. Antioch Historical Society
34. DOW Wetlands
35. Pittsburg High School (Pittsburg Phase 2)
36. Parkside Elementary School (Pittsburg Phase 2)
37. Marina Walk Park
38. Rancho Medanos Junior High School
39. United Spiral Pipe
40. Waste Recycle Center and Transfer Station (WRC&TS)
41. Praxair
42. Genon - Willow Pass Generating Station
43. Genon - Marsh Landing Generating Station
44. PG&E Gateway Generating Station
45. K2 Pure Solutions
46. Point Demand - Los Medanos College and Other Customers
47. Point Demand - Loveridge Corridor
48. Point Demand - East of A St

Date: 6/7/2012

Figure 3-1 Existing and Potential Recycled Water Users Map

3.1 Existing Recycled Water Users

A review of existing water users was conducted to determine the existing recycled water demand and understand the potential impact of Calpine ceasing purchase of RWF recycled water.

The existing recycled water users identified in the 2013 Recycled Water Master Plan were verified or amended in conversations with the District on June 15, 2021. During the meeting, the District indicated that the following users identified in 2013 are not currently using recycled water:

- Praxair
- Dow Chemical
- United Spiral Pipe (USP)
- K2 Pure Solutions
- PG&E Gateway Generation Station

It was also noted that Caltrans, Pittsburg High School, Parkside Elementary School, and Rancho Medanos Junior High School, which were all previously identified as potential recycled water users, are now currently using recycled water. Additionally, per conversations with Mt. Diablo Resource Recovery Park, their current average annual demand was updated to 4.9 acre-feet per year. As shown in **Table 3-1** Calpine uses significantly more recycled water compared to other existing industrial users. In total, the average peak day demand for Calpine's cooling towers and boiler feed is 9.69 mgd. However, during heatwaves peak Calpine demand can reach 12.8 mgd. As depicted in **Figure 3-1**, it was noted that DEC is not an existing user on the recycled water distribution system, rather, DEC demands flow through a separate pipeline. The demands for DEC are shown in **Table 3-1** for reference, however, the demands were not included in the analysis of the existing distribution system in **Section 4**, Recycled Water Distribution System Options.

Outside of industrial uses, landscape irrigation is the other major recycled water use. The peak day demand for landscape irrigation is 2.9 mgd.

Table 3-1 Existing Recycled Water Users

Fig. 3-1 Location	Fig. 4-1 Location	Customer	Description	Potential Recycled Water Use	Current Water Supply	Avg Annual Demand (AFY/ MGY)	Estimated Peak Day Demand (mgd)	Peak Hour Demand (gpm)
Existing Industrial Facilities								
7	7	Calpine – LMEC	Process water	Cooling tower and boiler feed	DD	3,011 / 981	3.93	3,059
Not shown	2	Calpine – DEC	Process water	Cooling tower	DD RW and CCWD	3,999 / 1,303	5.76	4,483
40	3	Mt. Diablo Resource Recovery Park – Waste Recycle Center and Transfer Station (WRC&TS)	Recycling center and waste processing	Dust control and irrigation	City of Pittsburgh/ CCWD	4.9 / 1.6	0.03	54
	Total					7,015 / 2,286	9.72	7,596
Existing Landscape Irrigation								
1, 2, 3	4	DD WWTP/RWF Demands	Landscaping	Landscape irrigation	DD	123.5 / 40.2	0.15	168
32	5	Caltrans (Hwy 4 at RW pipeline crossing)	Landscaping	Landscape irrigation	DD	16.0 / 5.2	0.04	78.2
4, 5	6	Central Park	Park	Landscape irrigation	DD	14.7 / 4.8	0.04	80
6, 8, 9	7	Pittsburg Linear Parks	Park	Landscape irrigation	DD	43.2 / 14.1	0.11	238
12	8	Mariner Park	Park	Landscape irrigation	DD	8.7 / 2.8	0.02	48
13, 14, 15	9	City Park (Pittsburg)	Park	Landscape irrigation	DD	30.0 / 9.8	0.1	195
16, 17	10	City Hall	Building	Landscape irrigation	DD	6.5 / 2.1	0.03	56
18	11	John Henry Johnson Park (Stoneman North Park)	Park	Landscape irrigation	DD	17.7 / 5.8	0.05	101
19, 20	12	Delta View Golf Course	Golf course	Landscape irrigation	DD	355 / 115.7	0.98	691
21	13	Fairview Park	Park	Landscape irrigation	DD	6.7 / 2.2	0.02	39
22	14	Antioch City Park	Park	Landscape irrigation	DD	8 / 2.6	0.02	52
23	15	Mountaire Park	Park	Landscape irrigation	DD	9.8 / 3.2	0.03	68
24	16	Chichibu Park	Park	Landscape irrigation	DD	24.5 / 8	0.06	126
25	17	Lone Tree Golf Course	Golf course	Landscape irrigation	DD	399 / 130	1.19	826
37	18	Marina Walk Park	Park	Landscape irrigation	DD	3.2 / 1	0.01	72
35	19	Pittsburg High School	School	Landscape irrigation	DD	22.7 / 7.4	0.02	44.6
36	20	Parkside Elementary School	School	Landscape irrigation	DD	13.9 / 4.5	0.02	34.6
38	21	Rancho Medanos Junior High School	School	Landscape irrigation	DD	9.5 / 3.1	0.01	23.6
Total						1,113 / 362	2.9	2,941

3.2 Potential Future Recycled Water Users

To identify potential future recycled water users, Hazen reviewed the potential users identified in the 2013 Recycled Water Master Plan with input from the District. Hazen also reached out to the cities of Antioch and Pittsburg and project developers. Per the meeting with the District on June 15, 2021, and discussions with the City of Antioch, the following previously identified potential users are not using, nor are expecting to use, recycled water:

- Genon Generating Station – Willow Pass
- Genon Generating Station – Marsh Landing
- City of Antioch – East of A Street project
- Babe Ruth Fields – The Babe Ruth fields were previously identified as a potential future recycled water user but have been since abandoned by the city since the time of this analysis. The demand is captured on **Table 3-2** for record, but the status of the project has been noted here and in **Table 3-2**.

The following subsections discuss identified potential future projects and estimates of recycled water demand. To estimate potential future landscape irrigation demand, assumptions were made based on recycled water estimates for arid regions. The assumptions are as follows:

- Recycled water demand of 2 acre-feet per year per acre of vegetation
- Irrigation would occur every other day for eight months per year (120 days)
- Irrigation would occur continuously for four hours per day

3.2.1 Stoneman Sports Complex

The Stoneman Sports Complex is a proposed sports complex with natural or artificial turf in the City of Pittsburg. Construction of the complex is contingent on construction of the adjacent residential development. The City of Pittsburg estimated that the recycled water demand for this project could range from 0 to 110.5 AFY based on comparison with an existing golf course. Using the assumptions for landscape irrigation referenced above, it was estimated that the peak day demand for this project would be approximately 0.3 mgd, and the peak hour demand would be approximately 1,250 gallons per minute (gpm). Discussions with the City indicate that this project would be executed in two phases. Currently the scope of each phase is not the known, and as such, the estimate for the project is presented as Phase 1 and 2.

Changes to the Stoneman Sports Complex may also impact John Henry Johnson Park (Stoneman North Park). The City is currently proposing to eliminate half of the natural turf at the John Henry Johnson Park, offsetting the potential increase in demand of the Stoneman Sports Complex.

3.2.2 BayWalk

The BayWalk development is being planned for an old Pacific Gas & Electric (PG&E) site located along Willow Pass Road and State Route 4 in the City of Pittsburg. Approximately 31.9 acres of the total area will be dedicated to open space. The BayWalk project will be implemented in three phases with construction projected to begin in 2024 and last for 10 years.

Under the assumptions noted under **Section 3.2**, it was estimated that the recycled water demand would be 63.8 AFY, with a peak day demand of 0.2 mgd and a peak hour demand of approximately 725 gpm.

3.2.3 Pittsburg Technology Park

The Pittsburg Technology Park development is planned to be a data center campus positioned on approximately 105 acres of a defunct golf course located south of West Leland Road and Golf Club Road in the City of Pittsburg. The campus is planned to include up to 4.5 million square feet of building area within 26 buildings. In previous discussions with the District, the developer of the data center campus mentioned that the recycled water quality is important, specifically that recycled water with low nitrate levels would be required. According to the CEQA Initial Study for the Pittsburg Technology Park (April 2020), the project will begin the initial phase of construction in 2021 and last for 15 years or more.

Hazen reached out to the City of Pittsburg several times to discuss potential recycled water use at the Pittsburg Technology Park but have not received a response. As such, further investigation of the Pittsburg Technology Park will be required to better understand their potential recycled water demands.

3.2.4 Mt. Diablo Resource Recovery Park (City of Pittsburg)

The Mt. Diablo Resource Recovery Park development is in the initial permitting phase, and there is a need to expand its recycled water use. Currently Mt. Diablo Park uses 9.7 million gallons of recycled water per year, or 29.7 AFY. With the proposed new development, which will be phased over the next 10 years, the demand could grow to over 16 million gallons per year, or 49 AFY. Using the landscape irrigation assumptions referenced above, the peak day demand was calculated to be approximately 0.05 mgd, and the peak hour demand approximately 122.9 gpm. Recently, the Mt. Diablo Resource Recovery Park received the District's approval to expand recycled water lines further into their development for landscaping irrigation, dust control, and equipment cleaning systems.

3.2.5 Los Medanos Industrial Park (City of Pittsburg)

The Los Medanos Industrial Park plans to develop a 7.16-acre site with four office buildings. According to Chapter 18.54 of the City of Pittsburg's Municipal Code, the site must include at least 15% landscape coverage. Therefore, it was assumed that approximately one acre of the proposed 7.16-acre site would require irrigation. Based on the above referenced assumptions for landscape irrigation, it was estimated that the recycled water demand would be 2.2 AFY, with a peak day demand of approximately 0.01 mgd and a peak hour demand of approximately 25 gpm. However, further investigation will be required to understand the timeline for this project.

3.2.6 Caltrans

Caltrans currently uses 16 AFY of recycled water within the Pittsburg and Antioch areas, along State Route 4, to help establish landscaping along renovated freeway sections. Caltrans intends to continue use of this irrigation system for at least the next five years while the landscaping is being established, however, they have no other upcoming projects beyond that.

3.2.7 City of Antioch

Per conversations with representatives from the City of Antioch, the City has limited additional uses for recycled water beyond any existing uses. City personnel indicated that they may want to add additional recycled water filling stations at three of the four parks where they currently use recycled water, however they did not quantify how much recycled water would be required, nor the location of the three parks.

3.2.8 Carbon Capture and Mineralization Project (City of Pittsburg)

The Carbon Capture and Mineralization Project is a pilot facility run by SF Bay Aggregates, a subsidiary of Blue Planet Ltd. The facility plans to remove CO_2 from a slipstream of flue gas from Calpine's Los Medanos Energy Center or an outlet stream of gas from the gas-fired steam boiler and combine the removed CO_2 with locally sourced demolished/returned concrete. For the purposes of this review, it was assumed that the Carbon Capture and Mineralization Project would only be built if Calpine continues to operate its facilities. For Calpine and the pilot facility to continue operations, Calpine is required to meet stricter air emission targets at their facilities. Preliminary estimates discussed with the District indicate up to 1,000 gpm of process water and 10,000 gpm of cooling water may be needed for this facility.

3.2.9 Diablo Energy Storage LLC

The Diablo Energy Storage LLC project will construct three 60,000-square-foot buildings to house advanced energy storage technology. This project would be connected via a new electric tie-in line to the existing PG&E Pittsburg Substation located 0.6 miles from the project site. The facility will be designed for full remote operation. Previous estimates (from 2018) indicated a potential 2 mgd recycled water demand for the Diablo Energy Storage project. As the project has evolved an updated estimate pursued, Hazen has reached out to Kevin Johnson, the project developer using contact information provided by the City of Pittsburg but have not heard back.

3.2.10 Summary of Potential Future Recycled Water Users

A summary of the estimated recycled water demands for potential future recycled water users post-construction can be found in **Table 3-2**. The summary table includes the potential users identified in the 2013 Recycled Water Master Plan with input from the District along with the projects mentioned in the subsections above. **Table 3-2** includes locations of potential future users, which correlate with **Figure 3-1** and **Figure 3-2**. As additional potential future users were identified since the 2013 Recycled Water Master Plan, some potential future users' locations are not shown on **Figure 3-1** but shown on **Figure 4-1.**

Table 3-2. Potential Future Recycled Water Users

Fig 3-1 Location	Fig. 4-1 Location	Customer	Description	Potential Recycled Water Use	Current Water Supply	Avg Annual Demand (AFY)	Peak Day Demand (mgd)	Peak Hour Demand (gpm)
Future Industrial Facilities								
40	3 [a]	Mt. Diablo Resource Recovery Park – Waste Recycle Center and Transfer Station (WRC&TS) [a]	Recycling center and waste processing	Landscape irrigation, dust control, and equipment cleaning systems	City of Pittsburg/CCWD	35.3	0.05	122.9
N/A	22	Pittsburg Technology Park (Data Center)[d]	Data center	Cooling tower	-	-	-	-
N/A	23	Diablo Energy Storage LLC	Advanced energy storage	TBD	-	-	-	-
N/A	24	San Francisco Bay Aggregates – Carbon Capture and Mineralization Project	Pilot facility	TBD	-	-	-	1,100
47	25	Loveridge Corridor	Zoned for future industrial use	TBD	-	Up to 3,266	Up to 5.4	Up to 3,778
	Total					**3,301**	**5.5**	**5,000**
Near-Term Landscape Irrigation								
18	26	Stoneman Sports Complex (Phase 1 and 2 less John Henry Johnson Park planned changes)	Athletic complex	Landscape irrigation	-	102	0.28	1,150
26	27	Babe Ruth Fields[c]	Athletic complex	Landscape irrigation	-	14.7	0.03	71.9
27	28	Antioch Little League	Athletic complex	Landscape irrigation	-	11.4	0.03	55.7
28	29	Memorial Park (Park Middle School)	Park and school	Landscape irrigation	-	18.7	0.04	91.4
29	30	Sutter Elementary School	School	Landscape irrigation	-	23.8	0.13	267
30	31	Antioch Fairgrounds (Contra Costa County Event Center)	Fairgrounds	Landscape irrigation	-	37.6	0.09	184
31	32	Prosserville Park (on 6th St between M&O)	Park	Landscape irrigation	-	2.3	0.01	16.7
N/A	N/A	City of Antioch [b]	Park	Landscape irrigation	-	-	-	-
33	33	Antioch Historical Society	Museum	Landscape irrigation	-	2.7	0.01	17.2
N/A	34	Los Medanos Industrial Park	Office	Landscape irrigation	-	2.1	0.01	24.3
N/A	35	BayWalk	Residential development	Landscape irrigation	-	63.8	0.2	725
34	36	Corteva Wetlands Preserve (DOW Wetlands)	Wetlands	Landscape irrigation	-	1.0	0.00	1.4
	Total					**281**	**0.83**	**2,605**

Long-Term Landscape Irrigation								
46	37	Los Medanos College (point demand)	School	Landscape irrigation	-	227	0.53	1,110
NA	NA	City of Pittsburg (Library, medians around courthouse, walkway along highway 4 on-ramp at railroad, fountains at City Hall, E14th St. landscape)	Public Landscaping	Landscape irrigation	-	-	-	-
NA	NA	Los Medans Elementary School	School	Landscape irrigation	-	-	-	-
NA	NA	RV and Boat Storage	Private Business	Landscape irrigation/ fire suppression	-	-	-	-
	Total					**227**	**0.53**	**1,110**

Notes

[a] Mt. Diablo Resource Recovery Park is an existing user, but their recycled water demands are expected to increase significantly. Their anticipated future demands are listed here.

[b] City of Antioch did not specify the location of the filling stations – only that the additional filling stations would be at three of the four parks. Therefore, this demand is not shown on the map.

[c] Babe Ruth Fields has been abandoned since the time of this analysis. It is shown here for to record the potential demand discussed with at the time.

[d] 2018 estimate of 2mgd. Updated information is expected.

3.3 Potential Large Users

Of the potential future projects shown in **Table 3-2,** the following have the potential to use large quantities of recycled water:

- Pittsburg Technology Park
- Diablo Energy Storage LLC
- Mt. Diablo Resource Recovery Park
- SF Bay Aggregates' Carbon Capture and Mineralization project
- Loveridge Corridor (previously identified from 2013 Recycled Water Master Plan)

Figure 3-2 shows the annual recycled water demand for the potential large users, and it was assumed that there would be linear growth in recycled water demand at multi-year project sites (not including Caltrans). As noted above, further investigation is required to estimate the recycled water demands for the Pittsburg Technology Park, Diablo Energy Storage LLC, and SF Bay Aggregates' Carbon Capture and Mineralization project. As such, projections for annual recycled water demand at these sites are not included on Figure 3-2. Figure 3-3 depicts the timeline for when these potential future large users would come online, when existing major users will end their agreements with the District, and the District's timeline for recycled water deliverables.

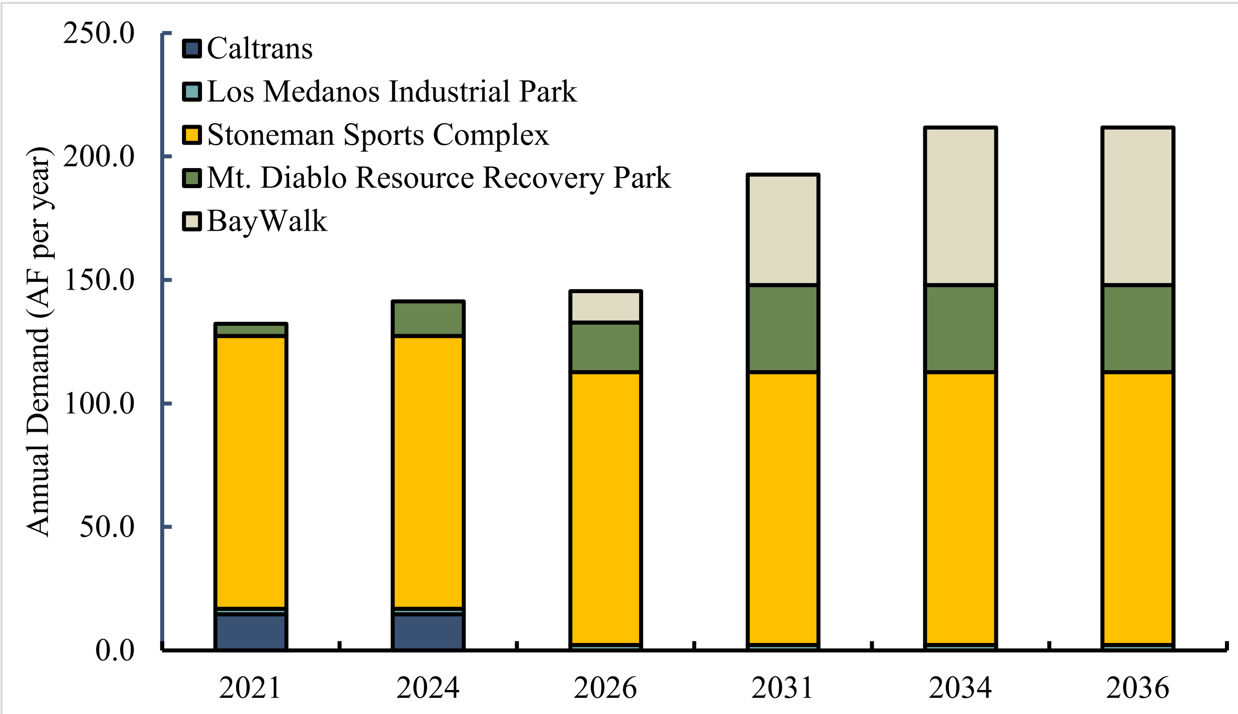


Figure 3-2. Annual recycled water demand for potential large users

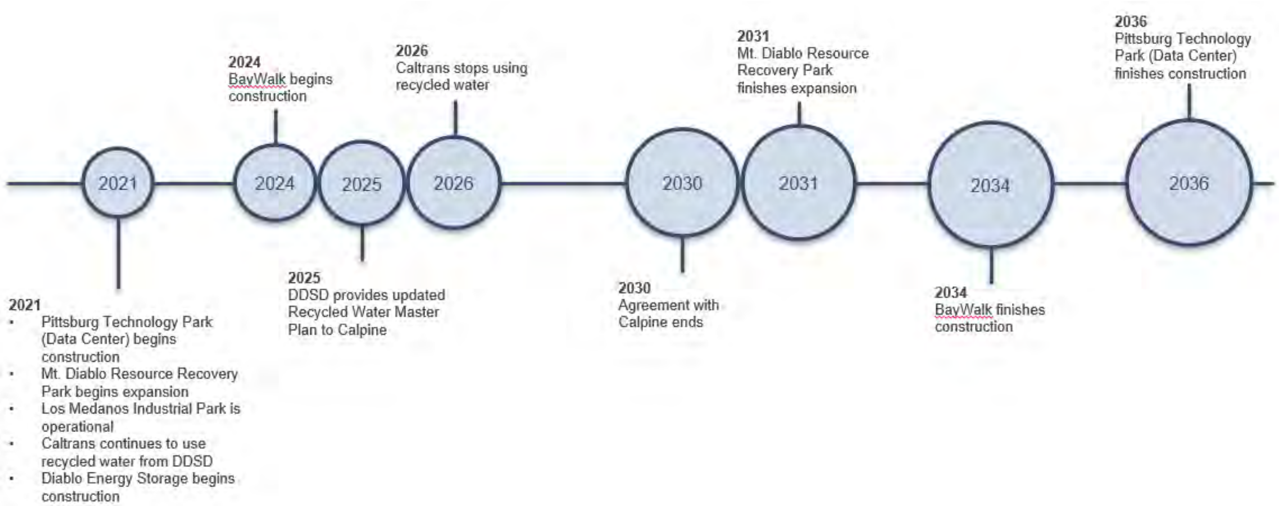


Figure 3-3. Timeline of upcoming milestones

Calpine's LMEC and DEC facilities use approximately 7,015 AFY, as shown in Table 3-1. The total estimated recycled water demand for Future Industrial Facilities, Near-Term Landscape Irrigation, and

Long-Term Landscape Irrigation is approximately 3,820 AFY. Therefore, the estimated future recycled water demand would only replace approximately 54% of the total LMEC and DEC's annual demand leaving a demand shortfall of 46%.

4. Recycled Water Distribution System Options

Hazen reviewed the capacity of the existing recycled water distribution system and its potential for new user connections. **Figure 4-1** shows the existing and potential recycled water users along with the existing distribution system. It is our understanding that recycled water flows to DEC leave the RWF through a separate dedicated pipeline, and so 5.76 MGD peak flow for DEC is not included in the remaining flows in the distribution system.

The analysis of adding potential future users to the existing recycled water distribution system is shown in **Table 4-1**. The average annual, max day, and peak hour demands of existing users and the potential future users are sourced from **Table 3-1** and **Table 3-2.** These demands are from the 2013 Recycled Water Master Plan and conversations with potential future users. In **Table 4-1**, the segment flow capacity in the distribution system was estimated by assuming a pipe velocity of 8 feet per second (ft/sec). The flow remaining in the distribution system was estimated by subtracting the segment demand from the overall demand in the existing distribution system. The available demand capacity was estimated by subtracting the flow remaining in the distribution system from the segment flow capacity. The available demand capacity for two scenarios is shown in **Table 4-1,** and those scenarios are as follows:

1. Scenario 1: Available demand capacity of the existing distribution system with existing and potential users.

2. Scenario 2: Available demand capacity of the existing distribution system with all existing users except LMEC and potential users.

In segments where the remaining flow is expected to exceed the capacity of the pipe segment, the available capacity is negative and shown in red. These segments indicate a need to upsize pipe diameters to accommodate the larger expected flow demands from potential future users.

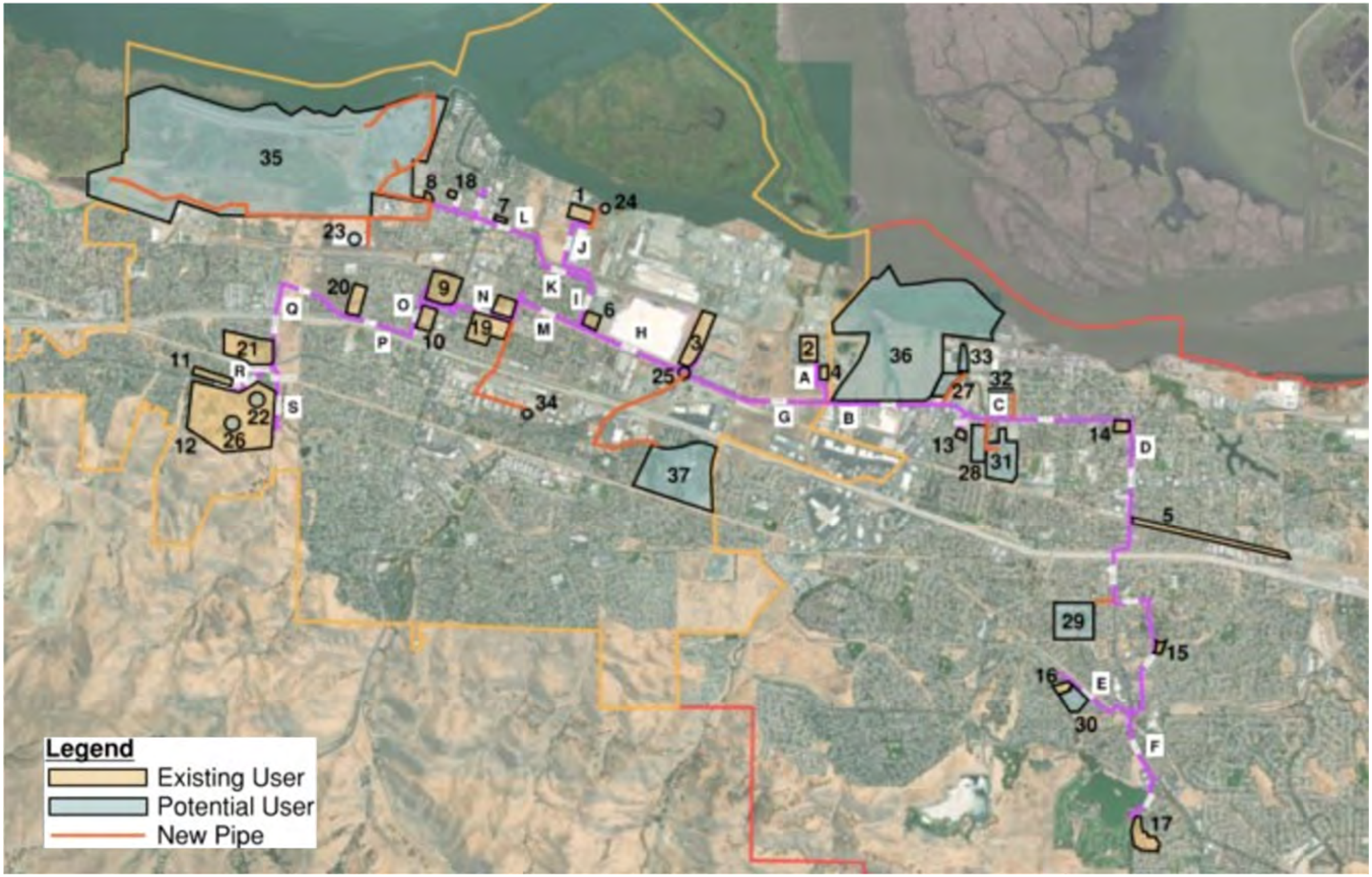


Figure 4-1 Existing and Potential Future Recycled Water Users Map (refer to Table 3-1 and Table 3-2)

Table 4-1 Existing Distribution Facility Capacity Analysis

Segment	Users`	Street(s)	Pipe Size (in)	Capacity (mgd)	Max Day Demand Leaving Distribution System (mgd)	Peak Hour Demand Leaving Distribution System (gpm)	Flow Remaining in Distribution System with Max Day Demands (mgd)	Flow Remaining in Distribution System with Peak Hour Demands (mgd)	Available Capacity in Distribution System with Max Day Demands (mgd)	Available Capacity in Distribution System with Max Day Demands *Without* LMEC Demands (mgd)	Available Capacity in Distribution System with Peak Hour Demands (mgd)	Available Capacity in Distribution System with Peak Hour Demands *Without* LMEC Demands (mgd)
A	DD WWTP/RWF	Arcy Ln	20	11.28	0.15	168.00	13.51	19.51	-2.23	1.70	-8.23	-3.82
B	Fairview Park, Babe Ruth Fields, Corteva Wetlands Preserve (DOW Wetlands), Antioch Historical Society	W 10th St	16	7.22	0.06	129.50	1.64	2.54	5.58	5.58	4.68	4.68
C	Antioch City Park, Antioch Little League, Antioch Fairgrounds (Contra Costa Event Center), Prosserville Park (on 6th St between M&O)	W 10th St	16	7.22	0.15	308.40	1.49	2.10	5.73	5.73	5.12	5.12
D	Caltrans, Mountaire Park, Memorial Park (Park Middle School)	A St, Lone Tree Way, Worrell Rd, Sunset Ln	14	5.53	0.11	237.60	1.38	1.76	4.15	4.15	3.77	3.77
E	Chichibu Park, Sutter Elementary School	Longview Rd	8	1.80	0.19	393.00	1.19	1.19	0.61	0.61	0.62	0.62
F	Lone Tree Golf Course	Lone Tree Way, Golf Course Rd	12	4.06	1.19	826.00	0.00	0.00	4.06	4.06	4.06	4.06
G	Mt. Diablo Resource Recovery Park – Waste Recycle and Transfer Station, Loveridge Corridor, Los Medanos College (point demand)	Pittsburg-Antioch Hwy, Loveridge Rd	18	9.14	5.98	5010.90	5.83	9.56	3.31	7.24	-0.43	3.98
H	Central Park	Pittsburg-Antioch Hwy	18	9.14	0.04	80.00	5.79	9.45	3.35	7.28	-0.31	4.09
I	None	Pittsburg-Antioch Hwy	18	9.14	0.00	0.00	5.79	9.45	3.35	7.28	-0.31	4.09
J	Calpine – LMEC, SF Bay Aggregates – Carbon Capture and Mineralization Project	Pittsburg-Antioch Hwy	18	9.14	3.93	3059.00	1.86	5.04	7.28	7.28	4.09	4.09
K	None	Pittsburg-Antioch Hwy, Harbor St	12	4.06	0.00	0.00	1.86	5.04	2.20	2.20	-0.98	-0.98
L	Pittsburg Linear Parks, Marina Walk Park, Mariner Park, BayWalk, Diablo Energy Storage LLC	E 8th St, W 8th St	8	1.80	0.34	1083.00	1.52	3.48	0.28	0.28	-1.68	-1.68
M	Los Medanos Industrial Park	E 14th St, Harbor St, Redwood St	12	4.06	0.01	24.30	1.51	3.45	2.55	2.55	0.61	0.61
N	Pittsburg High School, City Park	School St, Railroad Ave, Center Dr, Civic Ave	12	4.06	0.12	239.60	1.39	3.10	2.67	2.67	0.96	0.96
O	City Hall	Davi Ave	6	1.02	0.03	56.00	1.36	3.02	-0.34	-0.34	-2.01	-2.01
P	Parkside Elementary School	Power Ave	10	2.82	0.02	34.60	1.34	2.97	1.48	1.48	-0.15	-0.15
Q	Rancho Medanos Junior High School	N/A	14	5.53	0.01	23.60	1.33	2.94	4.20	4.20	2.59	2.59
R	John Henry Johnson Park	W Leland Rd	12	4.06	0.05	101.00	1.28	2.80	2.78	2.78	1.27	1.27
S	Delta View Golf Course, Stoneman Sports Complex, Pittsburg Technology Park	N/A	14	5.53	1.28	1941.00	0.00	0.00	5.53	5.53	5.53	5.53

Existing and potential future users were then categorized based on the level of modification that would be required to connect to the existing recycled water distribution system:

- Existing or new users located adjacent to the existing distribution system where the existing distribution system has adequate capacity to serve the new user at maximum day demands.
- Existing or new users located adjacent to the existing distribution system where the existing distribution system does not have adequate capacity to serve the new user at maximum day demands.
- Existing or new users located more than 2,000 feet from the existing distribution system, thereby requiring a new pipeline to serve that new user.

For potential future users previously identified in the 2017 Delta Diablo Recycled Water System Planning TM, new pipe connections, pipe routings, and sizing were obtained from this report. For potential future users that were not identified in the 2017 Delta Diablo Recycled Water System Planning TM, pipe routings were approximated based on existing roads, and pipe sizing was determined by estimating the pipe capacity. Potential future users and connections to the existing distribution system are presented in **Figure 4-1.**

As shown in **Figure 4-1**, some potential future landscape irrigation users were located over 2,000 feet from the existing distribution system. In these instances, a storage tank is recommended. Similarly, it is recommended that a storage tank is used for any large users with demands that exceeded 50% of the adjacent pipeline capacity to alleviate the need for replacing distribution pipe (i.e., the storage tank can be filled during the day when demands are low). The storage tank size was estimated by calculating the amount of storage required for one day of usage. For the landscape irrigation users, the average annual demand was divided by the number of irrigation days, which was assumed to be every other day for eight months, or 120 irrigation days, and this daily irrigation use was multiplied by two to get the storage tank size.

A summary of recommendations for incorporating potential future users into the existing distribution system can be found in **Table 4-2**. As part of the upcoming Recycled Water Master Plan, it is recommended that a hydraulic model be developed to evaluate the distribution system for both maximum day and peak hour demands.

Table 4-2 Recommendations to Incorporate Potential Future Users into Existing Distribution System

Location	Customer	Recommended Pipe Size (in)	Length (ft)	Recommended Storage Tank Instead of Adding New Pipe?	Storage Tank Size (gallons)
Existing and Potential Users – Minimal Modification					
3	Mt. Diablo Resource Recovery Park – Waste Recycle Center and Transfer Station (WRC&TS)	-	-	Y	32,000
25	Loveridge Corridor	-	-	-	-
26	Pittsburg Linear Parks	-	-	-	-
27	Mariner Park	-	-	-	-
30	City Park (Pittsburg)	-	-	-	-
36	Corteva Wetlands Preserve (DOW Wetlands)	-	-	-	-
Existing and Potential Users – Upsize Existing Distribution Pipe					
A	DD WWTP/RWF, DEC	24 [c]	1,837	N	-
O	City Hall	8	1,788	N	-
Existing and Potential Users – New Pipes and/or Storage Tank Required					
23	Diablo Energy Storage	Need more information	3,588	N	-
24	San Francisco Bay Aggregates – Carbon Capture and Mineralization Project	Need more information	943	N	-
28	Antioch Little League	8 [a]	825	N	-
29	Memorial Park (Park Middle School)	6 [a]	842	N	-
31	Antioch Fairgrounds (Contra Costa County Event Center)	8 [a]	1,476	N	-
32	Prosserville Park (on 6th St between M&O)	2.5 [a]	915	N	-
33	Antioch Historical Society	4	1,432	N	-
34	Los Medanos Industrial Park	4	4,714	Y	6,000
35	BayWalk	6	19,140	Y	175,000
37	Los Medanos College (point demand)	14 [a]	6,607 [b]	Y	650,000

Notes

[a] Recommended pipe sizes are from the *Delta Diablo Recycled Water System Planning TM* (2017)

[b] The *Delta Diablo Recycled Water System Planning TM* (2017) shows the user, Los Medanos College (point demand), located on the existing distribution line. Upon analysis by Hazen, Los Medanos College is 6,607 ft away from the existing distribution system.

[c] Recommendations for upsizing distribution pipes are based on maximum day demands and should be evaluated in more detail for peak hour demands during the upcoming master plan.

5. Recycled Water Facility High Level Capital Improvements

5.1 2013 Recycled Water Facility Master Plan Recommendations

As part of the 2013 Recycled Water Master Plan, several options were identified to maximize the use of recycled water. Three options for optimizing use of the existing RWF were proposed, expansion of the existing RWF, addition of advanced treatment processes and distribution system expansion. These are described in the sections below.

The 2022 Master Plan also included analysis of changes to the WWTP that could impact the water quality entering the RWF (**TM 04 Nutrient Management Analysis**). Nutrient reduction at the WWTP could result in Calpine increasing the number of times it cycles cooling water, reducing demand. Recycled water improvements discussed here do not assume no nutrient removal at the WWTP. It is recommended that when considering triggers for liquid stream changes at the WWTP, recycled water impacts are considered as part of the economic and non-economic analysis. While recycled water quality will likely not be a main driver to implement liquid stream improvements at the WWTP, it will certainly be a factor to consider.

5.1.1 Expansion of the Existing RWF

The RWF was designed to allow for future addition of a third treatment train consisting of similar treatment processes or new treatment process (e.g., MF/UF, cloth media filters, compressible media filtration). Cost estimates for adding a third treatment train (with similar treatment processes) to the existing RWF are outlined were determined in the 2013 Recycled Water Master Plan and are summarized in **Table 5-1** for reference.

Table 5-1. RWF Third Train Budgetary Construction Costs from DD Recycled Water Master Plan (2013)

Component	Estimated Construction Cost
Influent pump station improvements	$285,000
Flocculating clarifier	$902,000
Filter	$686,000
Chlorine contact basin	$1,731,000
Chemical storage & feed	$219,000
Electrical & compressor	$224,000
Yard piping allowance	$457,000
Subtotal	**$4,504,000**
Contingency (30%)	**$1,351,000**
Total	**$5,855,000**

There are additional options to expand the capacity of the existing RWF without capital improvement projects since the current system appears to be under-rated. Options for incremental expansion of the RWF would include re-rating the chlorine contact basins and running the filters at the 7.2 gpm/sf loading rate. Recycled water demands have not increased significantly since the 2013 Recycled Water Master Plan, therefore additional recycled water treatment capacity does not seem necessary.

5.1.2 Addition of Advanced Treatment Processes

The District has investigated adding advanced treatment to the RWF in order to improve the quality of recycled water and free up existing capacity by reducing the demands of existing industrial customers. Two advanced treatment strategies were evaluated:

5.1.2.1 Calpine Advanced Treatment Option

Providing higher quality water to the Calpine LMEC and DEC power plants would allow the plants to run a higher number of cycles through their cooling towers, thereby reducing their overall recycled water demand. Reducing cooling tower make-up demand would decrease chemical and water purchase costs for these users, while also freeing up supply on peak days so that the District can serve more users in times of capacity deficiencies. Two primary configurations for advanced treatment were considered:

1. Sidestream treatment in which a portion of the total recycled water flow is treated and blended back into the main recycled water stream.
2. Dedicated treatment to produce recycled water only for Calpine users (some blending of tertiary-treated recycled water would be required).

In both cases, the new advanced treatment train was assumed to be a combination of micro filtration and reverse osmosis (MF/RO). Total cost savings for a variety of MF/RO alternatives are provided in **Table 5-2**.

Overall, none of the alternatives produced a project with a payback period less than five years, even with 50% grant funding for construction costs. Calpine may have a vested interest in the District's upgrades to the secondary treatment process. However, in the event Calpine discontinues recycled water use after 2030, their interest in recycled water quality improvements diminish. Furthermore, the District wants to maintain their current outfall flows. They are not looking to increase overall recycled water supply, rather, the District would like to maintain its current level of demand.

Table 5-2. Total Cost Savings from DD Recycled Water Master Plan (2013)

Alternative	Nitrification in Cooling Tower?	Capital Cost	O&M Cost ($/yr)	Total Annualized Cost	Annual Difference ($/yr)	Payback Period w/ 50% Grant Funding (yr)
0.5-mgd sidestream	Yes	$1,780k	$99k	$202k	$16k	13
1.0-mgd sidestream	Yes	$3,550k	$197k	$402k	-$22k	22
1.5-mgd sidestream	Yes	$4,890k	$296k	$578k	-$41k	24
2.0-mgd sidestream	Yes	$7,100k	$394k	$771k	-$96k	47
0.5-mgd sidestream	No	$1,780	$99k	$202k	$50k	9
1.0-mgd sidestream	No	$3,550k	$197k	$402k	$41k	12
1.5-mgd sidestream	No	$4,890k	$296k	$578k	$49k	13
2.0-mgd sidestream	No	$7,100k	$394k	$771k	$20k	18
0.5-mgd dedicated to DEC	Yes	$2,300k	$99k	$213k	-$17k	38
1.0-mgd dedicated to DEC	Yes	$4,050k	$197k	$414k	-$17k	24
1.5-mgd dedicated to DEC	Yes	$5,390k	$296k	$590k	$2k	19
2.0-mgd dedicated to DEC	Yes	$7,020k	$394k	$782k	$9k	18
2.15-mgd dedicated to DEC	Yes	$7,210k	$424k	$841k	$8k	17
0.5-mgd dedicated to DEC	No	$2,300k	$99k	$213k	$25k	16
1.0-mgd dedicated to DEC	No	$4,050k	$197k	$414k	$69k	12
1.5-mgd dedicated to DEC	No	$5,390k	$296k	$590k	$131k	10
2.0-mgd dedicated to DEC	No	$7,020k	$394k	$782k	$180k	10
2.15-mgd dedicated to DEC	No	$7,210k	$424k	$841k	$192k	9

5.1.2.2 High Purity Water Treatment Facility (HPWTF) Option

This option explored the potential for building a Title XVI-eligible facility that would operate in parallel to the existing RWF and treat both secondary effluent and brackish water from the Antioch intake. Water from this facility would be treated to a much higher quality level, meeting the high purity needs of potential future industrial water users in Antioch. The conceptual configuration for this proposed advanced treatment facility was a two-pass MF/RO system to meet water quality goals for total dissolved solids (TDS), as shown in **Figure 5-1**. A cost summary for the proposed HPWTF is provided in **Table 5-3**. Note that this is concept is similar to Antioch brackish water desalination facility currently planned.

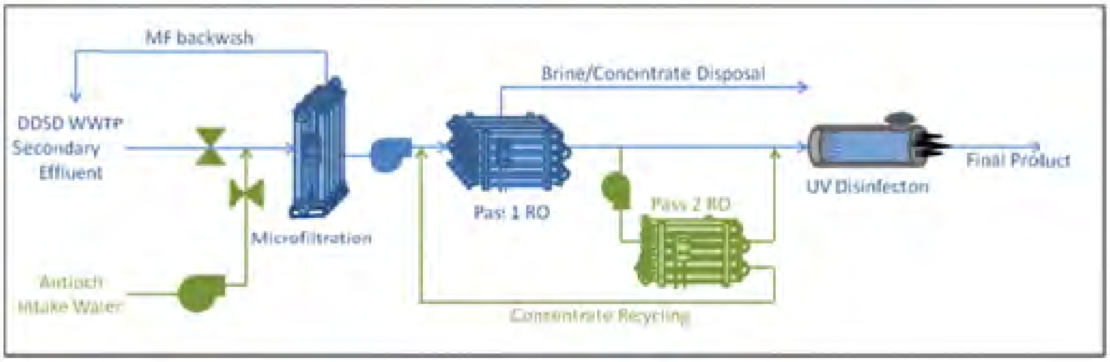


Figure 5-1. Conceptual Design for HPWTF from *DD Recycled Water Master Plan* (2013)

Table 5-3. HPWTF Annual Costs and Unit Cost Estimates from DD Recycled Water Master Plan (2013)

Item	1.0-mgd w/ 1-Pass RO	1.0-mgd w/ 2-Pass RO	Ultimate Phase Expansion Cost[1]	Ultimate Project Cost[2]
Annual Costs				
Annual O&M Cost[3]	$345,000	$484,000	$1,641,000	$2,125,000
Annualized Capital Cost[4]	$684,000	$1,213,000	$2,071,000	$3,245,000
Total Annual Cost	$1,038,000	$1,697,000	$3,658,000	$5,370,000
Unit Costs				
Estimated Unit Cost	$930	$1,510	$920	$960
Estimated Unit Cost w/ 50% Grant Funding	$620	$970	$700	$670

[1] Includes only incremental cost of adding 4.0-mgd of additional capacity and associated facilities.
[2] Includes total project cost (Initial Phase Cost + Ultimate Phase Expansion Cost).
[3] Basis for O&M cost shown in detailed cost estimate in Appendix G of the DD *Recycled Water Master Plan, July 2013*
[4] Based on a 2.5% interest rate and 20-year term (assumes State Revolving Fund financing).

5.1.3 Distribution System Upgrades

In the 2013 Recycled Water Master Plan, alternatives were evaluated to optimize the use of existing infrastructure, relieve capacity restrictions, and connect new users. These alternatives considered the addition of new pipelines, pump stations, and storage for recycled water resources. The four alternatives are described below:

1. Alternative 1: Separate Distribution Systems for Industrial Users

   Alternative 1 provides higher quality water for targeted industrial customers using a separate distribution system. This option assumes that an advanced treatment system is implemented at the RWF.

2. Alternative 2: Pressure Zones for Distribution System

   Alternative 2 provides in-system storage and in-system pump stations (zoned system) to save energy and optimize system operations by separating recycled water distribution into two pressure zones.

3. Alternative 3: Additional Terminal Storage at LMEC

   Alternative 3 provides additional terminal storage at the LMEC Power Plant, which would allow for better distribution of hourly demands from the RWF during peak day at buildout, lower peak hourly demands, and a reduction of the required pipe size for new pipelines.

4. Alternative 4: Separate, Nearby Distribution System Plus Additional Storage at LMEC

   Alternative 4 combine Alternatives 1 and 3 to include construction of a terminal reservoir at LMEC along with connection of all near term users.

A cost summary for each option is provided in Table 5-4.

Table 5-4. Distribution System Alternatives Cost Summary from the 2013 Recycled Water Master Plan

Alternative	Total Capital Cost	Annualized Capital Cost	Annual O&M Cost	Annual RW Delivered (AFY)	Project Unit Cost ($/AF)
Alternative 1	$38,760,000	$2,487,000	$465,000	2,758	$1,071
Alternative 2	$30,650,000	$1,967,000	$98,000	2,868	$720
Alternative 3	$31,190,000	$2,001000	$103,000	4,244	$496
Alternative 4	$31,590,000	$2,027,000	$103,000	4,461	$478

Due to the fact that the existing distribution system appears to be adequate to serve potential customers to replace Calpine, it is not recommended to implement distribution system expansions at this point in time. These alternatives should be revisited as part of the 2022/2023 Recycled Water Master Plan.

5.2 Summary of Capital Improvement Programs

Table 5-5 summarizes the Capital Improvement Programs and makes recommendations as to which improvements should be accomplished in the near-term.

Table 5-5 Proposed Title XVI Program from 2013 Recycled Water Master Plan

Recommendation	Description	Major Components	Purpose	Proceed with Recommendation?	Explanation
Distribution System Expansion Project (Alternative 4)	Implementation of pipeline, pump station, and storage improvements to the distribution system, and addition of a third train to the RWF	Construct new in-system terminal reservoir at LMEC	Required to meet near-term and buildout capacities	No	Wait for Recycled Water Master Plan and Calpine decision to continue beyond 2030
		Separate distribution system into two systems for industrial users and remaining customers	Optimizes distribution system and allows for future conveyance of high purity advanced treated water to industrial users	No	Consider as part of Recycled Water Master Plan – may want to delay to 2030 and Calpine decision
		Construct new close-by pump station at the RWF for industrial users	Required to accommodate the separate distribution system for industrial users	No	Wait for Recycled Water Master Plan and Calpine decision to continue beyond 2030
		Expand existing distribution system for non-close-by industrial users	Reaches new potential users	No	Should evaluate this as part of the Recycled Water Master Plan – potential non-close by industrial users are identified in Section 3 but would only be added if Calpine discontinues recycled water use
High Purity Water Treatment Facility (HPWTF) Implementation Program	Construction of a membrane filtration/reverse osmosis (MF/RO) treatment plant and related pipelines and pump stations; facility would have a capacity between 1 and 5 mgd and could treat effluent from the DD WWTP or water diverted from the Antioch Intake	Install the following: • Feedwater conveyance system • Blend tank (optional) • Microfiltration pretreatment system • Break tank • Booster pumps and cartridge filters • Reverse osmosis system • Clearwell • Product water conveyance system • Treatment facilities building	Produce high purity water for existing and future recycled water customers	No	Should evaluate this as part of the Recycled Water Master Plan – demand for this level of recycled water appears to be limited currently
Other RWF Improvements	Additional improvements to the RWF that benefit the recycled water system	Re-route industrial discharge pipeline	Improve water quality of tertiary-treated recycled water by reducing TDS	No	Should evaluate this as part of the Recycled Water Master Plan – also may want to wait for Calpine decision
		Re-rate chlorine contact basin	Increase overall RWF capacity (existing contact basin has higher actual capacity than permit states)	Yes	Re-rating provides the opportunity to increase recycled flow but doesn't require it.
		Replace RWF influent flowmeter with larger diameter meter	Reduce headloss at higher RWF flows	No	Should evaluate this as part of the Recycled Water Master Plan

6. Conclusions and Next Steps

This TM provides a brief background of the existing recycled water system, existing and potential recycled water users, and high-level capital improvements. The following are concluded based on the discussions in this TM:

- There are potential new industrial and irrigation users that could be added to the recycled water system, but their total demand would only replace about 54% of the recycled water currently used by LMEC and DEC.
- Of the 17 identified potential future users, seven users can be served without major modifications to the existing distribution system, and 10 users would require onsite recycled water storage tanks or additional pipes to connect into the existing distribution line. Two segments of the existing distribution system will likely need to be upsized to accommodate enough flow for potential future users.
- It is recommended that the chlorine contact basin is re-rated to increase recycled water flow and an additional Kruger Actiflo train is added. Other Capital Improvements Program recommendations should wait until Calpine makes its decision and/or to be evaluated as part of the upcoming Recycled Water Master Plan.

The next steps are recommended:

- Follow ups with the potential large users that did not respond to inquiries about project status and potential future recycled water use should occur.
- The upcoming Recycled Master Plan should look at the treatment and distribution system in more detail.

Appendix 7

TM – 07 Outfall Hydraulics

October 18, 2022

To: Brian Thomas, Delta Diablo

From: Serena Takada, Gregg Cummings, Hazen

Re: Master Plan – Outfall Hydraulics

TM - 07 Outfall Capacity Analysis

Final

Revision No.	Date	Description	Author	Reviewed
1	8/23/2021	Internal Draft	Takada, G. Cummings	I. Chu, M. Solomon
2	10/31/2022	Draft	Chu	District

Table of Contents

1. Introduction

As part of the 2022 Master Plan, the outfall hydraulics for the Delta Diablo (District) Wastewater Treatment Plant (WWTP) were evaluated to determine the timing of outfall cleaning and potential improvements. The impact of sea level rise (SLR), storm surge, increased flows and loads, and recycled water use on outfall capacity was determined.

1.1 Objectives

The objectives of this Technical Memorandum (TM) were to:

- Review previous planning studies that have identified a future need to construct a parallel WWTP outfall and outfall pump station to be used during high flow events.
- Review and summarize existing sea level rise projections for the area. The Consultant will incorporate sea level rise projections into the outfall hydraulics analysis to determine the impact on the plant hydraulic grade line. The Consultant will also provide recommendations for future studies focused on climate change resiliency that should be incorporated into the CIP.
- Use the updated flows and loads, anticipated sea level rise, and the District's agreement with the City of Antioch to determine the future outfall and effluent pumping requirements under various scenarios (future wet weather flows and with and without Antioch reverse osmosis concentrate).

2. Background

2.1 Wastewater Treatment Plant (WWTP)

Major treatment processes at the District's WWTP include screening, grit removal, primary clarification, tower trickling filters, aeration, secondary clarification, disinfection, and dechlorination, as shown on **Figure 2-1**. Secondary effluent is discharged to the New York Slough in the San Joaquin Delta or diverted to the Recycled Water Facility (RWF) prior to dechlorination for further treatment and distribution to local recycled water customers. The WWTP has a rated average dry weather capacity of 19.5 million gallons per day (mgd) and a peak wet weather flow capacity of 31.1 mgd.

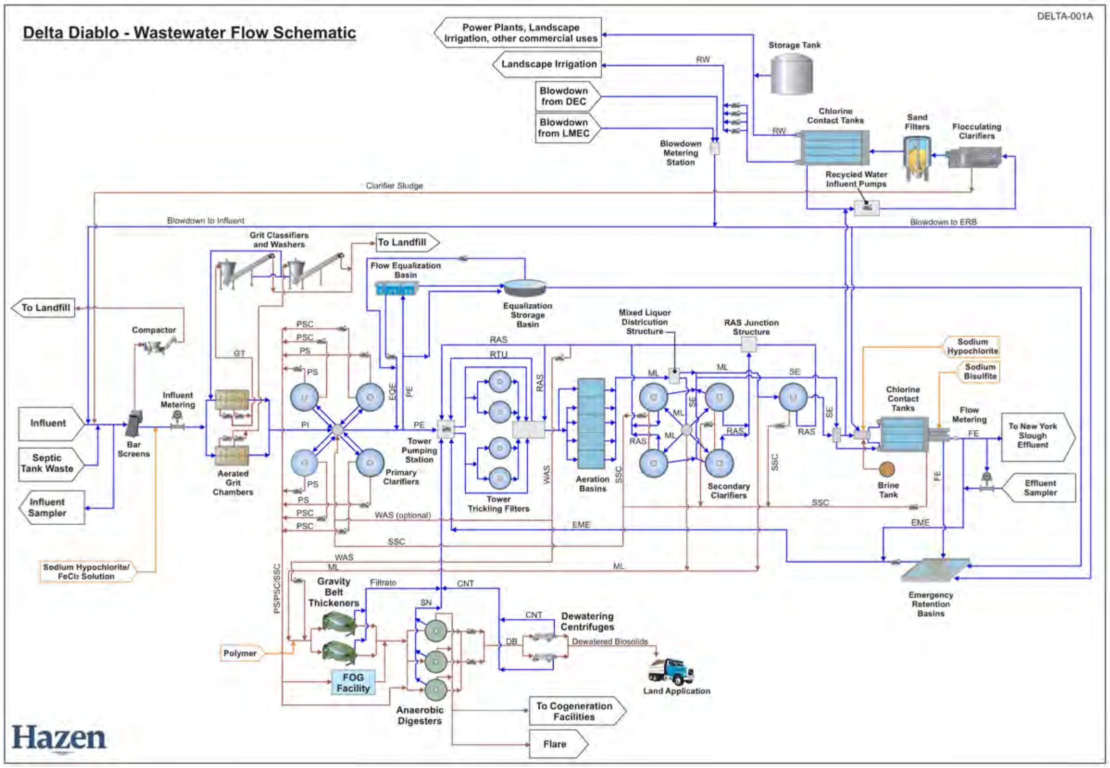


Figure 2-1 WWTP and RWF Process Flow Diagram from DD Recycled Water Master Plan, July 2013

2.2 Existing Outfall

The existing outfall was constructed in 1981. It consists of a 48-inch diameter pipe that subsequently transitions to a 42-inch diameter pipe that runs from the chlorine contact basin to New York Slough. **Figure 2-2** shows the approximate hydraulic profile for the outfall (source Brown & Caldwell drawings, 1979).

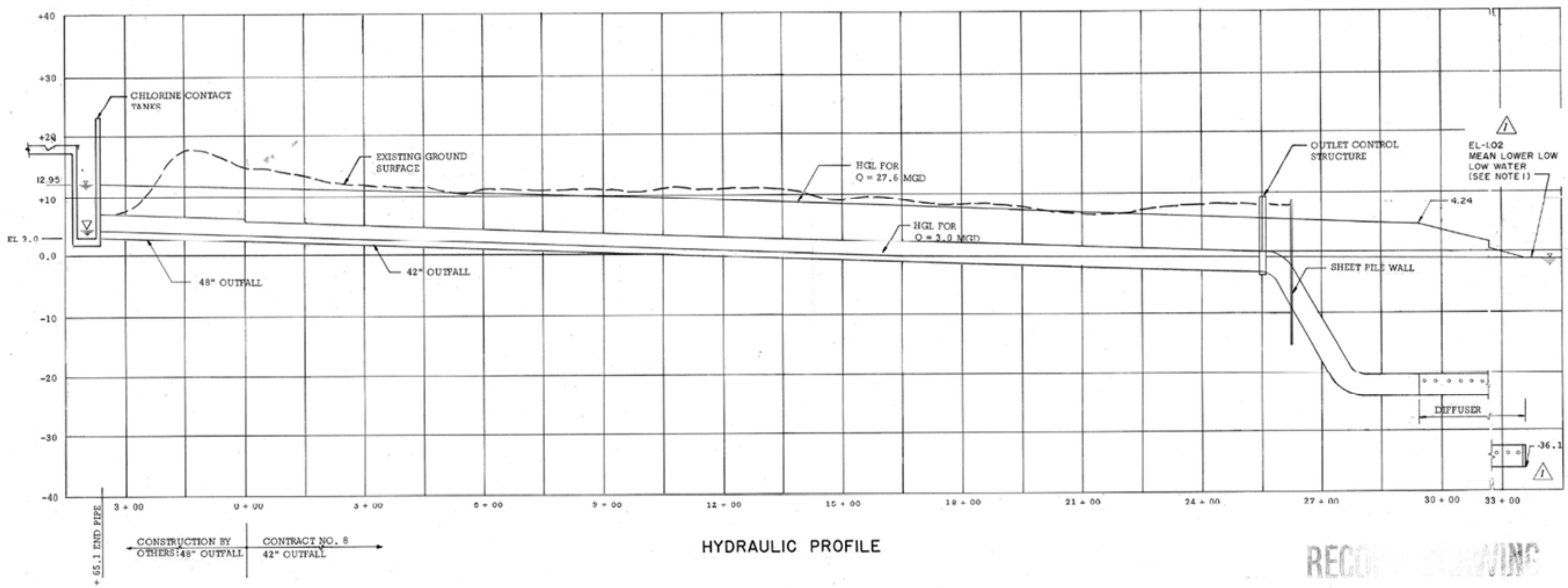


Figure 2-2 Outfall Hydraulic Profile (1979 Outfall CONTRACT NO. 8)

3. Review of Previous Planning Studies

3.1 List of information reviewed

The following information was reviewed for this project:

1. Brown & Caldwell, Industrial Shore Subregional Wastewater Facilities Outfall – CONTRACT NO. 8 drawings, December 1979
2. California Water Boards, Climate Change Information, April 2021.
3. Underwater Resources, Summary Inspection Report Delta Diablo Outfall, December 2018

3.2 Brown & Caldwell Drawings (1979)

Criteria used in the 1979 outfall design are presented in **Table 3-1**. Brown and Caldwell estimated the maximum water level in the receiving river to be at elevation 7.5 feet and the chlorine contact basin water level to be at elevation 19.45 feet. The 1979 plans and profiles were used to model the existing outfall hydraulics.

Table 3-1: 1979 Brown and Caldwell Outfall Design Criteria

Flow (mgd)	
Minimum	7.6
Average	12.6
Maximum	27.6
Outfall Pipeline – Onshore	
Diameter, in	42
Pipe Material	RCP
Outfall Pipeline – Offshore	
Diameter, in	42
Pipe Material	DI
Diffuser	
Diameter, in	42
Length, ft	400
No. Ports	50
Port Diameter, in	3
Port Spacing, ft	8
Port Depth, elevation, ft	-20.5 to -32.6

3.3 Underwater Resources Inspection Report

In 2018, Underwater Resources, working with National Plant Services, conducted an inspection of the existing outfall. The results of the inspection included the following observations:

- The 42-inch diameter outfall pipeline was found to be in generally good condition. The cement lining was found to be generally intact in the main sections of pipe but was found to be pulling away at many of the pipeline joints.
- The 3-inch circular ports in the diffuser section were found to be overgrown with marine growth or otherwise restricted due to corrosion.
- Approximately half of the diffuser section was found to be filled with sediment. In addition, plywood sheeting was found within the diffuser section.

4. Sea Level Rise Projections

Hazen reviewed the following information related to sea level rise, as further described below:

- Regional Water Quality Control Board (Regional Water Board) recommendations
- Verbal information provided by City of Pittsburg staff
- National Oceanic and Atmospheric Administration (NOAA) Sea Level Rise Data for Port Chicago

4.1 California RWQCB Information

In May 2020, the California Coastal Commission adopted Making California's Coast Resilient to Sea Level Rise: Principles for Aligned State Action. The Commission noted a significant risk of up to 0.8 feet of sea level rise by 2030 and 6.9 feet by 2100 in the San Francisco Bay region.

In April 2021, the San Francisco Bay Regional Water Board advised Bay Area agencies to plan for sea level rise of 3.5 feet by 2050. Both the California Environmental Protection Agency (CalEPA) and State Water Resources Control Board (SWRCB) endorse these planning principles.

4.2 City of Pittsburg and Antioch Information

Both the City of Pittsburg and the City of Antioch were contacted to discuss their approaches to sea level rise. The City of Antioch indicated that they are just starting sea level rise evaluations and have not developed any estimates for sea level rise to date. The City of Pittsburg is also in the initial stages of their sea level rise evaluation. However, the City of Pittsburg indicated that they are looking at 7 to 10 inches of sea level rise over the next 50 years (to 2070).

4.3 NOAA Sea Level Rise Information

NOAA has estimated sea level rise at certain monitoring locations. The closest NOAA monitoring location to the District's WWTP with available information is Port Chicago, which is located approximately 10.7 miles west of the WWTP. It should be noted that compared to the District's WWTP, Port Chicago is located closer to the San Francisco Bay and is directly connected to the Pacific Ocean. Thus, estimates for sea level rise at Port Chicago are expected to be higher than those for locations further upstream such as at the District's WWTP. Of the three intermediate sea level rise estimates shown in **Figure 4-1**, the intermediate low value of 11.8 inches is closest to the City of Pittsburg recommendation. As such, 11.8 inches of sea level rise by 2070 was used for this outfall capacity analysis.

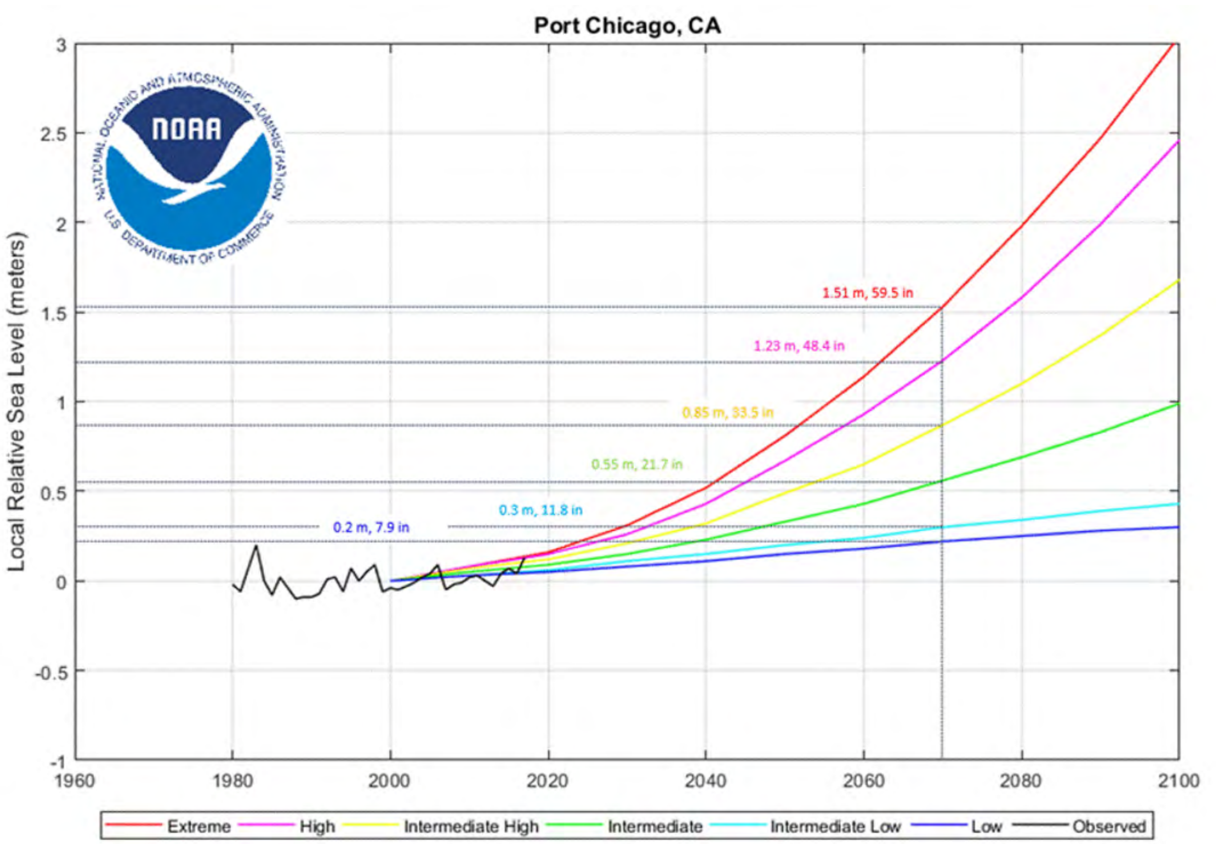


Figure 4-1: NOAA Sea Level Rise Projections

5. Storm Surge

Hazen reviewed the following information related to storm surge:

- NOAA tidal data for Port Chicago
- Federal Emergency Management Agency (FEMA) flood map for the District's WWTP

5.1 NOAA Tidal Information

The NOAA tidal gauge at Port Chicago reported the Mean Higher-High Water (MHHW) level as 6.01 feet NAVD88.[1] The maximum water level observed at Port Chicago was 3.01 feet with reference to MHHW, or 9.02 feet NAVD88.

5.2 FEMA Flood Information

FEMA has categorized the District's WWTP as Zone AE, or high risk for a 100-year storm. FEMA has projected the flood elevation during a 100-year storm at the WWTP to be 11 feet NAVD88. As such, this elevation was used as the current water elevation plus storm surge for this outfall capacity analysis. **Figure 5-1** presents the FEMA Flood Insurance Rate (FIRM) Map for the WWTP.

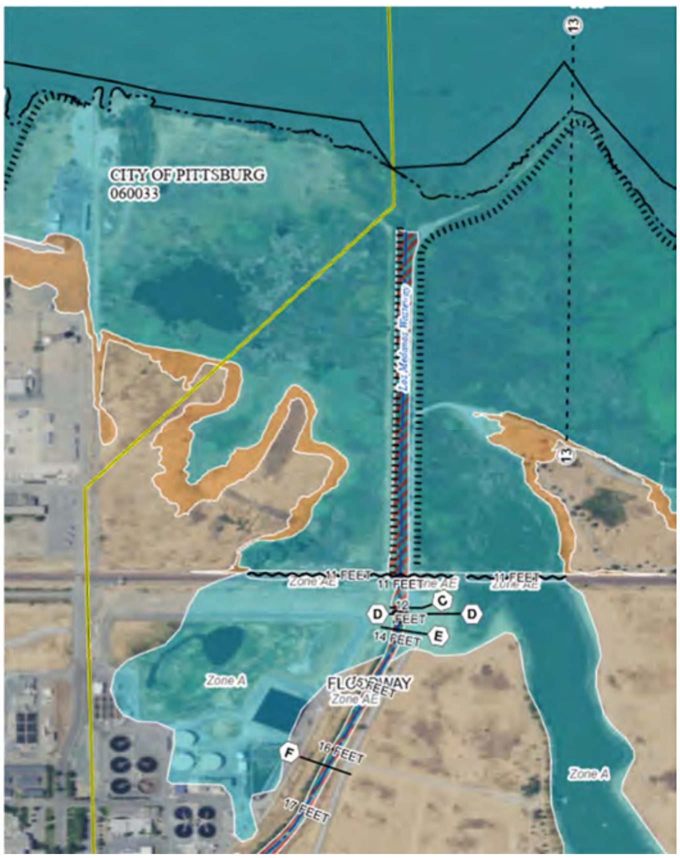


Figure 5-1: FEMA FIRM Map

[1] North American Vertical Datum of 1988

6. Outfall Modeling Results

6.1 Outfall Model Development

A spreadsheet-based hydraulic model for the existing outfall was developed for this evaluation based on the 1979 Brown & Caldwell drawings referenced above. The hydraulic model was calibrated using the Mean Lower Low Water (MLLW) elevation and the Max River Flood Level at the chlorine contact basin specified in the 1979 drawings.

6.2 Model Runs

The outfall hydraulic model was run for the following conditions:

- Ideal Condition – All diffuser ports open
- Partial Cleanout Condition – 75% diffuser ports open
- Current Condition – 50% diffuser ports open

The capacity for each condition was evaluated with respect to projected seasonal flows and receiving water elevations. Plant influent flow projections through 2040 used for this analysis are further described in TM 01 Flows and Load Projections. The modeled flows to the outfall account for wastewater effluent and additional flows to and from the facility as detailed below:

- 9.69 mgd of recycled water is sent to Los Medanos Energy Center (LMEC) and Delta Energy Center (DEC) per the 2013 Recycled Water Master Plan. Note that during heat waves, 12.8 mgd is sent to the LMEC and DEC, but 9.69 mgd is a more conservative estimate for this analysis.
- 5.00 mgd of blowdown is sent back from LMEC and DEC per discussions with the District on June 14th, 2021.
- 2.80 mgd of recycled water is sent to the City of Pittsburg and the City of Antioch for landscape irrigation per the 2013 Recycled Water master Plan.
- 2.00 mgd of reverse osmosis concentrate is sent back from the City of Antioch per discussions with the District on June 14th, 2021.

Summer outfall flows were estimated as follows:

- Total flow through the wastewater treatment secondary process in the summer, minus 9.69 mgd recycled water to LMEC/DEC, minus 2.80 mgd recycled water for irrigation purposes, plus 5.0 mgd returned blowdown from LMEC/DEC, plus 2.0 mgd returned reverse osmosis concentrate from the City of Antioch. In 2020, the total flow through the wastewater treatment secondary process in the summer was 12.8 mgd so the outfall summer flow is estimated as 7.32 mgd.

- Flows through the wastewater treatment secondary process were increased every five years to match the flow increases projected in the 2022 Master Plan.
- LMEC/DEC recycled water flows and blowdown return flows were assumed to remain constant.

Winter outfall flows were estimated as follows:

- Total flow through the wastewater treatment secondary process in the winter, minus 9.69 mgd to LMEC/DEC, plus 5.0 mgd returned blowdown from LMEC/DEC. In 2020, the total flow through the wastewater treatment secondary process in the winter was 18.4 so the outfall winter flow is estimated as 13.71 mgd.
- Recycled flows to irrigation were assumed to be zero during the winter.
- Reverse osmosis concentrate flows from the City of Antioch were assumed to be zero during the winter.
- Flows through the wastewater treatment secondary process were increased every five years to match the flow increases projected in the 2022 Master Plan.
- LMEC/DEC recycled water flows and blowdown return flows were assumed to remain constant.

Receiving water elevation was adjusted over time to include the projected sea level rise and storm surge information presented above.

6.3 Model Results

Figure 6-1 presents the District's projected outfall capacity through 2040 in five year increments. **Table 6-1** and

Table 6-2 summarize the hydraulic model results.

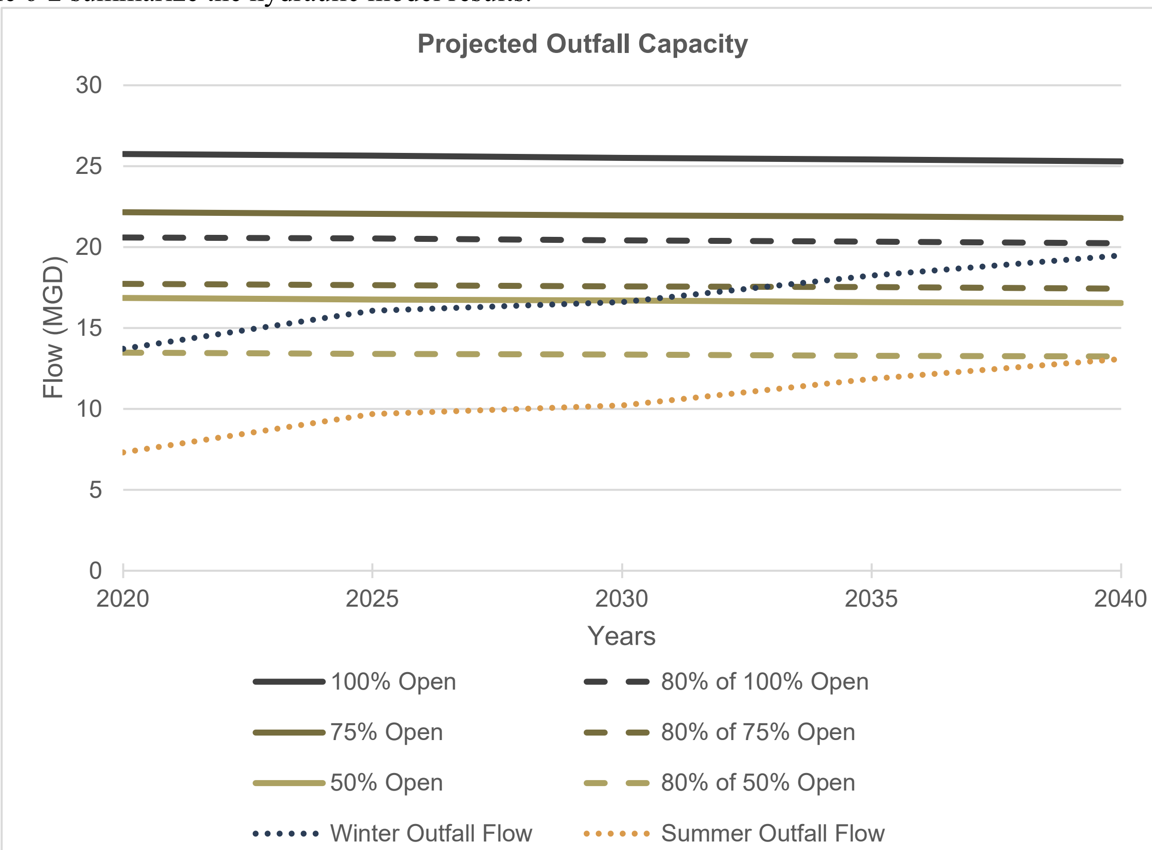


Figure 6-1: Projected Outfall Capacity

Table 6-1: Summer Outfall Model Results

Year	Max receiving water level	Summer Projected Outfall Flows	100% Open	80% of 100% Open	75% Open	80% of 75% Open	50% Open	80% of 50% Open
2020	11	**7.32**	25.75	20.6	22.15	17.72	16.85	13.48
2025	11.10	**9.67**	25.65	20.52	22.05	17.64	16.75	13.4
2030	11.20	**10.21**	25.5	20.4	21.95	17.56	16.7	13.36
2035	11.30	**11.85**	25.4	20.32	21.9	17.52	16.6	13.28
2040	11.39	**13.09**	25.3	20.24	21.8	17.44	16.55	13.24

Table 6-2: Winter Outfall Model Results

Year	Max receiving water level	Winter Projected Outfall Flows	100% Open	80% of 100% Open	75% Open	80% of 75% Open	50% Open	80% of 50% Open
2020	11	**13.71**	25.75	20.6	22.15	17.72	16.85	13.48
2025	11.10	**16.06**	25.65	20.52	22.05	17.64	16.75	**13.4**
2030	11.20	**16.6**	25.5	20.4	21.95	17.56	16.7	**13.36**
2035	11.30	**18.24**	25.4	20.32	21.9	**17.52**	16.6	**13.28**
2040	11.39	**19.48**	25.3	20.24	21.8	**17.44**	16.55	**13.24**

If the recycled water system were taken offline during the winter, the outfall would receive an additional 9.69 mgd of flow preciously reserved for recycled water and would not receive 5.0 mgd of blowdown flow from LMEC/DEC. In this scenario, the total flow to the outfall would be 18.4 mgd in 2020, which would already exceed the current outfall capacity for 80% of 75% and 80% of 50% open modeled scenarios.

Typical planning parameters in California state that planning for new wastewater facilities, including a new outfall, should start when the existing facilities reach 80% of capacity. Based on this rule-of-thumb, the estimated years when the outfall would reach 80% capacity are listed below for each condition:

- Summer Flows:
  - All diffuser ports open: beyond 2040
  - 75% diffuser ports open: beyond 2040
  - 50% diffuser ports open: beyond 2040
- Winter Flows:
  - All diffuser ports open: beyond 2040
  - 75% diffuser ports open: by 2035
  - 50% diffuser ports open: now

Based on this analysis, it is estimated that opening all of the plugged diffuser ports would give the District another 15 years before planning would need to begin on a new outfall. Opening half of the plugged diffuser ports (50%) would not be sufficient for winter flows but would postpone installing a new outfall for summer flows.

The above assumes that the current recycled water flows would continue. If operation of the RWF was discontinued, then the outfall would need to be cleaned (e.g., 100% of the diffuser ports open), and for winter flows planning for a second outfall would need to begin around 2025 even if all of the diffuser ports are open.

7. Key Findings

Based on the results of the hydraulic model outfall analysis, it appears that the outfall is already at 80% capacity during winter flows at MHHW levels in New York Slough with the current condition of 50% of the diffuser ports plugged. However, this scenario may not occur frequently. Therefore, the District may want to evaluate adding effluent equalization during MHHW level events. Alternatively, it appears that cleaning out the plugged diffuser ports could address the capacity issue for winter flows at MHHW level and give the District additional time to plan for a new parallel outfall.

If RWF operation is discontinued, then the plugged diffusers would need to be fully unclogged to accommodate both summer and winter flows. In addition, planning for a second outfall would need to begin around 2025 to handle winter flows.

The estimated cost to clean out 25% of the diffuser ports is $600,000, per information from the Project COL-010 Wastewater Treatment Plant Outfall (WWTO) Pipeline Cleaning & Inspection. The estimated project cost to install a parallel outfall and effluent pump station is $15,000,000.

Appendix 8

TM-08 Energy Management

October 18, 2022

To: Brian Thomas, Delta Diablo

From: Elizabeth Keddy, Bryan Lisk, Hazen

Re: Master Plan – Energy Management

TM - 08 Energy Management

Final

Revision No.	Date	Description	Author	Reviewed
0	December 2021	Energy Management	Keddy	Lisk, Chu
1	November 2022	Energy Management	Chu	Roa

Table of Contents

1. Introduction

As part of the 2022 Master Plan, the District is interested in developing a guidance document outlining specific tasks and procedures to further develop their existing energy management program (EMP). The purpose of this Energy Management Program Guidance Document (EMPGD) is to examine the District's current energy management program and practices and provide recommendations based on industry best practices and standards (i.e., ISO 50001, WEF, WaterRF, US DOE Better Plants, AWWA) for the Distirct's consideration to further develop their energy management program.

This EMPGD will focus on supporting the District to further expand their energy management program by examining the District's current energy management program development and providing guidance on implementing additional energy management best practices and standards. Specifically, the EMPGD will focus on the following five (5) key energy management program areas.

Energy Policy, Objectives and Targets

- Document the intentions, direction, and commitments for improving energy efficiency, resiliency, energy awareness, and existing practices.

Organizational Readiness and Planning

- Basic guidelines to incorporate energy management into core business practices.

Tools and Strategies for Continual Improvement

- Communication and monitoring to promote ongoing improvements and awareness.

Energy Monitoring and Visualization Considerations

- Information to enable plant staff to understand energy performance and inspire ideas for improvement

Energy Monitoring Infrastructure and Visualization Platform

- Infrastructure implementation considerations to communicate information to all levels of the organization

Figure 1-1 Key Energy Management Program Areas

It is recognized that the District strives to develop an energy management program that is not time or resource intensive and integrates easily with ongoing projects, procedures, operations, and enterprise systems. The sections below describe the recommended energy management program tasks and procedures relative to the five areas listed above.

2. Existing Energy Management Program

The District has performed the following steps to advanced their energy management program:

- Developed a draft Energy Manual

- Finalized a Board approved Energy Management System Pledge
- Established an energy team
- Participated in a US Department of Energy (DOE) Water and Wastewater Pilot Project and training on Superior Energy Performance (SEP) and ISO 50001
- Identified optimization opportunities including the aeration basins and tower pumps as significant energy uses (SEUs)
- Drafted plant reduction goals, administration goals (cultural awareness), and data monitoring goals
- Completed several energy audits and assessment reports

The District is now meeting with a DOE Better Plants Program Technical Account Manager regularly, including drafting several energy performance indicator (EnPI) models for the treatment plant.

Based on the work to date, the District is already an industry leader in energy management. The District has implemented many industry best practices and key elements of industry standards, such as those outlined in ISO 50001, WEF, WaterRF, US DOE Better Plants, and AWWA guidance documents. Of particular note is the Board approved Energy Management System Pledge which meets all the requirements of an ISO 50001 energy policy. It is a strong foundation for further developing the District's energy management program.

3. Energy Policy, Objectives, and Targets

The purpose of establishing an energy policy, objectives, and targets is to establish District-wide energy management principles to focus the District's energy management program on specific, measurable, and realistic goals. The energy policy, objectives and targets are designed to establish and communicate the key energy goals and policies to the District's staff and stakeholders and promote an "energy culture". However, internal or external communication of progress towards objectives and targets is always at the Board's discretion. **Figure 3-1** below shows the definitions established by ISO 50001.

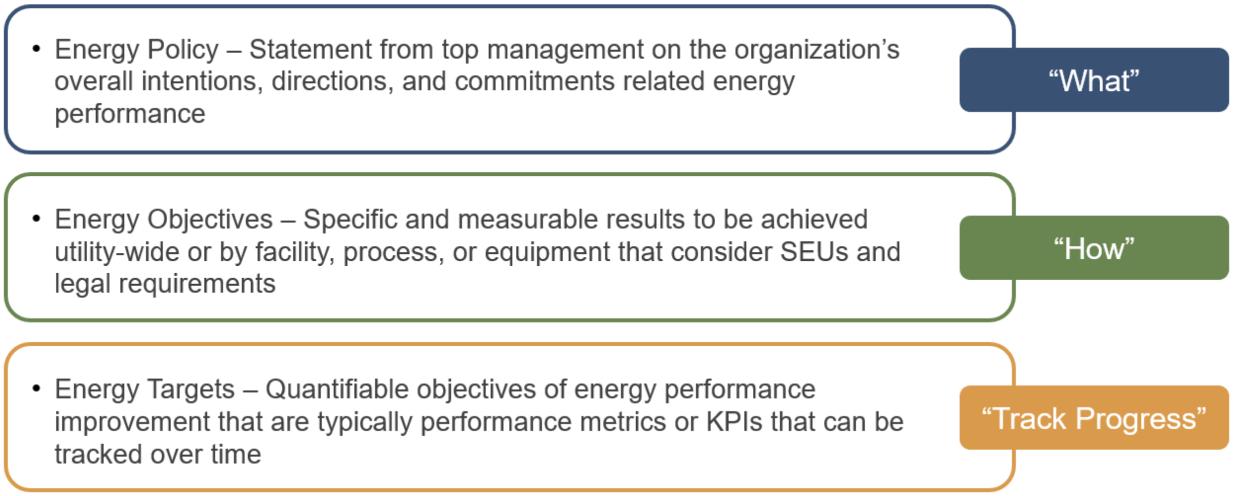


Figure 3-1 ISO 50001 Definitions

3.1 Energy Policy

The District's Board approved of an Energy Management System Pledge (**Figure 3-2**) that serves as Delta Diablo's energy policy. The term included in the District's pledge graphic "*Delta Diablo is committed to responsible energy management in our efforts to provide wastewater and other resource recovery services*" can be considered the energy policy since it stated the District's commitment and responsibility to energy and resource recovery.

3.2 Energy Objectives

The energy objectives should be a measurable result to be achieved that supports the District's energy policy. The District's "R.E.A.L." acronym representing Resources, Efficiency, Always Improving, and Legal are good objectives that supports the District's energy policy, however it was not clear if the District established energy targets that measures/monitors progress towards these objectives and if progress towards these objectives is being communicated to staff and stakeholders. Additional information on strategies to measure progress is included in **Section 3.3 Energy Targets.** It should be noted that the R.E.A.L. acronym is an effective mechanism to keep staff focused on the objectives of the District's energy management program

3.3 Energy Targets

Energy targets are quantitative and qualitative metrics that measure the District's progress toward the EMP energy objectives. It is important to point out that energy targets are not always focused on direct measurements of energy and process performance and should have the flexibility to include qualitative components that cannot be directly measured with instrumentation or meters. As noted, the District also takes part in US DOE Better Plants Program, therefore it has overall goals of reducing energy in all facilities by 25 percent by the end of 2025 from a 2015 baseline. The District also does annual reporting using the ENPI tool to report on this progress.

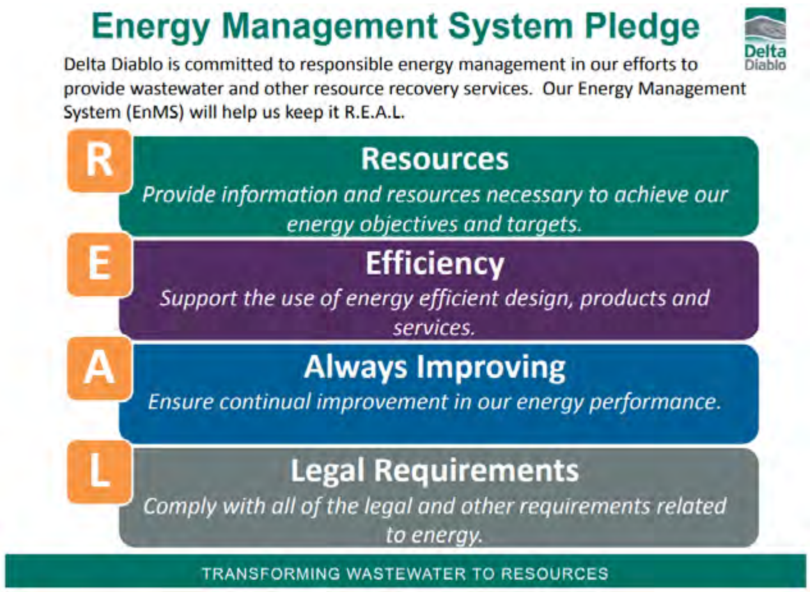


Figure 3-2 District's Energy Management System Pledge

The District's draft Energy Manual included objectives and targets related to energy data monitoring and reducing treatment plant and administration energy consumption. The objectives and targets included in the draft are displayed in **Table 3-1**.

Table 3-1 Current Objectives and Targets

Objectives	Targets
Improve energy related data collection and analysis	By the end of 2017, improve energy usage monitoring and tracking for SEU's
	By the end of 2017, improve and automate data collection of key energy data
Reduce WWTP energy consumption by 5% by the end of 2017 from a 2015 baseline	By the end of 2017, reduce electrical energy consumption of the tower pumps by 3% from 2015 baseline
	By the end of 2017, reduce electricity consumption for digester heating by 1% from 2015 baseline
	By the end of 2017, reduce electricity consumption of chlorine mixers by 2% from 2015 baseline
Reduce the energy consumption of the Treatment Plant and Administration buildings by 5% by the end of 2017 from 2015 baseline	By the end of 2017, reduce electricity consumption of the lighting systems by 20% from 2015 baseline
	By the end of 2017, reduce the electricity consumption by plug loads by 15% from 2015 baseline

It was noted that many of the energy targets listed in the existing documentation were focused on process performance and did not include metrics to measure progress toward the District's energy objectives. It is recommended that the District also include additional qualitative and quantitative metrics that can be used to communicate the District's progress towards its overall energy goals and objectives. The Data Collection Management Matrix from the District lists possible qualitative and quantitative data collected from utility billing, SCADA, and lab analysis.

3.4 Example Objectives and Targets that Build from the District's Energy Policy

The District may consider monitoring the following measures (and other similar measures) to measure progress towards the Energy Pledge. Building off of the R.E.A.L. acronym above, **Table 3-2** additional objectives and targets could strengthen the District's current policy.

Table 3-2 Example Objectives and Targets

Objectives	Targets
Installation of instrumentation and metering devices to ensure targets are being met	Number of power monitors installed – a quantifiable metric that measures the % completion of the overall power monitoring implementation
Document completion of standard operating procedures that integrate energy efficiency in design, products, and services	Number of energy focused standard operating procedures implemented
Maintain a record of staff identified and implemented energy optimization opportunities	Progress on energy visualization (% of major loads visualized) - document awareness efforts
Staff awareness	Number of awareness workshops/training, surveys/feedback, internal communications (emails/posters)
Identify specific regulatory requirements where energy plays a role in complying with the requirement?	Update review annually

The District may consider starting with qualitative objectives and targets, and selecting quantitative targets for unique conditions and baselines calibrated to historical plant operations.

4. Organizational Readiness and Planning

Organizational readiness and planning address the degree to which the District is integrating energy into their core business practice areas (i.e., operations, planning, engineering, etc.). This includes developing internal energy committees/working groups, communication strategies, and the willingness to implement projects that are specifically for achieving the District's energy objectives.

The District has already made great strides towards readiness by developing a draft Energy Manual, establishing an Energy Steering Committee, energy management representative, and Energy Team, and approving an Energy Management System Pledge.

The District can further their organizational readiness by developing and documenting program procedures that integrate energy considerations into core business practices, including capital planning, design, procurement, operations, and asset management. **Figure 4-1** summarizes these concepts.

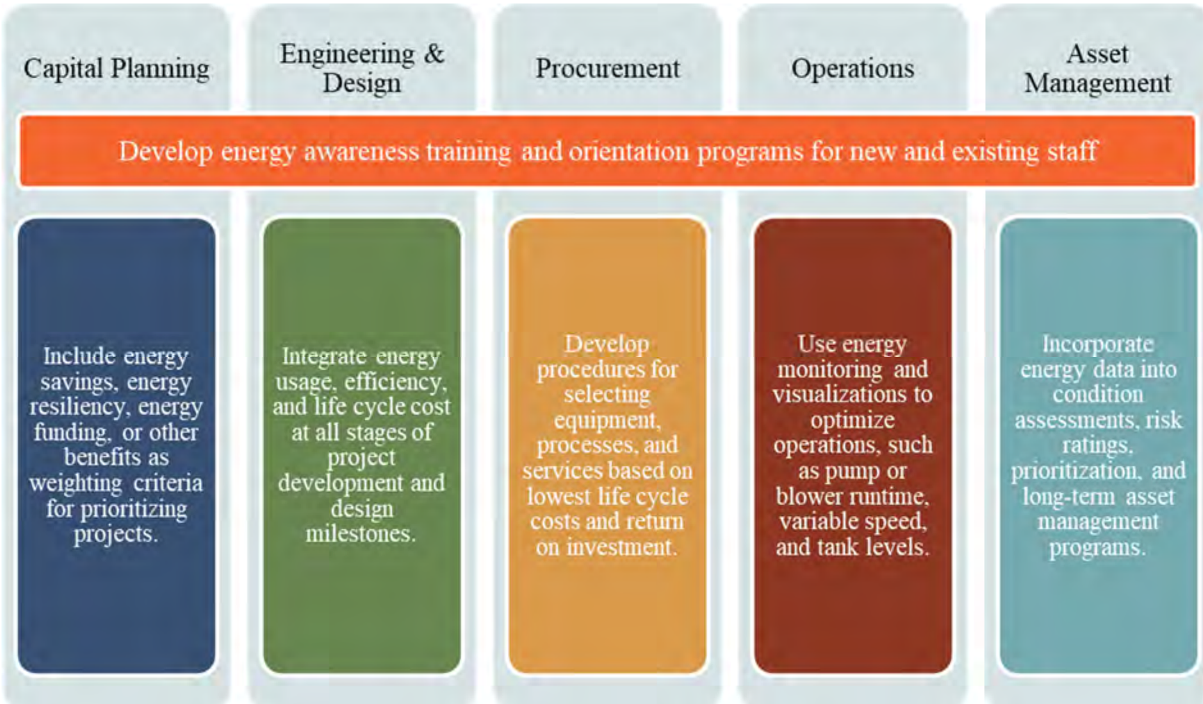


Figure 4-1 Energy Core Business Practices

The District may consider the following operating procedures to increase their organizational energy management readiness.

Capital Planning Considerations

•Define the District's Energy Team role in capital planning
•Develop energy evaluation framework to measure how capital projects generate progress towards energy objectives
-Include a simple estimate of energy savings, funding incentives, and payback for relevant projects in the capital plan
-Note which projects in the capital plan improve energy resiliency and consder the value of resiliency in capital planning decisions
-Include energy lifecycle costs in capital planning decisions

Design Considerations

•Develop/document design standards to promote the integration of energy management in design efforts
•Evaluate opportunities to implement energy management improvements as a part of the design (i.e., energy monitoring, VFDs)
•Develop standard design review framework that can be used to evaluate the integration of energy best practices into design (i.e., account for life cycle cost, energy monitoring, energy efficient technologies)
-Evaluate the energy cost impacts of major design/process alternatives on a life-cycle basis
-Pursue funding incentives for energy saving projects

Procurement Considerations

•Develop standardized evaluation framework and requirements for procurement of large energy consuming equipment
-Select large energy consuming equipment based on lowest life-cycle costs including energy and ROI
-Trigger procurement review if over a certain HP or purchase threshold
-Update specifications for higher efficiency, non-clogging pumps

Operations Considerations

•Identify parties responsible for tracking energy performance
•Develop metrics and key performance indicators that can be used by all operations staff to make more informed decisions
-Track efficiency of large energy consuming equipment with power metering monthly or wire-to-water testing at least every three years
•Develop energy training and awareness programs for key operations staff
-Consider how operations impact electric demand charges

Asset Management Considerations

•Include power metering or wire-to-water equipment efficiency testing data in condition assessments
•Include a simple estimate of energy savings, funding incentives, and payback for relevant projects in the asset management plan
•Include energy data in long-term asset management tools, such as a PowerBI dashboard to track asset condition

Figure 4-2 Example Operating Procedures

5. Tools and Strategies for Continual Improvement

Facilitating continual improvement is a key function of an energy management program. Tools and strategies for continual improvement includes data infrastructure, communication, and cultural elements.

Table 5-1 shows the key operating procedures and infrastructure needed to meet these strategies. **Figure 5-1** shows how continual improvement is an integral part of ISO 50001 best practices.

Table 5-1 Key Operating Procedures and Infrastructure

Means of reporting and communicating energy objectives, performance, and progress
Email, surveys, publications, dashboards, etc.
Energy communications and reporting program
Means to track benefits from optimization projects and improvements
Project specific baselines and monitoring strategies
Dependent on monitoring and instrumentation
Energy information visualization and integration
Facilitate staff driven optimization
Dependent on monitoring and instrumentation

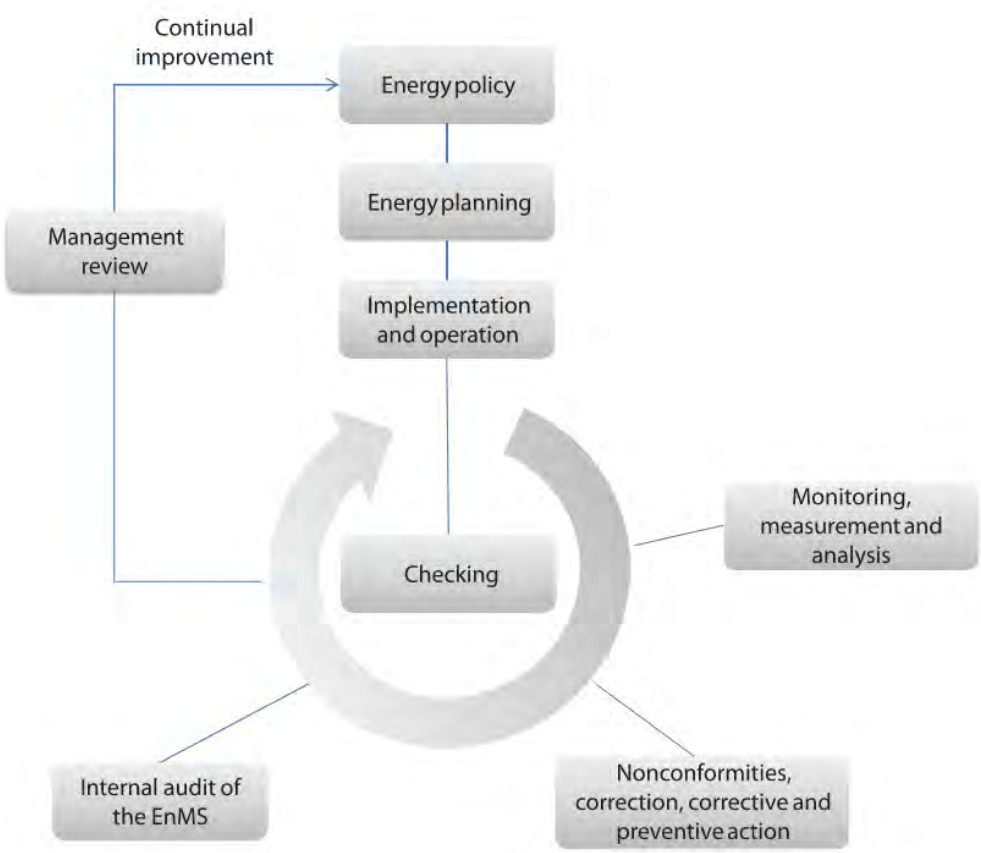


Figure 5-1 ISO 50001 Energy Program Diagram

The District intends to foster a culture of energy awareness. Fortunately, the District has taken an important first by establishing a Board-approved Energy Management System Pledge. If it has not been communicated recently, the District should remind employees of the Pledge through established channels, such as emails, an internal website, labor unions, or posters in frequented areas such as break rooms or SCADA control rooms. The next steps are 1) energy data monitoring and visualization, and 2) management review, communication, and recognition.

6. Energy Monitoring and Visualization Considerations

Energy data monitoring and visualization can be thought of as the engine behind the energy management program and are best practices from ISO 50001. The primary goal of energy monitoring and visualization is to provide actionable insights that staff can use to make informed operational and planning decisions. Data visualization, such as an energy dashboard, makes complex data more accessible, understandable, and usable. Presenting data visually makes interpretation easier. Patterns, trends, and correlations can be seen more clearly. Data visualization should be designed to anticipate and answer the user's questions, problems, needs, and goals in a way that reveals valuable insights and corrective or proactive actions.

The first step is understanding the audience viewing the data and their questions, problems, needs, and goals. The operations team may want to compare equipment and process performance daily to make sure their systems are optimized. Maintenance teams may want to use the equipment data monthly to plan proactive work orders. Engineering may analyze the data semi-annually to guide capital planning or as needed to improve designs. Utility and facility managers may track performance monthly or annually compared to objectives, targets, and budgets. It is not recommended that energy monitoring and visualizations be used for disciplinary actions or broad external communications. Some visualizations may apply utility wide, and others may be designed specifically for operators.

The second step is to establish energy baselines (EnBs), energy performance indicators (EnPIs), and other metrics that will answer the user's questions, problems, needs, and goals and allow users to track performance over time relative to benchmarks, relevant variables, objectives, targets, budgets, asset risk scores, maintenance records, repair and replacement plans, design points, and ideal operating ranges. EnPIs may be linked with a quantitative objective or target, whereas a more specific metric (such as pump efficiency or airflow per pound of BOD removed) may indicate how well a piece of equipment or a process is performing. The most effective visualizations are developed with those EnPIs and performance metrics in mind.

The next step is to identify the data sets required to calculate the EnBs, EnPIs, and performance metrics and compare with benchmarks, relevant variables, budgets, asset risk scores, maintenance records, repair and replacement plans, design points, and ideal operating ranges. Utilities are faced with huge sets of complex data. It is important to filter out the most relevant data to achieve the purpose of the data visualizations. In most cases, data is already available from existing meters, controls, and reports. Additional monitoring equipment, such as power quality meters or on-line ammonia probes, may be needed for more advanced analytics. Ideally, energy data is combined with other data driven programs, such as asset management.

It is recognized that the District strives to develop an energy monitoring and visualization program that is not time or resource intensive and integrates easily with ongoing projects, programs, and enterprise systems. Developing an energy monitoring and visualization program is greatly simplified by breaking down the process into manageable steps and starting with the most straightforward objectives, actions, and datasets. **Figure 6-1** presents a stepwise approach the District may consider.

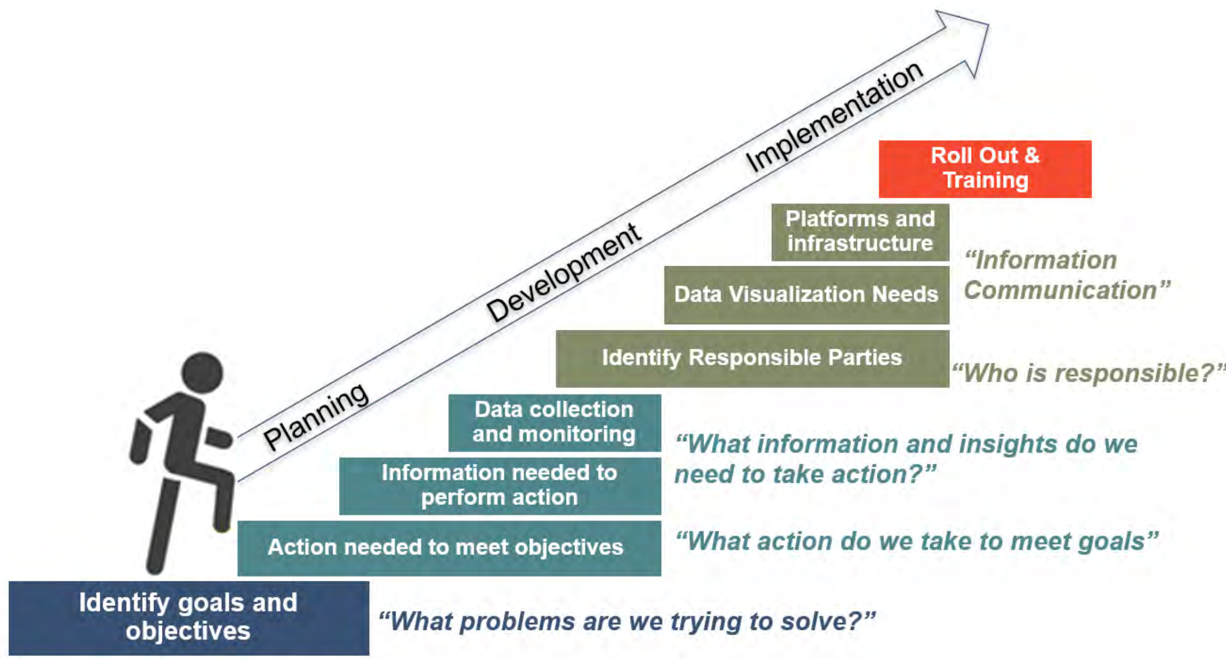


Figure 6-1 Stepwise Approach for Developing an Energy Monitoring and Visualization Program

Data visualization platforms can be deployed quickly and continually improved by starting with simple and intuitive visualizations and adding more functionality as needed. Prototype charts and graphs should be piloted to see if the users can easily decipher actionable insights. The most common data visualization formats are bar graphs, tables, gauges, bullet area charts, time series, scatterplots, diurnal charts, pie charts, stacked area charts, bubble charts, radar charts, moving analog indicators, sparklines, color coded indicators and alarms, and geographical maps.

In general, all visualizations should have slicers to filter by time or parameter range. The data visualization platform should allow data to be downloaded into Excel. Alarms can be added to alert users by email or text when parameters have gone outside of the acceptable range. More advanced tools can integrate calculators to estimate the cost savings of operational optimization, proactive maintenance, equipment replacement or process redesign. Engineers may also request a tool to select equipment based on the lowest life cycle cost. However, the more advanced functions should still be part of a uniform platform so that all staff have access to the data and dashboards.

Ultimately, the goal of a data visualization platform is to facilitate staff driven optimization at all levels of the utility by proving the data needed to understand energy performance and actively participate in ideas for continual improvement.

7. Energy Monitoring Infrastructure and Visualization Platform

It is recommended that the District expand its power monitoring capabilities to gain actionable energy performance insights. The addition of power monitors should be strategically implemented based on the following:

- Value of the power monitoring data. In general, large and continuously operating process loads have the potential to benefit from power monitoring. As described herein, the level "action" (i.e., motor speed, on/off scheduling, equipment selection) that can result from the energy data should also be taken into account. For example, loads such as mixers have a low level of control and operational flexibility compared to variable speed blowers.

- Planned modifications and/or replacement of the electrical equipment. The expense of adding power monitoring equipment to existing electric control equipment may exceed the benefit gained from the power monitoring data. The remaining life of the equipment should be taken into the decision to add power monitoring.

- Condition and construction of the motor control and electrical distribution equipment. The cost to add power monitoring and other current and voltage sensing devices can be elevated for equipment with limited internal space or equipment that is in poor condition. Electrical equipment with ample spare space and existing devices such as voltage and current transformers may facilitate power monitoring installations at a lower cost than equipment that would require extensive modifications.

7.1 Power Monitoring Type Considerations

Power monitors and monitoring systems are available with a very wide range of functions, capabilities, and communication protocols. Systems range from single function current transducers to advanced multifunction power quality meters with wireless internet protocol communication capabilities. The type of power monitor and level of functionality selected will depend on how the type of information desired and the load(s) that it is monitoring. A brief description of the range of power monitors available is included below.

Figure 7-1 Typical Type 1 and 2 Power Monitor

Advance Power Quality Meters (PQM). PQMs are advanced meters that include a wide array of metering functions, troubleshooting functions, and communications protocols. PQMs include advanced analytical functions such as event recording (i.e., surge, sag, spike, etc.) and waveform capture as well as advanced monitoring function such as harmonic distortion and phase angle. Energy and power monitoring functions typically include voltage, frequency, harmonic distortion, phase angle, amps, peak power, average power, and energy usage. These monitors are typically used on large distribution equipment such as medium voltage switchgear and service entrance equipment where power monitoring data is used for system management and troubleshooting. PQMs are typically furnished with a wide range of communications protocols built into the unit including Modbus RTU, Ethernet, Ethernet with Modbus, Profibus, and Profitnet. Costs for these meters range from $1,000 to $8,000 depending on the functionality and communications protocols. An example of a Type 1 monitor is shown on **Figure 7-1**.

Mid-Range Power Monitoring Meters. These meters include typical power monitoring functions used for the majority of power and energy monitoring applications (i.e., voltage, amps, power, and energy). The Type 2 meters are widely available from many manufacturers and come in a verity of configurations including individual meters, multi-channel meters and din rail mount meters. The configuration will depend largely on the numbers on loads to be metered and the space available for the meter installation. Most Type 2 meter are provided with basic communication protocols such as Modbus RTU and pulse outputs with options for faster data protocols such as Ethernet. The majority of the meters recommended in the report are Type 2 meters. Costs for these meters range from $300 to $1,000 depending on the functionality and communications protocols. An example of a Type 2 monitor is shown on **Figure 7-1**.

Single Function Current Transducers. These low-cost monitoring devices measure current only (amps) and provide an analog output that can be monitored through an input to a programmable logic controller (PLC). These devices do not have voltage inputs and therefore cannot monitor energy (KWH) or power (KW). While the data from these devices are very limited, the data can be used to determine if the equipment is operating in its expected operating load. An example of a Type 3 monitor is shown on **Figure 7-2**.

Figure 7-2 Typical Type 3 Current Transducer

7.2 Levels of Power Monitoring

Power monitoring data serves different purposes depend on where they are installed in the power distribution system and the loads they monitor. **Figure 7-3** and the text below describe the typical use of power monitors and monitoring data for the utility service, power distribution and utilization levels of a typical plant electrical system.

- Utility Service. Utility service power monitors installed at the service entrance to the plant are typically used to measure the overall plant demand profile and used to record power quality events that may originate from the electric utility service. The overall plant demand profile can provide valuable energy management information on demand management and electric utility billing rate optimization opportunities.

- Distribution Level. Power monitors installed on the incoming mains for power distribution and control equipment are typically used to monitor group loads and record power quality events for trouble shooting purposes. These power monitors do not provide detailed energy management data for individual loads but can provide energy consumption data for process units.

- Utilization Level. These power monitors monitor individual process loads which can provide valuable energy management insights into equipment efficiency and condition.

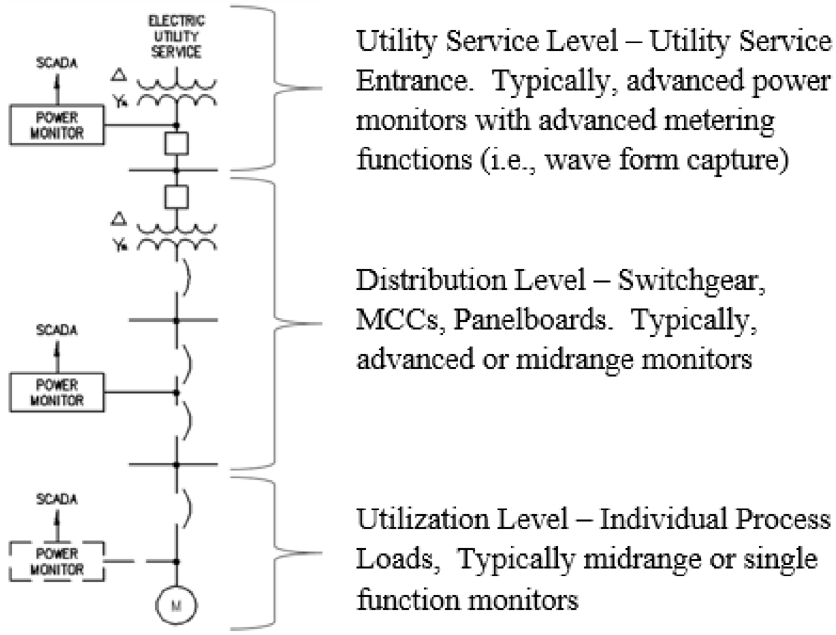


Figure 7-3 Levels of Power Monitoring

7.3 Network and Communication Considerations

Power monitoring data must be communicated via a plant wide network to a centralized data management system. The power monitoring network can be accomplished by using the existing SCADA Ethernet network (most common) or by installing a separate network infrastructure. The connection to the SCADA network is typically accomplished by the following means:

- Analog inputs to PLC – Individual monitoring points (i.e., kw, amps. Voltage, etc.) are communicated over a 4-20mA signal wired to the PLC analog input card(s). This method limits the number of monitoing points to the number of analog outputs provided with the monitor which is typically one or two.

- Networked inputs to PLC – All available monitoring points are communicated to the SCADA network via a network connection to the PLC processor. The power monitoring communications protocol is typically a “polling protocol” such as Modbus RTU or ethernet protocol such as Modbus TCP/IP. Networked connections have the advantage of communicating all monitoring points over a single connection. The power monitoring data is process by the local PLC processor and communicated to the plant control SCADA network.

- Network connection to the SCADA network – All available monitoring points are communicated directly to the SCADA network (bypasses PLC processor). This alternative is desireable if a local PLC is not available or if the PLC has limitied I/O or processor capabilities.

Most utilities elect to network the power monitoring devices with the SCADA network to save capital costs. The power monitoring networking decision will ultimately depend on existing network protocol and bandwidth, security, and cost.

7.4 Data Management and Visualization Considerations

Installing power monitors alone will not provide value unless the data is communicated to the plant staff in a meaningful way by a data management and visualization platform. Energy data management and visualization platforms commonly used include conventional local and cloud-based data management/visualization platforms (SQL, PowerBI, Tableau, etc.), plant control and HMI platforms, and proprietary "purpose built" power monitoring platforms. It is important to point out that there is no "right or wrong" platform and the platform selection should be based on the District's unique needs and capabilities.

The platform selected to manage and communicate power monitoring data should have the following key capabilities:

- Integrate easily with other utility data platforms (i.e., SCADA) to develop process and utility key performance indicators and metrics (i.e., KWH/MGD, energy cost/capita, etc.)
- Easily develop customized visualizations tailored to the specific needs and audiences
- Accessible to all levels within the organization
- Scalable and expandable as the need for additional information grows
- Able to maintain system security

A brief list of considerations for commonly used data management and visualization platforms are listed below:

- SCADA HMI
  - Existing system (lower cost potential)
  - Easily integrate energy and process data
  - Not specifically designed for data management but does have some capabilities
  - Customized visualizations may be difficult and may require outside support
  - May not be accessible to all levels in the organization
  - Depends on cost and internal capabilities
- Commonly available platforms such as PowerBI, Tableau, etc.
  - Build energy dashboards "from within"
  - Integrates with Azure and other cloud environments
  - Training and education usually required
- Purpose Built Platforms (i.e., Siemens WinPM, Schneider Power Advisor, etc.)
  - Direct integration with power monitors (advanced functions)
  - Proprietary platform (requires long term support)

7.5 Power Monitoring Implementation Recommendations

It is recommended that the District develop a power monitoring implementation plan that identifies the plant loads that warrant immediate, near-term, and long-term power monitoring systems as well as recommendations on power monitoring equipment type, configurations and communication protocol.

The District has already taken important first steps toward power monitoring and visualization, including:

- Comparing month to month electricity and natural gas consumption from the utility meters for the previous three years in the EnPI Tool
- Installing power meters on the aeration basin blowers and tower pumps
- Monitoring flow, temperature, BOD, DO, and runtime

An initial evaluation of the District's plant loads determined power monitoring should be considered for the loads shown in **Table 7-1.**

Table 7-1 Initial Power Monitoring Considerations

Equipment to Consider for Power Monitoring and Visualization
Aeration Blowers
Equalization Storage Return Pumps 1 and 2
Headworks Bioscubber Odor Control Exhaust Fan
Primary Sludge Pumps 1-4
Odor Control Facility Exhaust Fans 1 and 2
RAS Screw Pumps 1-3
Service Water Pumps 1 and 2
Injector Water Pumps 1 and 2
Emergency Effluent Pumps 1-3
Sludge Feed Pumps 1 and 2
Centrifuges 1 and 2
Centrifuge Platform Feed Pumps 1 and 2
WAS Pumps 1 and 2
Digester Heat Recovery Hot Water Pump
Digester Sludge Circulation Pumps 1 and 2
Gas Conditioning System
Pumps at Largest Pump Stations

However, the District may consider installing power monitoring on key process loads as projects from the Master Plan are identified and implemented.

These meters should be maintained such that reliable data can be read on an hour-by-hour basis. In addition, flow meters at key locations within the District system (such as pump stations) should be maintained to provide accurate and reliable data so that energy intensity of pumping stations can be monitored and corrective actions taken, if necessary.

8. Key Findings

The District is already an industry leader in energy management. The District has implemented many industry best practices and key elements of industry standards, including a Board approved Energy Management System Pledge which meets all the requirements of an ISO 50001 energy policy.

The District may consider the following next steps to advance the energy management program:

- Establish qualitative objectives that build from the Energy Pledge and incorporate quantitative targets as needed to measure progress towards continual energy performance and communicate with staff and stakeholders.
- Incorporate the life-cycle costs including energy in the capital decision planning process, to avoid making equipment replacement decisions which may effectively increase energy intensity and to capture opportunities to reduce energy intensity by implementing more energy efficient equipment.
- Continue to develop an internal energy communication and reporting program (reports, emails, surveys).
- Consider integrating energy management into core business practices, including design, procurement, capital planning, and asset management.
- Continue to develop a strategic power monitoring implementation program and incorporate critical energy intensity parameters such as flowrates.
- Develop a long-term energy monitoring and visualization plan that is in alignment with the District's overall Data Management Master Plan.

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