NATURE-BASED SOLUTIONS FOR NUTRIENT LOAD REDUCTION

DRAFT SCOPING AND EVALUATION PLAN

San Francisco Estuary Institute (SFEI), on behalf of Bay Area Clean Water Agencies (BACWA)

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TABLE OF CONTENTS

EXECUTIVE SUMMARY 1

INTRODUCTION 2

Project Goals and Objectives 2

Management Questions and Objectives 3

Technical Team and Advisors 4

Schedule 4

BACKGROUND 5

Nature-Based Wastewater Treatment in the Context of Shoreline Resiliency and Planning in the Bay Area 5

Relationship to Prior Studies 6

2017 Treatment Wetland Screening Study 6

Phase 1 Operational Landscape Units and Sea Level Rise Adaptation Framework 10

Relationship to Other On-Going Studies 10

Nature-Based Solutions: definitions & context 12

NBS Types Considered for this Regional Evaluation 12

METHODS 14

Discharger Survey 14

Desk-Based Screening Study 15

Preliminary Assessment 17

Approach to estimating nutrient load reductions 18

Site-Visits and Synthesis 20

Site-Specific Evaluation 21

CASE STUDIES & BARRIERS TO IMPLEMENTATION 22

Introduction to the History of Treatment Wetlands in the Bay Area 23

Barriers to Implementation: Processes & Recommendations 25

Geography 25

Institutions and Governance 26

Permitting 26

REFERENCES 27

APPENDIX A: 2ND NUTRIENT WATERSHED PERMIT LANGUAGE: NUTRIENT REDUCTION EVALUATIONS VIA NATURAL SYSTEMS 30

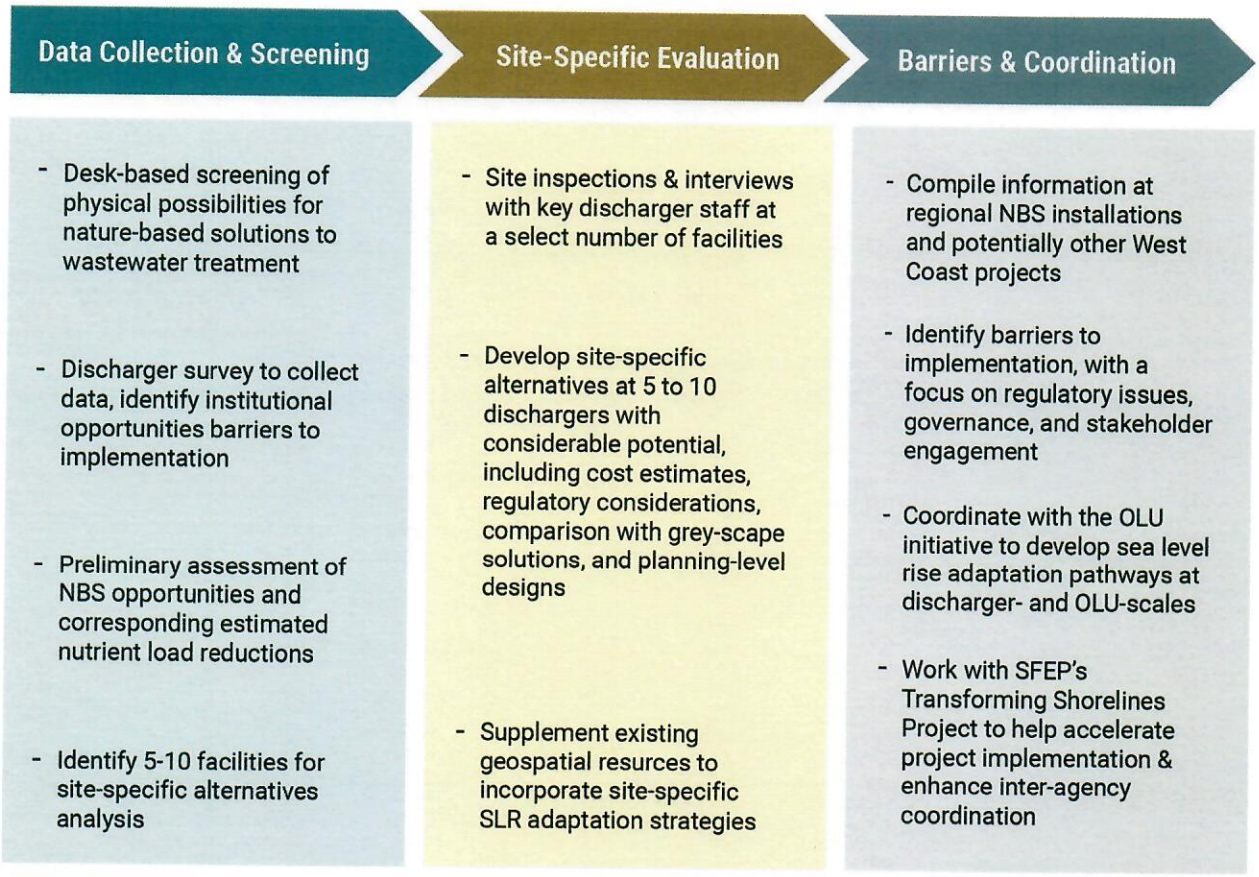
APPENDIX B: POTENTIALLY APPLICABLE PERMIT APPLICATIONS AND APPROVALS 32

APPENDIX C: SAMPLE AND COMPLIMENTARY PERMITTING STRATEGIES 40

EXECUTIVE SUMMARY

This Scoping and Evaluation Plan serves to establish the rationale, objectives, and approach to performing a regional evaluation of potential nutrient discharge reduction by nature-based systems, pursuant to Order No. R2-2019-0017, *Waste Discharge Requirements for Nutrients from Municipal Wastewater Dischargers to San Francisco Bay* (Nutrient Watershed Permit). This project represents one of several regional initiatives aimed to evaluate the potential for or encourage the implementation of nature-based solutions (NBS) for wastewater treatment.

The overarching goal is to evaluate opportunities and constraints to deploying one or more types of NBS to reduce nutrient loading to San Francisco Bay at each of the thirty-seven (37) wastewater treatment facilities classified as Dischargers under the Nutrient Watershed Permit. Secondary objectives surround stakeholder interest in addressing barriers to implementation of NBS projects. Pending available resources, support will be provided to projects in the planning stage, including identification of strategies to reduce governance- and regulatory-based challenges to obtaining buy-in among diverse stakeholders or agencies, and effectively securing permit approvals. Key activities include:



This project follows a study required pursuant to the first iteration of the Nutrient Watershed Permit, involving treatment plant optimization and upgrade studies for nutrient removal using traditional wastewater treatment technologies at each of the region's wastewater treatment facilities. In the event nutrient load reductions are required from wastewater sources, these studies will inform future decisions regarding the appropriate mix of nutrient load reduction strategies.

1. INTRODUCTION

On May 8, 2019, the San Francisco Regional Water Quality Control Board (Regional Water Board) issued Order No. R2-2019-0017, Waste Discharge Requirements for Nutrients from Municipal Wastewater Dischargers to San Francisco Bay (Nutrient Watershed Permit). This permit represents the second iteration of the Nutrient Watershed Permit, the first of which required treatment plant optimization and upgrade studies for nutrient removal for each of the region's thirty-seven (37) wastewater treatment facilities. That effort resulted in a comprehensive Optimization and Upgrade Study, analyzing the options for achieving three (3) nutrient concentration scenarios via optimization of existing treatment processes and upgrades to each wastewater treatment facility using grey infrastructure-based technologies.[1]

According to Provision C.2 of the 2019 Nutrient Watershed Permit, Dischargers must perform a Regional Evaluation of Potential Nutrient Discharge Reduction by Natural Systems (Regional Evaluation), the language of which is provided in Appendix A. This document outlines the scope and approach to performing the Regional Evaluation, in fulfillment of provision requirements to prepare Scoping and Evaluation Plans. The Nutrient Watershed Permit conceives these plans as separate reports, though this document represents a combined Scoping and Evaluation Plan.

1.1. Project Goals and Objectives

The overarching goal of the Regional Evaluation is to improve our understanding of the opportunities and constraints associated with employing nature-based solutions (NBS) to reduce nutrient loading to San Francisco Bay from the region's wastewater facilities.

Objectives of the Regional Evaluation include:

1. Perform a screening-level analysis to identify opportunities and constraints of applying NBS for nutrient load reduction at each of the region's wastewater Dischargers;

2. Identify a subset of wastewater facilities (~5-10) where the opportunity to employ NBS for nutrient load reduction is both a) moderate to high, and b) plans for nutrient management via NBS are not already under serious consideration. For that subset of facilities, the following analyses apply:
    a. Determine the type of NBS most appropriate, if any, for an individual facility (e.g., open water treatment wetlands, sub-surface denitrifying bioreactors, ecotone levees, enhancements to existing basins);
    b. Generate estimated nutrient load reductions resulting from the implementation of one or more NBS-based system, at the facility-scale, as well as the Operational Landscape Unit (OLU) scale, which are geographic units expected to support a coherent suite of ecosystem functions appropriate for a given place, along with the physical processes needed to sustain those functions;
    c. Identify the likely ancillary benefits, or adverse effects, associated with implementing NBS strategies (i.e., removal of emerging contaminants; creation of, or disturbance to, habitats and species of concern; protection against sea-level rise);
    d. Assess the feasibility, efficacy, reliability, and cost-effectiveness of site-specific NBS strategies. Specifically, this involves performing cost estimates for construction and operation; evaluation of likely regulatory- and governance-based challenges; as well as

other challenges, including land ownership, proximity to a wastewater source, environmental conflicts, and negative public perception;

3. Compile case studies and identify regulatory, governance, and institution-based limitations to the implementation of multi-benefit shoreline resiliency projects; and
4. Recommend strategies for integrated design and regulatory efficiency, to minimize environmental conflicts and enhance certainty associated with regulatory consultation and permitting.

In parallel to this Regional Evaluation, permittees of the Nutrient Watershed Permit are also required to perform a regional evaluation of potential nutrient discharge reduction by water recycling. Preparation of three complementary nutrient load management evaluations (Optimization and Upgrade Study, Regional NBS Evaluation, and Regional Water Recycling Evaluation) serves to identify a robust range of multi-benefit alternatives, in the event regulators determine the need for nutrient load reductions to San Francisco Bay.

1.2. Management Questions and Objectives

The Nutrient Watershed Permit and documents developed in support of the San Francisco Bay Nutrient Management Strategy (NMS) identify relevant management questions and objectives related to this Regional Evaluation. For instance:

- Per the Nutrient Watershed Permit Fact Sheet (F-11), the Regional Water Board identifies that one of the primary purposes of the five-year permit term is to "evaluate, on an individual and sub embayment scale, nutrient removal approaches using natural systems and wastewater recycling."
- Also, within the Fact Sheet (F-22), the Regional Water Board states that "If nutrient reductions are required for San Francisco Bay, the Regional Water Board's overarching goal would be to achieve nutrient load reductions through the implementation of a regional plan encompassing cost-effective and multiple-benefit nutrient reduction options. This Order requires major Dischargers to evaluate nutrient reduction opportunities through natural systems, which would be a component of such a plan."
- Among the management questions targeted by the NMS Science Plan, question seven asks, "What specific management actions, including load reductions, are needed to mitigate or prevent current or future impairment?"[2]

This Regional Evaluation could inform the construction of a decision support framework if nutrient load reductions are required to fulfill the Regional Water Board's overarching goal of achieving nutrient load reductions via cost-effective multi-benefit strategies.

In all likelihood, NBS solutions will not be possible or practical at most of the region's wastewater facilities to meet, as a stand-alone solution, any of the three nutrient load reduction scenarios considered in the Optimization and Upgrade Study (i.e. total Nitrogen (TN) concentrations of 15 mg L^{-1}, 6 mg L^{-1} and 3 mg L^{-1}). However, NBS and wastewater recycling likely represent significant opportunities for cost-effective load reductions, particularly in the context of the other ecological, societal, and water resource objectives attainable through thoughtful implementation. Construction of the most appropriate and compelling mix of solutions and technologies would likely follow regulatory decisions resulting in the need for nutrient load reductions.

1.3. Technical Team and Advisors

This project is led by SFEI under the direction of the Bay Area Clean Water Agencies (BACWA) Contract Management Group (CMG), which is a voluntary group of wastewater managers intended to receive updates on the status of this project, provide feedback or expert input, and serve as liaisons to the larger regional wastewater community. Additional direction and feedback shall be sought from key regulators and public stakeholders. HDR Inc. is a subcontractor to SFEI, to provide engineering and design support as this project enters the site-specific evaluation stage.

As the project progresses, SFEI shall seek out additional advisors with targeted expertise in the design and evaluation of nature-based strategies to inform final recommendations and provide peer review of nutrient load reduction calculations and designs.

1.4. Schedule

The Nutrient Watershed Permit describes the following milestones for this Regional Evaluation:

- December 1, 2019: Submit a Scoping Plan to the Regional Water Board;
- July 1, 2020: Submit an Evaluation Plan to the Regional Water Board;
- July 1, 2021, and 2022: Submit a Status Report to the Regional Water Board;
- July 1, 2023: Submit a Final Status Report describing the tasks completed and findings for each site identified in the Scoping Plan

An accelerated schedule is proposed here, to integrate the Scoping and Evaluation Plan for submission by December 1, 2019, as well as accelerate the initiation of site-specific evaluations. Table 1 presents an overview of the schedule, as well as approximate completion dates.

Table 1. Overall Schedule for the Regional Evaluation

TASK	START DATE	END DATE
Scoping & Evaluation Plan Development	September 2019	Dec. 1, 2019
Discharger Survey	December 2020	February 2020
Desk-Based Evaluation	February 2020	May 2020
Site Visits/Interviews	June 2020	August 2020
Site-Specific Evaluations	October 2020	July 2022

Annual status reports shall be submitted on July 1 of 2020 through 2023, consistent with the requirements of the Nutrient Watershed Permit. The anticipated completion date of the Final Evaluation Report is July 2022, one year prior to the specified Permit deadline.

2. BACKGROUND

Most of the Bay Area's wastewater treatment plants were not designed to remove nitrogen and phosphorus from wastewater, so over 50,000 kilograms or 110,000 pounds of total nitrogen is discharged with over 400 million gallons of treated wastewater into the Bay each day. The technology employed at most plants has not fundamentally changed in the decades following passage of the Clean Water Act and little precedent exists for managing nutrients outside the context of grey infrastructure-based technologies, from the local or international perspective.[3]

The San Francisco Bay Nutrient Management Strategy (NMS) serves to inform future regulatory decisions regarding the need for nutrient load reductions. Around the world, the general response to regulatory requirements for nutrient reductions has resulted in the application of tried and true, concrete and steel suspended growth processes or other innovative yet energy-intensive technologies.[4] These systems represent the most controlled and reliable approach to nutrient reduction. Though this comes at a cost, in terms of high capital and maintenance expenditures, intense energy and chemical demands, and the provision of few ancillary benefits. Recent estimates prepared by HDR, the engineering consulting firm, place the cost over $12 billion, depending on the potential level of nutrient reduction.[1]

Some water agencies in the region are considering the use of multi-benefit natural systems to assimilate nitrogen as an alternative to expensive and energy-intensive treatment systems that serve only to remove nutrients. Wastewater treatment wetlands have been successfully applied to thousands of sites throughout the world.[5] The key constraints for our region are that most wastewater plants are situated near the Bay's shoreline - often abutting sensitive ecological resources and susceptible to current and future flooding. Land in the region is scarce and notoriously expensive, increasing the need for collaboration among public agencies capable of sharing land and resources to achieve multiple needs.

Despite key constraints, opportunities exist for small (<5 acres) to large (>100 acres) scale treatment wetland installations at plants around the region. When designed correctly, benefits include water quality and recreational access improvements, flood risk reduction, habitat creation, and the reconstruction of marine to freshwater ecotones that were once ubiquitous along the shores of San Francisco Bay.

Existing regulations actively discourage the creation of such systems, however, over appropriate concerns with discharging wastewater close to the shore, protection of wildlife, and the longevity of these systems as sea-level rise increases. Through appropriate planning and design, these and other concerns can be addressed.

2.1. Nature-Based Wastewater Treatment in the Context of Shoreline Resiliency and Planning in the Bay Area

The Bay Area is making a concerted effort to protect communities and habitats from rising seas, reverse a legacy of habitat destruction and contamination, and improve access to San Francisco Bay – the region's iconic feature. Passage of Measure AA by an overwhelming majority indicated the region is taking the issue of habitat protection and sea-level rise more seriously. Resilient by Design's Bay Area Challenge attracted some of the world's top designers to escape the confines of what most in the region view as realistic to help us recognize a new reality.[6] And the success of habitat restoration efforts in the northern and southern extents of the Bay is steadily improving and teaching us more can be done in a shorter amount of time than previously imagined.[7]

The region is clearly willing and ready to leverage its wealth and innovative spirit to enhance habitat quality along the shorelines, enhance flood protection, and improve water quality. What is not clear is whether agencies, institutions, and regulatory frameworks can operate at a speed necessary to leverage this momentum and address the urgency of rising seas and the likelihood the Bay is losing its resiliency to fend off ongoing contamination. The fragmented nature of local and regional governance in the Bay Area, coupled with limited coordination among regulatory agencies, makes permitting costly and time intensive. At the same time, projects are generally not designed holistically to meet multiple benefits. Habitat projects generally do not represent nature-based solutions to flood control or water quality, for instance. As a result, projects do not maximize their potential natural capital.

Agencies have recently expressed more willingness to enhance coordination and provide greater clarity regarding expectations to reduce the burden and time required for project approvals. The San Francisco Bay Restoration Authority, which coordinates Measure AA efforts, is working with regulatory agencies to create the Bay Restoration Regulatory Integration Team (BRRIT) to enhance inter-agency coordination and lower the hurdles for Measure AA projects. From a project proponent perspective, there is still much ambiguity, however, regarding expectations surrounding design criteria, mitigation standards, and performance measures. To the extent this can be established in advance, multi-benefit projects will be viewed more favorably by cities and agencies, which currently have little incentive or mandate to pursue such projects.

Permit provisions require this Regional Evaluation to identify the physical and technical opportunities and constraints to deploying nature-based solutions for nutrient load reduction. Stakeholders and regulators also seek for this effort to address the regulatory, governance, and institution-based barriers to implementing multi-benefit shoreline projects in the region, more broadly. This aspect of the project represents is a less resource-intensive element, but no less significant than the identification of physical and land-use constraints and identification of engineered alternatives.

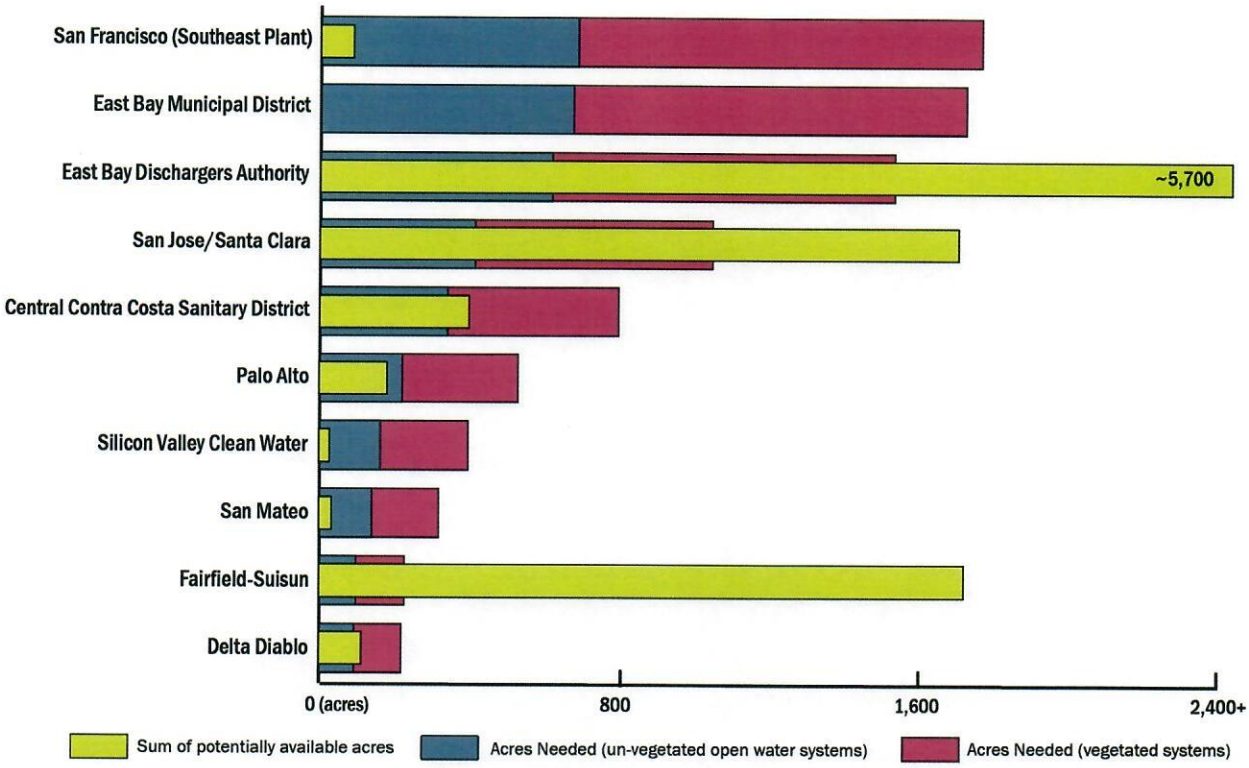
The sequence of this project is timely, considering the publication of several reports by the Regional Water Board regarding regulatory strategies and considerations of treatment wetlands and fill of the Bay for shoreline resiliency projects, in general.[8,9] Additionally, the Bay Conservation and Development Commission (BCDC) recently adopted amendments to the Bay Plan to recognize the critical role of fill, in select circumstances, to implement habitat and shoreline resiliency projects.[10]

2.2. Relationship to Prior Studies

2017 Treatment Wetland Screening Study

In 2017, the NMS supported a preliminary assessment to inform opportunities and constraints to deploying open water treatment wetlands at Bay Area wastewater facilities.[11] This discrete study served in part as the basis for this Regional Evaluation. Among the analyses performed, the estimated amount of land required, for conversion to two types of treatment wetland, was calculated and compared to the amount of land potentially available within a two-mile radius of each wastewater facility. First-order rate constants were taken from a recent demonstration project at the Town of Discovery Bay's wastewater treatment plant and compared against literature-based average nitrate removal rates from 84 FWS systems.[12,13] These were used to estimate the ability to meet total nitrogen (TN) based concentration reduction scenarios, assuming the deployment of these two types of NBS systems..

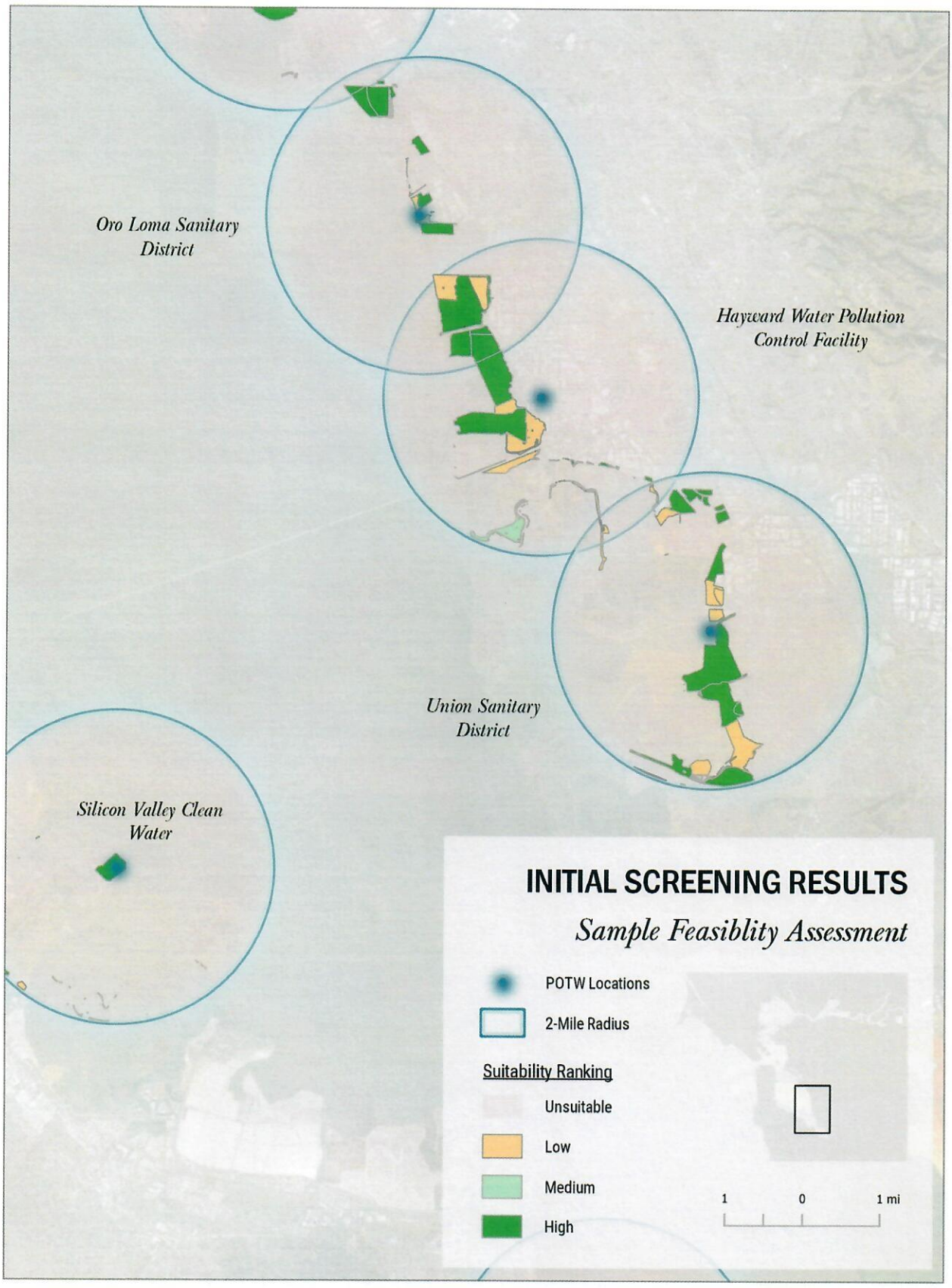
The following figure presents a sample output from the 2017 study, showing a subset of the screening results, in terms of estimated acreage required to meet the Level 3 (6 mg L^{-1}) TN reduction scenario, as defined in the *Optimization and Upgrade Study*, using two types of treatment wetlands, versus the sum of all potentially available land.

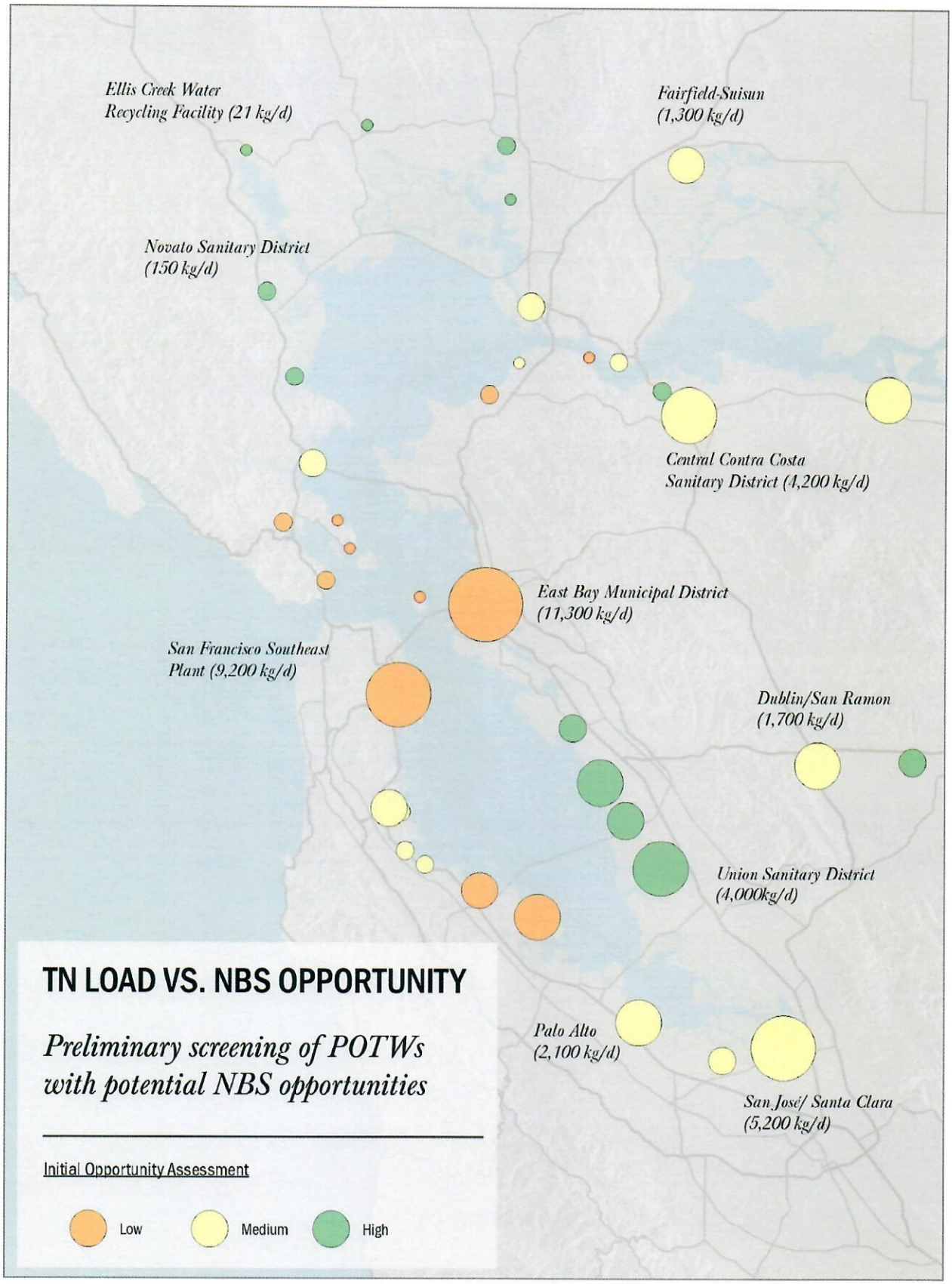


Summary of potentially available acres versus estimated treatment wetland acreage to meet the Level 3 TN concentration scenario (6 mg L-1), from the 10 POTWs with the highest concentration reduction needs

The 2017 study was subject to considerable uncertainty yet provided a valuable initial screening to inform the geographical distribution of wastewater facilities where NBS for nutrient load reductions may be feasible.

This Regional Evaluation will refine the screening criteria used in the 2017 study. However, the overall results of the proposed GIS exercise, in terms of which wastewater facilities generally have the most significant potential, is not expected to change dramatically. Regardless, the screening process is not intended to be the sole determinant of whether a more focused analysis is pursued at a given facility. Some agencies with moderate or low levels of opportunity may wish to explore NBS opportunities outside the immediate vicinity of their facilities, for instance. Another scenario that could alter the feasibility of deploying NBS at a given facility includes the opportunity to partner with adjacent agencies with available land or other shared resources.

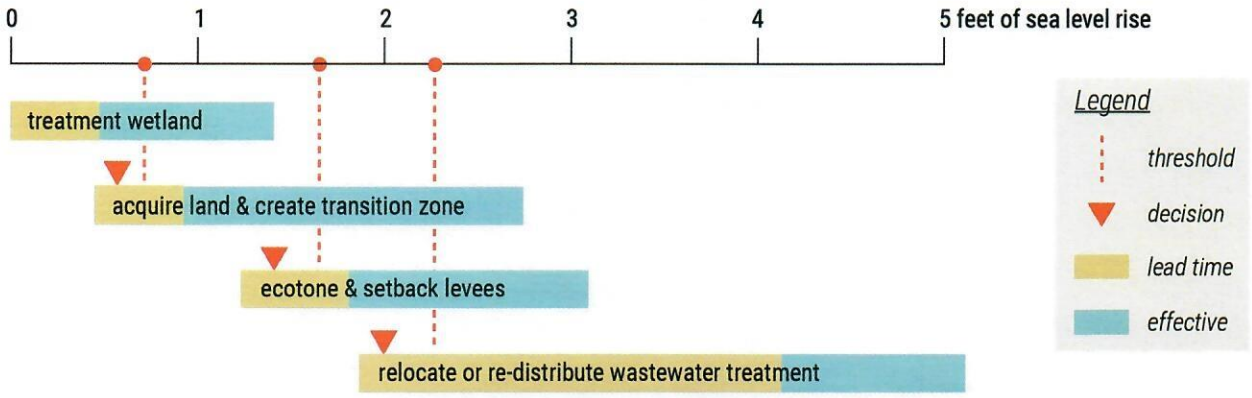

Oro Loma Sanitary District
Hayward Water Pollution Control Facility
Union Sanitary District
Silicon Valley Clean Water
INITIAL SCREENING RESULTS
Sample Feasiblity Assessment
POTW Locations
2-Mile Radius
Suitability Ranking
Unsuitable
Low
Medium
High
1
0
1 mi


Ellis Creek Water
Recycling Facility (21 kg/d)
Fairfield-Suisun
(1,300 kg/d)
Novato Sanitary District
(150 kg/d)
Central Contra Costa
Sanitary District (4,200 kg/d)
East Bay Municipal District
(11,300 kg/d)
San Francisco Southeast
Plant (9,200 kg/d)
Dublin/San Ramon
(1,700 kg/d)
Union Sanitary District
(4,000kg/d)
Palo Alto
(2,100 kg/d)
San José/ Santa Clara
(5,200 kg/d)
TN LOAD VS. NBS OPPORTUNITY
Preliminary screening of POTWs
with potential NBS opportunities
Initial Opportunity Assessment
Low
Medium
High

Phase 1 Operational Landscape Units and Sea Level Rise Adaptation Framework

Over the last several years, SFEI and partners have developed and continue to refine a science-based framework for identifying effective strategies for adapting to rising sea levels, which are both appropriate for settings and take advantage of natural processes. This framework has been termed Operational Landscape Units for San Francisco Bay. Two recent reports best illustrate the application of the framework on a regional and OLU-specific scale.[14,15]

The Regional Water Board has recently funded the second phase of OLU-specific work, and the intention is to work in close parallel with this Regional Evaluation to develop case studies and sea-level rise adaptation pathways for OLUs with POTWs that contain a significant potential to employ NBS for nutrient load reductions. Nearly every SF Bay OLU contains at least one wastewater facility, and Phase 2 of the OLU initiative will involve analysis of 2-3 additional OLUs, including their associated wastewater facilities. Phase 2 efforts include the evaluation of several scenarios for each OLU, as well as sea-level rise adaptation pathways. These pathways are conceptual strategies for how various SLR adaptation strategies can be modified, enhanced, or abandoned in favor or another measure as water levels increase.



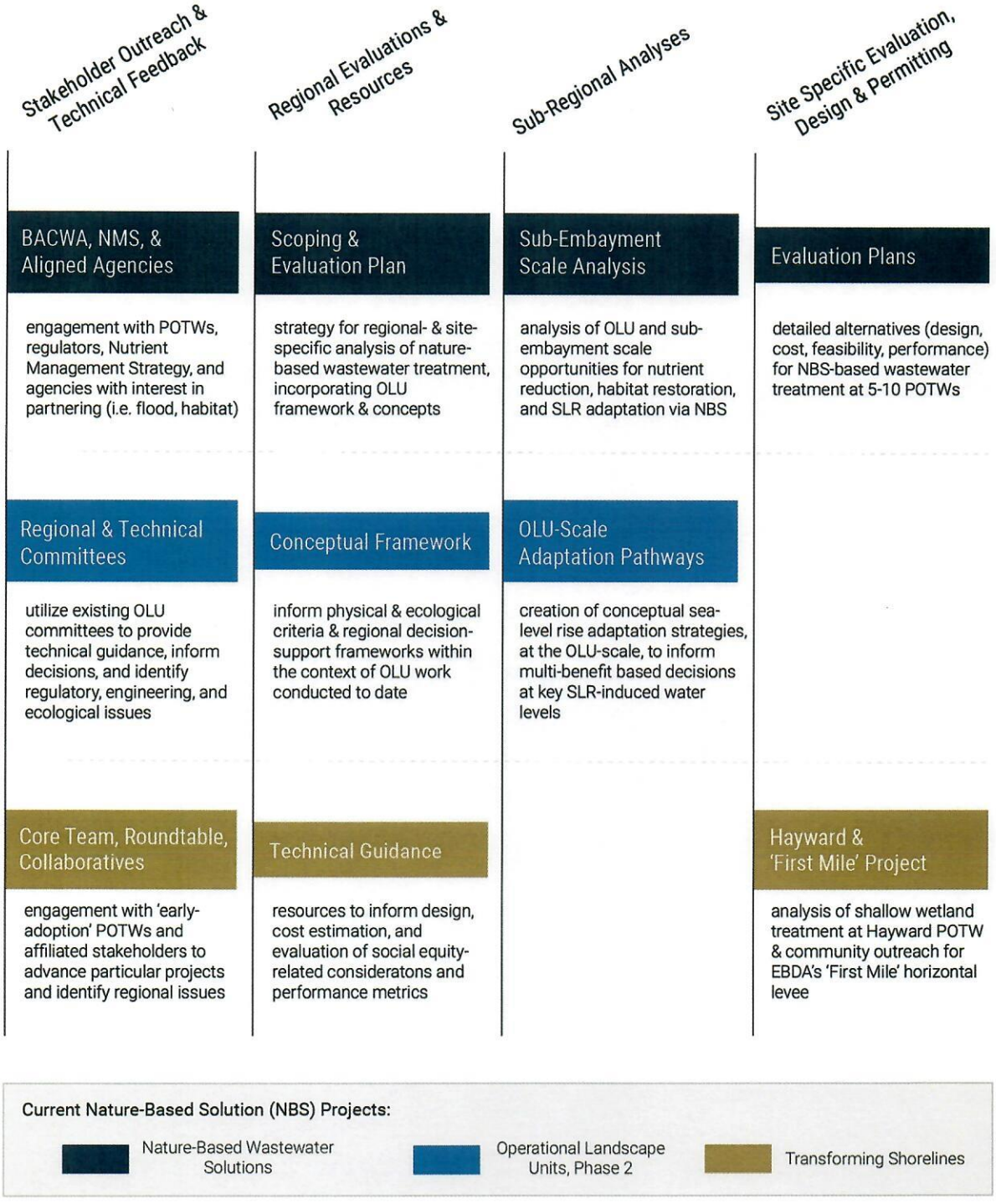
Sample conceptual sea level rise adaptation strategy involving adaptive management of NBS until the relocation of wastewater facilities may be necessary. Adapted from the San Francisco Bay Shoreline Adaptation Atlas.[14]

This Regional Evaluation intends to leverage the ongoing efforts to employ the OLU framework, as exemplified in the recent report, which presented an adaptation framework for Marin County.[15] That report contained a case study for the Novato OLU, which included consideration of an ecotone levee relying on treated effluent from the Novato Sanitation District. The report presented three separate scenarios, which were evaluated based on several metrics. This Regional Evaluation will reflect the outputs of the Phase 2 OLU project.

2.3. Relationship to Other On-Going Studies

In the process of developing this Regional Evaluation, two additional related projects were initiated, and managers of these efforts have sought to develop complementary work plans. These projects include the *Phase 2 OLU Project*, introduced above, as well as the San Francisco Estuary Partnership's (SFEP) *Transforming Shorelines Project*. Refer to the following diagram to illustrate the anticipated outputs and outcomes from the three (3) related projects.

RELATED NBS PROJECTS: ANTICIPATED OUTPUTS & OUTCOMES



The OLU initiative is most closely aligned to this Regional Evaluation, in large part because project team members intersect. Although SFEI and SFEP have refined the work plans for these three projects to minimize overlap and ensure that resources are leveraged to maximize the impact of the collective effort.

Of the three projects, Transforming Shorelines features the largest budget – the largest single task for which is dedicated to outreach and design of the 'First Mile' Horizontal Levee project. That project proposes to create a linear mile of ecotone levees in the vicinity of the Oro Loma Sanitary District and is intended to serve East Bay Dischargers Authority (EBDA) agencies. The project also proposes undertaking regional forums to discuss and address issues arising at specific projects currently in the outreach, design/permitting, or implementation phases. This Regional Evaluation continues to align efforts with SFEP and intends to participate in public forums and roundtables as they arise.

2.4. Nature-Based Solutions: definitions & context

The origins of the term are unclear, though in the last five years European institutions have adopted 'nature-based solutions', or NBS, as a guiding principle for policies shaping urban climate adaptation and mitigation efforts.[16] As noted by managers and academics advancing NBS policy and practice, use of the term marks a shift in the narrative, from 'working with nature' towards 'innovating with nature' - recognizing the highly engineered nature of urban infrastructure, including those involving natural processes.[17] The term is also more encompassing than related terms, such as green infrastructure or low-impact development.

Given the recent adoption of the term, there is no agreed-upon definition of NBS, but the International Union for Conservation of Nature (IUCN) and European Union Directorate General on Research and Innovation have adopted official working definitions.[18] Since these institutions intend for the term to encompass the universe of solutions capable of drawing on nature to achieve broad sustainability objectives, these expansive definitions lack specificity relevant to this Regional Evaluation effort. A more recent discussion of the science, policy, and practice of nature-based solutions provides a more concrete synthesis:

> *Nature based solutions beneficially exploit natural processes providing stand-alone solutions or hybrid approaches integrated with technology-based or engineered solutions to foster urban resilience and sustainability.*[19]

This characterization encompasses the types of shoreline resiliency and nature-based wastewater treatment systems being considered in the region, including horizontal levees, open-cell treatment wetlands, vegetated open water treatment systems, and denitrifying bioreactors (i.e. subsurface treatment). Such systems rely primarily on natural processes to achieve the intended treatment objectives. Yet they all rely on engineered elements, including pumps, pre-treatment, nitrification, control structures, and levees.

2.5. NBS Types Considered for this Regional Evaluation

One could argue that all wastewater treatment systems rely on natural processes, given the reliance on microbiological processes. Yet traditional wastewater treatment plants are resource intensive and provide few urban resilience and sustainability objectives beyond their intended water quality objectives. This Regional Evaluation considers a narrow list of NBS types for wastewater treatment in the evaluation procedure. Table 2 does not characterize the full range of treatment wetlands or other types of NBS suitable for wastewater treatment, though these broad categories include the types of systems currently

under consideration in the region; they capture the range of physical requirements necessary for implementing other types of NBS; and data regarding treatment performance is available or emerging.

Table 2. Classes of NBS for wastewater treatment considered in this Regional Evaluation

METRIC	DESCRIPTION
Free water surface constructed wetlands (FWS)	FWS wetlands have areas of open water and are similar in appearance to natural marshes. They contain areas of open water, floating vegetation, and emergent plants, either by design or as an unavoidable consequence of the design configuration. As wastewater flows through the wetland, it is treated by the processes of sedimentation, filtration, oxidation, reduction, adsorption, and precipitation.[5]
Unit-cell open water wetlands (UPOW)	Shallow (~.3m) open water treatment systems designed to promote photo- and biologically-mediated water treatment processes.[20] UPOW wetlands have been observed to have improved treatment efficiency compared to vegetated FWS wetlands due to a diversity of pathways available for contaminant removal, and a hydraulic regime that approaches plug flow, when designed and constructed correctly.[21,22,23]
Denitrifying bioreactor beds	Denitrifying bioreactors are a class of systems where solid carbon substrates are added into the flow path of contaminated water.[24] Denitrification beds are intended for concentrated discharges and are typically containers, ditches, or basins filled with wood chips, acting as a carbon source.[24] Nitrate (NO_3-) rich effluent is passed through the bed to promote heterotrophic denitrification to enhance NO_3- conversion to N gases.[25]
Ecotone levees	Also referred to as horizontal levees or wetland levees, these multi-benefit flood control systems are comprised of soil and planted with native wet meadow and/or riparian scrub vegetation and irrigated.[26] These systems have proven effective in NO_3- removal when coupled with "denitrification layers", which are another class of denitrifying bioreactors.[24] Horizontal layers of a woodchip-soil mix are installed under effluent-irrigated topsoil where rapid denitrification takes place.[27]

Refer to other texts such as *Treatment Wetlands*[5], *Principles of Design and Operation of Wastewater Treatment Pond Systems for Plant Operators, Engineers, and Managers*[28], and *Natural Wastewater Treatment Systems*[29] for a more complete characterization of the range of NBS types suitable for wastewater treatment, including design, operations, and maintenance criteria. Nesshöver et al (2017) and Frantseskaki et al (2019) provide a useful discussion of NBS as a framework for addressing climate resiliency in urban settings, as well as the challenges of advancing NBS as a viable alternative to traditional engineered solutions to meet societal needs, such as wastewater treatment and flood protection.[18,19]

3. METHODS

This section establishes the approach to completing this Regional Evaluation of NBS opportunities and potentially associated nutrient reductions, as well as site-specific evaluations at facilities with opportunities for deploying NBS. Section 4 describes the priorities for assisting in the advancement of ongoing projects or those in development.

3.1. Discharger Survey

The first step of the data collection process involves a survey and questionnaire, requesting plant-specific information. The questionnaire will supplement existing data collected in response to the request for information associated with the *Optimization and Upgrade Study*, which covered the following issues:

- Plant process and service area description
- Site layout
- Major unit process dimensions and information on the number of units in service
- Annual energy and chemical usage
- Future upgrade plans/expansion plans
- Identification of site constraints (e.g., space constraints, poor soils requiring piles, off-limits spaces, odor constraints, etc.)
- Prior reports and technical memoranda on existing facilities/nutrient removal plans
- Prior reports documenting nutrient reductions by other means. For example, plans for recycled water, wetlands treatment, etc.
- Background on regulatory drivers

Agencies will be asked to update this information, where any current or planned changes are applicable. The questionnaire will also request additional information applicable to the assessment and preliminary design of NBS:

- Current in-plant capacity for full- or partial-nitrification.
- Land under ownership by the applicable wastewater agency, affiliated municipalities, and partner agencies, for potential conversion to NBS use.
- Requests for effluent data not presented in CIWQS, or other public databases, including the concentration of nutrient species in effluent, on a seasonal basis, not subject to reporting requirements.
- Details regarding any existing or proposed treatment wetlands or other NBS for wastewater treatment (type, size, flow-through, treatment performance data, maintenance and monitoring, general performance issues).
- Information regarding internal interest in and institutional support for deploying NBS for wastewater treatment and other sustainability objectives. This may require follow-up interviews or site visits, on a case-by-case basis.
- Sea level rise planning initiatives and any intended actions.
- Real or perceived challenges to implementing NBS for wastewater treatment, including questions related to regulatory, institutional, and governance challenges.

Development of the survey and questionnaire shall take place in coordination with BACWA's CMG for this project, to ensure questions are designed to optimize clarity and elicit accurate responses.

3.2. Desk-Based Screening Study

To inform discharger-specific suitability assessments, SFEI's GreenPlanIT will be used to screen and score areas throughout the region based on a set of defined criteria. The original use case for the GreenPlanIT was to identify potentially suitable nature-based stormwater infrastructure sites.[30] Simple modifications will enable SFEI to perform similar analyses for wastewater applications. Specifically, the Site Locator Tool can be leveraged to combine the physical properties of different NBS types with local and regional GIS information to identify and rank potentially suitable sites.

The approach presented here outlines the application of outputs from GreenPlanIT to a screening criterion, though is subject to refinement, with the intent to reduce setup time by leveraging existing data sources. The approach is adapted from the site selection criteria in *Natural Wastewater Treatment Systems* and builds upon the method utilized to perform a simplified screening effort in 2017, consisting of assigning rating factors for several metrics for each site and then summing the scores.[11] For the purposes of this screening effort, three (3) general categories of NBS for wastewater treatment are considered (Table 3). Other approaches may be suitable on a site-specific basis though these broad categories likely capture the types of sites considered suitable for an array of NBS types, subject to site-specific evaluation.

Table 3. Special site requirements for wastewater treatment based NBS considered here

NBS STRATEGY CONSIDERED	SPECIAL SITE REQUIREMENTS
Unit-cell open water wetlands and Free water surface constructed wetlands	Proximity to surface water for discharge, impermeable soils or liner to minimize percolation, no steep slopes, out of flood plain, no bedrock or groundwater within excavation depth
Denitrifying bioreactor beds	Proximity to surface water for discharge, impermeable soils or liner to minimize percolation, slopes 0-6%, out of flood plain, no bedrock or groundwater within excavation depth
Ecotone levees	Proximity to surface water for discharge, ideally sloped 1-3% to a maximum of 10%

Those sites with moderate to high scores are candidates for serious consideration and site investigation, as defined according to the ranges in Table 4. The ranking for a specific site is obtained by summing the values from Table 5. Suitability rankings for the NBS strategies identified in Table 3 will be developed pending further data exploration.

Table 4. Special site requirements for wastewater treatment based NBS considered here

DEGREE OF SUITABILITY	SCORE
Low	<18
Moderate	16-34
High	34-45

Among the factors considered in the general procedure include depth to groundwater, land use, proximity to a wastewater source, and habitat type (Table 5). Factors for consideration regarding individual wastewater treatment concepts include site grade and elevation. As cited in *Natural Wastewater Treatment Systems*, the relative importance of the various factors in Table 5 is reflected in the magnitude of the values assigned, so the largest value indicates the most important characteristic. Custom suitability rankings for each type of NBS system will be developed pending further data exploration.

Table 5. Physical- and Land Use-based Rating Factors for Land Application of Wastewater

METRIC	VALUE	SUITABILITY RATING
Site Grade (%)	0-3	8
	3-8	6
	8-16	3
	>16	1
Land Use (Existing or Planned)	Industrial	0
	High density, residential or urban	0
	Low density, residential or Urban	1
	Agricultural, or open space	4
Land Cost and Management	No land cost, owned by wastewater agency	5
	No land cost, owned by a partner agency	3
	Land purchased	1
Depth to Groundwater (m)	<1	0
	1-3	4
	>3	6
Distance from Wastewater Source (km)	0-3	8
	3-8	6
	8-16	3
	>16	1

METRIC	VALUE	SUITABILITY RATING
Elevation Difference from Wastewater Source (m)	<0	6
	0-15	5
	15-60	3
	>200	1
Habitat Classification	Lagoons, Lakes on fill, Managed marsh and Diked Marsh	1
	former salt ponds not currently intended for restoration (i.e. Crystallizer, Medium & Low Salinity Salt Ponds), former military lands, urban open space	2
	Undeveloped Bayland, Storage or Treatment Basin (e.g. existing oxidation ponds or treatment ponds), Farmed Bayland, Undeveloped Fill, Developed Island or Fill, Undefined Bayland, Ruderal Bayland, Agriculture, Rangeland	4

Final scoring strategies will be informed by the availability of data, additional opportunities or constraints afforded by the GreenPlanIT tool, and initial testing. Additional factors may be introduced to refine suitability based on factors such as:

- Topography
- Utilities
- Environmental (i.e., critical habitat, wetlands, known legacy contamination)
- Land use (i.e., existing and adjacent, ownership, land value)
- Floodplain (i.e., current and SLR projections)
- Access limitations
- OLU-related opportunities and constraints

Information compiled through this desk-based screening process will be used in conjunction with data collected via the questionnaire to inform preliminary assessments.

3.3. Preliminary Assessment

Quantitative and qualitative data collected via the questionnaire and screening processes shall be compiled for each participating discharger. Any data gaps will be documented per plant and disseminated to each plant via email with a request for additional data and, if necessary, to perform additional sampling. Sampling request may include:

- Constituents of interest (example BOD, TKN, TP, alkalinity)
- Sampling location (example: raw influent, primary effluent, secondary effluent)

- Sampling frequency (example: daily, weekly)
- Sample method (example: daily composite, hand composite, grab)
- Analytical methodology and laboratory reporting limits

Similar requests for information were made pursuant to the *Optimization and Upgrade Study*, the responses to which will be reviewed to assess the availability of information and minimize duplicate requests. Where considered necessary, the collection of additional data will inform feasibility assessments as well as potential load reductions capable from various NBS approaches, based on site-specific effluent quality.

Questionnaire results and outputs from the desk-based analysis will be used to perform a preliminary assessment of NBS suitability and screening-level load reduction potential for each discharger, pursuant to Section VI.C.2 of the Nutrient Watershed Permit. Potentially suitable sites shall be identified, along with a reporting of the metrics and associated weighting factors used to judge suitability. Nutrient load reduction potential estimates for one or more NBS strategies will be illustrated in map-based and tabular formats.

Qualitative information obtained through the questionnaire process will also be compiled to express additional factors to consider when prioritizing NBS for a given discharger. For instance, parcels may be identified through the GIS exercise that may or may not be considered suitable for other factors. Or perhaps a discharger is intending on rapidly escalating wastewater recycling to the point where NBS for nutrient removal is not a priority and resources should be applied elsewhere.

The preliminary assessment will contain short (1-2 page) summaries of preliminary NBS suitability assessments for each discharger. Conclusions shall include recommendations for facilities where the application of additional resources could be applied to develop conceptual designs and planning-level cost estimates (Tasks 3.4 and 3.5). Decisions regarding which facilities shall be subject to additional evaluation, including site visits and interviews with discharger staff (Task 3.4) as well as the final decisions regarding which facilities will undergo in-depth analyses (Task 3.5), shall be made in coordination with BACWA and the Regional Water Board.

Approach to estimating nutrient load reductions

Preliminary assessments will include estimates of Total Inorganic Nitrogen (TIN) and total phosphorus (TP) reduction potential associated with the conceptual implementation of one or more types of NBS strategies suitable for a given discharger. Potential load reductions will be presented on a discharger basis as well as the OLU-scale. This will satisfy the requirements of the Nutrient Watershed Permit to identify potentially suitable sites and estimate resulting nutrient reductions, in terms of TIN and TP.

Quantitative estimates of TIN reductions will assume full conversion of TIN to NO_3^- for the purposes of conceptual estimates, which is required to maximize efficient denitrification rates as well as minimize ammonia toxicity in aquatic receiving waters. During site-specific evaluations (Task 3.5), analyses will include refinements to nitrification needs, including partial nitrification based on NBS capacity limitations. Facility information obtained during the *Optimization and Upgrade Project* will be utilized to inform site-specific nitrification requirements.

Several models and methods are available from the literature to estimate nutrient removal from wetlands and perform other wetland sizing parameters.[29,5] To estimate the conversion of NO_3^- to N gases from unit-cell open water wetlands (UPOW) and free water surface (FWS) constructed wetlands, the tanks-in-

series model has been used extensively and will be used for this Regional Evaluation.[7,13,20] This model can be transformed to estimate wetland area needs for corresponding nitrate concentration reduction scenarios:

$$\frac{C_{out}}{C_{in}} = \left(1 + \frac{kA}{NQ}\right)^{-N}$$

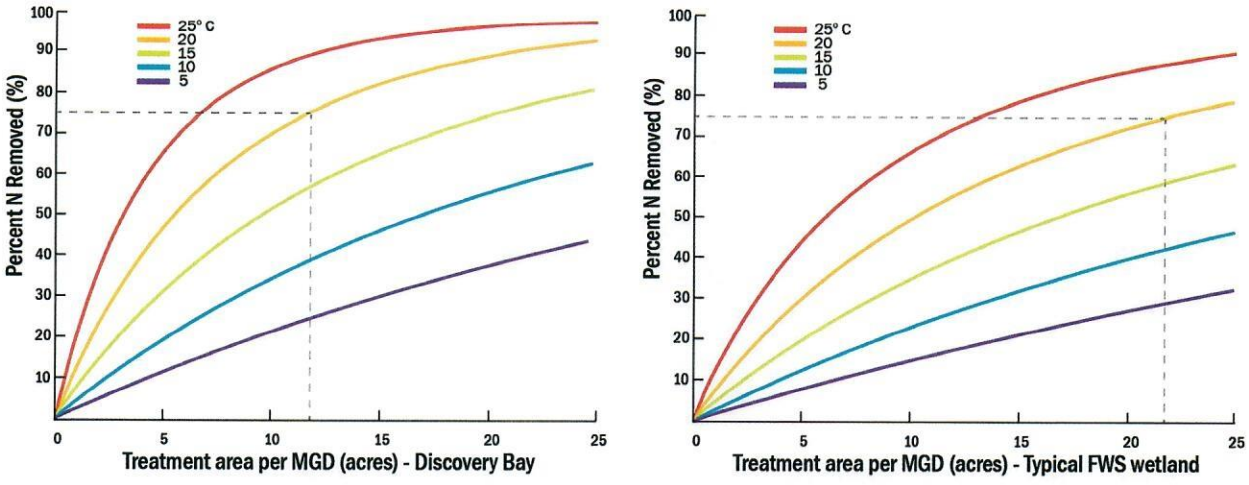
Where:

Cout is the outlet NO3 – concentration,
Cin is the inlet NO3 – concentration,
k is the areal removal rate (m yr^{-1}),
A is the wetland area (m^2),
Q is the influent flow rate (m^3 yr^{-1}), and
N is the number of tanks-in-series used to describe cell hydraulics.

First-order rate constants are available from the literature for FWS and UPOW wetlands. The k value reflects a strong seasonal dependence of NO_3^- removal, consistent with the effect of water temperature on denitrification rates, as predicted by the modified Arrhenius equation:

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

Where θ is the temperature coefficient, k_{20} is the first-order removal rate at 20 °C (m yr^{-1}), and T is the water temperature (°C). From a recent demonstration project at the Town of Discovery Bay's wastewater treatment plant, k_{20} was 59.4, whereas an average value for vegetated FWS treatment wetlands is 25, reflecting higher treatment performance from the unvegetated shallow basin system at Discovery Bay. In addition to k_{20}, N is a value particular to the system in question. Jasper et al (2014) assumed an N of 6.4 for the optimized shallow basin whereas Kadlek (2012) used a value of 4.4 to represent average FWS wetland systems.[12,13] The higher N value suggests a serpentine system with longer hydraulic residence time. The figures below illustrate the temperature-driven seasonal shifts in treatment performance for the two types of systems, which can be used to estimate wetland required to treat a given volume and to achieve an approximate level of treatment performance.



Nitrate removal performance in optimized shallow basins at Discovery Bay versus average performance of vegetated FWS treatment wetlands

Approaches to estimating TP removal is not as well established as those for NO_3^- and requires additional investigation and consultation with experts, regarding appropriate coefficient ranges for the NBS types under consideration. Additional investigation is also required to estimate NO_3^- removal from denitrifying bioreactor systems, including ecotone wetlands since the literature on these systems is limited. Preliminary data from the Oro Loma system is available and will be evaluated to confirm the most appropriate models and removal rates.

3.4. Site-Visits and Synthesis

Following the preliminary assessment phase, stakeholders may wish to perform additional outreach to a select group of dischargers to inform opportunities and constraints as well as narrow the list of dischargers undergoing in-depth site-specific evaluations. In consultation with the BACWA CMG for this project and the Regional Water Board, a list of up to twelve (12) facilities will be developed, representing dischargers where either additional site-specific information is required, or site-specific evaluation is likely (Task 3.5).

Site visits to each of these facilities will be undertaken by two-person teams, comprised of SFEI staff or contractors with experience in the design and siting of nature-based flood or wastewater-related solutions and/or landscape ecology. Key staff with intimate knowledge of plant operation, land ownership on and adjacent to the wastewater facility, and understanding of current or proposed master planning efforts, are expected to participate in the visit and escort SFEI staff or contractors to areas of interest. This likely includes the General/Plant Manager of the facility or other senior staff with a comparable understanding of plant operations and planning initiatives.

Objectives of the site visits include confirmations of how the plant operates, evaluate areas considered potentially suitable for conversion to nature-based wastewater treatment facilities, and identify opportunities and constraints to implementation. An example list of information that will be generated during the site visit is as follows:

- Confirm land ownership of potentially suitable lands for conversion to NBS
- Validate opportunities and constraints to nitrification of effluent
- Identify ecological and physical constraints, including likely environmental constraints or regulatory issues pertaining to sensitive species, wetlands, contamination.
- Identify available special studies or surveys available that could support site-specific evaluations, such as habitat surveys, topographic surveys, wetland delineations, groundwater, and geological surveys.
- Confirm the status of any on-going or proposed planning efforts pertaining to flood risk, wastewater recycling, sea level rise adaptation, or NBS for habitat and/or water quality improvement.
- Confirm the status of any on-going optimization/upgrade projects and summarize their potential impacts on nutrient discharge loads.
- Generate a list of suitable NBS types for wastewater treatment, as well as supporting information needed to validate this information in consultation with expert advisors, and their implications, such as:
    - Flow routing and pumping strategy
    - Nitrification requirements
    - Impacts to sensitive habitats
    - Vector control considerations

- Elevation constraints
- Need for carbon supplementation
- Conflicting land uses and potential stakeholder concerns
- Maintenance and operations issues

For each facility visited, a memorandum (<5 pages) will be prepared to summarize the site visit, information obtained and recommendations regarding further evaluations. Each facility will have the opportunity to review the memo and provide comments. The memo will include the following:

- Description of the plant and the current discharge requirements
- Description of the potential impact on nutrient discharge loads from on-going optimization/ upgrade projects and the status of any other projects with a nexus to NBS, nutrient reduction, wastewater recycling, or flood risk mitigation.
- Checklist confirming the preliminary assessment findings, including but not limited to land use, environmental constraints, and interest in pursuing NBS projects.
- List of potential NBS strategies, as well as an estimation of the range of nutrient removal benefits associated with each, and the likely ancillary benefits/negative consequences.
- Summary and conclusions

Each facility will have the opportunity to review the memo, provide comments, and inform decisions regarding whether the site should be subject to additional evaluations.

3.5. Site-Specific Evaluation

The selection of sites for in-depth evaluation will follow Tasks 3.3 (Preliminary Evaluation) and 3.4 (Site Visits and Synthesis). The focus of this effort will be to identify site-specific NBS strategies and costs at approximately 5-10 facilities. Final site selection decisions shall be based on the following criteria, in consultation with the Regional Water Board and BACWA's CMG for this project:

1. Information collected and recommendations made pursuant to Tasks 3.3 and 3.4;
2. The magnitude of potential NBS-based nutrient load reductions;
3. Internal support for pursuing NBS-based nutrient load reduction strategies, including management and board interest, technical capacity to oversee design and implementation, availability of funds to conduct further evaluations or provide matching grant funds; and
4. Whether a facility is pursuing an NBS-based project that could benefit from additional resources and analysis not otherwise possible or available.

With respect to selection criteria #4, in addition to developing planning-level alternatives for NBS strategies at facilities not already pursuing such projects, projects in progress will be evaluated for the purposes of developing real-time case studies and the need for additional support, for the purposes of advancing the science and policy of NBS implementation in the region. Should the Regional Water Board and BACWA agree one or more on-going projects require additional technical, outreach, or governance-based support, resources will be applied in consideration of available resources. The focus of site-specific evaluations, however, is to identify and advance new projects with agencies not already pursuing NBS for nutrient management.

One or more planning-level alternatives will be generated for each discharger selected for site-specific evaluation. Anticipated outputs for each discharger will include the following, presented in a compiled report suitable for submission to the Regional Water Board, to fulfill permit obligations, as well as for use in communication and outreach purposes:

1) Planning-level designs for one or more NBS alternatives will be generated to a level sufficient to enable cost estimation and serve as an outreach tool for decision-makers, the public, and regulators. The format of the designs has not been decided upon but will likely be generated with AutoCAD or compatible formats;
2) Cost estimates will be prepared to inform capital and operating costs for the most attractive option. Capital and operating costs will be presented for the NBS system as well as associated nitrification requirements. Effort shall be made to calculate and present costs in a manner allowing for comparability with outputs of the Optimization and Upgrade Study;
3) Estimation of nitrogen (TIN) and phosphorous (TP) discharge reductions associated with each project alternative;
4) Comparison of NBS nutrient reduction strategies with greyscape-based technologies, in terms of ability to meet Level 2 (15 mg L^{-1}), 3 (6 mg L^{-1}), and Advanced (3 mg L^{-1}) TIN reduction scenarios;
5) Ancillary benefits of each project, including estimates of emerging contaminant removal, restored habitat, degree of sea-level rise protection;
6) Negative consequences of implementation, such as lower degree of certainty regarding treatment performance versus traditional wastewater treatment approaches, GHG releases (methane/nitrous oxide), vector attraction/need for monitoring & control;
7) Likely and potential challenges to implementing each project, such as regulatory issues, cost, and potential stakeholder concerns; and
8) Incorporate outputs of the OLU Phase 2 project, including sea-level rise adaptation pathways on the OLU- and site-specific POTW scale (i.e., conceptual strategies for 2030, 2050, 2100 horizons). In-depth adaptation pathways are expected to be generated for three (3) dischargers, through the OLU Phase 2 Project, while more generalized adaptation pathways will be developed for the other dischargers where site-specific evaluations are performed.

4. CASE STUDIES & BARRIERS TO IMPLEMENTATION

Stakeholders and regulators have requested that this project also include a compilation of case studies of existing and on-going NBS projects in the region and elsewhere in California and other semi-arid regions, to identify lessons learned and strategies to reduce barriers to implementation. Stakeholders also wish to more thoroughly evaluate barriers to implementation, to minimize regulatory burden and implementation costs. This will include details of the regulatory processes involved in, as well as costs and institutional factors leading to success/failure.

Targeted outreach will be necessary to identify information on projects not already characterized or where additional information is needed. For those local agencies with NBS already in operation, the Discharger Survey (Task 3.1) will be targeted to request information including operations and maintenance, costs, treatment performance, as well as institutional and regulatory factors leading to success/failure.

The level of effort applied to this project element depends on the availability of resources and must be evaluated more fully. This section introduces projects in the region that could be analyzed and an introduction to the barriers to implementation that will be explored more fully on a project-specific or region-wide basis.

4.1. Introduction to the History of Treatment Wetlands in the Bay Area

Bay Area sanitation districts were some of the first along the West Coast to adopt treatment wetlands into their treatment trains. Based on a review of the available information, Mt. View Sanitation District was the first on the West Coast to adopt natural treatment, starting as a pilot project in 1974 and adopted as a permanent feature in 1977. This took place several years prior to initiation of the well-studied Arcata Marsh and Wildlife Sanctuary, in Humboldt County. Since then, Las Gallinas, Fairfield-Suisun Sewer District (FSSD), Sonoma Valley County Sanitation District (SVCSD), Union Sanitary and Petaluma have formally integrated wetlands into their treatment processes. Others have incorporated wetlands into their treatment process as demonstration projects, including Oro Loma Sanitation District and the Palo Alto Regional Water Quality Control Plant. For some of these examples, detailed case studies are compiled in EPA reports or through a recently prepared report by the Regional Water Board.[8,31]

Table 5. Summary of the permanent, pilot, or demonstration-scale treatment wetlands currently operating in the Bay Area

LOCATION	DISCHARGE TYPE	SUMMARY
Las Gallinas Valley SD	permanent discharges to wetlands and agriculture	Las Gallinas Valley Sanitary District employs a reclamation project consisting of 200 ac irrigated pasture, 40 acres (ac) of storage ponds, a 20-ac freshwater wetland, 10 ac salt marsh and landscape irrigation to eliminate dry weather discharges. This project has been active since 1984.
Ellis Creek Water Recycling Facility, Petaluma	permanent discharges to wetlands adjacent to a tidally influenced portion of the Petaluma River	~4.5 million gallons per day (MGD) of dry weather flows routed to treatment wetlands, beginning in 2009. Flow is routed from 146 ac oxidation ponds to 16 ac constructed wetlands. Water is then chlorinated then routed to 31 ac of polishing wetlands or a chlorine contact chamber. Dechlorinated water discharged to the Petaluma River or recycled for irrigation. Nutrient removal data from the wetlands is not available.
Moorhen Marsh; Mt. View SD	permanent discharges to treatment wetlands	1.3 MGD dry weather flow routed to treatment wetland, prior to release to Suisun Bay, representing 100% of the total flow from the facility. Nitrified effluent (~30 mg L–1 NO3) is discharged to the wetland and removal effectiveness ranges from 13% in winter months to 50% in the summer months (~30% annual average). Ponds A & B came online as a pilot project in 1974. Ponds C, D & E came online in 1977.

LOCATION	DISCHARGE TYPE	SUMMARY
Oro Loma SD	pilot/demonstration discharges to an open water pond and horizontal levee	The Oro Loma Sanitary District's Wet Weather Equalization and Ecotone Demonstration Project involves studying the application of treated wastewater to create upland ecotone habitats for tertiary treatment and sea-level rise adaptation. The project remains in the testing phase of treatment performance.
Union Sanitary	on-going discharges to Hayward Marsh	~2.6 MGD routed to three 145 ac freshwater marsh basins and two 60 ac brackish basins. NPDES permit was obtained in 1983 and effluent was supplied to Hayward Marsh starting in 1988. Ponds need maintenance and future use as a treatment wetland is uncertain.
Palo Alto	long-term demonstration project involving discharges to Matadero Creek via Renzel Marsh	Nitrified effluent discharged to Renzel Marsh prior to discharge to Matadero Creek, beginning in 1994. Wetland complex comprised of 15 ac freshwater marsh and Data from 2013-14 indicates Renzel Marsh can reduce marsh influent TN concentrations by 40% via denitrification and cellular uptake (based on 0.74 MGD flow). Phosphorus is reduced by only 4%. Phase II study involved 1.26 MGD, where TN removal reduced to 30%.12
Fairfield	on-going discharges of advanced secondary effluent to Boynton Slough (Suisun Marsh)	FSSD discharges ~14 MGD of advanced secondary effluent to Boynton Slough, part of the larger Suisun Marsh complex. Approximately 10-15% of FSSD effluent recycled for agricultural and landscape irrigation.
Napa-Sonoma Marsh	on-going discharges to Schell Slough, two managed wetlands and Napa-Sonoma Marsh	SVCSD discharges tertiary-treated effluent during the wet season to Schell Slough during the time of reduced demand for recycled water. Water is discharged to two managed wetlands during the dry season to maintain freshwater marshlands and ponds. Future discharges may occur to aid in the restoration of 9,460 ac of saline ponds in Sonoma Marsh.
Silicon Valley Advanced Water Purification Center	experimental-scale Unit-Cell Open Water Wetlands	Valley Water is partnering with the ReNUWIt consortium (Stanford & UC Berkeley), as well as SFEI to test the performance of UPOW systems for the treatment of reverse osmosis concentrate sourced from their advanced recycling system. Several other pilot projects are being considered for treatment evaluation, including the use of 'floating wetlands' and the horizontal levee at Oro Loma SD, as well as a non-NBS technology for metals removal.

4.2. Barriers to Implementation: Processes & Recommendations

The benefits of multi-benefit shoreline resiliency projects, including treatment wetlands, horizontal levees, beneficial reuse sites, and integrated habitat enhancement/flood risk reduction projects are well documented, widely encouraged, and not worth repeating here. Bay Area sanitation districts were some of the first along the West Coast to adopt treatment wetlands into their treatment trains and most agencies recognize their value in reducing contaminants and adapting to sea level rise.[32]

Virtually every management plan dedicated to Bay restoration and water quality enhancement have for years actively supported green infrastructure. Yet institutional and permitting-related challenges pose a persistent impediment to implementation. It is no agency's responsibility to champion these projects, let alone finance them. And permit processes across the resource management landscape make no distinction between grey infrastructure-based shoreline development (e.g. hotels and office complexes) and green infrastructure presenting multiple benefits to habitats and communities.

A summary of the governance and permit-based challenges are introduced here and will be explored further in the course of this Regional Evaluation. Remedies to these issues require coordination and coalition building on scales perhaps never initiated in the Bay Area. A framework for addressing these will be explored with key stakeholders and agencies with an interest in easing the regulatory and institutional hurdles of implementing multi-benefit projects. Opportunities for exploring these issues could be pursued through a selection of the complementary regional and sub-regional initiatives currently underway that could affect wetland planning and potentially help facilitate utilization of existing or created wetlands for multiple benefits, including wastewater treatment:

- BCDC's Adapting to Rising Tides (ART) project
- Baylands Ecosystem Habitat Goals Update (BEHGU)
- South Bay Salt Ponds Restoration Project (SBSP)
- Coastal Hazards Adaptation Resiliency Group (CHARG)
- San Francisco Bay Restoration Authority
- BCDC's Bay Fill Working Group

Targeted outreach to the appropriate representatives of these groups, some of which overlap, may result in funding opportunities or avoidance of duplicated regulatory engagement or community outreach.

Geography

The fundamental constraint to deploying natural treatment of wastewater effluent in an urban setting such as the Bay Area lies in securing enough land area to construct wetland treatment wetlands in quantities necessary to meet substantial load reductions. In those instances where land is available, however, nutrient reductions could be achieved with natural systems at a significantly lower cost, compared to traditional grey infrastructure approaches.

In addition to physical constraints of finding available land to construct or restore multi-benefit projects on the shoreline, other geographic constraints include those involving land use, infrastructure, and environmental conflicts, for instance:

- Prohibitively high land acquisition costs and/or the need for complex use agreements
- Restrictive land-use designations that may prohibit wastewater treatment facilities of any type

- Physical and institutional challenges of meeting multiple infrastructure needs (e.g. flood risk, habitat, water/power conveyance)
- Local objections to the utilization of baylands for wastewater treatment or discharging treated effluent to nearshore Waters of the U.S.
- Sea level rise considerations, requiring criteria for assessing appropriate elevation bands, specification of project lifetime, and other flood-related design criteria.

Land acquisition and use agreements will be of concern throughout high-cost and built-out portions of the Bay Area. In the Central Bay, for instance, little to no land acquisition opportunity exists and in most other portions of the region, treatment wetlands may only be feasible where lead or partner agencies have already acquired land. Environmental and stakeholder conflicts are sure to arise wherever real or perceived threats to existing or planned wetlands could occur. Careful outreach to resource agencies, grassroots NGOs, and community groups, as well as the incorporation of ecological risk management strategies throughout the design stage, must be prioritized to address such concerns.

Institutions and Governance

The planning, design, and implementation of constructed wetlands and multi-benefit projects, in general, requires inter-agency coordination and cooperation, potentially involving multiple municipalities and landowners. The successful coordination of these stakeholders relies on strong governance and modifications to institutional norms. Institutions refer to the structures, processes, rules, and norms that formalize the constraints and incentives facing participants pursuing a given action.[33] Governance refers to the systems and processes put into place to coordinate action and decision-making about the policies, financing, and management of multi-benefit projects likely to lead to nutrient load reductions.[32]

Efforts are underway to convene working groups around multi-benefit projects, modify regulatory structures or policies, and exchange best practices. It is not certain, however, that these changes are occurring with the level of scale or speed required in response to climate change or even our traditional regulatory frameworks. For instance, if large-scale nutrient reductions were deemed necessary and urgent, we cannot say that multi-benefit projects would be pursued over traditional nutrient removal technologies, despite interest and available funding. This Regional Evaluation intends to include an exploration of the governance and institutional barriers to implementation, which will be captured in part through the questionnaire process, and through on-going coordination with key stakeholders and regulators.

The release of recent research focused on barriers to implementation of multi-benefit projects and decision-making processes influencing nutrient management in the region provides a useful starting point.[34,32] Results generally suggest a preference for managing nutrients in the region through approaches that provide multiple benefits and indicate the strong need to address concerns surrounding the longevity of nature-based or traditionally engineered solutions when factoring in sea level rise and issues of aging infrastructure. This requires on-going dialogue and analysis extending beyond evaluations of technical opportunities and constraints to implementing one solution over the other.

Permitting

Projects involving the creation or enhancement of wetlands adjacent to or upland of SF Bay are subject to a number of regulatory requirements, generally pertaining to protection of water quality and sensitive species. Appendix B provides a summary of the range of applicable regulations and permits. Appendix C

contains an introduction to permitting processes for treatment wetlands in other parts of the country. This Regional Evaluation will include efforts to refine this information and identify a suite of regulatory and institutional constraints, as well as possible approaches to reduce these hurdles while maintaining appropriate protections and considerations.

The Regional Water Board and BCDC are actively investigating policies to address the challenges associated with granting approval to multi-benefit projects, particularly pertaining to treatment wetlands. Some recent policy updates and recommendations are included in Appendix B. This Regional Evaluation process could serve to inform policy and institutional modifications needed to advance NBS for wastewater treatment. Several NBS projects are currently in the planning, design, or permitting stages, serving as useful case studies to document changes made in response to evolving governance and institutional changes.

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APPENDIX A: 2ND NUTRIENT WATERSHED PERMIT LANGUAGE: NUTRIENT REDUCTION EVALUATIONS VIA NATURAL SYSTEMS

Section VI.C.2: Regional Evaluation of Potential Nutrient Discharge Reduction by Natural Systems

The major Dischargers listed in Table 1 shall, individually or in collaboration with other regional stakeholders, evaluate options and develop planning-level costs for nutrient discharge reduction by natural systems (e.g., wetlands and horizontal levees) as described below. These requirements do not apply to the minor Dischargers listed in Table 1.

a. Scoping Plan

By December 1, 2019, the Dischargers shall, individually or in collaboration with regional stakeholders, submit a Scoping Plan describing the level of work proposed to conduct the evaluation. The Scoping Plan shall include, but is not limited to, the level of work to complete the following for each Discharger's facility and sub embayment:

- Identification of sites, if any, for potential wetlands treatment systems;
- Identification of sites, if any, for potential wetlands creation or enhancement;
- Identification of sites, if any, for potential horizontal levee creation; and
- Identification of any of the above sites that are associated with a defined Operational Landscape Unit.

The Scoping Plan shall also include a schedule to complete, within one year of submitting the Scoping Plan, the identification of all potential sites that could use natural systems.

b. Evaluation Plan and Implementation

If a Discharger identifies potential sites, it shall proceed with an evaluation for its facility and sub embayment. By July 1, 2020, the Discharger shall, individually or in collaboration with regional stakeholders, submit an Evaluation Plan and schedule describing the methods and means for conducting the evaluation. The evaluation shall include, but not be limited to, the following tasks:

- Estimation of nitrogen (total inorganic nitrogen) and phosphorous (total phosphorus) discharge reductions associated with each project or associated Operational Landscape Unit;
- Identification of ancillary adverse effects and ancillary benefits from each project (e.g., removal of emerging contaminants, creation of habitat, or protection against sea level rise) or associated Operational Landscape Unit;
- Assessment of the feasibility, efficacy, reliability, and cost-effectiveness of each project; and
- Identification of potential challenges to implementing each project (e.g., regulatory barriers).

The Dischargers shall implement the Evaluation Plan tasks within 45 days of submittal.

c. Status Reports

By July 1, 2021, and again by July 1, 2022, the Dischargers shall submit, or cause to be submitted, a status report describing the tasks completed, preliminary findings, and tasks yet to be completed for each

site identified in the Scoping Plan, highlighting any adaptive changes made to the Evaluation Plan submitted in accordance with task b, above.

d. Final Status Report.

By July 1, 2023, the Dischargers shall submit, or cause to be submitted, a Final Status Report describing the tasks completed and findings for each site identified in the Scoping Plan. The Final Status Report shall also identify any remaining tasks or barriers for implementing an identified project.

APPENDIX B: POTENTIALLY APPLICABLE PERMIT APPLICATIONS AND APPROVALS

Potential permits and approvals required for nearshore multi-benefit projects in California are summarized here. This includes regulations governing wetlands, habitats and protected species and water quality.

Federal Approvals

National Environmental Policy Act (NEPA)

Overarching federal environmental review process triggered by federal actions or support from federal funds required for projects without an exemption (such as small projects, projects with a research focus, etc.). It can include cultural and historical resources review and other consultations. Treatment wetlands serving local POTWs are unlikely to require NEPA review though larger restoration and flood protection projects with a federal lead would generally integrate NEPA and CEQA reviews.

Clean Water Act, Section 404

Clean Water Act Section 404 permits, acquired through the U.S. Army Corps of Engineers (Corps), are needed for placement of fill in Waters of the U.S., which include most vegetated wetlands, canals, ditches, and sloughs except for waterbodies specifically used for water treatment purposes. Additionally, a Section 10 Rivers and Harbors Act Letter of Permission is required for placement of fill in navigable waters, such as tidal waters.

Consistent with EPA guidance, in most instances it is neither appropriate nor desired to construct treatment wetlands within Waters of the U.S., unless the source water associated with that project can be used to restore a degraded or former wetland.[1] Waters of the U.S. are waters or wetlands regulated by the CWA and by definition, waste treatment systems designed to meet the requirements of the CWA are not considered Waters of the U.S.[2]

While constructed treatment wetlands are generally not considered Waters of the U.S., if one is constructed in an existing Water of the U.S., the area will remain a Water of the U.S. unless an individual CWA Section 404 permit is issued that explicitly identifies it as an excluded waste treatment system designed to meet the requirements of the CWA. And if the constructed treatment wetland is abandoned or is no longer used as a treatment system, it may revert to, or become, a Water of the U.S. if it otherwise meets current definitions, subject to evaluation by the U.S. Army Corps of Engineers and/or the EPA. Additionally, if the constructed treatment wetland is not itself a Water of the U.S. but discharges pollutants into one, the discharge requires CWA Section 401 certification

[1] U.S. Environmental Protection Agency. Guiding Principles for Constructed Treatment Wetlands: Providing for Water Quality and Wildlife Habitat (EPA Publication 843-B-00-003, 2000; www.epa.gov/wetlands/guiding-principles-constructed-treatment-wetlands-providing-water-quality-and-wildlife).

[2] 40 CFR 122.2 9

The extent and magnitude of permitting challenges and mitigation requirements are informed by a wetland delineation to assess the extent, type and quality of Waters of the U.S. within the proposed project area. This will inform the type of permit needed (Nationwide vs. Individual), as well as mitigation. Impacts to Waters of the U.S. and/or State could require mitigation at a ratio of 3:1 or more, depending on the quality of habitat impacted, the type of mitigation proposed, and the location of the proposed mitigation site. Treatment wetland projects may be able to incorporate Waters of the U.S. in or in close vicinity to the proposed project location to minimize mitigation needs and associated expense.

The Corps uses Nationwide Permits (NWPs) to regulate projects with small environmental impacts under a more rapid permitting process than Individual Permits, which require much more time, effort, and expense. Potentially applicable NWPs include Nationwide Permit 27 (Aquatic Habitat Restoration, Establishment, and Enhancement Activities), Nationwide Permit 13 (Shoreline stabilization). New Nationwide Permit 54 (Construction of Living Shorelines) took effect in March 2017. These NWPs are reissued every 5 years and are subject to change.

Federal Endangered Species Act

In the event of potential take of species listed as threatened or endangered under the Federal Endangered Species Act (FESA) a Biological Opinion is required from either the U.S. Fish and Wildlife Service (USFWS) or National Marine Fisheries Service (NMFS). Take is broadly defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. Common species for consideration whenever tidal wetlands in San Francisco Bay may be impacted include the Ridgway's rail (*Rallus obsoletus*) and salt marsh harvest mouse (*Reithrodontomys raviventris*).

A Biological Opinion Is required from USFWS and/or NMFS prior to issuance of a CWA Section 404 permit, which may inform overall mitigation requirements.

Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) is the primary law governing marine fisheries management in U.S. federal waters, requiring NMFS consultation. This regulation is of significance to projects that may impact subtidal or intertidal habitats of San Francisco Bay, since all such habitat is designated as Essential Fish Habitat (EFH) within applicable fisheries management plans (FMPs) developed and implemented by NMFS. Avoidance and minimization measures to avoid impacts to species such as green sturgeon (*Acipenser medirostris*) and Central California Coast steelhead (*Oncorhynchus mykiss*) may be identified through consultation with NMFS.

State Approvals

California Environmental Quality Act

California Environmental Quality Act (CEQA) review is required for any project without an exemption (e.g. small projects, projects with a research focus) Requires examination of multiple environmental considerations in a broader context beyond the project footprint. Habitat restoration projects less than 5 acres with no anticipated negative impacts are categorically exempt under Guidelines Section 15333 (14 Cal. Code Regs. §15333). Multi-benefit treatment wetlands would not qualify for this exemption. CEQA review may involve assessment and mitigation for non-water quality and habitat-related impacts, such as cultural resources, air quality, and aesthetics.

Clean Water Act Section 401 Certification

Section 401 of the CWA requires an entity to obtain 401 certification whenever a federal agency is to issue a permit or license for an activity that may result in a discharge to Waters of the U.S, to address issues associated with placement of fill, turbidity, minimizing construction impacts to water quality. In this region, the SF Bay Regional Water Quality Control Board is delegated to authorize section 401 water quality certifications, which grants authority to review and approve, condition, or deny any Federal permits or licenses that may result in a discharge to waters of the United States within their borders, including wetlands. Examples of federal licenses and permits subject to section 401 certification include CWA section 404 permits for discharge of dredged or fill material issued by the Army Corps of Engineers (Corps), Federal Energy Regulatory Commission (FERC) hydropower licenses, and Rivers and Harbors Act section 9 and section 10 permits for activities that have a potential discharge in navigable waters issued by the Corps.

Waste Discharge Requirements and NPDES Permitting

Waste Discharge Requirements (WDRs) are required pursuant to California Water Code article 4, chapter 4, division 7 (commencing with § 13260). The Regional Water Board issues WDRs in an Order also consistent with federal Clean Water Act (CWA) section 402 and implementing regulations adopted by U.S. EPA and Water Code chapter 5.5, division 7 (commencing with § 13370). Orders also can serve as a National Pollutant Discharge Elimination System (NPDES) permit authorizing the Discharger to discharge into waters of the United States.

The Regional Water Board maintains significant authority to issue WDRs and NPDES permits. The San Francisco Bay Basin Plan serves in part to establish the SF Bay RWQCB's approach to management and permitting of projects in the region. The Basin Plan contains several discharge prohibitions related to direct or indirect discharges of wastewater discharges to the Bay, which conflict with nearshore discharges of treated wastewater through wetlands or point discharges. The prohibitions listed in Table 1 include those associated with discharge of secondary-treated wastewater, or higher. Additional prohibitions apply to wastewater solids and raw sewage.

To help facilitate the permitting of treatment wetlands and related multi-benefit projects, the Regional Water Board adopted Resolution No. 94-086, in 1994, to transparently grant exceptions to applicable Water Quality Control Plan waste discharge prohibitions regarding shallow discharges. Resolution No. 94-086 requires dischargers to demonstrate a net environmental benefit will be derived as a result of the discharge.

Regional Water Board staff have indicated a recognition that the Resolution should be updated to address sea level rise adaptation and incorporate lessons learned from existing projects. In a recent report, SF Bay RWQCB staff recommends updates to Resolution No. 94-086 with a list of minimum required elements that must be included in a marsh management plan including sea level rise planning, participation in regional monitoring efforts, and adaptive management.[8] More recently, the Regional Board has indicated a Basin Plan amendment may be necessary for fill projects, which may include multi-benefit fill projects including NBS for wastewater treatment.[4]

Table 1. Discharge Prohibitions Applicable to Wastewater Discharges to Treatment Wetlands

	DISCHARGE PROHIBITION	DESCRIPTION
1	Any wastewater which has particular characteristics of concern to beneficial uses at any point at which the wastewater does not receive a minimum initial dilution of at least 10:1, or into any non-tidal water, dead-end slough, similar confined waters, or any immediate tributaries thereof.	Waste discharges will contain some levels of pollutants regardless of treatment. This prohibition will require that these pollutants, when of concern to beneficial uses, be discharged away from areas such as non-tidal waters and dead-end sloughs. This prohibition will (a) provide an added degree of protection from the continuous effects of waste discharge, (b) provide a buffer against the effects of abnormal discharges caused by temporary plant upsets or malfunctions, (c) minimize public contact with undiluted wastes, and (d) reduce the visual (aesthetic) impact of waste discharges.
2	Any wastewater which has particular characteristics of concern to beneficial uses to San Francisco Bay south of the Dumbarton Bridge.	This prohibition is consistent with the 1974 Bays & Estuaries Policy. This area is one that has experienced chronic water quality problems.
3	Any wastewater which has particular characteristics of concern to beneficial uses to Suisun Marsh during the dry weather period of the year. Local irrigation return water is excepted in quantities and qualities consistent with good irrigation practices.	The threat of high concentrations of toxicants, biostimulants, and oxygen-demanding substances in Suisun Marsh, an area of low assimilative capacity, great ecological sensitivity and value, and poor dispersion by tidal or freshwater flushing, necessitates such protection for the Marsh for the critical portion of the year when freshwater flows are nonexistent.
4	Any wastewater which has particular characteristics of concern to beneficial uses to Alameda Creek when no natural flow occurs.	The threat of dissolved solids, stable organics, and other pollutant accumulation in the groundwater of the basins recharged with waters of Alameda Creek is critical in the dry weather period when wastewater could account for much of the water percolating to the basin.
5	Any wastewater which has particular characteristics of concern to beneficial uses to Tomales Bay, Drakes Estero, Limantour Estero, Bolinas Lagoon, or Richardson Bay (between Sausalito Point and Peninsula Point).	Tomales Bay, Drakes Estero, and Limantour Estero are nearly pristine bodies of water and of great value for wildlife habitat and as recreational and scientific study areas. Bolinas Lagoon and Richardson Bay both have poor dispersion capability and low assimilative capacity. They have experienced high coliform, nutrient, and algal concentrations. This prohibition will provide protection for the intensive recreational beneficial uses of these water bodies.
6	All conservative toxic and deleterious substances, above	The intent of the prohibition is to minimize the discharge of persistent toxicants into waters, thus protecting aquatic life and public water

	DISCHARGE PROHIBITION	DESCRIPTION
	those levels which can be achieved by a program acceptable to the Regional Board, to waters of the Basin.	supplies. The prohibition recognizes that these substances can be most economically reduced at their source.
16	Waste that is not a sufficient distance from areas designated as being of special biological significance to assure maintenance of natural water quality conditions in these areas.	The intent of this prohibition is to protect the relatively pristine nature of these special areas.

The SF Bay RWQCD recently prepared a staff report to support the evaluation of regulatory options associated with permitting multi-benefit projects designed to address sea level rise. Such projects could include treatment wetlands and other multi-benefit shoreline resiliency projects. Among the evaluations considered in the report were approaches to address the fact that discharge prohibitions of the Basin Plan discourage the use or application of treated effluent nearshore for habitat enhancement, water quality improvement, and climate resiliency. Discharge prohibitions must always be met unless an exception is granted. The four (4) identified exceptions are summarized in Table 2.

Table 6. Basin Plan Exceptions to Discharge Prohibition to Shallow Waters

	EXCEPTION	DESCRIPTION
1	Inordinate Burden/Equivalent Level of Protection	An inordinate burden would be placed on the discharger relative to beneficial uses protected and an equivalent level of environmental protection can be achieved by alternate means, such as an alternative discharge site, a higher level of treatment, and/or improved treatment reliability
2	Reclamation Project	A discharge is approved as part of a reclamation project
3	Net Environmental Benefit	It can be demonstrated that net environmental benefits will be derived as a result of the discharge
4	Groundwater Cleanup Site	A discharge is approved as part of a groundwater clean-up project, and in accordance with Resolution No. 88-160 "Regional Board Position on the Disposal of Extracted Groundwater from Groundwater Clean-up Projects," and it has been demonstrated that neither reclamation nor discharge to a POTW is technically and economically feasible, and the discharger has provided certification of the adequacy and reliability of treatment facilities and a plan that describes procedures for proper operation and maintenance of all treatment facilities. (The Water Board recognizes the resource value of extracted and treated groundwater and urges its utilization for the highest beneficial use for which applicable water quality standards can be achieved.)

Treatment wetlands permitted to date have been authorized by the Water Board after qualifying for one or more exceptions. Of the six (6) treatment and natural wetlands currently utilizing wastewater in the Bay Area, five (5) received an inordinate burden/net environmental benefit exception; four (4) were considered to maintain an equivalent level of protection, and three (3) were considered a reclamation project. The way these exceptions are applied are rather opaque, however. The Basin Plan itself recognizes as such in Section 4.2, where "This broad language has been and will be interpreted by the Water Board on a case-by-case basis".

The Water Board has recently developed several options for enhancing consistency and transparency. These alternatives include:

1. Create a Water Board resolution to guide the future permitting of multi-benefit projects designed to address sea level rise. The resolution could be based, in part, on updates to Resolution No. 94-086 to reflect current use of treatment wetlands and projected future use of wastewater as a resource in Bayland wetlands. The resolution could cover both:
    a. treatment wetlands and the use of wastewater to enhance existing wetlands; and
    b. the application of the No Net Loss Policy and wetland permitting to Bayland wetland projects that involve "beneficial fill."
2. Develop a general NPDES permit and WDRs for the discharge of treated wastewater to Bayland wetlands.
3. Develop general WDRs and Water Quality Certification for discharges of dredged or fill material in Bayland wetlands.
4. Develop an amendment to the Basin Plan with updates to reflect current practices with regards to designation of beneficial uses at wetlands; discharge prohibitions and exceptions; treatment standards; and application of the No Net Loss to Bayland climate change adaptation projects.

As of now, neither of these options have been actively pursued, though a Basin Plan amendment has been recommended.[3]

California Endangered Species Act

The California Endangered Species Act (CESA) prohibits the take of any species of wildlife designated by the California Fish and Game Commission as endangered, threatened, or candidate species. The California Department of Fish and Wildlife (CDFW) may authorize the take of any such species through several mechanisms, if certain conditions are met:

1. An Incidental Take Permit (ITP) may be obtained, pursuant to section 2081(b) of the Fish and Game Code, allowing CDFW to authorize take of species listed as endangered, threatened, candidate, or a rare plant, if that take is incidental to otherwise lawful activities and if certain conditions are met;
2. If a species is listed by both the federal Endangered Species Act and CESA, Fish and Game Code section 2080.1 allows an applicant who has obtained a federal incidental take statement (federal section 7 consultation) or a federal incidental take permit (federal section 10(a)(1)(B)) to request a finding of consistency with CESA; or

[3] *Staff Report: Bay Fill for Habitat Restoration, Enhancement, and Creation in a Changing Bay*, San Francisco Bay Conservation and Development Commission: San Francisco, CA, 2019; p 78.

3. A Safe Harbor Agreement (SHA) authorizes incidental take of a species listed as endangered, threatened, candidate, or a rare plant, if the implementation of the agreement is reasonably expected to provide a net conservation benefit to the species, among other provisions, pursuant to section 2089.2-2089.26 of the Fish and Game Code. SHAs are intended to encourage landowners to voluntarily manage their lands to benefit CESA-listed species. California SHAs are analogous to the federal safe harbor agreement program and CDFW has the authority to issue a consistency determination based on a federal safe harbor agreement.

California Department of Fish and Wildlife consultation and Letter of Authorization is required to obtain a Scientific Collecting Permit for projects involving the collection and transplantation of native plants and wildlife (e.g. eelgrass donor, native oyster, and other native species collections).

Streambed Alteration Agreements (California Fish and Game Code Sections 1600-1617)

Sections 1600-1617 of the CA Fish and Game Code involve the conservation of fish and wildlife through requirements associated with impacts to rivers, streams or lakes requiring a Streambed Alteration Agreement (Agreement). In general, an entity may not substantially divert or obstruct the natural flow of, or substantially change or use any material from the bed, channel, or bank of, any river, stream, or lake, or deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake, unless an Agreement has been obtained from CDFW. The Agreement may contain mitigation measures intended to reduce the effect of the activity on fish and wildlife resources and/or monitoring condition to assess the effectiveness of the proposed mitigations related to the activity. Waterbodies subject to these regulations include those that may or may not be Waters of the U.S., including vernal pools, ephemeral streams, desert washes, and watercourses with a subsurface flow.

Consistency Determination pursuant to California Coastal Act

The California Coastal Commission implements the California Coastal Act of 1976 and has regulatory authority over development along the coast in balance with the protection of coastal resources, environmentally sensitive habitats, and public access. This work is carried out through land use planning and permitting. The Commission also has a responsibility to work with local governments to establish Local Coastal Programs (LCPs) which, when certified by the Commission, becomes the land use plan basis for coastal permitting at the local level. More specifically, Coastal Development Permits (CDP) are typically required for living shoreline projects. CDP is the regulatory mechanism by which proposed developments in the coastal zone are brought into compliance with the policies of Chapter 3 of the Coastal Act. After the Commission certifies an LCP most coastal development permit authority is delegated and coastal development permit applications are then reviewed and acted on by cities and counties.

Bay Conservation and Development Commission

Pursuant to the McAteer-Petris Act, any person or governmental agency wishing to place fill in, or to extract materials exceeding $20 in value from, or make any substantial change in use of any land, water, or structure jurisdictional areas of BCDC jurisdiction must secure a permit from the Commission. Permits issued by BCDC include Administrative Permits (smaller footprint, minimal impacts) or Individual Permits (larger footprint, impacts). The Commission is currently undergoing review of their existing mandate and

any changes necessary to allow the appropriate use of 'beneficial fill' and allow experimental climate adaptation approaches such as living shorelines.

BCDC's jurisdiction includes the open water, marshes and mudflats of greater San Francisco Bay and the first 100 feet inland from the shoreline around San Francisco Bay, as well as salt ponds and certain other areas that have been diked-off from San Francisco Bay. The McAteer Petris Act provides that the Commission shall grant a permit if it finds that the project is either: (1) necessary to the health, safety, or welfare of the public in the entire Bay Area; or (2) consistent with the provision of Act and with the applicable provisions of the San Francisco Bay Plan (Bay Plan).

Key provisions of the Bay Plan prevent Bay fill, even for the purposes of wetland restoration. In 2015-2016 BCDC initiated the Policies for a Rising Bay Project, which was intended to address the fact that the McAteer Petris Act and BCDC's policies are intended to bar filling of the Bay and do not exempt certain projects that might serve to enhance sea level rise resiliency or improve habitat and water quality. The project resulted in a final report with recommendations in late-2016 and finalization of a Bay Plan amendment in 2019.[4]

California State Lands Commission

Coordination to confirm whether the project is on state-owned or leased lands, and to confirm CEQA compliance. Projects proposed on land under State Lands Commission ownership require Commission Approval and a Lease Agreement.

Local Permits and Approvals

Consultation with local jurisdiction (county, city, and/or municipality) may include grading permits, approval by City Council or other local jurisdictional body such as a Major Use Permit.

License Agreements or other permission mechanisms with landowner(s) may include agreements with (private, local, state, or federal) landowner(s) such as a Right of Entry Permit that provide permission to access or Encroachment Permit that provides permission to construct. Note that many coastal and estuarine shoreline and nearshore subtidal areas can have multiple landowners/parcels even in a small area.

[4] *Staff Report: Bay Fill for Habitat Restoration, Enhancement, and Creation in a Changing Bay*, San Francisco Bay Conservation and Development Commission: San Francisco, CA, 2019; p 78.

APPENDIX C: SAMPLE AND COMPLIMENTARY PERMITTING STRATEGIES

Florida's 'Wastewater to Wetlands' Program

Starting in 1989, Florida formally adopted regulations and standards specifically for domestic wastewater discharges to wetlands, making it likely the most experienced state in administering a 'wastewater to wetlands' permitting program.[5] This program was originally conceived in the 1970's as a means to address the loss of wetlands. Rules established starting in the 1980s regulate (1) the quality and quantity of wastewater which may be discharged to wetlands and (2) the quality of water discharged from wetlands to contiguous surface waters. It also provides water quality, vegetation, and wildlife standards (which provide protection of other wetland functions and values) and establishes permitting procedures and extensive monitoring requirements for wastewater discharges to wetlands.

Wetlands receiving wastewater effluent are classified based on the level of treatment provided by the wastewater facility (secondary treatment with nitrification or advanced wastewater treatment), background hydrology of the wetland (hydrologically altered or hydrologically unaltered), wetland's origin (man-made or natural), and the type of vegetation (herbaceous or woody). This classification system permits a transparent permitting process for dischargers wishing to create, enhance or restore wetlands using municipal wastewater.

Florida also specifies discharge limits to various types of treatment wetlands, requiring that all discharges must receive secondary treatment with nitrification. Discharge Limits for discharges to treatment wetlands and receiving wetlands are identified in Tables 1 and 2. These limits do not generally apply to man-made wetlands and the distinction between treatment wetlands and receiving wetlands is ambiguous from the regulations, with the exception that discharges to receiving wetlands are subject to stricter receiving water limits. These definitions differ from the California context, where treatment wetlands in California might be considered man made wetlands in Florida. Treatment and receiving wetlands in Florida generally seem to be lower quality wetlands enhanced or modified to receive domestic wastewater.

The rule promotes the use of man-made (constructed) and hydrologically altered wetlands by requiring less monitoring and allowing higher hydraulic and nutrient loading rates for those systems. These regulatory incentives attempt to create and restore wetlands. Many wetland systems are classified as reuse of reclaimed water, which states that if the applicant provides an affirmative demonstration that reclaimed water will be used to create, restore, or enhance wetlands, the project shall be classified as "reuse."[6]

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[5] Rule 62-611, Florida Administrative Code

[6] per Rule 62-610.810(2)(g), F.A.C.

Table 1. Discharge limits to treatment wetlands and receiving wetlands

Reclaimed Water Discharge Type	Parameter	Annual Average Discharge Limits ($mg\ L^{-1}$)
To a treatment wetland[7]	Total Ammonia	2 (monthly average)
To a receiving wetland[8]	Carbonaceous Biochemical Oxygen Demand (BOD)	5
	Total Suspended Solids (TSS)	5
	Total Nitrogen (as N)	3
	Total Phosphorus (as P)	1
	Total Ammonia	2 (monthly average)

Table 2. Discharge limits from treatment wetlands and receiving wetlands[9]

	Discharge Limits ($mg\ L^{-1}$) [10]			
Parameter	Annual Average	Monthly Average	Weekly Average	Single Sample
BOD	5	6.25	7.5	10
TSS	-	-	-	5
Total Ammonia	-	2	-	-
Un-ionized Ammonia	0.02	-	-	-
Total Nitrate	3	3.75	4.5	6
Total Nitrogen	3	-	-	-
Total Phosphorus	0.2	-	-	-

Based on the criteria, man-made wetlands as well as hydrologically altered wetlands used for wastewater treatment can be considered reuse provided the proper documentation of created or restored habitat is

[7] Treatment wetlands means a wetland within the landward extent of waters of the state that receive wastewater treated to secondary levels with nitrification

[8] Receiving wetlands means a wetland within the landward extent of waters of the state that receive wastewater treated to advanced wastewater treatment levels

[9] Presentation from Brady Skaggs, Lake Pontchartrain Basin Foundation at the 23rd Annual Tulane Environmental Law & Policy Summit, March 9, 2018. Available at www.youtube.com/watch?v=jqmfGz4B2Ho

[10] unless Water Quality Based Effluent Limitations (WQBEL) have been established

submitted.[11] Other wetlands projects may also be considered reuse if it is properly demonstrated that the application of reclaimed water will effectively "enhance" and continue to "enhance" the wetland. This "enhancement" however, is not clearly defined by the rules and is determined on a case-by-case basis.

Louisiana's 'Wetland Assimilation' Rules

Louisiana maintains a formal permitting program for the discharge of wastewater effluent to wetlands, which they refer to as wetland assimilation projects. Wetland Assimilation in Louisiana is characterized as the discharge of secondary-treated municipal effluent into natural wetlands to safely remove nutrients, sediment, and contaminants of emerging concern.[12]

Louisiana's Department of Environmental Quality (DEQ) identifies thirteen (13) wetland assimilation projects and the requirement associated with the permitting process, which appear far less stringent than Florida's. State regulations do govern the implementation of the program, which require an extensive baseline evaluation and a Water Quality Management Plan.[13] Assessment seems driven by an index of wetland biological integrity, guided by above-ground wetland vegetative production and diversity. Some water quality criteria are found in facility-specific permits, though they are generally less stringent than what would be expected in California and elsewhere.

Louisiana's examples appear to involve discharges to intact or degraded wetlands with less priority given to water quality indicators of influent or effluent quality, compared to Florida's program. Based on presentations from the recent 2018 Tulane Environmental Law Summit, scientists and activists are critical of the program based to limited wetland protections and weakened water quality criteria. California regulators will likely find Louisiana's approach lacks appropriate levels of protection, particularly with regards to treatment standards for discharges to natural wetlands. Outreach to LA-based practitioners and regulators, however, may be useful particularly with respect to gathering practical lessons learned on operations and maintenance of constructed wetlands.

Oregon Guidance for Treatment Wetlands

Oregon does not maintain regulations specific to treatment wetlands, though many municipal dischargers have adopted treatment wetland systems and the Department of Environmental Quality (DEQ) encourages appropriately designed and operated natural treatment systems. Consistent with water quality regulators in California and other states, Oregon's DEQ works with National Pollutant Discharge Elimination System (NPDES) permit holders interested in incorporating wetland treatments to add that system as an additional treatment train described in the permit. Oregon does, however, provide specificity in guidance documents regarding specific monitoring and reporting requirements for wetland treatment system, with special emphasis placed on early identification of the discharge point, mixing zone, and point of compliance.

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[11] Rule 62-610.810(2)(g), F.A.C.

[12] Presentation from Brady Skaggs, Lake Pontchartrain Basin Foundation at the 23rd Annual Tulane Environmental Law & Policy Summit, March 9, 2018. Available at www.youtube.com/watch?v=jqmfGz4B2Ho

[13] Louisiana Administrative Code (LAC) §33: IX.1109.J and § 33: IX.1113.B.12.b

Oregon notes a constructed wetland built outside of a natural wetland, waterway, or flood plain, is considered part of the wastewater treatment system and not subject to EPA, Army Corps of Engineers, or the Oregon Department of State Lands wetlands regulations.[14]

Integrated Permitting in the SF Bay Area for Dredging and Measure AA Projects

In 1990, the State Water Board, the SF Bay Regional Water Board, BCDC, the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, and the State Lands Commission created the Long-Term Management Strategy (LTMS) for the Dredged Material Management Office (DMMO). The DMMO is a collaborative partnership involving regulatory agencies, resource agencies, and stakeholders working together to address potential impacts from dredging and dredged material disposal to water quality, wildlife, and beneficial uses of the Bay. Among the main goals of the LTMS is to establish a cooperative permitting framework for dredging and disposal applications.

The LTMS was used as a model for the SF Bay Restoration Authority to develop a Regulatory Integration Team, the goal of which is to ease the permitting process for restoration and resiliency projects funded through the Measure AA grant program.[15] The aim is to facilitate faster permit approvals from the various permitting agencies in the Bay Area – with a target deadline of 120 days for simple restoration projects and 210 for more complex projects. A subgroup of the Team, the Policy and Management Group will develop and initiate policy initiatives, presumably with the intent of addressing governance and policy challenges associated with advancing beneficial projects in the region.

[14] Ibid.

[15] Estuary News. June 2018. "Permitting Made Easier". v.27 no. 2, P.2