Bay Area Clean Water Agencies

Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

FINAL Report

June 28, 2023

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Contents

Tables

Figures

Appendices

Abbreviations

AF	acre-foot/feet
American Canyon	American Canyon, City of
AOP	advanced oxidation process
BACWA	Bay Area Clean Water Agencies
Bay Area	San Francisco Bay Area
Benicia	Benicia, City of
BCE	Business Case Evaluation
Burlingame	Burlingame, City of
Central San	Central Contra Costa Sanitary District
CCI	Construction Cost Index
CIP	Capital Improvement Program
CMSA	Central Marin Sanitation Agency
d	day(s)
DDW	(California) Division of Drinking Water
DO	dissolved oxygen
DPR	direct potable reuse
DSRSD	Dublin San Ramon Services District
EBDA	East Bay Dischargers Authority
EBMUD	East Bay Municipal Utility District
ENR	*Engineering News-Record*
FAT	full advanced treatment
First Watershed Permit	Order R2-2014-0014, Waste Discharge Requirements for Nutrients from Municipal Wastewater Discharges to San Francisco Bay
FSSD	Fairfield-Suisun Sewer District
gpd	gallon(s) per day
GIS	geographic information system
HAB	harmful algal bloom
Hayward	City of Hayward
HVAC	heating, ventilation, and air conditioning
IPR	indirect potable reuse
kg	kilogram(s)
L	Liter(s)
Las Gallinas	Las Gallinas Valley Sanitary District
LAVWMA	Livermore-Amador Valley Water Management Agency
lb	pound(s)
Livermore	City of Livermore
MBR	membrane bioreactor
mg	milligram(s)
mgd	million gallons per day
Millbrae	Millbrae, City of
MS4	municipal separate storm sewer system
Mt. View	Mt. View Sanitary District
N	nitrogen
Napa	Napa Sanitation District
NbS	nature-based solutions
NMS	Nutrient Management Strategy
Novato	Novato Sanitary District
NOx	Nitrite plus Nitrate
NPDES	National Pollutant Discharge Elimination System
NPV	Net Present Value
OLSD	Oro Loma Sanitary District

O&M	Operations and Maintenance
P	Phosphorus
Palo Alto	Palo Alto, City of
Petaluma	Petaluma, City of
Pinole	Pinole, City of
POTW	publicly owned treatment works
RFI	request for information
Richmond	Richmond Municipal Sewer District, City of
RO	Reverse Osmosis
Rodeo	Rodeo Sanitary District
RW	Recycled Water
RWQCB	Regional Water Quality Control Board
San Jose	San Jose/Santa Clara Water Pollution Control Plant and Cities of San Jose and Santa Clara
San Leandro	City of San Leandro
San Mateo	San Mateo, City of
SASM	Sewerage Agency of Southern Marin
Second Watershed Permit	Order R2-2019-0017, Waste Discharge Requirements for Nutrients from Municipal Wastewater Discharges to San Francisco Bay
SF Bay	San Francisco Bay
SFBCDC	San Francisco Bay Conservation and Development Commission
SFEI	San Francisco Estuary Institute
SFO Airport	San Francisco (San Francisco International Airport), City and County of
SFPUC Southeast	San Francisco Public Utilities Commission (Southeast Plant)
SMCSD	Sausalito-Marin City Sanitary District
Sonoma Valley	Sonoma Valley County Sanitary District
South SF	South San Francisco and San Bruno, Cities of
Sunnyvale	Sunnyvale, City of
SVCW	Silicon Valley Clean Water
SWTP	surface water treatment plant
TIN	total inorganic nitrogen
Title 22	California's Title 22 Code of Regulations
TN	total nitrogen
TP	total phosphorus
Union San	Union Sanitary District
USGS	United States Geological Survey
Vallejo	Vallejo Flood and Wastewater District
West County	West County Agency
WRF	Water Research Foundation
WWTP	Wastewater Treatment Plant
yr	year(s)

Report Organization

This Potential Nutrient Reduction by Recycled Water is organized into the following chapters and appendices:

Executive Summary. This chapter presents a high-level summary of this Potential Nutrient Reduction by Recycled Water.

Chapter 1: Introduction. This chapter describes the study background, participating agencies, and other Watershed Permit–required nutrient-related activities.

Chapter 2: Basis of Evaluation. This chapter presents the project approach used to document the strategies and concepts for nutrient reduction through reuse.

Chapter 3: Nutrient Reduction Findings via Reuse. This chapter presents a summary of the findings for the treatment optimization, sidestream treatment, and treatment upgrades analyses, as well as a comparison of the three.

Chapter 4: Discussion and Observations*.* This chapter summarizes the key observations of this Potential Nutrient Reduction by Recycled Water with respect to the potential benefits of reuse on diverting nutrients from SF Bay, seasonality, confidence of projects, regulations for potable reuse projects, and a menu of options for nutrient management.

Chapter 5: Summary and Next Steps. This chapter summarizes the results and findings of the study and describes next steps that agencies should take.

Chapter 6: References. This chapter lists the external sources used to develop this Potential Nutrient Reduction by Recycled Water.

Appendices:

A. Scoping and Evaluation Plan
B. Individual Plant Reports
C. Agency Acceptance Letters

Acknowledgements

During the development of this Potential Nutrient Reduction by Recycled Water, the project team received invaluable assistance and cooperation from each of the participating agencies and their respective staff. We gratefully acknowledge BACWA leadership (specifically Lorien Fono, PhD, PE and Mary Cousins, PhD, PE), members of the BACWA Recycled Water Committee for their guidance and active participation, and the BACWA Executive Board.

Executive Summary

In 2019, the San Francisco Bay Regional Water Quality Control Board (RWQCB) issued Order R2-2019-0017, NPDES Permit No. CA0038873, *Waste Discharge Requirements for Nutrients from Municipal Wastewater Discharges to San Francisco Bay* (Second Watershed Permit). This permit replaced the previous permit under Order R2-2014-0014, *Waste Discharge Requirements for Nutrients from Municipal Wastewater Discharges to San Francisco Bay* (First Watershed Permit). The updated 5-year Watershed Permit, which became effective on July 1, 2019, covers each major (i.e., >1 mgd average dry weather flow permitted capacity) municipal publicly owned treatment works (POTW) that discharges to the San Francisco Bay (SF Bay) and its tributaries. The purpose of the Second Watershed Permit is as follows:

- Track and evaluate performance at each POTW through annual nutrient trending reports
- Fund nutrient studies and monitoring programs to advance the science
- Support load response modeling to advance the science
- Evaluate opportunities to manage nutrients through recycled water (RW) and/or nature-based solutions (NbS)

This *Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling* (Potential Nutrient Reduction by Recycled Water) was prepared in response to the Provision VI.C.3 in the Second Watershed Permit to evaluate the potential for nutrient discharge reduction by recycled water. Beyond recycled water, the Second Watershed Permit also included sampling at POTWs and the NbS evaluation. The outputs from the ongoing studies will improve the accuracy of inputs used in load response models, identify nutrient load reduction opportunities, and identify costs related to water recycling for the various SF Bay dischargers.

Background

The presence of nutrients in SF Bay is of significant concern for the San Francisco Bay Area (Bay Area) water quality community. Working through the framework of the San Francisco Bay Nutrient Management, scientists are investigating through San Francisco Estuary Institute (SFEI) the impact of nutrients on SF Bay water quality. While these studies continue, Bay Area Clean Water Agencies (BACWA) is collaborating with regulators to ensure that future nutrient management requirements are founded in science.

The Watershed Permit approach sets forth a regional framework to facilitate collaboration on studies that will inform future management decisions and regulatory strategies. The Second Watershed Permit (issued May 8, 2019) expands upon the First Watershed Permit (issued April 9, 2014) that focused on assessing treatment opportunities within each POTW. The Second Watershed Permit includes two key elements for evaluating nutrient load reduction opportunities for POTWs: (1) water recycling and (2) natural systems.

In response to the Second Watershed Permit, BACWA is working collectively through the joint powers agency, to submit a single coordinated study on behalf of all of the POTWs. This Potential Nutrient Reduction by Recycled Water is part of the coordinated study for the water recycling component of the Second Watershed Permit, which lists 37 POTWs as Dischargers. A separate coordinated report is being prepared for the NbS component, under a separate consulting contract.

Participating Agencies

The 37 participating POTWs and their corresponding total inorganic nitrogen (TIN) discharge loads are illustrated in Figure ES -1. Additional information about the 37 participating POTWs is found in Section 1.2 of the report.

Project Approach

The project approach was developed in a document titled "Scoping and Evaluation Plan," as well as in a presentation to the RWQCB in fall 2019 (HDR, 2019). Following the presentation, the RWQCB approved the Scoping and Evaluation Plan, which is provided in Appendix A.

The approach is predicated on four core steps: 1) initial request for information (RFI) to collect existing/projected RW volumes as well as barriers and drivers to RW projects, 2) follow-up RFI that focused on project descriptions, confirmation of barriers and drivers, and costs associated with the various RW Projects, 3) draft agency report and comment period, and 4) final draft agency report and agency sign-off. Upon receiving the RFI responses, the consultant team performed the RW volumes and nutrient load diversions analysis for the years 2020 through 2045 as described in the Scoping and Evaluation Plan (refer to Appendix A). An individual draft report was prepared for and reviewed by each participating agency, followed by finalization and agency acceptance.

A key feature of the analysis is the grouping of potential projects by confidence level. Given the uncertainty for future reuse projects, assigning confidence levels was deemed essential to better understand the likelihood of project implementation. It became clear that some potential projects had not been developed beyond the "conceptual" phase because they would require securing agreements across multiple jurisdictions and/or agencies. Furthermore, such potential conceptual projects were not included in the returned RFIs by the various POTWs. While not included in returned RFIs, such projects have been discussed across the region and thus included in this overall report as Confidence Level 4 projects. The grouping approach for the inclusion of such potential projects, a new group was created which is referred to as Confidence Level 4. Confidence Levels for each project are further described in Table ES - 1.

This Potential Nutrient Reduction by Recycled Water represents a summary and synthesis of the individual agency reports.

Figure ES - 1. Participating POTWs and Total Inorganic Nitrogen Discharge Loads to SF Bay (Source: Courtesy of Ian Wren, Staff Scientist, San Francisco Estuarine Institute)

(n = 37 with a combined average dry weather flow permitted capacity of 827 mgd; circle size relative to Annual Average TIN discharge loads)

Table ES - 1. Confidence Level Definition for Future Recycling Water Project

Confidence Level	Definition
1	Estimated delivery volume based only on existing recycled water projects and/or future projects in an adopted budget
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document
4 [a]	Estimated delivery volume based on projects that are conceptual in nature and require agreements across multiple jurisdictions/agencies

a. Confidence Level 4 projects were not included in the individual agency RFIs. In most cases, they require agreements across multiple jurisdictions and/or agencies.

Study Results

An overview of the study results is provided in the subsections that follow, with an emphasis on the potential RW volumes and nutrient loads diverted from SF Bay. A summary of the drivers and barriers, along with a menu of nutrient management options is also included. While information is provided for ammonia, TIN, and total phosphorus (TP) loads, the focus is on TIN nutrient management for the SF Bay.

Potential Recycled Water Volumes and Corresponding Nutrient Loads Diverted from SF Bay

A summary of the annual RW volume and corresponding nutrient loads diverted from SF Bay over time is illustrated in Figure ES - 2. A breakdown by POTW is provided in Table ES - 1. Note: the values in Figure ES - 2 and Table ES - 1 are based on average annual values. Details on the dry season (May 1 through September 30) are included in Sections 3 through 5. As expected, the daily dry season daily average RW volumes and corresponding nutrient load diversions from the SF Bay are more pronounced than annual average values as some RW demands are higher during the dry season (e.g., landscape irrigation). For perspective, the dry season volumes and load reductions represent approximately 55 to 60 percent of the average annual volumes (regardless of Confidence Level).

The projections in Figure ES - 2 suggests that the RW volumes for Confidence Levels 1 through 3 are expected to more than double from 2020 through 2045. The inclusion of Confidence Level 4 RW projects has the potential to more than triple RW volumes compared to 2020 by year 2045.

The net present values (NPV) for capital and O&M costs are listed in Figure ES - 2. The Confidence Level 1 NPV ($1.0 Bil) and Confidence Level 2 NPV ($0.5 Bil) have a combined cost of $1.5 Bil. The incorporation of Confidence Level 3 projects nearly doubles the combined cost of Confidence Levels 1 and 2. The primary reason for the increase in costs for Confidence Level 3 is that it includes several potable reuse projects. The cost for Confidence Level 4 (approximately $2.0 Bil) exceeds all but Confidence Level 3 projects. Confidence Level 4 is limited to two potable reuse projects that require advanced treatment.

The TIN load reductions increase in a similar fashion with recycled water volumes/flows through year 2035, after which the additional TIN load reductions are modest compared to additional RW volumes/flows. The modest increase in TIN load reductions after year 2035 is attributed to a few potable reuse projects that include RO treatment. Potable reuse projects will only have modest nutrient load reductions as POTWs will i) likely need to implement ammonia and TIN load reductions at the plant prior to advanced treatment facilities (if not already in place) and ii) the majority of the nutrient loads will end up in SF Bay via the RO concentrate return flows (assumed 84 percent of the advanced treatment feed load unless provided otherwise). Further details on the fate of nutrients for advanced treatment facilities is provided in Section 2.6.

This analysis assumes that POTWs considering potable reuse projects that do NOT already have ammonia and TIN load reduction facilities in place would implement such upgrades at the POTW. The anticipated TIN effluent concentrations for such POTWs would be on the order of 15 mg N/L. **Note: this analysis excludes costs for such plant upgrades. This analysis also assumed the plant effluent of 15 mg N/L which impacts the TIN load reductions associated with RW.**

It should be noted that potable reuse provides an important source of resilient local water supply for Bay Area communities, especially in the face of climate uncertainties (e.g., drought). The challenges associated with RO concentrate management are currently being studied as part of the NbS study and other studies (e.g., Valley Water) to develop innovative solutions to address this challenge. Further funding to support the advancement of these solutions, as well as funding to include these solutions as part of a water supply program that would provide multi-benefits to communities and the environment may allow both the water supply and nutrient challenge to be addressed concurrently.

The projected distribution of potential RW projects by POTW and confidence level is provided in Table ES - 3. A time-series plot that illustrates the information from Table ES - 3 for all 37 POTWs is provided in Figure ES - 3. The breakdown of potential RW projects across all 37 POTWs by confidence level is as follows (refer to Figure ES - 3):

- **Confidence Level 1:** up to 24 net reuse projects (blend of current and planned; no more than 23 projects at any listed five-year increment). While Table ES - 3 and Figure ES - 3 show up to 23 reuse projects for each year, the net number of reuse projects is 24 through year 2045 as three Confidence Level 1 projects stop producing recycled water by year 2035 (Sunnyvale, OLSD, and EBMUD) and a Confidence Level 1 Project begins producing recycled water in year 2030 (Treasure Island).
- **Confidence Level 2:** up to 5 potential reuse projects (master planned)
- **Confidence Level 3:** up 10 potential reuse projects (conceptual)
- **Confidence Level 4:** up to 2 potential reuse projects (conceptual)

An overall summary of the **average** values over a 25-year project duration for each confidence level is provided in Table ES - 4. Note that the values in Table ES - 4 are average values over the full 25-year duration and thus do not reflect values at each five-year increment. The average values are used to quantify the various unit metrics ($/lb TIN removed) that rely on average values. Furthermore, Table ES - 4 presents the net number of projects for each Confidence Level through year 2045 (not limited to the total at each five-year timeframe). As previously stated, the net number of Confidence Level 1 projects (n = 24) as three Confidence Level 1 projects stop producing recycled water by year 2035 (Sunnyvale, OLSD, and EBMUD) and a Confidence Level 1 Project begins producing recycled water in year 2030 (Treasure Island).

From a unit water volume/flows standpoint, the Confidence Level 1 projects are the most cost-efficient at less than or equal to $12 per gallon per day (gpd) ($730/AF, regardless of season). Confidence Level 1 projects were expected to be the most efficient because in most cases the treatment facilities are already in place. The Confidence Levels 2 through 4 projects are at least four times higher in terms of unit cost ($/gpd, $/AF) compared to the Confidence Level 1 projects (regardless of season). It is important to recognize that the cost for purchasing potable water (instead of RW) is not captured in the analysis as the cost for potable water is so wide-ranging (dependent on water provider, season, etc.).

From a unit load standpoint (emphasis on TIN), the Confidence Level 1 projects that represent current and/or planned reuse facilities are the most cost-efficient at less than or equal to $17 per pound TIN removed. Similar to volume/flow, this was expected as in most cases the facilities for Confidence Level 1 projects are already in place. The unit costs for Confidence Levels 2 through 4 projects are a magnitude or greater than the Confidence Level 1 projects.

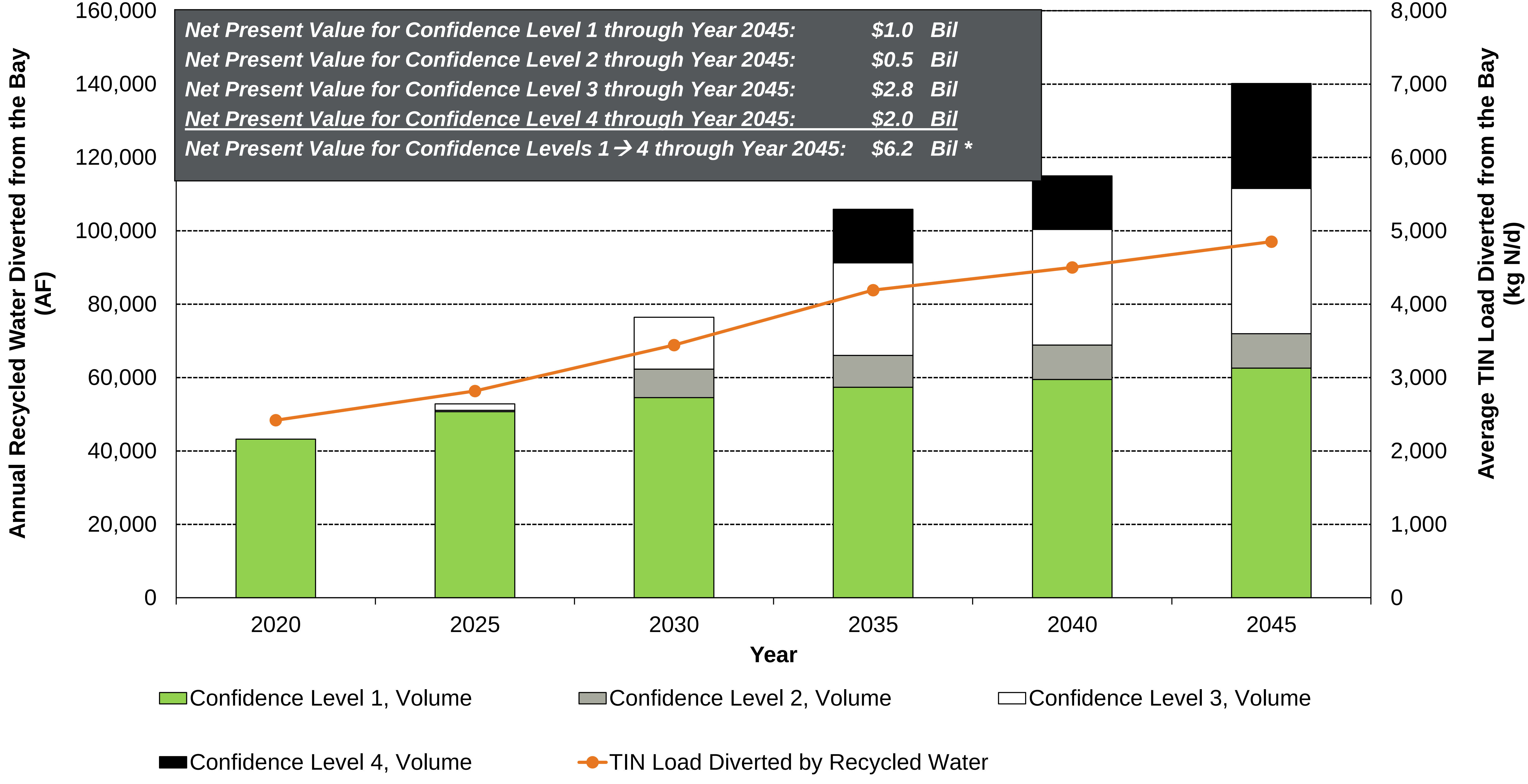

Figure ES - 2. Summary of Existing and Proposed Annual Recycled Water Flows and the Corresponding Total Inorganic Nitrogen Load Diversions from SF Bay Dischargers

Confidence level = level of confidence in the values provided. 1 = includes projects that are already in place and/or currently budgeted; 2 = includes projects that are in master planning stages; 3 = includes projects that are conceptual, and 4 = includes projects that are conceptual in nature and require agreements across multiple jurisdictions/agencies.

* The total net present value might vary from the sum of the listed confidence levels due to rounding.

Table ES - 2. Confidence Levels 1 through 4: Projected Average Annual Recycled Water Volumes/Flows and the Corresponding Nutrient Load Reductions

POTW	Year 2020		Year 2025		Year 2030		Year 2035		Year 2040		Year 2045	
	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN, Load Diverted kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d
American Canyon	313 (0.3)	6	619 (0.6)	13	619 (0.6)	13	1,235 (1)	26	1,235 (1)	26	1,235 (1)	26
Benicia	--	--	--	--	--	--	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--	--	--	--	--	--	--
Central San	1,600 (1)	141	1,950 (2)	172	2,240 (2)	197	17,280 (15)	311	17,830 (16)	359	18,260 (16)	398
CMSA	24 (<0.1)	2	24 (<0.1)	2	24 (<0.1)	2	24 (<0.1)	2	24 (<0.1)	2	24 (<0.1)	2
Delta Diablo	4,750 (4)	38	4,780 (4)	39	4,780 (4)	39	4,790 (4)	39	4,790 (4)	39	4,800 (4)	39
DSRSD	3,890 (3)	386	4,100 (4)	407	4,190 (4)	416	4,190 (4)	416	4,190 (4)	416	4,190 (4)	416
EBMUD	180 (0.2)	27	202 (0.2)	31	504 (0.4)	76	2,580 (2)	391	2,580 (2)	391	2,580 (2)	391
FSSD	1,030 (0.9)	73	1,030 (0.9)	73	1,030 (0.9)	73	1,030 (0.9)	73	1,030 (0.9)	73	1,030 (0.9)	73
Hayward	858 (0.8)	90	1,228 (1)	129	1,448 (1)	152	1,448 (1)	152	1,448 (1)	152	1,448 (1)	152
Las Gallinas	975 (0.9)	54	975 (0.9)	54	975 (0.9)	54	975 (0.9)	54	975 (0.9)	54	975 (0.9)	54
Livermore	1,620 (1)	218	1,680 (1)	226	1,730 (2)	233	1,790 (2)	241	1,840 (2)	248	1,840 (2)	248
Millbrae	--	--	--	--	--	--	--	--	--	--	--	--
Mt. View	1,150 (1)	72	1,180 (1)	73	1,210 (1)	75	1,240 (1)	77	1,270 (1)	79	1,300 (1)	81
Napa	3,300 (3)	103	3,400 (3)	106	3,400 (3)	106	3,400 (3)	106	3,400 (3)	106	3,880 (3)	109
Novato	1,470 (1)	53	1,450 (1)	52	5,030 (4)	183	5,930 (5)	216	5,930 (5)	216	5,930 (5)	216
OLSD	37 (<0.1)	1	37 (<0.1)	1	--	--	--	--	5,480 (5)	135	5,480 (5)	135
Palo Alto	705 (0.6)	69	752 (0.7)	70	13,695 (12)	261	13,695 (12)	261	13,695 (12)	261	13,695 (12)	261
Petaluma	981 (0.9)	8	1,200 (1)	10	3,397 (3)	24	3,397 (3)	24	4,138 (4)	29	4,198 (4)	30
Pinole	--	--	--	--	--	--	--	--	--	--	--	--
Richmond	--	--	--	--	--	--	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--	--	--	--	--	--	--
SFO Airport	--	--	90 (<0.1)	11	90 (<0.1)	11	90 (<0.1)	11	90 (<0.1)	11	90 (<0.1)	11
SFPUC Southeast	--	--	--	--	--	--	--	--	--	--	--	--
San Jose	12,600 (11)	670	15,000 (13)	800	17,000 (15)	906	20,000 (18)	1,070	22,000 (20)	1,170	39,000 (35)	1,405
San Mateo	--	--	--	--	602 (0.5)	31	635 (0.6)	32	865 (0.8)	44	8,035 (7)	117
SMCSD	--	--	--	--	--	--	--	--	--	--	--	--
San Leandro	292 (0.3)	33	292 (0.3)	33	292 (0.3)	33	292 (0.3)	33	292 (0.3)	33	292 (0.3)	33
SASM	38 (<0.1)	2	38 (<0.1)	2	38 (<0.1)	2	38 (<0.1)	2	38 (<0.1)	2	38 (<0.1)	2
Sonoma Valley	2,210 (2)	151	2,240 (2)	153	2,240 (2)	153	2,240 (2)	153	2,240 (2)	153	2,240 (2)	153
SVCW	856 (0.8)	96	1,230 (1)	138	1,310 (1)	147	8,710 (8)	245	8,720 (8)	246	8,720 (8)	246
South SF	--	--	280 (0.2)	34	954 (0.9)	60	954 (0.9)	60	954 (0.9)	60	954 (0.9)	60
Sunnyvale	443 (0.4)	33	1,100 (1)	81	1,400 (1)	103	1,680 (1)	124	1,680 (1)	124	1,680 (1)	124
Treasure Island	--	--	--	--	301 (0.3)	8	301 (0.3)	8	301 (0.3)	8	301 (0.3)	8
USD	--	--	--	--	--	--	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--	--	--	--	--	--	--
West County	3,920 (3)	93	7,950 (7)	189	7,950 (7)	189	7,950 (7)	189	7,950 (7)	189	7,950 (7)	189
Total [b]	43,200 (39)	2,420	52,800 (47)	2,900	76,400 (68)	3,550	105,900 (94)	4,320	115,000 (103)	4,620	140,200 (125)	4,980

a. The volumes in AF might vary from the values in the individual plant reports due to rounding (refer to Appendix B).
b. The total values might vary from the sum of the listed values by plant due to rounding.

Table ES - 3. Distribution of Potential Recycled Water Projects per POTW by Confidence Levels 1 through 4*

POTW	Year 2020	Year 2025	Year 2030	Year 2035	Year 2040	Year 2045
American Canyon	Confidence Level 1	Confidence Level 1; Confidence Level 2	Confidence Level 1; Confidence Level 2	Confidence Level 1; Confidence Level 2; Confidence Level 3	Confidence Level 1; Confidence Level 2; Confidence Level 3	Confidence Level 1; Confidence Level 2; Confidence Level 3
Benicia	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--
Central San	Confidence Level 1	Confidence Level 1 -- Confidence Level 3	Confidence Level 1 -- Confidence Level 3	Confidence Level 1 -- Confidence Level 3 Confidence Level 4	Confidence Level 1 -- Confidence Level 3 Confidence Level 4	Confidence Level 1 -- Confidence Level 3 Confidence Level 4
CMSA	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
Delta Diablo	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
DSRSD	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
EBMUD	Confidence Level 1	Confidence Level 1	Confidence Level 1	-- -- Confidence Level 3	-- -- Confidence Level 3	-- -- Confidence Level 3
FSSD	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
Hayward	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
Las Gallinas	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
Livermore	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
Millbrae	--	--	--	--	--	--
Mt. View	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
Napa	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1 -- Confidence Level 3
Novato	Confidence Level 1	Confidence Level 1	Confidence Level 1 Confidence Level 2	Confidence Level 1 Confidence Level 2	Confidence Level 1 Confidence Level 2	Confidence Level 1 Confidence Level 2
OLSD	Confidence Level 1	Confidence Level 1	--	--	-- -- Confidence Level 3	-- -- Confidence Level 3
Palo Alto	Confidence Level 1	Confidence Level 1	Confidence Level 1 -- Confidence Level 3	Confidence Level 1 -- Confidence Level 3	Confidence Level 1 -- Confidence Level 3	Confidence Level 1 -- Confidence Level 3
Petaluma	Confidence Level 1	Confidence Level 1	Confidence Level 1 Confidence Level 2	Confidence Level 1 Confidence Level 2	Confidence Level 1 Confidence Level 2	Confidence Level 1 Confidence Level 2
Pinole	--	--	--	--	--	--
Richmond	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--
SFO Airport	--	-- Confidence Level 2	-- Confidence Level 2	-- Confidence Level 2	-- Confidence Level 2	-- Confidence Level 2
SFPUC Southeast	--	--	--	--	--	--
San Jose	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1 -- -- Confidence Level 4
San Mateo	--	--	-- -- Confidence Level 3	-- -- Confidence Level 3	-- -- Confidence Level 3	-- -- Confidence Level 3
SMCSD	--	--	--	--	--	--

POTW	Year 2020	Year 2025	Year 2030	Year 2035	Year 2040	Year 2045
San Leandro	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
SASM	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
Sonoma Valley	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
SVCW	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1 -- Confidence Level 3	Confidence Level 1 -- Confidence Level 3	Confidence Level 1 -- Confidence Level 3
South SF	--	-- -- Confidence Level 3	-- Confidence Level 2 Confidence Level 3	-- Confidence Level 2 Confidence Level 3	-- Confidence Level 2 Confidence Level 3	-- Confidence Level 2 Confidence Level 3
Sunnyvale	Confidence Level 1	-- -- Confidence Level 3	-- -- Confidence Level 3	-- -- Confidence Level 3	-- -- Confidence Level 3	-- -- Confidence Level 3
Treasure Island	--	--	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
USD	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--
West County	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
Total	Confidence Level 1 = 23, Confidence Level 2 = 0, Confidence Level 3 = 0, Confidence Level 4 = 0	Confidence Level 1 = 22, Confidence Level 2 = 2, Confidence Level 3 = 3, Confidence Level 4 = 0	Confidence Level 1 = 22, Confidence Level 2 = 5, Confidence Level 3 = 5, Confidence Level 4 = 0	Confidence Level 1 = 21, Confidence Level 2 = 5, Confidence Level 3 = 8, Confidence Level 4 = 1	Confidence Level 1 = 21, Confidence Level 2 = 5, Confidence Level 3 = 9, Confidence Level 4 = 1	Confidence Level 1 = 21, Confidence Level 2 = 5, Confidence Level 3 = 10, Confidence Level 4 = 2

* Confidence Level 1 has up to 24 net projects through year 2045 (no more than 23 at any given listed five-year increment; three Confidence Level 1 projects stop producing recycled water in years 2025, 2030 and 2035; a Confidence Level 1 Project begins producing recycled water in year 2030).

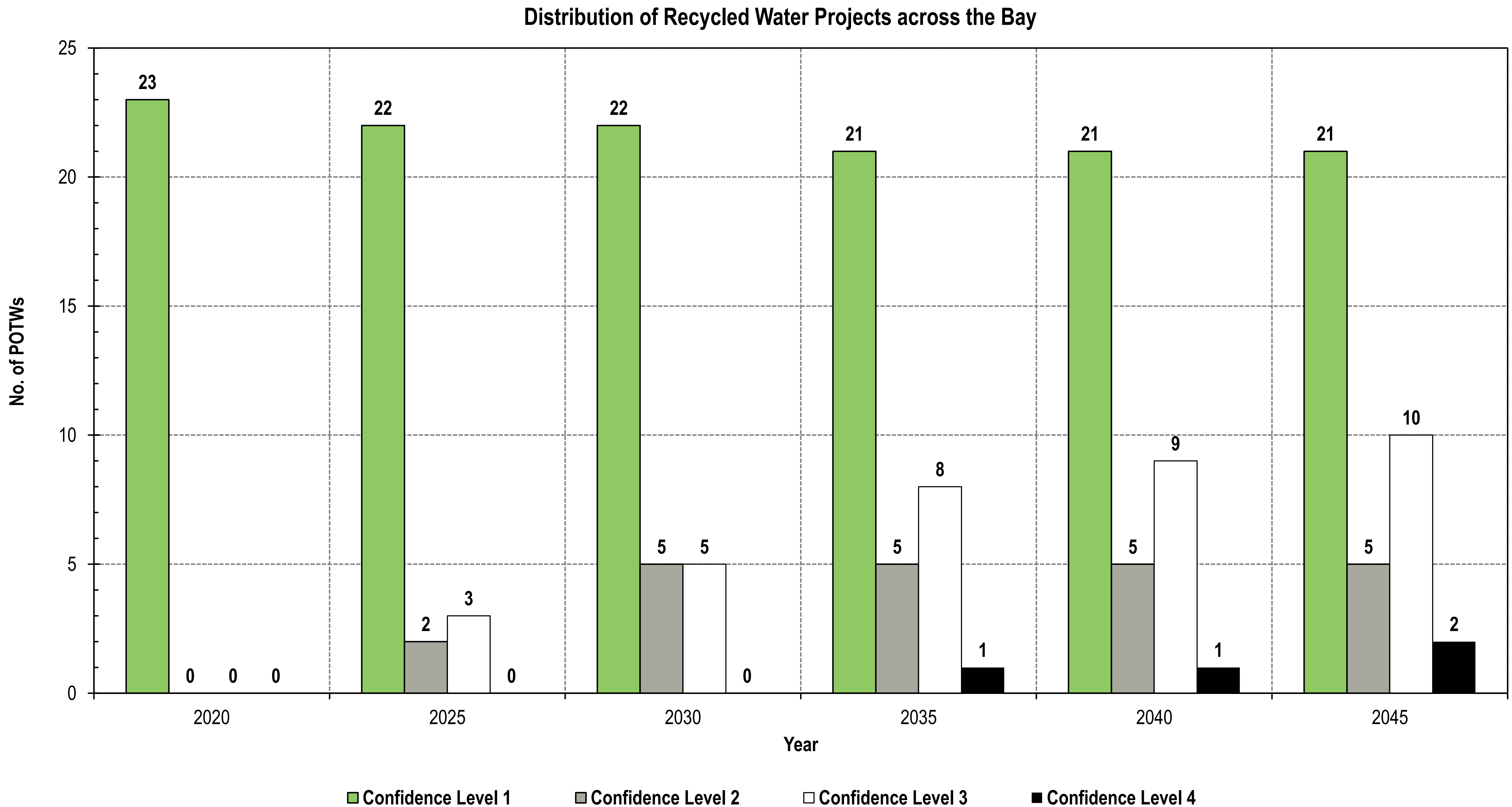

Figure ES - 3. Distribution of Potential Recycled Water Projects by Confidence Levels across the Bay*

* Confidence Level 1 has up to 24 net projects through year 2045 (no more than 23 at any given listed five-year increment; three Confidence Level 1 projects stop producing recycled water in years 2025, 2030, and 2035; a Confidence Level 1 Project begins producing recycled water in year 2030).

Table ES - 4. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions and Unit Costs

Parameter	Unit	Confidence Level 1 Grouping (Avg. from 2020–2045) [a]		Confidence Level 2 Grouping (Avg. from 2020–2045) [a]		Confidence Level 3 Grouping (Avg. from 2020–2045) [a]		Confidence Level 4 Grouping (Avg. from 2020–2045) [a]		Total (Includes all 4 Confidence Level Groupings (Avg. from 2020–2045) [a]	
		Average Dry Season (May 1–Sept 30)	Average Annual (Oct 1–Sept 30)	Average Dry Season (May 1–Sept 30)	Average Annual (Oct 1–Sept 30)	Average Dry Season (May 1–Sept 30)	Average Annual (Oct 1–Sept 30)	Average Dry Season (May 1–Sept 30)	Average Annual (Oct 1–Sept 30)	Average Dry Season (May 1–Sept 30)	Average Annual (Oct 1–Sept 30)
Number of Projects [b]											
Net Number from Year 2020 through 2045	No.	24	24	5	5	10	10	2	2	41	41
Flow/Volume Diverted from SF Bay [c]											
Flow	mgd	67	48	7	5	17	15	8	8	99	76
Annual Volume	AF	31,600	54,200	3,300	5,600	8,100	16,700	3,600	8,600	46,600	85,100
Load Diverted from SF Bay [c]											
Confidence	Unitless	1	1	2	2	3	3	4	4	--	--
Duration	Years	25	25	25	25	25	25	25	25	25	25
Flow diverted	%	17%	11%	2%	1%	5%	4%	2%	2%	23%	16%
Ammonia load diverted	kg N/d	1,700	1,200	85	73	450	270	2	2	2,300	1,600
TIN load diverted	kg N/d	4,120	2,900	210	180	880	660	44	44	5,300	3,800
TP load diverted	kg P/d	350	240	25	18	160	120	2	2	540	380
Cost [d,e]											
Capital cost	$ Mil	530	530	130	130	1,860	1,860	1,300	1,300	3,820	3,820
NPV O&M	$ Mil	300	480	270	330	400	950	280	660	1,250	2,420
NPV total (Capital+ NPV O&M)	$ Mil	830	1,010	400	460	2,260	2,810	1,580	1,960	5,070	6,240
Unit flow cost [f]											
Unit cost	$/gpd	12	21	57	92	132	188	205	254	51	82
Unit cost	$/AF	1,050	750	4,900	3,300	11,200	6,700	17,500	9,100	4,400	2,900
Unit load cost [g]											
Ammonia unit cost	$/lb Ammonia diverted	57	42	560	320	600	510	115,100	63,100	260	200
TIN unit cost	$/lb TIN diverted	24	17	230	130	300	210	4,300	2,200	110	80
TP unit cost	$/lb TP diverted	280	210	1,880	1,260	1,630	1,170	86,700	41,000	1,110	820

a. Confidence level = level of confidence in the values provided. 1 = includes projects that are already in place and/or currently budgeted; 2 = includes projects that are in master planning stages; 3 = includes projects that are conceptual, and 4 = includes projects that are conceptual in nature and require agreements across multiple jurisdictions/agencies.
b. Confidence Level 1 has up to 24 net projects through year 2045 (no more than 23 at any given listed five-year increment; three Confidence Level 1 projects stop producing recycled water in years 2025, 2030, and 2035; a Confidence Level 1 Project begins producing recycled water in year 2030).
c. Based on flows and loads diverted from the SF Bay discharge projected forward to the midpoint of the specific project duration (in this case 25-years assumed from year 2020 through 2045), as well as dry season (153 days per year) and average annual (365 days per year).
d. Estimated cost for RW production across the SF Bay (based on year 2021 dollars).
e. Net present value (NPV) is calculated based on a 2% discount rate for the listed project duration (project specific).
f. Unit flow cost is based on the NPV total divided by the listed average flow diverted from SF Bay.
g. Unit load costs are based on the NPV total divided by the average nutrient (ammonia, TIN, or TP) diverted from an SF Bay discharge for the project duration—e.g., NPV total divided by (daily average listed load × number of days for averaging period × unit conversion [kg to lb] × duration as years).

For perspective, the percentage of effluent flows and TIN loads diverted from SF Bay through reuse from year 2020 to 2045 is provided in Table ES - 5 and Table ES - 6, respectively. The analysis is based on comparing the reuse volumes and loads against recent discharge flows and loads to SF Bay (i.e., October 1, 2021, through September 30, 2022). The average SF Bay-wide discharge flow and TIN loads by all the major dischargers during year 2021/2022 was 399 mgd (446,880 AF) and 47,300 kg N/d, respectively. A detailed summary of the discharge flows and loads to SF Bay over the last 10 years is provided in this past year's BACWA Group Annual Report (HDR, 2023).

The reuse volumes diverted from SF Bay are primarily from projects under Confidence Level 1. Over time, the contributions from Confidence Levels 2, 3, and 4 are expected to increase. A similar trend is expected for TIN loads diverted from SF Bay.

Table ES - 5. Annual Average Discharge Flow Diverted from SF Bay for Reuse over Time (Percent of Total Discharge Volume) *,**

Year	Confidence Level				Total
	1	2	3	4	
2020	9%	--	--	--	9%
2025	10%	<1%	<1%	--	11%
2030	11%	2%	3%	--	16%
2035	12%	2%	5%	3%	22%
2040	12%	2%	6%	3%	23%
2045	13%	2%	8%	6%	29%

* The analysis is based on comparing the reuse volumes/loads against year 2021/2022 (October 1 through September 30) discharge flows and loads to SF Bay. A detailed summary of the discharge flows and loads to SF Bay over the last 10 years is provided in this past year's BACWA Group Annual Report (HDR, 2023).

** Percent calculation = RW volume from year 2020 compiled in this report divided by (discharge volume from 2021/2022+ RW volume from year 2020 compiled in this report).

Table ES - 6. Annual Average Total Inorganic Nitrogen (TIN) Load Diverted from SF Bay for Reuse over Time (Percent of Total Discharge Load) *,**

Year	Confidence Level				Total
	1	2	3	4	
2020	5%	--	--	--	5%
2025	6%	<1%	<1%	--	6%
2030	6%	<1%	1%	--	7%
2035	6%	1%	2%	<1%	9%
2040	6%	1%	2%	<1%	9%
2045	7%	1%	2%	<1%	10%

* The analysis is based on comparing the reuse volumes/loads against year 2021/2022 (October 1 through September 30) discharge flows and loads to SF Bay. A detailed summary of the discharge flows and loads to SF Bay over the last 10 years is provided in this past year's BACWA Group Annual Report (HDR, 2023).

** Percent calculation = RW load from year 2020 compiled in this report divided by (discharge load from 2021/2022 + RW load from year 2020 compiled in this report).

The distribution of RW users/customers for 2020 and 2045 is provided in Figure ES - 4. Overall, the top users in 2020 are **industrial followed by landscape irrigation, golf course irrigation, and agriculture**. While these users are still expected to be prominent in 2045, the key user/customer that expands into the future is potable reuse options (groundwater recharge and surface-water augmentation projects). Potable reuse projects identified in Confidence Levels 3 and 4 constitute over 50 mgd of recycled water production after year 2040.

Drivers and Barriers to Implementing Recycled Water Projects

As part of the initial RFI, each agency was asked to identify their respective drivers and barriers to implementing reuse projects. The distribution of responses is provided in Figure ES - 5 and Figure ES - 6, respectively.

Drivers to Implementing Recycled Water Projects

The distribution of drivers is as follows: **water supply needs, followed by proposed discharge regulations and institutional drivers**. Given the state's periodic drought and aims to diversify water supply and improve resilience, it was not a surprise that water supply needs led the list of drivers. The proposed discharge regulations were focused on nutrient regulations, of which reuse is one of several strategies to manage nutrients.

Barriers to Implementing Recycled Water Projects

The distribution of barriers is as follows: **funding, followed by jurisdictional issues, lack of need, and institutional barriers**. Based on the survey results, economics appears to represent approximately 40 percent of the barrier, whereas non-economic considerations constitute the remaining 60 percent of potential barriers. The economics are challenging for POTWs as the reuse projects can be cost-prohibitive, coupled with meeting their primary mission, which is to be environmental stewards by producing National Pollutant Discharge Elimination System (NPDES) compliant effluent. Of the non-economic limitations to reuse, the jurisdictional barrier is a blend of challenges between the drinking water and reuse providers, as well as issues that arise when distributing recycled water across jurisdictional boundaries.

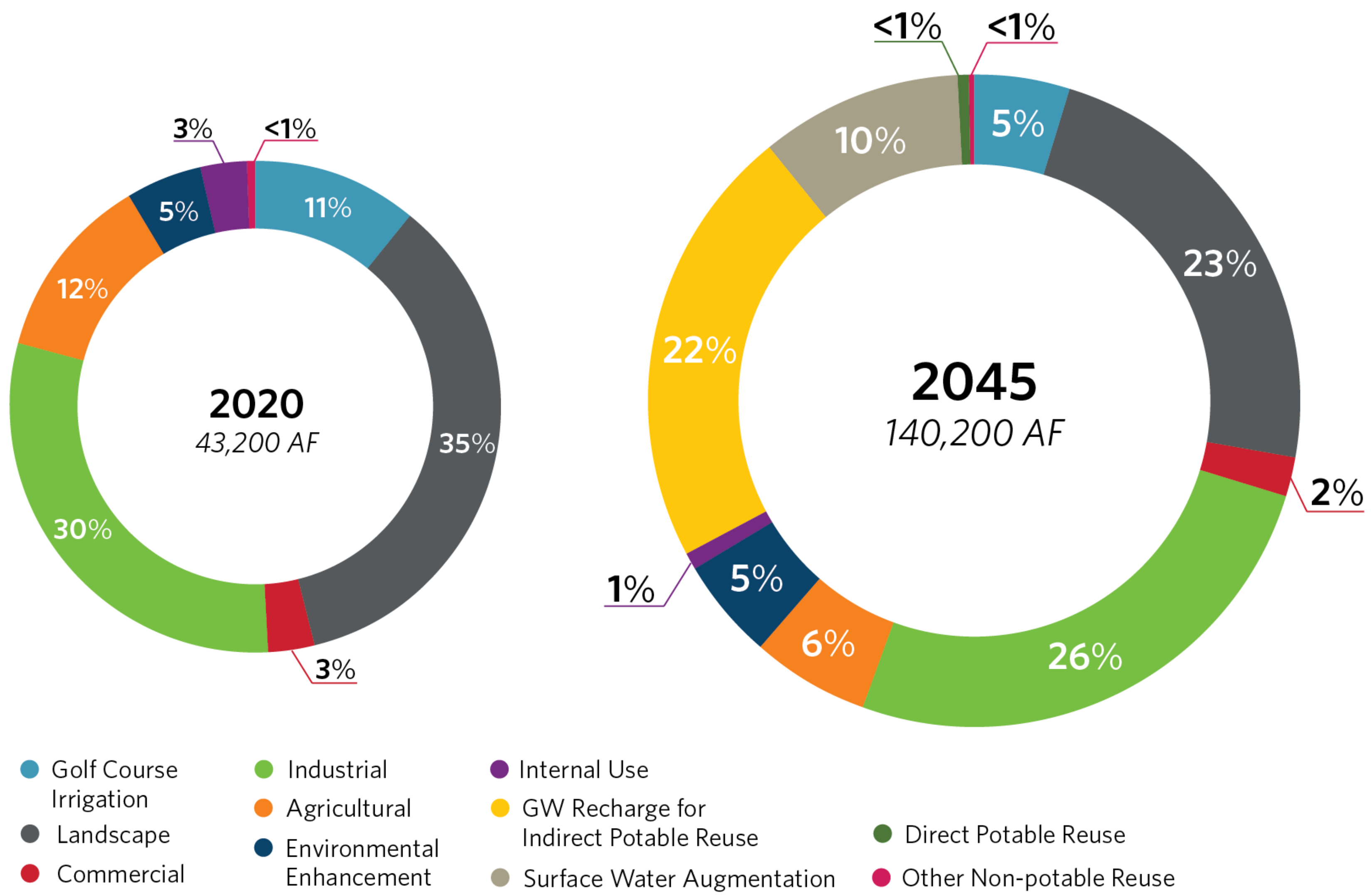

Figure ES - 4. Various Existing and Proposed Recycled Water User Types

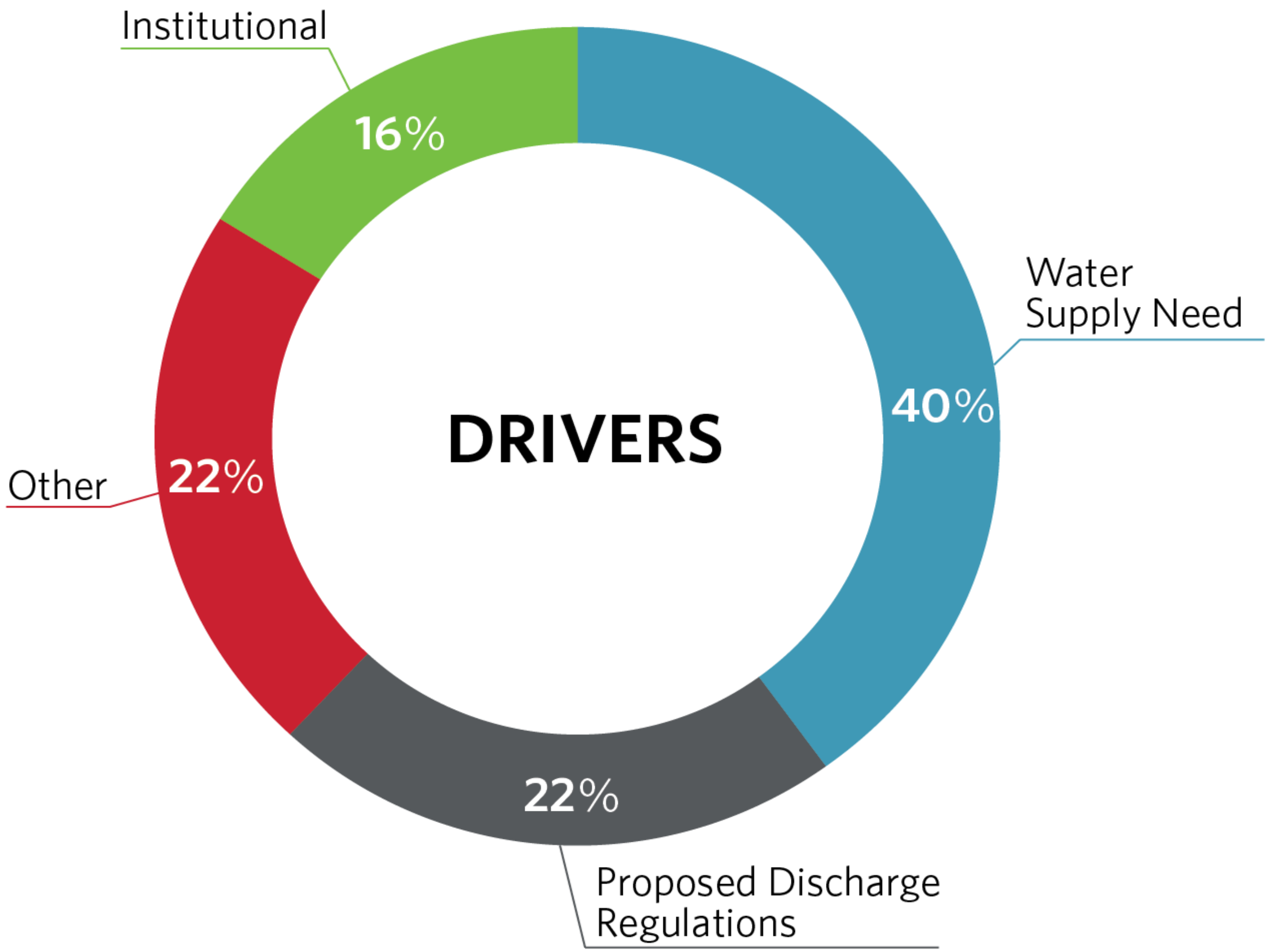

Figure ES - 5. Various Drivers to RW Projects in SF Bay

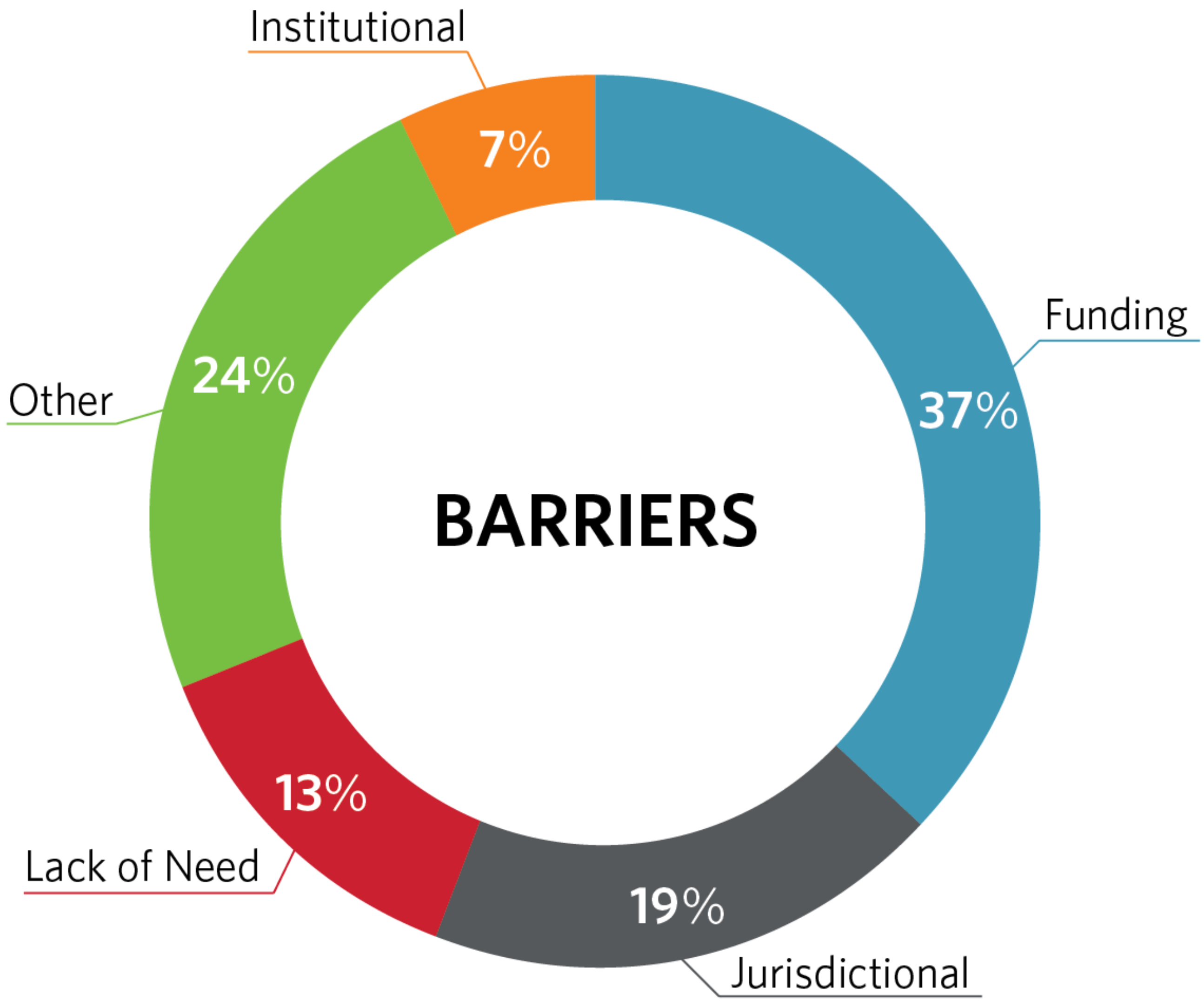

Figure ES - 6. Various Barriers to RW Projects in SF Bay

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Study Limitations

While this effort has provided an SF Bay-wide perspective on the potential for recycled water as a means to manage nutrients (emphasis on TIN reduction), it does have several limitations worth noting:

- **Various confidence levels:** The reader is advised to consider this uncertainty while interpreting the results as several of the projects are unlikely to be implemented or completed within the planning period (in particular, Confidence Levels 3 and 4).
- **Ability to keep nutrients out of SF Bay via reuse:** Several of the RW uses do not necessarily divert nutrients from SF Bay (on certain such as some industrial uses with a return stream to the plant; applications internal treatment plant uses; and portion of flows/loads for potable reuse applications). This RW study attempted to account for this discrepancy but in several instances, it might require a more detailed analysis to confirm the basis of evaluation.
- **Inconsistencies in cost information:** The First Watershed Permit report (HDR, 2018) applied a consistent cost estimating approach for all the projects included in the study. In contrast, this study relies on information provided by each agency. As a result, the approach to developing cost estimates may vary among the POTWs and it is unclear where differences may exist.
- **Limited to POTW effluent:** This Recycled Water Report is limited to using POTW effluent for recycled water applications. It ignores nutrient management measures as an overall strategy for managing nutrients that end up in SF Bay. For example, the nutrients contained in recycled water can be of added value as a strategy to reduce chemical fertilizers in agricultural/landscape irrigation applications.
- **Other factors beyond costs (both unit and total) for comparing the menu of nutrient management options:** While evaluating recycled water projects, the evaluation should extend beyond unit and load cost metrics factors as was the approach used in the First Watershed Permit findings (HDR, 2018). Recycled water projects provide other economic and non-economic benefits (e.g., water supply resiliency) which should be factored into making an informed decision on nutrient management strategies.
- **Potential for recycled water:** This Potential Nutrient Reduction by Recycled Water does not quantify the regional potential that is feasible for reuse. Rather, it compares the recycled water volumes and flows against all the agency effluent flows and loads across SF Bay. The ongoing Water Research Foundation (WRF) study 4962, led by Leverenz et al. (Leverenz, in preparation), will address the factors that impact the implementation of reuse projects, such as the required minimum instream flows (more inland focused), water quality, proximity to potential water reuse sites, and cost. Such a strategy could provide additional insights on recycled water potential across the region.
- **Reuse regulations:** The regulations for direct potable reuse are still under development by the State Water Resources Control Board. The final form of the direct potable reuse regulations could influence implementation of future potable reuse projects captured in this Potential Nutrient Reduction by Recycled Water.
- **Unit Costs for Projects that Extend Beyond Year 2045:** The unit cost values for projects that are not slated until closer to year 2045 are subject to skewed unit cost values. For instances where the project does not start until say year 2041, the analysis only considers water production through year 2045 which can result in skewed unit costs as it does not consider production years beyond year 2045.

Key Findings and Next Steps

Recycled water represents one of several nutrient management strategies across SF Bay. The fundamental challenge with the currently available information is the uncertainty associated with implementation. Specifically, it is unclear how many Confidence Levels 2 through 4 projects will be implemented. Regardless, this Potential Nutrient Reduction by Recycled Water provides context for the extent of current and potential future RW projects across SF Bay.

Recycled water uses currently divert just under 10 percent of the annual flow and 5 percent of the annual TIN loads from SF Bay. These values are expected to more than double in the next 25 years for those projects listed as Confidence Levels 1 through 3 (a majority is represented by those in Confidence Level 1). There is potential for significant increase for those listed as Confidence Level 4, which in most cases would occur closer to year 2035 and beyond. Such projects are highly dependent on funding, potable reuse regulations (still in draft), and multi-agency cooperation.

The key drivers and barriers for implementing reuse projects are water supply needs and funding, respectively. Having access to funding would likely expedite several of the potential projects (Confidence Levels 2 through 4). Another notable barrier is jurisdictional issues as a large portion of recycled water projects require the cooperation of drinking water providers. Most drinking water providers would impact their revenue stream by the implementation of such reuse projects. In many cases, a multi-agency agreement is needed between a POTW and the local drinking water agency to progress a project from concept through implementation. Furthermore, providing recycled water across jurisdictional lines has its own set of challenges.

The results of this study should be taken in context with the NbS task results (being performed separately), to provide a menu of nutrient management options that will complement those prepared in the First Watershed Permit. BACWA and its member agencies will need to consider the various evaluated options and content to inform the next steps. Specifically, other economic and non-economic parameters (e.g., water supply resilience, air emissions, etc.) should factor into future decision-making.

1 Introduction

In 2019, the San Francisco Regional Water Quality Control Board (RWQCB) issued Order R2-2019-0017, *Waste Discharge Requirements for Nutrients from Municipal Wastewater Dischargers to San Francisco Bay* (Second Watershed Permit). The Second Watershed Permit follows Order R2-2014-0014, *Waste Discharge Requirements for Nutrients from Municipal Wastewater Discharges to San Francisco Bay* (First Watershed Permit), and overall, they set forth a regional framework to facilitate collaboration on studies that will inform future management decisions and regulatory strategies. The Watershed Permit has four special provisions as follows:

1. Reopener provisions
2. Regional evaluation of potential nutrient discharge reduction by natural systems
3. Regional evaluation of potential nutrient discharge reduction by water recycling
4. Monitoring, modeling, and subembayment studies

This effort is focused exclusively on item 3 listed above (regional evaluation of potential nutrient discharge reductions by water recycling). The aim of this Potential Nutrient Reduction by Recycled Water is to identify potential load reductions and costs related to water recycling for each discharger to SF Bay, as well as across the SF Bay.

1.1 Background

The presence of nutrients in SF Bay is of significant concern for the San Francisco Bay Area (Bay Area) water quality community. Working through the framework of the San Francisco Bay Nutrient Management, scientists are investigating through San Francisco Estuary Institute (SFEI) the impact of nutrients on SF Bay water quality. While these studies continue, Bay Area Clean Water Agencies (BACWA) is collaborating with regulators to ensure that future nutrient management requirements are founded in science.

The Watershed Permit approach sets forth a regional framework to facilitate collaboration on studies that will inform future management decisions and regulatory strategies. The permit expands upon the First Watershed Permit that focused on treatment opportunities within each wastewater treatment plant (WWTP). The 2019 permit includes two key elements for evaluating nutrient load reduction opportunities for POTWs: (1) recycled water and (2) nature-based solutions. In response to the Second Watershed Permit, the publicly owned treatment works (POTWs) are working collectively through the joint powers agency, BACWA, to submit one coordinated study.

This Potential Nutrient Reduction by Recycled Water is part of the coordinated study for the water recycling component of the Second Watershed Permit, which includes analyses for 37 POTWs. A separate coordinated report is being prepared for the nature-based solutions (NbS) component under a separate consulting contract.

1.1.1 Nutrients and San Francisco Bay

SF Bay is the largest estuary along the U.S. Pacific coast and its watershed drainage includes about 40 percent of California's land (more than 60,000 square miles) and 47 percent of the state's total runoff. The land surrounding SF Bay is home to approximately 7.1 million people while the Central Valley supports an additional 6.5 million people.

While commonly referred to as “the Bay,” SF Bay is better characterized as a series of connected subembayments, as illustrated in Figure ES - 1, having distinct physical, chemical, and biological characteristics (Kimmerer, 2004). Approximately 90 percent of SF Bay’s annual freshwater supply enters through the Sacramento-San Joaquin Delta, causing Suisun and San Pablo Bays to (generally) experience the lowest salinities and they also have the shortest residence times (days to weeks) (Smith and Hollibaugh, 2006). The Central Bay, the deepest subembayment, receives little direct freshwater input, but exchanges readily with the Pacific Ocean. The Lower South Bay and South Bay receive considerably less fresh water than the northern SF Bay and have the longest residence times (weeks to months) (Kimmerer, 2004).

SF Bay receives large inputs of nutrients from anthropogenic sources (Cloern and Jassby, 2012; SFEI, 2014). On an SF Bay-wide and annual-average basis, effluent from POTWs accounts for more than 60 percent of nitrogen (N) loads to SF Bay. In the Lower South Bay, South Bay, and Central Bay, POTWs account for more than 90 percent of N loads.

Nitrogen and phosphorus (P) are essential components of a healthy estuary, supporting primary production at the base of the food web. However, ambient N and P concentrations in SF Bay exceed those in many other estuarine ecosystems (Cloern and Jassby, 2012), including those that experience nutrient-related impairment, such as excessive phytoplankton blooms and prolonged periods of low dissolved oxygen (DO). Unlike those other nutrient-enriched estuaries, SF Bay has exhibited resistance to classic eutrophication symptoms. High turbidity and strong tidal mixing in SF Bay cap light levels available to phytoplankton, leading to low growth rates, and allowing only a small portion of available nutrients to be converted into phytoplankton biomass (Cloern, 1999). During some years and in some regions, large populations of filter-feeding clams also limit phytoplankton accumulation (Cloern, 1982).

Observations over the past couple decades, suggests that SF Bay’s resistance to nutrient enrichment is weakening, or that SF Bay is more prone to nutrient-related impacts than previously thought (Cloern et al., 2007). These observations include:

- A two-fold increase in summer–fall phytoplankton biomass in South Bay since 1999 (Cloern et al., 2007)
- Frequent detections of algal species that form harmful algal blooms (HABs), and frequent detection of the toxins they produce (Sutula et al., 2017; SFEI, 2016; Peacock et al., 2018)
- Evidence of low DO in some sloughs and tidal creeks (SFEI 2016, 2017)
- A large-scale algal bloom in August 2022

The combination of the recent algal bloom (August 2022), SF Bay’s high-nutrient concentrations, and potential changes in the environmental factors that regulate nutrient-related responses has generated concern about whether some SF Bay habitats are moving toward experiencing nutrient-related impairment. To address this concern, the RWQCB worked collaboratively with stakeholders to develop the San Francisco Bay Nutrient Management Strategy (NMS) (refer to Section 1.3), which lays out an approach for gathering and applying information to inform major nutrient management decisions.

1.1.2 Nutrient Discharge Loads to San Francisco Bay

Nutrient loads arise from point and nonpoint sources. Point sources are typically from POTWs, which treat municipal wastewater, and from industries that directly discharge treated wastewater from processing, cleaning, and cooling. Municipal separate storm sewer systems (MS4s) permitted under the Phase I and Phase II stormwater National Pollutant Discharge Elimination System (NPDES) are also considered point sources.

Nonpoint sources are essentially everything that is not a point source, including diffuse agricultural pollutant runoff, stormwater runoff from areas not covered by MS4 stormwater permits, groundwater discharges, and atmospheric deposition.

> *Nonpoint source pollution is considered one of the top threats to the Bay's ecological health and may account for a considerable proportion of the Bay's total pollutant load. The Bay receives 90 percent of its freshwater from the Sacramento and San Joaquin Rivers and 10 percent from the watershed surrounding San Francisco Bay. (SFBCDC, 2003)*

Because most of the flow is from the Delta, most of the nonpoint source load is also from upstream. "Nonpoint source pollutants transported to the Bay come from Sacramento and San Joaquin Rivers, the Delta and the surrounding watersheds" (SFBCDC, 2003).

Municipal POTWs were significantly upgraded in the late 1970s, reducing the pollutant loads from POTWs. Today, the minimum level of performance is secondary treatment to remove organic matter and solids, but little reduction is made in nutrients as many WWTPs were not designed to remove nutrients. At the secondary treatment level, effluent nutrient discharges are typically about 30 to 35 milligrams per liter (mg N/L) TIN and 2 to 3 mg P/L total P. Lower effluent concentrations are possible with the addition of more advanced treatment as evidenced by numerous POTWs across the Bay (e.g., San Jose, OLS), Sunnyvale, Palo Alto, Pinole, FSSD, Petaluma, Sonoma Valley, Napa, Novato, etc.).

Table 1-1 through Table 1-4 present a summary of the flow and nutrient loads discharged to SF Bay from the POTWs included in the Watershed Permit (HDR, 2023).

1.1.3 Second Watershed Permit: Recycled Water Requirements

Provision VI.C.3.b of the Second Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling, and identifies the following requirements:

"The evaluation as included within the report shall include, but not be limited to, the following tasks for each agency:

- Description of all treatment plants, treatment plant processes, and service area
- Provide current and potential future recycled water projects that includes the various user types.
- Provide the seasonal volumes for current and potential future recycled water projects (if available).
- Provide cost estimates for current and potential future recycled water projects.
- Score the confidence of implementation (scale of 1 to 3) for current and potential future recycled water projects.
- Estimate the ammonia, TIN, and Total P discharge reductions associated with each RW opportunity.
- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance)"

1.1.4 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in SF Bay Area include the San Francisco Bay RWQCB and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of RW requirements is provided in Table 1-5.

1.1.4.1 Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Allowable uses are based on RW type. For tertiary disinfected recycled water – the highest quality of the four types with the most allowable uses – treatment requirements include a combination of filtration and disinfection.

1.1.4.2 Potable Reuse

Potable reuse is characterized by the degree of separation of RW treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects, other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely that DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in 2014 and 2018, respectively. DPR regulations are anticipated by the end of 2023.

Table 1-1. Discharge: Summary of Average Annual Flow and Loads to SF Bay

Constituent	2012/ 2013[a]	2013/ 2014[a]	2014/ 2015[a]	2015/ 2016[a]	2016/ 2017[a]	2017/ 2018[a]	2018/ 2019[a]	2019/ 2020[a]	2020/ 2021[a]	2021/ 2022[a]	10-Year Average
Flow, mgd	451	428	415	430	515	433	480	408	374	399	433
Ammonia, kg N/d	34,300	37,000	36,700	37,500	40,600	40,800	39,800	38,000	35,300	37,200	37,700
NO_x, kg N/d	14,900	14,300	14,200	13,600	14,500	12,400	12,900	11,600	10,700	10,100	12,900
TIN, kg N/d[b]	49,300	51,300	50,900	51,100	55,000	53,200	53,100	49,900	46,000	47,300	50,700
TP, kg P/d	3,860	3,750	3,770	4,070	4,020	4,190	4,210	4,010	3,670	3,500	3,910

a. Each reporting year represents the period between October 1 of the first year and September 30 of the second year. For example, 2012/2013 represents the period between October 1, 2012, and September 30, 2013.
b. The TIN values do not necessarily equal ammonia plus NOx because of a combination of rounding and instances when ammonia was sampled more frequently than NOx.

Table 1-2. Discharge: Summary of Dry Season Flow and Loads to SF Bay

Constituent	2013[a]	2014[a]	2015[a]	2016[a]	2017[a]	2018[a]	2019[a]	2020[a]	2021[a]	2022[a]	Trend [b,c]	10-Year Average
Flow, mgd	393	374	351	372	396	383	394	363	339	337	Down (-1.1%/yr)	370
Ammonia, kg N/d	34,000	36,300	36,200	37,300	38,900	38,900	38,200	35,400	33,600	35,800	None	36,500
NO_x, kg N/d	13,300	11,800	12,500	11,100	11,700	11,000	10,800	10,000	9,290	8,540	Down (-4.1%/yr)	11,010
TIN, kg N/d[d]	47,300	48,100	48,700	48,400	50,600	50,000	49,200	45,700	43,100	44,400	Down (-1.0%/yr)	47,500
TP, kg P/d	3,400	3,320	3,570	3,960	3,660	4,000	4,010	3,790	3,680	3,300	None	3,670

a. The dry season represents May 1 through September 30 for each calendar year.
b. Trend analysis is based on average monthly values. Discernible trends were identified based on the slope of a regression line determined using the method of least squares to fit the data (alpha = 0.05). Sample size is 45. Where "none" is stated, the limited data set does not indicate a statistically relevant trend.
c. The percent change represents the change per year as a percentage of the average value over the entire data set (2012–2022) (not considered if trend is "none").
d. The TIN values do not necessarily equal ammonia plus Nox because of a combination of rounding and instances when ammonia was sampled more frequently than NOx.

Table 1-3. Discharge: Summary of Average Annual Flow and Concentrations to SF Bay

Constituent	2012/ 2013[a]	2013/ 2014[a]	2014/ 2015[a]	2015/ 2016[a]	2016/ 2017[a]	2017/ 2018[a]	2018/ 2019[a]	2019/ 2020[a]	2020/ 2021[a]	2021/ 2022[a]	10-Year Average
Flow, mgd	451	428	415	430	515	433	480	408	374	399	433
Ammonia, mg N/L	20.1	22.8	23.4	23.0	20.8	24.9	21.9	24.6	24.9	24.6	23.0
NO_x, mg N/L	8.77	8.84	9.05	8.37	7.41	7.57	7.12	7.48	7.56	6.67	7.94
TIN, mg N/L[b]	28.8	31.6	32.4	31.4	28.2	32.5	29.3	32.3	32.5	31.3	31.0
TP, mg P/L	2.26	2.31	2.40	2.50	2.06	2.56	2.32	2.59	2.60	2.32	2.39

a. Each reporting year represents the period between October 1 of the first year and September 30 of the second year. For example, 2012/2013 represents the period between October 1, 2012, and September 30, 2013.
b. The TIN values do not necessarily equal ammonia plus NO_x because of instances when ammonia was sampled more frequently than NO_x.

Table 1-4. Discharge: Summary of Dry Season Flow and Concentrations to SF Bay

Constituent	2013[a]	2014[a]	2015[a]	2016[a]	2017[a]	2018[a]	2019[a]	2020[a]	2021[a]	2022[a]	Trend [b, c]	10-Year Average
Flow, mgd	393	374	351	372	396	383	393	363	339	337	None	370
Ammonia, mg N/L	22.8	25.6	27.3	26.5	26.0	26.8	25.6	25.8	26.2	28.1	Up (0.7%/yr)	26.1
NO_x, mg N/L	8.98	8.36	9.41	7.89	7.81	7.56	7.26	7.28	7.25	6.69	Down (-3.1%/yr)	7.85
TIN, mg N/L[d]	31.8	34.0	36.7	34.4	33.8	34.4	33.0	33.2	33.6	34.8	None	34.0
TP, mg P/L	2.28	2.34	2.69	2.81	2.44	2.76	2.69	2.76	2.87	2.58	None	2.62

a. The dry season represents May 1 through September 30 for each calendar year.
b. Trend analysis is based on average monthly values. Discernible trends were identified based on the slope of a regression line determined using the method of least squares to fit the data (alpha = 0.05). Sample size is 45. Where “none” is stated, the limited data set does not indicate a statistically relevant trend.
c. The percent change represents the change per year as a percentage of the average value over the entire data set (2012–2022) (not considered if trend is “none”).
d. The TIN values do not necessarily equal ammonia plus Nox because of a combination of rounding and instances when ammonia was sampled more frequently than NOx.

Table 1-5. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected secondary recycled water	Oxidation	Vineyard irrigation Non-food-bearing tree irrigation Fodder crop irrigation
Disinfected secondary-23 recycled water	Oxidation, disinfection	Cemetery irrigation Freeway landscape irrigation Restricted access golf course irrigation Industrial boiler feed Mixing concrete and dust control Flushing sanitary sewers
Disinfected secondary-2.2 recycled water	Oxidation, disinfection	Landscape irrigation Agricultural irrigation WWTP in-plant reuse
Disinfected tertiary recycled water	Oxidation, filtration, disinfection	Golf course irrigation Landscape irrigation Industrial (cooling towers, process water) Agricultural irrigation Environmental enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater recharge: spreading	Oxidation, filtration, disinfection	Groundwater recharge for spreading basins
Groundwater recharge: injection	Oxidation, full advanced treatment	Groundwater recharge via injection wells
Reservoir augmentation	Oxidation, full advanced treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw water augmentation	Oxidation, full advanced treatment+	Upstream of surface water treatment plant (SWTP)
Treated water augmentation	Oxidation, full advanced treatment+	Potable water distribution system

1.2 Participating Agencies

The Watershed Permit requires agencies to conduct a Potential Nutrient Reduction by Recycled Water. A list of the 42 agencies identified in the Watershed Permit is provided in Table 1-6.

Table 1-6. Agencies Included in the Second Watershed Permit

Discharger (Abbreviation)	POTW Facility Name
American Canyon, City of (American Canyon)	American Canyon Water Reclamation Facility
Benicia, City of (Benicia)	Benicia WWTP
Burlingame, City of (Burlingame)	Burlingame WWTP
Central Contra Costa Sanitary District (Central San)	Central Contra Costa Sanitary District WWTP
Central Marin Sanitation Agency (CMSA)	Central Marin Sanitation Agency WWTP
Delta Diablo	Delta Diablo WWTP
East Bay Dischargers Authority (EBDA)[b] City of Hayward (Hayward), City of San Leandro (San Leandro), Oro Loma/Castro Valley Sanitary District (OLSD), Union Sanitary District (Union San), Livermore-Amador Valley Water Management Agency (LAVWMA)[b], Dublin San Ramon Services District (DSRSD), and City of Livermore (Livermore)	EBDA Common Outfall
	Hayward Water Pollution Control Facility
	San Leandro Water Pollution Control Plant
	Oro Loma/Castro Valley Sanitary Districts Water Pollution Control Plant
	Raymond A. Boege Alvarado WWTP
	Livermore-Amador Valley Water Management Agency Export and Storage Facilities
	Dublin San Ramon Services District WWTP
	City of Livermore Water Reclamation Plant
East Bay Municipal Utility District (EBMUD)	East Bay Municipal Utility District, Special District No. 1 WWTP
East Bay Regional Park District[b]	--
Fairfield-Suisun Sewer District (FSSD)	Fairfield-Suisun WWTP
Hayward Marsh[b]	--
Las Gallinas Valley Sanitary District (Las Gallinas)	Las Gallinas Valley Sanitary District Sewage Treatment Plant
Millbrae, City of (Millbrae)	Millbrae Water Pollution Control Plant
Mt. View Sanitary District (Mt. View)	Mt. View Sanitary District WWTP
Napa Sanitation District (Napa)	Soscol Water Recycling Facility
Novato Sanitary District (Novato)	Novato Sanitary District WWTP
Palo Alto, City of (Palo Alto)	Palo Alto Regional Water Quality Control Plant
Petaluma, City of (Petaluma)	Ellis Creek Water Recycling Facility
Pinole, City of (Pinole)	Pinole-Hercules Water Pollution Control Plant
Richmond Municipal Sewer District, City of (Richmond)[b]	Richmond Municipal Sewer District Water Pollution Control Plant
Rodeo Sanitary District (Rodeo)	Rodeo Sanitary District Water Pollution Control Facility
San Francisco (San Francisco International Airport), City and County of (SFO Airport)	Mel Leong Treatment Plant, Sanitary Plant

Discharger (Abbreviation)	POTW Facility Name
San Francisco Public Utilities Commission (Southeast Plant) (SFPUC Southeast)	Southeast Water Pollution Control Plant
San Jose/Santa Clara Water Pollution Control Plant and Cities of San Jose and Santa Clara (San Jose)	San Jose-Santa Clara Regional Wastewater Facility
San Mateo, City of (San Mateo)	City of San Mateo WWTP
Sausalito-Marin City Sanitary District (SMCSD)	Sausalito-Marin City Sanitary District WWTP
Sewerage Agency of Southern Marin (SASM)	Sewerage Agency of Southern Marin WWTP
Sonoma Valley County Sanitary District (Sonoma Valley)	Sonoma Valley County Sanitation District WWTP
Silicon Valley Clean Water (SVCW)	SVCW WWTP
South San Francisco and San Bruno, Cities of (South SF)	South San Francisco and San Bruno Water Quality Control Plant
Sunnyvale, City of (Sunnyvale)	Sunnyvale Water Pollution Control Plant
U.S. Department of Navy (Treasure Island)	Treasure Island WWTP
Vallejo Flood and Wastewater District (Vallejo)	Vallejo WWTP
West County Agency (West County)	West County Wastewater District WWTP

a. As defined in the Watershed Permit.
b. This agency is not included in subsequent tables of this report, because this agency does not discharge.

No recycled water evaluation was conducted for five of the 42 agencies named as Dischargers in the Second Watershed Permit for the reasons provided below:

- EBDA was not evaluated separately because EBDA's discharge represents the combined flow from six POTWs: Hayward, San Leandro, OLSD, Union San, DSRSD, and Livermore. A separate evaluation was completed for each of these six POTWs. Opportunities using EBDA combined effluent are included with the facility evaluation for OLSD.
- LAVWMA was not evaluated because LAVWMA represents the combined flow from two POTWs: DSRSD and Livermore, which also flow through EBDA, as noted above. A separate evaluation was completed for each of these two POTWs.
- Hayward Marsh and the East Bay Regional Park District were not included because discharge from Union San's Raymond A. Boege Alvarado WWTP to the Hayward Marsh has permanently ceased at the request of the East Bay Regional Park District. In October 2022, the Regional Water Board issued Order R2-2022-0030 rescinding NPDES Permit No. CA0038636 for discharge to Hayward Marsh.
- A single recycled water evaluation was conducted for the City of Richmond and Richmond Municipal Sewer District. These two agencies jointly own the Richmond Municipal Sewer District Water Pollution Control Plant.

EBDA, LAVWMA, Hayward Marsh, East Bay Regional Park District are not included in subsequent tables of this report, while the City of Richmond and Richmond Municipal Sewer District are combined under the agency name "Richmond." As a result, there are 37 participating POTWs listed in most report tables.

1.3 Related Activities

Nutrient management across SF Bay includes several on-going efforts working in parallel toward the common goal of protecting SF Bay health. Besides this reuse component of the Second Watershed Permit, the other areas helping advance the science in parallel are the San Francisco Bay NMS, the other component of the Second Watershed Permit (NbS), and others.

The San Francisco Bay NMS Science Program was launched in 2014 to build the scientific foundation to support nutrient management decisions. The NMS Steering Committee, representing 13 stakeholder groups (regulators, dischargers, water purveyors, non-governmental organizations, and resource agencies) oversees the NMS's implementation, including financial oversight and alignment of NMS science activities with high-priority management questions. SFEI serves as the technical lead on implementing the NMS Science Program (sfbaynutrients.sfei.org), and collaborates with researchers from academia, the United States Geological Survey (USGS), and other agencies to carry out NMS projects, including field investigations, monitoring, and field data interpretation.

NMS Science Program activities are guided by management questions (shown in Table 1-7) that tie back to identifying protective nutrient loads for SF Bay habitats and that target priorities laid out in the NMS multi-year Science Plan (SFEI, 2022) and related technical reports. The primary technical program areas explored include nutrient loads and cycling, phytoplankton blooms and DO in deep subtidal habitats, DO in shallow margin habitats, HAB abundance, toxin abundance, phytoplankton assemblage, and coastal ocean impacts.

Table 1-7. Nutrient Management Strategy: Management Questions (SFEI, 2022)

Number	Question
1	What conditions represent adverse impacts or impairments that would require management or mitigation (Assessment Framework, AF)?
2	How do relevant water quality parameters vary spatially, seasonally, and interannually? Are adverse impacts or impairment currently occurring? (Monitoring, and comparison with AF)
3	How do SF Bay habitats respond to nutrient inputs (dose:response)? Are nutrients causing or contributing to current impacts or impairment?
4	What potential future impacts or impairments warrant pre-emptive management actions?
5	What are the contributions of individual nutrient sources to nutrient levels and ecosystem responses through SF Bay and over time (x,y,t)?
6	What management actions or load reductions are needed to prevent or mitigate current or future impairment?

Major NMS focus areas over the past few years have included:

- Building and refining the NMS Monitoring Program
- Advancing the SF Bay-wide model to inform nutrient management options and to better understand in-Bay processes
- Enhancing the assessment framework
- Synthesis and interpretation of long-term and new data sets

All NMS-related work products can be found at San Francisco Bay Nutrient Management Strategy | Status/Progress Tracking: San Francisco Bay Nutrient Management Strategy (sfei.org) (sfbaynutrients.sfei.org).

2 Basis of Evaluation

The project approach was provided as a document titled “Scoping and Evaluation Plan,” as well as a presentation to the RWQCB in fall 2019. Following the presentation, the RWQCB signed off on the Scoping and Evaluation Plan, which is provided in Appendix A. Note: The Scoping and Evaluation Plan presentation slides are also provided in Appendix A.

2.1 Approach Overview

A visual depiction of the core steps associated with completing the individual agency reports is provided in Figure 2-1. The initial two steps entailed two separate requests for information (RFIs) and development of the individual report template. Once the initial RFI responses were compiled, the consultant team sent out the second RFI to individual POTWs that requested additional information for each project, such as project description and costing information.

01

01: INITIAL RFI AND INDIVIDUAL REPORT TEMPLATE

a. First Watershed Permit plant reports: information used for to draft individual agency report Chapters 1 and 2
b. RFI: starting point for Chapter 3

02

02: SECOND RFI (PROJECT WRITE-UPS AND COSTS)

a. Write-ups: agencies to provided additional project descriptions
b. Cost (if available): agencies to provided info as available

03

03: DRAFT INDIVIDUAL PLANT REPORTS

a. Consultant team to update Executive Summary and Chapter 3 based on information provided in items 01 and 02 above
b. Agency: period to review and provide comments

04

04: COMMENTS, REVIEW CALL, AND FINALIZE/SIGN

a. Agency comments: Agencies to reviewed reports and provided consultant comments
b. Review call: Consultant to update reports and lead a call with clients
c. Finalize/sign: Consultant to finalized reports and agencies to sign

Figure 2-1. Overview of the Steps Associated with Developing Individual Agency Reports

Upon receiving the RFI responses, the consultant team performed the RW volumes and nutrient load diversions analysis that considered years 2020 through 2045 in 5-year increments as described in the Scoping and Evaluation Plan (refer to Appendix A). An individual draft report was issued to each participating agency, followed by a review period and report update prior to finalizing and agency sign-off.

The initial RFI requested WWTP-specific information such as current and future RW customers/demands, drivers and barriers to implementing recycled water projects, and costs. The individual POTWs were also requested for the confidence value for their future RW projects on a scale of 1 to 3 as defined in Table 2-1. A fourth confidence level was developed after the individual agency reports were drafted as it became evident that several POTWs were reluctant to provide information on potentially large reuse projects that were still in the infancy stage and require agreements across multiple jurisdictions. Such Confidence Level 4 projects are not included in the individual agency reports, but they are included in this Recycled Water Report.

Table 2-1. Confidence Level Definition for Future Recycling Water Project

Confidence Level	Definition
1	Estimated delivery volume based only on existing recycled water projects and/or future projects in an adopted budget
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document
4[a]	Estimated delivery volume based on projects that are conceptual in nature and require agreements across multiple jurisdictions

a. Confidence Level 4 projects were not included in the individual agency RFIs. In most cases, they require agreements across multiple jurisdictions and/or agencies.

2.2 Recycled Water Production

POTWs were asked to identify their existing and projected RW distribution uses and volumes from 2020 to 2045. POTWs listed the annual RW volume for each use category, and the total RW produced by the agency. Initially, a confidence value on a scale of 1 to 3 was placed on the various future RW projects identified as previously shown in Table 2-1. The Confidence Level 4 concept was added later in the development of this report.

RW user categories are defined in Table 2-2. These categories are identical to those used by the State Water Resources Control for Volumetric Annual Reporting (Volumetric Annual Report of Wastewater and Recycled Water | California State Water Resources Control Board).

Table 2-2. Recycled Water User Categories

Use Category [a]	Definition
Golf course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, and landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations used primarily for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, and other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are used primarily for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers and process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and thus does NOT include water that a WWTP must discharge to maintain habitat in the creek to which it is discharging.
Internal use	Includes facility process water, site irrigation, internal plumbing, fire protection, or other use at wastewater or RW facility.
Other non-potable reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, and fill stations if not included in other categories.

a. The RFI also included a category for return flows to better understand the fate of RW nutrient loads. Return flows includes RO reject or other return flows to the WWTP or point of discharge. Such information will be used for quantifying nutrient loads diverted from SF Bay.

2.3 Seasonality of Recycled Water Production

In addition to the annual production estimates described above, POTWs shared the seasonal distribution of their RW production. Average monthly RW volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with WWTPs and engineer's best judgment that considered known project constraints, existing WWTP reuse seasonality demands, and type of reuse project (e.g., irrigation demands are likely to be higher in the dry season).

2.4 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by the POTWs. Development of new cost estimates was not included as part of this Potential Nutrient Reduction by Recycled Water.

Construction cost estimates provided by each agency were normalized by escalating to the Average of 2022 *Engineering News-Record* (ENR) Construction Cost Index (CCI) for the Bay Area. O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV). The O&M cost focused on the chemical demands, electricity, operation, maintenance, and sampling costs (if available). Unfortunately, a complete set of O&M costs were not always available. As a result, the O&M costs might be underestimated.

The NPV is based on a 2 percent discount rate over the agency-provided project duration. NPV costs were prepared only if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 25-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - **Option 1 (NPV per million gallons per day [mgd]):** based on the NPV divided by the average flow diverted from an SF Bay discharge.
  - **Option 2 (NPV per acre-foot [AF]):** based on the NPV divided by the total volume of flow diverted from an SF Bay discharge over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (ammonia, TIN, or TP) diverted from an SF Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life-cycle period.

2.5 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects; identify potential challenges to implementing each opportunity; and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as barriers for implementation of RW projects?
- What do you see as drivers for implementing your RW projects?
- For your planned RW projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe that the issuance of regulations for DPR (expected by end of year 2023) will impact your agency's decisions on RW project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are any Capital Improvement Program (CIP) projects planned that would have a "synergistic benefit" for future RW and pollutant discharge load reduction (e.g., membrane bioreactor [MBR] to improve discharge water quality while simultaneously positioning your agency for future RW opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.6 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to SF Bay.

2.6.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in an RW stream that no longer enters SF Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below:

$$Load\ reduced\ \left(\frac{kg}{d}\right) = Conc.\left(\frac{mg}{L}\right) x\ RW\ volume\ \left(\frac{Acre\ feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ acre\ feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ year}{365\ days}\right)$$

2.6.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from SF Bay based on the evaluated RW projects. There are instances where the recycled water diverted from SF Bay does not result in a reduction in nutrients discharged to SF Bay, as illustrated in the following two examples:

- **Example 1:** An industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to SF Bay. For such an example, the volume of water is typically reduced via evaporation while the nutrient loads are maintained and thus do not result in a net reduction in nutrient loads discharged to SF Bay.
- **Example 2:** A potable reuse project with advanced treatment (includes RO treatment) has a brine concentrate/reject stream that is typically returned to a WWTP for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the RO process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

A simple mass balance to illustrate the fate of water and nutrient loads through advanced treatment facilities (that includes RO) is provided in Figure 2-2. Unless provided from the POTW, the analysis assumed that 80 percent of the feed water and 16 percent of the feed nutrient loads end up the permeate and used for reuse applications (i.e., diverted from the Bay). The remaining 20 percent feed water and 84 percent feed nutrient loads end in concentrate/reject streams which are typically discharged to the Bay via a treatment plant outfall. This effort considered the RO concentrate return streams while calculating nutrient load diversions from the Bay and thus, the nutrient load diversions associated with advanced treatment facilities are modest.

Additional nutrient removal could be achieved via treatment of RO concentrate, although this was not included in the load reduction estimates or cost estimates.

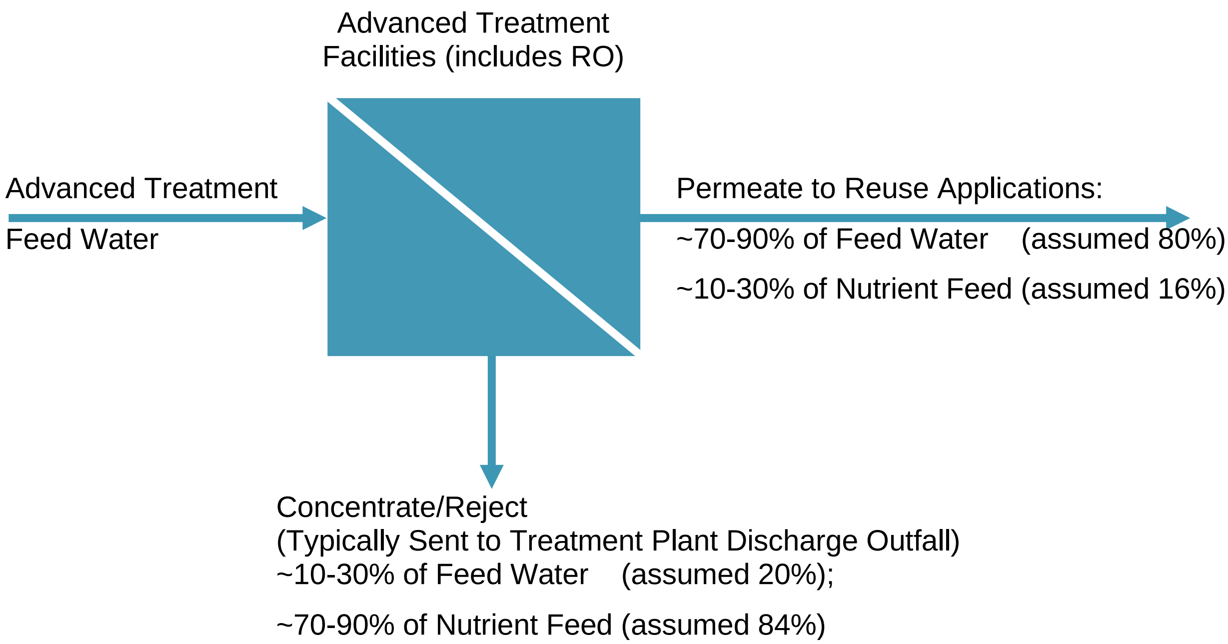

Figure 2-2. Simple Mass Balance of Water Production and Nutrient Loads around an Advanced Treatment Configuration

3 Nutrient Reduction Findings via Reuse

The findings for this reuse component of the Second Watershed Permit include subsections on RW volumes and the corresponding nutrient loads diverted from SF Bay (by confidence level), a discussion on the drivers and barriers to implementing reuse projects, and a menu of nutrient management options.

3.1 Recycled Water Volumes and Nutrient Loads Diverted from SF Bay

The RW volumes and corresponding nutrient loads diverted from SF Bay are divided by confidence level, followed by the overall total for Confidence Levels 1 through 4 (refer to Table ES - 1). The breakdown for each confidence level is provided in the subsections that follow.

3.1.1 Confidence Level 1 (Existing Projects or New Projects in an Adopted Budget)

A plot of the Confidence Level 1 RW volumes and corresponding TIN loads diverted from SF Bay is provided in Figure 3-1. The plot considers both the five-month dry season (May 1 through September 30) and average annual values. The survey responses suggest that approximately 60 percent of the reuse occurs in the dry season. Furthermore, the projected increase in reuse for this grouping is on the order of 50 percent over the next 25 years. If all of the listed projects expand as planned into the future, reuse would increase to upwards of 36,500 AFY during the dry season (average 78 mgd over 153 days) and 62,600 AFY for average annual (average 55 mgd over 365 days). The TIN load reductions would increase in a linear fashion with recycled water volumes/flows.

A breakdown by POTW for the **projected** volume, flow, and TIN load diversion from SF Bay Dischargers via recycled water is provided in Table 3-1 (dry season) and Table 3-2 (average annual). A breakdown by POTW for the **average** values from years 2020 through 2045 is provided in Table 3-3 (dry season) and Table 3-4 (average annual). Information from the average values is used to quantify the unit cost metrics.

Of the 37 POTWs evaluated, 23 currently have a RW program as evidenced by reuse volumes for such POTWs.

The largest existing RW program – regardless of season – is San Jose's, making up 30 to 40 percent of the total, followed by West County and Delta Diablo. San Jose's treatment plant provides ammonia and TIN removal, and the primary RW customers are landscape irrigation. Virtually all of San Jose's TIN load associated with reuse is diverted from SF Bay.

Delta Diablo's and West County's primary RW customers are neighboring industrial customers. Virtually none of Delta Diablo's TIN load associated with reuse is diverted from SF Bay, as the water returns after use and is discharged. West County's treatment plant provides ammonia and TIN removal prior to conveying the water to EBMUD's Richmond Advanced Recycled Expansion (RARE) Water Project at Chevron's Refinery. Chevron has their own NPDES permit (R2-2016-0047; ammonia limits of 50 mg N/L for average monthly and 150 mg N/L for maximum daily). Any reject/concentrate streams from the RARE facility are sent to West County's collection system and then the treatment plant.

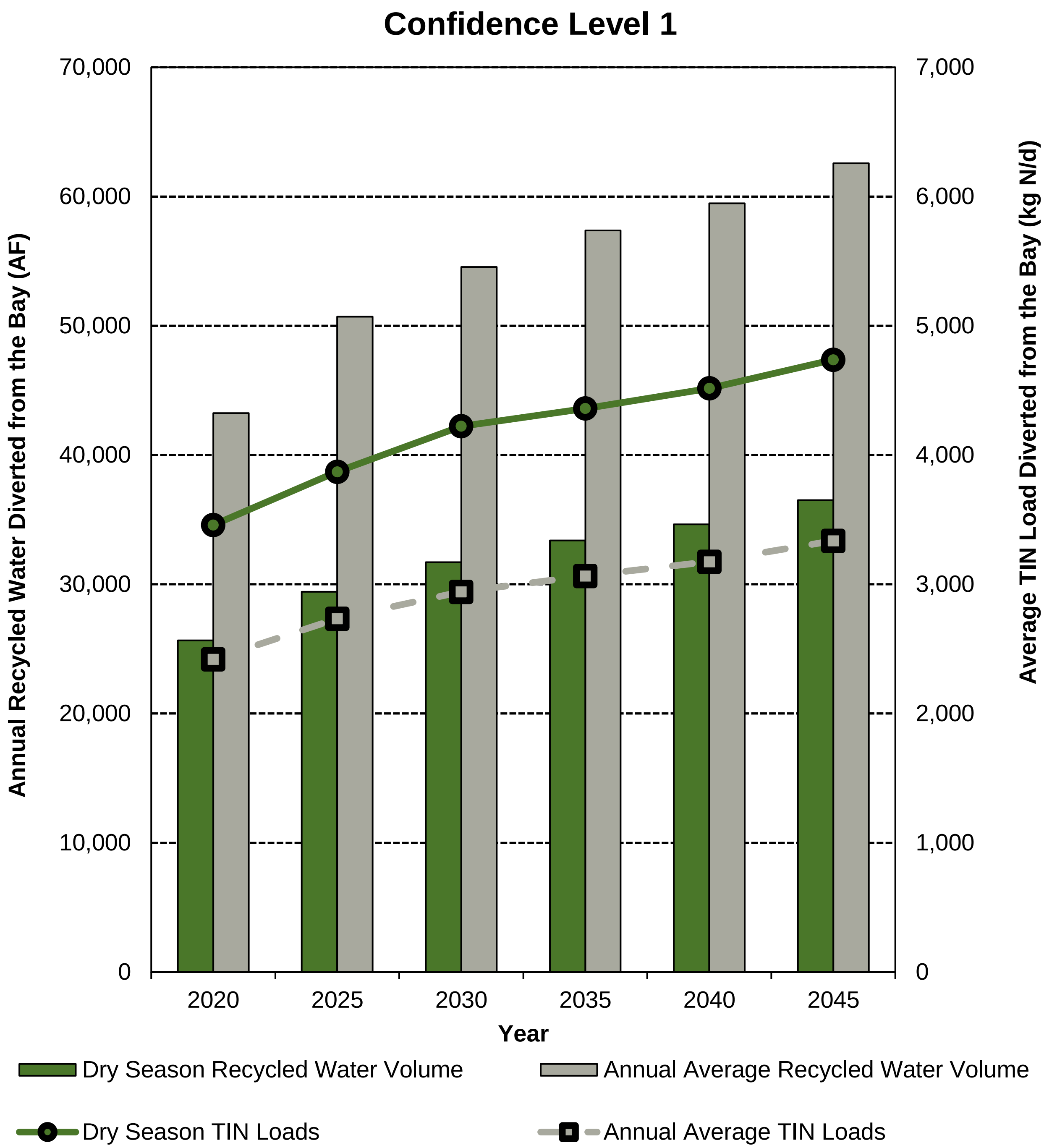

Figure 3-1. Summary of Confidence Level 1 Existing and Proposed Annual Recycled Water Flows and TIN Load Diversions from SF Bay Dischargers

Note: The Dry Season is May 1 through September 30 (153 days).

Table 3-1. Confidence Level 1: Projected Dry Season Recycled Water Volumes/Flows and the Corresponding Nutrient Load Reductions

POTW	Year 2020		Year 2025		Year 2030		Year 2035		Year 2040		Year 2045	
	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN, Load Diverted kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d
American Canyon	199 (0.4)	9	199 (0.4)	4	199 (0.4)	4	199 (0.4)	4	199 (0.4)	4	199 (0.4)	4
Benicia	--	--	--	--	--	--	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--	--	--	--	--	--	--
Central San	920 (2)	209	920 (2)	209	920 (2)	209	920 (2)	209	920 (2)	209	920 (2)	209
CMSA	20 (<0.1)	6	20 (<0.1)	6	20 (<0.1)	6	20 (<0.1)	6	20 (<0.1)	6	20 (<0.1)	6
Delta Diablo	2,070 (4)	55	2,080 (4)	56	2,080 (4)	56	2,080 (4)	56	2,090 (4)	56	2,090 (4)	56
DSRSD	1,790 (4)	410	1,890 (4)	432	1,930 (4)	441	1,930 (4)	441	1,930 (4)	441	1,930 (4)	441
EBMUD	117 (0.2)	52	131 (0.3)	59	327 (0.7)	146	--	--	--	--	--	--
FSSD	830 (2)	165	830 (2)	165	830 (2)	165	830 (2)	165	830 (2)	165	830 (2)	165
Hayward	532 (1)	138	733 (2)	189	916 (2)	236	916 (2)	236	916 (2)	236	916 (2)	236
Las Gallinas	764 (2)	85	764 (2)	85	764 (2)	85	764 (2)	85	764 (2)	85	764 (2)	85
Livermore	920 (2)	321	950 (2)	332	980 (2)	343	1,010 (2)	354	1,040 (2)	365	1,040 (2)	365
Millbrae	--	--	--	--	--	--	--	--	--	--	--	--
Mt. View	430 (0.9)	63	440 (0.9)	65	450 (1)	67	460 (1)	68	470 (1)	70	480 (1)	72
Napa	3,000 (6)	221	3,100 (7)	229	3,100 (7)	229	3,100 (7)	229	3,100 (7)	229	3,100 (7)	229
Novato	1,240 (3)	118	1,220 (3)	117	440 (0.9)	42	440 (0.9)	42	440 (0.9)	42	440 (0.9)	42
OLSD	37 (<0.1)	2	37 (<0.1)	2	--	--	--	--	--	--	--	--
Palo Alto	495 (1)	119	527 (1)	121	1,715 (4)	214	1,715 (4)	214	1,715 (4)	214	1,715 (4)	214
Petaluma	981 (2)	8	1,200 (3)	10	1,200 (3)	10	1,200 (3)	10	1,200 (3)	10	1,260 (3)	10
Pinole	--	--	--	--	--	--	--	--	--	--	--	--
Richmond	--	--	--	--	--	--	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--	--	--	--	--	--	--
SFO Airport	--	--	--	--	--	--	--	--	--	--	--	--
SFPUC Southeast	--	--	--	--	--	--	--	--	--	--	--	--
San Jose	7,500 (16)	909	8,900 (19)	1,080	10,100 (22)	1,230	11,900 (25)	1,450	13,100 (28)	1,590	14,900 (32)	1,810
San Mateo	--	--	--	--	--	--	--	--	--	--	--	--
SMCSD	--	--	--	--	--	--	--	--	--	--	--	--
San Leandro	233 (0.5)	71	233 (0.5)	71	233 (0.5)	71	233 (0.5)	71	233 (0.5)	71	233 (0.5)	71
SASM	31 (<0.1)	7	31 (<0.1)	7	31 (<0.1)	7	31 (<0.1)	7	31 (<0.1)	7	31 (<0.1)	7
Sonoma Valley	1,060 (2)	173	1,070 (2)	174	1,070 (2)	174	1,070 (2)	174	1,070 (2)	174	1,070 (2)	174
SVCW	677 (1)	194	973 (2)	279	1,040 (2)	297	1,210 (3)	347	1,220 (3)	350	1,220 (3)	350
South SF	--	--	--	--	--	--	--	--	--	--	--	--
Sunnyvale	272 (0.6)	35	--	--	--	--	--	--	--	--	--	--
Treasure Island	--	--	--	--	195 (0.4)	13	195 (0.4)	13	195 (0.4)	13	195 (0.4)	13
USD	--	--	--	--	--	--	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--	--	--	--	--	--	--
West County	1,560 (3)	89	3,160 (7)	180	3,160 (7)	180	3,160 (7)	180	3,160 (7)	180	3,160 (7)	180
Total [b]	25,700 (55)	3,460	29,400 (63)	3,870	31,700 (68)	4,220	33,400 (71)	4,360	34,700 (74)	4,520	36,500 (78)	4,740

a. The volumes in AF might vary from the values in the individual plant reports due to rounding (refer to Appendix B).
b. The total values might vary from the sum of the listed values by plant due to rounding.

Table 3-2. Confidence Level 1: Projected Average Annual Recycled Water Volumes/Flows and the Corresponding Nutrient Load Reductions

POTW	Year 2020		Year 2025		Year 2030		Year 2035		Year 2040		Year 2045	
	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN, Load Diverted kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d
American Canyon	313 (0.3)	6	313 (0.3)	6	313 (0.3)	6	313 (0.3)	6	313 (0.3)	6	313 (0.3)	6
Benicia	--	--	--	--	--	--	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--	--	--	--	--	--	--
Central San	1,600 (1)	141	1,600 (1)	141	1,600 (1)	141	1,600 (1)	141	1,600 (1)	141	1,600 (1)	141
CMSA	24 (<0.1)	2	24 (<0.1)	2	24 (<0.1)	2	24 (<0.1)	2	24 (<0.1)	2	24 (<0.1)	2
Delta Diablo	4,750 (4)	38	4,780 (4)	39	4,780 (4)	39	4,790 (4)	39	4,790 (4)	39	4,800 (4)	39
DSRSD	3,890 (3)	386	4,100 (4)	407	4,190 (4)	416	4,190 (4)	416	4,190 (4)	416	4,190 (4)	416
EBMUD	180 (0.2)	27	202 (0.2)	31	504 (0.4)	76	--	--	--	--	--	--
FSSD	1,030 (0.9)	73	1,030 (0.9)	73	1,030 (0.9)	73	1,030 (0.9)	73	1,030 (0.9)	73	1,030 (0.9)	73
Hayward	858 (0.8)	90	1,228 (1)	129	1,448 (1)	152	1,448 (1)	152	1,448 (1)	152	1,448 (1)	152
Las Gallinas	975 (0.9)	54	975 (0.9)	54	975 (0.9)	54	975 (0.9)	54	975 (0.9)	54	975 (0.9)	54
Livermore	1,620 (1)	218	1,680 (1)	226	1,730 (2)	233	1,790 (2)	241	1,840 (2)	248	1,840 (2)	248
Millbrae	--	--	--	--	--	--	--	--	--	--	--	--
Mt. View	1,150 (1)	72	1,180 (1)	73	1,210 (1)	75	1,240 (1)	77	1,270 (1)	79	1,300 (1)	81
Napa	3,300 (3)	103	3,400 (3)	106	3,400 (3)	106	3,400 (3)	106	3,400 (3)	106	3,400 (3)	106
Novato	1,470 (1)	53	1,450 (1)	52	530 (0.5)	19	530 (0.5)	19	530 (0.5)	19	530 (0.5)	19
OLSD	37 (<0.1)	1	37 (<0.1)	1	--	--	--	--	--	--	--	--
Palo Alto	705 (0.6)	69	752 (0.7)	70	2,495 (2)	102	2,495 (2)	102	2,495 (2)	102	2,495 (2)	102
Petaluma	981 (0.9)	8	1,200 (1)	10	1,200 (1)	10	1,200 (1)	10	1,200 (1)	10	1,260 (1)	10
Pinole	--	--	--	--	--	--	--	--	--	--	--	--
Richmond	--	--	--	--	--	--	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--	--	--	--	--	--	--
SFO Airport	--	--	--	--	--	--	--	--	--	--	--	--
SFPUC Southeast	--	--	--	--	--	--	--	--	--	--	--	--
San Jose	12,600 (11)	670	15,000 (13)	800	17,000 (15)	906	20,000 (18)	1,070	22,000 (20)	1,170	25,000 (22)	1,330
San Mateo	--	--	--	--	--	--	--	--	--	--	--	--
SMCSD	--	--	--	--	--	--	--	--	--	--	--	--
San Leandro	292 (0.3)	33	292 (0.3)	33	292 (0.3)	33	292 (0.3)	33	292 (0.3)	33	292 (0.3)	33
SASM	38 (<0.1)	2	38 (<0.1)	2	38 (<0.1)	2	38 (<0.1)	2	38 (<0.1)	2	38 (<0.1)	2
Sonoma Valley	2,210 (2)	151	2,240 (2)	153	2,240 (2)	153	2,240 (2)	153	2,240 (2)	153	2,240 (2)	153
SVCW	856 (0.8)	96	1,230 (1)	138	1,310 (1)	147	1,540 (1)	172	1,550 (1)	173	1,550 (1)	173
South SF	--	--	--	--	--	--	--	--	--	--	--	--
Sunnyvale	443 (0.4)	33	--	--	--	--	--	--	--	--	--	--
Treasure Island	--	--	--	--	301 (0.3)	8	301 (0.3)	8	301 (0.3)	8	301 (0.3)	8
USD	--	--	--	--	--	--	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--	--	--	--	--	--	--
West County	3,920 (3)	93	7,950 (7)	189	7,950 (7)	189	7,950 (7)	189	7,950 (7)	189	7,950 (7)	189
Total [b]	43,200 (39)	2,420	50,700 (45)	2,730	54,600 (49)	2,940	57,400 (51)	3,060	59,500 (53)	3,170	62,600 (56)	3,340

a. The volumes in AF might vary from the values in the individual plant reports due to rounding (refer to Appendix B).
b. The total values might vary from the sum of the listed values by plant due to rounding.

Table 3-3. Confidence Level 1: Summary of Dry Season Recycled Water Volumes, Loads, Costs, and Unit Costs (Averaged over 25 Years)

POTW	Average Values over 25 Years (2020–2045)					
	Volume [a]	Flow [a]	TIN Load Diverted [a]	NPV Total [b,c]	Unit Flow Cost [d]	Unit TIN Load Cost [e]
	AFY	mgd	kg N/d	$ Mil	$/gpd	$/lb TIN Diverted
American Canyon	199	0.4	9	10	23	122
Benicia	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--
Central San	920	2.0	209	4.0	2.0	2.3
CMSA	20	<0.1	6	1.0	24	19
Delta Diablo	2,080	4.4	56	37	8.3	78
DSRSD	1,900	4.1	434	2.8	0.7	0.8
EBMUD	115	0.2	51	--	--	--
FSSD	834	1.8	165	1.0	0.6	0.7
Hayward	797	1.7	206	5.1	3.0	2.9
Las Gallinas	764	1.6	85	1.1	0.7	1.6
Livermore	990	2.1	347	8.4	4.0	2.9
Millbrae	--	--	--	--	--	--
Mt. View	455	1.0	68	0.2	0.2	0.3
Napa	3,080	6.6	228	14	2.1	7.1
Novato	705	1.5	67	13	8.6	23
OLSD	--	--	--	--	--	--
Palo Alto	1,160	2.5	131	46	19	42
Petaluma	1,170	2.5	10	59	24	739
Pinole	--	--	--	--	--	--
Richmond	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--
SFO Airport	<1	<0.1	<1	7.4	49,800	33,500
SFPUC Southeast	--	--	--	--	--	--
San Jose	11,100	24	1,340	325	14	29
San Mateo	--	--	--	--	--	--
SMCSD	--	--	--	--	--	--
San Leandro	233	0.5	71	3.6	7.2	6.0
SASM	31	0.1	7	0.6	8.7	10
Sonoma Valley	1,070	2.3	174	0.9	0.4	0.6
SVCW	1,060	2.3	303	6.1	2.7	2.4
South SF	--	--	--	--	--	--
Sunnyvale	163	0.3	21	3.4	9.7	19
Treasure Island	117	0.2	8	282	1,130	4,400
USD	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--
West County	2,630	5.6	149	2.3	0.4	1.9
Total [f]	31,600	67	4,120	830	12	24

a. Flows and loads diverted from the SF Bay discharge are projected forward to the midpoint over 25 years.
b. Estimated cost for RW production based on year 2021 dollars.
c. NPV is calculated based on a 2% discount rate over 25 years.
d. Unit flow cost is based on the NPV total divided by the listed average flow diverted from SF Bay.
e. Based on the average TIN load diverted from SF Bay over 25 years (e.g., daily average listed load × number of days for averaging period × unit conversion [kg to lb] × duration as years).
f. The total values might vary from the sum of the listed values by plant due to rounding.

Table 3-4. Confidence Level 1: Summary of Annual Average Recycled Water Volumes, Loads, Costs, and Unit Costs (Averaged over 25 Years)

POTW	Average Values over 25 Years (2020–2045)					
	Volume [a]	Flow [a]	TIN Load Diverted [a]	NPV Total [b,c]	Unit Flow Cost [d]	Unit TIN Load Cost [e]
	AFY	mgd	kg N/d	$ Mil	$/gpd	$/lb TIN Diverted
American Canyon	313	0.3	6	15	54	125
Benicia	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--
Central San	1600	1.4	141	6.9	4.8	2.4
CMSA	24	<0.1	2	1.2	57	30
Delta Diablo	4,780	4.3	39	84	20	108
DSRSD	4,120	3.7	409	6.1	1.6	0.7
EBMUD	177	0.2	27	--	--	--
FSSD	1,030	0.9	73	1.2	1.3	0.8
Hayward	1,280	1.1	135	8.7	7.6	3.2
Las Gallinas	975	0.9	54	1.4	1.6	1.3
Livermore	1,750	1.6	236	15	9.5	3.1
Millbrae	--	--	--	--	--	--
Mt. View	1,230	1.1	76	0.5	0.4	0.3
Napa	3,380	3.0	105	15	5.0	7.1
Novato	837	0.7	30	15	20	25
OLSD	--	--	--	--	--	--
Palo Alto	1,680	1.5	78	48	32	30
Petaluma	1,450	1.3	5	73	57	740
Pinole	--	--	--	--	--	--
Richmond	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--
SFO Airport	<1	<0.1	<1	11	118,600	45,500
SFPUC Southeast	--	--	--	--	--	--
San Jose	18,600	17	991	368	22	18
San Mateo	--	--	--	--	--	--
SMCSD	--	--	--	--	--	--
San Leandro	292	0.3	33	4.5	17	6.8
SASM	38	0.0	2	0.7	21	15
Sonoma Valley	2,230	2.0	152	2.1	1.1	0.7
SVCW	1,340	1.2	150	7.8	6.5	2.6
South SF	--	--	--	--	--	--
Sunnyvale	266	0.2	20	5.5	23	14
Treasure Island	181	0.2	5	314	1,940	3,160
USD	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--
West County	6,610	5.9	157	5.9	1.0	1.9
Total [f]	54,200	48	2,900	1,010	21	17

a. Flows and loads diverted from the SF Bay discharge are projected forward to the midpoint over 25 years.
b. Estimated cost for RW production based on year 2021 dollars.
c. NPV is calculated based on a 2% discount rate over 25 years.
d. Unit flow cost is based on the NPV total divided by the listed average flow diverted from SF Bay.
e. Based on the average TIN load diverted from SF Bay over 25 years (e.g., daily average listed load × number of days for averaging period × unit conversion [kg to lb] × duration as years).
f. The total values might vary from the sum of the listed values by plant due to rounding.

3.1.2 Confidence Level 2 (Projects That Are in an Adopted Master Plan or Capital Improvement Plan)

A plot of the Confidence Level 2 RW volumes and corresponding TIN loads diverted from SF Bay is provided in Figure 3-2. The plot considers both dry season (May 1 through September 30) and average annual values. The projections suggest that RW projects begin in 2025 with a large increase through 2035, followed by marginal increases thereafter through 2045. Similar to Confidence Level 1, the dry season represents approximately 60 percent of the average annual values. The volumes associated with reuse would increase to upwards of 5,600 AF during the dry season (12 mgd over 153 days) and 9,400 AF for average annual (8 mgd) if all of the projects were implemented. The TIN load reductions would increase in a linear fashion with recycled water volumes/flows.

A breakdown by POTW of the **projected** volume, flow, and TIN load diversion from SF Bay Dischargers via recycled water is provided in Table 3-5 (dry season) and Table 3-6 (average annual). A breakdown by POTW for the **average** values from years 2020 through 2045 is provided in Table 3-7 (dry season) and Table 3-8 (average annual). Information from the average values is used to quantify the unit cost metrics.

Of the 37 POTWs evaluated, the number of POTWs with Confidence Level 2 projects is 5 compared to 23 associated with Confidence Level 1.

The largest RW programs for Confidence Level 2 projects are Petaluma and Novato (make up 85+ percent of the total; regardless of season). Petaluma's primary planned RW customers are landscape and agricultural irrigation. Novato has a unique planned reuse project that entails environmental enhancement for reuse. While Petaluma's entire TIN load associated with their reuse streams will be diverted from SF Bay, only a portion of Novato's TIN load associated with reuse will be diverted from SF Bay.

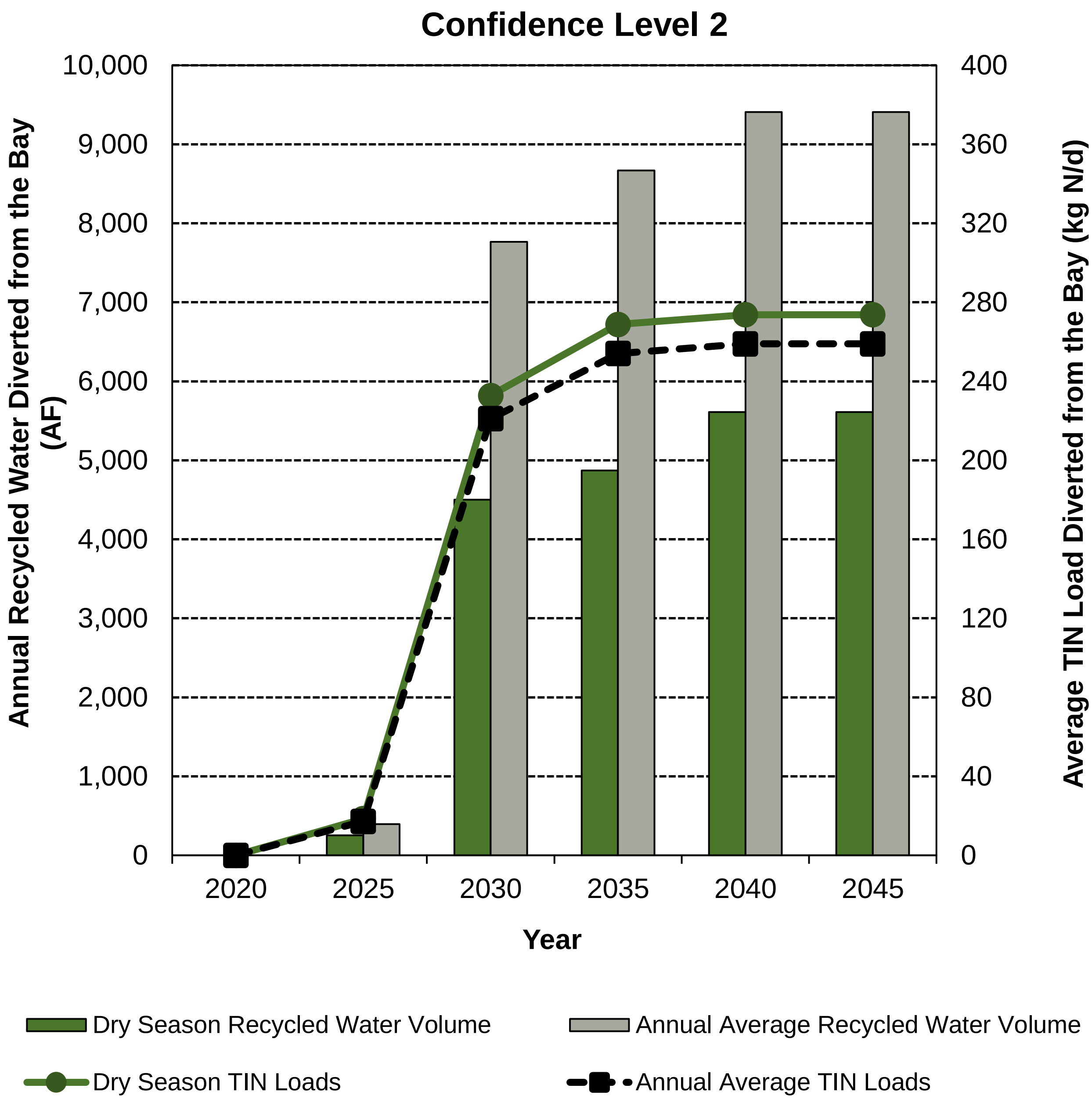

Figure 3-2. Confidence Level 2: Summary of Existing and Proposed Annual Recycled Water Flows and Nutrient Load Diversions from SF Bay Dischargers

Note: The Dry Season is May 1 through September 30 (153 days).

Table 3-5. Confidence Level 2: Projected Dry Season Recycled Water Volumes/Flows and the Corresponding Nutrient Load Reductions

POTW	Year 2020		Year 2025		Year 2030		Year 2035		Year 2040		Year 2045	
	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN, Load Diverted kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d
American Canyon	--	--	215 (0.5)	5	215 (0.5)	5	215 (0.5)	5	215 (0.5)	5	215 (0.5)	5
Benicia	--	--	--	--	--	--	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--	--	--	--	--	--	--
Central San	--	--	--	--	--	--	--	--	--	--	--	--
CMSA	--	--	--	--	--	--	--	--	--	--	--	--
Delta Diablo	--	--	--	--	--	--	--	--	--	--	--	--
DSRSD	--	--	--	--	--	--	--	--	--	--	--	--
EBMUD	--	--	--	--	--	--	--	--	--	--	--	--
FSSD	--	--	--	--	--	--	--	--	--	--	--	--
Hayward	--	--	--	--	--	--	--	--	--	--	--	--
Las Gallinas	--	--	--	--	--	--	--	--	--	--	--	--
Livermore	--	--	--	--	--	--	--	--	--	--	--	--
Millbrae	--	--	--	--	--	--	--	--	--	--	--	--
Mt. View	--	--	--	--	--	--	--	--	--	--	--	--
Napa	--	--	--	--	--	--	--	--	--	--	--	--
Novato	--	--	--	--	1,880 (4)	179	2,250 (5)	215	2,250 (5)	215	2,250 (5)	215
OLSD	--	--	--	--	--	--	--	--	--	--	--	--
Palo Alto	--	--	--	--	--	--	--	--	--	--	--	--
Petaluma	--	--	--	--	2,197 (5)	15	2,197 (5)	15	2,938 (6)	20	2,938 (6)	20
Pinole	--	--	--	--	--	--	--	--	--	--	--	--
Richmond	--	--	--	--	--	--	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--	--	--	--	--	--	--
SFO Airport	--	--	38 (<0.1)	14	38 (<0.1)	14	38 (<0.1)	14	38 (<0.1)	14	38 (<0.1)	14
SFPUC Southeast	--	--	--	--	--	--	--	--	--	--	--	--
San Jose	--	--	--	--	--	--	--	--	--	--	--	--
San Mateo	--	--	--	--	--	--	--	--	--	--	--	--
SMCSD	--	--	--	--	--	--	--	--	--	--	--	--
San Leandro	--	--	--	--	--	--	--	--	--	--	--	--
SASM	--	--	--	--	--	--	--	--	--	--	--	--
Sonoma Valley	--	--	--	--	--	--	--	--	--	--	--	--
SVCW	--	--	--	--	--	--	--	--	--	--	--	--
South SF	--	--	--	--	172 (0.4)	21	172 (0.4)	21	172 (0.4)	21	172 (0.4)	21
Sunnyvale	--	--	--	--	--	--	--	--	--	--	--	--
Treasure Island	--	--	--	--	--	--	--	--	--	--	--	--
USD	--	--	--	--	--	--	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--	--	--	--	--	--	--
West County	--	--	--	--	--	--	--	--	--	--	--	--
Total [b]	--	--	250 (0.5)	20	4,500 (10)	230	4,900 (10)	270	5,600 (12)	270	5,600 (12)	270

a. The volumes in AF might vary from the values in the individual plant reports due to rounding (refer to Appendix B).
b. The total values might vary from the sum of the listed values by plant due to rounding.

Table 3-6. Confidence Level 2: Projected Average Annual Recycled Water Volumes/Flows and the Corresponding Nutrient Load Reductions

POTW	Year 2020		Year 2025		Year 2030		Year 2035		Year 2040		Year 2045	
	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN, Load Diverted kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d
American Canyon	--	--	306 (0.3)	7	306 (0.3)	7	306 (0.3)	7	306 (0.3)	7	306 (0.3)	7
Benicia	--	--	--	--	--	--	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--	--	--	--	--	--	--
Central San	--	--	--	--	--	--	--	--	--	--	--	--
CMSA	--	--	--	--	--	--	--	--	--	--	--	--
Delta Diablo	--	--	--	--	--	--	--	--	--	--	--	--
DSRSD	--	--	--	--	--	--	--	--	--	--	--	--
EBMUD	--	--	--	--	--	--	--	--	--	--	--	--
FSSD	--	--	--	--	--	--	--	--	--	--	--	--
Hayward	--	--	--	--	--	--	--	--	--	--	--	--
Las Gallinas	--	--	--	--	--	--	--	--	--	--	--	--
Livermore	--	--	--	--	--	--	--	--	--	--	--	--
Millbrae	--	--	--	--	--	--	--	--	--	--	--	--
Mt. View	--	--	--	--	--	--	--	--	--	--	--	--
Napa	--	--	--	--	--	--	--	--	--	--	--	--
Novato	--	--	--	--	4,500 (4)	164	5,400 (5)	197	5,400 (5)	197	5,400 (5)	197
OLSD	--	--	--	--	--	--	--	--	--	--	--	--
Palo Alto	--	--	--	--	--	--	--	--	--	--	--	--
Petaluma	--	--	--	--	2,197 (2)	15	2,197 (2)	15	2,938 (3)	20	2,938 (3)	20
Pinole	--	--	--	--	--	--	--	--	--	--	--	--
Richmond	--	--	--	--	--	--	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--	--	--	--	--	--	--
SFO Airport	--	--	90 (<0.1)	11	90 (<0.1)	11	90 (<0.1)	11	90 (<0.1)	11	90 (<0.1)	11
SFPUC Southeast	--	--	--	--	--	--	--	--	--	--	--	--
San Jose	--	--	--	--	--	--	--	--	--	--	--	--
San Mateo	--	--	--	--	--	--	--	--	--	--	--	--
SMCSD	--	--	--	--	--	--	--	--	--	--	--	--
San Leandro	--	--	--	--	--	--	--	--	--	--	--	--
SASM	--	--	--	--	--	--	--	--	--	--	--	--
Sonoma Valley	--	--	--	--	--	--	--	--	--	--	--	--
SVCW	--	--	--	--	--	--	--	--	--	--	--	--
South SF	--	--	--	--	674 (0.6)	25	674 (0.6)	25	674 (0.6)	25	674 (0.6)	25
Sunnyvale	--	--	--	--	--	--	--	--	--	--	--	--
Treasure Island	--	--	--	--	--	--	--	--	--	--	--	--
USD	--	--	--	--	--	--	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--	--	--	--	--	--	--
West County	--	--	--	--	--	--	--	--	--	--	--	--
Total [b]	--	--	400 (0.4)	20	7,800 (7)	220	8,700 (8)	250	9,400 (8)	260	9,400 (8)	260

a. The volumes in AF might vary from the values in the individual plant reports due to rounding (refer to Appendix B).
b. The total values might vary from the sum of the listed values by plant due to rounding.

Table 3-7. Confidence Level 2: Summary of Dry Season Recycled Water Volumes, Loads, Costs, and Unit Costs (Averaged over 25 Years)

POTW	Average Values over 25 Years (2020–2045)					
	Volume [a]	Flow [a]	TIN Load Diverted [a]	NPV Total [b,c]	Unit Flow Cost [d]	Unit TIN Load Cost [e]
	AFY	mgd	kg N/d	$ Mil	$/gpd	$/lb TIN Diverted
American Canyon	172	0.4	9	17	45	213
Benicia	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--
Central San	--	--	--	--	--	--
CMSA	--	--	--	--	--	--
Delta Diablo	--	--	--	--	--	--
DSRSD	--	--	--	--	--	--
EBMUD	--	--	--	--	--	--
FSSD	--	--	--	--	--	--
Hayward	--	--	--	--	--	--
Las Gallinas	--	--	--	--	--	--
Livermore	--	--	--	--	--	--
Millbrae	--	--	--	--	--	--
Mt. View	--	--	--	--	--	--
Napa	--	--	--	--	--	--
Novato	1,300	2.8	124	11	4.0	11
OLSD	--	--	--	--	--	--
Palo Alto	--	--	--	--	--	--
Petaluma	1,590	3.4	11	271	80	3,040
Pinole	--	--	--	--	--	--
Richmond	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--
SFO Airport	30	0.1	5	103	1,600	2,680
SFPUC Southeast	--	--	--	--	--	--
San Jose	--	--	--	--	--	--
San Mateo	--	--	--	--	--	--
SMCSD	--	--	--	--	--	--
San Leandro	--	--	--	--	--	--
SASM	--	--	--	--	--	--
Sonoma Valley	--	--	--	--	--	--
SVCW	--	--	--	--	--	--
South SF [f]	220	0.5	63	--	--	--
Sunnyvale	--	--	--	--	--	--
Treasure Island	--	--	--	--	--	--
USD	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--
West County	--	--	--	--	--	--
					--	--
Total [g]	3,300	7	210	400	57	230

a. Flows and loads diverted from the SF Bay discharge are projected forward to the midpoint over 25 years.
b. Estimated cost for RW production based on year 2021 dollars.
c. NPV is calculated based on a 2% discount rate over 25 years.
d. Unit flow cost is based on the NPV total divided by the listed average flow diverted from SF Bay.
e. Based on the average TIN load diverted from SF Bay over 25 years (e.g., daily average listed load × number of days for averaging period × unit conversion [kg to lb] × duration as years).
f. South SF does not have any costs as the proposed project would be funded by a private company.
g. The total values might vary from the sum of the listed values by plant due to rounding.

Table 3-8. Confidence Level 2: Summary of Annual Average Recycled Water Volumes, Loads, Costs, and Unit Costs (Averaged over 25 Years)

POTW	Average Values over 25 Years (2020–2045)					
	Volume [a]	Flow [a]	TIN Load Diverted [a]	NPV Total [b,c]	Unit Flow Cost [d]	Unit TIN Load Cost [e]
	AFY	Mgd	kg N/d	$ Mil	$/gpd	$/lb TIN Diverted
American Canyon	204	0.2	4	18	99	202
Benicia	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--
Central San	--	--	--	--	--	--
CMSA	--	--	--	--	--	--
Delta Diablo	--	--	--	--	--	--
DSRSD	--	--	--	--	--	--
EBMUD	--	--	--	--	--	--
FSSD	--	--	--	--	--	--
Hayward	--	--	--	--	--	--
Las Gallinas	--	--	--	--	--	--
Livermore	--	--	--	--	--	--
Millbrae	--	--	--	--	--	--
Mt. View	--	--	--	--	--	--
Napa	--	--	--	--	--	--
Novato	3,110	2.8	113	24	8.5	10
OLSD	--	--	--	--	--	--
Palo Alto	--	--	--	--	--	--
Petaluma	1,850	1.6	5	313	190	3,010
Pinole	--	--	--	--	--	--
Richmond	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--
SFO Airport	72	0.1	3	108	1,670	1,600
SFPUC Southeast	--	--	--	--	--	--
San Jose	--	--	--	--	--	--
San Mateo	--	--	--	--	--	--
SMCSD	--	--	--	--	--	--
San Leandro	--	--	--	--	--	--
SASM	--	--	--	--	--	--
Sonoma Valley	--	--	--	--	--	--
SVCW	--	--	--	--	--	--
South SF [f]	404	0.4	50	--	--	--
Sunnyvale	--	--	--	--	--	--
Treasure Island	--	--	--	--	--	--
USD	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--
West County	--	--	--	--	--	--
Total [g]	5,630	5	180	463	92	131

a. Flows and loads diverted from the SF Bay discharge are projected forward to the midpoint over 25 years.
b. Estimated cost for RW production based on year 2021 dollars.
c. NPV is calculated based on a 2% discount rate over 25 years.
d. Unit flow cost is based on the NPV total divided by the listed average flow diverted from SF Bay.
e. Based on the average TIN load diverted from SF Bay over 25 years (e.g., daily average listed load × number of days for averaging period × unit conversion [kg to lb] × duration as years).
f. South SF does not have any costs as the proposed project would be funded by a private company.
g. The total values might vary from the sum of the listed values by plant due to rounding.

3.1.3 Confidence Level 3 (Projects That Are Conceptual or Not in an Adopted Document)

A plot of the Confidence Level 3 RW volumes and corresponding TIN loads diverted from SF Bay is provided in Figure 3-3. The plot considers both dry season (May 1 through September 30) and average annual values. The projections suggest that RW projects will begin in year 2025, followed by a large increase to year 2030 and a steady increase thereafter through year 2045. The distribution between the dry season and average annual is more even (approximately 45 percent) compared to Confidence Levels 1 and 2 (both at approximately 60 percent). The dry season volumes associated with reuse have the potential to increase from 0 AFY (0 mgd) in year 2020 to 18,300 AFY (average 39 mgd over 153 days) in year 2045. The average annual volumes associated with reuse have the potential to increase from 0 AFY (0 mgd) in year 2020 to 39,600 AFY (average 36 mgd over 365 days) in year 2045.

The TIN load reductions increase in a similar fashion with recycled water volumes/flows through year 2035, after which the additional TIN load reductions are modest compared to additional RW volumes/flows. The modest increase in TIN load reductions after year 2035 is attributed to a few potable reuse projects that include RO. As previously noted in Section 2.6, potable reuse projects will only have modest nutrient load reductions as most of the nutrient loads will end up in SF Bay via the RO concentrate return flows (assumed 84 percent of the advanced treatment feed load unless provided otherwise). Additional nutrient removal could be achieved via treatment of RO concentrate, although this was not included in the load reduction estimates or cost estimates.

A breakdown by POTW of the **projected** volume, flow, and TIN load diversion from SF Bay Dischargers via recycled water is provided in Table 3-9 (dry season) and Table 3-10 (average annual). A breakdown by POTW for the **average** values from years 2020 through 2045 is provided in Table 3-11 (dry season) and Table 3-12 (average annual). Information from the average values is used to quantify the unit cost metrics.

Of the 37 POTWs evaluated, the number of POTWs with Confidence Level 3 projects is 10 compared to 23 and 5 associated with Confidence Levels 1 and 2, respectively.

The largest listed RW program (regardless of season) is Palo Alto, making up 20 to 30 percent of the total, followed by San Mateo and Silicon Valley Clean Water. All three potential projects are potable reuse projects that would entail advanced treatment with modest TIN load reductions compared to volumes/flows for the previously stated reasons.

Both Palo and San Mateo are in construction with plans to enhance ammonia and TIN load reductions. In contrast, Silicon Valley Clean Water is planning for plant upgrades prior to implementing the listed Confidence Level 3 project. The potential nutrient load reductions for all three projects are based on the anticipated ammonia, TIN, and TP effluent levels associated with current and anticipated upgrades at each POTW. For example, the anticipated TIN effluent concentrations for all three projects is 15 mg N/L. This analysis assumes that Silicon Valley Clean Water would implement plant upgrades to remove ammonia and TIN loads prior to any advanced treatment reuse projects. Note: this analysis excludes costs for such plant upgrades.

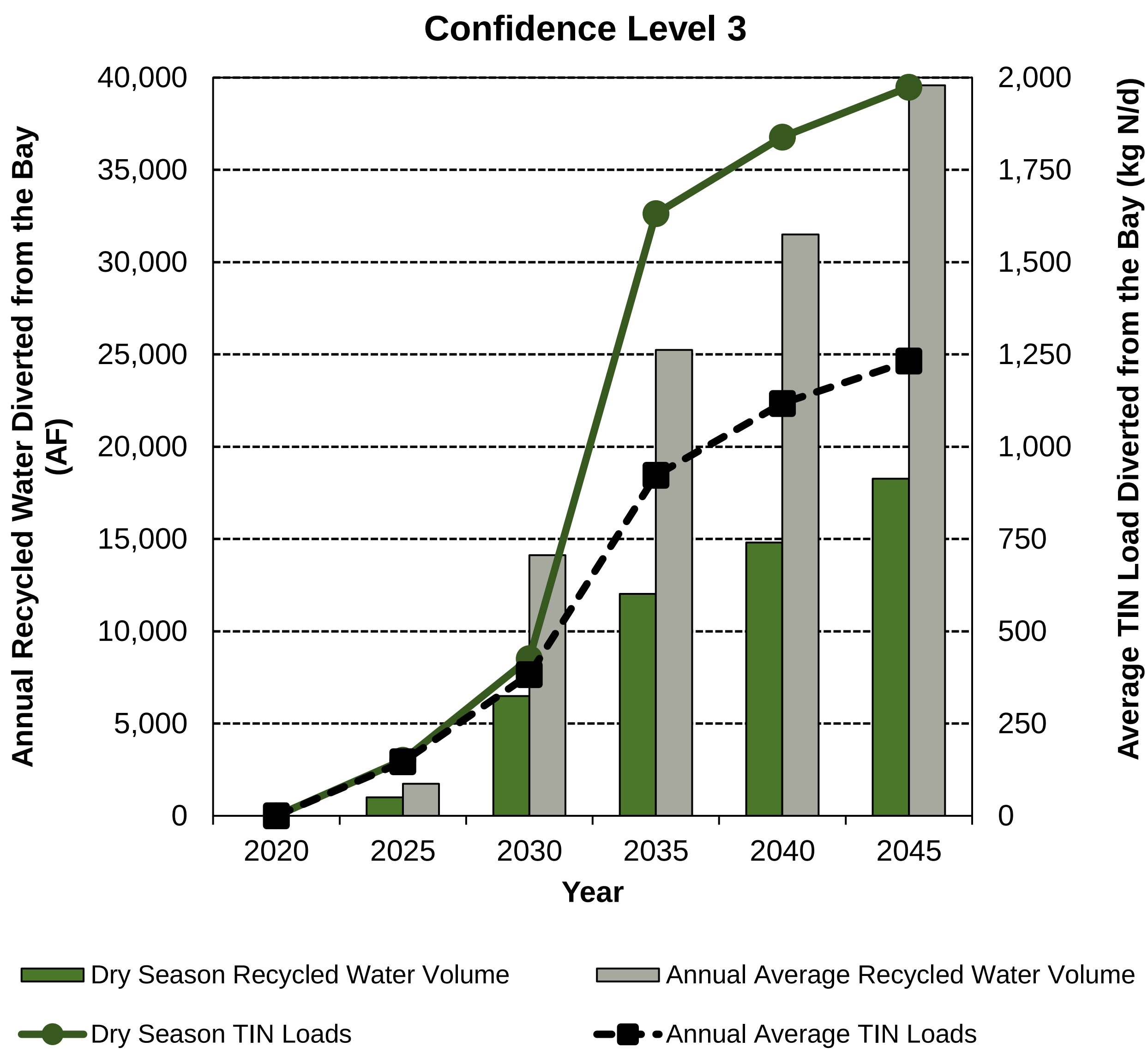

Figure 3-3. Confidence Level 3: Summary of Existing and Proposed Annual Recycled Water Flows and Nutrient Load Diversions from SF Bay Dischargers

Note: The Dry Season is May 1 through September 30 (153 days).

Table 3-9. Confidence Level 3: Projected Dry Season Recycled Water Volumes/Flows and the Corresponding Nutrient Load Reductions

POTW	Year 2020		Year 2025		Year 2030		Year 2035		Year 2040		Year 2045	
	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN, Load Diverted kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d
American Canyon	--	--	--	--	--	--	424 (0.9)	10	424 (0.9)	10	424 (0.9)	10
Benicia	--	--	--	--	--	--	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--	--	--	--	--	--	--
Central San	--	--	210 (0.5)	49	380 (0.8)	88	650 (1)	150	980 (2)	225	1,240 (3)	285
CMSA	--	--	--	--	--	--	--	--	--	--	--	--
Delta Diablo	--	--	--	--	--	--	--	--	--	--	--	--
DSRSD	--	--	--	--	--	--	--	--	--	--	--	--
EBMUD	--	--	--	--	--	--	1,670 (4)	747	1,670 (4)	747	1,670 (4)	747
FSSD	--	--	--	--	--	--	--	--	--	--	--	--
Hayward	--	--	--	--	--	--	--	--	--	--	--	--
Las Gallinas	--	--	--	--	--	--	--	--	--	--	--	--
Livermore	--	--	--	--	--	--	--	--	--	--	--	--
Millbrae	--	--	--	--	--	--	--	--	--	--	--	--
Mt. View	--	--	--	--	--	--	--	--	--	--	--	--
Napa	--	--	--	--	--	--	--	--	--	--	200 (0.4)	3
Novato	--	--	--	--	--	--	--	--	--	--	--	--
OLSD	--	--	--	--	--	--	--	--	2,280 (5)	112	2,280 (5)	112
Palo Alto	--	--	--	--	4,670 (10)	158	4,670 (10)	158	4,670 (10)	158	4,670 (10)	158
Petaluma	--	--	--	--	--	--	--	--	--	--	--	--
Pinole	--	--	--	--	--	--	--	--	--	--	--	--
Richmond	--	--	--	--	--	--	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--	--	--	--	--	--	--
SFO Airport	--	--	--	--	--	--	--	--	--	--	--	--
SFPUC Southeast	--	--	--	--	--	--	--	--	--	--	--	--
San Jose	--	--	--	--	--	--	--	--	--	--	--	--
San Mateo	--	--	--	--	451 (1)	55	477 (1)	58	648 (1)	78	3,638 (8)	151
SMCSD	--	--	--	--	--	--	--	--	--	--	--	--
San Leandro	--	--	--	--	--	--	--	--	--	--	--	--
SASM	--	--	--	--	--	--	--	--	--	--	--	--
Sonoma Valley	--	--	--	--	--	--	--	--	--	--	--	--
SVCW	--	--	--	--	--	--	2,990 (6)	361	2,990 (6)	361	2,990 (6)	361
South SF	--	--	117 (0.2)	14	117 (0.2)	14	117 (0.2)	14	117 (0.2)	14	117 (0.2)	14
Sunnyvale	--	--	675 (1)	87	861 (2)	111	1,030 (2)	134	1,030 (2)	134	1,030 (2)	134
Treasure Island	--	--	--	--	--	--	--	--	--	--	--	--
USD	--	--	--	--	--	--	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--	--	--	--	--	--	--
West County	--	--	--	--	--	--	--	--	--	--	--	--
Total [b]	--	--	1,000 (2)	150	6,500 (14)	430	12,000 (26)	1,630	14,800 (32)	1,840	18,300 (39)	1,970

a. The volumes in AF might vary from the values in the individual plant reports due to rounding (refer to Appendix B).
b. The total values might vary from the sum of the listed values by plant due to rounding.

Table 3-10. Confidence Level 3: Projected Average Annual Recycled Water Volumes/Flows and the Corresponding Nutrient Load Reductions

POTW	Year 2020		Year 2025		Year 2030		Year 2035		Year 2040		Year 2045	
	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN, Load Diverted kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d
American Canyon	--	--	--	--	--	--	616 (0.5)	13	616 (0.5)	13	616 (0.5)	13
Benicia	--	--	--	--	--	--	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--	--	--	--	--	--	--
Central San	--	--	350 (0.3)	31	640 (0.6)	56	1,080 (1)	96	1,630 (1)	144	2,060 (2)	183
CMSA	--	--	--	--	--	--	--	--	--	--	--	--
Delta Diablo	--	--	--	--	--	--	--	--	--	--	--	--
DSRSD	--	--	--	--	--	--	--	--	--	--	--	--
EBMUD	--	--	--	--	--	--	2,580 (2)	391	2,580 (2)	391	2,580 (2)	391
FSSD	--	--	--	--	--	--	--	--	--	--	--	--
Hayward	--	--	--	--	--	--	--	--	--	--	--	--
Las Gallinas	--	--	--	--	--	--	--	--	--	--	--	--
Livermore	--	--	--	--	--	--	--	--	--	--	--	--
Millbrae	--	--	--	--	--	--	--	--	--	--	--	--
Mt. View	--	--	--	--	--	--	--	--	--	--	--	--
Napa	--	--	--	--	--	--	--	--	--	--	480 (0.4)	3
Novato	--	--	--	--	--	--	--	--	--	--	--	--
OLSD	--	--	--	--	--	--	--	--	5,480 (5)	135	5,480 (5)	135
Palo Alto	--	--	--	--	11,200 (10)	159	11,200 (10)	159	11,200 (10)	159	11,200 (10)	159
Petaluma	--	--	--	--	--	--	--	--	--	--	--	--
Pinole	--	--	--	--	--	--	--	--	--	--	--	--
Richmond	--	--	--	--	--	--	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--	--	--	--	--	--	--
SFO Airport	--	--	--	--	--	--	--	--	--	--	--	--
SFPUC Southeast	--	--	--	--	--	--	--	--	--	--	--	--
San Jose	--	--	--	--	--	--	--	--	--	--	--	--
San Mateo	--	--	--	--	602 (0.5)	31	635 (0.6)	32	865 (0.8)	44	8,035 (7)	117
SMCSD	--	--	--	--	--	--	--	--	--	--	--	--
San Leandro	--	--	--	--	--	--	--	--	--	--	--	--
SASM	--	--	--	--	--	--	--	--	--	--	--	--
Sonoma Valley	--	--	--	--	--	--	--	--	--	--	--	--
SVCW	--	--	--	--	--	--	7,170 (6)	73	7,170 (6)	73	7,170 (6)	73
South SF	--	--	280 (0.2)	34	280 (0.2)	34	280 (0.2)	34	280 (0.2)	34	280 (0.2)	34
Sunnyvale	--	--	1,100 (1)	81	1,400 (1)	103	1,680 (1)	124	1,680 (1)	124	1,680 (1)	124
Treasure Island	--	--	--	--	--	--	--	--	--	--	--	--
USD	--	--	--	--	--	--	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--	--	--	--	--	--	--
West County	--	--	--	--	--	--	--	--	--	--	--	--
Total [b]	--	--	1,700 (2)	150	14,100 (13)	380	25,200 (23)	920	31,500 (28)	1,120	39,600 (35)	1,230

a. The volumes in AF might vary from the values in the individual plant reports due to rounding (refer to Appendix B).
b. The total values might vary from the sum of the listed values by plant due to rounding.

Table 3-11. Confidence Level 3: Summary of Dry Season Recycled Water Volumes, Loads, Costs, and Unit Costs (Averaged over 25 Years)

POTW	Average Values over 25 Years (2020–2045)					
	Volume [a]	Flow [a]	TIN Load Diverted [a]	NPV Total [b,c]	Unit Flow Cost [d]	Unit TIN Load Cost [e]
	AFY	mgd	kg N/d	$ Mil	$/gpd	$/lb TIN Diverted
American Canyon	170	0.4	9	21	59	276
Benicia	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--
Central San	553	1.2	127	73	62	68
CMSA	--	--	--	--	--	--
Delta Diablo	--	--	--	--	--	--
DSRSD	--	--	--	--	--	--
EBMUD [f]	668	1.4	299	--	--	--
FSSD	--	--	--	--	--	--
Hayward	--	--	--	--	--	--
Las Gallinas	--	--	--	--	--	--
Livermore	--	--	--	--	--	--
Millbrae	--	--	--	--	--	--
Mt. View	--	--	--	--	--	--
Napa	40	0.1	<1	6.0	70	1200
Novato	--	--	--	--	--	--
OLSD	608	1.3	30	347	267	1,380
Palo Alto	3,180	6.8	107	1080	160	1,200
Petaluma	--	--	--	--	--	--
Pinole	--	--	--	--	--	--
Richmond	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--
SFO Airport	--	--	--	--	--	--
SFPUC Southeast	--	--	--	--	--	--
San Jose	--	--	--	--	--	--
San Mateo	932	2.0	55	239	121	518
SMCSD	--	--	--	--	--	--
San Leandro	--	--	--	--	--	--
SASM	--	--	--	--	--	--
Sonoma Valley	--	--	--	--	--	--
SVCW	1,200	2.5	144	494	194	406
South SF	94	0.2	27	--	--	--
Sunnyvale	654	1.4	85	3.4	2.4	5
Treasure Island	--	--	--	--	--	--
USD	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--
West County	--	--	--	--	--	--
Total [g]	8,090	17	880	2,260	131	304

a. Flows and loads diverted from the SF Bay discharge are projected forward to the midpoint over 25 years.
b. Estimated cost for RW production based on year 2021 dollars.
c. NPV is calculated based on a 2% discount rate over 25 years.
d. Unit flow cost is based on the NPV total divided by the listed average flow diverted from SF Bay.
e. Based on the average TIN load diverted from SF Bay over 25 years (e.g., daily average listed load × number of days for averaging period × unit conversion [kg to lb] × duration as years).
f. EBMUD does not have any costs as the advanced treatment facilities have not been evaluated.
g. The total values might vary from the sum of the listed values by plant due to rounding.

Table 3-12. Confidence Level 3: Summary of Annual Average Recycled Water Volumes, Loads, Costs, and Unit Costs (Averaged over 25 Years)

POTW	Average Values over 25 Years (2020–2045)					
	Volume [a]	Flow [a]	TIN Load Diverted [a]	NPV Total [b,c]	Unit Flow Cost [d]	Unit TIN Load Cost [e]
	AFY	mgd	kg N/d	$ Mil	$/gpd	$/lb TIN Diverted
American Canyon	246	0.2	5	25	114	231
Benicia	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--
Central San	920	0.8	82	75	91	46
CMSA	--	--	--	--	--	--
Delta Diablo	--	--	--	--	--	--
DSRSD	--	--	--	--	--	--
EBMUD [f]	1,030	0.9	156	--	--	--
FSSD	--	--	--	--	--	--
Hayward	--	--	--	--	--	--
Las Gallinas	--	--	--	--	--	--
Livermore	--	--	--	--	--	--
Millbrae	--	--	--	--	--	--
Mt. View	--	--	--	--	--	--
Napa	96	0.1	<1	7.4	86	613
Novato	--	--	--	--	--	--
OLSD	730	0.7	18	371	569	1,030
Palo Alto	7,620	6.8	108	1,470	216	677
Petaluma	--	--	--	--	--	--
Pinole	--	--	--	--	--	--
Richmond	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--
SFO Airport	--	--	--	--	--	--
SFPUC Southeast	--	--	--	--	--	--
San Jose	--	--	--	--	--	--
San Mateo	1,880	1.7	37	296	176	397
SMCSD	--	--		--	--	--
San Leandro	--	--	--	--	--	--
SASM	--	--	--	--	--	--
Sonoma Valley	--	--	--	--	--	--
SVCW	2,870	2.6	145	555	217	190
South SF	224	0.2	27	--	--	--
Sunnyvale	1,060	1.0	78	5.5	5.8	3.5
Treasure Island	--	--	--	--	--	--
USD	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--
West County	--	--	--	--	--	--
Total [g]	16,680	15	660	2,800	188	212

a. Flows and loads diverted from the SF Bay discharge are projected forward to the midpoint over 25 years.
b. Estimated cost for RW production based on year 2021 dollars.
c. NPV is calculated based on a 2% discount rate over 25 years.
d. Unit flow cost is based on the NPV total divided by the listed average flow diverted from SF Bay.
e. Based on the average TIN load diverted from SF Bay over 25 years (e.g., daily average listed load × number of days for averaging period × unit conversion [kg to lb] × duration as years).
f. EBMUD does not have any costs as the advanced treatment facilities have not been evaluated.
g. The total values might vary from the sum of the listed values by plant due to rounding.

3.1.4 Confidence Level 4 (Projects That Are Conceptual in Nature and Require Agreements across Multiple Jurisdictions)

As previously noted, the Confidence Level 4 projects represent those that are conceptual in nature and require agreements across multiple jurisdictions. Given the complexity, the Level 4 projects were not included with the individual plant reports (refer to Appendix B). A summary of the various Level 4 projects with a brief description is provided in Table 3-13.

Table 3-13. Confidence Level 4: Summary of Dry Season Recycled Water Volumes, Loads, Costs, and Unit Costs

POTW	Brief Description	Potential Product Water Volume	Potential Product Water Flow[a]	Potential Start Data
		AFY	mgd	Year
Central San	The Refinery Recycled Water Exchange Project is a regional recycled water project with Central San and Contra Costa Water District. The project would consist of Valley Water partnering with Central San to design, build and operate a recycled water facility to serve the Martinez refineries. [a]	14,600	13.0	2035
Central San	Potable reuse opportunity with EBMUD[b]	--	--	>2040
San Jose	Indirect or direct potable reuse opportunity in partnership with the local area water provider, Valley Water [c] or other regional water providers	14,000	12.5	>2040
Total	--	28,600	25.5	--

a https://purewater4u.org/recycled-water-projects/
b This project is still in its infancy stages with a feasibility evaluation currently beginning. As a result, no flow or load information is provided. https://www.centralsan.org/sites/main/files/file-attachments/recycled_water_townhall_presentations.pdf?1666997186
c https://www.valleywater.org/

Besides the potential projects listed in Table 3-13, there are other projects under consideration across the Bay. For example, SFPUC is leading an effort known as the Alternative Water Supply (AWS) Program that considers regional and local water supply, storage, and conveyance projects in their service area. There are numerous projects under consideration, such as the Crystal Springs Reservoir surface water augmentation projects listed by both SVCW and San Mateo (both listed under Confidence Level 3).

SFPUC provides quarterly reports that focus on three sections:

1) Program highlights and updates;
2) Status of projects; and
3) Program fundamentals

The June 2023 AWS Quarterly Report can be found here: SFPUC issued alternative water supply quarterly report provides context: https://sfpuc.org/sites/default/files/programs/AWS_Quarterly%20Report%20June%202023.pdf

A plot of the Confidence Level 4 RW volumes and the corresponding TIN loads diverted from SF Bay is provided in Figure 3-4. The plot considers both dry season (May 1 through September 30) and average annual values. The initial Confidence Level 4 project might be completed by year 2035, with the other listed project occurring after 2040. If both projects were implemented, the volumes by year 2045 would increase to approximately 12,000 AF during the dry season (26 mgd over 153 days) and 28,600 AF annually (26 mgd). Both projects would have constant year-round production.

It is anticipated that both listed projects included in Figure 3-4 would include advanced treatment facilities. As previously noted in Section 2.6, the nutrient reductions associated with advanced treatment facilities will only have modest nutrient load reductions as most of the nutrient loads will end up in SF Bay via the RO concentrate return flows. Additional nutrient removal could be achieved via treatment of RO concentrate, although this was not included in the load reduction estimates or cost estimates.

A breakdown by POTW of the **projected** volume, flow, and TIN load diversion from SF Bay Dischargers via recycled water is provided in Table 3-13 (dry season) and Table 3-14 (average annual). A breakdown by POTW for the **average** values from years 2020 through 2045 is provided in Table 3-16 (dry season) and Table 3-17 (average annual). Information from the average values is used to quantify the unit cost metrics.

While San Jose already removes TIN loads, Central San currently performs secondary treatment. This analysis assumes that Central San would implement plant upgrades to remove ammonia and TIN loads prior to any advanced treatment reuse projects. Note: this analysis excludes costs for such plant upgrades at Central San.

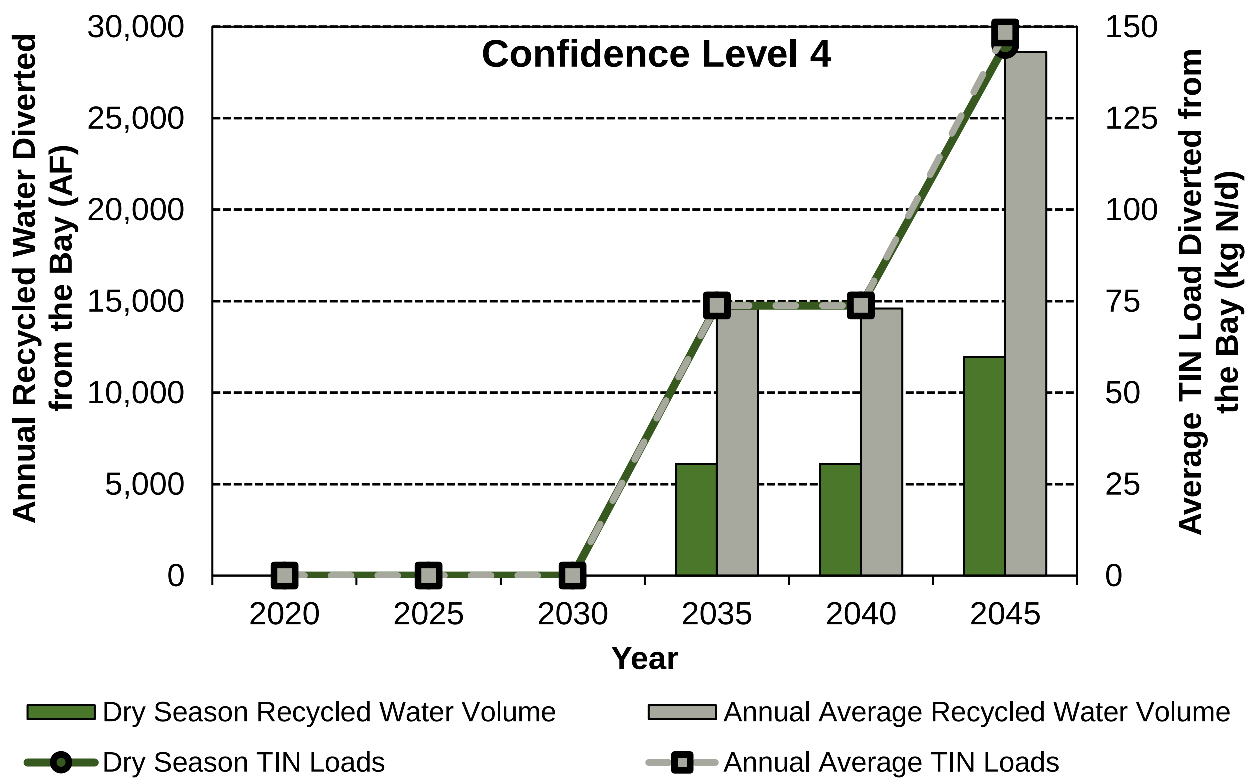

Figure 3-4. Confidence Level 4: Summary of Existing and Proposed Annual Recycled Water Flows and Nutrient Load Diversions from SF Bay Dischargers

Note: The Dry Season is May 1 through September 30 (153 days).

Table 3-14. Confidence Level 4: Projected Dry Season Recycled Water Volumes/Flows and the Corresponding Nutrient Load Reductions

POTW	Year 2020		Year 2025		Year 2030		Year 2035		Year 2040		Year 2045	
	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN, Load Diverted kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d
American Canyon	--	--	--	--	--	--	--	--	--	--	--	--
Benicia	--	--	--	--	--	--	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--	--	--	--	--	--	--
Central San	--	--	--	--	--	--	6,100 (13)	74	6,100 (13)	74	6,100 (13)	74
CMSA	--	--	--	--	--	--	--	--	--	--	--	--
Delta Diablo	--	--	--	--	--	--	--	--	--	--	--	--
DSRSD	--	--	--	--	--	--	--	--	--	--	--	--
EBMUD	--	--	--	--	--	--	--	--	--	--	--	--
FSSD	--	--	--	--	--	--	--	--	--	--	--	--
Hayward	--	--	--	--	--	--	--	--	--	--	--	--
Las Gallinas	--	--	--	--	--	--	--	--	--	--	--	--
Livermore	--	--	--	--	--	--	--	--	--	--	--	--
Millbrae	--	--	--	--	--	--	--	--	--	--	--	--
Mt. View	--	--	--	--	--	--	--	--	--	--	--	--
Napa	--	--	--	--	--	--	--	--	--	--	--	--
Novato	--	--	--	--	--	--	--	--	--	--	--	--
OLSD	--	--	--	--	--	--	--	--	--	--	--	--
Palo Alto	--	--	--	--	--	--	--	--	--	--	--	--
Petaluma	--	--	--	--	--	--	--	--	--	--	--	--
Pinole	--	--	--	--	--	--	--	--	--	--	--	--
Richmond	--	--	--	--	--	--	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--	--	--	--	--	--	--
SFO Airport	--	--	--	--	--	--	--	--	--	--	--	--
SFPUC Southeast	--	--	--	--	--	--	--	--	--	--	--	--
San Jose	--	--	--	--	--	--	--	--	--	--	5,900 (12)	71
San Mateo	--	--	--	--	--	--	--	--	--	--	--	--
SMCSD	--	--	--	--	--	--	--	--	--	--	--	--
San Leandro	--	--	--	--	--	--	--	--	--	--	--	--
SASM	--	--	--	--	--	--	--	--	--	--	--	--
Sonoma Valley	--	--	--	--	--	--	--	--	--	--	--	--
SVCW	--	--	--	--	--	--	--	--	--	--	--	--
South SF	--	--	--	--	--	--	--	--	--	--	--	--
Sunnyvale	--	--	--	--	--	--	--	--	--	--	--	--
Treasure Island	--	--	--	--	--	--	--	--	--	--	--	--
USD	--	--	--	--	--	--	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--	--	--	--	--	--	--
West County	--	--	--	--	--	--	--	--	--	--	--	--
Total [b]	--	--	--	--	--	--	6,100 (13)	70	6,100 (13)	70	12,000 (25)	150

a. The volumes in AF might vary from the values in the individual plant reports due to rounding (refer to Appendix B).
b. The total values might vary from the sum of the listed values by plant due to rounding.

Table 3-15. Confidence Level 4: Projected Average Annual Recycled Water Volumes/Flows and the Corresponding Nutrient Load Reductions

POTW	Year 2020		Year 2025		Year 2030		Year 2035		Year 2040		Year 2045	
	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN, Load Diverted kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d
American Canyon	--	--	--	--	--	--	--	--	--	--	--	--
Benicia	--	--	--	--	--	--	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--	--	--	--	--	--	--
Central San	--	--	--	--	--	--	14,600 (13)	74	14,600 (13)	74	14,600 (13)	74
CMSA	--	--	--	--	--	--	--	--	--	--	--	--
Delta Diablo	--	--	--	--	--	--	--	--	--	--	--	--
DSRSD	--	--	--	--	--	--	--	--	--	--	--	--
EBMUD	--	--	--	--	--	--	--	--	--	--	--	--
FSSD	--	--	--	--	--	--	--	--	--	--	--	--
Hayward	--	--	--	--	--	--	--	--	--	--	--	--
Las Gallinas	--	--	--	--	--	--	--	--	--	--	--	--
Livermore	--	--	--	--	--	--	--	--	--	--	--	--
Millbrae	--	--	--	--	--	--	--	--	--	--	--	--
Mt. View	--	--	--	--	--	--	--	--	--	--	--	--
Napa	--	--	--	--	--	--	--	--	--	--	--	--
Novato	--	--	--	--	--	--	--	--	--	--	--	--
OLSD	--	--	--	--	--	--	--	--	--	--	--	--
Palo Alto	--	--	--	--	--	--	--	--	--	--	--	--
Petaluma	--	--	--	--	--	--	--	--	--	--	--	--
Pinole	--	--	--	--	--	--	--	--	--	--	--	--
Richmond	--	--	--	--	--	--	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--	--	--	--	--	--	--
SFO Airport	--	--	--	--	--	--	--	--	--	--	--	--
SFPUC Southeast	--	--	--	--	--	--	--	--	--	--	--	--
San Jose	--	--	--	--	--	--	--	--	--	--	14,000 (12)	75
San Mateo	--	--	--	--	--	--	--	--	--	--	--	--
SMCSD	--	--	--	--	--	--	--	--	--	--	--	--
San Leandro	--	--	--	--	--	--	--	--	--	--	--	--
SASM	--	--	--	--	--	--	--	--	--	--	--	--
Sonoma Valley	--	--	--	--	--	--	--	--	--	--	--	--
SVCW	--	--	--	--	--	--	--	--	--	--	--	--
South SF	--	--	--	--	--	--	--	--	--	--	--	--
Sunnyvale	--	--	--	--	--	--	--	--	--	--	--	--
Treasure Island	--	--	--	--	--	--	--	--	--	--	--	--
USD	--	--	--	--	--	--	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--	--	--	--	--	--	--
West County	--	--	--	--	--	--	--	--	--	--	--	--
Total [b]	--	--	--	--	--	--	14,600 (13)	70	14,600 (13)	70	28,600 (26)	150

a. The volumes in AF might vary from the values in the individual plant reports due to rounding (refer to Appendix B).
b. The total values might vary from the sum of the listed values by plant due to rounding.

Table 3-16. Confidence Level 4: Summary of Dry Season Recycled Water Volumes, Loads, Costs, and Unit Costs (Averaged over 25 Years)

POTW	Average Values over 25 Years (2020–2045)					
	Volume [a]	Flow [a]	TIN Load Diverted [a]	NPV Total [b,c]	Unit Flow Cost [d]	Unit TIN Load Cost [e]
	AFY	mgd	kg N/d	$ Mil	$/gpd	$/lb TIN Diverted
American Canyon	--	--	--	--	--	--
Benicia	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--
Central San	2,440	5.2	30	729	140	2,935
CMSA	--	--	--	--	--	--
Delta Diablo	--	--	--	--	--	--
DSRSD	--	--	--	--	--	--
EBMUD	--	--	--	--	--	--
FSSD	--	--	--	--	--	--
Hayward	--	--	--	--	--	--
Las Gallinas	--	--	--	--	--	--
Livermore	--	--	--	--	--	--
Millbrae	--	--	--	--	--	--
Mt. View	--	--	--	--	--	--
Napa	--	--	--	--	--	--
Novato	--	--	--	--	--	--
OLSD	--	--	--	--	--	--
Palo Alto	--	--	--	--	--	--
Petaluma	--	--	--	--	--	--
Pinole	--	--	--	--	--	--
Richmond	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--
SFO Airport	--	--	--	--	--	--
SFPUC Southeast	--	--	--	--	--	--
San Jose	1,170	2.5	14	846	338	7,060
San Mateo	--	--	--	--	--	--
SMCSD	--	--	--	--	--	--
San Leandro	--	--	--	--	--	--
SASM	--	--	--	--	--	--
Sonoma Valley	--	--	--	--	--	--
SVCW	--	--	--	--	--	--
South SF	--	--	--	--	--	--
Sunnyvale	--	--	--	--	--	--
Treasure Island	--	--	--	--	--	--
USD	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--
West County	--	--	--	--	--	--
Total [f]	3,600	8	44	1,580	205	4,300

a. Flows and loads diverted from the SF Bay discharge are projected forward to the midpoint over 25 years.
b. Estimated cost for RW production based on year 2021 dollars.
c. NPV is calculated based on a 2% discount rate over 25 years.
d. Unit flow cost is based on the NPV total divided by the listed average flow diverted from SF Bay.
e. Based on the average TIN load diverted from SF Bay over 25 years (e.g., daily average listed load × number of days for averaging period × unit conversion [kg to lb] × duration as years).
f. The total values might vary from the sum of the listed values by plant due to rounding.

Table 3-17. Confidence Level 4: Summary of Annual Average Recycled Water Volumes, Loads, Costs, and Unit Costs (Averaged over 25 Years)

POTW	Average Values over 25 Years (2020–2045)					
	Volume [a]	Flow [a]	TIN Load Diverted [a]	NPV Total [b,c]	Unit Flow Cost [d]	Unit TIN Load Cost [e]
	AFY	mgd	kg N/d	$ Mil	$/gpd	$/lb TIN Diverted
American Canyon	--	--	--	--	--	--
Benicia	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--
Central San	5,840	5.2	30	978	188	1,650
CMSA	--	--	--	--	--	--
Delta Diablo	--	--	--	--	--	--
DSRSD	--	--	--	--	--	--
EBMUD	--	--	--	--	--	--
FSSD	--	--	--	--	--	--
Hayward	--	--	--	--	--	--
Las Gallinas	--	--	--	--	--	--
Livermore	--	--	--	--	--	--
Millbrae	--	--	--	--	--	--
Mt. View	--	--	--	--	--	--
Napa	--	--	--	--	--	--
Novato	--	--	--	--	--	--
OLSD	--	--	--	--	--	--
Palo Alto	--	--	--	--	--	--
Petaluma	--	--	--	--	--	--
Pinole	--	--	--	--	--	--
Richmond	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--
SFO Airport	--	--	--	--	--	--
SFPUC Southeast	--	--	--	--	--	--
San Jose	2,800	2.5	15	981	392	3,270
San Mateo	--	--	--	--	--	--
SMCSD	--	--	--	--	--	--
San Leandro	--	--	--	--	--	--
SASM	--	--	--	--	--	--
Sonoma Valley	--	--	--	--	--	--
SVCW	--	--	--	--	--	--
South SF	--	--	--	--	--	--
Sunnyvale	--	--	--	--	--	--
Treasure Island	--	--	--	--	--	--
USD	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--
West County	--	--	--	--	--	--
Total [f]	8,600	8	44	1,960	254	2,200

a. Flows and loads diverted from the SF Bay discharge are projected forward to the midpoint over 25 years.
b. Estimated cost for RW production based on year 2021 dollars.
c. NPV is calculated based on a 2% discount rate over 25 years.
d. Unit flow cost is based on the NPV total divided by the listed average flow diverted from SF Bay.
e. Based on the average TIN load diverted from SF Bay over 25 years (e.g., daily average listed load × number of days for averaging period × unit conversion [kg to lb] × duration as years).
f. The total values might vary from the sum of the listed values by plant due to rounding.

3.1.5 Overall (Confidence Levels 1 through 4)

A plot of the overall RW volumes and corresponding TIN loads diverted from SF Bay for all the confidence levels (1–4) is provided in Figure 3-5 (dry season) and Figure 3-6 (average annual). A breakdown by POTW is provided in Table 3-18 (dry season) and Table 3-19 (average annual).

The dry season constitutes the majority of the RW volumes and the corresponding nutrient load diversions from the SF Bay (approximately 55 to 60 percent of the average annual volumes). This was anticipated as several RW users are limited to the dry season (e.g., landscape irrigation).

Regardless of season, the RW volumes for Confidence Levels 1 through 3 are expected to more than double from year 2020 through 2045. The inclusion of Confidence Level 4 “conceptual” RW projects has the potential to more than triple RW volumes by year 2045. As previously stated, the presented RW volumes is limited to RW uses that translate to diversion of water from the Bay.

The NPV for Confidence Levels 1 ($0.8 to $1.0 Bil for dry season and average annual, respectively) and 2 ($0.5 to $0.5 Bil for dry season and average annual, respectively). The combined NPV for Confidence Levels 1 and 2 are approximately $1.2 to $1.5 Bil (for dry season and average annual, respectively). The incorporation of Confidence Level 3 projects essentially doubles the combined cost from both Confidence Levels 1 and 2 to Level 3. The primary reason for the increase in costs for Confidence Level 3 is that it includes several potable reuse projects (n = 3). The cost for Confidence Level 4 exceeds all but Confidence Level 3 projects (n = 2 potable reuse projects).

The TIN load reductions increase in a similar fashion with recycled water volumes/flows through year 2035, after which the additional TIN load reductions are modest compared to additional RW volumes/flows. The modest increase in TIN load reductions after year 2035 is attributed to a few potable reuse projects that include RO treatment. Potable reuse projects will only have modest nutrient load reductions as POTWs will i) likely need to implement ammonia and TIN load reductions at the plant prior to advanced treatment facilities (if not already in place) and ii) the majority of the nutrient loads will end up in SF Bay via the RO concentrate return flows (assumed 84 percent of the advanced treatment feed load unless provided otherwise) as previously noted in Section 2.6. Additional nutrient removal could be achieved via treatment of RO concentrate, although this was not included in the load reduction estimates or cost estimates.

This analysis assumes that POTWs considering potable reuse projects that do NOT already have ammonia and TIN load reduction facilities in place would implement such upgrades at the POTW. The anticipated TIN effluent concentrations for such POTWs would be on the order of 15 mg N/L. **Note: this analysis excludes costs for such plant upgrades. This analysis also assumed the plant effluent of 15 mg N/L which impacts the TIN load reductions associated with RW.**

The projected distribution of potential RW projects by POTW and confidence level is provided in Table 3-20. A time-series plot that illustrates the information from Table 3-20 for all 37 POTWs is provided in Figure 3-7. The breakdown of potential RW projects across all 37 POTWs by confidence level is as follows (refer to Figure 3-7):

- **Confidence Level 1:** up to 24 net reuse projects (blend of current and planned; no more than 23 projects at any listed five-year increment). While Table ES - 3 and Figure ES - 3 show up to 23 reuse projects at any listed five-year increment, the net number of reuse projects is 24 through year 2045 as two Confidence Level 1 projects stop producing recycled water by year 2035 (OLSD and EBMUD) and a Confidence Level 1 Project begins producing recycled water in year 2030 (Treasure Island).

- **Confidence Level 2:** up to 5 potential reuse projects (master planned)
- **Confidence Level 3:** up 9 potential reuse projects (conceptual)
- **Confidence Level 4:** up to 2 potential reuse projects (conceptual)

An overall summary of the **average** values over a 25-year project duration for each confidence level is provided in Table 3-21. Note that the values in Table 3-21 are average values over the full 25-year duration and thus do not reflect values at each five-year increment. The average values are used to quantify the various unit metrics ($/lb TIN removed) that rely on average values. Furthermore, Table 3-21 presents the net number of projects for each Confidence Level through year 2045 (not limited to the total at each five-year timeframe. As previously stated, the net number of Confidence Level 1 projects (n = 24) as two Confidence Level 1 projects stop producing recycled water by year 2035 (OLSD and EBMUD) and a Confidence Level 1 Project begins producing recycled water in year 2030 (Treasure Island).

From a unit water volume/flows standpoint, the Confidence Level 1 projects are the most cost-efficient at less than or equal to $12 per gallon per day (gpd) ($730/AF, regardless of season). Confidence Level 1 projects were expected to be the most efficient because in most cases the treatment facilities are already in place. The Confidence Levels 2 through 4 projects are at least four times higher in terms of unit cost ($/gpd, $/AF) compared to the Confidence Level 1 projects (regardless of season). It is important to recognize that the cost for purchasing potable water (instead of RW) is not captured in the analysis as the cost for potable water is so wide-ranging (dependent on water provider, season, etc.).

From a unit load standpoint (emphasis on TIN), the Confidence Level 1 projects that represent current and/or planned reuse facilities are the most cost-efficient at less than or equal to $17 per pound TIN removed. Similar to volume/flow, this was expected as in most cases the facilities for Confidence Level 1 projects are already in place. The unit costs for Confidence Levels 2 through 4 projects are a magnitude or greater than the Confidence Level 1 projects.

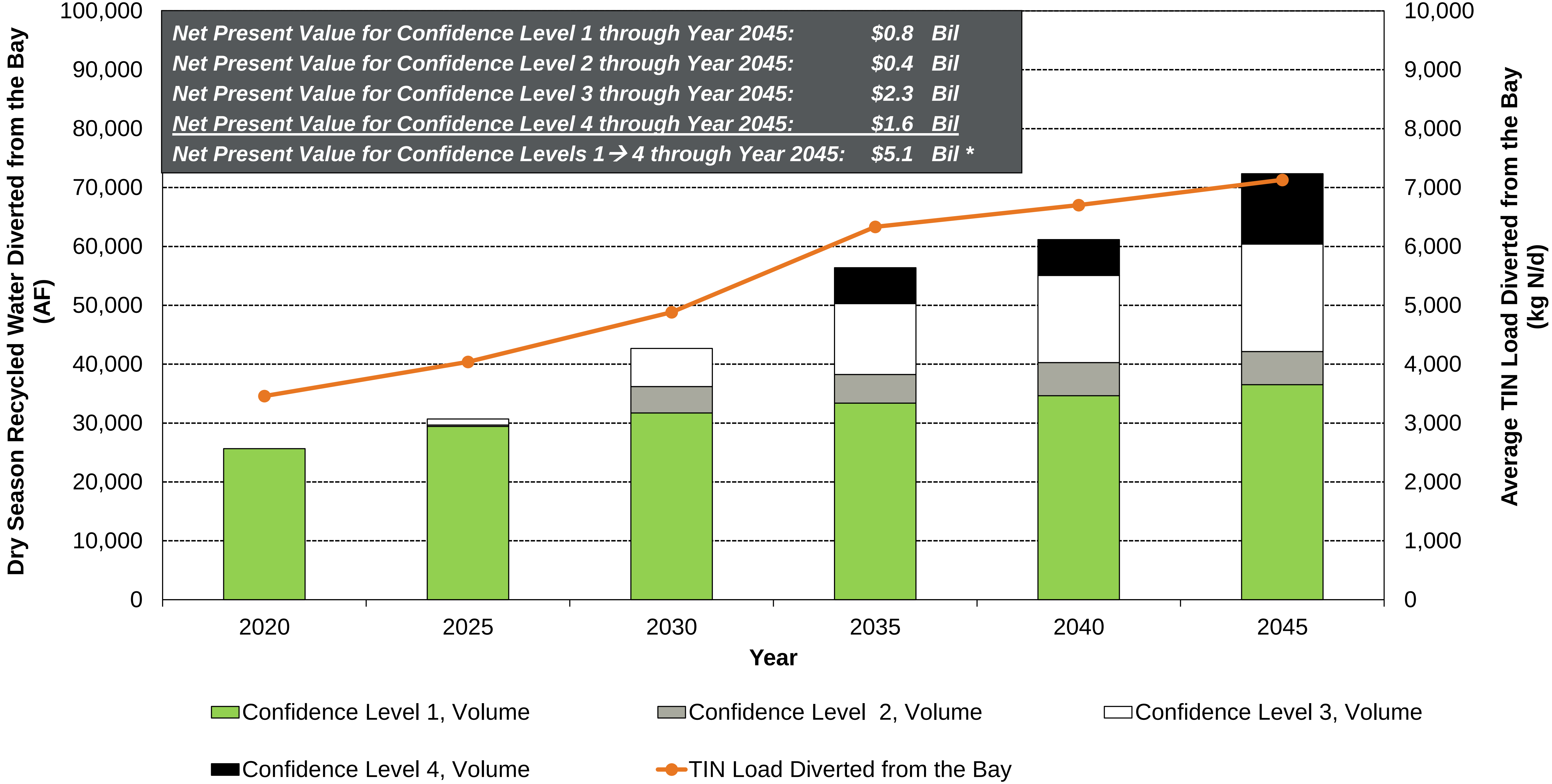

Figure 3-5. Overall Summary of Existing and Proposed Dry Season Recycled Water Flows and the Corresponding Total Inorganic Nitrogen Load Diversions from SF Bay Dischargers

Confidence level = level of confidence in the values provided. 1 = includes projects that are already in place and/or currently budgeted; 2 = includes projects that are in master planning stages; 3 = includes projects that are conceptual, and 4 = includes projects that are conceptual in nature and require agreements across multiple jurisdictions/agencies.

* The total net present value might vary from the sum of the listed confidence levels due to rounding.

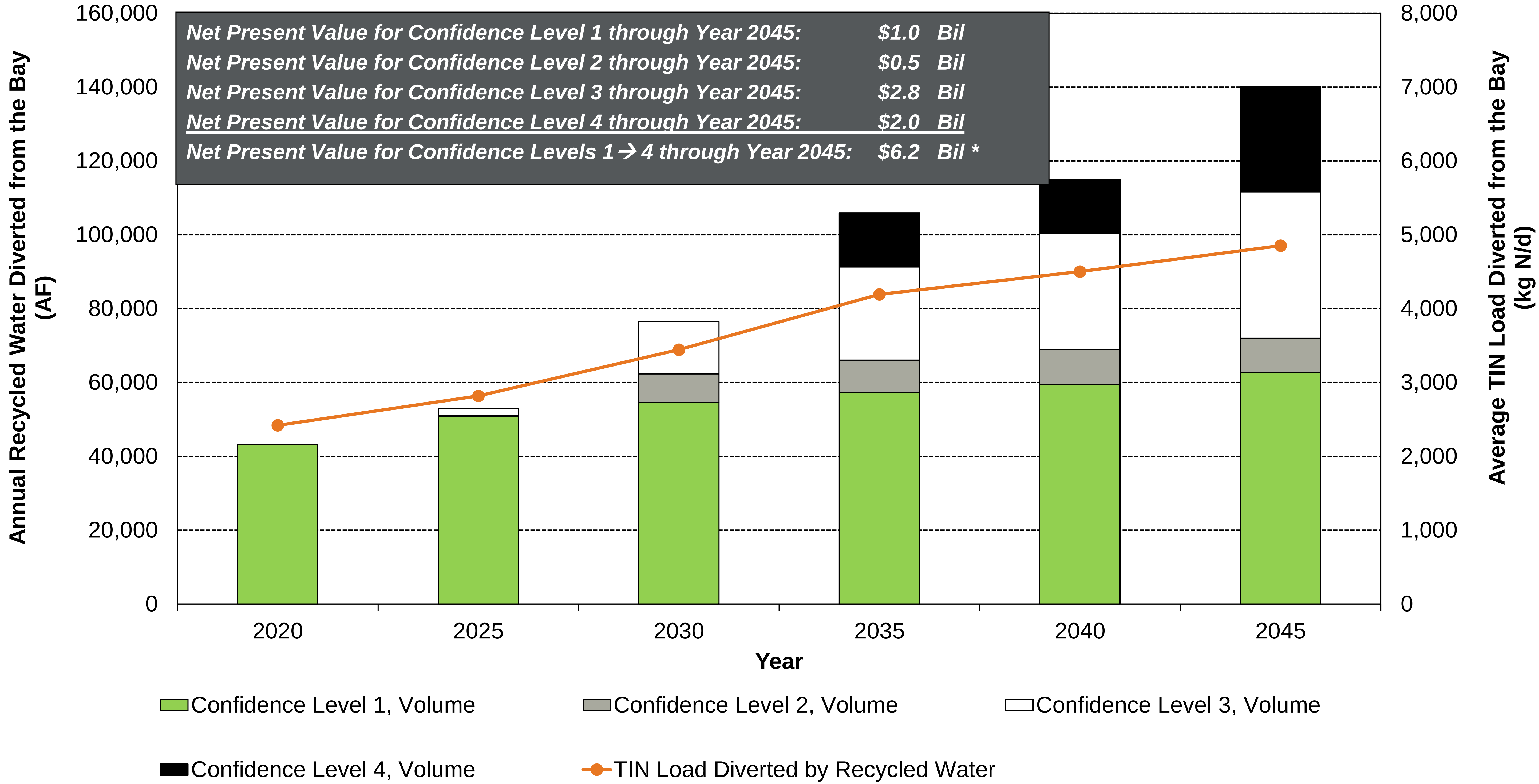

Figure 3-6. Overall Summary of Existing and Proposed Annual Average Recycled Water Flows and the Corresponding Total Inorganic Nitrogen Load Diversions from SF Bay Dischargers

Confidence level = level of confidence in the values provided. 1 = includes projects that are already in place and/or currently budgeted; 2 = includes projects that are in master planning stages; 3 = includes projects that are conceptual, and 4 = includes projects that are conceptual in nature and require agreements across multiple jurisdictions/agencies.

* The total net present value might vary from the sum of the listed confidence levels due to rounding.

Table 3-18. Confidence Levels 1 through 4: Projected Dry Season Recycled Water Volumes/Flows and the Corresponding Nutrient Load Reductions

POTW	Year 2020		Year 2025		Year 2030		Year 2035		Year 2040		Year 2045	
	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN, Load Diverted kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d
American Canyon	199 (0.4)	9	414 (0.9)	9	414 (0.9)	9	838 (2)	18	838 (2)	18	838 (2)	18
Benicia	--	--	--	--	--	--	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--	--	--	--	--	--	--
Central San	920 (2)	209	1,130 (2)	258	1,300 (3)	297	7,670 (16)	433	8,000 (17)	508	8,260 (18)	568
CMSA	20 (<0.1)	6	20 (<0.1)	6	20 (<0.1)	6	20 (<0.1)	6	20 (<0.1)	6	20 (<0.1)	6
Delta Diablo	2,070 (4)	55	2,080 (4)	56	2,080 (4)	56	2,080 (4)	56	2,090 (4)	56	2,090 (4)	56
DSRSD	1,790 (4)	410	1,890 (4)	432	1,930 (4)	441	1,930 (4)	441	1,930 (4)	441	1,930 (4)	441
EBMUD	117 (0.2)	52	131 (0.3)	59	327 (0.7)	146	1,670 (4)	747	1,670 (4)	747	1,670 (4)	747
FSSD	830 (2)	165	830 (2)	165	830 (2)	165	830 (2)	165	830 (2)	165	830 (2)	165
Hayward	532 (1)	138	733 (2)	189	916 (2)	236	916 (2)	236	916 (2)	236	916 (2)	236
Las Gallinas	764 (2)	85	764 (2)	85	764 (2)	85	764 (2)	85	764 (2)	85	764 (2)	85
Livermore	920 (2)	321	950 (2)	332	980 (2)	343	1,010 (2)	354	1,040 (2)	365	1,040 (2)	365
Millbrae	--	--	--	--	--	--	--	--	--	--	--	--
Mt. View	430 (0.9)	63	440 (0.9)	65	450 (1)	67	460 (1)	68	470 (1)	70	480 (1)	72
Napa	3,000 (6)	221	3,100 (7)	229	3,100 (7)	229	3,100 (7)	229	3,100 (7)	229	3,300 (7)	232
Novato	1,240 (3)	118	1,220 (3)	117	2,320 (5)	221	2,690 (6)	257	2,690 (6)	257	2,690 (6)	257
OLSD	37 (<0.1)	2	37 (<0.1)	2	--	--	--	--	2,280 (5)	112	2,280 (5)	112
Palo Alto	495 (1)	119	527 (1)	121	6,385 (14)	372	6,385 (14)	372	6,385 (14)	372	6,385 (14)	372
Petaluma	981 (2)	8	1,200 (3)	10	3,397 (7)	24	3,397 (7)	24	4,138 (9)	29	4,198 (9)	30
Pinole	--	--	--	--	--	--	--	--	--	--	--	--
Richmond	--	--	--	--	--	--	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--	--	--	--	--	--	--
SFO Airport	--	--	38 (<0.1)	14	38 (<0.1)	14	38 (<0.1)	14	38 (<0.1)	14	38 (<0.1)	14
SFPUC Southeast	--	--	--	--	--	--	--	--	--	--	--	--
San Jose	7,500 (16)	909	8,900 (19)	1,080	10,100 (22)	1,230	11,900 (25)	1,450	13,100 (28)	1,590	20,800 (44)	1,881
San Mateo	--	--	--	--	451 (1)	55	477 (1)	58	648 (1)	78	3,638 (8)	151
SMCSD	--	--	--	--	--	--	--	--	--	--	--	--
San Leandro	233 (0.5)	71	233 (0.5)	71	233 (0.5)	71	233 (0.5)	71	233 (0.5)	71	233 (0.5)	71
SASM	31 (<0.1)	7	31 (<0.1)	7	31 (<0.1)	7	31 (<0.1)	7	31 (<0.1)	7	31 (<0.1)	7
Sonoma Valley	1,060 (2)	173	1,070 (2)	174	1,070 (2)	174	1,070 (2)	174	1,070 (2)	174	1,070 (2)	174
SVCW	677 (1)	194	973 (2)	279	1,040 (2)	297	4,200 (9)	708	4,210 (9)	711	4,210 (9)	711
South SF	--	--	117 (0.2)	14	289 (0.6)	35	289 (0.6)	35	289 (0.6)	35	289 (0.6)	35
Sunnyvale	272 (0.6)	35	675 (1)	87	861 (2)	111	1,030 (2)	134	1,030 (2)	134	1,030 (2)	134
Treasure Island	--	--	--	--	195 (0.4)	13	195 (0.4)	13	195 (0.4)	13	195 (0.4)	13
USD	--	--	--	--	--	--	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--	--	--	--	--	--	--
West County	1,560 (3)	89	3,160 (7)	180	3,160 (7)	180	3,160 (7)	180	3,160 (7)	180	3,160 (7)	180
Total [b]	25,700 (55)	3,460	30,700 (65)	4,040	42,700 (91)	4,880	56,400 (120)	6,330	61,200 (130)	6,700	72,300 (154)	7,130

a. The volumes in AF might vary from the values in the individual plant reports due to rounding (refer to Appendix B).
b. The total values might vary from the sum of the listed values by plant due to rounding.

Table 3-19. Confidence Levels 1 through 4: Projected Average Annual Recycled Water Volumes/Flows and the Corresponding Nutrient Load Reductions

POTW	Year 2020		Year 2025		Year 2030		Year 2035		Year 2040		Year 2045	
	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN, Load Diverted kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d	AF (mgd) [a]	TIN Load Diverted, kg N/d
American Canyon	313 (0.3)	6	619 (0.6)	13	619 (0.6)	13	1,235 (1)	26	1,235 (1)	26	1,235 (1)	26
Benicia	--	--	--	--	--	--	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--	--	--	--	--	--	--
Central San	1,600 (1)	141	1,950 (2)	172	2,240 (2)	197	17,280 (15)	311	17,830 (16)	359	18,260 (16)	398
CMSA	24 (<0.1)	2	24 (<0.1)	2	24 (<0.1)	2	24 (<0.1)	2	24 (<0.1)	2	24 (<0.1)	2
Delta Diablo	4,750 (4)	38	4,780 (4)	39	4,780 (4)	39	4,790 (4)	39	4,790 (4)	39	4,800 (4)	39
DSRSD	3,890 (3)	386	4,100 (4)	407	4,190 (4)	416	4,190 (4)	416	4,190 (4)	416	4,190 (4)	416
EBMUD	180 (0.2)	27	202 (0.2)	31	504 (0.4)	76	2,580 (2)	391	2,580 (2)	391	2,580 (2)	391
FSSD	1,030 (0.9)	73	1,030 (0.9)	73	1,030 (0.9)	73	1,030 (0.9)	73	1,030 (0.9)	73	1,030 (0.9)	73
Hayward	858 (0.8)	90	1,228 (1)	129	1,448 (1)	152	1,448 (1)	152	1,448 (1)	152	1,448 (1)	152
Las Gallinas	975 (0.9)	54	975 (0.9)	54	975 (0.9)	54	975 (0.9)	54	975 (0.9)	54	975 (0.9)	54
Livermore	1,620 (1)	218	1,680 (1)	226	1,730 (2)	233	1,790 (2)	241	1,840 (2)	248	1,840 (2)	248
Millbrae	--	--	--	--	--	--	--	--	--	--	--	--
Mt. View	1,150 (1)	72	1,180 (1)	73	1,210 (1)	75	1,240 (1)	77	1,270 (1)	79	1,300 (1)	81
Napa	3,300 (3)	103	3,400 (3)	106	3,400 (3)	106	3,400 (3)	106	3,400 (3)	106	3,880 (3)	109
Novato	1,470 (1)	53	1,450 (1)	52	5,030 (4)	183	5,930 (5)	216	5,930 (5)	216	5,930 (5)	216
OLSD	37 (<0.1)	1	37 (<0.1)	1	--	--	--	--	5,480 (5)	135	5,480 (5)	135
Palo Alto	705 (0.6)	69	752 (0.7)	70	13,695 (12)	261	13,695 (12)	261	13,695 (12)	261	13,695 (12)	261
Petaluma	981 (0.9)	8	1,200 (1)	10	3,397 (3)	24	3,397 (3)	24	4,138 (4)	29	4,198 (4)	30
Pinole	--	--	--	--	--	--	--	--	--	--	--	--
Richmond	--	--	--	--	--	--	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--	--	--	--	--	--	--
SFO Airport	--	--	90 (<0.1)	11	90 (<0.1)	11	90 (<0.1)	11	90 (<0.1)	11	90 (<0.1)	11
SFPUC Southeast	--	--	--	--	--	--	--	--	--	--	--	--
San Jose	12,600 (11)	670	15,000 (13)	800	17,000 (15)	906	20,000 (18)	1,070	22,000 (20)	1,170	39,000 (35)	1,405
San Mateo	--	--	--	--	602 (0.5)	31	635 (0.6)	32	865 (0.8)	44	8,035 (7)	117
SMCSD	--	--	--	--	--	--	--	--	--	--	--	--
San Leandro	292 (0.3)	33	292 (0.3)	33	292 (0.3)	33	292 (0.3)	33	292 (0.3)	33	292 (0.3)	33
SASM	38 (<0.1)	2	38 (<0.1)	2	38 (<0.1)	2	38 (<0.1)	2	38 (<0.1)	2	38 (<0.1)	2
Sonoma Valley	2,210 (2)	151	2,240 (2)	153	2,240 (2)	153	2,240 (2)	153	2,240 (2)	153	2,240 (2)	153
SVCW	856 (0.8)	96	1,230 (1)	138	1,310 (1)	147	8,710 (8)	245	8,720 (8)	246	8,720 (8)	246
South SF	--	--	280 (0.2)	34	954 (0.9)	60	954 (0.9)	60	954 (0.9)	60	954 (0.9)	60
Sunnyvale	443 (0.4)	33	1,100 (1)	81	1,400 (1)	103	1,680 (1)	124	1,680 (1)	124	1,680 (1)	124
Treasure Island	--	--	--	--	301 (0.3)	8	301 (0.3)	8	301 (0.3)	8	301 (0.3)	8
USD	--	--	--	--	--	--	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--	--	--	--	--	--	--
West County	3,920 (3)	93	7,950 (7)	189	7,950 (7)	189	7,950 (7)	189	7,950 (7)	189	7,950 (7)	189
Total [a]	43,200 (39)	2,420	52,800 (47)	2,900	76,400 (68)	3,550	105,900 (94)	4,320	115,000 (103)	4,620	140,000 (125)	4,980

a. The volumes in AF might vary from the values in the individual plant reports due to rounding (refer to Appendix B).
b. The total values might vary from the sum of the listed values by plant due to rounding.

Table 3-20. Distribution of Potential Recycled Water Projects per POTW by Confidence Levels 1 through 4*

POTW	Year 2020	Year 2025	Year 2030	Year 2035	Year 2040	Year 2045
American Canyon	Confidence Level 1	Confidence Level 1; Confidence Level 2	Confidence Level 1; Confidence Level 2	Confidence Level 1; Confidence Level 2; Confidence Level 3	Confidence Level 1; Confidence Level 2; Confidence Level 3	Confidence Level 1; Confidence Level 2; Confidence Level 3
Benicia	--	--	--	--	--	--
Burlingame	--	--	--	--	--	--
Central San	Confidence Level 1	Confidence Level 1 -- Confidence Level 3	Confidence Level 1 -- Confidence Level 3	Confidence Level 1 -- Confidence Level 3 Confidence Level 4	Confidence Level 1 -- Confidence Level 3 Confidence Level 4	Confidence Level 1 -- Confidence Level 3 Confidence Level 4
CMSA	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
Delta Diablo	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
DSRSD	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
EBMUD	Confidence Level 1	Confidence Level 1	Confidence Level 1	-- -- Confidence Level 3	-- -- Confidence Level 3	-- -- Confidence Level 3
FSSD	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
Hayward	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
Las Gallinas	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
Livermore	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
Millbrae	--	--	--	--	--	--
Mt. View	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
Napa	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1 -- Confidence Level 3
Novato	Confidence Level 1	Confidence Level 1	Confidence Level 1 Confidence Level 2	Confidence Level 1 Confidence Level 2	Confidence Level 1 Confidence Level 2	Confidence Level 1 Confidence Level 2
OLSD	Confidence Level 1	Confidence Level 1	--	--	-- -- Confidence Level 3	-- -- Confidence Level 3
Palo Alto	Confidence Level 1	Confidence Level 1	Confidence Level 1 -- Confidence Level 3	Confidence Level 1 -- Confidence Level 3	Confidence Level 1 -- Confidence Level 3	Confidence Level 1 -- Confidence Level 3
Petaluma	Confidence Level 1	Confidence Level 1	Confidence Level 1 Confidence Level 2	Confidence Level 1 Confidence Level 2	Confidence Level 1 Confidence Level 2	Confidence Level 1 Confidence Level 2
Pinole	--	--	--	--	--	--
Richmond	--	--	--	--	--	--
Rodeo	--	--	--	--	--	--
SFO Airport	--	-- Confidence Level 2	-- Confidence Level 2	-- Confidence Level 2	-- Confidence Level 2	-- Confidence Level 2
SFPUC Southeast	--	--	--	--	--	--
San Jose	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1 -- -- Confidence Level 4
San Mateo	--	--	-- -- Confidence Level 3	-- -- Confidence Level 3	-- -- Confidence Level 3	-- -- Confidence Level 3
SMCSD	--	--	--	--	--	--

POTW	Year 2020	Year 2025	Year 2030	Year 2035	Year 2040	Year 2045
San Leandro	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
SASM	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
Sonoma Valley	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
SVCW	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1 -- Confidence Level 3	Confidence Level 1 -- Confidence Level 3	Confidence Level 1 -- Confidence Level 3
South SF	--	-- -- Confidence Level 3	-- Confidence Level 2 Confidence Level 3	-- Confidence Level 2 Confidence Level 3	-- Confidence Level 2 Confidence Level 3	-- Confidence Level 2 Confidence Level 3
Sunnyvale	Confidence Level 1	-- -- Confidence Level 3	-- -- Confidence Level 3	-- -- Confidence Level 3	-- -- Confidence Level 3	-- -- Confidence Level 3
Treasure Island	--	--	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
USD	--	--	--	--	--	--
Vallejo	--	--	--	--	--	--
West County	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1	Confidence Level 1
Total	Confidence Level 1 = 23, Confidence Level 2 = 0, Confidence Level 3 = 0, Confidence Level 4 = 0	Confidence Level 1 = 22, Confidence Level 2 = 2, Confidence Level 3 = 3, Confidence Level 4 = 0	Confidence Level 1 = 22, Confidence Level 2 = 5, Confidence Level 3 = 5, Confidence Level 4 = 0	Confidence Level 1 = 21, Confidence Level 2 = 5, Confidence Level 3 = 8, Confidence Level 4 = 1	Confidence Level 1 = 21, Confidence Level 2 = 5, Confidence Level 3 = 9, Confidence Level 4 = 1	Confidence Level 1 = 21, Confidence Level 2 = 5, Confidence Level 3 = 10, Confidence Level 4 = 2

* Confidence Level 1 has up to 24 net projects through year 2045 (no more than 23 at any given listed five-year increment; three Confidence Level 1 projects stop producing recycled water in years 2025, 2030, and 2035; a Confidence Level 1 Project begins producing recycled water in year 2030).

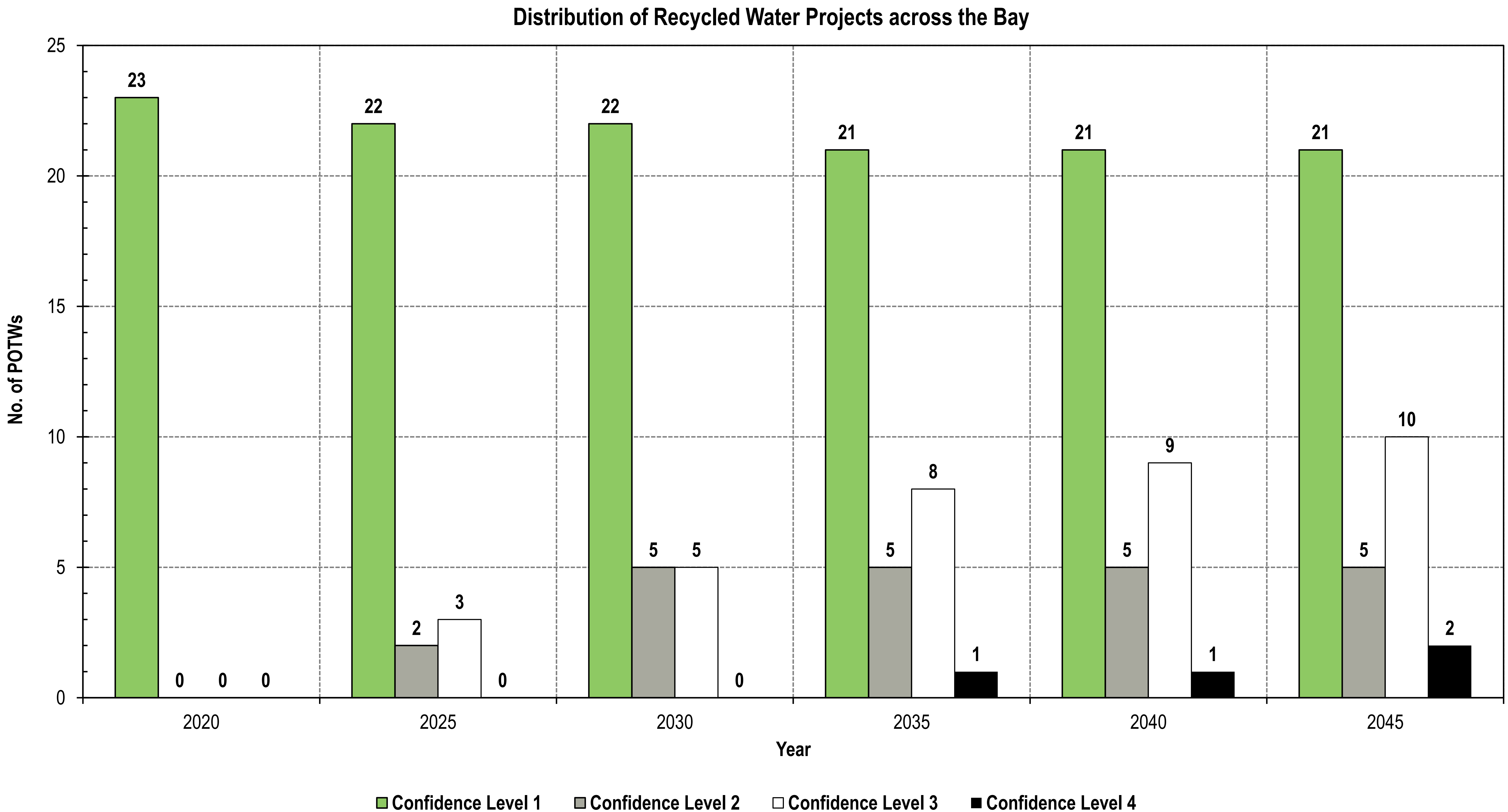

Figure 3-7. Distribution of Potential Recycled Water Projects by Confidence Levels over Time across the SF Bay*

* Confidence Level 1 has up to 24 net projects through year 2045 (no more than 23 at any given listed five-year increment; three Confidence Level 1 projects stop producing recycled water in years 2025, 2030, and 2035; a Confidence Level 1 Project begins producing recycled water in year 2030).

Table 3-21. Overall Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions and Unit Costs (Averaged over 25 Years)

Parameter	Unit	Confidence Level 1 Grouping (Avg. from 2020–2045) [a]		Confidence Level 2 Grouping (Avg. from 2020–2045) [a]		Confidence Level 3 Grouping (Avg. from 2020–2045) [a]		Confidence Level 4 Grouping (Avg. from 2020–2045) [a]		Total (Includes all 4 Confidence Level Groupings (Avg. from 2020–2045) [a]	
		Average Dry Season (May 1–Sept 30)	Average Annual (Oct 1–Sept 30)	Average Dry Season (May 1–Sept 30)	Average Annual (Oct 1–Sept 30)	Average Dry Season (May 1–Sept 30)	Average Annual (Oct 1–Sept 30)	Average Dry Season (May 1–Sept 30)	Average Annual (Oct 1–Sept 30)	Average Dry Season (May 1–Sept 30)	Average Annual (Oct 1–Sept 30)
Number of Projects [b]											
Net Number from Year 2020 through 2045	No.	24	24	5	5	10	10	2	2	41	41
Flow/Volume Diverted from SF Bay [c]											
Flow	mgd	67	48	7	5	17	15	8	8	99	76
Annual Volume	AF	31,600	54,200	3,300	5,600	8,100	16,700	3,600	8,600	46,600	85,100
Load Diverted from SF Bay [c]											
Confidence	Unitless	1	1	2	2	3	3	4	4	--	--
Duration	Years	25	25	25	25	25	25	25	25	25	25
Flow diverted	%	17%	11%	2%	1%	5%	4%	2%	2%	23%	16%
Ammonia load diverted	kg N/d	1,700	1,200	85	73	450	270	2	2	2,300	1,600
TIN load diverted	kg N/d	4,120	2,900	210	180	880	660	44	44	5,300	3,800
TP load diverted	kg P/d	350	240	25	18	160	120	2	2	540	380
Cost [d,e]											
Capital cost	$ Mil	530	530	130	130	1,860	1,860	1,300	1,300	3,820	3,820
NPV O&M	$ Mil	300	480	270	330	400	950	280	660	1,250	2,420
NPV total (Capital+ NPV O&M)	$ Mil	830	1,010	400	460	2,260	2,810	1,580	1,960	5,070	6,240
Unit flow cost [f]											
Unit cost	$/gpd	12	21	57	92	132	188	205	254	51	82
Unit cost	$/AF	1,050	750	4,900	3,300	11,200	6,700	17,500	9,100	4,400	2,900
Unit load cost [g]											
Ammonia unit cost	$/lb Ammonia diverted	57	42	560	320	600	510	115,100	63,100	260	200
TIN unit cost	$/lb TIN diverted	24	17	230	130	300	210	4,300	2,200	110	80
TP unit cost	$/lb TP diverted	280	210	1,880	1,260	1,630	1,170	86,700	41,000	1,110	820

a. Confidence level = level of confidence in the values provided. 1 = includes projects that are already in place and/or currently budgeted; 2 = includes projects that are in master planning stages; 3 = includes projects that are conceptual, and 4 = includes projects that are conceptual in nature and require agreements across multiple jurisdictions/agencies.
b. Confidence Level 1 has up to 24 net projects through year 2045 (no more than 23 at any given listed five-year increment; three Confidence Level 1 projects stop producing recycled water in years 2025, 2030, and 2035; a Confidence Level 1 Project begins producing recycled water in year 2030).
c. Based on flows and loads diverted from the SF Bay discharge projected forward to the midpoint of the specific project duration (in this case 25-years assumed from year 2020 through 2045), as well as dry season (153 days per year) and average annual (365 days per year).
d. Estimated cost for RW production across the SF Bay (based on year 2021 dollars).
e. Net present value (NPV) is calculated based on a 2% discount rate for the listed project duration (project specific).
f. Unit flow cost is based on the NPV total divided by the listed average flow diverted from SF Bay.
g. Unit load costs are based on the NPV total divided by the average nutrient (ammonia, TIN, or TP) diverted from an SF Bay discharge for the project duration—e.g., NPV total divided by (daily average listed load × number of days for averaging period × unit conversion [kg to lb] × duration as years).

For perspective, the projected percentage of effluent flows and TIN loads diverted from SF Bay because of reuse over time is provided in Table 3-22 through Table 3-25. The analysis is based on comparing the reuse volumes and loads against recent discharge flows and loads to SF Bay (i.e., October 1, 2021, through September 30, 2022) for both dry season and average annual.

3.1.5.3 Dry Season: Percentage Diverted from SF Bay

The average discharge SF Bay-wide flow and TIN loads by all the major dischargers during year 2021/2022 was 337 mgd (377,440 AF) and 44,400 kg N/d, respectively. A detailed summary of the discharge flows and loads to SF Bay over the last 10 years is provided in this past year's BACWA Group Annual Report (HDR, 2023). The dry-season volume diverted from SF Bay because of reuse is anticipated to more than double by 2045, from approximately 14 percent to upwards of 39 percent, as presented in Table 3-22.

Table 3-22. Percentage of Dry Season Volume Diverted from SF Bay because of Reuse over Time *,**

Year	Confidence Level				Total
	1	2	3	4	
2020	14%	--	--	--	14%
2025	16%	<1%	1%	--	17%
2030	17%	2%	4%	--	23%
2035	18%	3%	7%	3%	31%
2040	19%	3%	8%	3%	33%
2045	20%	3%	10%	6%	39%

* The analysis is based on comparing the reuse volumes/loads against year 2021/2022 (October 1 through September 30) discharge flows and loads to SF Bay. A detailed summary of the discharge flows and loads to SF Bay over the last 10 years is provided in this past year's BACWA Group Annual Report (HDR, 2023).

** Percent calculation = RW volume from year 2020 compiled in this report divided by (discharge volume from 2021/2022+ RW volume from year 2020 compiled in this report).

The dry season TIN load diverted from SF Bay because of reuse is not as high a percentage as the volume of effluent diverted, because some reuse applications do not reduce effluent TIN loads. For example, Delta Diablo sends more than 5 mgd (regardless of averaging period; translates to approximately 2,400 AF in the dry season) to an industrial reuse application that removes little or none of the TIN loads. The percentage of TIN loads diverted from SF Bay is anticipated to more than double from approximately 7 percent to upwards of 15 percent as presented in Table 3-23.

Table 3-23. Percentage of Dry Season TIN Loads Diverted from SF Bay because of Reuse over Time *,**

Year	Confidence Level				Total
	1	2	3	4	
2020	7%	--	--	--	7%
2025	8%	<1%	<1%	--	8%
2030	9%	<1%	1%	--	10%
2035	9%	1%	3%	<1%	13%
2040	9%	1%	4%	<1%	14%
2045	10%	1%	4%	<1%	15%

* The analysis is based on comparing the reuse volumes/loads against year 2021/2022 (October 1 through September 30) discharge flows and loads to SF Bay. A detailed summary of the discharge flows and loads to SF Bay over the last 10 years is provided in this past year's BACWA Group Annual Report (HDR, 2023).

** Percent calculation = RW load from year 2020 compiled in this report divided by (discharge load from 2021/2022 + RW load from year 2020 compiled in this report).

3.1.5.4 Average Annual: Percentage Diverted from SF Bay

The average discharge SF Bay-wide flow and TIN loads by all the major dischargers during year 2021/2022 was 399 mgd (446,880 AF) and 47,300 kg N/d, respectively. A detailed summary of the discharge flows and loads to SF Bay over the last 10 years is provided in this past year's BACWA Group Annual Report (HDR, 2023). The annual volume diverted from SF Bay because of reuse is anticipated to more than triple from approximately 9 percent to nearly 30 percent as presented in Table 3-24.

Table 3-24. Percentage of Average Annual Volume Diverted from SF Bay because of Reuse over Time *,**

Year	Confidence Level				Total
	1	2	3	4	
2020	9%	--	--	--	9%
2025	10%	<1%	<1%	--	11%
2030	11%	2%	3%	--	16%
2035	12%	2%	5%	3%	22%
2040	12%	2%	6%	3%	23%
2045	13%	2%	8%	6%	29%

* The analysis is based on comparing the reuse volumes/loads against year 2021/2022 (October 1 through September 30) discharge flows and loads to SF Bay. A detailed summary of the discharge flows and loads to SF Bay over the last 10 years is provided in this past year's BACWA Group Annual Report (HDR, 2023).

** Percent calculation = RW volume from year 2020 compiled in this report divided by (discharge volume from 2021/2022+ RW volume from year 2020 compiled in this report).

Similar to the dry season, the annual TIN loads diverted from SF Bay because of reuse is not as high as the volume because of various reuse applications that do not reduce TIN loads to SF Bay. The percentage of TIN loads diverted from SF Bay is anticipated to more than double from just over 5 percent to upwards of 10 percent as presented in Table 3-25.

Table 3-25. Percentage of Average Annual TIN Loads Diverted from SF Bay because of Reuse over Time *,**

Year	Confidence Level				Total
	1	2	3	4	
2020	5%	--	--	--	5%
2025	6%	<1%	<1%	--	6%
2030	6%	<1%	1%	--	7%
2035	6%	1%	2%	<1%	9%
2040	6%	1%	2%	<1%	9%
2045	7%	1%	2%	<1%	10%

* The analysis is based on comparing the reuse volumes/loads against year 2021/2022 (October 1 through September 30) discharge flows and loads to SF Bay. A detailed summary of the discharge flows and loads to SF Bay over the last 10 years is provided in this past year's BACWA Group Annual Report (HDR, 2023).

** Percent calculation = RW load from year 2020 compiled in this report divided by (discharge load from 2021/2022 + RW load from year 2020 compiled in this report).

3.2 Distribution of Recycled Water Customers

The distribution of RW users/customers for years 2020 and 2045 is provided in Figure 3-8. Overall, the top users in 2020 are as follows: **industrial, landscape irrigation, golf course irrigation, and agricultural**. However, it remains uncertain whether the different industrial customers will maintain the same level of activity in using RW in the future. For example, the energy demands for the power plant located next to Delta Diablo are reducing over time because of renewable energy projects, which might eventually result in closure of the power plant.

The top users at year 2045 are similar to those from year 2020 with the exception of potable reuse. Potable reuse is expected to expand in the future with most projects being implemented at year 2040 and beyond. The primary forms of potable reuse are groundwater recharge and surface-water augmentation. The extent of how many potable reuse projects listed under Confidence Levels 3 and 4 will be implemented.

3.3 Drivers and Barriers for Implementing Reuse Projects

As part of the initial RFI, each agency was tasked with identifying up to three drivers and three barriers for implementing reuse projects at its agency.

3.3.1 Drivers for Implementing Reuse Projects

The distribution of drivers is presented in Figure 3-9. The distribution is as follows: **water supply needs followed by proposed discharge regulations and institutional drivers**. Given the state's periodic drought and aims to diversify water supply and improve resilience, it was not a surprise that water supply needs led the list of drivers. The proposed discharge regulations were focused on nutrient regulations, of which reuse is one of several strategies to manage nutrients.

3.3.2 Barriers for Implementing Reuse Projects

The distribution of barriers is presented in Figure 3-10. The distribution is as follows: **funding followed by jurisdictional, lack of need, and institutional barriers**. Based on the survey responses, economics appears to represent approximately 40 percent of the barrier, whereas non-economic considerations constitute the remaining 60 percent of potential barriers. The economics are challenging for POTWs as the reuse projects can be cost-prohibitive, coupled with meeting their primary mission, which is to be environmental stewards by producing National Pollutant Discharge Elimination System (NPDES) compliant effluent. Of the non-economic limitations to reuse, the jurisdictional barrier is a blend of challenges between the drinking water and recycled water providers, as well as issues that arise when crossing jurisdictional lines while moving recycled water.

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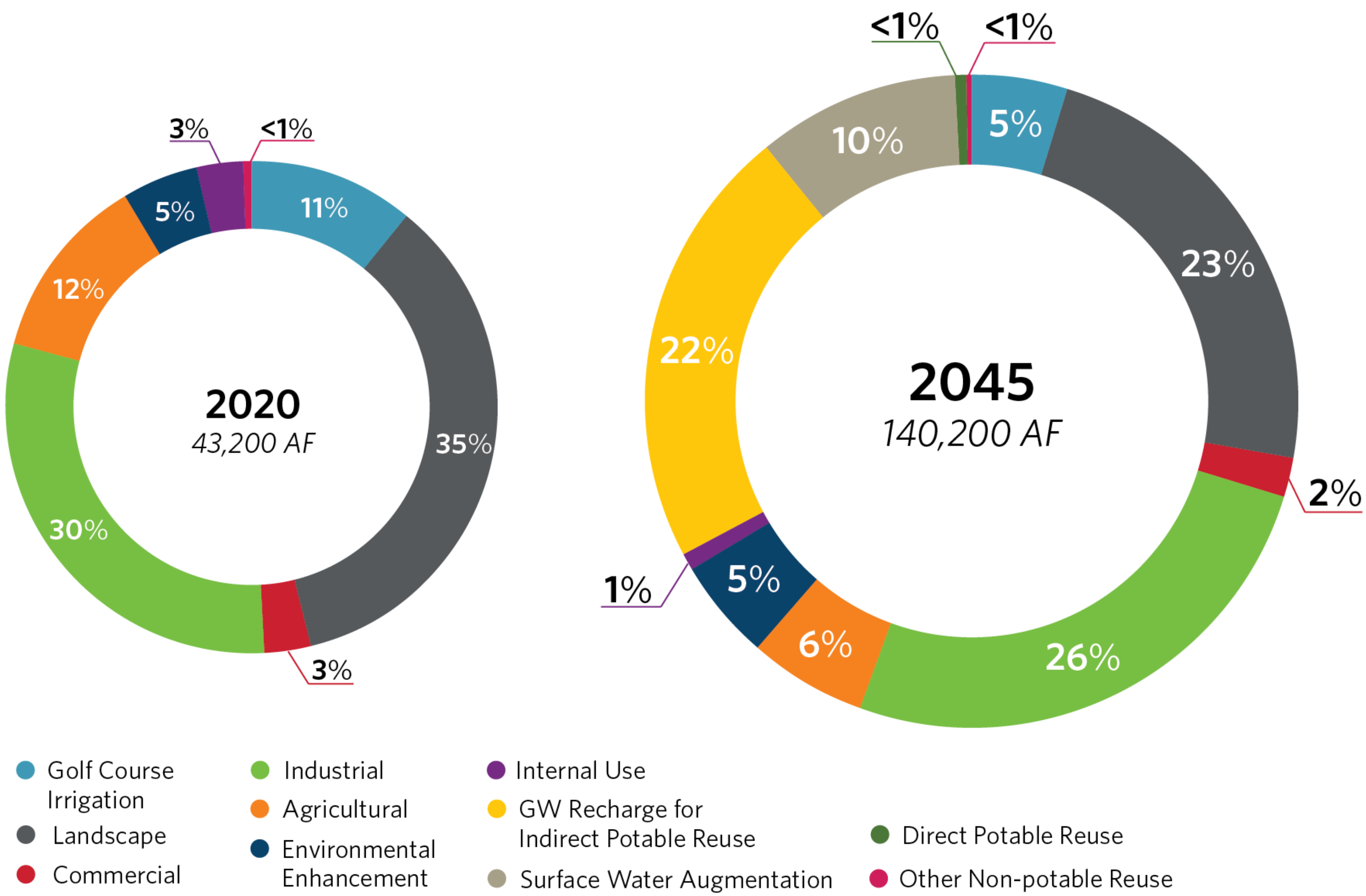

Figure 3-8. Existing and Proposed Recycled Water Use Types

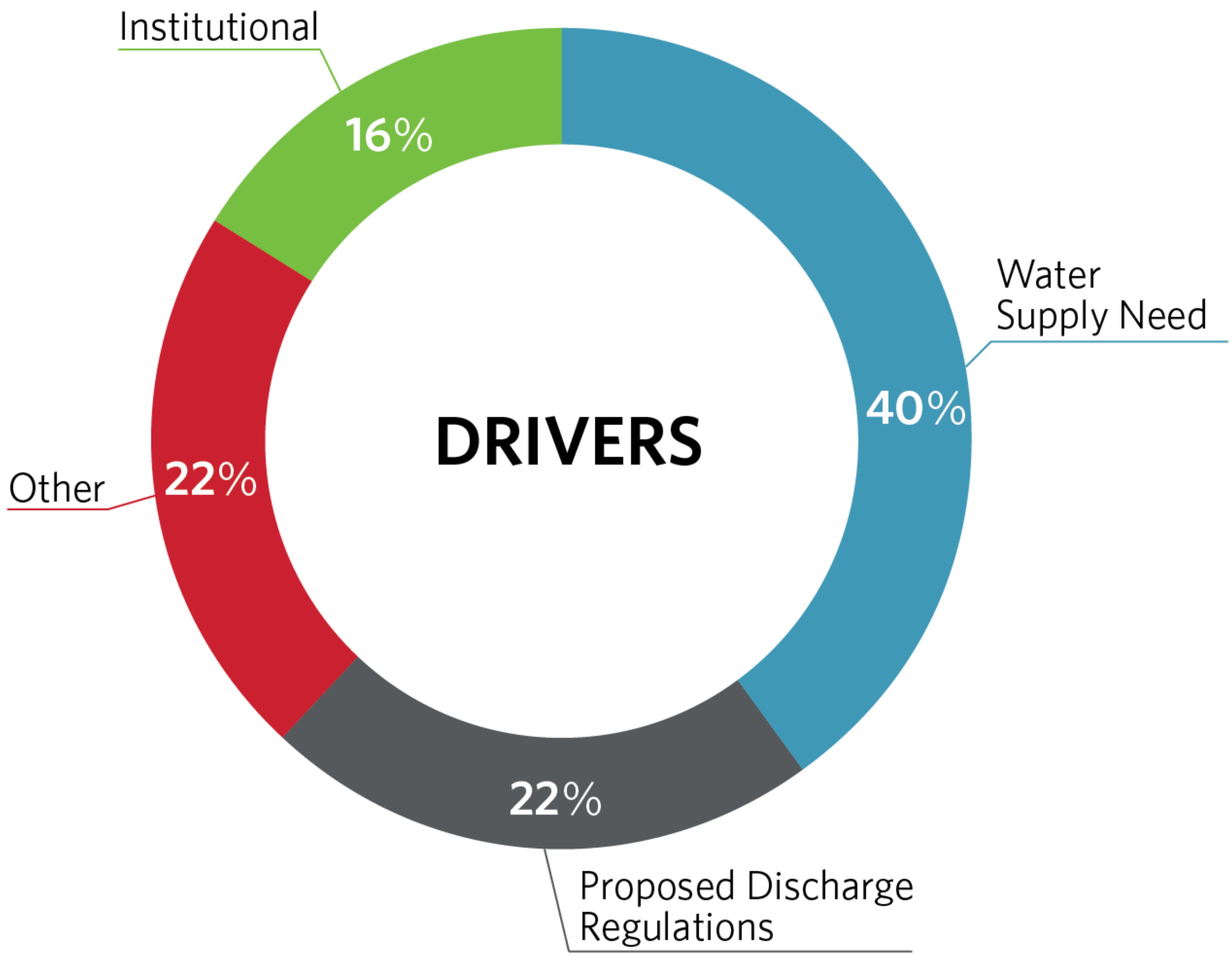

Figure 3-9. Drivers Based on Responses from the BACWA Participating Agencies

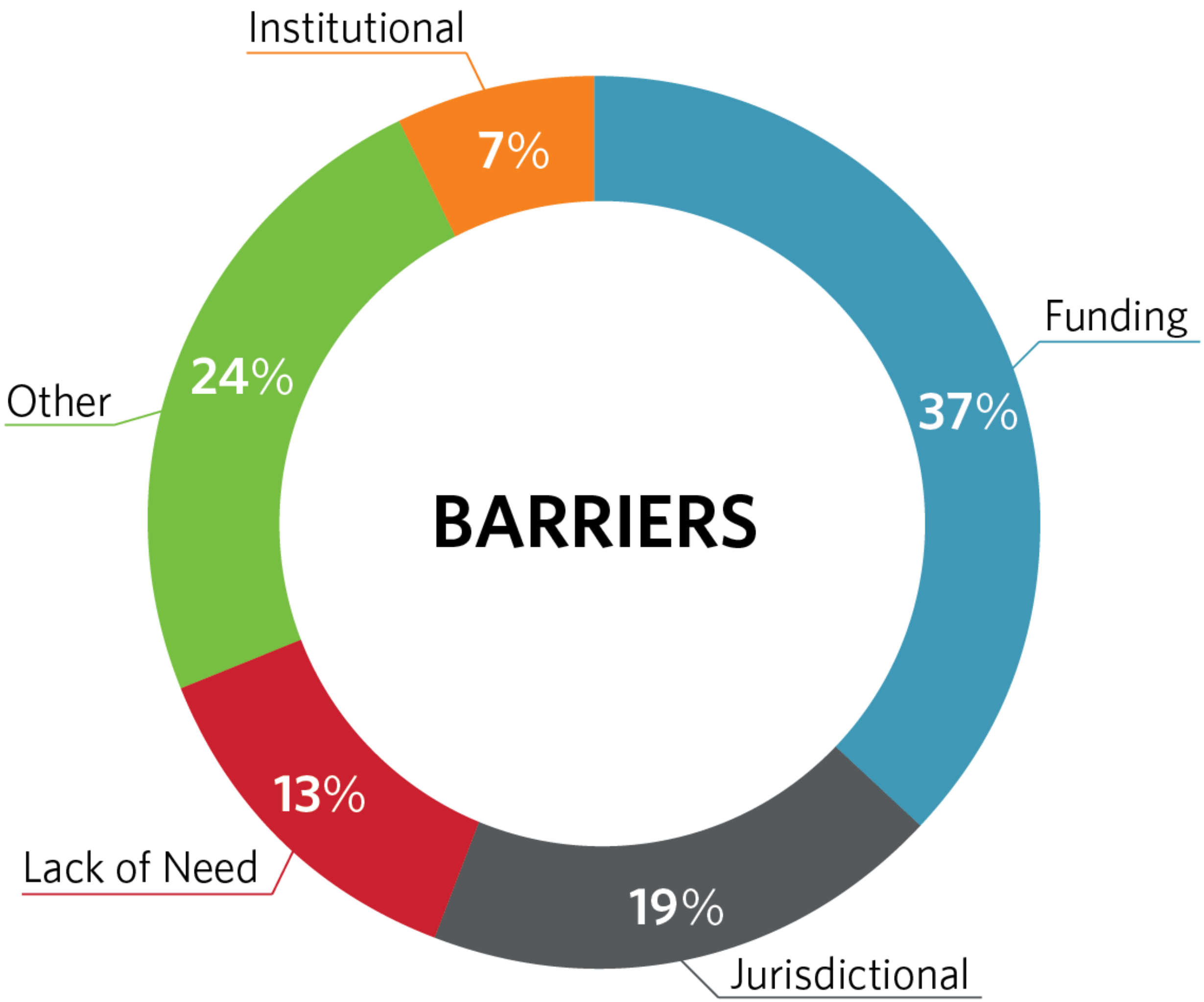

Figure 3-10. Barriers Based on Responses from the BACWA Participating Agencies

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4 Discussion and Observations

This chapter summarizes and discusses the key observations of this Potential Nutrient Reduction by Recycled Water with respect to the potential benefits of reuse on diverting nutrients from SF Bay, as well as this Recycled Water Reports limitations.

4.1 Benefits of Reuse on Nutrient Management

The subsections that follow discuss the multiple benefits of reuse, the impact of seasonality on reuse, and the menu of nutrient management options identified through the First and Second Watershed Permits.

4.1.1 Multi-Benefits of Reuse

Prior to delving into the recycled water opportunities for managing nutrients across SF Bay, it is important to highlight the various benefits associated with recycled water. An extensive list of recycled water benefits to water supply and nutrient management are as follows:

- Decreased diversion of freshwater from sensitive ecosystems (e.g., Sacramento-San Joaquin Delta) as a result of decreased potable water demands.
- Creation or enhancement of wetlands and riparian habitats. Recycled water that is fed to wetlands ensures that such sensitive and critical systems do not "run dry." The Bay Area is renowned for using recycled water to enhance such environmental systems as evidenced by numerous projects that have been operational for decades (e.g., Moorhen Marsh at Mt. View Sanitary District; polishing wetlands at Petaluma's Ellis Creek Water Recycling Facility) or are in the planning stages (e.g., the City of Novato's new brackish marsh habitat as part of the State Coastal Conservancy's Bel Marin Keys Unit V wetland restoration project that is slated to be constructed by year 2030).
- Diversification of water supply at a local and regional level. Recycled water offers a means to bolster a region's water supply resiliency with a local source, which is especially critical with drought-prone areas such as Northern California.
- When used for irrigation, the nutrients in recycled water may offset chemical fertilizer demands-, providing some economic benefit to users and environmental benefit from decreased chemical production.
- Public areas (e.g., parks) can stay green during drought-related water reductions.

4.1.2 The Seasonality of Reuse

Prior to receiving the RFI responses from the POTWs, it was anticipated that the dry season volumes would be more pronounced than the wet season. The responses supported to this notion, whereby the dry season volumes constitute approximately 55 to 60 percent of the average annual volumes (despite only representing 42 percent of the year). This nuance is critical to understanding the differences between the dry season and average annual projections.

It was apparent during discussions with numerous POTWs that they are limited during the dry season to POTW effluent as the recycled water demands exceeds production. This phenomenon has become more pronounced in recent years due to a combination of drought, an increase in recycled water customers, and water conservation that has reduced flows at POTWs, and others.

Data supporting such claims includes various POTWs that discharge to San Pablo Bay (e.g., Petaluma, Sonoma Valley, Napa, etc.) have not discharged to SF Bay during both the dry season, shoulder seasons (fall and spring), and even the winter. In fact, Sonoma Valley has had several years of late where every drop of effluent was used for recycled water applications.

The transition to more potable reuse projects is expected to translate into recycled water production that is nearly steady throughout the year. For the Confidence Level 4 projects included in this study, dry season production is less than 50 percent of the average annual flow, which is logical since the dry season makes up only 42 percent of the year (five months out of 12).

4.1.3 Menu of Nutrient Management Options

An overarching goal for the First and Second Watershed Permits is to produce a menu of nutrient management options. To date, the available options comprise enhancements at the POTWs involving optimization, sidestream treatment, and plant upgrades, exploring the potential of recycled water (as studied here), and ongoing research on Nature-based Solutions (NbS).

As BACWA and its member agencies further evaluate nutrient management solutions, the evaluation should consider the numerous benefits that recycled water offers. Specifically, the evaluation should look beyond basic economic benefits or costs, to look at non-economic factors to assess the project's overall sustainability. Stakeholders should consider the "triple bottom line", which is an approach used for justifying an investment taking the following three factors into account:

- **Economic vitality:** overall economic impact that expands the boundary conditions beyond simply the construction and operating costs. For example, what are the economic associated with the multi-benefits of reuse projects (refer to Section 4.1.1), as well as other infrastructure demands if such reuse projects are not implemented.
- **Environmental stewardship:** beyond water quality regulatory requirements (refer to Section 4.1.1)
- **Social responsibility:** watershed-based perspective at a minimum (refer to Section 4.1.1)

Each factor should consider criteria meaningful and significant to all stakeholders, and relevant to the project being considered. Ideally the criterion should be quantifiable so that it is less subjective, though this is not always possible particularly for criteria under the "social" category.

In developing a list of criteria, it is important to consider the number and weighting assigned to the criteria. A longer list of criteria is more comprehensive, but it dilutes the significance that each individual criterion will have in an overall scoring. Conversely, a shorter list of more pertinent criteria will add weight to each criterion, but it will be less comprehensive and may miss discussion of topics that are important to other stakeholders.

An example of a hypothetical triple bottom line scoring for a business case evaluation (BCE) that considered various disinfection alternatives is provided in Figure 4-1. A final step that can be taken is a sensitivity analysis, whereby the weightings of the criteria are shifted to see how far they would need to move to change the decision.

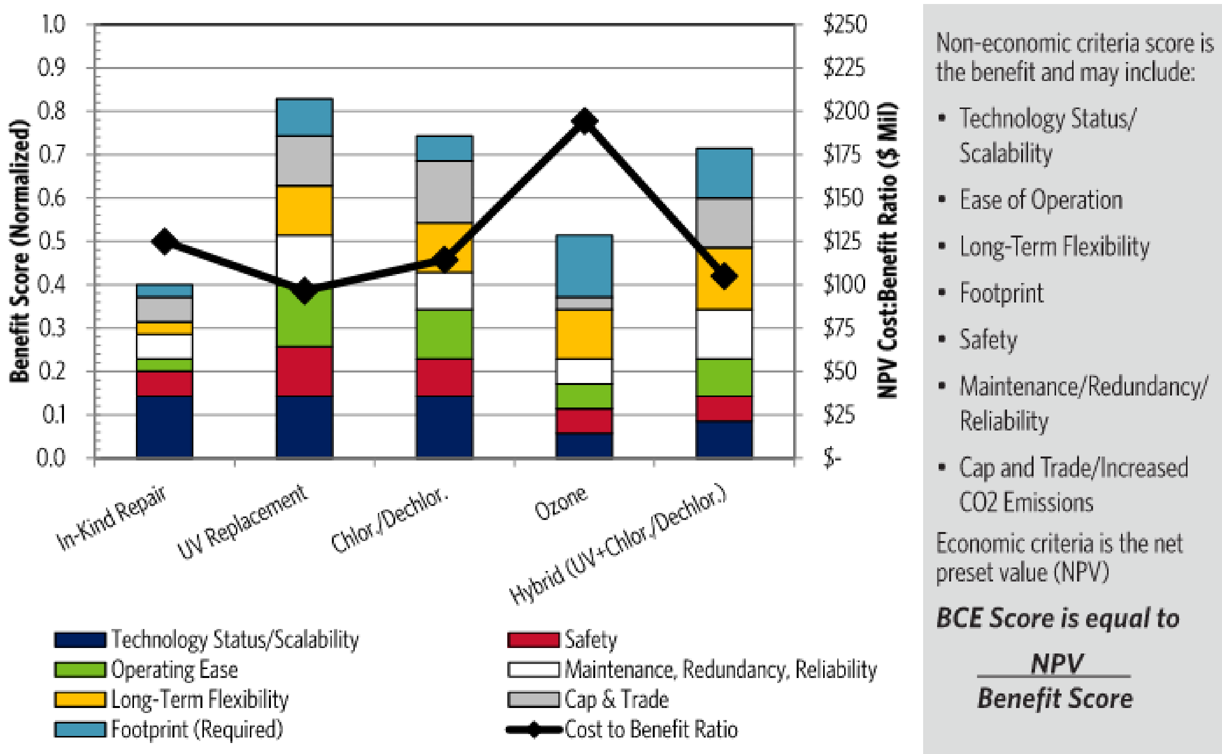

Figure 4-1. Example Triple-Bottom-Line Scoring (Source, HDR)

BCE = Business Case Evaluation

While Figure 4-1 provides a hypothetical triple bottom line, it is somewhat overly simplified compared to what would be needed for capturing the multi-benefits associated with reuse projects (refer to Section 4.1.1).

While there are numerous strategies to implement a triple bottom line analysis, it is not the intent of this Recycled Water Report to suggest an approach or strategy for implementing a TBL analysis. Rather, this focus should be that implementing a wider lensed analysis to inform future decision-making on how best to manage nutrients across SF Bay.

4.2 Study Limitations

While this Potential Nutrient Reduction by Recycled Water captures potential reuse projects to manage nutrients across SF Bay, this Recycled Water Report does have limitations that warrant further discussion. Each of these limitations is discussed in the subsections that follows.

4.2.1 Confidence in Projects

This analysis made a concerted effort to distinguish between various potential reuse projects based on defined confidence levels (1 through 4; refer to Table 2-1). For potential projects identified as Confidence Levels 3 or 4, the likelihood of project implementation is unclear. In contrast, projects identified as Confidence Levels 1 and 2 are already happening and/or have a strong likelihood of implementation. Incorporation of such levels is vital as it considers the likelihood of recycled water project implementation. Otherwise, the data might overstate the potential for future recycled water projects.

As previously stated in Section 3, several of the potential projects that are in between Confidence Levels 2 and 3 were conservatively grouped as Confidence Level 3. The basis for taking the more conservative approach in confidence was predicated on a blend of not wanting to overstate potential coupled with concerns over how such projects would be funded.

4.2.2 Advanced Treatment Reject Streams Associated with Potable Reuse Projects

As previously stated, several of the recycled water uses do not necessarily keep nutrients out of SF Bay (such as some industrial uses with a return stream to the plant; internal treatment plant uses; and portion of flows/loads for potable reuse applications). This effort attempted to account for this by discounting any flows and loads that would eventually end up in SF Bay.

Most notable of these streams are potable reuse, as several potable reuse projects are identified as Confidence Levels 3 and 4. As previously noted in Section 2.6, the nutrient reductions associated with advanced treatment facilities only have modest nutrient load reductions as most of the nutrient loads will end up in SF Bay via the RO concentrate return flows. This analysis assumed that such RO concentrate return flows would include 20 percent of the volume and 84 percent of the TIN loads (unless provided by the POTW). Additional nutrient removal could be achieved via treatment of RO concentrate, although this was not included in the load reduction estimates or cost estimates.

4.2.3 Inconsistencies in Cost Information

The First Watershed Permit report (HDR, 2018) applied a consistent approach to cost development for all the projects included in the report. In fact, the consultant team sized and costed each of the elements that composed the various optimization, sidestream, and upgrades for each agency.

The costs presented in this Potential Nutrient Reduction by Recycled Water are based on a combination of already quantified cost information and/or cost estimates provided by each agency. The basis for having each agency provide its cost information, was in most cases, such information was readily available from a blend of actual data and planning-level documents. Furthermore, relying on existing data reduced the level of effort to perform this study.

While effective for advancing the conversation to produce a menu of nutrient management options, the costs are not directly comparable as they may be based on different levels of project development and have other unclear differences. Regardless, the cost information is used to provide overall context to within a magnitude and nuanced differences can be further refined as POTWs advance their reuse programs.

4.2.4 Limited to POTW Effluent

This Recycled Water Report is limited to using POTW effluent for recycled water applications. It ignores nutrient management measures as an overall strategy for managing nutrients that end up in SF Bay. For example, the nutrients contained in recycled water can be of added value as a strategy to reduce chemical fertilizers in agricultural/landscape applications.

A more holistic watershed-based approach to nutrients could be warranted, especially as the nutrient management efforts continue to accelerate.

4.2.5 Comparison against First Watershed Permit and Nature-Based Solutions

As previously discussed in Section 4.1.3. This Potential Nutrient Reduction by Recycled Water, a more exhaustive evaluation beyond simple unit cost metrics is warranted to make informed decisions. For example, recycled water projects provide other economic and non-economic benefits (e.g., water supply resiliency) which should be factored into making an informed decision on nutrient management strategies.

4.2.6 Potential for Recycled Water

This Potential Nutrient Reduction by Recycled Water does not quantify the regional potential that is technically feasible for reuse. Rather, it compares projected recycled water volumes and flows against current effluent flows and loads across SF Bay. The ongoing WRF study 4962, led by Leverenz et al. (Leverenz, in preparation), will address the factors that impact the implementation of reuse projects, such as the required minimum instream flows (a constraint primarily affecting inland dischargers), water quality, proximity to potential water reuse sites, and cost. The study will develop a tabular and geographic information system (GIS) databases to estimate the current and future projected volumes of municipal wastewater available to recycle under applicable constraints. This information will help determine future RW targets, inform the potential for future mandates, and assist with the identification of funding needs and strategies to optimize recycled water in California.

4.2.7 Potable Reuse Regulations

The regulations for potable reuse are still in draft stage for the State of California. It is anticipated that the regulations will be finalized by the end of 2023. The draft framework is currently structured so that RO with an advanced oxidation process(es) (AOP) will be required to meet pathogen logarithmic reduction credits. It is anticipated that such requirements will remain intact for the final regulations. However, any significant changes beyond the draft potable reuse regulations could influence the implementation of any future potable reuse projects captured in this Potential Nutrient Reduction by Recycled Water.

4.2.8 Unit Costs for Projects that Extend Beyond Year 2045:

The unit cost values for projects that are not slated until closer to year 2045 are subject to skewed unit cost values. For instances where the project does not start until say year 2041, the analysis only considers water production through year 2045 which can result in skewed unit costs as it does not consider production years beyond year 2045. For example, the Confidence Level 4 project for San Jose has a unit value of approximately $14,000/AF as it is limited to five-years of water production. If this same project included 25-years of water production, the unit cost would be reduced to approximately $4,200/AF.

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5 Summary and Next Steps

Recycled water represents one of several nutrient management strategies across SF Bay. The fundamental challenge with the currently available information is the uncertainty associated with implementation. Specifically, it is unclear how many Confidence Levels 2 through 4 projects will be implemented. Regardless, this Reuse Study provides context for the extent of current and potential future RW projects across SF Bay.

Recycled water uses currently divert just under 10 percent of the annual flow and 5 percent of the annual TIN loads from SF Bay. These values are expected to more than double in the next 25 years for those projects listed as Confidence Levels 1 through 3 (a majority is represented by those in Confidence Level 1). There is potential for significant increase for those listed as Confidence Level 4, which in most cases would occur after year 2035. Such projects are highly dependent on funding, potable reuse regulations (still in draft), and multi-agency cooperation.

The key drivers and barriers for implementing reuse projects are water supply needs and funding, respectively. Having access to funding would likely expedite several of the potential projects (Confidence Levels 2 through 4). Another notable barrier is jurisdictional issues as a large portion of recycled water projects require collaboration with drinking water providers. In many cases, a multi-agency agreement is needed between a POTW and the local drinking water agency to progress a project from concept through implementation. Providing recycled water across jurisdictional lines has its own set of jurisdictional challenges.

The results of this study should be taken in context with the NbS task results (being performed separately), to provide a menu of nutrient management options that will complement those prepared in the First Watershed Permit. BACWA and its member agencies will need to consider the various evaluated options and content to inform the next steps. Specifically, other economic and non-economic parameters (e.g., water supply resilience, air emissions, etc.) should factor into future decision-making.

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A

Scoping and Evaluation Plan

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Bay Area Clean Water Agencies

Scoping and Evaluation Plan

Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

November 26, 2019

Table of Contents

List of Tables

Introduction

On May 8, 2019, the San Francisco Regional Water Quality Control Board (Water Board) issued Order No. R2-2019-0017, *Waste Discharge Requirements for Nutrients from Municipal Wastewater Discharges to San Francisco Bay* (Watershed Permit). The Watershed Permit sets forth a regional framework to facilitate collaboration on studies that will inform future management decisions and regulatory strategies. The 2019 Watershed Permit has four special provisions to implement as follows:

1. Reopener provisions.
2. Regional evaluation of potential nutrient discharge reduction by natural systems.
3. Regional evaluation of potential nutrient discharge reduction by water recycling.
4. Monitoring, modeling, and subembayment studies.

This Scoping and Evaluation Plan for the Regional Evaluation of Potential Nutrient Discharge Reduction is a component of item 3, listed above. The other provisions of the 2019 Watershed Permit that require submittals to the Water Board (natural systems and modeling systems) are being addressed separately. The Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling will result in a Recycled Water Study that will increase the understanding of potential effluent nutrient load reductions and the associated costs for water recycling projects by the publically owned treatment works (and other agencies) that discharge to the San Francisco Bay.

Forty four agencies, as listed in Appendix A, were identified in the 2019 Watershed Permit to conduct the water recycling evaluation. These agencies (the participating agencies) have agreed to conduct the evaluation collectively, as members of the Bay Area Clean Water Agencies (BACWA).

Scoping and Evaluation Plan

The 2019 Watershed Permit requires a Scoping and Evaluation Plan that describes the approach and schedule for completing the nutrient reduction studies by water recycling. The effluent nutrients of interest are nitrogen ion species and total phosphorus. The evaluation will consider both current and projected flows for water recycling. The evaluation includes the following steps:

- Issue a request for information (RFI) to each participating agency
- Compile data and planning documents and perform a preliminary assessment
- Review preliminary assessment with each participating agency
- Prepare draft report for each participating agency
- Review period for each agency to review their report
- Finalize each agency report based on report comments
- Prepare the Draft Recycled Water Study that summarizes the overall study findings
- Review period for BACWA to review the Draft Recycled Water Report
- Finalize the Recycled Water Report and submit to the Water Board

The following sections describe the study schedule and the tasks that will be implemented to complete the aforementioned steps.

Schedule

The 2019 Watershed Permit requires the submission of a status report by July 1, 2021 and again by July 1, 2022. The final report is due to the Water Board on July 1, 2023.

An overview of the schedule for completion of the water recycling study is presented in Table 1. The project schedule has been designed to efficiently execute the study ahead of the deadlines specified in the 2019 Watershed Permit.

Table 1. Schedule by Tasks

Task	Description	Permit Deadline	Proposed Completion Date	Comment
1. Scoping and Evaluation Plan	Prepare a combined document for review by BACWA and submission to the Water Board	Scoping Plan – 12/1/2019 Evaluation Plan - 7/1/2020	12/1/2019	These plans will be combined into one document that describes the project approach and schedule
2. Data Collection and Analysis	Issue RFIs to participating agencies; collect, review and compile data; perform analysis	N/A	2/2021	Collect agency information, including data and reports, provide guidance via webinar(s), compile data and consult with agencies for clarifications, and perform analysis
3. Status Report No. 1	Submittal to Water Board describing tasks completed	7/1/2021	7/1/2021	
4. Agency Reports and Validation	Prepare agency report template, individual agency reporting (draft and final), and collect agency validation letters	N/A	7/2022	Each agency will have an opportunity to review its respective draft agency report and provide comments. Upon receiving comments, a conference call will be held to review the comments prior to finalizing each agency report
5. Status Report No. 2	Submittal to Water Board describing tasks completed	7/1/2022	7/1/2022	
6. Recycled Water Study	Prepare Draft and Final Recycled Water Study	7/1/2023	7/1/2023	The study will summarize overall findings. The Final Study will be presented to the Water Board
7. Project Management	Participate in meetings to convey study progress and findings, manage the project, and perform QA/QC	N/A	6/2022	

Data Collection and Analysis

As part of the Nutrient Reduction Study that was conducted under the first Watershed Permit (R2-2014-0014), a series of RFIs were submitted to the participating agencies that focused initially on general plant information, plant facilities, and performance, followed by an RFI on future and projected recycled water projects. The recycled water survey from the first Watershed Permit (R2-2014-0014) focused on recycled water demands for various categories of recycled water use types, from existing through 2040 in five year increments. The RFI(s) associated with this Recycled Water Study will expand and refine the recycled water questionnaire from the first Watershed Permit (R2-2014-0014).

Following receipt of the requested information and documents, a preliminary assessment will be conducted, followed by a conference call with each agency to confirm the preliminary assessment and clarify any outstanding data needs.

The following sections provide additional detail regarding the data collection and analysis tasks.

Data Collection

The RFI will be submitted to each participating agency during the spring of 2020. This detailed request will expand and refine the recycled water questionnaire from the first Watershed Permit (R2-2014-0014). The expanded and refined RFI will seek the following information:

- Description of existing recycled water program and service area, including maps, figures, and details of existing demands and use types.
- Current recycled water flows and associated nutrient loads removed (if applicable and available).
- Updated status of previously identified recycled water projects, including the relative confidence that the project will be implemented (e.g., is the project conceptual, included in a CIP, currently in construction, etc.) and the anticipating timing of the project, and projected growth in recycled water use over time.
- Projected future recycled water use, in five-year increments. Where available, anticipated type of recycled water use will be collected to support the evaluation of nutrient loads removed. Recycled water seasonality demand will also be considered, particularly for those agencies with a dry season discharge prohibition
- Estimated capital and operations and maintenance (O&M) costs, for each respective anticipated project.

Once the RFIs have been issued to the participating agencies, consultant will confer with each agency to review and confirm the data provided and resolve any outstanding questions.

Analysis

Upon receiving the requested information, the data will be organized and compiled. The analysis for each participating agency will include the following:

- Recycled water flows by use type, in five year increments. Projected flows will be captured in acre-feet per year. An average daily use will be estimated in order to estimate the reduction in the nutrient load discharged to San Francisco Bay. Projections will be presented in five year increments, beginning in 2020 (as current).

- Nutrient load reduction projections for Ammonia and Total Inorganic Nitrogen constituents. Not all recycled water use types result in a reduction in nutrient loads discharged to the bay. Some uses, such as potable reuse, could increase nutrient concentrations discharged to the bay due to the concentrated return streams created during the advanced treatment processes. Generally, irrigation uses (i.e., landscape, golf course, and agricultural) result in a decrease of nutrient loads since the water is consumed at the application site. However, uses such as potable reuse and some industrial uses, will have a concentrated stream that is either returned to the wastewater treatment plant for discharge or otherwise discharged to the bay. Thus, with respect to identifying the nutrient reductions associated with future recycled water uses, the use type will be captured (if available) and the load reduction will be estimated accordingly.
- Capital and operations and maintenance (O&M) costs will be included, if available. Costs will be escalated to the ENR CCI for the SF Bay Area for the most current period prior to completing the draft recycled water study. It is assumed that cost estimates will be available from existing master plans (or more detailed cost estimates) as provided by the participating agency. Development of new cost estimates is not anticipated.
- Develop unit metrics for comparison with the 2018 Nutrient Reduction Study and to allow comparisons between the participating agencies. Unit metrics will include the following:
    - Cost per acre-foot for recycled water project yield ($/acre-foot). A 30 year planning period will be used to allow comparison with 2018 Nutrient Reduction Study (HDR, 2018).
    - Cost per pound of nutrient removed ($/lb nutrient removed). A 30 year planning period will be used to allow comparison with 2018 Nutrient Reduction Study (HDR, 2018). To maintain consistency with the 2018 Study, the projected discharge concentrations will be based on the 2015 BACWA Nutrient Reduction Study Group Annual Report (which includes nutrient effluent data from 7/2012 through 6/2015) and projected to the midpoint of the planning period.
    - Capital and/or present value cost per gallon of recycled water used per day ($/gpd). Present value costs can only be prepared if estimated O&M costs are available. In the absence of O&M costs, only capital cost per gallon of recycled water used per day will be provided. This unit metric will be prepared to allow for comparison with the 2018 Nutrient Reduction Study.
- Qualitative identification of adverse effects and benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, increase of nutrient concentration discharged to the bay, reduction of chemical fertilizer reliance, etc.).

- Assessment of feasibility, efficacy, and reliability for each project (e.g., low reliability for recycled water fill stations).
- Identification of potential challenges to implementation (e.g., regulatory barriers, disposal of concentrate from reverse osmosis (RO) treatment).

Agency Reporting

The results of the recycled water data collection and analyses will be documented in individual agency reports and provided to each participating agency for review and confirmation prior to finalization. Each individual report will have the following sections:

- Executive summary that includes a table (flow projections, load reduction, and cost of implementation in five-year increments) and a brief description of the future recycled water projects and uses.
- Introduction of each agency, plant and processes (limited to agencies with plant facilities), summary of relevant discharge requirements (e.g., dry season prohibition), and existing recycled water service area, flows, and use types.
- Description of study approach, including methods for projecting recycled water and nutrient load reductions from discharge, and unit cost calculations.
- Results that present the analysis in tables and figures and discusses the likelihood of implementation of future recycled water projects.
- Summary of adverse impacts and benefits, feasibility, and potential challenges to implementation.
- Appendices will include any relevant information from the RFI excluded from the main body and the agency acceptance letter.

Each agency will have an opportunity to review its draft agency report and provide comments prior to the report being finalized for inclusion in the Draft Recycled Water Study.

Recycled Water Study

Following completion of the agency specific reports, an executive summary style report will be prepared to summarize the information and results. The components of the Recycled Water Study will include:

- Executive summary that presents the overall findings and provides context on the role of recycled water as a means to reduce nutrient loads discharge to San Francisco Bay.
- Basis of evaluation that describes the approach and methodologies employed for the study.
- Results summarized by subembayment and bay-wide, presented with tables and graphics.

- Summary of study limitations.
- Key observations, as appropriate.
- Appendices, including each agency report, agency acceptance letters, scoping and evaluation plan, and other information if appropriate.

Appendix A – Participating Facilities

No.	Discharger	Facility Name	Facility Address	Minor/ Major
1	American Canyon, City of	Wastewater Treatment and Reclamation Facility	151 Mezzetta Court American Canyon, CA 94503 Napa County	Major
2	Benicia, City of	Benicia Wastewater Treatment Plant	614 East Fifth Street Benicia, CA 94510 Solano County	Major
3	Burlingame, City of	Burlingame Wastewater Treatment Plant	1103 Airport Boulevard Burlingame, CA 94010 San Mateo County	Major
4	Central Contra Costa Sanitary District	Central Contra Costa Sanitary District Wastewater Treatment Plant	5019 Imhoff Place Martinez, CA 94553 Contra Costa County	Major
5	Central Marin Sanitation Agency	Central Marin Sanitation Agency Wastewater Treatment Plant	1301 Andersen Drive San Rafael, CA 94901 Marin County	Major
6	Crockett Community Services District	Port Costa Wastewater Treatment Plant	End of Canyon Lake Drive Port Costa, CA 94569	Minor
7	Delta Diablo	Delta Diablo Wastewater Treatment Plant	2500 Pittsburg-Antioch Hwy Antioch, CA 94509 Contra Costa County	Major
8	East Bay Dischargers Authority (EBDA); Cities of Hayward and San Leandro; Oro Loma Sanitary District; Castro Valley Sanitary District; Union Sanitary District; East Bay Regional Parks District; Livermore-Amador Valley Water Management Agency, Dublin San Ramon Services District, and City of Livermore	*EBDA Common Outfall*[A]	EBDA Common Outfall 14150 Monarch Bay Drive San Leandro, CA 94577 Alameda County	Major
9		Hayward Water Pollution Control Facility		
10		San Leandro Water Pollution Control Plant		
11		Oro Loma/Castro Valley Sanitary Districts Water Pollution Control Plant		
12		Union Sanitary District, Raymond A. Boege Alvarado Wastewater Treatment Plant		
13		East Bay Regional Parks District[B]		
14		*Livermore-Amador Valley Water Management Agency Export and Storage Facilities*[A]		
15		Dublin San Ramon Services District Wastewater Treatment Plant (LAVMA)		
16		City of Livermore Water Reclamation Plant		
17	East Bay Municipal Utility District	East Bay Municipal Utility District, Special District No. 1 Wastewater Treatment Plant	2020 Wake Avenue Oakland, CA 94607 Alameda County	Major
18	Fairfield-Suisun Sewer District	Fairfield-Suisun Wastewater Treatment Plant	1010 Chadbourne Road Fairfield, CA 94534 Solano County	Major
19	Las Gallinas Valley Sanitary District	Las Gallinas Valley Sanitary District Sewage Treatment Plant	300 Smith Ranch Road San Rafael, CA 94903 Marin County	Major
20	Marin County (Paradise Cove), Sanitary District No. 5 of	Paradise Cove Treatment Plant	3700 Paradise Drive Tiburon, CA 94920	Minor
21	Marin County (Tiburon), Sanitary District No. 5 of	Wastewater Treatment Plant	2001 Paradise Drive Tiburon, CA 94920	Minor
22	Millbrae, City of	Water Pollution Control Plant	400 East Millbrae Avenue Millbrae, CA 94030 San Mateo County	Major

No.	Discharger	Facility Name	Facility Address	Minor/ Major
23	Mt. View Sanitary District	Mt. View Sanitary District Wastewater Treatment Plant	3800 Arthur Road Martinez, CA 94553 Contra Costa County	Major
24	Napa Sanitation District	Soscol Water Recycling Facility	1515 Soscol Ferry Road Napa, CA 94558 Napa County	Major
25	Novato Sanitary District	Novato Sanitary District Wastewater Treatment Plant	500 Davidson Street Novato, CA 94945 Marin County	Major
26	Palo Alto, City of	Palo Alto Regional Water Quality Control Plant	2501 Embarcadero Way Palo Alto, CA 94303 Santa Clara County	Major
27	Petaluma, City of	Ellis Creek Water Recycling Facility	3890 Cypress Drive Petaluma, CA 94954 Sonoma County	Major
28	Pinole, City of	Pinole-Hercules Water Pollution Control Plant	11 Tennent Avenue Pinole, CA, 94564 Contra Costa County	Major
29	Rodeo Sanitary District	Rodeo Sanitary District Water Pollution Control Facility	800 San Pablo Avenue Rodeo, CA 94572 Contra Costa County	Major
30	San Francisco (San Francisco International Airport), City and County of	Mel Leong Treatment Plant, Sanitary Plant	Bldg. 924 Clearwater Drive San Francisco, CA 94128 San Mateo County	Major
31	San Francisco (Southeast Plant), City and County of	Southeast Water Pollution Control Plant	750 Phelps Street San Francisco, CA 94124 San Francisco County	Major
32	San Jose and Santa Clara, Cities of	San Jose/Santa Clara Water Pollution Control Plant	700 Los Esteros Road San Jose, CA 95134 Santa Clara County	Major
33	San Mateo, City of	City of San Mateo Wastewater Treatment Plant	2050 Detroit Drive San Mateo, CA 94404 San Mateo County	Major
34	Sausalito-Marin City Sanitary District	Sausalito-Marin City Sanitary District Wastewater Treatment Plant	1 East Road Sausalito, CA 94965 Marin County	Major
35	Sewerage Agency of Southern Marin	Wastewater Treatment Plant	450 Sycamore Avenue Mill Valley, CA 94941 Marin County	Major
36	Silicon Valley Clean Water	Silicon Valley Clean Water Wastewater Treatment Plant	1400 Radio Road Redwood City, CA 94065 San Mateo County	Major
37	Sonoma Valley County Sanitary District	Municipal Wastewater Treatment Plant	22675 8th Street East Sonoma, CA 95476 Sonoma County	Major
38	South San Francisco and San Bruno, Cities of	South San Francisco and San Bruno Water Quality Control Plant	195 Belle Air Road South San Francisco, CA 94080 San Mateo County	Major
39	Sunnyvale, City of	Sunnyvale Water Pollution Control Plant	1444 Borregas Avenue Sunnyvale, CA 94089 Santa Clara County	Major
40	U.S. Department of Navy (Treasure Island)	Treasure Island Wastewater Treatment Plant	1220 Avenue M, San Francisco, CA 94130-1807 San Francisco County	Major

No.	Discharger	Facility Name	Facility Address	Minor/ Major
41	Vallejo Flood and Wastewater District	Vallejo Flood and Wastewater District Wastewater Treatment Plant	450 Ryder Street Vallejo, CA 94590 Solano County	Major
42	West County Agency; West County Wastewater District; City of Richmond; and Richmond Municipal Sewer District	West County Agency Combined Outfall[B]	2910 Hilltop Drive Richmond, CA 94806 Contra Costa County	Major
43		West County Wastewater District (WCWD) Treatment Plant		
44		Richmond Municipal Sewer District Water Pollution Control Plant		

Note:

A. Conveyance; no treatment facilities.

B. No treatment facilities

B

Individual Plant Reports

Organization of Individual Plant Reports (Participating POTWs):

1. American Canyon Water Reclamation Facility
2. Benicia WWTP
3. Burlingame WWTP
4. Central Contra Costa Sanitary District WWTP
5. Central Marin Sanitation Agency WWTP
6. Delta Diablo WWTP
7. Dublin San Ramon Services District WWTP
8. East Bay Municipal Utility District, Special District No. 1 WWTP
9. Fairfield Suisun WWTP
10. Hayward Water Pollution Control Facility
11. Las Gallinas Valley Sanitary District Sewage Treatment Plant
12. City of Livermore Water Reclamation Plant
13. Millbrae Water Pollution Control Plant
14. Mt. View Sanitary District WWTP
15. (Napa) Soscol Water Recycling Facility
16. Novato Sanitary District WWTP
17. Oro Loma / Castro Valley Sanitary Districts Water Pollution Control Plant (includes East Bay Dischargers Authority)
18. Palo Alto Regional Water Quality Control Plant
19. (Petaluma) Ellis Creek Water Recycling Facility
20. Pinole-Hercules Water Pollution Control Plant
21. Richmond Municipal Sewer District Water Pollution Control Plant
22. Rodeo Sanitary District Water Pollution Control Facility
23. (San Francisco International Airport) Mel Leong Treatment Plant, Sanitary Plant
24. (San Francisco Public Utilities Commission) Southeast Water Pollution Control Plant
25. San Jose-Santa Clara Regional Wastewater Facility
26. San Leandro Water Pollution Control Plant
27. City of San Mateo WWTP
28. Sausalito-Marin City Sanitary District WWTP
29. Sewerage Agency of Southern Marin WWTP
30. Silicon Valley Clean Water WWTP
31. Sonoma Valley County Sanitation District
32. South San Francisco and San Bruno Water Quality Control Plant
33. Sunnyvale Water Pollution Control Plant
34. Treasure Island WWTP
35. Union Sanitary District (Raymond A. Boege Alvarado WWTP)
36. Vallejo WWTP
37. West County Wastewater District WWTP

American Canyon Water Treatment Facility

BACWA Recycled Water Study

Final Individual Plant Report

American Canyon, CA
May 22, 2023

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Contents

Tables

Figures

Executive Summary

The American Canyon Water Reclamation Facility (American Canyon) discharges treated effluent to freshwater wetland ponds and the North Slough during the wet season. During the dry season, treated effluent is used for reclamation and is discharged to freshwater wetland ponds. It is located at 151 Mezzetta Court in American Canyon, CA. The facility serves the city of American Canyon, which has a population of approximately 16,800 (from Appendix F of NPDES Permit No. CA 0038768). The plant receives both domestic and industrial wastewater. The two wastewaters are conveyed separately to the treatment facility and can remain segregated during treatment or can be combined at the plant, upstream of treatment. Industrial dischargers to the plant include a food processing facility, winery and beverage bottling facilities. The plant has an average dry weather flow (ADWF) permitted capacity of 2.5 million gallons per day (mgd) and a peak permitted wet weather flow of 5.0 mgd.

American Canyon already removes ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP) loads with their existing treatment plant that includes a membrane bioreactor. The existing nutrient removal performance has TIN levels reliably below 10 mg N/L and modest TP load reduction (discharge around 4 mg P/L).

American Canyon (the City) has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The WRF currently recycles approximately 150 – 300+ acre-feet per year (43 to 86+ million gallons per year). The City is planning to expand the existing recycled water system to maximize connections and demands for landscape and agricultural use. This buildout is divided into two "phases" – near-term (0-10 years) and long-term (11-20 years). Near-term expansion will result in an additional 300+ acre-feet per year, and long-term expansion will result in an additional 600+ acre-feet per year. The City may identify additional customers over time.

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES-1. The timeline and corresponding load diversions from the Bay for projected listed in Table ES-1 is provided in Figure ES-1.

The drivers and barriers that govern American Canyon's ability to expand their recycled water services are as follows:

- Drivers: Water Supply Need
- Barriers: Institutional as American Canyon is focused on meeting NPDES limits with limited staffing to further advance a recycled water agenda.

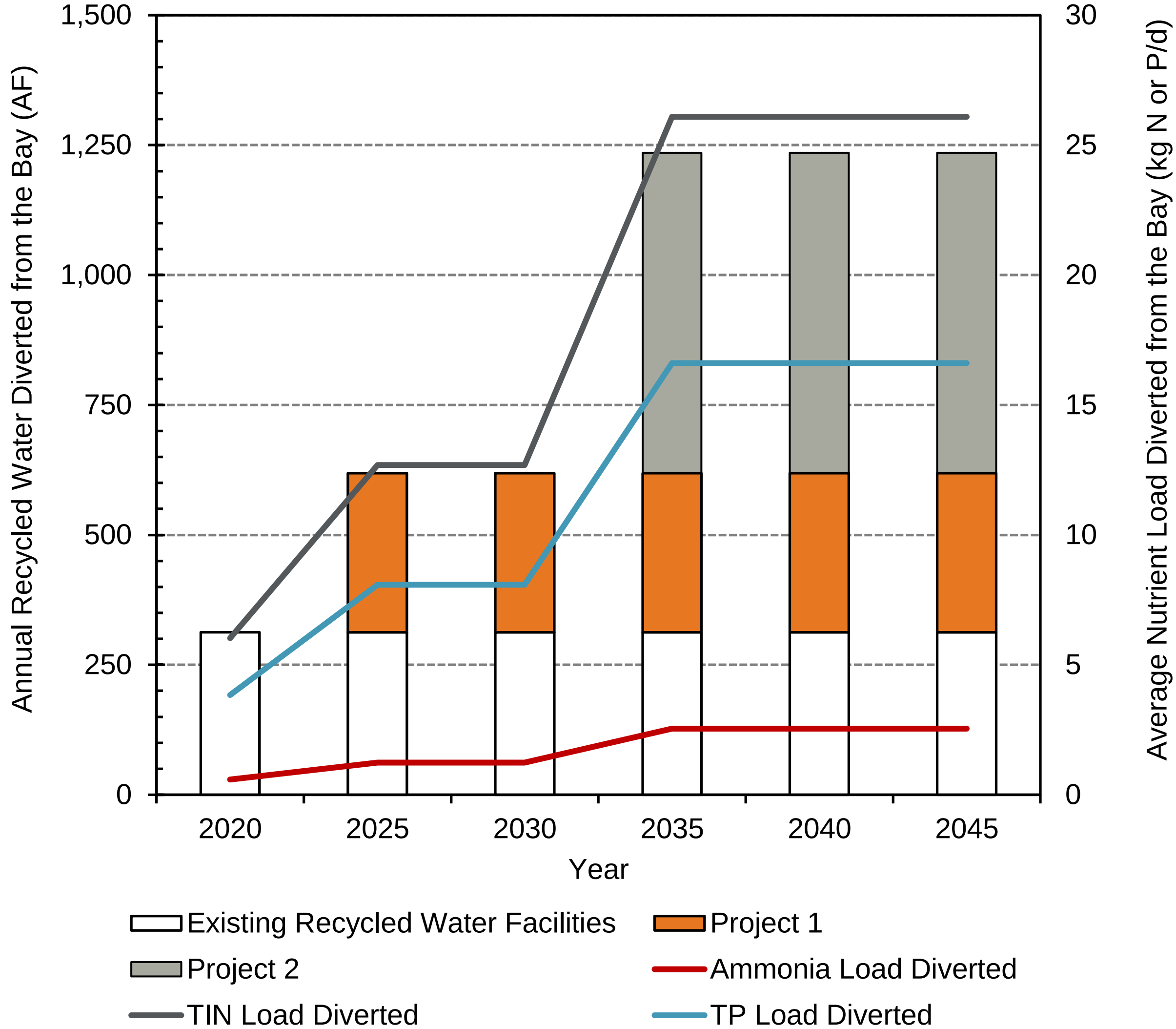

Figure ES-1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge

Table ES-1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Project 1 (Expand Existing in 1 - 10 years) *,**		Future Project 2 (Expand Existing in 11 - 20 years) *,**		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (May 1 - Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (May 1 - Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (May 1 - Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (May 1 - Sept 30)
Flow/Volume Diverted from the Bay[1]									
Flow	mgd	0.4	0.3	0.5	0.2	0.9	0.6	1.3	0.8
Volume	AF	199	313	215	255	424	616	591	876
Load Diverted from the Bay[2,3]									
Confidence	unitless	1	1	2	2	3	3	--	--
Duration	Years	25	25	20	20	10	10	25	25
Flow Diverted	%	27%	15%	29%	13%	29%	7%	53%	33%
Ammonia Load Diverted	kg N/d	1	1	1	1	2	1	2	2
TIN Load Diverted	kg N/d	9	6	12	6	23	13	28	16
TP Load Diverted	kg P/d	6	4	8	4	15	9	18	10
Cost[3,4,5]									
Capital Cost	$ Mil	--	--	13.4	13.4	13.3	13.3	26.8	26.8
NPV O&M	$ Mil	9.6	15.1	3.2	4.6	8.0	11.6	20.8	31.3
NPV Total (Capital+NPV O&M)	$ Mil	9.6	15.1	16.6	18.0	21.4	25.0	47.5	58.1
Unit Flow Cost[6]									
Unit Cost	$/gpd	23	54	36	79	24	45	38	74
Unit Cost	$/AF	1,920	1,920	3,860	3,540	5,030	4,050	3,220	2,650
Unit Load Cost[7,8,9]									
Ammonia Unit Cost	$/lb Ammonia Diverted	1,590	1,280	2,760	2,070	3,600	2,380	2,640	1,870
TIN Unit Cost	$/lb TIN Diverted	122	124	212	202	277	232	203	182
TP Unit Cost	$/lb TP Diverted	189	195	328	318	428	364	314	287

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the specific project duration (varies by project; details provided with each project in Section 3).

1. Flow/volume values consider the duration (both years and number of days per season (e.g., 153 days for average dry season and 365 days for average annual)).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by American Canyon (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the listed project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the listed average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration (e.g., daily average listed load X number of days for averaging period X unit conversion (kg to lb) X duration as years).
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (e.g., NPV total divided by (daily average listed load X number of days for averaging period X unit conversion (kg to lb) X duration as years)).

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1 Introduction and Current Conditions

The American Canyon Water Reclamation Facility (American Canyon) discharges treated effluent to freshwater wetland ponds and the North Slough during the wet season. During the dry season, treated effluent is used for reclamation and is discharged to freshwater wetland ponds. It is located at 151 Mezzetta Court in American Canyon, CA. The facility serves the city of American Canyon, which has a population of approximately 16,800 (from Appendix F of NPDES Permit No. CA 0038768). The plant receives both domestic and industrial wastewater. The two wastewaters are conveyed separately to the treatment facility and can remain segregated during treatment or can be combined at the plant, upstream of treatment. Industrial dischargers to the plant include a food processing facility, winery and beverage bottling facilities. The plant has an average dry weather flow (ADWF) permitted capacity of 2.5 million gallons per day (mgd) and a peak permitted wet weather flow of 5.0 mgd.

The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

American Canyon holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2019-2017 CA0038768). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations Order No. R2-2019-0010; CA0038768)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly
Influent Flow	mgd	2.5	--	--
Effluent BOD (1)	mg/L	--	10	15
Effluent TSS (1)	mg/L	--	10	15
Effluent Ammonia	mg/L	--	2	3

1. BOD and TSS include a minimum percent removal of 85% through the WRF
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;
- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for American Canyon. Both liquids processes and solids processes are shown. Primary treatment is not provided at the plant. Both industrial and domestic inflows are treated using nitrifying membrane bioreactors (MBRs). The plant has both chlorine and UV disinfection facilities; chlorine disinfection is used for the disinfection of recycled water and UV disinfection is used for the disinfection of effluent that is discharged to North Slough.

1.3 Existing Recycled Water Service

American Canyon has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The WRF currently recycles approximately 150 to 300+ acre-feet per year (43 million gallons per year) dependent on the extent of precipitation and demands.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users. As previously noted, the existing treatment plant already removes ammonia, TIN, and TP as evidenced by the listed concentrations in Table 1-3.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	1.13	1.90	1.58
Volume	AF	530	1,238	1,768
Ammonia	kg N/d	2.20	4.86	3.75
Total Inorganic Nitrogen (TIN)	kg N/d	28.6	45.6	38.5
Total Phosphorus (TP)	kg P/d	18.5	28.7	24.5
Ammonia	mg N/L	0.52	0.66	0.60
TIN	mg N/L	6.70	6.09	6.34
TP	mg P/L	4.48	4.11	4.26

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

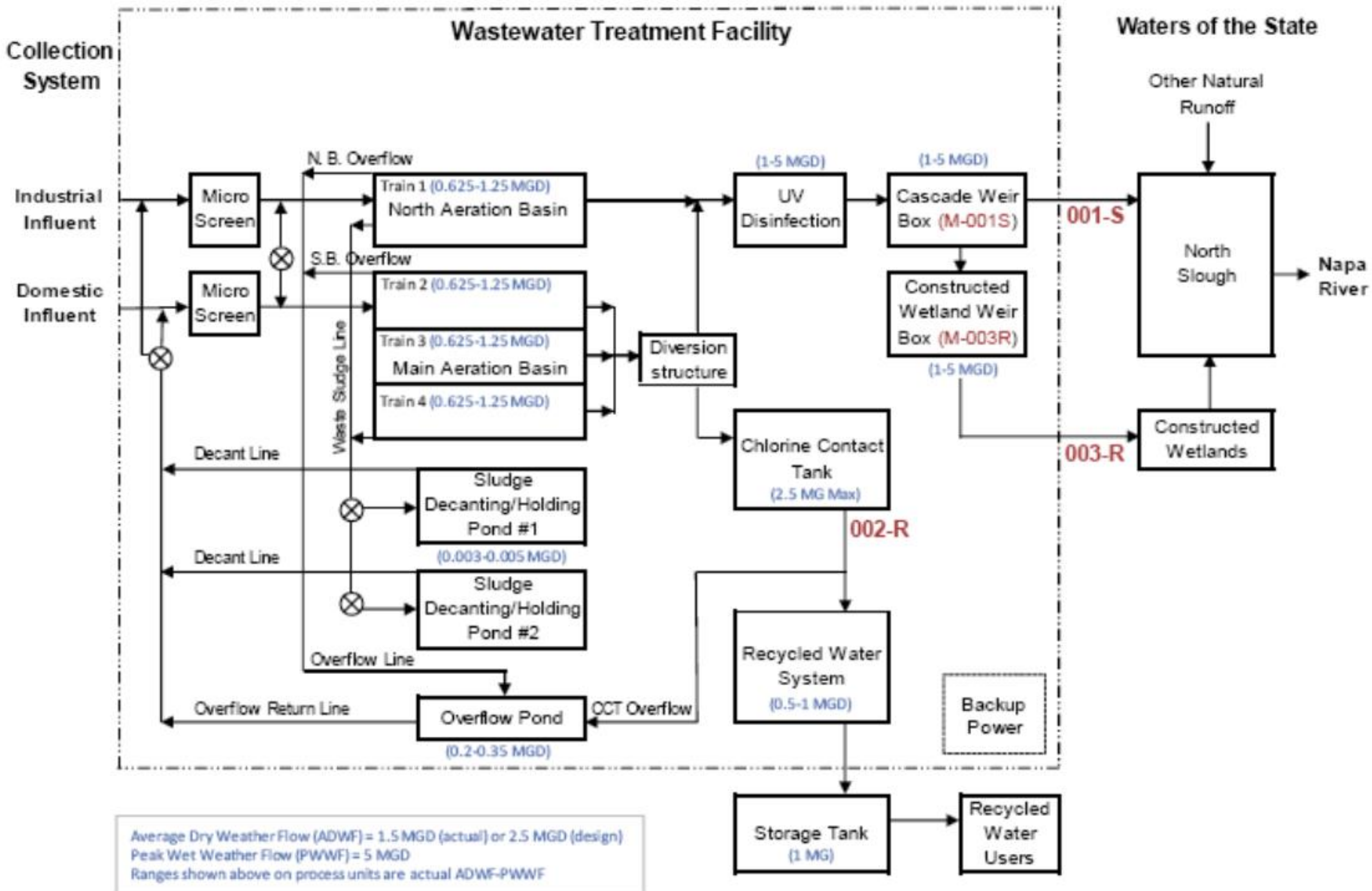

Figure 1-1. Process Flow Diagram for American Canyon (Source: NPDES Permit R2-2019-0017; CA0038768)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.

Use Category*	Definition
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility.
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with American Canyon WRF and Engineer’s best judgment that considered known project constraints, existing American Canyon WRF reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by American Canyon WRF. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects. The listed future projects both build upon the existing recycled water facility.

Table 3-1. Recycled Water Projects Identified by American Canyon WTF

Recycled Water Project	Description
Project 1	Buildout of existing recycled water facility in the near-term, within 0-10 years. Will expand for an additional 300+ AFY
Project 2	Buildout of existing recycled water facility in the long-term, within 11-20 years. Will expand for an additional 600+ AFY

The following sections summarize the flow and nutrient load reductions for each listed project in Table 3-1.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. As previously mentioned, the existing treatment plant currently removes ammonia, TIN, and TP load so the load reductions are modest associated with each recycled water project.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. Landscape irrigation is distributed throughout the year, with greater usage April-November. Commercial and internal use are also used year-round, with increased usage from July to December. The vast majority of agricultural irrigation is used in August, with a small amount in October.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence*	Distributed - Return Flows (AFY)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**1**	**313**	**1**	**6**	**4**
	Existing Facilities	1	313	1	6	4
	Project 1	2	--	--	--	--
	Project 2	3	--	--	--	--
2025	**Total**	**Blend 1 & 2**	**619**	**1**	**13**	**8**
	Existing Facilities	1	313	1	6	4
	Project 1	2	306	1	7	4
	Project 2	3	--	--	--	--
2030	**Total**	**Blend 1 & 2**	**619**	**1**	**13**	**8**
	Existing Facilities	1	313	1	6	4
	Project 1	2	306	1	7	4
	Project 2	3	--	--	--	--
2035	**Total**	**Blend of 1, 2, & 3**	**1,240**	**3**	**26**	**17**
	Existing Facilities	1	313	1	6	4
	Project 1	2	306	1	7	4
	Project 2	3	616	1	13	9
2040	**Total**	**Blend of 1, 2, & 3**	**1,240**	**3**	**26**	**17**
	Existing Facilities	1	313	1	6	4
	Project 1	2	306	1	7	4
	Project 2	3	616	1	13	9
2045	**Total**	**Blend of 1, 2, & 3**	**1,240**	**3**	**26**	**17**
	Existing Facilities	1	313	1	6	4
	Project 1	2	306	1	7	4
	Project 2	3	616	1	13	9

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

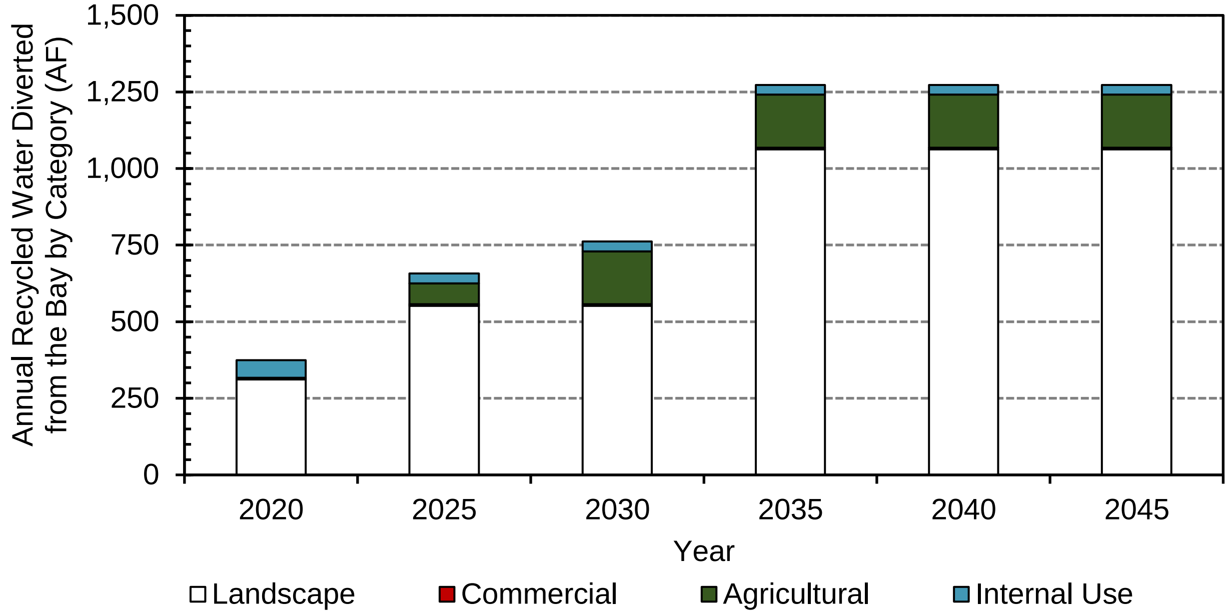

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. Now that the primary components of a distribution system have been constructed the City is interested in expanding the system to maximize connections and demands while creating loops within the pipe network for a more robust system with improved pressure distribution. The City's ultimate goal is to maximize water reuse for applications allowed under the State's Title 22 regulations and reserve potable water for drinking water supply and other appropriate indoor uses (RWMP Executive Summary, 2020).

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Projects 1 and 2 (similar ancillary and adverse impacts)	• Increased sustainable and reliable water source • Ability to meet recycled water demands	• While not necessarily adverse, the nutrient load reductions associated with recycled water are relatively modest as the treatment plant already reliably removes ammonia and TIN loads.

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. Capital costs were provided by the Recycled Water Master Plan's Executive Summary. O&M costs were assumed to be $1 million per 600 acre-feet per year (0.5 mgd). It is important to note that the unit cost ($/lb ammonia and TIN load reduced) values are relatively high due to the marginal load reductions as the treatment plant already reduces ammonia and TIN loads. Furthermore, the unit cost for water supply ($/AF) are relatively high for Projects 1 and 2. However, the existing facilities off-set such relatively high unit cost as evidenced by the total unit cost for water supply.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. The plot illustrates the expansion of the existing facilities with Projects 1 and 2 as discussed in Table 3-1. The nutrient load reductions to the Bay associated with an increase in recycled water are modest as the treatment plant already removes ammonia and TIN loads as previously noted.

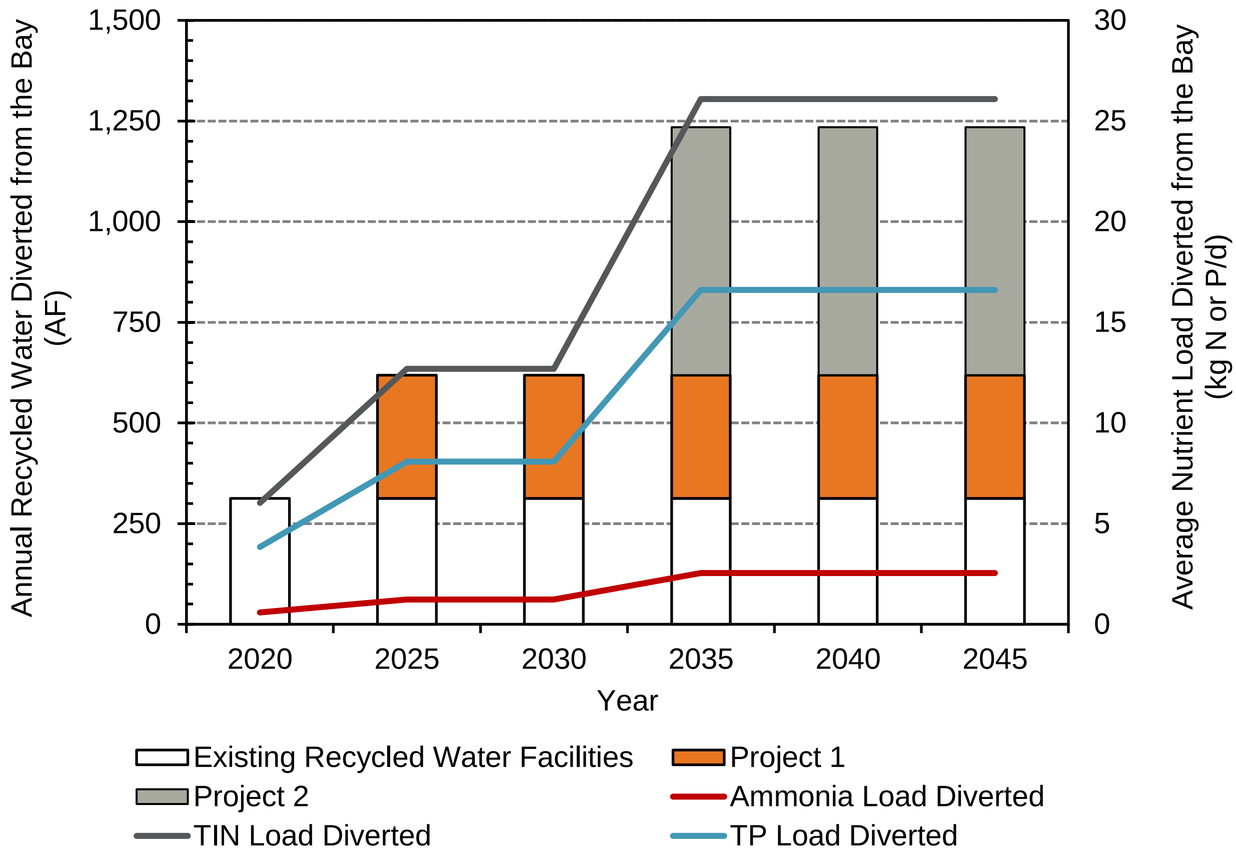

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge

3.4 Drivers and Barriers to Implementation

The drivers and barriers that govern American Canyon's ability to expand their recycled water services are as follows:

- Drivers: Water Supply Need
- Barriers: Institutional as American Canyon is focused on meeting NPDES limits with limited staffing to further advance a recycled water agenda.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Project 1 (Expand Existing in 1 - 10 years) *,**		Future Project 2 (Expand Existing in 11 - 20 years) *,**		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (May 1 - Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (May 1 - Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (May 1 - Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (May 1 - Sept 30)
Flow/Volume Diverted from the Bay[1]									
Flow	mgd	0.4	0.3	0.5	0.2	0.9	0.6	1.3	0.8
Volume	AF	199	313	215	255	424	616	591	876
Load Diverted from the Bay[2,3]									
Confidence	unitless	1	1	2	2	3	3	--	--
Duration	Years	25	25	20	20	10	10	25	25
Flow Diverted	%	27%	15%	29%	13%	29%	7%	53%	33%
Ammonia Load Diverted	kg N/d	1	1	1	1	2	1	2	2
TIN Load Diverted	kg N/d	9	6	12	6	23	13	28	16
TP Load Diverted	kg P/d	6	4	8	4	15	9	18	10
Cost[3,4,5]									
Capital Cost	$ Mil	--	--	13.4	13.4	13.3	13.3	26.8	26.8
NPV O&M	$ Mil	9.6	15.1	3.2	4.6	8.0	11.6	20.8	31.3
NPV Total (Capital+NPV O&M)	$ Mil	9.6	15.1	16.6	18.0	21.4	25.0	47.5	58.1
Unit Flow Cost[6]									
Unit Cost	$/gpd	23	54	36	79	24	45	38	74
Unit Cost	$/AF	1,920	1,920	3,860	3,540	5,030	4,050	3,220	2,650
Unit Load Cost[7,8,9]									
Ammonia Unit Cost	$/lb Ammonia Diverted	1,590	1,280	2,760	2,070	3,600	2,380	2,640	1,870
TIN Unit Cost	$/lb TIN Diverted	122	124	212	202	277	232	203	182
TP Unit Cost	$/lb TP Diverted	189	195	328	318	428	364	314	287

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the specific project duration (varies by project).

1. Flow/volume values consider the duration (both years and number of days per season (e.g., 153 days for average dry season and 365 days for average annual)).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by American Canyon (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the listed project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the listed average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration (e.g., daily average listed load X number of days for averaging period X unit conversion (kg to lb) X duration as years).
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (e.g., NPV total divided by (daily average listed load X number of days for averaging period X unit conversion (kg to lb) X duration as years)).

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Bay Area Clean Water Agencies
Recycled Water Study

City of Benicia Wastewater Treatment Plant

BACWA Recycled Water Study

Individual Plant Report

Benicia, CA
May 29, 2023
Final Report

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Contents

Tables

Figures

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Executive Summary

The City of Benicia (Benicia) owns and operates the Benicia Wastewater Treatment Plant (WWTP) located in Benicia, CA and discharges treated effluent to the Carquinez Strait. The plant has an average dry weather flow (ADWF) permitted capacity of 4.5 million gallons per day (mgd) and a peak wet weather capacity of 11 mgd.

Benicia does not currently have a recycled water program. In 2017, Benicia evaluated the feasibility of producing and delivering approximately 2.0 mgd (approximately 2,000 acre-feet per year (AFY) of recycled water to the nearby Valero Refinery for use as cooling tower makeup water, and to other City customers for non-potable uses[1]. In 2020, the City completed a citywide Wastewater Master Plan Update and Major Facility Condition Assessment[2]. Within the 2020 conditions assessment, both water reuse projects were evaluated. For Benicia, the addition of recycled water would increase future water supply reliability.

<u>Non-Potable Reuse Project (NPR)</u>

The Valero Refinery NPR Project would require a recycled water distribution pipeline system, agreements, and various upgrades at the Benicia WWTP prior to delivering recycled water for industrial and non- potable uses. Such upgrades would require removal of ammonia, phosphate, tertiary filtration, and disinfection upgrades to meet various California Division of Drinking Water's Title 22 requirements for unrestricted reuse and that protects the Refinery's assets. The capital cost for the wastewater treatment plant improvements, conveyance and storage upgrades were estimated at $28 Mil in 2019.

<u>Indirect Potable Reuse (IPR)</u>

In 2020, a surface water augmentation project was proposed as part of the City's Wastewater Master Plan Update and Major Facility Conditions Assessment. The proposed IPR project would convey advanced purified effluent via pipeline to Lake Herman for storage before being conveyed as a raw water source to the Water Treatment Plant (WTP) for further treatment. To achieve advanced purified effluent, upgrades would be required at the WWTP and an Advanced Water Purification Facility (AWPF) would need to be constructed. AWPF would include reverse osmosis (RO) and a UV advanced oxidation process (AOP). If the City chooses to pursue IPR, a detailed feasibility study would be conducted.

Within the 2020 Conditions Assessment, a triple bottom line (TBL) analysis of the two water reuse project options was completed to assess the feasibility of reusing treated wastewater effluent to improve water sustainability for the City. The TBL analysis compared the environmental, social, and economic impacts of two types of water reuse – indirect potable reuse and non-potable reuse (including industrial reuse).

IPR scores higher on water stress and institutional control over resources, and NPR scores higher on GHG emissions, capital cost, and O&M costs. Overall, IPR scores higher than NPR by one point. Additionally, NPR may not provide a reliable investment for the City and offers limited flexibility as compared to IPR due to having only one potential primary recycled water user. While the 2020 TBL

[1] Brown and Caldwell (2017) Benicia Water Reuse Study Feasibility Report.

[2] Stantec (2020) City of Benicia Wastewater Master Plan Update and Major Facility Condition Assessment Executive Summary.

and the 2017 evaluation found both projects to be technically feasible, neither project has advanced primarily due to funding issues. Federal or state grants are critical to overcome the funding barrier and make either project economically feasible.

1 Introduction and Current Conditions

The City of Benicia's Wastewater Treatment Plant (WWTP) serves a population of about 28,000, which includes the City of Benicia. It is located at 614 East 5th St, Benicia, CA. The plant has an average dry weather flow (ADWF) permitted capacity of 4.5 million gallons per day (mgd) and a 11 mgd wet weather capacity.

The sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

Benicia holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2019-0034; CA0038091). Table 1-1 provides a summary of the relevant permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2019-0034; CA0038091)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	4.5	--	--	--
Effluent BOD (1)	mg/L	--	30	45	--
Effluent TSS (1)	mg/L	--	30	45	--
Effluent Ammonia	mg N/L	--	64	--	110

1) BOD and TSS include a minimum percent removal of 85% through the WWTP
2) This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;
- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);

- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly part of the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Anticipated in Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for Benicia. Both liquids processes and solids processes are shown. The WWTP consists of screening and grit removal, primary sedimentation, followed by a conventional activated sludge and rotating biological contactors (RBC) for secondary treatment. Secondary effluent is disinfected with sodium hypochlorite and then dechlorinated prior to discharge. The WWTP has equalization basins (approximately 1 MG) for peak wet weather flow management. Solids treatment consists of waste activated sludge (WAS) thickening with a dissolved air flotation thickener (DAFT), anaerobic digestion of primary sludge and WAS and mechanical dewatering with a belt filter press.

1.3 Existing Recycled Water Service

Benicia does not have an existing recycled water program.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	1.88	2.47	2.23
Volume	AF	883	1,609	2,492
Ammonia	kg N/d	177	205	193
Total Inorganic Nitrogen (TIN)	kg N/d	224	249	239
Total Phosphorus (TP)	kg P/d	10.6	21.8	17.1
Ammonia	mg N/L	24.9	22.7	23.6
TIN	mg N/L	31.6	27.7	29.3
TP	mg P/L	1.45	2.36	1.98

* Represents three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

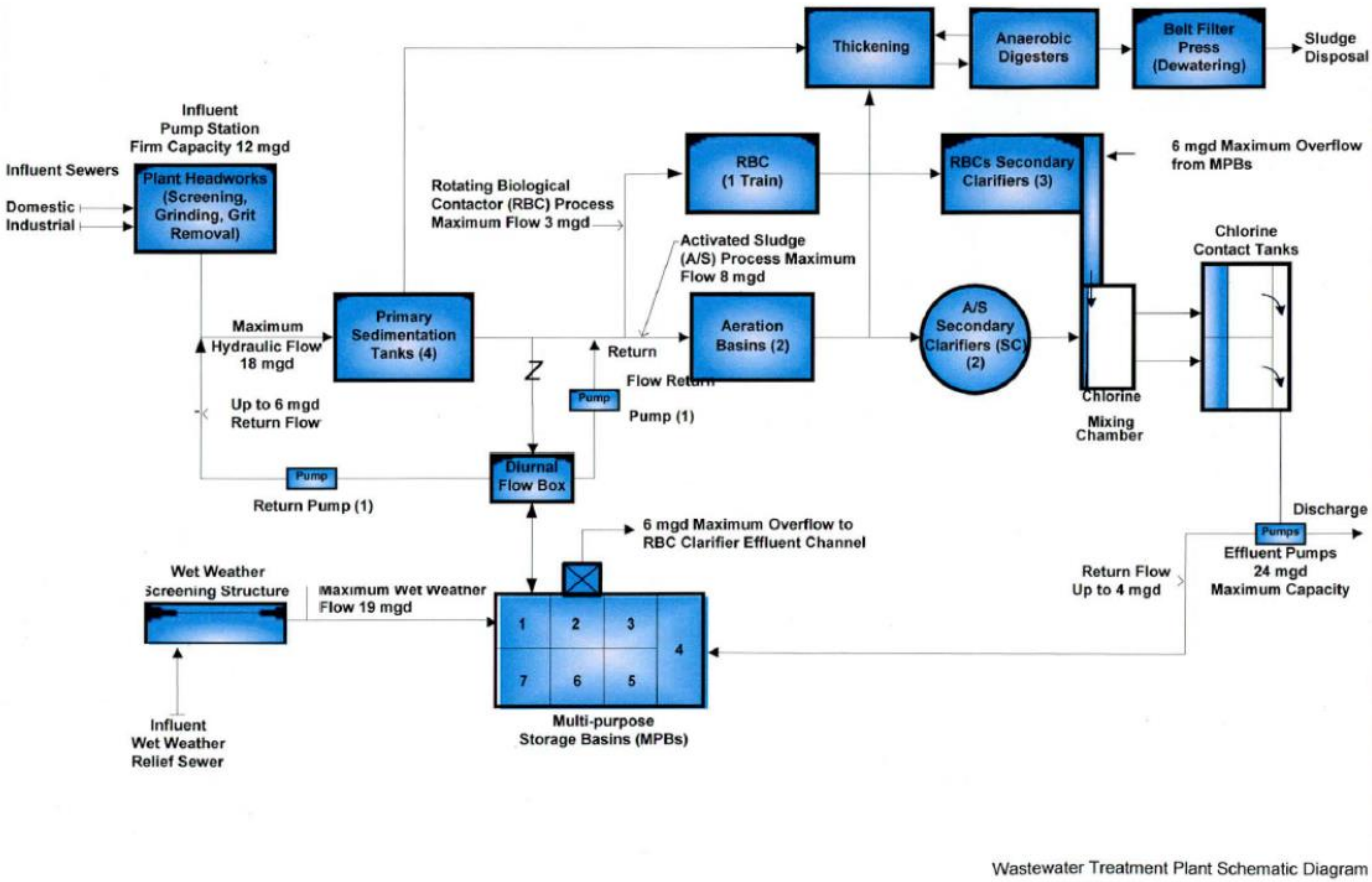

Figure 1-1. Process Flow Diagram for Benicia WWTP (R2-2019-0034; CA0038091)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections, if included, were based on a combination of working with Benicia WWTP and Engineer's best judgment that considered known project constraints, existing Benicia WWTP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs, if included, are as provided by Benicia WWTP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[3] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[3] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g. existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g. a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Benicia does not currently have a recycled water program. In 2017, Benicia evaluated the feasibility of producing and delivering approximately 2.0 mgd (approximately 2,000 acre-feet per year (AFY) of recycled water to the nearby Valero Refinery for use as cooling tower makeup water, and to other City customers for non-potable uses. In 2020, the City completed a citywide Wastewater Master Plan Update and Major Facility Condition Assessment. Within the 2020 conditions assessment, both water reuse projects were evaluated. For Benicia, the addition of recycled water would increase future water supply reliability.

Non-Potable Reuse Project (NPR)

The Valero Refinery NPR Project would require a recycled water distribution pipeline system, agreements, and various upgrades at the Benicia WWTP prior to delivering recycled water for industrial and non- potable uses. Such upgrades would require removal of ammonia, phosphate, tertiary filtration, and disinfection upgrades to meet various California Division of Drinking Water's Title 22 requirements for unrestricted reuse and that protects the Refinery's assets. The capital cost for the wastewater treatment plant improvements, conveyance and storage upgrades were estimated at $28 Mil in 2019.

Indirect Potable Reuse (IPR)

In 2020, a surface water augmentation project was proposed as part of the City's Wastewater Master Plan Update and Major Facility Conditions Assessment. The proposed IPR project would convey advanced purified effluent via pipeline to Lake Herman for storage before being conveyed as a raw water source to the Water Treatment Plant (WTP) for further treatment. To achieve advanced purified effluent, upgrades would be required at the WWTP, and an Advanced Water Purification Facility (AWPF) would need to be constructed. AWPF would include reverse osmosis (RO) and a UV advanced oxidation process (AOP). If the City chooses to pursue IPR, a detailed feasibility study would be conducted.

Within the 2020 Conditions Assessment, a triple bottom line (TBL) analysis of the two water reuse project options was completed to assess the feasibility of reusing treated wastewater effluent to improve water sustainability for the City. The TBL analysis compared the environmental, social, and economic impacts of two types of water reuse – indirect potable reuse and non-potable reuse (including industrial reuse).

IPR scores higher on water stress and institutional control over resources, and NPR scores higher on GHG emissions, capital cost, and O&M costs. Overall, IPR scores higher than NPR by one point. Additionally, NPR may not provide a reliable investment for the City and offers limited flexibility as compared to IPR due to having only one potential primary recycled water user. While the 2020 TBL and the 2017 evaluation found both projects to be technically feasible, neither project has advanced primarily due to funding issues. Federal or state grants are critical to overcome the funding barrier and make either project economically feasible.

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Burlingame WTF

BACWA Recycled Water Study

Final Individual Plant Report

Burlingame, CA

May 22, 2023

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Contents

Tables

Figures

Executive Summary

The City of Burlingame (City) owns and operates the Burlingame Wastewater Treatment Facility (Burlingame WTF) located in Burlingame, CA and discharges treated effluent along with the North Bayside System Unit (NBSU) to the Lower San Francisco Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 5.5 million gallons per day (mgd) and a peak permitted wet weather flow of 16 mgd.

The Burlingame WTF currently recycles approximately 107 AFY for internal use. This includes processes such as facility process water and internal plumbing at the facility. As such, internal use does not result in a net flow or load reduction from the Bay.

In 2016, a Recycled Water Evaluation was conducted to present a master plan to add recycled water treatment facilities at the Burlingame WTF. This evaluation provided an estimate of 70 AFY (70,000 gallons per day (gpd)) during peak demand of Phase I, and an additional 385 AFY (350,000 gpd) during peak demand. Phase I was estimated to cost $4.2 million and the project overall was estimated to be $14.0 million. This project is still in a conceptual stage, with no expected timeline for construction and implementation, and therefore no projected nutrient or flow diversion tables and graphs are presented.

An overview of the drivers and barriers for implementing recycled water projects at Burlingame:

- Drivers for implementing recycled water projects:
  - Decreased reliance on external water sources
- Barriers for implementing recycled water projects:
  - Acquiring funding sources for the conceptual project
  - Jurisdictional boundaries
  - Lack of viable users

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1 Introduction and Current Conditions

The City of Burlingame (City) owns and operates the Burlingame Wastewater Treatment Facility (Burlingame WTF) located in Burlingame, CA and discharges treated effluent along with the North Bayside System Unit (NBSU) to the Lower San Francisco Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 5.5 million gallons per day (mgd) and a peak permitted wet weather flow of 16 mgd.

The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

Burlingame holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2018-0024). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2018-0024)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	5.5	--	--	--
Effluent BOD [(1)]	mg/L	--	30	45	--
Effluent TSS [(1)]	mg/L	--	30	45	--
Effluent Ammonia	mg N/L	--	67	--	130

1. BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for the Burlingame WTF. Both liquids processes and solids processes are shown. The Burlingame WTF consists of screening and grit removal, primary clarification, followed by an activated sludge process. Secondary effluent is disinfected by chlorine disinfection. Solids treatment consists of sludge thickening, anaerobic digestion and mechanical dewatering.

1.3 Existing Recycled Water Service

The Burlingame WTF has an existing recycled water service resulting in 107.41 AFY of internal use.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	2.61	3.48	3.12
Volume	AF	1,220	2,270	3,490
Ammonia	kg N/d	270	375	331
Total Inorganic Nitrogen (TIN)	kg N/d	370	416	397
Total Phosphorus (TP)	kg P/d	24	35.7	30.9
Ammonia	mg N/L	27.9	29.9	29.00
TIN	mg N/L	38.4	33.2	35.3
TP	mg P/L	2.45	3.00	2.65

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

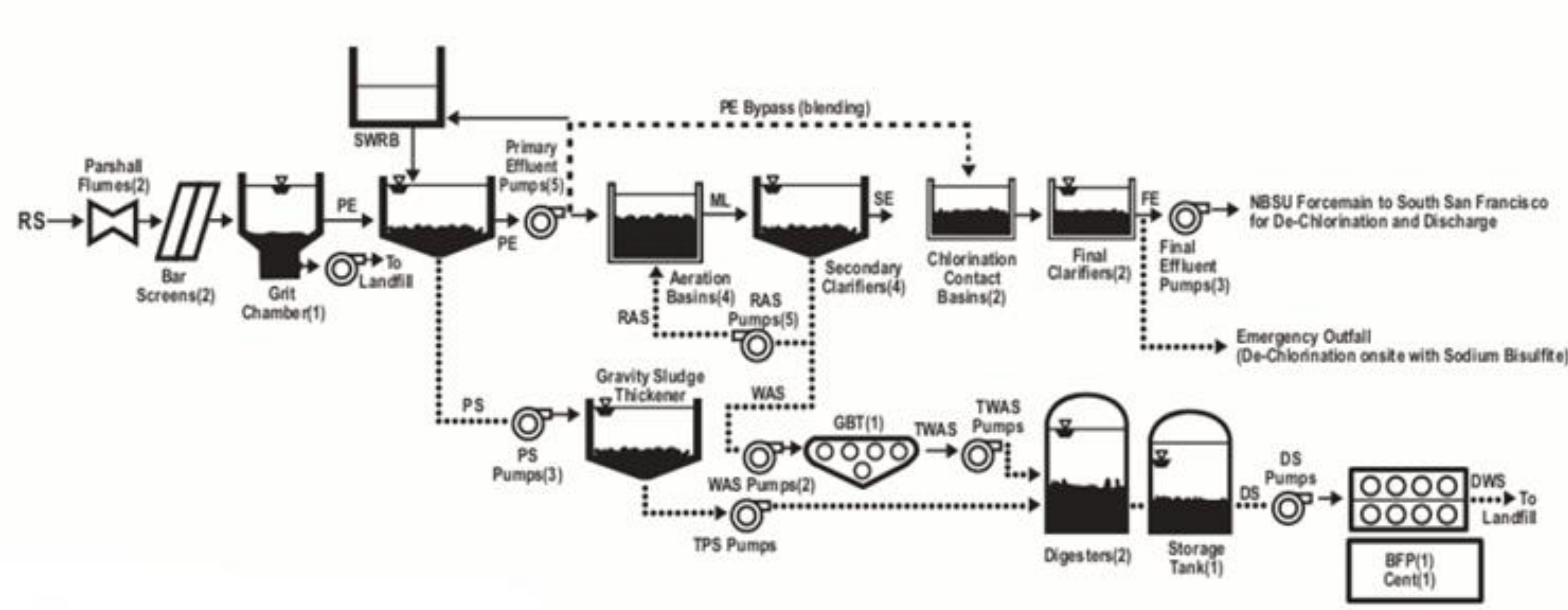

Figure 1-1. Process Flow Diagram for Burlingame WTF (Order No. R2-2018-0024; CA0037788)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
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Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with Burlingame WTF and Engineer's best judgment that considered known project constraints, existing Burlingame WTF reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by Burlingame WTF. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^{6}\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^{6}\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects.

Table 3-1. Recycled Water Projects Identified by Burlingame WTF

Recycled Water Project	Description
Existing Facilities	Approximately 107 AF per year for internal use at the WTF. The primary uses are facility process water and internal plumbing at the facility. As such, internal use does not result in a net flow or load reduction from the Bay.
Project 1: Recycled Water Facilities at the WTF	Projected to be approximately 70 AFY for day to day use (up to 385 AFY for peak use). The application would be for irrigation use within their service area. This project is conceptual and not planned for implementation, as such no projected nutrient or flow diversion tables and graphs are presented.

In 2016, a Recycled Water Evaluation was conducted to present a master plan to add recycled water treatment facilities at the Burlingame WTF. This evaluation provided an estimate of 70 AFY (70,000 gallons per day (gpd) during use periods) during peak demand of Phase I, and an additional 385 AFY (350,000 gpd during use periods) during peak demand. Phase I was estimated to cost $4.2 million and the project overall was estimated to be $14.0 million. This project is still in a conceptual stage, with no expected timeline for construction and implementation, and therefore no projected nutrient or flow diversion tables and graphs are presented. Funding and jurisdictional issues could be potential barriers for implementation of this recycled water project.

Existing facilities produce recycled water for internal use and do not result in flow and nutrient load reductions. Project 1 is in a conceptual stage and does not have a schedule set for construction and implementation. As such, anticipated flow and nutrient load reductions have not been calculated. An overview of the drivers and barriers for implementing recycled water projects at Burlingame:

- Drivers for implementing recycled water projects:
  - Decreased reliance on external water sources
- Barriers for implementing recycled water projects:
  - Acquiring funding sources
  - Jurisdictional boundaries
  - Lack of viable users

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Central Contra Costa Sanitary District

BACWA Recycled Water Study

Final Individual Plant Report

Martinez, CA
June 13, 2023

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Contents

Tables

Figures

Executive Summary

The Central Contra Costa Sanitary District (Central San) owns and operates the Central San Wastewater Treatment Plant (WWTP) located in Martinez, CA and discharges treated effluent to Suisun Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 53.8 million gallons per day (mgd).

Central San has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The WWTP currently recycles approximately 1,800 acre-feet per year (557 million gallons per year). There are no specific plans to further expand the recycled water program; however, there are several possible projects that Central San is anticipating could increase their future recycled water deliveries.

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES- 1. Note: this report excludes any potential advanced reuse projects as those are conceptual at best. However, such projects are referenced and included in the overall report.

The timeline and corresponding volume and load diversions from the Bay is provided in Figure ES - 1. Note: the dry season volume and load diversions from the Bay discharge represents approximately 60 percent of the average annual values presented in Figure ES – 1.

The various barriers to implement recycled water projects at Central San are as follows:

- Barriers:
    - Infrastructure/Proximity: new connections to the existing distribution system are limited to redevelopment of properties adjacent to the mainline. It is typically cost prohibitive for property owners to fund the expansion of the mainline. Major expansions of the existing Title 22 may require filtration upgrades at the WWTP, additional distribution pipeline(s), and additional storage.
    - Other Water Supply Options: the costs, benefits, and disadvantages of other water supply options need to be compared with large recycled water project opportunities. For example, industrial recycled water for nearby refineries would need to be compared with continued supply of raw water from Contra Costa Water District, and potable reuse opportunities would need to be compared with other potable water supply opportunities.
    - Jurisdictional: large recycled water projects and expansions require partnerships/agreements across multiple agencies and industries.

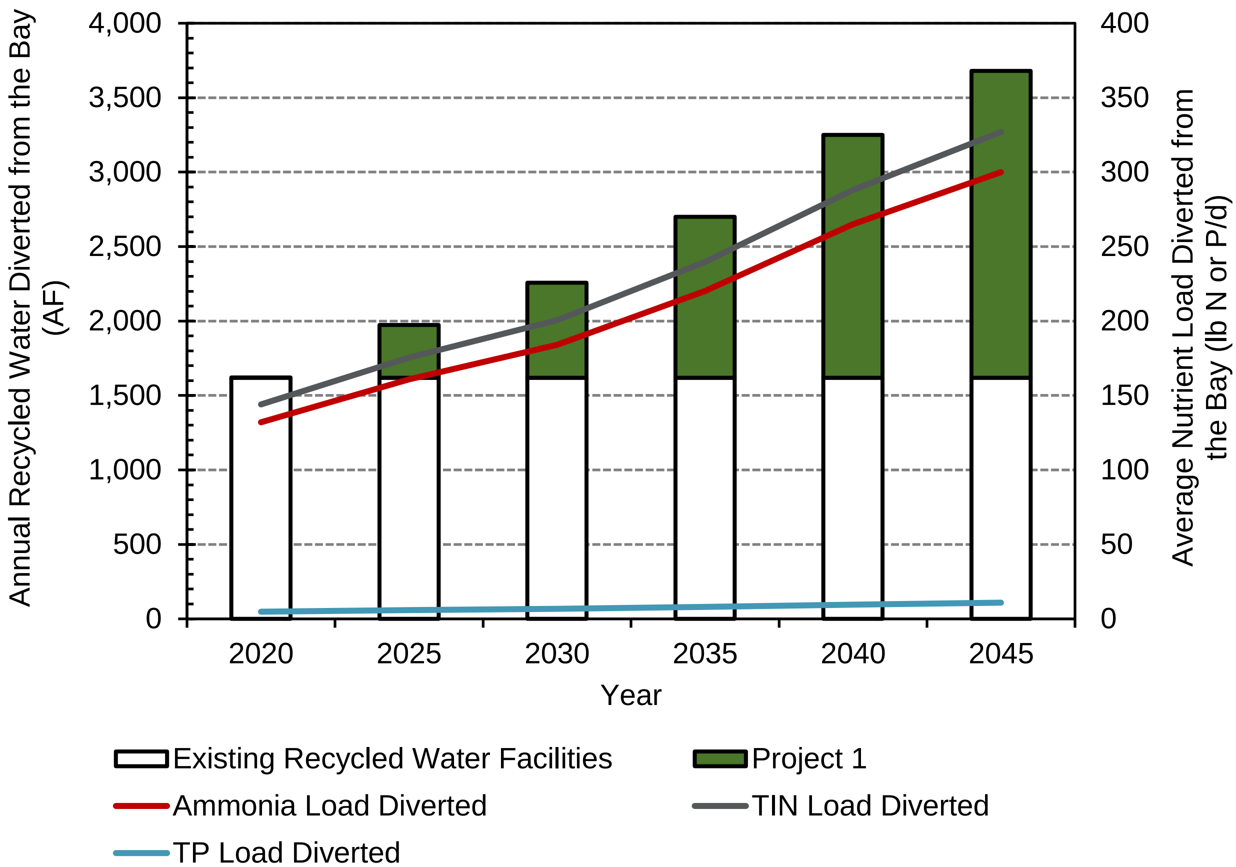

Figure ES - 1. Summary of Existing and Proposed Recycled Water Volumes and the Corresponding Nutrient Load Diversions from a Bay Discharge*,**

* The dry season volumes and corresponding nutrient load diversions from a Bay discharge represent approximately 60 percent of the values presented in this figure.

** Project 1 is the Concord Community Reuse Project; this future project will result in an additional 2.9 mgd ADWF of influent wastewater to the WWTP.

Table ES- 1: Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Project 1 (Concord Community Reuse Project) *,**		Total (Average over 25-Year Project Duration) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	2.0	1.4	1.5 ǂ	1.0 ǂ	3.2	2.3
Volume	AF	920	1,600	691 ǂ	1,150 ǂ	1,500	2,560
Load Diverted from the Bay[2,3]							
Confidence	Unitless	1	1	3	3	Blend of 1 and 3	Blend of 1 and 3
Duration	Years	25	25	20	20	25	25
Flow Diverted	%	6%	4%	4%	2%	8%	5%
Ammonia Load Diverted	kg N/d	191	130	145	94	307	205
TIN Load Diverted	kg N/d	209	141	159	102	337	223
TP Load Diverted	kg P/d	7	5	5	3	11	7
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	69	69	69	69
NPV O&M	$ Mil	4.0	6.9	3.5	5.8	7.5	12.7
NPV Total (Capital+NPV O&M)	$ Mil	4.0	6.9	73	75	77	82
Unit Flow Cost[6]							
Unit Cost	$/gpd	2.0	4.8	50	73	24	36
Unit Cost	$/AF	174	172	5,270	3,270	2,060	1,280
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	2.5	2.6	74	50	30	20
TIN Unit Cost	$/lb TIN Diverted	2.3	2.4	68	46	27	18
TP Unit Cost	$/lb TP Diverted	72	73	2,150	1,380	860	551

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the specific project duration (varies by project; details provided with each project in Section 3).

ǂ The listed flow and volume values represent the average values over 20 years. For CCCSD, the dry season and average annual build-out values for Future Project 1 are approximately 1.3 mgd (820 AF) and 1.9 mgd (2,060 AF), respectively.

1. Flow/volume values consider the duration (both years and number of days per season (e.g., 153 days for average dry season and 365 days for average annual)).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by CCCSD (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the listed project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the listed average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration (e.g., daily average listed load X number of days for averaging period X unit conversion (kg to lb) X duration as years).
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (e.g., NPV total divided by (daily average listed load X number of days for averaging period X unit conversion (kg to lb) X duration as years)).

Note: Project 1 is the Concord Community Reuse Project; this future project will result in an additional 2.9 mgd ADWF of influent wastewater to the WWTP.

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1 Introduction and Current Conditions

The Central Contra Costa Sanitary District (Central San) owns and operates the Central San Wastewater Treatment Plant (WWTP) located in Martinez, CA and discharges treated effluent to Suisun Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 53.8 million gallons per day (mgd).

The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

Central San holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2022-0020). Table 1-1 provides a summary of the permit limitations for the plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2022-0020; CA0037648)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	53.8	--	--	--
Effluent BOD (1)	mg/L	--	25	40	--
Effluent TSS (1)	mg/L	--	30	45	--
Effluent Ammonia	mg N/L	--	54	--	74

1. BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;
- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);

- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge – Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for CCCSD. Both liquids processes and solids processes are shown. The Central San wastewater treatment consists of screening and grit removal, primary sedimentation, followed by an activated sludge (AS) process with an anaerobic selector. The AS process maintains a low SRT (1.1 to 1.3 days) for secondary treatment. The selector is used to improve activated sludge settling properties. In addition, the selector provides some biological phosphorus removal. Secondary effluent is disinfected by ultraviolet (UV) disinfection prior to discharge. A portion of the secondary effluent is filtered and chlorine disinfected to produce recycled water; the remaining effluent is discharged to Suisun Bay. Solids treatment consists of waste activated sludge (WAS) thickening, centrifuge dewatering of combined primary and thickened WAS sludge and incineration.

1.3 Existing Recycled Water Service

The CCCSD has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The WWTP currently recycles approximately 1,800 acre-feet per year (557 million gallons per year).

1.4 Existing Discharge Flows and Loads to the Bay

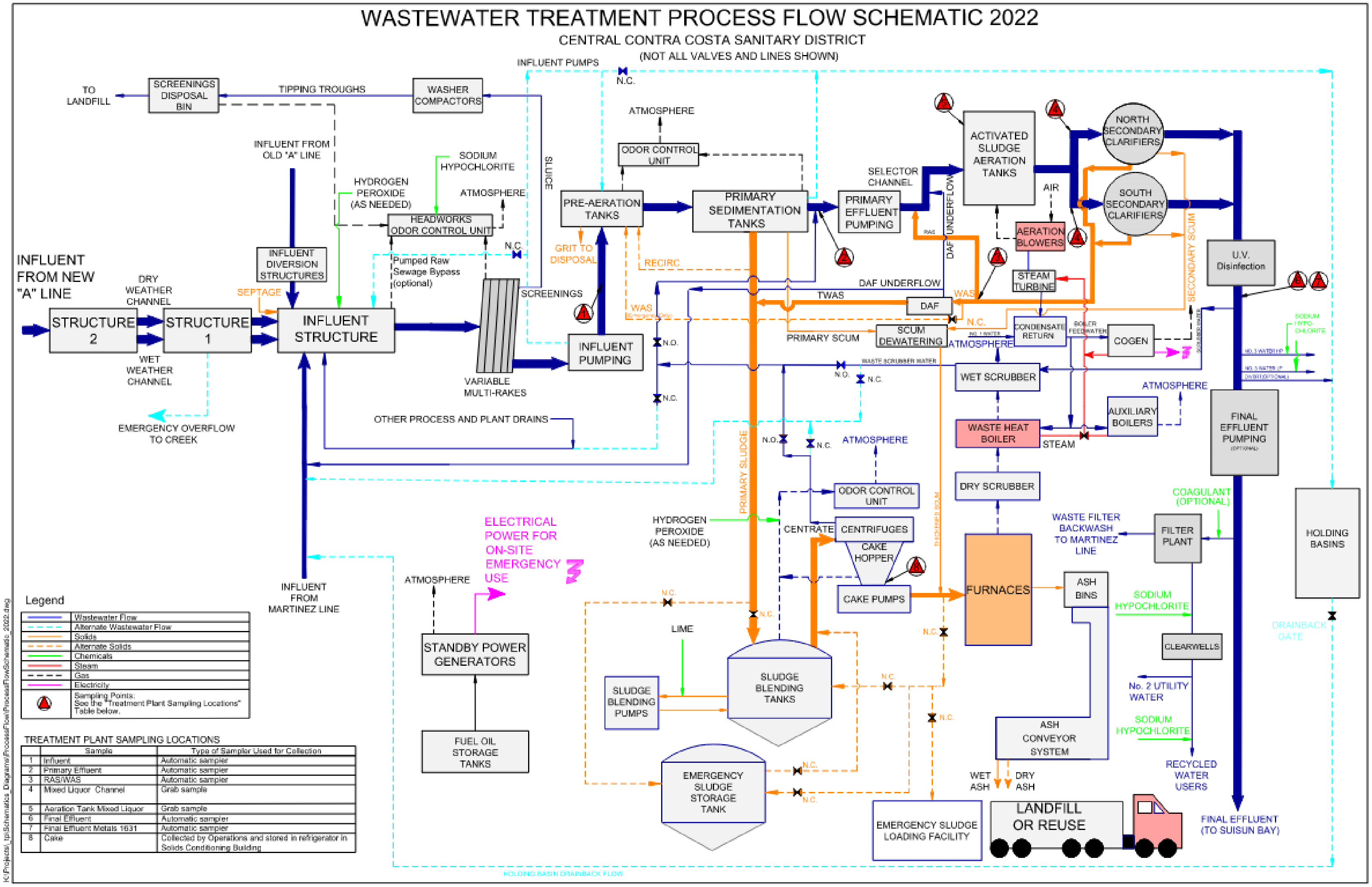
A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 – 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	32.6	43.5	39.0
Volume	AF	15,330	28,310	43,640
Ammonia	kg N/d	3,220	3,810	3,570
Total Inorganic Nitrogen (TIN)	kg N/d	3,530	4,130	3,880
Total Phosphorus (TP)	kg P/d	111	142	129
Ammonia	mg N/L	26.2	24.6	25.3
TIN	mg N/L	28.6	26.6	27.4
TP	mg P/L	0.90	0.86	0.88

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.



	Sample	Type of Sampler Used for Collection
1	Influent	Automatic sampler
2	Primary Effluent	Automatic sampler
3	RAS/WAS	Automatic sampler
4	Mixed Liquor Channel	Grab sample
5	Aeration Tank Mixed Liquor	Grab sample
6	Final Effluent	Automatic sampler
7	Final Effluent Metals 1631	Automatic sampler
8	Cake	Collected by Operations and stored in refrigerator in Solids Conditioning Building

Figure 1-1. Process Flow Diagram for CCCSD (Order No. R2-2022-0020; CA0037648)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with Central San and Engineer’s best judgment that considered known project constraints, existing Central San reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by Central San. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
    - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
    - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g. existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g. a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a "synergistic benefit" for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects. There are no concrete plans to expand the existing non-potable recycled water program; however Central San has identified several locations that could be served with recycled water in the future. Central San provided a will serve letter to provide recycled water for the Concord Community Reuse Project (CCRP). That project is included in Table 3-1. Other potential expansions are in the conceptual discussion stage and are not included in this report.

Table 3-1. Recycled Water Projects Identified by Central San

Recycled Water Project	Description
Existing Recycled Water Facilities	The Central San WWTP tertiary facilities consist of a portion of the UV-disinfected secondary effluent being filtered and chlorine disinfected prior to distribution. The remaining UV-disinfected secondary effluent is discharged to Suisun Bay. Title 22 tertiary disinfected recycled water is provided to commercial truck fill users, residential fill station program users, connected purple pipe customers, and is used at the treatment plant. Some re-development and increased recycled water use is expected through the Existing Recycled Water Programs.
Future Project 1 – Concord Community Reuse Project	Title 22 (Non-Potable Applications) New distribution of recycled water is planned for the Concord Community Reuse Project.
Possible Future Projects (not shown in this report; included in the overall report)	Advanced recycled water for potable reuse or advanced industrial reuse at nearby refineries (included in overall report only), satellite water recycling facilities, and other Title 22 system expansions.

The following sections summarize the flow and nutrient load reductions for each listed project in Table 3-1.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. Recycled water distribution is expected to increase starting in 2030, as it is anticipated new recycled water customers will be connected as part of Future Project 1 – Concord Community Reuse Project. As mentioned above, other new projects are in early planning phases and therefore not defined at this time. Possible projects include satellite water recycling facilities, and several others listed in Central San's Annual Recycled Water Report.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. Current uses include golf course and landscape irrigation, commercial, industrial, and internal use. It is anticipated that there will be an increase in future recycled water demand from the Concord Community Reuse Project; exact timing is unknown but assumed to be built out over many years starting in 2030.

Central San's recycled water demand is higher during the dry season for the irrigation, commercial, and industrial categories. Internal uses are stable throughout the year, with slight increases during the dry season.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay*

Year	Project #	Confidence**	Average Distributed - Return Flows (AF)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**1**	**1,600**	**130**	**141**	**5**
	Existing Facilities	1	1,600	130	141	5
	Future Project	--	--	--	--	--
2025	**Total**	**Blend of 1 and 3**	**1,960**	**158**	**172**	**6**
	Existing Facilities	1	1,600	130	141	5
	Future Project	3	354	29	31	1
2030	**Total**	**Blend of 1 and 3**	**2,240**	**181**	**197**	**7**
	Existing Facilities	1	1,600	130	141	5
	Future Project	3	637	52	56	2
2035	**Total**	**Blend of 1 and 3**	**2,680**	**218**	**237**	**8**
	Existing Facilities	1	1,600	130	141	5
	Future Project	3	1,080	88	96	3
2040	**Total**	**Blend of 1 and 3**	**3,230**	**263**	**285**	**9**
	Existing Facilities	1	1,600	130	141	5
	Future Project	3	1,630	133	144	5
2045	**Total**	**Blend of 1 and 3**	**3,660**	**298**	**324**	**11**
	Existing Facilities	1	1,600	130	141	5
	Future Project	3	2,060	168	183	6

* The dry season volumes and corresponding nutrient load diversions from a Bay discharge represent approximately 60 percent of the values presented in this table.

** Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

Note: Future Project is the Concord Community Reuse Project; this future project will result in an additional 2.9 mgd ADWF of influent wastewater to the WWTP from the new development.

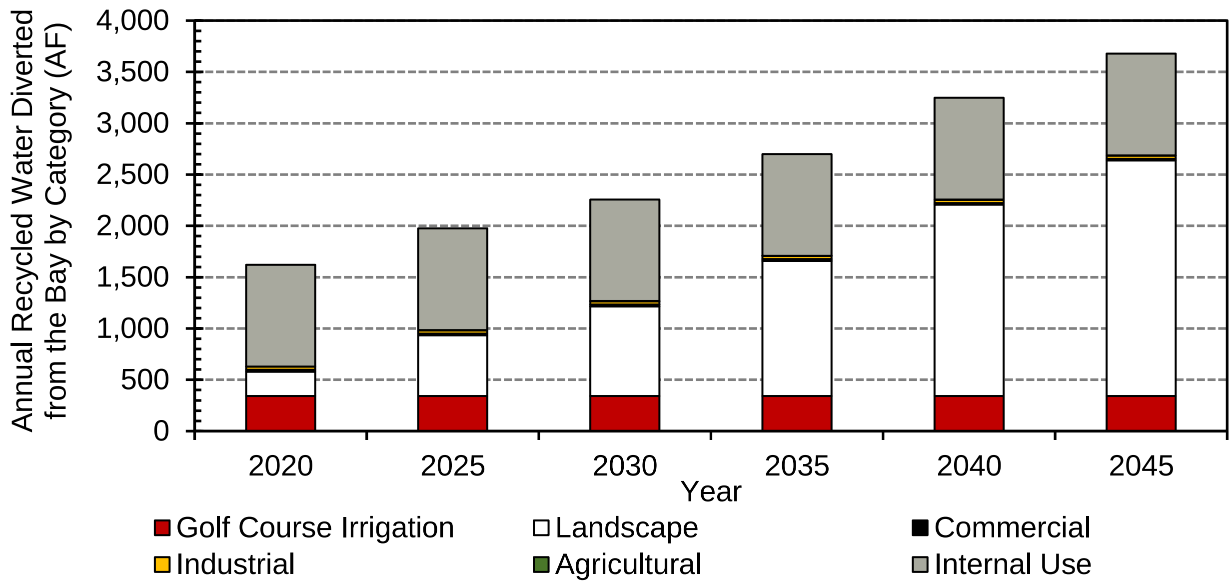

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)*,**

* The dry season volumes represent approximately 60 percent of the values presented in this figure.

** Project 1 is the Concord Community Reuse Project; this future project will result in an additional 2.9 mgd ADWF of influent wastewater to the WWTP from the new development.

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. Existing facilities are already paid for and in place. Several future recycled water projects are being considered at this time. As described before, several projects that will contribute to future recycled water distribution are in early planning phases. A planned redevelopment project that includes wholesale of recycled water from the Central San WWTP is be used as an example for the discussion of ancillary benefits in Table 3-3. This development project consists of a mixture of commercial, residential, institutional, and recreational land uses interspersed between parks and open space. Other future projects being considered have similar ancillary benefits.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities	• Facilities are already in place and providing recycled water • Operator familiarity with existing recycled water facilities • Existing facilities reliably meet recycled water treatment requirements	• None
Future Project 1 – Concord Community Reuse Project	• Increased water supply reliability, as recycled water can replace potable water use • Increased recycled water demand and utilization of existing plant flows for recycled water distribution	• Recycled water demands are greatest in the dry season (influent wastewater flows are lowest), but recycled water demand in categories such as irrigation are the highest (storage may be required to meet dry season recycled water demands)

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. Note: this report excludes any potential advanced reuse projects as those are conceptual at best. However, such projects are referenced and included in the overall report. As previously noted, the WWTP already reliably removes Total P so the corresponding load reductions and unit costs are modest for Total P. The $/AF values for future project(s) are relatively high compared to other reuse projects primarily due to the cost for the connections, distribution pipeline(s), storage, and controls. However, it is anticipated that any new customers would be paid for and/or reimbursed by development with a long-term net zero cost to Central San.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. As previously noted, the WWTP already reliably removes Total P so the corresponding load reductions with recycled water are marginal.

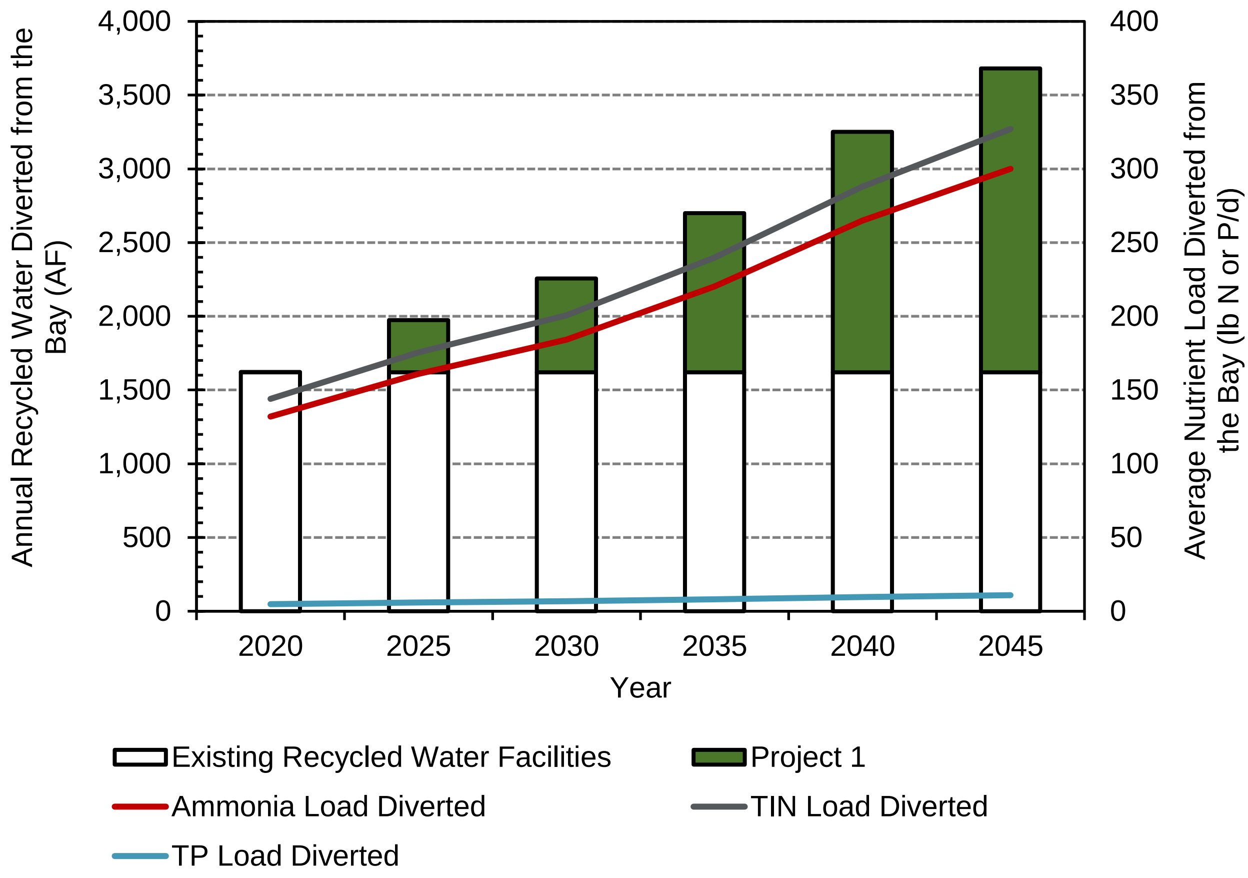

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge*,**

* The dry season volumes and corresponding nutrient load diversions from a Bay discharge represents approximately 60 percent of the values presented in this figure.

** Project 1 is the Concord Community Reuse Project; this future project will result in an additional 2.9 mgd ADWF of influent wastewater to the WWTP.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Project 1 (Concord Community Reuse Project) *,**		Total (Average over 25-Year Project Duration) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	2.0	1.4	1.5 ǂ	1.0 ǂ	3.2	2.3
Volume	AF	920	1,600	691 ǂ	1,150 ǂ	1,500	2,560
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	3	3	Blend of 1 and 3	Blend of 1 and 3
Duration	Years	25	25	20	20	25	25
Flow Diverted	%	6%	4%	4%	2%	8%	5%
Ammonia Load Diverted	kg N/d	191	130	145	94	307	205
TIN Load Diverted	kg N/d	209	141	159	102	337	223
TP Load Diverted	kg P/d	7	5	5	3	11	7
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	69	69	69	69
NPV O&M	$ Mil	4.0	6.9	3.5	5.8	7.5	12.7
NPV Total (Capital+NPV O&M)	$ Mil	4.0	6.9	73	75	77	82
Unit Flow Cost[6]							
Unit Cost	$/gpd	2.0	4.8	50	73	24	36
Unit Cost	$/AF	174	172	5,270	3,270	2,060	1,280
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	2.5	2.6	74	50	30	20
TIN Unit Cost	$/lb TIN Diverted	2.3	2.4	68	46	27	18
TP Unit Cost	$/lb TP Diverted	72	73	2,150	1,380	860	551

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the specific project duration (varies by project).

ǂ The listed flow and volume values represent the average values over 20 years. For CCCSD, the dry season and average annual build-out values for Future Project 1 are 1.3 mgd (821 AF) and 1.9 mgd (2,056 AF), respectively.

1. Flow/volume values consider the duration (both years and number of days per season (e.g., 153 days for average dry season and 365 days for average annual)).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by CCCSD (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the listed project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the listed average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration (e.g., daily average listed load X number of days for averaging period X unit conversion (kg to lb) X duration as years).
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (e.g., NPV total divided by (daily average listed load X number of days for averaging period X unit conversion (kg to lb) X duration as years)).

Note: Project 1 is the Concord Community Reuse Project; this future project will result in an additional 2.9 mgd ADWF of influent wastewater to the WWTP.

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3.4 Drivers and Barriers to Implementation

The various barriers to implement recycled water projects at Central San are as follows:

- Barriers:
  - Infrastructure/Proximity: new connections to the existing distribution system are limited to redevelopment of properties adjacent to the mainline. It is typically cost prohibitive for property owners to fund the expansion of the mainline. Major expansions of the existing Title 22 may require filtration upgrades at the WWTP, additional distribution pipeline(s), and additional storage.
  - Other Water Supply Options: the costs, benefits, and disadvantages of other water supply options need to be compared with large recycled water project opportunities. For example, industrial recycled water for nearby refineries would need to be compared with continued supply of raw water from Contra Costa Water District, and potable reuse opportunities would need to be compared with other potable water supply opportunities.
  - Jurisdictional: large recycled water projects and expansions require partnerships/agreements across multiple agencies and industries.

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Central Marin Sanitation Agency

BACWA Recycled Water Study

Individual Plant Report

San Rafael, CA
June 6, 2023
Final Report

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Contents

Tables

Figures

Executive Summary

The Central Marin Sanitation Agency Wastewater Treatment Plant (CMSA WWTP) discharges to Central San Francisco Bay. It is located at 1301 Andersen Drive, San Rafael, CA 94901 and serves about 52,200 service connections throughout the City of Larkspur, the Towns of Corte Madera, Fairfax, Ross, San Anselmo, portions of the City of San Rafael, the unincorporated areas of Ross Valley, San Quentin Village, and San Quentin State Prison. The plant has an average dry weather flow (ADWF) permitted capacity of 10 million gallons per day (mgd).

The CMSA WWTP has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The WWTP currently recycles approximately 1,200 acre-feet per year (AFY; 400 million gallons per year). Not all of the recycled water users translate to a reduction of flow and nutrient loads to the Bay. There are no existing plans to further expand the recycled water program.

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP)), and the corresponding unit costs are provided in Table ES - 1. The existing system is cost-effective as evidenced by relatively low unit cost values. The unit cost for nutrient load reductions is comparable for ammonia and TIN. In contrast, the unit cost for total phosphorus load reductions is greater than ammonia and TIN as the CMSA WWTP removes a portion of the raw influent total phosphorus (not shown).

While the plant recycles approximately 1,200 AFY, the majority of those uses eventually end up in the Bay (e.g., sewer collection cleaning). Such recycled water uses were not accounted for in Table ES - 1. The primary users are internal at the WWTP (including landscape irrigation), as well as the sewer collection cleaning. While the recycled water uses that eventually up in the Bay do not reduce loads, such uses reduce potable water supply demand. The timeline and corresponding load diversions from the Bay is provided in Figure ES – 1.

An overview of the drivers and barriers for implementing recycled water projects at CMSA:

- Drivers for implementing recycled water projects:
  - Water Supply Need: any strategies to reduce demands on the existing water supply system.
  - Proposed Discharge Regulations: concerns over future nutrient and other regulations.
- Barriers for implementing recycled water projects:
  - Lack of Need: CMSA and Marin Municipal Water District completed a recycled water feasibility study several years ago and learned that there are only small users in the CMSA service area, which results in a delivery cost range of $3,000 to 12,000/acre-foot. The only sizeable user is San Quentin with 184 acre-feet which was an $8 Mil project with modest demands.
  - Institutional: CMSA does not have the infrastructure in place (both physically and administrative) to enter into this market space.
  - Jurisdictional: challenges with coordinating across jurisdictions.

- Funding: the costs for such efforts are prohibitive as noted with the recent San Quentin evaluation.

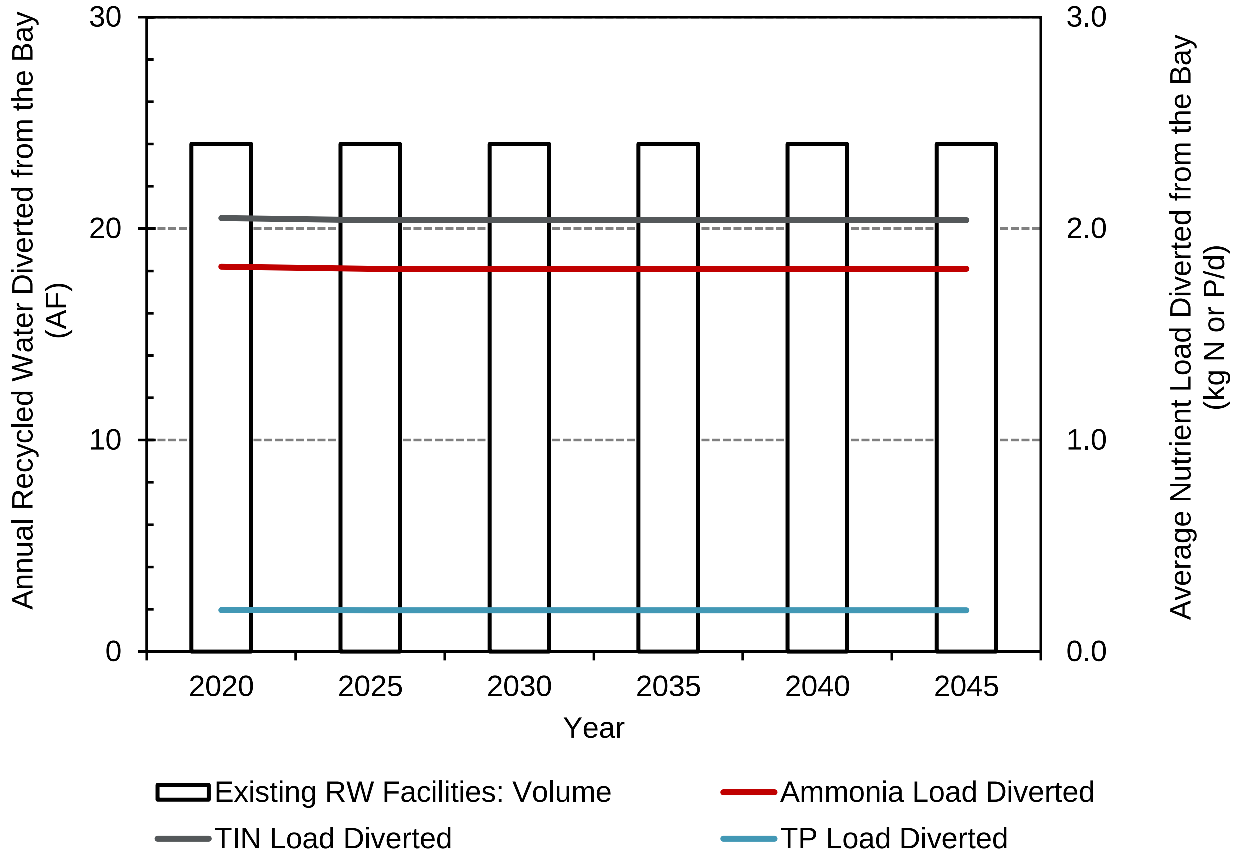

Figure ES - 1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge

Note: the annual recycle water demands are approximately 1,200 AF. The values in this figure represent flows and loads associated with recycled water that would be diverted from the Bay (approximately 20 to 25 AFY).

Table ES - 1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Projects (None Planned) *,**		Total (Projected into the Future) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	0.04	0.02	--	--	0.04	0.02
Volume	AF	20	24	--	--	20	24
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	1%	0%	--	--	1%	0%
Ammonia Load Diverted	kg N/d	5	2	--	--	5	2
TIN Load Diverted	kg N/d	6	2	--	--	6	2
TP Load Diverted	kg P/d	1	<1	--	--	1	<1
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	1.0	1.2	--	--	1.0	1.2
NPV Total (Capital+NPV O&M)	$ Mil	1.0	1.2	--	--	1.0	1.2
Unit Flow Cost[6]							
Unit Cost	$/gpd	24	57	--	--	24	57
Unit Cost	$/AF	2,020	2,020	--	--	2,020	2,020
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	22	33	--	--	22	33
TIN Unit Cost	$/lb TIN Diverted	19	29	--	--	19	29
TP Unit Cost	$/lb TP Diverted	181	308	--	--	181	308

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045).

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production based on the energy required to produce water at the plant for various recycled water uses by CMSA (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay over the project duration.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

Note: the annual recycle water demands are approximately 1,200 AF. The values in this figure represent flows and loads associated with recycled water that would be diverted from the Bay (approximately 20 to 25 AFY).

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1 Introduction and Current Conditions

The Central Marin Sanitation Agency Wastewater Treatment Plant (CMSA WWTP) discharges to Central San Francisco Bay. It is located at 1301 Andersen Drive, San Rafael, CA 94901 and serves about 52,200 service connections throughout the City of Larkspur, the Towns of Corte Madera, Fairfax, Ross, San Anselmo, portions of the City of San Rafael, the unincorporated areas of Ross Valley, San Quentin Village, and San Quentin State Prison. The plant has an average dry weather flow (ADWF) permitted capacity of 10 million gallons per day (mgd).

The subsections that follow provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

CMSA holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2023-0006). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2023-0006; CA0038628)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	10	--	--	--
Effluent cBOD (1)	mg/L	--	25	40	--
Effluent TSS (1)	mg/L	--	30	45	--
Effluent Ammonia	mg N/L	--	60	--	110

1. cBOD and TSS include a minimum percent removal of 85 percent through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for the CMSA WTP. Both liquids processes and solids processes are shown. Treatment processes consist of screening, grit removal, primary sedimentation, secondary biological treatment (high-rate biofilters and aeration tanks), secondary clarification, chlorination, and dechlorination. No major nutrient removal systems are currently in place. Solids from the secondary clarifiers are processed via rotary drum thickeners, then thickened secondary solids and primary solids are processed via anaerobic digestion and dewatering using high speed centrifuges.

1.3 Existing Recycled Water Service

CMSA has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The WWTP currently recycles 750+ acre-feet per year (210+ million gallons per year). There are no existing plans to further expand the recycled water program.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	7.46	14.4	11.5
Volume	AF	3,500	9,400	12,900
Ammonia	kg N/d	953	995	977
Total Inorganic Nitrogen (TIN)	kg N/d	1,090	1,100	1,100
Total Phosphorus (TP)	kg P/d	116	96	105
Ammonia	mg N/L	34.1	21.6	26.8
TIN	mg N/L	39.0	24.2	30.4
TP	mg P/L	4.23	2.31	3.11

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

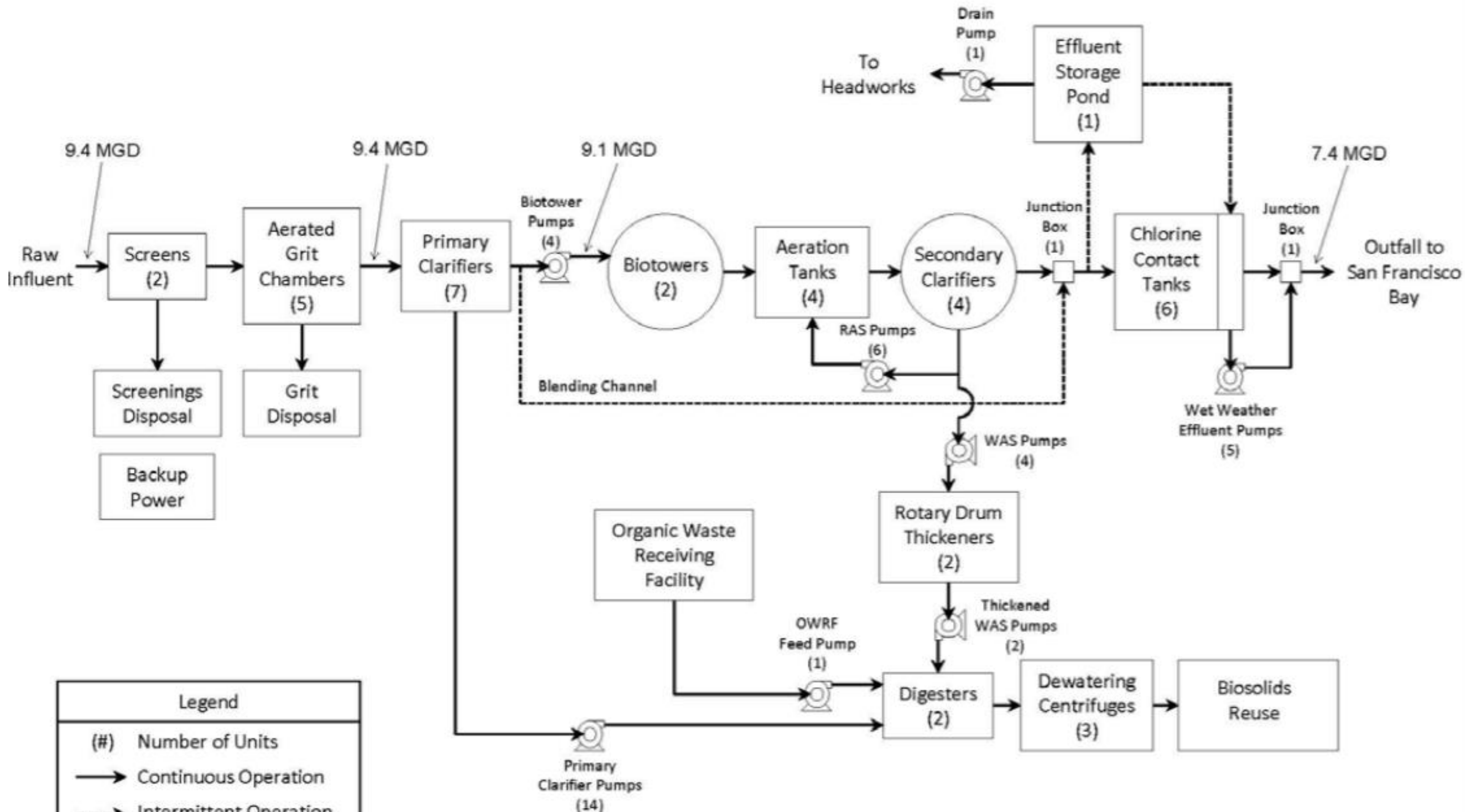

Figure 1-1. Process Flow Diagram for Central Marin Sanitation Agency (Source: NPDES Order No. R2-2023-0006)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2020 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial

Use Category*	Definition
	building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with CMSA WWTP and Engineer’s best judgment that considered known project constraints, existing CMSA WWTP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by CMSA WWTP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering,

construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN, or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?

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[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects. The following subsections summarize the flow and nutrient load reductions for each listed project in Table 3-1.

Table 3-1. Recycled Water Projects Identified by CMSA WWTP

Recycled Water Project	Description
Current and Into the Future: Approximately 1,200 AFY	Almost all distributed recycled water is consumed by internal use, such as boiler, odor control, sodium bisulfite carrier, and facility irrigation. Other non-potable uses are for sewer cleaning. Of the 1,200 AFY, approximately 20 to 25 AF is diverted from the Bay for facility irrigation. The remaining 1,175+ AF ends up in the Bay and is thus excluded from this analysis. CMSA plans to continue this approach into the future.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. The existing facility has reached its projected demand capacity with no plans for future expansion.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. To date, the majority of their reuse water is used for internal uses and other non-potable uses, such as boiler, odor control, sodium bisulfite carrier, facility irrigation, and sewer collection cleaning.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Distributed - Return Flows (AFY)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**1**	**24**	**2**	**2**	**<1**
	Existing Facilities	1	24	2	2	<1
	Other Projects	--	--	--	--	--
2025	**Total**	**1**	**24**	**2**	**2**	**<1**
	Existing Facilities	1	24	2	2	<1
	Other Projects	--	--	--	--	--
2030	**Total**	**1**	**24**	**2**	**2**	**<1**
	Existing Facilities	1	24	2	2	<1
	Other Projects	--	--	--	--	--
2035	Total	**1**	**24**	**2**	**2**	**<1**
	Existing Facilities	1	24	2	2	<1
	Other Projects	--	--	--	--	--
2040	**Total**	**1**	**24**	**2**	**2**	**<1**
	Existing Facilities	1	24	2	2	<1
	Other Projects	--	--	--	--	--
2045	**Total**	**1**	**24**	**2**	**2**	**<1**
	Existing Facilities	1	24	2	2	<1
	Other Projects	--	--	--	--	--

* Confidence Levels:

(1) Includes existing or new projects in an adopted budget.

(2) Includes projects that are in an adopted Master Plan or CIP.

(3) Includes projects that are in the conceptual stage and not included in an adopted document.

Note: the annual recycle water demands are approximately 1,200 AF. The values in this table represent flows and loads associated with recycled water that would be diverted from the Bay (approximately 20 to 25 AFY).

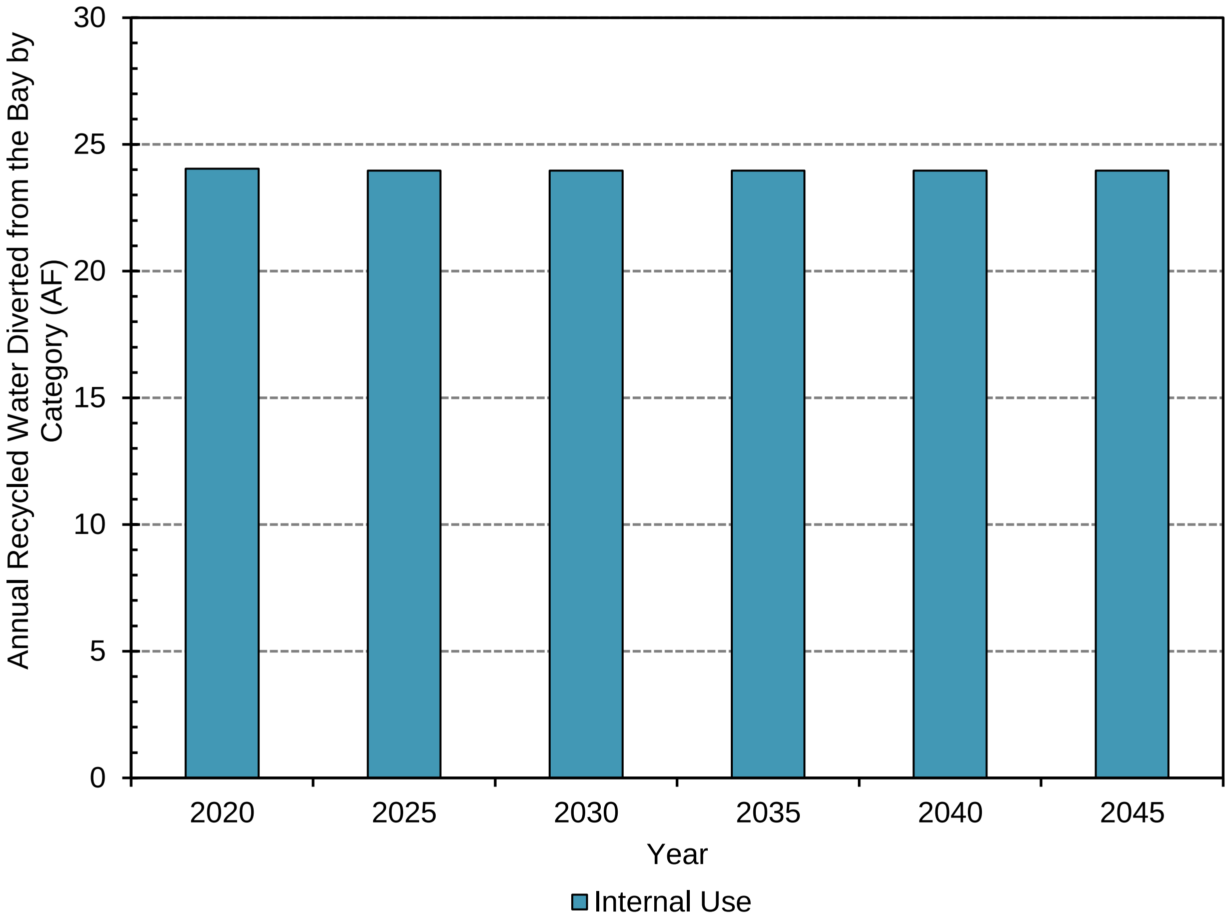

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

Note: the annual recycle water demands are approximately 1,200 AF. The values in this figure represent flows and loads associated with recycled water that would be diverted from the Bay (approximately 20 to 25 AFY).

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. The existing facilities are already paid for and in place. There are no anticipated future planned projects.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water System	• Reduces potable water supply demands • Water is readily accessible for staff • Staff is familiar with the existing system	• Does not divert all loads from the Bay. However, such recycled water practices reduces potable water supply demands
Future Projects	None Planned	None Planned

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. The existing system is cost-effective as evidenced by relatively low unit cost values. The unit cost for nutrient load reductions is comparable for ammonia and TIN. In contrast, the unit cost for total phosphorus load reductions is greater than ammonia and TIN as the CMSA WWTP removes a portion of the raw influent total phosphorus (not shown).

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. The recycled water volumes are not anticipated to change over the next 25 years. As a result, the projected nutrient loads diverted to the Bay are also not anticipated to change unless the effluent nutrient concentrations change over time. The analysis is based on the existing effluent nutrient concentrations over the project duration.

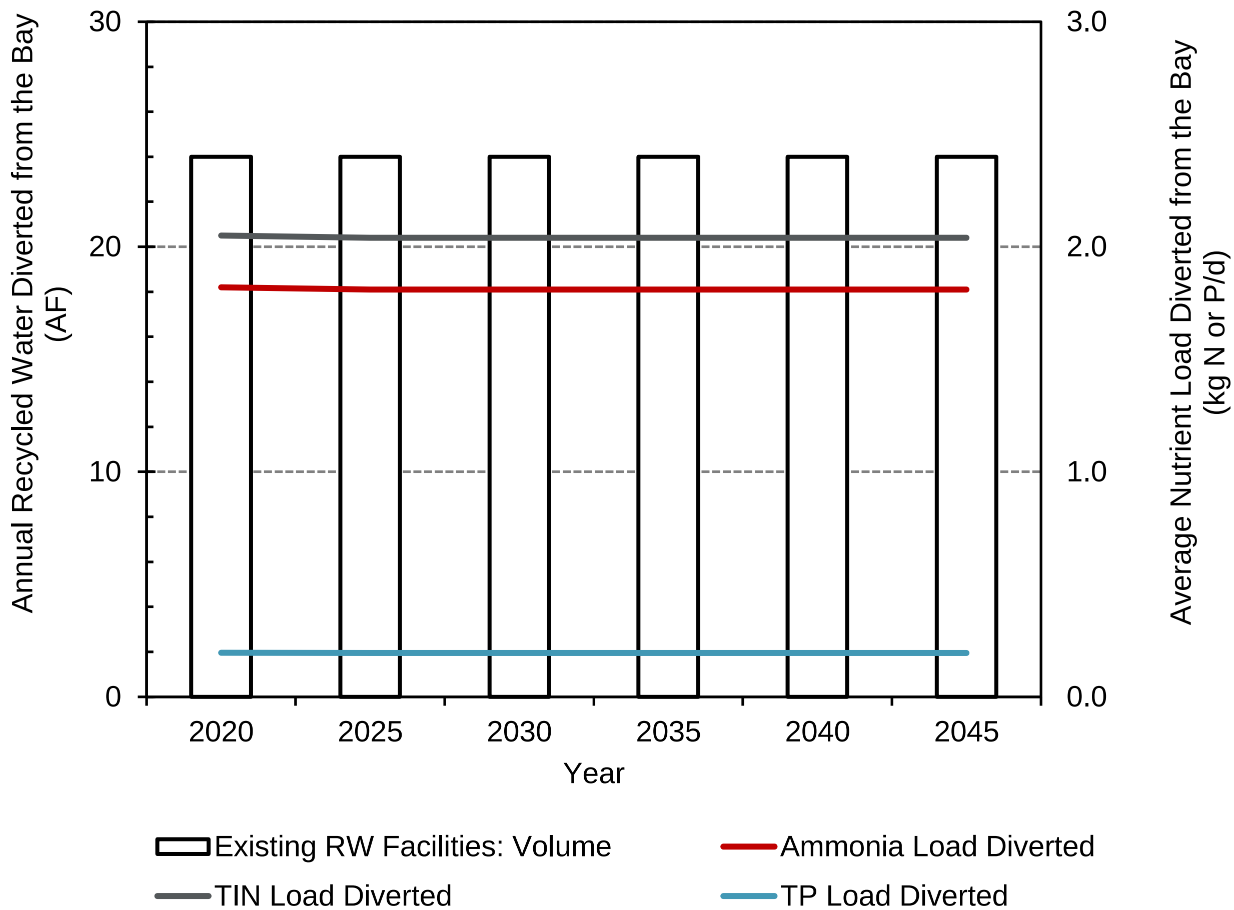

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge

Note: the annual recycle water demands are approximately 1,200 AF. The values in this figure represent flows and loads associated with recycled water that would be diverted from the Bay (approximately 20 to 25 AFY).

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Projects (None Planned) *,**		Total (Projected into the Future) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	Mgd	0.04	0.02	--	--	0.04	0.02
Volume	AF	20	24	--	--	20	24
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	1%	0%	--	--	1%	0%
Ammonia Load Diverted	kg N/d	5	2	--	--	5	2
TIN Load Diverted	kg N/d	6	2	--	--	6	2
TP Load Diverted	kg P/d	1	<1	--	--	1	<1
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	1.0	1.2	--	--	1.0	1.2
NPV Total (Capital+NPV O&M)	$ Mil	1.0	1.2	--	--	1.0	1.2
Unit Flow Cost[6]							
Unit Cost	$/gpd	24	57	--	--	24	57
Unit Cost	$/AF	2,020	2,020	--	--	2,020	2,020
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	22	33	--	--	22	33
TIN Unit Cost	$/lb TIN Diverted	19	29	--	--	19	29
TP Unit Cost	$/lb TP Diverted	181	308	--	--	181	308

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045).

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production based on the energy required to produce water at the plant for various recycled water uses by CMSA (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay over the project duration.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

Note: the annual recycle water demands are approximately 1,200 AF. The values in this figure represent flows and loads associated with recycled water that would be diverted from the Bay (approximately 20 to 25 AFY).

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3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at CMSA:

- Drivers for implementing recycled water projects:
  - Water Supply Need: any strategies to reduce demands on the existing water supply system.
  - Proposed Discharge Regulations: concerns over future nutrient and other regulations.
- Barriers for implementing recycled water projects:
  - Lack of Need: CMSA and Marin Municipal Water District completed a recycled water feasibility study several years ago and learned that there are only small users in the CMSA service area, which results in a delivery cost range of $3,000 to 12,000/acre-foot. The only sizeable user is San Quentin with 184 acre-feet which was an $8 Mil project with modest demands.
  - Institutional: CMSA does not have the infrastructure in place (both physically and administrative) to enter into this market space.
  - Jurisdictional: challenges with coordinating across jurisdictions.
  - Funding: the costs for such efforts are prohibitive as noted with the recent San Quentin evaluation.

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Delta Diablo

BACWA Recycled Water Study

Final Individual Plant Report

Antioch, CA
June 21, 2023

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Contents

Tables

Figures

Executive Summary

The Delta Diablo Wastewater Treatment Plant (DDWWTP) discharges to New York Slough (a tributary to the San Joaquin River which feeds into Suisun Bay). It is located at 2500 Pittsburg-Antioch Highway, Antioch, CA 94509, and it serves about 57,700 service connections throughout Pittsburg, Antioch, and the unincorporated community of Bay Point. The plant has an average dry weather flow (ADWF) permitted capacity of 19.5 million gallons per day (mgd).

Delta Diablo also operates a Recycled Water Facility (RWF) designed to treat up to 12.8 MGD of secondary level effluent from the WWTP to tertiary level standards. The RWF operates year-round and diverts secondary effluent upstream of the disinfection process from the WWTP and sends it to the RWF for tertiary treatment before being distributed to recycled water users. The existing recycled water program has the effect of reducing nutrients discharged to the Bay.

The RWF currently recycles approximately 9,000 acre-feet per year (AFY) or 2,900 million gallons per year. The RWF is limited by influent flows and is unable to add any additional large, recycled water customers because of summer peak demand periods. Based on annual average recycled water flows, the RWF has additional capacity but is constrained during peak summer months as a result of high cooling tower demands from the power plants and increased demand from irrigation customers. Cooling tower use accounts for approximately 90 percent of RWF's recycled water production.

A new carbon capture project is under consideration at Delta Energy Center. Such a project could result in increased industrial demand; however, the future of this project is uncertain from both a recycled water availability standpoint and likelihood of implementation. As a result, demands from the carbon capture project are not included in this plant report.

As part of the on-going contract with the two local power plants, Delta Diablo is under contract to continue providing recycled water through June 2031. The contract requires a detailed Facilities Assessment to be completed by June 2025 to evaluate the capital investments needed to maintain operation of the RWF over the subsequent 30 years. The evaluation could include the impacts of improved water quality which may allow the power plants to use less recycled water, thereby freeing up capacity for other users. Similar to the aforementioned carbon capture project at Delta Energy Center, any potential gains are not included in this plant report due to uncertainties.

Delta Diablo has recently completed a Resource Recovery Facility Master Plan (November 2022); however, there are only minor projects planned because of the supply limitation.

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES - 1. The timeline and corresponding load diversions from the Bay for projected listed in Table ES - 1 is provided in Figure ES - 1. It is worth noting that the WWTP reliably removes TP so the corresponding TP load reduction with recycled water is marginal. Also, the plant has little or no nitrite plus nitrate so ammonia and TIN loads are comparable.

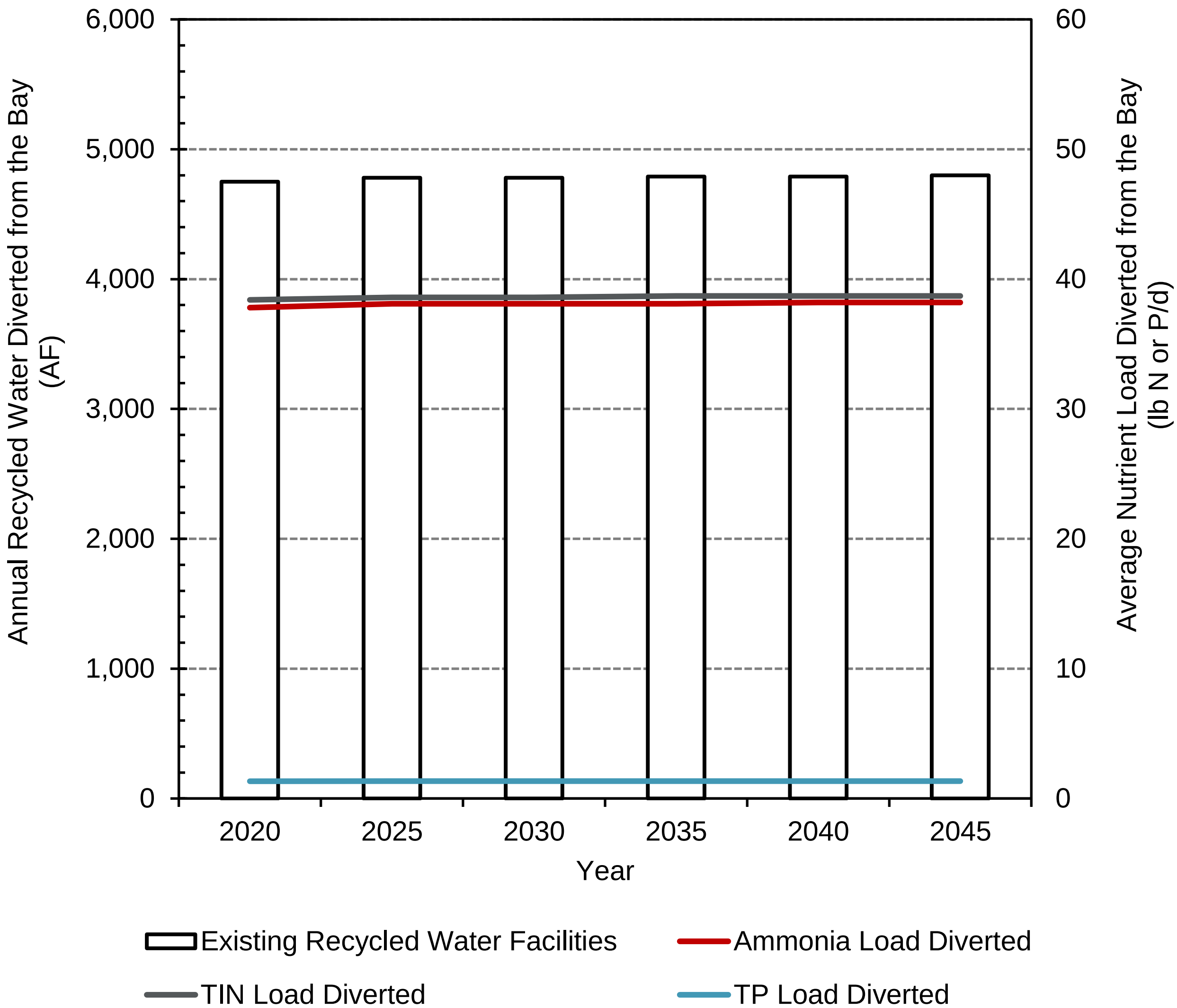

Figure ES - 1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge*

* A new carbon capture project is under consideration that would increase recycled water demands. The project is not shown due to uncertainties on recycled water production and likelihood of implementation.

An overview of the drivers and barriers for implementing recycled water projects at Delta Diablo:

- Drivers for implementing recycled water projects:
  - Water Supply: primarily due to drought conditions
  - Proposed Discharge Regulations: focus on future nutrient regulations and other discharge limits
- Barriers for implementing recycled water projects:
  - Water Volume: RWF is currently limited by influent flows (largely during peak demand periods) and are thus unable to add recycled water customers
  - Funding: additional distribution pipeline(s) and connections is costly.

Table ES - 1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Projects *,**, ǂ		Total (Projected into the Future) *,**, ǂ	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	4.4	4.3	--	--	4.4	4.3
Volume	AF	2,080	4,780	--	--	2,080	4,780
Load Diverted from the Bay[2,3]							
Confidence	unitless	2	2	--	--	2	2
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	35%	32%	--	--	35%	32%
Ammonia Load Diverted	kg N/d	55	38	--	--	55	38
TIN Load Diverted	kg N/d	56	39	--	--	56	39
TP Load Diverted	kg P/d	2	1	--	--	2	1
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	37	84	--	--	37	84
NPV Total (Capital+NPV O&M)	$ Mil	37	84	--	--	37	84
Unit Flow Cost[6]							
Unit Cost	$/gpd	8.2	20	--	--	8.2	20
Unit Cost	$/AF	702	702	--	--	702	702
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	79	110	--	--	79	110
TIN Unit Cost	$/lb TIN Diverted	78	108	--	--	78	108
TP Unit Cost	$/lb TP Diverted	2,100	3,120	--	--	2,100	3,120

* Existing RW Projects refers to existing treatment facilities producing RW (Delta Diablo has the opportunity for modest increases within the existing RWF); Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045).

ǂ A new carbon capture project is under consideration at Delta Energy Center that would increase recycled water demands. The project is not shown due to uncertainties on recycled water production and likelihood of implementation.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by DDWWTP (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

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1 Introduction and Current Conditions

The Delta Diablo Wastewater Treatment Plant (DDWWTP) discharges to New York Slough (a tributary to the San Joaquin River which feeds into Suisun Bay). It is located at 2500 Pittsburg-Antioch Highway, Antioch, CA 94509, and it serves about 57,700 service connections throughout Pittsburg, Antioch, and the unincorporated community of Bay Point. The plant has an average dry weather flow (ADWF) permitted capacity of 19.5 million gallons per day (mgd).

The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

DDWWTP holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2019-0035). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2019-0035; CA0038547)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Effluent Flow	mgd	19.5	--	--	--
Influent BOD (1)	mg/L	--	30	45	--
Influent TSS (1)	mg/L	--	30	45	--
Influent Ammonia (3)	mg N/L	--	170	--	220

1. BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.
3. Prior to Antioch Brackish Water Desalination Project Implementation. After implementation the average monthly ammonia limit is 77 mg N/L and the max daily ammonia limit is 110 mg N/L.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for the DDWWTP and the RWF. Both liquids processes and solids processes are shown. The DDWWTP has primary clarifiers, followed by the option to divert flows to flow equalization and a trickling filter/activated sludge (TF/AS) system for secondary treatment. The TF/AS maintains a low SRT (less than 3 days) for secondary treatment. A portion of secondary effluent is conveyed to the RWF and the remaining portion is sent to disinfection prior to discharge. A majority of the recycled water is sent to nearby power plants for use in cooling towers and the blowdown from the cooling towers is returned to the DDWWTP upstream of disinfection. Solids treatment consists of thickening, anaerobic digestion, and dewatering.

Phosphorus is removed in the primary clarifiers as a result of the ferrous chloride added in the collection system coupled with aluminum sulfate in the RWF clarifier sludge that is returned to the headworks of the DDWWTP.

1.3 Existing Recycled Water Service

Delta Diablo operates a Recycled Water Facility (RWF) designed to treat up to 12.8 MGD of secondary level effluent from the WWTP to tertiary level standards. The RWF operates year-round and diverts secondary effluent upstream of the disinfection process from the WWTP and sends it to the RWF for tertiary treatment before being distributed to recycled water users. The existing recycled water program has the effect of reducing nutrients discharged to the Bay. The RWF currently recycles approximately 9,000 acre-feet per year (2,900 million gallons per year). The RWF is limited by influent flows and is unable to add additional large, recycled water customers because of summer peak demand periods. Based on annual average recycled water flows, the RWF has additional capacity but is constrained during peak summer months as a result of high cooling tower demands from the power plants and increased demand from irrigation customers. Cooling tower use accounts for approximately 90 percent of RWF's recycled water production.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	8.18	10.0	9.22
Volume	AF	3,840	6,490	10,330
Ammonia	kg N/d	1,330	1,560	1,470
Total Inorganic Nitrogen (TIN)	kg N/d	1,340	1,600	1,490
Total Phosphorus (TP)	kg P/d	49.8	52.8	51.6
Ammonia	mg N/L	43.7	41.9	42.6
TIN	mg N/L	44.0	43.0	43.4
TP	mg P/L	1.58	1.39	1.47

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

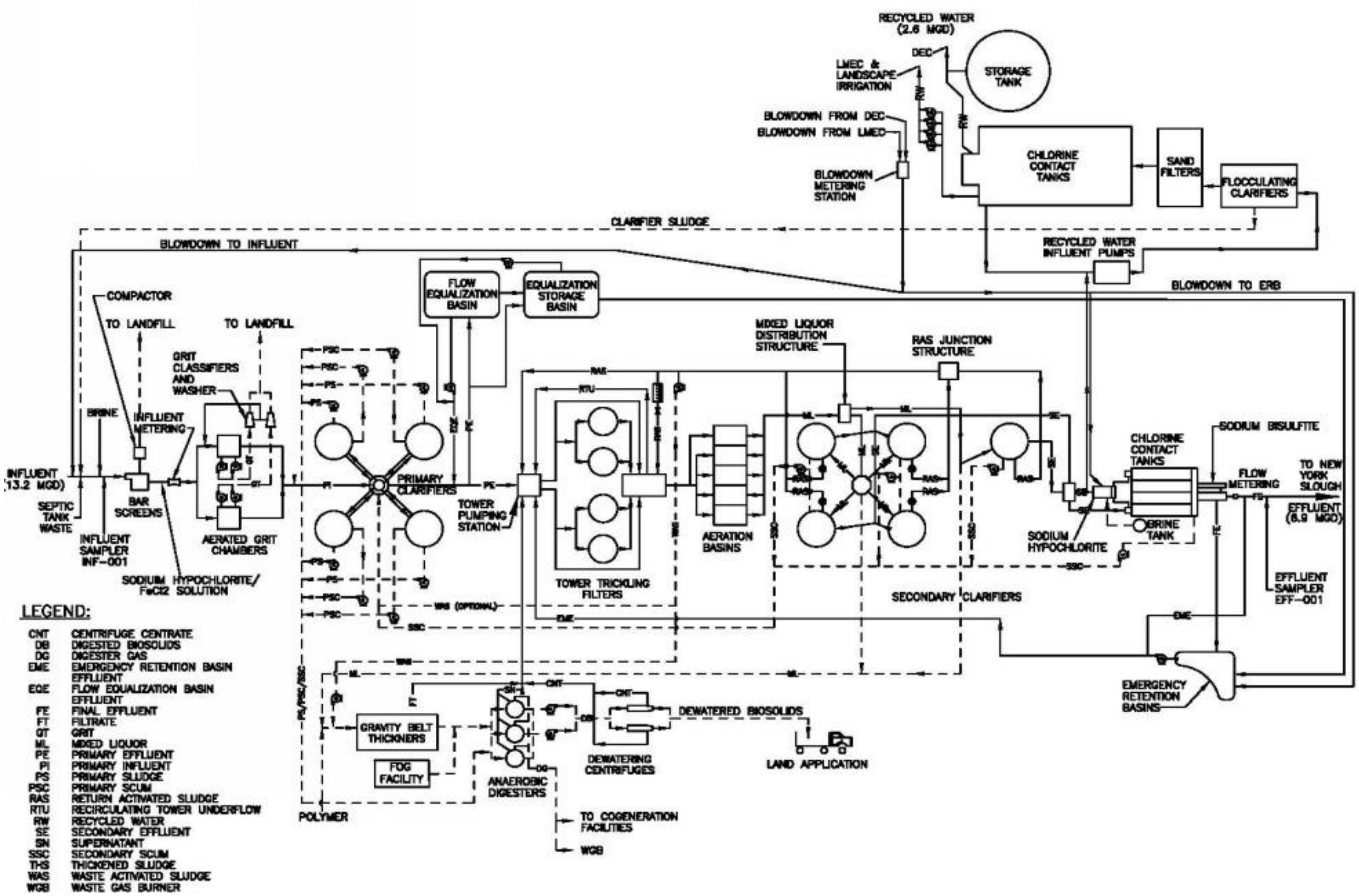

Figure 1-1. Process Flow Diagram for Delta Diablo (Source: NPDES Permit R2-2019-0035; CA0038547)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility.
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections, if included, were based on a combination of working with Delta Diablo and Engineer's best judgment that considered known project constraints, existing RWF reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by Delta Diablo. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects.

Table 3-1. Recycled Water Projects Identified by Delta Diablo

Recycled Water Project	Description
Existing Recycled Water Facilities	The RWF includes flocculation, filtration, and chlorine disinfection to meet total coliform, disinfection, and turbidity limits prior to distribution to irrigation and industrial customers. The RWF has additional capacity during the majority of the year but is supply constrained during multi-day heat waves in the peak summer months as a result of high cooling tower demands from the power plants and increased demand from irrigation customers. An upcoming detailed Facilities Assessment (will be completed by June 2025) will evaluate the capital investments needed to maintain operation of the RWF over the subsequent 30 years. The evaluation could include the impacts of improved water quality which may allow the power plants to use less recycled water, thereby freeing up capacity for other users. Any potential gains are not included in this plant report due to uncertainties.
Future Project(s)	A new carbon capture project is under consideration at Delta Energy Center that would increase recycled water demands. The project is not shown though as it has uncertainty from both a recycled water volume standpoint and likelihood of implementation.

The following subsections summarize the flow and nutrient load reductions for each listed project in Table 3-1.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. Recycled water deliveries via existing facilities are anticipated to be roughly constant through 2045.

Figure 3-1 presents a distribution of the recycled water volumes diverted from the Bay by use categories from 2020 through 2045. Current and future recycled water uses via existing facilities include golf course, landscape, industrial, and internal uses. Industrial cooling tower use accounts for approximately 90 percent of RWF's recycled water production. The following assumptions were made for flow and load diversions from the Bay for Delta Diablo's various demands:

- Irrigation (golf course, landscape): 100 percent flow diverted, 100 percent nutrients diverted
- Industrial (cooling towers): 65 percent flow diverted, 0 percent nutrients diverted. Note: the cooling towers blowdown does occasionally nitrify and subsequently negatively impact downstream chlorination at the DDWWTP. For this exercise, 0 percent nutrients diverted was conservatively assumed.
- Internal uses: 10 percent flow diverted, 10 percent nutrients diverted

In general, the recycled water demands peak in the dry season, but there are year-round demands.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence*	Distributed - Return Flows (AFY)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**2**	**4,750**	**38**	**38**	**1**
	Existing Facilities**	2	4,750	38	38	1
	Other Projects***	--	--	--	--	--
2025	**Total**	**2**	**4,780**	**38**	**39**	**1**
	Existing Facilities**	2	4,780	38	39	1
	Other Projects***	--	--	--	--	--
2030	**Total**	**2**	**4,780**	**38**	**39**	**1**
	Existing Facilities**	2	4,780	38	39	1
	Other Projects***	--	--	--	--	--
2035	**Total**	**2**	**4,790**	**38**	**39**	**1**
	Existing Facilities**	2	4,790	38	39	1
	Other Projects***	--	--	--	--	--
2040	**Total**	**2**	**4,790**	**38**	**39**	**1**
	Existing Facilities**	2	4,790	38	39	1
	Other Projects***	--	--	--	--	--
2045	**Total**	**2**	**4,800**	**38**	**39**	**1**
	Existing Facilities**	2	4,800	38	39	1
	Other Projects***	--	--	--	--	--

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

** The RWF has additional capacity during the majority of the year, but it is supply constrained during multi-day heat waves in the peak summer months as a result of high cooling tower demands from the power plants and increased demand from irrigation customers.

*** A new carbon capture project is under consideration that would increase recycled water demands. The project is not shown due to uncertainties on recycled water production and likelihood of implementation.

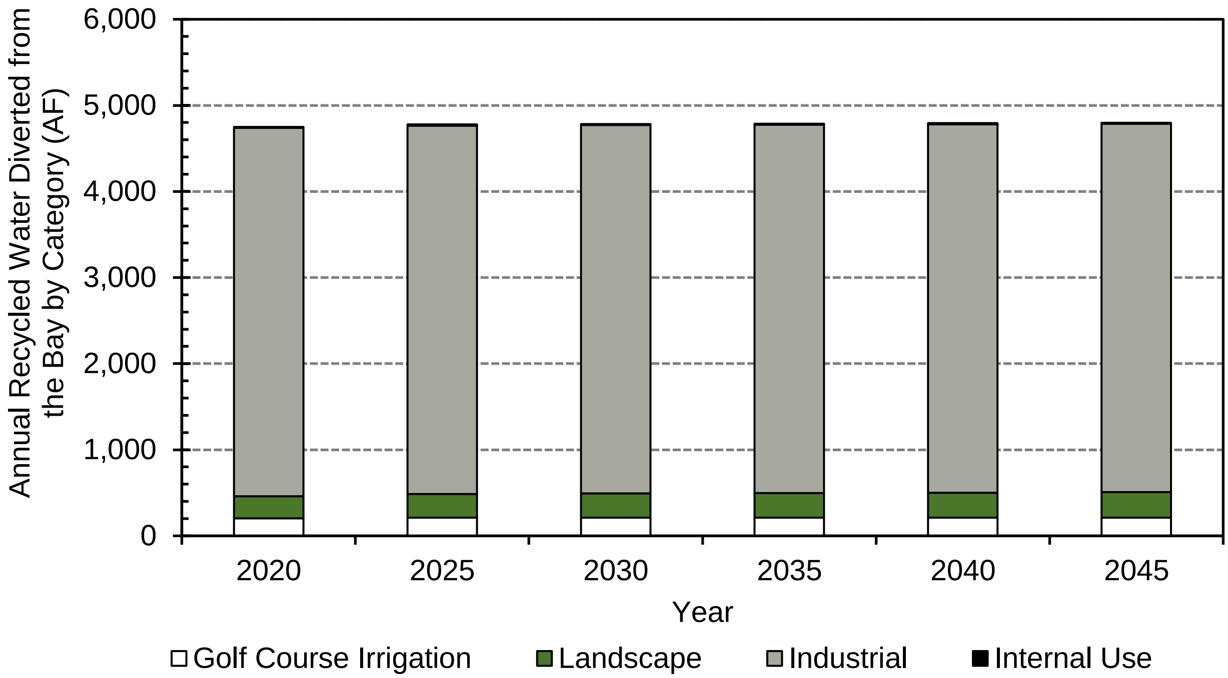

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)*

* A new carbon capture project is under consideration that would increase recycled water demands. The project is not shown due to uncertainties on recycled water production and likelihood of implementation.

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. The existing facilities are already paid for and in place.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities	• Facilities are already in place and providing recycled water • Operator familiarity with existing recycled water facilities • Existing facilities reliably meet recycled water treatment requirements	• Facilities are limited by DDWWTP influent flows during dry season. Additional recycled water customers cannot be added due to capacity limitations. • The flow that is sent to the industrial customers results in little or no nutrient removal
Future Project(s)*	• Non-Applicable*	• Non-Applicable*

* A new carbon capture project is under consideration that would increase recycled water demands. The project is not shown due to uncertainties on recycled water production and likelihood of implementation.

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. Recycled water deliveries via existing facilities are anticipated to be roughly constant through 2045. There are no plans to further expand existing non-potable water program.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. As previously noted, the WWTP reliably removes TP so the corresponding TP load reduction with recycled water is marginal. Also, the plant has little or no nitrite plus nitrate so ammonia and TIN loads are comparable.

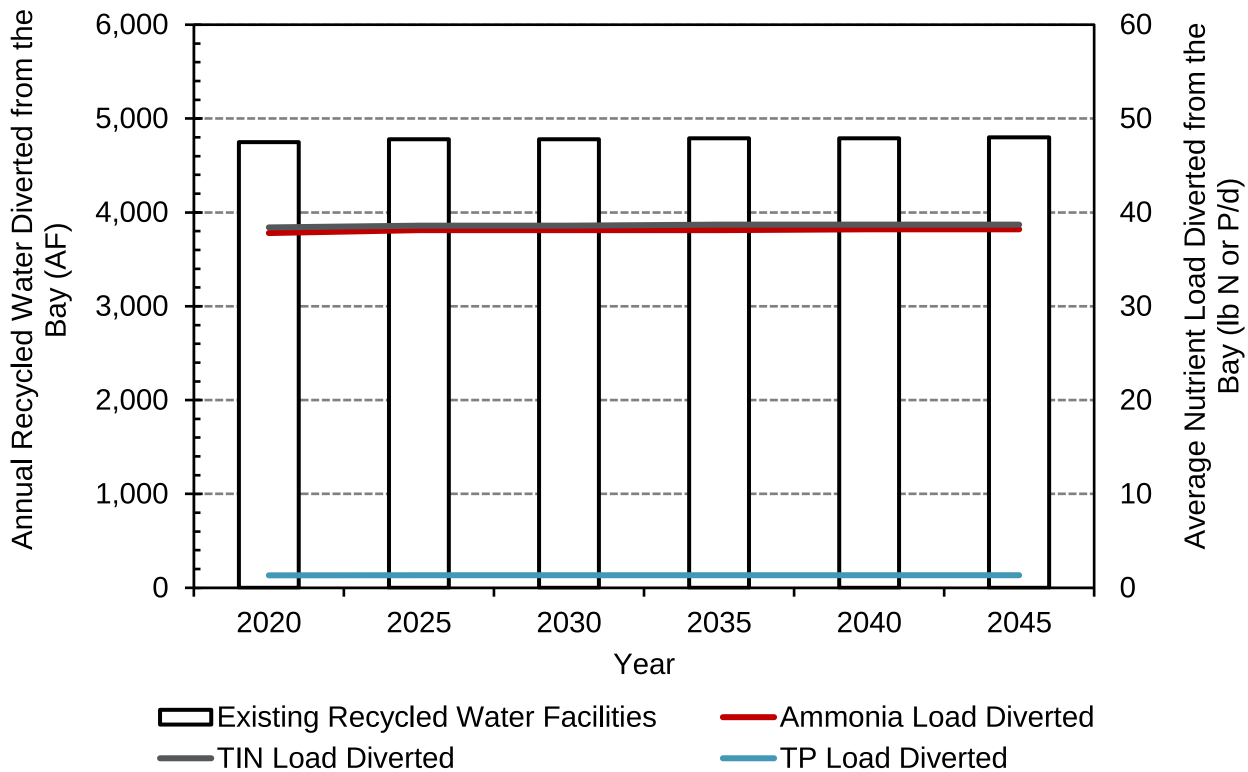

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge*

* A new carbon capture project is under consideration that would increase recycled water demands. The project is not shown due to uncertainties on recycled water production and likelihood of implementation.

3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at Delta Diablo:

- Drivers for implementing recycled water projects:
    - Water Supply: primarily due to drought conditions
    - Proposed Discharge Regulations: focus on future nutrient regulations and other discharge limits
- Barriers for implementing recycled water projects:
    - Water Volume: DDWWTP is currently limited by their influent flow (largely during peak demand periods) and are thus unable to add recycled water customers
    - Funding: additional distribution pipeline(s) and connections is costly.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Projects *,**, ǂ		Total (Projected into the Future) *,**, ǂ	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	4.4	4.3	--	--	4.4	4.3
Volume	AF	2,080	4,780	--	--	2,080	4,780
Load Diverted from the Bay[2,3]							
Confidence	unitless	2	2	--	--	2	2
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	35%	32%	--	--	35%	32%
Ammonia Load Diverted	kg N/d	55	38	--	--	55	38
TIN Load Diverted	kg N/d	56	39	--	--	56	39
TP Load Diverted	kg P/d	2	1	--	--	2	1
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	37	84	--	--	37	84
NPV Total (Capital+NPV O&M)	$ Mil	37	84	--	--	37	84
Unit Flow Cost[6]							
Unit Cost	$/gpd	8.2	20	--	--	8.2	20
Unit Cost	$/AF	702	702	--	--	702	702
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	79	110	--	--	79	110
TIN Unit Cost	$/lb TIN Diverted	78	108	--	--	78	108
TP Unit Cost	$/lb TP Diverted	2,100	3,120	--	--	2,100	3,120

* Existing RW Projects refers to existing treatment facilities producing RW (Delta Diablo has the opportunity for modest increases within the existing RWF); Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045).

ǂ A new carbon capture project is under consideration at Delta Energy Center that would increase recycled water demands. The project is not shown due to uncertainties on recycled water production and likelihood of implementation.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by DDWWTP (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

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Dublin San Ramon Services District Regional Wastewater Facility

BACWA Recycled Water Study

FINAL Individual Plant Report

Dublin, CA
March 19, 2023

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Contents

Tables

Figures

Executive Summary

The Dublin San Ramon Sanitary District (DSRSD) owns and operates the DSRSD Wastewater Regional Facility (DSRSD RWF) located in Pleasanton, CA and conveys treated effluent to East Bay Dischargers Authority (EBDA). EBDA discharges the treated effluent to the South Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 17 million gallons per day (mgd).

The DSRSD RWF has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The RWF currently recycles approximately 4,000 acre-feet per year (approximately 1,160 million gallons per year). The reuse demands are primarily from golf course and landscape irrigation applications, as well as internal uses at the RWF. Note: the internal uses at the RWF are not included in this analysis as such flows are typically discharged to the Bay.

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES - 1. The unit costs values are relatively low both on a volume and nutrient load reduction basis (with the exception of TP). This relatively efficient flow and load reduction is attributed to the facilities already being in place. For perspective, the optimization and upgrades study that evaluated nutrient load reduction across Bay Area WWTPs had an average value of $0.5/gpd for optimizing existing facilities,[1] which is relatively close to the $0.7 and $1.7/gpd values (dry season and average annual, respectively) for DSRSD RWF in this report.

The timeline and corresponding load diversions from the Bay is provided in Figure ES – 1. As stated in the footnote, the future flow and nutrient load diversions from the Bay do not include internal use applications (<< 20 AFY), as such flows will be returned to the DSRSD RWF and typically not diverted from the Bay. The DSRSD RWF is at or nearing capacity of the existing facilities as evidenced by current and future reuse projections being similar.

An overview of the drivers and barriers for implementing recycled water projects at DSRSD RWF:

- Drivers for implementing recycled water projects:
  - Water supply needs across DSRSD's service area, as well as at other neighboring service areas.
  - Expand their service area.
- Barriers for implementing recycled water projects:
  - Jurisdictional: DSRSD RWF is challenged while working across jurisdictions.
  - Supply: ability to produce more recycled water.
  - Funding: ability to fund expansion of the existing service area.

[1] Bay Area Clean Water Agencies (2018) Bay Area Clean Water Agencies Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream Treatment, Treatment Upgrades, and Other Means. Prepared by HDR. Oakland, CA.

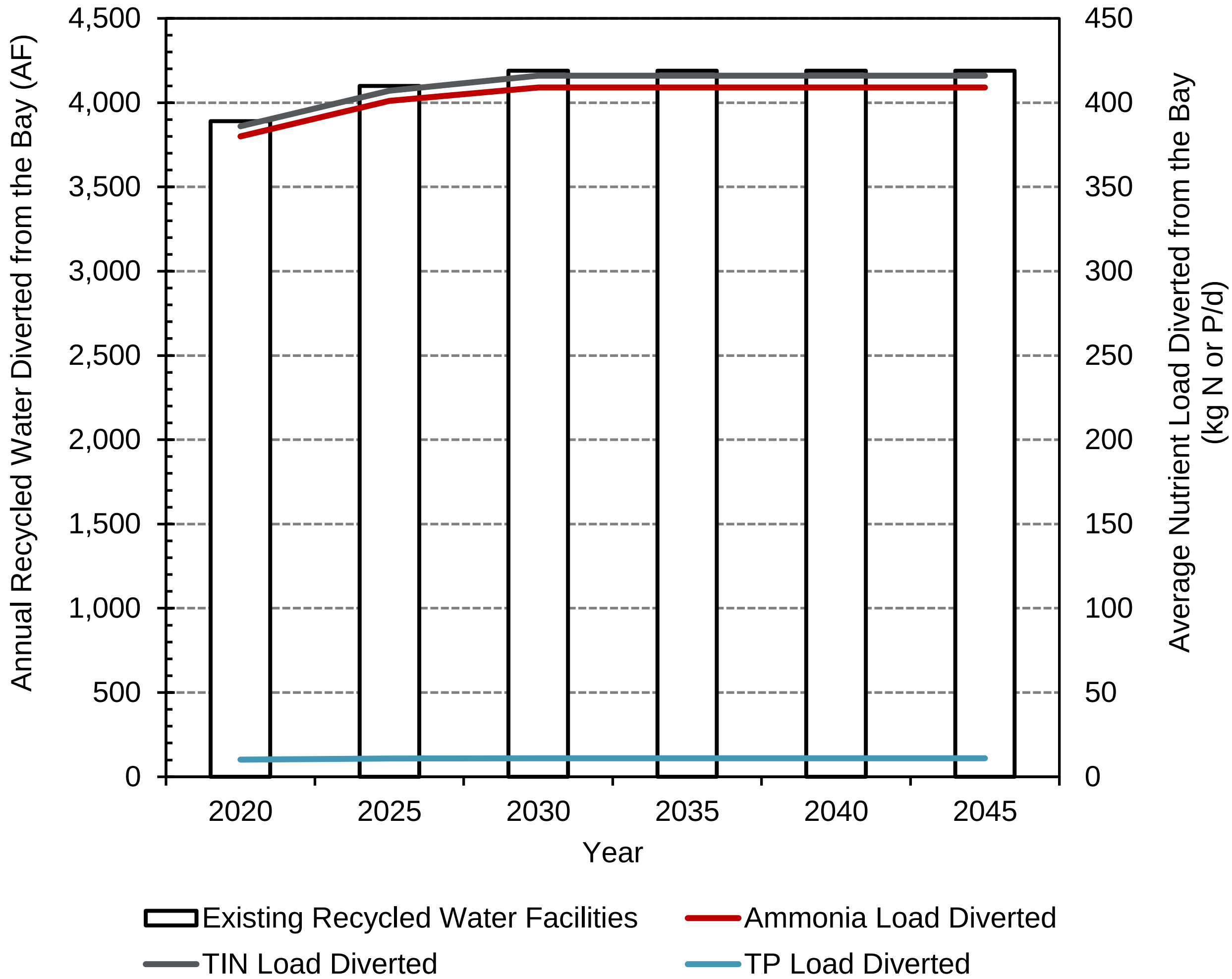

Figure ES - 1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge*

* The plant does use recycled water for internal uses (not shown; <<20 AFY). Note: the internal uses at the RWF are not included in this analysis as such flows are eventually discharged to the Bay.

Table ES - 1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (None Planned) *, **		Total (Includes Existing and Future Projects (None Planned) Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	4.1	3.7	--	--	4.1	3.7
Volume	AF	1,900	4,120	--	--	1,900	4,120
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	60%	36%	--	--	60%	36%
Ammonia Load Diverted	kg N/d	421	403	--	--	421	403
TIN Load Diverted	kg N/d	434	409	--	--	434	409
TP Load Diverted	kg P/d	5	11	--	--	5	11
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	2.8	6.1	--	--	2.8	6.1
NPV Total (Capital+NPV O&M)	$ Mil	2.8	6.1	--	--	2.8	6.1
Unit Flow Cost[6]							
Unit Cost	$/gpd	0.7	1.7	--	--	0.7	1.7
Unit Cost	$/AF	59	59	--	--	59	59
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	0.8	0.7	--	--	0.8	0.7
TIN Unit Cost	$/lb TIN Diverted	0.8	0.7	--	--	0.8	0.7
TP Unit Cost	$/lb TP Diverted	61	28	--	--	61	28

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3). For the Total columns, the project start period is from year 2020 through year 2045.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by DSRSD RWF in 2021 dollars.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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1 Introduction and Current Conditions

The Dublin San Ramon Sanitary District (DSRSD) owns and operates the DSRSD Wastewater Regional Facility (DSRSD RWF) located in Pleasanton, CA and conveys treated effluent to East Bay Dischargers Authority (EBDA). EBDA discharges the treated effluent to the South Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 17.0 million gallons per day (mgd).

The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

DSRSD RWF holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2022-0024; CA0037613). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2022-0024; CA0037613)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	Mgd	17.0	--	--	--
Effluent BOD (1)	mg/L	--	25	40	--
Effluent TSS (1)	mg/L	--	30	45	--
Effluent Ammonia	mg N/L	--	86	--	110

1. BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;
- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);

- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for DSRSD RWF. Both liquids processes and solids processes are shown. DSRSD provides secondary treatment consisting of screening, grit removal, primary clarification, activated sludge, secondary clarification, and disinfection using sodium hypochlorite. Sludge is thickened by dissolved air floatation, anaerobically digested, further conditioned onsite at facultative sludge lagoons for approximately four years, and then injected into the soil at an onsite dedicated land disposal facilities.

1.3 Existing Recycled Water Service

The DSRSD RWF has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The RWF currently recycles approximately 4,000 acre-feet per year (approximately 1,160 million gallons per year). The reuse demands are primarily from golf course and landscape irrigation applications, as well as internal uses at the RWF. Note: the internal uses at the RWF are not included in this analysis as such flows are typically discharged to the Bay.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	2.75	9.32	6.59
Volume	AF	1,290	6,070	7,360
Ammonia	kg N/d	286	1,300	722
Total Inorganic Nitrogen (TIN)	kg N/d	295	1,320	733
Total Phosphorus (TP)	kg P/d	3.67	40.4	19.4
Ammonia	mg N/L	27.5	36.8	29.0
TIN	mg N/L	28.3	37.4	29.4
TP	mg P/L	0.35	1.15	0.78

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

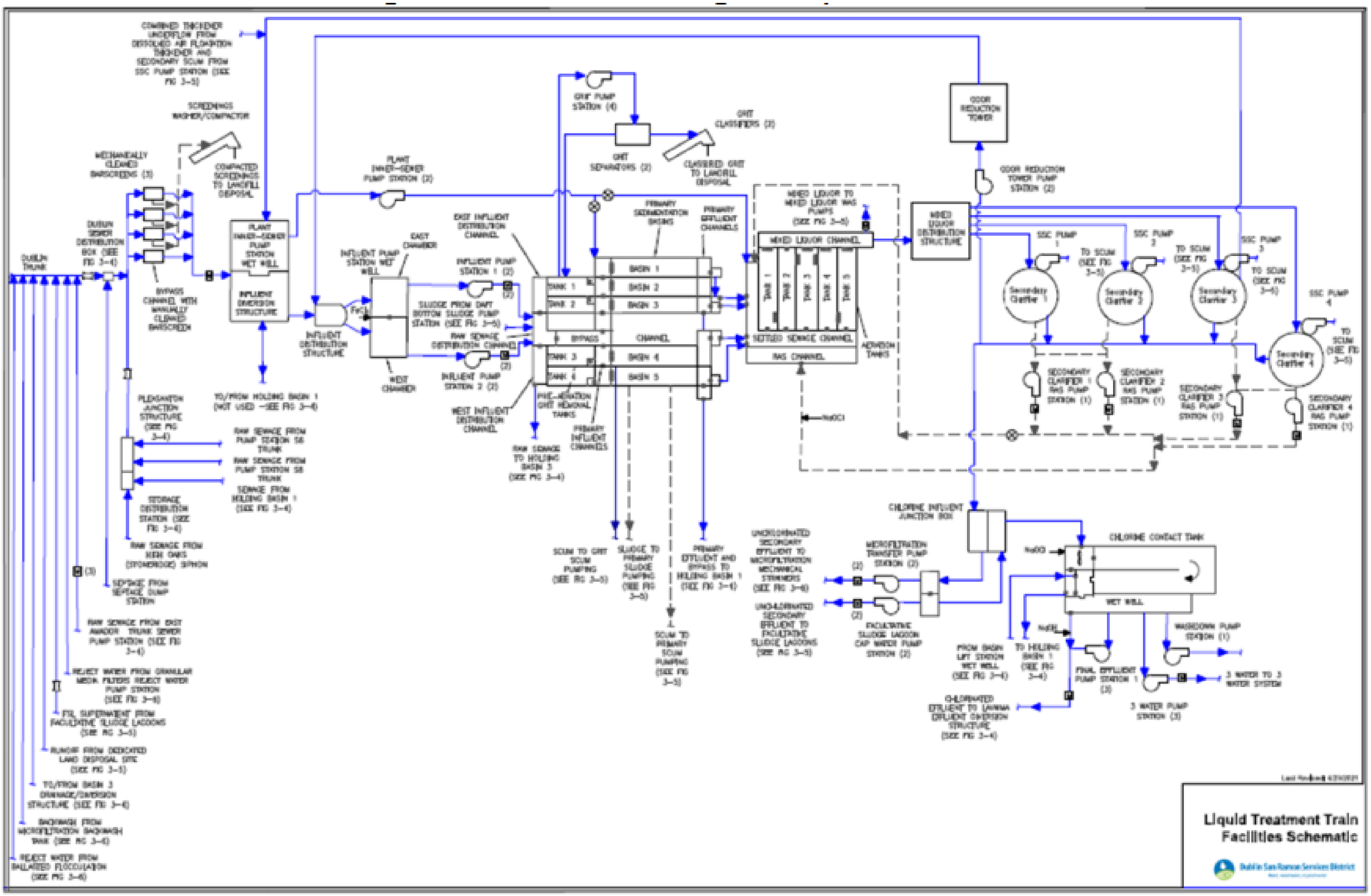

Figure 1-1. Process Flow Diagram for Dublin San Ramon Services District Regional Wastewater Facility (Source: NPDES Permit R2-2022-0024; CA0037613)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2020 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with DSRSD RWF and Engineer's best judgment that considered known project constraints, existing DSRSD RWF reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by DSRSD RWF. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[2] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[2] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g. existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g. a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects. The subsections that follow summarize the flow and nutrient load reductions for each listed project in Table 3-1.

Table 3-1. Recycled Water Projects Identified by DSRSD RWF

Recycled Water Project	Description
Existing Recycled Water Facilities	The DSRSD RWF has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The RWF currently recycles approximately 4,000 acre-feet per year (approximately 1,160 million gallons per year). The reuse demands are primarily from golf course and landscape irrigation applications, as well as internal uses at the RWF. Note: the internal uses at the RWF are not included in this analysis as such flows are eventually discharged to the Bay.
Future Project(s)	None Planned

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. The existing facility is at or near capacity as evidenced by future projections only increasing to just below 4,200 AFY.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Distributed – Return Flows (AFY)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**1**	**3,890**	**380**	**386**	**10**
	Existing Facilities	1	3,890	380	386	10
	Other Projects**	--	--	--	--	--
2025	**Total**	**1**	**4,100**	**401**	**407**	**11**
	Existing Facilities	1	4,100	401	407	11
	Other Projects**	--	--	--	--	--
2030	**Total**	**1**	**4,190**	**409**	**416**	**11**
	Existing Facilities	1	4,190	409	416	11
	Other Projects**	--	--	--	--	--
2035	**Total**	**1**	**4,190**	**409**	**416**	**11**
	Existing Facilities	1	4,190	409	416	11
	Other Projects**	--	--	--	--	--
2040	**Total**	**1**	**4,190**	**409**	**416**	**11**
	Existing Facilities	1	4,190	409	416	11
	Other Projects**	--	--	--	--	--
2045	Total	**1**	**4,190**	**409**	**416**	**36**
	Existing Facilities	1	4,190	409	416	36
	Other Projects**	--	--	--	--	--

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.
** Other Projects: none planned

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. The primary user is landscape irrigation. The demands are year-round, albeit with an increase during the dry season.

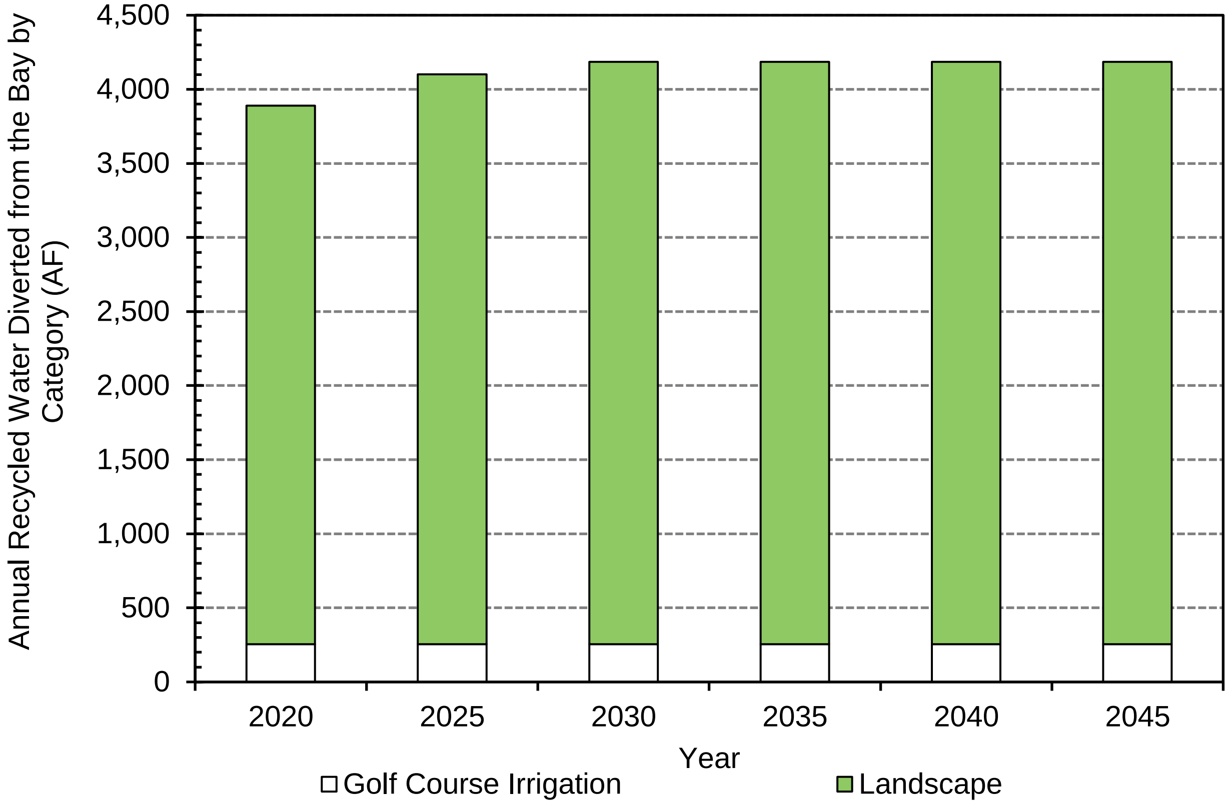

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)*

* The plant does use recycled water for internal uses (not shown; <<20 AFY). Note: the internal uses at the RWF are not included in this analysis as such flows are eventually discharged to the Bay.

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. The key ancillary benefits are the facilities are already in place and operator familiarity. The primary adverse impact is the recycled water applications portfolio is limited to golf course and landscape irrigation.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities	• Facilities are already in place and provide recycled water and in turn reduce water supply demands. • Operator familiarity with existing recycled water facilities. • Existing facilities reliably meet recycled water treatment requirements.	• Ability to deliver full capacity of approximately 4,200 AFY. • Limited portfolio diversity of recycled water applications.
Future Project(s)	None Planned	None Planned

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. The unit costs values are relatively low both on a volume and nutrient load reduction basis (with the exception of TP). This relatively efficient flow and load reduction is attributed to the facilities already being in place. For perspective, the optimization and upgrades study that evaluated nutrient load reduction across Bay Area WWTPs had an average value of $0.5/gpd for optimizing existing facilities,[3] which is relatively close to the $0.7 and $1.7/gpd values (dry season and average annual, respectively) for DSRSD RWF in this report.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. As stated in the footnote, the future flow and nutrient load diversions from the Bay do not include internal use applications (<< 20 AFY), as such flows will be returned to the DSRSD RWF and not be diverted from the Bay. The DSRSD RWF is at or nearing capacity of the existing facilities as evidenced by current and future reuse projections being similar.

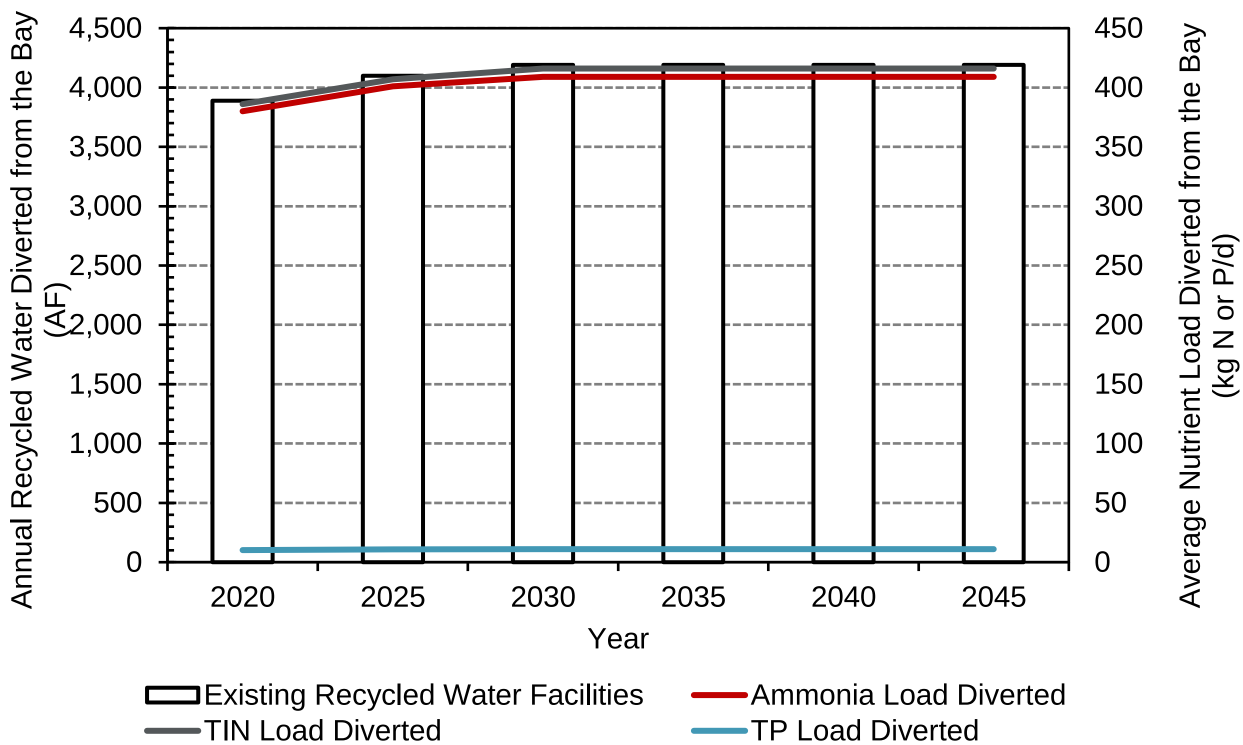

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge*

* The plant does use recycled water for internal uses (not shown; <<20 AFY). Note: the internal uses at the RWF are not included in this analysis as such flows are eventually discharged to the Bay.

[3] Bay Area Clean Water Agencies (2018) Bay Area Clean Water Agencies Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream Treatment, Treatment Upgrades, and Other Means. Prepared by HDR. Oakland, CA.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (None Planned) *, **		Total (Includes Existing and Future Projects (None Planned) Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	4.1	3.7	--	--	4.1	3.7
Volume	AF	1,900	4,120	--	--	1,900	4,120
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	60%	36%	--	--	60%	36%
Ammonia Load Diverted	kg N/d	421	403	--	--	421	403
TIN Load Diverted	kg N/d	434	409	--	--	434	409
TP Load Diverted	kg P/d	5	11	--	--	5	11
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	2.8	6.1	--	--	2.8	6.1
NPV Total (Capital+NPV O&M)	$ Mil	2.8	6.1	--	--	2.8	6.1
Unit Flow Cost[6]							
Unit Cost	$/gpd	0.7	1.7	--	--	0.7	1.7
Unit Cost	$/AF	59	59	--	--	59	59
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	0.8	0.7	--	--	0.8	0.7
TIN Unit Cost	$/lb TIN Diverted	0.8	0.7	--	--	0.8	0.7
TP Unit Cost	$/lb TP Diverted	61	28	--	--	61	28

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045). For the Total columns, the project start period is from year 2020 through year 2045.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by DSRSD RWF in 2021 dollars.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at DSRSD RWF:

- Drivers for implementing recycled water projects:
  - Water supply needs across DSRSD's service area, as well as at other neighboring service areas.
  - Expand their service area.
- Barriers for implementing recycled water projects:
  - Jurisdictional: DSRSD RWF is challenged while working across jurisdictions.
  - Supply: ability to produce more recycled water.
  - Funding: ability to fund expansion of the existing service area.

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East Bay Municipal Utility District

BACWA Recycled Water Study

Final Individual Plant Report

Oakland, CA
June 26, 2023

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Contents

Tables

Figures

Executive Summary

The East Bay Municipal Utility District (EBMUD or District) owns and operates the EBMUD Wastewater Treatment Plant (WWTP or SD-1) located in Oakland, CA and discharges treated effluent to the San Francisco Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 120 million gallons per day (mgd). The plant is allowed to blend primary with secondary effluent when secondary influent exceeds 150 mgd.

EBMUD's East Bayshore Recycled Water Project (EBRWP) currently supplies recycled water year-round to landscape irrigation users. This program has the effect of reducing nutrients discharged to the Bay. The EBRWP provides microfiltration (MF) and chlorine disinfection of the District's secondary effluent at SD-1. A portion of recycled water has been used for cooling tower makeup and for toilet/urinal flushing, but these uses were discontinued due to water quality issues. The EBWRP currently recycles approximately 199 acre-feet per year (AFY) (65 million gallons per year).

EBRWP uses microfiltration (MF) and chlorine disinfection to produce recycled water that meets Title 22 requirements for use in several industrial and commercial applications; however, due to its poor water quality, EBRWP effluent is currently used only for landscape irrigation. Improving EBRWP effluent quality would increase the opportunities to use recycled water for industrial and commercial purposes, thus, increasing its capacity. Hence, an evaluation of the EBRWP effluent quality was completed in 2018 to identify improvement options.

Results of the 2018 evaluation recommend that EBRWP effluent be partially or fully treated with reverse osmosis (RO) and breakpoint chlorination (BC), which is expected to result in a total of 2.3 mgd, or 2,576 AFY (industrial and landscape irrigation uses). In 2020, Office of Water Recycling (OWR) started to conduct a water quality improvements pilot study to test and to determine operational parameters for using RO and BC to improve East Bayshore recycled water quality. Results of the study, expected by 2024, will provide implementation guidelines to improve East Bayshore recycled water. A cost estimate for RO and BC improvements has not yet been evaluated, as it is still in the beginning conceptual stages.

A summary of the recycled water flows and load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP)) are provided in Table ES-1. Note: the total columns on the right-hand side include both values for average over 25-years and from Year 2035 onwards. The average values over 25-years (Year 2020 through 2045) are included as such information will be used for future efforts to develop unit cost metrics. The values from Year 2035 onwards reflect potential values associated with upgrading the existing recycled water facility with advanced treatment and expanding users. The timeline and corresponding load diversions from the Bay for projects listed in Table ES-1 are provided in Figure ES - 1.

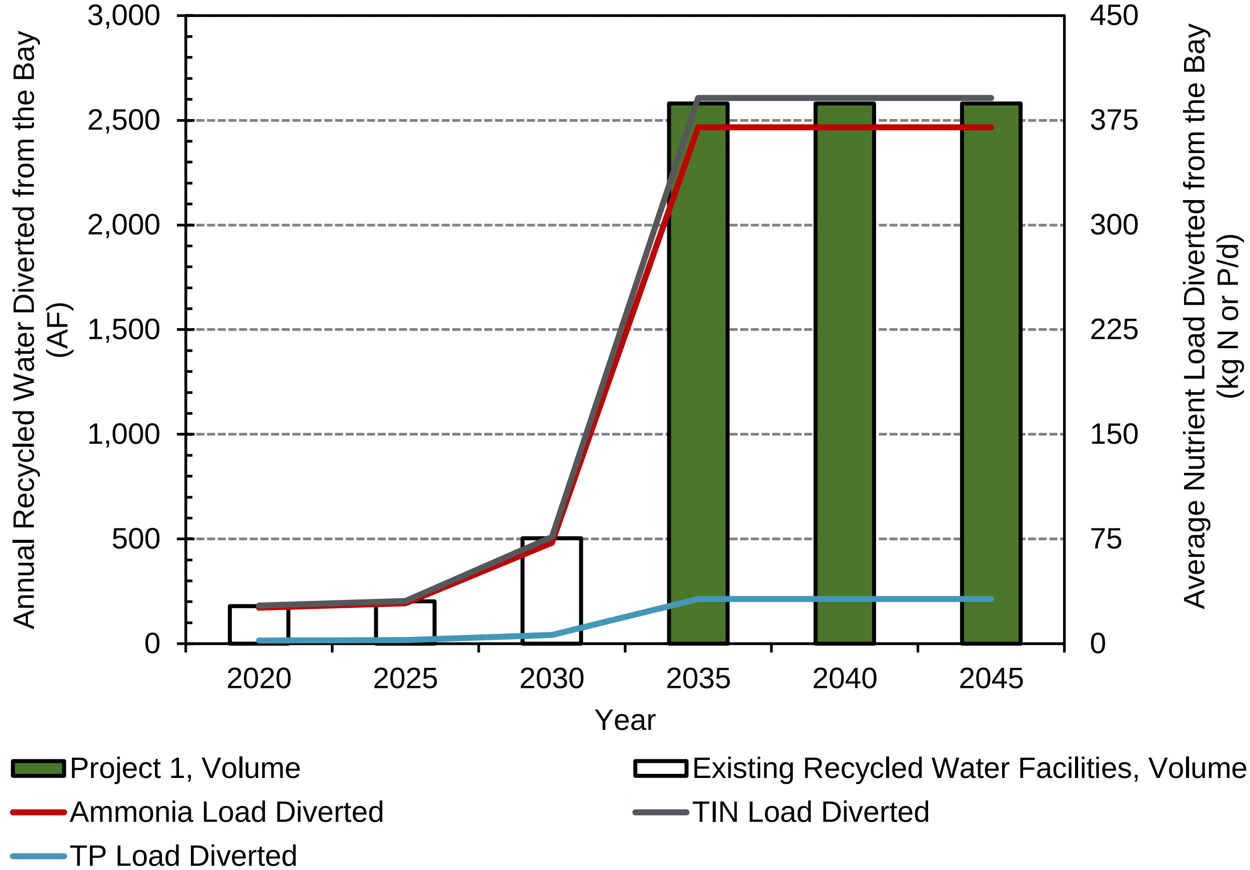

Figure ES - 1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge

Note: Project 1 will upgrade the existing recycled water facility with advanced treatment and expand the existing customer base.

An overview of the drivers and barriers for implementing recycled water projects at EBMUD:

- Drivers for implementing recycled water projects:
  - Water Supply Needs: desired to offset potable water supply demands.
  - Institutional: EBMUD has a recycled water goal of 20 mgd by Year 2040.
  - Other: Potential California goals or various requirements for recycling more water can serve as a driver.
- Barriers for implementing recycled water projects:
  - Limitations: the customer utilization is limited to the purple pipeline distribution system.
  - Funding: the cost to initiate such projects is expensive.
  - Other: there are concerns over the existing recycled water quality for various applications. Adding RO and BC to the existing system should attenuate such concerns

Table ES - 1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Projects (Upgrade Existing Recycled Water Facilities with Advanced Treatment and Expand Users) *, **		Total (Averaged from Years 2020 through 2045 and from Year 2035 Onwards) *, **, ***	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	0.41	0.26	3.6	2.3	1.7 Averaged over 25-Years (3.6 from Year 2035 Onwards)	1.1 Averaged over 25-Years (2.3 from Year 2035 Onwards)
Volume	AF	191	295	1,670	2,580	783 Averaged over 25-Years (1,670 from Year 2035 Onwards)	1,210 Averaged over 25-Years (2,580 from Year 2035 Onwards)
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	3	3	Blend of 1 and 3	Blend of 1 and 3
Duration	Years	15	15	10	10	25	25
Flow Diverted	%	1%	0%	7%	4%	3% Averaged over 25-Years (7% from Year 2035 Onwards)	2% Averaged over 25-Years (4% from Year 2035 Onwards)
Ammonia Load Diverted	kg N/d	82	42	715	370	335 Averaged over 25-Years (715 from Year 2035 Onwards)	173 Averaged over 25-Years (370 from Year 2035 Onwards)
TIN Load Diverted	kg N/d	86	45	747	391	350 Averaged over 25-Years (747 from Year 2035 Onwards)	183 Averaged over 25-Years (391 from Year 2035 Onwards)
TP Load Diverted	kg P/d	7	4	65	32	31 Averaged over 25-Years (65 from Year 2035 Onwards)	15 Averaged over 25-Years (32 from Year 2035 Onwards)
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	--	--	--	--	--	--
NPV Total (Capital+NPV O&M)	$ Mil	--	--	--	--	--	--
Unit Flow Cost[6]							
Unit Cost	$/gpd	--	--	--	--	--	--
Unit Cost	$/AF	--	--	--	--	--	--
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	--	--	--	--	--	--
TIN Unit Cost	$/lb TIN Diverted	--	--	--	--	--	--
TP Unit Cost	$/lb TP Diverted	--	--	--	--	--	--

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045 (details provided with each project in Section 3).

*** The total values include two sets of values: the average from Year 2020 through 2045 (i.e., 25-years) and from Year 2035 onwards (i.e., same values as the Future Project column). The average values over 25-years are included as such information will be used for future efforts to develop unit cost metrics.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production has not yet been evaluated.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

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1 Introduction and Current Conditions

The East Bay Municipal Utility District (EBMUD) owns and operates the EBMUD Wastewater Treatment Plant (WWTP) located in Oakland, CA and discharges treated effluent to the San Francisco Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 120 million gallons per day (mgd). The plant is allowed to blend primary with secondary effluent when secondary influent exceeds 150 mgd.

The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

EBMUD holds the National Pollutant Discharge Elimination System (NPDES) permit CA0037702 (Order No. R2-2020-0024). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2020-0024; CA0037702)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	120	--	--	--
Effluent cBOD (1)	mg/L	--	25	40	--
Effluent TSS (1)	mg/L	--	30	45	--
Effluent Ammonia	mg N/L	--	80	--	110

1. cBOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for EBMUD. Both liquids processes and solids processes are shown. The wastewater treatment process consists of odor control, grit removal, primary clarification, high purity oxygen activated sludge, secondary clarification, disinfection, and dechlorination. The activated sludge maintains a low SRT for secondary treatment. The plant currently removes over 40 percent of raw influent total phosphorus loads. Such load reduction does not include any total phosphorus added to the digesters by trucked wastes for resource recovery. Sludge is thickened, anaerobically digested and dewatered.

1.3 Existing Recycled Water Service

EBMUD's East Bayshore Recycled Water Project (EBRWP) currently supplies recycled water year-round to landscape irrigation users. This program has the effect of reducing nutrients discharged to the Bay. The EBRWP provides microfiltration (MF) and chlorine disinfection of the District's secondary effluent at EBMUD's primary wastewater treatment plant (referred to as SD-1). A portion of recycled water has been used for cooling tower makeup and for toilet/urinal flushing, but these uses were discontinued due to water quality issues. The EBWRF currently recycles approximately 199 acre-feet per year (65 million gallons per year).

1.4 Existing Discharge Flows and Loads to the Bay

A summary of three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	47.4	66.7	58.7
Volume	AF	22,280	43,400	65,680
Ammonia	kg N/d	9,530	9,370	9,440
Total Inorganic Nitrogen (TIN)	kg N/d	9,960	9,980	9,970
Total Phosphorus (TP)	kg P/d	869	781	818
Ammonia	mg N/L	53.2	40.3	45.7
TIN	mg N/L	55.7	42.8	48.2
TP	mg P/L	4.92	3.49	4.08

* Represents three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

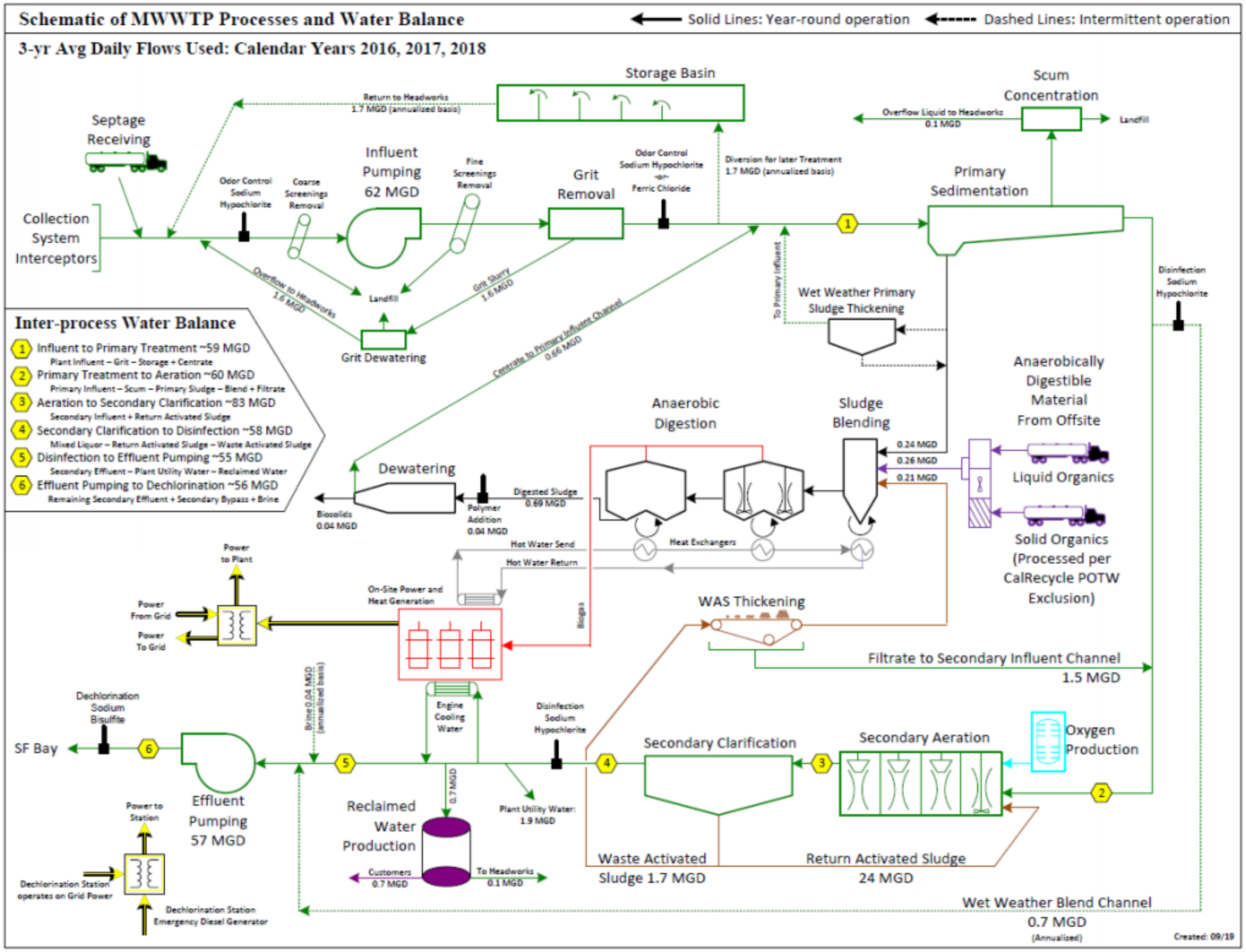

Figure 1-1. Process Flow Diagram for EBMUD (Order No. R2-2020-0024; CA0037702)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2020 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter.

Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility.
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with EBMUD and Engineer’s best judgment that considered known project constraints, existing EBMUD reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by EBMUD. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2021 ENR CCI for the San Francisco Bay Area.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN, or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects.

Table 3-1. Recycled Water Projects Identified by EBMUD

Recycled Water Project	Description
Existing Recycled Water Facilities	EBRWP facilities include MF and chlorine disinfection to meet total coliform, disinfection, and turbidity limits prior to distribution.
Future Projects	Add RO and BC to the existing facilities to improve recycled water quality and increase treatment capacity. The additional treatment/capacity will increase uses/users by providing up to 2,576 AFY by 2045.

The following sections summarize the flow and nutrient load reductions for each listed project in Table 3-1.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3.

To address water quality issues and increase opportunities to use recycled water for industrial and commercial purposes, the addition of RO and BC to the existing facilities has been proposed. The expansion and upgrade project will deliver up to 2,576 AFY by year 2045.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. Current and future recycled water uses via the existing EBWRF facility and the anticipated upgrades include industrial and landscape irrigation uses. It was assumed that one hundred percent of the flows and loads associated with both applications are diverted from the Bay.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence*	Average Distributed - Return Flows (AF)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**1**	**180**	**26**	**27**	**2**
	Existing Facilities	1	180	26	27	2
	Project 1**	3	--	--	--	--
2025	**Total**	**1**	**202**	**29**	**31**	**3**
	Existing Facilities	1	202	29	31	3
	Project 1**	3	--	--	--	--
2030	**Total**	**1**	**504**	**72**	**76**	**6**
	Existing Facilities	1	504	72	76	6
	Project 1**	3	--	--	--	--
2035	**Total**	**3**	**2,580**	**370**	**391**	**32**
	Existing Facilities	1	--	--	--	--
	Project 1**	3	2580	370	391	32
2040	**Total**	**3**	**2,580**	**370**	**391**	**32**
	Existing Facilities	1	--	--	--	--
	Project 1**	3	2,580	370	391	32
2045	**Total**	**3**	**2,580**	**370**	**391**	**32**
	Existing Facilities	1	--	--	--	--
	Project 1**	3	2,580	370	391	32

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

** Project 1 will upgrade the existing recycled water facilities with advanced treatment and expand the existing customer base.

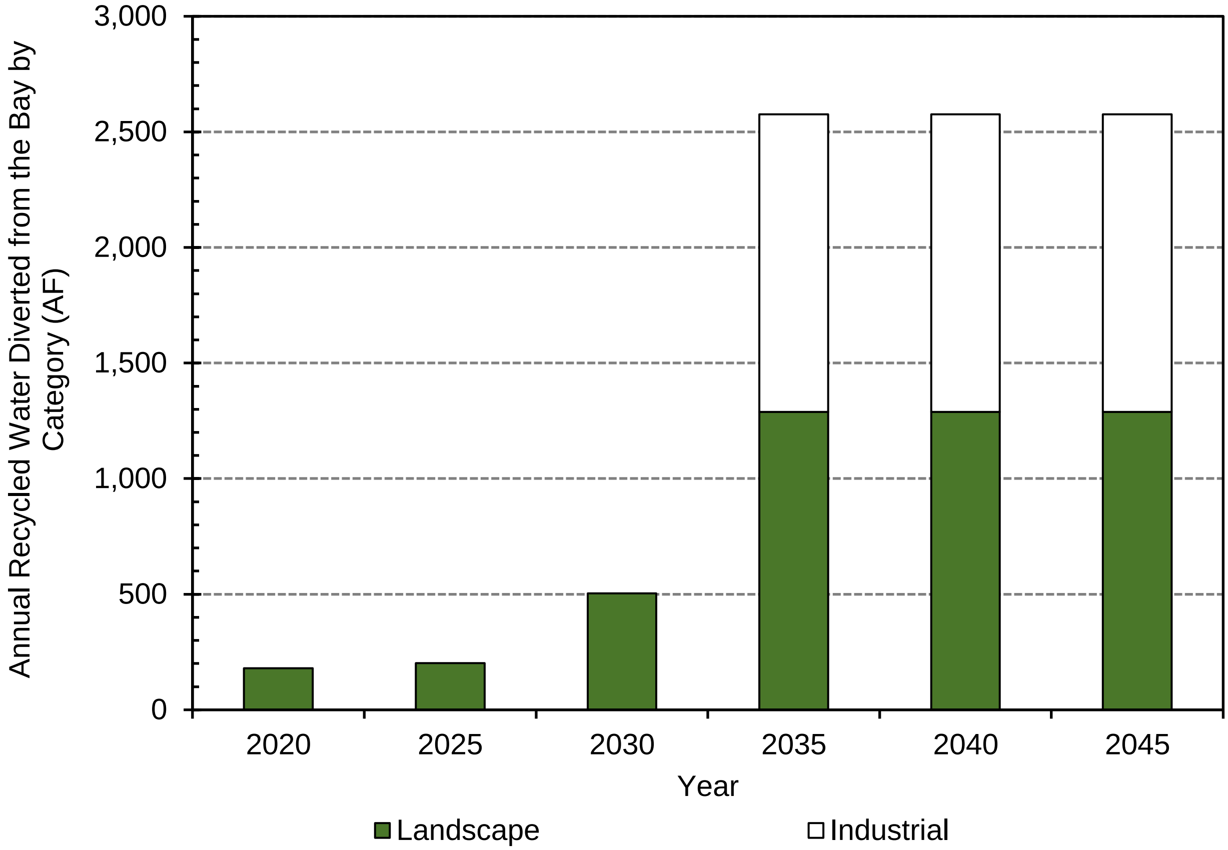

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the existing EBWRF and the anticipated expansion.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities	• Facilities are already in place and providing recycled water • Operator familiarity with existing recycled water facilities • Existing facilities reliably meet recycled water treatment requirements	• Water quality issues limit customer uses
Project 1 (EBWRF RO and BC Expansion and Facilities Upgrade)	• Improved water quality and expanded potential customer base • Increased capacity	• Construction and implementation of new processes/facilities • Additional unit energy cost to operate the RO and BC

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows and load reductions is provided in Table 3-4. It was assumed that one hundred percent of the flows and loads associated with reuse applications are diverted from the Bay. Note: the total columns on the right-hand side include both values for average over 25-years and from Year 2035 onwards. The average values over 25-years (Year 2020 through 2045) are included as such information will be used for future efforts to develop unit cost metrics. The values from Year 2035 onwards reflect potential values associated with upgrading the existing recycled water facility with advanced treatment and expanding users.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. The recycled water volumes through existing facilities are anticipated to increase incrementally through 2030.

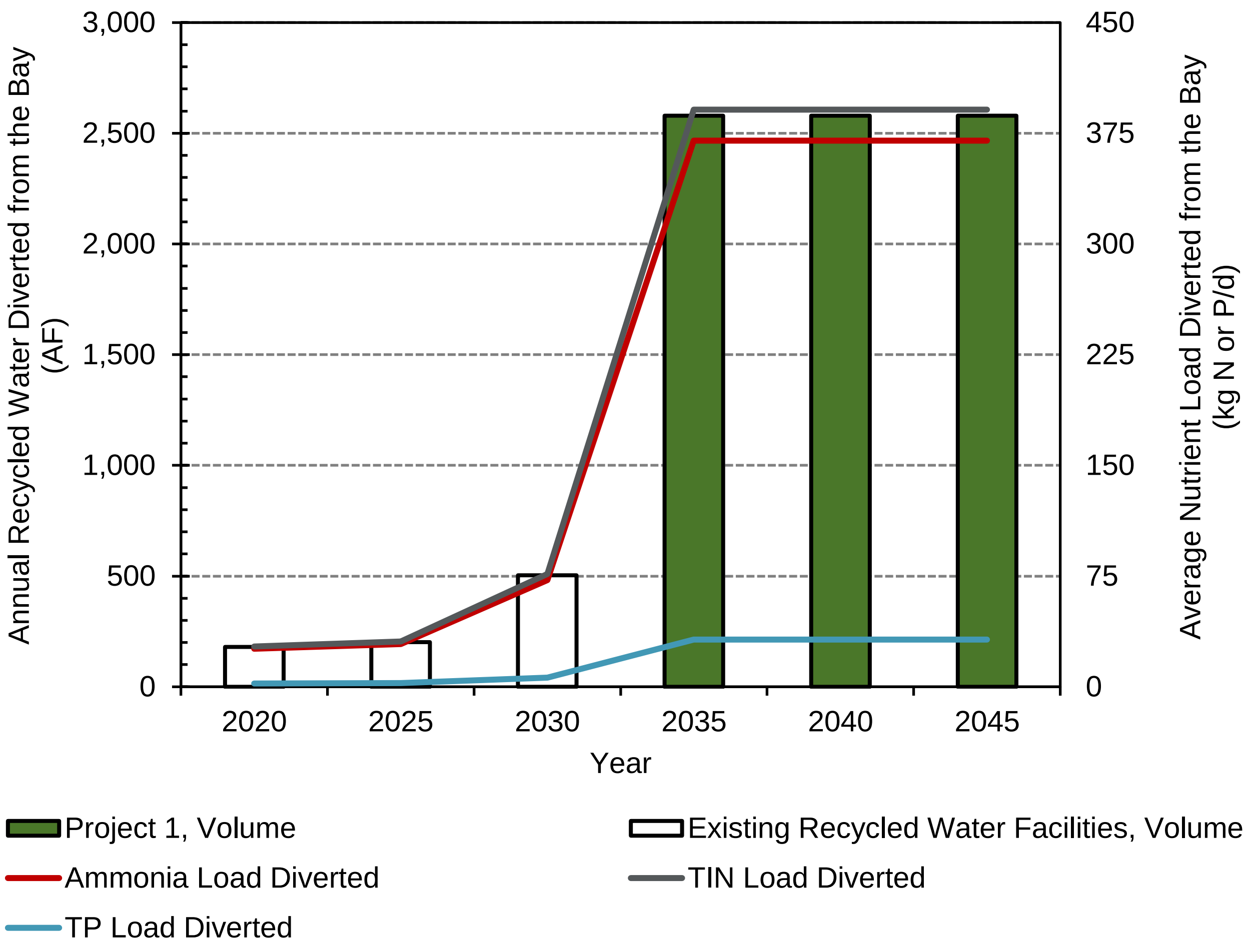

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge

Note: Project 1 will upgrade the existing recycled water facilities with advanced treatment and expand the existing customer base.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Projects (Upgrade Existing Recycled Water Facilities with Advanced Treatment and Expand Users) *, **		Total (Averaged from Years 2020 through 2045 and from Year 2035 Onwards) *, **, ***	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	0.41	0.26	3.6	2.3	1.7 Averaged over 25-Years (3.6 from Year 2035 Onwards)	1.1 Averaged over 25-Years (2.3 from Year 2035 Onwards)
Volume	AF	191	295	1,670	2,580	783 Averaged over 25-Years (1,670 from Year 2035 Onwards)	1,210 Averaged over 25-Years (2,580 from Year 2035 Onwards)
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	3	3	Blend of 1 and 3	Blend of 1 and 3
Duration	Years	15	15	10	10	25	25
Flow Diverted	%	1%	0%	7%	4%	3% Averaged over 25-Years (7% from Year 2035 Onwards)	2% Averaged over 25-Years (4% from Year 2035 Onwards)
Ammonia Load Diverted	kg N/d	82	42	715	370	335 Averaged over 25-Years (715 from Year 2035 Onwards)	173 Averaged over 25-Years (370 from Year 2035 Onwards)
TIN Load Diverted	kg N/d	86	45	747	391	350 Averaged over 25-Years (747 from Year 2035 Onwards)	183 Averaged over 25-Years (391 from Year 2035 Onwards)
TP Load Diverted	kg P/d	7	4	65	32	31 Averaged over 25-Years (65 from Year 2035 Onwards)	15 Averaged over 25-Years (32 from Year 2035 Onwards)
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	--	--	--	--	--	--
NPV Total (Capital+NPV O&M)	$ Mil	--	--	--	--	--	--
Unit Flow Cost[6]							
Unit Cost	$/gpd	--	--	--	--	--	--
Unit Cost	$/AF	--	--	--	--	--	--
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	--	--	--	--	--	--
TIN Unit Cost	$/lb TIN Diverted	--	--	--	--	--	--
TP Unit Cost	$/lb TP Diverted	--	--	--	--	--	--

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045.

*** The total values include two sets of values: the average from Year 2020 through 2045 (i.e., 25-years) and from Year 2035 onwards (i.e., same values as the Future Project column). The average values over 25-years are included as such information will be used for future efforts to develop unit cost metrics.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production has not yet been evaluated.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at EBMUD:

- Drivers for implementing recycled water projects:
  - Water Supply Needs: desired to offset potable water supply demands.
  - Institutional: EBMUD has a recycled water goal of 20 mgd by Year 2040.
  - Other: Potential California goals or various requirements for recycling more water can serve as a driver.
- Barriers for implementing recycled water projects:
  - Limitations: the customer utilization is limited to the purple pipeline distribution system.
  - Funding: the cost to initiate such projects is expensive.
  - Other: there are concerns over the existing recycled water quality for various applications. Adding RO and BC to the existing system should attenuate such concerns

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Fairfield-Suisun Sewer District

BACWA Recycled Water Study

FINAL Individual Plant Report

Fairfield, CA
November 29, 2022

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Contents

Tables

Figures

Executive Summary

Fairfield-Suisun Sewer District (FSSD) owns and operates the Fairfield-Suisun Wastewater Treatment Plant (WWTP) located in Fairfield, CA and discharges treated effluent to Boynton Slough, Duck Pond 1, Duck Pond 2, and Ledgewood Creek. The plant has an average dry weather flow (ADWF) permitted capacity of 23.7 million gallons per day (mgd).

FSSD has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The WWTP currently recycles approximately 2,250 acre-feet per year (AFY; approximately 730 million gallons per year). Approximately 1,220 AFY out of the 2,250 AFY is used for internal uses and subsequently does not reduce flow and/or nutrient loads to the Bay. The remaining 1,030 AFY is used primarily for commercial, industrial, and agricultural uses which in all cases diverts the flows and/or nutrient loads from the Bay. There are no existing plans to further expand the recycled water program.

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES - 1. Note: the unit cost for ammonia load is a log greater than TIN and Total P as the WWTP already reliably nitrifies. As a result, there is little or no ammonia remaining to remove which subsequently increases the unit cost. The timeline and corresponding load diversions from the Bay is provided in Figure ES – 1.

An overview of the drivers and barriers for implementing recycled water projects at FSSD:

- Drivers for implementing recycled water projects:
  - Discharge regulations: NPDES permit requirements to maximize recycled water
  - Institutional: FSSD has a culture of maximizing use of resources as evidenced by their highly optimized treatment facility, the use of renewable energy, as well as maximizing recycled water for nearby customers.
- Barriers for implementing recycled water projects:
  - Lack of need: the treatment plant maximizes reuse for nearby customers. There is a lack of recycled water distribution system to reach other potential customers.
  - Lack of funding: the cost to design and construct a recycled water distribution system is prohibitive.

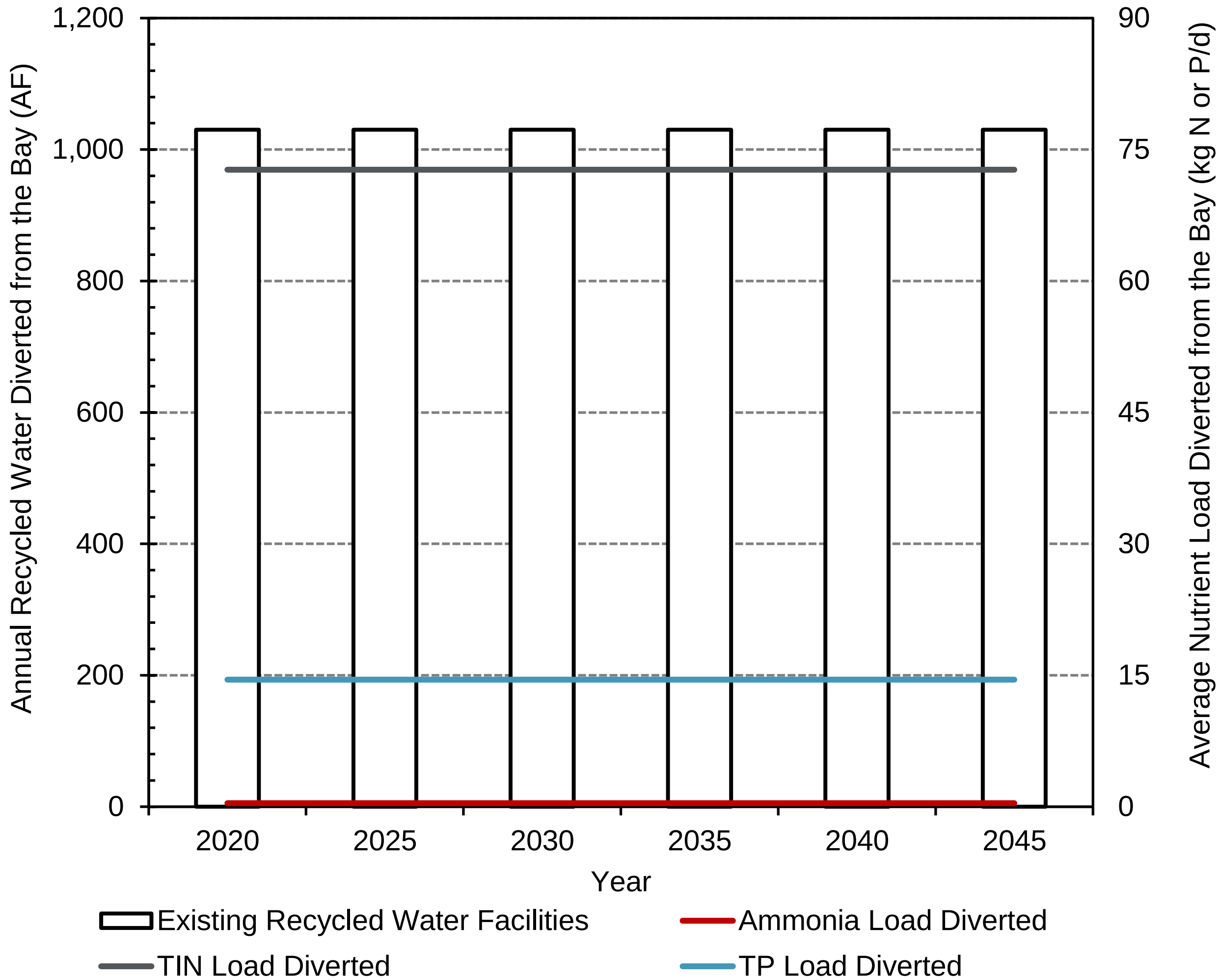

Figure ES - 1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge

Note: the annual recycle water demands are 2,250 AFY. The values in this table represent flows and loads that would be diverted from the Bay (approximately 1,220 AFY (not shown) is used for internal uses that does not translate to flow and load reductions to the Bay).

Table ES - 1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Projects (None Planned) *,**		Total (Projected into the Future) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	1.8	0.9	--	--	1.8	0.9
Volume	AF	834	1,030	--	--	834	1,030
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	13%	6%	--	--	13%	6%
Ammonia Load Diverted	kg N/d	0.8	0.4	--	--	0.8	0.4
TIN Load Diverted	kg N/d	165	73	--	--	165	73
TP Load Diverted	kg P/d	33	15	--	--	33	15
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	1.0	1.2	--	--	1.0	1.2
NPV Total (Capital+NPV O&M)	$ Mil	1.0	1.2	--	--	1.0	1.2
Unit Flow Cost[6]							
Unit Cost	$/gpd	0.6	1.3	--	--	0.6	1.3
Unit Cost	$/AF	47	47	--	--	47	47
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	151	149	--	--	151	149
TIN Unit Cost	$/lb TIN Diverted	0.7	0.8	--	--	0.7	0.8
TP Unit Cost	$/lb TP Diverted	3.6	4.2	--	--	3.6	4.2

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045).

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production based on the energy required to produce water at the plant for various recycled water uses by FSSD (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

Note: the annual recycle water demands are 2,250 AFY. The values in this table represent flows and loads that would be diverted from the Bay (approximately 1,220 AFY (not included here) is used for internal uses that does not translate to flow and load reductions to the Bay).

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1 Introduction and Current Conditions

Fairfield-Suisun Sewer District (FSSD) owns and operates the Fairfield-Suisun Wastewater Treatment Plant (WWTP) located in Fairfield, CA and discharges treated effluent to Boynton Slough, Duck Pond 1, Duck Pond 2, and Ledgewood Creek. The plant has an average dry weather flow (ADWF) permitted capacity of 23.7 million gallons per day (mgd).

The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

FSSD holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2020-0012). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2020-0012)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	23.7	--	--	--
Effluent BOD (1)	mg/L	--	10	15	--
Effluent TSS (1)	mg/L	--	10	15	--
Effluent Ammonia	mg N/L	--	2.0	--	4.0

1. BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for FSSD. Both liquids processes and solids processes are shown. The FSSD WWTP has headworks, primary clarifiers, oxidation towers, an activated sludge system that fully nitrifies and partially denitrifies, filtration, and ultraviolet (UV) disinfection. There is the ability to bypass the oxidation towers to the aeration trains. The activated sludge maintains a high SRT for full nitrification and it partially denitrifies in one of the three trains (receives approximately 40 to 45 percent of the feed flow). The advanced secondary treated effluent is conveyed to a combination of marsh and other water recycling users.

Solids treatment consists of thickening, anaerobic digestion and dewatering. The biosolids cake diverted to an on-site organic material recovery facility, operated by Lystek International. This facility began receiving FSSD biosolids in August 2016.

1.3 Existing Recycled Water Service

FSSD has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The WWTP currently recycles approximately 2,250 acre-feet per year (AFY; approximately 730 million gallons per year). There are no existing plans to further expand the recycled water program).

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	12.2	17.4	15.3
Volume	AF	5,750	11,340	17,090
Ammonia	kg N/d	5.31	7.64	6.72
Total Inorganic Nitrogen (TIN)	kg N/d	1,131	1,212	1,210
Total Phosphorus (TP)	kg P/d	225	240	241
Ammonia	mg N/L	0.115	0.116	0.116
TIN	mg N/L	24.5	18.4	20.9
TP	mg P/L	4.87	3.65	4.16

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

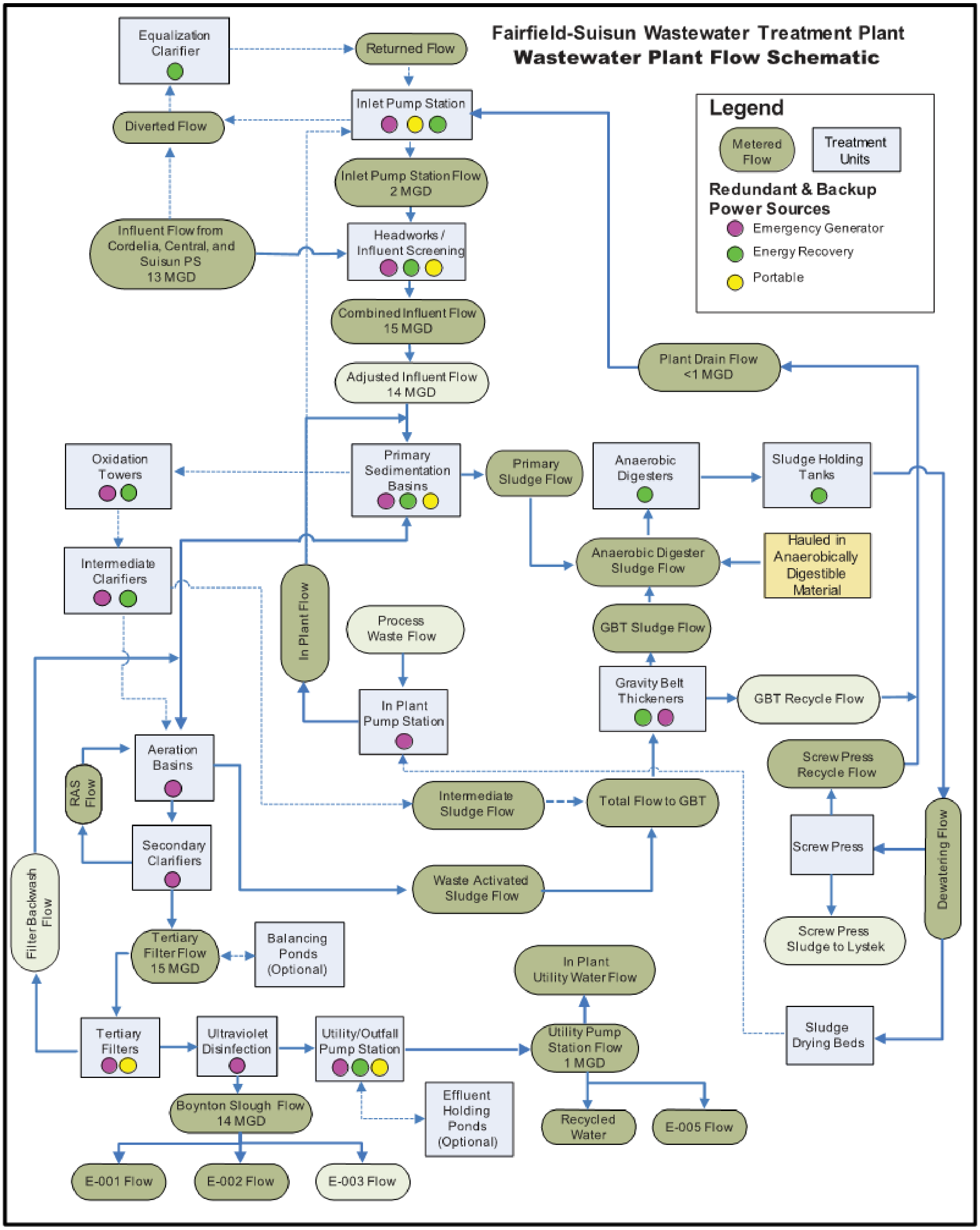

Figure 1-1. Process Flow Diagram for FSSD (Order No. R2-2020-0012)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with WWTP and Engineer's best judgment that considered known project constraints, existing WWTP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by WWTP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g. existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g. a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects.

Table 3-1. Recycled Water Projects Identified by FSSD

Recycled Water Project	Description
Existing Recycled Water Facilities	The FSSD advanced secondary is filtered and disinfected to meet the total coliform, disinfection, and turbidity limits prior to distribution. The recycled water is used for a combination of purposes that includes agricultural, environmental enhancement to Suisun Marsh (majority of flow), internal use, and plant drains. Note: the flows sent to Suisun Marsh were excluded from this analysis.
Future Projects	No future projects are planned.

The following sections summarize the flow and nutrient load reductions for each listed project in Table 3-1.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. Refer to Table 3-1 for a description of the current recycled water distribution volumes that comprise Table 3-2.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2019 through 2045. Current and future recycled water uses via existing facilities include commercial, industrial, agricultural, and internal uses. It was assumed that one hundred percent of the flows and loads associated with commercial, industrial, and agricultural uses results in diversions from the Bay. In contrast, the internal uses do not constitute a diversion of flows and loads from the Bay and thus are not included in such calculations.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Distributed - Return Flows (AFY)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**--**	**1,030**	**<1**	**73**	**15**
	Existing Recycled Water Facilities	1	1,030	<1	73	15
	Others	--	--	--	--	--
2025	**Total**	**--**	**1,030**	**<1**	**73**	**15**
	Existing Recycled Water Facilities	1	1,030	<1	73	15
	Others	--	--	--	--	--
2030	**Total**	**--**	**1,030**	**<1**	**73**	**15**
	Existing Recycled Water Facilities	1	1,030	<1	73	15
	Others	--	--	--	--	--
2035	**Total**	**--**	**1,030**	**<1**	**73**	**15**
	Existing Recycled Water Facilities	1	1,030	<1	73	15
	Others	--	--	--	--	--
2040	**Total**	**--**	**1,030**	**<1**	**73**	**15**
	Existing Recycled Water Facilities	1	1,030	<1	73	15
	Others	--	--	--	--	--
2045	**Total**	**--**	**1,030**	**<1**	**73**	**15**
	Existing Recycled Water Facilities	1	1,030	<1	73	15
	Others	--	--	--	--	--

* Confidence Levels:

(1) Includes existing or new projects in an adopted budget.

(2) Includes projects that are in an adopted Master Plan or CIP.

(3) Includes projects that are in the conceptual stage and not included in an adopted document.

Note: the annual recycle water demands are 2,250+ AFY. The values in this table represent flows and loads that would be diverted from the Bay (approximately 1,220 AFY (not shown) is used for internal uses that does not translate to flow and load reductions to the Bay).

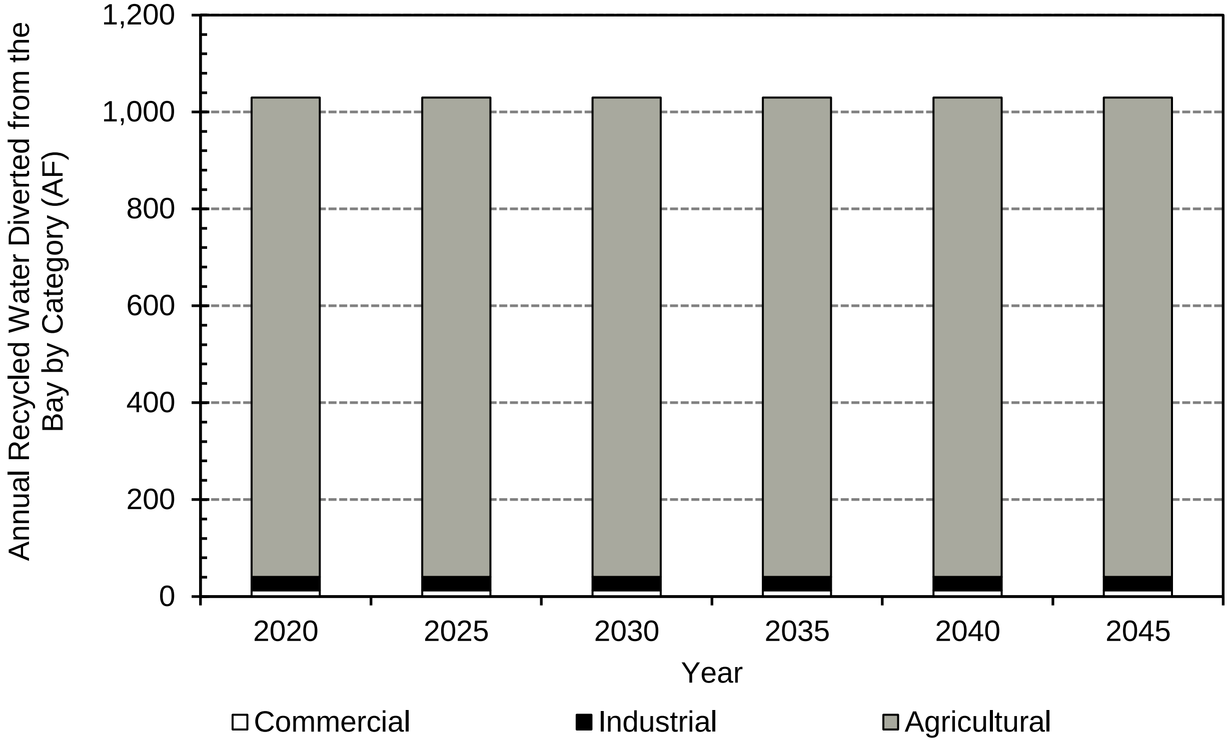

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

Note: the annual recycle water demands are 2,250 AFY. The values in this table represent flows and loads that would be diverted from the Bay (approximately 1,220 AFY (not shown) is used for internal uses that does not translate to flow and load reductions to the Bay).

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. The recycled water demands for existing recycled water customers is primarily during the dry season. There are no plans to increase demand for either existing recycled water customers.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities	• Facilities are already in place and providing recycled water • Operator familiarity with existing recycled water facilities • Existing facilities reliably meet recycled water treatment requirements • Marginal increase in operational costs for FSSD WWTP to provide the recycled water • Habitat restoration in Suisun Marsh (prior to discharging to Suisun Bay)	• Lack of future demands • Extent of nutrient load reduction across Suisun Marsh is unclear
Other Projects (None Planned)	• Non-Applicable	• Non-Applicable

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. The current recycled water uses are landfill, irrigation, use by Lystek International who handles FSSD's biosolids, and other internal uses. It was assumed that all of the flows and loads associated with internal uses eventually end up in the Bay (not diverted from the Bay). Note: the unit cost for ammonia load is a log greater than TIN and Total P as the WWTP already reliably nitrifies. As a result, there is little or no ammonia remaining to remove which subsequently increases the unit cost. The WWTP also removes a portion of TIN through biological nitrification/denitrification which is the basis for the TIN unit cost being greater than Total P.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. The recycled water volumes with existing facilities are anticipated to be maintained through year 2045 with no plans to expand their current recycled water program.

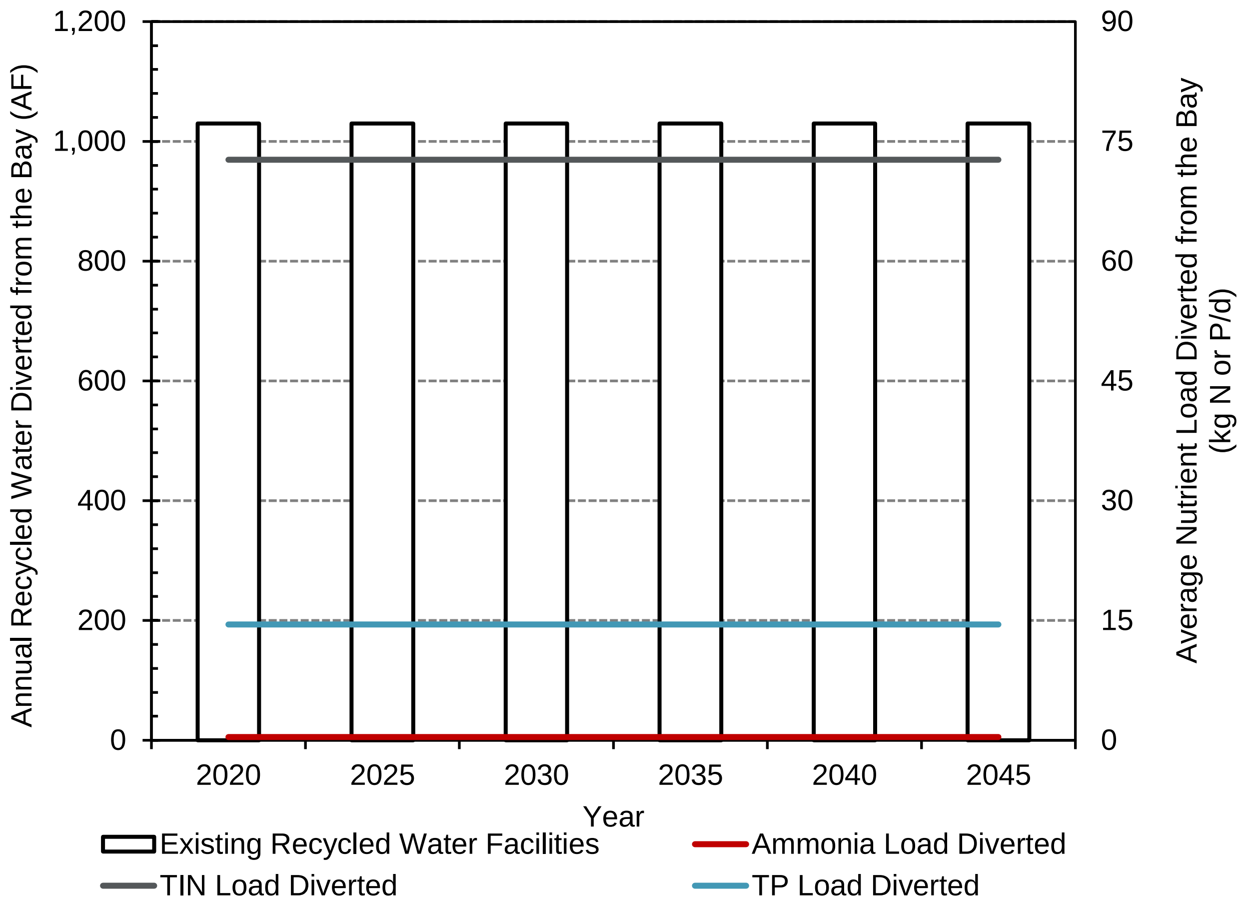

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge

Note: the annual recycle water demands are 2,250 AFY. The values in this table represent flows and loads that would be diverted from the Bay (approximately 1,220 AFY (not shown) is used for internal uses that does not translate to flow and load reductions to the Bay).

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Projects (None Planned) *,**		Total (Projected into the Future) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	1.8	0.9	--	--	1.8	0.9
Volume	AF	834	1,030	--	--	834	1,030
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	13%	6%	--	--	13%	6%
Ammonia Load Diverted	kg N/d	0.8	0.4	--	--	0.8	0.4
TIN Load Diverted	kg N/d	165	73	--	--	165	73
TP Load Diverted	kg P/d	33	15	--	--	33	15
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	1.0	1.2	--	--	1.0	1.2
NPV Total (Capital+NPV O&M)	$ Mil	1.0	1.2	--	--	1.0	1.2
Unit Flow Cost[6]							
Unit Cost	$/gpd	0.6	1.3	--	--	0.6	1.3
Unit Cost	$/AF	47	47	--	--	47	47
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	151	149	--	--	151	149
TIN Unit Cost	$/lb TIN Diverted	0.7	0.8	--	--	0.7	0.8
TP Unit Cost	$/lb TP Diverted	3.6	4.2	--	--	3.6	4.2

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045).

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production based on the energy required to produce water at the plant for various recycled water uses by FSSD (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

Note: the annual recycle water demands are 2,250 AFY. The values in this table represent flows and loads that would be diverted from the Bay (approximately 1,220 AFY (not included) is used for internal uses that does not translate to flow and load reductions to the Bay).

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3.4 Drivers and Barriers to Implementation

- Drivers for implementing recycled water projects:
  - Discharge regulations: NPDES permit requirements to maximize recycled water
  - Institutional: FSSD has a culture of maximizing use of resources as evidenced by their highly optimized treatment facility, the use of renewable energy, as well as maximizing recycled water for nearby customers.
- Barriers for implementing recycled water projects:
  - Lack of need: the treatment plant maximizes reuse for nearby customers. There is a lack of recycled water distribution system to reach other potential customers.
  - Lack of funding: the cost to design and construct a recycled water distribution system is prohibitive.

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City of Hayward Water Pollution Control Facility

BACWA Recycled Water Study

Final Individual Plant Report

Hayward, CA
June 13, 2023

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Contents

Tables

Figures

Executive Summary

The City of Hayward (Hayward) owns and operates the Hayward Water Pollution Control Facility (WPCF) located in Hayward, CA and discharges treated effluent to a common outfall under the Joint Exercise of Power Agency (JEPA) of the East Bay Dischargers Authority (EBDA). The plant has an average dry-weather flow (ADWF) permitted capacity of 18.5 million gallons per day (mgd) and a peak permitted wet-weather flow of 35 mgd.

Hayward's Recycled Water Facility began production and delivery of tertiary-treated recycled water in 2022. Currently, more than 200 AF per year (approximately 0.2 mgd on average) of tertiary-treated recycled water is supplied to 31 irrigation customers as part of the City's Phase 1 Recycled Water Project. The neighboring Russell City Energy Center (RCEC), when operational, receives secondary-treated effluent from the Hayward WPCF that is further treated at the RCEC facility to a tertiary-level and used for cooling water in energy production. RCEC's use of recycled water in their cooling towers is ultimately concentrated into a brine that is crystalized and hauled off-site. Therefore, nutrients are not returned in their waste streams back to the City's WPCF. The production and use of recycled water at the City's WPCF, as well as diversion of secondary effluent to RCEC for use in their cooling towers reduces flows to the EBDA outfall, thereby reducing nutrients discharged to the Bay.

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES-1. The Phase I Recycled Water Project and secondary-treated effluent supplied to RCEC are presented separately. The City will be evaluating the feasibility of expanding the use of recycled water to serve additional customers in the future. The timeline and corresponding load diversions from the Bay for projects listed in Table 1-2 are shown in Figure ES-1.

An overview of the drivers and barriers for implementing recycled water projects in Hayward is as follows:

- Drivers for implementing recycled water projects:
    - Environmental improvement through decreased discharge of flow and nutrients into the Bay
    - More sustainable and reliable water supply; reduced dependence on other water sources
- Barriers for implementing recycled water projects:
    - Funding sources have been challenging to identify; projects are costly to implement
    - Identifying potential customers in order to secure demand for recycled water

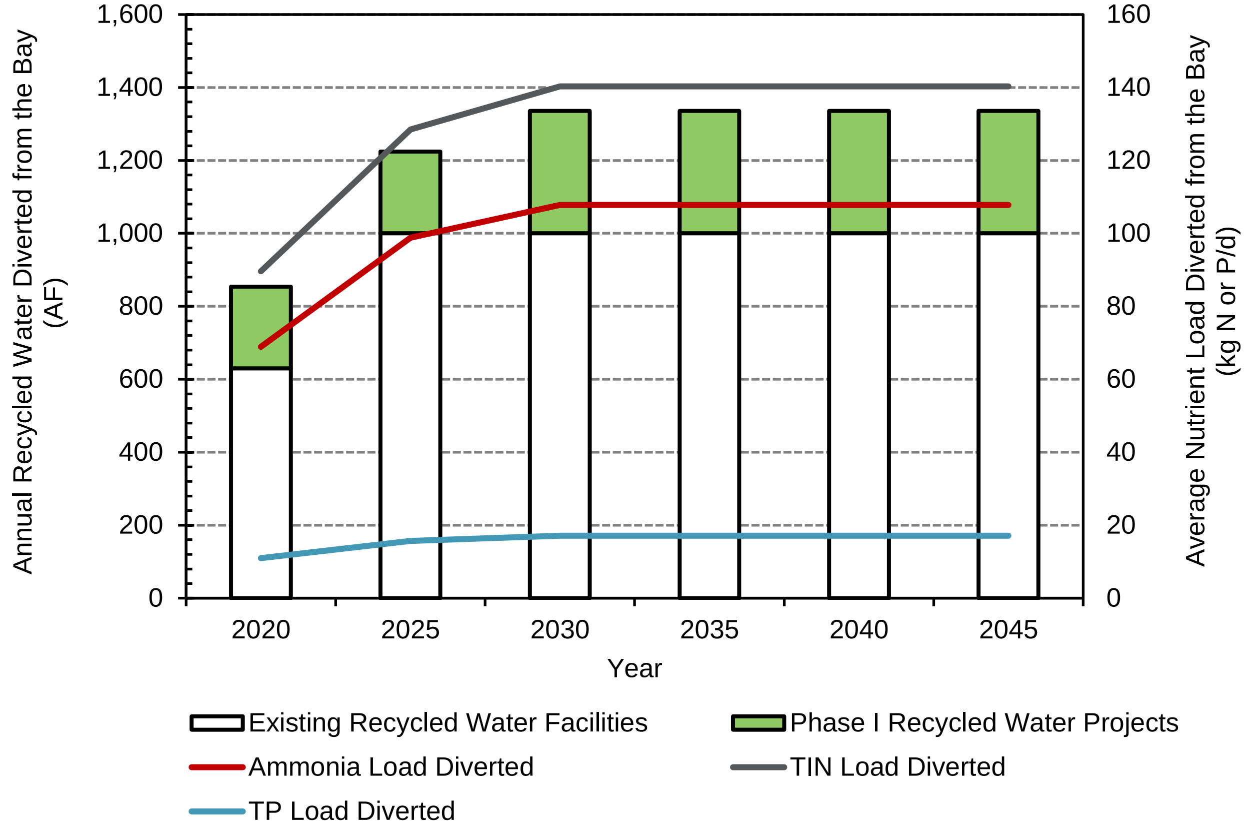

Figure ES-1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge

Note: 2045 values assume RCEC is operational through 2045. RCEC's current projected design life is 30 years, or facility operational through 2041.

Table ES-1: Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Project to Russell City Energy Center (Projected into the Future) *,**		Phase I Recycled Water Projects (Projected into the Future) *,**		Total (Projected into the Future; Averaged from Year 2020 -2045) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	1.1	0.8	0.5	0.3	1.6	1.1
Volume	AF	510	938	249	299	759	1,240
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	1	1	1 / 1	1 / 1
Duration	Years	25	25	23	23	25	25
Flow Diverted	%	9%	7%	5%	2%	13%	9%
Ammonia Load Diverted	kg N/d	106	76	52	24	153	98
TIN Load Diverted	kg N/d	132	99	64	31	191	127
TP Load Diverted	kg P/d	14	12	7	4	21	16
Cost[3,4,5,9]							
Capital Cost	$ Mil	--	--	27.3	27.3	27.3	27.3
NPV O&M	$ Mil	4.0	7.4	1.5	1.8	5.5	9.2
NPV Total (Capital+NPV O&M)	$ Mil	4.0	7.4	28.8	29.1	32.8	36.5
Unit Flow Cost[6,9]							
Unit Cost	$/gpd	3.7	8.8	54	109	20	33
Unit Cost	$/AF	313	313	5,030	4,240	1,730	1,180
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	4.5	4.8	72	65	25	19
TIN Unit Cost	$/lb TIN Diverted	3.6	3.7	58	50	20	14
TP Unit Cost	$/lb TP Diverted	33	30	529	410	187	116

* Existing RW Project refers to existing treatment facilities (RCEC) producing RW for industrial uses at the RCEC site; Total includes a sum of the Existing RW Project (projected into the future) plus other proposed future projects.

** Flows and loads diverted from Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3).

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = only projects that are currently budgeted; 2 = projects that are in master plan; 3 = projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by Hayward (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from Bay discharge for the project duration (project specific).
9. RCEC's capital and operating costs unknown.

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1 Introduction and Current Conditions

The City of Hayward (City) owns and operates the Hayward Water Pollution Control Facility (WPCF) located in Hayward, CA and discharges treated effluent to a common outfall under the Joint Exercise of Power Agency (JEPA) of the East Bay Dischargers Authority (EBDA). The plant has an average dry-weather flow (ADWF) permitted capacity of 18.5 million gallons per day (mgd) and a peak permitted wet-weather flow of 35 mgd.

The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water reuse potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

Hayward is a member of the East Bay Dischargers Authority (EBDA) that discharges Hayward's effluent through EBDA's common outfall. EBDA holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2022-0023; CA0037869). Table 1-1 provides a summary of the permit limitations for Hayward under the EBDA permit. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2022-0023; CA0037869)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	18.5[3]	--	--	35
Effluent BOD [1]	mg/L	--	25	40	--
Effluent TSS [1]	mg/L	--	30	45	--
Effluent Ammonia	mg N/L	--	86	--	110

1. BOD and TSS include a minimum percent removal of 85% through the WPCF
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.
3. 18.5 mgd is the permitted flow; current average dry-weather flow is around 11.4 mgd.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation included in the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance)
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers)

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements based on intended use of the water is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater recharge by spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in 2014 and 2018, respectively. DPR regulations are anticipated by the end of 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for Hayward's WPCF. Both liquids processes and solids processes are shown. The Hayward WPCF consists of screening and grit removal, vacuators, and primary clarification, followed by a trickling filter/solids contact process. Secondary effluent is disinfected by chlorine disinfection. Solids treatment consists of primary and waste secondary sludge thickening, anaerobic digestion and drying beds.

1.3 Existing Recycled Water Service

Hayward has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The WPCF currently diverts approximately 1,000 acre-feet per year of secondary effluent to a neighboring power production facility known as the Russell City Energy Center (RCEC). RCEC further treats the water to tertiary treatment standards for use in their cooling towers. Additionally, Hayward WPCF began delivering tertiary-treated recycled water to 31 irrigation customers in 2022 as part of its Phase 1 Recycled Water Project. Hayward anticipates delivering approximately 224 AFY (0.2 mgd) initially with the intent of increasing to about 336 AFY (0.34 mgd) by 2030. A master plan for expansion to the recycled water facilities is planned to get underway in 2024. This master plan will guide the expansion of the facility to 2045 and beyond.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the October 2016 through September 2019 discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Dry Season (May 1–Sept 30)	Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	10.8	11.8	11.4
Volume	AF	5,070	7,680	12,750
Ammonia	kg N/d	1,050	1,010	1,030
Total Inorganic Nitrogen (TIN)	kg N/d	1,310	1,330	1,340
Total Phosphorus (TP)	kg P/d	143	196	164
Ammonia	mg N/L	25.5	22.7	23.9
TIN	mg N/L	31.5	29.7	31.2
TP	mg P/L	3.45	4.35	3.81

* Represents the average of the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

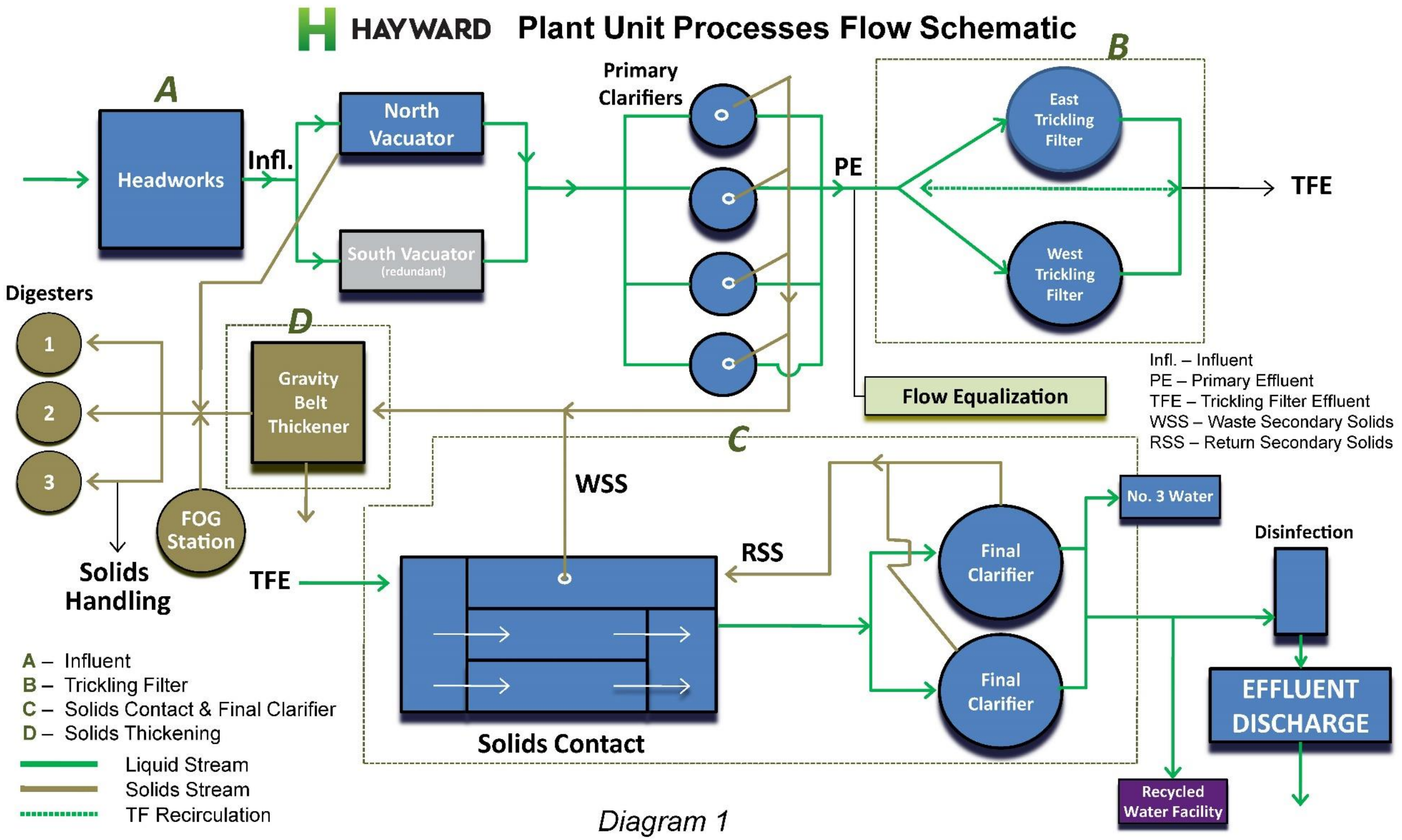

Figure 1-1. Process Flow Diagram for Hayward (Source: City Files)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the request for recycled water information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, estimated load reductions to the Bay, variations in operation due to seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. Recycled water use categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, and other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial

Use Category*	Definition
	building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter.
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed their annual recycled water volume for each use, and the total recycled water produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified by the agencies and is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume for existing operational projects or for new projects in an adopted budget.
2	Estimated delivery volume for projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume for projects that are conceptual and not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly recycled water production were collected.

Future seasonality projections were based on a combination of working with Hayward and Engineer's best judgment that considered known project constraints, existing Hayward reuse seasonality demands, and type of reuse project (e.g., irrigation is likely to increase in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by City of Hayward staff. Development of new cost estimates was not performed as part of this study. Project costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration was not provided, a 30-year project duration was assumed.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from the Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of recycled water projects, identify potential implementation challenges, and assess the feasibility, efficacy, reliability, and cost-effectiveness of project implementation. The following seven questions were included:

- What do you see as barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g. existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g. a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by end of 2023) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Nutrient Loads Diverted from the Bay due to Recycled Water

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for calculating the net nutrient loads diverted from the Bay due to Recycled Water.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a recycled water stream which no longer enters the Bay. The load reduction from each agency is determined using the recycled water distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The net nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user receives agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the net nutrient load reduction considered volumes and nutrient loads that eventually end up in the Bay (situation specific).

3 Results and Discussion

Table 3-1 presents a summary of the on-going recycled water projects. No new projects are currently underway, but the City of Hayward will be evaluating the feasibility of expanding the use of recycled water to serve additional customers, including industrial customers, in the future and the infrastructure required.

Table 3-1. Recycled Water Projects Identified by Hayward

Recycled Water Project	Description
Secondary Effluent Diversion to RCEC	Hayward's WPCF supplies Russell City Energy Center (RCEC) with secondary-treated effluent on an as-needed basis that is further treated at the RCEC facility to a tertiary-level and used for cooling water in energy production. Approximately 1,000 AF is supplied to RCEC and is expected to continue through the facility's operational life (2041).
Phase I Recycled Water Project	Hayward's WPCF began delivering tertiary-treated recycled water to 31 irrigation customers in 2022 as part of its Phase 1 Recycled Water Project. The project includes the addition of a 0.5 mgd membrane treatment plant at the WPCF, a 1.0 MG recycled water storage tank, a recycled water pump station, and approximately 8.5 miles of distribution pipelines. Hayward anticipates delivering approximately 224 AFY (0.2 mgd) initially with the intent of increasing to about 336 AFY (0.34 mgd) by 2030. Following completion of the City's recycled water master plan, it is expected the recycled water system will be expanded with additional customer connections.

The following sections summarize the flow and nutrient load reductions for each listed project in Table 3-1.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding current and projected future nutrient reductions to the Bay are provided in Table 3-2. Also shown in Table 3-2 is the confidence of the projections on a scale of 1 to 3.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. RCEC, an industrial user, has some variations in recycled water use depending on electrical demand (i.e., temperature), electrical production (i.e., availability of hydroelectric power), and as needed by the California Independent System Operator. Use is year-round but varies depending on energy supply and demand, but generally is higher in the later summer months. Hayward's Phase 1 Recycled Water Project currently provides recycled water for irrigation only with the majority of irrigation taking place during the dry months (Apr-Sept). The project includes a 1.0 MG storage tank to assist with seasonal and diurnal demand variability.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Average Distributed - Return Flows (AFY)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**1**	**854**	**69**	**90**	**11**
	Russell City Energy Center	1	630	51	66	8
	Phase I Recycled Water Project	1	224	18	24	3
2025	**Total**	**1**	**1,220**	**99**	**128**	**16**
	Russell City Energy Center	1	1,000	81	105	13
	Phase I Recycled Water Project	1	224	18	24	3
2030	**Total**	**1**	**1,340**	**108**	**140**	**17**
	Russell City Energy Center	1	1,000	81	105	13
	Phase I Recycled Water Project	1	336	27	35	4
2035	**Total**	**1**	**1,340**	**108**	**140**	**17**
	Russell City Energy Center	1	1,000	81	105	13
	Phase I Recycled Water Project	1	336	27	35	4
2040	**Total**	**1**	**1,340**	**108**	**140**	**17**
	Russell City Energy Center	1	1,000	81	105	13
	Phase I Recycled Water Project	1	336	27	35	4
2045	**Total**	**1**	**1,340**	**108**	**140**	**17**
	Russell City Energy Center	1	1,000	81	105	13
	Phase I Recycled Water Project	1	336	27	35	4

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

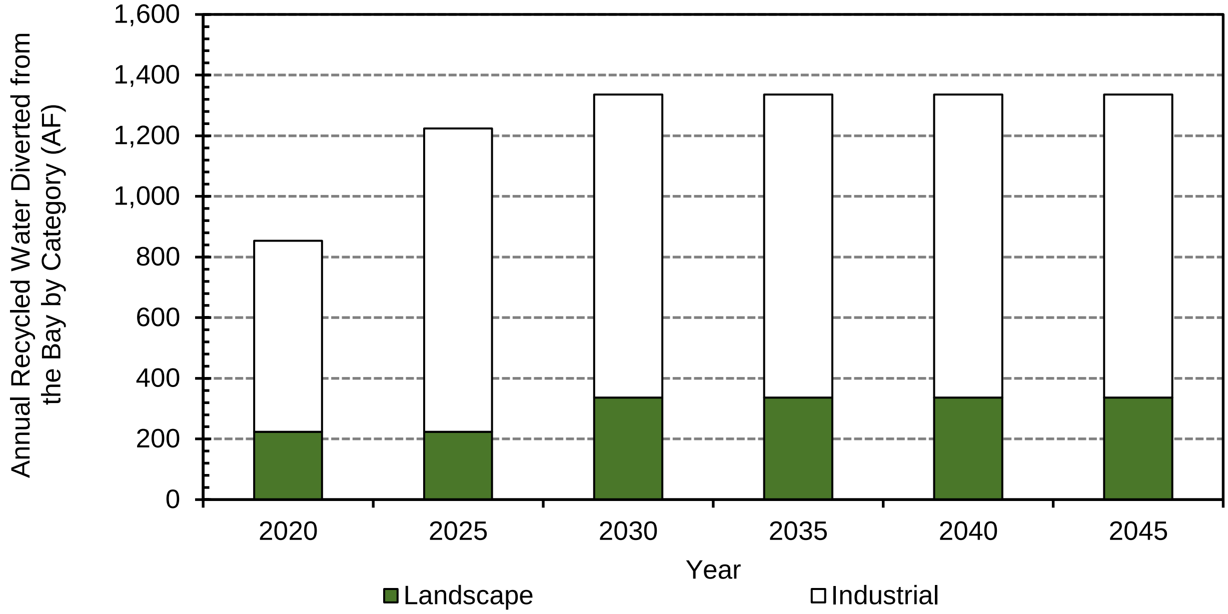

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. The existing facilities are already paid for and in place.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Secondary Effluent Diversion to RCEC	• Reduces overall water supply demand as the industrial user would use potable water if recycled water were not available • Facilities are already in place and producing tertiary-level recycled water from the City's secondary effluent • Operator familiarity with existing recycled water facilities • Existing facilities reliably meet recycled water treatment requirements	• None
Phase I Recycled Water Project	• Reduces overall water supply demand as the irrigation user would use potable water if recycled water were not available • Facilities are already in place and providing recycled water • Existing facilities reliably meet recycled water treatment requirements • Facilities have storage (1-MG) to address diurnal demand variability	• Require additional treatment and infrastructure to meet some industrial customer needs. • Additional Operations and Maintenance costs to operate and maintain the system

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. Approximately 1,000 AF of secondary-treated water is provided to RCEC, which treats it to a tertiary-level at their facilities for their use. The increases beginning in 2022 from the Phase I Recycled Water Project involve existing infrastructure and irrigation customers. The Phase I Recycled Water Project was enrolled under the State Water Resources Control Board's General Water Reclamation Requirements for Recycled Water Use Order WQ 2016-0068-DDW in late 2021 and began operating in March2022.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. The Phase I Recycled Water Project is captured in year 2025 as it became operational in 2022.

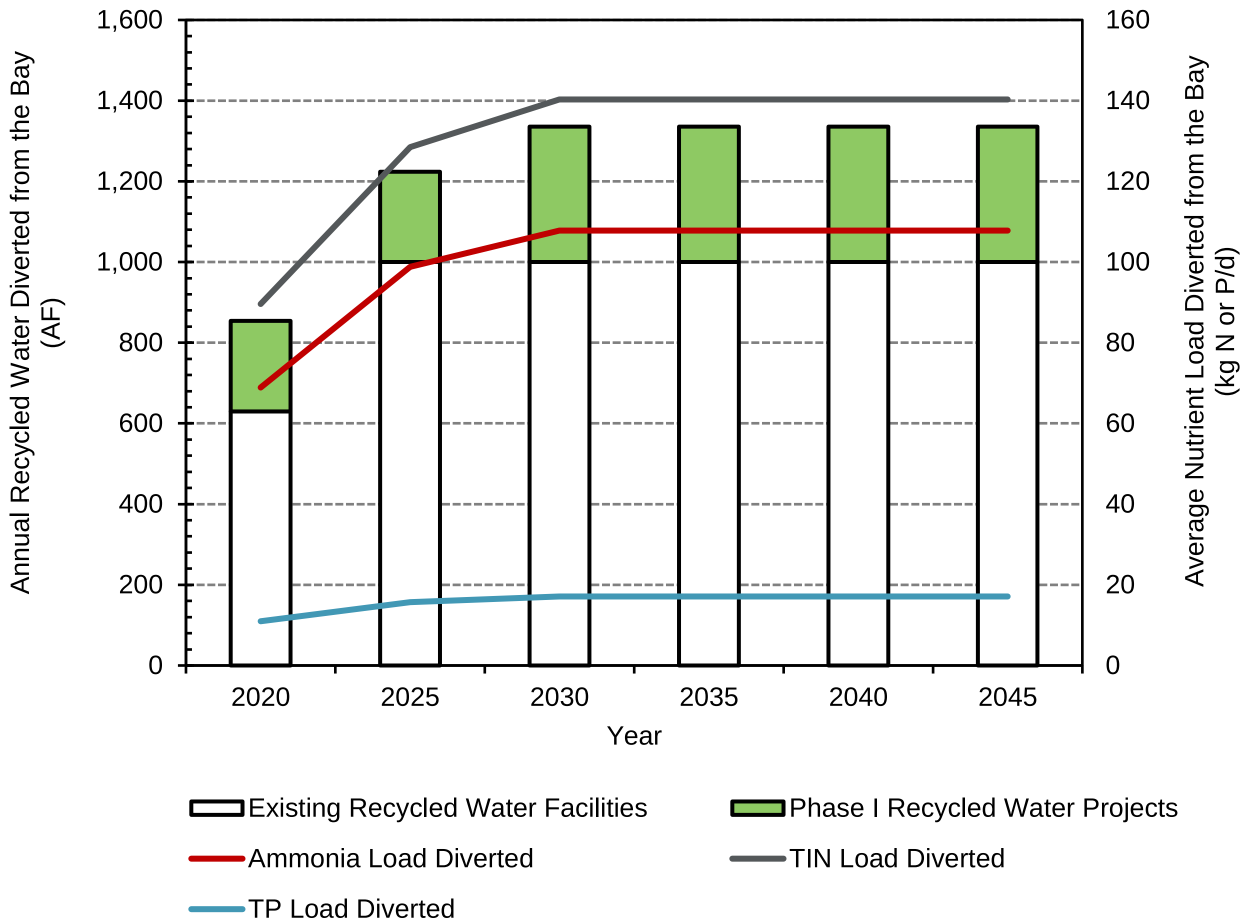

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge

Note: 2045 values assume RCEC is operational through 2045. RCEC's current projected design life is 30 years, or facility operational through 2041.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Project to Russell City Energy Center (Projected into the Future) *,**		Phase I Recycled Water Projects (Projected into the Future) *,**		Total (Projected into the Future; Averaged from Year 2020 -2045) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	1.1	0.8	0.5	0.3	1.6	1.1
Volume	AF	510	938	249	299	759	1,240
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	1	1	1 / 1	1 / 1
Duration	Years	25	25	23	23	25	25
Flow Diverted	%	9%	7%	5%	2%	13%	9%
Ammonia Load Diverted	kg N/d	106	76	52	24	153	98
TIN Load Diverted	kg N/d	132	99	64	31	191	127
TP Load Diverted	kg P/d	14	12	7	4	21	16
Cost[3,4,5,9]							
Capital Cost	$ Mil	--	--	27.3	27.3	27.3	27.3
NPV O&M	$ Mil	4.0	7.4	1.5	1.8	5.5	9.2
NPV Total (Capital+NPV O&M)	$ Mil	4.0	7.4	28.8	29.1	32.8	36.5
Unit Flow Cost[6,9]							
Unit Cost	$/gpd	3.7	8.8	54	109	20	33
Unit Cost	$/AF	313	313	5,030	4,240	1,730	1,180
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	4.5	4.8	72	65	25	19
TIN Unit Cost	$/lb TIN Diverted	3.6	3.7	58	50	20	14
TP Unit Cost	$/lb TP Diverted	33	30	529	410	187	116

* Existing RW Project refers to existing treatment facilities (RCEC) producing RW and industrial uses at the RCEC site; Total includes a sum of the Existing RW Project (projected into the future) plus other proposed future projects.

** Flows and loads diverted from Bay Discharge are projected forward to the average from project start through year 2045.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = only projects that are currently budgeted; 2 = projects that are in master plan; 3 = projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by Hayward (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay over the project duration.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from Bay discharge for the project duration (project specific).
9. RCEC's capital and operating costs unknown.

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3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects in Hayward:

- Drivers for implementing recycled water projects:
  - Environmental improvement through decreased discharge of flow and nutrients into the Bay
  - More sustainable and reliable water supply; decreased dependence on other water sources
- Barriers for implementing recycled water projects:
  - Funding sources have been challenging to identify; projects are costly to implement
  - Identifying potential customers in order to secure demand for new projects

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Las Gallinas Valley Sanitary District Sewage Treatment Plant

BACWA Recycled Water Study

Individual Plant Report

San Rafael, CA
May 31, 2023
FINAL Report

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Contents

Tables

Figures

Executive Summary

Las Gallinas Valley Sanitary District owns and operates the Las Gallinas Valley Sanitary District Sewage Treatment Plant (LGVSD STP) located in San Rafael, CA and discharges treated effluent to Miller Creek, which drains to San Pablo Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 2.92 million gallons per day (mgd).

The LGVSD STP has an existing recycled water program that is employed year-round. A portion of effluent is used for on-site District pastureland. The water applied to the pasture is beneficially used by an agricultural contractor to grow commercial hay crops. Because it is diverted from the NPDES discharge stream, the diversion reduces nutrient loadings to the Bay. This District pastureland reuse application is critical for meeting LGVSD's 5-month "no discharge" provision within their NPDES permit. District pastureland accounts for approximately 250 acre-feet per year (AFY; 80 million gallons per year) for reuse.

In addition to pastureland reuse, LGVSD STP has two existing recycled water customers, Marin Municipal Water District (MMWD) and North Marin Water District (NMWD). Such customers use the reuse water for landscape irrigation, golf course irrigation, commercial, and industrial uses. Such reuse customers recycles approximately 725 AFY (236 million gallons per year; excludes District pastureland.

The total recycled water for District pastureland, MMWD, and NMWD is approximately 975 AFY (316 million gallons per year). There are no existing plans to further expand the recycled water program.

A summary of the ongoing and proposed recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES - 1. The table includes existing facilities, any planned future recycled water projects (in this case none), and the total (sum of existing plus planned future projects). The timeline and corresponding load diversions from the Bay for the projected projects, if any are identified, are described in Table ES - 1 is illustrated in Figure ES - 1.

An overview of the drivers and barriers for implementing recycled water projects at LGVSD:

- Drivers for implementing recycled water projects:
  - NPDES Permit: a significant driver for LGVSD (as recycled water producer) is NPDES permit requirement that prohibits discharge of treatment plant effluent to surface water from June-October.
  - Institutional: LGVSD's desire to maximize water recycling.
- Barriers for implementing recycled water projects:
  - Funding: the high cost of recycled water distribution infrastructure.
  - Demand: the absence of large potential users close to the existing system is a barrier for the distributor/retailer.
  - Jurisdictional: as recycled water producer only, LGVSD does not control demand.

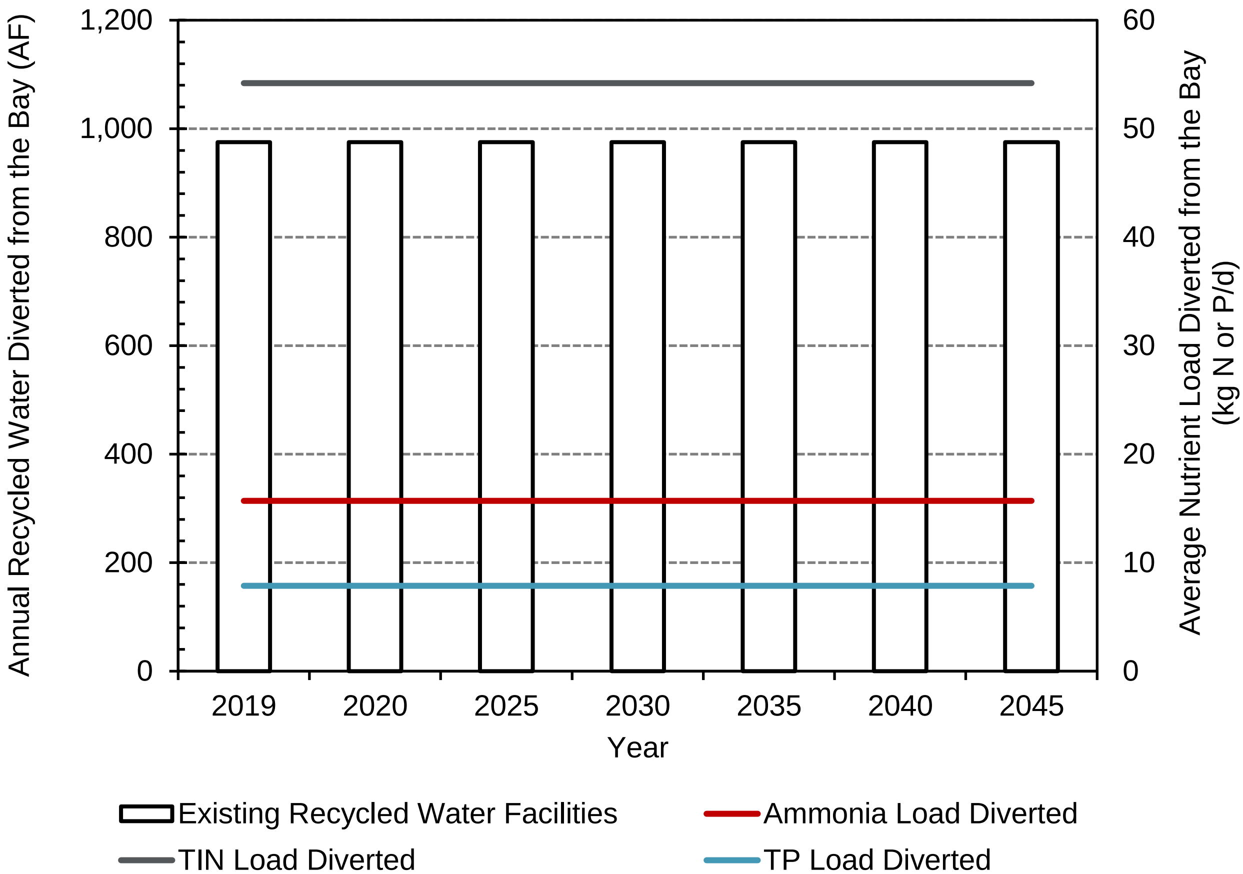

Figure ES - 1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge

Table ES - 1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Projects (None Planned) *,**		Total (Projected into the Future) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	1.6	0.9	--	--	1.6	0.9
Volume	AF	764	975	--	--	764	975
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	81%	28%	--	--	81%	28%
Ammonia Load Diverted	kg N/d	19	16	--	--	19	16
TIN Load Diverted	kg N/d	85	54	--	--	85	54
TP Load Diverted	kg P/d	16	8	--	--	16	8
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	1.1	1.4	--	--	1.1	1.4
NPV Total (Capital+NPV O&M)	$ Mil	1.1	1.4	--	--	1.1	1.4
Unit Flow Cost[6]							
Unit Cost	$/gpd	0.7	1.6	--	--	0.7	1.6
Unit Cost	$/AF	59	59	--	--	59	59
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	7.0	4.5	--	--	7.0	4.5
TIN Unit Cost	$/lb TIN Diverted	1.6	1.3	--	--	1.6	1.3
TP Unit Cost	$/lb TP Diverted	8.1	9.0	--	--	8.1	9.0

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045; details provided with each project in Section 3).

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by LGVSD (based on year 2021 dollars). Note: the capital costs to implement are excluded as the facilities are already in place.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

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1 Introduction and Current Conditions

Las Gallinas Valley Sanitary District owns and operates the Las Gallinas Valley Sanitary District Sewage Treatment Plant (LGVSD STP) located in San Rafael, CA and discharges treated effluent to Miller Creek, which drains to San Pablo Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 2.92 million gallons per day (mgd).

The sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

LGVSD holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2020-0022). Table 1-1 and Table 1-2 provide a summary of the relevant plant permit limitations for the dry and wet seasons, respectively. Both tables are not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations for Dry Season (Order No. R2-2020-0022; CA0037575)*

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	2.92	--	--	--
Effluent BOD (1)	mg/L	--	20	25	30
Effluent TSS (1)	mg/L	--	15	18	20
Effluent Ammonia	mg/L	--	6		18

* Dry Season for NPDES at LGVSD refers to May 1 through October 31.
1. BOD and TSS include a minimum percent removal of 85% through the WWTP.
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

Table 1-2. NPDES Permit Limitations for Wet Season (Order No. R2-2020-0022; CA0037575)*

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	2.92	--	--	--
Effluent BOD (1)	mg/L	--	30 (25) **	45 (40) **	--
Effluent TSS (1)	mg/L	--	15 (30) **	18 (45) **	20
Effluent Ammonia	mg/L	--	6 (10) **		18 (18) **

* Wet Season for NPDES at LGVSD refers to November 1 through April 30.

** Values in parentheses reflect those to be used once construction is completed for a combined fixed film/activated sludge nitrification and denitrification process, and supporting structures, to increase the plant's biological treatment capacity to 18 mgd.

1. BOD and TSS include a minimum percent removal of 85% through the WWTP.
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;
- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-3.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-3. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 shows the process flow diagram for the LGVSD STP during normal operation. Both liquids processes and solids processes are shown. The LGVSD STP consists of screening, grit removal, primary clarification, hybrid fixed-film/activated sludge, secondary clarifiers, deep-bed filters, and chlorine disinfection. Solids treatment consists of gravity thickening, anaerobic digestion, sludge storage lagoons, and onsite land disposal.

1.3 Existing Recycled Water Service

The LGVSD STP has an existing recycled water program that is employed year-round. LGVSD has no Bay discharge during the dry season. Recycled water is used for on-site pastureland, landscape irrigation, golf course irrigation, and commercial and industrial uses. The existing program has the effect of reducing nutrients discharged to the Bay. LGVSD currently recycles approximately 975 acre-feet per year (316 million gallons per year). There are no existing plans to further expand the recycled water program.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-4. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-4. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)[1]	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	0.39	3.6	2.3
Volume	AF	181	2,361	2,542
Ammonia	kg N/d	4.50	67.3	41.2
Total Inorganic Nitrogen (TIN)	kg N/d	20.1	229	142
Total Phosphorus (TP)	kg P/d	3.88	32.5	20.6
Ammonia	mg N/L	2.72	5.30	5.04
TIN	mg N/L	12.0	19.6	18.9
Total P	mg P/L	2.18	2.77	2.71

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

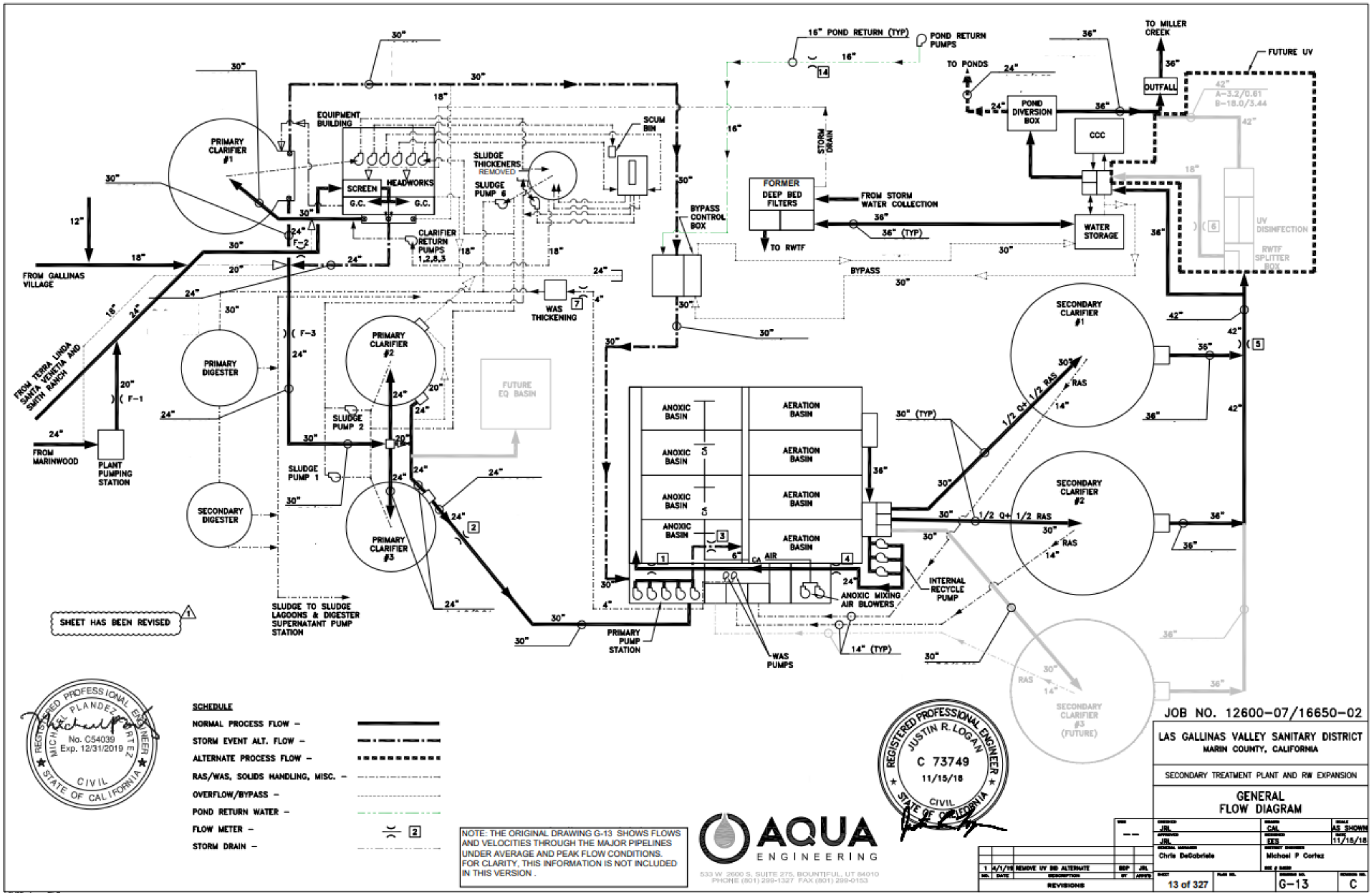

Figure 1-1. Process Flow Diagram for Las Gallinas Valley Sanitary District Sewage Treatment Plant (Source: R2-2020-0022)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2020 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with LGVSD STP and Engineer's best judgment that considered known project constraints, existing LGVSD STP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by LGVSD STP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^{6}\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^{6}\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects.

Table 3-1. Recycled Water Projects Identified by LGVSD

Recycled Water Project	Description
Current: District Pastureland a 250 AFY	A portion of effluent is used for on-site District pastureland. The water applied to the pasture is beneficially used by an agricultural contractor to grow commercial hay crops. Because it is diverted from the NPDES discharge stream, the diversion reduces nutrient loadings to the Bay. This District pastureland reuse application is critical for meeting LGVSD's 5-month "no discharge" provision within their NPDES permit. District pastureland accounts for approximately 250 AFY (80 million gallons per year) for reuse.
Current: Marin Municipal Water District (MMWD) at 575 AFY	From the late 1980s through 2019, LGVSD STP provided secondary effluent from its treatment plant to the MMWD, which operated a facility for production of disinfected tertiary recycled water on the LGVSD STP site. Under SF Water Board Order 89-127, MMWD served as both Producer and Distributor of recycled water, used by its customers for landscape irrigation and variety of other approved uses. The MMWD production facility was retired in 2019. From 2019 through early 2021, the RWF was expanded to increase its "firm" capacity (excluding redundancy) from 0.7 mgd to 4 mgd, approximately 2 mgd of which is committed to MMWD. The expanded RWF at LGVSD STP will utilize the existing MMWD chlorine contact tank and clearwell for disinfection and on-site storage of recycled water delivered to both MMWD and NMWD. LGVSD will initiate deliveries from the expanded RWF to both agencies starting in the spring of 2021.
Current: North Marin Water District (NMWD) at 150 AFY	LGVSD STP provides Title 22 Disinfected Tertiary recycled water to the NMWD transmission pipeline for use in the Southern Novato (Hamilton Field) area which is currently used for landscape irrigation only. There are no plans to expand the 150 AFY.
Future Projects	No future projects are planned.

The following sections summarize the flow and nutrient load reductions for each listed project in Table 3-1.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. Refer to Table 3-1 for a description of the current recycled water distribution volumes that comprise Table 3-2.

Figure 3-1 presents a distribution of the recycled water volumes diverted from the Bay by use categories from 2020 through 2045. Current and future recycled water uses via existing facilities include on-site pastureland irrigation (i.e., agricultural), golf course, landscape, commercial, and industrial uses. It was assumed that 100 percent of the flows and loads associated with pastureland, golf course, landscape, commercial, and agricultural use; a 67 percent flow reduction and zero load reduction associated with industrial use.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Average Distributed - Return Flows (AFY)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**1**	**975**	**16**	**54**	**8**
	Existing Facilities	1	975	16	54	8
	Future Projects **	--	--	--	--	--
2025	**Total**	**1**	**975**	**16**	**54**	**8**
	Existing Facilities	1	975	16	54	8
	Future Projects **	--	--	--	--	--
2030	**Total**	**1**	**975**	**16**	**54**	**8**
	Existing Facilities	1	975	16	54	8
	Future Projects **	--	--	--	--	--
2035	**Total**	**1**	**975**	**16**	**54**	**8**
	Existing Facilities	1	975	16	54	8
	Future Projects **	--	--	--	--	--
2040	**Total**	**1**	**975**	**16**	**54**	**8**
	Existing Facilities	1	975	16	54	8
	Future Projects **	--	--	--	--	--
2045	**Total**	**1**	**975**	**16**	**54**	**8**
	Existing Facilities	1	975	16	54	8
	Future Projects **	--	--	--	--	--

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

** None Planned

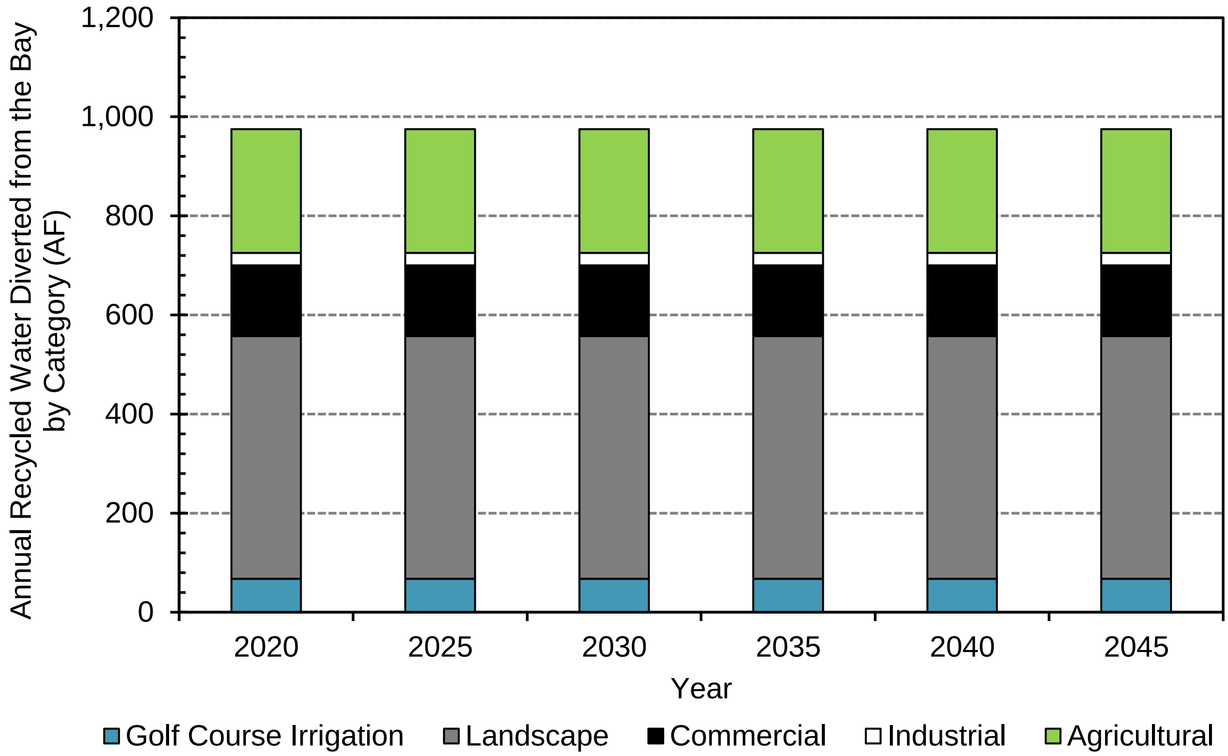

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the current and proposed recycled water projects. The recycled water demands for existing recycled water customers is primarily during the dry season. There are no plans to increase demand for either existing recycled water customers.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing: District Pastureland at 250 AFY; Marin Municipal Water District (MMWD) at 575 AFY; and North Marin Water District (NMWD) at 150 AFY	• Provides a means for LGVSD STP to meet their NPDES flow limits by diverting the largest portion of flow from the Bay during the dry season (approx. 80% demand occurs during the dry season). • Reduction on potable water supply. • LGVSD STP already removes a portion of ammonia, TIN, and TP. The biology that removes ammonia can result in additional contaminants of emerging concern (CEC) removal compared to treatment plants performing cBOD removal.	• Reduced demand during the wet season. • Lack of demand to expand as the treatment and distribution system our already in place. • Concerns over total dissolved solids long-term build-up (dependent on recycled user type, location, etc.).
Future Projects	None Planned	None Planned

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. The current recycled water customers are on-site pastureland, MMWD, and NMWD. There are no plans to increase demand for either existing recycled water customers.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. The recycled water volumes appear to be fixed at 975 AFY with little or no plans to expand the recycled water distribution to reach new customers.

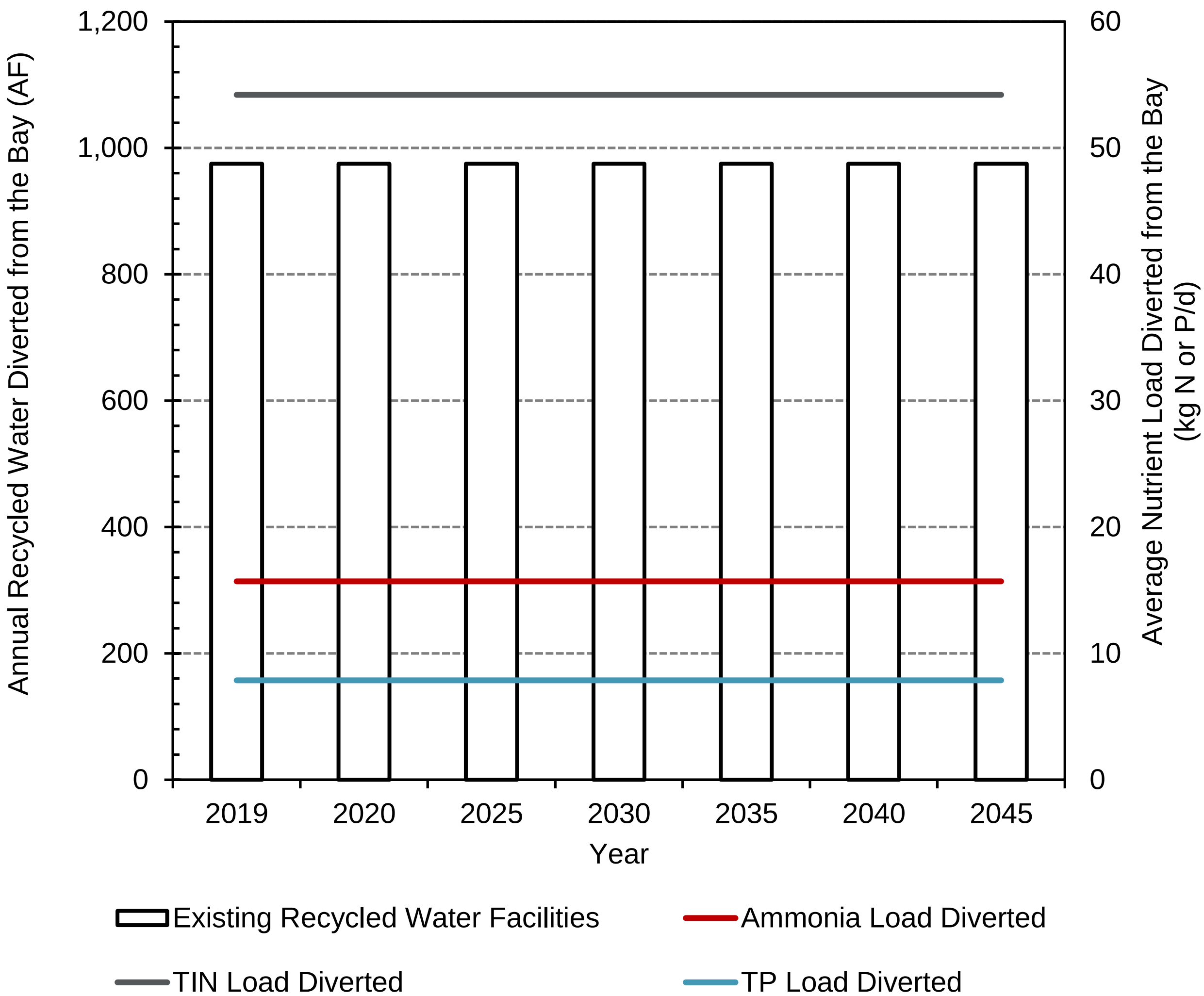

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Projects (None Planned) *,**		Total (Projected into the Future) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	1.6	0.9	--	--	1.6	0.9
Volume	AF	764	975	--	--	764	975
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	81%	28%	--	--	81%	28%
Ammonia Load Diverted	kg N/d	19	16	--	--	19	16
TIN Load Diverted	kg N/d	85	54	--	--	85	54
TP Load Diverted	kg P/d	16	8	--	--	16	8
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	1.1	1.4	--	--	1.1	1.4
NPV Total (Capital+NPV O&M)	$ Mil	1.1	1.4	--	--	1.1	1.4
Unit Flow Cost[6]							
Unit Cost	$/gpd	0.7	1.6	--	--	0.7	1.6
Unit Cost	$/AF	59	59	--	--	59	59
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	7.0	4.5	--	--	7.0	4.5
TIN Unit Cost	$/lb TIN Diverted	1.6	1.3	--	--	1.6	1.3
TP Unit Cost	$/lb TP Diverted	8.1	9.0	--	--	8.1	9.0

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045)

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by LGVSD (based on year 2021 dollars). Note: the capital costs to implement are excluded as the facilities are already in place.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

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3.4 Drivers and Barriers to Implementation

Drivers for implementing recycled water projects:

- Drivers for implementing recycled water projects:
  - NPDES Permit: a significant driver for LGVSD (as recycled water producer) is NPDES permit requirement that prohibits discharge of treatment plant effluent to surface water from June-October.
  - Institutional: LGVSD's desire to maximize water recycling.
- Barriers for implementing recycled water projects:
  - Funding: the high cost of recycled water distribution infrastructure.
  - Demand: the absence of large potential users close to the existing system is a barrier for the distributor/retailer.
  - Jurisdictional: as recycled water producer only, LGVSD does not control demand.

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City of Livermore Water Reclamation Plant

BACWA Recycled Water Study

FINAL Individual Plant Report

Livermore, CA

May 15, 2023

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Contents

Tables

Figures

Executive Summary

The City of Livermore owns and operates the Livermore Water Reclamation Plant (Livermore WRP) located in Livermore, CA and discharges treated effluent to Lower San Francisco Bay through a common outfall operated by the East Bay Dischargers Association (EBDA). The plant has an average dry weather flow (ADWF) permitted capacity of 8.5 million gallons per day (mgd).

The Livermore WRP has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The WWTP recycled approximately 2,600 acre-feet (AF; 900 million gallons) in year 2020. However, not all of the recycled water uses translate to a reduction of flow and nutrient loads to the Bay. Specifically, approximately 30 to 40 percent of the recycled water is used for internal uses which eventually ends up in the Bay. While the recycled water uses that eventually up in the Bay do not reduce loads per se, such uses reduce potable water supply demand. There are no existing plans to further expand the recycled water program.

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES -1. The timeline and corresponding load diversions from the Bay is provided in Figure ES - 1.

An overview of the drivers and barriers for implementing recycled water projects at Livermore:

- Drivers for implementing recycled water projects: reduce burden on potable water supply
- Barriers for implementing recycled water projects:
    - Infrastructure (Distribution Capacity): existing recycled water distribution system has a limited capacity to reach and meet any potential new customer demands.
    - Infrastructure (Storage Capacity): Livermore does not have recycled water storage capacity to address variations in seasonal demands. For example, the maximum month demands are approximately five times greater than the minimum month demands. The inability to store and accommodate such variations reduces recycled water opportunities for Livermore. Zone 7 has an on-going recycled water feasibility study that includes an evaluation of such storage options.
    - Funding: construction of new recycled water distribution systems to reach new customers is cost prohibitive

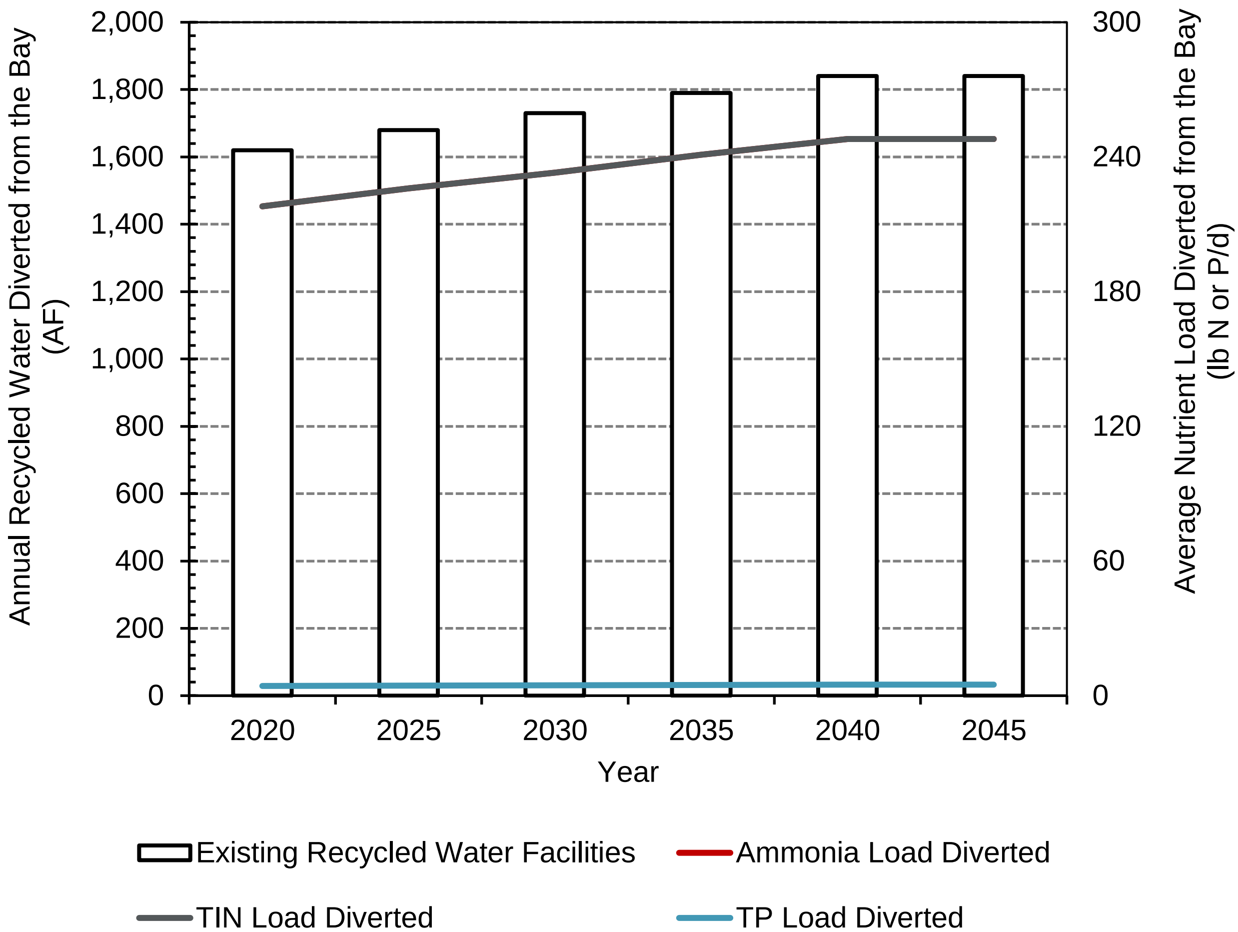

Figure ES - 1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge

Note 1: the ammonia/TIN loads are comparable. The ammonia loads are located behind TIN and are challenging to see.

Note 2: the annual recycle water demands are approximately 2,600 AF. Approximate 800 AFY of recycled water is not shown as those represent internal uses which would not result in loads diverted from the Bay.

Table ES - 1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future RW Projects (None Planned) *,**		Total RW Projects (Projected into the Future) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	2.1	1.6	--	--	2.1	1.6
Volume	AF	990	1,750	--	--	990	1,750
Load Diverted from the Bay[2,3]							
Confidence	unitless	1***	1***	--	--	1***	1***
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	38%	25%	--	--	38%	25%
Ammonia Load Diverted	kg N/d	346	236	--	--	346	236
TIN Load Diverted	kg N/d	347	236	--	--	347	236
TP Load Diverted	kg P/d	7	5	--	--	7	5
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	8.4	14.8	--	--	8.4	14.8
NPV Total (Capital+NPV O&M)	$ Mil	8.4	14.8	--	--	8.4	14.8
Unit Flow Cost[6]							
Unit Cost	$/gpd	4.0	9.5	--	--	4.0	9.5
Unit Cost	$/AF	337	337	--	--	337	337
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	2.9	3.1	--	--	2.9	3.1
TIN Unit Cost	$/lb TIN Diverted	2.9	3.1	--	--	2.9	3.1
TP Unit Cost	$/lb TP Diverted	137	157	--	--	137	157

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045).

*** While the recycled water users and demands are in place and thus have a confidence of 1, there is concern over the long-term reliability after year 2030.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production based on the energy required to produce water at the plant for various recycled water uses by Livermore (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

Note: the annual recycle water demands are approximately 2,600 AF. The values in this table represent flows and loads that would be diverted from the Bay (approximately 800 AFY is not shown as it represents internal uses whereby the flows and loads would eventually end up in the Bay.

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1 Introduction and Current Conditions

The City of Livermore owns and operates the Livermore Water Reclamation Plant (Livermore WRP) located in Livermore, CA and discharges treated effluent to Lower San Francisco Bay through a common outfall operated by the East Bay Dischargers Association (EBDA). The plant has an average dry weather flow (ADWF) permitted capacity of 8.5 million gallons per day (mgd).

The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

The Livermore WRP holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2022-0025). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2022-0025)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	8.5*	--	--	--
Effluent Carbonaceous BOD (1)	mg/L	--	25	40	--
Effluent TSS (1)	mg/L	--	30	45	--
Effluent Ammonia	mg N/L	--	86	--	110

1. Carbonaceous BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

* The influent average dry weather will increase from 8.5 to 11. mgd once the WRP completes various upgrades as noted in their NPDES Permit.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for the Livermore WRP. Both liquids processes and solids processes are shown. Livermore currently has four primary clarifiers, followed by two aeration basins (only one is in service) and three secondary clarifiers for secondary treatment. A low SRT is maintained in the activated sludge system to prevent nitrification. The operating aeration basin includes an anaerobic selector that may perform some phosphorus removal. Ferric chloride is added at the headworks for hydrogen sulfide control. Livermore provides tertiary treatment for use as recycled water with four anthracite media filters. The facility also has two flocculation tanks to improve filtration. Solids treatment consists of waste activated sludge (WAS) thickening, anaerobic digestion, and belt filter press dewatering.

1.3 Existing Recycled Water Service

The Livermore WRP has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The WWTP recycled approximately 2,600 acre-feet (AF; 900 million gallons) during year 2020. However, not all of the recycled water uses translate to a reduction of flow and nutrient loads to the Bay. Specifically, approximately 30 to 40 percent of the recycled water is used for internal uses which eventually ends up in the Bay. While the recycled water uses that eventually up in the Bay do not reduce loads per se, such uses reduce potable water supply demand. There are no existing plans to further expand the recycled water program).

1.4 Existing Discharge Flows and Loads to the Bay

A summary of recent discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	3.44	5.42	4.58
Volume	AF	1,620	3,520	5,140
Ammonia	kg N/d	565	814	690
Total Inorganic Nitrogen (TIN)	kg N/d	566	815	690
Total Phosphorus (TP)	kg P/d	11.8	15.3	13.7
Ammonia	mg N/L	43.4	39.7	39.8
TIN	mg N/L	43.5	39.7	39.8
TP	mg P/L	0.900	0.750	0.790

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

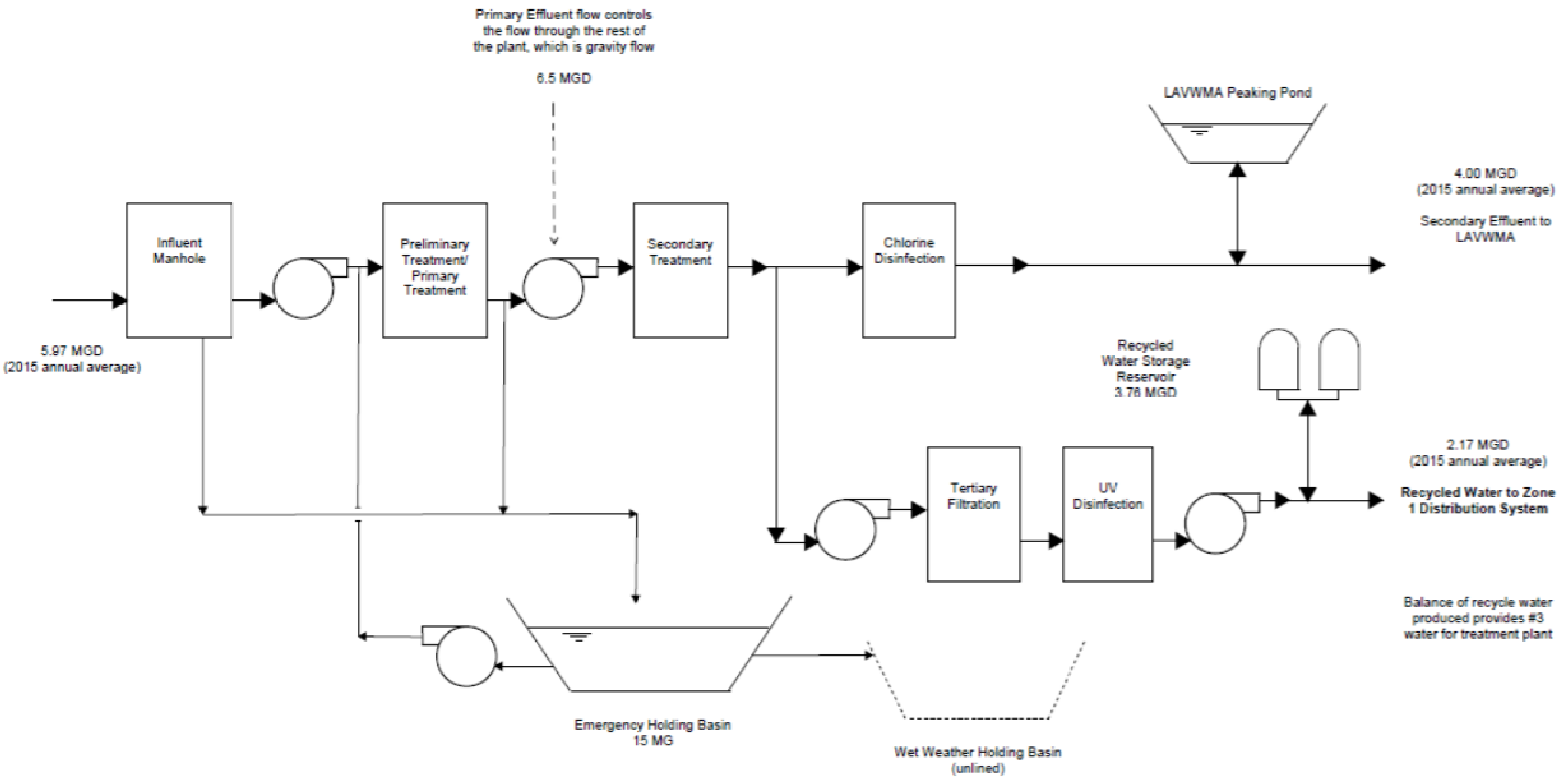

Figure 1-1. Process Flow Diagram for Livermore WRP (Source: Order No. R2-2017-0018)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial

Use Category*	Definition
	building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with Livermore WRP and Engineer’s best judgment that considered known project constraints, existing Livermore WRP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by Livermore WRP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering,

construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
    - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
    - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a "synergistic benefit" for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects. The subsections that follow summarize the flow and nutrient load reductions for each listed project in Table 3-1.

Table 3-1. Recycled Water Projects Identified by Livermore WRP

Recycled Water Project	Description
Existing Recycled Water System	Has various recycled water users as follows: golf course (Las Pasitas Golf Course), landscape irrigation (parks, schools, commercial, residential, and export to the City of Pleasanton), commercial (offices, dual plumbing, and a car wash), internal uses at the WRP (not included for flow and nutrient load diversions from the Bay), and other non-potable uses (e.g., construction and fire protection)
Future Planned Recycled Water Projects	None planned

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. Overall, the recycled water volumes and loads diverted from the Bay suggest modest changes through year 2045. Livermore does not have any significant planned recycled water projects. As previously noted, the annual recycle water demands are greater than listed (approximately 2,600 AFY). Approximate 800 AFY of recycled water is not shown as those represent internal uses which would not result in loads diverted from the Bay.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. Except for modest increases in landscape irrigation over time, the volumes for each category are relatively flat through year 2045. Golf course irrigation, commercial, and landscape irrigation constitute the majority recycled users. “Other non-potable” constitute the other minor uses.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Distributed - Return Flows (AFY)	Annual Average Ammonia Load Removed (kg N/d)	Annual Average TIN Load Removed (kg N/d)	Annual Average Total P Load Removed (kg P/d)
2020	**Total**	**--**	**1,620**	**218**	**218**	**4**
	Existing Facilities	1	1,620	218	218	4
	Other Projects	--	--	--	--	--
2025	**Total**	**--**	**1,680**	**226**	**226**	**4**
	Existing Facilities	1	1,680	226	226	4
	Other Projects	--	--	--	--	--
2030	**Total**	**--**	**1,730**	**233**	**233**	**5**
	Existing Facilities	2	1,730	233	233	5
	Other Projects	--	--	--	--	--
2035	**Total**	**--**	**1,790**	**241**	**241**	**5**
	Existing Facilities	2	1,790	241	241	5
	Other Projects	--	--	--	--	--
2040	**Total**	**--**	**1,840**	**248**	**248**	**5**
	Existing Facilities	2	1,840	248	248	5
	Other Projects	--	--	--	--	--
2045	Total	--	**1,840**	**248**	**248**	**5**
	Existing Facilities	2	1,840	248	248	5
	Other Projects	--	--	--	--	--

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

Note 1: the ammonia/TIN loads are comparable as ammonia represents the majority of nitrogen species that comprise TIN loads.

Note 2: the annual recycle water demands are approximately 2,600 AF. Approximate 800 AFY of recycled water is not shown as those represent internal uses which would not result in loads diverted from the Bay.

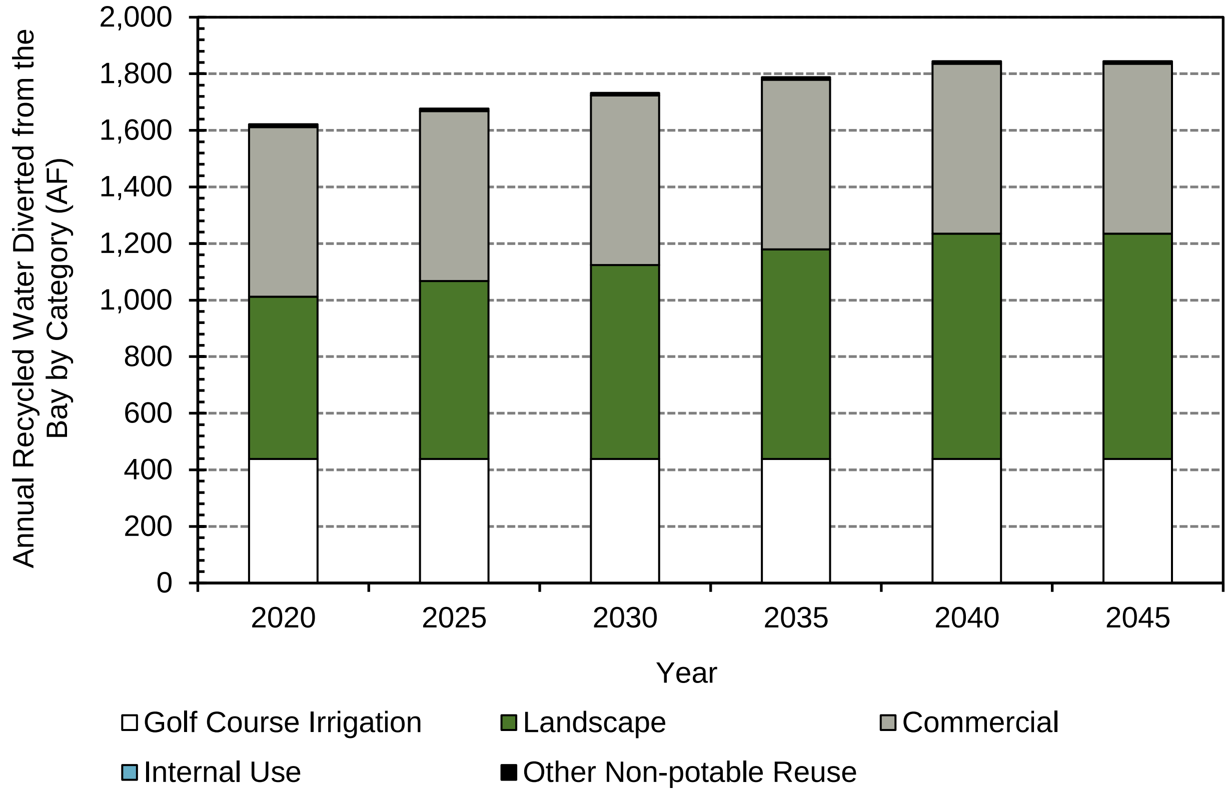

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

Note: the annual recycle water demands are approximately 2,600 AF. Approximate 800 AFY of recycled water is not shown as those represent internal uses which would not result in loads diverted from the Bay.

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. The existing facilities are already paid for an in place. There are no anticipated future planned projects.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water System	• Reduces potable water supply demands. The dry season demands make up over half of the annual demands which is when the water supply is most stressed. • Water is readily accessible for staff.	• Does not divert all loads from the Bay (it simply reduces potable water supply demands which include inherent loads)
Future Planned Recycled Water Projects (None Planned)	Non-Applicable	Non-Applicable

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. Just over 38 percent of the discharge flow and load is diverted from Bay discharge during the dry season. The costs are relatively inexpensive at less than $400/AF. Furthermore, the unit nutrient costs are less than $5/lb ammonia OR TIN which is comparable to the baywide average cost for plant upgrades in the first Watershed Permit 1.0 (R2-2014-0017; HDR, 2018). In contrast, the unit nutrient cost for total phosphorus load reduction is relatively high in comparison to the baywide average cost for plant upgrades in the first Watershed Permit 1.0 (R2-2014-0017; HDR, 2018). This elevated cost for total phosphorus load reduction is attributed to Livermore WRP is already removing total phosphorus as evidenced by discharge concentrations reliably below 1.0 mg P/L (see Table 1-3).

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay.

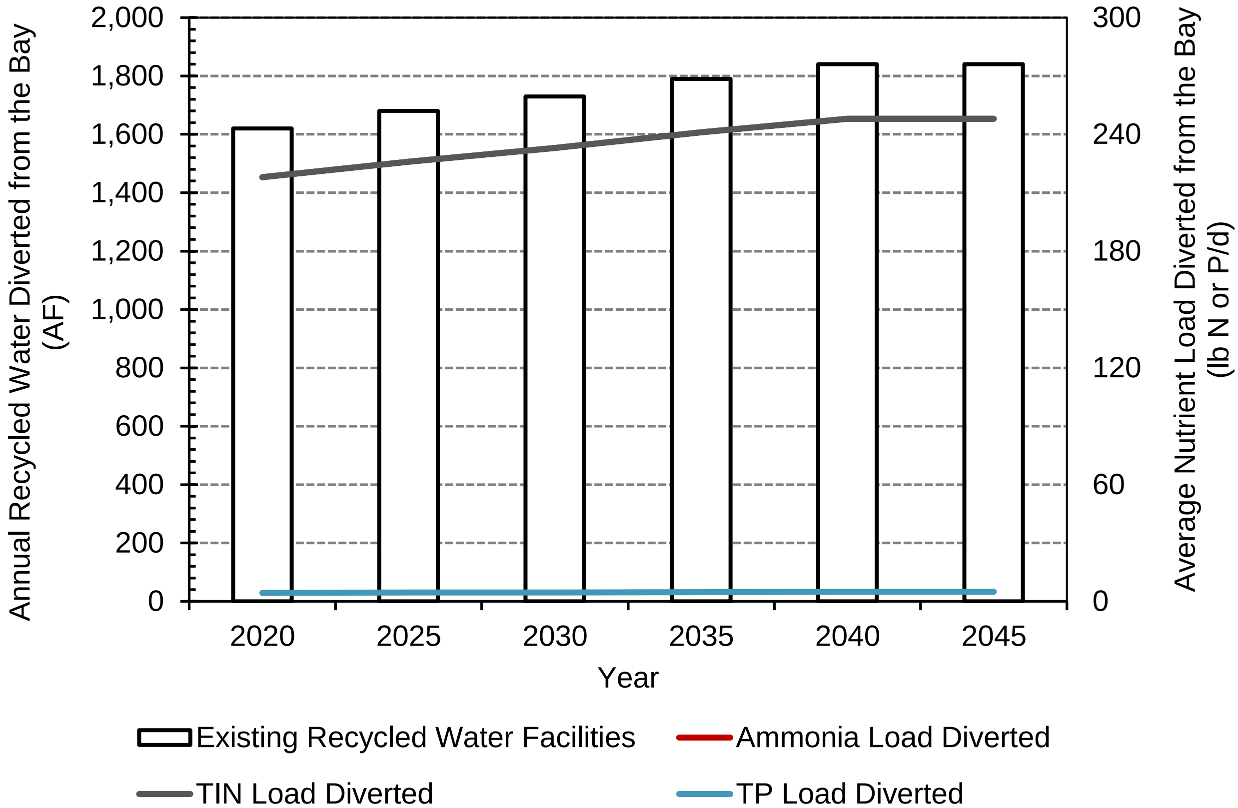

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge

Note 1: the ammonia/TIN loads are comparable. The ammonia loads are located behind TIN and are challenging to see.

Note 2: the annual recycle water demands are approximately 2,600 AF. Approximate 800 AFY of recycled water is not shown as those represent internal uses which would not result in loads diverted from the Bay.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future RW Projects (None Planned) *,**		Total RW Projects (Projected into the Future) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	2.1	1.6	--	--	2.1	1.6
Volume	AF	990	1,750	--	--	990	1,750
Load Diverted from the Bay[2,3]							
Confidence	unitless	1***	1***	--	--	1***	1***
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	38%	25%	--	--	38%	25%
Ammonia Load Diverted	kg N/d	346	236	--	--	346	236
TIN Load Diverted	kg N/d	347	236	--	--	347	236
TP Load Diverted	kg P/d	7	5	--	--	7	5
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	8.4	14.8	--	--	8.4	14.8
NPV Total (Capital+NPV O&M)	$ Mil	8.4	14.8	--	--	8.4	14.8
Unit Flow Cost[6]							
Unit Cost	$/gpd	4.0	9.5	--	--	4.0	9.5
Unit Cost	$/AF	337	337	--	--	337	337
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	2.9	3.1	--	--	2.9	3.1
TIN Unit Cost	$/lb TIN Diverted	2.9	3.1	--	--	2.9	3.1
TP Unit Cost	$/lb TP Diverted	137	157	--	--	137	157

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045).

*** While the recycled water users and demands are in place and thus have a confidence of 1, there is concern over the long-term reliability after year 2030.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production based on the energy required to produce water at the plant for various recycled water uses by Livermore (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

Note: the annual recycle water demands are approximately 2,600 AF. The values in this table represent flows and loads that would be diverted from the Bay (approximately 800 AFY is not shown as it represents internal uses whereby the flows and loads would eventually end up in the Bay.

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3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at Livermore:

- Drivers for implementing recycled water projects: reduce burden on potable water supply
- Barriers for implementing recycled water projects:
    - Infrastructure (Distribution Capacity): existing recycled water distribution system has a limited capacity to reach and meet any potential new customer demands.
    - Infrastructure (Storage Capacity): Livermore does not have recycled water storage capacity to address variations in seasonal demands. For example, the maximum month demands are approximately five times greater than the minimum month demands. The inability to store and accommodate such variations reduces recycled water opportunities for Livermore. Zone 7 has an on-going recycled water feasibility study that includes an evaluation of such storage options.
    - Funding: construction of new recycled water distribution systems to reach new customers is cost prohibitive

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City of Millbrae Water Pollution Control Plant

BACWA Recycled Water Study

Final Individual Plant Report

Millbrae, CA

May 22, 2023

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Contents

Tables

Figures

Executive Summary

The City of Millbrae Water Pollution Control Plant (Millbrae WPCP) discharges to the South Bay. It is located at 400 East Millbrae Avenue, Millbrae, CA 94030, and it serves approximately 6,550 service connections throughout the City of Millbrae. The plant has an average dry weather flow (ADWF) permitted capacity of 3 million gallons per day (mgd).

The Millbrae WPCP reuses water at the WPCP for internal use. The WPCP used to monitor flows of such water but stopped recording it several years back. During periods of recording, the WPCP would use approximately 60 acre-feet per year (19.6 million gallons per year). Regardless of recording, use at the WPCP for internal uses would not translate to a reduction in flows and/or nutrient loads to the Bay as that water would eventually end up in the outfall. Since Millbrae WPCP is no longer monitoring internal uses volumes and/or O&M costs, summary tables and figures are not included.

The WPCP is currently working on a recycled water demand study and they previously completed a recycled water facility feasibility study. There is funding for the planning phase, but funding has not been acquired for the design and construction of any new proposed facilities.

Funding is the main barrier for implementation of any project(s). Drivers for implementing any recycled water projects include reducing impact on water supply needs and proposed discharge requirements (nutrients focused), as well as institutional factors.

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1 Introduction and Current Conditions

The City of Millbrae Water Pollution Control Plant (Millbrae WPCP) discharges to the South Bay. It is located at 400 East Millbrae Avenue, Millbrae, CA 94030, and it serves approximately 6,550 service connections throughout the City of Millbrae. The plant has an average dry weather flow (ADWF) permitted capacity of 3 million gallons per day (mgd).

The subsections that follow provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

The Millbrae WPCP holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2019-0009). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2019-0009)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	3.0			
Effluent BOD (1)	mg/L		25	40	
Effluent TSS (1)	mg/L		35	45	
Effluent Ammonia	mg N/L		110		160

1. BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for DDWWTP. Both liquids processes and solids processes are shown. The treatment processes include screens and grit removal, flow equalization, primary sedimentation, biological activated sludge treatment, secondary clarification, disinfection with sodium hypochlorite, and final effluent skimming. Sludge from primary and secondary clarifiers is thickened, anaerobically digested and dewatered with belt filters.

1.3 Existing Recycled Water Service

The Millbrae WPCP reuses water at the WPCP for internal use. The WPCP used to monitor flows of such water but stopped recording it several years back. During periods of recording, the WPCP would use approximately 60 acre-feet per year (19.6 million gallons per year). Regardless of recording, use at the WPCP for internal uses would not translate to a reduction in flows and/or nutrient loads to the Bay as that water would eventually end up in the outfall.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (Oct 1-Sept 30)
Flow	mgd	1.4	1.9	1.7
Volume	AF	657	1,238	1,895
Ammonia	kg N/d	281	277	279
Total Inorganic Nitrogen (TIN)	kg N/d	283	279	280
Total Phosphorus (TP)	kg P/d	15.1	10.5	12.4
Ammonia	mg N/L	53.1	41.0	46.1
TIN	mg N/L	53.4	41.3	46.3
TP	mg P/L	2.81	2.00	2.08

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

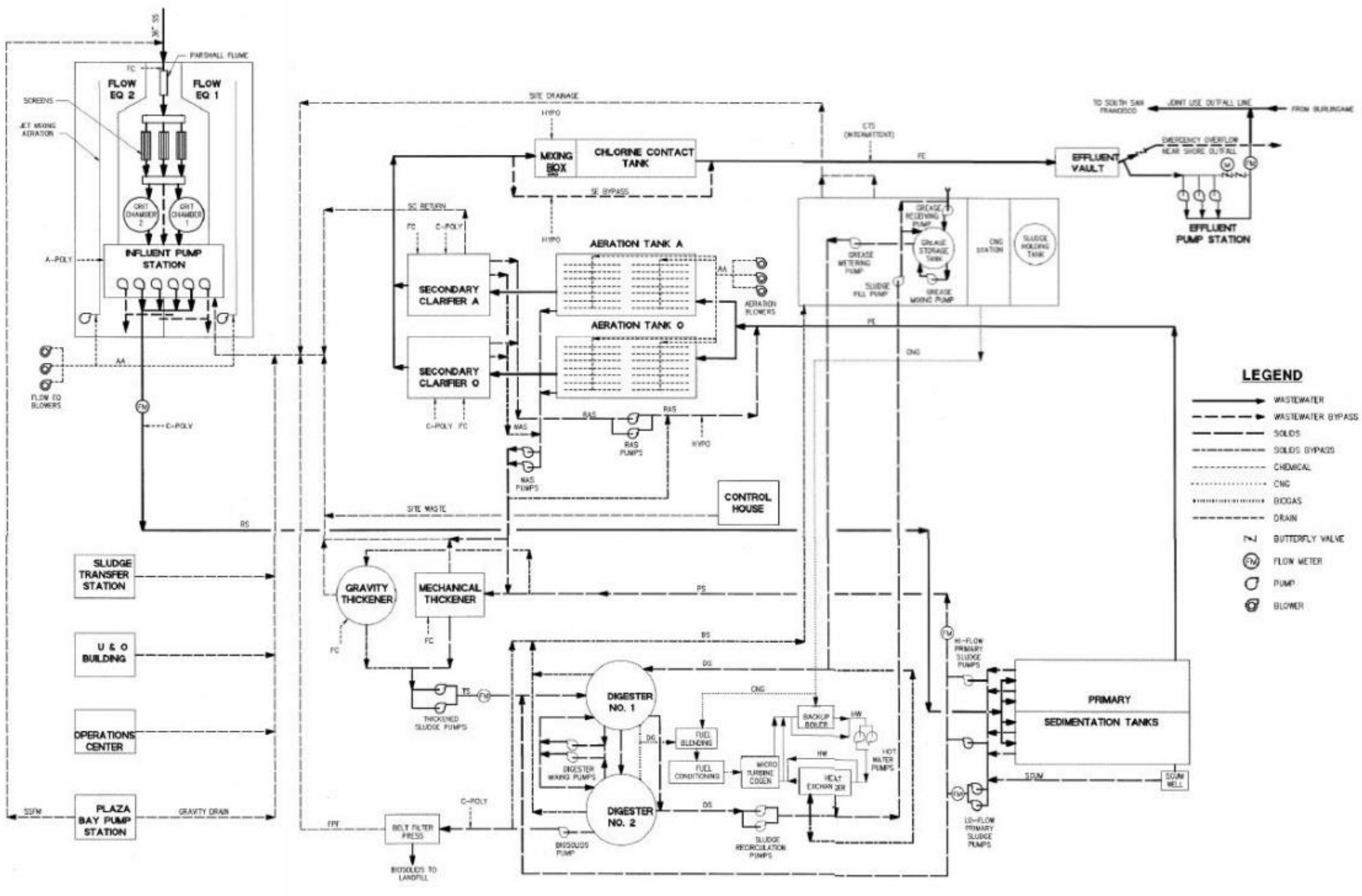

Figure 1-1. Process Flow Diagram for the Millbrae WPCP (Order No. R2-2019-0009; CA0037532)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if

Use Category*	Definition
	landscape is the dominant use of mixed uses served by a single meter
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with Millbrae WPCP and Engineer’s best judgment that considered known project constraints, existing Millbrae WPCP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are not included, as they are not monitored by Millbrae WPCP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects.

Table 3-1. Recycled Water Projects Identified by Millbrae WPCP

Recycled Water Project	Description
Existing Projects	The Millbrae WPCP reuses water for internal uses at the WPCP. The plant has not monitored such volumes in years. Such reuse measures do not translate to flow and/lor load reductions to the Bay as the water eventually ends up in the Bay.
Ongoing Evaluation	A recycled water demand study is currently underway, with funding for the planning phase. Funding has not been acquired for design or construction phases of this study.

Funding is the main barrier for implementation of any project(s). Drivers for implementing any recycled water projects include reducing impact on water supply needs and proposed discharge requirements (nutrients focused), as well as institutional factors.

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Mt. View Sanitary District Wastewater Treatment Plant

BACWA Recycled Water Study

FINAL Individual Plant Report

Martinez, CA
May 22, 2023

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Contents

Tables

Figures

Executive Summary

Mt. View Sanitary District Wastewater Treatment Plant (Mt. View WWTP) services a population of about 21,900, which includes unincorporated areas of Contra Costa County and portions of the City of Martinez. It is located at 3800 Arthur Road, Martinez, CA. The plant has an average dry weather flow (ADWF) permitted capacity of 3.2 million gallons per day (mgd) and a peak permitted wet weather flow of 10.9 mgd.

The Mt. View WWTP has an existing recycled water program that is employed year-round. All of the effluent flow is used for either environmental enhancement and internal uses. The recycled water sustains a 20-acre constructed marsh for wastewater treatment, Moorhen marsh, which also provides high quality wildlife habitat for indigenous and migrating birds and animal species. This existing program has the effect of reducing nutrients discharged to the Bay. The Mt. View WWTP currently recycles approximately 1,150 acre-feet per year (375 million gallons per year) and they are planning to increase recycling to 1,300 acre-feet per year (400 million gallons per year) by 2045.

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES – 1. All of the effluent flow is recycled through environmental enhancement to Moorhen Marsh. The unit costs values are relatively low both on a volume and nutrient load reduction basis (with the exception of Ammonia). The unit ammonia and TP load reduction values are higher than the other nutrients as the WWTP already reliably removes ammonia and TP. The relatively efficient flow and load reduction is attributed to the facilities already being in place, the additional treatment associated with the marsh being minor, and the marsh being located next to the WWTP (minimal distribution/pumping). For perspective, the optimization and upgrades study that evaluated nutrient load reduction across Bay Area WWTPs had a range of $2.0 - $8.7/lb TIN load reduced,[1] which is higher than $ <1/lb TIN load removed for Mt. View WWTP in this report (regardless of averaging period).

The timeline and corresponding load diversions from the Bay is provided in Figure ES – 1. The Mt. View WWTP projections suggest that the recycled water demands are relatively flat from now and into the future.

An overview of the drivers and barriers for implementing recycled water projects at Mt. View WWTP:

- Drivers for implementing recycled water projects:
  - Potential Nutrient Regulations: The District reuses 100% of discharge. New projects are not feasible unless mandated by regulation.
- Barriers for implementing recycled water projects:
  - Funding: the District facility is 100 years old and requires significant capital improvements to ensure continued efficient treatment. With a small rate base that includes disadvantaged communities, the District must focus expenditures on treatment

[1] Bay Area Clean Water Agencies (2018) Bay Area Clean Water Agencies Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream Treatment, Treatment Upgrades, and Other Means. Prepared by HDR. Oakland, CA.

facility improvements/updates. Attempts at securing grant funding have not been successful.

- Lack of Need: Considering that 100 percent of discharge is used for either environmental enhancement or internal uses, reuse of discharge is already in place, new recycled water projects are not prioritized.

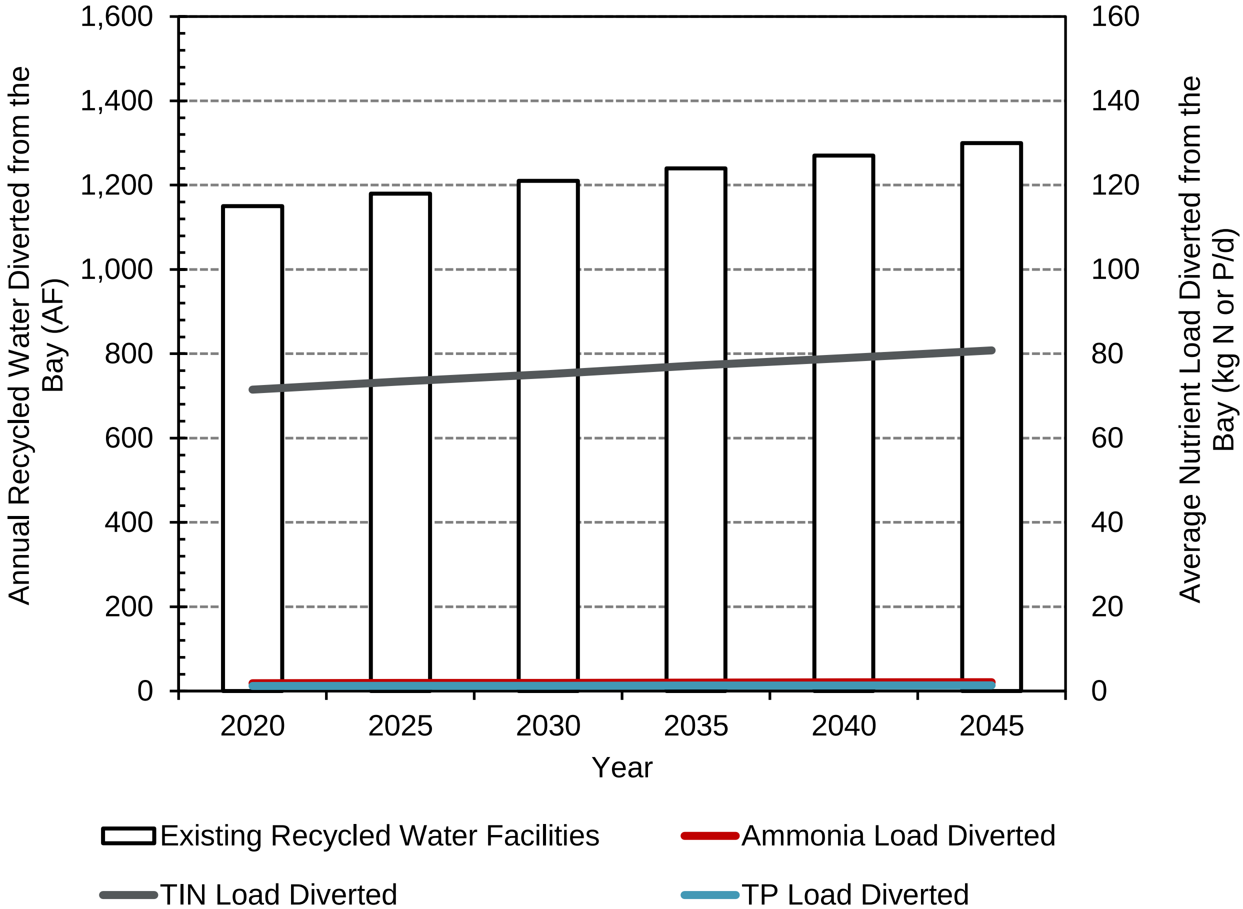

Figure ES – 1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge

Table ES – 1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (None Planned) *, **		Total (Includes Existing and Future Projects (None Planned) Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 – Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	1.0	1.1	--	--	1.0	1.1
Volume	AF	455	1,230	--	--	455	1,230
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	70%	70%	--	--	70%	70%
Ammonia Load Diverted	kg N/d	2	2	--	--	2	2
TIN Load Diverted	kg N/d	68	76	--	--	68	76
TP Load Diverted	kg P/d	1	1	--	--	1	1
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	0.2	0.5	--	--	0.2	0.5
NPV Total (Capital+NPV O&M)	$ Mil	0.2	0.5	--	--	0.2	0.5
Unit Flow Cost[6]							
Unit Cost	$/gpd	0.2	0.4	--	--	0.2	0.4
Unit Cost	$/AF	15	15	--	--	15	15
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	11	12	--	--	11	12
TIN Unit Cost	$/lb TIN Diverted	0.3	0.3	--	--	0.3	0.3
TP Unit Cost	$/lb TP Diverted	17	18	--	--	17	18

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3). For the Total columns, the project start period is from year 2020 through year 2045.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by Mt. View WWTP in 2021 dollars.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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1 Introduction and Current Conditions

Mt. View Sanitary District Wastewater Treatment Plant (Mt. View WWTP) services a population of about 21,900, which includes unincorporated areas of Martinez and portions of the City of Martinez. It is located at 3800 Arthur Road, Martinez, CA. The plant has an average dry weather flow (ADWF) permitted capacity of 3.2 million gallons per day (mgd) and a peak permitted wet weather flow of 10.9 mgd.

The subsections that follow provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

Mt. View WWTP holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2021-0026; CA0037770). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2021-0026; CA0037770)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	3.2	--	--	--
Effluent BOD (1)	mg/L	--	15	25	--
Effluent TSS (1)	mg/L	--	15	25	--
Effluent Total Ammonia	mg N/L	--	1.1	--	3.2

1. BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 shows the process flow diagram for the Mt. View WWTP. Both liquids processes and solids processes are shown. The Mt. View WWTP consists of pretreatment, primary clarification, trickling filter, biotower nitrification, secondary clarification, filtration, and UV disinfection. Solids treatment consists of sludge thickening, anaerobic digestion, centrifuge dewatering and drying beds.

1.3 Existing Recycled Water Service

The Mt. View WWTP has an existing recycled water program that is employed year-round. All of the effluent flow is used for either environmental enhancement and internal uses. The recycled water sustains a 20-acre constructed marsh for wastewater treatment, Moorhen marsh, which also provides high quality wildlife habitat for indigenous and migrating birds and animal species. This existing program has the effect of reducing nutrients discharged to the Bay. The Mt. View WWTP currently recycles approximately 1,150 acre-feet per year (375 million gallons per year) and they are planning to increase recycling to 1,300 acre-feet per year (400 million gallons per year) by 2045.

1.4 Existing Discharge Flows and Loads to the Bay.

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	1.4	1.7	1.6
Volume	AF	650	1,105	1,755
Ammonia	kg N/d	3.6	3.7	3.7
Total Inorganic Nitrogen (TIN)	kg N/d	125	155	142
Total Phosphorus (TP)	kg P/d	13	15	14
Ammonia	mg N/L	0.66	0.52	0.58
TIN	mg N/L	23.9	24.9	24.5
TP	mg P/L	2.55	2.59	2.58

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

Note: Moorhen Marsh provides additional treatment. It is anticipated that the marsh provides upwards of 77 and 17 percent load reduction for TIN and TP. Such reductions were assumed in this analysis.

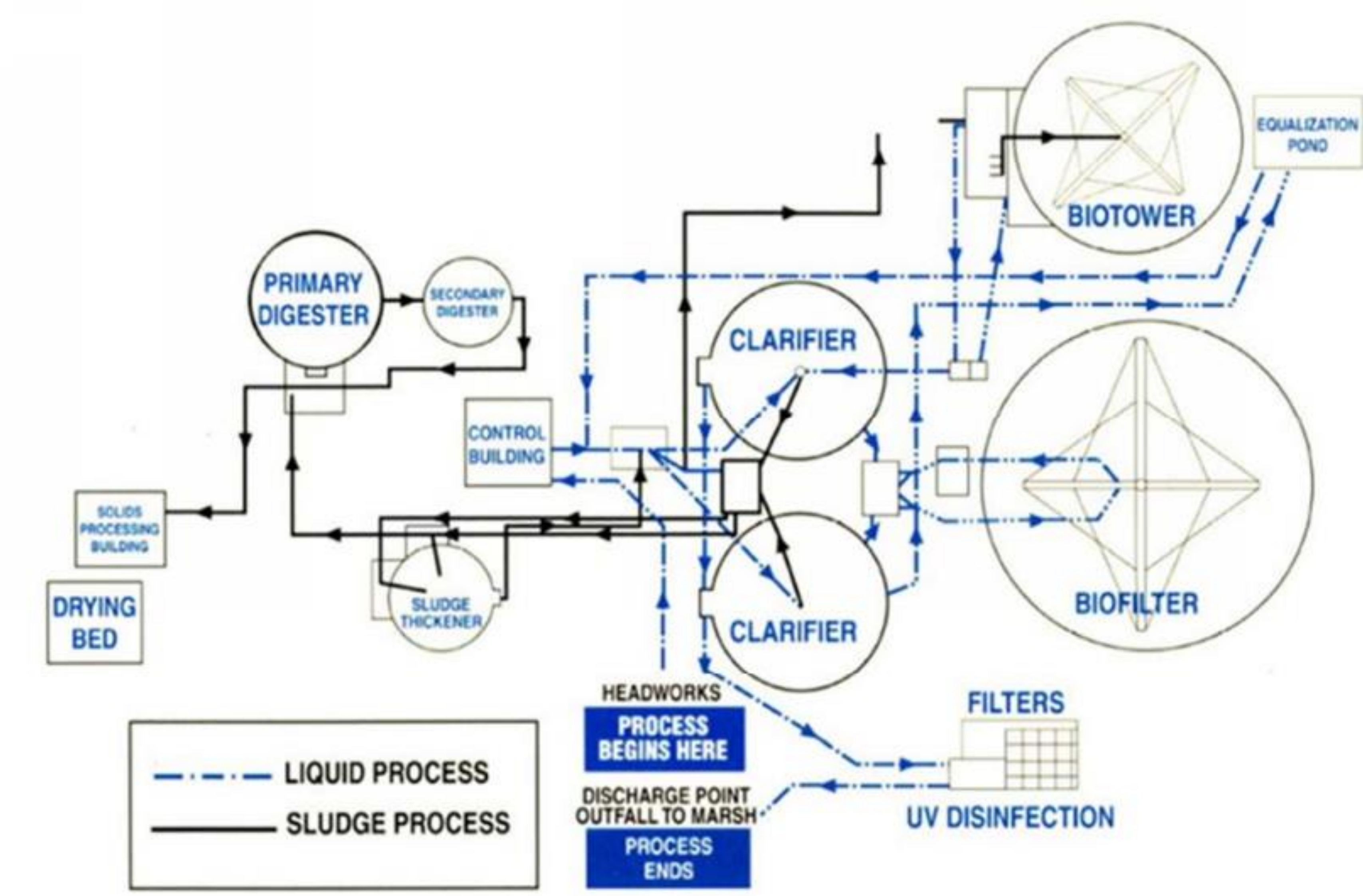

Figure 1-1. Process Flow Diagram for Mt. View WWTP (Source: NPDES Permit R2-2021-0026; CA0037770)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2020 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
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Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
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* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with Mt. View WWTP and Engineer's best judgment that considered known project constraints, existing Mt. View WWTP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by Mt. View WWTP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[2] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[2] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects. The subsections that follow summarize the flow and nutrient load reductions for each listed project in Table 3-1.

Table 3-1. Recycled Water Projects Identified by Mt. View WWTP

Recycled Water Project	Description
Existing Recycled Water Facilities	The Mt. View WWTP has an existing recycled water program that is employed year-round. All of the effluent flow is used for either environmental enhancement and internal uses. The recycled water sustains a 20-acre constructed marsh for wastewater treatment, Moorhen marsh, which also provides high quality wildlife habitat for indigenous and migrating birds and animal species. This existing program has the effect of reducing nutrients discharged to the Bay. The Mt. View WWTP currently recycles approximately 1,150 acre-feet per year (375 million gallons per year) and they are planning to increase recycling to 1,300 acre-feet per year (400 million gallons per year) by 2045.
Future Project(s)	None Planned

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. All of the effluent flow is used for either environmental enhancement and internal uses. The marsh provides supplemental treatment as evidenced anecdotally while comparing effluent nutrient levels versus those leaving the marsh.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Distributed – Return Flows (AFY)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**1**	**1,150**	**2**	**72**	**1**
	Existing Facilities	1	1150	2	72	1
	Other Projects**	--	--	--	--	--
2025	**Total**	**1**	**1,180**	**2**	**73**	**1**
	Existing Facilities	1	1,180	2	73	1
	Other Projects**	--	--	--	--	--
2030	**Total**	**1**	**1,210**	**2**	**75**	**1**
	Existing Facilities	1	1,210	2	75	1
	Other Projects**	--	--	--	--	--
2035	**Total**	**1**	**1,240**	**2**	**77**	**1**
	Existing Facilities	1	1,240	2	77	1
	Other Projects**	--	--	--	--	--
2040	**Total**	**1**	**1,270**	**2**	**79**	**1**
	Existing Facilities	1	1,270	2	79	1
	Other Projects**	--	--	--	--	--
2045	Total	**1**	**1,300**	**2**	**81**	**1**
	Existing Facilities	1	1,300	2	81	1
	Other Projects**	--	--	--	--	--

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

** Other Projects: none planned

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. The current and projections are relatively flat at approximately 1,150 to 1,300 AFY with all the reuse going to environmental enhancement at Moorhen Marsh and internal use. The internal use water eventually ends up in Moorhen Marsh for environmental enhancement.

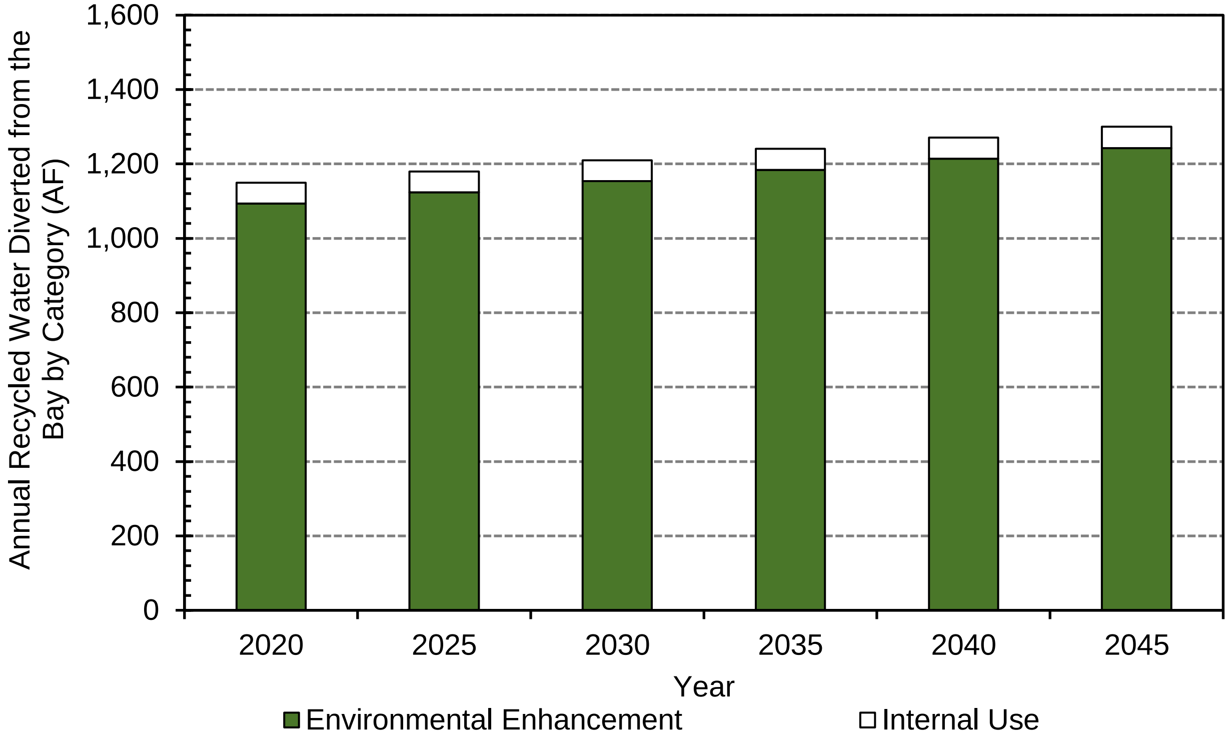

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. The key ancillary benefits are the facilities are already in place and operator familiarity. The primary adverse impact is the recycled water facility is already nearing production capacity.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities	• All the effluent flow is conveyed to Moorhen Marsh for environmental enhancement. • Facilities are already in place and provide recycled water and in turn reduce water supply demands. • Operator familiarity with existing recycled water facilities. • Existing facilities reliably meet recycled water treatment requirements. • Additional treatment associated with environmental enhancement (emphasis on contaminants of emerging concern)	• Limited portfolio diversity of recycled water applications (environmental enhancement and internal use).
Future Project(s)	None Planned	None Planned

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project is provided in Table 3-4. All of the effluent flow is recycled through environmental enhancement to Moorhen Marsh. The unit costs values are relatively low both on a volume and nutrient load reduction basis (with the exception of Ammonia). The unit ammonia load reduction values are higher than the other nutrients as the WWTP already reliably removes ammonia. The relatively efficient flow and load reduction is attributed to the facilities already being in place, the additional treatment associated with the marsh being minor, and the marsh being located next to the WWTP (minimal distribution/pumping). For perspective, the optimization and upgrades study that evaluated nutrient load reduction across Bay Area WWTPs had a range of $2.0 - $8.7/lb TIN load reduced,[3] which is higher than $ <1/lb TIN load removed for Mt. View WWTP in this report (regardless of averaging period).

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. The Mt. View WWTP projections suggest that the recycled water demands are relatively flat from now and into the future.

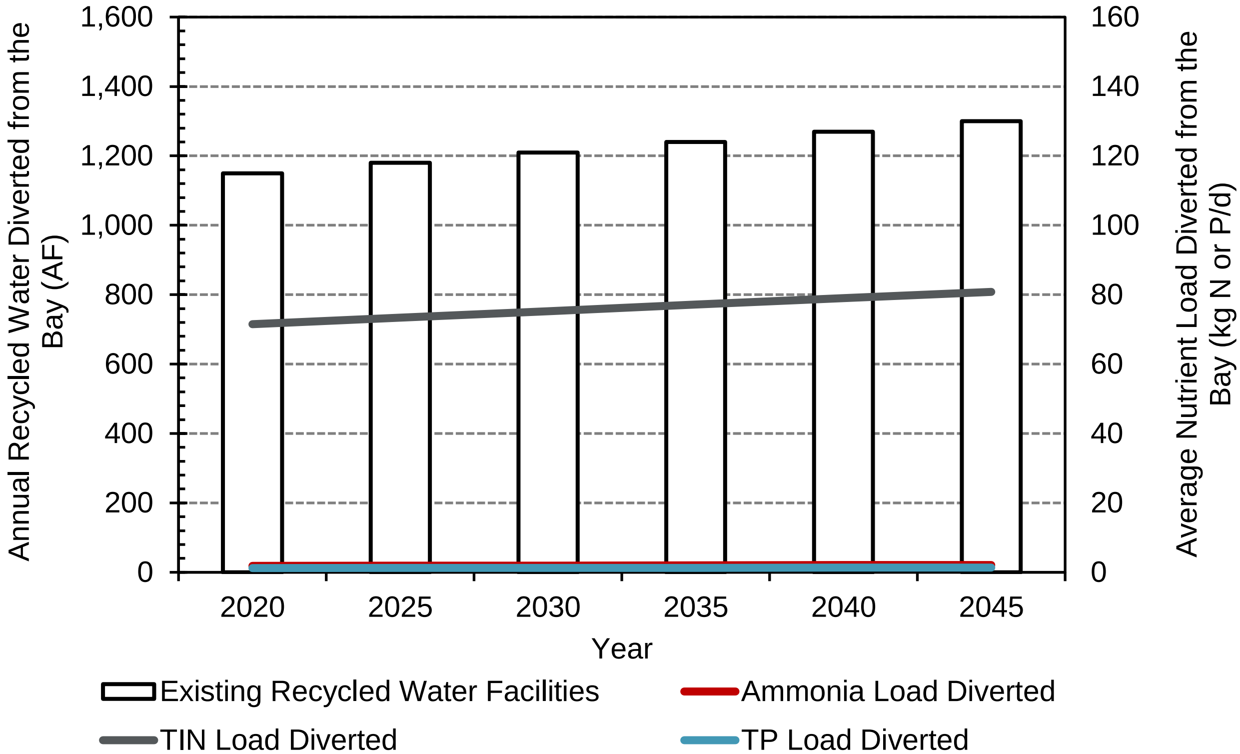

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge

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[3] Bay Area Clean Water Agencies (2018) Bay Area Clean Water Agencies Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream Treatment, Treatment Upgrades, and Other Means. Prepared by HDR. Oakland, CA.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (None Planned) *, **		Total (Includes Existing and Future Projects (None Planned) Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	1.0	1.1	--	--	1.0	1.1
Volume	AF	455	1,230	--	--	455	1,230
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	70%	70%	--	--	70%	70%
Ammonia Load Diverted	kg N/d	2	2	--	--	2	2
TIN Load Diverted	kg N/d	68	76	--	--	68	76
TP Load Diverted	kg P/d	1	1	--	--	1	1
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	0.2	0.5	--	--	0.2	0.5
NPV Total (Capital+NPV O&M)	$ Mil	0.2	0.5	--	--	0.2	0.5
Unit Flow Cost[6]							
Unit Cost	$/gpd	0.2	0.4	--	--	0.2	0.4
Unit Cost	$/AF	15	15	--	--	15	15
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	11	12	--	--	11	12
TIN Unit Cost	$/lb TIN Diverted	0.3	0.3	--	--	0.3	0.3
TP Unit Cost	$/lb TP Diverted	17	18	--	--	17	18

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045). For the Total columns, the project start period is from year 2020 through year 2045.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by Mt. View WWTP in 2021 dollars.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at Mt. View WWTP:

- Drivers for implementing recycled water projects:
  - Potential Nutrient Regulations: The District reuses 100% of discharge. New projects are not feasible unless mandated by regulation.
- Barriers for implementing recycled water projects:
  - Funding: the District facility is 100 years old and requires significant capital improvements to ensure continued efficient treatment. With a small rate base that includes disadvantaged communities, the District must focus expenditures on treatment facility improvements/updates. Attempts at securing grant funding have not been successful.
  - Lack of Need: Considering that 100 percent of discharge is used for either environmental enhancement or internal uses, reuse of discharge is already in place, new recycled water projects are not prioritized.

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Napa Sanitation District Soscol Water Recycling Facility

BACWA Recycled Water Study

Final Individual Plant Report

Napa, CA

May 19, 2023

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Contents

Tables

Figures

Executive Summary

Napa Sanitation District owns and operates the Soscol Water Recycling Facility (Napa San WRF) located in Napa, CA and discharges treated effluent to the Napa River (part of the San Pablo Bay watershed). The plant has an average dry weather flow (ADWF) permitted capacity of 15.4 million gallons per day (mgd).

Napa San has an existing recycled water program that is employed mainly in the dry season (May through October) due to Bay discharge prohibitions from July 1 through September 30; there are some year-round demands as well. This existing program has the effect of reducing nutrients discharged to the Bay. The WWTP currently recycles approximately 3,300 acre-feet per year (AFY) (1,075 million gallons per year) and has the infrastructure in place to deliver up to 3,700 AFY (1,205 million gallons per year).

To meet the 3,400 AF irrigation season capacity, Napa San is anticipating development within the infill areas along the existing distribution system and connections of users in the Milliken-Sarco-Tulucay (MST) and Los Carneros Water District (LCWD) areas. There are no plans to further expand the existing non-potable recycled water program beyond the 3,400 AF irrigation season capacity.

Besides non-potable recycled water, Napa San is developing a conceptual 600 AFY direct potable reuse (DPR) project in partnership with the City of Napa Water Division. The DPR project is anticipated to be operational sometime between year 2040 and 2045 and included in this report.

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES-1. The unit nutrient removal costs (e.g., $/lb ammonia removed) are relatively high as Napa San WRF already removes ammonia/TIN loads as part of their existing process. The timeline and corresponding load diversions from the Bay is provided in Figure ES-1.

An overview of the drivers and barriers for implementing recycled water projects at Napa San WRF:

- Drivers for implementing recycled water projects:
    - Enhance and improve water supply resiliency.
- Barriers for implementing recycled water projects:
    - Infrastructure: Napa San has infrastructure in place to deliver up to 3,400 AF during the irrigation season. Additional customer demand during the non-irrigation season is required to increase that number. Non-irrigation season demand is irrigation during dry periods in the winter and/or filling of privately owned reservoirs during the winter for summer irrigation use.
    - Funding: Napa San is waiting for customers adjacent to constructed distribution pipelines to convert irrigation systems and connect to the recycled water system.
    - Regulations: The uncertain DPR regulations (slated for year 2023) might influence the decision to move forward with a DPR project.

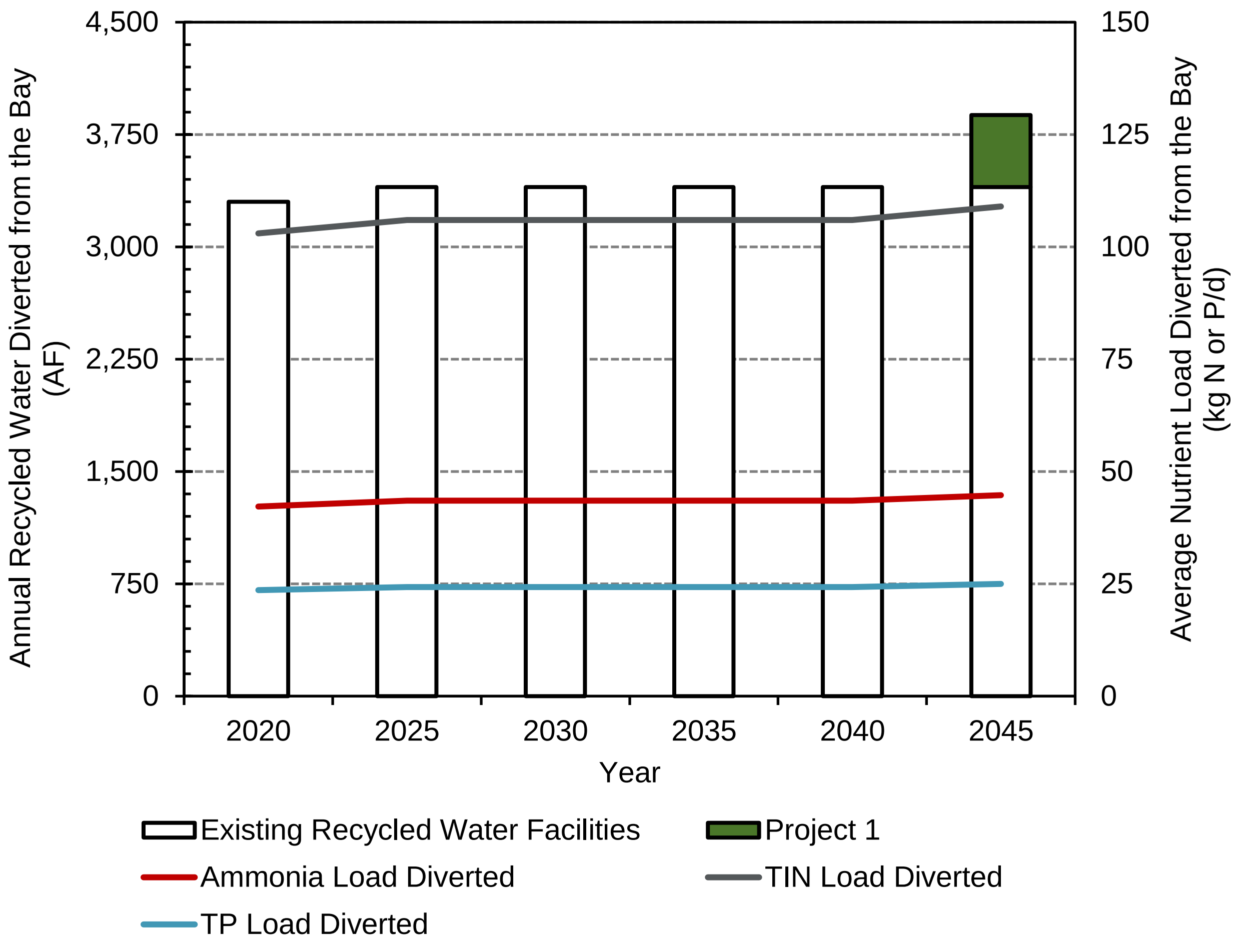

Figure ES-1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge

Note 1: the existing annual recycle water demands are approximately 3,300 AF annually.

Note 2: Napa San WRF has a Bay discharge prohibition from July 1 through September 30 unless i) facility inflow will exceed the influent storage capacity and facility effluent flow exceed the recycled water distribution and storage system capacity; and ii) the discharge meets the listed limits.

Table ES-1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (Direct Potable Reuse Starting in Year 2045) *, **		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 - Sept 30)***	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)***	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)***	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	6.6	3.0	0.4	0.4	6.6	3.1
Volume	AF	3,080	3,380	200	480	3,120	3,460
Load Diverted from the Bay[2,3]							
Confidence	unitless	2	2	3	3	Blend of 2 and 3	Blend of 2 and 3
Duration	Years	25	25	5	5	25	25
Flow Diverted	%	100%	30%	100%	6%	100%	31%
Ammonia Load Diverted	kg N/d	94	43	1	1	94	44
TIN Load Diverted	kg N/d	228	105	3	3	228	106
TP Load Diverted	kg P/d	52	24	1	1	52	24
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	5.0	5.0	5.0	5.0
NPV O&M	$ Mil	13.6	15.0	1.0	2.4	14.6	17.3
NPV Total (Capital+NPV O&M)	$ Mil	13.6	15.0	6.0	7.4	19.6	22.3
Unit Flow Cost[6]							
Unit Cost	$/gpd	2.1	5.0	14	17	3.0	7.2
Unit Cost	$/AF	177	177	5,980	3,070	252	258
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	17	17	2,920	1,490	25	26
TIN Unit Cost	$/lb TIN Diverted	7.1	7.1	1,200	612	10	11
TP Unit Cost	$/lb TP Diverted	31	31	5,230	2,660	44	46

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3). For the Total columns, the project start period is from year 2020 through year 2045.

*** Napa San WRF has a Bay discharge prohibition from July 1 through September 30 unless i) facility inflow will exceed the influent storage capacity and facility effluent flow exceed the recycled water distribution and storage system capacity; and ii) the discharge meets the listed limits.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by Napa in 2021 dollars.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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1 Introduction and Current Conditions

Napa Sanitation District owns and operates the Soscol Water Recycling Facility (Napa WRF) located in Napa, CA and discharges treated effluent to the Napa River (part of the San Pablo Bay watershed). The plant has an average dry weather flow (ADWF) permitted capacity of 15.4 million gallons per day (mgd).

The subsections that follow provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

The Napa WRF holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2022-0003). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2022-0003; CA0037575)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	15.4	--	--	--
Effluent BOD (1)	mg/L	--	30[a] 10[b]	45[a] 20[b]	--
Effluent TSS (1)	mg/L	--	30[a] 20[b]	45[a] 30[b]	--
Effluent Ammonia	mg N/L	--	15[a,b]	--	48[a,b]

1. BOD and TSS include a minimum percent removal of 85% through the WWTP.
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

a Limits for October 1 through June 30

b Bay discharge is prohibited from July 1 through September 30 unless i) facility inflow will exceed the influent storage capacity and facility effluent flow exceed the recycled water distribution and storage system capacity; and ii) the discharge meets the listed limits.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;
- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for Napa. Both liquids processes and solids processes are shown.

The Napa WRF consists of screening and grit removal, primary clarification, followed by a split secondary treatment system. A step-feed BNR activated sludge process including anoxic zones removes nitrogen from a portion of the flow, followed by secondary clarifiers. Caustic is added to the step-feed BNR to provide alkalinity for nitrification. Primary effluent not treated in the step-feed BNR is routed to facultative ponds, which also provide seasonal storage. Nutrient removal through the facultative ponds varies through the year, with high pond effluent ammonia concentrations possible during the winter season. Water returned from the facultative ponds is treated if needed with coagulant and polymer before either a DAF clarifier or a flocculating clarifier. Secondary effluent is combined and chlorinated before discharge. Continuous backwash upflow filters followed by chlorination are used for Title 22 unrestricted reuse.

Solids treatment consists of secondary sludge thickening, anaerobic digestion and dewatering.

1.3 Existing Recycled Water Service

Napa has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The WWTP currently recycles approximately 3,300 acre-feet per year (1,075 million gallons per year), but has the infrastructure in place to deliver up to 3,700 AFY (1,205 million gallons per year). There are no plans to further expand the existing non-potable recycled water program.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)[1]	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	0	12.00	6.97
Volume	AF	0	7,778	7,778
Ammonia	kg N/d	0	171	99.8
Total Inorganic Nitrogen (TIN)	kg N/d	0	416	243
Total Phosphorus (TP)	kg P/d	0	95.6	55.8
Ammonia	mg N/L	0	3.47	3.47
TIN	mg N/L	0	9.40	9.40
TP	mg P/L	0	2.00	2.00

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

1 Napa San WRF does not discharge to the Bay during the listed dry season.

Figure C-1: Operation During River Discharge (Process flows are only illustrative of typical operations.)

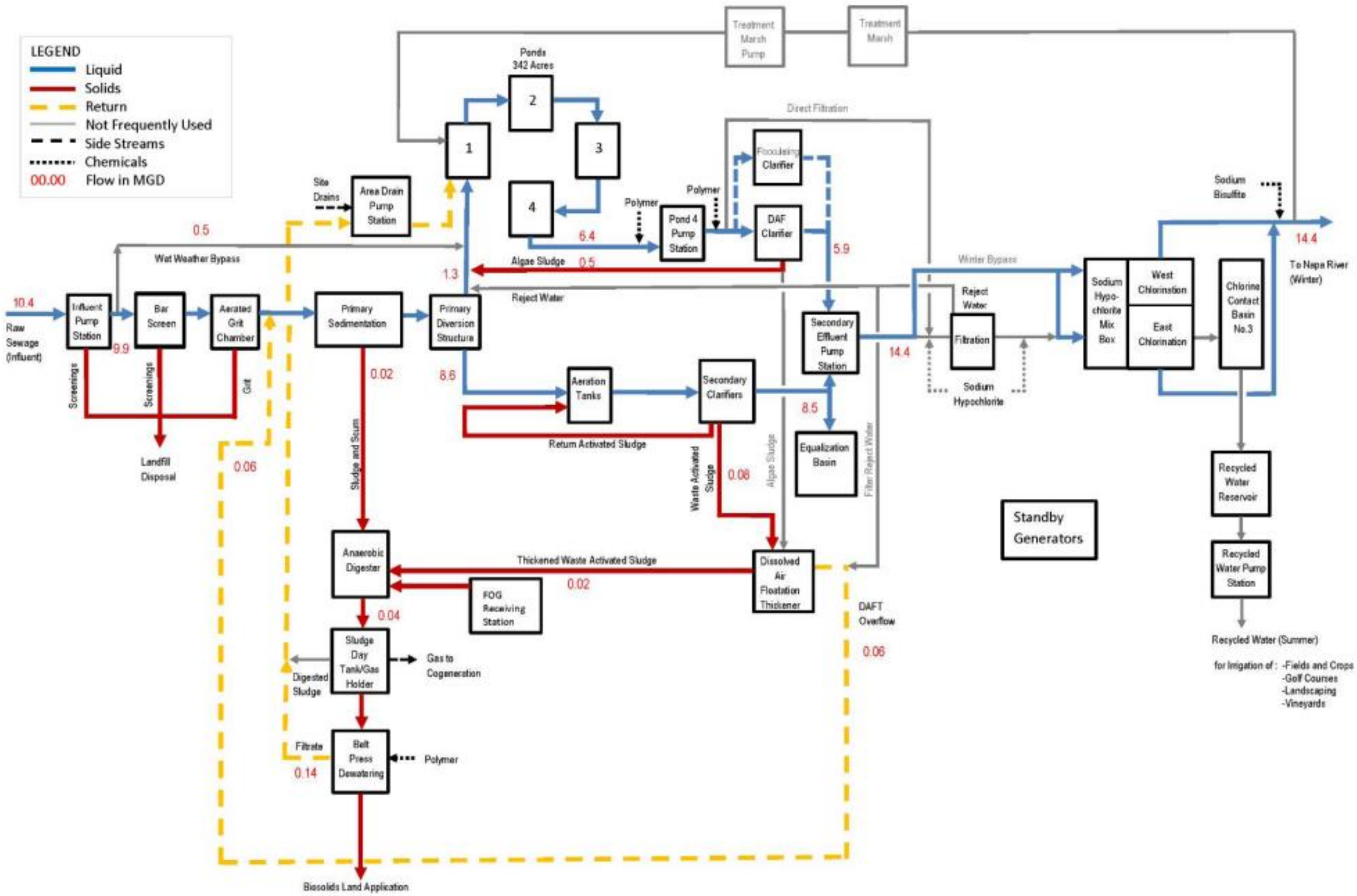

Figure 1-1. Process Flow Diagram for Napa San WRF (Order No. R2-2022-0003; CA0037575)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2020 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with Napa San WRF and Engineer's best judgment that considered known project constraints, existing Napa San WRF reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by Napa San WRF. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g. existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g. a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects.

Table 3-1. Recycled Water Projects Identified by Napa San

Recycled Water Projects	Description
Existing Recycled Water Facilities	The Napa San WRF tertiary facilities include sand filtration and chlorine disinfection to meet total coliform, disinfection, and turbidity limits prior to distribution. The recycled water customers include a blend of golf course irrigation, landscape irrigation, agriculture, and internal uses. Napa San expects further expansion of demand to meet their 3,400 AF irrigation season supply through additional irrigation connections within the infill areas along the existing distribution system and connections of users in the Milliken-Sarco-Tulucay (MST) and Los Carneros Water District (LCWD) areas
Future Project: Direct Potable Reuse	A conceptual 600 AFY direct potable reuse (DPR) project is currently being developed as part of a partnership with the City of Napa Water Division. It is important to note that the advanced treatment train will include a brine reject stream laden with nutrients. The existing Napa San WWTP already removes nutrients and a large portion of those returned will be subsequently treated at the WWTP.

The following subsections summarize the flow and nutrient load reductions for each listed project in Table 3-1.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. Recycled water deliveries via existing facilities will increase and meet Napa San's irrigation season supply of 3,400 AF by 2040. Once ultimate capacity is met, Napa San has conceptualized a DPR project sometime between 2040 and 2045 that will annually deliver 600 AF.

Figure 3-1 presents a distribution of the recycled water volumes diverted from the Bay by use categories from 2020 through 2045. Current and future recycled water uses via existing facilities include golf course, landscape, and agricultural irrigation. The DPR option will require new advanced facilities and it will potentially come online sometime between 2040 and 2045.

In general, the recycled water demands peak in the dry season during Napa San's Bay discharge prohibition (July 1 through September 30), but there are year-round demands.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Distributed – Return Flows (AFY)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**1**	**3,300**	**42**	**103**	**24**
	Existing Facilities	1	3,300	42	103	24
	Other Projects**	--	--	--	--	--
2025	**Total**	**2**	**3,400**	**44**	**106**	**24**
	Existing Facilities	2	3,400	44	106	24
	Other Projects**	--	--	--	--	--
2030	**Total**	**2**	**3,400**	**44**	**106**	**24**
	Existing Facilities	2	3,400	44	106	24
	Other Projects**	--	--	--	--	--
2035	**Total**	**2**	**3,400**	**44**	**106**	**24**
	Existing Facilities	2	3,400	44	106	24
	Other Projects**	--	--	--	--	--
2040	**Total**	**2**	**3,400**	**44**	**106**	**24**
	Existing Facilities	2	3,400	44	106	24
	Other Projects**	--	--	--	--	--
2045	**Total**	**Blend of 2 and 3**	**3,880**	**45**	**109**	**25**
	Existing Facilities	2	3,400	44	106	24
	Other Projects**	3	480	1	3	1

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

** Other Projects = a new direct potable reuse project that would potentially begin in year 2045.

Note 1: the existing annual recycle water demands are approximately 3,300 AF annually.

Note 2: Napa San WRF has a Bay discharge prohibition from July 1 through September 30 unless i) facility inflow will exceed the influent storage capacity and facility effluent flow exceed the recycled water distribution and storage system capacity; and ii) the discharge meets the listed limits.

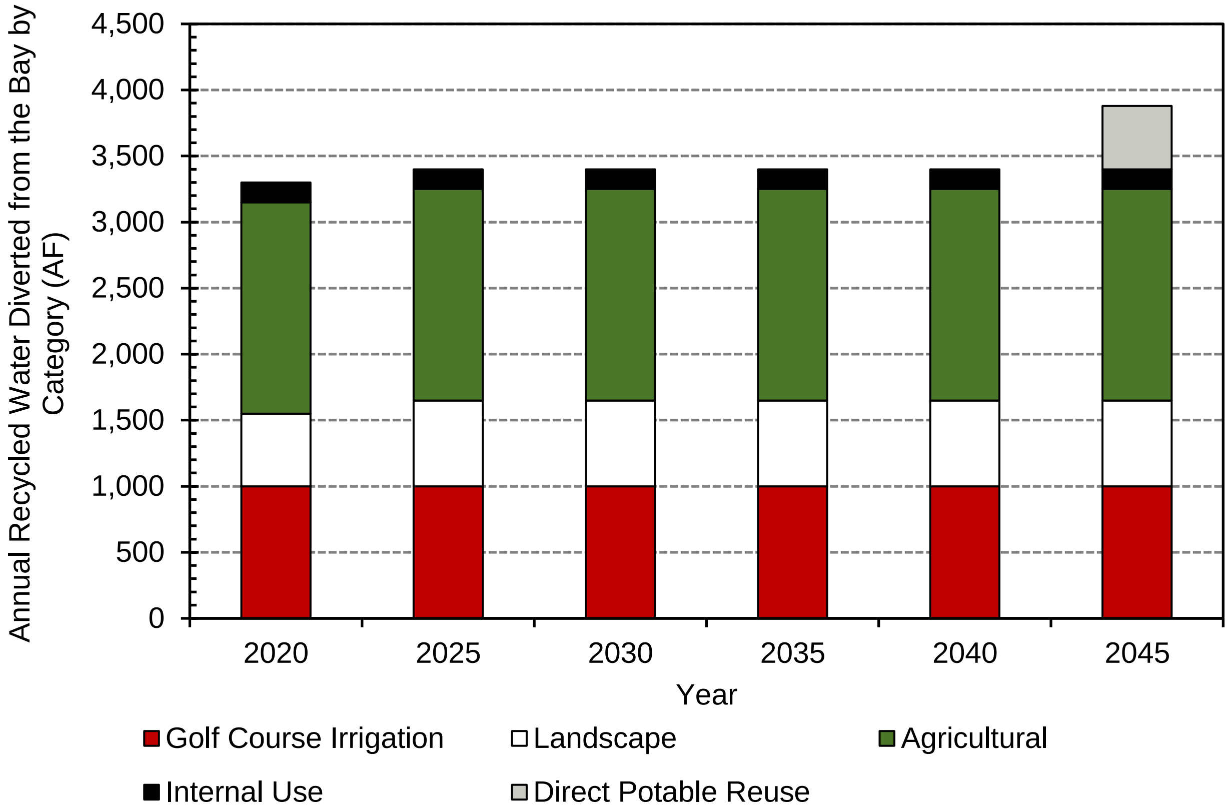

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

Note 1: the golf course irrigation, landscape irrigation, and agricultural are based on the existing system. The direct potable reuse is based on a new project that would potentially begin in year 2045.

Note 2: the existing annual recycle water demands are approximately 3,300 AF annually.

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. The existing facilities are already paid for and in place. A conceptual 600 AFY DPR project is planned between 2040 and 2045.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities	• Facilities are already in place and provide recycled water and in turn reduce water supply demands. • Operator familiarity with existing recycled water facilities. • Existing facilities reliably meet recycled water treatment requirements. • Diverse portfolio of recycled water customers.	• Ability to deliver full capacity of 3,400 AFY during the irrigation season
Project 1 (600 AFY DPR slated for sometime between year 2040 and 2045)	• Increased water supply reliability and independence from imported water. • Drought resiliency. • Consistent demand/usage throughout the year. • Enhanced treatment, such as additional removal of contaminants of emerging concern.	• Portion of nutrient loads returned to the WRF/Bay as part of advanced treatment process train (specifically brine reject) • Energy and chemical intensive process to provide advanced treatment • Additional operators to maintain and operate the advanced treatment system. Furthermore, it might require a new operator grade.

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. It was assumed that the 600 AFY DPR Project will require a RO process step, which will produce a brine reject (concentrate stream), typically discharged to the Bay. For the RO process in Project 1, it was assumed that 20% of the feed flow and 20% of the nutrients would be returned to the Bay as brine. The basis for the latter is that any nutrients returned to Napa San WRF would be treated for nutrient removal (plant already removes ammonia/TIN/TP loads).

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. The recycled water volumes through existing facilities are anticipated to increase incrementally through 2040 as infill areas are developed and new customers are connected. The conceptual 600 AFY DPR project is anticipated to be online between 2040 and 2045 with minimal increased flow and nutrient diversions based on anticipated brine discharge.

The unit cost for water production (i.e., $/AF or $/gpd) are modest for the existing system but increase exponential for DPR. The increase is attributed to the new advanced treatment facilities to construct and operate. Furthermore, the nutrient removal unit costs (e.g., $/lb ammonia removed) are relatively high as the Napa San WRF already removes a portion of the ammonia, TIN, and TP loads. As a result, the unit cost for additional removal is higher than plants with little or no nutrient removal since the nutrient removal loads are in the calculation denominator.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (Direct Potable Reuse Starting in Year 2045) *, **		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 - Sept 30)***	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)***	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)***	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	6.6	3.0	0.4	0.4	6.6	3.1
Volume	AF	3,080	3,380	200	480	3,120	3,460
Load Diverted from the Bay[2,3]							
Confidence	unitless	2	2	3	3	Blend of 2 and 3	Blend of 2 and 3
Duration	Years	25	25	5	5	25	25
Flow Diverted	%	100%	30%	100%	6%	100%	31%
Ammonia Load Diverted	kg N/d	94	43	1	1	94	44
TIN Load Diverted	kg N/d	228	105	3	3	228	106
TP Load Diverted	kg P/d	52	24	1	1	52	24
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	5.0	5.0	5.0	5.0
NPV O&M	$ Mil	13.6	15.0	1.0	2.4	14.6	17.3
NPV Total (Capital+NPV O&M)	$ Mil	13.6	15.0	6.0	7.4	19.6	22.3
Unit Flow Cost[6]							
Unit Cost	$/gpd	2.1	5.0	14	17	3.0	7.2
Unit Cost	$/AF	177	177	5,980	3,070	252	258
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	17	17	2,920	1,490	25	26
TIN Unit Cost	$/lb TIN Diverted	7.1	7.1	1,200	612	10	11
TP Unit Cost	$/lb TP Diverted	31	31	5,230	2,660	44	46

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3). For the Total columns, the project start period is from year 2020 through year 2045.

*** Napa San WRF has a Bay discharge prohibition from July 1 through September 30 unless i) facility inflow will exceed the influent storage capacity and facility effluent flow exceed the recycled water distribution and storage system capacity; and ii) the discharge meets the listed limits.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by Napa in 2021 dollars
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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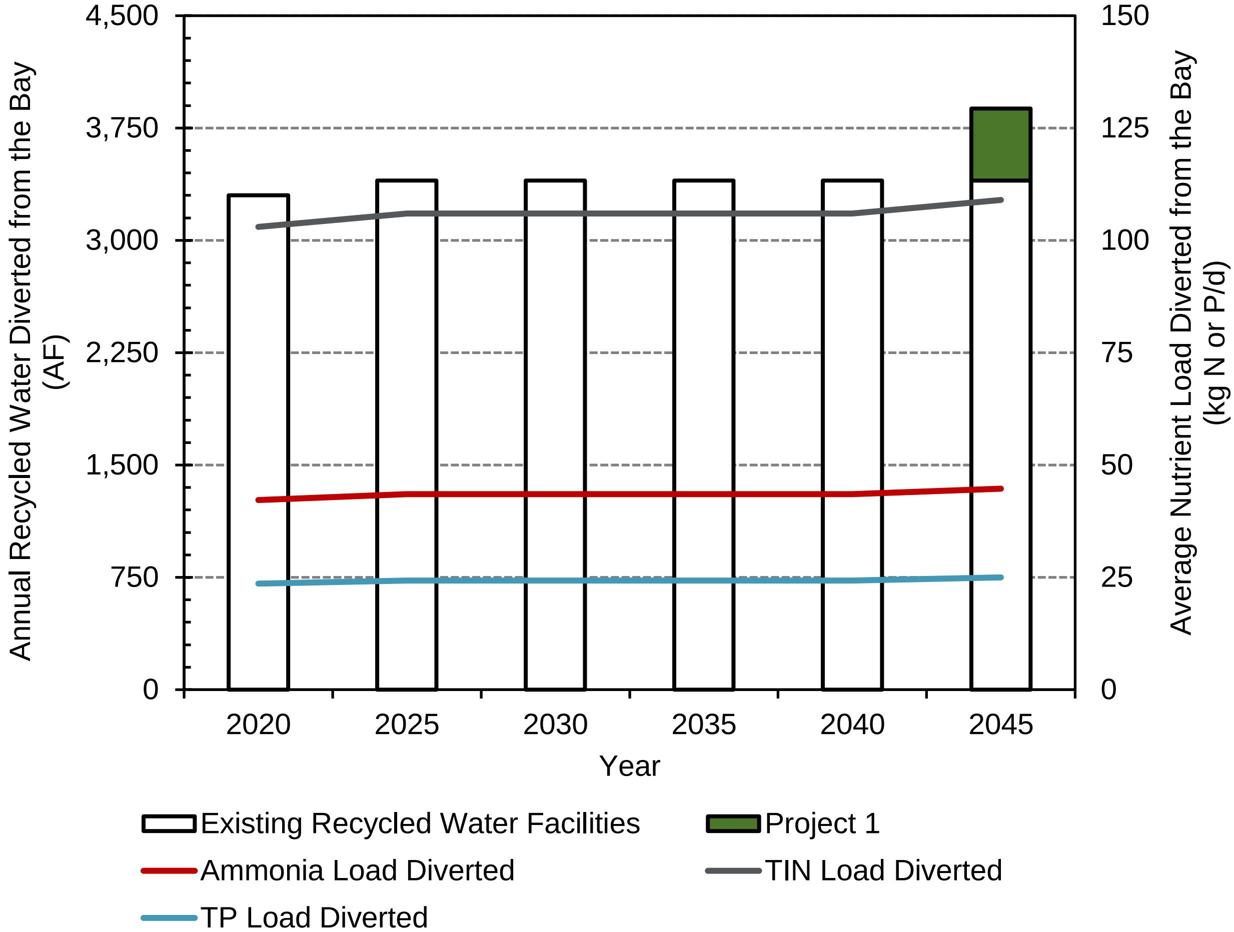

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge

Note 1: the existing annual recycle water demands are approximately 3,300 AF annually.

Note 2: Napa San WRF has a Bay discharge prohibition from July 1 through September 30 unless i) facility inflow will exceed the influent storage capacity and facility effluent flow exceed the recycled water distribution and storage system capacity; and ii) the discharge meets the listed limits.

3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at Napa San WRF:

- Drivers for implementing recycled water projects:
  - Enhance and improve water supply resiliency.
- Barriers for implementing recycled water projects:
  - Infrastructure: Napa San has infrastructure in place to deliver up to 3,400 AFY during the irrigation season. Additional customer demand is required to increase distribution from current levels to 3,400 AF.

- Funding: Napa San is waiting for customers adjacent to constructed distribution pipelines to convert irrigation systems and connect to the recycled water system.
- Regulations: The uncertain DPR regulations (slated for year 2023) might influence the decision to move forward with a DPR project.

Novato Sanitary District Wastewater Treatment Plant

BACWA Recycled Water Study

Final Individual Plant Report

Novato, CA

May 24, 2023

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Contents

Tables

Figures

Executive Summary

Novato Sanitary District (NSD) owns and operates the Novato Sanitary District Wastewater Treatment Plant (Novato WWTP) located in Novato, CA and discharges treated effluent to San Pablo Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 7 million gallons per day (mgd).

The Novato WWTP has an existing recycled water program that has the capability to be employed year-round. Production is typically suspended in the winter and starts up again after spring rains end. This existing program has the effect of reducing nutrients discharged to the Bay. The WWTP currently recycles approximately 1,480 acre-feet per year (420 million gallons per year). The current recycled water uses are diverse and include golf course irrigation, landscape irrigation, commercial, agricultural, and other non-potable uses. An additional 60 AFY is anticipated by year 2025 for golf course irrigation.

By year 2030, Novato WWTP plans to relocate its discharge location to support new brackish marsh habitat as part of the State Coastal Conservancy's Bel Marin Keys Unit V (BMKV) wetland restoration project as described in their NPDES Permit (R2-2020-0019; Fact Sheet section II.C.). The BMKV wetlands discharge project will annually increase recycled water use approximately 4,500 AF as environmental enhancement by year 2030. The annual recycled water will increase an additional 900 AFY in 2035 to the BMKV wetlands.

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES-1. The costs associated for producing recycled water with the current reuse projects, as well as the future BMKV wetlands for environmental enhancement is less than $750/AF (regardless of averaging period). The unit costs for removing nutrients by recycled water is relatively high for both ammonia and total phosphorus as NSD's WWTP already reliably removes both nutrients.

The timeline and corresponding load diversions from the Bay are provided in Figure ES-1. The decline at year 2030 for the existing recycled water system is attributed to no longer having agricultural use. Such volumes will be conveyed to the BMKV wetlands discharge project. As previously stated, it is anticipated that the nutrient loads diverted to the BMKV wetlands will be removed prior to eventual San Pablo Bay discharge.

An overview of the drivers and barriers for implementing recycled water projects at Novato WWTP:

- Drivers for implementing recycled water projects:
  - Partnership – the distributor of NSD's recycled water is North Marin Water District (NMWD). On-going and future reuse projects are dependent on NMWD's need to offset potable supply which appears to be supportive of such efforts.
  - Water supply need to reduce potable demand (dependent on NMWD).
- Barriers for implementing recycled water projects:
  - Funding for constructing any future recycled water projects
  - Jurisdictional as previously stated with the NMWD partnership.
  - Site constraints/available area

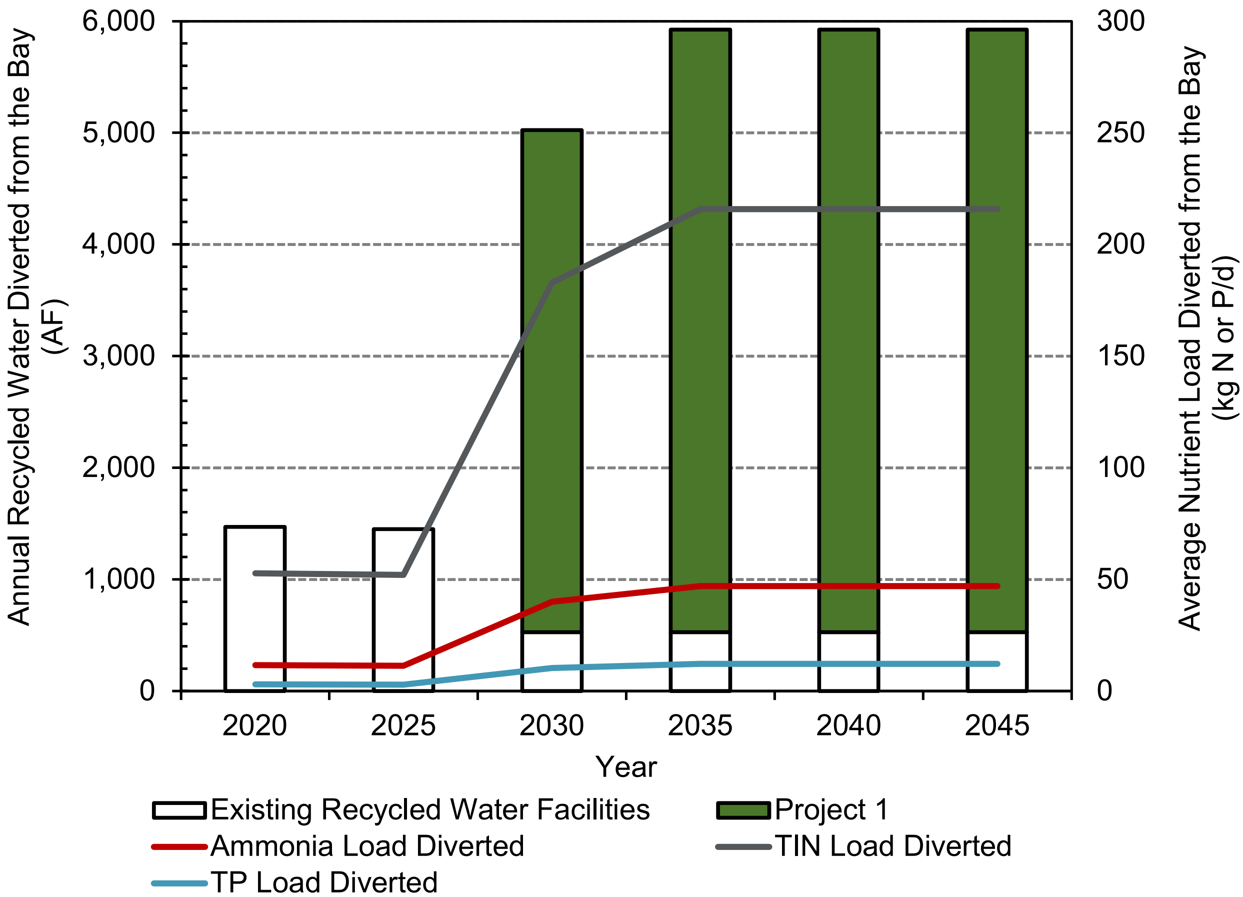

Figure ES-1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge

Note: Project 1 represents the BMKV wetlands discharge project. Once the BMKV wetlands are operational, approximately 1,000 AFY of recycled water that currently goes to agriculture (Permit No. WRR 92-065) will cease. This evaluation is based on the BMKV wetlands discharge project conservatively starting in year 2030 (date could be as early as year 2025).

Table ES-1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (BMKV Wetland Project Starting in Year 2030) *, **, ***		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	1.50	0.75	4.59	4.62	4.56	3.83
Volume	AF	705	837	2,160	5,180	2,140	4,290
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	2	2	Blend of 1 and 2	Blend of 1 and 2
Duration		25	25	15	15	25	25
Flow Diverted	%	46%	4%	72%	52%	72%	47%
Ammonia Load Diverted	kg N/d	12	7	35	41	33	31
TIN Load Diverted	kg N/d	67	30	206	189	191	143
TP Load Diverted	kg P/d	1	2	4	11	4	8
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	2.0	2.0	2.0	2.0
NPV O&M	$ Mil	12.9	15.3	9.0	21.6	21.9	36.9
NPV Total (Capital+NPV O&M)	$ Mil	12.9	15.3	11.0	23.6	23.9	38.9
Unit Flow Cost[6]							
Unit Cost	$/gpd	8.6	21	2.4	5.1	5.2	10.2
Unit Cost	$/AF	732	732	340	303	446	363
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	133	116	62	47	87	62
TIN Unit Cost	$/lb TIN Diverted	23	25	11	10	15	14
TP Unit Cost	$/lb TP Diverted	1,220	452	568	184	799	240

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3). For the Total columns, the project start period is from year 2020 through year 2045.

*** Project 1 represents the BMKV wetlands discharge project. Once the BMKV wetlands are operational, approximately 1,000 AFY of recycled water that currently goes to agriculture will cease. This evaluation is based on the BMKV wetlands discharge project conservatively starting in year 2030 (date could be as early as year 2025).

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by Novato WWTP.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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1 Introduction and Current Conditions

Novato Sanitary District owns and operates the Novato Sanitary District Wastewater Treatment Plant (Novato WWTP) located in Novato, CA and discharges treated effluent to San Pablo Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 7 million gallons per day (mgd).

The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

The Novato WWTP holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2020-0019; CA0037958). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2020-0019)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	7.0	--	--	--
Effluent BOD (1)	mg/L	--	15[a] 25[b]	30[a] 40[b]	--
Effluent TSS (1)	mg/L	--	10[a] 25[b]	20[a] 40[b]	--
Effluent Ammonia	mg N/L	--	5.9[a,b]	--	21[a,b]

1. BOD and TSS include a minimum percent removal of 85% through the WWTP.
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

a Limits for May 1 through October 31
b Limits for November 1 through April 30

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for the Novato WWTP. Both liquids processes and solids processes are shown. The Novato WTP consists of screening and grit removal, primary clarification, followed by a Modified Ludzack-Ettinger (MLE) activated sludge process including anoxic zones and mixed liquor recycle for secondary treatment. Contact stabilization mode is used when flow exceeds 20 to 24 mgd. The plant includes continuous backwash upflow filters (1.7 mgd firm capacity) and chlorination for Title 22 unrestricted reuse. Secondary effluent is disinfected by ultraviolet disinfection. Solids treatment consists of secondary sludge thickening, anaerobic digestion and sludge lagoons.

1.3 Existing Recycled Water Service

The Novato WWTP has an existing recycled water program that can be employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The WWTP currently recycles approximately 1,480 acre-feet per year (420 million gallons per year). The current recycled water uses are diverse and include golf course irrigation, landscape irrigation, commercial, agricultural, and other non-potable uses.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	1.79	6.06	4.28
Volume	AFY	839	3,942	4,781
Ammonia	kg N/d	13.7	55.5	38.1
Total Inorganic Nitrogen (TIN)	kg N/d	80.4	243.0	175.0
Total Phosphorus (TP)	kg P/d	1.5	15.8	9.8
Ammonia	mg N/L	1.81	1.86	1.84
TIN	mg N/L	12.3	10.7	11.2
TP	mg P/L	0.2	0.5	0.4

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

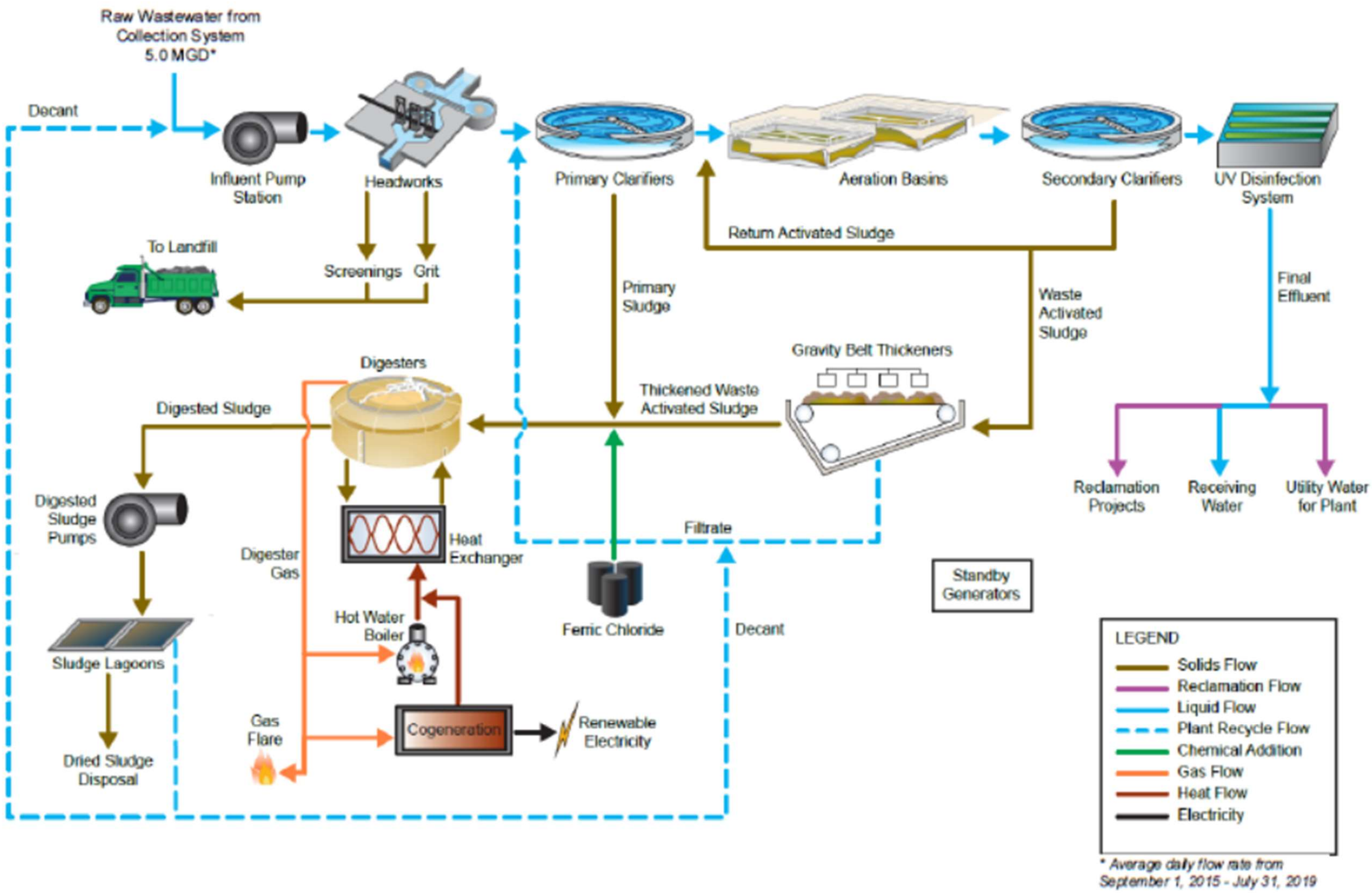

Figure 1-1. Process Flow Diagram for the Novato WWTP (Order No. R2-2020-0019)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial

Use Category*	Definition
	building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with NSD and Engineer's best judgment that considered known project constraints, existing NSD reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by NSD. Development of new cost estimates was not included as part of this study. Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN, or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g. existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g. a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects.

Table 3-1. Recycled Water Projects Identified by Novato Sanitary District

Recycled Water Project	Description
Existing Recycled Water Facilities	The Novato WWTP currently treats approximately 1,500 AFY. The users are diverse and include golf course irrigation, landscape irrigation, commercial, agricultural, and other non-potable uses. The majority of non-potable use is for the Wetlands Discharge Project (in construction) for “dust control, soil conditioning and compaction, and plant irrigation. An additional 60 AFY is anticipated by year 2025 for golf course irrigation.
BMKV Wetland Discharge Project	Novato WWTP plans to relocate its discharge location to support new brackish marsh habitat as part of the State Coastal Conservancy’s Bel Marin Keys Unit V (BMKV) wetland restoration project as described in their NPDES Permit (R2-2020-0019; Fact Sheet section II.C.). The BMKV wetlands discharge project will increase recycled water use approximately 4,500 AFY as environmental enhancement by year 2030. The annual recycled water will increase an additional 900 AFY in 2035 to the BMKV wetlands.

The following subsections summarize the flow and nutrient load reductions for each listed project in Table 3-1.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. Recycled water deliveries via existing facilities will reach a total of 1,450 AFY by 2025. The BMKV wetlands discharge project is planned for 2030 for an increase in 4,500 AFY. The implementation of BMKV wetlands around year 2030 will stop the existing recycled water volume for agricultural applications (typically 900 to 1,000 AF per year. The annual recycled water will increase an additional 900 AFY in 2035 to the BMKV wetlands.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. Current and future recycled water uses via existing facilities include golf course irrigation, landscape, agricultural, environmental enhancement, and other non-potable reuse. In general, the recycled water demands peak in the dry season during NSD’s Bay discharge prohibition, but there are year-round demands.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Distributed – Return Flows (AFY)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**1**	**1,470**	**12**	**53**	**3**
	Existing Facilities	1	1,470	12	53	3
	Other Projects**	2	0	0	0	0
2025	**Total**	**1**	**1,450**	**11**	**52**	**3**
	Existing Facilities	1	1,450	11	52	3
	Other Projects**	2	0	0	0	0
2030	**Total**	**Blend of 1 and 2**	**5,030**	**40**	**183**	**10**
	Existing Facilities	1	525	4	19	1
	Other Projects**	2	4,500	36	164	9
2035	**Total**	**Blend of 1 and 2**	**5,930**	**47**	**216**	**12**
	Existing Facilities	1	525	4	19	1
	Other Projects**	2	5,400	43	197	11
2040	**Total**	**Blend of 1 and 2**	**5,930**	**47**	**216**	**12**
	Existing Facilities	1	525	4	19	1
	Other Projects**	2	5,400	43	197	11
2045	**Total**	**Blend of 1 and 2**	**5,930**	**47**	**216**	**12**
	Existing Facilities	1	525	4	19	1
	Other Projects**	2	5,400	43	197	11

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

** Other Projects = Project 1 represents the BMKV wetlands discharge project. Once the BMKV wetlands are operational, approximately 1,000 AFY of recycled water that currently goes to agriculture will cease. This evaluation is based on the BMKV wetlands discharge project conservatively starting in year 2030 (date could be as early as year 2025).

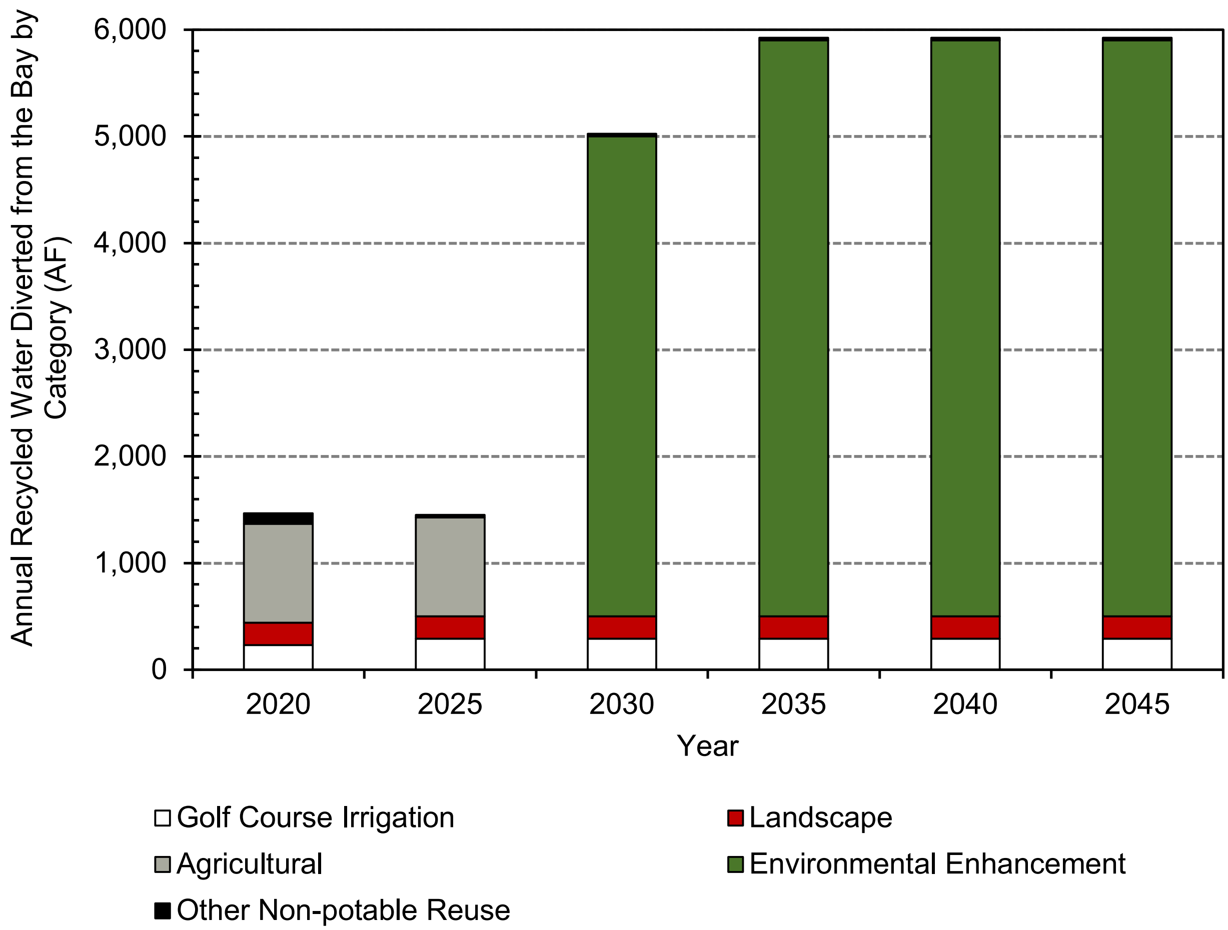

Figure 3-1: Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

Note: Environmental Enhancement represents the BMKV wetlands discharge project anticipated around year 2030 (date could be as early as year 2025). Once the BMKV wetlands are operational, approximately 900 to 1,000 AFY of recycled water that currently goes to agriculture will cease.

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. The existing facilities are already paid for and in place.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities	• Facilities are already in place and provide recycled water and in turn reduce water supply demands. • Operator familiarity with existing recycled water facilities. • Existing facilities reliably meet recycled water treatment requirements. • Diverse portfolio of recycled water customers.	• Jurisdictional challenges with expanding recycled water production due to NMWD partnership.
BMKV Wetland Discharge Project	• Environmental enhancement for the community. • Ability to accept larger volumes than existing recycled water customers. • Consistent demand/usage throughout the year. • Potential for enhanced treatment, such as additional removal of contaminants of emerging concern.	

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. The costs associated for producing recycled water with the current reuse projects, as well as the future BMKV wetlands for environmental enhancement is less than $750/AF (regardless of averaging period). The unit costs for removing nutrients by recycled water is relatively high for both ammonia and total phosphorus as NSD's WWTP already reliably removes both nutrients.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. The decline at year 2030 for the existing recycled water system is attributed to no longer having agricultural use. Such volumes will be conveyed to the BMKV wetlands discharge project. As previously stated, it is anticipated that the nutrient loads diverted to the BMKV wetlands will be removed prior to eventual San Pablo Bay discharge.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (BMKV Wetland Project Starting in Year 2030) *, **, ***		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	1.50	0.75	4.59	4.62	4.56	3.83
Volume	AF	705	837	2,160	5,180	2,140	4,290
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	2	2	Blend of 1 and 2	Blend of 1 and 2
Duration		25	25	15	15	25	25
Flow Diverted	%	46%	4%	72%	52%	72%	47%
Ammonia Load Diverted	kg N/d	12	7	35	41	33	31
TIN Load Diverted	kg N/d	67	30	206	189	191	143
TP Load Diverted	kg P/d	1	2	4	11	4	8
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	2.0	2.0	2.0	2.0
NPV O&M	$ Mil	12.9	15.3	9.0	21.6	21.9	36.9
NPV Total (Capital+NPV O&M)	$ Mil	12.9	15.3	11.0	23.6	23.9	38.9
Unit Flow Cost[6]							
Unit Cost	$/gpd	8.6	21	2.4	5.1	5.2	10.2
Unit Cost	$/AF	732	732	340	303	446	363
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	133	116	62	47	87	62
TIN Unit Cost	$/lb TIN Diverted	23	25	11	10	15	14
TP Unit Cost	$/lb TP Diverted	1,220	452	568	184	799	240

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3). For the Total columns, the project start period is from year 2020 through year 2045.

*** Project 1 represents the BMKV wetlands discharge project. Once the BMKV wetlands are operational, approximately 1,000 AFY of recycled water that currently goes to agriculture will cease. This evaluation is based on the BMKV wetlands discharge project conservatively starting in year 2030 (date could be as early as year 2025).

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by Novato WWTP.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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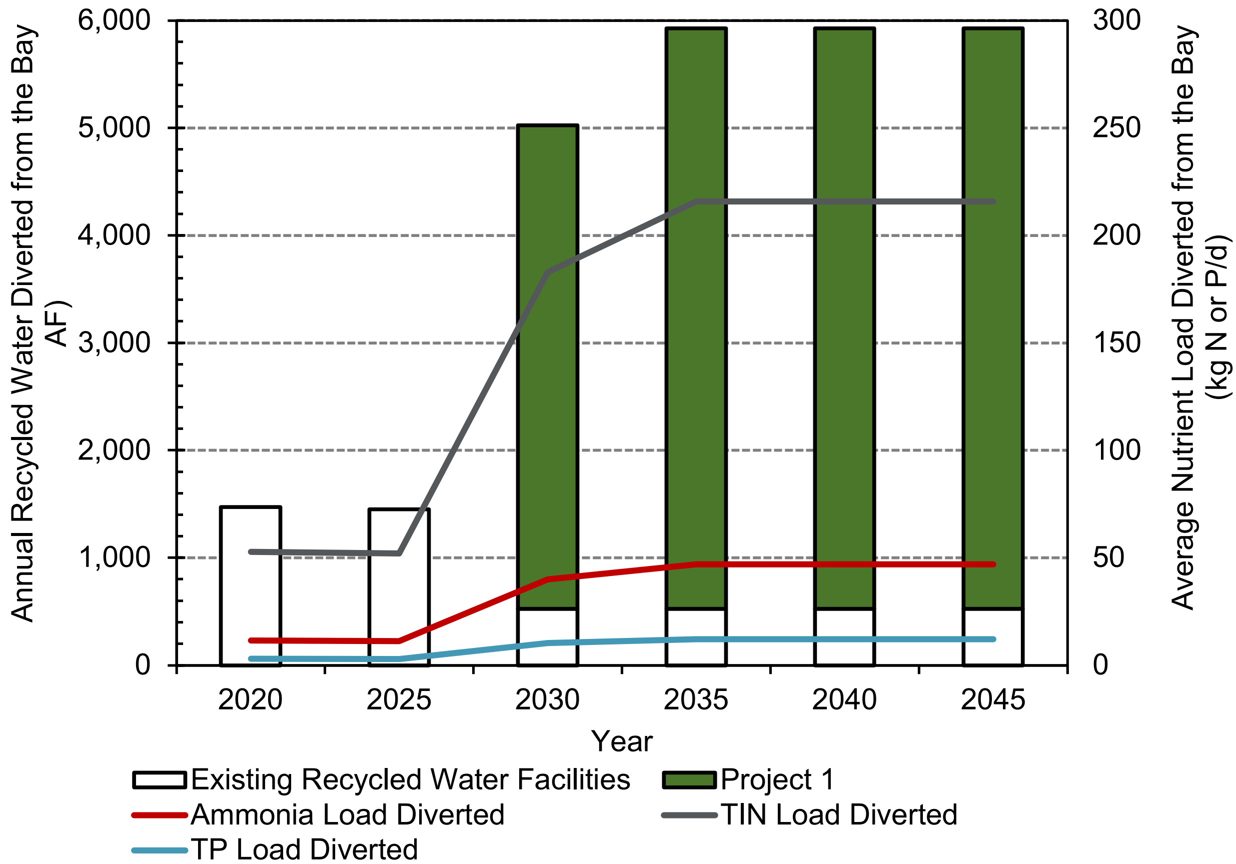

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge

Note: Project 1 represents the BMKV wetlands discharge project. Once the BMKV wetlands are operational, approximately 900 to 1,000 AFY of recycled water that currently goes to agriculture (Permit No. WRR 92-065) will cease. This evaluation is based on the BMKV wetlands discharge project conservatively starting in year 2030 (date could be as early as year 2025).

3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at Novato WWTP:

- Drivers for implementing recycled water projects:
  - Partnership – the distributor of NSD's recycled water is North Marin Water District (NMWD). On-going and future reuse projects are dependent on NMWD's need to offset potable supply which appears to be supportive of such efforts.
  - Water supply need to reduce potable demand (dependent on NMWD).
- Barriers for implementing recycled water projects:
  - Funding for constructing any future recycled water projects
  - Jurisdictional as previously stated with the NMWD partnership.
  - Site constraints/available area

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Bay Area Clean Water Agencies
Recycled Water Study

Oro Loma/Castro Valley Sanitary Districts Water Pollution Control Plant

BACWA Recycled Water Study

Final Individual Plant Report

San Lorenzo, CA
May 29, 2023

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Contents

Tables

Figures

Executive Summary

The Oro Loma Sanitary District (OLSD) operates the Oro Loma/Castro Valley Sanitary Districts Water Pollution Control Plant (OLSD WPCP) that discharges to the South Bay. It is located at 2655 Grant Ave San Lorenzo, CA 94580, and it serves approximately 47,000 service connections throughout the cities of San Lorenzo, Ashland, Cherryland, Fairview, and portions of Castro Valley and the cities of San Leandro and Hayward. The Castro Valley Sanitary District owns 25% of the treatment plant and contributes flow from an additional 20,300 connections. The plant has average dry weather flow (ADWF) permitted capacity of 20 million gallons per day (mgd).

The OLSD WPCP currently produces 37 AFY for golf course irrigation through East Bay Dischargers Authority (EBDA). It is anticipated that this will continue for the next several years and it will eventually cease as the golf course is no longer in operation. This report assumes that it will cease at the end of year 2025. OLSD WPCP does not have plans to develop any expansions to the existing recycled water facility after the golf course irrigation stops.

OLSD WPCP evaluated several potable reuse alternatives several years back. Of the alternatives considered, groundwater recharge was the most attractive at the time. Since producing the report, OLSD WPCP has concluded that it is not interested in advancing the groundwater recharge option as the cost estimates for such an alternative would be approximately double the marginal cost of potable water. The water purveyor in OLSD's service area, East Bay Municipal Utility District, does not anticipate supply shortages to justify such recycled water production costs. While the groundwater recharge alternative is not under any further consideration, it is included in this report as the drivers might change in the future. Given that, the reader should proceed with caution for this included potential future project.

A summary of the recycled water flows and load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP) are provided in Table ES-1. The table includes both the existing recycled water to the neighboring golf course, as well as the groundwater recharge alternative. As previously noted, the unit costs for the groundwater recharge are relatively high with $/AF greater than $7,000/AF and nutrient unit costs at greater than $800/lb nutrient removed.

The timeline and corresponding load diversions from the Bay for projected is provided in Figure ES-1. The potential future groundwater recharge option has TIN loads diverted from the Bay at approximately 140 kg N/d (the WPCP currently discharges approximately 350 kg N/d).

An overview of the drivers and barriers for implementing recycled water projects at OLSD WPCP:

- Drivers for implementing recycled water projects:
  - Changing thoughts about sustainable business practices
  - Potential regulatory limitations on release of fresh water to salt sinks
- Barriers for implementing recycled water projects:
  - Economics as the cost to produce potable reuse quality water is currently cost prohibitive compared to producing potable water
  - Political: Public acceptance of IRP/DPR is not universal. Environmental justice concerns as more affluent areas of EBMUD's service area have not proceeded with similar projects.

- Lack of demand: water supplier has ample supply of high-quality water

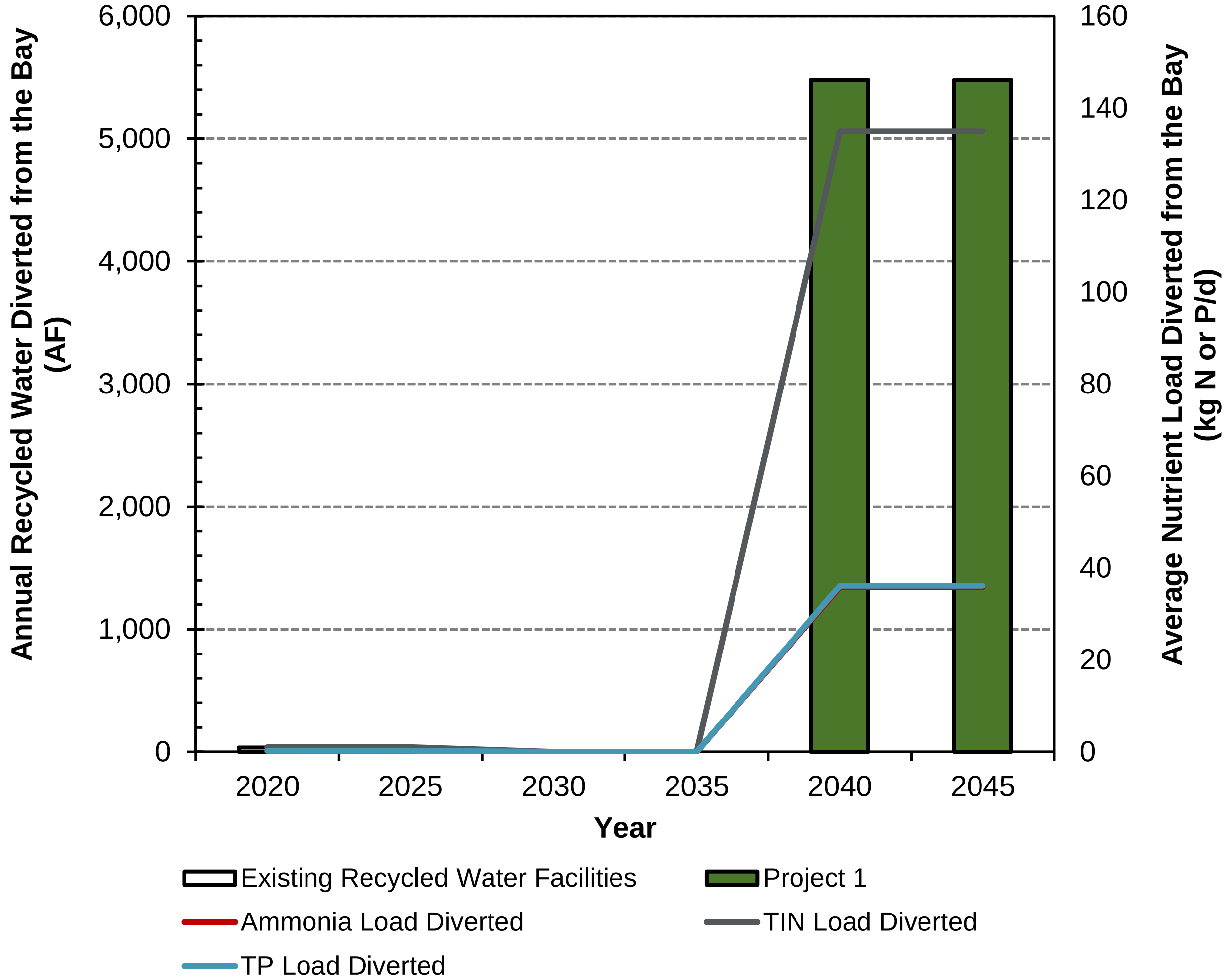

Figure ES-1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge*

* Note: Project 1 represents a groundwater recharge project that was evaluated several years back. Since the evaluation, OLSD WPCP has concluded it is cost prohibitive and thus not under consideration. However, it is included in this report as the cost, public perception, and regulatory drivers might change in the future.

Table ES-1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (Indirect Potable Reuse: Groundwater Recharge) *, **, ***		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *, **, ***	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	0.08	0.03	3.2	3.3	1.0	1.0
Volume	AF	37	37	1,520	3,650	471	1,110
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	3	3	--	--
Duration		5	5	10	5	25	25
Flow Diverted	%	100%	100%	100%	100%	100%	100%
Ammonia Load Diverted	kg N/d	<1	<1	16	24	7	5
TIN Load Diverted	kg N/d	2	1	74	90	30	18
TP Load Diverted	kg P/d	1	<1	22	24	9	5
Cost[3,4,5]							
Capital Cost	$ Mil	--[9]	--[9]	329	329	329	329
NPV O&M	$ Mil	--[9]	--[9]	18	42	18	42
NPV Total (Capital+NPV O&M)	$ Mil	--[9]	--[9]	347	372	347	372
Unit Flow Cost[6]							
Unit Cost	$/gpd	--[9]	--[9]	107	114	346	375
Unit Cost	$/AF	--[9]	--[9]	22,800	20,400	29,500	13,400
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	--[9]	--[9]	6,360	3,870	6,270	3,820
TIN Unit Cost	$/lb TIN Diverted	--[9]	--[9]	1,380	1,030	1,360	1,010
TP Unit Cost	$/lb TP Diverted	--[9]	--[9]	4,740	3,830	4,680	3,790

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3). For the Total columns, the project start period is from year 2020 through year 2045.

***** Future Projects represents a groundwater recharge project that was evaluated several years back. Since the evaluation, OLSD WPCP has concluded it is cost prohibitive and thus not under consideration. However, it is included in this report as the cost and drivers might change in the future.**

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by OLSD WPCP. The provided values escalated to 2021 dollars (ENR index values of 9,972 for Jan 2015 and 11,628 for Jan 2021).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).
9. Costs not available as they are not quantified at OLSD WPCP. The costs are thought to be negligible.

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1 Introduction and Current Conditions

The Oro Loma Sanitary District (OLSD) operates the Oro Loma/Castro Valley Wastewater Treatment Plant (OLSD WPCP) that discharges to the South Bay. It is located at 2655 Grant Ave San Lorenzo, CA 94580, and it serves approximately 47,000 service connections throughout the cities of San Lorenzo, Ashland, Cherryland, Fairview, and portions of Castro Valley and the cities of San Leandro and Hayward. The Castro Valley Sanitary District owns 25% of the treatment plant and contributes flow from an additional 20,300 connections. The plant has average dry weather flow (ADWF) permitted capacity of 20 million gallons per day (mgd).

The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

OLSD is a member of the East Bay Dischargers Authority (EBDA) that discharges OLSD effluent through EBDA's common outfall. EBDA holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2022-0023; CA0037869). Table 1-1 provides a summary of the permit limitations for OLSD under the EBDA permit. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2022-0023; CA0037869)

Criteria	Unit	Average Dry Weather	Average Annual *	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	--	--	--	--	--
Effluent BOD (1)	mg/L	--	--	25	40	--
Effluent TSS (1)	mg/L	--	--	30	45	--
Effluent Ammonia	mg N/L	--	*	--	--	--

* The annual average total ammonia percent removal shall not be less than 70 percent per calendar year.
1. BOD and TSS include a minimum percent removal of 85% through the WPCP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;
- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for the OLSD WPCP. Both liquids processes and solids processes are shown. Liquid stream treatment consists of a headworks, primary sedimentation, activated sludge, secondary clarification, chlorination, and then conveyed to EBDA for dechlorination/discharge. The activated sludge system was expanded and upgraded in 2020 for ammonia and total inorganic nitrogen load reduction via conversion to a Modified Ludzak-Ettinger Process.

Solids treatment includes thickening, anaerobic digesters, dewatering using a belt filter press followed by drying beds.

1.3 Existing Recycled Water Service

The OLSD WPCP currently produces 37 AFY for golf course irrigation through East Bay Dischargers Authority (EBDA). While the golf course is no longer operational, OLSD WPCP/EBDA are still sending recycled water to maintain the grounds. The delivery of recycled water is expected to cease around year 2025. OLSD WPCP does not have plans to develop and/or expand the existing recycled water facility. The City of Hayward is expanding its network of irrigation piping to the industrial areas near the Airport Complex. Hayward's service provides additional disincentive to developing recycled water supplies in the area.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/20 - 9/21)*,**

Criteria	Unit	Dry Season (May 1–Sept 30)	Wet Season (Oct 1–Apr 30)	Average Annual (10/2020-9/2021)
Flow	mgd	10.7	11.3	11.1
Volume	AFY	5,040	7,380	12,400
Ammonia	kg N/d	61.4	114	92.0
Total Inorganic Nitrogen (TIN)	kg N/d	280	410	350
Total Phosphorus (TP)	kg P/d	82.0	105	93.0
Ammonia	mg N/L	1.5	2.7	2.2
TIN	mg N/L	6.9	9.6	8.3
TP	mg P/L	2.01	2.45	2.22

* Represents the most recent published data included as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). Note: the other recycled water reports relied on data from 10/16 – 9/19. The more recent data from OLSD was used as the treatment plant had upgrades that has improved the nutrient removal performance (emphasis on ammonia and TIN) and thus, is more reflective of current conditions.

**Represents the average volume over the duration listed in the table header.

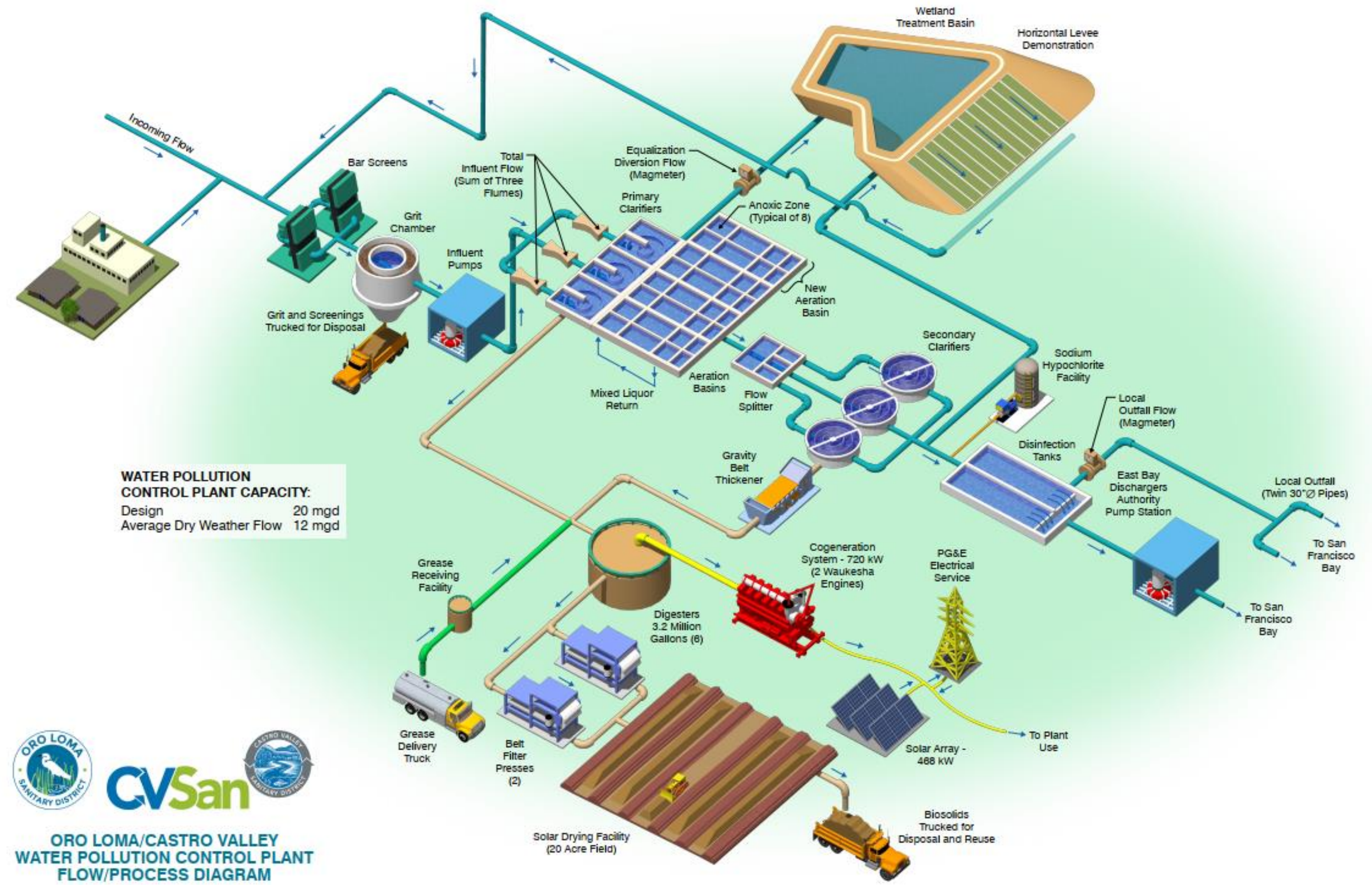

Figure 1-1. Process Flow Diagram for Oro Loma/Castro Valley Sanitary Districts Water Pollution Control Plantt (Source: OLSD)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial

Use Category*	Definition
	building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with OLSD WPCP and Engineer’s best judgment that considered known project constraints, existing OLSD WPCP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs were not provided by OLSD WPCP, as the 37 AFY produced through EBDA have negligible costs associated.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering,

construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g. existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g. a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

water quality while simultaneously positioning your agency for future recycled water opportunities)?

- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the existing and potential future recycled water projects at OLSD WPCP. There are no concrete plans to expand the existing non-potable recycled water program. A conceptual future project is listed that at this stage is cost prohibitive.

Table 3-1. Recycled Water Projects Identified by OLSD

Year	Project #
Existing Recycled Water Facilities (Golf Course Irrigation)	OLSD WPCP in coordination with EBDA diverts a portion of the OLSD WPCP to a neighboring golf course. The golf course is no longer in operation, but OLSD WPCP/EBDA continue to send irrigation water to maintain the grounds. It is anticipated that this will continue through approximately year 2025. The most recent reuse volume (37 AFY) was assumed through year 2025.
Future Project (Indirect Potable Reuse: Groundwater Recharge)	OLSD evaluated various reuse opportunities in year 2015 that included both unrestricted Title 22 and potable reuse opportunities. Of the alternatives evaluated, a 5 mgd groundwater recharge alternative was the most attractive. However, OLSD WPCP has since concluded it is cost prohibitive given existing supplies and thus not under further consideration. Despite this, the project is included in this report as the cost and drivers might change in the future.

The following subsections summarize the flow and nutrient load reductions for each listed project in Table 3-1.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. The existing reuse customer (golf course) is anticipated to cease over the next few years. Furthermore, the existing reuse customer (golf course) provides a marginal benefit with respect to diverting nutrient loads from the Bay. Despite the potential benefits of diverting approximately 50% of the total flow, the impacts are muted because the District is already treating a significant portion of the influent nutrients. Due to the limited nutrient impacts and availability of existing potable supplies, Oro Loma expects to continue to hold on the development of recycled water supplies until at least 2040. However, it is included in this report as the cost and drivers might change in the future.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. Current uses include golf course irrigation which is expected to stop after 2025 as the golf course is no longer in operation. The prospective groundwater recharge project is included but not currently budgeted or a part of the Districts existing capital plan.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Distributed – Return Flows (AFY)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**1**	**37**	**<1**	**1**	**<1**
	Existing Facilities	1	37	<1	1	<1
	Other Projects**	--	--	--	--	--
2025	**Total**	**2**	**37**	**<1**	**1**	**<1**
	Existing Facilities	2	37	<1	1	<1
	Other Projects**	--	--	--	--	--
2030	**Total**	**--**	**--**	**--**	**--**	**--**
	Existing Facilities	--	--	--	--	--
	Other Projects**	--	--	--	--	--
2035	**Total**	**--**	**--**	**--**	**--**	**--**
	Existing Facilities	--	--	--	--	--
	Other Projects**	--	--	--	--	--
2040	**Total**	**3**	**5,480**	**36**	**135**	**36**
	Existing Facilities	--	--	--	--	--
	Other Projects**	3	5,480	36	135	36
2045	Total	**3**	**5,480**	**36**	**135**	**36**
	Existing Facilities	--	--	--	--	--
	Other Projects**	3	5,480	36	135	36

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

** Other Projects represents a groundwater recharge project that was evaluated several years back. Since the evaluation, OLSD WPCP has concluded that further action is not warranted. However, it is included in this report as the cost and drivers might change in the future.

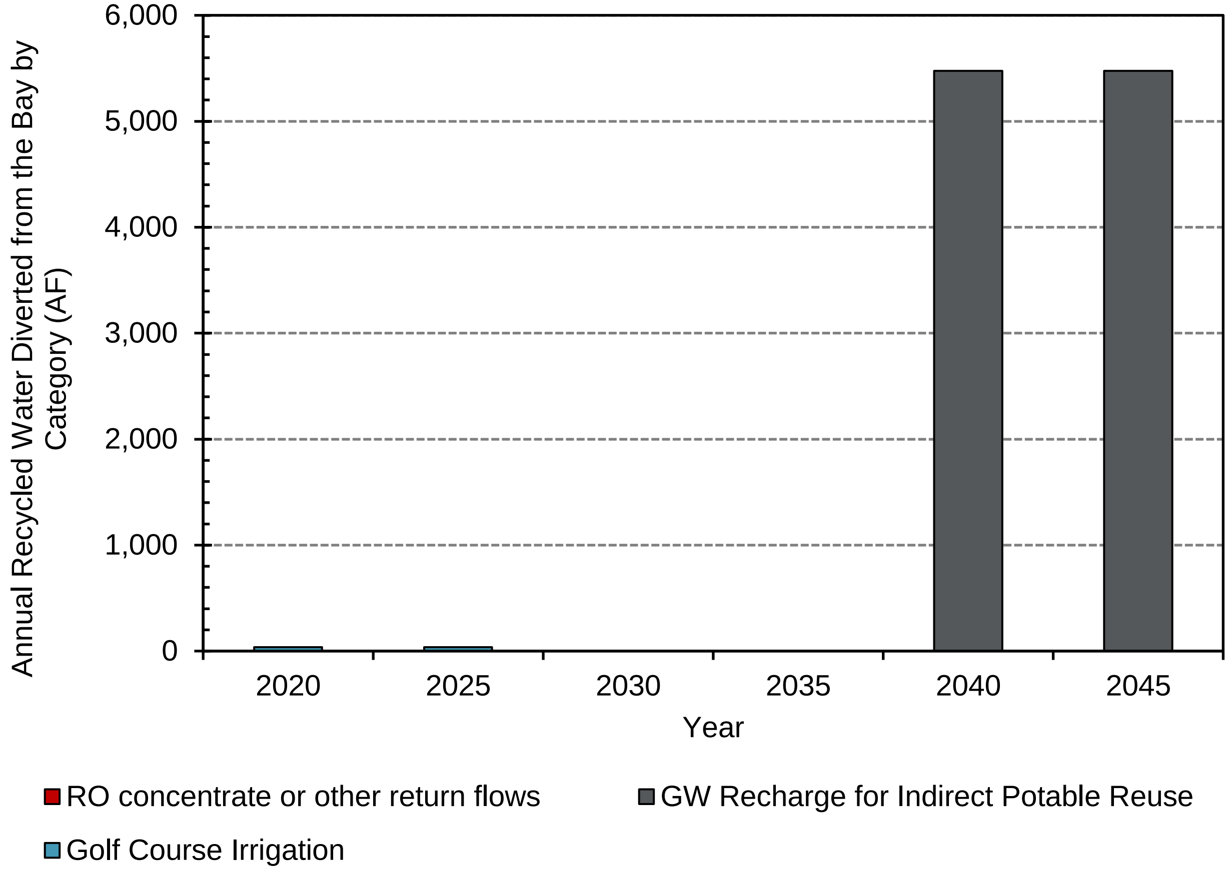

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)*,**

* The volume for "RO concentrate or other return flows" will not result in a flow diversion from the Bay and thus do not have any volume. However, a portion of the loads associated with this stream would be removed by OLSD WPCP.

** The "GW Recharge for Indirect Potable Reuse" and corresponding "RO concentrate or other return flows" represent a groundwater recharge project that was evaluated several years back. Since the evaluation, OLSD WPCP has concluded that further action is not warranted. However, it is included in this report as the cost and drivers might change in the future.

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the existing recycled water project.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities (Golf Course Irrigation)	• Facilities are already in place and providing recycled water • Operator familiarity with existing recycled water facilities • Existing facilities reliably meet recycled water treatment requirements • Costs are deemed negligible	• Golf course is no longer in operation with an anticipating cease after year 2025.
Future Project (Indirect Potable Reuse: Groundwater Recharge)	• Enhanced water supply volumes, diversity, and reliability • Further reduce nutrient loads to the Bay • Enhanced removal of contaminants of emerging concern (associated with the advanced treatment train)	• Would require an agreement between OLSD WPCP and the water provider, EBMUD • Construction, operational and maintenance, and unit costs are relatively high • Energy intensive to produce the product water • Potential for an increase in greenhouse gas emissions unit costs for producing water (compared to emissions associated with the water provider producing water)

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows and load reductions is provided in Table 3-4. The table includes both the existing recycled water to the neighboring golf course, as well as the groundwater recharge alternative. As previously noted, the unit costs for the groundwater recharge are relatively high with $/AF greater than $7,000/AF and nutrient unit costs at greater than $800/lb nutrient removed. Given these values, OLSD WPCP is not taking further action to implement this alternative.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. The potential future groundwater recharge option has TIN loads diverted from the Bay at approximately 140 kg N/d (the WPCP currently discharges approximately 350 kg N/d).

Table 3-4. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (Indirect Potable Reuse: Groundwater Recharge) *, **, ***		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *, **, ***	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	0.08	0.03	3.2	3.3	1.0	1.0
Volume	AF	37	37	1,520	3,650	471	1,110
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	3	3	--	--
Duration		5	5	10	5	25	25
Flow Diverted	%	100%	100%	100%	100%	100%	100%
Ammonia Load Diverted	kg N/d	<1	<1	16	24	7	5
TIN Load Diverted	kg N/d	2	1	74	90	30	18
TP Load Diverted	kg P/d	1	<1	22	24	9	5
Cost[3,4,5]							
Capital Cost	$ Mil	--[9]	--[9]	329	329	329	329
NPV O&M	$ Mil	--[9]	--[9]	18	42	18	42
NPV Total (Capital+NPV O&M)	$ Mil	--[9]	--[9]	347	372	347	372
Unit Flow Cost[6]							
Unit Cost	$/gpd	--[9]	--[9]	107	114	346	375
Unit Cost	$/AF	--[9]	--[9]	22,800	20,400	29,500	13,400
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	--[9]	--[9]	6,360	3,870	6,270	3,820
TIN Unit Cost	$/lb TIN Diverted	--[9]	--[9]	1,380	1,030	1,360	1,010
TP Unit Cost	$/lb TP Diverted	--[9]	--[9]	4,740	3,830	4,680	3,790

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045). For the Total columns, the project start period is from year 2020 through year 2045.

<u>* Future Projects represents a groundwater recharge project that was evaluated several years back. Since the evaluation, OLSD WPCP has concluded it is cost prohibitive and thus not under consideration. However, it is included in this report as the cost and drivers might change in the future.</u>**

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by OLSD WPCP. The provided values escalated to 2021 dollars (ENR index values of 9,972 for Jan 2015 and 11,628 for Jan 2021).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).
9. Costs not available as they are not quantified at OLSD WPCP. The costs are thought to be negligible.

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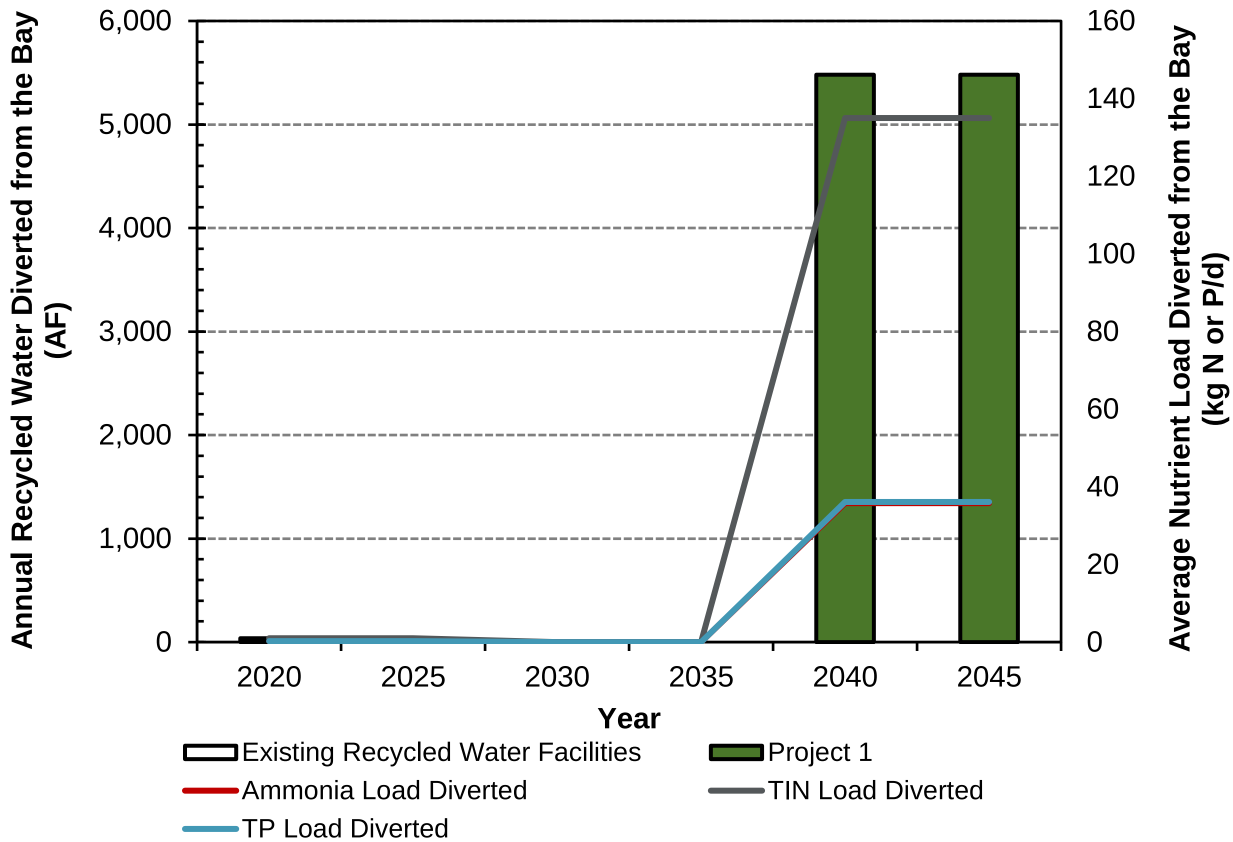

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge*

* Note: Project 1 represents a groundwater recharge project that was evaluated several years back. Since the evaluation, OLSD WPCP has concluded it is cost prohibitive and thus not under consideration. However, it is included in this report as the cost and drivers might change in the future.

3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at OLSD WPCP:

- Drivers for implementing recycled water projects:
  - Changing thoughts about sustainable business practices
  - Potential regulatory limitations on release of fresh water to salt sinks
- Barriers for implementing recycled water projects:
  - Economics as the cost to produce potable reuse quality water is currently cost prohibitive compared to producing potable water
  - Political: Public acceptance of IRP/DPR is not universal. Environmental justice concerns as more affluent areas of EBMUD's service area have not proceeded with similar projects.
  - Lack of demand: water supplier has ample supply of high-quality water

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City of Palo Alto Regional Water Quality Control Plant

BACWA Recycled Water Study

Individual Plant Report

Palo Alto, CA
June 16, 2023
FINAL Report

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Contents

Tables

Figures

Executive Summary

The City of Palo Alto (Palo Alto) owns and operates the Palo Alto Regional Water Quality Control Plant (RWQCP) located in Palo Alto, CA and discharges treated effluent to the South San Francisco Bay under a National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2019-0015, NPDES No. CA0037834). The plant has an average dry weather flow (ADWF) permitted capacity of 39 million gallons per day (mgd) and a peak permitted wet weather flow of 80 mgd.

The RWQCP is currently under construction to upgrade their secondary treatment system to enhance nutrient loads reduction. Such improvements will maintain nitrification and enhance total inorganic nitrogen (TIN) load reduction capabilities. This upgrade project should be completed and commissioned around year 2028. The analysis considers the future TIN effluent levels from year 2028 and thereafter.

Palo Alto has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The RWQCP currently recycles approximately 700 acre-feet per year (AFY; 200 million gallons per year) to various users for golf course irrigation, landscaping, and commercial non-potable uses.

There are two future recycled water projects under consideration. Future Project #1 has a confidence level of 1, as it is currently being designed. Future Project #2 has a confidence level of 3 which is defined as being in the conceptual stages. The issuance of Potable Reuse regulations (anticipated by the end of year 2023) will impact Palo Alto's decisions on recycled water project types and their implementation plan moving forward.

Both Future Projects #1 and #2 include an advanced treatment component that includes reverse osmosis (RO). A simple mass balance around advanced treatment facilities as presented in Figure ES – 1 illustrates the extent of volume and nutrient loads that end up in advanced treatment permeate and concentrate/reject streams. For Projects #1 and #2, it was assumed that 28 percent of the advanced treatment facilities nutrient feed loads pass through such facilities, and they would be diverted from the Bay. The remaining 72 percent end up in the concentrate/reject streams (referred to RO concentrate from herein) would be discharged to the Bay via the treatment plant outfall. The analysis considered the RO concentrate return streams while calculating nutrient load diversions from the Bay and thus, the nutrient load diversions associated with both Future Projects are modest.

Future Project 1: refers to the local advanced water purification system (AWPS), which is expected to increase recycled water production for golf course irrigation, landscape, industrial, and environmental enhancement, as well as increase reverse osmosis (RO) concentrate return flows. The RWQCP already has customers in place from the cities of Palo Alto and Mountain View. The volume and nutrient loads associated with the RO concentrate stream would not be diverted from the Bay for the previously stated reasons (refer to Figure ES – 1). The recycled water volumes diverted from the Bay would initially divert approximately 50 AFY from the Bay in year 2025, followed by an additional approximately 1,800 AFY by year 2030 and onwards.

Future Project 2: involves a regional purification plant for groundwater recharge, which will further increase recycled water distribution annually by 11,200 AFY, possibly starting in year 2028. Similar to Future Project #1, there is an RO concentrate stream laden with nutrients that would not be diverted from the Bay for the previously stated reasons (refer to Figure ES – 1). The recycled water volumes diverted from the Bay would divert approximately 11,200 AFY by year 2030 and onwards.

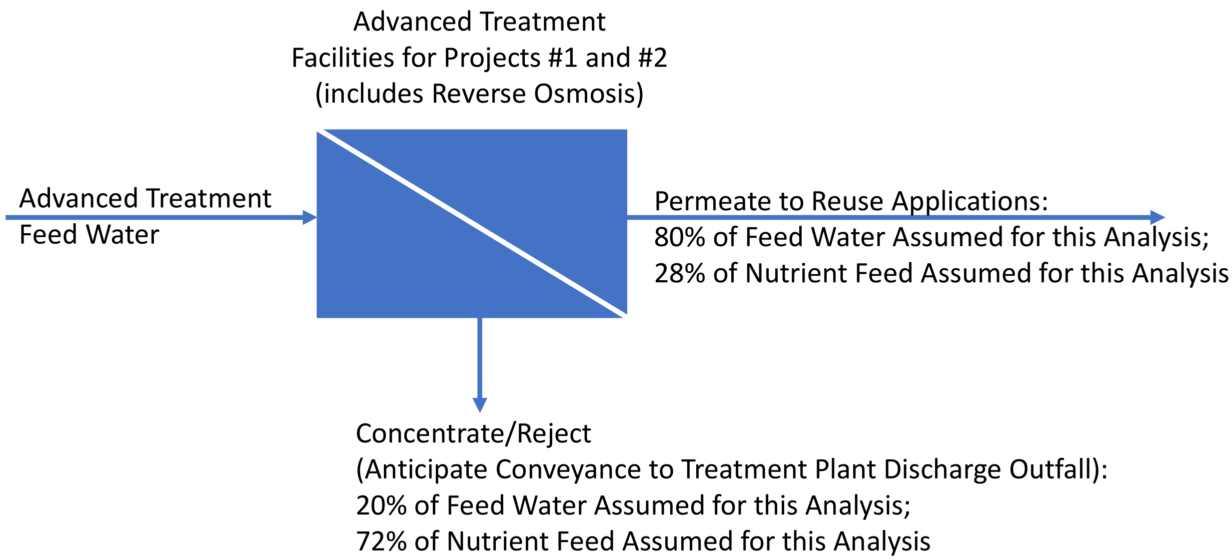

Figure ES – 1. Simple Mass Balance of Water Production and Nutrient Loads around an Advanced Treatment Configuration

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP)), and the corresponding unit costs are provided in Table ES - 1. The nutrient load reductions for the existing recycled water facilities assumes that effluent TIN concentration will improve after commissioning the on-going plant upgrades around year 2028 and onwards by way of a time-weighted analysis. The nutrient load reductions for Future Projects #1 and #2 are predicated on the anticipated effluent TIN concentration for the on-going plant upgrades that will further reduce nutrients. The analysis assumed a conservative 15 mg N/L for effluent TIN concentrations after the plant upgrades are commissioned and operational.

The unit costs in terms of volume and nutrients for Future Project #1 are less cost-effective than the current facilities. This was expected as the existing facilities are already in place, and they rely on less energy-intensive equipment. As previously noted, the nutrient reductions associated with Projects #1 and #2 only have modest nutrient load reductions due to the majority of nutrients ending up in the plant outfall via the RO concentrate return flows.

The costs increase exponentially with the transition to Future Project #2 (if it moves forward) as the construction and O&M are both more expensive per AF than existing and Future Project #1. As such, the unit costs in terms of volume and nutrients are both greater than existing and Future Project #1.

Note: both Future Projects #1 and #2 are anticipated to be in operation beyond the listed year 2045. Both projects are anticipated to be operational for 30 years. Thus, the unit costs are likely over-stated in this analysis.

Table ES - 1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) [a, b, c]		Future Project 1 (Local Advanced Water Purification System) [a, b, c, d]		Future Project 2 (Regional Purification Plant for Groundwater Recharge) [a, b, c, e]		Total (Includes Existing and Future Projects Averaged from Year 2020 through 2045) [a, b, c]	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]									
Flow	mgd	1.1	0.6	2.1	1.3	10	10	9.4	8.4
Volume	AF	495	705	980	1,440	4,670	11,200	4,420	9,370
Load Diverted from the Bay[2,3]									
Confidence	unitless	1	1	1	1	3	3	Blend of 1 and 3	Blend of 1 and 3
Duration	Years	25	25	17	17	17	17	25	25
Flow Diverted	%	5%	3%	11%	6%	53%	47%	51%	39%
Ammonia Load Diverted	kg N/d	1	<1	1	<1	2	2	3	2
TIN Load Diverted	kg N/d	79	46	44	27	158	159	216	173
TP Load Diverted	kg P/d	20	11	11	6	52	49	63	49
Cost[3,4,5]									
Capital Cost	$ Mil	--	--	43	43	800 ǂ	800 ǂ	843 ǂ	843 ǂ
NPV O&M	$ Mil	0.5	0.7	2.8	4.2	280 ǂ	672 ǂ	283 ǂ	677 ǂ
NPV Total (Capital+NPV O&M)	$ Mil	0.5	0.7	46	47	1,080 ǂ	1,470 ǂ	1,130 ǂ	1,520 ǂ
Unit Flow Cost[6]									
Unit Cost	$/gpd	0.5	1.1	22	37	109	147	120	182
Unit Cost	$/AF	38	38	2,750	1,920	13,600	7,730	10,200	6,490
Unit Load Cost[7,8]									
Ammonia Unit Cost	$/lb Ammonia Diverted	63	89	16,000	16,000	79,200	64,300	46,700	45,500
TIN Unit Cost	$/lb TIN Diverted	0.7	0.7	183	130	1,190	677	619	438
TP Unit Cost	$/lb TP Diverted	2.9	3.0	728	543	3,610	2,180	2,130	1,540

a Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.

b The on-going plant upgrades at the RWQCP are the primary reason for reducing Bay nutrient discharge loads after year 2028 (not Projects #1 or #2). For Projects #1 and #2, the analysis assumed that 28 percent of the nutrient feed loads would be diverted from the Bay. The remaining 72 percent of the nutrient feed loads would end up in the Bay discharge.

c Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3. For the Total columns, the project start period is from year 2020 through year 2045.

d Future Project 1: refers to the local AWPS, which is expected to increase recycled water production for golf course irrigation, landscape, industrial, environmental enhancement, and reverse osmosis (RO) concentrate return flows applications. Of these applications, the RO concentrate return flows end up in the Bay via RWQCP outfall.

e Future Project 2: involves a regional purification plant for groundwater recharge, which will further increase recycled water distribution annually by 11,200 AFY starting in year 2040. Similar to Future Project #1, there is an RO concentrate return flow that ends up in the Bay via RWQCP outfall.

ǂ Note: the Future Project #2 cost would be zero for the RWQCP; the Santa Clara Valley Water District would pay to treat final effluent for groundwater recharge.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by Palo Alto RWQCP.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

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The timeline and corresponding load diversions from the Bay are provided in Figure ES - 2. The volume increases exponentially with the transition to Future Project #2 (if it moves forward). As for nutrients, the plant upgrades are the primary reason for nutrients loads diverted from the Bay after year 2028 (not Projects #1 or #2). As previously noted, the nutrient reductions associated with Projects #1 and #2 will only have modest nutrient load reductions as most of the nutrient loads will end up in the plant outfall via the RO concentrate return flows (assumed 72 percent of the advanced treatment feed load). Note: the ammonia load diverted from the Bay is relatively small compared to TIN and Total P loads as the RWQCP already reliably removes ammonia.

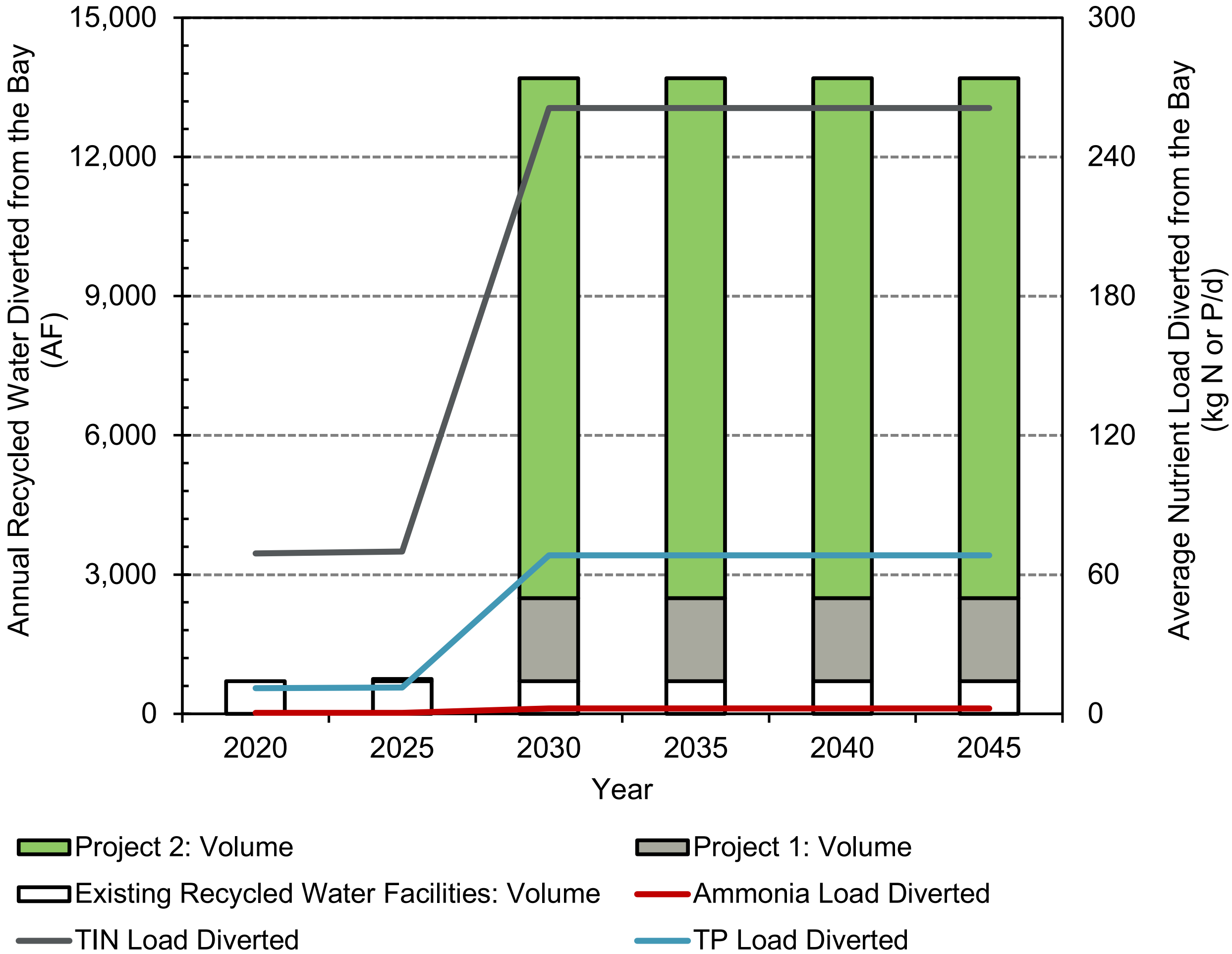

Figure ES – 2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge*

Future Project 1: refers to the local AWPS to provide additional non-potable recycled water.
Future Project 2: involves a regional purification plant for groundwater recharge.
*** The on-going plant upgrades at the RWQCP are the primary reason for the increase in nutrients loads diverted from the Bay after year 2028 (not Projects #1 or #2). Both Projects #1 and #2 will only have modest nutrient load reductions as most of the nutrient loads will end up in the plant outfall via the RO concentrate return flows (assumed 72 percent of the advanced treatment feed load).**

An overview of the drivers and barriers for implementing recycled water projects at Palo Alto RWQCP:

- Drivers for implementing recycled water projects:
  - Water supply need – successive droughts have strained the water supplies for Palo Alto, as well as all of Santa Clara Valley. As such, the need to diversify and decrease reliance on external water supplies has resulted in Palo Alto's support of expanding recycled water use.
  - Sustainability goals – the City has active sustainability goals that include the continued production and use of recycled water as a local, drought-resilient water supply.
  - Proposed discharge regulations – non-potable reuse projects could reduce regulated pollutants discharged by the RWQCP and support the need for expansion projects. However, this benefit relies heavily upon consistent and reliable customer usage. This driver becomes even less important if the recycled water is used for potable reuse due to the continued discharge of those pollutants despite increased recycled water use.
- Barriers for implementing recycled water projects:
  - Funding – funds and staffing needed for recycled water projects stem from the same sources as that needed for infrastructure repairs elsewhere in the treatment plant. The RWQCP is facing needed capital improvements that add up to more than $340 million over the next 20 years. It's difficult to prioritize recycled water projects over significant repairs needed upstream to ensure basic treatment processes continue.
  - Jurisdictional – recycled water projects, especially potable reuse projects, require cooperation not only of wastewater treatment plants but also water providers that often times have differing goals and timelines.

1 Introduction and Current Conditions

The City of Palo Alto (Palo Alto) owns and operates the Palo Alto Regional Water Quality Control Plant (RWQCP) located in Palo Alto, CA and discharges treated effluent to the South San Francisco Bay under a National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2019-0015, NPDES No. CA0037834). The plant has an average dry weather flow (ADWF) permitted capacity of 39 million gallons per day (mgd) and a peak permitted wet weather flow of 80 mgd.

The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the NPDES permit (R2-2019-0015), the Regional Nutrient Watershed Permit (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

Palo Alto holds the NPDES permit (Order No. 93-160) that governs discharge requirements from the RWQCP. Table 1-1 provides a summary of the permit limitations for the RWQCP. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. RWQCP NPDES Permit Limitations (Order No. 93-160)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Flow	mgd	39.0	--	--	--
BOD (1)	mg/L	--	10	--	20
TSS (1)	mg/L	--	10	--	20
Ammonia	mg/L	--	2.7	--	9.5

1. BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling which will be satisfied by this report. The evaluation shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;
- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);

- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2. Note the RWQCB has issued Palo Alto a site-specific order for recycled water that Palo Alto currently operates under.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge – Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for the RWQCP. Both liquids and solids processes are shown. The RWQCP has primary clarifiers followed by trickling filters, nitrifying activated sludge for secondary treatment and dual media filtration. The facility currently meets the Level 2 and Level 3 ammonia objectives.

1.3 Existing Recycled Water Service

The RWQCP has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The RWQCP currently recycles approximately 700 acre-feet per year (200 million gallons per year) to various users for golf course irrigation, landscaping, and commercial use.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge from a blend of the on-going plant upgrades and recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 – 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	18.6	23.4	21.4
Volume	AF	8,740	15,200	23,940
Ammonia	kg N/d	15.9	10.6	12.8
Total Inorganic Nitrogen (TIN)	kg N/d	2,090	2,530	2,350
Total Phosphorus (TP)	kg P/d	349	397	377
Ammonia	mg N/L	0.22	0.12	0.16
TIN	mg N/L	29.7	29.1	29.3
TP	mg P/L	4.96	4.63	4.77

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Nutrient Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads. Note: the RWQCP is currently under construction for a secondary treatment upgrades project that will maintain ammonia removal and enhance TIN removal. This project is anticipated to be completed and commissioned around year 2028

**Represents the average volume over the duration listed in the table header.

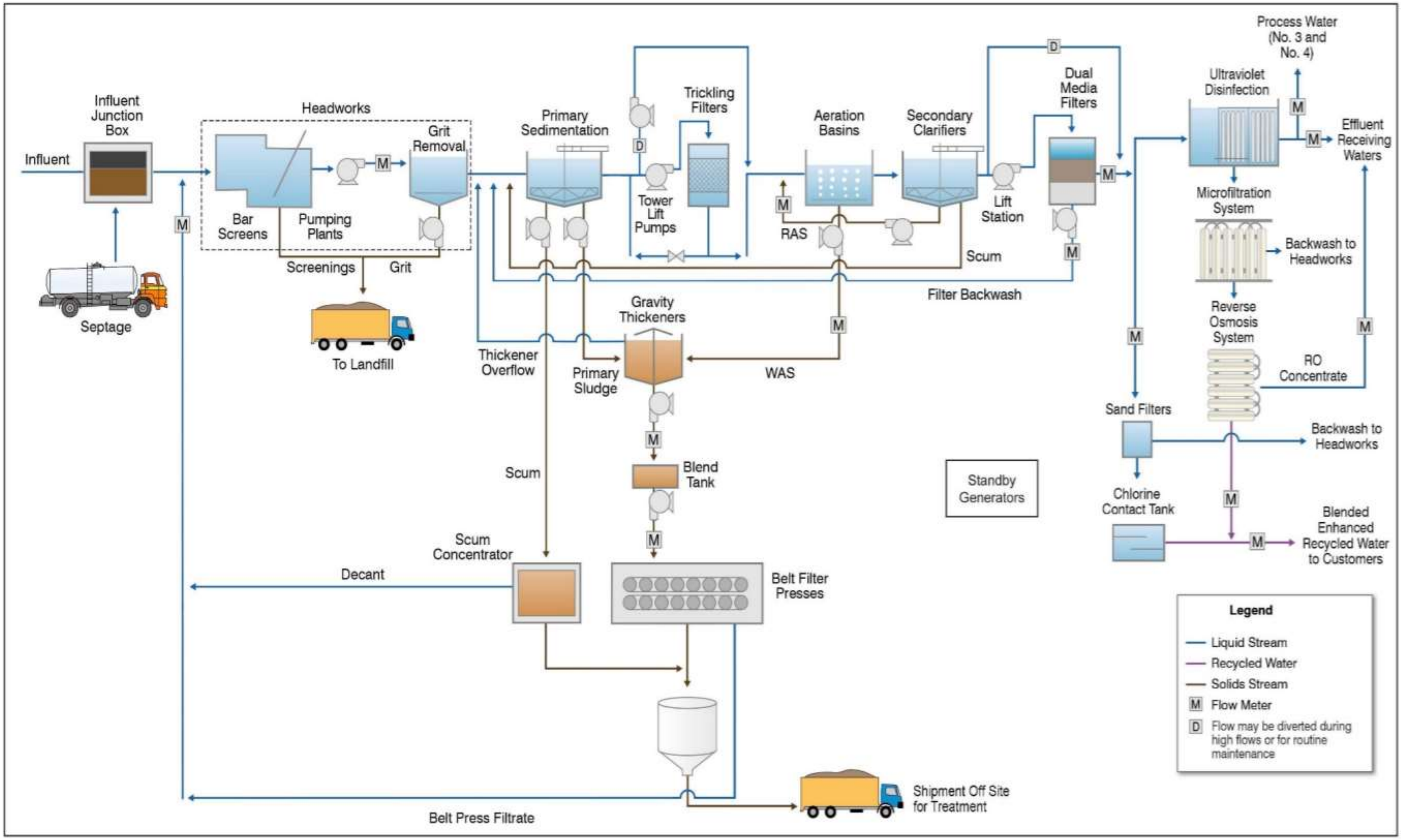

Figure 1-1. Process Flow Diagram for City of Palo Alto Regional Water Quality Control Plant (Source: NPDES Permit R2-2019-0015; CA0037834). Note microfiltration and reverse osmosis Systems are future elements to be added in Future Project #1.

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Nutrient Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial

Use Category*	Definition
	building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility.
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows include reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified as defined in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with the RWQCP and Engineer’s best judgment that considered known project constraints, existing RWQCP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by the RWQCP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Nutrient Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g. existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g. a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency’s decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the Bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI, and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

Note: the load reduction for Palo Alto RWQCP is based on anticipated effluent concentrations with the on-going project (ammonia = current effluent levels as the plant already fully nitrifies, TIN = 15 mg N/L; Total P = current effluent levels).

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects. The subsections that follow summarize the flow and nutrient load reductions for each listed project in Table 3-1.

Table 3-1. Recycled Water Projects Identified by Palo Alto RWQCP

Recycled Water Project	Description
Existing Recycled Water Facilities	The existing recycled water program is employed year-round. The RWQCP currently recycles approximately 700 acre-feet per year (200 million gallons per year) to various users for golf course irrigation, landscaping, and commercial use.
Future Project 1: Local Advanced Water Purification System:	It is expected to increase recycled water production for golf course irrigation, landscape, industrial, and environmental enhancement. Of these applications, the RO concentrate return flows and nutrient loads end up in the Bay. The initial production in year 2025 is slated for 1.125 mgd of product water, followed by a doubling to 2.25 mgd by year 2030 and thereafter. The additional demands for golf course and landscape irrigation are anticipated once the production doubles in year 2030.
Future Project 2: potable reuse (groundwater recharge project)	It is anticipated as soon as year 2028 and it will produce 10 mgd of product water on average. The aquifer will be recharged with this product water as a means to increase water supply reliability and independence from imported water (in particular during drought years). Similar to conceptual project 1, the RO concentrate return flows and nutrient loads end up in the Bay.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also includes the confidence of the projection on a scale of 1 to 3 with both listed Future Projects #1 and #2 having a confidence of 3. The volumes/loads increase exponentially with the transition to Future Project #2 (if it moves forward). Note: the ammonia load diverted from the Bay is relatively small compared to TIN and Total P loads as the RWQCP already reliably removes ammonia prior to discharge.

Both Future Projects #1 and #2 include an advanced treatment component that includes reverse osmosis (RO). As previously shown, a simple mass balance around advanced treatment facilities as presented in Figure 3-1 illustrates the extent of volume and nutrient loads that end up in advanced treatment permeate and concentrate/reject streams. For Projects #1 and #2, it was assumed that 28 percent of the advanced treatment facilities nutrient feed loads pass through such facilities, and they would be diverted from the Bay. The remaining 72 percent end up in the concentrate/reject streams (referred to RO concentrate from herein) would be discharged to the Bay via the treatment plant outfall. The analysis considered the RO concentrate return streams while calculating nutrient load diversions from the Bay and thus, the nutrient load diversions associated with both Future Projects are modest.

Figure 3-2 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. Current recycled water demands include golf course irrigation, landscaping, commercial, and other non-potable uses. Future Project #1 will add industrial, environmental enhancement, and RO concentrate returns flows. Future Project #2 will further increase RO concentrate return flows production, as well as add groundwater recharge for indirect potable reuse. Recycled water deliveries will occur throughout the year, but peak from late spring to early fall, when seasonal demands increase.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Average Distributed – Return Flows (AF)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**1**	**705**	**<1**	**69**	**11**
	Existing Facilities	1	705	<1	69	11
	Project 1**	1	--	--	--	--
	Project 2***	3	--	--	--	--
2025	**Total**	**1**	**752**	**<1**	**70**	**11**
	Existing Facilities	1	705	<1	69	11
	Project 1**	1	47	<1	1	0
	Project 2***	3	--	--	--	--
2030	**Total**	**Blend of 1 & 3**	**13,700**	**2**	**261**	**68**
	Existing Facilities	1	705	<1	69	11
	Project 1**	1	1,790	<1	33	8
	Project 2***	3	11,200	2	159	49
2035	**Total**	**Blend of 1 & 3**	**13,700**	**2**	**261**	**68**
	Existing Facilities	1	705	<1	69	11
	Project 1**	1	1,790	<1	33	8
	Project 2***	3	11,200	2	159	49
2040	**Total**	**Blend of 1 & 3**	**13,700**	**2**	**261**	**68**
	Existing Facilities	1	705	<1	69	11
	Project 1**	1	1,790	<1	33	8
	Project 2***	3	11,200	2	159	49
2045	**Total**	**Blend of 1 & 3**	**13,700**	**2**	**261**	**68**
	Existing Facilities	1	705	<1	69	11
	Project 1**	3	1,790	<1	33	8
	Project 2***	3	11,200	2	159	49

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

** **Future Project 1:** refers to the local AWPS. The RO concentrate return flows and nutrient loads end up in the Bay.

*** **Future Project 2:** involves a regional purification plant for groundwater recharge. The RO concentrate return flows and nutrient loads end up in the Bay.

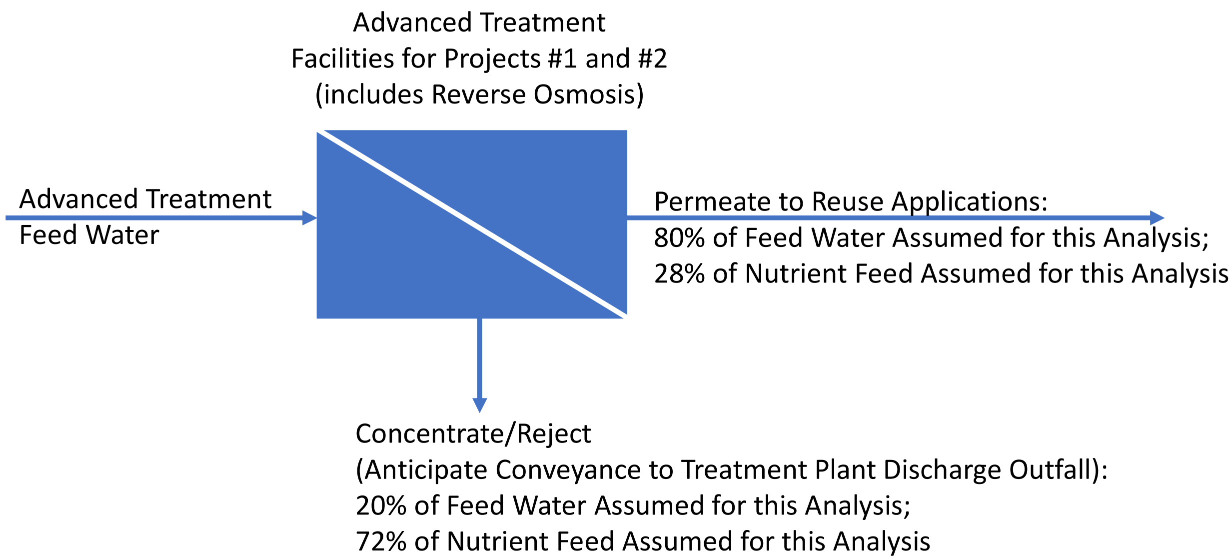

Figure 3-1. Simple Mass Balance of Water Production and Nutrient Loads around an Advanced Treatment Configuration

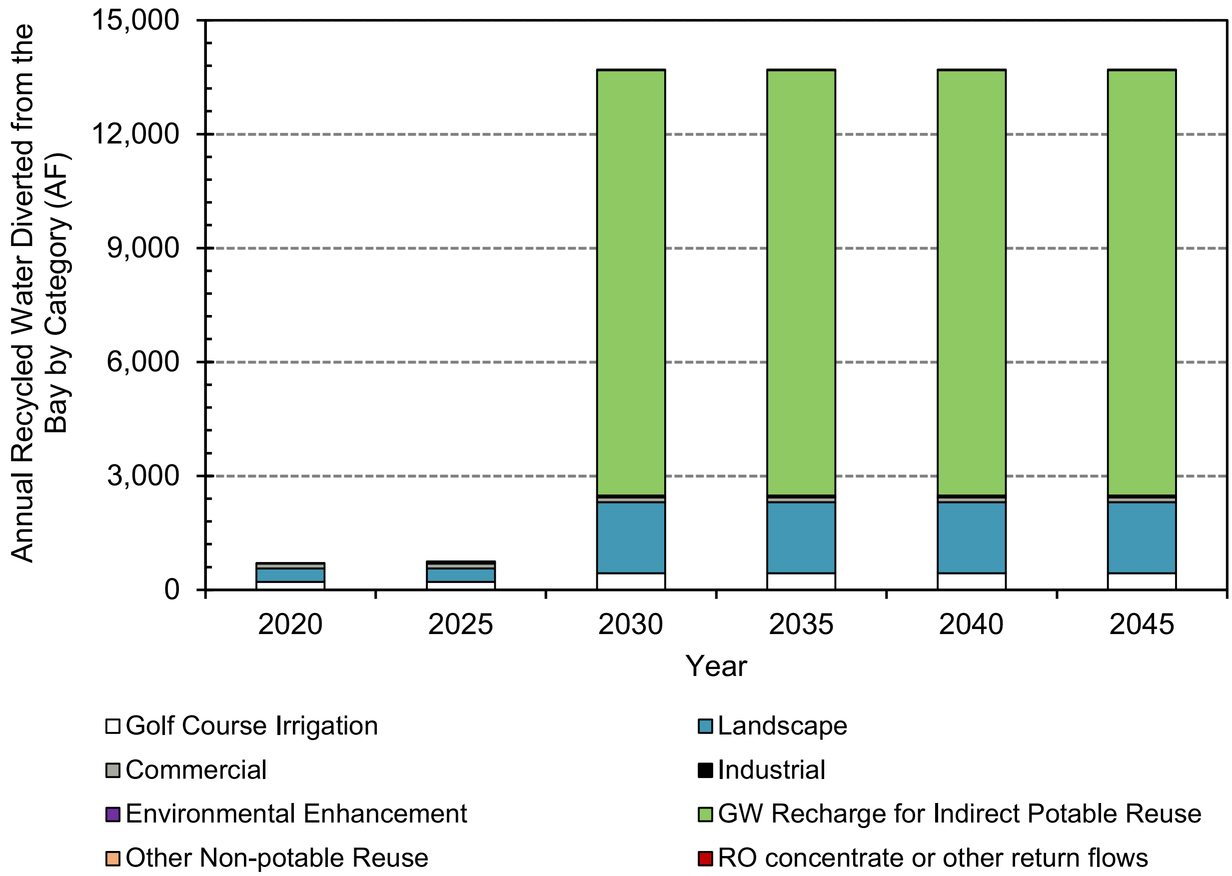

Figure 3-2. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

Note: RO concentrate return flows end up in the Bay.

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects expected. The Future Project #1 is anticipated to begin in 2025, whereas Future Project #2 is anticipated to begin as soon as 2028.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities	• Operator familiarity • Facilities are already in place • Additional load reduction (emphasis on particulates due to filtration that otherwise likely would not be in place)	• Costs to operate and maintain (emphasis on filtration which otherwise likely would not be in place). Replacing or rehabilitating current infrastructure is likely needed, as some facilities are near their end of useful life.
Future Project 1: Local Advanced Water Purification System:	• Increased water supply reliability and independence from imported water • Drought resiliency • Broadening customers and use types of recycled water • Additional treatment associated with the AWPS (emphasis on contaminants of emerging concern) • Valley Water providing funding for a portion of the project	• A portion of the nutrient loads are returned to the Bay as RO concentrate (such analyses were included in this evaluation) • Costs to construct, operate, and maintain
Future Project 2: Groundwater Recharge Project)	• Increased water supply reliability and independence from imported water • Drought resiliency via groundwater recharge • Additional treatment (emphasis on contaminants of emerging concern) • Valley Water will produce funding the project	• A portion of the nutrient loads are returned to the Bay as RO concentrate (such analyses were included in this evaluation) • Costs to construct, operate, and maintain • Costs to expand and implement enhanced source control program

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. As previously noted, the nutrient reductions associated with Projects #1 and #2 only have modest nutrient load reductions due to the majority of nutrients ending up in the plant outfall via the RO concentrate return flows. As a result, the nutrient loads diverted from the Bay are modest.

The unit costs in terms of volume and nutrients for Future Project #1 are less cost-effective than the current facilities. This was expected as the existing facilities are already in place, and they rely on less energy-intensive equipment.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) [a, b, c]		Future Project 1 (Local Advanced Water Purification System) [a, b, c, d]		Future Project 2 (Regional Purification Plant for Groundwater Recharge) [a, b, c, e]		Total (Includes Existing and Future Projects Averaged from Year 2020 through 2045) [a, b, c]	
		Average Dry Season (May 1 – Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]									
Flow	mgd	1.1	0.6	2.1	1.3	10	10	9.4	8.4
Volume	AF	495	705	980	1,440	4,670	11,200	4,420	9,370
Load Diverted from the Bay[2,3]									
Confidence	unitless	1	1	1	1	3	3	Blend of 1 and 3	Blend of 1 and 3
Duration	Years	25	25	17	17	17	17	25	25
Flow Diverted	%	5%	3%	11%	6%	53%	47%	51%	39%
Ammonia Load Diverted	kg N/d	1	<1	1	<1	2	2	3	2
TIN Load Diverted	kg N/d	79	46	44	27	158	159	216	173
TP Load Diverted	kg P/d	20	11	11	6	52	49	63	49
Cost[3,4,5]									
Capital Cost	$ Mil	--	--	43	43	800 ǂ	800 ǂ	843 ǂ	843 ǂ
NPV O&M	$ Mil	0.5	0.7	2.8	4.2	280 ǂ	672 ǂ	283 ǂ	677 ǂ
NPV Total (Capital+NPV O&M)	$ Mil	0.5	0.7	46	47	1,080 ǂ	1,470 ǂ	1,130 ǂ	1,520 ǂ
Unit Flow Cost[6]									
Unit Cost	$/gpd	0.5	1.1	22	37	109	147	120	182
Unit Cost	$/AF	38	38	2,750	1,920	13,600	7,730	10,200	6,490
Unit Load Cost[7,8]									
Ammonia Unit Cost	$/lb Ammonia Diverted	63	89	16,000	16,000	79,200	64,300	46,700	45,500
TIN Unit Cost	$/lb TIN Diverted	0.7	0.7	183	130	1,190	677	619	438
TP Unit Cost	$/lb TP Diverted	2.9	3.0	728	543	3,610	2,180	2,130	1,540

a Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.
b The on-going plant upgrades at the RWQCP are the primary reason for reducing Bay nutrient discharge loads after year 2028 (not Projects #1 or #2). For Projects #1 and #2, the analysis assumed that 28 percent of the nutrient feed loads would be diverted from the Bay. The remaining 72 percent of the nutrient feed loads would end up in the Bay discharge.
c Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3. For the Total columns, the project start period is from year 2020 through year 2045.
d Future Project 1: refers to the local AWPS, which is expected to increase recycled water production for golf course irrigation, landscape, industrial, environmental enhancement, and reverse osmosis (RO) concentrate return flows applications. Of these applications, the RO concentrate return flows end up in the Bay via RWQCP outfall.
e Future Project 2: involves a regional purification plant for groundwater recharge, which will further increase recycled water distribution annually by 11,200 AFY starting in year 2040. Similar to Future Project #1, there is an RO concentrate return flow that ends up in the Bay via RWQCP outfall.
ǂ Note: the Future Project #2 cost would be zero for the RWQCP; the Santa Clara Valley Water District would pay to treat final effluent for groundwater recharge.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by Palo Alto RWQCP.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

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The costs increase exponentially with the transition to Future Project #2 (if it moves forward). Note: the unit costs for Project 2 (both $/AF and $/lb nutrient removed) are relatively high as the project duration is only for five years (year 2040 through 2045). If implemented, the project would have a useful life longer than year 2045 so the values are likely over-stated in this analysis.

Figure 3-3 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. Similar to costs, the volumes increase exponentially with the transition to Future Project #2 (if it moves forward). As previously noted, the nutrient reductions associated with Projects #1 and #2 will only have modest nutrient load reductions as most of the nutrient loads will end up in the plant outfall via the RO concentrate return flows (assumed 72 percent of the advanced treatment feed load). Note: the ammonia load diverted from the Bay is relatively small compared to TIN and Total P loads as the RWQCP already reliably removes ammonia.

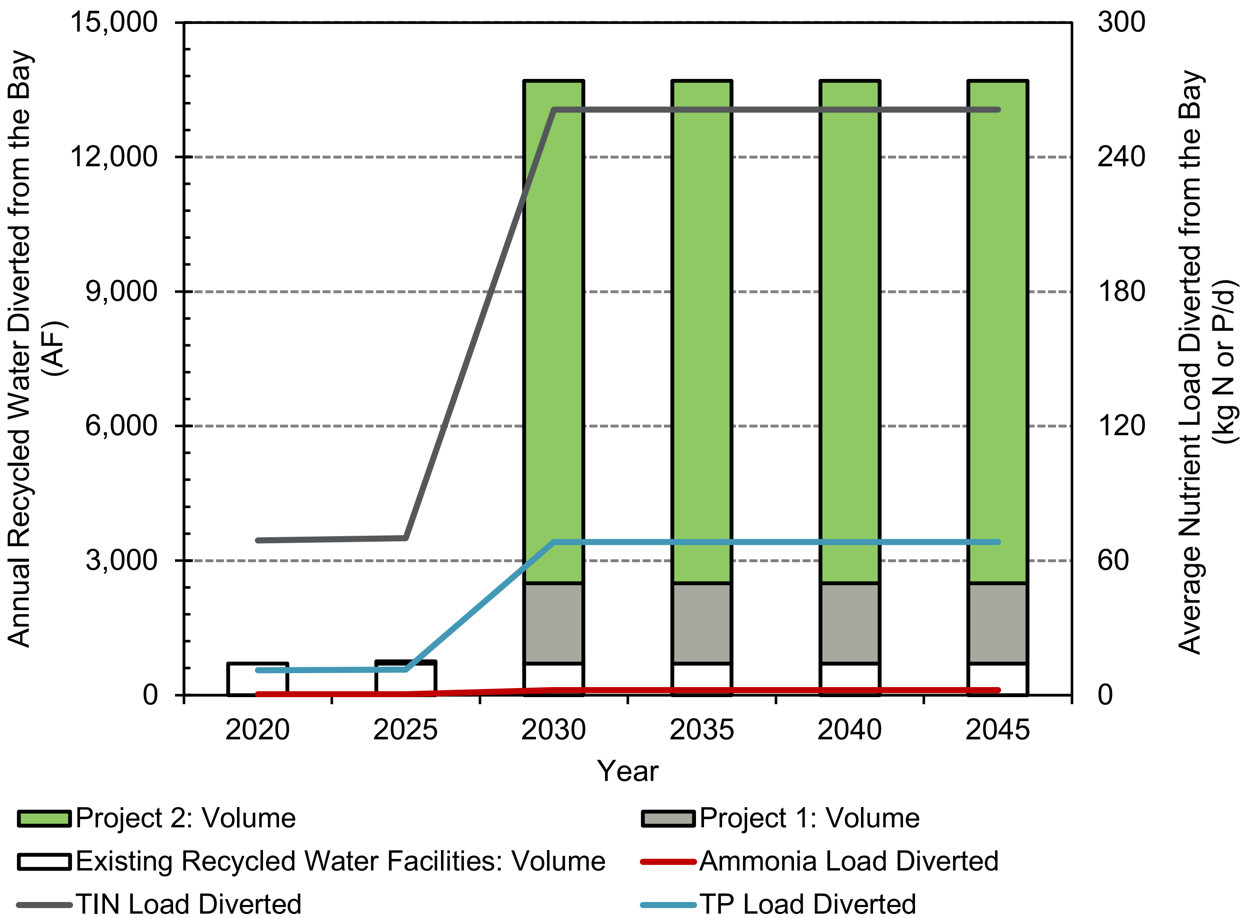

Figure 3-3. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge*

Future Project 1: refers to the local AWPS

Future Project 2: involves a regional purification plant for groundwater recharge

*** The on-going plant upgrades at the RWQCP are the primary reason for the increase in nutrients loads diverted from the Bay after year 2028 (not Projects #1 or #2). Both Projects #1 and #2 will only have modest nutrient load reductions as most of the nutrient loads will end up in the plant outfall via the RO concentrate return flows (assumed 72 percent of the advanced treatment feed load).**

3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at Palo Alto RWQCP:

- Drivers for implementing recycled water projects:
  - Water supply need – successive droughts have strained the water supplies for Palo Alto as well as all of Santa Clara Valley. As such, the need to diversify and decrease reliance on external water supplies has resulted in Palo Alto's support of expanding recycled water use.
  - Sustainability goals – the City has active sustainability goals that include the continued production and use of recycled water as a local, drought-resilient water supply.
  - Proposed discharge regulations – non-potable reuse projects could reduce regulated pollutants discharged by the RWQCP and support the need for expansion projects. However, this benefit relies heavily upon consistent and reliable customer usage. This driver becomes even less important if the recycled water is used for potable reuse due to the continued discharge of those pollutants despite increased recycled water use.
- Barriers for implementing recycled water projects:
  - Funding – funds and staffing needed for recycled water projects stem from the same sources as that needed for infrastructure repairs elsewhere in the treatment plant. The RWQCP is facing needed capital improvements that add up to more than $340 million over the next 20 years. It's difficult to prioritize recycled water projects over significant repairs needed upstream to ensure basic treatment processes continue.
  - Jurisdictional – recycled water projects, especially potable reuse projects, require cooperation not only of wastewater treatment plants but also water providers that often times have differing goals and timelines.

City of Petaluma Ellis Creek Water Recycling Facility

BACWA Recycled Water Study

Final Individual Plant Report

Petaluma, CA

June 8, 2023

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Contents

Tables

Figures

Executive Summary

The City of Petaluma Ellis Creek Water Recycling Facility (Petaluma WRF) discharges to the Petaluma River that is connected to San Pablo Bay. It is located at 3890 Cypress Drive, Petaluma, CA 94954 and it serves about 25,300 service connections throughout Petaluma and Penngrove. The plant has average dry weather flow (ADWF) design capacity of 6.7 million gallons per day (mgd).

The Petaluma WRF has an existing recycled water program that is employed year-round. The various reuse applications include golf course irrigation, landscape irrigation, agricultural, internal use, and other non-potable reuse applications. Of those listed, internal reuse applications do not result in the diversion of volume from the Bay as the volumes are eventually returned to the plant and discharged (albeit, limited to the wet season). Given that, such volumes from internal uses (upwards of 530 acre-feet per year (AFY)) are excluded from this evaluation. Subsequently, the current reuse volume considered for this evaluation is approximately 1,600 AFY (based on 2020 values; 550 million gallons per year).

A recycled water system expansion project for schools and city parks began in year 2019 and is expected to be completed by year 2025. A new pipeline will connect to the Prop 1A/Sonoma Mountain pipeline and create a looped system to increase system reliability and efficiency. It will loop via Maria Drive, and connect Meadow Elementary and Loma Vista Elementary Schools, along with various city parks.

There are two potential future recycled water projects under consideration. Both potential future projects have a confidence level of 2, as they are both budgeted. In order to provide capacity for both projects, the existing tertiary filtration system is undergoing an expansion that began in 2023. This expansion includes additional pumping capacity, two new cloth media filters, and a third ultraviolet light system for increased filtration and disinfection capacity. The production of tertiary recycled water will increase from 5.0 mgd to 6.8 mgd. This expansion project is anticipating completion by year 2026.

Future project 1 refers to additional landscape reuse application that is scheduled to begin by year 2026. As for future project 2, it refers to additional agricultural applications that is also scheduled to begin by year 2026. For both projects, the recycled water demands will peak in the dry season. In order to distribute this additional water to agricultural irrigation accounts, a recycled water system expansion is also currently underway with an expected completion date of 2026.

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES-1. Note: the total column on the far right-hand side represents the average value over a 25-year duration (year 2020 to 2045), not the peak of upwards of 4,940 AFY. The future projects range in cost from approximately $2M to $16M with the cost going towards treatment capacity expansion, as well as recycled water distribution and delivery infrastructure. The unit cost by volume is relatively high at greater than $5,000/AF for both listed future projects. Furthermore, the unit cost to reduce nutrients is relatively high as the Petaluma WRF already reliably remove nutrients (e.g., total inorganic nitrogen (TIN) concentrations are reliably less than 3 mg N/L).

The timeline and corresponding load diversions from the Bay for projected listed in Table ES-1 is provided in Figure ES-1-1. Both future projects are slated to begin recycled water deliveries by year

2026. The combined recycled water volumes are anticipated to provide approximately 4,940 AFY by year 2045.

An overview of the drivers and barriers for implementing recycled water projects at Petaluma WRF:

- Drivers for implementing recycled water projects: water supply needs
- Barriers for implementing recycled water projects: Design and construction taking longer than planned.

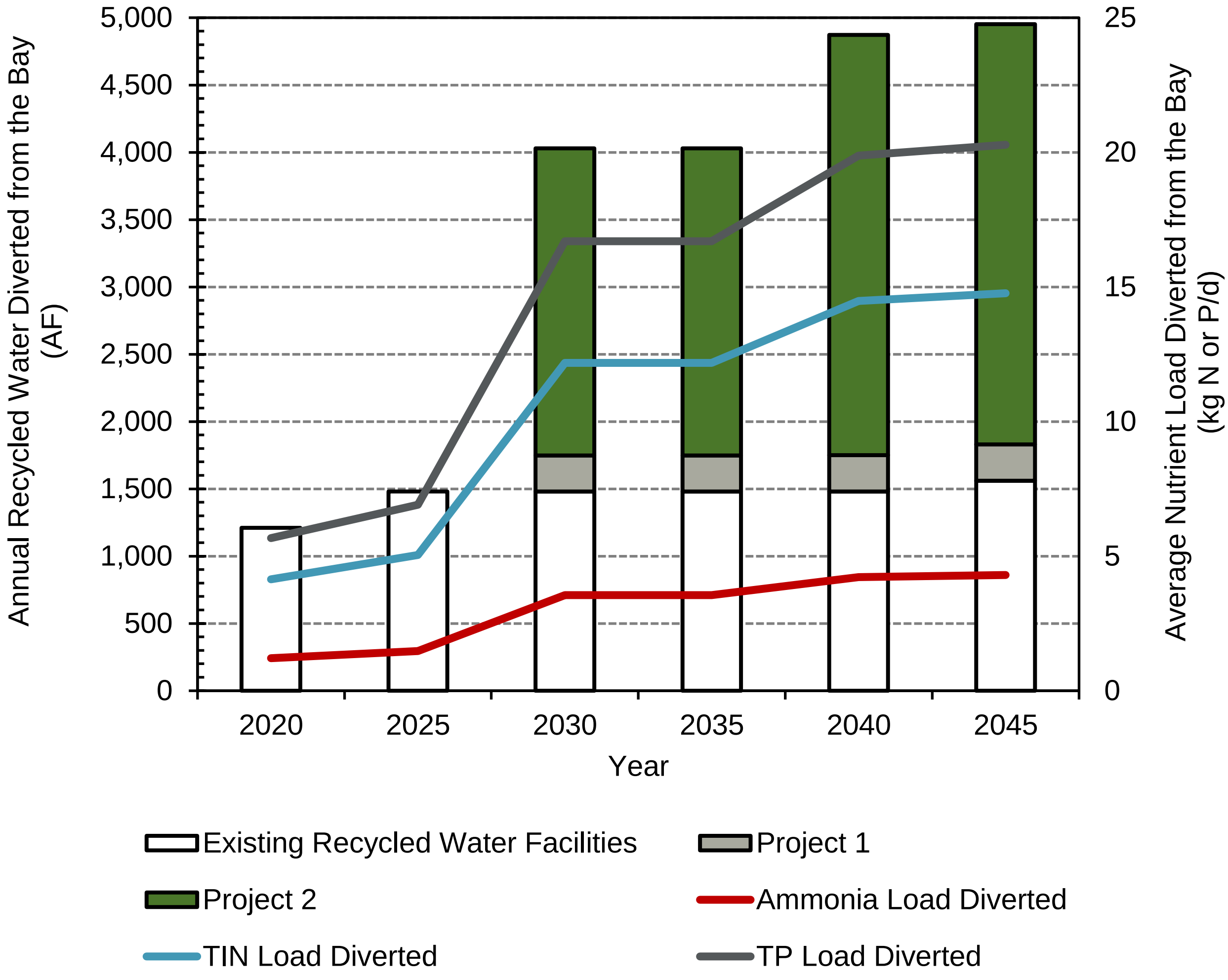

Figure ES-1-1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge

Existing Recycled Water Facilities: excludes internal reuse volumes (upwards of 530 AFY) as such volumes do not result in the diversion of volume from the Bay.

Future Project 1: refers to additional landscape reuse application that is scheduled to begin by year 2026.

Future Project 2: it refers to additional agricultural applications that is also scheduled to begin by year 2026.

Table ES-1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project 1 (Landscape Application Starting by Year 2026) *, **, ***		Future Project 2 (Agricultural Application Starting by Year 2026) *, **, ***		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]									
Flow	mgd	2.5	1.3	0.40	0.24	4.1	1.9	6.1	3.1
Volume	AF	1,160	1,440	188	270	1,900	2,160	2,880	3,430
Load Diverted from the Bay[2,3]									
Confidence	unitless	1	1	2	2	2	2	Blend of 1 and 2	Blend of 1 and 2
Duration	Years	25	25	19	19	19	19	25	25
Flow Diverted	%	100%	25%	100%	6%	100%	2%	100%	44%
Ammonia Load Diverted	kg N/d	3	1	0	0	4	2	6	3
TIN Load Diverted	kg N/d	10	5	2	1	12	6	20	10
TP Load Diverted	kg P/d	13	7	2	1	17	8	28	14
Cost[3,4,5]									
Capital Cost	$ Mil	--	--	2.6	2.6	16.2	16.2	18.8	18.8
NPV O&M	$ Mil	59.4	73.4	28.0	40.4	224	254	311	367
NPV Total (Capital+NPV O&M)	$ Mil	59.4	73.4	30.6	42.9	240	270	330	386
Unit Flow Cost[6]									
Unit Cost	$/gpd	24	57	77	178	59	140	54	126
Unit Cost	$/AF	2,040	2,040	8,590	8,370	6,630	6,580	4,580	4,510
Unit Load Cost[7,8]									
Ammonia Unit Cost	$/lb Ammonia Diverted	2,550	2,550	10,700	10,500	10,300	10,300	6,660	6,510
TIN Unit Cost	$/lb TIN Diverted	741	743	3,120	3,050	3,010	2,990	1,940	1,900
TP Unit Cost	$/lb TP Diverted	541	542	2,280	2,220	2,200	2,180	1,420	1,380

* Existing RW Projects refers to existing treatment facilities producing RW. Note: this excludes internal reuse volumes (upwards of 530 AFY) as such volumes do not result in the diversion of volume from the Bay; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3). For the Total columns, the project start period is from year 2020 through year 2045.

*** Future Project 1: refers to additional landscape reuse application that is scheduled to begin by year 2026.

**** Future Project 2: refers to additional agricultural applications that is also scheduled to begin by year 2026.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by Petaluma WRF.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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1 Introduction and Current Conditions

The City of Petaluma Ellis Creek Water Recycling Facility (Petaluma WRF) discharges to Petaluma River that is connected to San Pablo Bay. It is located at 3890 Cypress Drive, Petaluma, CA 94954 and it serves about 25,300 service connections throughout Petaluma and Penngrove. The plant has average dry weather flow (ADWF) design capacity of 6.7 million gallons per day (mgd). Effluent flow that is not discharged to the Petaluma River is diverted to recycled water whenever possible. Discharge to Petaluma River is prohibited May 1 through October 20, except when the Facility inflow exceeds the recycled water distribution and storage system capacity.

The subsections that follow provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

Petaluma WRF holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2021-0008). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2021-0008; CA0037810)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	6.7	--	--	--
Effluent BOD (1)	mg/L	--	30	45	--
Effluent TSS (1)	mg/L	--	30	45	--
Effluent Ammonia	mg N/L	--	3.0	--	8.0

1. BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for Petaluma WRF. Both liquids processes and solids processes are shown. Facility influent is treated by screening and grit removal, activated sludge (oxidation ditches), and clarification. After clarification, some of the water is pumped to the Discharger’s tertiary treatment system (flocculation, filtration, and UV disinfection), and subsequently recycled. Remaining flows are directed through a series of oxidation ponds and constructed wetlands for additional biological treatment. After the treatment wetlands, the water is chlorinated and then flows to either polishing wetlands or a chlorine contact chamber and dechlorination process. Oxidation ditches provide long retention time to achieve nitrogen removal. Solids are thickened, anaerobically digested and dewatered.

1.3 Existing Recycled Water Service

The Petaluma WRF has an existing recycled water program that is employed year-round. The various reuse applications include golf course irrigation, landscape irrigation, agricultural, internal use, and other non-potable reuse applications. Of those listed, internal reuse applications do not result in the diversion of volume from the Bay as the volumes are eventually returned to the plant and discharged (albeit, limited to the wet season). Given that, such volumes from internal (upwards of 530 AFY) are excluded from this evaluation. Subsequently, the current reuse volume considered for this evaluation is approximately 1,600 acre-feet per year (based on 2020 values; 550 million gallons per year).

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)[1]	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	0	6.76	3.95
Volume	AF	0	4,400	4,400
Ammonia	kg N/d	0	7.54	4.40
Total Inorganic Nitrogen (TIN)	kg N/d	0	25.9	15.1
Total Phosphorus (TP)	kg P/d	0	35.5	20.7
Ammonia	mg N/L	0	0.30	0.30
TIN	mg N/L	0	0.90	0.90
TP	mg P/L	0	1.37	1.37

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

1 Petaluma WRF does not discharge to the Bay during the listed dry season as the WRF is prohibited from discharging to the Petaluma River during this time-frame (May 1 through October 20), except when the Facility inflow exceeds the recycled water distribution and storage system capacity.

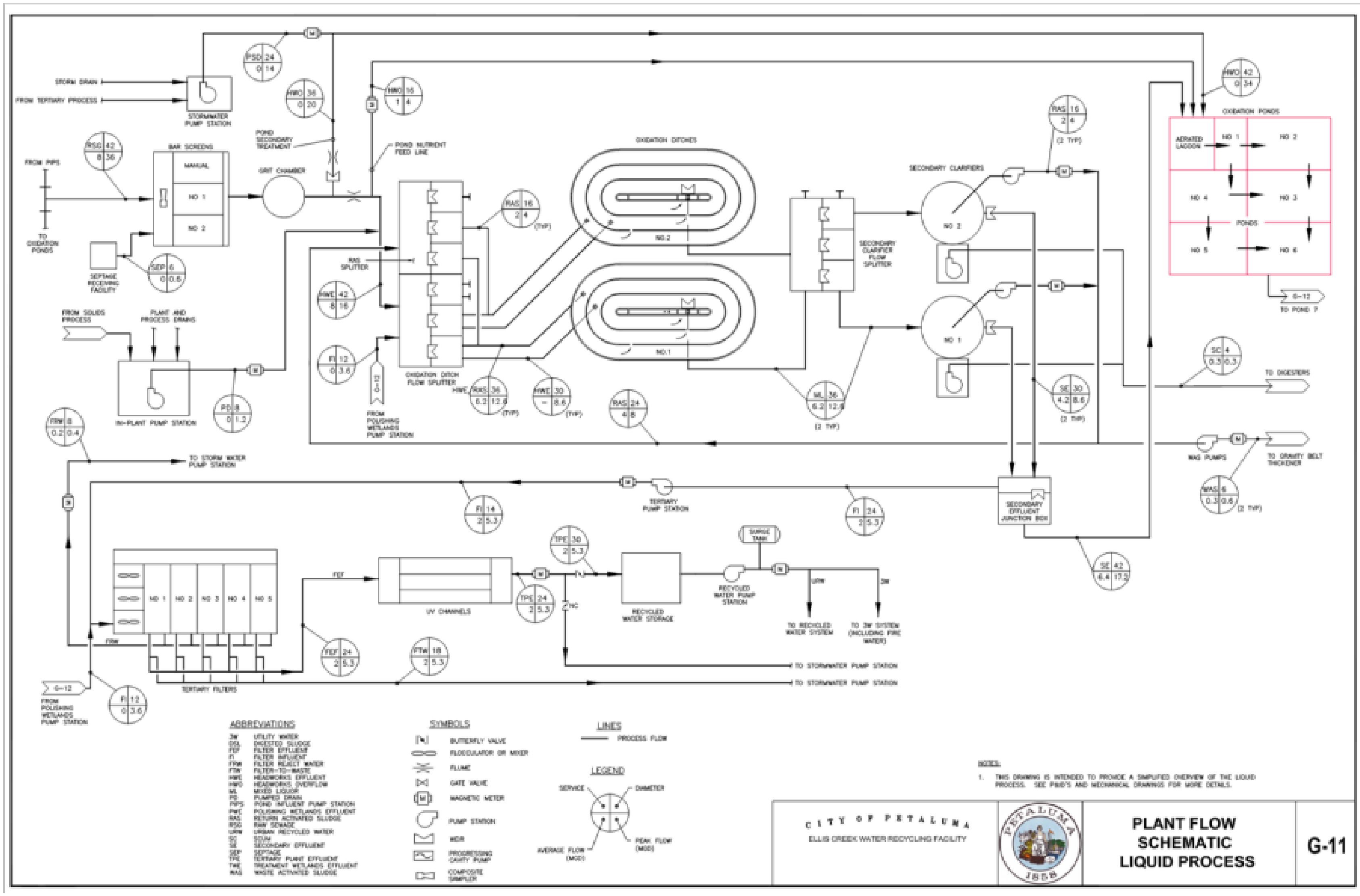

Figure 1-1. Process Flow Diagram for City of Petaluma Ellis Creek Water Recycling Facility (Source: NPDES Permit Order No. R2-2021-0008; CA0037810)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial

Use Category*	Definition
	building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with Petaluma WRF and Engineer's best judgment that considered known project constraints, existing Petaluma WRF reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by Petaluma WRF. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering,

construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g. existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g. a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects.

Table 3-1. Recycled Water Projects Identified by Petaluma WRF

Recycled Water Project	Description
Existing Recycled Water Facilities	The Petaluma RWF provides tertiary treatment, specifically sand filters and UV disinfection to meet total coliform, disinfection, and turbidity limits prior to distribution. The various reuse applications include golf course irrigation, landscape irrigation, agricultural, internal use, and other non-potable reuse applications. Of those listed, internal applications do not result in the diversion of volume from the Bay as such volumes are eventually returned to the plant and discharged (albeit, limited to the wet season). Given that, such volumes from internal uses (upwards of 530 AFY) are excluded from this evaluation. Subsequently, the current reuse volumes considered for this evaluation are approximately 1,200 acre-feet per year (based on 2020 values; 400 million gallons per year.
Future Project 1 (Landscape)	Anticipated to begin delivering recycled water in year 2026. The program will provide upwards of approximately 270 AFY by year 2045 for elementary school and urban park irrigation.
Future Project 2 (Agricultural)	Anticipated to begin delivering recycled water in year 2026. The program will provide upwards of approximately 3,120 AFY by 2045 for additional tertiary treatment capacity and agricultural irrigation

The subsections that follow summarize the flow and nutrient load reductions for each listed project in Table 3-1.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. Recycled water deliveries via existing facilities will increase and meet Petaluma's capacity of approximately 1,500 AFY by 2045 (excludes volumes from internal reuse applications). Project 1 will allow for an additional 270 AFY by year 2045. Project 2 will allow for an additional 3,120 AFY by year 2045. This will create a combined total of approximately 4,940 AFY by year 2045.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Distributed – Return Flows (AFY)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**1**	**1,210**	**1**	**4**	**6**
	Existing Facilities‡	1	**1,210**	**1**	**4**	**6**
	Project 1**	2	**--**	**--**	**--**	**--**
	Project 2***	2	**--**	**--**	**--**	**--**
2025	**Total**	**1**	1,480	1	5	7
	Existing Facilities‡	1	1,480	1	5	7
	Project 1**	2	**--**	**--**	**--**	**--**
	Project 2***	2	**--**	**--**	**--**	**--**
2030	**Total**	**Blend of 1 and 2**	**4,030**	**4**	**14**	**19**
	Existing Facilities‡	1	1,480	1	5	7
	Project 1**	2	269	<1	1	1
	Project 2***	2	2,280	2	8	11
2035	**Total**	**Blend of 1 and 2**	**4,030**	**4**	**14**	**19**
	Existing Facilities‡	1	1,480	1	5	7
	Project 1**	2	269	<1	1	1
	Project 2***	2	2,280	2	8	11
2040	**Total**	**Blend of 1 and 2**	**4,870**	**5**	**17**	**23**
	Existing Facilities‡	1	1,480	1	5	7
	Project 1**	2	271	<1	1	1
	Project 2***	2	3,120	3	11	15
2045	**Total**	**Blend of 1 and 2**	**4,950**	**5**	**17**	**23**
	Existing Facilities‡	1	1,560	2	5	7
	Project 1**	2	271	<1	1	1
	Project 2***	2	3,120	3	11	15

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

‡ **Existing Recycled Water Facilities:** excludes internal reuse volumes (upwards of 530 AFY) as such volumes do not result in the diversion of volume from the Bay (albeit limited to the wet season).

** **Future Project 1:** refers to additional landscape reuse application that is scheduled to begin by year 2026.

*** **Future Project 2:** it refers to additional agricultural applications that is also scheduled to begin by year 2026.

Figure 3-1 presents a distribution of the recycled water volumes diverted from the Bay by use categories from 2020 through 2045. Current and future recycled water uses via existing facilities include golf course, landscape, and agricultural irrigation. It was assumed that one hundred percent of the flows and loads associated with internal uses are returned to the plant (not diverted from the Bay).

In general, the recycled water demands peak in the dry season. Golf course irrigation occurs April-November, peaking in July and August. Landscape irrigation occurs year-round, peaking in August and September. Agricultural irrigation occurs June-November, peaking in July and August.

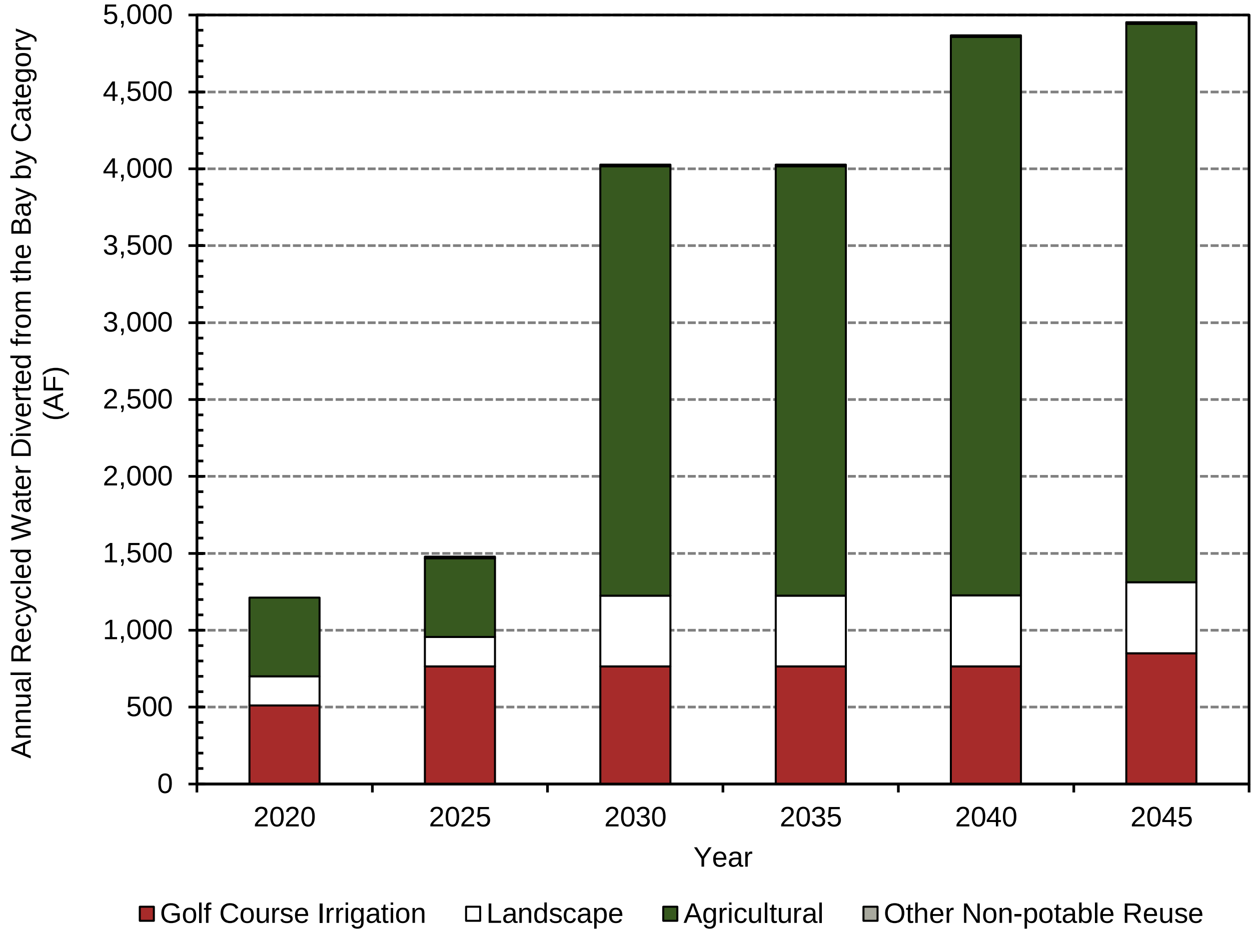

Figure 3-1: Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

Note: volumes associated with internal reuse applications are excluded from this evaluation.

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. Project 1 is in progress with anticipated completion in 2025 (deliveries by year 2026). Project 2 is also in progress, with anticipated completion in 2025 (deliveries by year 2026).

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities	• Facilities are already in place. • Staff is familiar with the treatment and distribution facilities. • Provides a means to eliminate dry season discharge. • Facilities are expandable (as they are currently being expanded to increase treatment capacity). • Removes additional particulate loads (from filtration)	--
Future Project 1 (Landscape)	• Increased filtration and disinfection capacity with subsequent increase in water supply for landscape and agricultural irrigation customers. • Increased water supply as this project will reduce potable water supply demands. • Builds upon the existing recycled water facilities (albeit requiring additional distribution) • Similar ancillary benefits as existing recycled water facilities.	--
Future Project 2 (Agricultural)	• Increased water supply as this project will reduce potable water supply demands. • Builds upon the existing recycled water facilities (albeit requiring additional distribution) • Similar ancillary benefits as existing recycled water facilities.	--

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. The recycled water volumes through existing facilities are anticipated to increase incrementally through 2045. Project 1 will allow for increased water supply for landscape purposes, such as schools and city parks. Project 2 will allow for increased water supply for agricultural irrigation. It is anticipated that both of these water usages will result in 100% of the flow and 100% of the nutrients being diverted from the Bay.

The future projects range in cost from approximately $2M to $16M with the cost going towards treatment capacity expansion, as well as recycled water distribution and delivery infrastructure. The unit cost by volume is relatively high at greater than $5,000/AF for both listed future projects. Furthermore, the unit cost to reduce nutrients is relatively high as the Petaluma WRF already reliably remove nutrients (e.g., total inorganic nitrogen (TIN) concentrations are reliably less than 3 mg N/L).

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project 1 (Landscape Application Starting by Year 2026) *, **, ***		Future Project 2 (Agricultural Application Starting by Year 2026) *, **, ***		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]									
Flow	mgd	2.5	1.3	0.40	0.24	4.1	1.9	6.1	3.1
Volume	AF	1,160	1,440	188	270	1,900	2,160	2,880	3,430
Load Diverted from the Bay[2,3]									
Confidence	unitless	1	1	2	2	2	2	Blend of 1 and 2	Blend of 1 and 2
Duration	Years	25	25	19	19	19	19	25	25
Flow Diverted	%	100%	25%	100%	6%	100%	2%	100%	44%
Ammonia Load Diverted	kg N/d	3	1	0	0	4	2	6	3
TIN Load Diverted	kg N/d	10	5	2	1	12	6	20	10
TP Load Diverted	kg P/d	13	7	2	1	17	8	28	14
Cost[3,4,5]									
Capital Cost	$ Mil	--	--	2.6	2.6	16.2	16.2	18.8	18.8
NPV O&M	$ Mil	59.4	73.4	28.0	40.4	224	254	311	367
NPV Total (Capital+NPV O&M)	$ Mil	59.4	73.4	30.6	42.9	240	270	330	386
Unit Flow Cost[6]									
Unit Cost	$/gpd	24	57	77	178	59	140	54	126
Unit Cost	$/AF	2,040	2,040	8,590	8,370	6,630	6,580	4,580	4,510
Unit Load Cost[7,8]									
Ammonia Unit Cost	$/lb Ammonia Diverted	2,550	2,550	10,700	10,500	10,300	10,300	6,660	6,510
TIN Unit Cost	$/lb TIN Diverted	741	743	3,120	3,050	3,010	2,990	1,940	1,900
TP Unit Cost	$/lb TP Diverted	541	542	2,280	2,220	2,200	2,180	1,420	1,380

* Existing RW Projects refers to existing treatment facilities producing RW. Note: this excludes both internal reuse volumes (upwards of 530 AFY) as they do not result in the diversion of volume from the Bay; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project). For the Total columns, the project start period is from year 2020 through year 2045.

*** Future Project 1: refers to additional landscape reuse application that is scheduled to begin by year 2026.

**** Future Project 2: refers to additional agricultural applications that is also scheduled to begin by year 2026.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by Petaluma WRF.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. Both future projects are slated to begin recycled water deliveries by year 2026. The combined recycled water volumes are anticipated to provide approximately 4,940 AFY by year 2045.

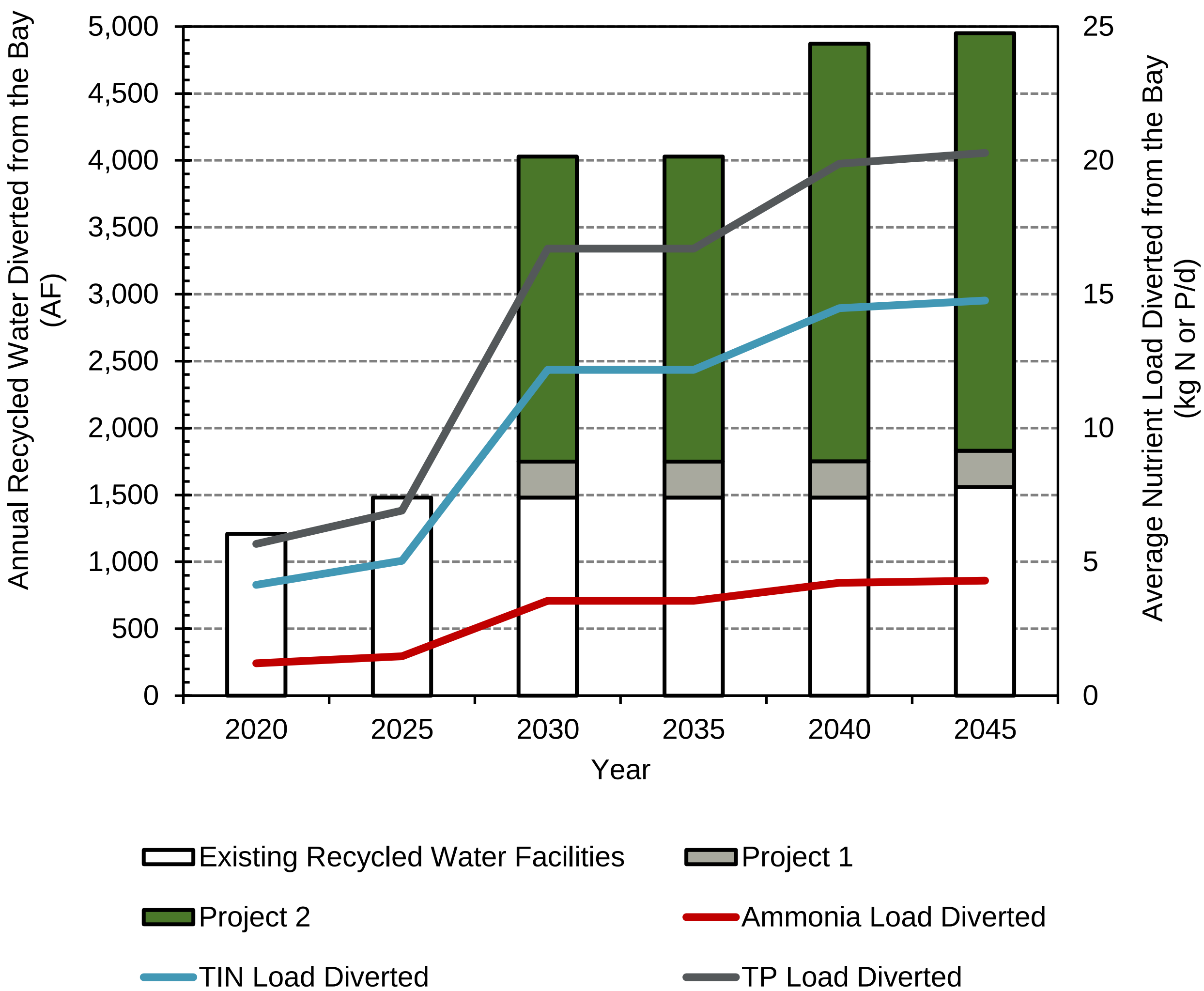

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge

Existing Recycled Water Facilities: excludes internal reuse volumes (upwards of 530 AFY) as such volumes do not result in the diversion of volume from the Bay.

Future Project 1: refers to additional landscape reuse application that is scheduled to begin by year 2026.

Future Project 2: it refers to additional agricultural applications that is also scheduled to begin by year 2026.

3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at Petaluma WRF:

- Drivers for implementing recycled water projects: water supply needs
- Barriers for implementing recycled water projects: Design and construction taking longer than planned.

Pinole-Hercules Water Pollution Control Plant

BACWA Recycled Water Study

Individual Plant Report

Pinole, CA
May 28, 2023
Final Report

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Contents

Tables

Figures

Executive Summary

The Pinole-Hercules Water Pollution Control Plant (PH WPCP) discharges to San Pablo Bay. It is located at 11 Tennent Avenue, Pinole, CA 94564, and it serves about 11,215 service connections throughout the cities of Pinole and Hercules. The plant has an average dry weather flow (ADWF) permitted capacity of 4.06 million gallons per day (mgd) and a peak permitted flow of 10.2 mgd.

The PH WPCP does not have an existing recycled water program and currently does not have plans to develop a program. The PH WPCP is not located in close proximity to landscape irrigation demands and conveyance to such demands would require significant capital investment. The PH WPCP is embarking on a recycled water recycled water opportunities assessment that is slated to begin in year 2023. Previous recycled water evaluations have been performed in collaboration with East Bay Municipal Utility District (EBMUD) and the Rodeo Sanitary District Water Pollution Control Facility (RSD WPCF) for the delivery of recycled water to a nearby refinery. The concept would entail continued use of the outfall pipeline from the PH WPCP and diversion from the outfall pipeline to the refinery for advanced treatment (as needed) to meet the refinery's water quality specifications. Historically, the refinery demands exceeded the dry weather discharges from the PH WPCP. If EBMUD has interest in expansion of their recycled water program to the local refinery, there may be an opportunity for the PH WPCP to produce and deliver recycled water year-round. Additional coordination with EBMUD and the refinery would be needed to develop recycled water quality specifications, user agreements, and to develop a cost sharing framework that is suitable to all partners.

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1 Introduction and Current Conditions

The Pinole-Hercules Water Pollution Control Plant (PH WPCP) discharges to San Pablo Bay. It is located at 11 Tennent Avenue, Pinole, CA 94564, and it serves about 11,215 service connections throughout the cities of Pinole and Hercules. The plant has an average dry weather flow (ADWF) permitted capacity of 4.06 million gallons per day (mgd) and a peak permitted flow of 10.2 mgd.

The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

The PH WPCP holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2018-0004; CA0037796). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2018-0004; CA0037796)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	4.06			
Effluent cBOD (1)	mg/L		25	40	-
Effluent TSS (1)	mg/L		30	45	-
Effluent Ammonia	mg/L		100	-	180

1. BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;
- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);

- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for PH WPCP. Both liquids processes and solids processes are shown. The wastewater treatment process consists of screening, primary clarification, activated sludge biological treatment, secondary clarification, disinfection with sodium hypochlorite, and dechlorination with sodium bisulfite. Sludge is thickened, anaerobically digested and dewatered.

The plant recently underwent an upgrade to address disinfection and potential future nutrient treatment requirements. The plant is removing ammonia and total inorganic nitrogen (TIN) with an emphasis on removal during the dry season.

1.3 Existing Recycled Water Service

The PH WPCP does not have an existing recycled water program or plans to develop one in the future. The primary barrier for such a program is lack of local demand for recycled water.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	2.38	3.02	2.75
Volume	AF	1,116	1,963	3,079
Ammonia	kg N/d	173	237	210
Total Inorganic Nitrogen (TIN)	kg N/d	242	321	288
Total Phosphorus (TP)	kg P/d	29.6	28.8	29.1
Ammonia	mg N/L	19.5	22.5	21.3
TIN	mg N/L	27.2	29.4	28.5
TP	mg P/L	3.30	2.68	2.94

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

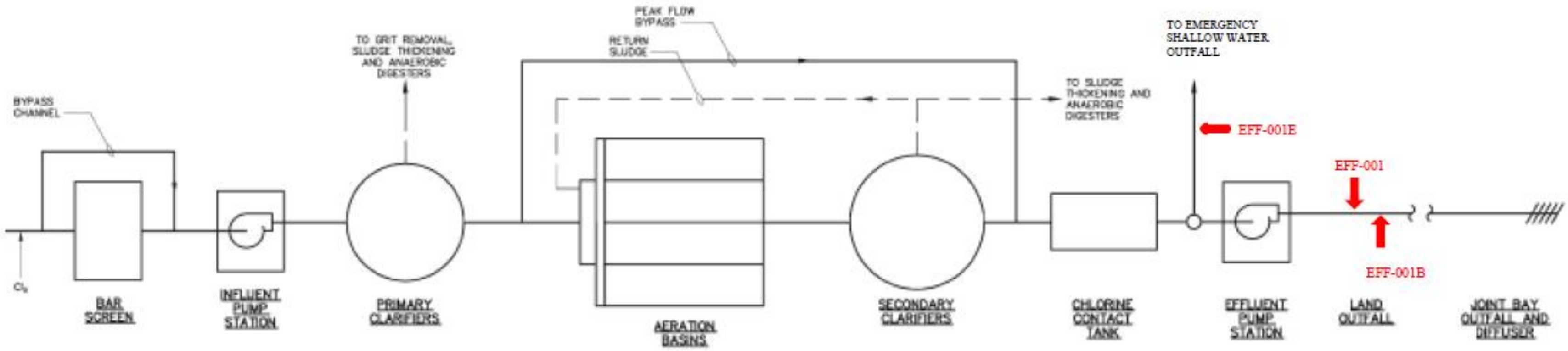

Figure 1-1. Process Flow Diagram for Pinole-Hercules Water Pollution Control Plant (Source: NPDES Permit Order No. R2-2018-0004)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with PH WPCP and Engineer's best judgment that considered known project constraints, existing PH WPCP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by PH WPCP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g. existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g. a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

The PH WPCP does not have an existing recycled water program and currently does not have plans to develop a program. The PH WPCP is not located in close proximity to landscape irrigation demands and conveyance to such demands would require significant capital investment. The PH WPCP is embarking on a recycled water recycled water opportunities assessment that is slated to begin in year 2023. Previous recycled water evaluations have been performed in collaboration with East Bay Municipal Utility District (EBMUD) and the Rodeo Sanitary District Water Pollution Control Facility (RSD WPCF) for the delivery of recycled water to a nearby refinery. The concept would entail continued use of the outfall pipeline from the PH WPCP and diversion from the outfall pipeline to the refinery for advanced treatment (as needed) to meet the refinery's water quality specifications. Historically, the refinery demands exceeded the dry weather discharges from the PH WPCP. If EBMUD has interest in expansion of their recycled water program to the local refinery, there may be an opportunity for the PH WPCP to produce and deliver recycled water year-round. Additional coordination with EBMUD and the refinery would be needed to develop recycled water quality specifications, user agreements, and to develop a cost sharing framework that is suitable to all partners.

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Richmond Municipal Sewer District

BACWA Recycled Water Study

Individual Plant Report

Richmond, CA

June 20, 2023

FINAL Report

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Contents

Tables

Figures

Executive Summary

The Richmond Municipal Sewer District (RMSD) Water Pollution Control Plant (WPCP) discharges to the Central San Francisco Bay. It shares a common outfall and discharge permit with the West County Wastewater District (WCWD) Treatment Plant (TP). It is located at 601 Canal Boulevard Richmond, CA 94804, and it serves approximately 20,000 service connections throughout the City of Richmond. The plant has an average dry weather flow (ADWF) permitted capacity of 16 million gallons per day (mgd).

This individual plant report represents both the RMSD, as well as the City of Richmond. From herein, both entities are referred to as the RMSD as the RMSD WPCP would be in the lead for producing recycled water.

RMSD does not have an existing recycled water program nor any plans to develop a program in the future. The primary barriers for such a program are water quality and geographic constraints. RMSD's collection system struggles with infiltration of seawater, especially during higher tides. As a result, the salt and corresponding conductivity levels are relatively high in WPCP influent. Such high conductivities at the RMSD influent (~5,000 microsiemens per centimeter [umhos/cm]) is undesirable for recycled water users (e.g., irrigation).[1] The most common treatment technology to remove such salts is reverse osmosis which is cost prohibitive from both construction and operational perspectives. Furthermore, such a technology creates a brine reject stream that requires downstream handling and treatment.

Geographically, the RMSD is surrounded by water and/or hills so it is costly to deliver water to any potential recycled water customers. While possible, delivering water over hills requires extensive pumping stations to lift the water over the hills which can be costly.

In order to advance a recycled water program at the RMSD, it would initially require addressing the conductivity issue. If the seawater infiltration can be reduced or eliminated, recycled water production may be feasible at the RMSD WPCP. After addressing conductivity, a recycled water program would require further treatment at the plant, as well as recycled water customers and a distribution system to provide such recycled water.

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[1] Carollo (2010) Richmond Wastewater Treatment Master Plan. Prepared for the City of Richmond and Veolia Water. Richmond, CA.

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1 Introduction and Current Conditions

The Richmond Municipal Sewer District (RMSD) Water Pollution Control Plant (WPCP) discharges to the Central San Francisco Bay. It shares a common outfall and discharge permit with the West County Wastewater District (WCWD) Treatment Plant (TP). It is located at 601 Canal Boulevard Richmond, CA 94804, and it serves approximately 20,000 service connections throughout the City of Richmond. The plant has an average dry weather flow (ADWF) permitted capacity of 16 million gallons per day (mgd).

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The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant requirements for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the applicable recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

RMSD holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2019-0003). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2019-0003)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Flow (1)	mgd	16	--	--	--
BOD (1), (2)	mg/L	--	30	45	--
TSS (1), (2)	mg/L	--	30	45	--
Ammonia (before Richmond Upgrades) (3)	mg N/L	--	32	--	59
Ammonia (after Richmond Upgrades) (3)	mg N/L	--	57	--	65

1. Flow, BOD, and TSS limits are based on RMSD effluent.
2. BOD and TSS include a minimum percent removal of 85% through the WWTP
3. Ammonia limits are applied to the combined effluent (i.e., West County Wastewater District and RMSD)
4. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;
- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

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For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for RMSD. Both liquids processes and solids processes are shown. Treatment processes consist of a wet weather flow diversion box plus storage, screening, grit removal (chambers present but not functional), flow equalization, primary sedimentation, activated sludge, chlorination, and dechlorination. No major nutrient removal systems are currently in place.

Waste activated sludge is thickened with dissolved air flotation units and blended with primary solids before anaerobic digestion. The digested biosolids are currently transported approximately 5 miles to the WCWD TP for further processing and disposal.

1.3 Existing Recycled Water Service

RMSD does not have an existing recycled water program nor any plans to develop a program in the future. The primary barrier for such a program is the WPCP is surrounding by water and hills so it is hard to deliver water to any potential recycled water customers.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Dry Season (May 1–Sept 30)	Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	9.16	14.2	12.1
Volume	AF	28.1	43.6	37.2
Ammonia	kg N/d	758	774	767
Total Inorganic Nitrogen (TIN)	kg N/d	934	1,060	1,010
Total Phosphorus (TP)	kg P/d	79.8	114	99.7
Ammonia	mg N/L	22.1	16.6	18.9
TIN	mg N/L	27.2	22.0	24.2
TP	mg P/L	2.32	2.43	2.39

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

** Note: the values represent the common outfall levels at the City of Richmond (includes discharge flows from the West County Wastewater District Treatment Plant).

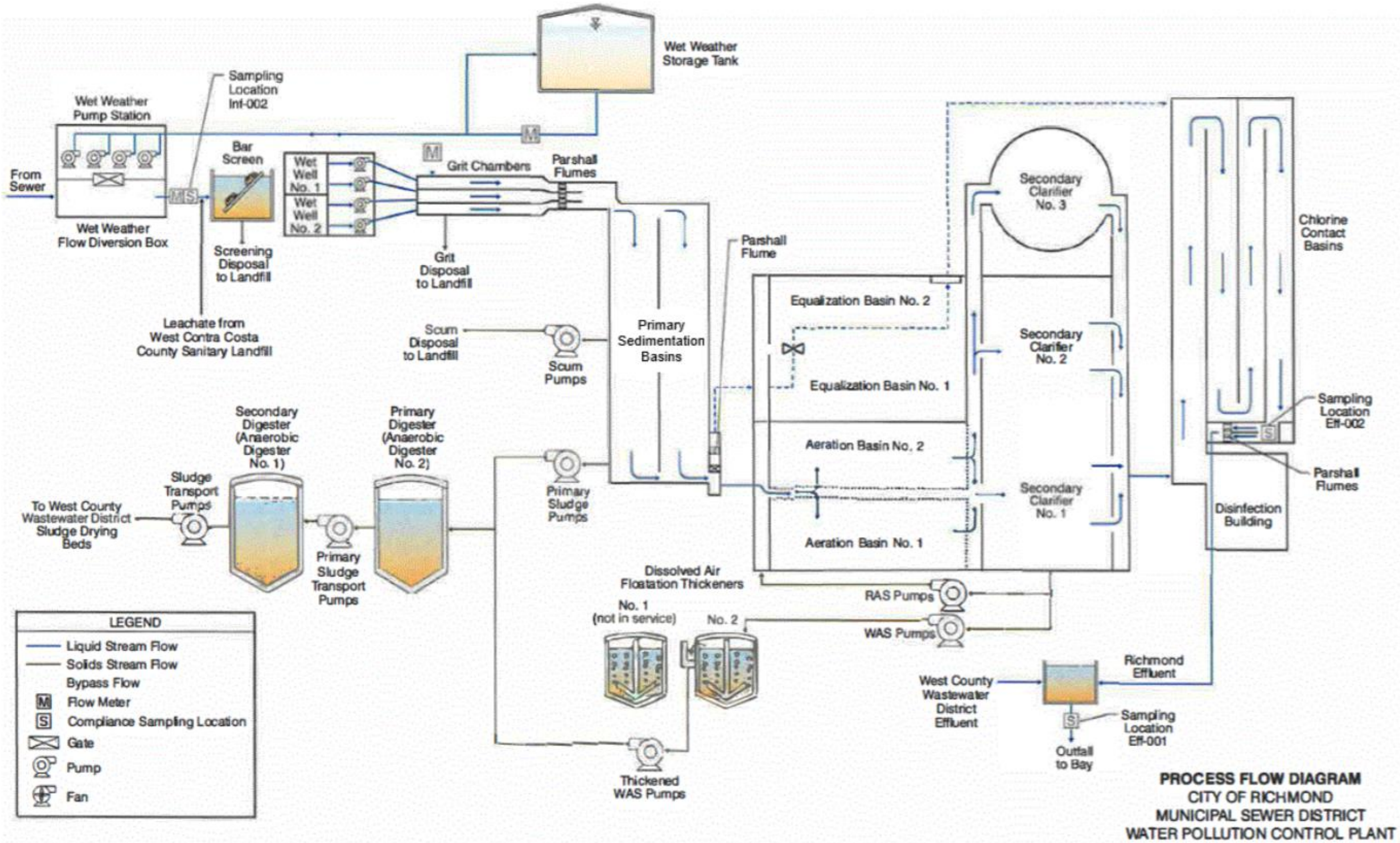

Figure 1-1. Process Flow Diagram for Richmond Municipal Sewer District (Source: NPDES Permit R2-2019-0003)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with RMSD WPCP and Engineer's best judgment that considered known project constraints, existing RMSD WPCP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by RMSD WPCP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[2] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[2] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

RMSD does not have an existing recycled water program nor any plans to develop a program in the future. The primary barriers for such a program are water quality and geographic constraints. RMSD's collection system struggles with infiltration of seawater, especially during higher tides. As a result, the salt and corresponding conductivity levels are relatively high in WPCP influent. Such high conductivities at the RMSD influent (~5,000 microsiemens per centimeter [umhos/cm]) is undesirable for recycled water users (e.g., irrigation).[1] The most common treatment technology to remove such salts is reverse osmosis which is cost prohibitive from both construction and operational perspectives. Furthermore, such a technology creates a brine reject stream that requires downstream handling and treatment.

Geographically, the RMSD is surrounded by water and/or hills so it is costly to deliver water to any potential recycled water customers. While possible, delivering water over hills requires extensive pumping stations to lift the water over the hills which can be costly.

In order to advance a recycled water program at the RMSD, it would initially require addressing the conductivity issue. If the seawater infiltration can be reduced or eliminated, recycled water production may be feasible at the RMSD WPCP. After addressing conductivity, a recycled water program would require further treatment at the plant, as well as recycled water customers and a distribution system to provide such recycled water.

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Rodeo Sanitary District

BACWA Recycled Water Study

Individual Plant Report

Rodeo, CA
June 1, 2023
FINAL Report

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Contents

Tables

Figures

Executive Summary

The Rodeo Sanitary District (RSD) Water Pollution Control Plant (WPCP) discharges to San Pablo Bay. It is located at 800 San Pablo Avenue, Rodeo, CA 94572, and it serves a population of approximately 10,000 people in Rodeo and Tormey. The plant has an average dry weather flow (ADWF) permitted capacity of 1.14 million gallons per day (mgd). It is worth noting that RSD WPCP is the smallest “major” discharger of the BACWA member agencies as defined by having a permitted capacity of $\geq$1 mgd. The current average dry season dry weather discharge flow is 0.48 mgd.

The RSD WPCP does not have an existing recycled water program and does not currently have plans to develop a program in the future. The primary barrier for such a program is lack of local demand for recycled water.

Studies have been performed in collaboration with East Bay Municipal Utility District (EBMUD) and the Pinole/Hercules Water Pollution Control Plant (PH WPCP) for the delivery of recycled water to a nearby refinery. The concept would entail continued use of the outfall pipeline from the PH WPCP and diversion from the outfall pipeline to the refinery for advanced treatment (as needed) to meet the refinery’s water quality specifications.

Historically, the refinery demands exceeded the dry weather discharges from the PH WPCP and RSD WPCP. If EBMUD has interest in expansion of their recycled water program to the local refinery, there may be an opportunity for the RSD WPCP to produce and deliver recycled water year-round. Additional coordination with EBMUD, PH WPCP, and the refinery would be needed to develop recycled water quality specifications, user agreements, and to develop a cost sharing framework that is suitable to all partners.

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1 Introduction and Current Conditions

The Rodeo Sanitary District (RSD) Water Pollution Control Facility (WPCF) discharges to San Pablo Bay. It is located at 800 San Pablo Avenue, Rodeo, CA 94572, and it serves a population of approximately 10,000 people in Rodeo and Tormey. The plant has an average dry weather flow (ADWF) permitted capacity of 1.14 million gallons per day (mgd). The current average dry season dry weather discharge flow is 0.48 mgd.

The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

RSD WPCF holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2022-0037). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2022-0037)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	1.14	--	--	--
Effluent Carbonaceous BOD (1)	mg/L	--	25	40	--
Effluent TSS (1)	mg/L	--	30	45	--
Effluent Ammonia	mg N/L	--	54	--	140

1. Carbonaceous BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for RSD WPCP. Both liquids processes and solids processes are shown. The treatment plant consists of comminutors, bar screens, aerated grit removal, primary clarification, activated sludge biological treatment, secondary clarification, disinfection with sodium hypochlorite, and dechlorination with sodium bisulfite. The aeration basin operates at a high enough SRT to facilitate full nitrification. Solids removed from the wastewater stream are thickened, digested anaerobically, and dewatered for off-site disposal.

1.3 Existing Recycled Water Service

The RSD WPCP does not have an existing recycled water program nor any plans to develop a program in the future. The primary barrier for such a program is lack of local demand for recycled water.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	0.54	0.80	0.69
Volume	AF	250	520	770
Ammonia	kg N/d	3.3	7.6	5.88
Total Inorganic Nitrogen (TIN)	kg N/d	32.4	43	38.5
Total Phosphorus (TP)	kg P/d	7.67	9.25	8.59
Ammonia	mg N/L	1.56	2.6	2.18
TIN	mg N/L	15.7	14.6	15.1
TP	mg P/L	3.74	3	3.56

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

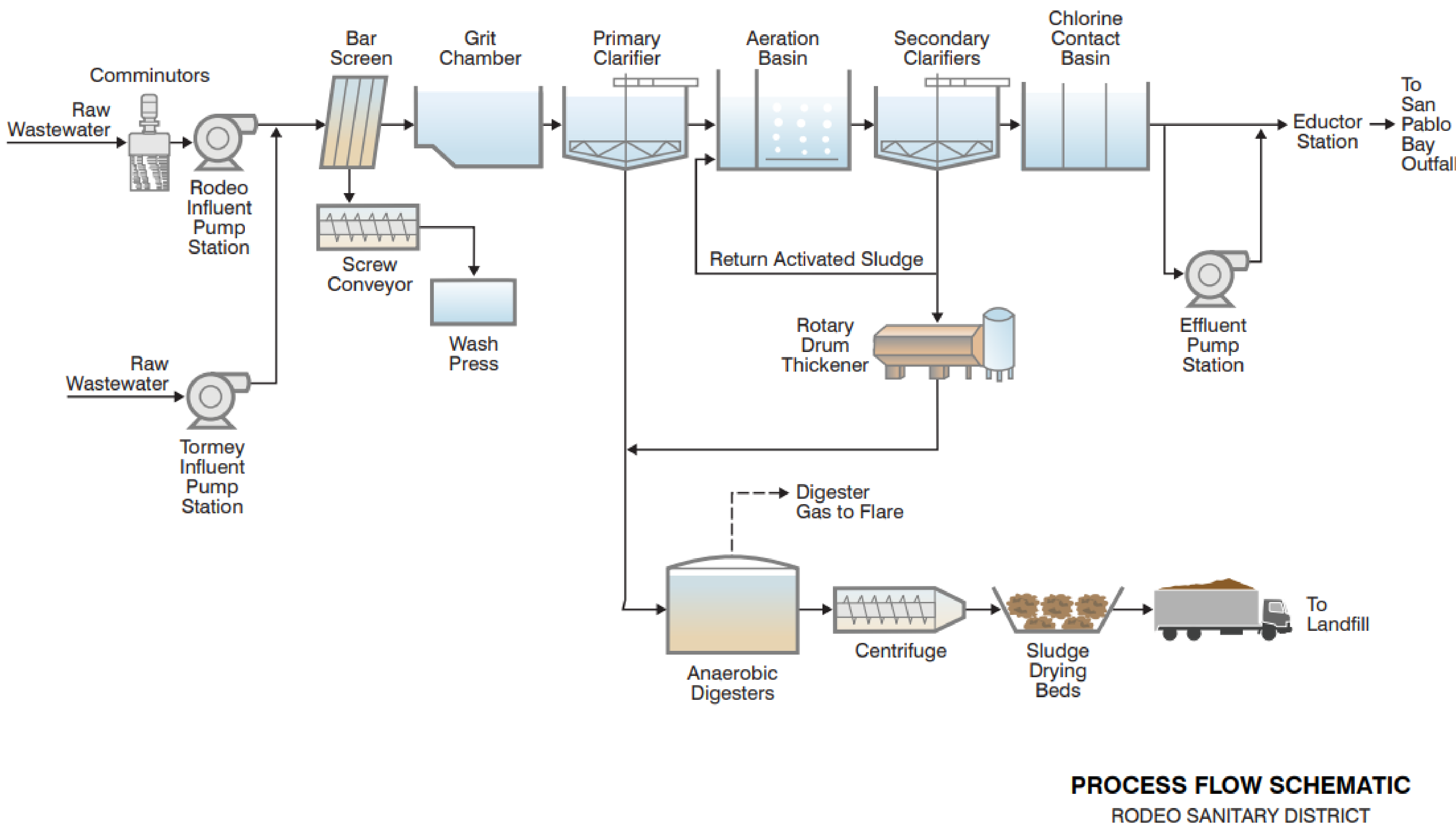

Figure 1-1. Process Flow Diagram for Rodeo Sanitary District

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2020 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
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Use Category*	Definition
	building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter
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Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
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Future seasonality projections were based on a combination of working with RSD WPCF and Engineer’s best judgment that considered known project constraints, existing RSD WPCF reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

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- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN, or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

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A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

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- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

The RSD WPCF does not have an existing recycled water program and does not currently have plans to develop a program in the future. The primary barrier for such a program is lack of local demand for recycled water.

Studies have been performed in collaboration with East Bay Municipal Utility District (EBMUD) and the Pinole/Hercules Water Pollution Control Plant (PH WPCP) for the delivery of recycled water to a nearby refinery. The concept would entail continued use of the outfall pipeline from the PH WPCP and diversion from the outfall pipeline to the refinery for advanced treatment (as needed) to meet the refinery's water quality specifications.

Historically, the refinery demands exceeded the dry weather discharges from the PH WPCP and RSD WPCP. If EBMUD has interest in expansion of their recycled water program to the local refinery, there may be an opportunity for the RSD WPCF to produce and deliver recycled water year-round. Additional coordination with EBMUD, PH WPCP, and the refinery would be needed to develop recycled water quality specifications, user agreements, and to develop a cost sharing framework that is suitable to all partners.

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San Francisco International Airport, Mel Leong Treatment Plant

BACWA Recycled Water Study
Final Individual Plant Report

South San Francisco, CA
May 24, 2023

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Contents

Tables

Figures

Executive Summary

The City and County of San Francisco, San Francisco International Airport, Mel Leong Treatment Plant (SFO MLTP) is located in San Francisco, CA and discharges treated effluent to the Lower San Francisco Bay. The SFO MLTP is comprised of a Sanitary Plant and Industrial Plant treating sanitary wastewater and industrial wastewater, respectively. The Sanitary Plant has an average dry weather flow (ADWF) permitted capacity of 2.2 million gallons per day (mgd), and the Industrial Plant has an ADWF permitted capacity of 1.6 mgd.

Construction is scheduled to start in 2025 for a recycled water distribution pipeline and Advanced Water Treatment (AWT) facility at SFO. Flows will be treated through granular activated carbon (GAC), ion exchange (IX), membrane filtration (MF), reverse osmosis (RO), and UV disinfection. The product water will be utilized within the airport campus for toilet flushing, car washing, cooling tower use, and other non-potable uses. The AWT facility is anticipated to be online by 2026 with a production capacity of approximately 225 AFY. Of the 225 AFY, approximately 40 percent of the flow and load would be diverted from the Bay as 60% of the flow would be returned to the sanitary plant based on the various uses. Therefore, 90 AFY (i.e., 40% of 225 AFY) was assumed for this analysis. Design and planning work has also begun on the addition of a proprietary aerobic granular sludge process (AquaNereda) that reduces nutrients. Construction on this system is slated to begin in 2025 or 2026.

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES-1. Note: the existing recycled water facilities will be replaced with an AWT system around year 2025. The AWT will increase reuse production capacity up to 225 AFY. Of that, about 40 percent will be diverted from the Bay as show on this plot (approximately 90 AFY).

The costs for the AWT around year 2026 is $100 Mil plus $0.5M per year for O&M. The unit costs on a flow/volume basis are relatively high as evidenced by $/gpd over 1,000, regardless of project (similar perspective for $/AF). The unit costs for nutrients are also relatively high with values greater than $500/lb nutrient removed, regardless of nutrient removed, averaging period, or project. It is worth noting that the project is focused on reducing potable water demands at the airport campus.

The timeline and corresponding load diversions from the Bay is provided in Figure ES-1. Note: the existing recycled water facilities will be replaced with an AWT system around year 2026. Approximately 50 percent of the flow and corresponding nutrient load will be diverted from the Bay as previously stated.

An overview of the drivers and barriers for implementing recycled water projects at SFO MLTP:

- Drivers for implementing recycled water projects:
    - Nutrient and emerging contaminant regulations will make discharge more difficult in coming permit cycles. SFO also seeks to diversify its water supply sources.
    - Water supply need
    - Proposed discharge regulations
    - Institutional

- Barriers for implementing recycled water projects:
  - Permitting from the Water Board
  - Institutional
  - Jurisdictional
  - Inability for users outside of the Airport's service area to use the recycled water

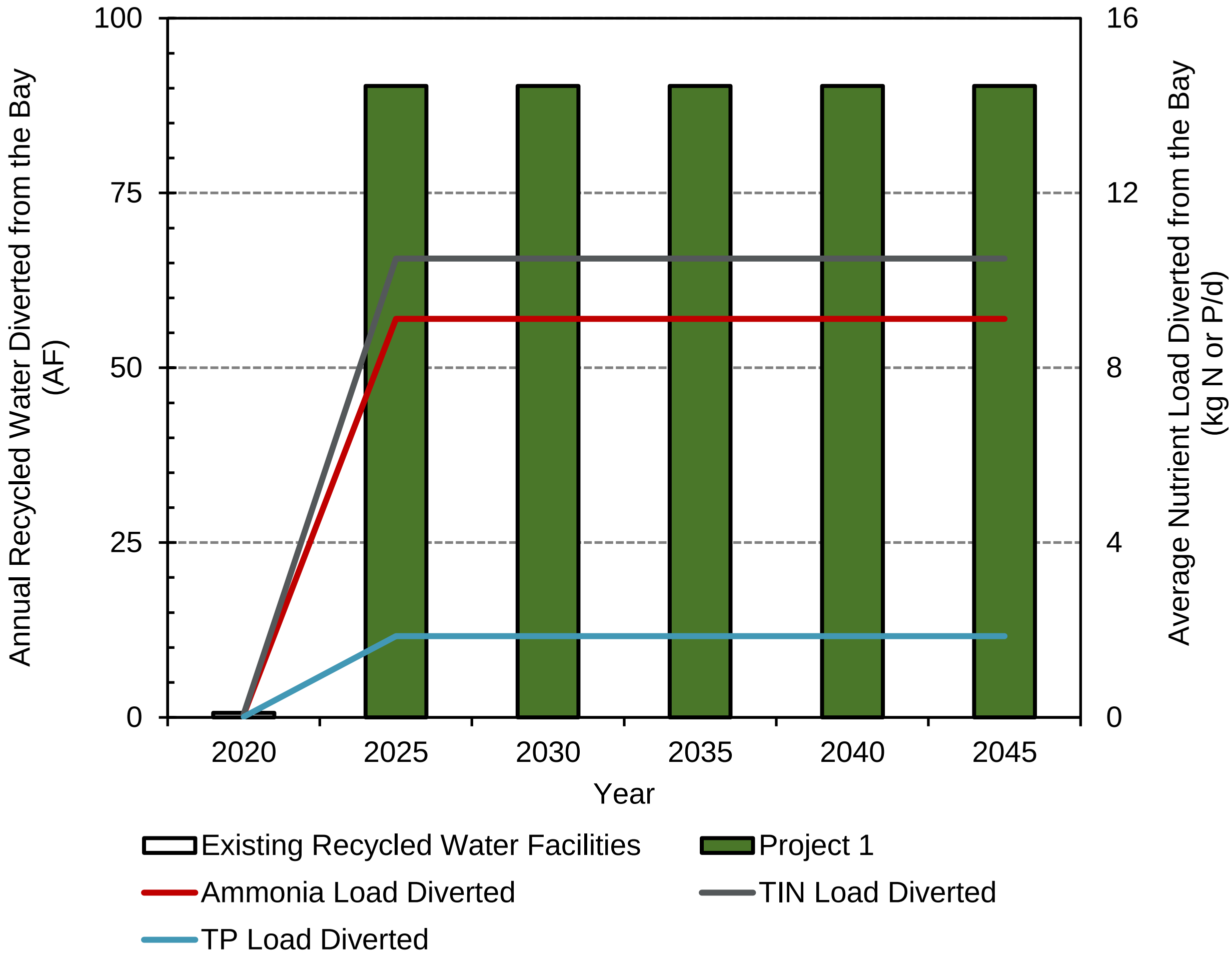

Figure ES-1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge

Note: the existing recycled water facilities will be replaced with an AWT system around year 2025. The AWT will increase reuse production capacity up to 225 AFY. Of that, about 40 percent will be diverted from the Bay as show on this plot (approximately 90 AFY).

Table ES-1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (Advanced Water Treatment Facility Slated for Year 2025) *, **, ***		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *, **, ***	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	0.001	0.001	0.08	0.08	0.07	0.07
Volume	AF	0.4	0.7	38	90	32	75
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	2	2	Blend of 1 and 2	Blend of 1 and 2
Duration	Years	4	4	20	20	25	25
Flow Diverted	%	<1%	<1%	7%	6%	6%	5%
Ammonia Load Diverted	kg N/d	<1	<1	5	4	4	3
TIN Load Diverted	kg N/d	<1	<1	6	4	5	3
TP Load Diverted	kg P/d	<1	<1	1	1	1	1
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	100	100	100	100
NPV O&M	$ Mil	7.4	11	3.4	8.2	11	20
NPV Total (Capital+NPV O&M)	$ Mil	7.4	11	103	108	111	120
Unit Flow Cost[6]							
Unit Cost	$/gpd	7,970	19,000	1,290	1,340	1,650	1,780
Unit Cost	$/AF	4,240,000	4,240,000	137,000	59,900	140,000	63,500
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	38,000	52,200	3,050	1,830	3,250	2,020
TIN Unit Cost	$/lb TIN Diverted	33,500	45,500	2,680	1,600	2,860	1,760
TP Unit Cost	$/lb TP Diverted	207,000	256,000	16,500	9,000	17,600	9,920

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (AWT planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3). For the Total columns, the project start period is from year 2020 through year 2045.

***** The existing recycled water facilities will be replaced with an AWT system around year 2025. The AWT will increase reuse production capacity up to 225 AFY. Of that, about 40 percent will be diverted from the Bay as show on this plot (approximately 90 AFY).**

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by SFO MLTP. The provided values escalated to 2020 dollars.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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1 Introduction and Current Conditions

The City and County of San Francisco, San Francisco International Airport, Mel Leong Treatment Plant (SFO MLTP) is located in San Francisco, CA and discharges treated effluent to the Lower San Francisco Bay. The Sanitary Plant has an average dry weather flow (ADWF) permitted capacity of 2.2 million gallons per day (mgd). The facility also includes the Industrial Plant, which is not evaluated in this study.

The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The four most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements. SFO will require and individual Waste Discharge Permit from the Water Control Board for recycled water use.

1.1.1 National Pollutant Discharge Elimination System

SFO holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2018-0045). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2018-0045; CA0038318)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	2.2	--	--	--
Effluent BOD [(1)]	mg/L	--	25	40	--
Effluent TSS [(1)]	mg/L	--	30	45	--
Effluent Ammonia	mg N/L	--	120	--	310

1. BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for SFO. Both liquids processes and solids processes are shown. Figure 2-1 shows the process flow diagram for the Sanitary Plant. Both liquids and solids processes are shown. The Sanitary Plant consists of screening and grit removal, flow equalization, followed by sequencing batch reactors (SBRs) for secondary treatment. Secondary effluent is disinfected by chlorination. Solids treatment consists of secondary sludge thickening, anaerobic digestion and dewatering using either drying beds or belt filter press.

1.3 Existing Recycled Water Service

SFO MLTP has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. SFO MLTP currently recycles approximately 1 acre-feet per year (<0.1 million gallons per year).

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Dry Season (May 1–Sept 30)	Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	1.14	1.25	1.21
Volume	AF	537	814	1,350
Ammonia	kg N/d	177	107	137
Total Inorganic Nitrogen (TIN)	kg N/d	201	126	157
Total Phosphorus (TP)	kg P/d	33	25	28
Ammonia	mg N/L	39.8	23.5	30.3
TIN	mg N/L	45.3	27.5	34.9
TP	mg P/L	7.58	5.24	6.22

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

Figure C-1. Sanitary Plant Process Flow Diagram

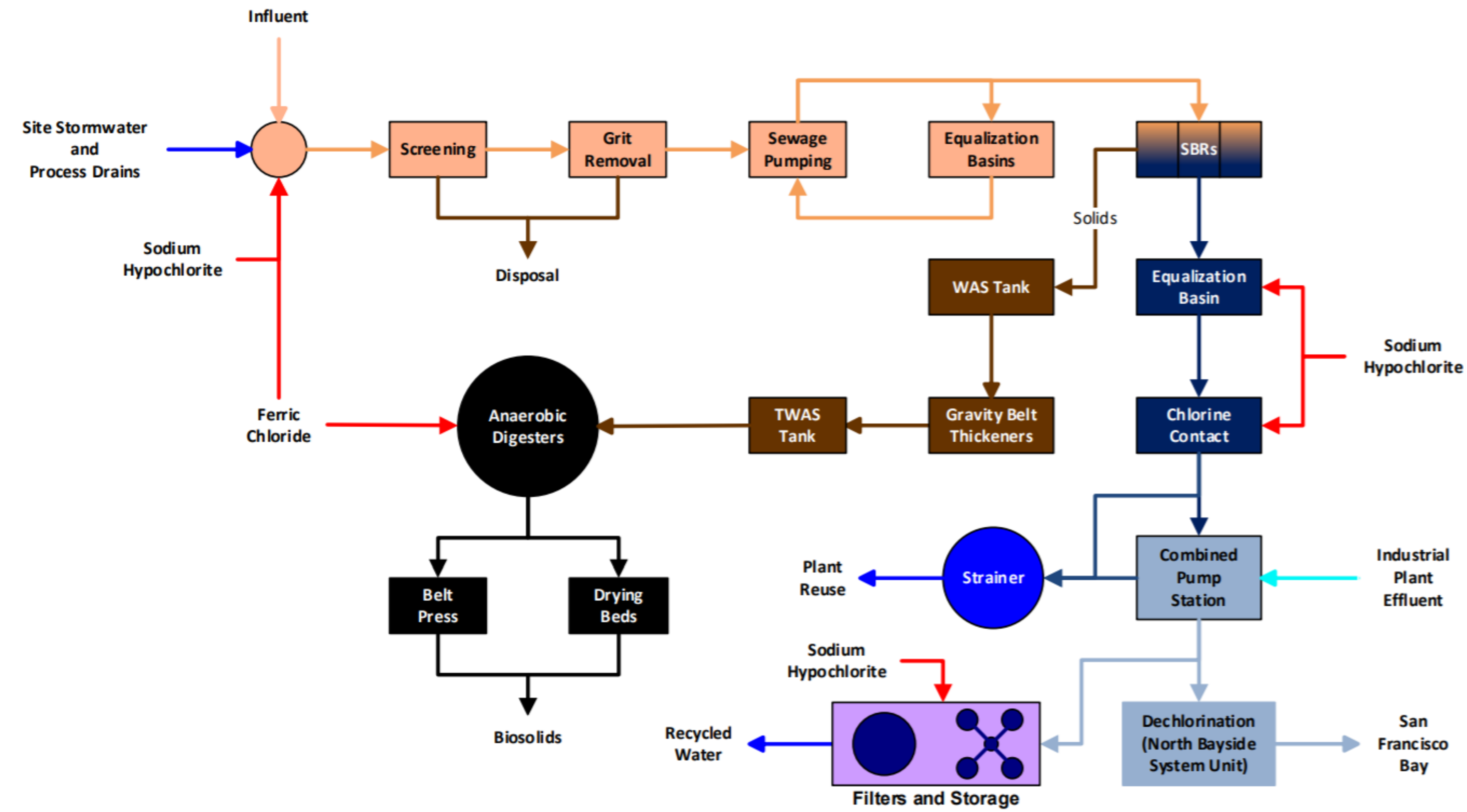

Figure 1-1. Process Flow Diagram for SFO MLTP (Source: NPDES Permit Order No. R2-2018-0045; CA CA0038318)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2020- to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with SFO MLTP and Engineer's best judgment that considered known project constraints, existing SFO MLTP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by SFO MLTP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects. The subsections that follow summarize the flow and nutrient load reductions for each listed project in Table 3-1.

Table 3-1. Recycled Water Projects Identified by SFO MLTP

Recycled Water Project	Description
Existing Recycled Water Facilities	SFO sanitary plant facilities include sequencing batch reactors for biological treatment, chlorination, and filtration to meet Title 23 requirements prior to distribution.
Future Project	225 AFY Advanced Water Treatment Facility.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. Construction is currently underway for a recycled water distribution pipeline and AWT. The AWT is anticipated to be online by 2025 with a production capacity of approximately 225 AFY. In addition to the new 224 AFY demand for toilet flushing, car washing, cooling tower use, and other non-potable uses, it is assumed that this facility will also meet the existing 0.7 AFY demand for landscape irrigation, dust control, and street sweeping.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence*	Average Distributed – Return Flows (AF)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**1**	**1**	**<1**	**<1**	**<1**
	Existing Facilities**	1	1	<1	<1	<1
	Future Projects‡	2	--	--	--	--
2025	**Total**	**Blend of 1 & 2**	90	9	11	2
	Existing Facilities**	1	--	--	--	--
	Future Projects‡	2	90	9	11	2
2030	**Total**	**Blend of 1 & 2**	90	9	11	2
	Existing Facilities**	1	--	--	--	--
	Future Projects‡	2	90	9	11	2
2035	**Total**	**Blend of 1 & 2**	90	9	11	2
	Existing Facilities**	1	--	--	--	--
	Future Projects‡	2	90	9	11	2
2040	**Total**	**Blend of 1 & 2**	90	9	11	2
	Existing Facilities**	1	--	--	--	--
	Future Projects‡	2	90	9	11	2
2045	**Total**	**Blend of 1 & 2**	90	9	11	2
	Existing Facilities**	1	--	--	--	--
	Future Projects ‡	2	90	9	11	2

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

** The existing facilities are anticipated to be decommissioned once the future project is commissioned.

‡ The future project is a 225 AFY AWT. The AWT will increase reuse production capacity up to 225 AFY. Of that, about 40 percent will be diverted from the Bay and as used in this table (approximately 90 AFY).

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. Current uses include landscape irrigation and dust control/street sweeping. After completion of the new AWT, recycled water will be utilized within the SFO campus for dual plumbing applications, cooling tower make-up water, and car washing. The following assumptions were made for flow and load diversions from the Bay for SFO's various demands:

- Landscape irrigation: 100% flow diverted, 100% nutrients diverted
- Internal Use (cooling towers, dual plumbing, car washing): 40% flow and nutrients load diverted based on conversation with SFO MLTP.
- Other non-potable reuse (dust control/street sweeping): 100% flow diverted, 100% nutrients diverted

In general, recycled water demands peak in the dry season, but there are year-round demands.

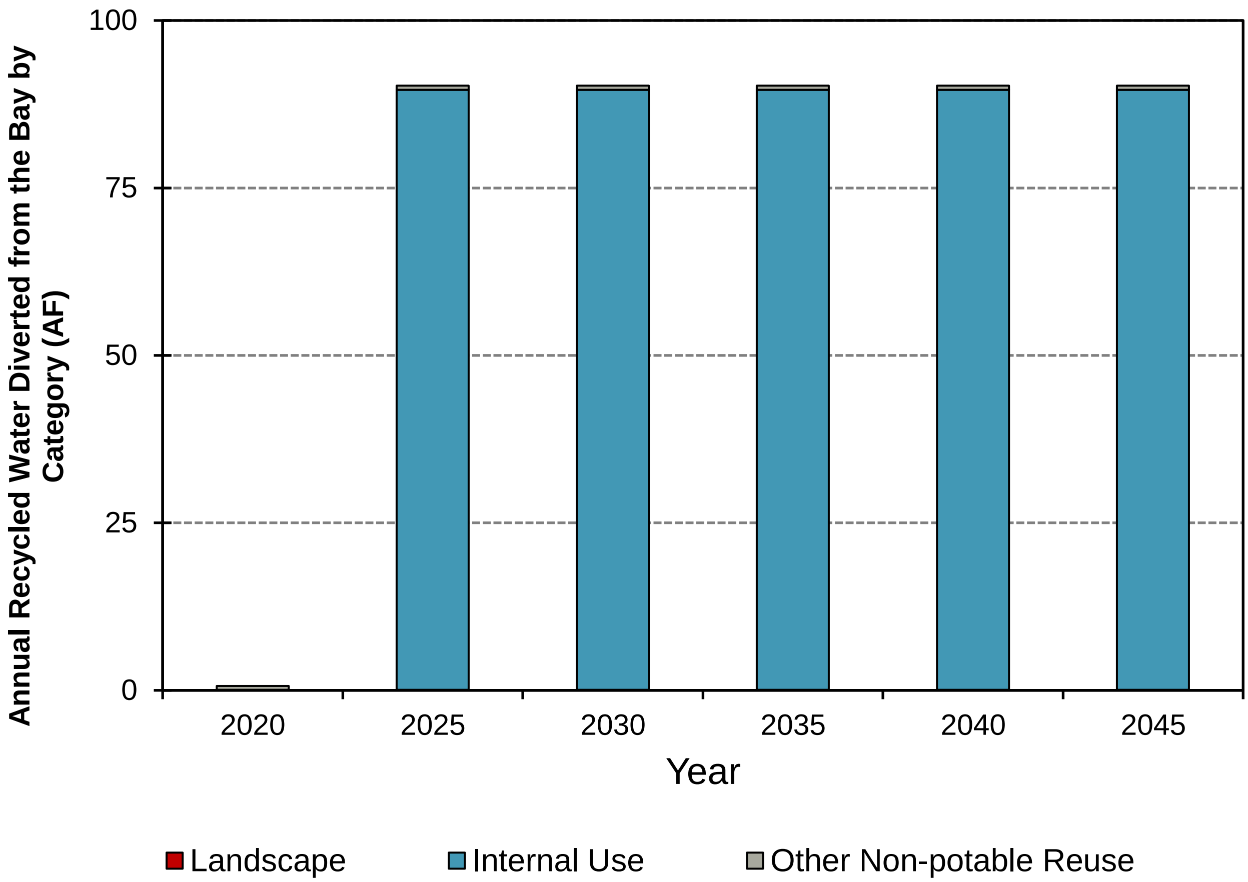

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

Note: the existing recycled water facilities will be replaced with an AWT system around year 2025. The AWT will increase reuse production capacity up to 225 AFY. Of that, about 40 percent will be diverted from the Bay as show on this plot (approximately 90 AFY).

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. The future AWT project offers several benefits, that include water supply and portfolio diversity, as well as additional treatment. However, the future AWT project comes at a cost of approximately $100 Mil for construction and $0.5 Mil to operate and maintain.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities	• Facilities are already in place and providing recycled water. • Operator familiarity with existing recycled water facilities.	• Requires maintenance for such relatively small volumes.
Project 1 (225 AFY AWT)	• Increased water supply reliability and independence from imported water. • Drought resiliency. • Consistent demand/usage throughout the year. • AWT will meet Title 22 requirements and beyond. • Additional removal of contaminants of emerging concern.	• Nutrient loads returned to Bay as concentrate. • Increased operational complexity. • Construction and operations and maintenance costs.

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. The 225 AFY AWT will require a RO process step, which will produce a brine reject (concentrate stream), typically discharged to the Bay. For the RO process in Project 1, it was assumed that 20% of the feed flow and 90% of the nutrients would be returned to the Bay as brine.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. As captured in the plot, the existing recycled water facility volumes/loads will be replaced around year 2025 with the new AWT project that will maintain capacity production from years 2025 to 2045.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (Advanced Water Treatment Facility Slated for Year 2025) *, **, ***		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *, **, ***	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	0.001	0.001	0.08	0.08	0.07	0.07
Volume	AF	0.4	0.7	38	90	32	75
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	2	2	Blend of 1 and 2	Blend of 1 and 2
Duration	Years	4	4	20	20	25	25
Flow Diverted	%	<1%	<1%	7%	6%	6%	5%
Ammonia Load Diverted	kg N/d	<1	<1	5	4	4	3
TIN Load Diverted	kg N/d	<1	<1	6	4	5	3
TP Load Diverted	kg P/d	<1	<1	1	1	1	1
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	100	100	100	100
NPV O&M	$ Mil	7.4	11	3.4	8.2	11	20
NPV Total (Capital+NPV O&M)	$ Mil	7.4	11	103	108	111	120
Unit Flow Cost[6]							
Unit Cost	$/gpd	7,970	19,000	1,290	1,340	1,650	1,780
Unit Cost	$/AF	4,240,000	4,240,000	137,000	59,900	140,000	63,500
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	38,000	52,200	3,050	1,830	3,250	2,020
TIN Unit Cost	$/lb TIN Diverted	33,500	45,500	2,680	1,600	2,860	1,760
TP Unit Cost	$/lb TP Diverted	207,000	256,000	16,500	9,000	17,600	9,920

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (AWT planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3). For the Total columns, the project start period is from year 2020 through year 2045.

***** The existing recycled water facilities will be replaced with an AWT system around year 2025. The AWT will increase reuse production capacity up to 225 AFY. Of that, about 40 percent will be diverted from the Bay as show on this plot (approximately 90 AFY).**

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by SFO MLTP. The provided values escalated to 2020 dollars.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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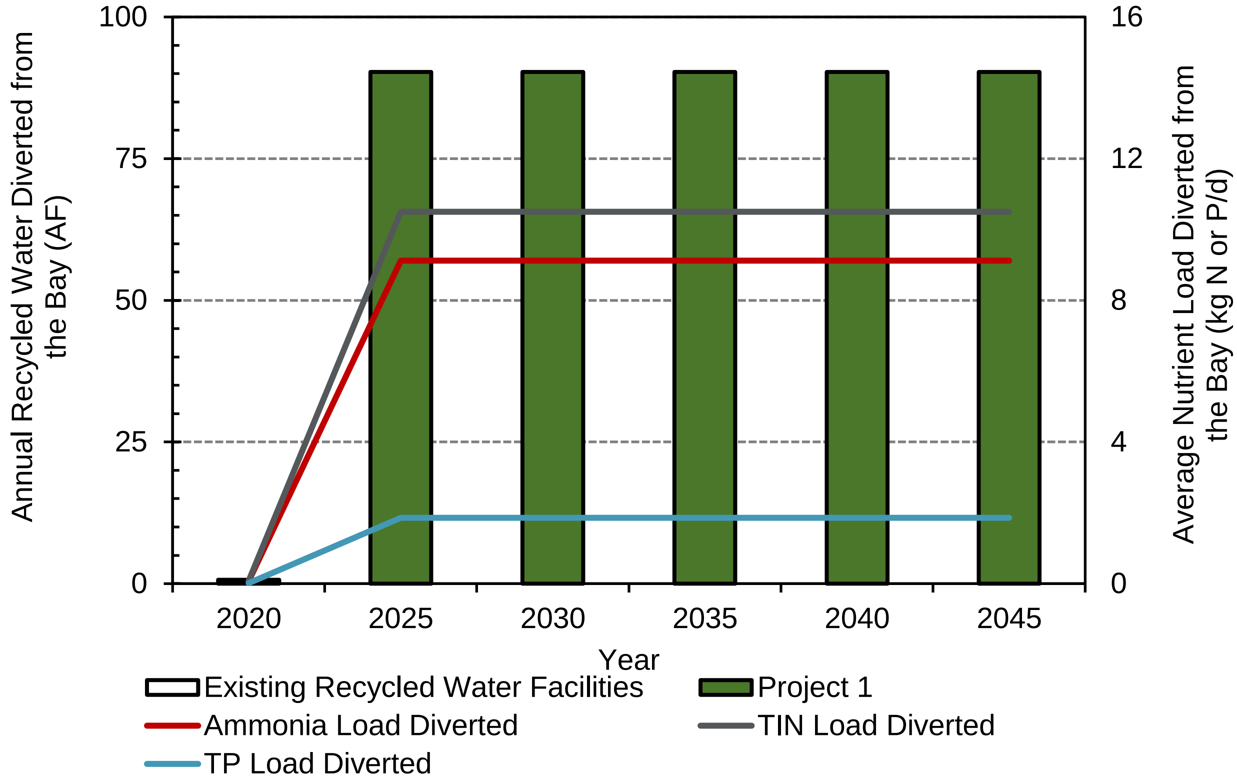

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge

Note: the existing recycled water facilities will be replaced with an AWT system around year 2025. The AWT will increase reuse production capacity up to 225 AFY. Of that, about 40 percent will be diverted from the Bay as show on this plot (approximately 90 AFY).

3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at SFO MLTP:

- Drivers for implementing recycled water projects:
  - Nutrient and emerging contaminant regulations will make discharge more difficult in coming permit cycles. SFO also seeks to diversify its water supply sources.
  - Water supply need
  - Proposed discharge regulations
  - Institutional
- Barriers for implementing recycled water projects:
  - Permitting from the Water Board
  - Institutional
  - Jurisdictional
  - Inability for users outside of the Airport's service area to use the recycled water

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Bay Area Clean Water Agencies
Recycled Water Study

San Francisco Public Utilities Commission Southeast Water Pollution Control Plant

BACWA Recycled Water Study

Individual Plant Report

San Francisco, CA

June 9, 2023
Final Report

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Contents

Tables

Figures

Executive Summary

The San Francisco Public Utilities Commission owns and operates the Southeast Water Pollution Control Plant (SEP WPCP) located in San Francisco, CA and discharges treated effluent to Lower San Francisco Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 85.4 million gallons per day (mgd).

SEP WPCP has a recycled water truck-fill station that on average served approximately 5 acre-feet per year (1.5 million gallons per year) of secondary-23 recycled water. The fill station is currently inactive due to the need for treatment upgrades. Staff are hoping to start the fill station back up within the next two to five years.

The SFPUC is currently studying the opportunities to produce recycled water with SEP WPCP wastewater effluent.

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1 Introduction and Current Conditions

The San Francisco Public Utilities Commission owns and operates the Southeast Water Pollution Control Plant (SEP WPCP) located in San Francisco, CA and discharges treated effluent to Lower San Francisco Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 85.4 million gallons per day (mgd).

The sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) permit as an indicator of the existing water quality produced at the facility, the Second Regional Watershed Permit as part of this effort (Order No. R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

SEP WPCP holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2013-0029; CA0037664). Table 1-1 provides a summary of the relevant permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2013-0029; CA0037664)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Effluent Flow	mgd	85.4	--	--	--
Effluent BOD (1)	mg/L	--	30	45	--
Effluent TSS (1)	mg/L	--	30	45	--
Effluent Ammonia	mg N/L	--	190	--	290

1) BOD and TSS include a minimum percent removal of 85% through the facility.
2) This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly part of the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Anticipated in Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 shows the process flow diagram for SEP WPCP. Both liquids processes and solids processes are shown. SEP WPCP provides primary and secondary treatment to combined wastewater and stormwater. During wet weather, 150 mgd receives primary and secondary treatment, and up to 100 mgd of additional flow receives primary treatment. The treatment train consists of screening and grit removal, primary clarification, followed by secondary treatment with a high purity oxygen activated sludge process including anaerobic selector zones for filament control.

All effluent flow is disinfected by chlorination. Solids treatment consists of secondary sludge thickening, anaerobic digestion and centrifuge dewatering.

1.3 Existing Recycled Water Service

SEP WPCP has a recycled water truck-fill station that on average served approximately 5 acre-feet per year (1.5 million gallons per year) of secondary-23 recycled water. The fill station is currently inactive due to water quality issues with no defined schedule for start-up.

The SFPUC is currently studying the opportunities to produce recycled water (non-potable) and purified water (potable) with SEP WPCP wastewater effluent. The SFPUC promotes water recycling on a centralized and decentralized scale for appropriate end uses. San Francisco's Onsite Water Reuse Program requires the collection, treatment, and use of alternate water sources such as graywater, rainwater, and foundation drainage for non-potable applications such as toilet flushing and irrigation at the building and neighborhood scale. Through partnerships with neighboring utilities, recycled water is being produced at a centralized scale to irrigate Harding Park and Fleming golf courses in San Francisco as well as Sharp Park Golf Course in Pacifica. Additionally, the SFPUC is building its own centralized recycled water plant at the Oceanside Water Pollution Control Plant: the Westside Enhanced Water Recycling Project will serve large, irrigated landscapes, such as Golden Gate Park, Lincoln Park Golf Course, and, in the future, the San Francisco Zoo. In 2022, the SFPUC completed studies to evaluate a satellite treatment facility to produce non-potable recycled water supplies as well as the potential for purified water for potable use. Further investigation is underway for purified water planning for the advanced treatment of effluent from SEP WPCP as well as Oceanside WPCP.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19) *

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	53.2	61.9	58.3
	AFY	163	190	179
Ammonia	kg N/d	8,920	8,840	8,870
Total Inorganic Nitrogen (TIN)	kg N/d	9,290	9,350	9,320
Total Phosphorus (TP)	kg P/d	383	302	336
Ammonia	mg N/L	44.3	38.0	40.6
TIN	mg N/L	46.1	40.1	42.6
TP	mg P/L	1.91	1.30	1.56

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

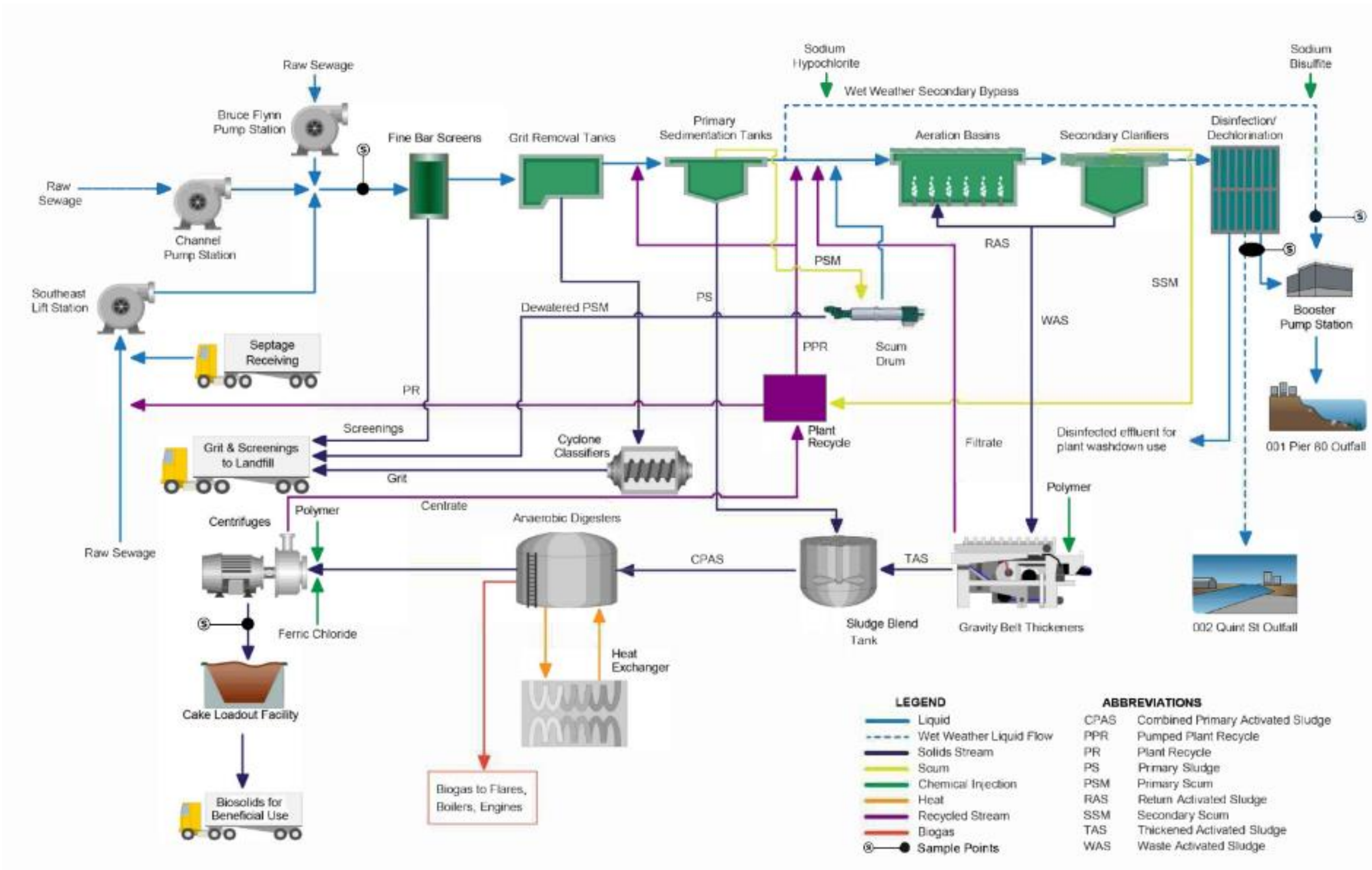

Figure 1-1. Process Flow Diagram for SEP WPCP (Source: 2022 Annual Self-Monitoring Report)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter.

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility.
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with SEP WPCP and Engineer's best judgment that considered known project constraints, existing SEP WPCP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by SEP WPCP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g. existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g. a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^{6}\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^{6}\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

There are no results to discuss as SEP WPCP does not have an active recycled water program; the SFPUC is currently studying the opportunities to produce recycled water with SEP WPCP wastewater effluent.

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San Jose/Santa Clara Regional Wastewater Facility

BACWA Recycled Water Study

Final Individual Plant Report

San Jose, CA
June 21, 2023

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Contents

Tables

Figures

Executive Summary

The City of San Jose (City) owns and operates the San Jose/Santa Clara Regional Wastewater Facility (RWF) located in San Jose, CA and discharges treated effluent to the San Francisco Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 167 million gallons per day (mgd) and a peak permitted wet weather flow of 261 mgd.

The RWF has an existing recycled water program that is employed year-round. The recycled water product water is provided to the South Bay Water Recycling (SBWR) who is the regional permit holder for recycled water in San Jose, Santa Clara and Milpitas, ensuring compliance with State regulations for recycled water quality and use. The RWF currently recycles approximately 12,000 acre-feet per year (3,430 million gallons per year). The recycled water customers include golf course and landscape irrigation, commercial and industrial, and agricultural. The reverse osmosis (RO) reject streams associated with recycled water production are returned to the RWF. Throughout the next 25 years, it is expected that the distribution volume will increase incrementally to 25,000 acre-feet per year. There are no existing plans to further expand the recycled water program.

The RWF completed (2021) a treatment plant process optimization study over the last several years that took a broad look at all treatment systems existing and planned and forecasted impacts to effluent total inorganic nitrogen (TIN). The process optimization study then evaluated a broad suite of upgrades that included possible upgrades/processes changes to primary, advanced secondary, and filtration systems that could be used to meet projected TIN load caps through 2051. From this broad suite of possible upgrades, the range of technology upgrades was winnowed down to an upgrade to the existing secondary BNR system that would reconfigure aeration basins to better utilize carbon, improve denitrification, and add hydro-cyclones to the activated-waste selection system to improve the quality of return activated sludge into the advanced secondary basins. These upgrades have not been implemented yet but are being worked in to existing CIP project planning and budgeted so the basin upgrades and hydro-cyclones will be phased in as possible and as needed over the coming years. Additionally, since 2020, TIN levels have been reduced due to ongoing operational changes implemented by the O&M team to use the existing systems in an attempt to optimize N-removal to the extent possible just within the existing BNR infrastructure, basins, clarifiers, mixed liquor channels, etc. It has been remarkably successful.

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES-1. Note: this report excludes any potential potable reuse project(s) as such project(s) are still conceptual at best. However, such projects are referenced and included in the overall report. The listed volumes represent the average flow/volume from year 2020 through 2045 (not the peak). The majority of costs are associated with capital, whereas the total net present value is greater than $300M (regardless of averaging period). The unit costs for water production in terms of $/AF over 25 years is between $800/AF to $1,200/AF (dependent on averaging period). The unit costs for nutrient load reduction associated with recycled water is relatively high for ammonia and TP (>>$400/lb nutrient) as the RWF already reliably removes such nutrients. As for TIN load reduction, it is <<$30/lb TIN.

The timeline and corresponding flow and load diversions from the Bay is provided in Figure ES-1. This plot captures the increase in recycled water volumes over time (peak at 25,000 AF by year 2045) and the corresponding load diversions from the Bay. As previously noted, the ammonia and TP load reductions are marginal as the RWF already reliably removes both nutrients. The TIN load reductions are upwards of 1,300 kg N/d, whereby they currently discharge approximately 3,500 kg N/d.

An overview of the drivers and barriers for implementing recycled water projects at RWF:

- Drivers for implementing recycled water projects:
  - Environmental: Recycled water provides an environmental benefit by reducing the amount of nutrients and other contaminants being discharged into the southern portion of the San Francisco Bay.
  - Institutional
    - Recycled Water is responsible use of a local resource for irrigation at parks, schools, and universities to the benefit of the community.
    - Public and private interest is high for expanding the use of recycled water.
    - Recycled water reduces the need for capital investments for additional potable water infrastructure and provides an incremental cost-savings back to the community.
- Barriers for implementing recycled water projects:
    - Determine if recycled water expansion will support or benefit RWF Operations and wastewater discharge requirements.
    - Determine appropriate mixture of funding sources, based upon all beneficiaries.

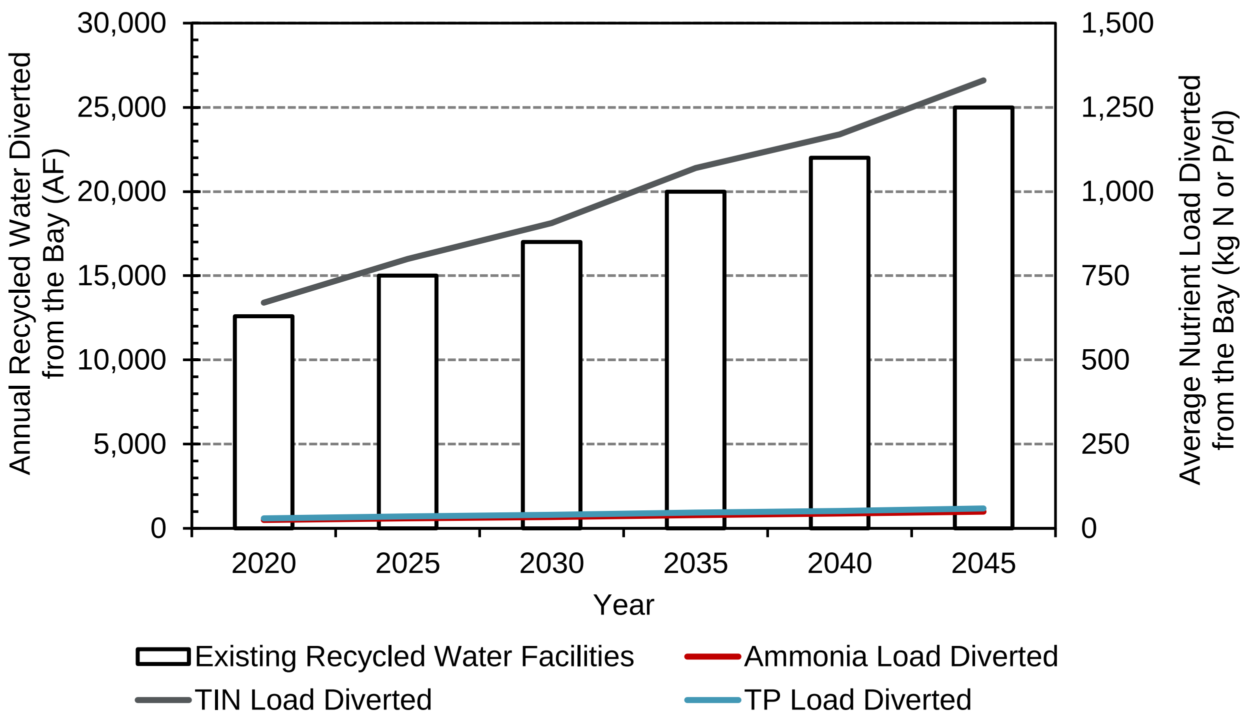

Figure ES-1: Summary of Existing Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge Projected to Year 2045

Note: Volumes associated with Other Non-Potable Reuse applications are excluded from this evaluation as such water represents a return flow that eventually ends up in the Bay.

Table ES-1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (None Planned) *, **		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	23.6	16.6	--	--	23.6	16.6
Volume	AF	11,100	18,600	--	--	11,100	18,600
Load Diverted from the Bay[2,3]							
Confidence	unitless	Blend of 1, 2, and 3 ǂ	Blend of 1, 2, and 3 ǂ	--	--	Blend of 1, 2, and 3 ǂ	Blend of 1, 2, and 3 ǂ
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	22%	15%	--	--	22%	15%
Ammonia Load Diverted	kg N/d	61	37	--	--	61	37
TIN Load Diverted	kg N/d	1,340	991	--	--	1,340	991
TP Load Diverted	kg P/d	36	44	--	--	36	44
Cost[3,4,5]							
Capital Cost	$ Mil	262	262	--	--	262	262
NPV O&M	$ Mil	63	106	--	--	63	106
NPV Total (Capital+NPV O&M)	$ Mil	325	368	--	--	325	368
Unit Flow Cost[6]							
Unit Cost	$/gpd	14	22	--	--	14	22
Unit Cost	$/AF	1,180	792	--	--	1,180	792
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	637	497	--	--	637	497
TIN Unit Cost	$/lb TIN Diverted	29	19	--	--	29	19
TP Unit Cost	$/lb TP Diverted	1,070	416	--	--	1,070	416

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3. For the Total columns, the project start period is from year 2020 through year 2045.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by San Jose WPCP. The provided values escalated to 2020 dollars.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

ǂ The confidence through year 2024 is a value of 1; from year 2025 through year 2034 a value of 2; from year 2035 through year 2045 a value of 3.

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1 Introduction and Current Conditions

The City of San Jose (City) owns and operates the San Jose/Santa Clara Regional Wastewater Facility (RWF) located in San Jose, CA and discharges treated effluent to the San Francisco Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 167 million gallons per day (mgd) and a peak permitted wet weather flow of 261 mgd.

The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

The RWF holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2020-0001). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2020-0001)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	167	--	--	--
Effluent BOD (1)	mg/L	--	10	20	--
Effluent TSS (1)	mg/L	--	10	20	--
Effluent Ammonia	mg N/L	--	3.0	--	8.0

1. BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for the RWF. Both liquids processes and solids processes are shown. The RWF has primary clarifiers followed by a biological nutrient removal activated sludge system for secondary treatment. The RWF currently meets ammonia and level 2 phosphorus removal criteria, but effluent total nitrogen levels have reliably been below 17 mg N/L (performance has improved in recent years (not shown)).

1.3 Existing Recycled Water Service

The RWF has an existing recycled water program that is employed year-round. The recycled water product water is provided to the South Bay Water Recycling (SBWR) who is the regional permit holder for recycled water in San Jose, Santa Clara and Milpitas, ensuring compliance with State regulations for recycled water quality and use. In terms of production, the RWF currently recycles approximately 12,000 acre-feet per year (3,430 million gallons per year). The recycled water customers include golf course and landscape irrigation, commercial and industrial, and agricultural. The reverse osmosis (RO) reject streams associated with recycled water production are returned to the RWF. Throughout the next 25 years, it is expected that the distribution volume will increase incrementally to 25,000 acre-feet per year. There are no existing plans to further expand the recycled water program.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 – 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	81.8	96.8	90.6
Volume	AF	38,400	63,000	101,400
Ammonia	kg N/d	210	195	201
Total Inorganic Nitrogen (TIN)	kg N/d	4,670	5,940	5,410
Total Phosphorus (TP)	kg P/d	125	322	240
Ammonia	mg N/L	0.68	0.54	0.60
TIN	mg N/L	15.1	16.3	15.8
TP	mg P/L	0.40	0.90	0.69

* Represents three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads at SJ-SC RWF.

**Represents the average volume over the duration listed in the table header.

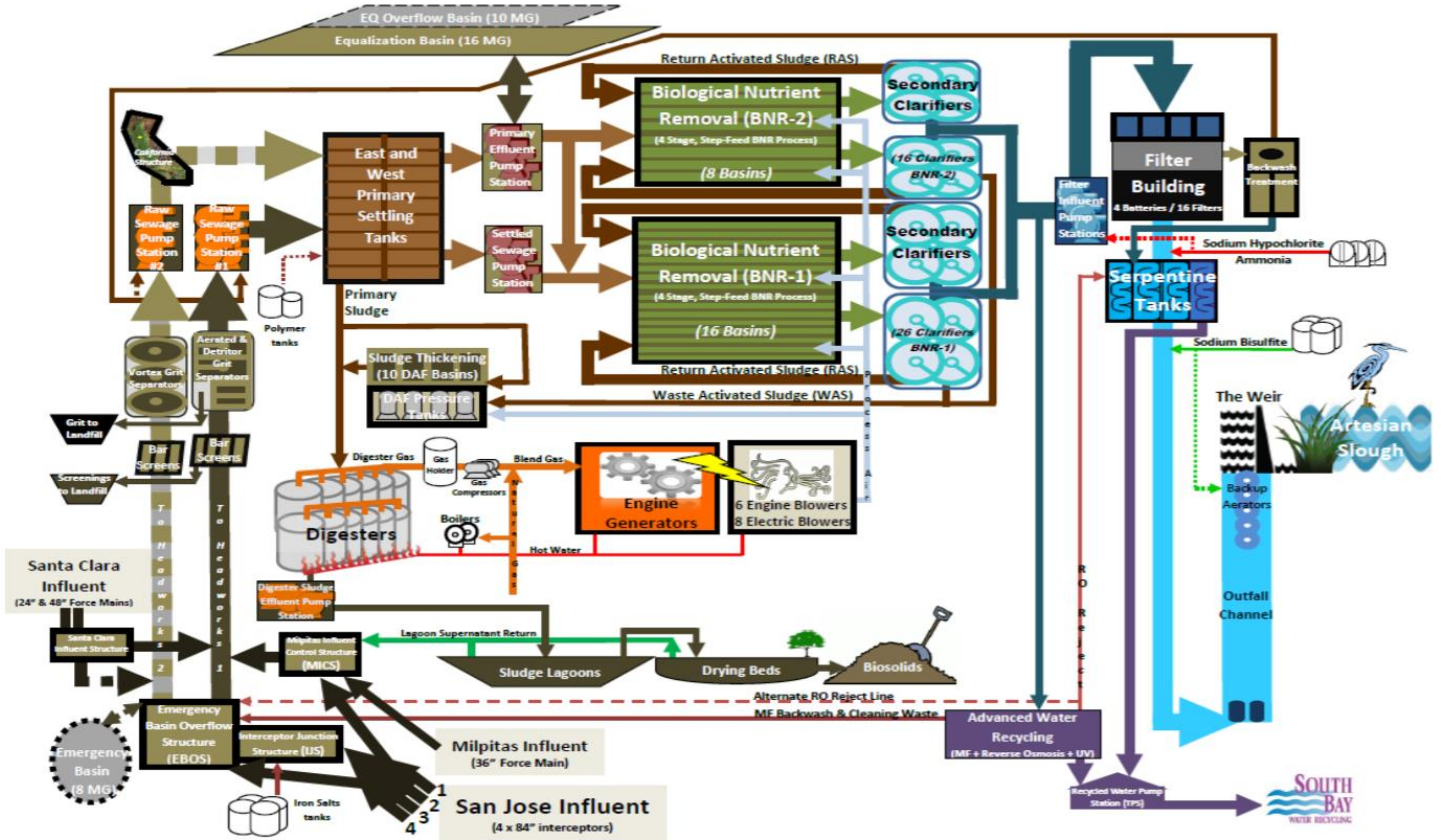

Figure 1-1. Process Flow Diagram for SJ-SC RWF (Source: NPDES Permit Order No. R2-2020-0001)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with San Jose-Santa Clara Regional Wastewater Facility and Engineer’s best judgment that considered known project constraints, existing San Jose-Santa Clara Regional Wastewater Facility reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included (Table 3-4), as provided by San Jose-Santa Clara Regional Wastewater Facility. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering,

construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects. Note: San Jose-Santa Clara Regional Wastewater Facility has no anticipated recycled water projects through 2045. The subsections that follow summarize the flow and nutrient load reductions for each listed project in Table 3-1.

Table 3-1. Recycled Water Projects Identified by SJ-SC RWF

Recycled Water Project	Description
Existing Recycled Water Facilities	The RWF currently recycles approximately 12,000 acre-feet per year (3,430 million gallons per year). The recycled water customers include golf course and landscape irrigation, commercial and industrial, and agricultural. The reverse osmosis (RO) reject streams associated with recycled water production is returned to the RWF. Throughout the next 25 years, it is expected that the distribution volume will increase incrementally to 25,000 acre-feet per year. Although this will require additional recycled water infrastructure, there are no existing plans to further expand the recycled water program.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. San Jose-Santa Clara Regional Wastewater Facility has no additional recycled water projects through 2045, therefore existing facilities make up the total.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence*	Average Distributed – Return Flows (AFY)	Average Ammonia Load Diverted (kg N/d)	Average TIN Load Diverted (kg N/d)	Average Total P Load Diverted (kg P/d)
2020	**Total**	**1**	**12,600**	**25**	**670**	**30**
	Existing Facilities**	1	12,600	25	670	30
	Future Projects‡	--	--	--	--	--
2025	**Total**	**Blend of 1 and 2**	**15,000**	**30**	**800**	**36**
	Existing Facilities**	2	15,000	30	800	36
	Future Projects‡	--	--	--	--	--
2030	**Total**	**Blend of 1 and 2**	**17,000**	**34**	**906**	**40**
	Existing Facilities**	2	17,000	34	906	40
	Future Projects‡	--	--	--	--	--
2035	**Total**	**Blend of 1, 2, and 3**	**20,000**	**40**	**1,070**	**47**
	Existing Facilities**	3	20,000	40	1,070	47
	Future Projects‡	--	--	--	--	--
2040	**Total**	**Blend of 1, 2, and 3**	**22,000**	**44**	**1,170**	**52**
	Existing Facilities**	3	22,000	44	1,170	52
	Future Projects‡	--	--	--	--	--
2045	**Total**	**Blend of 1, 2, and 3**	**25,000**	**50**	**1,330**	**59**
	Existing Facilities**	3	25,000	50	1,330	59
	Future Projects ‡	--	--	--	--	--

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

** The confidence through year 2024 is a value of 1; from year 2025 through year 2034 a value of 2; from year 2035 through year 2045 a value of 3. Thus, the overall confidence for the existing facilities is a blend of 1, 2, and 3.

‡ No future projects are planned

Note: Volumes associated with Other Non-Potable Reuse applications are excluded from this evaluation as such water represents a return flow that eventually ends up in the Bay.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. Regardless of year, industrial and landscape irrigation represent the primary users with landscape irrigation primed to further expand in future years. All categories use recycled water year-round; however, they all use significantly more water in the May/June to October/November time frame.

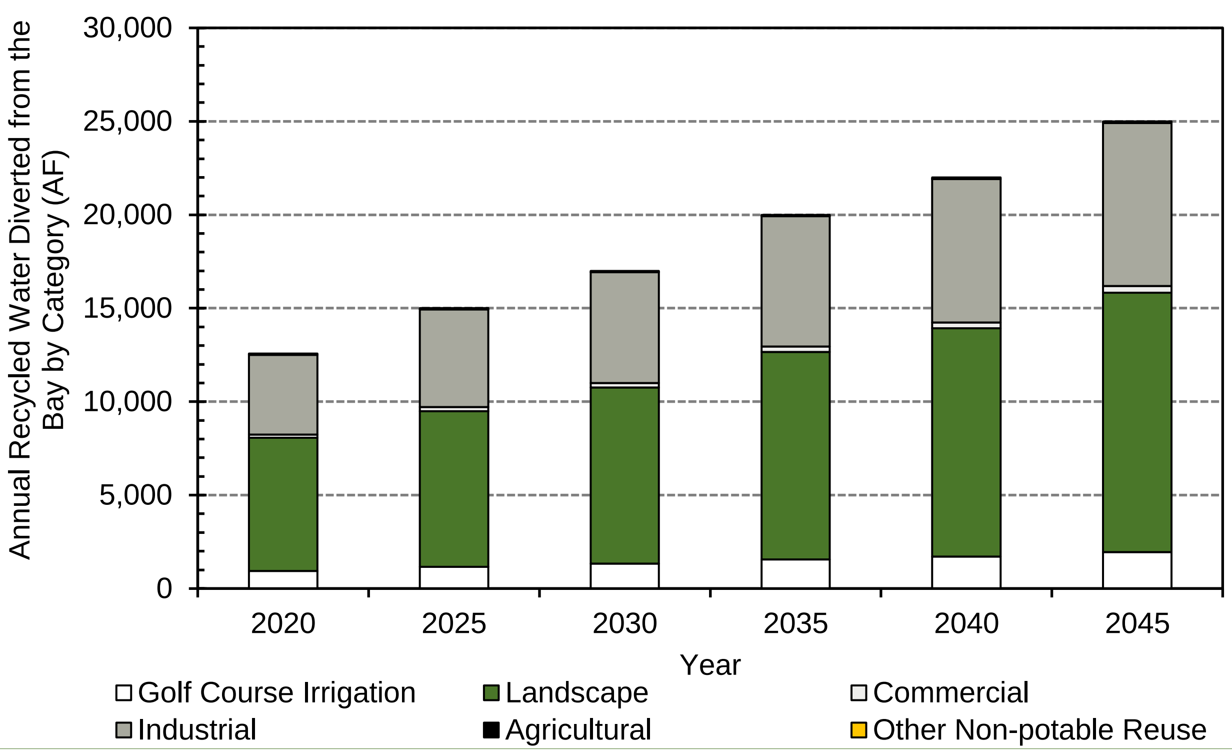

Figure 3-1. Existing (Includes Projections) Recycled Water Diverted from the Bay by Category (2020 – 2045)

Note: Volumes associated with Other Non-Potable Reuse applications are excluded from this evaluation as such water represents a return flow that eventually ends up in the Bay.

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. The fundamental ancillary benefits are the facilities are already in place, the staff is familiar with the system, and it is expandable as evidenced by an increase in future flows.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities	• Staff is familiar with the existing treatment and distribution facilities. • Reduces potable water supply demands • Removes additional particulate loads (associated with filtration)	• Need to maintain treatment and distribution system. • RO reject streams are laden with nutrients that are returned to the RWF outfall.
Future Project(s)	None Planned	None Planned

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. Note: this report excludes any potential potable reuse project(s) as such project(s) are still conceptual at best. However, such projects are referenced and included in the overall report. The listed volumes represent the average flow/volume from year 2020 through year 2045 (not the peak). San Jose-Santa Clara Regional Wastewater Facility provided both O&M and CIP costs projected for the next 25 years.

The majority of costs are associated with capital, whereas the total net present value is greater than $300M (regardless of averaging period). The unit costs for water production in terms of $/AF over 25 years is between $800/AF to $1,200/AF (dependent on averaging period). The unit costs for nutrient load reduction associated with recycled water is relatively high for ammonia and TP (>>$400/lb nutrient) as the RWF already reliably removes such nutrients. As for TIN load reduction, it is <<$30/lb TIN.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. This plot captures the increase in recycled water volumes over time (peak at 25,000 AF by year 2045) and the corresponding load diversions from the Bay. As previously noted, the ammonia and TP load reductions are marginal as the RWF already reliably removes both nutrients. The TIN load reductions are upwards of 1,300 kg N/d, whereby they currently discharge approximately 3,500 kg N/d.

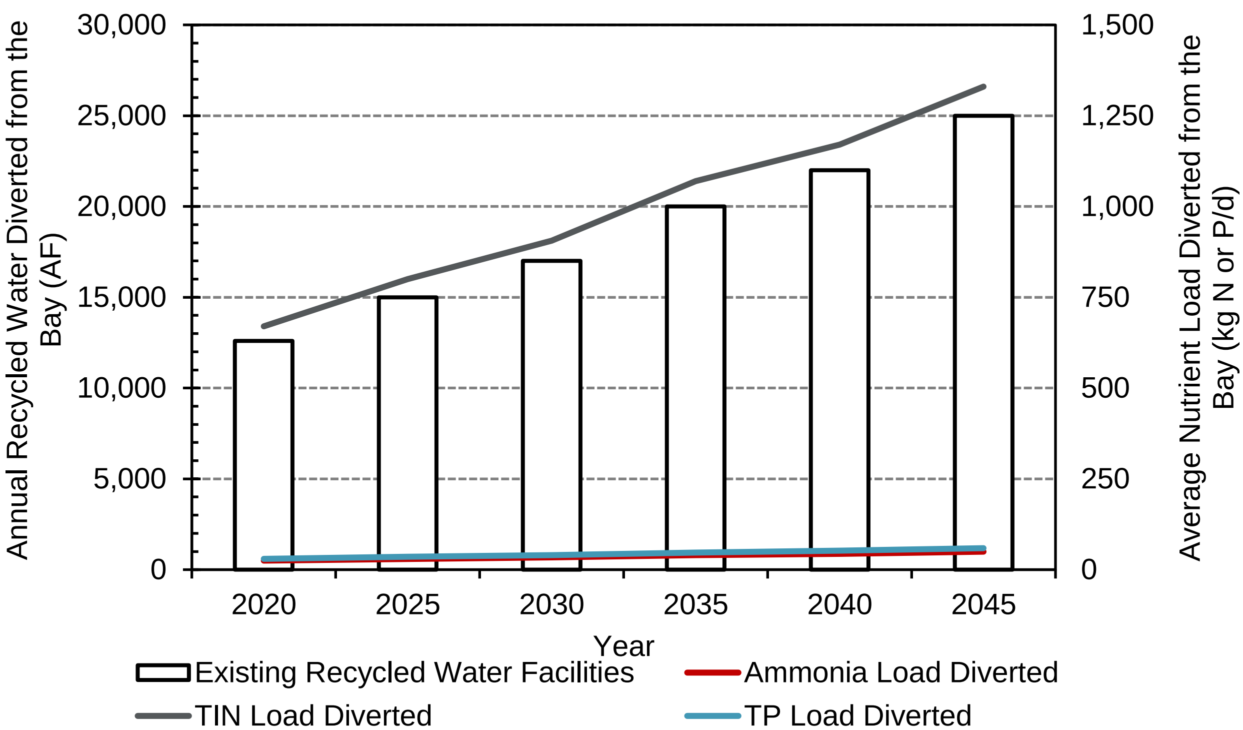

Figure 3-2. Summary of Existing Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge Projected to Year 2045

Note: Volumes associated with Other Non-Potable Reuse applications are excluded from this evaluation as such water represents a return flow that eventually ends up in the Bay.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (None Planned) *, **		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	23.6	16.6	--	--	23.6	16.6
Volume	AF	11,100	18,600	--	--	11,100	18,600
Load Diverted from the Bay[2,3]							
Confidence	unitless	Blend of 1, 2, and 3 ǂ	Blend of 1, 2, and 3 ǂ	--	--	Blend of 1, 2, and 3 ǂ	Blend of 1, 2, and 3 ǂ
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	22%	15%	--	--	22%	15%
Ammonia Load Diverted	kg N/d	61	37	--	--	61	37
TIN Load Diverted	kg N/d	1,340	991	--	--	1,340	991
TP Load Diverted	kg P/d	36	44	--	--	36	44
Cost[3,4,5]							
Capital Cost	$ Mil	262	262	--	--	262	262
NPV O&M	$ Mil	63	106	--	--	63	106
NPV Total (Capital+NPV O&M)	$ Mil	325	368	--	--	325	368
Unit Flow Cost[6]							
Unit Cost	$/gpd	14	22	--	--	14	22
Unit Cost	$/AF	1,180	792	--	--	1,180	792
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	637	497	--	--	637	497
TIN Unit Cost	$/lb TIN Diverted	29	19	--	--	29	19
TP Unit Cost	$/lb TP Diverted	1,070	416	--	--	1,070	416

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3. For the Total columns, the project start period is from year 2020 through year 2045.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by the RWF. The provided values escalated to 2020 dollars.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

ǂ The confidence through year 2024 is a value of 1; from year 2025 through year 2034 a value of 2; from year 2035 through year 2045 a value of 3.

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3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at RWF:

- Drivers for implementing recycled water projects:
  - Environmental: Recycled water provides an environmental benefit by reducing the amount of nutrients and other contaminants being discharged into the southern portion of the San Francisco Bay.
  - Institutional
    - Recycled Water is responsible use of a local resource for irrigation at parks, schools, and universities to the benefit of the community.
    - Public and private interest is high for expanding the use of recycled water.
    - Recycled water reduces the need for capital investments for additional potable water infrastructure and provides an incremental cost-savings back to the community.
- Barriers for implementing recycled water projects:
    - Determine if recycled water expansion will support or benefit RWF Operations and wastewater discharge requirements.
    - Determine appropriate mixture of funding sources, based upon all beneficiaries.

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City of San Leandro

BACWA Recycled Water Study

FINAL Individual Plant Report

San Leandro, CA
May 29, 2023

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Contents

Tables

Figures

Executive Summary

The City of San Leandro operates the City of San Leandro Water Pollution Control Plant (SLWPCP) which discharges to South San Francisco Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 7.6 million gallons per day (mgd).

The SLWPCP has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The WWTP currently recycles just under 300 acre-feet per year (95 million gallons per year). Golf course (irrigation) makes up the majority of recycled water use and it is highly seasonal with the majority during the dry season.

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Tables ES – 1. Note: the infrastructure for providing recycled water is already in place so the unit costs are relatively modest (except for total phosphorus load reduction). The total phosphorus unit cost is greater than ammonia and TIN values as a portion of the total phosphorus is removed at the plant so the total phosphorus load diverted from the Bay is less profound.

The timeline and corresponding load diversions from the Bay is provided in Figure ES – 1. The recycled water volumes are anticipated to be relatively constant over the next 25 years at just under 300 AF per year. The majority of recycled water occurs during the dry season as the primary recycled water consumer is the golf course (irrigation). The nutrient loads diverted from the Bay associated with recycled water are also relatively constant as it is dependent on water volume.

An overview of the drivers and barriers for implementing recycled water projects at SLWPCP:

- Drivers for implementing recycled water projects: address **water supply needs**
- Barriers for implementing recycled water projects: **jurisdictional** as the City of San Leandro receives drinking water from East Bay Municipal Utility District (EBMUD) and therefore has little influence over non-City facilities.

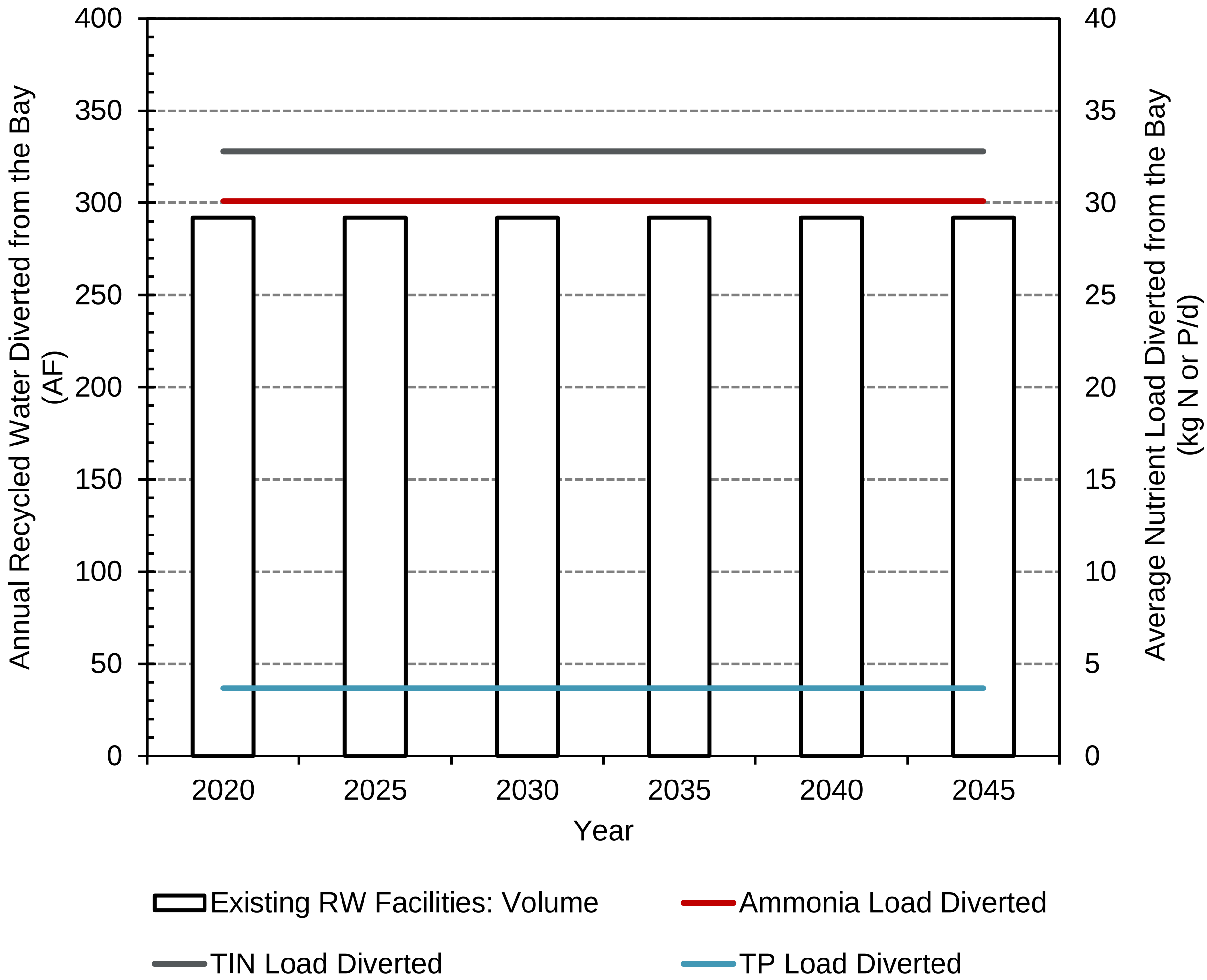

Figure ES - 1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge

Table ES - 1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Projects (None Planned) *,**,***		Total (Projected into the Future) *,**,***	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	0.5	0.3	--	--	0.5	0.3
Volume	AF	233	292	--	--	233	292
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Flow Diverted	%	25	25	--	--	25	25
Duration	Years	9%	5%	--	--	9%	5%
Ammonia Load Diverted	kg N/d	60	30	--	--	60	30
TIN Load Diverted	kg N/d	71	33	--	--	71	33
TP Load Diverted	kg P/d	8	4	--	--	8	4
Cost[3,4,5]							
Capital Cost4	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	3.6	4.5	--	--	3.6	4.5
NPV Total (Capital+NPV O&M)	$ Mil	3.6	4.5	--	--	3.6	4.5
Unit Flow Cost[6]							
Unit Cost	$/gpd	7.2	17.2	--	--	7.2	17.2
Unit Cost	$/AF	614	614	--	--	614	614
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	7.0	7.4	--	--	7.0	7.4
TIN Unit Cost	$/lb TIN Diverted	6.0	6.8	--	--	6.0	6.8
TP Unit Cost	$/lb TP Diverted	52	61	--	--	52	61

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045; details provided with each project in Section 3).

*** The Monarch Bay Golf Course area that currently receives SLWPCP recycled water for irrigation has plans for redevelopment. If this project goes forward, the recycled water station may be relocated and upgraded to provide disinfected tertiary recycled water, which would allow additional uses. It is not clear if the total amount of water produced would change because of this project. Given the uncertainty, this evaluation is based on continuation of the existing recycled water demands into the future with the understanding that this might change.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by SLWPCP (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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1 Introduction and Current Conditions

The City of San Leandro operates the City of San Leandro Water Pollution Control Plant (SLWPCP) which discharges to South San Francisco Bay through the East Bay Dischargers Authority (EBDA)'s outfall. The plant has an average dry weather flow (ADWF) permitted capacity of 7.6 million gallons per day (mgd).

The sections that follow provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

SLWPCP is a member of the East Bay Dischargers Authority (EBDA) that dischargers SLWPCP effluent through EBDA's common outfall. EBDA holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2022-0023; CA0037869). Table 1-1 provides a summary of the permit limitations for SLWPCP under the EBDA permit. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2022-0023; CA0037869)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	7.6	--	--	--
Effluent BOD (1)	mg/L	--	25	40	--
Effluent TSS (1)	mg/L	--	30	45	--
Effluent Ammonia	mg N/L	--	86	--	110

1. BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for the SLWPCP. Both liquids processes and solids processes are shown. Treatment consists of screening, primary sedimentation, trickling filter, activated sludge, secondary clarification, and disinfection by sodium hypochlorite. Treated wastewater from the wastewater treatment facility is transported to EBDA's system for final dechlorination and discharge to the EBDA Common Outfall. The activated sludge process maintains a low SRT for secondary treatment. No major nutrient removal systems are currently in place.

Sludge is anaerobically digested, dewatered using a belt filter press and further dried in open drying beds.

Solids removed from the wastewater stream are treated by gravity thickening, primary and secondary digestion, and dewatering by belt filter press.

1.3 Existing Recycled Water Service

The SLWPCP has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The WWTP currently recycles approximately 290 acre-feet per year (95 million gallons per year).

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	4.8	5.36	5.13
Volume	AF	2,254	3,487	5,741
Ammonia	kg N/d	583	607	592
Total Inorganic Nitrogen (TIN)	kg N/d	685	596	644
Total Phosphorus (TP)	kg P/d	79	67	72
Ammonia	mg N/L	32.1	29.9	30.5
TIN	mg N/L	37.7	29.4	33.2
TP	mg P/L	4.33	3.30	3.73

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

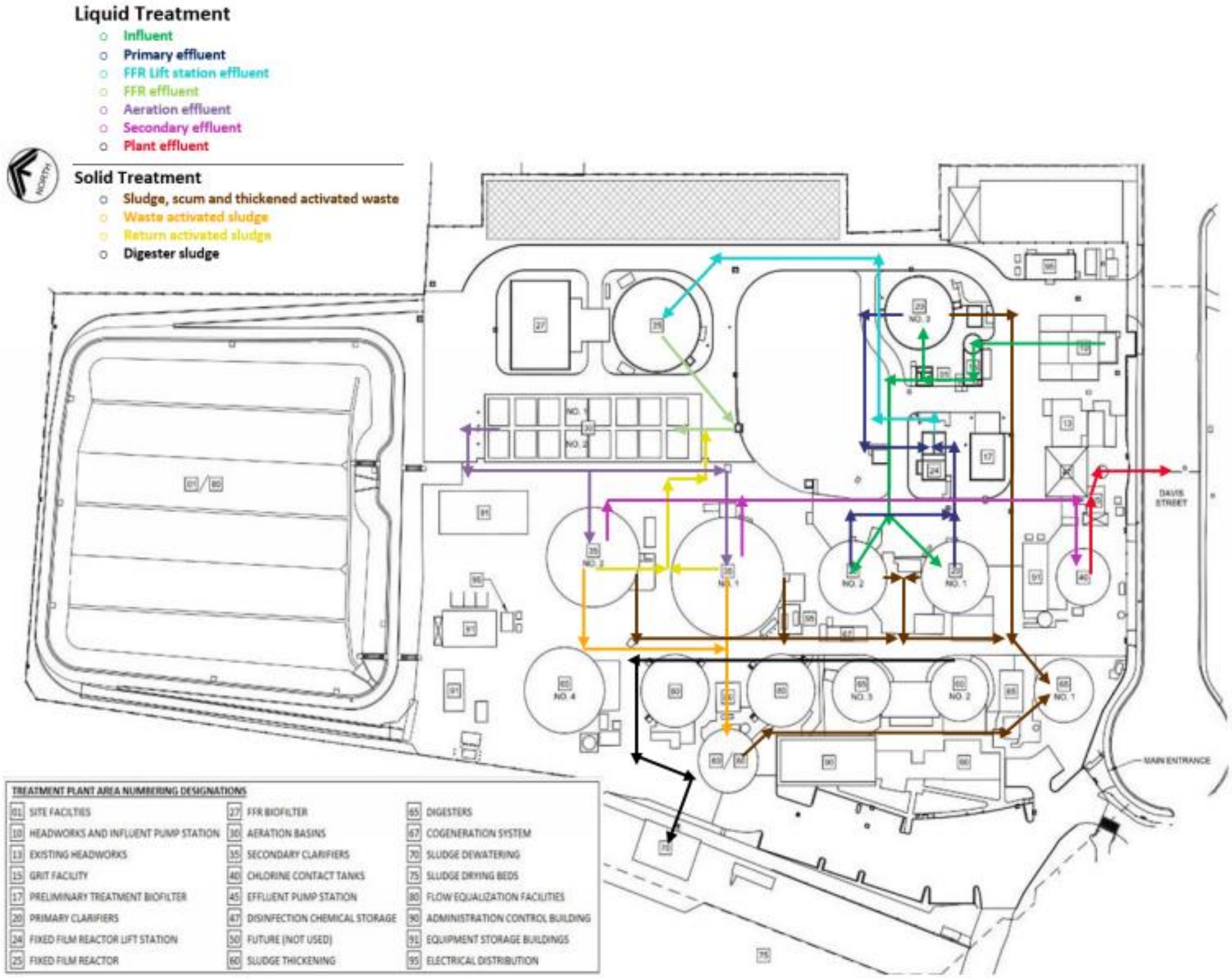

Figure 1-1. Process Flow Diagram for City of San Leandro

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by SLWPCP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects. The subsections that follow summarize the flow and nutrient load reductions for each listed project in Table 3-1.

Table 3-1. Recycled Water Projects Identified by City of San Leandro WPCP

Recycled Water Project	Description
Existing Recycled Water Facilities	The SLWPCP has an existing recycled water program that treats secondary effluent for golf course irrigation at Monarch Bay Golf Course, as well as a fill station that produces Secondary 23 water. SLWPCP produced about 140,000 gal of truck fill station water in 2022 for dust control (<AF). Until 2016, EBMUD operated a station at the San Leandro WPCP that provided water to the Chuck Corica Golf Course. This station produced approximately 99 MG per year. EBMUD has indicated that they intend to refurbish the station and put it back in service, but EBMUD has not indicated a time frame for completing this work. Given the uncertainty, the golf course irrigation opportunity at Churck Corica Golf Course is excluded from this analysis. The golf course (irrigation) demands are predominantly seasonal (emphasis on the dry season).
Future Projects	The Monarch Bay Golf Course area that currently receives SLWPCP recycled water for irrigation has plans for redevelopment. If this project goes forward, the recycled water station may be relocated and upgraded to provide disinfected tertiary recycled water, which would allow additional uses. It is not clear if the total amount of water produced would change because of this project. Given the uncertainty, this evaluation is based on continuation of the existing recycled water demands into the future with the understanding that this might change.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3 and addresses seasonality. The existing facility has reached its projected demand capacity with no plans for future expansion.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. To date, golf course irrigation and commercial dust control represent the only use categories under SLWPCP's recycled water program. In general, the recycled water demands peak in the dry season as the golf course demands are at their peak.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Distributed - Return Flows (AFY)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**1**	**292**	**30**	**33**	**4**
	Existing Facilities	1	292	30	33	4
	Future Projects	--	--	--	--	--
2025	**Total**	**1**	**292**	**30**	**33**	**4**
	Existing Facilities	1	292	30	33	4
	Future Projects	--	--	--	--	--
2030	**Total**	**1**	**292**	**30**	**33**	**4**
	Existing Facilities	1	292	30	33	4
	Future Projects	--	--	--	--	--
2035	**Total**	**1**	**292**	**30**	**33**	**4**
	Existing Facilities	1	292	30	33	4
	Future Projects	--	--	--	--	--
2040	**Total**	**1**	**292**	**30**	**33**	**4**
	Existing Facilities	1	292	30	33	4
	Future Projects	--	--	--	--	--
2045	**Total**	**1**	**292**	**30**	**33**	**4**
	Existing Facilities	1	292	30	33	4
	Future Projects	--	--	--	--	--

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

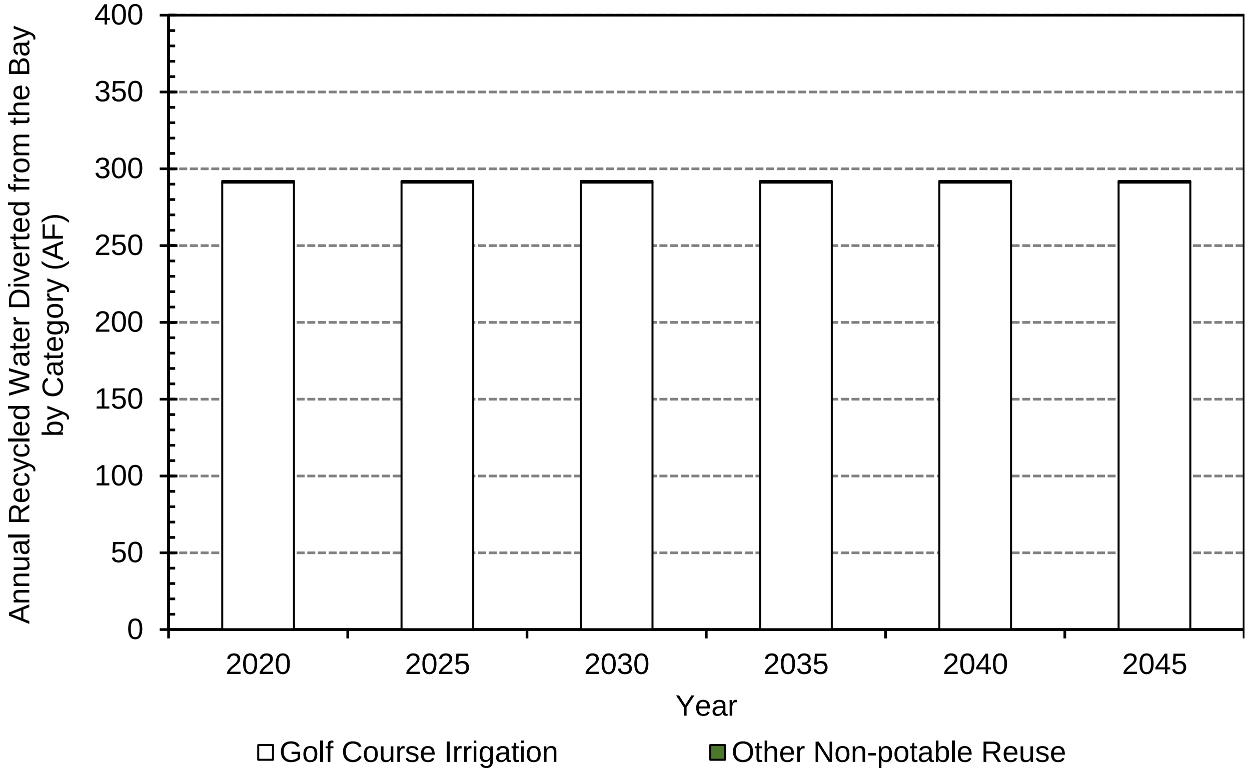

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

Note: Other Non-potable reuse is <1 AFY for a truck fill station used for dust control

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and adverse impacts associated with the listed recycled water projects. The existing facilities are already paid for an in place.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities	• Facilities are already in place and providing recycled water • Operator familiarity with existing recycled water facilities	• Challenges with expanding beyond the existing jurisdictional boundaries
Other Projects*	• If the use at Monarch Bay Golf Course area expands, the same ancillary benefits would apply as listed above	• If the use at Monarch Bay Golf Course area expands, the same adverse benefits would apply as listed above

* The Monarch Bay Golf Course area that currently receives SLWPCP recycled water for irrigation has plans for redevelopment. If this project goes forward, the recycled water station may be relocated and upgraded to provide disinfected tertiary recycled water, which would allow additional uses. It is not clear if the total amount of water produced would change because of this project. Given the uncertainty, this evaluation is based on continuation of the existing recycled water demands into the future with the understanding that this might change.

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. Note: the infrastructure for providing recycled water is already in place so the unit costs are relatively modest (except for total phosphorus load reduction). The total phosphorus unit cost is greater than ammonia and TIN values as a portion of the total phosphorus is removed at the plant so the total phosphorus load diverted from the Bay is less profound.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. The recycled water volumes are not anticipated to change over the next 25 years with annual volumes at just under 300 AF. As a result, the projected nutrient loads diverted to the Bay are also not anticipated to change unless the effluent nutrient concentrations change over time. The analysis is based on the existing effluent nutrient concentrations over the project duration.

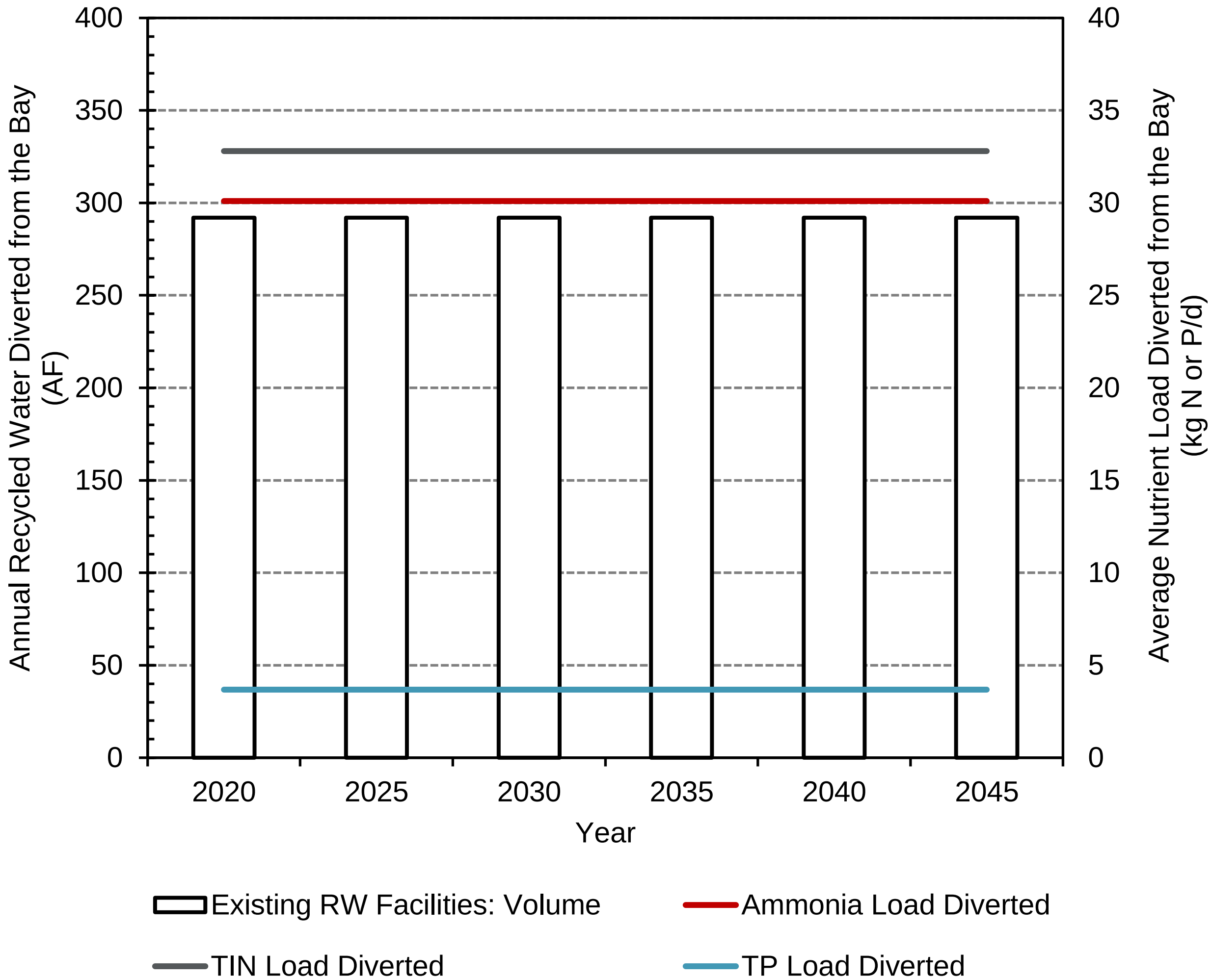

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Projects (None Planned) *,**,***		Total (Projected into the Future) *,**,***	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	0.5	0.3	--	--	0.5	0.3
Volume	AF	233	292	--	--	233	292
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Flow Diverted	%	25	25	--	--	25	25
Duration	Years	9%	5%	--	--	9%	5%
Ammonia Load Diverted	kg N/d	60	30	--	--	60	30
TIN Load Diverted	kg N/d	71	33	--	--	71	33
TP Load Diverted	kg P/d	8	4	--	--	8	4
Cost[3,4,5]							
Capital Cost4	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	3.6	4.5	--	--	3.6	4.5
NPV Total (Capital+NPV O&M)	$ Mil	3.6	4.5	--	--	3.6	4.5
Unit Flow Cost[6]							
Unit Cost	$/gpd	7.2	17.2	--	--	7.2	17.2
Unit Cost	$/AF	614	614	--	--	614	614
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	7.0	7.4	--	--	7.0	7.4
TIN Unit Cost	$/lb TIN Diverted	6.0	6.8	--	--	6.0	6.8
TP Unit Cost	$/lb TP Diverted	52	61	--	--	52	61

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045; details provided with each project in Section 3).

*** The Monarch Bay Golf Course area that currently receives SLWPCP recycled water for irrigation has plans for redevelopment. If this project goes forward, the recycled water station may be relocated and upgraded to provide disinfected tertiary recycled water, which would allow additional uses. It is not clear if the total amount of water produced would change because of this project. Given the uncertainty, this evaluation is based on continuation of the existing recycled water demands into the future with the understanding that this might change.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by SLWPCP (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at SLWPCP:

- Drivers for implementing recycled water projects: address **water supply needs**
- Barriers for implementing recycled water projects: **jurisdictional** as the City of San Leandro receives drinking water from East Bay Municipal Utility District (EBMUD) and therefore has little influence over non-City facilities.

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San Mateo Wastewater Treatment Plant

BACWA Recycled Water Study

Individual Plant Report

San Mateo, CA
June 14, 2023

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Contents

Tables

Figures

Executive Summary

The San Mateo Wastewater Treatment Plant (San Mateo WWTP) services a population of about 150,000, which includes the industrial, commercial, and domestic wastewater from the Cities of San Mateo, Foster City, Hillsborough and portions of Belmont and unincorporated San Mateo County. The San Mateo WWTP is located at 2050 Detroit Drive in San Mateo, CA. The plant has an average dry weather flow (ADWF) permitted capacity of 15.7 million gallons per day (mgd).

The San Mateo WWTP does not currently produce recycled water. The San Mateo WWTP is currently under construction for upgrades that will improve effluent water quality at $500+ Mil. As part of the on-going plant upgrades, the San Mateo WWTP will have the ability to produce Title 22 unrestricted water.

In 2017, a recycled water facilities plan was performed by Hydroscience.[1] This study identified and evaluated various recycled water uses into the future. As part of the study, it considered both near- and long-term Title 22 unrestricted reuse opportunities, as well as potable reuse opportunities. This report is focused on the opportunities listed in the 2017 report for the Estero Municipal Improvement District (EMID). Specifically, project 1-2 and all of those listed for regions 5 and 6 as noted in the report, as well as the potable reuse alternative to augment the Crystal Springs Reservoir. **Note: all the future projects listed for this report are conceptual as there are numerous competing factors for implementation, such as costs to fund the projects and jurisdictional challenges.**

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES – 1. Note: the values in the right-hand total columns represent values over the 25-year duration (2020 through 2045). While attractive from a water supply and diversification standpoint, both sets of future projects are relatively inefficient in terms of unit costs (both by flow and nutrient load costs). For perspective, the optimization and upgrades study that evaluated nutrient load reduction across Bay Area WWTPs had a range of values from $2.0 - $8.7/lb TIN load reduced,[2] which is considerably more cost-effective than $75/lb or greater for TIN load reduced associated with recycled water at San Mateo WWTP.

The timeline and corresponding load diversions from the Bay is provided in Figure ES – 1. The San Mateo WWTP projections suggest that the recycled water demands are initiated around year 2030 with a steady increase through year 2040 (includes Project 1 elements), followed by an exponential increase after year 2041 for Project 2 (Surface Water Augmentation). Note: the majority of nutrients associated with Project 2 would be captured as part of the advanced treatment and returned to the San Mateo WWTP with eventual Bay discharge. This report considered such a return stream laden with nutrients.

[1] Hydroscience (2017) Cities of San Mateo & Foster City/Estero Municipal Improvement District Recycled Water Facilities Plan, June 2017.

[2] Bay Area Clean Water Agencies (2018) Bay Area Clean Water Agencies Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream Treatment, Treatment Upgrades, and Other Means. Prepared by HDR. Oakland, CA.

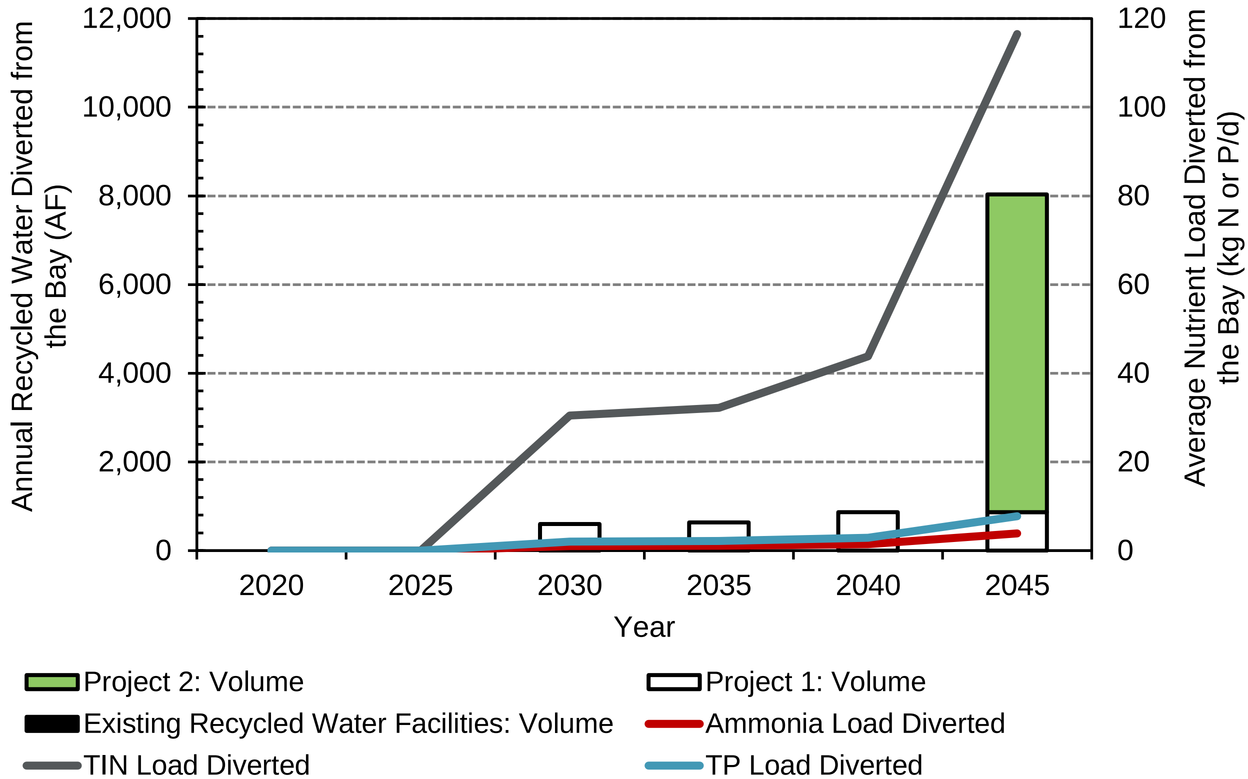

Figure ES – 1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge*,**

* Project 1 = golf course and various landscape irrigation projects as identified for EMID as project 1-2 and all of those for regions 5 and 6 in the 2017 Recycled Water Facilities Plan.[1]

** Project 2 = surface water augmentation to Crystal Springs Reservoir as identified in the 2017 Recycled Water Facilities Plan.[1] The listed volume represents production water following advanced treatment required for potable reuse. Approximately 20 percent of the advanced treatment feed flow would be returned to the San Mateo WWTP as brine reject water and discharged to the Bay.

An overview of the drivers and barriers for implementing recycled water projects at San Mateo WWTP:

- Drivers for implementing recycled water projects:
  - Beneficial reuse: reduce potable water supply demand and diversify supply.
  - Proposed Discharge Regulations: increased water reuse can further reduce discharge loads beyond the on-going upgrades.
- Barriers for implementing recycled water projects:
  - Funding: all the projects under consideration have a cost that will impact the ability to implement.
  - Jurisdictional: there are two drinking water providers for the service area (EMID and Cal Water) so agreements would need to be in place prior to implementation.

Table ES – 1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (None) *, **		Future Project #1 (Golf Course and Various Landscape Irrigation Projects Starting at Approximately Year 2030) *, **		Future Project #2 (Potable Reuse: Crystal Springs Reservoir Augmentation after Year 2040) *, **		Total (Includes Existing and Future Projects Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 – Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]									
Flow	mgd	--	--	1.2	0.7	6.4	6.4	1.9	1.5
Volume	AF	--	--	556	742	2,990	7,170	869	1,690
Load Diverted from the Bay[2,3]									
Confidence	**unitless**	**--**	**--**	**3**	**3**	**3**	**3**	**3**	**3**
Duration	Years	--	--	15	15	5	5	25	25
Flow Diverted	%	--	--	12%	6%	65%	56%	19%	13%
Ammonia Load Diverted	kg N/d	--	--	2	1	2	2	2	1
TIN Load Diverted	kg N/d	--	--	67	38	72	73	55	37
TP Load Diverted	kg P/d	--	--	4	3	5	5	4	2
Cost[3,4,5]									
Capital Cost	$ Mil	--	--	26	26	169	169	194	194
NPV O&M	$ Mil	--	--	6	8	39	93	45	101
NPV Total (Capital+NPV O&M)	$ Mil	--	--	32	34	207	262	239	295
Unit Flow Cost[6]									
Unit Cost	$/gpd	--	--	27	51	33	41	129	196
Unit Cost	$/AF	--	--	3,830	3,050	13,900	7,300	11,000	7,000
Unit Load Cost[7,8]									
Ammonia Unit Cost	$/lb Ammonia Diverted	--	--	2,810	2,240	51,000	26,800	15,500	11,900
TIN Unit Cost	$/lb TIN Diverted	--	--	94	75	1,700	894	518	396
TP Unit Cost	$/lb TP Diverted	--	--	1,410	1,120	25,500	13,400	7,760	5,940

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045 (details provided with each project in Section 3). For the Total columns, the project start period is from year 2020 through year 2045.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by San Mateo WWTP in 2021 dollars. Capital cost values from the 2017 Hydroscience Report were escalated from 2017 to 2021 dollars based on Engineering News and Record values. O&M values were escalated forward at 3 percent from the 2017 values.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay over the project duration.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

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1 Introduction and Current Conditions

The San Mateo Wastewater Treatment Plant (San Mateo WWTP) services a population of about 150,000, which includes the industrial, commercial, and domestic wastewater from the Cities of San Mateo, Foster City, Hillsborough and portions of Belmont and unincorporated San Mateo County. The San Mateo WWTP is located at 2050 Detroit Drive in San Mateo, CA. The plant has an average dry weather flow (ADWF) permitted capacity of 15.7 million gallons per day (mgd).

The San Mateo WWTP is currently under construction for upgrades that will provide nutrient removal and improve overall effluent water quality (at $500+ Mil). As part of the on-going plant upgrades, the San Mateo WWTP will have the ability to produce recycled water with minor modifications.

The future recycled water projects include golf and various landscape irrigation projects (referred to as Project 1 from herein), as well as potable reuse project that would send advanced treatment water to augment the Lower Crystal Springs Reservoir (referred to as Project 2 from herein). **Note: all the future projects listed for this report are conceptual as there are numerous competing factors for implementation, such as costs to fund the projects and jurisdictional challenges.**

Project 1 includes storage and pumping at the San Mateo WWTP, followed by Project 1-2 and all those listed for Regions 5 and 6 in the 2017 Hydroscience Report.[1] Note: the projects considered are limited to those under EMID. T[1]

Project 2 considers surface water augmentation to Crystal Springs Reservoir as this was the most attractive of the various potable reuse projects evaluated in the 2017 Hydroscience Report.[1] Such an alternative would require full advanced treatment of San Mateo WWTP product water and distribution to the lower Crystal Springs Reservoir to augment raw water supplies prior to treatment and distribution. It is anticipated that upwards of 8 mgd of San Mateo WWTP product water would be treated and transported to the reservoir.

The subsections that follow provide information on permit requirements, process flow diagram, discharge to the Bay, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

San Mateo WWTP holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2018-0016; CA0037541). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2018-0016; CA0037541)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Wet Season Effluent Limitations – October 1 through April 30					
Influent Flow	mgd	15.7	--	--	--
Effluent cBOD (1)	mg/L	--	25	40	--
Effluent TSS (1)	mg/L	--	30	45	--
Effluent Total Ammonia	mg N/L	--	66	--	120
Dry Season Effluent Limitations – May 1 through September 30					
Influent Flow	mgd	15.7	--	--	--
Effluent cBOD (1)	mg/L	--	15	25	--
Effluent TSS (1)	mg/L	--	20	30	--
Effluent Total Ammonia	mg N/L	--	66	--	120

1. BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;
- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

1.2 Process Flow Diagram

Figure 1-1 shows the existing process flow diagram for the San Mateo WWTP. Both liquids and solids processes are shown. The existing San Mateo WWTP consists of primary clarification followed by conventional activated sludge for secondary treatment (i.e., carbonaceous treatment only). Effluent is disinfected by chlorination, then dechlorinated prior to discharge to the San Francisco Bay. Solids treatment consists of primary and secondary sludge thickening, anaerobic digestion and centrifuge dewatering.

Note: the San Mateo WWTP is undergoing construction for plant upgrades as previously noted. When completed, the plant will provide preliminary screening, grit removal, fine screening, primary clarification, biological nutrient removal, filtration with activated sludge treatment (through a membrane bioreactor), and chlorine disinfection.

1.3 Existing Recycled Water Service

The San Mateo WWTP does not currently produce recycled water. As part of the on-going plant upgrades, the San Mateo WWTP will have the ability to produce Title 22 unrestricted water with minor modifications.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flows (10/16 - 9/19) and Anticipated Nutrient Discharge Levels to the Bay once the Plant Upgrades are Completed *,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (Oct 1 – Sept 30)
Flow	mgd	9.76	12.6	11.4
Volume	AF	4,580	8,210	12,790
Ammonia	kg N/d	18.5	23.8	21.6
Total Inorganic Nitrogen (TIN)	kg N/d	554	715	647
Total Phosphorus (TP)	kg P/d	36.9	47.7	43.1
Ammonia	mg N/L	<1	<1	<1
TIN	mg N/L	15.0	15.0	15.0
TP	mg P/L	1.0	1.0	1.0

* Represents the anticipated discharge concentrations once the plant upgrades are completed. Note: the other recycled water reports relied on data from 10/16 – 9/19.

**Represents the average volume over the duration listed in the table header.

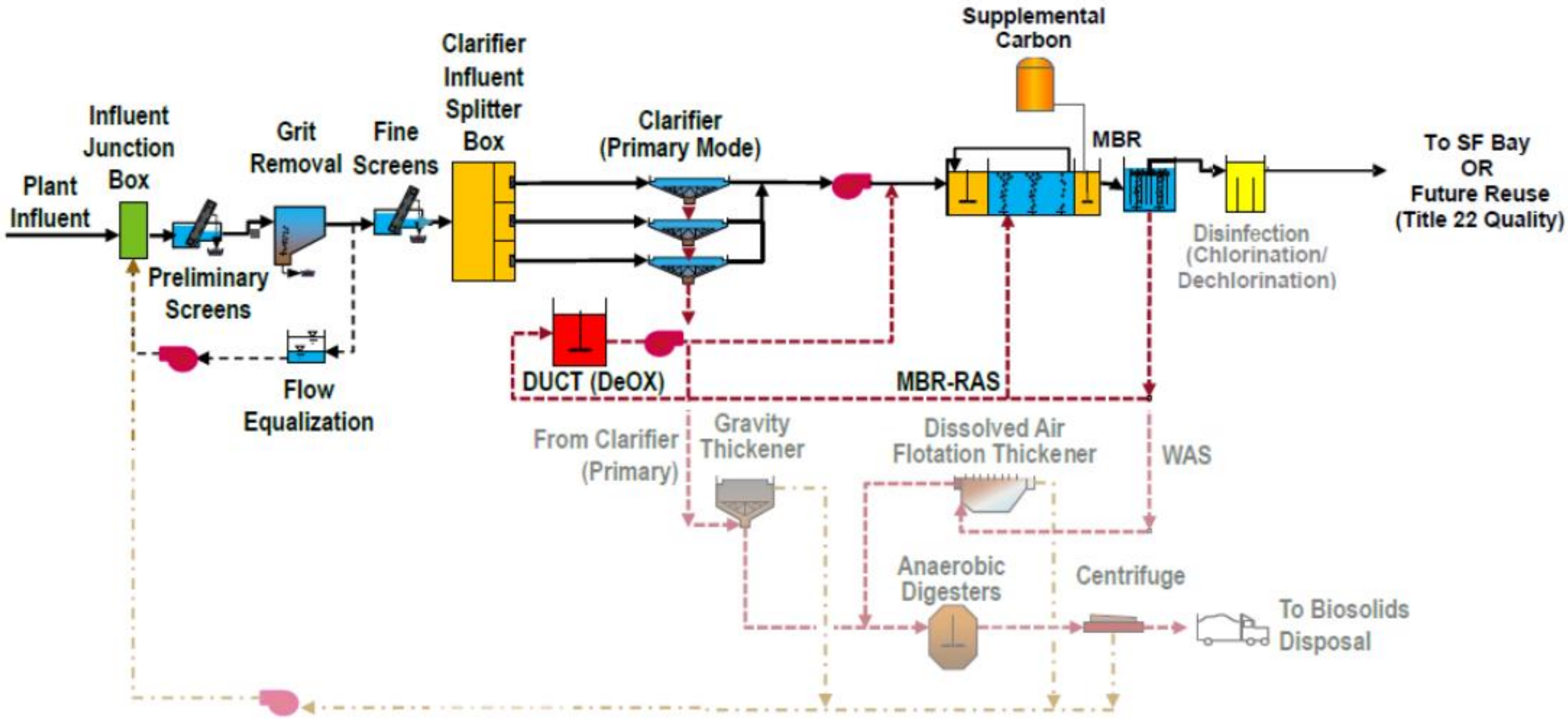

Figure 1-1. Process Flow Diagram for San Mateo WWTP after June 2023 (Dry Weather Operation; Source: NPDES Permit R2-2018-0016; CA0037541)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2020 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial

Use Category*	Definition
	building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility.
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with San Mateo WWTP and Engineer's best judgment that considered known project constraints, existing San Mateo WWTP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by San Mateo WWTP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[2] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN, or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by end of 2023) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^{6}\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^{6}\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects. The subsections that follow summarize the flow and nutrient load reductions for each listed project in Table 3-1.

Table 3-1. Recycled Water Projects Identified by San Mateo WWTP

Recycled Water Project	Description
Existing Recycled Water Facilities	None
Future Project 1: Golf and Various Landscape Irrigation as Identified in the 2017 Hydroscience Report[1]	These projects include storage and pumping at the San Mateo WWTP, followed by Project 1-2 and all those listed for Regions 5 and 6 in the 2017 Hydroscience Report.[1] Note: the projects considered are limited to those under EMID.
Future Project 2: Surface water augmentation to Crystal Springs Reservoir as Identified in the 2017 Hydroscience Report[1]	The 2017 Hydroscience Report considered four different potable reuse alternatives. Of those evaluated, the surface water augmentation to Crystal Springs Reservoir appears was deemed most attractive and thus included with this report. Such an alternative would require full advanced treatment of San Mateo WWTP product water and distribution to the lower Crystal Springs Reservoir to augment raw water supplies prior to treatment and distribution. It is anticipated that 8 mgd of San Mateo WWTP product water would be treated and transported to the reservoir.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. **Note: all the future projects listed for this report are conceptual as there are numerous competing factors for implementation, such as costs to fund the projects and jurisdictional challenges.** The recycled water projects are anticipated to begin around year 2030 with a steady increase through year 2040 (Project 1), after which an exponential increase could occur after year 2040 when Project 2 could come online. The projected dates are based on those from the HydroScience Report with an additional five years added.[1] Note: the majority of nutrients associated with Project 2 would be captured as part of the advanced treatment and returned to the San Mateo WWTP with eventual Bay discharge. This report considered such a return stream laden with nutrients.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Distributed – Return Flows (AFY)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**--**	**--**	**--**	**--**	**--**
	Existing Facilities	--	--	--	--	--
	Project 1**	3	--	--	--	--
	Project 2***	3				
2025	**Total**	**--**	**--**	**--**	**--**	**--**
	Existing Facilities	--	--	--	--	--
	Project 1**	3	--	--	--	--
	Project 2***	3				
2030	**Total**	**3**	**602**	**1**	**31**	**2**
	Existing Facilities	--	--	--	--	--
	Project 1**	3	602	1	31	2
	Project 2***	3	--	--	--	--
2035	**Total**	**3**	**635**	**1**	**32**	**2**
	Existing Facilities	--	--	--	--	--
	Project 1**	3	635	1	32	2
	Project 2***	3	--	--	--	--
2040	**Total**	**3**	**865**	**1**	**44**	**3**
	Existing Facilities	--	--	--	--	--
	Project 1**	3	865	1	44	3
	Project 2***	3	--	--	--	--
2045	**Total**	**3**	**8,030**	**4**	**117**	**8**
	Existing Facilities	--	--	--	--	--
	Project 1**	3	865	1	44	3
	Project 2***	3	7,170	2	73	5

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

** Project 1 = golf course and various landscape irrigation projects as identified for EMID as project 1-2 and all of those for regions 5 and 6 in the 2017 Recycled Water Facilities Plan.[1]

*** Project 2 = surface water augmentation to Crystal Springs Reservoir as identified in the 2017 Recycled Water Facilities Plan.[1] The listed volume represents production water following advanced treatment required for potable reuse. Approximately 20 percent of the advanced treatment feed flow would be returned to the San Mateo WWTP as brine reject water laden with nutrients and discharged to the Bay.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. Recycled water is slated to begin at approximately year 2030 with the primary customers being golf course and landscape irrigation. The recycled water values presented suggests a steady increase through year 2040 (includes Project 1 elements), followed by an exponential increase after year 2041 for Project 2 (Surface Water Augmentation).

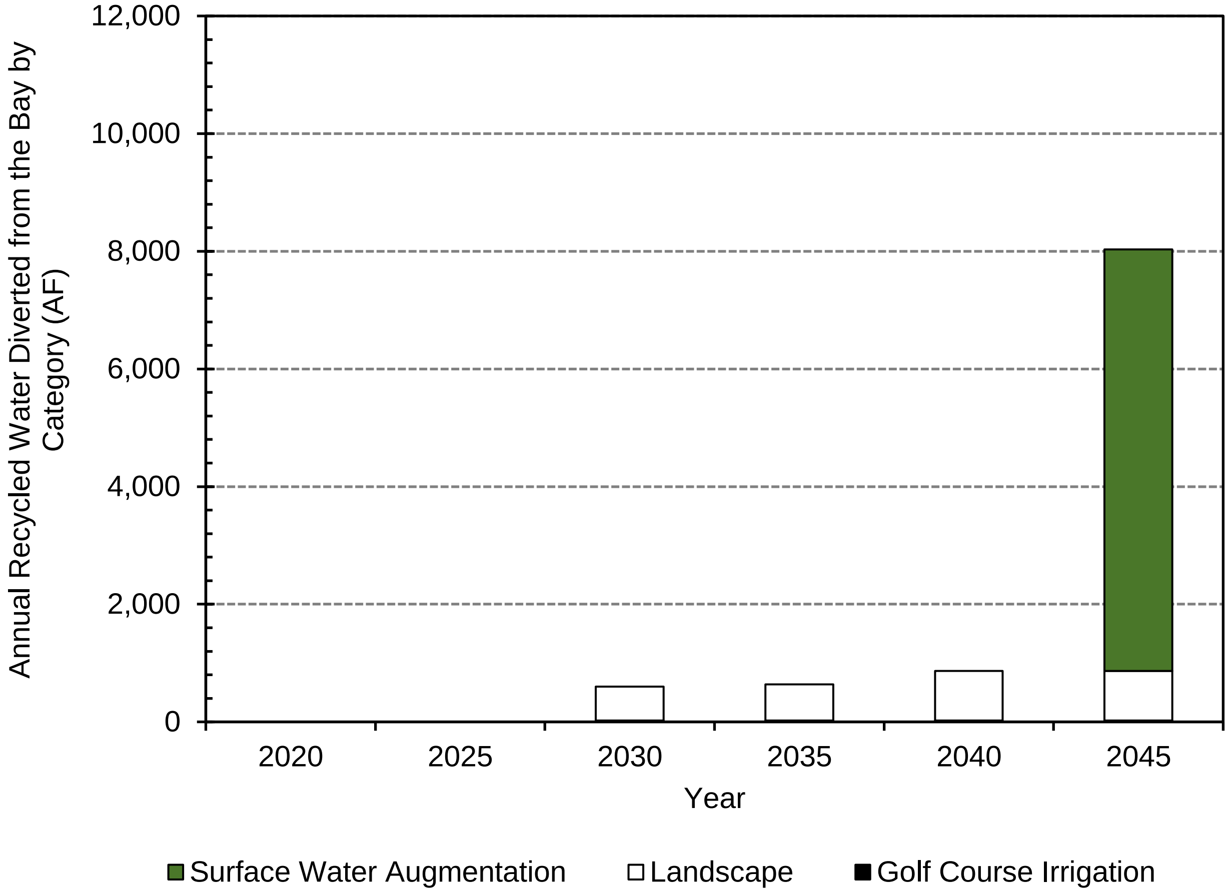

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)*

* The golf course and landscape irrigation represent Project 1, whereas the surface water augmentation represents Project 2.

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. The key ancillary benefits are reducing potable water supply and diversifying the portfolio, as well as reducing the strain on the Hetch Hetchy System (limited to Project 2). The primary adverse impact is operating and maintaining treatment, distribution, and delivery of recycled water would be new to the area.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities	--	--
Future Project 1: Golf and Various Landscape Irrigation as Identified in the 2017 Hydroscience Report[1]	• The on-going upgrades will require minor modifications with disinfection to meet unrestricted Title 22 recycled water. • The on-going upgrades will decrease any existing particulate and nutrient loads to the Bay. • By reducing nutrients as part of the on-going upgrades, additional removal for contaminants of emerging concern will occur due to a longer solids residence time. • The Recycled Water distribution and delivery facilities will be maintained by EMID. • Reduction in potable water supply.	• Limited portfolio of recycled water applications (golf course and landscape irrigation). • Concerns over elevated total dissolved solids levels as the potable water supply already has concerns. This would require treating a portion of the recycled water with a salt removal technology, such as reverse osmosis which is costly to construct and operate. • Miles of distribution pipeline to construct and maintain.
Future Project 2: Surface water augmentation to Crystal Springs Reservoir as Identified in the 2017 Hydroscience Report[1]	• Increased water supply reliability and independence from imported water. Specifically, this would ease the dependence on the Hetch Hetchy system. • Drought resiliency. • Consistent demand/usage throughout the year (less seasonal dependency than Project 1). • Enhanced treatment, such as additional removal of contaminants of emerging concern.	• Portion of nutrient loads returned to the WWTP/Bay as part of advanced treatment process train (specifically brine reject) • Energy and chemical intensive process to provide advanced treatment • Additional operators to maintain and operate the advanced treatment system. Furthermore, it might require a new operator grade.

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project is provided in Table 3-4. Note: the values in the right-hand total columns represent values over the 25-year duration (2020 through 2045). While attractive from a water supply and diversification standpoint, both sets of future projects are relatively inefficient in terms of unit costs (both by flow and nutrient load costs). For perspective, the optimization and upgrades study that evaluated nutrient load reduction across Bay Area WWTPs had a range of values from $2.0 - $8.7/lb TIN load reduced,[2] which is considerably more cost-effective than $75/lb or greater for TIN load reduced associated with recycled water at San Mateo WWTP.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (None) *, **		Future Project #1 (Golf Course and Various Landscape Irrigation Projects Starting at Approximately Year 2030) *, **		Future Project #2 (Potable Reuse: Crystal Springs Reservoir Augmentation after Year 2040) *, **		Total (Includes Existing and Future Projects Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 – Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]									
Flow	mgd	--	--	1.2	0.7	6.4	6.4	1.9	1.5
Volume	AF	--	--	556	742	2,990	7,170	869	1,690
Load Diverted from the Bay[2,3]									
Confidence	**unitless**	**--**	**--**	3	3	**3**	**3**	**3**	**3**
Duration	Years	--	--	15	15	5	5	25	25
Flow Diverted	%	--	--	12%	6%	65%	56%	19%	13%
Ammonia Load Diverted	kg N/d	--	--	2	1	2	2	2	1
TIN Load Diverted	kg N/d	--	--	67	38	72	73	55	37
TP Load Diverted	kg P/d	--	--	4	3	5	5	4	2
Cost[3,4,5]									
Capital Cost	$ Mil	--	--	26	26	169	169	194	194
NPV O&M	$ Mil	--	--	6	8	39	93	45	101
NPV Total (Capital+NPV O&M)	$ Mil	--	--	32	34	207	262	239	295
Unit Flow Cost[6]									
Unit Cost	$/gpd	--	--	27	51	33	41	129	196
Unit Cost	$/AF	--	--	3,830	3,050	13,900	7,300	11,000	7,000
Unit Load Cost[7,8]									
Ammonia Unit Cost	$/lb Ammonia Diverted	--	--	2,810	2,240	51,000	26,800	15,500	11,900
TIN Unit Cost	$/lb TIN Diverted	--	--	94	75	1,700	894	518	396
TP Unit Cost	$/lb TP Diverted	--	--	1,410	1,120	25,500	13,400	7,760	5,940

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3). For the Total columns, the project start period is from year 2020 through year 2045.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by San Mateo WWTP in 2021 dollars. Capital cost values from the 2017 Hydroscience Report were escalated from 2017 to 2021 dollars based on Engineering News and Record values. O&M values were escalated forward at 3 percent from the 2017 values.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay over the project duration.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. The San Mateo WWTP projections suggest that the recycled water demands are initiated around year 2030 with a steady increase through year 2040 (includes Project 1 elements), followed by an exponential increase after year 2041 for Project 2 (Surface Water Augmentation). Note: the majority of nutrients associated with Project 2 would be captured as part of the advanced treatment and returned to the San Mateo WWTP with eventual Bay discharge. This report considered such a return stream laden with nutrients.

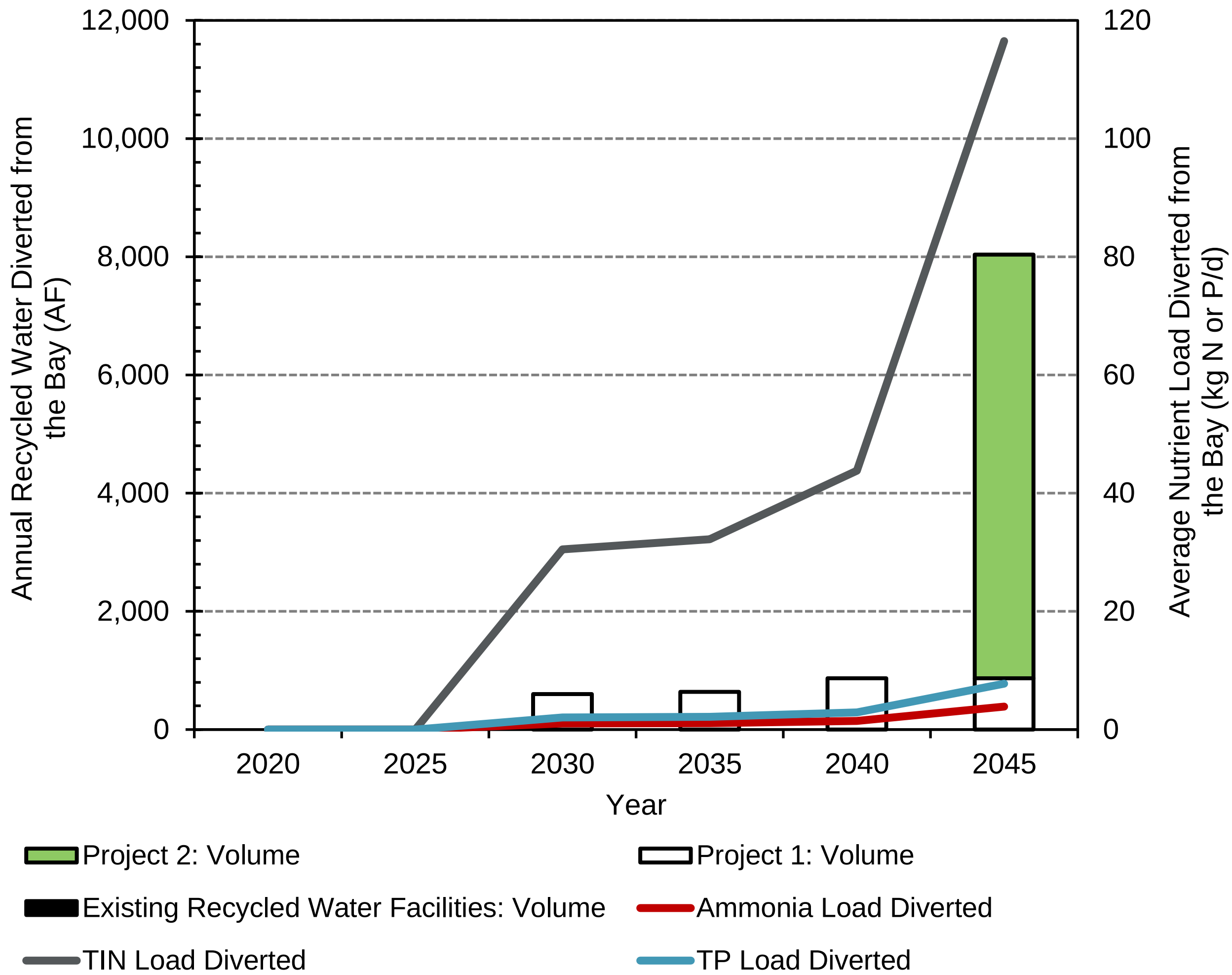

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge*,**

* Project 1 = golf course and various landscape irrigation projects as identified for Foster City and EMID as project 1-2 and all of those for regions 5 and 6 in the 2017 Recycled Water Facilities Plan.[1]

** Project 2 = surface water augmentation to Crystal Springs Reservoir as identified in the 2017 Recycled Water Facilities Plan.[1] The listed volume represents production water following advanced treatment required for potable reuse. Approximately 20 percent of the advanced treatment feed flow would be returned to the San Mateo WWTP as brine reject water and discharged to the Bay.

3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at San Mateo WWTP:

- Drivers for implementing recycled water projects:
  - Beneficial reuse: reduce potable water supply demand and diversify supply.
  - Proposed Discharge Regulations: increased water reuse can further reduce discharge loads beyond the on-going upgrades.
- Barriers for implementing recycled water projects:
  - Funding: all the projects under consideration have a cost that will impact the ability to implement.
  - Jurisdictional: there are two drinking water providers for the service area (EMID and Cal Water) so agreements would need to be in place prior to implementation.

Bay Area Clean Water Agencies
Recycled Water Study

Sausalito-Marin City Sanitary District

BACWA Recycled Water Study

FINAL Individual Plant Report

Sausalito, CA

May 11, 2023

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Contents

Tables

Figures

Executive Summary

The Sausalito-Marin City Sanitary District (SMCSD) Wastewater Treatment Plant (WWTP) discharges to the Central San Francisco Bay. It is located at 1 East Road, Sausalito, CA 94965, and it serves approximately 6,500 service connections throughout the City of Sausalito, unincorporated Marin City, Tamalpais Community Service District, and the Golden Gate National Recreation Area (National Park Service). The plant has an average dry weather flow (ADWF) permitted capacity of 1.8 million gallons per day (mgd).

The SMCSD WWTP does not currently employ a recycled water program and there are no planned recycled water projects through 2045. There have been some internal discussions regarding recycled water options and a feasibility study was conducted due to drought and political pressures. Several major obstacles were identified including water suitability/funding, ownership rights, and demand. In addition, the ability to produce, operator certifications, and space requirements would also be barriers. Consequently, the outcome of the study was to minimize or eliminate the use of potable water used for operations, rather than to produce potable water.

Water Suitability/Funding: the current SMCSD effluent water contains levels of turbidity, conductivity, dissolved solids, chloride, fluoride, salinity, and coliforms. To meet water quality for ends uses would require further treatment. A pilot would likely be required to verify the ability and the associated costs to produce suitable recycled water quality.

Water Rights: Marin Municipal Water District is the communities water purveyor. As such, the water rights would need to be clarified and communicated to stakeholders. Such information would be needed to assess any potential benefits and risks going forward.

Demand: demand for recycled water, although growing and a future need to be considered, is only part of the equation. Distribution, location of a distribution station or purple pipe implementation may be problematic given the location within the National Park Service and the space SMCSD currently leases with the National Park Service.

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1 Introduction and Current Conditions

The Sausalito-Marin City Sanitary District (SMCSD) Wastewater Treatment Plant (WWTP) discharges to the Central San Francisco Bay. It is located at 1 East Road, Sausalito, CA 94965, and it serves approximately 6,500 service connections throughout the City of Sausalito, unincorporated Marin City, Tamalpais Community Service District, and the Golden Gate National Recreation Area (National Park Service). The plant has an average dry weather flow (ADWF) permitted capacity of 1.8 million gallons per day (mgd).

The sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

SMCSD holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2018-0025; CA0038067). Table 1-1 provides a summary of the relevant permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2018-0025; CA0038067)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	1.8	--	--	--
Effluent cBOD (1)	mg/L	--	25	40	--
Effluent TSS (1)	mg/L	--	30	45	--
Effluent Ammonia	mg N/L	--	180	--	380

1) cBOD and TSS include a minimum percent removal of 85% through the WWTP
2) This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly part of the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Anticipated in Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 shows the existing process flow diagram for the SMCSD WWTP. Both liquids processes and solids processes are shown. Treatment consists of primary clarification, biological treatment through fixed-film reactors, secondary clarification, filtration (up to 1 mgd of flow), disinfection with chlorine and de-chlorination. The fixed-film reactors remove a portion of the ammonia load. Solids treatment consists of co-thickening in the primaries, anaerobic digestion and mechanical dewatering using a screw press.

1.3 Existing Recycled Water Service

The SMCSD WWTP does not currently employ a recycled water program.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19) *,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	1.07	1.50	1.32
Volume	AF	500	980	1,480
Ammonia	kg N/d	121	51.4	80.4
Total Inorganic Nitrogen (TIN)	kg N/d	150	125	136
Total Phosphorus (TP)	kg P/d	18.5	15.6	16.8
Ammonia	mg N/L	30.1	10.5	18.7
TIN	mg N/L	37.4	24.3	29.7
TP	mg P/L	4.61	3.09	3.72

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

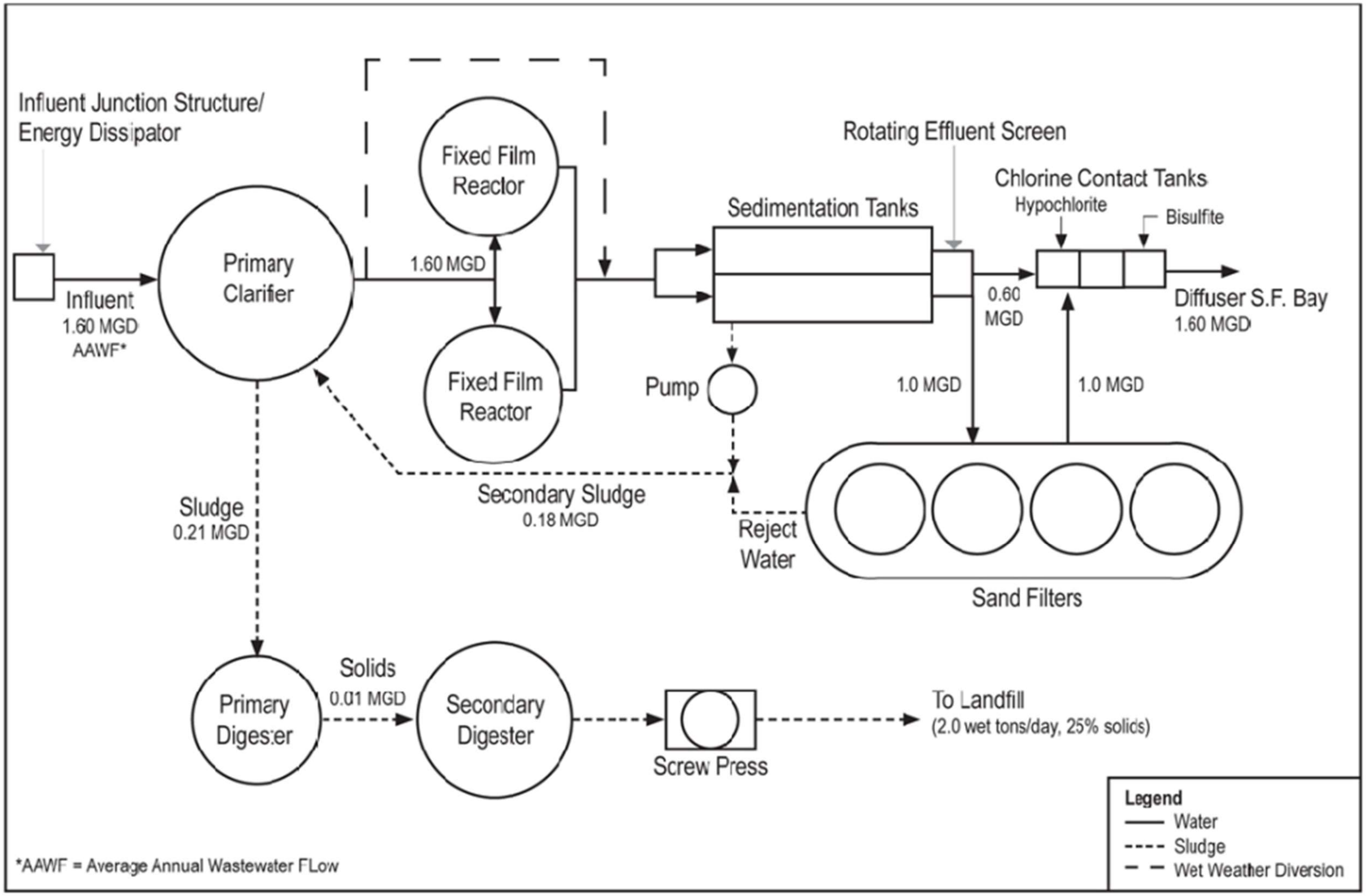

Figure 1-1. Process Flow Diagram for SMCSD WWTP (Source: NPDES Permit Order R2-2018-0025; CA0038067)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with SMCSD and Engineer's best judgment that considered known project constraints, existing SMCSD reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by SMCSD. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g. existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g. a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

The SMCSD WWTP does not currently employ a recycled water program and there are no planned recycled water projects through 2045. There have been some internal discussions regarding recycled water options and a feasibility study was conducted due to drought and political pressures. Several major obstacles were identified including water suitability/funding, ownership rights, and demand. In addition, the ability to produce, operator certifications, and space requirements would also be barriers. Consequently, the outcome of the study was to minimize or eliminate the use of potable water used for operations, rather than to produce potable water.

Water Suitability/Funding: the current SMCSD effluent water contains levels of turbidity, conductivity, dissolved solids, chloride, fluoride, salinity, and coliforms. To meet water quality for ends uses would require further treatment. A pilot would likely be required to verify the ability and the associated costs to produce suitable recycled water quality.

Water Rights: Marin Municipal Water District is the communities water purveyor. As such, the water rights would need to be clarified and communicated to stakeholders. Such information would be needed to assess any potential benefits and risks going forward.

Demand: demand for recycled water, although growing and a future need to be considered, is only part of the equation. Distribution, location of a distribution station or purple pipe implementation may be problematic given the location within the National Park Service and the space SMCSD currently leases with the National Park Service.

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Sewerage Agency of Southern Marin

BACWA Recycled Water Study

FINAL Individual Plant Report

Mill Valley, CA
June 27, 2023

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Contents

Tables

Figures

Executive Summary

The Sewerage Agency of Southern Marin (SASM) Wastewater Treatment Plant (WWTP) discharges to Central San Francisco Bay. It is located at 450 Sycamore Avenue, Mill Valley, CA 94941, and it serves approximately 29,000 residents in Southern Marin County. It provides secondary treatment of domestic wastewater for its six member agencies: the City of Mill Valley (CMV), Almonte Sanitary District, Alto Sanitary District, Homestead Valley Sanitary District, Richardson Bay Sanitary District, and the Kay Park Area of the Tamalpais Community Sanitary District. The plant has an average dry weather flow (ADWF) permitted capacity of 3.6 million gallons per day (mgd).

The existing SASM/CMV recycled water facility operates under the Regional Water Quality Control Board (RWQCB) General Water Reuse Order 96-011 and the National Pollutant Discharge Elimination System (NPDES) permit. Its tertiary recycled water is coagulated, filtered, and disinfected to meet total coliform limits, disinfection, and turbidity limits prior to distribution. The existing recycled water facilities are owned by the City of Mill Valley and operated by SASM, and they are sized to treat up to 180,000 gallons per day (gpd) of secondary effluent. Approximately 38 acre-feet per year (AFY; 12.5 million gallons per year) are currently used for irrigation of landscaping and athletic fields at City of Mill Valley parks and sanitary sewer cleaning by SASM member agencies. SASM installed a recycled water fill station in 2021 at the SASM Wastewater Treatment Plant. The fill station water is collected by member agencies and their contractors for sanitary sewer cleaning purposes only. There are currently no plans to further expand the existing water recycling program in future years.

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES - 1. The table includes existing facilities, proposed future recycled water projects (in this case none), and the total (sum of existing plus proposed future projects). The timeline and corresponding load diversions from the Bay for projects listed in Table ES - 1 are provided in Figure ES - 1.

An overview of the drivers and barriers for implementing recycled water projects at SASM:

- Drivers for implementing recycled water projects: the primary driver is institutional as SASM has a desire to maximize recycled water.
- Barriers for implementing recycled water projects:
    - Funding: SASM in partnership with Marin Municipal Water District (MMWD), conducted a recycled water Study in 2014. This study identified a potential project mainly for landscape irrigation. The projected cost at the time was approximately $2 Mil and was recommending a partnership with the MMWD.
    - Water Quality: SASM's product water is impacted by salt content within the raw wastewater from the San Francisco Bay tidal impact on the sanitary sewer collection system.

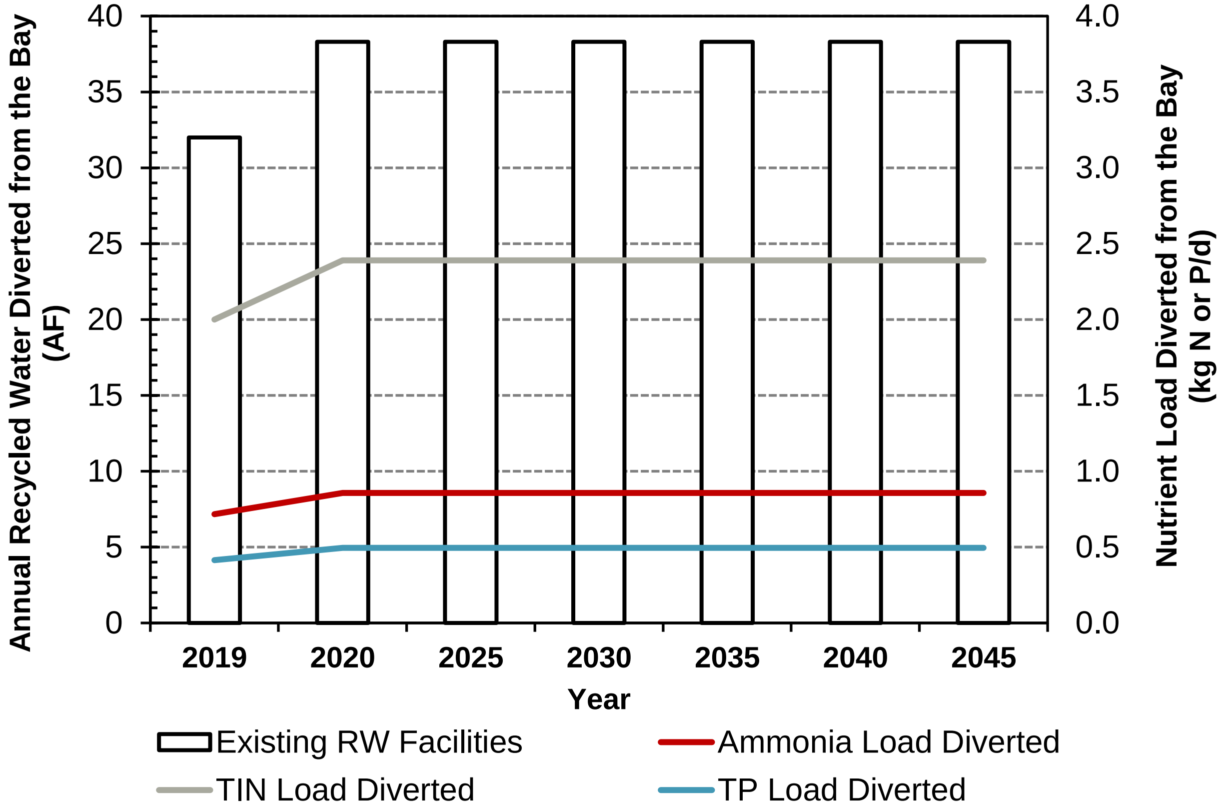

Figure ES - 1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge

Table ES - 1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Projects (None Planned) *,**		Total (Projected into the Future) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	0.065	0.034	--	--	0.065	0.034
Volume	AF	30.5	38.3	--	--	30.5	38.3
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Flow Diverted	%	4%	1%	--	--	4%	1%
Ammonia Load Diverted	kg N/d	3.0	0.9	--	--	3.0	0.9
TIN Load Diverted	kg N/d	6.5	2.4	--	--	6.5	2.4
TP Load Diverted	kg P/d	1.4	0.5	--	--	1.4	0.5
Cost[3,4,5]							
Capital Cost4	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	0.6	0.7	--	--	0.6	0.7
NPV Total (Capital+NPV O&M)	$ Mil	0.6	0.7	--	--	0.6	0.7
Unit Flow Cost[6]							
Unit Cost	$/gpd	8.7	21	--	--	8.7	21
Unit Cost	$/AF	739	739	--	--	739	739
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	22	41	--	--	22	41
TIN Unit Cost	$/lb TIN Diverted	10	15	--	--	10	15
TP Unit Cost	$/lb TP Diverted	49	71	--	--	49	71

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045; details provided with each project in Section 3).

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by SASM (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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1 Introduction and Current Conditions

The Sewerage Agency of Southern Marin (SASM) Wastewater Treatment Plant (WWTP) discharges to Central San Francisco Bay. It is located at 450 Sycamore Avenue, Mill Valley, CA 94941, and it serves approximately 29,000 residents in Southern Marin County. It provides secondary treatment of domestic wastewater for its six member agencies: the City of Mill Valley (CMV), Almonte Sanitary District, Alto Sanitary District, Homestead Valley Sanitary District, Richardson Bay Sanitary District, and the Kay Park Area of the Tamalpais Community Sanitary District. The plant has an average dry weather flow (ADWF) permitted capacity of 3.6 million gallons per day (mgd). The current dry season flows are approximately 1.8 mgd.

The sub-sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2018-0039), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

SASM holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2018-0039). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2018-0039)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	3.6	--	--	--
Effluent BOD (1)	mg/L	--	30	45	--
Effluent TSS (1)	mg/L	--	30	45	--
Effluent Ammonia	mg/L	--	12.3	--	32

1. BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Nutrient Watershed Permit: Recycled Water Requirements

The Nutrient Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge – Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for the SASM Wastewater Treatment Plant. Both liquids processes and solids processes are shown. Treatment processes consist of screening, grit removal, flow equalization, primary sedimentation, secondary treatment (trickling filters), secondary clarification, disinfection (chlorination), and dechlorination. Trickling filters provide partial ammonia removal. No major nutrient removal systems are currently in place.

Solids removed from the wastewater stream are treated by gravity thickening, primary and secondary digestion, and dewatering by belt filter press.

1.3 Existing Recycled Water Service

The existing SASM/CMV recycled water facility operates under the Regional Water Quality Control Board (RWQCB) General Water Reuse Order 96-011 and the National Pollutant Discharge Elimination System (NPDES) permit. Its tertiary recycled water is coagulated, filtered, and disinfected to meet the total coliform, disinfection, and turbidity limits prior to distribution. The existing recycled water facilities are owned by the City of Mill Valley and operated by SASM, and they are sized to treat up to 180,000 gallons per day (gpd) of secondary effluent. Approximately 38 acre-feet per year (12.5 million gallons per year). SASM installed a recycled water fill station in 2021 at the SASM Wastewater Treatment Plant. The fill station water is collected by member agencies and their contractors for sanitary sewer cleaning purposes only. There are currently no plans to further expand the existing water recycling program in future years.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	1.81	3.29	2.67
Volume**	AF	850	2,138	2,989
Ammonia	kg N/d	84.7	54.3	67.0
Total Inorganic Nitrogen (TIN)	kg N/d	181	191	187
Total Phosphorus (TP)	kg P/d	38.0	39.2	38.7
Ammonia	mg N/L	12.4	5.03	8.10
TIN	mg N/L	26.7	17.6	21.4
TP	mg P/L	5.58	3.77	4.53

* Represents the three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

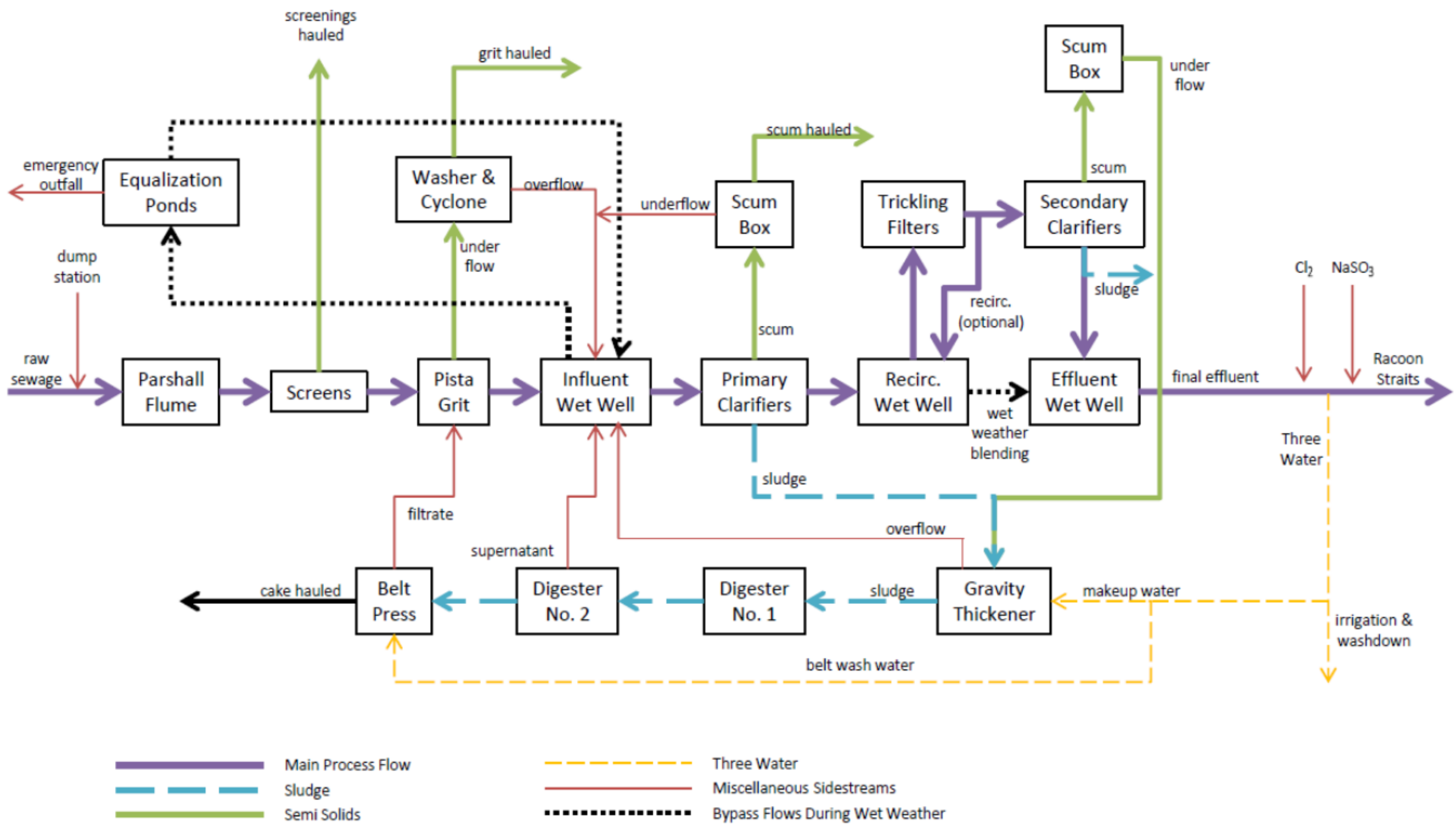

Figure 1-1. Process Flow Diagram for Sewerage Agency of Southern Marin (Source: NPDES Order No. R2-2018-0039)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.

Use Category*	Definition
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter
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Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with Napa San WRF and Engineer's best judgment that considered known project constraints, existing Napa San WRF reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by Napa San WRF. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering,

construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g. existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g. a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects.

Table 3-1. Recycled Water Projects Identified by Napa San

Recycled Water Project	Description
Existing Recycled Water Facilities	The SASM/CMV tertiary facility is coagulated, filtered, and disinfected to meet the total coliform, disinfection, and turbidity limits prior to distribution.
Future Projects	No future projects are planned.

The following sections summarize the flow and nutrient load reductions for each listed project in Table 3-1.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. The existing facility has reached its projected demand capacity with no plans for future expansion. The recycled water demands peak in the dry season months.

Table 3-2. Current and Projected Average Annual Recycled Water Production, Confidence, and Average Annual Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Distributed - Return Flows (AFY)	Ammonia Load Removed (kg N/d)	TIN Load Removed (kg N/d)	Total P Load Removed (kg P/d)
2020	**Total**	**1**	**38**	**1**	**2**	**<1**
	Existing Recycled Water Facilities	1	38	1	2	<1
	Others	--	--	--	--	--
2025	**Total**	**1**	**38**	**1**	**2**	**<1**
	Existing Recycled Water Facilities	1	38	1	2	<1
	Others	--	--	--	--	--
2030	**Total**	**1**	**38**	**1**	**2**	**<1**
	Existing Recycled Water Facilities	1	38	1	2	<1
	Others	--	--	--	--	--
2035	**Total**	**1**	**38**	**1**	**2**	**<1**
	Existing Recycled Water Facilities	1	38	1	2	<1
	Others	--	--	--	--	--
2040	**Total**	**1**	**38**	**1**	**2**	**<1**
	Existing Recycled Water Facilities	1	38	1	2	<1
	Others	--	--	--	--	--
2045	**Total**	**1**	**38**	**1**	**2**	**<1**
	Existing Recycled Water Facilities	1	38	1	2	<1
	Others	--	--	--	--	--

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. To date, landscape irrigation by the City of Mill Valley and sanitary sewer cleaning by SASM member agencies are the permitted users under the SASM water reuse program. Under this permit, the current application sites include the Hauke Park, Bayfront Park, the “Passive Area”, the Mill Valley Dog Run and “The Meadow”. The addition of drinking water from Marin Municipal Water District to the tertiary recycled water helps control the conductivity (salinity) of the final recycled water. In general, the recycled water demands peak in the dry season but there are year-round demands.

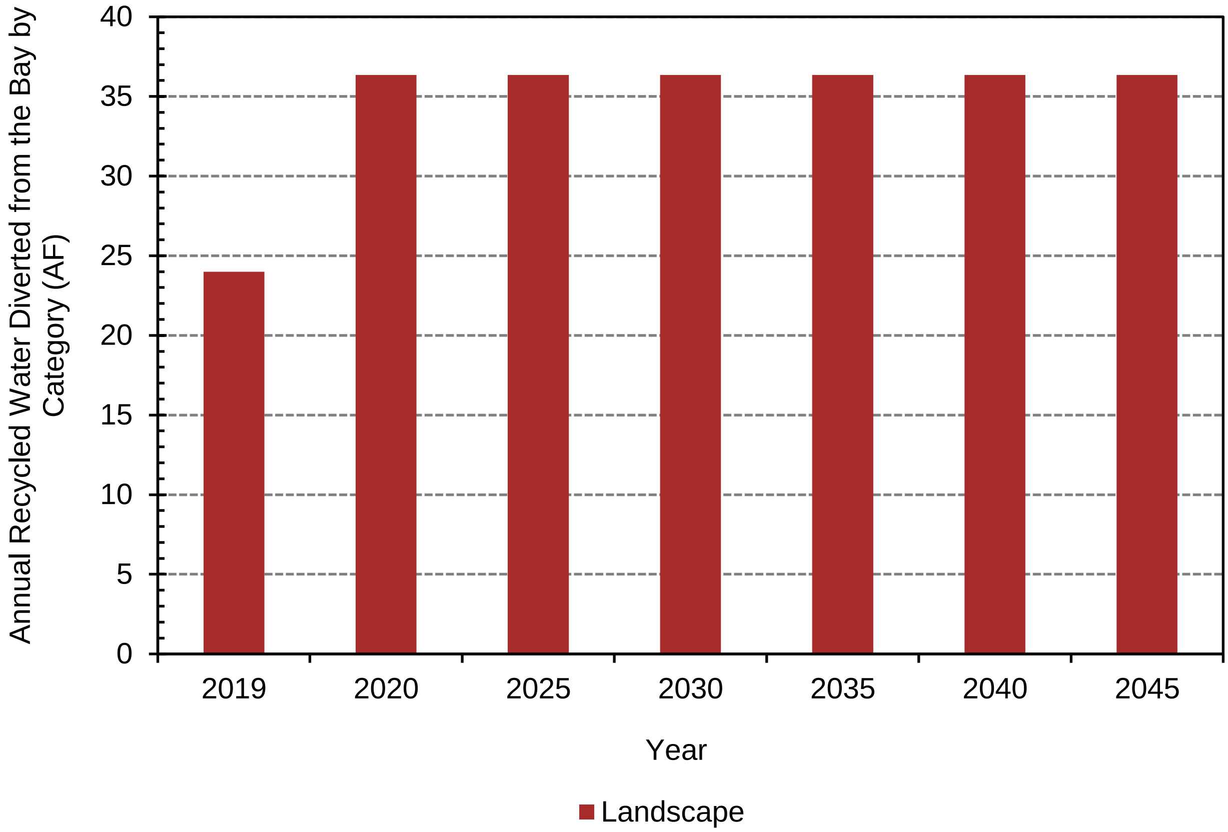

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. The existing facilities are already paid for an in place. There are no anticipated future planned projects.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities	• Facilities are already in place and providing recycled water • Operator familiarity with existing recycled water facilities • Existing facilities reliably meet recycled water treatment requirements • Marginal increase in operational costs for SASM WWTP to provide the recycled water	• Limited to 180,000 gpd
Other Projects (None Planned)	• Non-Applicable	• Non-Applicable

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. The recycled water volumes are not anticipated to change over the next 25 years. As a result, the projected nutrient loads diverted to the Bay are also not anticipated to change unless the effluent nutrient concentrations change over time. The analysis is based on the existing effluent nutrient concentrations over the project duration.

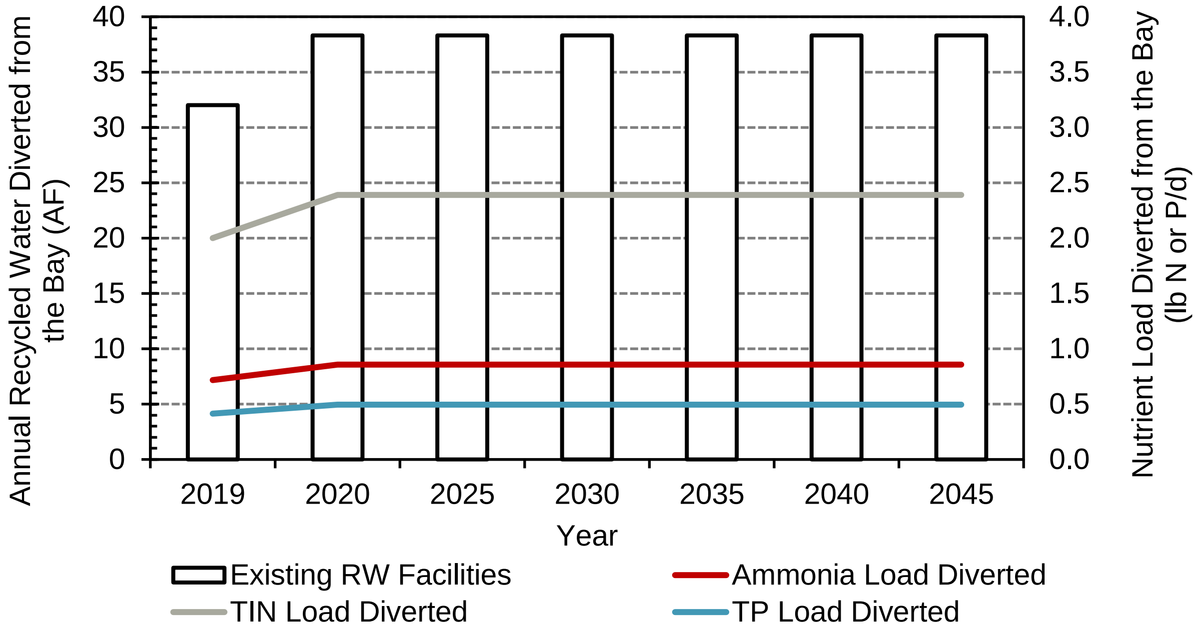

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge

3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at SASM:

- Drivers for implementing recycled water projects: the primary driver is institutional as SASM has a desire to maximize recycled water.
- Barriers for implementing recycled water projects:
  - Funding: SASM in partnership with Marin Municipal Water District (MMWD), conducted a recycled water Study in 2014. This study identified a potential project mainly for landscape irrigation. The projected cost at the time was approximately $2 Mil and was recommending a partnership with the MMWD.
  - Water Quality: SASM's product water is impacted by salt content within the raw wastewater from the San Francisco Bay tidal impact on the sanitary sewer collection system.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Projects (None Planned) *,**		Total (Projected into the Future) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	0.065	0.034	--	--	0.065	0.034
Volume	AF	30.5	38.3	--	--	30.5	38.3
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Flow Diverted	%	4%	1%	--	--	4%	1%
Ammonia Load Diverted	kg N/d	3.0	0.9	--	--	3.0	0.9
TIN Load Diverted	kg N/d	6.5	2.4	--	--	6.5	2.4
TP Load Diverted	kg P/d	1.4	0.5	--	--	1.4	0.5
Cost[3,4,5]							
Capital Cost4	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	0.6	0.7	--	--	0.6	0.7
NPV Total (Capital+NPV O&M)	$ Mil	0.6	0.7	--	--	0.6	0.7
Unit Flow Cost[6]							
Unit Cost	$/gpd	8.7	21	--	--	8.7	21
Unit Cost	$/AF	739	739	--	--	739	739
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	22	41	--	--	22	41
TIN Unit Cost	$/lb TIN Diverted	10	15	--	--	10	15
TP Unit Cost	$/lb TP Diverted	49	71	--	--	49	71

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045).

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by SASM (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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Silicon Valley Clean Water Wastewater Treatment Plant

BACWA Recycled Water Study

Individual Plant Report

Redwood City, CA
June 28, 2023
FINAL Report

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Contents

Tables

Figures

Executive Summary

Silicon Valley Clean Water owns and operates the Silicon Valley Clean Water (SVCW) Wastewater Treatment Plant (WWTP) located in Redwood City, CA and discharges treated effluent to lower San Francisco Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 29.0 million gallons per day (mgd).

SVCW has an existing recycled water program that is employed year-round. The lone customer is Redwood City, and they have a recycled water facility on the SVCW WWTP site that can produce up to 12.9 mgd. SVCW WWTP sends tertiary filtered wastewater to the Redwood City Recycled Water Facility and the water is disinfected at their facility and placed in storage tanks. Redwood City then distributes the recycled water to their customers (primarily landscape irrigation with a greater demand during the dry season). Redwood City covers all cost including Operation and Maintenance of the distribution portion the recycled water. SVCW currently recycles approximately 860 acre-feet per year (AFY; 280 million gallons per year). Recycled water demands are projected to increase at a steady rate through year 2035, after which marginal increases are anticipated through year 2045.

SVCW has been evaluating a potable reuse project that would require advanced treatment of SVCW WWTP effluent to meet anticipated potable reuse treatment requirements. The advanced treated effluent has numerous potable reuse opportunities that would initially consider surface water augmentation (known as Phase 1). This conceptual analysis is limited to the Phase 1 surface water augmentation as the future beyond Phase 1 is unclear. Phase 1 is anticipated to be implemented by year 2035 which was assumed for this analysis. **A key feature of any potable reuse project is the likelihood of upstream nutrient removal (emphasis on ammonia and total inorganic nitrogen (TIN)) as such improvements offer numerous downstream advanced treatment benefits. Given that, this analysis is predicated on SVCW WWTP implementing ammonia/TIN load reduction upgrades by year 2035 (costs associated with such improvements are separate from this analysis).**

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES – 1. Upwards of 168 AFY are anticipated for dual plumbing applications for the existing RW system. Such volumes are excluded from this analysis as those volumes would end up in the Bay. The unit cost values for the existing RW projects are relatively low both on a volume and nutrient load reduction basis (with the exception of TP). The unit costs for ammonia and TIN includes anticipated plant upgrades by year 2035, whereas the TP unit costs assume current effluent values through year 2035. The relatively efficient flow and load reduction is attributed to the facilities already being in place (i.e., no capital costs) coupled with Redwood City providing disinfection, storage, and distribution. For perspective, the regional optimization and upgrades study that evaluated nutrient load reduction across Bay Area WWTPs had a range of values of $2.0 - $8.7/lb TIN load reduced,[1] which is relatively close to the $2.4 and $2.6/lb TIN load removed (dry season and average annual, respectively) for SVCW WWTP in this report.

[1] Bay Area Clean Water Agencies (2018) Bay Area Clean Water Agencies Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream Treatment, Treatment Upgrades, and Other Means. Prepared by HDR. Oakland, CA.

The unit cost values for the potential future potable reuse project are exponentially more expensive than the existing RW efforts. It is important to recognize that the potential future potable reuse project would produce a higher quality water than current that has the potential to offset potable water demands from Hetch Hetchy. The capital and O&M cost values are engineer's best judgment based on recent estimates at upwards of $5,000/AF (over 25 years or greater). The values in Table ES – 1 are larger (>>$7,500/AF) as the project duration is limited to 10 years. A longer project duration would reduce the listed values to approximately $5,000/AF. The relatively large unit values were anticipated as SVCW would need to design and construct new advanced treatment facilities, distribution, and O&M control measures. While such values would be reduced if the duration was 25 or more years, the values would still be higher than the existing RW facilities for the reasons stated. The various ancillary benefits associated with such potable reuse projects should be factored into any subsequent decision-making.

The timeline and corresponding load diversions from the Bay is provided in Figure ES – 1. The existing RW facilities are anticipated to steadily increase through year 2035, after which marginal increases are anticipated through year 2045. The potential future potable reuse project would be expected to begin providing water by year 2035. As previously stated, SVCW WWTP would need to provide plant upgrades to remove ammonia/TIN loads to improve feed water quality for the listed potential future potable reuse project. This analysis includes such improvements in load reductions associated with recycled water. However, the costs associated with ammonia/TIN load reductions at the WWTP is excluded as the removal strategy is unclear at this stage.

An overview of the drivers and barriers for implementing recycled water projects at SVCW WWTP:

- Drivers for implementing recycled water projects:
  - Water supply need: recycled water can serve as a strategy to reduce potable water supply demands and diversify water sources.
  - Proposed discharge regulations: recycled water can serve as a strategy to reduce nutrient discharge loads to the Bay.
- Barriers for implementing recycled water projects:
  - Funding: any recycled water opportunities beyond the existing would likely require costly distribution and possibly treatment to implement, as well as funding to operate and maintain.
  - Jurisdictional (for existing RW facilities): Redwood City controls the recycled water customers within the area. Furthermore, any additional opportunities would require working across jurisdictions.
  - Jurisdictional (for potential future potable reuse project): would require working across jurisdictions that includes both the drinking water provider and conveying water across jurisdictions.

Table ES – 1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (Surface Water Augmentation from Year 2035 through 2045) *, **, ***		Total (Includes Existing and Future Projects Averaged from Year 2020 through 2045) *, **, ***	
		Average Dry Season (May 1 – Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	2.3	1.2	6.36	6.40	5.4	4.4
Volume	AF	1,060	1,340	2,990	7,170	2,550	4,920
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	3	3	Blend of 1 and 3	Blend of 1 and 3
Duration	Years	25	25	10	10	25	25
Flow Diverted	%	15%	7%	49%	42%	42%	29%
Ammonia Load Diverted	kg N/d	250	122	12	12	255	126
TIN Load Diverted	kg N/d	303	150	361	363	447	295
TP Load Diverted	kg P/d	39	18	110	97	83	57
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	450ǂ	450ǂ	450ǂ	450ǂ
NPV O&M	$ Mil	6.1	7.8	44ǂ	105ǂ	50ǂ	113ǂ
NPV Total (Capital+NPV O&M)	$ Mil	6.1	7.8	494ǂ	555ǂ	500ǂ	563ǂ
Unit Flow Cost[6]							
Unit Cost	$/gpd	2.7	6.5	78	87	92	128
Unit Cost	$/AF	232	232	16,500	7,750	7,840	4,570
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	2.9	3.2	12,200	5,700	232	221
TIN Unit Cost	$/lb TIN Diverted	2.4	2.6	405	190	133	95
TP Unit Cost	$/lb TP Diverted	19	21	1,330	709	714	490

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3). For the Total columns, the project start period is from year 2020 through year 2045.

*** Future Project: surface water augmentation to Crystal Springs Reservoir (8 mgd effluent fed to advanced treatment starting in year 2036). Note: this project has the potential to evolve into a direct potable reuse effort as part of phase 2 (excluded from this analysis). Costs for this effort are conceptual at best based on other potable reuse evaluations.

ǂ The capital and O&M cost values are engineer's best judgment based on recent estimates at upwards of $5,000/AF (over 25 years or greater). The values in in this table are larger (>>$7,500/AF) as the project duration is limited to 10 years. A longer project duration would reduce the listed values to approximately $5,000/AF.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by SVCW WWTP in 2021 dollars.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

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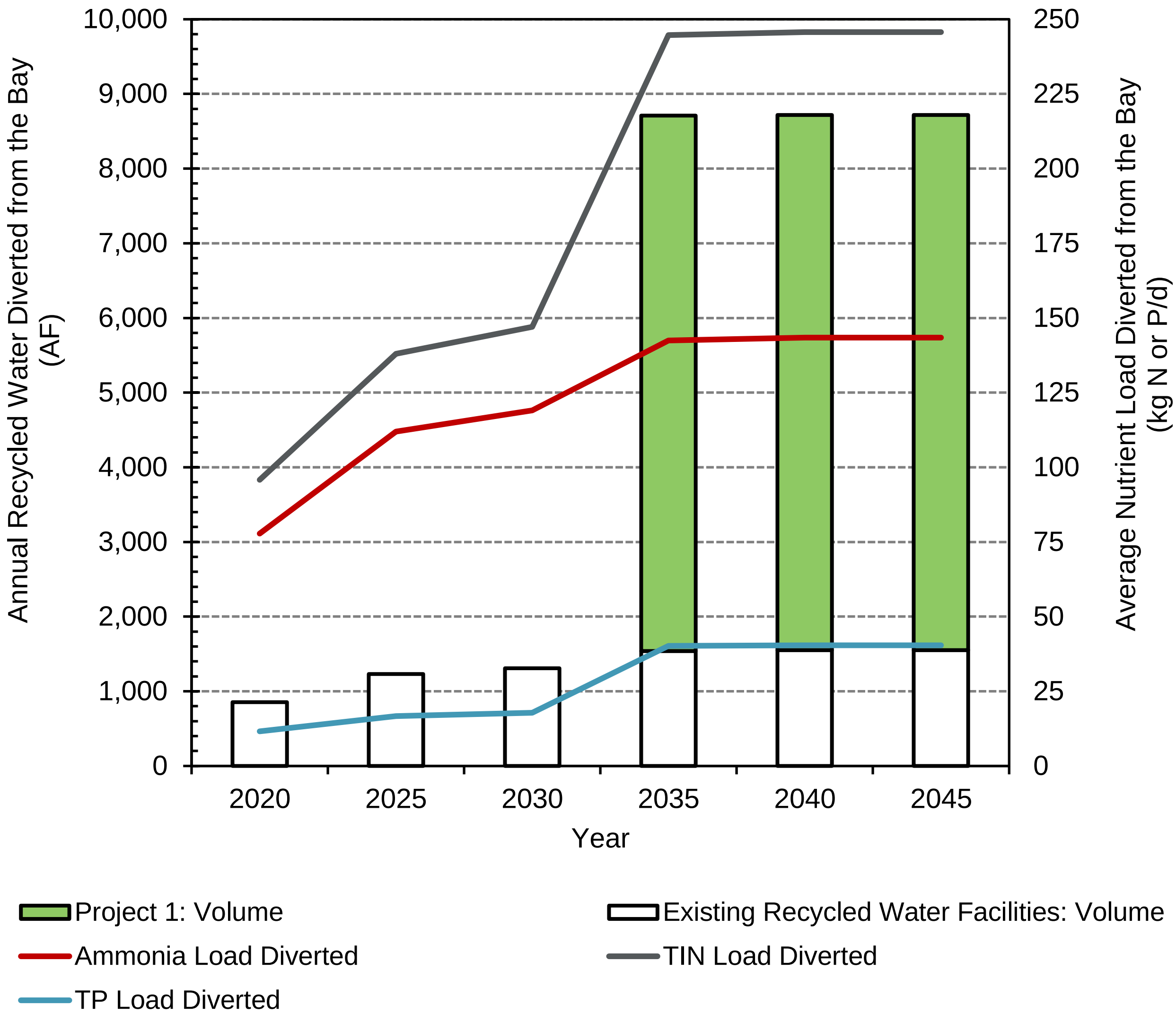

Figure ES – 1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge*, **

* Upwards of 168 AFY are anticipated for dual plumbing applications. Such volumes are excluded from this analysis as those volumes would end up in the Bay.

** Project 1 = Potable reuse project that is in the conceptual phase (i.e., Confidence Level 3) that will initially provide surface water augmentation by approximately year 2035. A key feature of any potable reuse project is the likelihood of upstream nutrient removal (emphasis on ammonia and total inorganic nitrogen (TIN)) as such improvements offer numerous downstream advanced treatment benefits. Given that, this analysis is predicated on SVCW WWTP implementing ammonia/TIN load reduction upgrades by year 2035 (costs associated with such improvements are separate from this analysis).

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1 Introduction and Current Conditions

The Silicon Valley Clean Water Wastewater Treatment Plant (SVCW) serves a population of about 199,000, which includes the West Bay Sanitary District, City of Belmont, City of San Carlos, and City of Redwood City. It is located at 1400 Radio Rd., Redwood City, CA. The plant has an average dry weather flow (ADWF) permitted capacity of 29.0 million gallons per day (mgd).

The subsections that follow provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

SVCW WWTP holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2023-0003; CA0038369). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2023-0003; CA0038369)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Wet Season Effluent Limitations – October through April					
Influent Flow	mgd	29.0	--	--	--
Effluent cBOD (1)	mg/L	--	16	24	--
Effluent TSS (1)	mg/L	--	16	24	--
Effluent Total Ammonia	mg N/L	--	170	--	250
Dry Season Effluent Limitations – May through September					
Influent Flow	mgd	29.0	--	--	--
Effluent cBOD (1)	mg/L	--	8	12	--
Effluent TSS (1)	mg/L	--	8	12	--
Effluent Total Ammonia	mg N/L	--	170	--	250

1. BOD and TSS include a minimum percent removal of 85% through the WWTP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;
- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge – Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 shows the process flow diagram for SVCW. Both liquids processes and solids processes are shown. SVCW provides advanced secondary treatment, with primary clarifiers, a trickling filter and activated sludge system for secondary treatment, dual-media filters, and chlorine disinfection. No major nutrient removal systems are currently in place. Solids treatment consists of primary and secondary sludge thickening, anaerobic digestion, rotary press dewatering and sludge drying beds.

1.3 Existing Recycled Water Service

SVCW has an existing recycled water program that is employed year-round. The lone customer is Redwood City, and they have a recycled water facility on the SVCW WWTP site that can produce up to 12.9 mgd. SVCW WWTP sends tertiary filtered wastewater to the Redwood City Recycled Water Facility and the water is disinfected at their facility and placed in storage tanks. Redwood City then distributes the recycled water to their customers (primarily landscape irrigation with a greater demand during the dry season). Redwood City covers all cost including Operation and Maintenance of the distribution portion the recycled water. SVCW currently recycles approximately 860 acre-feet per year (AFY; 280 million gallons per year). Recycled water demands are projected to increase at a steady rate through year 2035, after which marginal increases are anticipated through year 2045.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 – 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	13.0	16.8	15.2
Volume	AF	6,090	10,900	16,990
Ammonia	kg N/d	2,390	2,680	2,560
Total Inorganic Nitrogen (TIN)	kg N/d	2,420	2,720	2,600
Total Phosphorus (TP)	kg P/d	225	236	231
Ammonia	mg N/L	48.8	44.3	46.2
TIN	mg N/L	49.4	45.0	46.8
TP	mg P/L	4.59	3.89	4.19

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

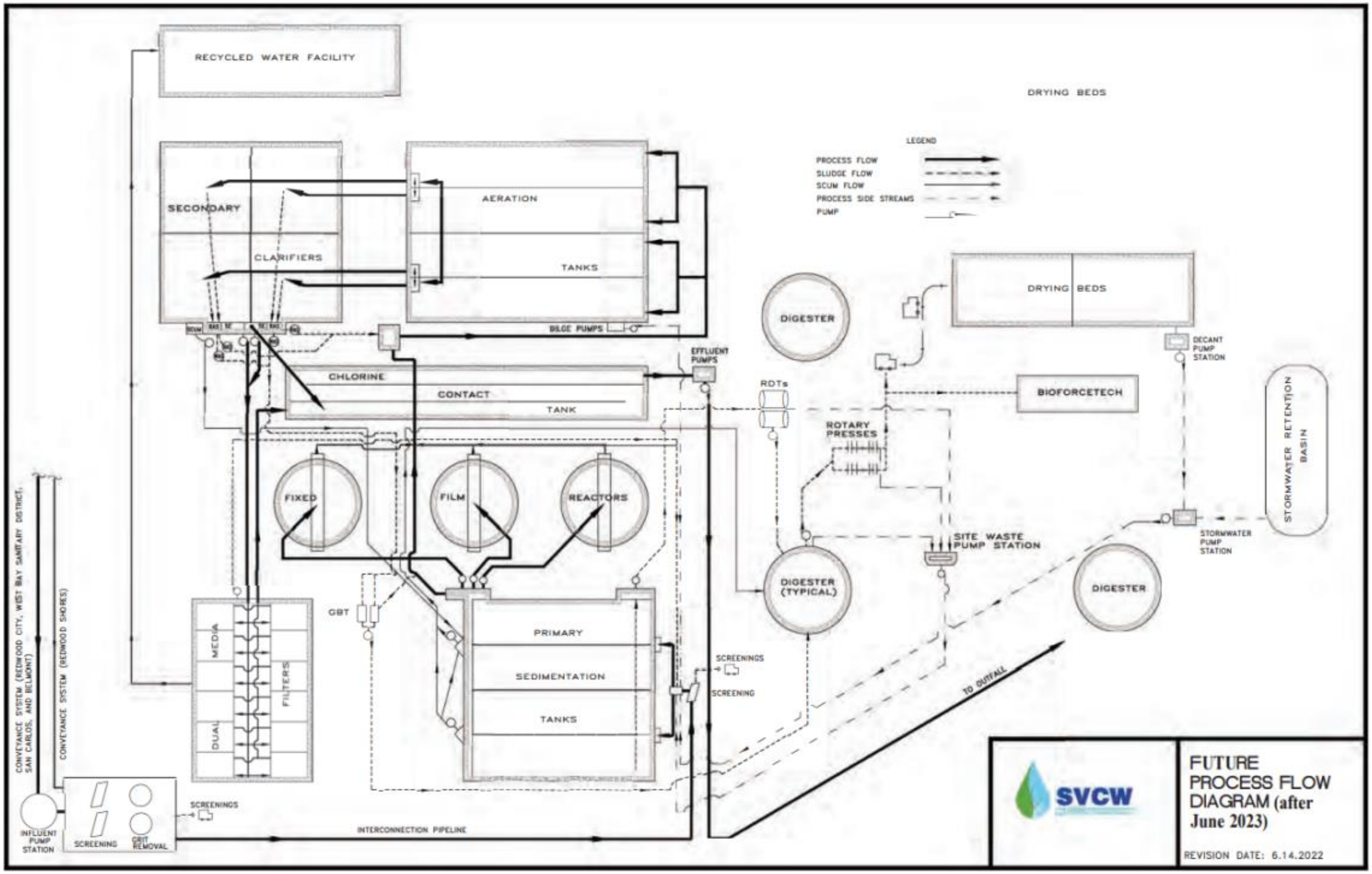

Figure 1-1. Process Flow Diagram for SVCW WWTP after June 2023 (Source: NPDES Permit R2-2023-0003; CA0038369)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2020 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with SVCW WWTP and Engineer's best judgment that considered known project constraints, existing SVCW WWTP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by SVCW WWTP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[2] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[2] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN, or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a "synergistic benefit" for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^{6}\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^{6}\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects. The subsections that follow summarize the flow and nutrient load reductions for each listed project in Table 3-1.

Table 3-1. Recycled Water Projects Identified by SVCW WWTP

Recycled Water Project	Description
Existing Recycled Water Facilities	SVCW has an existing recycled water program that is employed year-round. The lone customer is Redwood City, and they have a recycled water facility on the SVCW WWTP site that can produce up to 12.9 mgd. SVCW WWTP sends tertiary filtered wastewater to the Redwood City Recycled Water Facility and the water is disinfected in their facility and placed in storage tanks. Redwood City then distributes the recycled water to their customers (primarily landscape irrigation with a greater demand during the dry season). Redwood City covers all cost including Operation and Maintenance of the distribution portion the recycled water. SVCW currently recycles approximately 860 acre-feet per year (280 million gallons per year) and this is projected to increase steadily through year 2045.
Future Project 1: Surface water augmentation to Crystal Springs Reservoir	Surface water augmentation to Crystal Springs Reservoir would require advanced treatment of SVCW WWTP product water and distribution to the lower Crystal Springs Reservoir to augment raw water supplies prior to drinking water treatment and distribution. It is anticipated that upwards of 8 mgd of SVCW WWTP product water would be treated and transported to the reservoir. Note: the volumes could increase in the future (as part of future phases). Such future phases were excluded from this analysis. A key feature of any potable reuse project is the likelihood of upstream nutrient removal (emphasis on ammonia and total inorganic nitrogen (TIN)) as such improvements offer numerous downstream advanced treatment benefits. Given that, this analysis is predicated on SVCW WWTP implementing ammonia/TIN load reduction upgrades by year 2035 (costs associated with such improvements are separate from this analysis).

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. The existing facility demands are expected to expand into the future. A potential future project (listed as “Other Projects) is anticipated to be implemented around year 2035..

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence*	Average Distributed – Return Flows (AF)	Average Ammonia Load Removed (kg N/d) ***	Average TIN Load Removed (kg N/d) ***	Average Total P Load Removed (kg P/d) ***
2020	**Total**	1	856	78	96	12
	Existing Facilities**	1	856	78	96	12
	Other Projects***	3	--	--	--	--
2025	**Total**	1	1,230	112	138	17
	Existing Facilities**	1	1,230	112	138	17
	Other Projects***	3	--	--	--	--
2030	**Total**	1	1,310	119	147	18
	Existing Facilities**	1	1,310	119	147	18
	Other Projects***	3	--	--	--	--
2035	**Total**	**Blend of 1 and 3**	**8,700**	**142**	**244**	**40**
	Existing Facilities**	1	1,540	140	172	21
	Other Projects***	3	7,170	2	73	19
2040	**Total**	**Blend of 1 and 3**	**8,720**	**143**	**246**	**40**
	Existing Facilities**	1	1,550	141	173	21
	Other Projects***	3	7,170	2	73	19
2045	Total	**Blend of 1 and 3**	**8,720**	**143**	**246**	**40**
	Existing Facilities**	1	1,550	141	173	21
	Other Projects***	3	7,170	2	73	19

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

** Upwards of 168 AFY are anticipated for dual plumbing applications. Such volumes are excluded from this analysis as those volumes would end up in the Bay.

*** Other Projects: potable reuse project that would initially send water to Crystal Springs Reservoir. There is potential for future direct potable reuse in future phases (excluded from this evaluation). The "Other Projects" would require nutrient removal at existing facilities. Given that, this analysis is based on SVCW WWTP implementing nitrogen removal facilities by year 2035 and it assumes average effluent values of 0.5 mg N/L (ammonia), 15 mg N/L (TIN), and total phosphorus to remain as is.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. The current recycled water customer type is focused on landscape irrigation, commercial, industrial, and other. The landscape volumes are relatively flat through year 2045, whereas the commercial values are anticipated to increase steadily through year 2035 and they relatively stable thereafter. Note: there are also plans for dual plumbing which is anticipated to begin at approximately year 2025. The volumes associated with dual plumbing were not included in this evaluation as such volumes would be returned to the WWTP and eventually end up in the Bay. As previously stated, the potable reuse project that includes surface water augmentation is anticipated to be operational by year 2035. The potable reuse project will likely include a reverse osmosis (RO) concentrate return stream. Such streams do NOT result in a diversion from the Bay and are thus excluded from any values in Figure 3-1. However, RO concentrate return streams were considered in this analysis as the volume/nutrient loads associated with such streams typically end up as Bay discharge.

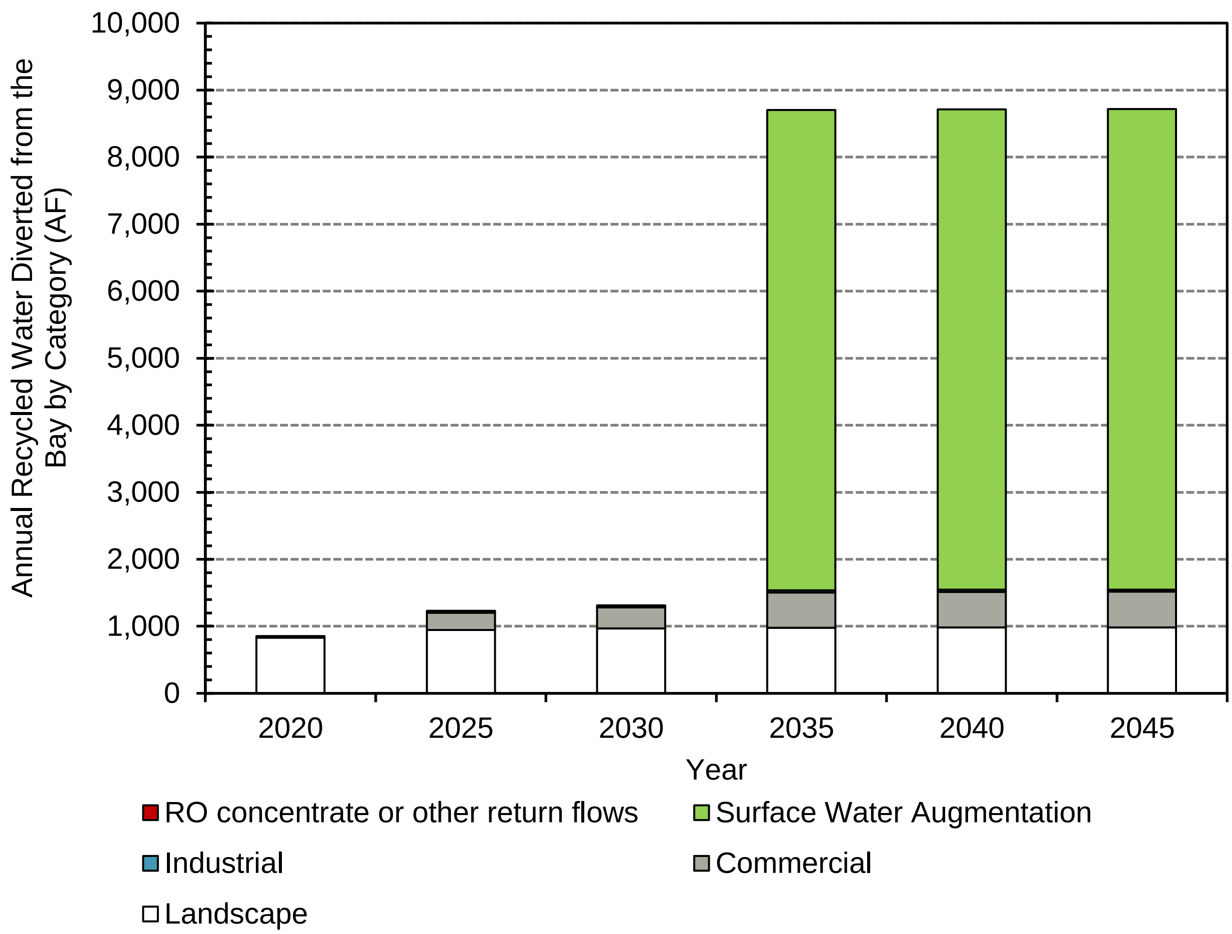

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)*

* Upwards of 168 AFY are anticipated for dual plumbing applications. Such volumes are excluded from this analysis as those volumes would end up in the Bay.

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. The key ancillary benefits are the facilities are already in place and operator familiarity. The primary adverse impact is the recycled water facility is already nearing production capacity.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities	• Recycled water facilities operated and maintained by Redwood City (not SVCW WWTP) • Facilities are already in place and provide recycled water and in turn reduce water supply demands. • Existing facilities reliably meet recycled water treatment requirements.	• Limited portfolio diversity of recycled water applications (only landscape irrigation).
Future Project 1: Surface water augmentation to Crystal Springs Reservoir	• Increased water supply reliability and independence from imported water. Specifically, this would ease the dependence on the Hetch Hetchy system. • Drought resiliency. • Consistent demand/usage throughout the year (less seasonal dependency than existing recycled water customers). • Enhanced treatment which offers additional removal of contaminants of emerging concern.	• Portion of nutrient loads returned to the WWTP/Bay as part of advanced treatment process train (specifically RO concentrate). • Energy and chemical intensive process to provide advanced treatment. • Additional operators to maintain and operate the advanced treatment system. Furthermore, it might require a new operator grade.

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project is provided in Table 3-4. Upwards of 168 AFY are anticipated for dual plumbing applications for the existing RW system. Such volumes are excluded from this analysis as those volumes would end up in the Bay. The unit cost values for the existing RW projects are relatively low both on a volume and nutrient load reduction basis (with the exception of TP). The unit costs for ammonia and TIN includes anticipated plant upgrades by year 2035, whereas the TP unit costs assume current effluent values through year 2035. The relatively efficient flow and load reduction is attributed to the facilities already being in place (i.e., no capital costs) coupled with Redwood City providing disinfection, storage, and distribution. For perspective, the regional optimization and upgrades study that evaluated nutrient load reduction across Bay Area WWTPs had a range of values of \$2.0 - \$8.7/lb TIN load reduced,[3] which is relatively close to the \$2.4 and \$2.6/lb TIN load removed (dry season and average annual, respectively) for SVCW WWTP in this report.

The unit cost values for the potential future potable reuse project are exponentially more expensive than the existing RW efforts. It is important to recognize that the potential future potable reuse project would produce a higher quality water than current that has the potential to offset potable water demands from Hetch Hetchy. The capital and O&M cost values are engineer's best judgment based on recent estimates at upwards of \$5,000/AF (over 25 years or greater). The values in Table ES – 1 are larger (>>\$7,500/AF) as the project duration is limited to 10 years. A longer project duration would reduce the listed values to approximately \$5,000/AF.

[3] Bay Area Clean Water Agencies (2018) Bay Area Clean Water Agencies Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream Treatment, Treatment Upgrades, and Other Means. Prepared by HDR. Oakland, CA.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (Surface Water Augmentation from Year 2035 through 2045) *, **, ***		Total (Includes Existing and Future Projects Averaged from Year 2020 through 2045) *, **, ***	
		Average Dry Season (May 1 – Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 – Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	2.3	1.2	6.36	6.40	5.4	4.4
Volume	AF	1,060	1,340	2,990	7,170	2,550	4,920
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	3	3	Blend of 1 and 3	Blend of 1 and 3
Duration	Years	25	25	10	10	25	25
Flow Diverted	%	15%	7%	49%	42%	42%	29%
Ammonia Load Diverted	kg N/d	250	122	12	12	255	126
TIN Load Diverted	kg N/d	303	150	361	363	447	295
TP Load Diverted	kg P/d	39	18	110	97	83	57
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	450ǂ	450ǂ	450ǂ	450ǂ
NPV O&M	$ Mil	6.1	7.8	44ǂ	105ǂ	50ǂ	113ǂ
NPV Total (Capital+NPV O&M)	$ Mil	6.1	7.8	494ǂ	555ǂ	500ǂ	563ǂ
Unit Flow Cost[6]							
Unit Cost	$/gpd	2.7	6.5	78	87	92	128
Unit Cost	$/AF	232	232	16,500	7,750	7,840	4,570
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	2.9	3.2	12,200	5,700	232	221
TIN Unit Cost	$/lb TIN Diverted	2.4	2.6	405	190	133	95
TP Unit Cost	$/lb TP Diverted	19	21	1,330	709	714	490

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3). For the Total columns, the project start period is from year 2020 through year 2045.

*** Future Project: surface water augmentation to Crystal Springs Reservoir (8 mgd effluent fed to advanced treatment starting in year 2036). Note: this project has the potential to evolve into a direct potable reuse effort as part of phase 2 (excluded from this analysis). Costs for this effort are conceptual at best based on other potable reuse evaluations.

ǂ The capital and O&M cost values are engineer's best judgment based on recent estimates at upwards of $5,000/AF (over 25 years or greater). The values in in this table are larger (>>$7,500/AF) as the project duration is limited to 10 years. A longer project duration would reduce the listed values to approximately $5,000/AF.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by SVCW WWTP in 2021 dollars.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).

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The relatively large unit values were anticipated as SVCW would need to design and construct new advanced treatment facilities, distribution, and O&M control measures. While such values would be reduced if the duration was 25 or more years, the values would still be higher than the existing RW facilities for the reasons stated. The various ancillary benefits associated with such potable reuse projects should be factored into any subsequent decision-making.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. The existing RW facilities are anticipated to steadily increase through year 2035, after which marginal increases are anticipated through year 2045. The potential future potable reuse project would be expected to begin providing water by year 2035. As previously stated, SVCW WWTP would need to provide plant upgrades to remove ammonia/TIN loads to improve feed water quality for the listed potential future potable reuse project. This analysis includes such improvements in load reductions associated with recycled water. However, the costs associated with ammonia/TIN load reductions at the WWTP is excluded as the removal strategy is unclear at this stage.

3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at SVCW WWTP:

- Drivers for implementing recycled water projects:
  - Water supply need: recycled water can serve as a strategy to reduce potable water supply demands and diversify water sources.
  - Proposed discharge regulations: recycled water can serve as a strategy to reduce nutrient discharge loads to the Bay.
- Barriers for implementing recycled water projects:
  - Funding: any recycled water opportunities beyond the existing would likely require costly distribution and possibly treatment to implement, as well as funding to operate and maintain.
  - Jurisdictional (for existing RW facilities): Redwood City controls the recycled water customers within the area. Furthermore, any additional opportunities would require working across jurisdictions.
  - Jurisdictional (for potential future potable reuse project): would require working across jurisdictions that includes both the drinking water provider and conveying water across jurisdictions.

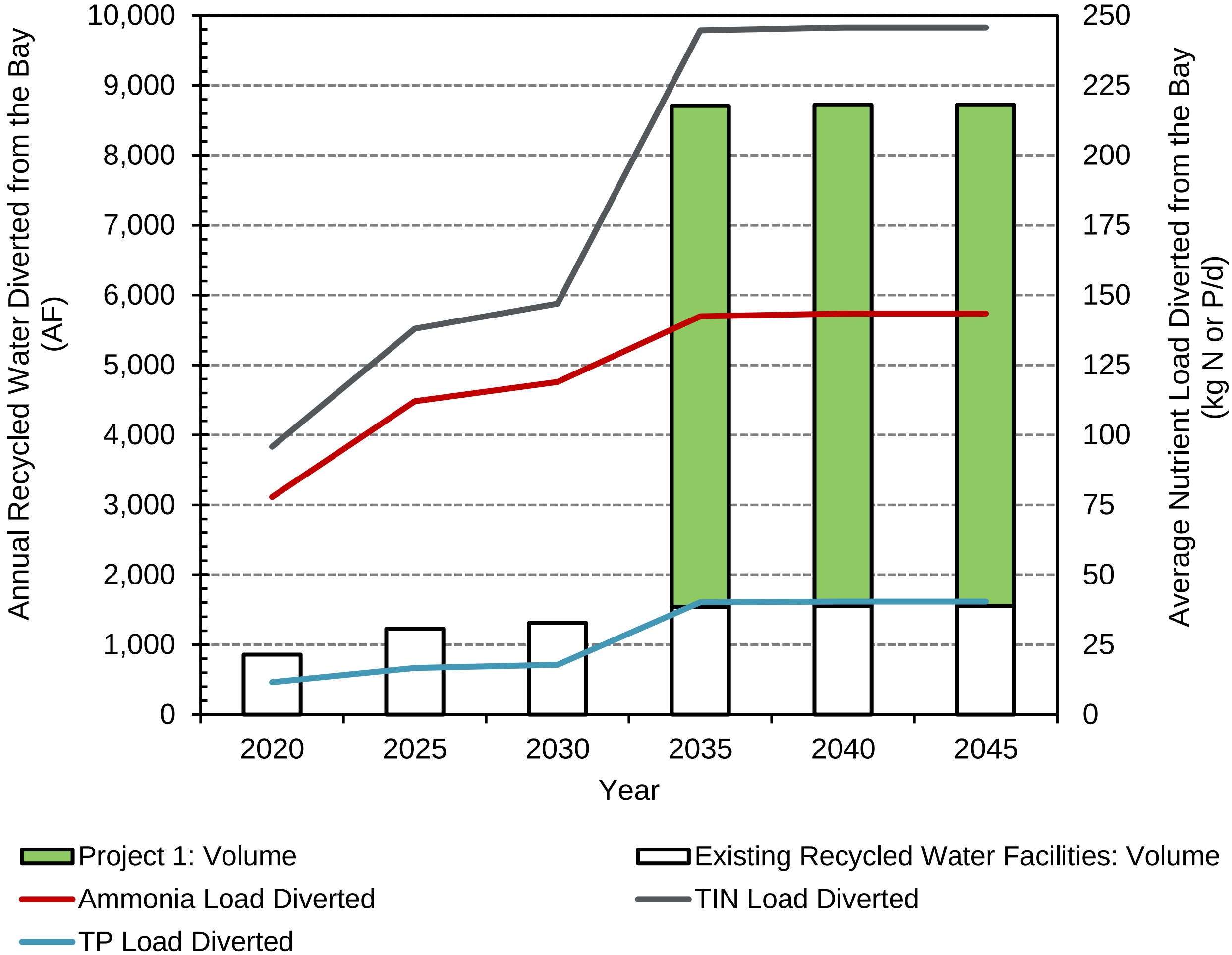

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge*, **

* Upwards of 168 AFY are anticipated for dual plumbing applications. Such volumes are excluded from this analysis as those volumes would end up in the Bay.

** Project 1 = Potable reuse project that is in the conceptual phase (i.e., Confidence Level 3) that will initially provide surface water augmentation by approximately year 2035. A key feature of any potable reuse project is the likelihood of upstream nutrient removal (emphasis on ammonia and total inorganic nitrogen (TIN)) as such improvements offer numerous downstream advanced treatment benefits. Given that, this analysis is predicated on SVCW WWTP implementing ammonia/TIN load reduction upgrades by year 2035 (costs associated with such improvements are separate from this analysis).

Bay Area Clean Water Agencies
Recycled Water Study

Sonoma Valley County Sanitation District

Sonoma, CA

June 6, 2023
FINAL Report

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Contents

Tables

Figures

Executive Summary

The Sonoma Valley County Sanitation District (SVCSD) Wastewater Treatment Plant (WWTP) discharges to tributaries of San Pablo Bay. It is located at 22675 8th Street East, Sonoma, CA 95476, and it serves approximately 17,200 service connections throughout the City of Sonoma and the unincorporated areas of Agua Caliente, Boyes Hot Springs, Eldridge, Fetters Hot Springs, Glen Ellen, Schellville, Temelec, and Vineburg. The plant has an average dry weather flow (ADWF) permitted capacity of 3 million gallons per day (mgd).

The SVCSD WWTP has an existing recycled water program that is employed year-round with no Bay discharge during the dry season. In recent dry years, SVCSD WWTP has recycled all of their effluent year-round with no Bay discharge. This existing program has the effect of reducing nutrients discharged to the Bay, especially for the dry season when there is no Bay discharge. SVCSD currently recycles approximately 2,300 acre-feet per year (760 million gallons per year).

A summary of the ongoing and proposed recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES – 1. The costs are relatively inexpensive as evidenced by relatively low unit costs ($/gpd and $/AF) as the infrastructure is already in place. The unit cost for ammonia reduction by recycled water is relatively high as the treatment plant fully nitrifies so the ammonia levels are low (reliably less than 1 mg N/L).

The timeline and corresponding load diversions from the Bay for the projected projects, if any are identified, is illustrated in Figure ES - 1. The volumes and corresponding nutrient reductions are relatively flat over-time.

The drivers and barriers that govern SVCSD's ability to expand their recycled water services are as follows:

- Drivers: water supply needs for the region.
- Barriers:
  - Lack of Need as SVCSD WWTP cannot produce anymore recycled water as evidence by no Bay discharge the last couple year (heavy drought period).
  - Funding: SVCSD could potentially expand the recycled water distribution system from 8th Street East to Napa Road/Denmark Street if funding were available.

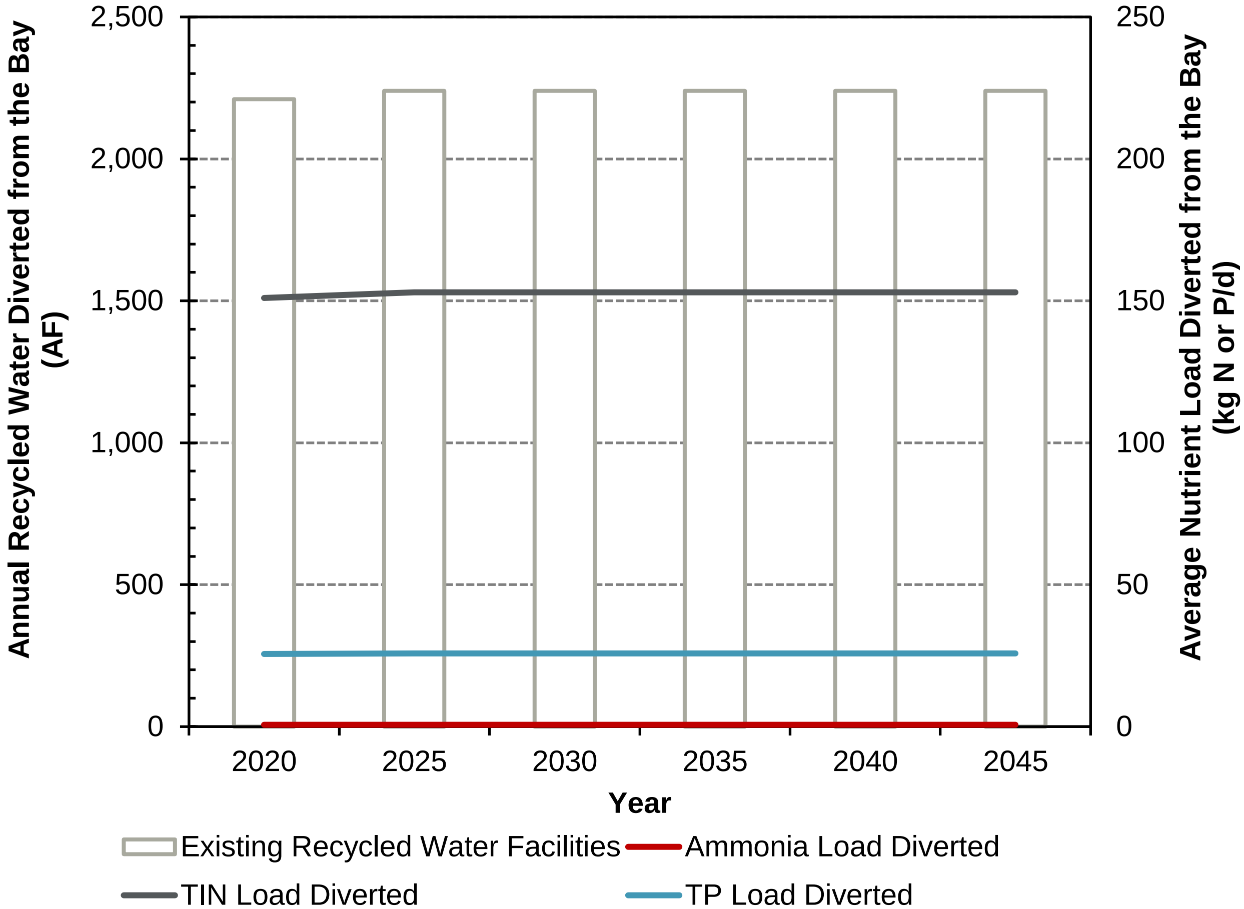

Figure ES - 1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge

Table ES - 1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Projects (None Planned) *,**		Total (Projected into the Future) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	2.3	2.0	--	--	2.3	2.0
Volume	AF	1,070	2,230	--	--	1,070	2,230
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Flow Diverted	%	25	25	--	--	25	25
Duration	Years	99%	62%			99%	62%
Ammonia Load Diverted	kg N/d	1	1	--	--	1	1
TIN Load Diverted	kg N/d	174	152	--	--	174	152
TP Load Diverted	kg P/d	29	26	--	--	29	26
Cost[3,4,5]							
Capital Cost4	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	0.9	2.1	--	--	0.9	2.1
NPV Total (Capital+NPV O&M)	$ Mil	0.9	2.1	--	--	0.9	2.1
Unit Flow Cost[6]							
Unit Cost	$/gpd	0.4	1.1	--	--	0.4	1.1
Unit Cost	$/AF	35	38	--	--	35	38
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	146	157	--	--	146	157
TIN Unit Cost	$/lb TIN Diverted	0.6	0.7	--	--	0.6	0.7
TP Unit Cost	$/lb TP Diverted	3.8	4.0	--	--	3.8	4.0

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045; details provided with each project in Section 3).

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by SVCSD (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay over the project duration.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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1 Introduction and Current Conditions

The Sonoma Valley County Sanitation District (SVCSD) Wastewater Treatment Plant (WWTP) discharges to tributaries of San Pablo Bay. It is located at 22675 8th Street East, Sonoma, CA 95476, and it serves approximately 17,200 service connections throughout the City of Sonoma and the unincorporated areas of Agua Caliente, Boyes Hot Springs, Eldridge, Fetters Hot Springs, Glen Ellen, Schellville, Temelec, and Vineburg. The plant has an average dry weather flow (ADWF) permitted capacity of 3 million gallons per day (mgd).

The sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

SVCSD holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2019-0019). Table 1-1 provides a summary of the relevant permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2019-0019)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	3.0	--	--	--
Effluent BOD (1)	mg/L	--	10	20	--
Effluent TSS (1)	mg/L	--	10	20	--
Effluent Ammonia	mg N/L	--	1.8	--	--

1) BOD and TSS include a minimum percent removal of 85% through the WWTP
2) This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly part of the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Anticipated in Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 shows the process flow diagram for the SVCSD WWTP. Both liquids processes and solids processes are shown. Influent is treated by the following processes in succession: screening, grit removal, primary treatment and flow equalization using aerated equalization basins, secondary treatment in aeration basins, secondary clarification, tertiary treatment using cloth media filtration, chlorination and dechlorination. Secondary treatment provides ammonia and total nitrogen load removal.

Solids are thickened, dewatered and disposed of in a landfill.

1.3 Existing Recycled Water Service

The SVCSD WWTP has an existing recycled water program that is employed year-round with little or no Bay discharge during the dry season. In recent dry years, SVCSD WWTP has recycled all of their effluent year-round with no Bay discharge. This existing program has the effect of reducing nutrients discharged to the Bay, especially for the dry season when there is no Bay discharge. SVCSD currently recycles approximately 2,300 acre-feet per year (760 million gallons per year).

The primary recycled water customers are agricultural, environmental enhancement, and landscape. The majority of environmental enhancement volumes go to the salt ponds and remaining to management units. The landscape recycled water includes a nearby high school and residential customers that use the water for irrigation.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users. Note: the treatment plant already recycles the majority (if not all) of the flows during the dry season. During the drought, the plant has not discharged any flow to the Bay.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19) *,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	0.02	2.1	1.2
Volume	AF	9	1,368	1,367
Ammonia	kg N/d	0.0	0.7	0.4
Total Inorganic Nitrogen (TIN)	kg N/d	1	63	37
Total Phosphorus (TP)	kg P/d	0.2	15.0	8.9
Ammonia	mg N/L	0.1	0.1	0.1
TIN	mg N/L	20.3	8.6	9.9
TP	mg P/L	3.43	2.14	2.29

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

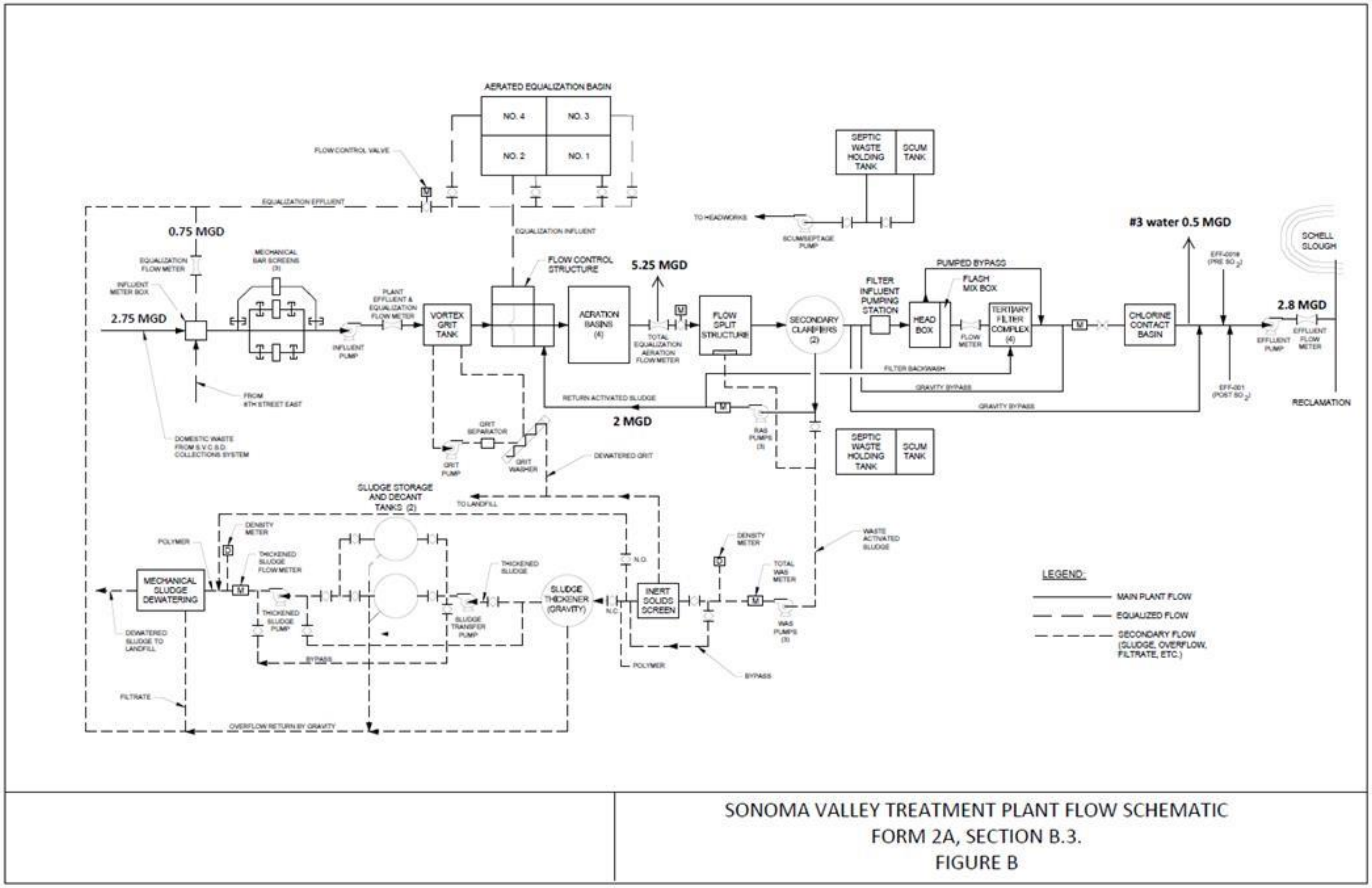

Figure 1-1. Process Flow Diagram for SVCSD WWTP (Source: NPDES Order No. R2-2019-0019)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with SVCSD and Engineer's best judgment that considered known project constraints, existing SVCSD reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by SVCSD. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects.

Table 3-1. Recycled Water Projects Identified by SVCSD WWTP

Recycled Water Project	Description
Existing (No Bay Discharge during the Dry Season)	The primary recycled water customers are agricultural, environmental enhancement, and landscape. The majority of environmental enhancement volumes go to the salt ponds and remaining to management units. The salt ponds will be rehabilitated with an anticipated completion date of year 2030. Following salt pond rehabilitation, more of the recycled water volume will be shifted towards agricultural applications. The landscape recycled water customer is for a nearby high school and residential customers that uses the water for irrigation.
Future Projects	No future projects are planned.

The following subsections summarize the flow and nutrient load reductions for each listed project in Table 3-1.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. Note: the average ammonia and total phosphorus loads removed by recycled water are modest as the existing treatment plant reliably removes both.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. Agriculture and environmental enhancement constitute the two largest users of recycled water. Note: around year 2030, the recycled water volumes will shift from environmental enhancement to agriculture as the primary customer. The basis for this change is the salt ponds will be rehabilitated and following that project, less water will be used for environmental enhancement. Agricultural use will increase during this period and offset any reduction in volume for environmental enhancement.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Average Distributed - Return Flows (AFY)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**--**	**2,210**	**1**	**151**	**26**
	Existing Facilities	1	2,210	1	151	26
	Future Projects	--	--	--	--	--
2025	**Total**	**--**	**2,240**	**1**	**153**	**26**
	Existing Facilities	1	2,240	1	153	26
	Future Projects	--	--	--	--	--
2030	**Total**	**--**	**2,240**	**1**	**153**	**26**
	Existing Facilities	1	2,240	1	153	26
	Future Projects	--	--	--	--	--
2035	**Total**	**--**	**2,240**	**1**	**153**	**26**
	Existing Facilities	1	2,240	1	153	26
	Future Projects	--	--	--	--	--
2040	**Total**	**--**	**2,240**	**1**	**153**	**26**
	Existing Facilities	1	2,240	1	153	26
	Future Projects	--	--	--	--	--
2045	**Total**	**--**	**2,240**	**1**	**153**	**26**
	Existing Facilities	1	2,240	1	153	26
	Future Projects	--	--	--	--	--

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

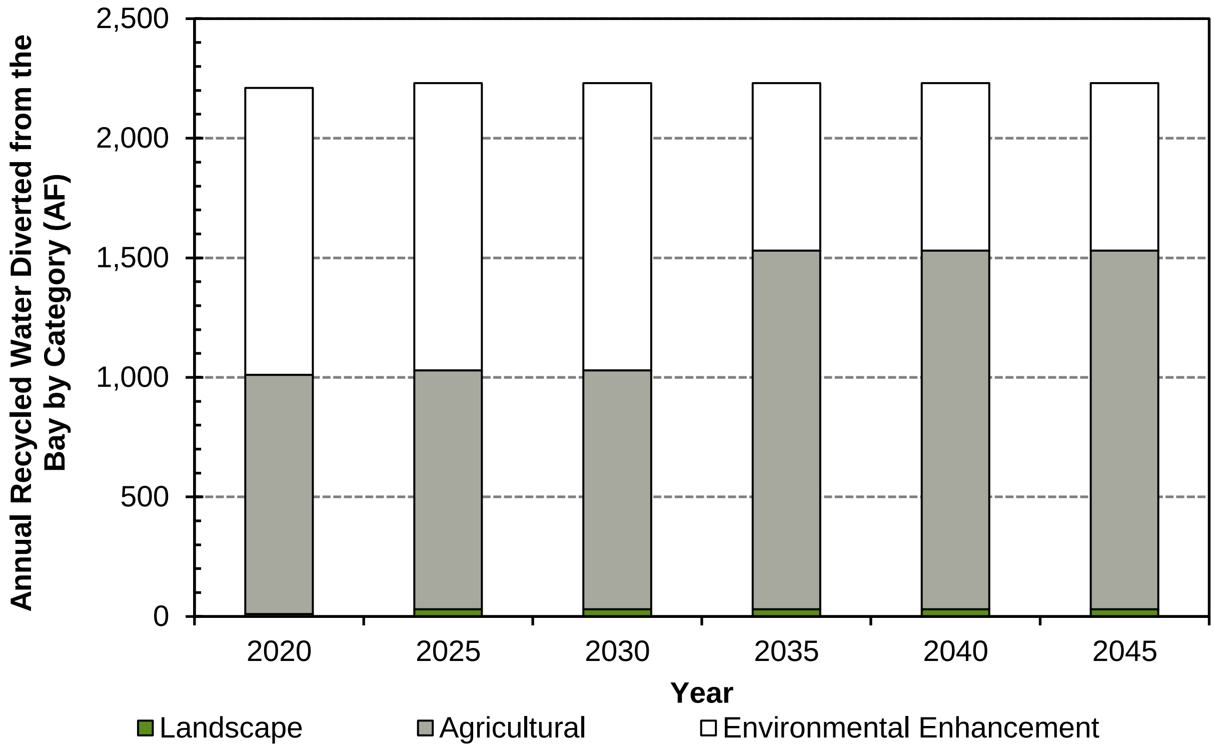

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. Given that SVCSD WWTP recycles all of their water during the dry season, this provides a tremendous benefit on water supply during the most stressful period (dry season).

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing	• Reduces water supply burden • Improved product water due to the additional filtration and enhanced disinfection not required for typical Bay discharge • It may benefit fish and other wildlife when less treated wastewater is discharged into and less fresh water is diverted from rivers and other water bodies • Provides water for wetlands restoration (i.e., environmental enhancement)	• Non-applicable
Future Projects	• Non-Applicable	• Non-Applicable

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. The costs are relatively inexpensive as evidenced by relatively low unit costs ($/gpd and $/AF) as the infrastructure is already in place. The unit cost for ammonia reduction by recycled water is relatively high as the treatment plant fully nitrifies so the ammonia levels are low (reliably less than 1 mg N/L).

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. The overall volumes are relatively flat for the next 25 years. SVCSD WWTP simply cannot produce anymore recycled water as evidence by no Bay discharge the last couple year (heavy drought period). As a result, the nutrient loads diverted from the Bay are also relatively flat over the next 25 years as SVCSD WWTP has maximized the recycled water use in their system.

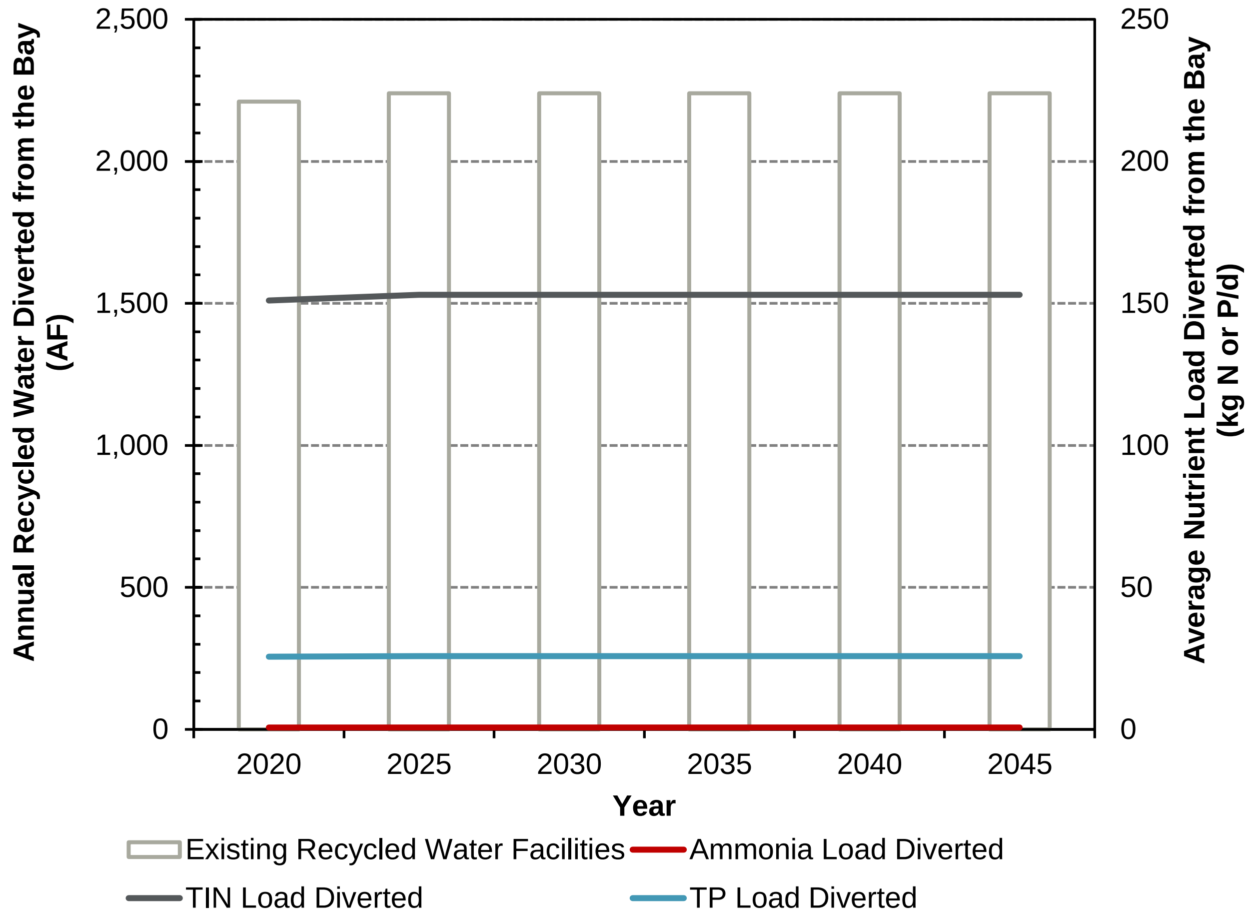

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Projects (None Planned) *,**		Total (Projected into the Future) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	2.3	2.0	--	--	2.3	2.0
Volume	AF	1,070	2,230	--	--	1,070	2,230
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Flow Diverted	%	25	25	--	--	25	25
Duration	Years	99%	62%			99%	62%
Ammonia Load Diverted	kg N/d	1	1	--	--	1	1
TIN Load Diverted	kg N/d	174	152	--	--	174	152
TP Load Diverted	kg P/d	29	26	--	--	29	26
Cost[3,4,5]							
Capital Cost4	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	0.9	2.1	--	--	0.9	2.1
NPV Total (Capital+NPV O&M)	$ Mil	0.9	2.1	--	--	0.9	2.1
Unit Flow Cost[6]							
Unit Cost	$/gpd	0.4	1.1	--	--	0.4	1.1
Unit Cost	$/AF	35	38	--	--	35	38
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	146	157	--	--	146	157
TIN Unit Cost	$/lb TIN Diverted	0.6	0.7	--	--	0.6	0.7
TP Unit Cost	$/lb TP Diverted	3.8	4.0	--	--	3.8	4.0

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045).

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by SVCSD (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay over the project duration.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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3.4 Drivers and Barriers to Implementation

The drivers and barriers that govern SVCSD's ability to expand their recycled water services are as follows:

- Drivers: water supply needs for the region.
- Barriers:
    - Lack of Need as SVCSD WWTP cannot produce anymore recycled water as evidence by no Bay discharge the last couple year (heavy drought period).
    - Funding: SVCSD could potentially expand the recycled water distribution system from 8^{th} Street East to Napa Road/Denmark Street if funding were available.

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South San Francisco and San Bruno Water Quality Control Plant

BACWA Recycled Water Study

Final Individual Plant Report

South San Francisco, CA

May 24, 2023

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Contents

Tables

Figures

Executive Summary

The City of South San Francisco and San Bruno Water Quality Control Plant (South SF-SB WQCP) located in South San Francisco, CA discharges treated effluent to San Francisco Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 13 million gallons per day (mgd).

The South SF-SB WQCP does not currently produce recycled water. Planning studies have identified 950 acre-feet per year (AFY; this translates to 310 million gallons per year (0.85 mgd on average) of industrial and irrigation demands. The Conceptual Genentech Project would require 280 AFY of recycled water for industrial use (starting in early 2020's). There are also two separate projects planned for year 2030: i) the California Golf Club would demand 206 AFY for golf course irrigation and ii) Phase 1 landscaping projects would require an additional 468 AFY for parks, such as Orange Memorial Park, Golden Gate National Cemetery, and Linear Park. The timeline for the latter Phase 1 projects is still uncertain. All three of these project needs would be met by the private users, and thus no expense would be incurred by South SF-SB WQCP.

A summary of the ongoing and proposed recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES-1. The timeline and corresponding load diversions from the Bay for the projected projects, if any are identified, are described in Table ES-1 is illustrated in Figure ES-1.

An overview of the drivers and barriers for implementing recycled water projects at South SF-SB WQCP:

- Drivers for implementing recycled water projects:
  - Potential revenue
  - Recycling water for reuse and the corresponding benefits to water supply
  - Economic and Ecofriendly
- Barriers for implementing recycled water projects:
  - Costs
  - Challenges with having infrastructure (i.e., pipes) crossing under Highway 101
  - End user demand

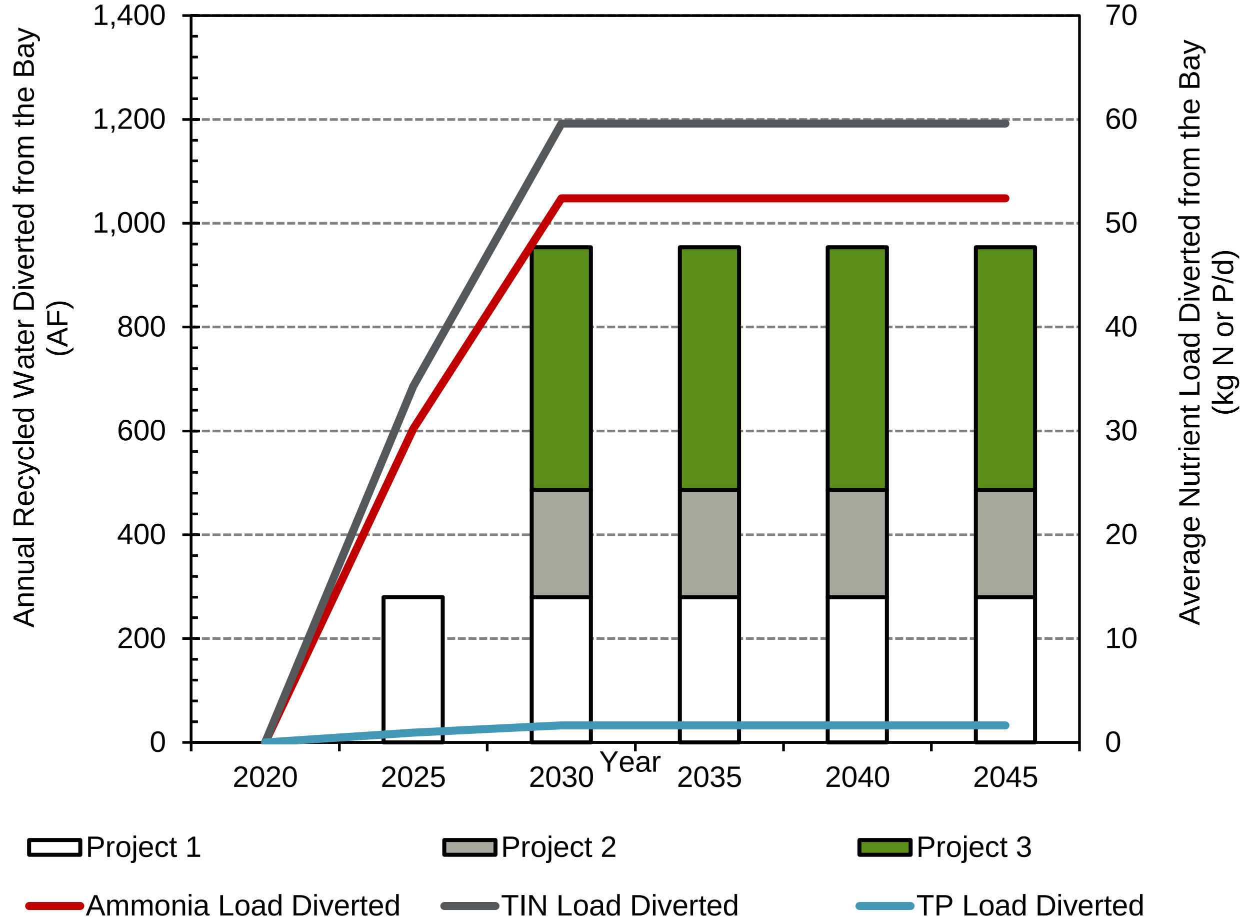

Figure ES-1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge*

* Project 1: The Conceptual Genentech Project that would use 280 AFY for industrial use; Project 2: The California Golf Club would demand 206 AFY for golf course irrigation; and Project 3: Landscaping projects would require an additional 468 AFY for various parks.

Table ES-1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (None) *, **		Future Project 1 (The Conceptual Genentech Project that would use 280 AFY for industrial use) *, **		Future Project 2 (The California Golf Club would demand 206 AFY for golf course irrigation) *, **		Future Project 3 (Landscaping projects would require an additional 468 AFY for various parks.) *, **		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30
Flow/Volume Diverted from the Bay[1]											
Flow	mgd	--	--	0.25	0.25	0.37	0.18	0.42	0.42	0.67	0.56
Volume	AF	--	--	117	280	172	206	195	468	313	628
Load Diverted from the Bay[2,3]											
Confidence	unitless	--	--	3	3	2	2	2	2	Blend of 2/3	Blend of 2/3
Duration	Years	--	--	20	20	15	15	15	15	25	25
Flow Diverted	%	--	--	3%	3%	3%	3%	3%	5%	8%	6%
Ammonia Load Diverted	kg N/d	--	--	30	30	44	22	49	50	79	68
TIN Load Diverted	kg N/d	--	--	33	34	49	25	56	57	90	77
TP Load Diverted	kg P/d	--	--	1	1	1	1	2	2	3	2
Cost[3,4,5]											
Capital Cost	$ Mil	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]
NPV O&M	$ Mil	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]
NPV Total (Capital+NPV O&M)	$ Mil	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]
Unit Flow Cost[6]											
Unit Cost	$/gpd	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]
Unit Cost	$/AF	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]
Unit Load Cost[7,8]											
Ammonia Unit Cost	$/lb Ammonia Diverted	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]
TIN Unit Cost	$/lb TIN Diverted	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]
TP Unit Cost	$/lb TP Diverted	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]

* Existing RW Projects refers to existing treatment facilities producing RW (none); Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3). For the Total columns, the project start period is from year 2020 through year 2045.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production were not provided as South SF-SB WQCP is not responsible for such costs (private party funded).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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1 Introduction and Current Conditions

The City of South San Francisco and San Bruno Water Quality Control Plant (South SF-SB WQCP) located in South San Francisco, CA discharges treated effluent to San Francisco Bay. The plant has an average dry weather flow (ADWF) permitted capacity of 13 million gallons per day (mgd).

The sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

The South SF-SB WQCP holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2019-0021). Table 1-1 provides a summary of the relevant permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2019-0021; CA0038130)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	13[3]	--	--	--
Effluent BOD [1]	mg/L	--	30	45	--
Effluent TSS [1]	mg/L	--	30	45	--
Effluent Ammonia	mg N/L	--	110	--	190

1) BOD and TSS include a minimum percent removal of 85% through the WWTP
2) This table identifies relevant permit limitations only and does not include a complete list of permit limitations.
3) Current permitted capacity. Permitted capacity for peak wet weather flow with secondary treatment is 30 mgd. When influent flow exceeds 30 mgd, excess primary effluent receives separate disinfection and then combines with secondary treatment prior to dechlorination and disposal. When the Plant's effluent (NBSU pipeline) flow rate exceeds 64 mgd, fully treated effluent is pumped to a 7-million-gallon effluent storage pond.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly part of the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Anticipated in Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 shows the process flow diagram for the South SF-SB WQCP. Only liquids processes are shown. The South SF-SB WQCP consists of screening and grit removal, primary clarification, followed by conventional activated sludge for secondary treatment. Flow is split between two sets of aeration basin trains. One set includes selector zones. Most of the effluent nitrogen is ammonia, indicating that the plant does not consistently nitrify. Secondary effluent is disinfected by chlorination.

Solids treatment consists of secondary sludge thickening, anaerobic digestion and belt filter press dewatering.

When influent flow exceeds 30 mgd, excess primary effluent receives separate disinfection and then combines with secondary treatment prior to dechlorination and disposal. When the Plant's effluent (NBSU pipeline) flow rate exceeds 64 mgd, fully treated effluent is pumped to a 7-million-gallon effluent storage pond.

1.3 Existing Recycled Water Service

The South SF-SB WQCP does not currently produce recycled water. Planning studies have identified 950 acre-feet per year (310 million gallons per year) of industrial and irrigation demands.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of historical discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19) *,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	7.28	9.16	8.37
Volume	AF	3,418	5,957	9,375
Ammonia	kg N/d	866	1,110	1,010
Total Inorganic Nitrogen (TIN)	kg N/d	978	1,270	1,150
Total Phosphorus (TP)	kg P/d	130	138	135
Ammonia	mg N/L	31.5	33.0	32.4
TIN	mg N/L	35.6	36.7	36.2
TP ***	mg P/L	4.74	4.20	4.42

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

** Represents the average volume over the duration listed in the table header.

***** The South SF-SB WQCP recently completed the construction of a new anaerobic selector (early 2022) to improve solids settleability. A co-benefit of the anaerobic selector is it removes a portion of TP loads. As such, concentrations that reflect more recent data will be used in this evaluation (1 mg P/L as effluent).**

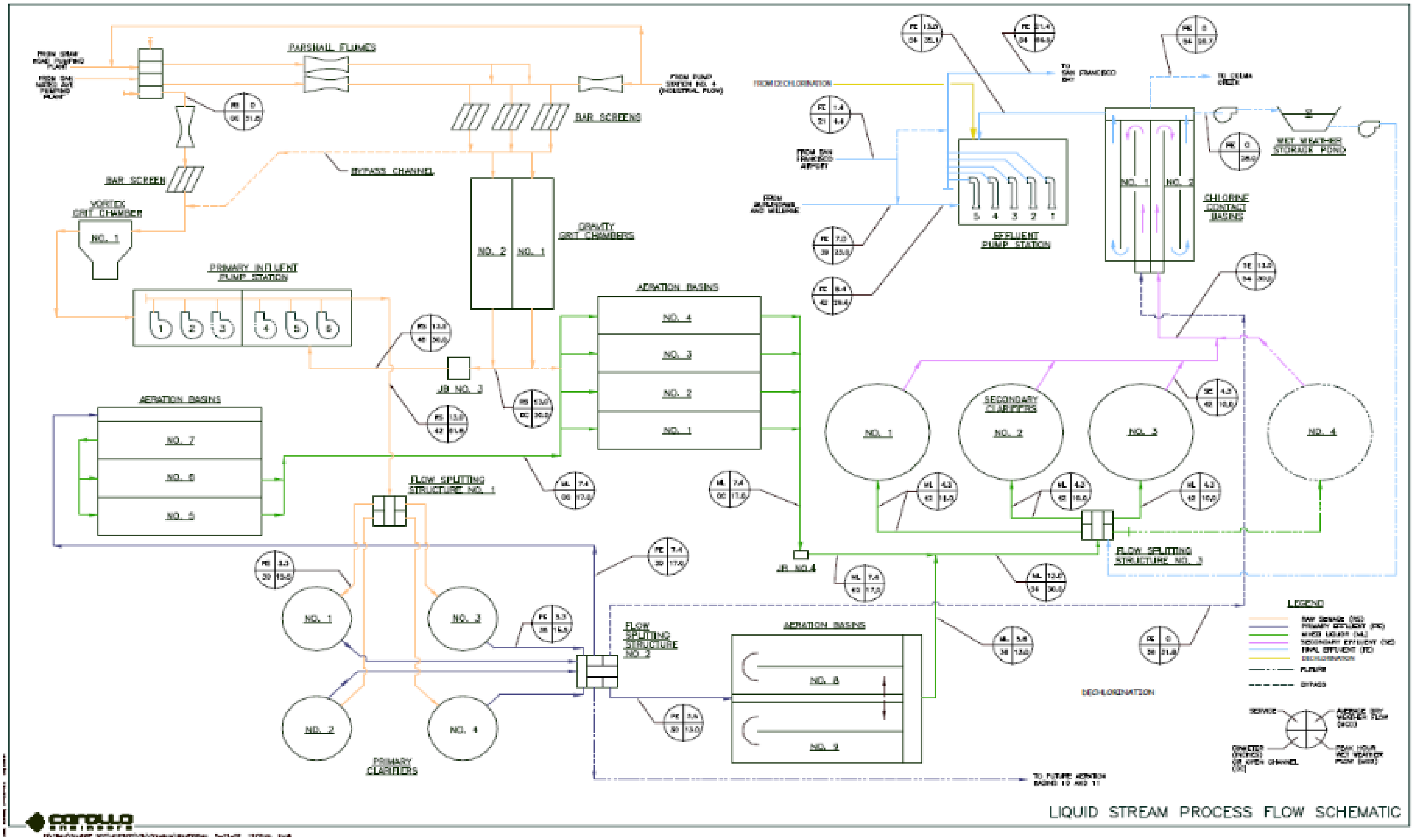

Figure 1-1. Process Flow Diagram for South SF-SB WQCB (Source: NPDES Permit Order R2-2019-0021; CA0038130)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with South SF-SB WQCP and Engineer's best judgment that considered known project constraints, existing South SF-SB WQCP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by South SF-SB WQCP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
    - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
    - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g. existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g. a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects.

Table 3-1. Recycled Water Projects Identified by South SF-SB WQCP

Recycled Water Project	Adverse Impacts
Project 1 (280 AFY Industrial with Genentech)	The Conceptual Genentech Project would require 280 AFY of recycled water for industrial use (starting in early 2020's). There are also two separate projects planned for year 2030: i) the California Golf Club would demand 206 AFY for golf course irrigation and ii) Phase 1 landscaping projects would require an additional 468 AFY for parks, such as Orange Memorial Park, Golden Gate National Cemetery, and Linear Park. Will increase industrial RW use 280 AFY starting in the mid-2020's (assumed year 2025 for this analysis)
Project 2 (206 AFY Golf Course)	This project is anticipated for year 2030 and it will result in an additional 206 AFY. The user is the California Golf Club.
Project 3 (468 AFY Landscape for Various Parks)	This project is anticipated for year 2030 and it will result in an additional 468 AFY for various users are as follows: such as Orange Memorial Park, Golden Gate National Cemetery, and Linear Park.

The following subsections summarize the flow and nutrient load reductions for each listed project in Table 3-1.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. Project 1, The Conceptual Genentech Project, will result in 280 AFY of recycled water for industrial use (assumed year 2025). In 2030, Project 2 will increase demand by 206 AFY for golf course irrigation at the California Golf Club. Project 3, or Phase 1 landscaping projects for parks such as Orange Memorial Park, Golden Gate National Cemetery, and Linear Park, will result in an additional 468 AFY. This will create a total of 954 AFY distributed by South SF-SB WQCP. It is important to note that all three of these projects would be privately funded and the providers would be responsible for any plant improvements/upgrades, as well as conveyance.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. It is important to note that the plant does not currently have any recycled water facilities or customers. All three projects would come online in the future. Future recycled water uses include golf course irrigation, landscape irrigation, and industrial use. Each use represents a different project. It was assumed that all the industrial reuse applications result in nutrient flow and load diversions from the Bay.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Average Distributed – Return Flows (AF)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**--**	--	--	--	--
	Existing Facilities	--	--	--	--	--
	Project 1**	3	--	--	--	--
	Project 2**	2	--	--	--	--
	Project 3**	2	--	--	--	--
2025	**Total**	**3**	**280**	**30**	**34**	**1**
	Existing Facilities	--	--	--	--	--
	Project 1**	3	280	30	34	1
	Project 2**	2	--	--	--	--
	Project 3**	2	--	--	--	--
2030	**Total**	**Blend of 2 and 3**	**954**	**103**	**117**	**3**
	Existing Facilities	--	--	--	--	--
	Project 1**	3	280	30	34	1
	Project 2**	2	206	22	25	1
	Project 3**	2	468	50	57	2
2035	**Total**	**Blend of 2 and 3**	**954**	**103**	**117**	**3**
	Existing Facilities	--	--	--	--	--
	Project 1**	3	280	30	34	1
	Project 2**	2	206	22	25	1
	Project 3**	2	468	50	57	2
2040	**Total**	**Blend of 2 and 3**	**954**	**103**	**117**	**3**
	Existing Facilities	--	--	--	--	--
	Project 1**	3	280	30	34	1
	Project 2**	2	206	22	25	1
	Project 3**	2	468	50	57	2
2045	**Total**	**Blend of 2 and 3**	**954**	**103**	**117**	**3**
	Existing Facilities	--	--	--	--	--
	Project 1**	3	280	30	34	1
	Project 2**	2	206	22	25	1
	Project 3**	2	468	50	57	2

* Confidence Levels:

(1) Includes existing or new projects in an adopted budget; (2) Includes projects that are in an adopted Master Plan or CIP; (3) Includes projects that are in the conceptual stage and not included in an adopted document.

** Project 1: The Conceptual Genentech Project that would use 280 AFY for industrial use; Project 2: The California Golf Club would demand 206 AFY for golf course irrigation; and Project 3: Landscaping projects would require an additional 468 AFY for various parks.

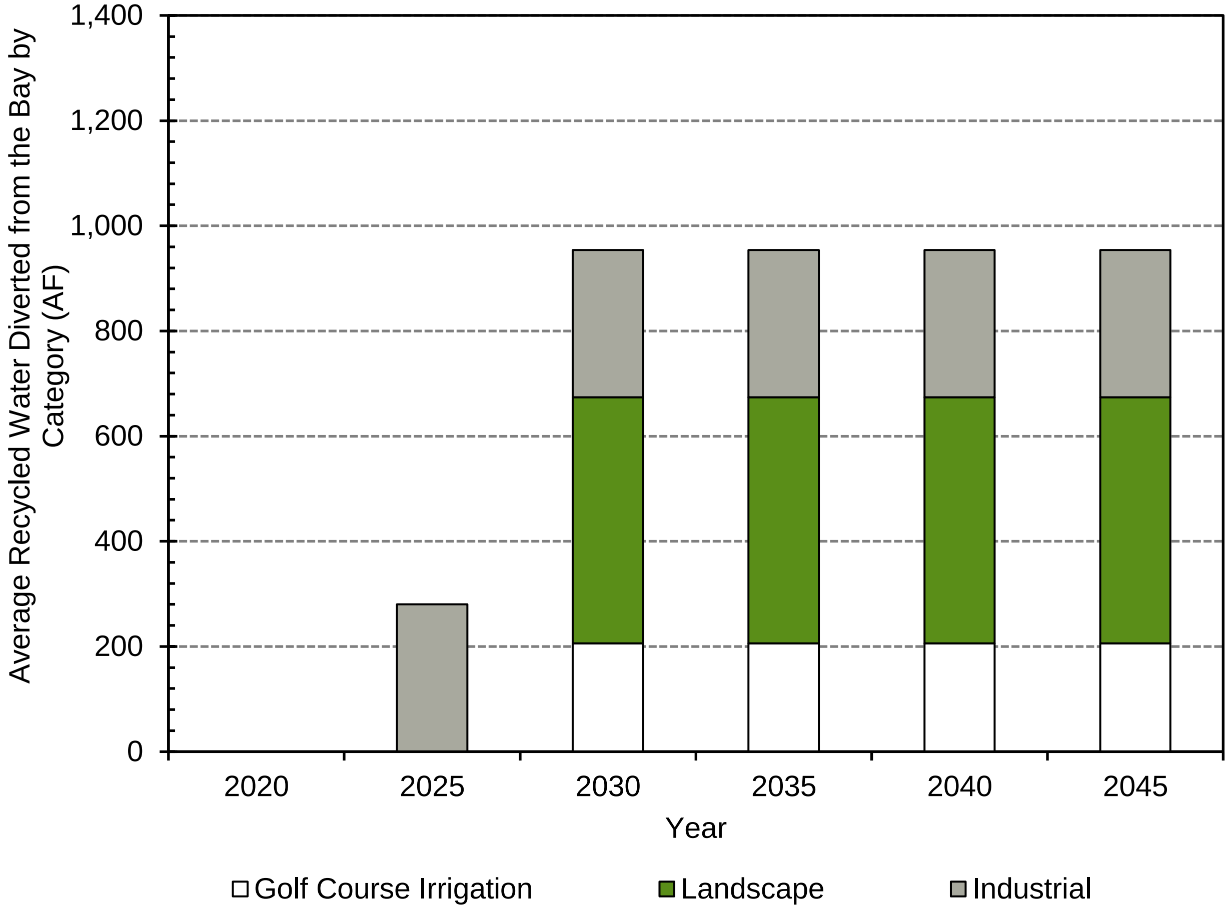

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. All three projects would have similar ancillary and adverse impacts as listed in Table 3-3.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
All 3 Projects have similar ancillary and adverse impacts	• Privately funded to pay for any new infrastructure at South SF-SB WQCP • Potential revenue from the reuse water • Eco-friendly	• Concerns over whether the private company would be in the area for the long-term. Specifically, what happens if the business leaves the area? • Pipes crossing under Highway 101 • Likely additional equipment for South SF-SB WQCP to maintain and operate

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. Project 1 will result in 280 AFY of recycled water for industrial use in the mid-2020's (assumed 2025). In 2030, Project 2 will increase demand by 206 AFY for golf course irrigation and Project 3 will result in an additional 468 AFY for landscape irrigation. This will create a total of 954 AFY distributed by South SF-SB WQCP. It is anticipated that these water usages will result in 100% of both the flow and nutrient loads diverted from the Bay.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay.

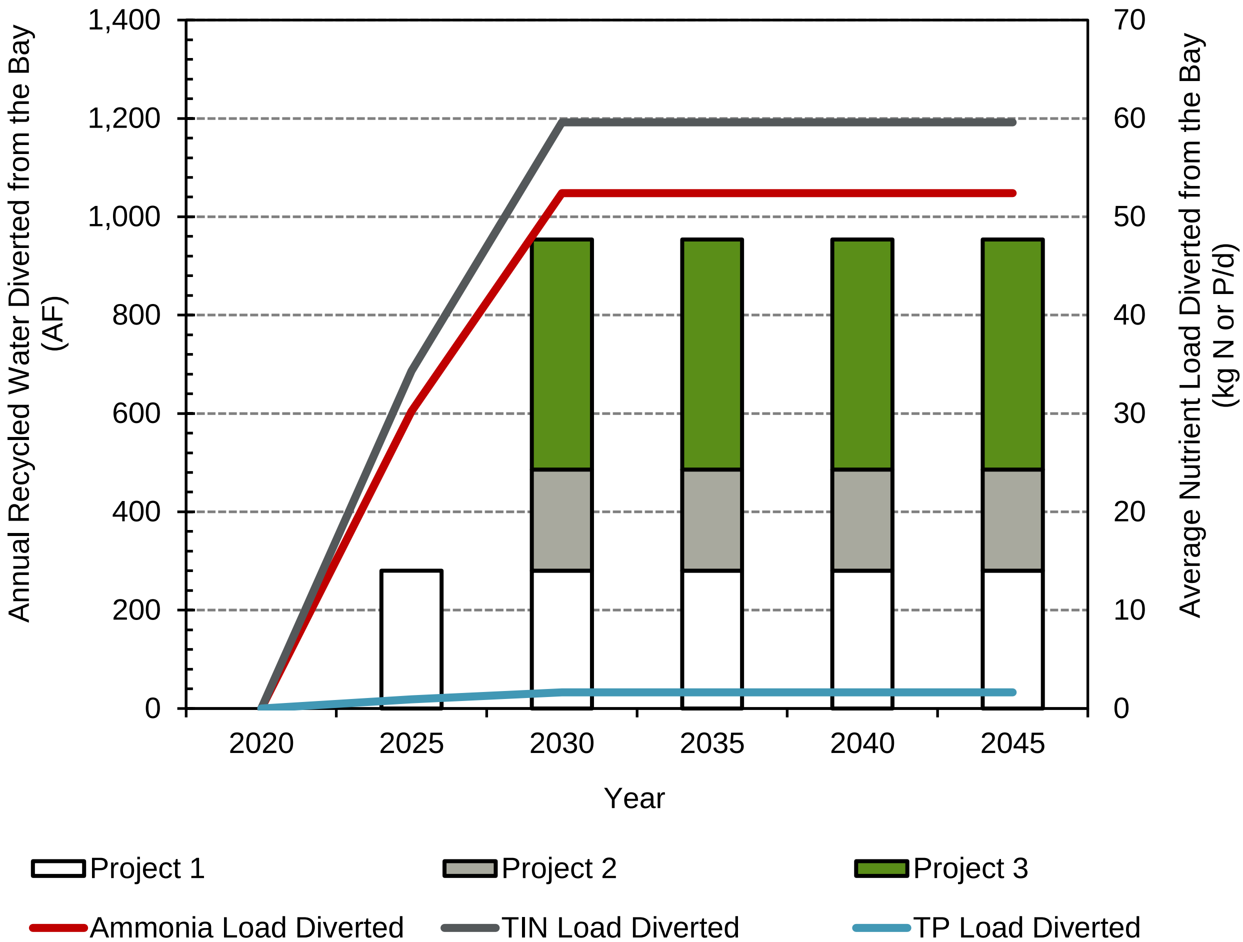

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge*

* Project 1: The Conceptual Genentech Project that would use 280 AFY for industrial use; Project 2: The California Golf Club would demand 206 AFY for golf course irrigation; and Project 3: Landscaping projects would require an additional 468 AFY for various parks.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (None) *, **		Future Project 1 (The Conceptual Genentech Project that would use 280 AFY for industrial use) *, **		Future Project 2 (The California Golf Club would demand 206 AFY for golf course irrigation) *, **		Future Project 3 (Landscaping projects would require an additional 468 AFY for various parks.) *, **		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30
Flow/Volume Diverted from the Bay[1]											
Flow	mgd	--	--	0.25	0.25	0.37	0.18	0.42	0.42	0.67	0.56
Volume	AF	--	--	117	280	172	206	195	468	313	628
Load Diverted from the Bay[2,3]											
Confidence	unitless	--	--	3	3	2	2	2	2	Blend of 2/3	Blend of 2/3
Duration	Years	--	--	20	20	15	15	15	15	25	25
Flow Diverted	%	--	--	3%	3%	3%	3%	3%	5%	8%	6%
Ammonia Load Diverted	kg N/d	--	--	30	30	44	22	49	50	79	68
TIN Load Diverted	kg N/d	--	--	33	34	49	25	56	57	90	77
TP Load Diverted	kg P/d	--	--	1	1	1	1	2	2	3	2
Cost[3,4,5]											
Capital Cost	$ Mil	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]
NPV O&M	$ Mil	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]
NPV Total (Capital+NPV O&M)	$ Mil	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]
Unit Flow Cost[6]											
Unit Cost	$/gpd	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]
Unit Cost	$/AF	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]
Unit Load Cost[7,8]											
Ammonia Unit Cost	$/lb Ammonia Diverted	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]
TIN Unit Cost	$/lb TIN Diverted	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]
TP Unit Cost	$/lb TP Diverted	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]	--[4]

* Existing RW Projects refers to existing treatment facilities producing RW (none); Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3). For the Total columns, the project start period is from year 2020 through year 2045.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production were not provided as South SF-SB WQCP is not responsible for such costs (private party funded).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at South SF-SB WQCP:

- Drivers for implementing recycled water projects:
  - Potential revenue
  - Recycling water for reuse and the corresponding benefits to water supply
  - Economic and Ecofriendly
- Barriers for implementing recycled water projects:
  - Costs
  - Challenges with having infrastructure (i.e., pipes) crossing under Highway 101
  - End user demand

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Sunnyvale Water Pollution Control Plant

BACWA Recycled Water Study

Individual Plant Report

Sunnyvale, CA
June 24, 2023
FINAL Report

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Contents

Tables

Figures

Executive Summary

The Sunnyvale Water Pollution Control Plant (WPCP) discharges to the tributary of South San Francisco Bay. It is located at 1444 Borregas Ave, Sunnyvale, CA 94088 and it serves approximately 28,300 service connections throughout the City of Sunnyvale, Rancho Rinconada, and Moffett Field. The plant has an average dry weather flow (ADWF) permitted capacity of 29.5 million gallons per day (mgd).

The Sunnyvale WPCP has an existing recycled water program that is employed year-round. The volumes were approximately 440 acre-feet per year (AFY; approximately 140 million gallons (MG) per year) in year 2020 to a projected 1,680 AFY (approximately 550 MG per year) from year 2030 and beyond. The volumes in years 2019 and 2020 were reduced due to O&M constraints and an abundance of potable water allocations. As such, these more recent volumes are an underrepresentation and does not reflect normal operating conditions. Furthermore, the Sunnyvale WPCP routinely supplements recycled water distribution system with potable water when demand exceeds supply. Potable supplementation is typically highest during the wet weather season. For years 2027 and beyond, it is assumed that recycled water will be used to satisfy 100 percent of the demand. The recycled water users are broad, and include golf course and landscape irrigation, commercial (includes dual-plumbed systems), and industrial.

A summary of the recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP)), and the corresponding unit costs are provided in Table ES - 1. The unit cost values are relatively low both on a volume and nutrient load reduction basis except for ammonia. The unit ammonia load reduction cost is overstated as the WPCP already reliably removes ammonia. The relatively efficient flow and load reduction is attributed to the facilities already being in place (i.e., no capital costs). For perspective, the optimization and upgrades study that evaluated nutrient load reduction across Bay Area WWTPs had a range of values of \$2.0 - \$8.7/lb TIN load reduced,[1] which is relatively close to the \$3.8 and \$2.8/lb TIN load removed (dry season and average annual, respectively) for Sunnyvale WPCP in this report.

The timeline and corresponding load diversions from the Bay is provided in Figure ES – 1. The Sunnyvale WPCP projections suggest that the underrepresented 2019 and 2020 recycled volumes increase to approximately 1,400 AFY by year 2025, followed by reaching capacity (1,680 AFY) by year 2030 and beyond. The projections include the potential indirect potable reuse project which could be larger in the future (listed as up to 30 AFY).

An overview of the drivers and barriers for implementing recycled water projects at Sunnyvale WPCP:

- Drivers for implementing recycled water projects:
  - Water supply needs across Sunnyvale's service area, as well as at other neighboring service areas.
  - Proposed discharge regulations: looming nutrient regulations might incentivize the Sunnyvale WPCP to expand their recycled water production and distribution.

[1] Bay Area Clean Water Agencies (2018) Bay Area Clean Water Agencies Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream Treatment, Treatment Upgrades, and Other Means. Prepared by HDR. Oakland, CA.

- Institutional: Sunnyvale WPCP is committed to recycling as much recycled water as possible (when deemed viable)

- Barriers for implementing recycled water projects:
  - Funding: ability to produce more product water is limited by funding.
  - Jurisdictional: Sunnyvale WPCP is challenged while working across jurisdictions.
  - Infrastructure: aging infrastructure and construction delays impacting the timelines of Capital Improvement Projects.

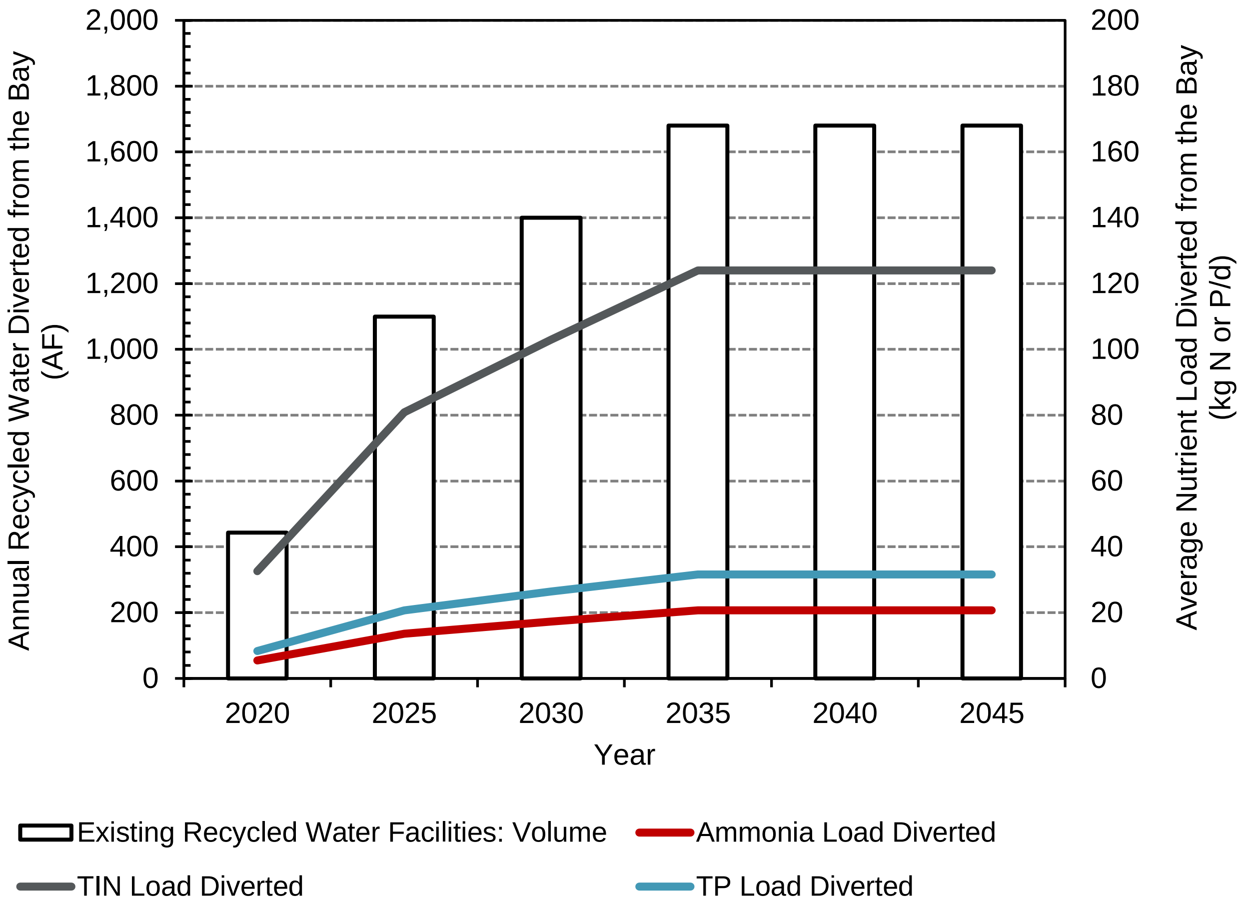

Figure ES - 1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge

Table ES - 1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (None Planned) *, **		Total (Includes Existing and Future Projects (None Planned) Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	1.7	1.2	--	--	1.7	1.2
Volume	AF	817	1,330	--	--	817	1,330
Load Diverted from the Bay[2,3]							
Confidence	unitless	1 for Year 2020; 3 for Year 2025 Onwards	1 for Year 2020; 3 for Year 2025 Onwards	--	--	1 for Year 2020; 3 for Year 2025 Onwards	1 for Year 2020; 3 for Year 2025 Onwards
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	16%	10%	--	--	16%	10%
Ammonia Load Diverted	kg N/d	5	16	--	--	5	16
TIN Load Diverted	kg N/d	106	98	--	--	106	98
TP Load Diverted	kg P/d	45	25	--	--	45	25
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	3.4	5.5	--	--	3.4	5.5
NPV Total (Capital+NPV O&M)	$ Mil	3.4	5.5	--	--	3.4	5.5
Unit Flow Cost[6]							
Unit Cost	$/gpd	1.9	4.6	--	--	1.9	4.6
Unit Cost	$/AF	165	165	--	--	165	165
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	84	17	--	--	84	17
TIN Unit Cost	$/lb TIN Diverted	3.8	2.8	--	--	3.8	2.8
TP Unit Cost	$/lb TP Diverted	8.9	10.9	--	--	8.9	10.9

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045; details provided with each project in Section 3). For the Total columns, the project start period is from year 2020 through year 2045.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by Sunnyvale WPCP in 2021 dollars.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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1 Introduction and Current Conditions

The Sunnyvale Water Pollution Control Plant (WPCP) discharges to the tributary of South San Francisco Bay. It is located at 1444 Borregas Ave, Sunnyvale, CA 94088 and it serves approximately 28,300 service connections throughout the City of Sunnyvale, Rancho Rinconada, and Moffett Field. The plant has an average dry weather flow (ADWF) permitted capacity of 29.5 million gallons per day (mgd).

The subsections that follow provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES; R2-2020-0002) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements (R2-1994-069).

1.1.1 National Pollutant Discharge Elimination System

Sunnyvale WPCP holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2020-0002; CA0037621). Table 1-1 provides a summary of the permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2020-0002; CA0037621)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	29.5	--	--	--
Effluent Carbonaceous BOD (1)	mg/L	--	10	--	20
Effluent TSS (1)	mg/L	--	20	--	30
Effluent Ammonia (October – May)	mg N/L	--	18	--	26
Effluent Ammonia (June – September)	mg N/L	--	2	--	5

1. BOD and TSS include a minimum percent removal of 85% through the WPCP
2. This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;

- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;
- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely that DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 shows the current process flow diagram for the Sunnyvale WPCP. Wastewater treatment processes at the plant include grinding and grit removal, primary sedimentation, secondary and advanced treatment through the use of oxidation ponds, fixed-growth reactors (FGRs), dissolved air flotation tanks (DAFTs), dual media filtration, disinfection (chlorine gas), and dechlorination (sodium bisulfite). The ponds, FGRs, and DAFTs provide nitrification and partial denitrification. Sludge is anaerobically digested, and mechanically dewatered in a belt-filter press.

1.3 Existing Recycled Water Service

The Sunnyvale WPCP has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The volumes were approximately 440 acre-feet per year (AFY; approximately 140 million gallons per year) in year 2020 to a projected 1,680 AFY (approximately 550 million gallons per year) from year 2030 and beyond. The volumes in years 2019 and 2020 were reduced due to operations and maintenance (O&M) constraints and an abundance of potable water allocations. As such, these more recent volumes are an underrepresentation and does not reflect normal operating conditions. Furthermore, the Sunnyvale WPCP routinely supplements recycled water distribution system with potable water when demand exceeds supply. Potable supplementation is typically highest during the wet weather season. For years 2027 and beyond, this effort assumes that recycled water will be used to satisfy 100 percent of the demand. The recycled water users are broad and include golf course irrigation, landscape irrigation, commercial (including dual-plumbing), and industrial.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of recent historical nutrient discharge data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19)*,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	8.98	13.0	11.3
Volume	AF	4,220	8,440	12,660
Ammonia	kg N/d	24.4	250	156
Total Inorganic Nitrogen (TIN)	kg N/d	546	1,210	931
Total Phosphorus (TP)	kg P/d	231	243	238
Ammonia	mg N/L	0.66	5.09	3.25
TIN	mg N/L	16.0	24.6	21.0
TP	mg P/L	6.85	5.14	5.86

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Regional Nutrient Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

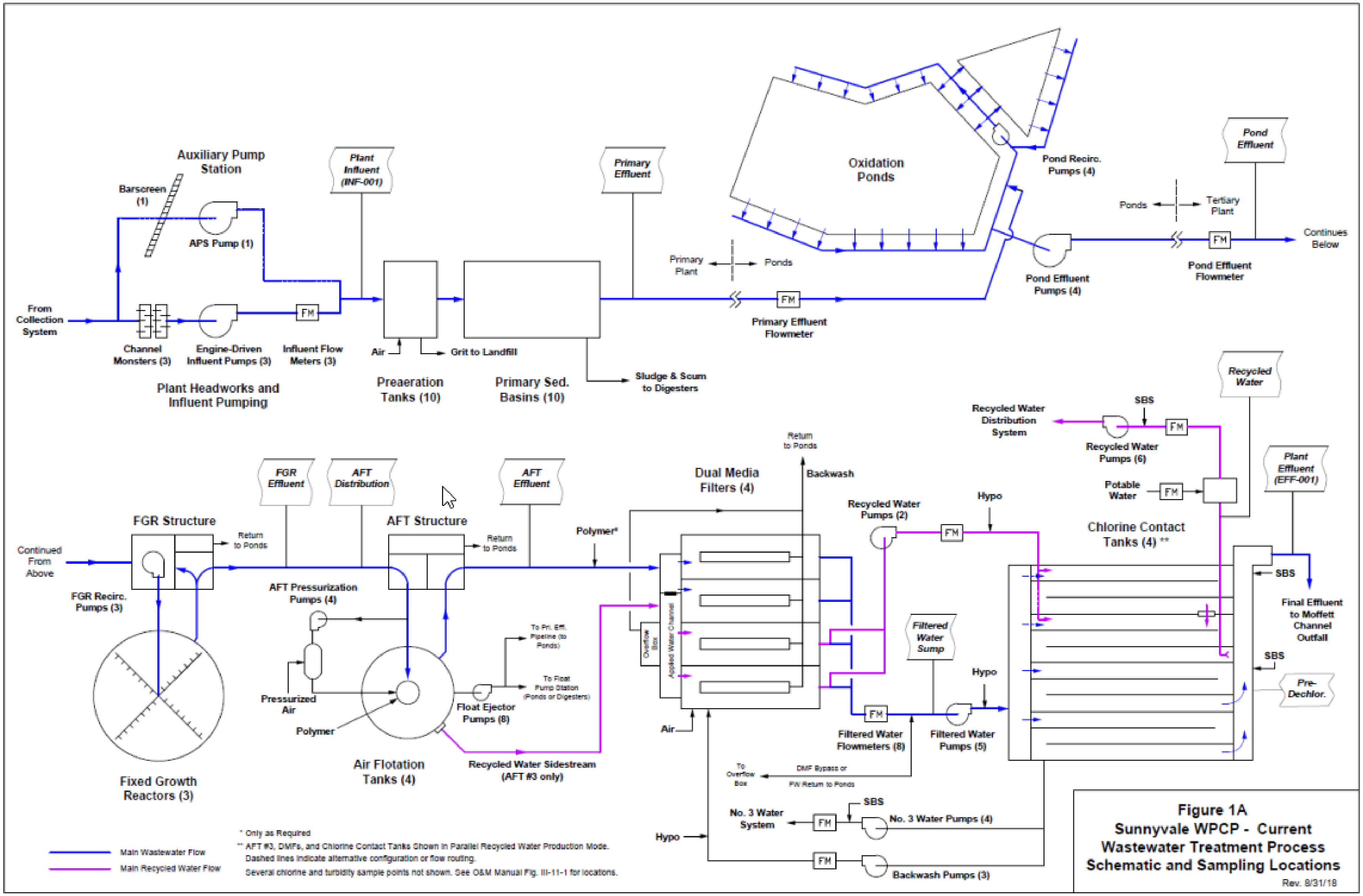

Figure 1-1. Process Flow Diagram for Sunnyvale WPCP (Source: NPDES Permit R2-2020-0002; CA0037621)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2020 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility.
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with Sunnyvale WPCP and Engineer's best judgment that considered known project constraints, existing Sunnyvale WPCP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by Sunnyvale WPCP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[2] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[2] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects. The subsections that follow summarize the flow and nutrient load reductions for each listed project in Table 3-1.

Table 3-1. Recycled Water Projects Identified by Sunnyvale WPCP

Recycled Water Project	Description
Existing Recycled Water Facilities	The Sunnyvale WPCP has an existing recycled water program that is employed year-round. This existing program has the effect of reducing nutrients discharged to the Bay. The WPCP currently recycles approximately 400 acre-feet per year (approximately 140 million gallons per year). The reuse demands are primarily from golf course and landscape irrigation applications, as well as internal uses at the WPCP. Note: the internal uses at the WPCP are not included in this analysis as such flows are eventually discharged to the Bay.
Future Project(s)	None Planned

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. The existing facility will be nearing capacity by year 2030 (1,400 AFY) as evidenced by future projections only increasing to approximately 1,680 AFY.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. The Sunnyvale WPCP projections suggest that the underrepresented 2019 and 2020 recycled volumes increase to approximately 1,100 AFY by year 2025, followed by an increase in year 2030 until reaching capacity (1,680 AFY) by year 2035 and beyond. The projections include several assumptions, including a cap on industrial demand (30 AFY), a golf course irrigation cap (300 AFY), landscape irrigation cap (330 AFY), commercial application (990 AFY), and a potential indirect potable reuse project which could be larger in the future (listed as up to 30 AFY).

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Distributed – Return Flows (AFY)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**1**	**443**	**5**	**33**	**8**
	Existing Facilities	1	443	5	33	8
	Other Projects**	--	--	--	--	-
2025	**Total**	**3**	**1,100**	**14**	**81**	**21**
	Existing Facilities	3	1,100	14	81	21
	Other Projects**	--	--	--	--	-
2030	**Total**	**3**	**1,400**	**17**	**103**	**26**
	Existing Facilities	3	1,400	17	103	26
	Other Projects**	--	--	--	--	-
2035	**Total**	**3**	**1,680**	**21**	**124**	**32**
	Existing Facilities	3	1,680	21	124	32
	Other Projects**	--	--	--	--	-
2040	**Total**	**3**	**1,680**	**21**	**124**	**32**
	Existing Facilities	3	1,680	21	124	32
	Other Projects**	--	--	--	--	-
2045	Total	**3**	**1,680**	**21**	**124**	**32**
	Existing Facilities	3	1,680	21	124	32
	Other Projects**	--	--	--	--	-

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

** Other Projects: none planned

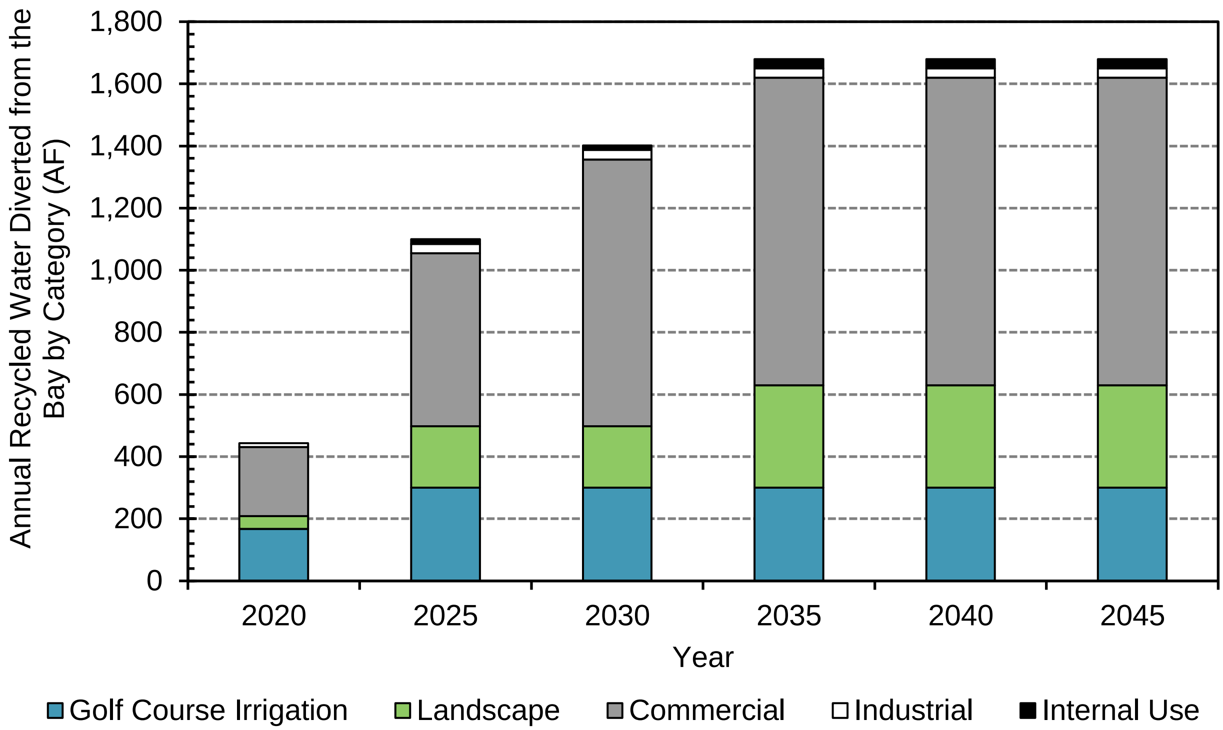

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. The key ancillary benefits are the facilities are already in place and operator familiarity. The primary adverse impact is the recycled water facility is already nearing production capacity.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing Recycled Water Facilities	• Recycled water facilities recently upgraded to foster simultaneous reuse distribution and effluent pumping. • Facilities are already in place and provide recycled water and in turn reduce water supply demands. • Operator familiarity with existing recycled water facilities. • Existing facilities reliably meet recycled water treatment requirements. • Expansive portfolio diversity of recycled water applications.	• Ability to increase recycled water volumes as Sunnyvale is already nearing capacity (estimated at 1,680 AFY, albeit with estimated volume caps per application).
Future Project(s)	None Planned	None Planned

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project is provided in Table 3-4. The unit costs values are relatively low both on a volume and nutrient load reduction basis (except for ammonia). The unit ammonia load reduction cost is overstated though as the WPCP already reliably removes ammonia. The relatively efficient flow and load reduction is attributed to the facilities already being in place. For perspective, the optimization and upgrades study that evaluated nutrient load reduction across Bay Area WWTPs had a range of values of $2.0 - $8.7/lb TIN load reduced,[3] which is relatively close to the $3.8 and $2.8/lb TIN load removed (dry season and average annual, respectively) for Sunnyvale WPCP in this report.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. Of all the estimated volume caps, the indirect potable reuse could be significantly larger. The indirect potable reuse projections are governed by the outcome and timeline of Santa Clara Valley Water's Countywide Water Reuse Master Plan (CWRMP) since Sunnyvale is being considered as a partner in that project. What is shown here is the same data as the 2015 survey prior to the CWRMP. Consequently, this value could potentially be much higher and in addition to Sunnyvale's demand depending on the size and location of the proposed advanced water purification facility and Sunnyvale's relative contribution of its process water.

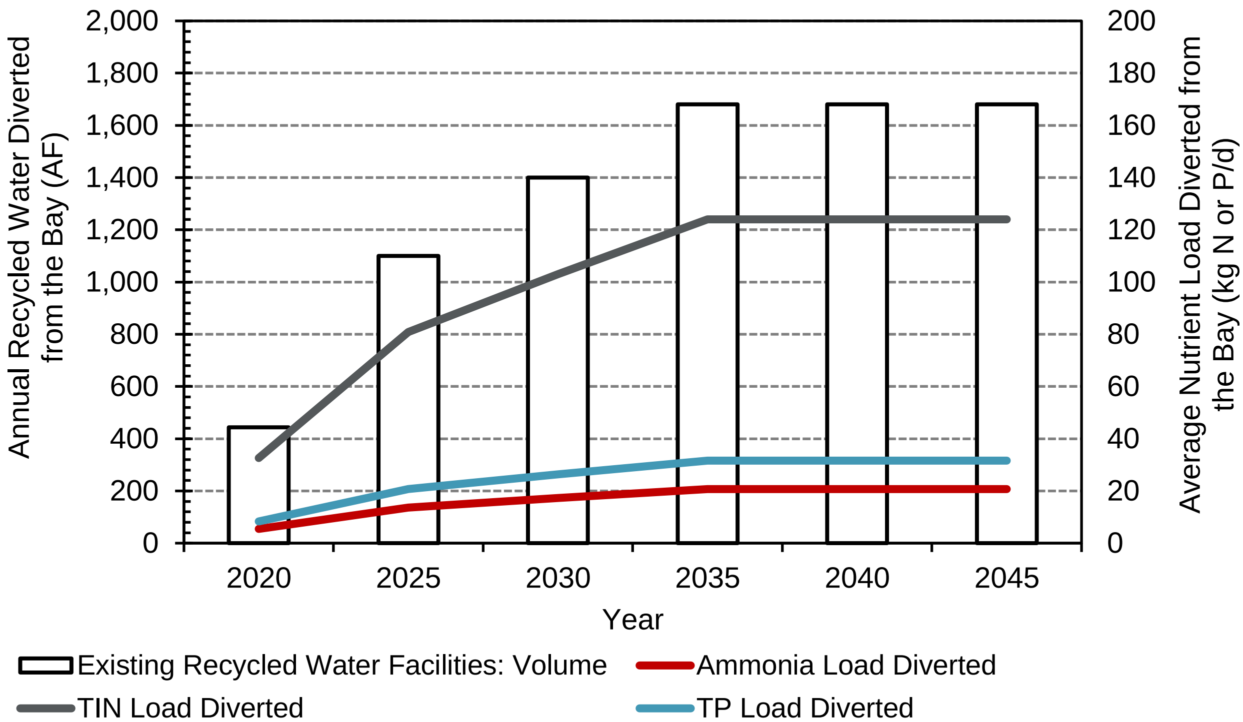

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge

[3] Bay Area Clean Water Agencies (2018) Bay Area Clean Water Agencies Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream Treatment, Treatment Upgrades, and Other Means. Prepared by HDR. Oakland, CA.

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *, **		Future Project (None Planned) *, **		Total (Includes Existing and Future Projects (None Planned) Averaged from Year 2020 through 2045) *, **	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	1.7	1.2	--	--	1.7	1.2
Volume	AF	817	1,330	--	--	817	1,330
Load Diverted from the Bay[2,3]							
Confidence	unitless	1 for Year 2020; 3 for Year 2025 Onwards	1 for Year 2020; 3 for Year 2025 Onwards	--	--	1 for Year 2020; 3 for Year 2025 Onwards	1 for Year 2020; 3 for Year 2025 Onwards
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	16%	10%	--	--	16%	10%
Ammonia Load Diverted	kg N/d	5	16	--	--	5	16
TIN Load Diverted	kg N/d	106	98	--	--	106	98
TP Load Diverted	kg P/d	45	25	--	--	45	25
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	3.4	5.5	--	--	3.4	5.5
NPV Total (Capital+NPV O&M)	$ Mil	3.4	5.5	--	--	3.4	5.5
Unit Flow Cost[6]							
Unit Cost	$/gpd	1.9	4.6	--	--	1.9	4.6
Unit Cost	$/AF	165	165	--	--	165	165
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	84	17	--	--	84	17
TIN Unit Cost	$/lb TIN Diverted	3.8	2.8	--	--	3.8	2.8
TP Unit Cost	$/lb TP Diverted	8.9	10.9	--	--	8.9	10.9

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned).

** Flows and loads diverted from the Bay Discharge are projected forward to the average from project start through year 2045). For the Total columns, the project start period is from year 2020 through year 2045.

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by Sunnyvale WPCP in 2021 dollars.
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at Sunnyvale WPCP:

- Drivers for implementing recycled water projects:
  - Water supply needs across Sunnyvale's service area, as well as at other neighboring service areas.
  - Proposed discharge regulations: nutrient regulations might incentivize the Sunnyvale WPCP to expand their recycled water production and distribution.
  - Institutional: Sunnyvale WPCP is committed to recycling as much recycled water as possible (when deemed viable)
- Barriers for implementing recycled water projects:
  - Funding: ability to produce more product water is limited by funding.
  - Jurisdictional: Sunnyvale WPCP is challenged while working across jurisdictions.
  - Infrastructure: aging infrastructure and construction delays impacting the timelines of Capital Improvement Projects.

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Bay Area Clean Water Agencies
Recycled Water Study

Treasure Island Wastewater Treatment Plant

San Francisco, CA

June 13, 2023
Final Report

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Contents

Tables

Figures

Executive Summary

The Treasure Island Development Authority owns the Treasure Island Wastewater Treatment Plant (TI WWTP) located in San Francisco, CA and discharges treated effluent to Central San Francisco Bay. Facility ownership was transferred from the United States Department of Navy to the Treasure Island Development Authority on April 30, 2021. The TI WWTP serves Treasure Island, which is in the midst of comprehensive redevelopment. The San Francisco Public Utilities Commission operates and maintains the treatment plant. The plant has an average dry weather flow (ADWF) permitted capacity of 2 million gallons per day (mgd).

The existing wastewater infrastructure is being replaced as part of the island redevelopment. While the existing treatment plant does not produce recycled water, a new facility that will replace the TI WWTP (Planned Facility) will result in recycled water upon completion in approximately year 2026. Based on the 2016 Treasure Island Recycled Water Master Plan, the Planned Facility will recycle approximately 460 acre-feet per year (AFY) for outdoor use (landscape irrigation; approximately 301 AFY) and indoor use (commercial for indoor use; approximately 162 AFY) by year 2030. The flows for the commercial application will be returned to the plant. As such, the flows and loads associated with the commercial application will not be diverted from the Bay and are thus excluded from this analysis.

A summary of the ongoing and proposed recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES - 1. As previously stated, the upgrades at TI WWTP will result in recycled water implementation by year 2030. The nutrient concentrations used to calculate loads is based on the anticipated effluent nutrient concentrations from the TI WWTP (Facility Planned) as noted in Table ES – 1 (ammonia = 0.5 mg N/L; TIN = 8.1 mg N/L; TP at current effluent levels). The unit costs values are relatively high both on a volume and nutrient load reduction basis. For perspective, the optimization and upgrades study that evaluated nutrient load reduction across Bay Area WWTPs had an average value of less than $60/lb nutrient removed.[1] The timeline and corresponding load diversions from the Bay for the projected projects is illustrated in Figure ES – 1.

An overview of the drivers and barriers for implementing recycled water projects at TI WWTP:

- Drivers for implementing recycled water projects: redevelopment of the island will produce the need for recycled water
- Barriers for implementing recycled water projects:
    - Lack of need for water supply
    - Treasure Island Community Development (TICD) is the lead for recycled water infrastructure; infrastructure development is tied to the island development phases. Full build (Phase 4) is anticipated to be from 2026-2037 depending on the economy.

[1] Bay Area Clean Water Agencies (2018) Bay Area Clean Water Agencies Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream Treatment, Treatment Upgrades, and Other Means. Prepared by HDR. Oakland, CA.

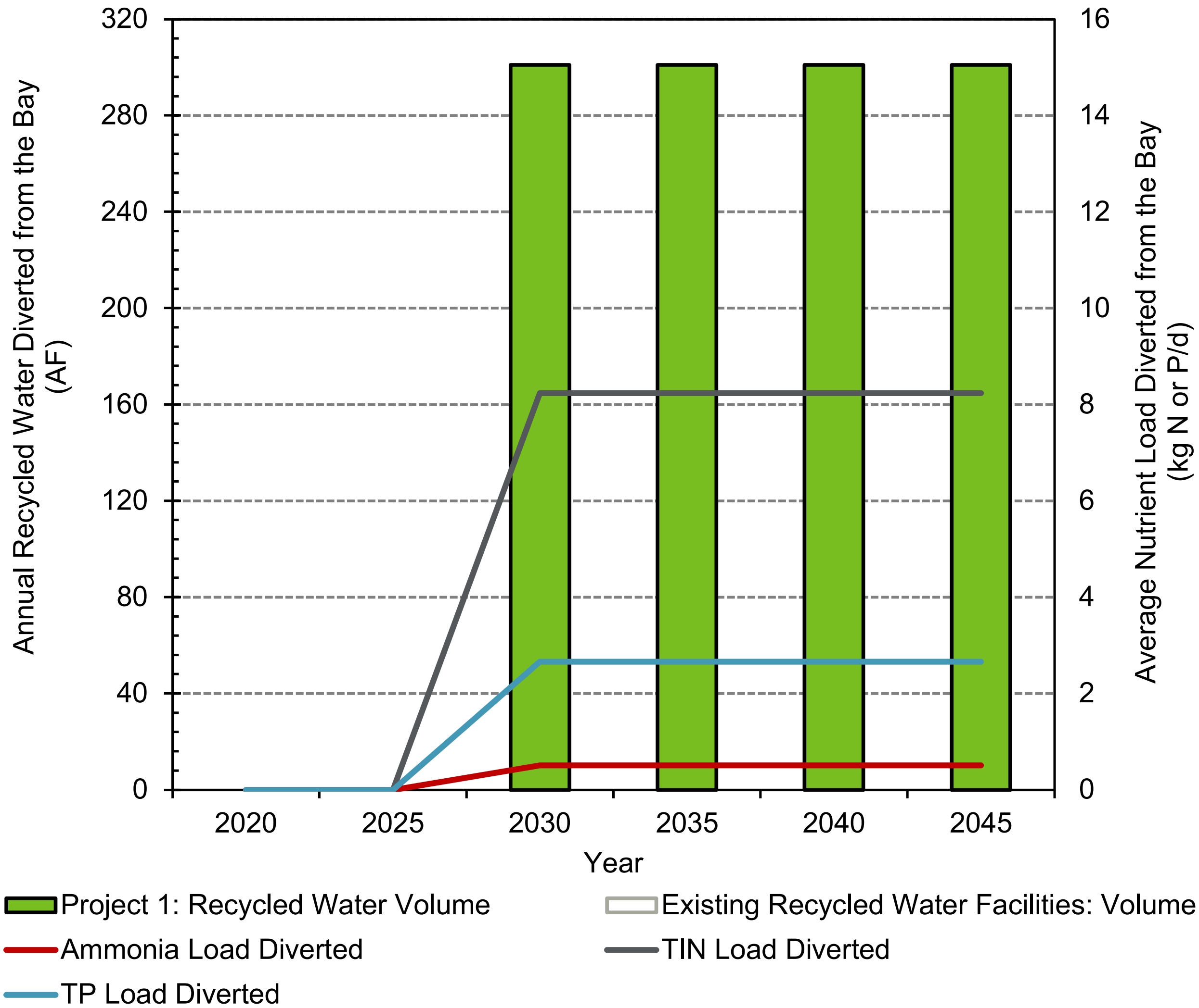

Figure ES - 1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge on Treasure Island*

* Note: Project 1 represents landscape irrigation (approximately 301 AFY) and commercial indoor use (approximately 162 AFY) from the Planned Facility. The flows for the commercial indoor use application will be returned to the plant. As such, the flows and loads associated with the commercial application will not be diverted from the Bay and are thus excluded from this analysis. Furthermore, the nutrient concentrations used to calculate loads is based on the anticipated effluent nutrient concentrations from the TI WWTP (Facility Planned) (ammonia = 0.5 mg N/L; TIN = 8.1 mg N/L; TP = current effluent levels).

Table ES - 1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (None) *,**		Future Projects (Beginning in Year 2030; Predicated on TI WWTP Upgrades being Completed) *,**,***		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *,**,***	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1, 9]							
Flow	mgd	--	--	0.42	0.27	0.25	0.16
Annual Volume	AFY	--	--	195	301	117	181
Load Diverted from the Bay[2,3]							
Confidence	unitless	--	--	1	1	1	1
Duration	Years	--	--	15	15	25	25
Flow Diverted	%	--	--	58%	42%	46%	31%
Ammonia Load Diverted	kg N/d	--	--	1	1	<1	<1
TIN Load Diverted	kg N/d	--	--	13	8	8	5
TP Load Diverted	kg P/d	--	--	5	3	3	2
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	224	224	224	224
NPV O&M	$ Mil	--	--	58	90	58	90
NPV Total (Capital+NPV O&M)	$ Mil	--	--	282	314	282	314
Unit Flow Cost[6]							
Unit Cost	$/gpd	--	--	679	1,170	1,130	1,950
Unit Cost	$/AF	--	--	96,400	69,500	96,400	69,500
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	--	--	70,900	51,100	70,900	51,100
TIN Unit Cost	$/lb TIN Diverted	--	--	4,380	3,160	4,380	3,160
TP Unit Cost	$/lb TP Diverted	--	--	10,700	9,780	10,700	9,780

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045; details provided with each project in Section 3).

*** Future Project: this excludes commercial application volumes (approximately 200 AFY) as the flows are returned to the plant and thus do not result in the diversion of volume/loads from the Bay. Furthermore, the nutrient concentrations used to calculate loads is based on the anticipated effluent nutrient concentrations from the TI WWTP (Facility Planned) (ammonia = 0.5 mg N/L; TIN = 8.1 mg N/L; TP = current effluent levels).

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by TI WWTP (based on year 2023 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay over the project duration.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).
9. Values based on the Treasure Island and Yerba Buena Island Redevelopment Recycled Water Master Plan.[2]

[2] BKF (2016) Treasure Island and Yerba Buena Island Redevelopment: Recycled Water Master Plan. Prepared for SFPUC. San Francisco, CA.

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1 Introduction and Current Conditions

The Treasure Island Development Authority owns the Treasure Island Wastewater Treatment Plant (TI WWTP) located in San Francisco, CA and discharges treated effluent to Central San Francisco Bay. Facility ownership was transferred from the United States Department of Navy to the Treasure Island Development Authority on April 30, 2021. The TI WWTP serves Treasure Island, which is in the midst of comprehensive redevelopment. The San Francisco Public Utilities Commission operates and maintains the treatment plant. The plant has an average dry weather flow (ADWF) permitted capacity of 2 million gallons per day (mgd).

The sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) permit as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (Order No. R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

Treasure Island WWTP holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2020-0020). Table 1-1 provides a summary of the relevant permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2020-0020; CA0110116)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	2.0[(3)]	--	--	--
Effluent BOD [(1)]	mg/L	--	30	45	--
Effluent TSS [(1)]	mg/L	--	30	45	--
Effluent Ammonia	mg N/L	--	130	--	330

1) BOD and TSS include a minimum percent removal of 85% through the WWTP
2) This table identifies relevant permit limitations only and does not include a complete list of permit limitations.
3) The facility is designed to provide secondary treatment for a flow of 4.4 mgd during wet weather.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (Order No. R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly part of the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

1.2 Process Flow Diagram

Figure 1-1 shows the process flow diagram for the Treasure Island WWTP. Both liquids processes and solids processes are shown. The TI WWTP consists of screening and grit removal, primary clarification, trickling filters, secondary sedimentation, and chlorine disinfection. Solids and sludge from the TI WWTP are sent to Oceanside Water Pollution Control Plant in San Francisco for treatment and disposal.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Anticipated in Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.3 Existing Recycled Water Service

The TI WWTP does not currently produce recycled water. Based on the 2016 Treasure Island Recycled Water Master Plan, by 2030 a new plant will recycle 301 AFY for outdoor use (landscape irrigation). Another 162 AFY will be used for indoor use, which will be returned to the treatment plant.

1.4 Discharge Flows and Loads (Historical and Future Values)

A summary of historical three years of the discharge nutrient data is provided in Table 1-3. Given the upcoming plant upgrades (Planned Facility), the effluent ammonia and TIN concentrations will be further reduced. A summary of the projected discharge flows and the anticipated effluent concentrations to SF Bay after constructing and commissioning the TI WWTP (Planned Facility) is provided in Table 1-4. The data in Table 1-4 should serve as an indicator of potential flows and loads from recycled water that could be diverted from Bay discharge.

Table 1-3. Historical Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19) *,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	0.30	0.42	0.37
Volume	AF	139	271	410
Ammonia	kg N/d	4.70	4.78	4.75
Total Inorganic Nitrogen (TIN)	kg N/d	14.1	14.0	14.0
Total Phosphorus (TP)	kg P/d	3.72	3.57	3.63
Ammonia	mg N/L	4.23	3.04	3.54
TIN	mg N/L	12.7	9.35	10.8
TP	mg P/L	3.37	2.43	2.82

* Represents the three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (Order No. R2-2014-0014 and R2-2019-0017).

**Represents the average value over the duration listed in the table header.

Table 1-4. Projected Flow and Anticipated Nutrient Discharge Levels to the Bay after the TI WWTP (Planned Facility)

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (projected – flow and volume only; loads and concentrations are anticipated)
Flow	mgd	0.33	0.47	0.41
Volume	AF	157	305	462
Ammonia	kg N/d	0.6	0.9	0.8
Total Inorganic Nitrogen (TIN)	kg N/d	10.3	14.4	12.7
Total Phosphorus (TP)	kg P/d	4.3	4.3	4.4
Ammonia *	mg N/L	0.5	0.5	0.5
TIN *	mg N/L	8.1	8.1	8.1
TP *	mg P/L	3.4	2.4	2.8

* The anticipated effluent levels for the TI WWTP (Facility Planned) were used to calculate loads (ammonia = 0.5 mg N/L; TIN = 8.1 mg N/L; TP = current effluent levels as listed in Table 1-3 aboveTable 1-3).

TREASURE ISLAND WWTP

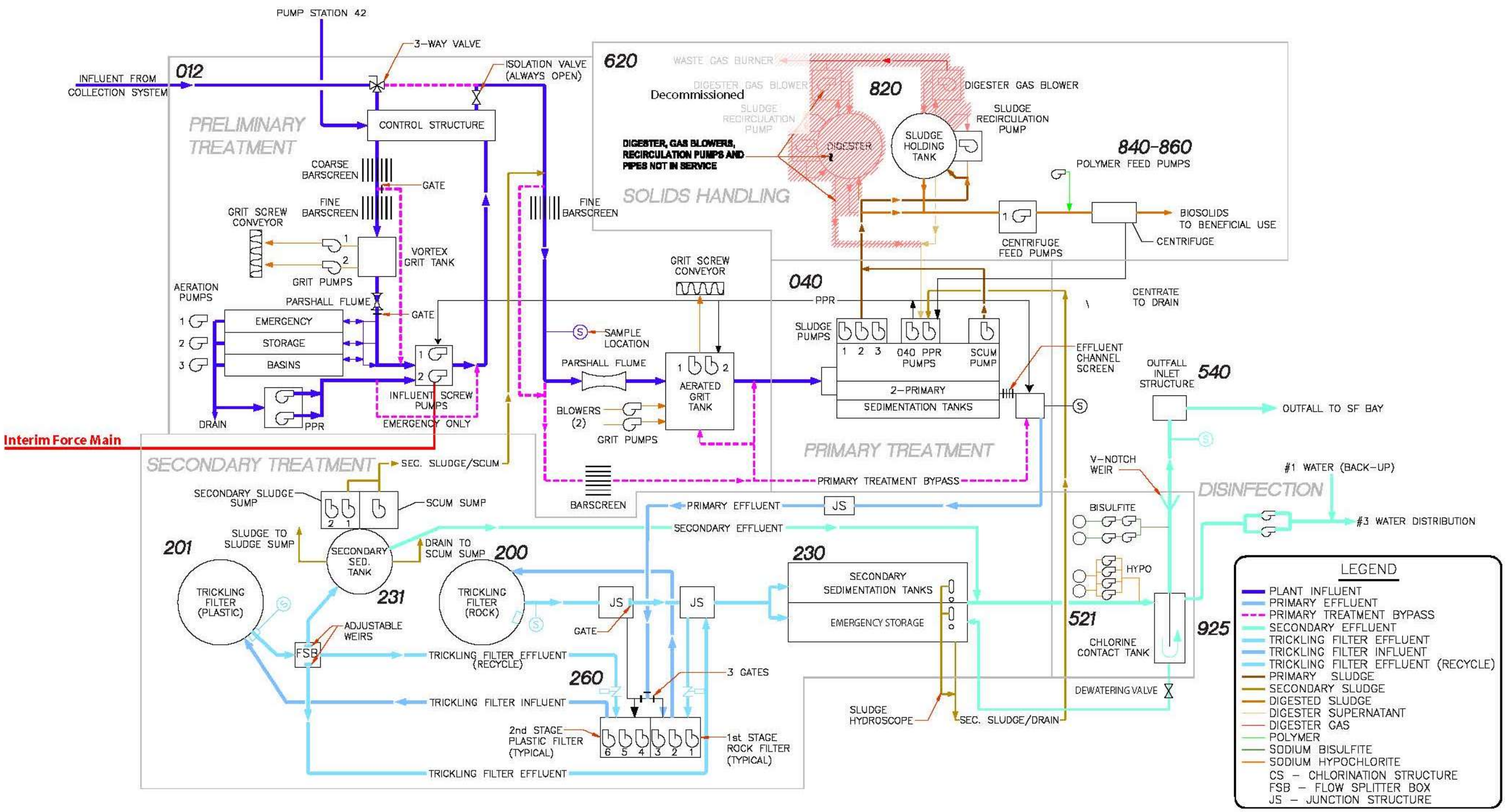

Figure 1-1. Process Flow Diagram for Treasure Island WWTP (Source: 2022 Annual Self-Monitoring Report)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (Order Nos. R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter.

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility.
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with Treasure Island WWTP staff and Engineer’s best judgment that considered known project constraints and type of reuse project (e.g., irrigation based reuse more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by Treasure Island WWTP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Unless otherwise noted, construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction for TI WWTP is determined using the RW distribution volumes reported in the RFI and the calculated load reduction for the Planned Facility. The calculated load reduction for TI WWTP is based on the anticipated effluent concentrations for the TI WWTP (Planned Facility) as noted in Table 1-4 (ammonia = 0.5 mg N/L, TIN = 8.1 mg N/L; Total P = current effluent levels). The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The net nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the net nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects. The following subsections summarize the flow and nutrient load reductions for each listed project in Table 3-1.

Table 3-1. Recycled Water Projects Identified by Treasure Island WWTP

Recycled Water Project	Description
Existing	Non-Applicable as the TI WWTP does not currently recycled water.
Project 1: Landscape and Commercial Applications Starting at Year 2030	The Planned Facility will be designed to achieve the disinfected tertiary treatment standards of California Code of Regulations, Title 22, Division 4, section 60301.230. The average annual recycled water demand is anticipated to be 0.43 mgd, with a peak flow of 0.98 mgd. The recycled water system will serve indoor and outdoor non-potable water demands, including landscape irrigation, urban farming, and dual plumbing. The flows and loads associated with the indoor applications are excluded from this analysis as such flows/loads will be returned to the TI WWTP.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Average Distributed – Return Flows (AF)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**--**	**--**	**--**	**--**	**--**
	Existing Facilities	1	--	--	--	--
	Other Projects**	1	--	--	--	--
2025	**Total**	**--**	**--**	**--**	**--**	**--**
	Existing Facilities	1	--	--	--	--
	Other Projects**	1	--	--	--	--
2030	**Total**	**--**	**--**	**--**	**--**	**--**
	Existing Facilities	1	--	--	--	--
	Other Projects**	1	--	--	--	--
2035	**Total**	**1**	**301**	**1**	**8**	**3**
	Existing Facilities	1	--	--	--	--
	Other Projects**	1	301	3	8	3
2040	**Total**	**1**	**301**	**3**	**8**	**3**
	Existing Facilities	1	--	--	--	--
	Other Projects**	1	301	3	8	3
2045	**Total**	**1**	**301**	**3**	**8**	**3**
	Existing Facilities	1	--	--	--	--
	Other Projects**	1	301	3	8	3

* Confidence Levels:
(1) Includes existing or new projects in an adopted budget.
(2) Includes projects that are in an adopted Master Plan or CIP.
(3) Includes projects that are in the conceptual stage and not included in an adopted document.

** Other Projects represents landscape irrigation (approximately 301 AFY) and commercial (approximately 162 AFY). The flows for the commercial application will be returned to the plant. As such, the flows and loads associated with the commercial application will not be diverted from the Bay and are thus excluded from this analysis. Furthermore, the nutrient concentrations used to calculate loads is based on the anticipated effluent nutrient concentrations for the TI WWTP (Facility Planned) as noted in Table 1-3 (ammonia = 0.5 mg N/L; TIN = 8.1 mg N/L; TP = current effluent levels).

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. Commercial use is distributed evenly throughout the year, and landscape irrigation is used year-round, but more heavily from April to November.

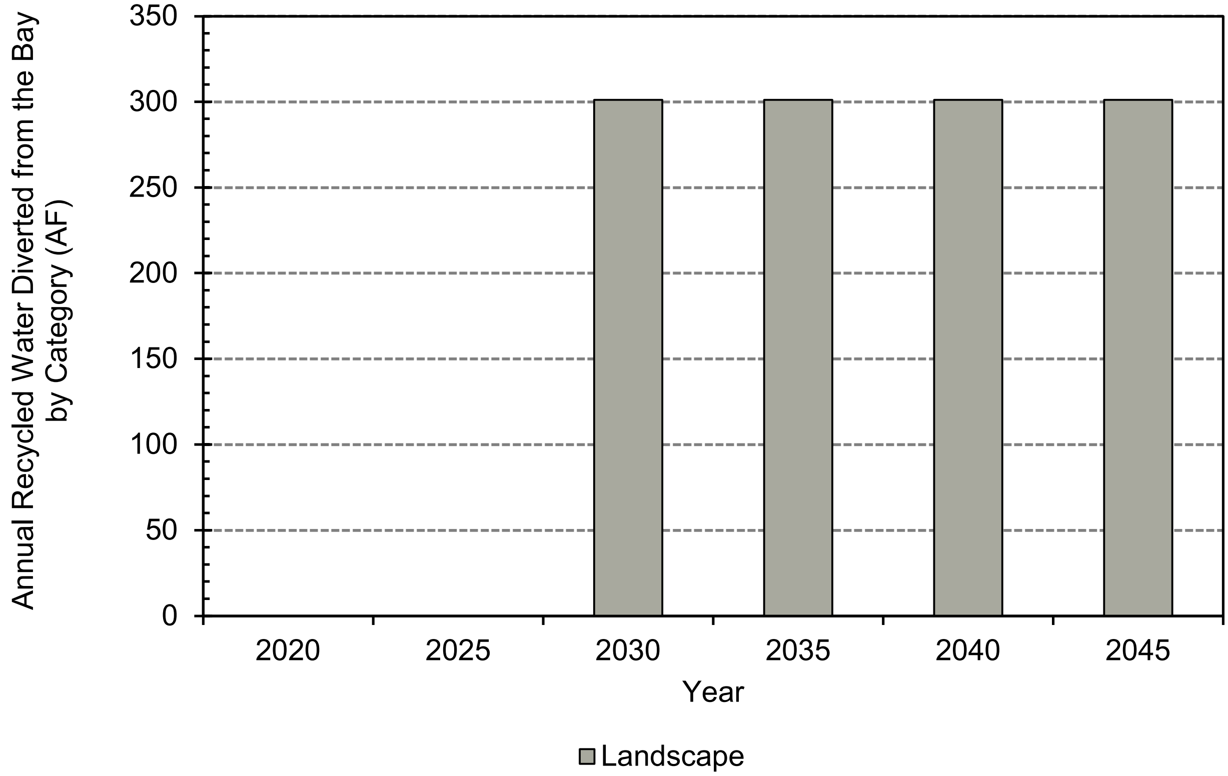

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045) *

* Note: Project 1 represents landscape irrigation (approximately 301 AFY) and commercial (approximately 162 AFY). The flows for the commercial application will be returned to the plant. As such, the flows and loads associated with the commercial application will not be diverted from the Bay and are thus excluded from this analysis.

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts
Existing	Non-Applicable as the TI WWTP does not currently recycle water.	Non-Applicable as the TI WWTP does not currently recycle water.
Project 1: Landscape and Commercial Applications Starting at Year 2030	• More sustainable and reliable source of water • Improved wastewater effluent quality • Increased removal of particulates associated with the upgrade treatment technologies • Increased removal of contaminants of emerging concern (CECs) associated the upgrade treatment technologies	Non-Applicable

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. Currently, there are no existing recycled water projects. The future project is slated for year 2030 and it is anticipated to cost $224M for capital and $7M per year for Operations and Maintenance (2023 dollars). The unit costs values are relatively high both on a volume and nutrient load reduction basis. For perspective, the optimization and upgrades study that evaluated nutrient load reduction across Bay Area WWTPs had an average value of less than $60/lb nutrient removed.[1]

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. As stated in the footnote, the future flow and nutrient load diversions from the Bay do not include commercial indoor applications (approximately 162 AFY) in this instance, as such flows will be returned to the TI WWTP and not be diverted from the Bay.

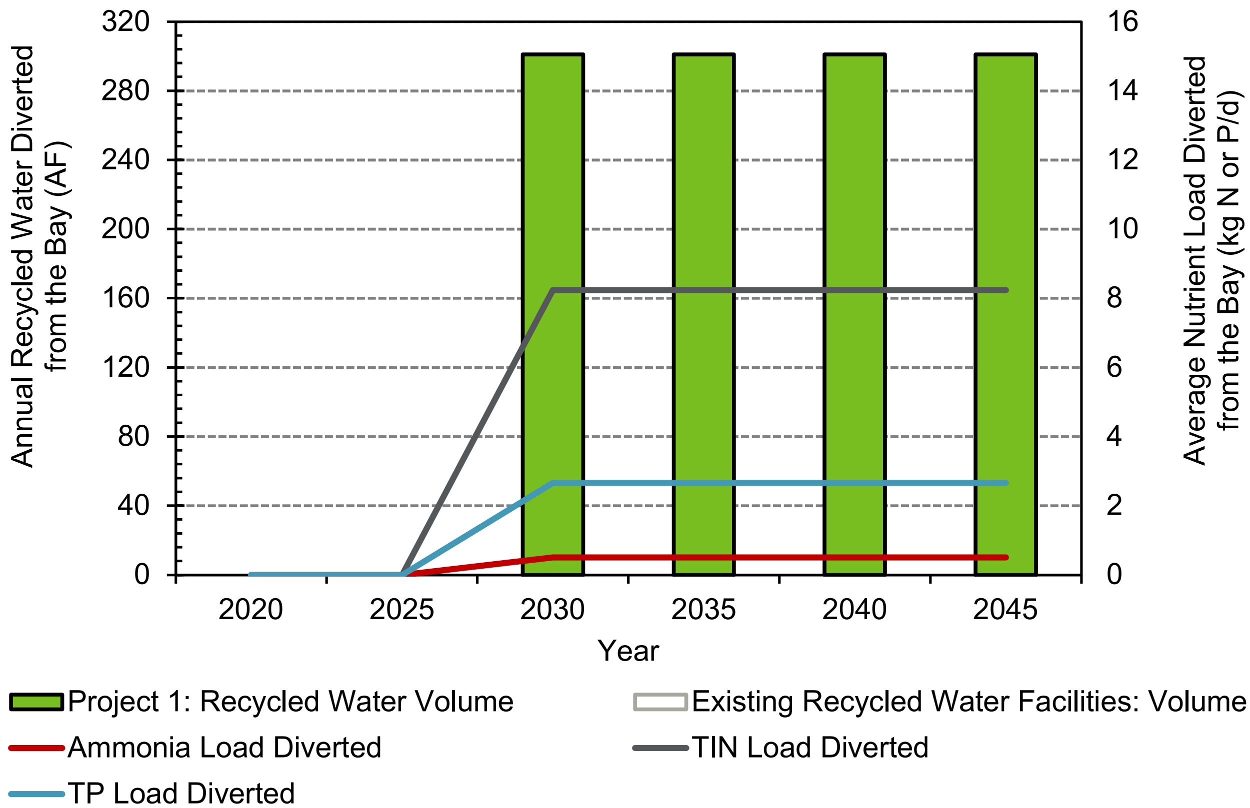

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge*

* Note: Project 1 represents landscape irrigation (approximately 301 AFY) and commercial (approximately 162 AFY). The flows for the commercial indoor application will be returned to the plant. As such, the flows and loads associated with the commercial application will not be diverted from the Bay and are thus excluded from this analysis. Furthermore, the nutrient concentrations used to calculate loads is based on the anticipated effluent nutrient concentrations for the TI WWTP (Facility Planned) as noted in Table 1-3 (ammonia = 0.5 mg N/L; TIN = 8.1 mg N/L; TP = current effluent levels).

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (None) *,**		Future Projects (Beginning in Year 2030; Predicated on TI WWTP Upgrades being Completed) *,**,***		Total (Includes Existing and Future Project Averaged from Year 2020 through 2045) *,**,***	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1,9]							
Flow	mgd	--	--	0.42	0.27	0.25	0.16
Annual Volume	AFY	--	--	195	301	117	181
Load Diverted from the Bay[2,3]							
Confidence	unitless	--	--	1	1	1	1
Duration	Years	--	--	15	15	25	25
Flow Diverted	%	--	--	58%	42%	46%	31%
Ammonia Load Diverted	kg N/d	--	--	1	1	<1	,1
TIN Load Diverted	kg N/d	--	--	13	8	8	5
TP Load Diverted	kg P/d	--	--	5	3	3	2
Cost[3,4,5]							
Capital Cost	$ Mil	--	--	224	224	224	224
NPV O&M	$ Mil	--	--	58	90	58	90
NPV Total (Capital+NPV O&M)	$ Mil	--	--	282	314	282	314
Unit Flow Cost[6]							
Unit Cost	$/gpd	--	--	679	1,170	1,130	1,950
Unit Cost	$/AF	--	--	96,400	69,500	96,400	69,500
Unit Load Cost[7,8]							
Ammonia Unit Cost	$/lb Ammonia Diverted	--	--	70,900	51,100	70,900	51,100
TIN Unit Cost	$/lb TIN Diverted	--	--	4,380	3,160	4,380	3,160
TP Unit Cost	$/lb TP Diverted	--	--	10,700	9,780	10,700	9,780

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects.

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045).

*** Future Project: this excludes commercial application volumes (approximately 200 AFY) as the flows are returned to the plant and thus do not result in the diversion of volume/loads from the Bay. Furthermore, the nutrient concentrations used to calculate loads is based on the anticipated effluent nutrient concentrations for the TI WWTP (Facility Planned) as noted in Table 1-3 (ammonia = 0.5 mg N/L; TIN = 8.1 mg N/L; TP = current effluent levels).

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by TI WWTP (based on year 2023 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay over the project duration.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN, or TP) diverted from a Bay discharge for the project duration (project specific).
9. Values provided by Recycled Water Master Plan.[2]

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3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at TI WWTP:

- Drivers for implementing recycled water projects: redevelopment of the island will produce the need for recycled water
- Barriers for implementing recycled water projects:
    - Lack of need for water supply
    - Treasure Island Community Development (TICD) is the lead for recycled water infrastructure; infrastructure development is tied to the island development phases. Full build (Phase 4) is anticipated to be from 2026-2037 depending on the economy.

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Union Sanitary District Wastewater Treatment Plant

BACWA Recycled Water Study
Final Individual Plant Report

Union City, CA
June 5, 2023

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Contents

Tables

Figures

Executive Summary

Union Sanitary District (USD) owns and operates the Raymond A. Boege Alvarado Wastewater Treatment Plant (WWTP) located in Union City, CA and discharges treated effluent to the San Francisco Bay through the East Bay Dischargers Authority deep water outfall. The plant has an average dry weather flow (ADWF) permitted capacity of 33 million gallons per day (mgd).

The USD WWTP previously sent approximately 3,100 acre-feet per year (1,100 million gallons per year) to the Hayward Marsh but was discontinued in August 2019 at the request of the owner/operator due to repurposing of the space. There are no future plans to send recycled water to Hayward Marsh. Other recycled water uses at USD WWTP are for internal uses, whereby the WWTP uses over 1,000 acre-feet per year of secondary effluent water for such applications. While effective at reducing potable water demands, any such water eventually ends up as Bay discharge and is thus not included in any flows and loads diverted from the Bay due to recycled water. Given this, there are no existing or projected recycled water projects at USD WWTP that will result in a diversion of flows and loads to the Bay.

An overview of the barriers for implementing recycled water projects at USD WWTP:

- Barriers for implementing recycled water projects:
  - Funding – recycled water projects are very costly, especially when compared to other water supply options (e.g. desal) with very few financial incentives provided to facilitate these projects.
  - Jurisdictional- A reclaimed water program is not possible without the cooperation and approval of ACWD, the local water purveyor.
  - Regulatory – Even with renewed interest and support for recycled water projects. Public outreach and permitting of these projects can take years to maneuver the varying levels public support and various permitting required to fund, construct and operate such a facility.

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1 Introduction and Current Conditions

The Union Sanitary District (USD) Raymond A. Boege Alvarado Wastewater Treatment Plant (WWTP) serves a population of about 342,000, which includes the industrial, commercial, and domestic wastewater for the Newark, Union City and the Fremont area. It is located at 5072 Benson Rd., Union City, CA. The plant has an average dry weather flow (ADWF) permitted capacity of 33 million gallons per day (mgd).

The sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

USD is a member of the East Bay Dischargers Authority (EBDA) that discharges USD effluent through EBDA's common outfall. EBDA holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2022-0023; CA0037869). Table 1-1 provides a summary of the relevant permit limitations for USD under the EBDA permit. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (ORDER No. R2-2022-0023; CA0037869)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	33.0	-	-	-
Effluent CBOD (1)	mg/L		25	40	-
Effluent TSS (1)	mg/L	-	30	45	-
Effluent Ammonia	mg/L	-	93	-	130

1) BOD and TSS include a minimum percent removal of 85% through the WWTP
2) This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly part of the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Anticipated in Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 presents the process flow diagram for USD WWTP. Both liquids processes and solids processes are shown. The USD WWTP consists of screening, primary clarification, activated sludge process including aeration basins and secondary clarifiers. Secondary effluent is disinfected by chlorine disinfection. Solids treatment consists of primary sludge degritting, separate primary and secondary sludge thickening, anaerobic digestion and centrifuge dewatering.

1.3 Existing Recycled Water Service

The USD WWTP previously sent approximately 3,100 acre-feet per year (1,000 million gallons per year) to the Hayward Marsh but was discontinued in August 2019 at the request of the owner/operator due to repurposing of the area.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the discharge nutrient data is provided in Table 1-3 from October of 2016 through September of 2019. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19) *,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	23.10	24.3	23.8
Volume	AF	10,900	15,800	26,700
Ammonia	kg N/d	3,520	3,550	3,540
Total Inorganic Nitrogen (TIN)	kg N/d	3,490	3,640	3,590
Total Phosphorus (TP)	kg P/d	230.0	252.0	243.0
Ammonia	mg N/L	40.3	38.7	39.2
TIN	mg N/L	39.9	39.6	39.8
TP	mg P/L	2.63	2.74	2.69

* Represents three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header.

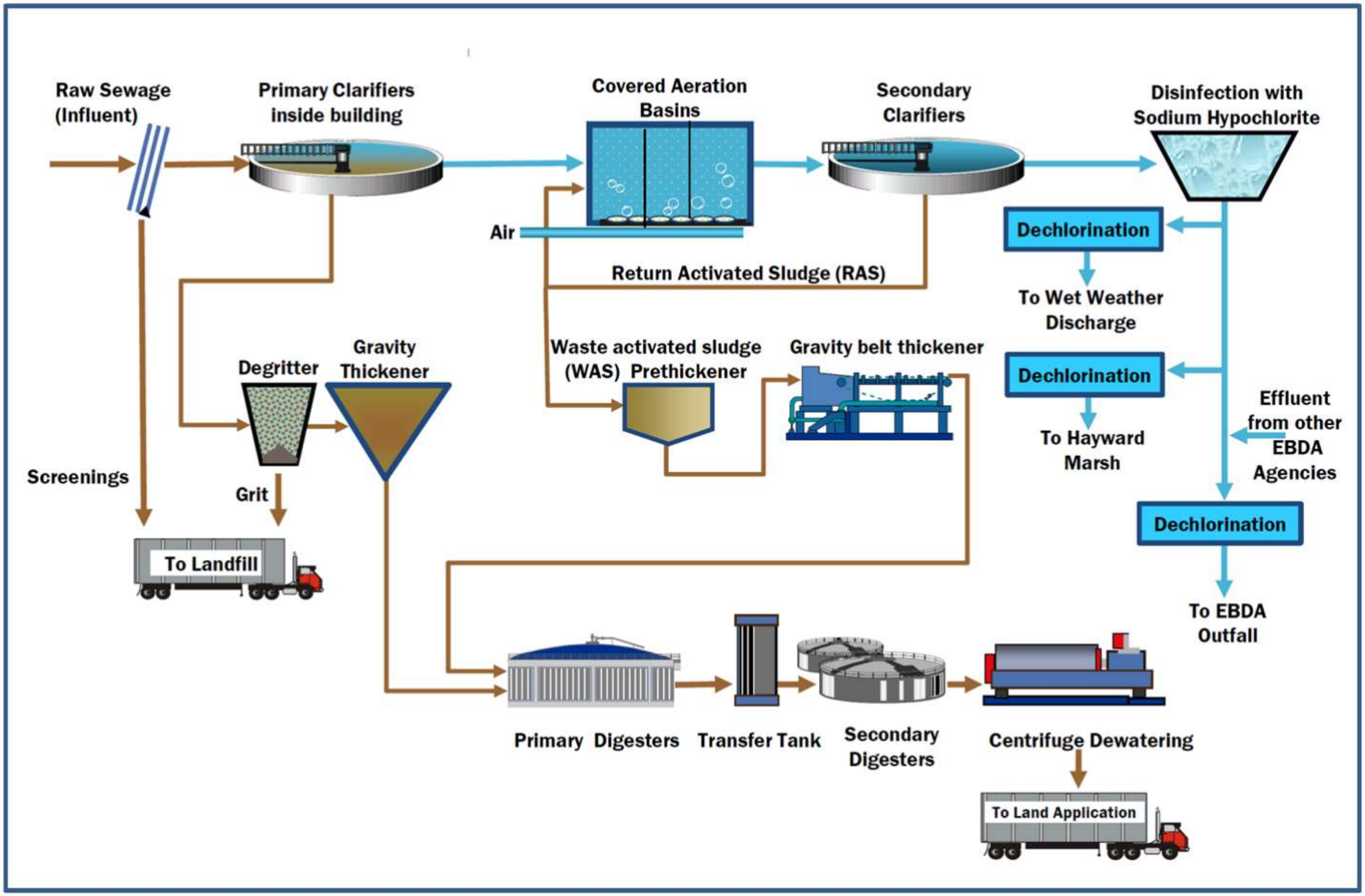

Figure 1-1. Process Flow Diagram for USD WWTP (Source: NPDES No. CA0038733) (note use at Hayward Marsh was discontinued in 2019)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with USD and Engineer's best judgment that considered known project constraints, existing USD reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by USD. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g. existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g. a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Over 1,000 acre-feet per year of secondary effluent water is used internally, for in plant industrial usage. Internal use does not qualify for any flow or load reduction to the Bay. While effective at reducing potable water demands, any such water eventually ends up as Bay discharge and is thus no included in any flows and loads diverted from the Bay due to recycled water. Given this, there are no existing or projected recycled water projects at USD WWTP that will result in a diversion of flows and loads to the Bay.

An overview of the barriers for implementing recycled water projects at USD WWTP:

- Barriers for implementing recycled water projects:
    - Funding – recycled water projects are very costly, especially when compared to other water supply options (e.g. desal) with very few financial incentives provided to facilitate these projects.
    - Jurisdictional- A reclaimed water program is not possible without the cooperation and approval of ACWD, the local water purveyor.
    - Regulatory – Even with renewed interest and support for recycled water projects. Public outreach and permitting of these projects can take years to maneuver the varying levels public support and various permitting required to fund, construct and operate such a facility.

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Bay Area Clean Water Agencies
Recycled Water Study

Vallejo Flood and Wastewater District Wastewater Treatment Plant

BACWA Recycled Water Study

Final Individual Plant Report

Vallejo, CA
June 1, 2023

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Contents

Tables

Figures

Executive Summary

The Vallejo Flood and Wastewater District owns and operates the Wastewater Treatment Plant (Vallejo WWTP) located in Vallejo, CA and discharges treated effluent year-round to Mare Island Strait, and to Carquinez Strait when wet weather flows exceed 35 million gallons per day (mgd). The plant has an average dry weather flow (ADWF) permitted capacity of 15.5 mgd.

Vallejo does not currently produce recycled water. Vallejo completed a recycled water facilities plan in 2018 to determine what treatment processes would be needed to create recycled water, identify potential customers, and determine how to partner with the City of Vallejo to potentially distribute recycled water in the future. There are currently no plans in place for recycled water through year 2045.

The barriers for recycled water projects are funding and a lack of need. Specifically, the City of Vallejo is the water purveyor and has an abundance of water resources. The cost to implement recycled water combined with lack of market have resulted in the decision to not produce recycled water at the Vallejo WWTP.

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1 Introduction and Current Conditions

The Vallejo Flood and Wastewater District owns and operates Wastewater Treatment Plant (Vallejo WWTP) located in Vallejo, CA and discharges treated effluent year-round to Mare Island Strait, and to Carquinez Strait when wet weather flows exceed 35 million gallons per day (mgd). The plant has an average dry weather flow (ADWF) permitted capacity of 15.5 mgd.

The sections below provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

The Vallejo WWTP holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2023-0001; CA0037699). Table 1-1 provides a summary of the relevant permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2023-0001; CA0037699)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	15.5	--	--	--
Effluent BOD (1)	mg/L	--	25	40	--
Effluent TSS (1)	mg/L	--	30	45	--
Effluent Ammonia	mg N/L	--	43	--	71

1) BOD and TSS include a minimum percent removal of 85% through the WWTP
2) This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly part of the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

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Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Anticipated in Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 1-1 shows the process flow diagram for the Vallejo WWTP. The plant has primary clarifiers, followed by a trickling filter/solids contact system for secondary treatment. The trickling filters have been observed to perform some nitrification. Solids are lime stabilized and hauled off site.

1.3 Existing Recycled Water Service

Vallejo does not currently produce recycled water. Vallejo completed a recycled water facilities plan in 2018 to determine what treatment processes would be needed to create recycled water, identify potential customers, and determine how to partner with the City of Vallejo to potentially distribute recycled water in the future.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (10/16 - 9/19) *,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	8.25	12.2	10.6
Volume	AF	3,870	7,960	11,830
Ammonia	kg N/d	770	867	826
Total Inorganic Nitrogen (TIN)	kg N/d	867	961	922
Total Phosphorus (TP)	kg P/d	110	125	119
Ammonia	mg N/L	24.8	21.1	22.6
TIN	mg N/L	27.9	23.2	25.1
TP	mg P/L	3.54	2.93	3.19

* Represents the last three years of data (10/1/2016 through 9/30/2019) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

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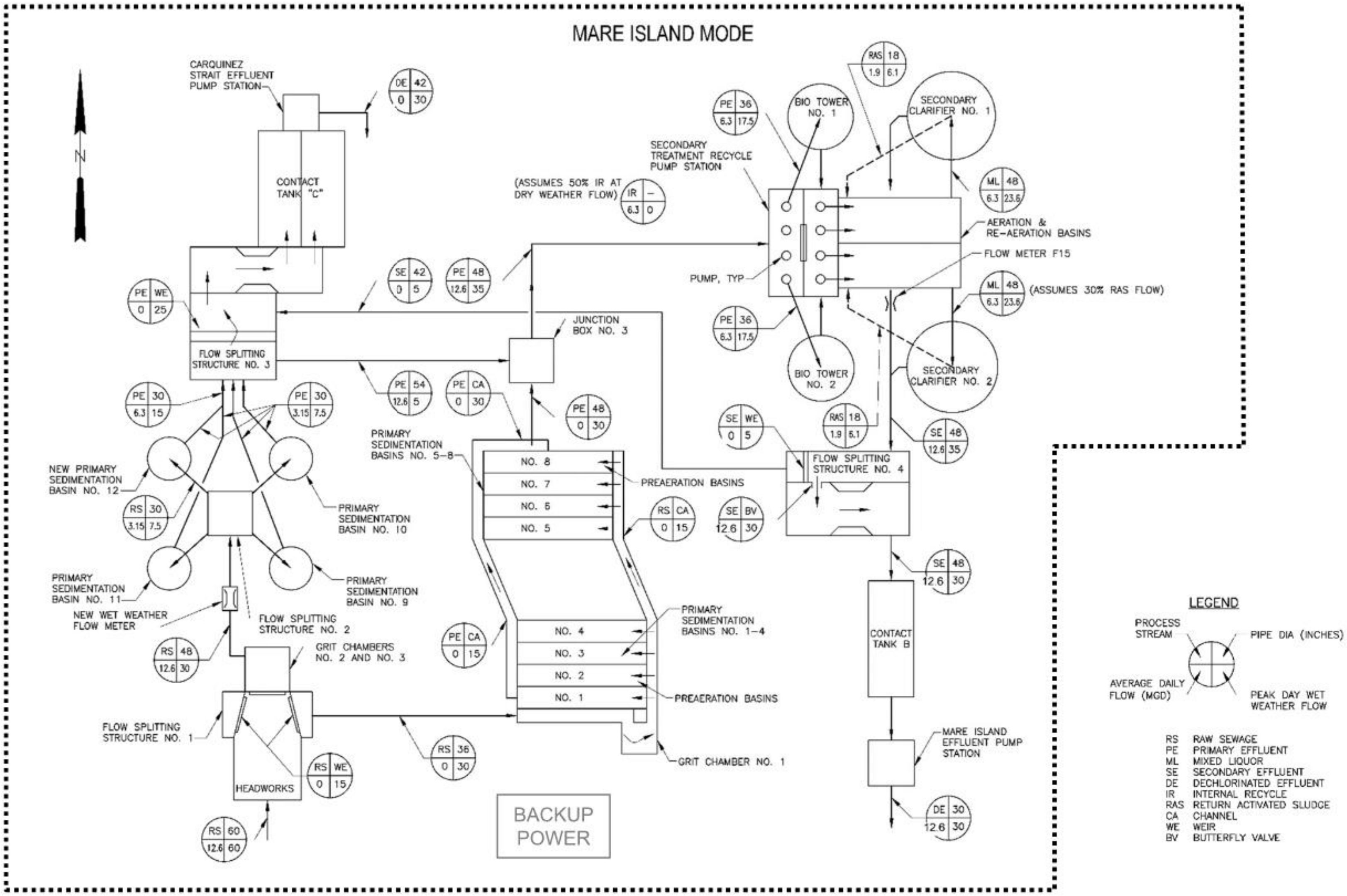

Figure 1-1. Process Flow Diagram for Vallejo Flood and Wastewater District Wastewater Treatment Plant (Source: NPDES Permit R2-2023-0001; CA0037699)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
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Use Category*	Definition
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Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows includes reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with Vallejo WWTP and Engineer's best judgment that considered known project constraints, existing Vallejo WWTP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by Vallejo WWTP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as your barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g. existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g. a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrients loads are maintained and thus do not result in a net reduction in nutrient loads discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Vallejo does not currently produce recycled water. Vallejo completed a recycled water facilities plan in 2018 to determine what treatment processes would be needed to create recycled water, identify potential customers, and determine how to partner with the City of Vallejo to potentially distribute recycled water in the future. There are currently no plans in place for recycled water through year 2045.

The barriers for recycled water projects are funding and a lack of need. Specifically, the City of Vallejo is the water purveyor and has an abundance of water resources. The cost to implement recycled water combined with lack of market have resulted in the decision to not produce recycled water at the Vallejo WWTP.

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Bay Area Clean Water Agencies
Recycled Water Study

West County Wastewater District

Richmond, CA

May 31, 2023
FINAL Report

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Contents

Tables

Figures

Executive Summary

The West County Wastewater District (WCW) Treatment Plant (TP) discharges to the Central San Francisco Bay. It shares a common outfall and discharge permit with the Richmond Municipal Sewer District (RMSD) Water Pollution Control Plant (WPCP). The WCW TP is located at 2377 Garden Tract Road, Richmond, CA 94801, and serves approximately 32,300 service connections throughout parts of the City of Richmond, City of San Pablo, and adjacent unincorporated areas. The plant has an average dry weather flow (ADWF) permitted capacity of 12.5 million gallons per day (mgd).

WCW partners with EBMUD on an extensive recycled water program that reduces effluent flows and loads to SF Bay by about 80%. The customer is the nearby Chevron Richmond, CA refinery through the East Bay Municipal Utility District Richmond Advanced Recycled Expansion (EBMUD RARE) and North Richmond Water Recycling Plant (NRWRP).

The EBMUD RARE includes an influent storage tank (1 million gal), a 4 mgd microfiltration, a 4 mgd reverse osmosis treatment facility, and other ancillary facilities to double the amount of reclaimed water that the Chevron Richmond, CA refinery can use daily. The NRWRP delivers recycled water to the Chevron refinery in Richmond. It treats secondary effluent from WCW via reactor clarifiers to remove calcium, phosphorus, and magnesium using caustic soda softening technology. The water is then neutralized with sulfuric acid and passed through a sand filter to remove any remaining particles. The recycled water is disinfected with sodium hypochlorite to meet tertiary treatment levels for use in Chevron’s cooling towers. EBMUD and Chevron have worked together to implement improvements to recycled water service to Chevron, and EBMUD has also worked extensively with WCW to improve its effluent water quality.

It is important to note that the WCW TP has undergone major recent upgrades with more on the way. Specifically, the TP converted their trickling filter/activated sludge to activated sludge with nutrient removal within the last five years. Such improvements have improved the feed water quality and subsequent treatment capacity to the EBMUD RARE facility. Furthermore, the TP is in construction to upgrade the biosolids handling facility which will improve biosolids quality and reduce overall greenhouse gas emissions.

A summary of the ongoing and proposed recycled water flows, costs, load reductions (ammonia, total inorganic nitrogen (TIN), and total phosphorus (TP), and the corresponding unit costs are provided in Table ES – 1. Note: the WCW TP reliably nitrifies as evidenced by average ammonia loads less than 5 kg N/d. Such reliable nitrification results in a relatively high unit cost ($/lb ammonia removed) for recycled water as the load is in the denominator. A portion of the ammonia that is nitrified to nitrate is removed via biological denitrification. Furthermore, the Total P levels are not as low as ammonia, but the WCW TP has Total P levels reliably below 3 mg P/L. Similar to ammonia, such removal translates to a relatively high recycled water unit cost ($/lb total P) for recycled water as the load is in the denominator.

The timeline and corresponding load diversions from the Bay for the projected projects, if any are identified, are illustrated in Figure ES - 1. The recycled water volumes are anticipated to flat line around year 2025 at just under 8,000 AFY. The nutrient loads diverted from the Bay associated with recycled water will also flatten with the volume. The ammonia and total P load diversions are modest due to removal already occurring at the WCW TP.

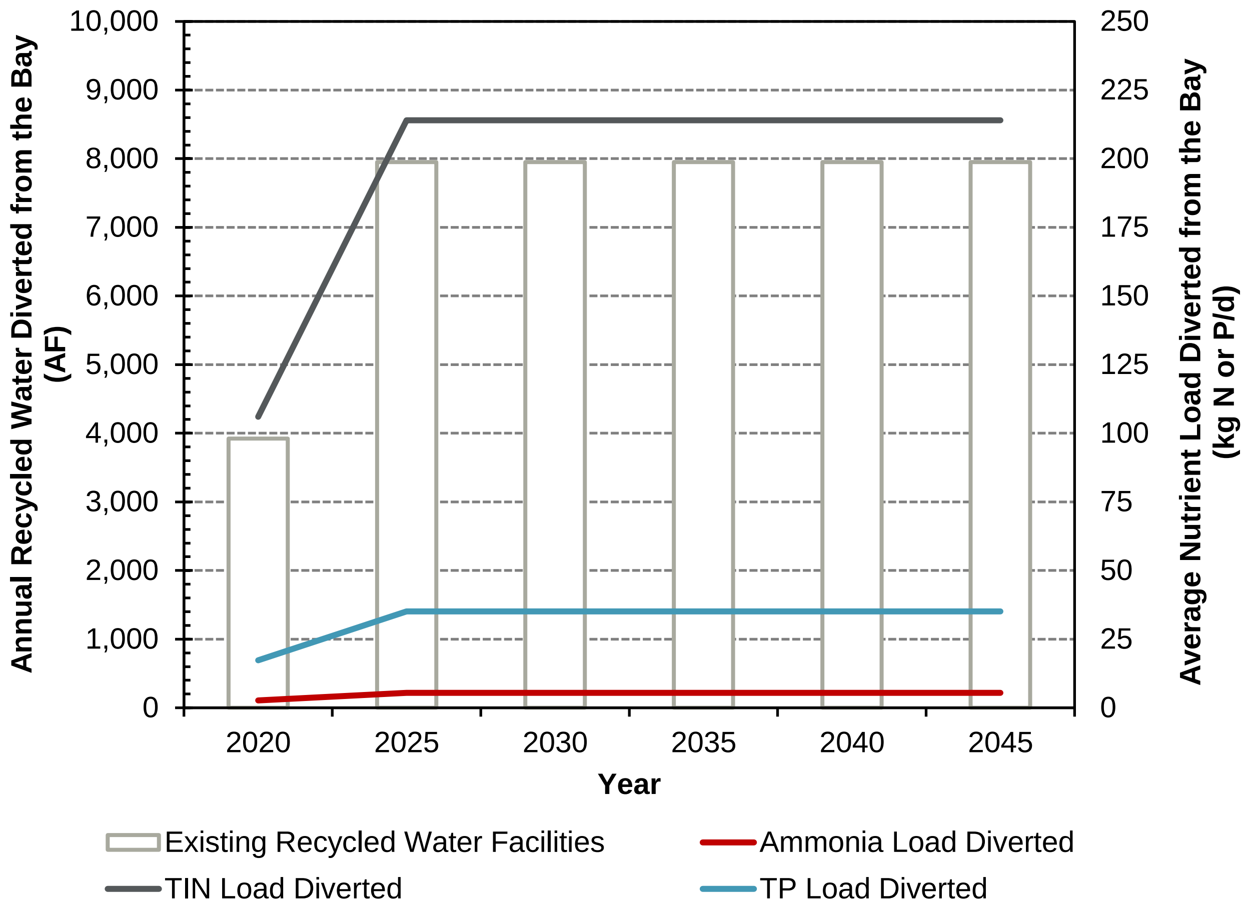

Figure ES - 1. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from a Bay Discharge

An overview of the drivers and barriers for implementing recycled water projects at West County TP:

- Drivers for implementing recycled water projects:
  - Demand: the EBMUD RARE project uses approximately 80 percent of the TP's effluent flows and loads.
  - Institutional: West County TP would like to further use treated effluent for other recycled water customers.
- Barrier for implementing recycled water projects: capacity at EBMUD RARE and the North Richmond Water Reclamation Plant (NRWRP) are the limiting factors. Chevron and EBMUD are considering expanding the RARE facility. There have been several meetings discussing the capacity for West County TP to provide more recycled water if the project moves forward.

Table ES - 1. Summary of Recycled Water Project Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Projects (None Planned) *,**		Total (Projected into the Future) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	5.60	5.90	--	--	5.60	5.90
Volume	AF	2,630	6,610	--	--	2,630	6,610
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	90%	81%			90%	81%
Ammonia Load Diverted	kg N/d	3.9	4.1	--	--	3.9	4.1
TIN Load Diverted	kg N/d	149	157	--	--	149	157
TP Load Diverted	kg P/d	24	26	--	--	24	26
Cost[3,4,5]							
Capital Cost4	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	2.3	5.9	--	--	2.3	5.9
NPV Total (Capital+NPV O&M)	$ Mil	2.3	5.9	--	--	2.3	5.9
Unit Flow Cost[6]							
Unit Cost	$/gpd	0.4	1.0	--	--	0.4	1.0
Unit Cost	$/AF	36	36	--	--	36	36
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	155	65	--	--	155	65
TIN Unit Cost	$/lb TIN Diverted	4.0	1.7	--	--	4.0	1.7
TP Unit Cost	$/lb TP Diverted	25	10	--	--	25	10

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045; details provided with each project in Section 3).

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by West County Wastewater District Treatment Plant (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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1 Introduction and Current Conditions

The West County Wastewater District (WCW) Treatment Plant (TP) discharges to the Central San Francisco Bay. It shares a common outfall and discharge permit with the Richmond Municipal Sewer District (RMSD) Water Pollution Control Plant (WPCP). The WCW TP is located at 2377 Garden Tract Road, Richmond, CA 94801, and it serves approximately 32,300 service connections throughout parts of the City of Richmond, City of San Pablo, and adjacent unincorporated areas. The plant has an average dry weather flow (ADWF) permitted capacity of 12.5 million gallons per day (mgd).

The sections that follow provide information on permit requirements, process flow diagram, existing raw influent flows and loads to provide perspective on water potential, and existing recycled water services.

1.1 Permits

The three most relevant permits for this effort are the National Pollutant Discharge Elimination System (NPDES) as an indicator of the existing water quality produced at the facility, the Regional Watershed Permit as part of this effort (R2-2019-0017), and the existing recycled water treatment requirements.

1.1.1 National Pollutant Discharge Elimination System

WCW holds the National Pollutant Discharge Elimination System (NPDES) permit (Order No. R2-2019-0003). Table 1-1 provides a summary of the relevant permit limitations for plant. Table 1-1 is not intended to provide a complete list of constituent limitations in the NPDES permit.

Table 1-1. NPDES Permit Limitations (Order No. R2-2019-0003; CA0038539)

Criteria	Unit	Average Dry Weather	Average Monthly	Average Weekly	Maximum Daily
Influent Flow	mgd	12.5	--	--	--
Effluent BOD (1)	mg/L	--	30	45	--
Effluent TSS (1)	mg/L	--	30	45	--
Effluent Ammonia	mg/L	--	32	-	59

1) BOD and TSS include a minimum percent removal of 85% through the WWTP
2) This table identifies relevant permit limitations only and does not include a complete list of permit limitations.

1.1.2 Watershed Permit: Recycled Water Requirements

The Watershed Permit (R2-2019-0017) requires a Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The evaluation as included within the report shall include, but not be limited to, the following tasks:

- Description of all treatment plants, treatment plant processes, and service area;
- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorous) discharge reductions associated with each recycled water opportunity;

- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., reduction of natural water resource diversion, reduction of potable water demand, or reduction of chemical fertilizer reliance);
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity; and
- Identification of potential challenges to implementing each opportunity (e.g., regulatory barriers).

1.1.3 Reuse Water Treatment Requirements

The regulatory entities that have jurisdiction over the treatment and use of recycled water in the San Francisco Bay Area include the San Francisco Bay Regional Water Quality Control Board (RWQCB) and the California Division of Drinking Water (DDW), formerly part of the California Department of Public Health. California's Title 22 Code of Regulations (Title 22) specifies treatment levels and acceptable uses for non-potable and potable reuse projects. A summary of recycled water requirements is provided in Table 1-2.

Non-Potable Reuse

For non-potable uses, Title 22 defines four types of recycled water with varying levels of treatment requirements and coliform and turbidity water quality criteria. Treatment requirements include a combination of filtration and disinfection. Allowable beneficial uses are based on recycled water type.

Potable Reuse

Potable reuse is characterized by the degree of separation of recycled water treatment from consumption. Indirect potable reuse (IPR) is defined by the use of an environmental buffer, either groundwater aquifer or surface water reservoir, separating treatment from consumption, whereas direct potable reuse (DPR) is defined by the absence of an environmental buffer. IPR projects other than groundwater spreading, require full advanced treatment (FAT), including reverse osmosis (RO) and an advanced oxidation process (AOP). It is likely DPR projects will require treatment in addition to FAT. Groundwater recharge and reservoir augmentation regulations were adopted in, 2014 and 2018, respectively. DPR regulations are anticipated by 2023.

Table 1-2. Recycled Water Regulatory Requirements and the Corresponding Beneficial Uses

Regulatory Requirement	Minimum Treatment Requirement	Bay Area Beneficial Use Examples
Non-Potable Reuse		
Undisinfected Secondary Recycled Water	Oxidation	Vineyard Irrigation Non-Food Bearing Tree Irrigation Fodder Crop Irrigation
Disinfected Secondary-23 Recycled Water	Oxidation, Disinfection	Cemetery Irrigation Freeway Landscape Irrigation Restricted Access Golf Course Irrigation Industrial Boiler Feed Mixing Concrete & Dust Control Flushing Sanitary Sewers
Disinfected Secondary-2.2 Recycled Water	Oxidation, Disinfection	Landscape Irrigation Agricultural Irrigation Wastewater Treatment Plant (WWTP) in-plant reuse
Disinfected Tertiary Recycled Water	Oxidation, Filtration, Disinfection	Golf Course Irrigation Landscape Irrigation Industrial (cooling towers, process water) Agricultural Irrigation Environmental Enhancement WWTP in-plant reuse
Potable Reuse		
Indirect Potable Reuse		
Groundwater Recharge - Spreading	Oxidation, Filtration, Disinfection	Groundwater recharge for spreading basins
Groundwater Recharge – Injection	Oxidation, Full Advanced Treatment	Groundwater recharge via injection wells
Reservoir Augmentation	Oxidation, Full Advanced Treatment	Drinking water reservoir supply augmentation
Direct Potable Reuse (Anticipated in Future)		
Raw Water Augmentation	Oxidation, Full Advanced Treatment+	Upstream of Surface Water Treatment Plant (SWTP)
Treated Water Augmentation	Oxidation, Full Advanced Treatment+	Potable water distribution system

1.2 Process Flow Diagram

Figure 2-1 shows the existing process flow diagram for the WCW TP. Both liquids processes and solids processes are shown. Treatment processes consist of screening, grit removal, flow equalization, primary sedimentation, Modified Ludzack-Ettinger (MLE) biological nutrient removal (BNR), secondary sedimentation, chlorination, and dechlorination. The MLE BNR facilities fully nitrify.

Approximately 80 percent of the treated water is recycled at East Bay Municipal Utility District water reclamation plants. The water is filtered separately at each water reclamation plant.

Waste activated sludge is thickened with dissolved air flotation units and blended with primary solids before anaerobic digestion. The digested biosolids are combined with those from RMSD WPCP and further treated in a sludge drying lagoon.

1.3 Existing Recycled Water Service

The WCW TP has an extensive recycled water program that reduces approximately 80 percent of their discharge flows and loads year-round. The primary customer is the nearby Chevron Richmond, CA refinery through the East Bay Municipal Utility District Richmond Advanced Recycled Expansion (EBMUD RARE). The EBMUD RARE includes an influent storage tank (1 million gal), a 4 mgd microfiltration, a 4 mgd reverse osmosis treatment facility, and other ancillary facilities to double the amount of reclaimed water that the Chevron Richmond, CA refinery can use daily.

1.4 Existing Discharge Flows and Loads to the Bay

A summary of the last three years of the discharge nutrient data is provided in Table 1-3. This data should serve as an indicator of potential flows and loads that could be diverted from Bay discharge to recycled water users.

Table 1-3. Current Flow and Nutrient Discharge Levels to the Bay (07/19 - 05/22) *,**

Criteria	Unit	Average Dry Season (May 1–Sept 30)	Average Wet Season (Oct 1–Apr 30)	Average Annual (10/2016-9/2019)
Flow	mgd	0.7	2.0	1.4
Volume	AF	305	1,269	1,574
Ammonia	kg N/d	0.5	1.2	0.9
Total Inorganic Nitrogen (TIN)	kg N/d	17.3	50.1	36.9
Total Phosphorus (TP)	kg P/d	2.8	22.5	11.2
Ammonia	mg N/L	0.2	0.2	0.17
TIN	mg N/L	7.1	6.8	6.92
TP	mg P/L	1.2	3.1	2.10

* Represents the last three years of sampling for nutrient sampling days (typically quarterly; 7/2019 through 5/2022) collected as part of the Group Annual Reporting requirements under the Watershed Permits (R2-2014-0014 and R2-2019-0017). The values presented are the combined raw industrial and domestic wastewater flows and loads.

**Represents the average volume over the duration listed in the table header. This value differs from the other individual plant reports as WCW TP does not have such information readily available during the periods used by other individual plant reports (10/16 – 09/19).

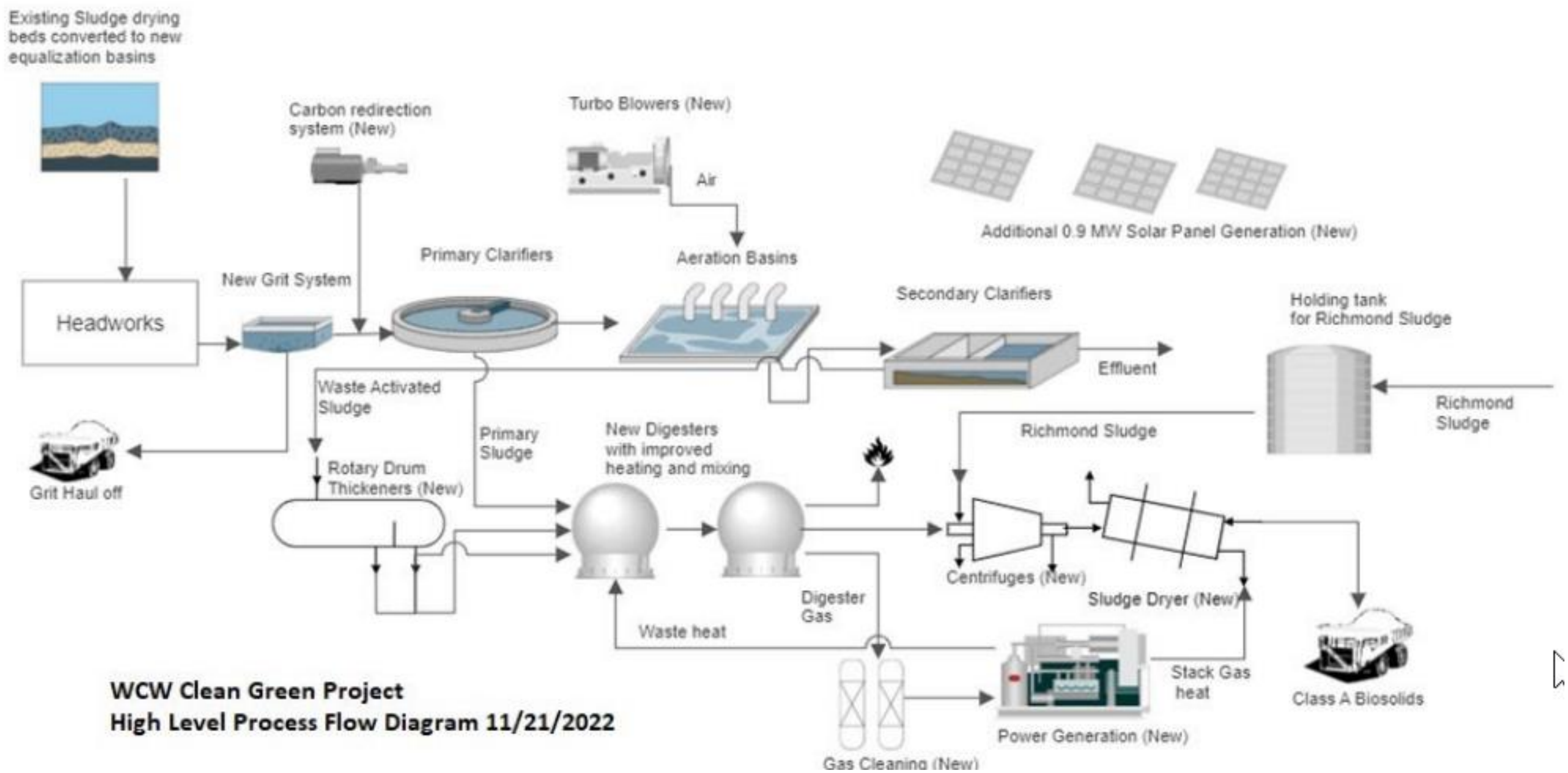

Figure 1-1. Process Flow Diagram for WCW TP
(Source: West County Wastewater District Treatment Plant via Email Exchange on 11/28/2022; Includes the WCW Clean Green Project)

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2 Methodology

The methodology section includes an overview of the information sources for existing wastewater discharges to the Bay, the recycled water request for information, and the approach for calculating the nutrient balance to capture loads diverted from the Bay to recycled water users.

2.1 Existing Discharges to the Bay

The Bay Area dischargers have been collecting nutrient discharge data to the Bay since July 2012. The initial data request was under a Section 13267 Letter Data Request and provides data from July 2012 through June 2014. This initial Section 13267 Letter Data Request was replaced with a permit requirement under the first and second Watershed Permits (R2-2014-0014 and R2-2019-0017) that began in July 2014 and it is required through June 2024. While the sampling requirements have varied for each sampling request, the overall goal has been to develop a nutrient load database over time.

2.2 Request for Information

A request for information (RFI) was sent to agencies in the first half of 2020 that considered existing and potential future recycled water projects, demands, type of recycled water users, load reduction, seasonality, and a questionnaire about barriers and drivers of additional recycled water production.

2.2.1 Recycled Water Production

Agencies were asked to identify their existing and projected recycled water distribution uses and volumes from 2019 to 2045. RW user categories are defined in Table 2-1.

Table 2-1. Recycled Water User Categories

Use Category*	Definition
Golf Course	Includes irrigation of golf courses, whether public or private. Water used to maintain aesthetic impoundments within golf courses is also included with golf course irrigation.
Landscape	Includes parks, sports fields, green belts, landscaped areas. Irrigation of parks, schools, cemeteries, churches, residential, streetscapes, slope protection, or public facilities. Golf course irrigation is not included. Water to maintain aesthetic impoundments within landscaped areas is included with landscape irrigation. Fill stations primarily used for public use should be classified as landscape irrigation.
Commercial	Includes dual-plumbed projects, fire protection, other uses at commercial facilities not included in other categories. Includes uses by commercial water users, except landscape irrigation. A commercial water user is a water user that provides or distributes a product or service. Examples of commercial water users: commercial building use (toilets, HVAC, etc.), car washes, laundries, and retail nurseries. Landscape irrigation of commercial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter. Fill stations, if they are primarily used for commercial use, should be classified as commercial use.
Industrial	Includes cooling towers, process water. Includes uses by industrial water users, except landscape irrigation and geothermal energy production. An industrial user is a water user that is primarily a manufacturer or processor of materials. Examples of industrial water uses are cooling towers, oil refining, process water, and mining. Landscape irrigation of industrial building areas is to be classified as landscape irrigation if it is separately metered or if landscape is the dominant use of mixed uses served by a single meter

Use Category*	Definition
Agriculture	Includes irrigation, frost protection, and agricultural reservoir augmentation. Irrigation of food, fiber, and fodder crops, and pastureland. This also includes Christmas tree production, pasture for farm animals, and wholesale plant nurseries.
Environmental Enhancement	Includes wildlife habitat, wetland/marsh applications, and natural system restoration. The area must be designated as a wetland or wildlife area and so does NOT include water that a wastewater facility must discharge to maintain habitat in the creek to which it is discharging.
Internal Use	Includes facility process water, site irrigation, internal plumbing, fire protection or other use at wastewater or RW facility
Other Non-Potable Reuse	Includes a saltwater intrusion barrier, recreational impoundments, geothermal energy production, dust control, fill stations if not included in other categories.

* The RFI also included a category on return flows to better understand the fate of recycled water nutrient loads. Return flows include reverse osmosis reject or other return flows to the wastewater treatment plant. Such information will be used for quantifying nutrient loads diverted from the Bay.

Agencies listed the annual RW volume to each use, and the total RW produced by the agency. A confidence value on a scale of 1 to 3 was placed on the various future recycled water projects identified is shown in Table 2-2.

Table 2-2. Confidence Level Definitions for Future Recycled Water Projects

Confidence	Definition
1	Estimated delivery volume based only on existing projects or new projects in an adopted budget.
2	Estimated delivery volume based on projects that are in an adopted Master Plan or CIP.
3	Estimated delivery volume based on projects that are conceptual or not in an adopted document.

2.2.2 Seasonality of Recycled Water Production

In addition to the annual data described above, agencies shared the seasonal distribution of their RW production. Average monthly recycled water volumes for each use category and the total monthly RW production were collected.

Future seasonality projections were based on a combination of working with WCW TP and Engineer's best judgment that considered known project constraints, existing WCW TP reuse seasonality demands, and type of reuse project (e.g., irrigation based more apt to occur in the dry season).

2.2.3 Cost Estimates

Capital and operations and maintenance (O&M) costs are included, as provided by WCW TP. Development of new cost estimates was not included as part of this study.

Construction cost estimates provided by each agency were normalized by extracting the major facility costs and applying the same allowances used in the first Watershed permit for engineering, construction management, legal and other administrative costs.[1] Construction costs are escalated to the August 2020 ENR CCI for the San Francisco Bay Area.

[1] HDR (2018) Nutrient Reduction Study: Potential Nutrient Reduction by Treatment Optimization, Sidestream. Bay Area Clean Water Agencies, Oakland, CA

O&M cost estimates provided by each agency (if available) were included for determining the net present value (NPV).

The NPV is based on a 2 percent discount rate over the agency provided project duration. NPV costs were only prepared if estimated O&M costs were available. In the absence of O&M costs, only capital cost was used (and is noted as such). For instances where a project duration has not been defined, a 30-year project duration was used.

Unit cost metrics were developed to facilitate comparisons between various nutrient management strategies as follows:

- Unit flow metrics (for both dry season and year-round analysis):
  - Option 1 (NPV per mgd): based on the NPV divided by the average flow diverted from a Bay discharge over the project duration.
  - Option 2 (NPV per AF): based on the NPV divided by the total volume of flow diverted from a Bay over the project duration.
- Unit load metric (for both dry season and year-round analysis): based on the NPV divided by the average nutrient load (Ammonia, TIN or TP) diverted from a Bay discharge over the project duration (project specific). The nutrient reduction is calculated based on the average removal over the life cycle period.

2.2.4 Drivers and Barriers

A questionnaire was included in the RFI to allow the agency to identify ancillary adverse effects and benefits of RW projects, identify potential challenges to implementing each opportunity, and assess the feasibility, efficacy, reliability, and cost-effectiveness of each opportunity. The following seven questions were included:

- What do you see as barriers for implementation of recycled water projects?
- What do you see as drivers for implementing your recycled water projects?
- For your planned recycled water projects, are your proposed customers primarily existing businesses (e.g., existing parks, manufacturing) or are your proposed customers primarily new/redevelopment businesses (e.g., a new golf course, a new power plant)?
- Do you believe the issuance of regulations for Direct Potable Reuse (expected by 2024) will impact your agency's decisions on recycled water project type and implementation going forward?
- Please include an itemized list of existing industrial RW users.
- Are there any CIP projects planned that would have a “synergistic benefit” for future recycled water and pollutant discharge load reduction (e.g., MBR to improve discharge water quality while simultaneously positioning your agency for future recycled water opportunities)?
- Please include any comments on seasonal RW demand/production, as well as storage capabilities.

2.3 Net Nutrient Loading

This section describes the nutrient load reduction calculation conducted for each agency, as well as the methodology for the net nutrient load to the bay.

2.3.1 Nutrient Load Reduction

Load reduction refers to the mass of a given nutrient present in a RW stream which no longer enters the Bay. The load reduction from each agency is determined using the RW distribution volumes reported in the RFI, and the average effluent concentration of the nutrient as reported in the Group Annual Report. The load reduction calculation is shown below.

$$Load\ Reduced\ \left(\frac{kg}{d}\right) = Conc.\ \left(\frac{mg}{L}\right) x\ RW\ Volume\ \left(\frac{Acre\ Feet}{Yr}\right) x \left(\frac{1.233x10^6\ L}{1\ Acre\ Feet}\right) x \left(\frac{1\ kg}{1x10^6\ mg}\right) x \left(\frac{1\ Yr}{365\ Days}\right)$$

2.3.2 Nutrient Balance

The nutrient balance refers to the overall diversion of nutrient loads from the Bay based on the evaluated recycled water projects. There are instances where the recycled water diverted from the Bay does not result in a reduction in nutrients discharged to the Bay, as illustrated in the following two examples:

- Example 1: an industrial user accepts agency recycled water that is used for cooling water that is eventually discharged to the Bay. For such an example, the volume of water is typically reduced due to evaporation while the nutrient loads are maintained and thus do not result in a net reduction of nutrients discharged to the Bay.
- Example 2: a potable reuse project that relies on reverse osmosis treatment has a brine reject (a concentrate stream) that is typically returned to a treatment plant for discharge. The concentrate includes the bulk of nutrients as they are removed from the recycled water through the reverse osmosis process.

For each project evaluated, the nutrient balance was considered as it is treatment specific.

3 Results and Discussion

Table 3-1 presents a summary of the on-going and proposed recycled water projects.

Table 3-1. Recycled Water Projects Identified by WCW TP

Recycled Water Project	Description
Existing: with nearby Chevron Refinery in Richmond, CA	East Bay Municipal Utility District Richmond Advanced Recycled Expansion (EBMUD RARE) utilizes treated wastewater from WCW TP for high pressure boiler feed water at Chevron refinery. The blowdown from the refinery and RO concentrate from EBMUD RARE is nitrified at Chevron's WWTP and is then released to the Central Bay. The EBMUD RARE facility might expand in the future. Such expansion is not reflected in this report as it is unclear if this will move forward.
Future Projects	No future projects are planned.

The following sections summarize the flow and nutrient load reductions for each listed project in Table 3-1.

3.1 Recycled Water Distribution & Load Reduction

A summary of the current and projected recycled water distribution volumes and the corresponding nutrient reductions potential are provided in Table 3-2. Table 3-2 also shows the confidence of the projection on a scale of 1 to 3. Note: the average ammonia loads are reliably less than 5 kg N/d. This is attributed to the WCW TP already reliably removing ammonia via biological nitrification. A portion of the ammonia that is nitrified to nitrate is removed via biological denitrification. Furthermore, the Total P levels are not as low as ammonia, but the WCW TP has Total P levels reliably below 3 mg P/L.

Figure 3-1 presents a distribution of the recycled water volumes by use categories from 2020 through 2045. The primary user is industrial (EBMUD RARE). During the dry season, EBMUD RARE typically uses 90 percent or greater of WCW TP effluent.

Table 3-2. Current and Projected Recycled Water Production, Confidence, and Nutrient Loads Diverted from the Bay

Year	Project #	Confidence	Average Distributed - Return Flows (AF)	Average Ammonia Load Removed (kg N/d)	Average TIN Load Removed (kg N/d)	Average Total P Load Removed (kg P/d)
2020	**Total**	**1**	**3,920**	**3**	**106**	**17**
	Existing Facilities	1	3,920	3	106	17
	Future Projects	--	--	--	--	--
2025	**Total**	**1**	**7,950**	**5**	**214**	**35**
	Existing Facilities	1	7,950	5	214	35
	Future Projects	--	--	--	--	--
2030	**Total**	**1**	**7,950**	**5**	**214**	**35**
	Existing Facilities	1	7,950	5	214	35
	Future Projects	--	--	--	--	--
2035	**Total**	**1**	**7,950**	**5**	**214**	**35**
	Existing Facilities	1	7,950	5	214	35
	Future Projects	--	--	--	--	--
2040	**Total**	**1**	**7,950**	**5**	**214**	**35**
	Existing Facilities	1	7,950	5	214	35
	Future Projects	--	--	--	--	--
2045	**Total**	**1**	**7,950**	**5**	**214**	**35**
	Existing Facilities	1	7,950	5	214	35
	Future Projects	--	--	--	--	--

* Confidence Levels:

(1) Includes existing or new projects in an adopted budget.

(2) Includes projects that are in an adopted Master Plan or CIP.

(3) Includes projects that are in the conceptual stage and not included in an adopted document.

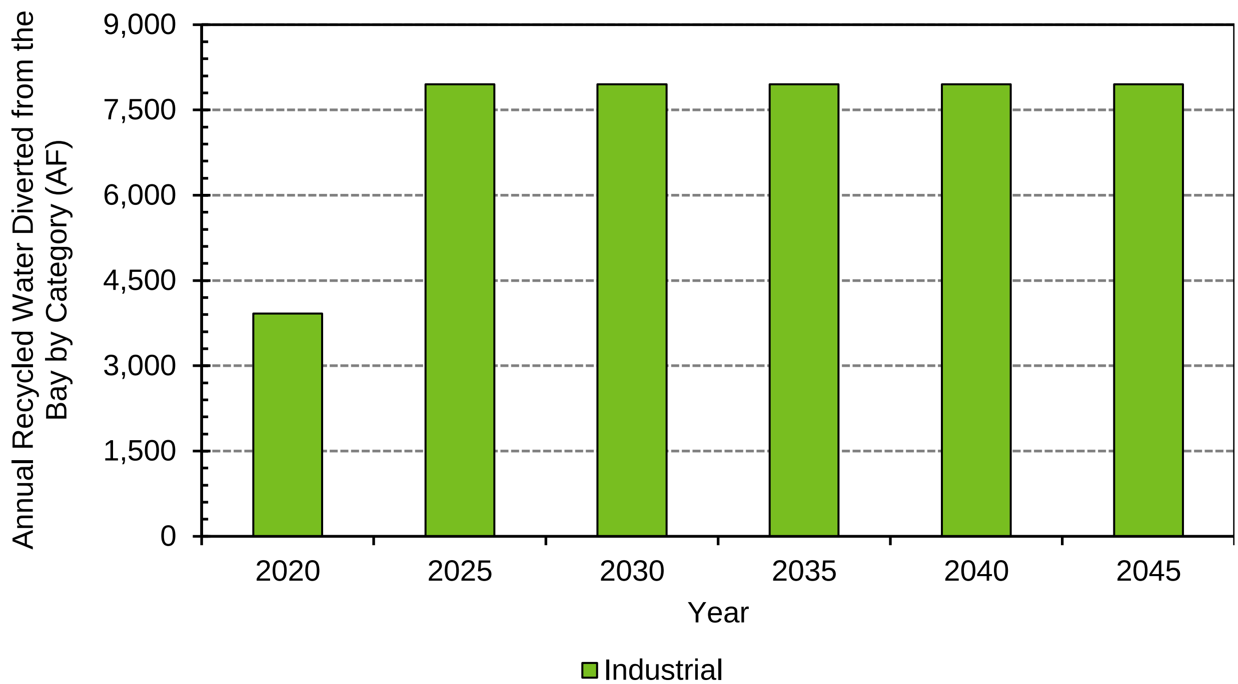

Figure 3-1. Existing and Proposed Recycled Water Diverted from the Bay by Category (2020 – 2045)

3.2 Ancillary Benefits and Adverse Impacts for Recycled Water Projects

Table 3-3 lists the ancillary benefits and impacts associated with the listed recycled water projects. The table also includes a comparison of ancillary benefits associated with the recent plant upgrades to MLE BNR.

Table 3-3. Adverse and Ancillary Impacts per Recycled Water Project

Recycled Water Project	Ancillary Benefits	Adverse Impacts

Existing: with nearby Chevron Refinery in Richmond, CA	• EBMUD RARE further treats the water via microfiltration and RO member facilities.
	• The Chevron WWTP that uses the EBMUD RARE treated water is responsible for treating the RO reject and any blowdown from the Chevron Refinery (prior to Bay Discharge; separated NPDES permit from WCW TP)
	• The recent plant upgrades to MLE BNR have resulted in the following ancillary benefits:
	  o Alkalinity and aeration recovery associated with biological denitrification
	  o Improved removal of contaminants of emerging concern due to a longer solids residence time.
		• Concerns over the long-term refinery demands (if production declines due to other competing energy renewables)

Future Projects	• Non/Applicable	• Non/Applicable

3.3 Summary of Recycled Water Flows, Costs, Load Reductions, and Unit Costs per Project and Overall

A summary of the flows, costs, load reductions and the corresponding unit cost per project and overall is provided in Table 3-4. Note: the WCW TP reliably nitrifies as evidenced by average ammonia loads less than 5 kg N/d. Such reliable nitrification results in a relatively high unit cost ($/lb ammonia removed) for recycled water as the load is in the denominator. A portion of the ammonia that is nitrified to nitrate is removed via biological denitrification. Furthermore, the Total P levels are not as low as ammonia, but the WCW TP has Total P levels reliably below 3 mg P/L. Similar to ammonia, such removal translates to a relatively high recycled water unit cost ($/lb total P) for recycled water as the load is in the denominator.

Figure 3-2 illustrates a summary of recycled water flows and the corresponding nutrient loads diverted from the Bay. The recycled water volumes are anticipated to flat line around year 2025 at just under 8,000 AFY. The nutrient loads diverted from the Bay associated with recycled water will also flatten with the volume. The ammonia and total P load diversions are modest due to removal already occurring at the WCW TP.

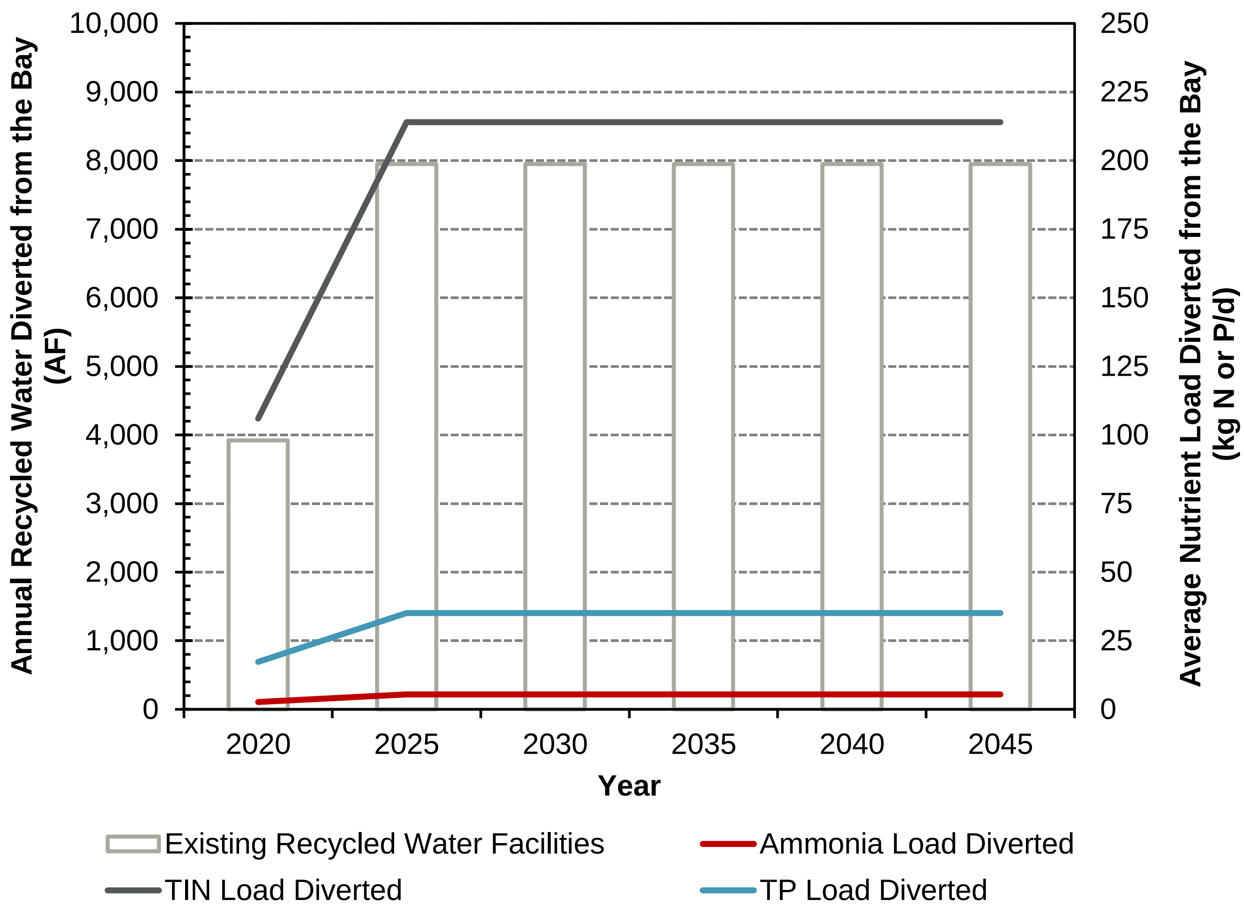

Figure 3-2. Summary of Existing and Proposed Recycled Water Flows and the Corresponding Nutrient Load Diversions from Bay Discharge

Table 3-4. Summary of Existing and Proposed Recycled Water Costs and the Corresponding Nutrient Load Reductions/Unit Costs

Parameter	Unit	Existing RW Projects (Projected into the Future) *,**		Future Projects (None Planned) *,**		Total (Projected into the Future) *,**	
		Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Average Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)	Dry Season (May 1 - Sept 30)	Average Annual (Oct 1 – Sept 30)
Flow/Volume Diverted from the Bay[1]							
Flow	mgd	5.60	5.90	--	--	5.60	5.90
Volume	AF	2,630	6,610	--	--	2,630	6,610
Load Diverted from the Bay[2,3]							
Confidence	unitless	1	1	--	--	1	1
Duration	Years	25	25	--	--	25	25
Flow Diverted	%	90%	81%			90%	81%
Ammonia Load Diverted	kg N/d	3.9	4.1	--	--	3.9	4.1
TIN Load Diverted	kg N/d	149	157	--	--	149	157
TP Load Diverted	kg P/d	24	26	--	--	24	26
Cost[3,4,5]							
Capital Cost4	$ Mil	--	--	--	--	--	--
NPV O&M	$ Mil	2.3	5.9	--	--	2.3	5.9
NPV Total (Capital+NPV O&M)	$ Mil	2.3	5.9	--	--	2.3	5.9
Unit Flow Cost[6]							
Unit Cost	$/gpd	0.4	1.0	--	--	0.4	1.0
Unit Cost	$/AF	36	36	--	--	36	36
Unit Load Cost[7,8,9]							
Ammonia Unit Cost	$/lb Ammonia Diverted	155	65	--	--	155	65
TIN Unit Cost	$/lb TIN Diverted	4.0	1.7	--	--	4.0	1.7
TP Unit Cost	$/lb TP Diverted	25	10	--	--	25	10

* Existing RW Projects refers to existing treatment facilities producing RW; Total includes a sum of the Existing RW Projects (projected into the future) plus other proposed future projects (none planned for this treatment plant).

** Flows and loads diverted from the Bay Discharge are projected forward to the midpoint of the project duration (typically 2020-2045).

1. Flow/volume values consider the duration (i.e., 153 days for average dry season and 365 days for average annual).
2. Confidence = level of confidence in the values provided. 1 = includes only projects that are currently budgeted; 2 = includes projects that are in master plan; 3 = includes projects that are conceptual.
3. Based on the average recycled water flow diverted from the Bay for the listed averaging period (dry season or average annual) over the project duration (i.e., years).
4. Estimated cost for recycled water production provided by West County Wastewater District Treatment Plant (based on year 2021 dollars).
5. Net Present Value (NPV) is calculated based on a 2 percent discount rate for the project duration (project specific).
6. Unit flow cost is based on the NPV total divided by the average flow diverted from the Bay.
7. Based on the average nutrient (Ammonia, TIN, or TP) load diverted from the Bay over the project duration.
8. Unit load costs are based on the NPV total divided by the average nutrient (Ammonia, TIN or TP) diverted from a Bay discharge for the project duration (project specific).

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3.4 Drivers and Barriers to Implementation

An overview of the drivers and barriers for implementing recycled water projects at West County TP:

- Drivers for implementing recycled water projects:
  - Demand: the EBMUD RARE project uses approximately 80 percent of the TP's effluent flows and loads.
  - Institutional: West County TP would like to further use treated effluent for other recycled water customers.
- Barrier for implementing recycled water projects: capacity at EBMUD RARE and the North Richmond Water Reclamation Plant (NRWRP) are the limiting factors. Chevron and EBMUD are considering expanding the RARE facility. There have been several meetings discussing the capacity for West County TP to provide more recycled water if the project moves forward.

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C

Agency Acceptance Letters

Contents of Appendix C:

1. American Canyon Water Reclamation Facility
2. Benicia WWTP
3. Burlingame WWTP
4. Central Contra Costa Sanitary District WWTP
5. Central Marin Sanitation Agency WWTP
6. Delta Diablo WWTP
7. Dublin San Ramon Services District WWTP
8. East Bay Municipal Utility District, Special District No. 1 WWTP
9. Fairfield Suisun WWTP
10. Hayward Water Pollution Control Facility
11. Las Gallinas Valley Sanitary District Sewage Treatment Plant
12. City of Livermore Water Reclamation Plant
13. Millbrae Water Pollution Control Plant
14. Mt. View Sanitary District WWTP
15. (Napa) Soscol Water Recycling Facility
16. Novato Sanitary District WWTP
17. Oro Loma / Castro Valley Sanitary District's Water Pollution Control Plant (includes East Bay Dischargers Authority)
18. Palo Alto Regional Water Quality Control Plant
19. (Petaluma) Ellis Creek Water Recycling Facility
20. Pinole-Hercules Water Pollution Control Plant
21. Richmond Municipal Sewer District Water Pollution Control Plant
22. Rodeo Sanitary District Water Pollution Control Facility
23. (San Francisco International Airport) Mel Leong Treatment Plant, Sanitary Plant
24. (San Francisco Public Utilities Commission) Southeast Water Pollution Control Plant
25. San Jose-Santa Clara Regional Wastewater Facility
26. San Leandro Water Pollution Control Plant
27. City of San Mateo WWTP
28. Sausalito-Marin City Sanitary District WWTP
29. Sewerage Agency of Southern Marin WWTP
30. Silicon Valley Clean Water WWTP
31. Sonoma Valley County Sanitation District
32. South San Francisco and San Bruno Water Quality Control Plant
33. Sunnyvale Water Pollution Control Plant
34. Treasure Island WWTP
35. Union Sanitary District (Raymond A. Boege Alvarado WWTP)
36. Vallejo WWTP
37. West County Wastewater District WWTP

CITY OF AMERICAN CANYON

May 30, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of the City of American Canyon, I have reviewed the individual plant report prepared for the Water Reclamation Facility that is included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The City of American Canyon's report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for the City of American Canyon, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Felix Hernandez, III
Maintenance and Utilities Director

THE CITY OF
BENICIA
CALIFORNIA

CITY HALL • 250 EAST L STREET • BENICIA, CA 94510 • (707) 746-4200 • FAX (707) 747-8120

June 29, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of the City of Benicia, I have reviewed the individual plant report prepared for the Wastewater Treatment Plant that is included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The City of Benicia's report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for the City of Benicia, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Jeff Gregory

Jeff Gregory

City of Benicia Wastewater Treatment Plant Superintendent

The City of Burlingame

PUBLIC WORKS DEPARTMENT
TEL: (650) 558-7230
FAX: (650) 685-9310

CITY HALL - 501 PRIMROSE ROAD
BURLINGAME, CALIFORNIA 94010-3997
www.burlingame.org

CORPORATION YARD
TEL: (650) 558-7670
FAX: (650) 696-1598

June 29, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of the City of Burlingame, I have reviewed the individual plant report prepared for the Burlingame Wastewater Treatment Plant that is included as an appendix to the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The City of Burlingame's report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review, and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for the City of Burlingame, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Art Morimoto

Art Morimoto
Assistant Director of Public Works

Central Contra Costa Sanitary District
Protecting public health and the environment
5019 Imhoff Place, Martinez, CA 94553-4392

PHONE: (925) 228-9500
FAX: (925) 335-7746
www.centralsan.org

ROGER S. BAILEY
General Manager

KENTON L. ALM
Counsel for the District
(510) 375-4571

KATIE YOUNG
Secretary of the District

June 23, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board
15 Clay Street, Suite 1400
Oakland, CA 94612

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of the Central Contra Costa Sanitary District (Central San), I have reviewed the individual plant report prepared for Central San that is included as an appendix to [Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR and Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The Central San report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review, and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for Central San, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Roger Bailey

Roger S. Bailey, General Manager
Central Contra Costa Sanitary District

RSB/lm

Enclosure

cc: G. Norby
L. Schectel
D. Frost

CENTRAL MARIN
SANITATION AGENCY

Jason R. Dow P.E.
General Manager

1301 Andersen Drive, San Rafael, CA 94901-5339 Phone (415) 459-1455 Fax (415) 459-3971 www.cmsa.us

June 16, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen,

I reviewed the individual plant report prepared for Central Marin Sanitation Agency (CMSA) that is included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The CMSA report was prepared after the Consultants interacted with CMSA staff, prepared a draft report for our staff's review, and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Jason Dow, P.E.
General Manager

Delta Diablo
A CALIFORNIA SPECIAL DISTRICT

June 21, 2023

TRANSMITTED VIA EMAIL

Ms. Eileen White, Executive Officer
San Francisco Bay Regional Water Quality Control Board

SUBJECT: ACCEPTANCE OF PLANT-SPECIFIC FINDINGS FOR REGIONAL EVALUATION OF POTENTIAL NUTRIENT DISCHARGE REDUCTION BY WATER RECYCLING

Dear Ms. White:

On behalf of Delta Diablo (District), the District has reviewed the individual plant report prepared for the Delta Diablo Wastewater Treatment Plant (WWTP), which is included as an appendix to the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). Following engagement with key District staff, the Consultants prepared a draft report for review and incorporated responses to staff comments prior to finalizing the report. In addition, the BACWA Recycled Water Committee provided direction to the Consultants regarding preparation of the individual plant reports, as well as the overall summary for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The District's individual plant report documents our current understanding of recycled water expansion opportunities at the Delta Diablo WWTP through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for Delta Diablo, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

Vince De Lange
General Manager

AWR/VPD:cnf

Dublin San Ramon Services District
Water, wastewater, recycled water

Regional Wastewater Treatment Facility
7399 Johnson Drive
Pleasanton, CA 94588-3862

main (925) 846-4565
fax (925) 462-0658
www.dsrsd.com

June 6, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of Dublin San Ramon Services District, I have reviewed the individual plant report prepared for the Dublin San Ramon Services District that is included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The Dublin San Ramon Services District report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review, and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for Dublin San Ramon Services District, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Virgil Sevilla
DSRSD Wastewater Treatment Plant Operations Superintendent

EAST BAY
MUNICIPAL UTILITY DISTRICT

AMIT MUTSUDDY
DIRECTOR OF WASTEWATER
(510) 287-1149
amit.mutsuddy@ebmud.com

June 28, 2023

Eileen M. White
Executive Officer
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Ms. White:

On behalf of the East Bay Municipal Utility District (EBMUD), I have reviewed the individual plant report prepared for the Main Wastewater Treatment Plant that is included as an appendix to the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The EBMUD report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review, and responded to staff comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for EBMUD, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

Amit Mutsuddy, P.E.

375 ELEVENTH STREET . OAKLAND . CA 94607-4240
P.O. BOX 24055 . OAKLAND . CA 94623-1055

FAIRFIELD-SUISUN SEWER DISTRICT

1010 Chadbourne Road • Fairfield, California 94534 • (707) 429-8930 • www.fssd.com

June 8, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

RE: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White:

On behalf of the Fairfield-Suisun Sewer District, I have reviewed the individual plant report prepared for the Fairfield Suisun Wastewater Treatment Plant that is included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The Fairfield-Suisun Sewer District report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review, and responded to staff comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for the Fairfield-Suisun Sewer District, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

Jordan Damerel (Jun 8, 2023 12:46 PDT)

Jordan Damerel
Assistant General Manager / District Engineer

HAYWARD

June 16, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: City of Hayward Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Ms. White:

On behalf of The City of Hayward (City), I have reviewed the individual plant report prepared for the City that is included as an appendix to the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The City's Water Pollution Control Facility report was prepared after the Consultants interacted with City staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report represents my understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultants in preparing the report for the City, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report.

Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

Alex Ameri
Director of Public Works

DEPARTMENT OF PUBLIC WORKS & UTILITIES

777 B STREET, HAYWARD, CA 94541-5007
TEL: 510/583-4700 • FAX: 510/583-3620 • TDD: 510/247-3340

June 26, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of Las Gallinas Valley Sanitary District, I have reviewed the individual plant report prepared for the LGVSD that is included as an appendix to [Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The LGVSD report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review, and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for LGVSD, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Mel Liebmann, *Plant Manager*

LIVERMORE
CALIFORNIA

June 20, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of the City of Livermore, I have reviewed the individual plant report prepared for the Livermore Water Reclamation Plant that is included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The City of Livermore report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for the City of Livermore, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Anthony Smith
Water Resources Division Manager
Water Resources Division/Public Works Department
City of Livermore

ANN SCHNEIDER
Mayor

MAURICE GOODMAN
Vice Mayor

ANDERS FUNG
Councilmember

ANGELINA CAHALAN
Councilmember

GINA PAPAN
Councilmember

City of Millbrae
621 Magnolia Avenue, Millbrae, CA 94030

May 11, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White

On behalf of City of Millbrae, I have reviewed the individual plant report prepared for the Millbrae Water Pollution Control Plant that is included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The City of Millbrae report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for City of Millbrae, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Craig Centis, Deputy Director of Public Works

MT. VIEW SANITARY DISTRICT
3800 ARTHUR ROAD
MARTINEZ, CA 94553
TEL 925.228.5635
FAX 925.228.7585
WWW.MVSD.ORG

June 27, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of Mt. View Sanitary District, I have reviewed the individual plant report prepared for Mt. View Sanitary District that is included as an appendix to [Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The Mt. View Sanitary District report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for Mt. View Sanitary District, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Lilia M. Corona, General Manager

NapaSan
1515 Soscol Ferry Road
Napa, CA 94558

Office (707) 258-6000
Fax (707) 258-6048

www.napasan.com

May 25, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of Napa Sanitation District (NapaSan), I have reviewed the individual plant report prepared for the NapaSan Wastewater Treatment Plant that is included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). NapaSan's report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for NapaSan, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report.

I certify under penalty of law that this document and all attachments are prepared either under my direction or supervision, or in accordance with a system designed to assure the qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Sincerely,

James Keller Jr
Operations Services Director, Napa Sanitation District
(707) 258-6020 ext. 601

NOVATO SANITARY DISTRICT

500 DAVIDSON STREET * NOVATO * CALIFORNIA 94945 * PHONE (415) 892-1694 * FAX (415) 898-2279
www.novatosan.com

May 30, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board.

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of Novato Sanitary District, I have reviewed the individual plant report prepared for the Novato Wastewater Treatment Plant that is included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The Novato Sanitary District report was prepared after the Consultants interacted with plant staff and prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for Nov at Sanitary District, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Sandeep Karkal
General Manager-Chief Engineer

ORO LOMA SANITARY DISTRICT

May 15, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of Oro Loma Sanitary District, I have reviewed the individual plant report prepared for the Oro Loma/Castro Valley Water Pollution Control Plant that is included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The Oro Loma Sanitary District report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for Oro Loma Sanitary District, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Jimmy Dang
General Manager

CITY OF PALO ALTO

PUBLIC WORKS

2501 Embarcadero Way
Palo Alto, CA 94303
650.329.2598

May 22, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Ms. White,

On behalf of the City of Palo Alto's Regional Water Quality Control Plant (RWQCP), I have reviewed the individual plant report prepared for the RWQCP that is included as an appendix to the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA) in compliance with the 2019 Nutrient Watershed Permit (Order No. R2-2019-0017, NPDES No. CA0038873) on behalf of the Dischargers. The RWQCP report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review, and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for the RWQCP, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

DocuSigned by:
James Allen
D1CB990D46174E9...

James Allen
Regional Water Quality Control Plant Manager
City of Palo Alto

CITY OF PETALUMA

POST OFFICE BOX 61
PETALUMA, CA 94953-0061

June 13, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of the City of Petaluma, I have reviewed the individual plant report prepared for the Ellis Creek Water Recycling Facility that is included as an appendix to the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The City of Petaluma report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for the City of Petaluma, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Matthew Pierce

Matthew Pierce
Operations Supervisor

c: Chelsea Thompson, Deputy Director of Environmental Services

June 22, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of Pinole-Hercules Water Pollution Control Plant, I have reviewed the individual plant report prepared for the Pinole-Hercules WPCP that is included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The Pinole-Hercules Water Pollution Control Plant report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for Pinole-Hercules Water Pollution Control Plant, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Joshua Binder, WWTP Manager

PUBLIC WORKS DEPARTMENT

City of Richmond

Water Resource Recovery Division

June 26, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of City of Richmond, I have reviewed the individual plant report prepared for the Richmond Water Pollution Control Plant that is included as an appendix to the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The City of Richmond report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review, and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for the City of Richmond, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report.

Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted.

Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Robert Armijo, P.E.
Deputy Public Works Director
City of Richmond

Copies: Denise Conners, Larry Walker & Associates
Mary Phelps, Project Manager, City of Richmond
Anderson Dill, Veolia Water North America
Michael McKenzie, Veolia Water North America
File

RODEO SANITARY DISTRICT

800 SAN PABLO AVE. · RODEO, CA 94572-1232
(510) 799-2970 · FAX (510) 799-5403

June 5, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Ms. White,

On behalf of the Rodeo Sanitary District, I have reviewed the individual plant report prepared for the Rodeo Sanitary District Water Pollution Control Plant that is included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The Rodeo Sanitary District report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review, and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents the Rodeo Sanitary District's best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for the Rodeo Sanitary District, the Rodeo Sanitary District agrees that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Steven S. Beall, P.E.
District Manager
Rodeo Sanitary District

SFO

San Francisco International Airport

June 29, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White:

On behalf of San Francisco International Airport, I have reviewed the individual plant report prepared for the Mel Leong Treatment Plan that is included as an appendix to [Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The San Francisco International Airport report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for San Francisco International Airport, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of a fine and imprisonment for knowing violations.

Thank you,

for

Leroy Sisneros
Director of Facilities

Enclosures

Post Office Box 8097 San Francisco, California 94128 Tel 650.821.5000 Fax 650.821.5005 www.flysfo.com

San Francisco Water Power Sewer
Services of the San Francisco Public Utilities Commission

525 Golden Gate Avenue, 13th Floor
San Francisco, CA 94102
T 415.554.3155
F 415.554.3161
TTY 415.554.3488

May 22, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of San Francisco Public Utilities Commission's Wastewater Enterprise (SFPUC WWE), I have reviewed the individual plant report prepared for the Southeast Water Pollution Control Plant (SEP) and the Treasure Island Wastewater Treatment Plant (TIP) that are included as appendices to the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant reports were prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The SEP and TIP reports were prepared after the Consultants prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. These reports represent my best understanding of our facilities' concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for SFPUC WWE, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my

knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Joel Prather
Acting Assistant General Manager, Wastewater Enterprise

June 20, 2023

Ms. Eileen White, Executive Officer
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612

SUBJECT: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Ms. White,

On behalf of the San Jose-Santa Clara Regional Wastewater Facility (SJ-SC RWF), I have reviewed the individual plant report prepared for the SJ-SC RWF that is included as an appendix to the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The SJ-SC RWF report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for SJ-SC RWF, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

700 Los Esteros Rd. San José, CA 95134 *tel* (408) 635-6600 *fax* (408) 945-5442 www.sanjoseca.gov/esd

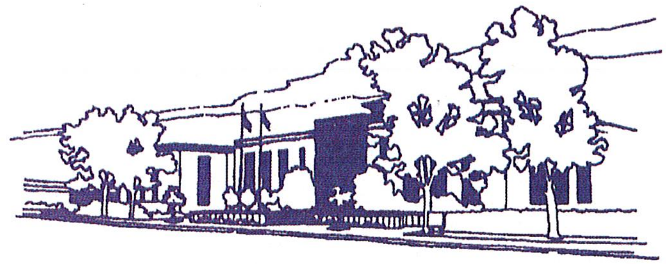
Ms. Eileen White
Regional Water Quality Control Board
RE: Regional Evaluation of Potential Nutrient Reductions by Water Recycling
June 20, 2023

For any questions regarding the SJ-SC RWF plant report, please direct them to Eric Dunlavey, Wastewater Compliance Manager, at 408-635-4017.

Thank you,

Jennifer Voccola-Brown
Sustainability and Compliance Manager

City of San Leandro
Civic Center, 835 E. 14th Street
San Leandro, California 94577
www.sanleandro.org



June 23, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of the City of San Leandro, I have reviewed the individual plant report prepared for the City of San Leandro that is included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The City of San Leandro report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for the City of San Leandro, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Hayes Morehouse, Water Pollution Control Manager
hmorehouse@sanleandro.org

CITY OF SAN MATEO
PUBLIC WORKS DEPARTMENT
Azalea Mitch, P.E., Director of Public Works

330 W. 20th Avenue
San Mateo, CA 94403
www.cityofsanmateo.org
(650) 522-7300

June 15, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, #1400
Oakland, CA 94612

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of the City of San Mateo I have reviewed the individual plant report prepared for the City of San Mateo Wastewater Treatment Plant that is included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The City of San Mateo report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for *the* City of San Mateo*,* I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report.

Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my

knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you.

Sincerely,

Azalea Mitch

Azalea Mitch, P.E.
Director of Public Works

SAUSALITO-MARIN CITY SANITARY DISTRICT

1 EAST ROAD • SAUSALITO, CALIFORNIA 94965
OFFICE 415.332.0244 • PLANT 415.332.0240 • FAX 415.332.0453

June 15, 2023

Ms. Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Ms. White,

On behalf of Sausalito-Marin City Sanitary District, I have reviewed the individual plant report prepared for the Sausalito-Marin City Sanitary District treatment plant that is included as an appendix to [Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The Sausalito-Marin City Sanitary District report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for Sausalito-Marin City Sanitary District, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,
Jeffrey Kingston
General Manager

SASM
SEWERAGE AGENCY OF
SOUTHERN MARIN

A Joint Powers Agency
- Almonte S.D.
- Alto S.D.
- City of Mill Valley
- Homestead Valley S.D.
- Richardson Bay S.D.
- Tamalpais C.S.D.

June 27, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of Sewerage Agency of Southern Marin (SASM), I have reviewed the individual plant report prepared for the SASM WWTP that is included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). SASM's report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review, and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for SASM, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

M. Grushayev

Mark Grushayev
WWTP Director

26 Corte Madera Avenue - Mill Valley, California 94941 Tel: (415) 388-2402 Fax: (415) 381-8128

June 27, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of Silicon Valley Clean Water, I have reviewed the individual plant report prepared for the Silicon Valley Clean Water that is included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The Silicon Valley Clean Water report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for Silicon Valley Clean Water, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Sincerely,
SILICON VALLEY CLEAN WATER

Teresa Herrera, P.E.
Manager

SILICON VALLEY CLEAN WATER | 1400 Radio Road, Redwood City, CA 94065 | 1-650-591-7121 | info@svcw.org www.svcw.org

June 26, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board
Eileen.White@waterboards.ca.gov

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of the Sonoma Valley County Sanitation District, I have reviewed the individual plant report prepared for the Sonoma Valley County Sanitation District Wastewater Treatment Plant that is included as an appendix to the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The Sonoma Valley County Sanitation District report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for the Sonoma Valley County Sanitation District, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Frank Mello

Frank Mello
Operations Coordinator

kt T:\Pinks\06-19-23\Agency Sign-Off Letter - RW Evaluation.docx

WATER QUALITY CONTROL PLANT DIVISION
(650) 877-8555

May 31, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

On behalf of City of South San Francisco-San Bruno Water Quality Control Plant, qualified staff have reviewed the individual plant report prepared for the City of South San Francisco-San Bruno Water Quality Control Plant included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. HDR/Woodard & Curran consulting team (Consultants) prepared the plant report under a contract with the Bay Area Clean Water Agencies (BACWA). Consultants interacted with plant staff, prepared a draft report for our staff's review, and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents the best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who collaborated with the Consultant in preparing the report, the City of South San Francisco-San Bruno Water Quality Control Plant, supports the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

Brian Schumacker
Plant Superintendent
South San Francisco-San Bruno Water Quality Control Plant

June 27, 2023

Water Pollution Control Plant
1444 Borregas Avenue
Sunnyvale, CA 94088-3707
TDD/TYY 408-730-7501
sunnyvale.ca.gov

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of the City of Sunnyvale (Sunnyvale), I have reviewed the individual plant report prepared for the Sunnyvale Water Pollution Control Plant that is included as an appendix to [Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The Sunnyvale report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for Sunnyvale, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sunnyvale

Sincerely,

RAWikramanayake

RAWikramanayake (Jun 27, 2023 16:36 PDT)

Rohan Wikramanayake, PE

WPCP Division Manager

San Francisco
Water Power Sewer
Services of the San Francisco Public Utilities Commission

525 Golden Gate Avenue, 13th Floor
San Francisco, CA 94102
T 415.554.3155
F 415.554.3161
TTY 415.554.3488

May 22, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of San Francisco Public Utilities Commission's Wastewater Enterprise (SFPUC WWE), I have reviewed the individual plant report prepared for the Southeast Water Pollution Control Plant (SEP) and the Treasure Island Wastewater Treatment Plant (TIP) that are included as appendices to the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant reports were prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The SEP and TIP reports were prepared after the Consultants prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. These reports represent my best understanding of our facilities' concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for SFPUC WWE, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my

knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Joel Prather
Acting Assistant General Manager, Wastewater Enterprise

USD TREAT PROTECT PRESERVE est.1918
TRI-CITY WASTEWATER

Directors
Manny Fernandez
Tom Handley
Pat Kite
Anjali Lathi
Jennifer Toy

Officers
Paul R. Eldredge
General Manager/
District Engineer

Karen W. Murphy
Attorney

June 20, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board
1515 Clay St, Suite 1400
Oakland, CA 94612

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling (Via email only)

Dear Eileen,

On behalf of Union Sanitary District, I have reviewed the individual plant report prepared for the Alvarado Wastewater Treatment Plant that is included as an appendix to Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The Union Sanitary District report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for Union Sanitary District, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, the information pertaining to Union Sanitary District was prepared under my direction or supervision. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

DocuSigned by:

Paul R. Eldredge

91F3D7DCBD12473...

Paul R. Eldredge, P.E.
General Manager/District Engineer
Union Sanitary District

(707) 644-8949 (Admin)
(707) 644-8976 (Billing)
www.VallejoWastewater.org
450 Ryder Street
Vallejo, CA 94590

June 12, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of the Vallejo Flood and Wastewater District, I have reviewed the individual plant report prepared for the Vallejo Flood and Wastewater District that is included as an appendix to [Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The Vallejo Flood and Wastewater District report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who worked with the Consultant in preparing the report for the Vallejo Flood and Wastewater District, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

VALLEJO FLOOD AND WASTEWATER DISTRICT

Melissa M Morton

MELISSA MORTON
District Manager

WEST COUNTY WASTEWATER

June 23, 2023

Eileen White
Executive Officer
San Francisco Bay Regional Water Quality Control Board

Re: Acceptance of Plant-Specific Findings for the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling

Dear Eileen White,

On behalf of West County Wastewater District (WCW), I have reviewed the individual plant report prepared for the WCW Water Quality and Resource Recovery facility which is included as an appendix to the Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. The plant report was prepared by the HDR/Woodard & Curran consulting team (Consultants) under a contract with the Bay Area Clean Water Agencies (BACWA). The WCW report was prepared after the Consultants interacted with plant staff, prepared a draft report for our staff's review and responded to staff's comments. BACWA's Recycled Water Committee also provided direction to the Consultants in preparing the individual plant reports and the overall summary for Regional Evaluation of Potential Nutrient Discharge Reduction by Water Recycling. This report represents my best understanding of our facility's concepts for expanding recycled water through 2040.

With this level of involvement and oversight of our staff who collaborated with the Consultant in preparing the report for WCW, I agree that the recommended approach and cost estimates for reducing nutrients via recycled water at our facility are reasonable with respect to the context of the overall report. Furthermore, in accordance with the Watershed Permit requirement for report certification, I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thank you,

Aaron J Winer

Aaron J Winer

DIRECTOR OF WATER QUALITY AND RESOURCE RECOVERY
awiner@wcwd.org

DIRECT; (510) 837-6223 MOBILE; (510) 812-9586