SAN FRANCISCO BAY PLAN
CLIMATE CHANGE POLICY GUIDANCE

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION

PRODUCED AND PUBLISHED BY

SAN FRANCISCO BAY CONSERVATION & DEVELOPMENT COMMISSION

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The Richmond-San Rafael Bridge from the shoreline. Source: BCDC Staff.

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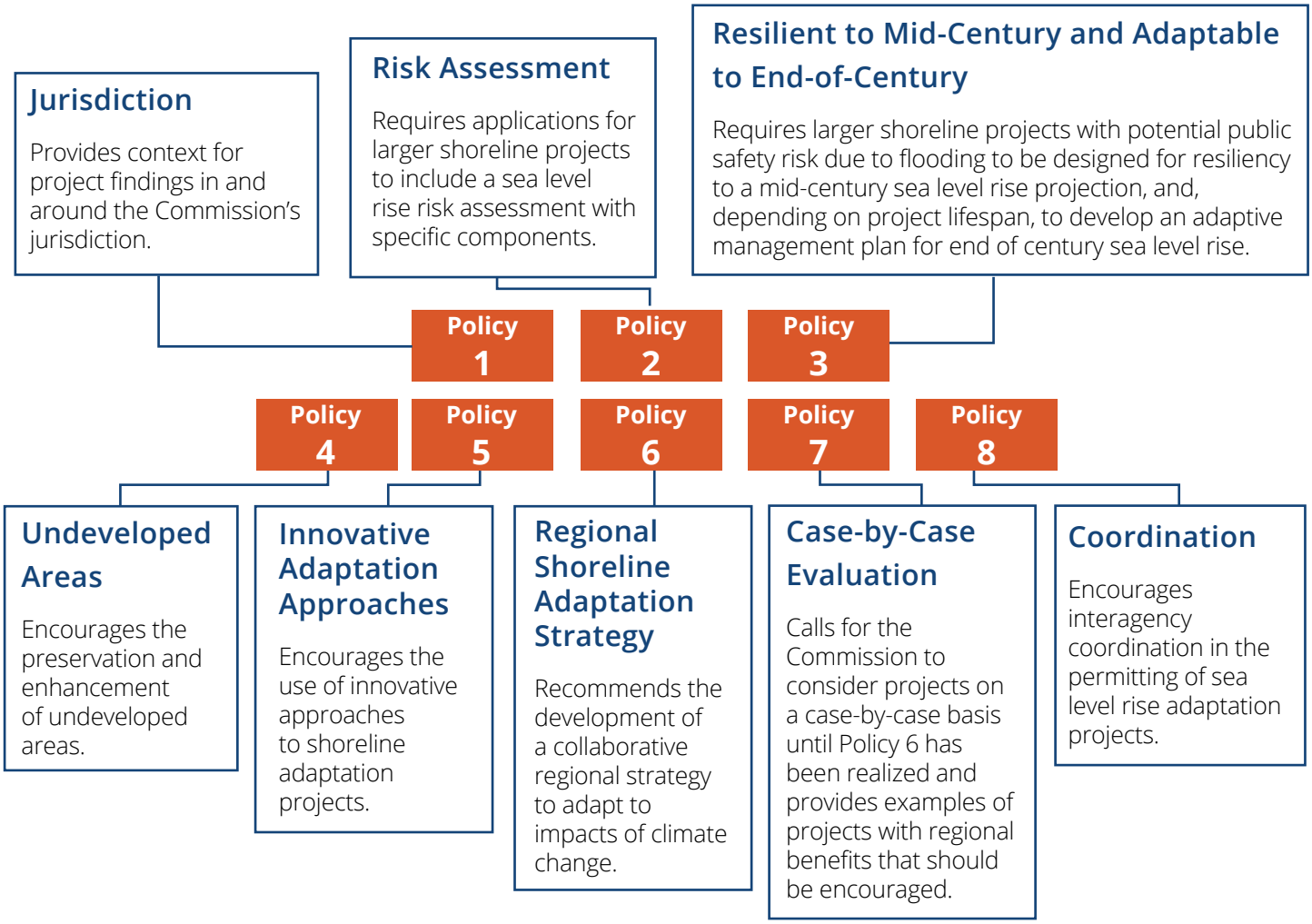
KEY TAKEAWAYS

THE BAY PLAN CLIMATE CHANGE AMENDMENT ADDRESSED THE NEED TO PLAN AND PREPARE FOR SEA LEVEL RISE

Climate change and sea level rise in particular will reshape the San Francisco Bay and its surrounding region. Sea level rise threatens the Bay's unique and critical ecosystems, public access to the shore and water, and developed areas including homes, ports, businesses, and other uses. In 2011, BCDC amended the San Francisco Bay Plan to add new policies and amend existing policies to include the authority to require climate change and sea level rise considerations for applicable projects, among other changes. The amendment addresses the need for resilience and adaptation on the San Francisco Bay and its shoreline through BCDC's permitting and planning authorities.



BAY PLAN POLICIES RELEVANT TO SEA LEVEL RISE ADAPTATION ARE PROVIDED AND DISCUSSED IN THE FOLLOWING CHAPTERS

The Climate Change Policies are summarized above and discussed in detail in Section 2.3. Other related Policies are discussed in Section 2.4. These related Policies allow for additional sea level rise considerations such as shoreline protection, public access resiliency, special considerations for habitat projects, or nature-based feasibility assessments.

THE CLIMATE CHANGE POLICIES DIRECT BCDC'S APPROACH TO ADAPTATION

The Climate Change Policies and the amended Policies in other sections of the Bay Plan range widely in scope. All Policies referenced in this report may be applied on a case-by-case basis to any project requiring a permit from BCDC. In most cases, the materials required as part of the permit application process will be adequate to enable BCDC staff to make the requisite findings and a recommendation to the Commission regarding a proposed project's consistency with respect to the Climate Change Policies. Contact BCDC staff to determine if a pre-application consultation is appropriate for your project.

The marina at Fisherman s Wharf. Source: BCDC Staff.

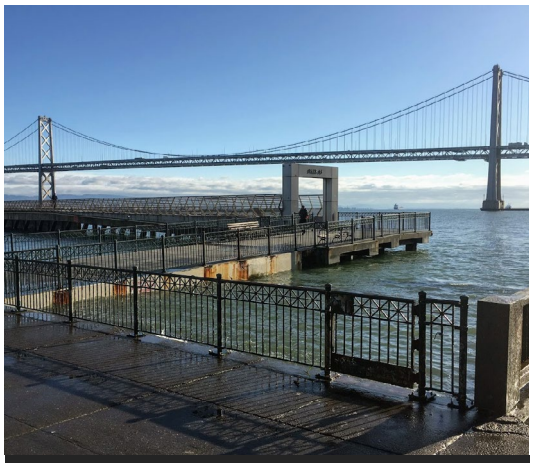
THIS GUIDANCE IS BASED ON A DECADE'S WORTH OF APPLICATION OF THE CLIMATE CHANGE POLICIES

BCDC regulates a range of activites, from residential improvements to public access improvements, habitat restoration, dredging, and development of complex shoreline infrastructure; see BCDC's Permitting Program. This guidance document is not a source of new regulations or processes, nor does it describe a step-by-step process for obtaining a permit. Prospective applicants are encouraged to consult BCDC staff to determine which Policies may apply to any project. A decade's worth of BCDC's permits were reviewed to provide example permit condition language for a variety of project types. Future projects may require new or innovative approaches to interpreting the policies and permitting projects that are not described in this Guidance. Readers are encouraged to review the examples to learn how the Commission has in past instances applied the Climate Change Policies in BCDC's permitting.

Wetland vegetation near the Bay. Source: BCDC Staff.

THIS GUIDANCE INCLUDES TECHNICAL RESOURCES AND INFORMATION FOR CONSIDERING SEA LEVEL RISE IMPACTS

This Guidance includes a range of resources that can be useful at various stages in adaptation planning and project design. It includes a primer on climate change science (**Appendix A**), as well as an overview of the advisory adaptation planning guidance, tools, and projects offered through BCDC's Adapting to Rising Tides Program (**Appendix B**). **Section 4** and **Section 5** provide an introduction to selecting climate scenarios based on the State of California's best available science, as well as information about different types of flooding and related coastal hazards.



King Tide at the Embarcadero. Source: BCDC Staff.

Alameda County shoreline. Source: BCDC Staff.

1. INTRODUCTION

1.1. How to Use this Resource

This document synthesizes a decade of institutional knowledge on the use and application of BCDC's Climate Change Policies. Each user will find various parts of the document more or less useful depending on specific needs. Section 1.1.4 provides various suggested navigation paths for different users to jump quickly to the most useful sections of the Guidance to further help users identify how policies may apply to their specific needs.

1.1.1. Intended Audience

This document is intended to provide guidance primarily to BCDC permit applicants regarding the Commission's application of the San Francisco Bay Plan (Bay Plan) Climate Change Policies in past permitting decisions and planning program efforts since adoption in 2011. Applicants with small projects (single parcel residential, non-material amendments, or similar scope) should consult BCDC staff to determine if this Guidance is an appropriate resource. In addition, this guidance may aid BCDC staff in analyzing proposed projects. Technical guidance in Section 4 and Section 5 and can be of use to other groups, such as local planning departments working to create resilient shorelines by integrating related measures into general plans, zoning, and/or discretionary approval processes.

Readers should consult the Table of Contents, Section 1.1.4, and optionally Section 2.2 to identify relevant information.

1.1.2. About this Guidance

The San Francisco Bay is the largest estuary on the West Coast: it is home to 500 species, billions of dollars of public and private sector investment, and is one of the most urbanized estuaries in North America. Sea level rise and increased frequency and extent of storm flooding pose an unprecedented threat to the Bay and its people, natural resources, communities and infrastructure. As understanding of the impacts of climate change has grown, BCDC has taken steps to address these challenges. Notably, in 2011, the Commission adopted a ground-breaking amendment to the Bay Plan to address climate change.

Since the adoption of the Climate Change Policies, BCDC has implemented these regulations by permitting hundreds of projects, creating and expanding the Adapting to Rising Tides Program, and collaborating regularly with federal, state, regional, and local agencies and organizations grappling with climate change. As the region prepares to spend millions of dollars on resilience planning, habitat restoration, and shoreline protection, it is timely and necessary to develop concise and transparent guidance on the Commission's policies and the application of the best available climate science. As of the publishing date, the Commission considers the State of California's Sea Level Rise Guidance (2018 Update) to be a source of best available science. This Guidance pertains specifically to the application of the Climate Change Policies; applicants should be advised that recent Bay Plan updates such as the Fill for Habitat and Environmental Justice amendments along with updated guidance at the State level such as the Principles for Aligning State Action (OPC) and Executive Order N-82-20 prioritizing nature-based solutions are not discussed.

Reliance on this guidance is not mandated by the Bay Plan Climate Change Policies, nor is this guidance binding on the Commission's discretion or determinative of the issues discussed herein. In all cases, the Commission retains full discretion in interpreting and implementing the Bay Plan's Climate Change Policies, and such application of the policies is made by the Commission on a case-by-case basis, considering site-specific circumstances and the nature of the proposed project. Bay Plan policies described herein are used in conjunction with the full list of policies in the Bay Plan, as well as with the McAteer-Petris Act, and, when applicable, the Nejedly-Bagley-Z'berg Suisun Marsh Preservation Act, BCDC's Suisun Marsh Protection Plan, BCDC's Special Area Plans, and other applicable laws and regulations.

This document is guidance, not new regulations; it is written to assist applicants by discussing the Commission's past actions with respect to the Climate Change Policies.

1.1.3. Climate Guidance is Flexible

Since the Bay Plan Climate Change Policies were adopted in 2011, the Commission's application of the policies has evolved, particularly given updates to the best available science on sea level rise over the same timeframe. The Commision's application of the policies may change in the future as the science on climate change and sea level rise continues to advance, as the range of potential sea level rise projections narrows, and as adaptation planning and implementation best practices are refined. Projects are evaluated on a case-by-case basis using the most reasonable interpretation and application of the policies and the best available science and information at the time of permit application submission. This guidance is written to easily incorporate updates to resources that draw upon best available science, such as the Ocean Protection Council's (OPC) State of Caliofornia Sea Level Rise Guidance (2018 Update).

1.1.4. Navigating this Resource

This guidance is divided into three main parts: 1) Introduction, 2) Guidance on Climate Change Policies and Permitting, and 3) Technical Sea Level Rise Guidance. There are also several appendices that include an overview of climate and sea level rise science, how the climate change policies relate to BCDC's Adapting to Rising Tides (ART) Program, and an example risk assessment and adaptive management plan.

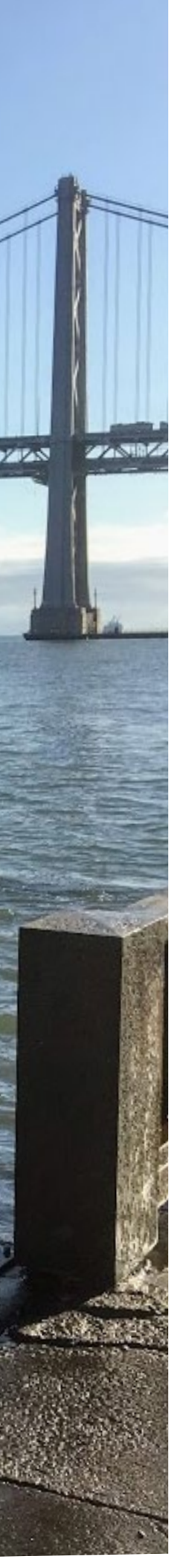
This guidance assists permit applicants through its descriptions and examples, rather than offering step-by-step instruction. While it could be read cover to cover, the user is advised to first consult the following page and the list of Frequently Asked Questions in **Section 2** to find specific relevant information. It is also important to note that this guidance does not replace the need for BCDC permit applicants to engage in pre-application discussions with BCDC staff, which BCDC advises initiating as early as possible in the planning and design process for projects that will need a BCDC permit. Early communication and coordination can help ensure that the project will be consistent with BCDC's requirements and can increase the efficiency of the permitting process. This guidance can be used as a tool to support those discussions and the planning and design of resilient and adaptable habitat and development projects in and around the San Francisco Bay.

USING THIS DOCUMENT:

The following suggested navigation paths and quick access to specific aspects of the Guidance are provided for BCDC partners that may be using this guidance for clarity on aspects of shoreline projects as opposed to a general overview of the Climate Change Policies.

Do you need a permit from BCDC? Do you want to determine which Climate Change Policies may apply to your project?

↳ If determining whether a project is subject to BCDC's jurisdiction and authority, review **Section 1.2** and consult BCDC staff with further questions. This Guidance is not intended as general guidance for obtaining a BCDC permit. If the project is known to be subject to BCDC's jurisdiction and authority, applicants should be familiar with the appropriate Climate Change Policies. Applicants for small, routine projects should consult BCDC staff to determine if these Policies are applicable to the proposed project. Proceed to **Section 2.2** for specific project-related questions, and **Section 2.3** for an overview and guidance regarding each Bay Plan Climate Change Policy. **Section 2.4** provides an overview of additional policies that may be applicable. **Section 3** provides example permit conditions and findings for past projects that may be similar in scope. **Appendix C** provides non-exhaustive examples of Risk Assessments prepared in part by requirement of BCDC's Climate Change Policy 2.



Are you deciding which sea level rise projections are most appropriate for your project?

Section 4 provides BCDC's suggested process for selecting projections. Appendix A provides an overview of the science and an introduction to the complexity of sea level rise projections. Section 5.2 includes examples of additional flooding sources for designers to consider.

Are you looking for information on performing sea level rise risk assessments?

Section 2.2 includes Frequently Asked Questions related to risk assessments. Section 2.3.2 provides guidance as to whether a specific project may be subject to Climate Change Policy 2 - Risk Assessment. The entirety of Section 5 - Assessing Flood Impacts should be considered when embarking on a risk assessment exercise. Appendix A includes introductions to sea level rise and flood science, Appendix B introduces core functions of the Adapting to Rising Tides Program, which regularly advises and undertakes risk assessment projects, and Appendix C provides non-exhaustive examples of Risk Assessments prepared in part by requirement of BCDC's Climate Change Policy 2.

Are you designing an innovative nature-based or demonstration project in the Bay?

Section 2.3 and Section 2.4 are useful references for innovative adaptation approaches. Section 3 includes sample language for sea level rise projects incorporating restoration and habitat enhancement. Section 4, Section 5 and Appendix A provide background for design considerations.

Are you initiating the design of a resilient shoreline project or plan?

Adaptation planners should consider Section 1.2 and Section 1.3 when planning processes may impact the permitting of shoreline projects in the future. Section 2 provides an overview and guidance regarding each Bay Plan Climate Change Policy, and Section 4 provides valuable information on sea level rise projection selection. Appendix B provides an overview of the Adapting to Rising Tides program, which regularly advises on risk assessment and adaptation planning processes. Consider reviewing Section 5 and Appendix A for risk or vulnerability assessments.

1.2. BCDC's Jurisdiction and Authority

Understanding BCDC's jurisdiction and authority is crucial to comprehending how the Commission has applied the Bay Plan Climate Change Policies in past cases. The McAteer-Petris Act of 1965 established BCDC as a state agency, designated the San Francisco Bay as a state-protected resource, and charged the Commission with preparing a plan for the long-term use of the Bay and regulating development in and around the Bay. BCDC was also established as the nation's first coastal zone management agency. The original San Francisco Bay Plan (Bay Plan) was adopted by BCDC in 1968 and by the California Legislature in 1969. The Bay Plan is periodically updated to incorporate best management practices and best available science, among other reasons. It is divided into five parts: a summary, including major conclusions and policies; objectives; findings and policies focused on natural resource protection; findings and policies focused on controlling shoreline development; and the Bay Plan maps, which designate priority use areas (see following page on Section 66602 of the McAteer-Petris Act).

While Section 66610 of the McAteer-Petris Act should be consulted for a legal description regarding BCDC's jurisdiction (Figures 1 & 2), the Commission's jurisdiction generally includes:

- San Francisco Bay, which includes Suisun, San Pablo, Honker, Richardson, San Rafael, San Leandro and Grizzly Bays and the Carquinez Strait;
- Certain waterways that flow into the Bay;
- Salt ponds and managed wetlands around the Bay;
- A shoreline band extending 100 feet inland from the Bay; and
- The Suisun Marsh.

Additionally, BCDC's jurisdiction extends to the mean high water line if the area does not contain tidal marsh, and up to 5 feet above mean sea level in areas containing tidal marsh (Figure 2). Contact BCDC for information about the jurisdictional determination process

The types of activities that require a permit from the Commission, as well as requirements neccessary for the Commission to grant the permit, are stipulated in Section 66632 of the McAteer-Petris Act:

> *"(a) Any person or governmental agency wishing to place fill, to extract materials, or to make any substantial change in use of any water, land or structure, within the area of the commission's jurisdiction shall secure a permit from the commission and, if required by law or by ordinance, from any city or county within which any part of the work is to be performed. For purposes of this title, "fill" means earth or any other substance or material, including pilings or structures placed on pilings, and structures floating at some or all times and moored for extended periods, such as houseboats and floating docks. For the purposes of this section "materials" means items exceeding twenty dollars ($20) in value. [...(f)...] A permit shall be granted for a project if the commission finds and declares that the project is either (1) necessary to the health, safety or welfare of the public in the entire bay area, or (2) of such a nature that it will be consistent with the provisions of this title and with the provisions of the San Francisco Bay Plan then in effect. To effectuate those purposes, the commission may grant a permit subject to reasonable terms and conditions including the uses of land or structures, intensity of uses, construction methods and methods for dredging or placing of fill [...]"*

For the Commission to approve fill (as defined in Section 66632) within its jurisdiction, the standards of Section 66605 of the McAteer-Petris Act must also be met:

> *"(a) That further filling of San Francisco Bay and certain waterways specified in subdivision (e) of Section 66610 should be authorized only when public benefits from fill clearly exceed public detriment from the loss of the water areas and should be limited to water-oriented uses (such as ports, water-related industry, airports, bridges, wildlife refuges, water-oriented recreation, and public assembly, water intake and discharge lines for desalinization plants and power generating plants requiring large amounts of water for cooling purposes) or minor fill for improving shoreline appearance or public access to the bay;*
> *(b) That fill in the bay and certain waterways specified in subdivision (e) of Section 66610 for any purpose should be authorized only when no alternative upland location is available for such purpose;*
> *(c) That the water area authorized to be filled should be the minimum necessary to achieve the purpose of the fill;*
> *(d) That the nature, location, and extent of any fill should be such that it will minimize harmful effects to the bay area, such as, the reduction or impairment of the volume surface area or circulation of water, water quality, fertility of marshes or fish or wildlife resources, or other conditions impacting the environment, as defined in Section 21060.5 of the Public Resources Code;*
> *(e) That public health, safety, and welfare require that fill be constructed in accordance with sound safety standards which will afford reasonable protection to persons and property against the hazards of unstable geologic or soil conditions or of flood or storm waters;*
> *(f) That fill should be authorized when the filling would, to the maximum extent feasible, establish a permanent shoreline;*
> *(g) That fill should be authorized when the applicant has such valid title to the properties in question that he or she may fill them in the manner and for the uses to be approved."*

The authority for BCDC to designate certain priority land use areas that are essential to the public welfare of the Bay Area is provided in Section 66602 of the McAteer-Petris Act:

> *"The Legislature further finds and declares that certain water-oriented land uses along the bay shoreline are essential to the public welfare of the bay area, and that these uses include ports, water-related industries, airports, wildlife refuges, water-oriented recreation and public assembly, desalinization plants, upland dredged material disposal sites, and power plants requiring large amounts of water for cooling purposes; that the San Francisco Bay Plan should make provision for adequate and suitable locations for all these uses, thereby minimizing the necessity for future bay fill to create new sites for these uses; that existing public access to the shoreline and waters of the San Francisco Bay is inadequate and that maximum feasible public access, consistent with a proposed project, should be provided."*

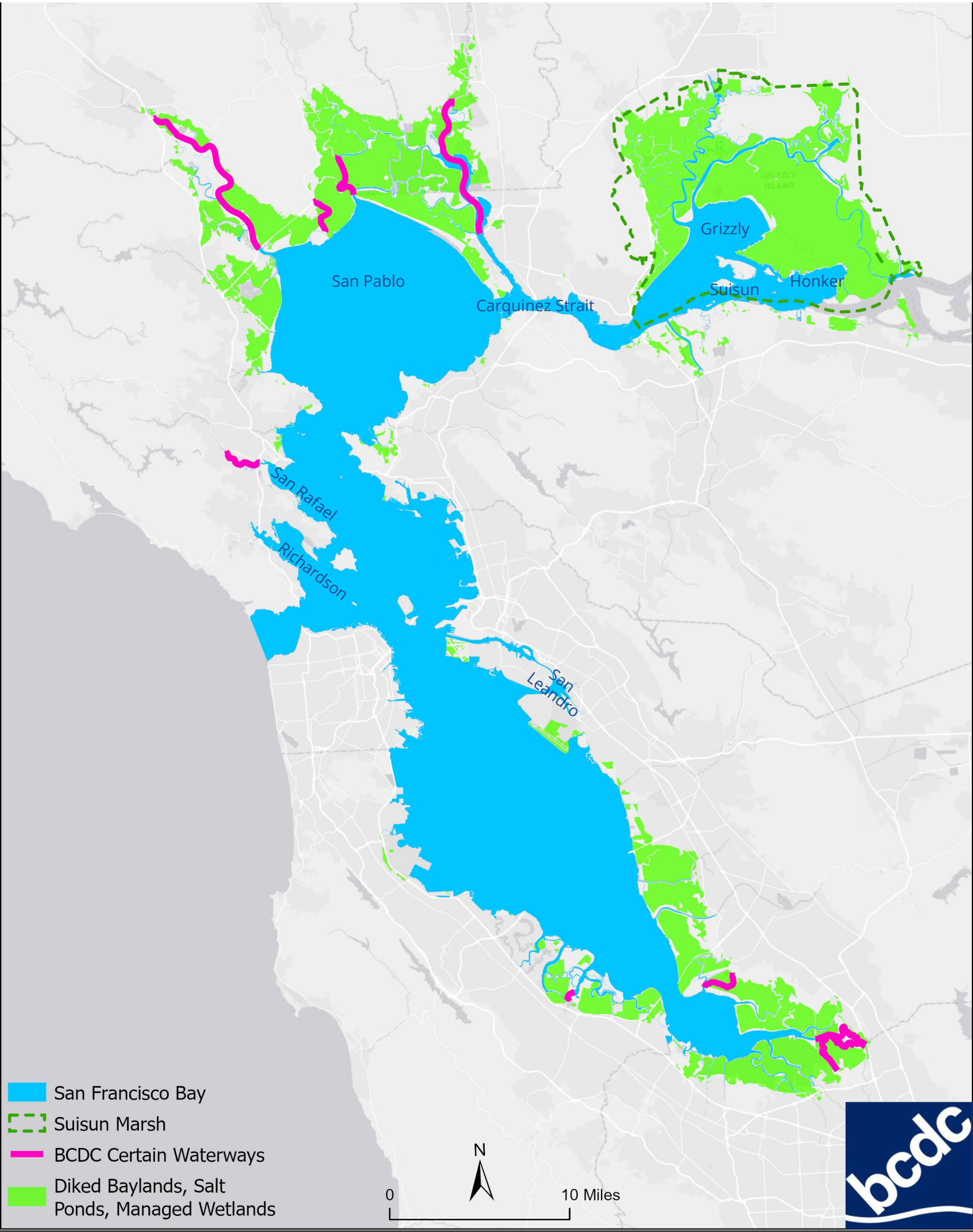


Figure 1. Map of BCDC Bay jurisdiction for illustrative purposes. Determinations are made on a case-by-case basis. Source: BCDC.

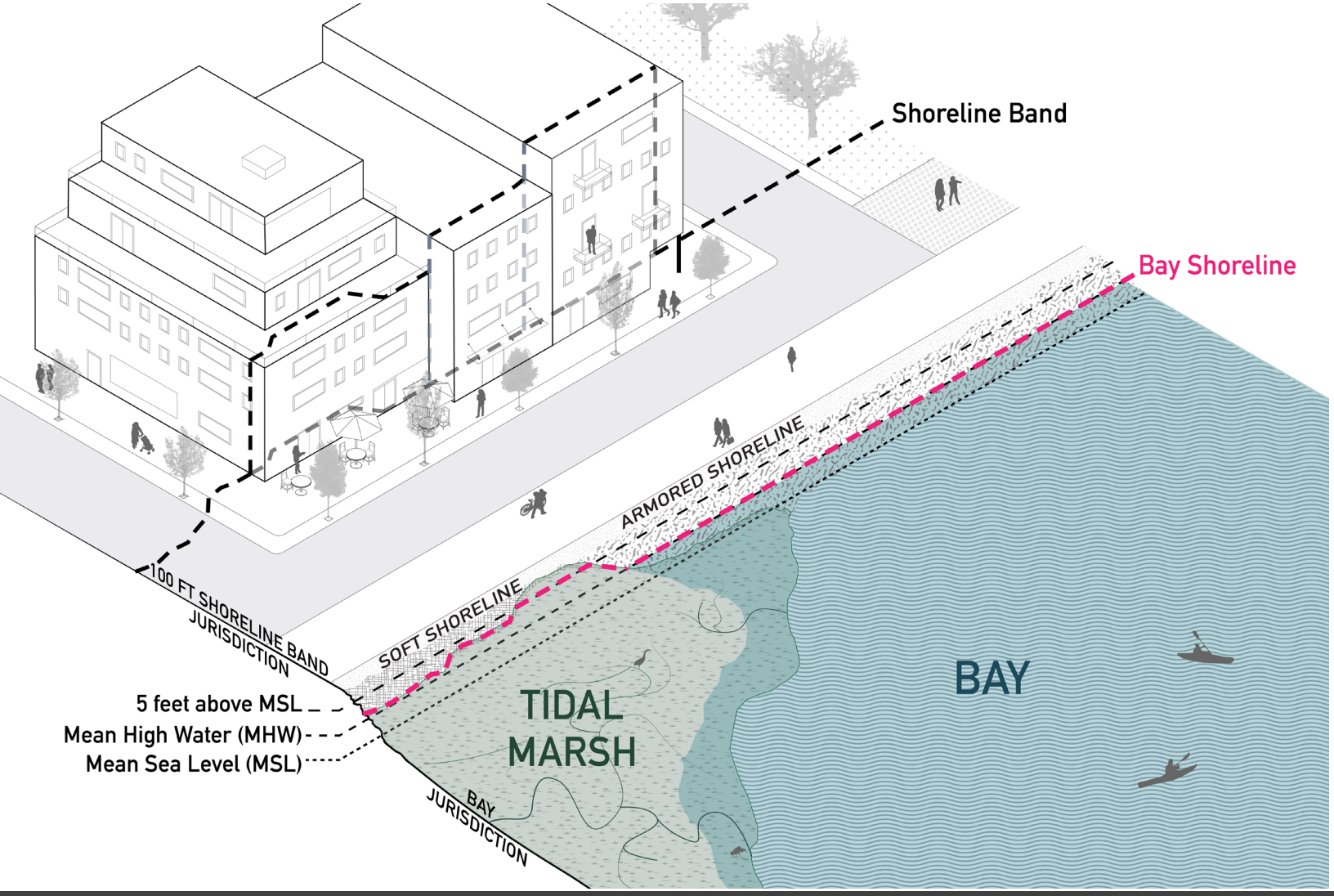


Figure 2. Conceptual illustration of BCDC Bay and Shoreline Band jurisdiction. Determinations are made on a case-by-case basis. Source: BCDC.

For a project proposed within a priority use area, the project must be consistent with the designated priority use and the Bay Plan policies associated with the designated priority use (e.g., if a project proposed is a Waterfront Park).

Section 66632.4 of the McAteer-Petris Act provides the conditions under which the Commission may deny a permit for a project within the shoreline band jurisdiction that is located outside of the boundaries of water-oriented priority land uses:

> *"Within any portion or portions of the shoreline band that are located outside the boundaries of water-oriented priority land uses, as fixed and established pursuant to Section 66611, the commission may deny an application for a permit for a proposed project only on the grounds that the project fails to provide maximum feasible public access, consistent with the proposed project, to the bay and its shoreline. When considering whether a project provides maximum feasible public access in areas of sensitive habitat, including tidal marshlands and mud flats, the commission shall, after consultation with the Department of Fish and Game, and using the best available scientific evidence, determine whether the access is compatible with wildlife protection in the bay."*

If an applicant is planning a project in the Commission's jurisdiction in one of the nine Bay Area counties, the applicant will likely need to apply for and receive a permit from BCDC prior to commencing the project. BCDC issues several different types of permits for work in its jurisdiction, and the appropriate type of permit is determined by the size, location and impacts of the project. The different types of permits that BCDC issues, details on BCDC's permitting process and requirements, and related information can be found on BCDC's website.

BCDC has two advisory boards that review technical aspects of projects that often incorporate the Bay Plan Climate Change Policies and provide advice to the Commission and staff: the Design Review Board and the Engineering Criteria Review Board.

> The **Design Review Board (DRB)** is comprised of seven members, including at least one architect, one landscape architect, and one engineer, who volunteer their time and expertise to advise the Commission on the adequacy of public access proposed as a part of projects in the Commission's jurisdiction. Public access may include both physical improvements as well as visual access. The Board advises the Commission on a project's effects on appearance, design, and scenic views in accordance with the Commission's Bay Plan policies and the Public Access Design Guidelines, which can be found on BCDC's website.
>
> The **Engineering Criteria Review Board (ECRB)** assists the Commission in evaluating the engineering aspects of projects that require BCDC permits. Currently, the ECRB is made up of ten professionals, including structural, coastal, and geotechnical engineers, a geologist, a geophysicist, and an architect. The ECRB members are professionals in private practice, government service, and academia, and volunteer their time and expertise to advise the Commission and its staff regarding seismic, flooding, and other engineering safety concerns of shoreline projects and to assist applicants in evaluating their projects with appropriate engineering safety criteria. Bay Plan Safety of Fills Policy 2 requires that "no fill or building (in the Bay) should be constructed if hazards cannot be overcome adequately for the intended use in accordance with the criteria prescribed by the Engineering Criteria Review Board."

In addition to carrying out its regulatory authority under state law, BCDC exercises authority under Section 307 of the federal Coastal Zone Management Act (CZMA) over federal activities and development projects and non-federal projects that require a federal permit or license or are supported by federal funding. The Commission carries out its "federal consistency" responsibilities by reviewing federal projects much like it does permit applications. However, the Commission cannot require federal agencies to submit permit applications. Nevertheless, federal agencies and applicants for federal approvals must provide project details, data, and other materials to ensure that the Commission has the information it needs to evaluate the project for consistency with the portion of the state's coastal management program that BCDC implements under the CZMA.

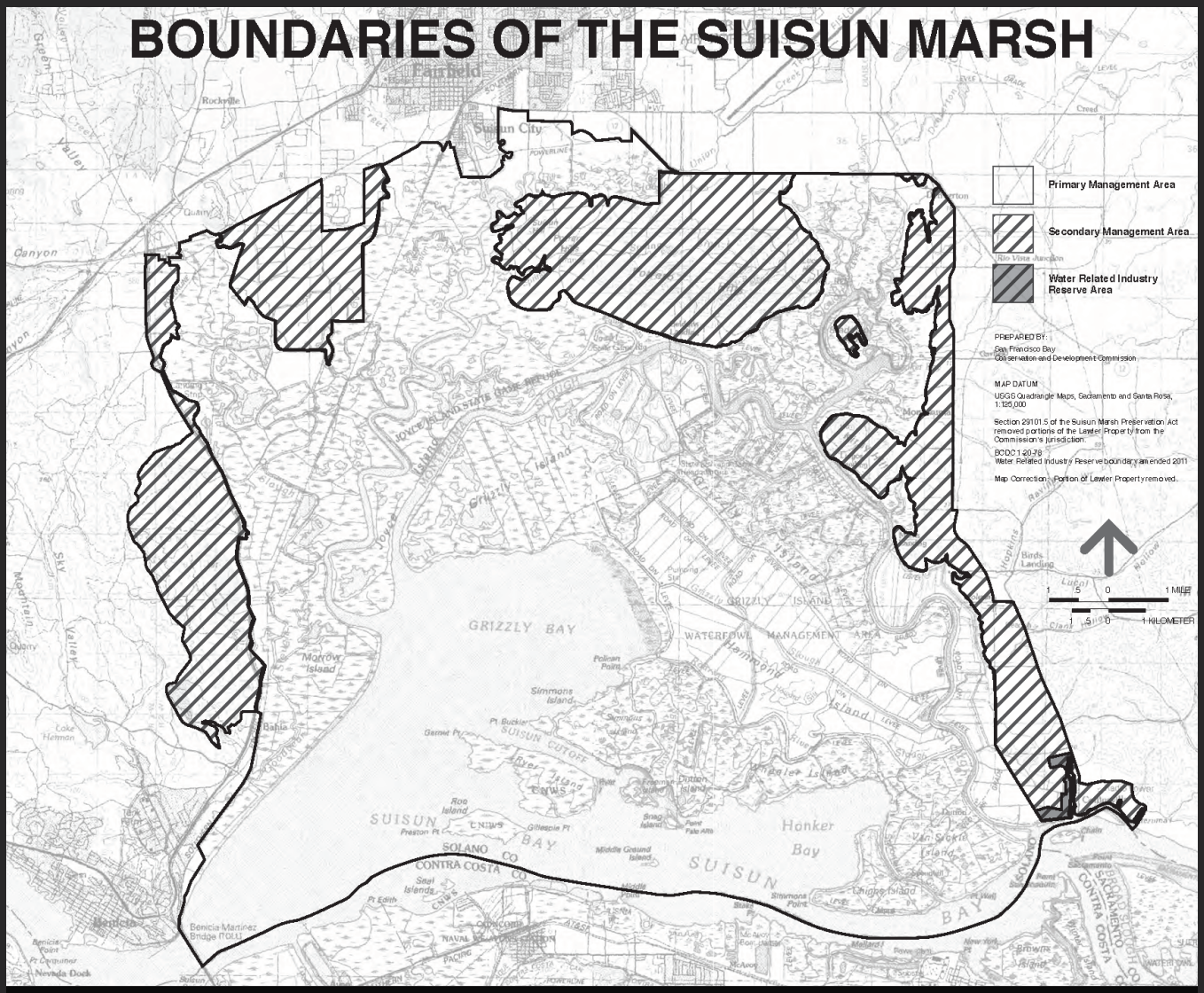


Figure 3. BCDC's jurisdiction in Suisun Marsh. Source: BCDC.

The **Nejedly-Bagley-Z'berg Suisun Marsh Preservation Act** of 1974 directed BCDC and the Department of Fish and Game to prepare a Suisun Marsh Protection Plan (SMPP) "to preserve the integrity and assure continued wildlife use" of the Suisun Marsh. The SMPP is intended to be a more specific application of the general, regional policies of the Bay Plan and to supplement those policies where appropriate because of the unique characteristics of the Suisun Marsh. Therefore, the policies of both the Bay Plan and the SMPP apply in the area covered by the latter, except where the two may conflict. In that case, the more specific policies of the SMPP are used. The Bay Plan Climate Change policies apply across almost the entire primary management area, which includes the water-covered areas, tidal marsh, diked-off wetlands, seasonal marsh, and lowland grassland specified on the map (Figure 3).

1.3. BCDC's Climate Change Program and Policies

BCDC's climate change program builds the region's capacity to plan for sea level rise and ensures that the Commission's laws and policies support and encourage appropriate resilience and adaptation. Recent amendments to the Bay Plan have focused on promoting shoreline resilience in light of climate change. In October 2011, BCDC amended the Bay Plan to update the 22-year-old sea level rise findings and policies and to add a new section dealing more broadly with climate change and adapting to sea level rise via Bay Plan Amendment No. 1-08. The Background Report for the Climate Change Bay Plan Amendment, titled Living with a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and on its Shoreline (as approved on October 6, 2011), helped guide the development of the Climate Change Policies, and provides background on the basis for the proposed findings and policies. A fact sheet on the Climate Change Policies can be found on BCDC's website.

BCDC's Adapting to Rising Tides (ART) Program was established in 2012 as a collaborative planning effort to help San Francisco Bay Area communities adapt to sea level rise and flooding from storm events. Since then, it has conducted extensive research and planning for climate change vulnerability and adaptation. The ART Program has engaged with local, regional, state and federal agencies and organizations, as well as non-profit and private associations. More information on the ART Program, with a focus on how the ART Program relates to the Bay Plan Climate Change Policies, is provided in **Appendix B**.

In October 2011, BCDC amended the San Francisco Bay Plan to update the 22-year-old sea level rise findings and policies and to add a new section dealing more broadly with climate change and adapting to sea level rise.

From 2015-2016, BCDC led the Policies for a Rising Bay project, through which BCDC collaboratively evaluated Bay Plan policies in light of sea level rise, resulting in the identification of four overarching policy issues where BCDC's policies were found to be inadequate regarding risks associated with rising sea level. Potential Bay Plan updates that would better support climate change include allowing increasing volumes of Bay fill for habitat restoration and protection projects as well as innovative shoreline protection projects, such as horizontal levees, improving environmental justice and social equity, and improving guidance around adaptive management.

In 2016, BCDC conducted a series of Commission workshops on lessons learned from the Climate Change Bay Plan Amendment, BCDC's role in regional planning, and recommendations as the Bay Area adapts to rising sea level. These workshops identified potential changes to the Commission's laws, policies, regulations, and practices, and resulted in the Commission's unanimous initiation of two Bay Plan amendments.

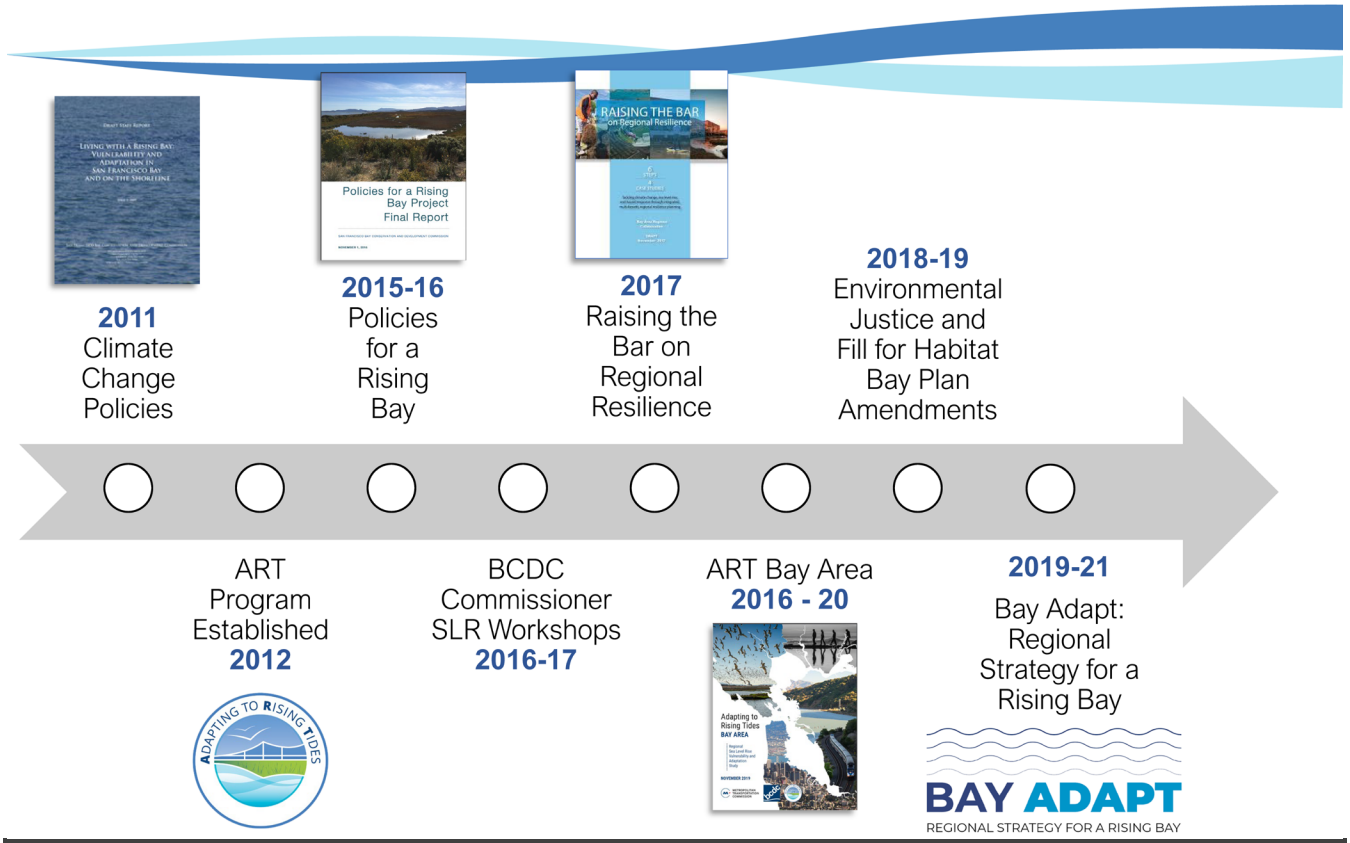


Figure 4. Timeline of major projects of BCDC's climate change program. Source: BCDC.

In October 2019, the Commission adopted Bay Plan Amendments to address fill for habitat, Bay Plan Amendment No. 1-17, and environmental justice and social equity, Bay Plan Amendment 2-17. Figure 4 shows a timeline of BCDC's recent climate change program accomplishments.

In late 2019, BCDC began to facilitate the development of a regional adaptation strategy for the Bay, called Bay Adapt. This is a collaborative effort led by a leadership advisory group comprised of state, regional, and local agencies, as well as community-based organizations to identify and establish agreement on the actions the region must take together to protect people and the natural and built environment from rising sea levels. At the time of publishing this guidance, the Bay Adapt process is still underway and is expected to release its Joint Platform in 2021. More information can be found on the Bay Adapt website.

Suisun Marsh. Source: BCDC Staff.

2. GUIDANCE ON BAY PLAN CLIMATE CHANGE POLICIES AND PERMITTING

2.1 About this Section

This section begins with a summary of the Climate Change Policies, relevant Bay Plan definitions, and a Frequently Asked Questions section to help users quickly understand various aspects of the Climate Change Policies. It then outlines how the Commission has applied each of the eight Bay Plan Climate Change Policies in past permitting decisions and planning efforts by explaining how the Commission in the past has interpreted key terms and phrases of the policies and providing examples from past permitted projects. This section also provides guidance on other related Bay Plan policies for habitat projects and projects that propose Bay fill, shoreline protection, and/or public access.

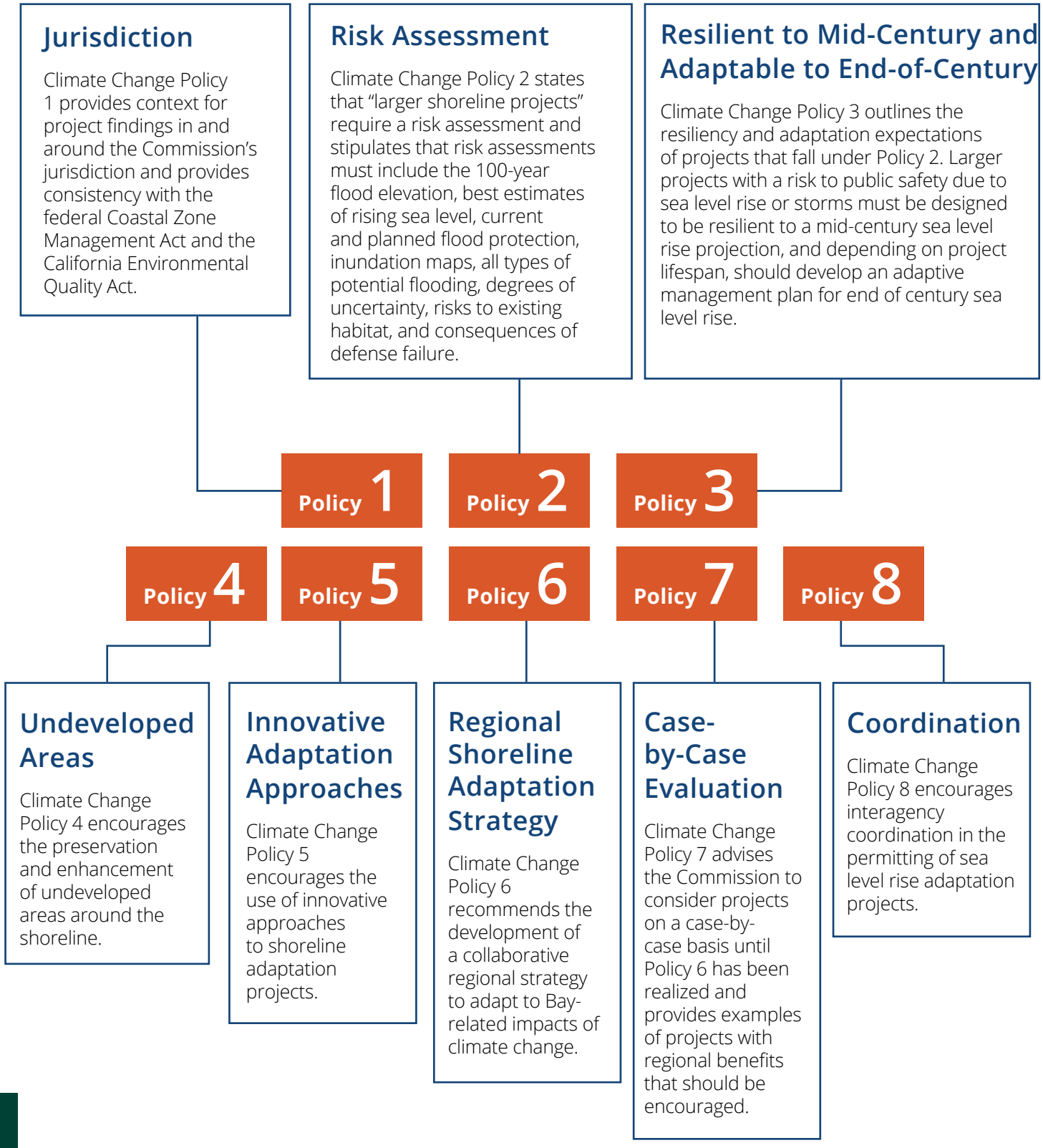
This guidance is intended to be illustrative and assistive through descriptions and examples rather than offering step-by-step instruction. BCDC permit applicants can use the policy guidance and examples from past projects as a tool to inform the planning and design of proposed projects as well as what types of information they should provide in their BCDC permit applications.

Local government planning departments can similarly learn from how BCDC has in the past planned for, and regulated, habitat and development projects in and around the Bay in light of sea level rise and other coastal hazards. This analysis may help inform local policies related to, and/or consistent with, the Climate Change Policies in their own general plans, zoning codes, and/or discretionary approval processes. This guidance does not detract from the importance of BCDC permit applicants engaging in pre-application discussions with BCDC permit staff, which BCDC advises initiating as early as possible in the planning and design process for projects that will need a BCDC permit.

Early communication and coordination can help ensure that the project will be consistent with BCDC's requirements and can increase the efficiency of the permitting process. This guidance can be used as a tool to support those discussions and the planning and design of resilient and adaptable habitat and development projects in and around the San Francisco Bay.

2.1.1. Summary of Bay Plan Climate Change Policies

This section summarizes the eight Climate Change Policies adopted in 2011. Detailed policy language and guidance for each policy can be found in **Section 2.3.**



2.1.2. Relevant Bay Plan Definitions

The Bay Plan provides specific definitions for adaptation and adaptive management, terms that regularly appear in climate change efforts. These definitions are used in interpretation and implementation of the aforementioned Climate Change Policies. The following excerpts are provided directly from the Bay Plan Climate Change Findings.

Climate Change Finding f:

"Natural systems and human communities are considered to be resilient when they can absorb and rebound from the impacts of weather extremes or climate change and continue functioning without substantial outside assistance."

Climate Change Finding g:

"In the context of climate change, mitigation refers to actions taken to reduce greenhouse gas emissions, and adaptation refers to actions taken to address potential or experienced impacts of climate change that reduce risks. Adaptation actions that protect existing development and infrastructure can include protecting shorelines, promoting appropriate infill development, and designing new construction to be resilient to sea level rise. Another option is relocating structures out of flood and inundation zones. Some actions can integrate adaptation, mitigation, and flood protection strategies and may be cost-effective when implemented before sea level rises. For example restoring tidal marshes sequesters carbon, provides flood protection and provides habitat, and may protect lives, property and ecosystems. Identifying appropriate adaptation strategies requires complex policy considerations. Implementing many adaptation strategies will require action and funding by federal, state, regional and local agencies with planning, funding and land use decision-making authority beyond the Commission's jurisdiction."

Climate Change Finding i:

"Adaptive management is a cyclic, learning-oriented approach that is especially useful for complex environmental systems characterized by high levels of uncertainty about system processes and the potential for different ecological, social and economic impacts from alternative management options. Effective adaptive management requires setting clear and measurable objectives, collecting data, reviewing current scientific observations, monitoring the results of policy implementation or management actions, and integrating this information into future actions."

2.2 Frequently Asked Questions

The following list of Frequently Asked Questions can direct the reader to the section(s) of the guidance where their question(s) may be addressed or may be directly answered.

Project Scope and Scale

Is the project site subject to BCDC jurisdiction?

Section 1.2 of this Guidance provides an overview of BCDC's jurisdiction. Climate Change Policy 1 provides context for project findings in and around the Commission's jurisdiction. Potential applicants are highly encouraged to reach out to BCDC staff for a jurisdictional determination prior to beginning the pre-application process.

Is the project a larger shoreline project?

Climate Change Policy 2 requires "larger shoreline projects" to submit a risk assessment as part of their permit application. However, "larger shoreline project" is not defined in the Bay Plan. Section 2.3.2 provides examples of past projects that were considered larger shoreline projects, as well as other potentially relevant factors for determining if the project may qualify as a larger shoreline project. Contact BCDC staff for consultation on any specific projects that may be considered a larger shoreline project.

If the project is not a larger shoreline project, which policies regarding sea level rise and flooding apply?

While Climate Change Policies 2 and 3 regarding risk assessments and adaptive management plans are tailored to "planning shoreline areas" or "larger shoreline projects," the other Climate Change Policies, as well as related policies in other sections of the Bay Plan, may still apply to the project. In particular, Bay Plan Public Access policies require public access to be viable and may require the project to be resilient to sea level rise and flooding from storms. Other Bay Plan policies that relate to sea level rise and flooding and may be applicable to a project are discussed in Section 2.4. Policies that specifically apply to habitat projects are discussed in Section 2.4.5.

What if the project has a short lifespan? (i.e., a design life that ends before 2050)

Each of the Climate Change Policies may potentially apply to short-term projects depending on the circumstances. As demonstrated in past cases, the determination of whether the project is considered a "larger shoreline project" (Climate Change Policy 2) requiring a risk assessment depends more on the project's physical characteristics (e.g., scale or intensity of use) than the life of the project. The Commission also considers what is at risk and the level of uncertainty when assessing projects. However, a shorter-term project may not necessarily warrant a risk assessment if it is, for example, a repair to an existing project. If the project is not required to prepare a risk assessment, the project may still be subject to other Bay Plan policies related to sea level rise and flooding, as discussed in Section 2.4.

How are habitat projects evaluated and permitted for sea level rise and flood resilience?

While each of the Climate Change Policies can potentially apply to habitat projects, other related policies that specifically apply to habitat projects are discussed in Section 2.4.5.

What specific considerations regarding the Climate Change Policies apply if the project is located in…

THE SHORELINE BAND? Taking into account the provisions of the McAteer-Petris Act and policies of the Bay Plan relating to public access in conjunction with the Climate Change Policies, projects in the shoreline band may be required to be specifically evaluated for the risks to, and resilience of, public access. **Section 1.2** provides more information on BCDC's jurisdiction and authority and **Section 2.4.4** includes descriptions of the specific Bay Plan Public Access policies related to sea level rise and flooding.

THE BAY? All Climate Change Policies can potentially apply to projects in the Bay. Additional policies related to sea level rise and flooding are also important to consider for projects in the Bay. These related Bay Plan policies are discussed in **Section 2.4**. Related policies specific to habitat projects are discussed in **Section 2.4.5.**

SUISUN MARSH? **Section 1.2** contains a sidebar explaining the interaction between the Suisun Marsh Protection Plan and the San Francisco Bay Plan.

Risk assessments

Does the project require a risk assessment?

If a proposed project falls under the categories of "planning shoreline areas or designing larger shoreline projects" (Climate Change Policy 2), it will require a risk assessment so that the Commission can effectively analyze the project's vulnerability to, and potential impacts from, sea level rise, storms, and flooding. This is discussed in **Section 2.3.2**, along with specific considerations potentially relevant to a risk assessment. Note that if a project is not required to complete a risk assessment, it may still be subject to other Bay Plan policies regarding sea level rise, storms, and flooding, such as those discussed in **Section 2.4**.

What should be included in the project's risk assessment?

Climate Change Policy 2 stipulates what should be included in a project's risk assessment and is discussed extensively in **Section 2.3.2**.

Sea level rise, flooding, and storm analysis

What range of sea level rise projections should the project use?

Section 4 of this guidance explains how the Commission has used the State of California Sea-level Rise Guidance to select appropriate projections of sea level rise used to plan and design projects that required a BCDC permit. **Section 5** and **Appendix A** of this guidance provide extensive supporting information concerning the science of sea level rise and other types of flooding, how to read and understand the table of projections, and an overview of potential impacts of sea level rise that may inform planning and permitting decisions for a project. **Section 2.3.3** of this guidance discusses how the Commission has evaluated and conditioned past projects for resilience to sea level rise and flooding. **Section 4** of this guidance explains how the permitting requirements of the Bay Plan Climate Change Policies can integrate with the stepwise process in the State of California Sea-Level Rise Guidance for selecting appropriate projections of sea-level rise based on a project's risk aversion.

Why is there a range of possible projections of sea level rise?

There is a range of projected sea level rise due to a degree of uncertainty in the modeling of sea level rise and unknown future greenhouse gas emissions scenarios, which influence how much Earth's climate will continue to change. BCDC has used the projections of sea level rise provided in the State of California Sea-Level Rise Guidance, and **Appendix A** of this guidance summarizes the scientific basis of these projections.

Which tidal elevations should be accounted for in the project's risk assessment and/or other related BCDC permit application materials?

In addition to the 100-year flood elevation and appropriate projections of sea level rise, other specific daily tidal elevations that BCDC has considered in risk assessments include Mean Higher High Water and Mean High Water, relative to the North American Vertical Datum (NAVD88). Mean Low Water and Mean Lower Low Water may also be relevant for certain projects, particularly those that include a navigation element, such as a marina. More information is provided in **Section 2.3.2**.

How are projects evaluated for resilience to sea-level rise and flooding?

Projects are evaluated on a case-by-case basis for consistency with all Bay Plan policies regarding sea-level rise and flooding. Project "resilience" to sea level rise and flooding is specifically discussed in **Section 2.3.3**. While Bay Plan policies are applied on a project-by-project basis, including requirements for resilience to sea level rise and flooding, Bay Plan policies also encourage shoreline protection measures to be integrated with adjacent shoreline protection plans and projects. BCDC as an agency supports voluntary local efforts to align with larger shoreline and regional resilience and adaptation planning efforts, such as through the Adapting to Rising Tides (ART) Program and Bay Adapt.

Adaptation planning

Does the project require an adaptive management plan?

Climate Change Policy 3 stipulates the conditions under which an adaptive management plan for sea level rise may be required for a project, discussed in **Section 2.3.3**. Section 2.3.3 also discusses approaches to adaptive management that the Commission has previously used in past permitting decisions, including triggers used in past permit conditions for initiating the implementation of the plan. Adaptive management of habitat projects is also discussed in **Section 2.4.5**.

What is BCDC's Adapting to Rising Tides (ART) Program, and how does it relate to permitting?

Projects seeking BCDC permits are not required to use or participate in BCDC's ART Program. However, the ART Program provides support and many resources for conducting sea level rise vulnerability analyses and for planning adaptation and has conducted large scale (not project-specific) vulnerability assessments for many parts of the Bay. More information on the ART Program, including potential areas of integration between an individual project seeking a BCDC permit and ART projects and resources, is provided in **Appendix B**.

King Tide at Bothin Marsh in Marin. Source: BCDC Staff.

2.3. The Bay Plan Climate Change Policies

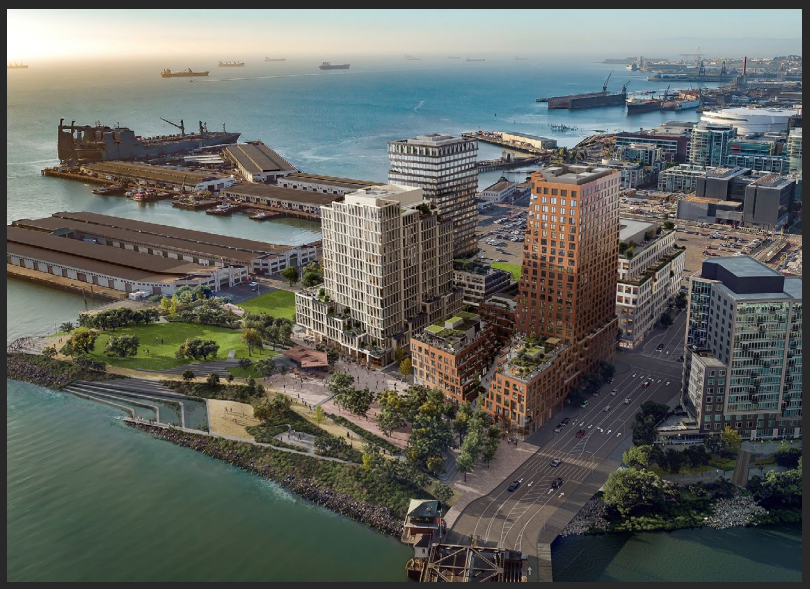
This section provides guidance on how the Commission has interpreted and applied the eight policies of the Climate Change section of the Bay Plan in past permitting decisions and planning program efforts, including references to specific examples from past projects. Background information on the Climate Change Bay Plan Amendment, which added these policies to the Bay Plan in 2011, is provided in **Section 1.3.**

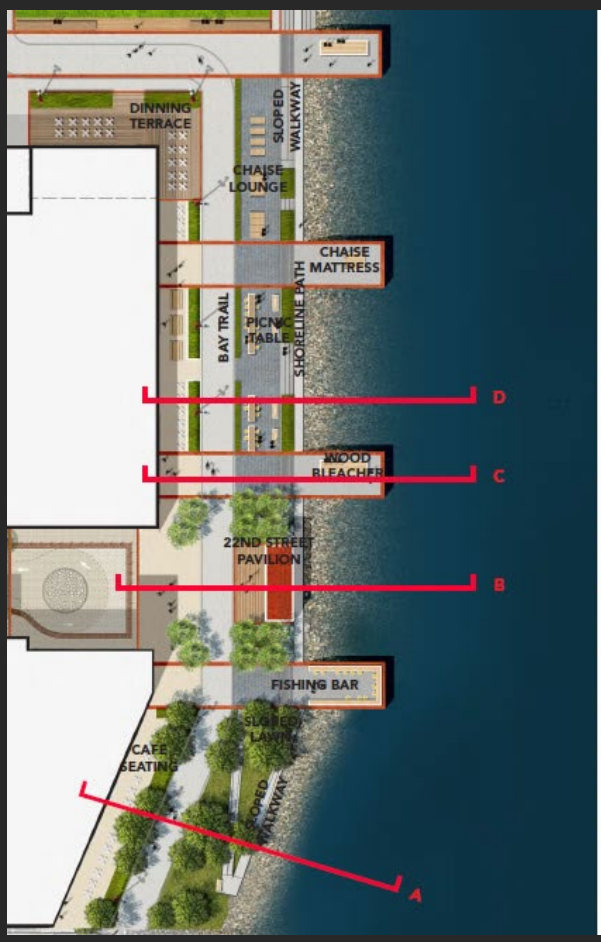
2.3.1. Climate Change Policy 1- Jurisdiction

Climate Change Policy 1 frames how the following Climate Change policies should be used by the Commission by stipulating its jurisdiction and authority in relation to the policies:

> *"The Commission intends that the Bay Plan Climate Change findings and policies will be used as follows:*
>
> *a. The findings and policies apply only to projects and activities located within the following areas: San Francisco Bay, the 100-foot shoreline band, salt ponds, managed wetlands, and certain waterways, as these areas are described in Government Code section 66610, and the Suisun Marsh, as this area is described in Public Resources Code section 29101;*
>
> *b. For projects or activities that are located partly within the areas described in subparagraph a and partly outside such area, the findings and policies apply only to those activities or that portion of the project within the areas described in subparagraph a;*
>
> *c. For the purposes of implementing the federal Coastal Zone Management Act, the findings and policies do not apply to projects and activities located outside the areas described in subparagraph a, even if those projects or activities may otherwise be subject to consistency review pursuant to the federal Coastal Zone Management Act; and*
>
> *d. For purposes of implementing the California Environmental Quality Act, the findings and policies are not applicable portions of the Bay Plan for purposes of CEQA Guideline 15125(d) for projects and activities outside the areas described in subparagraph a and, therefore, a discussion of whether such proposed projects or activities are consistent with the policies is not required in environmental documents."*

This is a general policy that informs how, when, and where the Bay Plan Climate Change Policies can be used. An important note in Section a. above is that BCDC jurisdiction pertains to all salt ponds and managed wetlands, whether historic or current, as defined in Government Code section 66610(c) and (d), respectively, and as specifically described in the Bay Plan. Many areas along the Bay shoreline were salt pond or managed wetland before development and may be considered BCDC jurisdiction regardless of the current use. BCDC's jurisdiction and authority are discussed more extensively in **Section 1.2**.





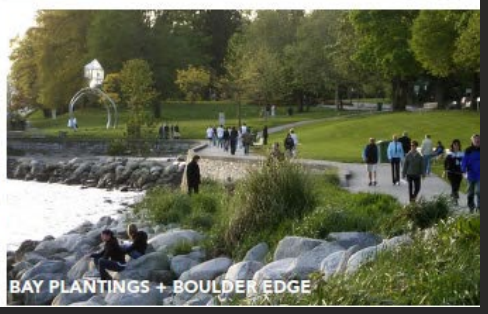


Figure 5. Renderings of recently approved permits.

Top left: Treasure Island Redevelopment Project in San Francisco. Source: Treasure Island Community Development (TICD).

Top right: Mission Rock Development in San Francisco. Source: Binyan Studios.

Bottom: Pier 70 Mixed-Use Development in San Francisco. Source: James Corner Field Operations.

2.3.2. Climate Change Policy 2- Risk Assessment

Climate Change Policy 2 requires a risk assessment for certain types of proposed projects and stipulates the specific components that should be included in the risk assessment:

> *"When planning shoreline areas or designing larger shoreline projects, a risk assessment should be prepared by a qualified engineer and should be based on the estimated 100-year flood elevation that takes into account the best estimates of future sea level rise and current flood protection and planned flood protection that will be funded and constructed when needed to provide protection for the proposed project or shoreline area. A range of sea level rise projections for mid-century and end of century based on the best scientific data available should be used in the risk assessment. Inundation maps used for the risk assessment should be prepared under the direction of a qualified engineer. The risk assessment should identify all types of potential flooding, degrees of uncertainty, consequences of defense failure, and risks to existing habitat from proposed flood protection devices."*

Risk assessments are an important tool for determining and analyzing the potential impacts of sea level rise, flooding, and storms on a proposed project, as well as the likelihood of those impacts occurring. Climate Change Finding f states, in part, "Understanding vulnerabilities to climate change is essential for assessing climate change risks to a project, the Bay or the shoreline. Risk is a function of the likelihood of an impact occurring and the consequence of that impact. Climate change risk assessments identify and prioritize issues that can be addressed by adaptation strategies." As stipulated in the policy, when "planning shoreline areas" and "designing larger shoreline projects", a risk assessment is needed. However, the terms "planning shoreline areas" and "designing larger shoreline projects" are not defined in the Bay Plan. In past permitting decisions, the Commission has interpreted "planning shoreline areas" as referring to a variety of activities, such as the broader shoreline planning completed as part of a particular project. However, this policy has more often been used by the Commission in the past permitting of "larger shoreline projects." The Commission makes the determination of whether a project qualifies as a "larger shoreline project" on a case-by-case basis considering the facts presented. In past permitting decisions, the Commission has considered factors such as what is at risk and the level of uncertainty when determining if a project should be considered a larger shoreline project.

Projects approved by the Commission as "larger shoreline projects" include but are not necessarily limited to:

- India Basin Open Space / 700 Innes Mixed-Use Development (BCDC Permit No. 2020.001.00)
- Pier 70 Mixed-Use Development (BCDC Permit No. 2018.008.00)
- Oyster Point Development (BCDC Permit No. 2017.007.00)
- Mission Rock Development (BCDC Permit No. 2017.004.00)
- Foster City Levee Protection Planning and Improvements Project (BCDC Permit No. 2018.005.00)
- Treasure Island Redevelopment Project (BCDC Permit No. 2016.005.00)
- Alameda Landing Development (BCDC Permit No. 2018.004.00)
- Terminal One Development (BCDC Permit No. 2018.006.00)
- Hill Slough Tidal Restoration (BCDC Permit No. 2017.003.00md)
- Bay Point Restoration Project (BCDC Permit No. 2017.006.00)

f

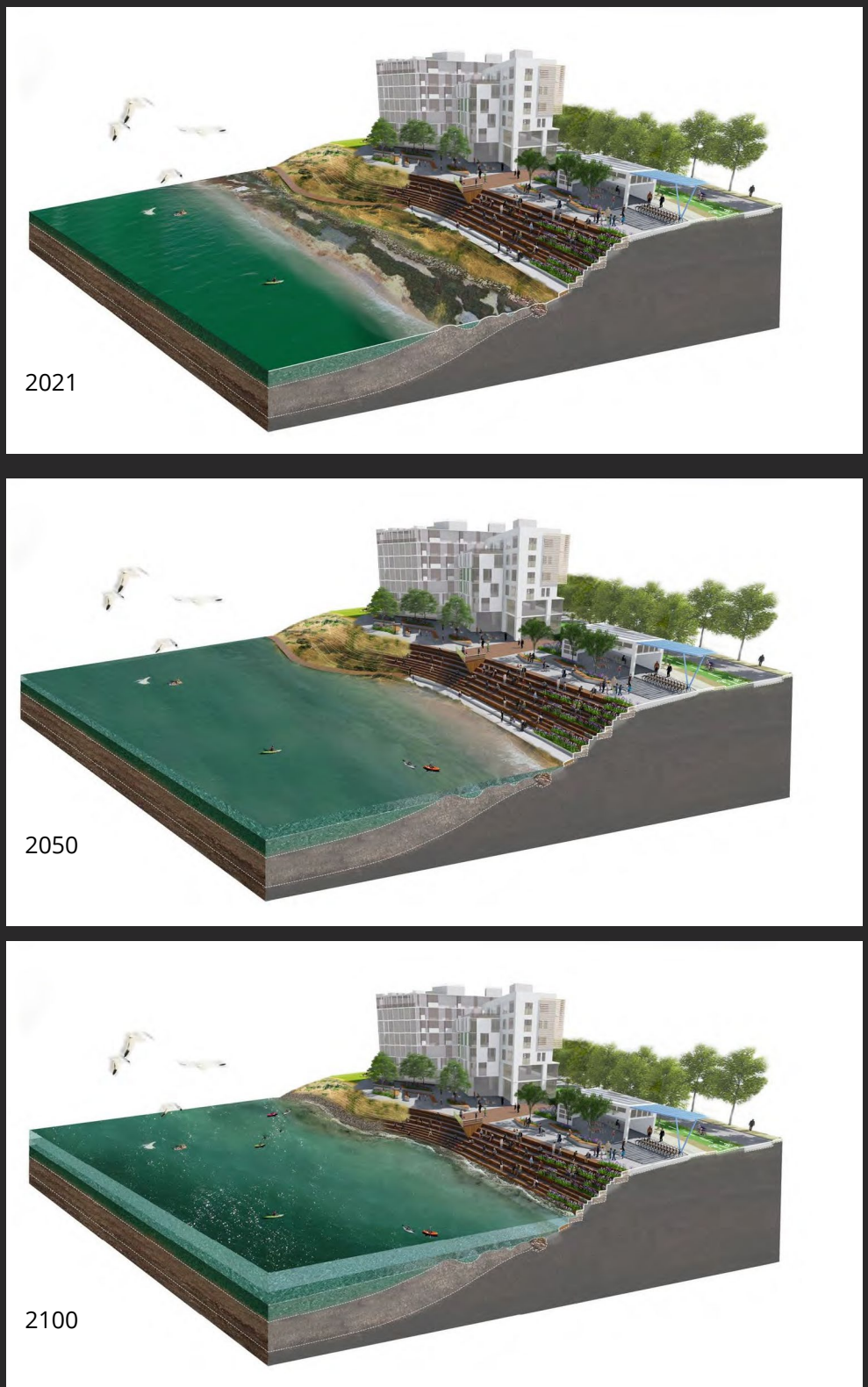


Figure 6. Renderings of the recently approved permit for India Basin Open Space / 700 Innes Mixed Use Development. Source: San Francisco Recreation & Parks.

If the Commission determines that the project is not a "larger shoreline project" or does not include "planning a shoreline area" and therefore is not required to prepare a risk assessment, the project could still potentially be subject to other Bay Plan policies related to sea level rise and flooding, such as those that are discussed in **Section 2.4**.

The following paragraphs detail each of the required components of a risk assessment, as stipulated in Climate Change Policy 2. See **Section 3** for sample permit conditions from past Commission approvals relating to risk assessments. See **Appendix C** for examples of risk assessments provided in order to satisfy Climate Change Policy 2.

100-YEAR FLOOD ELEVATION • Risk assessments should include the "100-year flood elevation," which is the water level of a flood event that has a 1-in-100 chance (or 1% probability) of occurring in any given year. Although most BCDC permit applicants use the elevation determined by the Federal Emergency Management Agency (FEMA), applicants can use 100-year flood elevations calculated for the site by other qualified coastal engineers if supporting information for the determination is provided. More information regarding the 100-year flood elevation is provided in **Section 5.2.5** of this guidance.

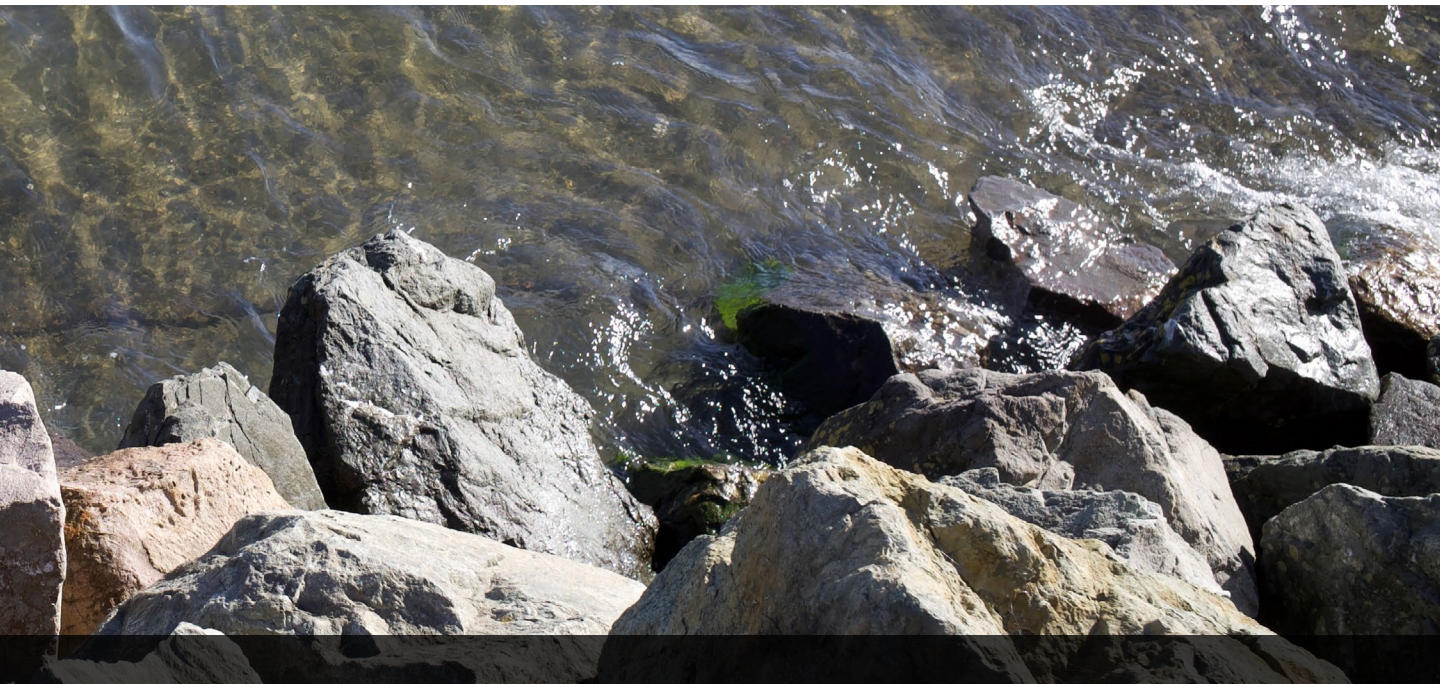
BEST ESTIMATES OF RISING SEA LEVEL • The "best estimates of future sea level rise" should be used in a project's risk assessment. As of publication of this guidance, BCDC considers the best estimates of future sea level rise to be the projections included in the 2018 update to the State of California Sea-Level Rise Guidance (State Guidance). The Ocean Protection Council updates the State Guidance on a 5-year interval, with the next Guidance expected in 2023. An explanation of how to select projections from the State Guidance to use in the planning and design of projects that will require a BCDC permit is discussed in **Section 4**. While BCDC follows the State Guidance, project proponents can choose to use other projections of sea level rise in the planning and design of their project if the approach is consistent with best available science and is still found to be consistent with BCDC's laws and policies.

King Tides in Sausalito. Source: The California King Tides Project.

CURRENT AND PLANNED FLOOD PROTECTION • Because the 100-year flood elevation included in risk assessments is based on existing site conditions at the time of the study, the risk assessment should also account for any "current flood protection and planned flood protection that will be funded and constructed when needed to provide protection for the proposed project or shoreline area" as this will influence the flood risks posed by the 100-year flood elevation analyzed in the risk assessment.

As discussed further in **Section 2.4.2** and **Section 2.4.3**, to assess the credibility of proposed flood protection structures in accordance with standard coastal engineering practice, the risk assessment should demonstrate that the protection structure has the capacity to withstand the tidal forces at the site for the life of the project. The evidence should be based on a coastal engineering study and supported by a soil/geotechnical assessment of the site, particularly regarding subsidence risks. Engineering analysis should support the argument that the tidal forces, or the demand loads, are less than the designed capacity of the land or structure and that the structure is designed to endure or be adaptable to higher water levels in the future.

The specifics of the analysis of current and planned flood protection varies depending on the type of flood protection measure, the proposed project, the proposed land uses on site, and other related factors. However, in past cases BCDC staff has used the information and maps included in the project's risk assessment in combination with BCDC's web-based Adapting to Rising Tides (ART) Bay Shoreline Flood Explorer (see **Appendix A**), and BCDC's flood elevation table (see **Section 2.3**) to assess the credibility of current and planned flood protection. In certain cases where the project requires an adaptive management plan (Climate Change Policy 3), an analysis of planned flood protection may be provided in the adaptive management plan, rather than the risk assessment.



INUNDATION MAPS • Risk assessments should also include inundation maps prepared by a qualified engineer. Many applicants provide a cross-section of the shoreline where their project is located with depictions of various water levels, such as the tidal range, sea level rise projections, and the 100-year flood elevation. Figures 7, 8, and 9 show some examples of inundation maps provided in the risk assessments for past projects permitted by the Commission.

Additionally, BCDC's Adapting to Rising Tides (ART) Bay Shoreline Flood Explorer (Flood Explorer) serves as an example for how flooding can be illustrated in plan view. However, the Flood Explorer is a planning-level tool (rather than parcel or project-level) and its Total Water Level approach, used to signify various potential combinations of sea level rise and storm surge, is different than the method typically used by coastal engineers to define Total Water Level. The Flood Explorer is discussed in greater detail in **Appendix A**.

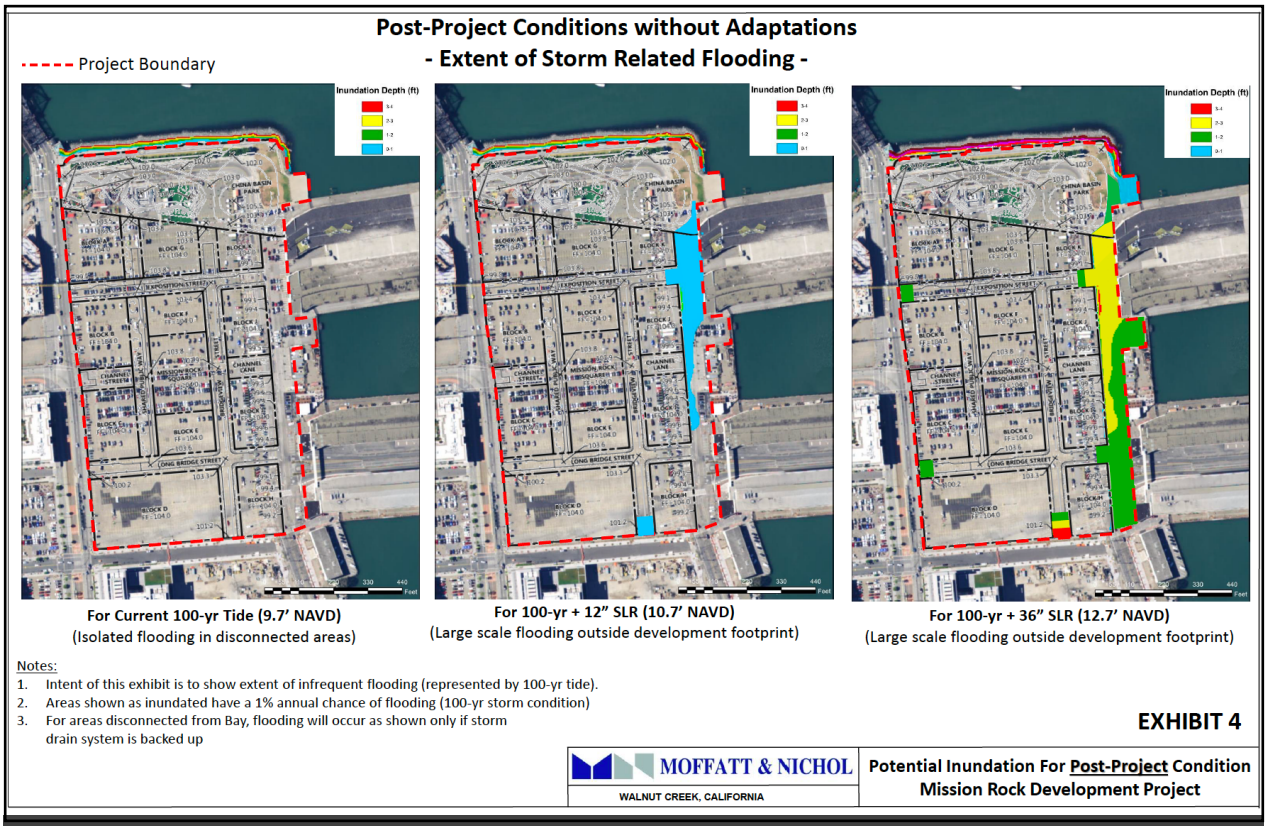


Figure 7. Inundation map for the Mission Rock Development in San Francisco. Source: Moffat Nichol.

Figure 8. Inundation map for the Alameda Landing Development in Alameda. Source: Catellus.

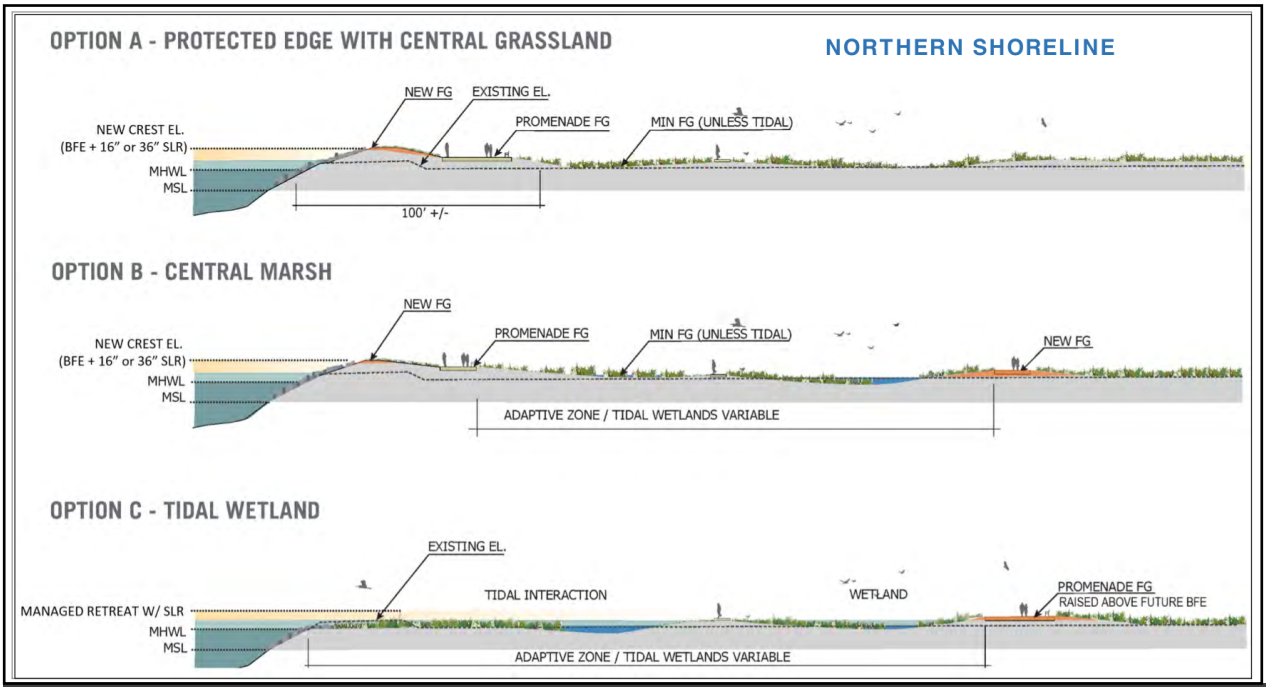


Figure 9. Cross section for part of the Treasure Island Redevelopment project. Source: TICD.

ALL TYPES OF POTENTIAL FLOODING • If applicable, the Commission may require an analysis of other types of flooding, such as fluvial flooding, groundwater flooding, and coastal flooding as a result of different storm events (e.g., a 25-year storm) at different points in time. In considering a proposed development, the Commission must consider all relevant conditions under which the project could be expected to flood in the future, in addition to present tidal conditions. See **Section 5.2** for more information on the types of potential flooding that a project proponent could consider addressing in their project's risk assessment.

Specific daily tidal elevations that BCDC has previously required in risk assessments include mean higher high water and mean high water, relative to the North American Vertical Datum (NAVD88). Inclusion of mean low water and mean lower low water would be appropriate for certain projects, particularly those that include a navigation element such as a marina.

While future sea level rise projections can generally be added to current stillwater elevations in risk assessments, wave run-up elevations may need to be re-calculated with the new stillwater elevation (that includes sea level rise) to account for any changes in the influence of the underlying bathymetry due to greater water depth at the project site in the future. For more information on the science and technical information referenced here, see **Section 5**, and see **Appendix C** for examples of these calculations.

DEGREES OF UNCERTAINTY • Degrees of uncertainty should also be identified in the risk assessment. This is often demonstrated when an applicant analyzes the potential impacts to, and adaptive capacity of, the proposed project under various sea level rise projections and flooding scenarios, as described in **Section 4**, which outlines the State Guidance's sea level rise projection decision-making process. The preparation of an adaptive management plan (Climate Change Policy 3) is also a response to uncertainty.

RISKS TO EXISTING HABITAT • Climate Change Policy 2 requires that the risk assessment describe risks to existing habitat from proposed flood protection measures. This assessment may be captured in the discussion of consequences of defense failure in a project's risk assessment (see next paragraph), but is often included in BCDC permit applications under the analysis of impacts to Bay resources and/or public access. In other cases, where there is no habitat in the project area, this aspect of Policy 2 may not be applicable.

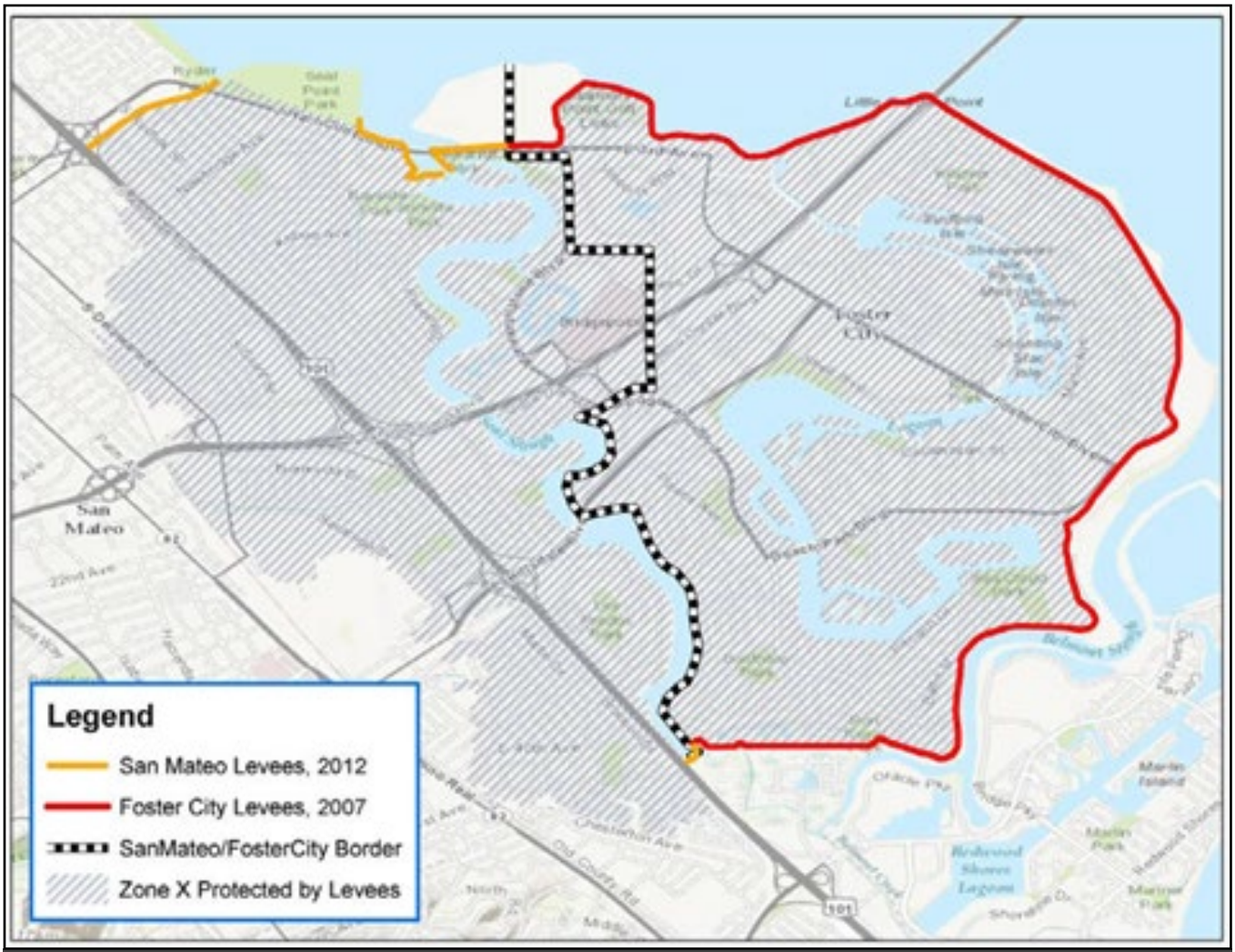


Figure 10. Consequence map from the Foster City Levee Protection Planning and Improvements project. Source: Foster City.

CONSEQUENCES OF DEFENSE FAILURE • Risk assessments should also consider the consequences of flood control, shoreline protection, and/or defense failure, particularly for potential impacts to public access, public safety, and Bay resources. While the potential consequences can be described, they are often incorporated into the inundation maps and cross-sections provided with risk assessments, as shown in the above example (Figure 10), by illustrating the areas that are protected from current and future flood risks by a flood control, shoreline protection, or defense mechanism.

2.3.3. Climate Change Policy 3 - Resilient to Mid-Century and Adaptable to End of Century

RESILIENT TO MID-CENTURY

Climate Change Policy 3, in part, requires certain projects to be resilient to sea level rise:

> *"To protect public safety and ecosystem services, within areas that a risk assessment determines are vulnerable to future shoreline flooding that threatens public safety, all projects––other than repairs of existing facilities, small projects that do not increase risks to public safety, interim projects and infill projects within existing urbanized areas––should be designed to be resilient to a mid-century sea level rise projection [….]"*

If Climate Change Policy 2 applies to the project and the completed risk assessment demonstrates that there are threats to public safety as a result of future shoreline flooding, the project must comply with the requirements of Climate Change Policy 3 by demonstrating how the project will be "resilient" through the year 2050 ("mid-century") or through the end of the project's life (whichever comes sooner) to the flood risks associated with future sea level rise, storms, wave action, and all other types of potential flooding that are detailed in the project's risk assessment. Flooding that "threatens public safety" is not defined in the Bay Plan but, considering the core policy goals of the McAteer-Petris Act, could reasonably mean impacts to the provision of maximum feasible public access and/or the safety of Bay fills.

Climate Change Finding (f) states, in part, that "Natural systems and human communities are considered to be resilient when they can absorb and rebound from the impacts of weather extremes or climate change and continue functioning without substantial outside assistance."

Some examples of measures that projects have undertaken to demonstrate resilience to 2050 include: elevating levees; installing water control structures to maintain appropriate water levels; enhancing or preserving marsh habitat where flooding is a part of the ecological functioning of the site by providing evidence of sustainable sediment accumulation and marsh accretion rates; elevating roads; creating berms; installing floating structures that can rise with water levels; raising the project site; and using designs that can withstand flooding, such as floodable structures and open spaces that can drain effectively and efficiently. It is important to recognize that "resilient," considering a commonly understood definition of the term, does not necessarily mean that the development must never experience flooding, but rather suggests that it should be able to absorb, rebound, and continue functioning following flood impacts.

BCDC has developed a flood elevation table which staff have in past cases used to analyze a project's risk and resilience with proposed elevation changes or protection measures under current and future water elevations. Users may reach out to BCDC staff to discuss whether the use of the flood elevation table is appropriate for their specific project. Figure 11 shows how the table was populated for the Mission Rock Development in San Francisco. The proposed elevation of any protection measures are entered (or if no protection measures have been proposed, the elevation(s) of the project site can be entered), along with time scales related to the sea level

rise projections; greenhouse gas emissions level (or scenario); the project's risk tolerance (see **Section 4**); and the closest tidal datum information. The white cells show freeboard, or the vertical distance from the waterline to the top of the protection measure or project site, and the blue cells show flooding, with the color gradient indicating the depth of the flood water. The spreadsheet containing this table can be shared with project proponents upon request, and the elevations are in NAVD88.

The table has in past instances enabled BCDC staff to gain a more nuanced understanding of a project's flood risks by considering if and how flooding would occur between daily tides and storm events that are more probable than a 100-year storm, which helps BCDC staff assess if and how a project could be considered resilient even if it will flood during a 100-year storm event. Using the flood elevation table, BCDC staff has in the past analyzed significant parts of the project, including low points at the site where overtopping would first occur, and the Bay Trail (when applicable). Generally in these cases, multiple locations on the project site were analyzed, but there are typically two main areas of the project that represent the average and worst case scenarios for flooding based on their elevation. Since proposed resilience and adaptation measures can be entered into the table, BCDC staff have used this table alongside BCDC's ART Bay Shoreline Flood Explorer, which has also been used to visualize overtopping and extent of flooding at existing conditions (discussed further in **Appendix A**). This tool has also helped BCDC staff more comprehensively analyze the proposed project's risk and resilience to flooding in past cases.

Project Name **Mission Rock - China Basin park**

Beach	8.8
Bay Trail	13.3

White cell shows freeboard in (##) feet *Blue means asset is flooded by amount shown (-##) feet*	Curent Elevation in feet (NAVD88)			Projected Sea Level Rise (feet)	Year: 2050 Emissions Level: High Emissions Risk Category: Medium - High Risk		Projected Sea Level Rise (feet)	Year: 2080 Emissions Level: High Emissions Risk Category: Medium - High Risk	
	Water Level	Beach	Bay Trail	1.9	Beach	Bay Trail	4.5	Beach	Bay Trail
Seasonal Water Level									
Mean lower low water (MLLW)	-0.22	9.02	13.52	1.68	7.12	11.62	4.28	4.52	9.02
Mean low water (MLW)	0.87	7.93	12.43	2.77	6.03	10.53	5.37	3.43	7.93
Mean tide level (MTL)	3.30	5.50	10.00	5.20	3.60	8.10	7.80	1.00	5.50
Mean sea level (MSL)	3.24	5.56	10.06	5.14	3.66	8.16	7.74	1.06	5.56
Mean high water (MHW)	5.74	3.06	7.56	7.64	1.16	5.66	10.24	-1.44	3.06
Mean higher high water (MHHW)	6.32	2.48	6.98	8.22	0.58	5.08	10.82	-2.02	2.48
Flood Event									
FEMA 1 year stillwater elevation (100%) (AKA King Tide)	7.59	1.21	5.71	9.49	-0.69	3.81	12.09	-3.29	1.21
FEMA 2 year stillwater elevation (50%)	7.88	0.92	5.42	9.78	-0.98	3.52	12.38	-3.58	0.92
FEMA 5 year stillwater elevation (20%)	8.27	0.53	5.03	10.17	-1.37	3.13	12.77	-3.97	0.53
FEMA 10 year stillwater elevation (10%)	8.56	0.24	4.74	10.46	-1.66	2.84	13.06	-4.26	0.24
FEMA 25 year stillwater elevation (4%)	8.98	-0.18	4.32	10.88	-2.08	2.42	13.48	-4.68	-0.18
FEMA 50 year stillwater elevation (2%)	9.32	-0.52	3.98	11.22	-2.42	2.08	13.82	-5.02	-0.52
FEMA 100 year stillwater elevation (1%)	9.70	-0.90	3.60	11.60	-2.80	1.70	14.20	-5.40	-0.90
FEMA 500 year stillwater elevation (0.2%)	10.71	-1.91	2.59	12.61	-3.81	0.69	15.21	-6.41	-1.91
FEMA Base Flood Elevation (1%)	9.70	-0.90	3.60	11.60	-2.80	1.70	14.20	-5.40	-0.90

Figure 11. BCDC's Flood Elevation Table. Source: BCDC.

ADAPTABLE TO END OF CENTURY

Climate Change Policy 3 also requires certain projects that have a lifespan that extends beyond 2050 to develop an adaptive management plan for future sea level rise:

> *"[…] If it is likely the project will remain in place longer than mid-century, an adaptive management plan should be developed to address the long-term impacts that will arise based on a risk assessment using the best available science-based projection for sea level rise at the end of the century."*

Climate Change Finding (i) defines adaptive management as, "[…] a cyclic, learning-oriented approach that is especially useful for complex environmental systems characterized by high levels of uncertainty about system processes and the potential for different ecological, social and economic impacts from alternative management options. Effective adaptive management requires setting clear and measurable objectives, collecting data, reviewing current scientific observations, monitoring the results of policy implementation or management actions, and integrating this information into future actions."

If the life of the project is likely to extend beyond 2050, an adaptive management plan to either the end of the life of the project or up to 2100, whichever is sooner, may need to be prepared. In certain past cases, if the life of the project extended beyond 2050, but the project was designed to be resilient to the impacts of sea level rise and flooding to the end of its life, the Commission did not require an adaptive management plan as a condition of approval. As described in **Section 4**, while the lifespan of the project is determined on a case-by-case basis, in past permitting decisions the lifespan of the project has been influenced by factors such as the project type and design, and land use in the project area.

Climate Change Policy 3 does not stipulate the specific components that should be included in an adaptive management plan or how one should be developed. Therefore, the following information and examples are based on the Commission's interpretation and application of Climate Change Policy 3 in past permitting decisions. Undertaking one of the approaches described below is not compelled by Climate Change Policy 3, and any proposed adaptive management plan must be tailored to the specific project considering the facts presented. In particular, as the determination of best available science evolves and best practices for sea level rise adaptation are developed, the Commission encourages project proponents to consider innovative approaches to adaptive management.

Depending, among other factors, on a project's resources, scale, impacts, and the level of certainty that a project will be resilient until the end-of-century, past projects have generally used an adaptation pathways approach and generally either developed an adaptive management plan at the time of permitting or been conditioned to require the development and implementation of an adaptive management plan subject to specified performance criteria when certain thresholds or triggers occur in the future.

Generally, in past permitting decisions, adaptive management plans have been developed by a qualified engineer and coordinated with whomever will manage the property in the long term. Depending on the proposed adaptation measure(s), an amendment to the existing permit or a new permit will likely be needed to implement the measures.

Sample projects that included an adaptive management plan in the BCDC permit •

For past projects where an adaptive management plan was developed before the project was permitted by the Commission, the associated permits have typically included special conditions requiring that periodic updates to the risk assessment and the adaptive management plan occur, based on flood monitoring at the project site, updates to relevant guidance, and the best available science among other requirements. Special conditions such as reporting of flood events, monitoring of subsidence, or flood impacts at the project site have been included in past permits. When this approach is used, the specific contents of such a disclosure would have to be justified under the facts presented and would be detailed in each individual project's permit conditions but may include disclosure of the date and duration of flooding, the source of flooding, any resulting damage or cleanup, and photographs of the flooding. In certain other cases, the permit was conditioned so that an occurrence would trigger implementation of a particular adaptation mechanism.

As conditioned in past permits, updates to the risk assessment and adaptive management plan have been undertaken by the corresponding project proponent and reviewed by BCDC staff if deemed necessary. The specific thresholds that may prompt an update must be tailored to the specific circumstances of any given project proposal and will be included in the permit conditions. Circumstances that have been conditioned in past projects to prompt an update to the risk assessment and adaptive management plan include, but are not limited to: results from the flood monitoring and reporting as conditioned in the permit; changes to best available science; changes to guidance from state and federal agencies; findings in the documentation of instances of flooding; changes to FEMA flood maps and accreditation; land settlement and/or subsidence; and regional or sub-regional adaptation planning efforts.

The following two examples of projects permitted by BCDC had developed an adaptive management plan before the project was permitted. Click on the permit titles to be redirected to excerpted language specific to each adaptive management plan in **Section 3**.

- **Levee Protection Planning and Improvements Project in Foster City** (BCDC Permit No. 2018.005.00)
- **Treasure Island Redevelopment Project in San Francisco** (BCDC Permit No. 2016.005.00)

King Tides at Foster City. Source: The California King Tides Project.

Sample permits conditioned to require development of an adaptative management plan •

The Commission has conditioned past permits so that specific future site conditions would trigger adaptation planning for the project. Under this approach, the specific thresholds would be determined on a case-by-case basis under the facts presented, but may be based on, for example, project type, vulnerability, life of project, available funding, and capacity of the permittee. The permit may also be conditioned so that once triggered, the adaptation measures must be planned and implemented within a specified timeframe.

For the following two permits, the Commission required that the risk assessment be reevaluated and, potentially, an adaptive management plan be prepared at a specific date in the future based on an evaluation of risk of the project. Click on the permit titles to be directed to excerpted language specific to these requirements in **Section 3**.

- **Oyster Point Development in South San Francisco** (BCDC Permit No. 2017.007.00)
- **Terminal One Development in Richmond** (BCDC Permit No. 2018.006.00)

Some past permits approved by the Commission have included conditions that require an adaptive management plan when the project is flooded a specified number of times over a specific time period. Two such permits are listed below. Click on the permit titles to be directed to excerpted language specific to these requirements in **Section 3.**

- **Alameda Landing Development** (BCDC Permit No. 2018.004.00)
- **San Francisco Fireboat Station (**BCDC Permit No. 2018.002.00)

In past instances the Commission has also included special conditions that require an adaptive management plan when sea level rise reaches a specified level. This approach was used in the permits listed below. Click on the permit titles to be directed to excerpts of these permit conditions.

- **Mission Rock Development** (BCDC Permit No. 2017.004.00)
- **Hill Slough Wildlife Area and Grizzly Island Road (**BCDC Permit No. 2017.004.00md)
- **The elevated area of Pier 70 Mixed-Use Development** (BCDC Permit No. 2018.008.00)

See **Section 3** for example permit conditions related to flood monitoring and reporting and adaptive management planning and implementation, and see **Appendix C** for example risk assessments and adaptive management plans.

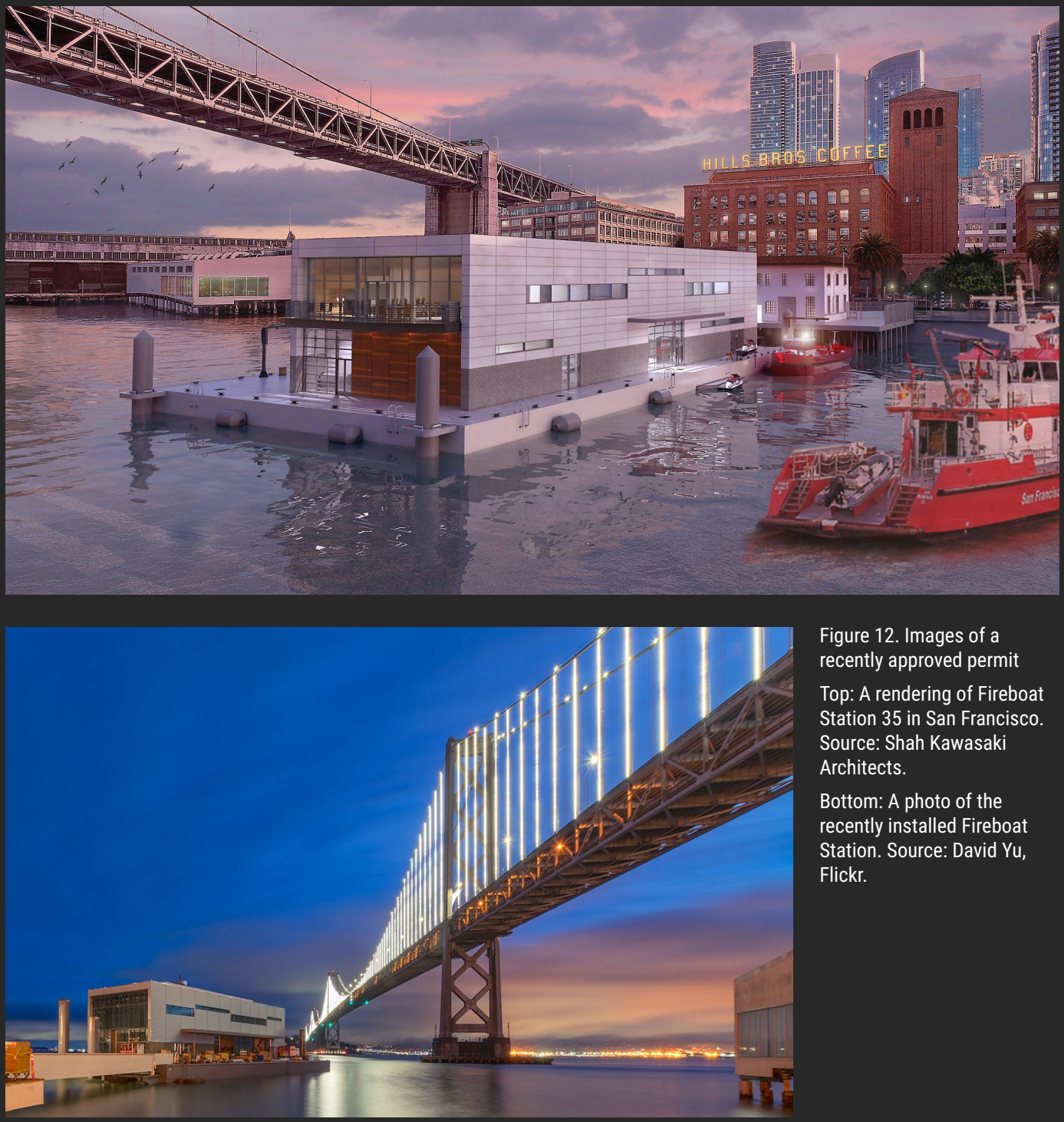


Figure 12. Images of a recently approved permit

Top: A rendering of Fireboat Station 35 in San Francisco. Source: Shah Kawasaki Architects.

Bottom: A photo of the recently installed Fireboat Station. Source: David Yu, Flickr.

2.3.4. Climate Change Policy 4 - Undeveloped Areas

Climate Change Policy 4 encourages the preservation and enhancement of undeveloped areas around the shoreline:

> *"To address the regional adverse impacts of climate change, undeveloped areas that are both vulnerable to future flooding and currently sustain significant habitats or species, or possess conditions that make the areas especially suitable for ecosystem enhancement, should be given special consideration for preservation and habitat enhancement and should be encouraged to be used for those purposes."*

Climate Change Policy 4 has not been used often in past permitting decisions by the Commission. Instead, the Commission has in past instances interpreted Climate Change Policy 4 as an advisory policy for applicants, local governments, and other regional stakeholders, as evidenced by the Commission's comments on local and/or large-scale regional planning efforts as well as in BCDC's programmatic planning efforts.

Climate Change Policy 4 is reinforced by Bay Plan Tidal Marshes and Tidal Flats Policies 4 and 5. Tidal Marshes and Tidal Flats Policy 5, which is discussed in **Section 2.4.5** along with other Bay Plan policies related to sea level rise and flooding that apply to habitat projects, encourages tidal restoration and the use of the best available science, and lists a number of specific project goals regarding the health and resilience of the Bay's wetlands. Tidal Marshes and Tidal Flats Policy 4 states "To provide for the restoration of Bay wetlands, state, regional, and local government land use, tax, and funding policies should not lead to the conversion of restorable lands to uses that would preclude or deter potential restoration. The public should make every effort to acquire these lands for the purpose of habitat restoration and wetland migration."

These policies could be heeded in local general plans and zoning; land acquisition decisions and restoration planning, such as San Francisco Bay Restoration Authority, Measure AA, and San Francisco Bay Joint Venture projects; Comprehensive Conservation and Management Plans; Plan Bay Area Priority Conservation Area designations; various public land management plans; and other related plans and projects around the shoreline of the San Francisco Bay.

King Tides at the Hayward Regional Shoreline. Source: The California King Tides Project.

2.3.5. Climate Change Policy 5 - Innovative Adaptation Approaches

Climate Change Policy 5 encourages the use of innovative shoreline adaptation approaches:

> *"Wherever feasible and appropriate, effective, innovative sea level rise adaptation approaches should be encouraged."*

Climate Change Finding (h) defines this type of adaptation approach as such: "Effective, innovative adaptation approaches minimize public safety risks and impacts to critical infrastructure; maximize compatibility with and integration of natural processes; are resilient over a range of sea levels, potential flooding impacts and storm intensities; and are adaptively managed."

This policy can help the Commission evaluate a project and weigh its risks against its public benefits. When feasible and appropriate, the Commission encourages planners and project proponents to consider using innovative adaptation approaches in order to test and refine them to ensure that they can effectively protect the Bay ecosystem and public safety before they are implemented on a large scale.

BCDC staff may use various resources and tools as part of their analysis of shoreline planning and adaptation approaches for proposed projects, such as the San Francisco Bay Shoreline Adaptation Atlas, which was developed by the San Francisco Estuary Institute and SPUR. If appropriate, BCDC staff may ask project proponents whether they considered certain types of innovative shoreline adaptation approaches, in particular nature-based options. Project proponents may share an analysis of the suitability and feasibility of certain innovative approaches that they have considered.

When an innovative shoreline adaptation approach is proposed as part of a project requiring a BCDC permit, a qualified coastal engineer should submit an analysis, supplemented by the opinions of other coastal processes professionals, such as geomorphologists, marsh biologists, and/or ecologists.

One example of an innovative adaptation approach that was authorized in a past project permitted by the Commission was for the Larkspur Condominiums along Corte Madera Creek in Marin County (Permit No. M2017.009.00), in which the permittee used a hybrid living shoreline protection system constructed of cobble, native rock, eucalyptus logs, and native soil.

Other examples include the San Francisco Bay Giant Marsh Living Shoreline Project (BCDC Permit No. M2016.026.00), a multi-habitat experiment to determine how various strategies of innovative living shoreline methods affect erosion, and Heron's Head Park Shoreline Resilience Project (BCDC Permit No. M1998.003.05), an erosion control project incorporating installation of a coarse gravel beach and rock groynes along with habitat enhancements such as oyster reefs and woody debris.

2.3.6. Climate Change Policy 6 - Regional Shoreline Adaptation Strategy

Climate Change Policy 6 recommends that a regional strategy to adapt to the Bay-related impacts of climate change should be developed:

"The Commission, in collaboration with the Joint Policy Committee, other regional, state and federal agencies, local governments, and the general public, should formulate a regional sea level rise adaptation strategy for protecting critical developed shoreline areas and natural ecosystems, enhancing the resilience of Bay and shoreline systems and increasing their adaptive capacity.

The Commission recommends that: (1) the strategy incorporate an adaptive management approach; (2) the strategy be consistent with the goals of SB 375 and the principles of the California Climate Adaptation Strategy; (3) the strategy be updated regularly to reflect changing conditions and scientific information and include maps of shoreline areas that are vulnerable to flooding based on projections of future sea level rise and shoreline flooding; (4) the maps be prepared under the direction of a qualified engineer and regularly updated in consultation with government agencies with authority over flood protection; and (5) particular attention be given to identifying and encouraging the development of long-term regional flood protection strategies that may be beyond the fiscal resources of individual local agencies.

Ideally, the regional strategy will determine where and how existing development should be protected and infill development encouraged, where new development should be permitted, and where existing development should eventually be removed to allow the Bay to migrate inland.

The entities that formulate the regional strategy are encouraged to consider the following strategies and goals:

a. advance regional public safety and economic prosperity by protecting: (i) existing development that provides regionally significant benefits; (ii) new shoreline development that is consistent with other Bay Plan policies; and (iii) infrastructure that is crucial to public health or the region's economy, such as airports, ports, regional transportation, wastewater treatment facilities, major parks, recreational areas and trails;

b. enhance the Bay ecosystem by identifying areas where tidal wetlands and tidal flats can migrate landward; assuring adequate volumes of sediment for marsh accretion; identifying conservation areas that should be considered for acquisition, preservation or enhancement; developing and planning for flood protection; and maintaining sufficient transitional habitat and upland buffer areas around tidal wetlands;

c. integrate the protection of existing and future shoreline development with the enhancement of the Bay ecosystem, such as by using feasible shoreline protection measures that incorporate natural Bay habitat for flood control and erosion prevention;

d. encourage innovative approaches to sea level rise adaptation;

e. identify a framework for integrating the adaptation responses of multiple government agencies;

f. integrate regional mitigation measures designed to reduce greenhouse gas emissions with

regional adaptation measures designed to address the unavoidable impacts of climate change;

g. address environmental justice and social equity issues;

h.integrate hazard mitigation and emergency preparedness planning with adaptation planning by developing techniques for reducing contamination releases, structural damage and toxic mold growth associated with flooding of buildings, and establishing emergency assistance centers in neighborhoods at risk from flooding;

i. advance regional sustainability, encourage infill development and job creation, provide diverse housing served by transit and protect historical and cultural resources;

j. encourage the remediation of shoreline areas with existing environmental degradation and contamination in order to reduce risks to the Bay's water quality in the event of flooding;

k. support research that provides information useful for planning and policy development on the impacts of climate change on the Bay, particularly those related to shoreline flooding;

l. identify actions to prepare and implement the strategy, including any needed changes in law; and

m. identify mechanisms to provide information, tools, and financial resources so local governments can integrate regional climate change adaptation planning into local community design processes."

At the time of publishing this guidance, this policy has not yet been realized and has not been applied in the Commission's past permitting decisions.

2.3.7. Climate Change Policy 7 - Case-by-Case Evaluation

Climate Change Policy 7 advises the Commission on the types of projects that should be encouraged due to their regional benefits:

> *"Until a regional sea level rise adaptation strategy can be completed, the Commission should evaluate each project proposed in vulnerable areas on a case-by-case basis to determine the project's public benefits, resilience to flooding, and capacity to adapt to climate change impacts.*
>
> *The following specific types of projects have regional benefits, advance regional goals, and should be encouraged, if their regional benefits and their advancement of regional goals outweigh the risk from flooding:*
>
> *a. remediation of existing environmental degradation or contamination, particularly on a closed military base;*
> *b. a transportation facility, public utility or other critical infrastructure that is necessary for existing development or to serve planned development;*
> *c. a project that will concentrate employment or housing near existing or committed transit service (whether by public or private funds or as part of a project), particularly within those Priority Development Areas that are established by the Association of Bay Area Governments and endorsed by the Commission, and that includes a financial strategy for flood protection that will minimize the burdens on the public and a sea level rise adaptation strategy that will adequately provide for the resilience and sustainability of the project over its designed lifespan; and*
> *d. a natural resource restoration or environmental enhancement project.*
> *The following specific types of projects should be encouraged if they do not negatively impact the Bay and do not increase risks to public safety:*
> *e. repairs of an existing facility;*
> *f. a small project;*
> *g. a use that is interim in nature and either can be easily removed or relocated to higher ground or can be amortized within a period before removal or relocation of the proposed use would be necessary; and*
> *h. a public park."*

Climate Change Policy 7 describes an interim approach to authorizing and regulating development in areas within the Commission's jurisdiction that are vulnerable to future flooding until a regional sea level rise adaptation strategy is developed that would replace the need for a case-by-case evaluation of certain projects by the Commission. Because this type and scale of a regional strategy is yet to be developed, the Commission continues to evaluate projects on a case-by-case basis. In part, Climate Change Policy 7 prompted the creation of this guidance, as this guidance attempts to highlight notable outcomes and observations regarding the Commission's past evaluations of individual projects under the Climate Change Policies.

Climate Change Policy 7 also enumerates which types of projects should be encouraged if their regional benefits outweigh the risk of flooding as well as the specific types of projects that should be encouraged if they do not negatively impact the Bay and do not increase risks to public safety. The Commission uses this policy when evaluating relevant projects. Project proponents may provide information to help BCDC staff develop a recommendation of project consistency with this policy.

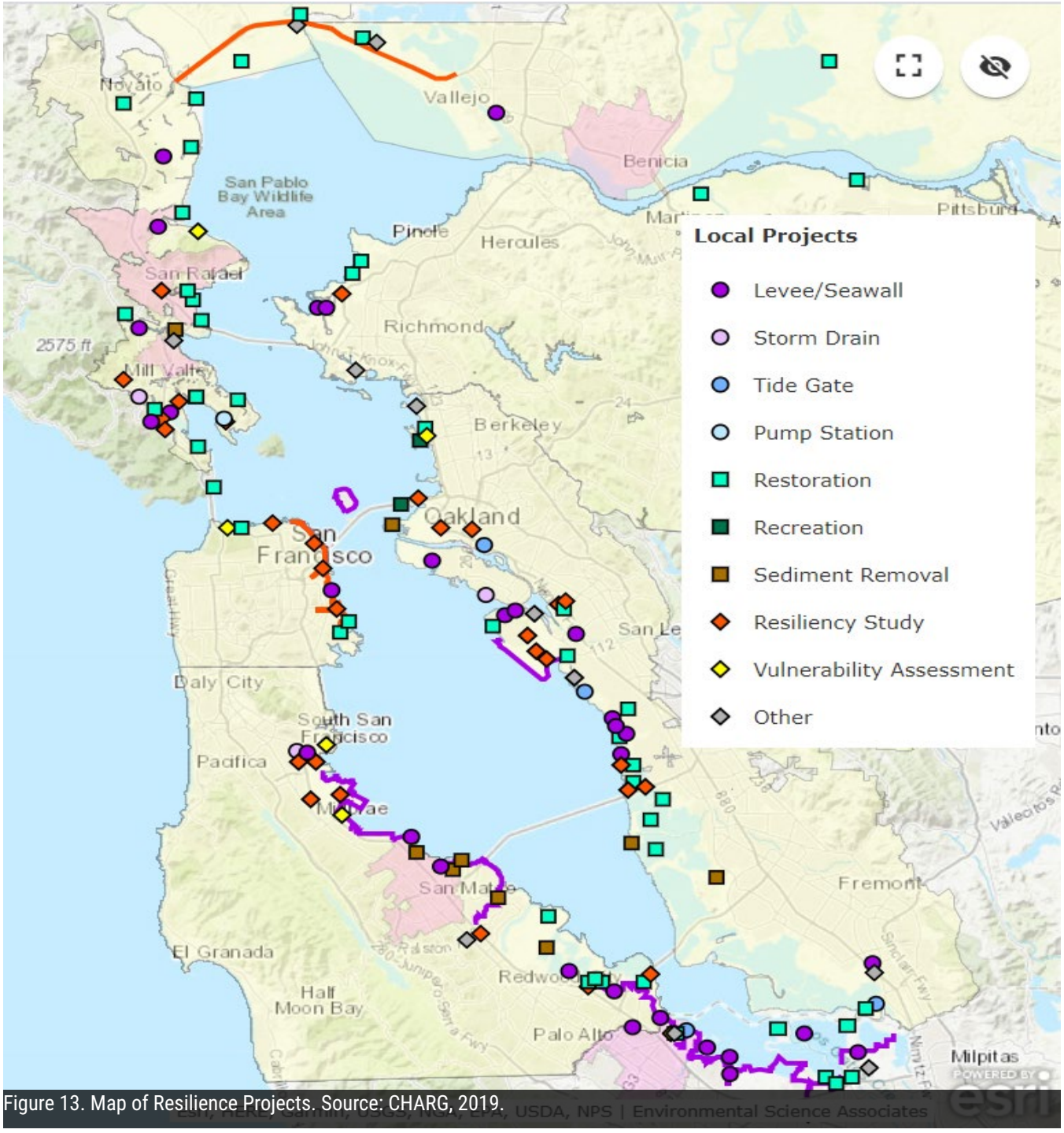


Figure 13. Map of Resilience Projects. Source: CHARG, 2019.

2.3.8. Climate Change Policy 8 - Coordination

Climate Change Policy 8 acknowledges the importance of interagency coordination to address sea level rise in project permitting:

> *"To effectively address sea level rise and flooding, if more than one government agency has authority or jurisdiction over a particular issue or area, project reviews should be coordinated to resolve conflicting guidelines, standards or conditions."*

One past example of where this type of coordination occurred was in the Levee Protection Planning and Improvements Project in Foster City (BCDC Permit No. 2018.005.00), for which BCDC coordinated and will continue to coordinate with the San Francisco Bay Regional Water Quality Control Board (Water Board) on each agency's adaptive management requirements. This policy has been applied sparingly in the permitting of past projects at BCDC, as this policy has typically only been relevant when there is a conflict between the conditions of other regulatory agencies and BCDC's. However, as state and regional regulatory efforts on sea level rise adaptation advance, BCDC will continue to work towards increased coordination with other regulatory bodies, such as the Water Board and the State Lands Commission.

BCDC does regularly engage in interagency coordination with the Bay Restoration Regulatory Integration Team (BRRIT), the purpose of which is to improve the permitting process for multi-benefit habitat restoration projects and associated flood management and public access infrastructure in the San Francisco Bay and along the shoreline of the nine Bay Area counties, excluding the Delta Primary Zone. The BRRIT consists of staff dedicated to this purpose from the six state and federal regulatory agencies with jurisdiction over habitat restoration projects in San Francisco Bay. More information on the BRITT can be found on the San Francisco Bay Restoration Authority's website. BCDC also participates in the United States Army Corps of Engineers interagency meetings in which discussions of projects in a pre-application phase regularly occur.

As stated throughout this guidance, BCDC strongly advises BCDC permit applicants to engage in pre-application discussions with BCDC staff early on in project planning and design, particularly for larger projects in which early interagency coordination is more likely to be needed. As BCDC's role generally comes later in the permitting process after several other regulatory agencies' permits have been attained, this point reinforces the need for early engagement in pre-application discussions and interagency coordination, when appropriate.

King Tides at Pier 7 in San Francisco. Source: BCDC Staff.

2.4. Other Related Bay Plan Policies

2.4.1. About the Other Related Bay Plan Policies

In addition to the Climate Change section, other sections of the Bay Plan contain findings and policies related to sea level rise, flooding, and storms, some of which the Commission has applied in conjunction with the Climate Change Policies and others which may apply to projects regardless of the applicability of the Climate Change Policies. As mentioned in **Section 1.3**, the Climate Change Bay Plan Amendment adopted by the Commission in 2011, in part, revised findings and policies in the existing Tidal Marshes and Tidal Flats, Safety of Fills, Shoreline Protection, and Public Access sections. Since then, there have been two other major amendments to the Bay Plan focused on promoting shoreline resilience in response to climate change. Similar to the previous section, this section provides guidance on how the Commission has interpreted and applied these other related Bay Plan policies in past permitting decisions and planning program efforts, including references to specific examples from past projects.

2.4.2. Shoreline Protection

SHORELINE PROTECTION POLICY 1 • If the project proposes shoreline protection, an important applicable policy would be Shoreline Protection Policy 1:

> *"New shoreline protection projects and the maintenance or reconstruction of existing projects and uses should be authorized if: (a) the project is necessary to provide flood or erosion protection for (i) existing development, use or infrastructure, or (ii) proposed development, use or infrastructure that is consistent with other Bay Plan policies; (b) the type of the protective structure is appropriate for the project site, the uses to be protected, and the causes and conditions of erosion and flooding at the site; (c) the project is properly engineered to provide erosion control and flood protection for the expected life of the project based on a 100-year flood event that takes future sea level rise into account; (d) the project is properly designed and constructed to prevent significant impediments to physical and visual public access; (e) the protection is integrated with current or planned adjacent shoreline protection measures; and (f) adverse impacts to adjacent or nearby areas, such as increased flooding or accelerated erosion, are avoided or minimized. If such impacts cannot be avoided or minimized, measures to compensate should be required. Professionals knowledgeable of the Commission's concerns, such as civil engineers experienced in coastal processes, should participate in the design."*

This policy was updated and expanded as part of the Climate Change Bay Plan Amendment in 2011 to reflect the need to provide protection for existing or proposed development, use, and infrastructure from flooding due to sea level rise and storm activity. Bay Plan Amendment 2-17 (Environmental Justice and Social Equity), which was adopted on October 17, 2019, further amended Shoreline Protection Policy 1 to add subpart (f) as an additional criterion for authorizing new shoreline protection projects and/or the maintenance or reconstruction of existing projects and uses.

If Shoreline Protection Policy 1 is applicable to a proposed project, the project proponent should provide an explanation for the proposed type of shoreline protection, such as hard (e.g., riprap, armoring), soft (e.g., marsh vegetation), or hybrid approaches, including evidence based on inspections of site conditions and engineering drawings that are signed by an engineer.

In accordance with subpart (c), the BCDC permit application should explain how the shoreline protection is properly engineered to provide erosion control and flood protection for the life of the project based on a 100-year flood event that accounts for future sea level rise. In accordance with standard coastal engineering practice, the proponent should demonstrate, based on physical evidence, that the project structure has the capacity to withstand the tidal forces at the site for the estimated life of the project. The engineering evidence should be based on a coastal study and supported by a soil/geotechnical assessment of the site, as subsidence is a significant concern along many areas of the Bay shoreline. Both engineering analyses should support the conclusion that the tidal forces or the dynamic loads are less than the designed capacity of the land and structure and that the latter is designed to endure or be adaptable to higher water levels with future sea level rise.

In accordance with subpart (e) and standard coastal engineering practice, the project proponent may need to submit a tidal fetch analysis by a coastal engineer of wave deflection and refraction when designing the end points of the new shoreline protection in order to minimize any impacts to the neighboring shoreline. This relates to subpart (f), which requires that project applicants evaluate and address adverse impacts caused by shoreline protection projects to adjacent or nearby areas. This requirement is supported by Shoreline Protection Finding (g): "Some hardened shoreline protection structures may intensify wave reflection and contribute to shoreline erosion and overtopping at adjacent or nearby vulnerable areas. At all sites, but particularly at sites in or adjacent to lower income communities that may lack resources to adequately protect their shoreline, it is important to design projects to minimize such impacts. Given the appropriate site conditions, natural and nature-based shoreline protection methods can dissipate wave energy more effectively than certain types of hardened shoreline protection structures, diminishing wave reflection impacts such as accelerated erosion and flooding in adjacent or nearby areas."

Ideally, under subpart (f), adverse impacts will be avoided by using shoreline protection that dissipates wave energy. If the shoreline protection proposal for a project does not fully avoid adverse impacts to adjacent or nearby areas, adjacent impacts may need to be mitigated through compensatory measures. See **Appendix C** for examples of this type of analysis.

SHORELINE PROTECTION POLICY 4 • Shoreline Protection Policy 4, which was also updated through the Climate Change Bay Plan Amendment, requires the incorporation of flood protection as a criterion for shoreline protection design and maintenance:

> *"Authorized protective projects should be regularly maintained according to a long-term maintenance program to assure that the shoreline will be protected from tidal erosion and flooding and that the effects of the shoreline protection project on natural resources during the life of the project will be the minimum necessary."*

The specific requirements for this policy depend upon the facts presented in any given project and compliance with this policy is assured through conditioning of any permit authorization.

SHORELINE PROTECTION POLICY 5 • Another policy that applies to all projects that propose shoreline protection is Shoreline Protection Policy 5, which requires the consideration of nature-based features:

> *"All shoreline protection projects should evaluate the use of natural and nature-based features such as marsh vegetation, levees with transitional ecotone habitat, mudflats, beaches, and oyster reefs, and should incorporate these features to the greatest extent practicable. Ecosystem benefits, including habitat and water quality improvement, should be considered in determining the amount of fill necessary for the project purpose. Suitability and sustainability of proposed shoreline protection and restoration strategies at the project site should be determined using the best available science on shoreline adaptation and restoration. Airports may be exempt from incorporating natural and nature-based features that could endanger public safety by attracting potentially hazardous wildlife."*

Bay Plan Amendment 1-17, which addressed Bay fill for habitat projects, was adopted on October 3, 2019. It revised Shoreline Protection Policy 5 to strengthen BCDC's requirement that all projects evaluate and include natural and nature-based features to the greatest extent practicable, and includes language to address the most recent science on shoreline adaptation and restoration as suitable and sustainable shoreline protection strategies. The policy is reinforced by Climate Change Policy 5, which encourages innovative sea level rise adaptation approaches. As Climate Change Finding (h) states, in part, "effective, innovative adaptation approaches [...] maximize compatibility with and integration of natural processes [...]."

BCDC staff may use various resources and tools as part of their analysis of shoreline planning and adaptation for proposed projects, such as the San Francisco Bay Shoreline Adaptation Atlas, which was developed by the San Francisco Estuary Institute and SPUR. BCDC staff may ask the project proponent to consider certain types of natural and nature-based shoreline protection measures, and the project proponent may share an analysis of the suitability and feasibility of certain natural and nature-based approaches that they have considered.

When a natural and/or nature-based shoreline protection approach is proposed as part of a project seeking a BCDC permit, a qualified coastal engineer should submit an analysis, supplemented by the opinions of other coastal professionals, such as geomorphologists, marsh biologists, and/or ecologists. The project proponent should provide justification for the type of shoreline protection, including evidence based on inspections of site conditions, and engineering drawings that are signed by an engineer.

SHORELINE PROTECTION POLICY 8 • Shoreline Protection Policy 8 requires that contamination remediation projects in the Bay and in the shoreline band incorporate consideration of sea level rise and flooding into their design:

> *"All contamination remediation projects in the Bay or along the Bay shoreline should integrate the best available science on sea level rise, storm surge, and associated groundwater level changes into the project design in order to protect human and ecological health by preventing the mobilization of contaminants into the environment and preventing harm to the surrounding communities."*

Bay Plan Amendment No. 2-17, which addressed Environmental Justice and Social Equity, was adopted on October 17, 2019. It added this policy, which is supported by Shoreline Protection Finding (l): "There are many contaminated sites on San Francisco Bay's shoreline and in adjacent subtidal areas. Current and future flooding of these sites could potentially mobilize contaminants into the environment of surrounding communities. These contaminants are associated with a number of adverse public health impacts. Many of these sites are in or near low-income communities of color facing various other adverse environmental impacts, creating compound negative health impacts. These impacts can be minimized if measures are taken to remove contaminants (if deemed safe for human and environmental health) and if remediation projects are designed using the best available science on sea level rise, storm surge, and associated groundwater level changes to prevent contaminant mobilization."

If the project involves contamination remediation, the project proponent should provide information on whether sea level rise, groundwater rise, and other potential types of flooding could mobilize pollutants in the contaminated area, and how the potential risks and impacts of mobilized contaminants will be mitigated.

King Tides at Pier 14 in San Francisco. Source: BCDC Staff.

2.4.3. Safety of Fills

SAFETY OF FILLS POLICY 4 • Safety of Fills Policy 4 requires projects that involve Bay fill to be designed to withstand the impacts of sea level rise, flooding, and storms:

> *"Adequate measures should be provided to prevent damage from sea level rise and storm activity that may occur on fill or near the shoreline over the expected life of a project. The Commission may approve fill that is needed to provide flood protection for existing projects and uses. New projects on fill or near the shoreline should either be set back from the edge of the shore so that the project will not be subject to dynamic wave energy, be built so the bottom floor level of structures will be above a 100-year flood elevation that takes future sea level rise into account for the expected life of the project, be specifically designed to tolerate periodic flooding, or employ other effective means of addressing the impacts of future sea level rise and storm activity. Rights-of-way for levees or other structures protecting inland areas from tidal flooding should be sufficiently wide on the upland side to allow for future levee widening to support additional levee height so that no fill for levee widening is placed in the Bay."*

Projects on Bay fill should be designed by engineering professionals, including coastal, structural, and geotechnical engineers, to ensure that the design of any water-related facilities meet the minimum standards of construction based on the California Building Code and the practices and standards of the American Society of Civil Engineers. Qualified professionals are responsible for the design of water-related facilities that are safe for the public and that protect the Bay against the potential adverse impacts of flooding and earthquakes.

If Safety of Fills Policy 4 applies to a proposed project, the project proponent will need to demonstrate their project's resilience by explaining how it includes adequate measures to prevent damage from sea level rise and storm activity, tolerate periodic flooding, and employ other effective means of addressing the impacts of future sea level rise and storm activity over the expected life of a project. Project design and analysis could consider potential impacts resulting from overtopping, seepage, settlement, creep, and/or damage from waves, erosion, and seismic hazards.

2.4.4. Public Access

PUBLIC ACCESS POLICY 6 AND 7 • If a proposed project includes public access it will need to be consistent with Public Access Policy 6 and 7, which address sea level rise and flooding:

> *"Public access should be sited, designed, managed and maintained to avoid significant adverse impacts from sea level rise and shoreline flooding [...] Whenever public access to the Bay is provided as a condition of development, on fill or on the shoreline, the access should be permanently guaranteed. This should be done wherever appropriate by requiring dedication of fee title or easements at no cost to the public, in the same manner that streets, park sites, and school sites are dedicated to the public as part of the subdivision process in cities and counties. Any public access provided as a condition of development should either be required to remain viable in the event of future sea level rise or flooding, or equivalent access consistent with the project should be provided nearby."*

The Climate Change Bay Plan Amendment added Public Access Policy 6 and updated Public Access Policy 7 to incorporate sea level rise and flooding considerations. In order to determine whether the public access will remain "viable" (Public Access Policy 7) in the event of future sea level rise or flooding, the applicant may be required to provide information regarding how the public access component(s) of the project will be resilient and adaptable over the life of the project. In some past permits for "larger shoreline projects" (Climate Change Policy 2), the Commission has applied Climate Change Policies 2 and 3 regarding risk assessments, resilience, and adaptive management plans in order to assess whether the public access would remain "viable" (Public Access Policy 7) in the event of future sea level rise and flooding.

In the context of public access that is expected to be submerged or is otherwise vulnerable to long term impacts of climate change, applicants may be expected to apply adaptive management and consider equivalent access options consistent with the original function. See **Section 4 (Step 2. Evaluate Project Lifespan)** for guidance on selecting functional lifespan. Certain past project approvals have incorporated an acknowledgement that a change or loss of public access infrastructure is expected due to future flooding. In these cases the Commission required as a condition of approval the retreat of infrastructure to increase benefits from restoration components while maintaining Maximum Feasible Public Access. An additional design consideration required was redundancy in available public access that is planned to adapt as sea levels rise. See **Section 3** (or **Dotson Family Marsh**) for example permit language.

As discussed in **Section 2.3.2**, in past situations where required public access is determined to be vulnerable, the Commission, relying on the State Guidance, has required that project proponents use a higher level of risk aversion when selecting the projections of sea level rise that are used in the project designs. For example, when public access is required as a condition of the project's permit, the State Guidance suggests that a "medium-high risk aversion" projection of sea level rise may be appropriate if there is a lack of room to effectively adapt the public access or provide equivalent access nearby in response to future sea level rise and flooding. In this context, in past permitting decisions, the Commission interpreted "adaptable" to mean that there is room to implement adaptation measures to preserve the viability of the public access in the future as sea level rises. As discussed in **Section 2.3.3**, "resilient" does not necessarily mean that the project will never experience flooding, but rather suggests that the public access should be able to absorb, rebound, and continue functioning following flood impacts. "Viable" could generally be interpreted with a similar understanding.

It should be noted that existing projects permitted prior to the Climate Change Bay Plan Amendment may be required to maintain viable public access as sea level rise, flooding, and storm impacts increase as a result of existing maintenance conditions in the executed permit.

2.4.5. Habitat Projects

While each of the Climate Change Policies could potentially apply to a proposed habitat project, with Climate Change Policy 7(d) and Climate Change Policy 4 particularly relevant, the Commission has applied other key Bay Plan policies when examining the risk, resilience, and adaptive management of habitat projects to sea level rise and flooding. Among these policies, Tidal Marshes and Tidal Flats Policy 6, Subtidal Areas Policy 3, and Fish, Other Aquatic Organisms and Wildlife Policy 6 require that sea level rise is considered in the planning, design, and permitting of habitat projects in the Commission's jurisdiction. As with all types of projects permitted by the Commission and all policies discussed in this guidance, the three policies discussed in the following paragraphs are considered in context with all other applicable BCDC laws and policies when permitting a habitat project in the Commission's jurisdiction.

It is important to note that there are different types of habitat projects that could be proposed in the San Francisco Bay and, depending on the specific project, could be subject to different requirements. Habitat projects that have been approved by the Commission have included habitat enhancement, restoration, and creation projects. Past habitat enhancement projects have improved the functions of an existing resource that is degraded in comparison to historic conditions (e.g., establishing native vegetation in an existing tidal marsh). Habitat restoration projects have restored a resource where it was formerly located (e.g., restoration of tidal marsh from a diked former tidal marsh area). Finally, habitat creation projects have created a new resource in an area that does not currently or did not historically support that type of resource (e.g., the creation of a tidal marsh in a subtidal area). Generally speaking, since habitat creation is not based on historically successful ecological functioning, creation projects may have a higher degree of uncertainty, which may impact the scope and scale of the design, monitoring, and adaptive management that may be warranted.

TIDAL MARSHES AND TIDAL FLATS POLICY 6 AND SUBTIDAL AREAS POLICY 3 • Tidal Marshes and Tidal Flats Policy 6 requires that appropriate habitat projects analyze resilience strategies, adaptability to sea level rise and potential for marsh migration:

> *"Any habitat project should include clear and specific long-term and short-term biological and physical goals, success criteria, a monitoring program, and as appropriate, an adaptive management plan. Design and evaluation of the project should include an analysis of: (a) how the project's adaptive capacity can be enhanced so that it is resilient to sea level rise and climate change; (b) the impact of the project on the Bay's and local embayment's sediment transport and budget; (c) localized sediment erosion and accretion; (d) the role of tidal flows; (e) potential invasive species introduction, spread, and their control; (f) rates of colonization by vegetation; (g) the expected use of the site by fish, other aquatic organisms and wildlife; (h) an appropriate buffer, where feasible, between shoreline development and habitats to protect wildlife and provide space for marsh migration as sea level rises; (i) site characterization; (j) how the project adheres to regional restoration goals; (k) whether the project would be sustained by natural processes; and (l) how the project restores, enhances, or creates connectivity across Bay habitats at a local, sub-regional, and/or regional scale."*

Subtidal Areas Policy 3 includes similar requirements to Tidal Marshes and Tidal Flats Policy 6, but for a subtidal habitat project:

> *"Any subtidal habitat project should include clear and specific long-term and short-term biological and physical goals, success criteria, a monitoring program, and as appropriate, an adaptive management plan. Design and evaluation of the project should include an analysis of: (a) the ecological need for the project; (b) the effects of relative sea level rise; (c) the impact of the project on regional and local sediment budget and transport; (d) localized sediment erosion and accretion; (e) the role of tidal flows; (f) potential invasive species introduction, spread, and control; (g) rates of colonization by vegetation, where applicable; (h) the expected use of the site by fish, other aquatic organisms and wildlife; (i) characterization of and changes to local bathymetric features; (j) how the project will adhere to the best available and regionally appropriate science on subtidal restoration and conservation goals; and (k) whether the project would be sustained by natural processes."*

As contemplated by subsection (b), project proponents may need to provide information regarding how a proposed habitat project may be affected by sea level rise consistent with the size and impact of the project. One example of a past habitat project approved by the Commission in which Climate Change Policy 2 did not apply, but sea level rise was a key consideration in the design and engineering, was the Tule Red Tidal Restoration Project in Suisun Marsh (BCDC Permit No. 2016.002.00md). Example permit condition language for the Tule Red Tidal Restoration Project is included in **Section 3.3.**

Aquatic plants along the shoreline. Source: BCDC Staff.

FISH, OTHER AQUATIC ORGANISMS, AND WILDLIFE 6 • Fish, Other Aquatic Organisms and Wildlife Policy 6 requires habitat projects in the Bay to use best available science on sea level rise:

> *"Allowable fill for habitat projects in the Bay should (a) minimize near term adverse impacts to and loss of existing Bay habitat and native species; (b) provide substantial net benefits for Bay habitats and native species; and (c) be scaled appropriately for the project and necessary sea level rise adaptation measures in accordance with the best available science. The timing, frequency, and volume of fill should be determined in accordance with these criteria."*

This policy includes general guiding principles for the permissibility of a fill for habitat project, including the risk of habitat loss from sea level rise, and the need to consider the substantial net benefits of fill for sea level rise adaptation of habitat, even if some organisms and habitats may be adversely affected. The placement of larger volumes of fill for habitat projects in the Bay has the potential to adversely impact existing habitats, and to convert existing habitats into other habitat types. Decisions about when and where habitat type conversion occurs are complex and are therefore made on a case-by-case basis. This policy may apply in conjunction with other relevant policies to require that the design of habitat projects ensures that these projects are resilient to sea level rise, while minimizing adverse impacts to the Bay.

Flying Great Blue Heron. Source: US EPA.

Downtown San Francisco. Source: BCDC Staff.

3. EXAMPLE PERMIT CONDITIONS

3.1 About this Section

The example permit conditions provided in **Section 3.2** and **Section 3.3** are from previously issued Commission permits implementing the Bay Plan Climate Change Policies. They are provided solely for illustrative and guidance purposes. In future permitting decisions, the Commission retains full discretion in determining the terms and precise language of any permit conditions necessary to ensure consistency with the Climate Change Policies, as well as other applicable Bay Plan policies, laws, and regulations.

The Climate Change Policy amendment was the first set of actions adopted by an agency operating under the Coastal Zone Management Act that address the challenge of sea level rise. The following examples include language written over a decade of applying these innovative policies and working with partners on place-based adaptation, often taking into account site-specific requirements and nuances. **Section 3.2** provides condition language for smaller shoreline projects that were permitted without the application of Climate Change Policies 2 and 3. **Section 3.3** provides language from selected permits that were considered "larger shoreline projects" and were permitted with the application of Climate Change Policies 2 and 3. These examples of thresholds and adaptation pathways written into permit conditions should provide an overview of how BCDC has confronted the challenges of uncertainty over the past decade.

3.2 Examples for Smaller Shoreline Projects

3.2.1. Example Permit Condition Language

CESAR E. CHAVEZ PARK (BCDC PERMIT NO. 1978.033.07): "Time-Limited Authorization. The authorization for the improvements granted or provided by Amendment No. Seven (the Eastern Shoreline riprap revetment repairs and improvements) shall expire on December 31, 2050, the designed life of the project. Prior to this date, the permittee shall seek an amendment to this permit or a new permit to retain, remove, modify, repair or replace the permanent improvements authorized under Amendment No. Seven in a manner that is consistent with the Commission's laws and policies at that time (Amendment No. Seven)."

DUNPHY PARK IMPROVEMENTS (BCDC PERMIT NO. M2017.019.00): "Flooding of Public Access Areas. The permittee shall maintain all public access amenities required herein consistent with the document entitled, "Climate Change Adaptation Plan Dunphy Park Improvement Project," dated June 2018, and prepared by Prunuske Chatham, Inc. Any updates to this plan, or adoption of any other plan that would affect viability of the public access amenities required herein at Dunphy Park to impacts from flooding from sea level rise and storms shall be approved by or on behalf of the Commission. Prior to implementation of the adaptive management measures, the permittee shall seek approval by or on behalf of the Commission, including a separate permit action or possible amendment to this permit."

SHEETPILE BULKHEAD IN SAN FRANCISCO (BCDC PERMIT NO. M2018.007.00): "Flood Reports. If any portion of the project, including the required public access area, is subject to coastal flooding that results in its closure in whole or in part, the permittees shall submit to the Commission a written report within 30 days after the flooding with documentation of: the date and duration of the closure; the location of the affected site; the recorded water levels during the closure period; the source of flooding (e.g., coastal flooding or stormwater backup or overland flow); the resulting damage or cleanup; and illustrative photographs with site details. Coastal flooding is defined as Bay overtopping of the shoreline during tides, storms, or both."

"Adaptation Planning Process. The permittees shall initiate a sea level rise adaptation planning process for the project, including the public access areas required by Special Condition 11.B.1, that will ensure the provision of shoreline access into the future as long as any use authorized herein remains in place. Within 180 days of the first occurrence of coastal flooding that affects the project or results in closure of any portion of the public access, as described in the flood reports required by Special Condition 11.D.1, or earlier at the discretion of the permittees, the permittees shall submit for Commission review and approval a sea level rise adaptation plan that conforms to the requirements in Special Condition 11.D.3, below. The plan shall be reviewed by or on behalf of the Commission pursuant to Special Condition 11.A.2. Depending on the actions required to implement the sea level rise adaptation plan, the permittees may be required to obtain a permit or permit amendment from the Commission.

Adaptation Plan Requirements. According to the schedule in Special Condition 11.D.2, above, the permittees shall submit for Commission review and approval a sea level rise adaptation plan that achieves the following objectives:

> a. Measures shall be developed that will address impacts to the project that arise as a result of flooding for the period during which the authorized uses will remain in place. The public access area required in Special Condition 11.B.1 shall be protected from flooding through raising the elevation of the public access, installing a flood protection device (e.g., a barrier wall or guardrail) or by another method acceptable to the Commission. Alternatively, the permittees may propose an alternative, equivalent public access area that provides

maximum feasible public access consistent with the project.

b. A timeline shall be established to implement the required adaptation measures to ensure that the project addresses the impacts of flooding and storm activities and that the required public access remains viable and is not subject to regular flooding events. The adaptation plan shall incorporate sea level rise and storm projections based on the current best available science at the time it is developed and/or updated."

SEAPLANE LAGOON FERRY TERMINAL (BCDC PERMIT NO. M2018.025.00): "Sea Level Rise Adaptation. If, by the year 2050, no measures have been constructed to provide sea level rise resilience for the interim landside public access areas required by special condition 11.B of this permit, the permittee shall be required to submit a plan for review and approval by or on behalf of the Commission, pursuant to Special Condition II.A of this permit, for adaptation measures to provide sea level rise resilience for those public access areas, consistent with the Commission's policies, for the expected life of the ferry terminal structure, and shall construct the approved measures."

3.2.2. Example Permit Findings Language

DIKE IMPROVEMENTS AT THE OAKLAND AIRPORT (BCDC PERMIT NO. M2017.002.01): "Amendment No. One. The project authorized in Amendment No. One of this permit involves, within the Commission's 100-foot shoreline band jurisdiction and a San Francisco Bay Plan-designated Airport Priority Use Area, construction and maintenance to raise and stabilize an existing perimeter dike around the South Field of the Oakland International Airport, including ancillary infrastructure. The project is designed to raise the dike to withstand potential impacts from a 100-year flood event over the life of the project through the year 2050 with approximately 1.9 feet of projected sea level rise at the site, based on the Ocean Protection Council (OPC) 2018 Sea Level Rise Guidance for high emissions and medium-to-high risk aversion. Special Condition II.C requires the permittee to construct and maintain shoreline protection in conformance with sound safety standards."

DUNPHY PARK IMPROVEMENTS (BCDC PERMIT NO. M2017.019.00): "Special Condition 11.B. has been included to ensure that the permittee continues to maintain the public access and that the public access will not be adversely impacted by sea level rise. The park is designed to be resilient to sea level rise through 2050, through raising the elevation of the shoreline areas and grading the areas to drain if they are overtopped. Additionally, the finish floor of the restroom, which is the only public structure within the park, will be raised and waterproofed to avoid damage from flooding."

SEAPLANE LAGOON FERRY TERMINAL (BCDC PERMIT NO. M2018.025.00): "The ferry terminal structure will be designed to withstand potential impacts from 100-year flooding over the life of the project through the year 2070 with approximately 3.5 feet of projected sea level rise at the site, based on the Ocean Protection Council (OPC) 2018 Sea Level Rise Guidance for high emissions and medium-to-high risk aversion. The proposed landside elevation for the interim landside improvements proposed as part of this project would be resilient to a 100-year storm with 1.9 feet of projected sea level rise for the year 2050. The Site B development is envisioned to begin construction well before the year 2050. Special Condition 11.H requires adaptive measures for sea level rise resilience after the year 2050 if by that time, Site B has not been developed yet or the interim landside improvements have not been redeveloped."

CORTE MADERA MARSH RESTORATION (BCDC PERMIT NO. M2019.011.00): "New public access amenities will be added along the length of this new trail, and along the length of an existing trail on the northern berm and an existing public access easement on the eastern and southern portions of the District's 72-acre parcel. Besides the addition of amenities, no changes are required to the existing 816-linear-foot trail on the northern berm or the public access easement on the eastern berm (required by BCDC permit No. 1973.022.00). Based on low risk aversion scenario projections (66% likelihood) in the Ocean Protection Council's State of California 2018 Sea Level Rise Guidance, the wetland area is expected to gradually convert to mudflat by the year 2100, and the public access areas are expected to convert to tidal marsh and no longer be usable between 2060 and 2080. Additionally, the required public access trail is expected to start experiencing some shallow, localized flooding by 2030. Beyond maintenance, the District does not plan to adapt the project site to sea level rise, but may restore other parts of the 72-acre parcel to tidal action in future years, and may re-locate the public access accordingly."

"The tidal marsh area of the project is expected to convert to mudflat by the year 2100. Tidal Marshes and Tidal Flats policy 5 states, in part, that "To the greatest extent feasible, habitat projects should be sustained by natural processes; increase habitat connectivity; restore hydrological connections; provide opportunities for endangered species recovery; and provide opportunities for landward migration of Bay habitats. As conditions change, management measures may be needed to maintain habitat and ecological function in some areas." While this policy encourages long-term sustainability of habitat projects, it also provides for cases in which long-term maintenance of habitat projects is not necessary or feasible. The project authorized by this permit is expected to increase habitat connectivity, restore hydrological connections, and provide opportunities for endangered species recovery during the life of the project. In addition, the District has planned a larger restoration project for the entirety of the District's 72-acre property. The larger proposed restoration project is expected to have a longer life and increase the long-term sustainability of the area."

"Because the proposed restoration is expected to provide habitat for endangered species—California Ridgway's rail and Salt Marsh Harvest Mouse—it is important to minimize conflicts between public access and wildlife habitat. Public Access policy 4 states, in part, that, "Public access should be sited, designed, and managed to prevent significant adverse effects on wildlife…" To minimize wildlife conflicts, Special Condition II-D-4 requires construction and maintenance of a wildlife exclusion fence along the length of the required public access trail.

The public access trail required by Special Condition II.D.1 of this permit is also expected to be partially submerged by sea level rise between 2060 and 2080. Public Access policy 6 states that, "Public access should be sited, designed, managed and maintained to avoid significant adverse impacts from sea level rise and shoreline flooding." Public Access policy 7 states, in part, that, "Any public access provided as a condition of development should either be required to remain viable in the event of future sea level rise or flooding, or equivalent access consistent with the project should be provided nearby." As conditioned, the public access required by Special Condition II.D.1 is resilient to mid-century sea level rise flooding projections, and is viable in the event of future sea level rise and flooding from storms. The public access provided by the project is the maximum feasible public access consistent with the project, including the life of the restoration project.

The District has plans to restore the entirety of the 72-acre property in the future. Constructing the larger restoration project may require the removal or modification of the public access required by this permit. In addition, any permit authorizing future restoration activity could supersede the requirements of this permit."

3.3 Examples for Larger Shoreline Projects

3.3.1. Risk Assessments

FOSTER CITY LEVEE PROTECTION PLANNING AND IMPROVEMENTS (BCDC PERMIT NO. 2018.005.00): "Every 5 years following the issuance of this permit, the permittee shall prepare an assessment to determine if an update to the risk assessment and adaptive management plan ("RAAMP") for the project (the document entitled "City of Foster City, Levee Protection Planning and Improvements Project (CIP 301-657), Risk Assessment and Adaptive Management Plan for Future Sea Level Rise", prepared by Schaaf & Wheeler Consulting Civil Engineers, dated October 24, 2019, or any subsequent update approved by or on behalf of the Commission) is necessary given the status of the following (compared to the existing RAAMP):

a. The best available science, including: up-to-date sea level rise projections; tidal datum and extreme tides datum; available modeling of tidal dynamics and Bay hydrological process; tide gauge data over the subject five-year period;

b. The most up-to-date sea level rise guidance from state and federal agencies, including, but not limited to, the Commission, the State of California, the U.S. Army Corps of Engineers and Federal Emergency Management Agency ("FEMA");

c. Documentation of any occurrences of flooding at the public access areas, as required in Special Condition II.C.1;

d. The current FEMA flood maps and accreditation;

e. Land settlement of the levee system or throughout public access areas at the project site; and

f. Regional planning efforts.

By January 31, 2025, and by January 31 of every fifth year thereafter, the permittee shall submit for review by or on behalf of the Commission, pursuant to Special Condition II.A.2, the assessment, including a determination of whether an update to the RAAMP is necessary at that time. The assessment shall include a monitoring report that summarizes all of the flood events reported pursuant to Special Condition II.C.1 since the last update to the RAAMP. If the assessment, following review and approval by or on behalf of the Commission, makes a determination that an update is necessary, the permittee shall prepare an update to the RAAMP pursuant to Special Condition II.C.3.

The permittee may submit update assessments to the commission sooner than required. The permittee may also request time extensions to the deadlines for providing assessment documentation, to be reviewed and approved by or on behalf of the Commission pursuant to the procedures in Special Condition II.A.2.

If an update to the RAAMP for the project is determined necessary by the permittee or by or on behalf of the Commission pursuant to Special Condition II.C.2, within 6 months of that determination the permittee shall prepare and submit an update to the RAAMP for review and approval by or on behalf of the Commission pursuant to the procedures in Special Condition II.A.2.

Each update to the RAAMP shall include a determination of whether adaptation is expected to be necessary within the following five years from the time of the completion of the RAAMP update in order for the public access required by the project in Special Condition II.B to remain resilient to flooding during a 100-year storm event, including wave run-up, that takes into account the best estimates of sea level rise. If the updated RAAMP, following review and approval by or on behalf of the Commission, makes a determination that adaptive measures are necessary within the next five years, the permittee shall prepare and implement an adaptation work plan pursuant to Special Condition II.C.4.

The permittee may update RAAMP for the project sooner than required. The permittee may also request time extensions to the deadlines for providing their assessment documentation, to be reviewed and approved by or on behalf of the Commission pursuant to the procedures in Special Condition II.A.2."

King Tide near SMART rail tracks in Marin. Source: BCDC Staff.

3.3.2. Flood Reporting

FOSTER CITY LEVEE PROTECTION PLANNING AND IMPROVEMENTS (BCDC PERMIT NO. 2018.005.00): "If any portion of the project, including the required public access areas as defined in Special Condition II.B, is subject to coastal flooding that results in its closure in whole or in part, the permittees shall submit to the Commission a written report within 30 days after the flooding with documentation of: the date and duration of the closure; the location of the affected site; the recorded water levels during the closure period; the source of flooding (e.g., coastal flooding or stormwater backup or overland flow); the resulting damage or cleanup; and illustrative photographs with site details. Coastal flooding is defined as Bay overtopping of the shoreline during tides, storms, or both."

PIER 70 MIXED-USE DEVELOPMENT (BCDC PERMIT NO. 2018.008.00): "If any portion of the required public access area is subject to coastal flooding that results in its closure in whole or in part, the permittees shall submit to the Commission a written report within 60 days after the flooding documenting the flood event. Coastal flooding is defined as Bay overtopping of the shoreline during tides, storms, or both. The written report shall include: the date and duration of the closure; the location of the affected site; the recorded water levels during the closure period; the source of flooding (e.g., coastal flooding or stormwater backup or overland flow); the resulting damage or cleanup; and illustrative photographs with site details."

"Within 180 days of the first instance of coastal flooding that results in closure of a required public access area in whole or in part, the permittees shall submit a monitoring report generally based on the Pier 70 Shoreline Improvement Design Criteria and Sea Level Risk Assessment, ("M&N Sea Level Rise Report") prepared by Moffat and Nichol, for review by or on behalf of the Commission. The monitoring report will be revised and resubmitted for review by or on behalf of the Commission every 5 years thereafter. Each 5-year report shall:

a. Reflect the best-available science and include: up-to-date sea level rise projections; global projections of sea level rise based on downscaled Global Climate Models; sea level rise projections for the San Francisco Bay Area; tidal datum and extreme tides datum; updated modeling in tidal dynamics and Bay hydrological process; tide gauge data over the subject 5-year period; and a comparison of updated projections on sea level rise versus projections cited in the M&N Sea Level Rise Report.

b. Provide a summary of all flooding events during the 5-year period to any public access area that results in their closure, including the following detail: the date and duration of the public access closure; the location of the affected site; the recorded water levels during the closure period; the source of the flooding; the resulting damage and/or cleanup; and representative photographs of the flooding event.

c. Include data based on observations of water levels at the shoreline adjacent to the public access areas, including measurements of water levels over the subject 5-year monitoring period and photographic evidence (with date, location, hour and actual tide levels recorded at tide gauges) of completed and planned public access areas during King Tide events.

d. Provide a review of the M&N Sea Level Rise Report, including a recommendation as to whether it should be revised based on site conditions, sea level rise and storm projections, updated policy guidance, or other findings.

The monitoring report shall be reviewed for adequacy and may be approved pursuant to the plan review process identified in Special Condition II.A."

ALAMEDA LANDING DEVELOPMENT (BCDC PERMIT NO. 2018.004.00): "If any portion of the public access areas required by Special Condition 1.B.1 is subject to coastal flooding that necessitates closure of the public access in whole or in part, and such closures are the result of two or more separate coastal flooding events in any given twelve-month period, the permittees shall notify the Commission of such events and shall initiate a planning process in consultation with the Commission to identify feasible (e.g., based on financial, wharf loading, and/or other site constraints) modifications to the design of the park to ensure that the required public access areas will remain viable. Coastal flooding is defined as Bay overtopping of the waterfront park shoreline edge during tides, storms, or both."

TREASURE ISLAND REDEVELOPMENT (BCDC PERMIT NO. 2016.005.00): "At any time, if any portion of the completed or future public access required by this permit is subject to flooding that requires a closure of public access, the permittees shall submit a monitoring report documenting the date, location, recorded tide level, rainfall (amount and duration), source of flooding (for example, coastal shoreline overtopping or stormwater system backup), how long the flooding lasted, any damage or cleanup necessary, how long the public access was closed if at all, photographs of the flooding with date/time/location/orientation. The monitoring report must be submitted within 45 days of any flood event. If flooding occurs in any area for future or completed public access area required herein where remediation of contaminated lands has occurred and for which a "no further action letter" or similar regulatory closure has not yet been obtained, the permittees shall notify the Commission in the event that any additional cleanup and permitting is necessary."

"Every five years following the date of permit issuance— with the initial report due on or around October 1, 2021—the permittees shall submit to the Commission staff a monitoring report generally based on the Sea Level Risk Assessment and Adaptation Strategy for Rising Sea Levels ("Assessment and Strategy") prepared by Moffatt & Nichol Engineers dated August 1, 2016 (V.3), which shall reflect the best available science and include: up-to-date sea level rise projections; global projections of sea level rise based on downscaled Global Climate Models; sea level rise projections for the San Francisco Bay Area; tidal datum and extreme tides datum; updated modeling in tidal dynamics and Bay hydrological process; tide gauge data over the subject five-year period; a comparison of updated projections on sea level rise v. projections cited in the August 1, 2016 Assessment and Strategy document; and an assessment as to whether remediated lands located within the public access area required herein are or would be vulnerable to flooding. In addition, the monitoring report shall:

a. Describe whether the 2016 Assessment and Strategy report is consistent with the most up-to-date guidance from state and federal agencies, including, but not limited to, the Commission, the U.S. Army Corps of Engineers, the State of California Ocean Protection Council, and Federal Emergency Management Agency ("FEMA");

b. Present data on land settlement since 2016 throughout public access areas required herein to be acquired through periodic topographic surveys of the project site by licensed surveyors based on benchmarks, which shall be installed as approved by or on behalf of the Commission through plan review, as required in Special Condition A;

c. Present data based on observations of water levels at the public access, including measurements of water levels over the subject five-year monitoring period and photographic evidence (with date, location, hour and actual tide levels recorded at tide gauges) of completed and planned public access areas during king tide events;

d. Document any occurrence of flooding at the public access areas required herein, including

date, location, recorded tide level, rainfall (amount and duration), source of flooding (e.g., shoreline overtopping or stormwater system backup), duration of flooding, damage or cleanup necessary, and duration of access closure; and

e. An assessment of the Assessment and Strategy report, including a recommendation as to whether it should be revised based on findings, site conditions, sea level rise and storm projections, and updated policy guidance.

Within 30 days of receipt of the monitoring report, the Commission staff shall conduct a review in consideration of, among other things, the best available science, most recent state and federal guidance, and BCDC policies then in-effect. Within 30 days of receipt of the monitoring report, the permittees shall be notified by or on behalf of the Commission as to whether:

a. The Commission accepts the monitoring report and recommends no changes to the permittees' approach, including the 2016 Assessment and Strategy report, or the original permit;

b. The Commission recommends revisions to the monitoring report on the basis that it is incomplete; or

c. The Commission requires revisions to the 2016 Assessment and Strategy report and/or the original permit based on findings and information contained in the monitoring report that reveal circumstances substantially different from those described in the 2016 Assessment and Strategy report, where such revisions are necessary to protect public access of the size and usability required by this permit."

FIREBOAT STATION IN SAN FRANCISCO (BCDC PERMIT NO. 2018.002.00): "If any portion of the project, including the required public access area, is subject to flooding that results in its closure in whole or in part, the permittees shall submit to the Commission a written report within 30 days after the flooding with documentation of: the date and duration of the closure; the location of the affected site; the recorded water levels during the closure period; the source of flooding (e.g., coastal flooding or stormwater backup or overland flow); the resulting damage or cleanup; and illustrative photographs with site details. Coastal flooding is defined as Bay overtopping of the shoreline during tides, storms, or both;"

OYSTER POINT DEVELOPMENT (BCDC PERMIT NO. 2017.007.00): "Flood Reporting. If any portion of the public access required herein and described in Special Condition 11.B.2 is subject to flooding that results in a closure of any area, the permittee shall submit to the Commission a written report within 30 days after the closure of the public access area. The written report shall include: the date and duration of the public access closure; the location of the affected site; the recorded water levels during the closure period; the source of flooding (e.g., Bay shoreline overtopping, stormwater backup, or overland flow); the resulting damage and/or cleanup; and representative photographs with site details."

HILL SLOUGH WILDLIFE AREA AND GRIZZLY ISLAND ROAD (BCDC PERMIT NO. 2017.003.02md): "Flood Reporting and Adaptive Management Plan for Grizzly Island Road and the Restored Hill Slough Wildlife Area. The permittees shall ensure that the project meets the requirements of the Suisun Marsh Habitat Restoration Plan and other entities that have jurisdiction over the site and surrounding area and are responsible for assuming adequate flood protection for the surrounding communities from flooding originating from the project. In preparation for projected sea level rise, and more frequent inundations due to fluvial flooding, high tides and/or storm events, CDFW and Solano County shall monitor and document flooding at their respective public access areas,

required herein. If at any time, any portion of the public access, road or bicycle lanes required by this permit is subject to flooding that requires a closure of public access for a period of two weeks or more, the co-permittees shall submit a report documenting the date, location, recorded local tide level, duration and extent of flooding, any damage or cleanup necessary, and include any photographs of the flooding noting the date, time, location, and orientation."

TERMINAL ONE DEVELOPMENT (BCDC PERMIT NO. 2018.006.00): "If any portion of the Public Access Area, is subject to flooding that results in its closure in whole or in part, the permittees shall submit to the Commission a written report within 30 days after the flooding with documentation of: the date and duration of the closure; the location of the affected site; the recorded water levels during the closure; the source of flooding (e.g., coastal flooding, stormwater backup, or overland flow); the resulting damage or cleanup; and illustrative photographs with site details. Coastal flooding is defined as Bay overtopping of the shoreline during tides, storms, or both."

MISSION ROCK DEVELOPMENT (BCDC PERMIT NO. 2017.004.00): "Upon opening of China Basin Park or five years following the date of permit issuance, whichever is later, the permittees shall submit a monitoring report generally based on the Sea Level Rise Risk Assessment and Adaptation Strategy ("Assessment and Strategy") prepared by Moffat and Nichol, dated November 21, 2017 (revised February 16, 2018), for review by or on behalf of the Commission. The report will be revised and resubmitted for review by or on behalf of the Commission every five years thereafter. The report shall reflect the best available science and include: up-to-date sea level rise projections; global projections of sea level rise based on downscaled Global Climate Models; sea level rise projections for the San Francisco Bay Area; tidal datum and extreme tides datum; updated modeling in tidal dynamics and Bay hydrological process; tide gauge data over the subject five-year period; and a comparison of updated projections on sea level rise versus projections cited in the Assessment and Strategy document. In addition, the monitoring report shall:

a. Provide a summary of all flooding events during the five-year period to any public access area that results in their closure, including the following detail: the date and duration of the public access closure; the location of the affected site; the recorded water levels during the closure period; the source of the flooding; the resulting damage and/or cleanup; and representative photographs of the flooding event;

b. Include data based on observations of water levels at the shoreline adjacent to the public access areas, including measurements of water levels over the subject five-year monitoring period and photographic evidence (with date, location, hour and actual tide levels recorded at tide gauges) of completed and planned public access areas during King Tide events; and

c. Provide a review of the Assessment and Strategy report, including a recommendation as to whether it should be revised based on site conditions, sea level rise and storm projections, updated policy guidance, and other findings."

San Francisco Bay wetlands. Source: BCDC Staff.

3.3.3. Adaptive Management Plans

FOSTER CITY LEVEE PROTECTION PLANNING AND IMPROVEMENTS (BCDC PERMIT NO. 2018.005.00): "Within 6 months of approval by or on behalf of the Commission of the updated risk assessment and adaptive management plan ("RAAMP") for the project, if the determination is made by the update that adaptation is expected to be necessary within following 5 years the public access required by the project in Special Condition II.B to remain resilient to flooding during a 100-year storm event, including wave runup, pursuant to Special Condition II.C.3, the permittee shall prepare and submit a work plan describing the planning process to identify proposed adaptation measures to address the risk of flooding from sea level rise and storms and to protect the required public access areas, and provide a timeline for permitting and implementation of those measures. Any adaptation measures proposed pursuant to the planning process required in this condition shall not result in a reduction of the size or usability of the public access required herein or, if reduction of the size or usability of the public access is unavoidable, equivalent access must be provided nearby. The permittees shall obtain additional Commission review and approval of any such changes to the public access required herein.

The submitted work plan shall be reviewed by or on behalf of the Commission pursuant to the procedures in Special Condition II.A.2. Review of adaptation timelines proposed in the work plan should take into account any records of flooding at the project site, as reported according to Special Condition II.C.1.

Following approval of the adaptation work plan by or on behalf of the Commission, the permittee shall implement that work consistent with timeline proposed in work plan.

The permittee may request time extensions to the deadlines for providing their work plan documentation or implementing adaptation measures, to be reviewed and approved by or on behalf of the Commission pursuant to the procedures in Special Condition II.A.2.

Review by or on behalf of the Commission of the submittals required in parts II.C.2, II.C.3, and II.C.4, of this special condition shall consider, among other things, the best available science, most recent state and federal guidance, and BCDC policies then in-effect. The Commission may: (i) accept the submittals and recommend no changes to the permittees' approach; (ii) recommend revisions to submittals on the basis that they are incomplete; or (iii) require revisions based on findings and information that they are necessary to protect public access of the size and usability required by this permit."

TREASURE ISLAND REDEVELOPMENT (BCDC PERMIT NO. 2016.005.00): "Phased Development (Phases 2, 3 and 4), Earlier Adaptation. Based on the information contained in the required five-year monitoring report, when mean sea level reaches 12 inches NAVD88 or higher compared to 2000 levels at the required public access areas associated with Phases 2, 3, and 4 of the project, the permittees shall initiate an adaptation planning process to protect the public access from flooding. Within 45 days of notifying the Commission of such conditions, the permittees shall provide the Commission with a work plan describing the adaptation approach and such a plan shall be reviewed and approved by or on behalf of the Commission. Within six months of Commission approval of the adaptation plan, including through any necessary Commission permits or amendments to permits, the permittees shall commence and diligently proceed to implement the measures described in such a plan to completion.

Phased Development (Phases 1 to 4), Later Adaptation. Based on the information contained in the required five-year monitoring report(s), when mean sea level reaches 30 inches NAVD88 or higher compared to 2000 levels at the required public access area(s), the permittees shall initiate an adaptation planning process to protect the public access areas from flooding.

Any flooding adaptation measures proposed pursuant to the planning process required in this

condition shall not result in a reduction of the size or usability of the public access required herein or, if unavoidable, equivalent access (in area and free of any structures not associated with the public access) must be provided nearby. The permittees shall obtain additional Commission review and approval of any such changes to the public access required herein."

3.3.4. Adaptation Thresholds

Thresholds based on a specific date:

OYSTER POINT DEVELOPMENT (BCDC PERMIT NO. 2017.007.00): "Adaptation Plan. By December 31, 2050, or when flooding of the public access areas occurs due to sea level rise and associated storm events, whichever is sooner, the permittees shall prepare and submit a risk assessment for the public access areas required herein, to be approved by or on behalf of the Commission, pursuant to Special Condition II.A.

The risk assessment shall incorporate: (1) the most up-to-date sea level rise guidance from state and federal agencies; (2) an analysis of current water levels; (3) an analysis of landfill subsidence and its contribution to flooding; (4) any observed flooding events as reported in Special Condition 11.B.6.a; (5) all types of potential flooding; (6) degrees of uncertainty; (7) preferred adaptation strategies to ensure the viability of the public access to flooding from sea level rise and storms; (8) consequences of defense failure; and (9) a timeline for implementation of shoreline adaptation to protect the required public access areas from flooding.

Upon review and approval of the risk assessment by or on behalf of the Commission, the permittees shall implement, including through any necessary Commission permits or amendments to Commission permits, all approved adaptation strategies within the approved timelines.

No permanent restrictions or closures of required public access areas may take place without additional approval by or on behalf of the Commission. If avoiding permanent closures is infeasible, the permittee shall provide equivalent public access to ensure public access to and along the shoreline in the event of permanent restrictions or closures contingent in part on the Commission's review and approval of such project modifications."

TERMINAL ONE DEVELOPMENT (BCDC PERMIT NO. 2018.006.00): "To address the potential impacts on the Public Access Areas and Waterfront Park Improvements from inundation caused by a rise in sea level of greater than 3 feet, the permittees shall implement the "Sea Level Rise Adaptation Strategies" prescribed by "Project Design Feature HYD-3," as set forth at pages 6-15 through 6-17 of the Terminal One EIR "Final Mitigation and Features Monitoring and Reporting Program" (see Exhibit B to this permit). Project Design Feature HYD-3 requires the permittees to prepare an "Adaptive Flood Risk Management Plan" that includes a "Monitoring and Reporting Program," an "Adaptive Flood Risk Management Strategy," and a "Financing Strategy." The initial adaptation plan is required to be completed by January 1, 2035 and updated every ten years (by January 1, 2045, and so on). As applicable to the Public Access Areas and the Waterfront Park Improvements, the Adaptive Flood Risk Management Strategy shall be designed to ensure that the project will continue to provide maximum feasible public access, consistent with the project, to the Bay and its shoreline.

The initial adaptation plan, as well as each update, shall be submitted for review and approval by the Executive Director on behalf of the Commission through the plan review process established in Special Condition II.A.2. Within 90 days of receipt, the Executive Director shall either approve

or disapprove the adaptation plan as submitted. The Executive Director's decision in this regard will be based on whether the adaptation strategy, including the selected adaptation responses and the implementation schedule, is sufficient to ensure that the project will continue to provide maximum feasible public access, consistent with the project, to the Bay and its shoreline. In the event a determination is made to disapprove the plan, the Executive Director shall provide the permittees with a written notice explaining the reasons the plan was not approved. Upon receipt of such notice of disapproval, the permittees shall have the option of submitting a written request for reconsideration to the Executive Director pursuant to Special Condition II.A.2.d.; revising the plan to address the Executive Director's concerns and resubmitting the revised plan for further review and approval; or appealing the Executive Director's determination to the Commission.

After the plan has been approved by or on behalf of the Commission, the permittees shall diligently proceed to implement the measures described in the plan to completion according to the implementation schedule outlined in the plan. The work required to implement the adaptation measures selected, as well as modifications to the public access required by this permit, may require additional Commission review and approval, including a BCDC permit or an amendment to this permit."

Thresholds based on flooding events:

ALAMEDA LANDING DEVELOPMENT (BCDC PERMIT NO. 2018.004.00): "Within 180 days of the second coastal flooding event within a twelve-month period that results in closure of the public access in whole or in part, or earlier at the discretion of the permittees, the permittees shall submit for Commission review and approval a sea level rise adaptation plan that conforms to the requirements in Special Condition 11.E.3 below. Depending on the actions required to implement the sea level rise adaptation plan, the permittees may be required to obtain a permit or permit amendment from the Commission. The goal of the Adaptation Plan shall be to maintain maximum feasible public access consistent with the project and to ensure that the public access remains viable under sea level rise conditions. At minimum, the Adaptation Plan shall ensure a minimum 31-foot-wide continuously accessible east-west shoreline public access area Bayward of the upland residential and commercial development provided by the project. The continuous east-west shoreline public access area shall include, at minimum, a shoreline trail that meets San Francisco Bay Trail design standards with connections to Fifth Street, the Western Greenway, and the pocket parks. The continuous east-west shoreline public access area shall be protected to the same extent as the upland residential and commercial development. Outside of the minimum 31-foot-wide continuous east-west shoreline public access area, the maximum feasible area of public access required in Special Condition II.B.1 shall be protected from coastal flooding through measures designed to maximize the size and usability of the public access areas. A reduction in the area of public access provided by the project may be allowed (i.e., some areas may be occasionally or regularly flooded) if the overall shoreline public access experience is enhanced through a redesign of the shoreline as determined by or on behalf of the Commission. Alternatively, the permittees may propose an alternative, equivalent public access area or areas that provides maximum feasible public access consistent with the project. The Adaptation Plan shall also include a timeline to implement the adaptation measures approved and required by or on behalf of the Commission to ensure that the project continues to provide maximum feasible public access. The Adaptation Plan and schedule therein shall incorporate sea level rise and storm projections based on the best available science."

FIREBOAT STATION IN SAN FRANCISCO (BCDC PERMIT NO. 2018.002.00): "The permittees shall initiate a sea level rise adaptation planning process for the project, including the public access areas required by Special Condition 11.B.1 that will ensure the provision of shoreline access into the future as long as any use authorized herein remains in place. Within 180 days-of the first occurrence of coastal flooding that affects the project or results in closure of any portion of the public access, as described in the flood reports required by Special Condition 11.D.l, or earlier at the discretion of the permittees, the permittees shall submit for Commission review and approval a sea level rise adaptation plan that conforms to the requirements in Special Condition 11.D.3, below. The plan shall be reviewed by or on behalf of the Commission pursuant to Special Condition 11.A.2. Depending on the actions required to implement the sea level rise adaptation plan, the permittees may be required to obtain a permit or permit amendment from the Commission; and according to the schedule in Special Condition 11.D.2, above, the permittees shall submit for Commission review and approval a sea level rise adaptation plan that achieves the following objectives:

a. Measures shall be developed that will address impacts to the project that arise as a result of flooding for the period during which the authorized uses will remain in place. The public access area required in Special Condition 11.B.1 shall be protected from flooding through raising the elevation of the public access, installing a flood protection device (e.g., a barrier wall or guardrail) or by another method acceptable to the Commission. Alternatively, the permittees may propose an alternative, equivalent public access area that provides maximum feasible public access consistent with the project;

b. A timeline shall be established to implement the required adaptation measures to ensure that the project addresses the impacts of flooding and storm activities and that the required public access remains viable and is not subject to regular flooding events; and

c. The adaptation plan shall incorporate sea level rise and storm projections based on the current best available science at the time it is developed and/or updated."

BCDC Permit No. 2018.008.00: "Lower-Lying Public Access Areas (i.e., Shoreline Path and Craneways). For areas within the "Shoreline Adaptive Area" as defined in Special Condition II.B.1.c and identified in Exhibit 18: When flooding requires closure in whole or part of any of public access area on at least 10 days (consecutive or non-consecutive) during a calendar year, the permittees shall initiate a planning process to select and implement adaptation measures for this area. Within 180 days of notifying the Commission of such conditions the permittees shall provide a sea level rise adaptation plan. The plan shall be reviewed by or on behalf of the Commission pursuant to Special Condition II.A. Within 12 months of approval of the adaptation plan by or on behalf of the Commission, the permittees shall commence and diligently proceed to implement the measures described in the plan to completion according to an implementation timeline outlined in the plan, including through any necessary Commission permits or amendments to permits. Appropriate adaptation measures may include managed retreat (i.e., removal of improvements within portions of the entirety of the area), installation of shoreline protection or other flood control measures, some combination of the two, or another method acceptable to the Commission."

Thresholds based on observed local sea level rise:

PIER 70 MIXED-USE DEVELOPMENT (BCDC PERMIT NO. 2018.008.00): "Elevated Public Access Areas (i.e., Bay Trail and the Majority of the Shoreline Park). For public access areas required in Special Condition II.B.1.a outside the "Shoreline Adaptive Area": Based on the assessment contained in the required 5-year monitoring report, when mean sea level increases by 54 inches NAVD88 compared to 2000 levels at the project site, the permittees shall initiate an adaptation planning process to protect the public access from flooding. Within 180 days of notifying the Commission of such conditions the permittees shall provide a plan describing the adaptation approach for review and approval by or on behalf of the Commission. Within 12 months of Commission approval of the adaptation plan, the permittees shall commence and diligently proceed to implement the measures described in the plan to completion, including through any necessary Commission permits or amendments to permits. Appropriate adaptation measures may include, but are not limited to, raising the elevation of the public access, installing a flood protection device (e.g., a barrier wall or guardrail), or another method acceptable to the Commission. Any adaptation measures implemented shall not result in a reduction of the size or usability of the public access areas. If reduction to the size or usability of the public access required herein is unavoidable, equivalent access (in area and functionality) must be provided nearby."

MISSION ROCK DEVELOPMENT (BCDC PERMIT NO. 2017.004.00): "The permittees shall plan and implement a two-phased sea level rise strategy as follows:

> a. Intermediate-Term Adaptation Measures. Based on information contained in the required five-year monitoring report, when mean sea level increases by 8 inches NAVD88 compared to 2000 levels at the shoreline public access areas, the permittees shall initiate an adaptation planning process to protect the public access from flooding. Within 180 days of notifying the Commission of such conditions, the permittees shall provide a plan describing the adaptation approach for review and approval by or on behalf of the Commission. Within twelve months of Commission approval of the adaptation plan, including through any necessary Commission permits or amendments to permits, the permittees shall commence and diligently proceed to implement the measures described in the plan to completion.
>
> b. Long-Term Adaptation Measures. Based on information contained in the required five-year monitoring report, when mean sea level increases by 36 inches NAVD88 compared to 2000 levels at the shoreline public access areas, the permittees shall initiate an adaptation planning process to protect the public access from flooding. Within 180 days of notifying the Commission of such conditions, the permittees shall provide a plan describing the adaptation approach for review and approval by or on behalf of the Commission. Within twelve months of Commission approval of the adaptation plan, including through any necessary Commission permits or amendments to permits, the permittees shall commence and diligently proceed to implement the measures described in the plan to completion.

Any flooding adaptation measures proposed pursuant to the planning process required in this condition shall not result in a reduction of the size or usability of the public access areas required herein, except for occasional inundation to stormwater treatment planters. If reduction to the size or usability of the public access required herein is unavoidable, equivalent access (in area and functionality) must be provided nearby. The permittees shall obtain additional Commission review and approval of any such changes to the public access required herein."

HILL SLOUGH WILDLIFE AREA AND GRIZZLY ISLAND ROAD (BCDC PERMIT NO. 2017.003.02md): "Every five years, for as long as Grizzly Island Road is in use, CDFW (restoration site and public access) and Solano County (Grizzly Island Road) shall assess and summarize the extent and duration of flooding and the overall conditions of Grizzly Island Road and public access trails. This assessment and summary shall include: the stability of the improved section of Grizzly Island Road; scour at the culverts, trails, bridge and protective berms surrounding transmission towers; and any erosion of levees or habitat features. The summary shall also identify any interim adaptation measures that are needed to protect the roadway and public access areas from intermittent flooding. If interim adaptation measures are warranted, CDFW and Solano County shall apply for and obtain an amendment to this permit if additional construction Is proposed.

When the Mean High Water level at or near the public access areas required herein reaches 8.4 feet NAVD88 (the elevation at which flooding of public access areas is predicted to occur) the permittees shall notify Commission staff and Initiate an adaptation planning process to identify and implement long-term adaptive management measures for the tidal marsh, public access and roadway. Within a year of notifying the Commission of such conditions, the permittees shall provide the Commission with a work plan describing the adaptation approach and the plan shall be reviewed by or on behalf of the Commission.

Any adaptation measures proposed pursuant to the planning process required in this condition shall not result in a reduction of the size or usability of the public access required herein or, if unavoidable, equivalent access shall be provided nearby. The permittees shall obtain any necessary review and approval, or amendment to this permit, if required, to be consistent with the Commission's laws and policies."

DOTSON FAMILY MARSH (BCDC PERMIT NO. 2013.009.01): "With the exception of the temporary unimproved footpath along the shoreline spit (which may be permanently closed upon consultation with and approval by or on behalf of the Commission if changing shoreline conditions and/ or sea level rise render it unsafe for access), the public access improvements required in Amendment No. One shall be constructed and maintained to avoid damage and flooding caused by changing shoreline conditions and/ or sea level rise for as long as the site may feasibly remain open for public use. If necessary, such maintenance of the public access improvements shall include raising land elevations and structures or redesigning or relocating public access features to ensure the usability of the public access improvements. When such maintenance becomes infeasible (e.g., the maintenance required to prevent damage or flooding from sea level rise is exceedingly costly, impractical, or potentially damaging to natural resources), the permittee shall work with the Commission and other stakeholders to provide alternative public access inland (Amendment No. One)."

"The temporary, unimproved, pedestrian-only trail extending past the spur trail to a shoreline spit may be permanently closed upon consultation with and approval by or on behalf of the Commission if changing shoreline conditions and/ or sea level rise render it unsafe for access (e.g. significant erosion or flooding of the spit). The permittee is not required to improve the shoreline spit trail such that it would be in place until or beyond 2050 because stabilizing and raising the trail would likely require fill in the Bay and construction in a sensitive habitat area thereby adversely impacting habitat and wildlife. All other public access improvements are designed such that they should not be flooded before 2050."

King Tides at The Embarcadero in San Francisco. Source: The California King Tides Project

Albany Bulb at high tide. Source: BCDC Staff.

4. SELECTING SEA LEVEL RISE PROJECTIONS

4.1 About this Section

As discussed in greater detail in **Appendix A**, at the time of publication of this guidance, BCDC considers the best estimates of future sea level rise to be those provided in the State of California Sea-Level Rise Guidance: 2018 Update (State Guidance), developed by the California Ocean Protection Council (OPC). This section introduces the State Guidance and the methods of projection selection based on probabilistic values of sea level rise under various emission scenarios.

4.2 Introduction to State Guidance on Sea Level Rise

The State Guidance provides probabilistic projections for sea level rise for the San Francisco Bay Area over various time scales for "low emissions" (RCP 2.6) and "high emissions" (RCP 8.5) scenarios, along with an extreme "H++" scenario, provided without an associated probability (Figures 14 and 15). Note that these are the projections of permanent sea level rise and do not account for acute, short-term increases in sea levels or wave run-up, which are discussed in Section 5.2. See Appendix A of this guidance for summaries of the science of sea level rise, the scientific basis for these projections, and other related technical information on sea level rise, flooding, and the impacts of flooding and waves.

		Probabilistic Projections (in feet) (based on Kopp et al. 2014)					*H++ scenario (Sweet et al. 2017) *Single scenario*
		MEDIAN	**LIKELY RANGE**		**1-IN-20 CHANCE**	**1-IN-200 CHANCE**	
		50% probability sea-level rise meets or exceeds...	*66% probability sea-level rise is between...*		*5% probability sea-level rise meets or exceeds...*	*0.5% probability sea-level rise meets or exceeds...*	
				Low Risk Aversion		**Medium - High Risk Aversion**	**Extreme Risk Aversion**
High emissions	2030	0.4	0.3 -	0.5	0.6	0.8	1.0
	2040	0.6	0.5 -	0.8	1.0	1.3	1.8
	2050	0.9	0.6 -	1.1	1.4	1.9	2.7
Low emissions	2060	1.0	0.6 -	1.3	1.6	2.4	
High emissions	2060	1.1	0.8 -	1.5	1.8	2.6	3.9
Low emissions	2070	1.1	0.8 -	1.5	1.9	3.1	
High emissions	2070	1.4	1.0 -	1.9	2.4	3.5	5.2
Low emissions	2080	1.3	0.9 -	1.8	2.3	3.9	
High emissions	2080	1.7	1.2 -	2.4	3.0	4.5	6.6
Low emissions	2090	1.4	1.0 -	2.1	2.8	4.7	
High emissions	2090	2.1	1.4 -	2.9	3.6	5.6	8.3
Low emissions	2100	1.6	1.0 -	2.4	3.2	5.7	
High emissions	2100	2.5	1.6 -	3.4	4.4	6.9	10.2
Low emissions	2110*	1.7	1.2 -	2.5	3.4	6.3	
High emissions	2110*	2.6	1.9 -	3.5	4.5	7.3	11.9
Low emissions	2120	1.9	1.2 -	2.8	3.9	7.4	
High emissions	2120	3	2.2 -	4.1	5.2	8.6	14.2
Low emissions	2130	2.1	1.3 -	3.1	4.4	8.5	
High emissions	2130	3.3	2.4 -	4.6	6.0	10.0	16.6
Low emissions	2140	2.2	1.3 -	3.4	4.9	9.7	
High emissions	2140	3.7	2.6 -	5.2	6.8	11.4	19.1
Low emissions	2150	2.4	1.3 -	3.8	5.5	11.0	
High emissions	2150	4.1	2.8 -	5.8	5.7	13.0	21.9

Figure 14. Projections of Sea Level Rise for the San Francisco Bay Area. Source: Ocean Protection Council, 2018.

Estimated probabilities that sea-level rise will meet or exceed a particular height are based on Kopp et al. 2014. All heights are with respect to a 1991 – 2009 baseline; values refer to a 19-year average centered on the specified year. Areas shaded in grey have less than a 0.1% probability of occurrence. Values below are based on probabilistic projections; for low emissions (RCP 2.6) the starting year is 2060 as we are currently on a high emissions (RCP 8.5) trajectory through 2050; ***the H++ scenario is not included in this table.***

SAN FRANCISCO - High emissions (RCP 8.5)

	Probability that sea-level rise will meet or exceed... (excludes H++)									
	1 FT.	2 FT.	3 FT.	4 FT.	5 FT.	6 FT.	7 FT.	8 FT.	9 FT.	10 FT.
2030	0.1%									
2040	3.3%									
2050	31%	0.4%								
2060	65%	3%	0.2%	0.1%						
2070	84%	13%	1.2%	0.2%	0.1%					
2080	93%	34%	5%	0.9%	0.3%	0.1%	0.1%			
2090	96%	55%	14%	3%	0.9%	0.3%	0.2%	0.1%	0.1%	
2100	96%	70%	28%	8%	3%	1%	0.5%	0.3%	0.2%	0.1%
2150	100%	96%	79%	52%	28%	15%	8%	4%	3%	2%

SAN FRANCISCO - Low emissions (RCP 2.6)

	Probability that sea-level rise will meet or exceed... (excludes H++)									
	1 FT.	2 FT.	3 FT.	4 FT.	5 FT.	6 FT.	7 FT.	8 FT.	9 FT.	10 FT.
2060	43%	1.4%	0.2%							
2070	62%	4%	0.6%	0.2%	0%					
2080	74%	11%	2%	0.4%	0.2%	0.1%				
2090	80%	20%	3%	1.0%	0.4%	0.2%	0.1%	0.1%		
2100	84%	31%	7%	2%	0.8%	0.4%	0.2%	0.1%	0.1%	
2150	93%	62%	31%	14%	7%	4%	2%	2%	1%	1%

Figure 15. Probabilities of Amounts of Sea Level Rise for the San Francisco Bay Area. Source: OPC.

The State Guidance also walks the user through a step-wise process to determine which of the sea level rise projections to use for a given time horizon and level of risk aversion, as shown in Figure 16. Information on how the Commission has applied this step-wise process within the context of BCDC's permitting authority is provided below.

Figure 16. The State Guidance's Sea Level Rise Projection Decision-Making Process. Source: OPC.

Step 1: Identify the nearest tide gauge.

The State Guidance uses one tide gauge for its projections of future sea level rise for the San Francisco Bay Area, located adjacent to the Golden Gate Bridge. BCDC's Adapting to Rising Tides Program, in partnership with AECOM, supported the development of a comprehensive San Francisco Bay Tidal Datums and Extreme Tides Study. The study leveraged past efforts for FEMA's San Francisco Bay Coastal Study, which modeled tidal datums and extreme tides for over 900 locations around the Bay. A supporting dataset is available at the BCDC Open Data Portal. The Commission applies the regional sea level rise projections for the Bay Area from the State Guidance to the tide data of the nearest modeled location to the proposed project, provided in the AECOM study. If there is not valid modeled tide data (or a tide gauge) near the project site, which is often the case for projects in Suisun Marsh, the project proponent will need to use the nearest location with valid tidal data or the applicant will be required to provide the relevant water levels (e.g., Mean Sea Level, Mean High Water, 100-year extreme tide) for the project site for analysis.

Step 2: Evaluate project lifespan.

The lifespan of the project is generally provided by the applicant in pre-application and/or application materials and should consider the functional lifespan of the project, which often extends beyond the design life of the project. A common understanding of the functional lifespan is the period in which a structure can still meet the purposes for which it was constructed at its location, including through one or more repair and maintenance cycles. While the lifespan of the project is determined on a case-by-case basis, in past permitting decisions the lifespan of the project has been influenced by factors such as the type of project, land use in the project area, and the project design. In order to apply Bay Plan Climate Change Policy 3 regarding a project's resilience to sea level rise and flooding, the Commission needs to know if the project is going to be in place at mid-century (i.e., 2050) and end of century (i.e., 2100). If the project is expected to be in place at mid-century but not end of century, the Commission analyzes the project's resilience and/or adaptability to the end of its life.

Step 3: For the nearest tide gauge and project lifespan, identify range of sea level rise projections.

Once the nearest tide gauge has been identified and the project lifespan determined, State Guidance recommends using the table of probabilistic projections (Figure 14, above) to identify a range of projections appropriate for low, medium-high, and extreme levels of risk aversion (see Figure 18, below). The State Guidance recommends using a set of projections appropriate for different levels of risk aversion in order to evaluate a spectrum of potential impacts, consequences, and responses. Similarly, Climate Change Policy 2 identifies the use of a range of sea level rise projections in the context of a required risk assessment.

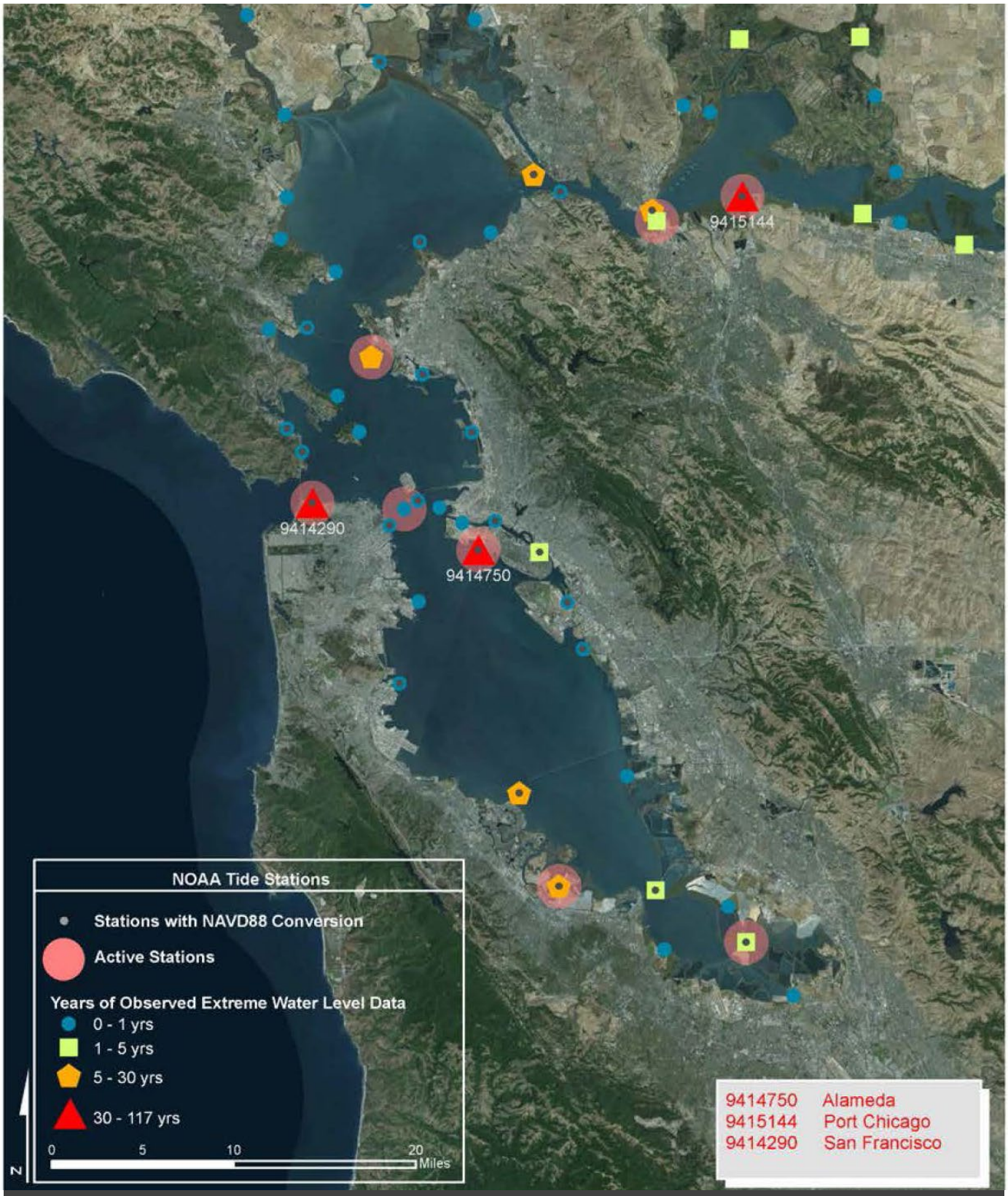


Figure 17. Locations of NOAA Tide Stations. Source: NOAA.

Step 4: Evaluate potential impacts and adaptive capacity across a range of sea-level rise projections and emissions scenarios.

The State Guidance outlines a process for evaluating impacts across the scenarios identified in Step 3 using sea-level rise visualization and mapping tools (see **Appendix A**) and analyzing the consequences of potential impacts, what is at risk of flooding, adaptive capacity of the project, and economic impacts. However, if Climate Change Policy 2 applies to a proposed project, the project should develop a risk assessment to evaluate the potential impacts of sea-level rise on the project and the project's adaptive capacity under the range of projections and emissions scenarios in accordance with the specific requirements stipulated in the policy, which are explained in **Section 2.3.2**.

The Commission uses risk assessments and/or other information provided in a proposed project's permit application and evaluates the risks posed by sea-level rise and flooding to the project through the application of various Bay Plan policies described throughout this guidance. Depending on what is relevant to the specific project, the Commission considers the risks to and potential consequences for public access, public safety, Bay resources, and habitat. Multiple projections of future sea level rise should be assessed in the planning and design of projects that will need a BCDC permit in order for the Commission to analyze risk under various potential future scenarios and so that the potential implications for future adaptation measures can be considered.

Step 5: Select sea-level rise projections based on risk tolerance and, if necessary, develop adaptation pathways that increase resiliency to sea-level rise and include contingency plans if projections are exceeded.

The State Guidance includes a framework (Figure 18) for determining the project's level of risk aversion, or the level of acceptance associated with the consequences of sea level rise and associated hazards, based on risk considerations and evaluation of the results of the vulnerability assessment completed during Step 4. The project proponent should select which sea level rise projections to use based on a level of risk tolerance that is consistent with BCDC's laws and policies, as described throughout this guidance. In past permitting decisions, the Commission has required project proponents to use a higher level of risk aversion in their project design under certain site conditions and when the risks have included the loss of public access to the Bay, threats to public safety, and/or adverse impacts to natural resources. As an example, when public access is required as a condition of the project's permit, "medium-high risk aversion" may be appropriate if there is a lack of space to allow for the migration or elevation of the public access over time in response to future sea-level rise and flooding. Each risk aversion level is assigned to probabilistic projections of sea-level rise to help project proponents select which sea-level rise scenario(s) to use based on their project's risk tolerance. Specifically, "low risk aversion" is assigned to the range of sea-level rise projections in a given decade that has a 66% probability (the likely range). "Medium-high risk aversion" is assigned to the sea-level rise projections that have a 0.5% probability (1-in-200 chance) of being met or exceeded in a given decade. Lastly, "extreme risk aversion" is assigned to the H++ scenario, which represents the most dramatic scenario of projected sea-level rise, resulting from major losses of the West Antarctic ice sheet. The probabilistic projections are explained in greater detail in **Appendix A**.

Risk Decision Framework

(Adapted from the Governor's Office of Planning and Research's "Planning and Investing for a Resilient California: A Guidebook for State Agencies")

This framework serves to help planners and decision makers evaluate sea-level rise impacts across a range of projections to inform appropriate design, adaptation pathways, and contingency plans that build resilience.

RISK CONSIDERATIONS & EVALUATION	**Consequences of Impact or Disruption**	**LOW** *Minimum Disruption, Limited Scale and Scope*	**MEDIUM TO HIGH** *Inconvenience, but Limited in Scope and Scale*	**EXTREME** *Unacceptable Risk and/or Extensive Scale and Scope*
	Adaptive Capacity	• Future flexibility maintained • People or systems readily able to respond or adapt	• Limited future flexibility	• Irreversible • Threat to public health and safety
	Who or What is Affected?	• Low impact on communities, infrastructure, or natural systems	• Communities, systems, or infrastructure readily able to adapt or respond to change	• Vulnerable populations • Critical infrastructure • Critical natural systems • Areas of economic, historic, or cultural significance
	Economic Impacts	**LOW**	**MEDIUM**	**HIGH**
		←		→
EMISSIONS SCENARIO EVALUATION	**Pre-2050**	**RCP 8.5** *(high emissions)*	**RCP 8.5** *(high emissions)*	**RCP 8.5** *(high emissions)*
	Post-2050	← **EVALUATE RCP 2.6 AND RCP 8.5** *(low emissions and high emissions)* →		
SLR PROJECTIONS SELECTION		**LOW RISK AVERSION**	**MEDIUM-HIGH RISK AVERSION**	**EXTREME RISK AVERSION**

Figure 18. The State Guidance's Risk Decision Framework. Source: OPC.

King Tides on Mission Creek in San Francisco. Source: BCDC Staff.

5. ASSESSING FLOOD IMPACTS

5.1 About this Section

This section of the San Francisco Bay Plan Climate Change Policy Guidance is intended to serve as a scientific and technical reference to support the understanding and application of the Climate Change and other related Bay Plan policies. This section provides information on various types of potential flooding that could impact a proposed project, including defining the 100-year flood elevation and various examples of potential impacts from sea level rise, flooding, and storms that could be considered in the planning, design, and analysis of projects in the Bay and along the shoreline.

5.2. Types of Potential Flooding

5.2.1. Introduction

This section aims to provide guidance regarding types of potential flooding and related vulnerability factors that could be considered when planning, designing, or analyzing a project in the Bay or along the shoreline. This information is intended to be an accessible introduction to the science and technical information relevant to the Climate Change and related Bay Plan policies and should not be considered a comprehensive source. Project proponents can use this information to inform what further research and analysis may be needed to effectively plan and design resilient and adaptable projects in the Bay and along the shoreline. It should be noted that Climate Change Policy 2 stipulates specific information that should be included in the risk assessments required for certain type of projects. For guidance on determining if a risk assessment is required for your project and what other information should be included in the assessment, see **Section 2.3.2**, and for example risk assessments, see **Appendix C**.

Analyzing comprehensive flood risk is complex, and a multitude of varying factors can influence any given project's flood vulnerability. The types of potential flooding can combine and interact with each other in different ways. In particular, climate change will alter key factors that contribute to shoreline flooding, including sea level and storm frequency and intensity. During a storm, low air pressure can cause storm surge and increased wind and wave activity can cause wave run-up, which will be higher as sea level rises. These storm events can be exacerbated by El Niño events, which generally result in persistent low air pressure, greater rainfall, high winds, and higher sea level. The coincidence of intense winter storms, extreme high tides, and high runoff, in combination with higher sea level, will increase the frequency and duration of shoreline flooding long before areas are permanently inundated by sea level rise alone. Additionally, sea level rise influences the elevations and impacts of wave run-up and introduces significant new hazards, such as rising groundwater.

Risk assessments may refer to the combination of the stillwater elevation and any wave run up as the "total water level" that may cause coastal flooding at a site. However, this and other terms used throughout this guidance may be used differently in other documents, programs, agencies, etc. For example, BCDC's ART program uses "Total Water Level" in reference to the increase in water level above the current mean higher high water (MHHW) elevation, as a result of various combinations of storm surge and sea level rise, but not including all of the types of potential flooding discussed in the following paragraphs. Permit applicants should contact BCDC staff to clarify any questions that may arise from the use of certain terminology. More information about the ART Program and how it relates to BCDC permitting is provided in **Appendix B**.

5.2.2. Stillwater Elevation

The stillwater elevation is the water level in the absence of waves resulting from wind or seismic effects. Determinations of the stillwater elevation generally include the daily tidal range, king tides, and storm surge, although other factors provided in the following paragraphs may also influence the stillwater elevation at a site for various time intervals. In assessments of future flood risk, such as in BCDC risk assessments (see Climate Change Policy 2 described in **Section 2.3.2**), the stillwater elevation can also include projections of future sea level rise associated with the life of the project if sea level rise is not being considered separately.

TIDAL RANGE • "The tide," or the astronomical tide, refers to the regular upward and downward movement of the ocean due to the gravitational pull of the moon and the sun and the rotation of Earth. The San Francisco Bay experiences a mixed semidiurnal tide, where there are two high tides and two low tides of unequal heights each day, the range of which is the "tidal range." The four daily tidal elevations of the mixed semidiurnal tide are Mean Higher High Water (MHHW), Mean High Water (MHW), Mean Low Water (MLW), and Mean Lower Low Water (MLLW). Due to the Bay's complex bathymetry and geographic configuration, the tidal range in the Bay varies around the shoreline. The South Bay in particular has a larger tidal range and higher tides on average than the rest of the San Francisco Bay, and the San Pablo and Suisun bays to the north and extending into the Delta exhibit a smaller tidal range and lower high tides.

KING TIDE • "King tides" are exceptionally high tides that typically occur several times per year during a new or full moon and when the Earth is closest to the moon. They cause water levels to increase by as much as 12 inches above normal tide and are the highest predicted high tide of the year at a given coastal location. King tides are already known to produce significant coastal flooding around the Bay Area, such as along the Embarcadero in San Francisco. Therefore, they present a preview of areas that will be regularly flooded in the future with sea level rise.

STORM SURGE • Storm surge is the sudden, abnormal build-up of water during a storm, generated by high winds and low atmospheric pressure. While storm surge along the coast of California is considerably less than that experienced on the Gulf and Atlantic Coasts of the United States, it can elevate local sea levels as much as 3 feet above the predicted astronomical tide during major winter storms. Although the rise in water levels is temporary, storm surge can cause significant flooding and, as with other sources of coastal flooding, the impacts of storm surge will become more severe combined with future sea level rise.

SEA LEVEL RISE • In considering the stillwater elevation at the site of a proposed project, BCDC permit applicants should consider how it will change over the life of the project by including projections of future sea level rise. The projections that BCDC currently considers the best estimates of future sea level rise for the San Francisco Bay Area are provided in **Section 4**. Where appropriate, the influences of river discharge and precipitation events may also be included in the determination of the stillwater elevation at a project site. Especially as climate change is increasing the frequency and intensity of storms and other climate phenomena, BCDC permit applicants could consider including the effects of storms, precipitation, and riverine flooding in their risk assessments.

EL NINO • Storms in California occur during the winter from November-April and are influenced by several climate patterns, most prominently the El Niño-Southern Oscillation (ENSO). ENSO is a climate fluctuation involving changes in the temperature of waters in the central and eastern tropical Pacific Ocean, on irregular periods ranging from about three to seven years. The oscillating warming and cooling pattern can have a strong influence on weather across the United States and other parts of the world. During "El Niño" years, which can last anywhere between nine months and two years, the San Francisco Bay Area experiences persistently low air pressure, greater rainfall, and high winds, all of which contribute to elevated flood hazards. While water levels are often 0.5 to 1.0 foot above average during an El Niño event, the intense rainfall, storm conditions, and wave setup can raise water levels further. Most of the significant storm damage to California's coastline has occurred during major El Niño events. During the El Niño events of 1940-41, 1982-83, and 1997-98, the San Francisco tide gauge recorded that sea levels were elevated 8-12 inches for several months at a time (Griggs et al.). Climate models suggest that the frequency of extreme El Niño events may increase under a warmer climate.

COMBINED COASTAL-RIVERINE FLOODING • Precipitation across 40% of California drains into the Bay through the Sacramento-San Joaquin River Delta and out through the Golden Gate Strait. Areas around the Bay shoreline in proximity to the Delta and areas around the shoreline where streams drain into the Bay face additional flood risks from riverine, or fluvial, flooding. During storms with high rainfall, a river's flood stage, i.e., the level at which water has risen to inundate areas of land that are not normally covered, can extend beyond the amount of flooding resulting from storm surge alone, and the low air pressure of the storm increases wind activity, which can generate erosive waves superimposed on the already high water levels. Furthermore, flooding at the outlets of tributaries into the Bay can be exacerbated when the outflow is obstructed by elevated Bay water levels or high tides. As a result of climate change, more precipitation is projected to fall as rain, rather than snow, and precipitation could fall in a shorter time frame. This could intensify the volume and velocity of river discharge into the Bay at times, which could result in higher water levels and flooding, particularly when combined with sea level rise and other flood hazards, such as storm surge. Depending on the influence of water supply infrastructure and management, among other factors, there may be larger volumes of freshwater releases into the Bay in the future amidst climate change, as more precipitation falls as rain and as snow in the Sierra Nevada Mountains melts sooner. The flood risk this poses is higher when considered alongside the increasing intensities of atmospheric rivers (below) and other precipitation events expected as a result of climate change.

ATMOSPHERIC RIVERS • Atmospheric rivers are flowing streams of condensed water vapor in the atmosphere that produce significant amounts of precipitation, particularly in the Western United States, when they move inland and flow over the mountains. The amount of water vapor they contain and the strength of their associated winds vary, and while they often provide beneficial rain or snow, they can create extreme rainfall and floods often by stalling over watersheds. On average, about 30-50% of annual precipitation on the West Coast comes from just a few atmospheric river events. For example, the series of atmospheric rivers that affected the west coast of the United States in December 2010 produced up to 25 inches of rain in certain areas. While the number of atmospheric rivers is expected to decrease annually with continued climate change, studies show that climate change will intensify atmospheric rivers so that they are significantly longer and wider than those observed today.

TSUNAMIS • A tsunami is defined as a shallow water progressive wave induced by a sudden change in the topography of the sea floor caused by an underwater earthquake, underwater avalanche, or underwater volcanic eruption. Since these are seismic events rather than tidally influenced, tsunamis are seismic sea waves. Large tsunamis are not considered a major threat to the Bay as the San Andreas Fault is a slip-strike fault, where two tectonic plates slide past each other horizontally, displacing little ocean water, and because the Bay is a sheltered water body with shorelines that are not subjected to the direct action of undiminished ocean waves. However, small tsunami waves can enter and cause damage to parts of the Bay's shoreline, particularly on either side of the Golden Gate Strait, Treasure Island and Yerba Buena Island, and Oakland and Alameda. At the shoreline, tsunamis resemble a sudden, extremely high tide, forming a strong flood or surge of water that causes the ocean to advance, rather than a huge breaking wave. While not often included in risk assessments, certain permit applicants could consider the potential effects of tsunamis on the proposed project depending on the project location.

5.2.3. Wave run-up elevation

The wave run-up elevation is the distance or extent that water from a breaking wave will extend up the shoreline. Note that wave set-up, which results from a set of large waves breaking in rapid succession, can elevate the overall water level along the shoreline as much as 4 or 5 feet for a few minutes at a time. The following paragraphs describe sources of waves that could be included when calculating the wave run-up elevation at the site of a proposed project when developing a risk assessment (see Climate Change Policy 2 described in **Section 2.3.2**). As bottom friction dissipates wave energy and affects wave growth in shallow areas, increased water depth in the future as a result of sea level rise may increase the upland extent of waves at a site. Therefore, project proponents could consider calculating wave run-up at the site at various points in the project's lifetime with stillwater elevations that include projections of future sea level rise to account for any changes to the impact of the underlying bathymetry on the wave run-up elevation.

WIND WAVES • Wind blowing across the surface of the ocean generates most ocean waves. Energy from the wind increases the height, length, and speed of the wave. The amount of wave energy is determined by the wind speed, the length of time during which the wind blows in one direction, and the fetch, i.e., the distance over which the wind blows in one direction. At a certain height, waves cannot grow further and they begin to lose energy by breaking as whitecaps under the force of gravity. The low air pressure and high winds during a storm can increase wind wave activity and total wave run-up.

PACIFIC SWELLS • Swells are uniform, symmetrical waves that have traveled away from the area where they originated. They form when waves generated in a part of the ocean then move toward its margins and, as wind speeds diminish, begin to move faster than the wind, causing them to become long-crested. Swells move with little loss of energy over large stretches of the ocean surface, transporting energy away from one area and depositing it in another. This is how there can be waves where there is no wind. However, in the San Francisco Bay, as with all sheltered water bodies with shorelines that are not subjected to the direct action of undiminished ocean waves, waves primarily result from local processes rather than distant weather conditions.

WAVE REFLECTION • Wave reflection refers to the process whereby waves bounce off a smooth vertical barrier, such as a seawall or a rock ledge, back into the ocean with little loss of energy. Waves most often hit a barrier at an angle and reflect at an equal angle. However, if they hit the barrier perpendicularly, they reflect back at and can interfere with the incoming wave. Wave reflection may become increasingly important to consider in a project planning, design, and analysis if more vertical shoreline protection structures are built around the Bay in response to continued sea level rise.

BOAT WAKE • Boats within the Bay also create waves, known as boat wake, that can cause flooding, erosion, and other impacts. Particularly if a project involves or is sited near a ferry, ship, or other type of boat terminal, the potential impacts of boat wake could be considered when assessing a project's risk.

5.2.4. Additional flood risk considerations

SHALLOW GROUNDWATER RISE • As sea level rises, shallow groundwater tables, i.e., the upper zones of saturated soil, around certain areas of the Bay's shoreline may also rise, which could result in damage to underground infrastructure, as well as emergent flooding, permanent inundation, and/or other flooding impacts (See Figure 19). Higher groundwater tables can interfere with both natural and engineered stormwater management systems, resulting in flooding during rainfall or coastal overtopping events when an area is not able to drain properly. Shallow groundwater rise also poses challenges to many traditional forms of engineered flood protection as the water moves up from below ground and therefore cannot be held back by typical shoreline flood control structures such as seawalls and levees. The risks of shallow groundwater rise have been largely unknown in the past. However, recent research suggests that flooding as a result of groundwater rise could be as extensive or worse than that resulting from overland coastal flooding due to sea level rise. For example, research from the University of California, Berkeley, has found that with 3 feet of sea level rise, shallow groundwater tables within a half mile of the shoreline will also rise 3 feet. Therefore, project proponents could consider assessing the potential risks and impacts that shallow groundwater rise may pose to their project. **Section 5.3 - Impacts of Sea Level Rise, Flooding, and Related Hazards** provides more examples of the challenges posed by groundwater rise, and **Appendix A** provides some additional information and resources on this topic.

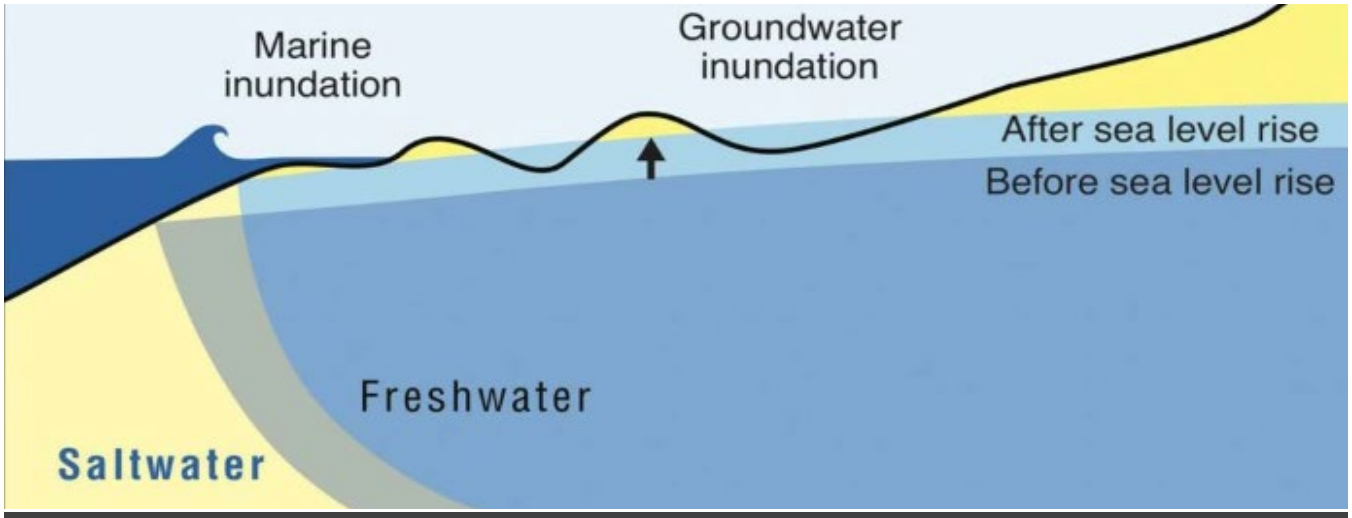


Figure 19. Shallow groundwater rise. Source: UHM Coastal Geology Group.

SETTLEMENT, SUBSIDENCE, AND OTHER LAND ELEVATION CHANGES • Another consideration is the potential for settlement, subsidence, or other forms of vertical land movement that could exacerbate relative sea level rise at the site of a proposed project over time. Vertical land movement can alter the difference in elevation between the total water level and the project or the project's flood protection structure, thereby either increasing or decreasing a project's flood risk. Land elevation change around the Bay is variable; thus, some areas will experience greater relative sea level rise. For example, parts of the South Bay's shoreline have experienced high rates of subsidence from groundwater depletion in the past, though subsidence now seems to have largely stopped. On the other hand, the Santa Clara Valley recently showed some uplift, potentially from groundwater recharge. Managed wetlands, such as those in Suisun Marsh, continue to experience subsidence that leads to enhanced relative sea level rise. Portions of Treasure Island, Brisbane, San Francisco International Airport, and Foster City, among other areas, have also experienced significant rates of subsidence. In general, subsidence around the Bay occurs on substrates of Bay mud or man-made landfills that are subject to long-term compaction. Pumping is a common approach to addressing certain flooding issues; however it can lead to increased subsidence rates and actually exacerbate flood risks and challenges. The influence of vertical land movement on flood risk at the site of a proposed project could be considered in planning, design, and analysis. In BCDC permit applications, the elevation of a project and/or its flood protection structure should account for any settlement that is expected to occur at the site.

5.2.5. 100-Year Flood Elevation

The 100-year flood elevation refers to the computed elevation to which floodwater is anticipated to rise during the flood scenario that has a 1% annual chance of being equaled or exceeded in any given year for a particular location. Although the Commission has in past permitting decisions used the 100-year flood elevation determined by the Federal Emergency Management Agency (FEMA), BCDC permit applicants can choose to calculate and/or use a different 100-year flood elevation in their risk assessment, with supporting information (see **Section 2.3.2** for more information). BCDC published a tidal datums study as a report and a downloadable GIS that underpins the FEMA flood maps and includes the 100-year stormwater elevation alongside other water levels relevant to the permitting process. The FEMA-designated 100-year flood elevation is included in sea level rise scenarios in BCDC's web-based Adapting to Rising Tides (ART) Bay Shoreline Flood Explorer, which is described in **Appendix A**. The following paragraphs provide more background on how FEMA determines this elevation.

FEMA publishes a National Flood Hazard Layer (NFHL) map with information about 100-year base flood elevation. FEMA also identifies flood hazards, assesses flood risks, and provides flood risk data to support mitigation actions and increased resilience, while also administering the National Flood Insurance Program. As part of the FEMA mapping process, FEMA Mapping Partners conduct flood hazard analysis and mapping studies to produce Flood Insurance Rate Maps (FIRMs). These maps include flood zone designations that indicate areas at high risk of flooding, and each of these zones has a "base flood elevation" (BFE), which is equivalent to the 100-year flood elevation.

Although each of FEMA's studies is unique, their coastal flood hazard analysis and mapping process generally involves the following steps: defining the base topography; evaluating water levels and storm surge; defining cross-shore transects and identifying shoreline barriers, which can include steep dune features and shoreline armoring structures; evaluating storm-induced erosion and shoreline protection structures; modeling wave hazards; mapping coastal flood

hazards; and finally, producing the Flood Insurance Study (FIS) report and the FIRM map.

While the study methods, modeling software, and which effects they consider are tailored to each study, all FEMA coastal flood studies for California include the effects of tides, storm surge, and waves as well as historical coastal flood events that have affected the study area. Historical data is used to validate flood, wave, and erosion analyses to determine the flood level with a 1-percent chance of being equaled or exceeded in any given year, i.e., the BFE or the 100-year flood elevation.

As FEMA flood maps are based on historic storm data, existing shoreline characteristics, and current wave and storm climatology at the time the study was conducted, these maps do not reflect flood hazards from anticipated future sea level rise, shallow groundwater rise, increased intensity of storms, and other impacts associated with climate change, or the influence of planned flood protection that will be constructed as part of a proposed project. However, certain Bay Plan policies, such as Climate Change Policy 2, account for this by requiring consideration of sea level rise and other risk factors that may not be accounted for in the 100-year flood elevation.

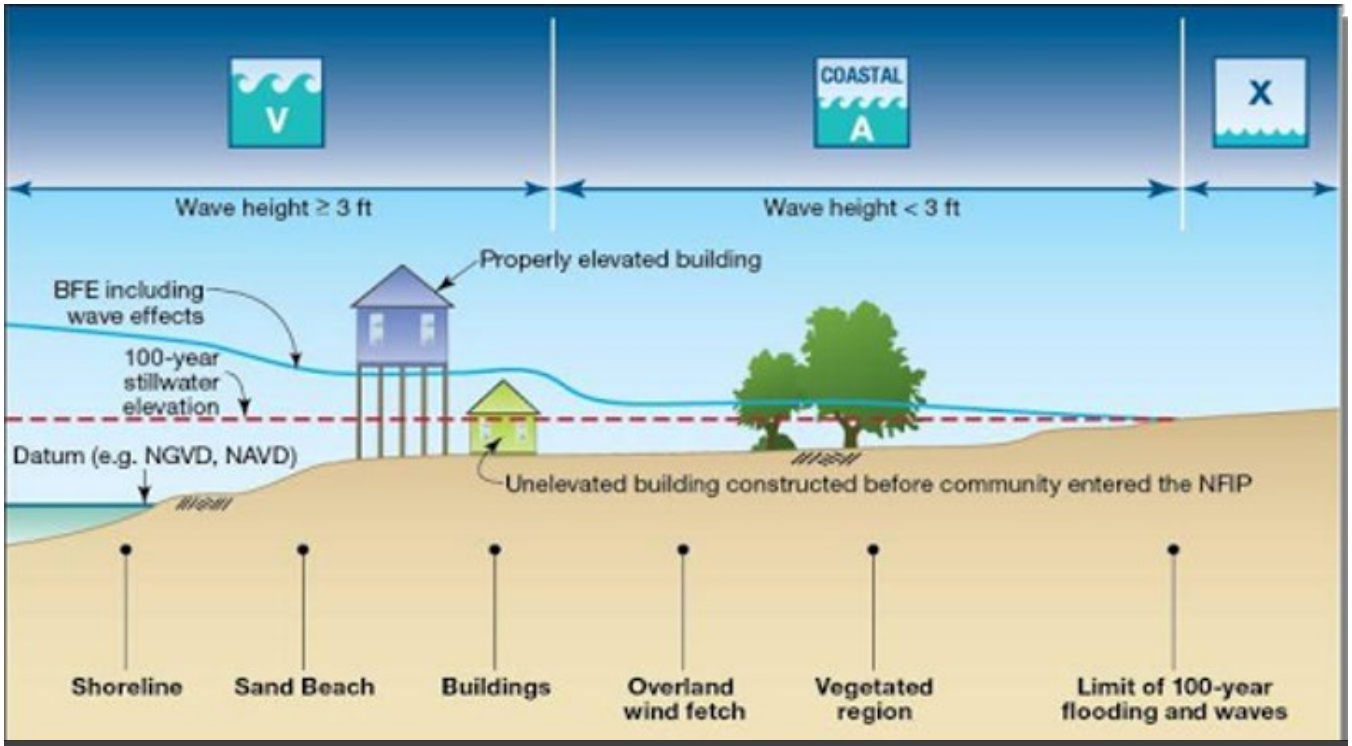


Figure 20. 100-year Flood Elevation. Source: FEMA.

King Tides at China Camp in Marin. Source: Cindy Pavlic via The California King Tides Project.

5.3 Impacts of Sea Level Rise, Flooding, and Related Hazards

5.3.1. Introduction

The following section describes some of the potential impacts associated with sea level rise and increased flood risks that could be considered when planning, designing, and/or analyzing a project in the Bay or along the shoreline. This information is intended to be an accessible introduction to the science and technical information relevant to the Climate Change and related Bay Plan polices and should not be considered a comprehensive source. Project proponents can use this information to inform what further research and analysis may be needed to effectively plan and design resilient and adaptable projects in the Bay and along the shoreline.

5.3.2. Extent of impacts

As discussed in Section 5.2.1, climate change and sea level rise will likely lead to increased frequency and intensity of certain flood events, as well as increased extents of permanent inundation of the shoreline. Flooding can range from minor nuisance flooding to longer lasting and more damaging floods to permanent inundation. Likewise, the impacts of flooding can also range from minor to significant. These impacts can be economic, ecological, physical, and social in nature. Completing a risk assessment for a project can identify and inform design elements that can mitigate many of the impacts described in the following paragraphs.

Nuisance, or relatively minor flooding, splash, and spray can be disruptive when it interferes with uses of the shoreline such as for transit, private business, or recreation when it occurs regularly, is lingering, or results in damage. These shorter-term, less extensive flood events can result in more significant disruption when they interfere with power, access to certain goods, services, and jobs and can cause economic losses if job sites, government services, or businesses are disrupted by a loss in communications, utilities, goods, or commuter access. While many assets and areas can maintain their function after being temporarily flooded, splashed, or sprayed, some can be permanently damaged by any amount or duration of flooding. This sort of temporary or nuisance flooding can also interfere with emergency services.

As sea levels rise, episodic flood events will increase in extent, depth, and duration, leading to more extensive impacts on areas that are currently flood-prone and increasing risk for areas that do not currently experience flooding. These more significant flood events can cause greater damage to structures, can disrupt power, water supply, and wastewater services, and can reduce access to goods, medical care, schools, jobs, and other critical services, all of which can have lasting effects. These impacts may be felt most strongly by vulnerable or disadvantaged communities located along the shoreline that are less able to prepare, respond, and recover from a flood event due to pre-existing socioeconomic inequities.

An area is considered permanently inundated when it is exposed to daily tidal impacts. As sea levels rise, the area that is permanently inundated around the Bay's shoreline, connected tributaries, and other waterways will increase, requiring actions to protect, accommodate, or relocate at-risk assets. At particular risk to inundation are low-lying areas and water-oriented development, such as ports, wastewater treatment facilities, and access points for recreating in and around the Bay, as well as habitats around the shoreline.

The impacts of sea level rise can have wide-ranging implications. As discussed below, critical infrastructure located along the shoreline is at risk of flooding and damage from coastal hazards, and disruptions could lead to cascading impacts on critical services, such as power supply, wastewater treatment, and goods movement. The cumulative impacts of increased inundation, flooding, and associated damages will be significant, and may affect the Bay Area as a region, the state, and potentially the nation, if, for example, international trade is significantly disrupted at the Port of Oakland.

Sea level rise and increasing flood risks anticipated as a result of climate change may also have secondary effects, such as an increased amount of hardened shoreline protection structures around the Bay, causing adverse consequences for the natural resources of the Bay. Some shoreline protection structures can have impacts, including but not limited to increasing erosion on adjacent shorelines through wave reflection; placing fill that has adverse impacts on Bay resources; acting as a barrier that restricts the inland migration of wetlands and other shoreline habitats as sea level rises; and impeding physical and visual access to the Bay.

5.3.3. Impacts to development

The shoreline of the Bay is highly developed with private residential and commercial, and public infrastructure, including public access and recreation areas, which are at risk of flooding and inundation.

Residential property in vulnerable areas is threatened by sea level rise and an increased extent, duration, and depth of flooding, as most housing is not resilient to flooding or salinity exposure, potentially resulting in the loss of property and income or the temporary or permanent relocation of structures. Housing with living spaces, equipment, or other assets below-grade, such as basements and septic systems, are particularly likely to be damaged when exposed to flooding. Health risks associated with flooding can result from the growth of dangerous molds or exposure to mobilized pollutants from nearby contaminated areas such as industrial sites or landfills. Flooding in residential communities can also disrupt access to important goods and services. Some communities may be displaced by rising sea levels when the risks and impacts are significant enough. Communities that lack financial means, physical capacity, necessary information, or access to services are especially vulnerable to the impacts of sea level rise and flooding.

Other development around the shoreline is at risk from similar impacts to that of residential property. Private businesses and public facilities located in areas vulnerable to flooding can be directly impacted by flood events or inundation, resulting in operational closures, but can also be secondarily impacted when, for example, transportation routes to a business are flooded, impeding goods movement and consumer access. This could result in significant economic losses for the region. Without sufficient adaptation, water-oriented development such as ports and airports will be subject to significant flooding in the future, causing rippling economic impacts far beyond the Bay Area. Based on current sea level rise projections, transportation infrastructure such as railroads and roadways will be impacted without intervention.

Critical infrastructure such as transportation routes, storm and wastewater infrastructure, and energy, pipeline, and telecommunication infrastructure is located along the shoreline of the Bay. Flooding could disrupt telephone and internet service, electricity and natural gas for homes and businesses, or fuel for transportation. Damage or disruption to these services can have a range of far-reaching effects on daily function, emergency response, and the region's economy.

Flooding can block access to underground utilities and damage electrical equipment, such as boxes and substations, causing prolonged power outages or equipment failure. Flooding, salinity intrusion, and rising groundwater can corrode buried pipelines that are not properly protected. Pipelines are particularly vulnerable to damage as rising groundwater increases risk of soil liquefaction, which takes place when loosely packed, water-logged sediments at or near the ground surface lose their strength in response to strong ground shaking such as from an earthquake. Damage to pipelines can interrupt services, but also present significant public and environmental health and safety risks if damage results in explosions or fire, such as if gas lines are damaged, or releases of hazardous materials.

The vulnerability of stormwater and wastewater infrastructure depends on its current storage and flow capacity, the elevation and location of its outfalls, and whether it is gravity-drained or pumped. Much of stormwater and wastewater infrastructure is located underground, where groundwater rise can cause corrosion and other damage. Some of the region's systems are already at capacity or experiencing backups during high tide events. If flow capacity is exceeded, it can lead to urban flooding and damage to roads, basements, and parking lots. Sewage can back up into homes and other development or get washed out into the Bay before being treated, presenting public and environmental health concerns.

Damage or disruption to transportation systems in the Bay Area can have significant impacts on commuter and goods movement, public health and safety, and quality of life the region, and much of the ground transportation assets are located in shoreline areas vulnerable to flooding now and in the future. The ground transportation network also relies on a supporting system of electric and communication infrastructure, parking lots, and roadways that are also vulnerable to flooding. Rail lines are highly sensitive to flooding as a small amount of water on the tracks can result in the closure of many miles of connected track. Similarly, the Bay Trail functions as a system of interconnected pathways for recreation and non-motorized commuting, so closures to parts of the trail can significantly disrupt its use for these purposes. The Bay Trail is highly vulnerable to flooding and damage from storm events as it is located along the shoreline where erosion, poor drainage, and surface damage can result in closures for long periods of time.

Erosion and scouring due to tidal and wave energy can damage structures in the Bay, such as bridges, bridge footings, and piers, and development along the shoreline, such as roads and foundations. Piers and marinas, can be damaged by increased pressure from higher sea levels and wave action, including scour, erosion, and wave reflection. Scour induced by wave and / or current action around a structure leads to foundation undermining or reduction in the load-bearing capacity of pile foundations, which can pose significant risks to public safety, particularly when shoreline protection structures are affected. More extensive, longer duration flooding can also cause shoreline protection structures, such as levees, berms, and revetments, to be damaged

or fail due to increased water levels and wave energy. Wave impacts can also erode the shoreline, creating safety concerns around stability of roads, trails, and shoreline development.

The shoreline also consists of significant public access and recreation opportunities that contribute to quality of life, public health, and the region's connection to the Bay. These areas are particularly vulnerable to sea level rise and storm events because of their location, physical characteristics, and the functions they serve. Grassy areas and landscaping can be damaged by flooding and salinity; beaches in the Bay are eroding from waves and tidal impacts and require nourishment to be maintained; and parts of the Bay Trail are surfaced with materials that erode easily, so even minor damage or temporary flooding of trails can impede the use of that area of the shoreline. Certain trails, beaches, vistas, picnic areas, small boat launches, and other shoreline recreation and public access areas will be inundated or flooded frequently enough as to not be functional without efforts to adapt them to sea level rise. Furthermore, the highly developed shoreline leaves limited opportunity to relocate shoreline parks and recreation areas, and certain historical and cultural resources of regional value are rooted in specific places along the shoreline.

Permanent inundation and to some extent episodic flooding can result in the mobilization of pollutants or hazardous or toxic materials from contaminated lands, industrial facilities, storage tanks, landfills, interference with wastewater treatment plants, and other sources around the shoreline. Landfills and contamination remediation sites may not have been designed to withstand rising groundwater and other increased flood risks associated with sea level rise and climate change. The interference of higher bay water levels and the various types of potential flooding with stormwater and wastewater infrastructure may result in backups or upwelling out of drains and sewage systems or accidental releases of untreated wastewater into the Bay. These events can result in degraded water, soil, sediment, and, in some cases, air quality, depending on factors of the pollutants and how they react when flooded. Pollution and degraded Bay water quality can impact human and wildlife health, critical freshwater resources, and the innate value and beauty of the Bay.

5.3.4. Impacts to natural areas and habitat

Thousands of acres of undeveloped natural areas and critical habitats exist along the shoreline of the Bay. These areas include natural shorelines such as cliffs and bluffs, beaches, tidal marshes, and managed wetlands that are at risk of exposure to flooding, sea level rise, and wave impacts. Loss of natural open spaces would result in loss of ecosystem functions including habitat for wildlife, loss of the buffering services against wave impacts and other coastal hazards, as well as loss of public access in areas designated for recreation and nature and wildlife viewing.

Rocky intertidal areas, wetlands, tidal marshes, tidal flats, eelgrass beds, and tidally influenced streams and rivers around the Bay are all likely to be affected by sea level rise. Of particular concern is the threat of significant losses of the Bay's remaining wetlands, which provide critical ecosystem services such as carbon sequestration, water filtration, and wave attenuation, as well as habitat, recreational open space, and others. Wetlands have adjusted naturally to rising sea level for thousands of years through upland migration and sediment build-up but will be lost if they cannot keep pace with the rates of sea level rise that are anticipated or if they are unable to migrate upland due to physical impediments, such as seawalls.

Salinity levels in the Bay may also increase as a result of sea level rise as more ocean water flows into the estuary, which could impact ecosystem and wildlife health. Some plant species in vulnerable areas are salinity-intolerant and will be damaged or killed by rising groundwater that has increased in salinity as a result of greater saltwater influence, as well as due to episodic overland flooding or permanent inundation as a result of sea level rise.

Vulnerable natural areas along the shoreline provide habitat to several state and federally listed threatened and endangered species as well as for migrating and wintering birds that rely on habitat for breeding, foraging, and for high tide refugia.

Cliffs and bluffs are susceptible to large erosive events with increased wave energy, as their steeper slopes will cause wave energy to increase at faster rates than sea level rise itself. Beaches, intertidal areas, and wetlands can also be highly sensitive to erosion from increased storm activity or higher levels of tidal inundation. Wave impacts on natural areas include recession of sandy shorelines, sedimentation in tidal creeks and flood control channels, and disruption of wetlands and natural habitats. Sea level rise and increased wave impacts will require increasingly larger volumes of sediment to nourish, maintain, and adapt the shoreline, posing challenges to sediment management and long-term sustainability.

It should also be noted that climate change will impact Bay ecosystems in ways that aren't the direct result of sea level rise or increased flooding and erosion, such as by increasing the acidity of Bay waters, altering the freshwater inflow and salinity dynamics, and influencing the species composition and food webs of the Bay.

Marsh, beach, and shoreline in the San Francisco Bay. Source: BCDC.

Bay Bridge. Source: BCDC Staff.

APPENDICES

A. FOUNDATIONAL CLIMATE CHANGE AND SEA LEVEL RISE SCIENCE

B. HOW THE BAY PLAN CLIMATE CHANGE POLICIES RELATE TO BCDC'S ADAPTING TO RISING TIDES PROGRAM

C. EXAMPLE RISK ASSESSMENT AND ADAPTIVE MANAGEMENT PLANS

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Appendix A. Foundational Climate Change and Sea Level Rise Science

This appendix provides an overview of climate change and sea level rise science that serves as the foundation for BCDC's Climate Change Policies. It includes summaries of what BCDC considers the best estimates of future sea level rise, including a condensed version of the scientific basis for the projections, which can help project proponents understand and use the table of projections from the State of California Sea-Level Rise Guidance provided in **Section 4.** This section also provides information on sea level rise mapping and visualization tools, in particular BCDC's Adapting to Rising Tides (ART) Bay Shoreline Flood Explorer. This information is intended to be an accessible introduction to the science and technical information relevant to the Climate Change and related Bay Plan polices and should not be considered a comprehensive source. Scientific content is sourced heavily from the OPC Rising Seas in California report and the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report unless otherwise cited.

The greenhouse effect

Anthropogenic, or human-induced, climate change primarily results from the accelerated rate of greenhouse gas (GHG) emissions produced by industrial activities, as well as from altered land cover and land use practices. The greenhouse effect that drives climate change is a natural process whereby greenhouse gases, such as carbon dioxide and methane, absorb and re-radiate

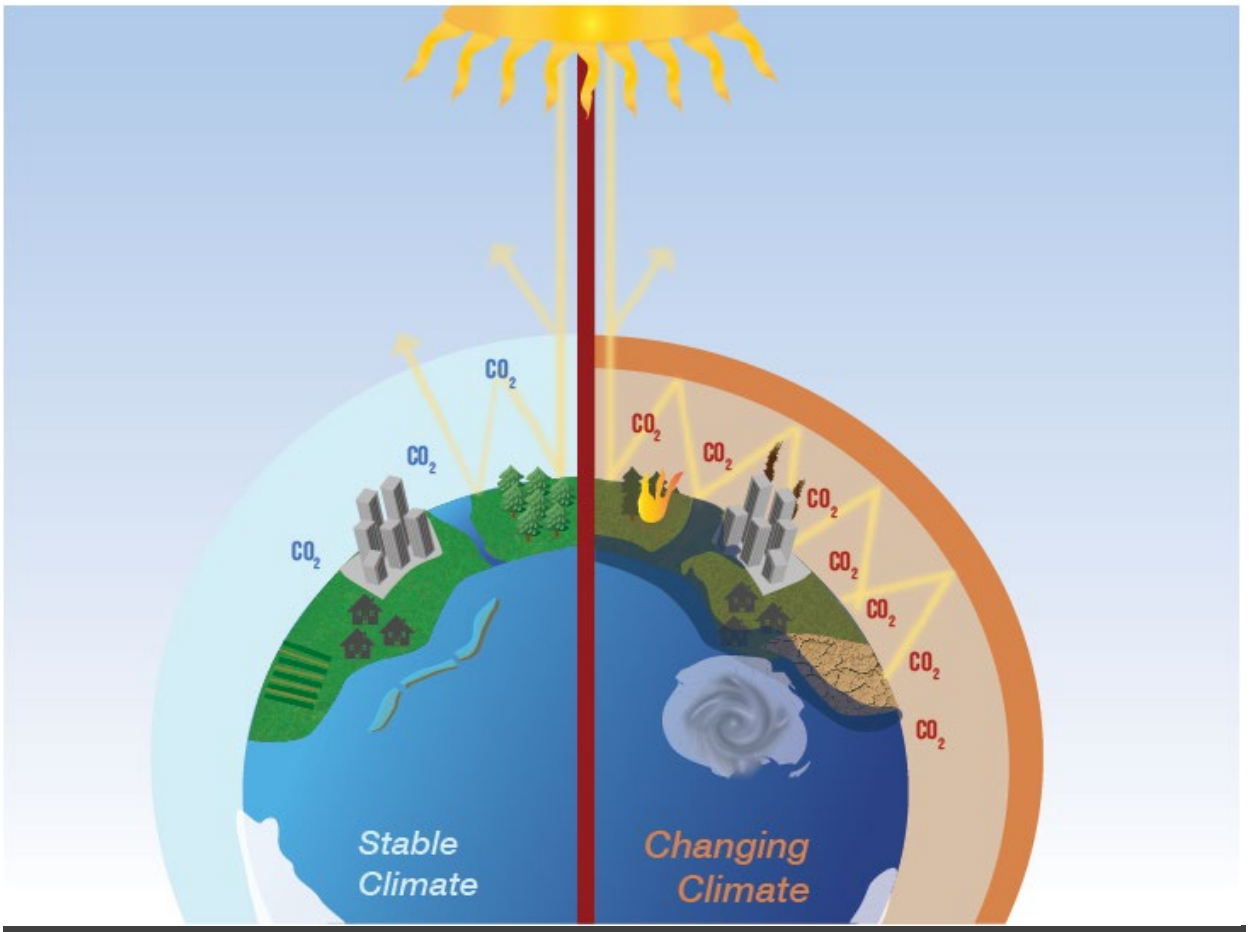

Figure A-1. The greenhouse effect. Source: BCDC.

a portion of the heat reflected from the earth's surface that would otherwise disperse back into space. This process is critical as it generates a warm enough climate to support life on Earth and regulates the global environment. However, current concentrations of atmospheric GHGs are approximately 45% higher than pre-industrial levels, intensifying the greenhouse effect so that Earth's climate system is absorbing more energy that was previously emitted back into space. This trapped energy raises global average temperatures, a phenomenon called global warming, generating complex, systematic impacts on global environmental processes and localized ecological interactions. Of particular relevance to BCDC, climate change is causing sea levels to rise, as well as more frequent and intense weather events, which can lead to increased flooding, erosion, and other risks to Bay resources and shoreline development.

Emissions scenarios

Although there is broad scientific consensus that anthropogenic climate change is occurring, the full range of effects of climate change and the extent of impacts we should anticipate are uncertain. Scientific uncertainty around the projections of future sea level rise is largely due to the fact that the results of scientific modeling depend upon the GHG emissions trajectory used in the model, and future emissions cannot be known for sure.

Since a certain amount of GHGs have already been emitted and land and sea ice have slow response times to global warming, there is more certainty in projections of sea level rise up until the year 2050. Therefore, the range of potential sea level rise in 2050 is significantly smaller than the range beyond 2050. After 2050, projections diverge significantly depending upon the potential range of global GHG emissions, as well as the scientific modeling of ice loss dynamics, which is discussed below.

To address the range of possible future emissions scenarios, the IPCC adopted a set of "representative concentration pathways," or RCPs, used for scientific modeling of climate change as the basis for its climate predictions and projections in the Fifth Assessment Report, released in 2014, which is a comprehensive report of the latest science on climate change, including its causes, potential impacts, and response options. RCPs are named for the associated radiative forcing level, in watts per square meter, in 2100: 8.5, 6.0, 4.5, and 2.6. They were developed by Moss et al. (2008) to represent a collection of possible underlying socioeconomic conditions, policy options, and technological considerations that would influence emissions rates or production of GHGs, aerosols, and chemically active gases, as well as changes to land use/land cover. In other words, each RCP represents a specific scenario that has a range of influencing factors and varying emissions rates along its trajectory before reaching atmospheric GHG concentration levels of the year 2100.

The sea level rise projections in the 2018 update of the State of California Sea-Level Rise Guidance (State Guidance) are based on two of the four RCP emissions scenarios that were adopted in the IPCC's Fifth Assessment Report: the high emissions (RCP 8.5) and the low emissions (RCP 2.6) scenarios.

The high emissions scenario follows a path in which current GHG emissions trends continue and there are no successful globally significant efforts to reduce emissions. The low emissions scenario aligns most closely with the global emissions reductions goals set during the United Nations

Framework Convention on Climate Change's (UNFCCC) 2015 Paris Agreement, which called for limiting average global warming to less than 2° Celsius and achieving net-zero GHG emissions in the second half of this century. The authors of the State Guidance used this range to 1) reflect California's ambitious emissions reduction goals, or a path similar to RCP 2.6, and 2) reflect that RCP 8.5 most closely resembled our emissions trajectory at the time.

To support decision-making amidst the uncertainty of future emissions, the State Guidance includes probabilistic projections of sea level rise, where the projections are given a relative likelihood associated with future emissions scenarios. The table of sea level rise projections for the San Francisco Bay Area was provided in **Section 4,** and information on why these projections were adopted for use in the State Guidance is provided below.

Since the release of the 2018 update to the State Guidance, the low emissions scenario has become increasingly unlikely to occur because emissions rates have not been sufficiently reduced thus far. There is ongoing discussion in the scientific community about the likelihood of the high emissions scenario as well, with some evidence pointing towards a scenario somewhere in the middle as the current most likely trajectory. An update to the State Guidance is anticipated in 2023. As mentioned throughout this guidance, the Commission currently uses the State Guidance as best available science on sea level rise, but BCDC permit applicants are not precluded from using other projections as long as the project is still found to be consistent with BCDC's laws and policies. See **Section 4** for the information regarding OPC's guidance on selecting a projection of sea level rise to use when designing a project that will require a BCDC permit.

The science of global mean sea level rise

Before reviewing specific scientific factors that are contributing to sea level rise, it is important to recognize that sea level rise is a component of global change as the earth shifts towards equilibrium, meaning that no amount of emissions reductions is expected to completely curb sea level rise at this point. The earth's current era of warming as a result of human impacts is drastically increasing an already occurring rate of sea level rise. Ice will continue to melt and the oceans will continue to expand for centuries before equilibrium is reached. The science on eventual sea level suggests the potential for at least 20-30 feet of total sea level rise over several centuries, not including the effects of further global warming*.

Global mean sea level rise refers to the permanent average global increase in ocean water levels, rather than a temporary increase, such as a local King Tide event, and it is primarily caused by the thermal expansion of warming ocean waters and the melting of land ice.

About 50% of global mean sea level rise over the last century can be attributed to ocean thermal expansion, which makes it the greatest contributor to sea level rise thus far. The global ocean absorbs more than 90% of the heat trapped in the atmosphere by the greenhouse effect, causing increases in surface water temperatures and the melting of glaciers and other forms of sea ice. As the ocean warms, it expands in volume in a process known as thermal expansion, resulting in elevated sea level.

The other half of the contributions to global mean sea level rise over the last century have resulted primarily from melting land ice, including mountain glaciers, ice caps, and the expansive polar ice

*DeConto RM, Pollard D. Contribution of Antarctica to past and future sea-level rise. Nature. 2016 Mar;531(7596):591-7.

sheets covering Greenland and Antarctica. These two polar ice sheets are also the greatest source of potential future contributions to sea level rise, as they contain enough ice to raise global mean sea level 24 and 187 feet, respectively, as compared to the 1.5 feet that the world's mountain glaciers and ice caps have the potential to contribute. Scientific understanding of the dynamics of ice loss is still limited. Therefore, the future contributions of the polar ice sheets to sea level rise presents the greatest source of uncertainty in the rate and amount of sea level rise after the year 2050. However, the rates of ice loss are shown to be increasing from the Greenland and West Antarctic ice sheets, suggesting that the melting of the polar ice sheets will likely soon pass ocean thermal expansion as the greatest contributor to sea level rise. Furthermore, due to their massive size, even a small fraction of either of the polar ice sheets could raise sea level significantly.

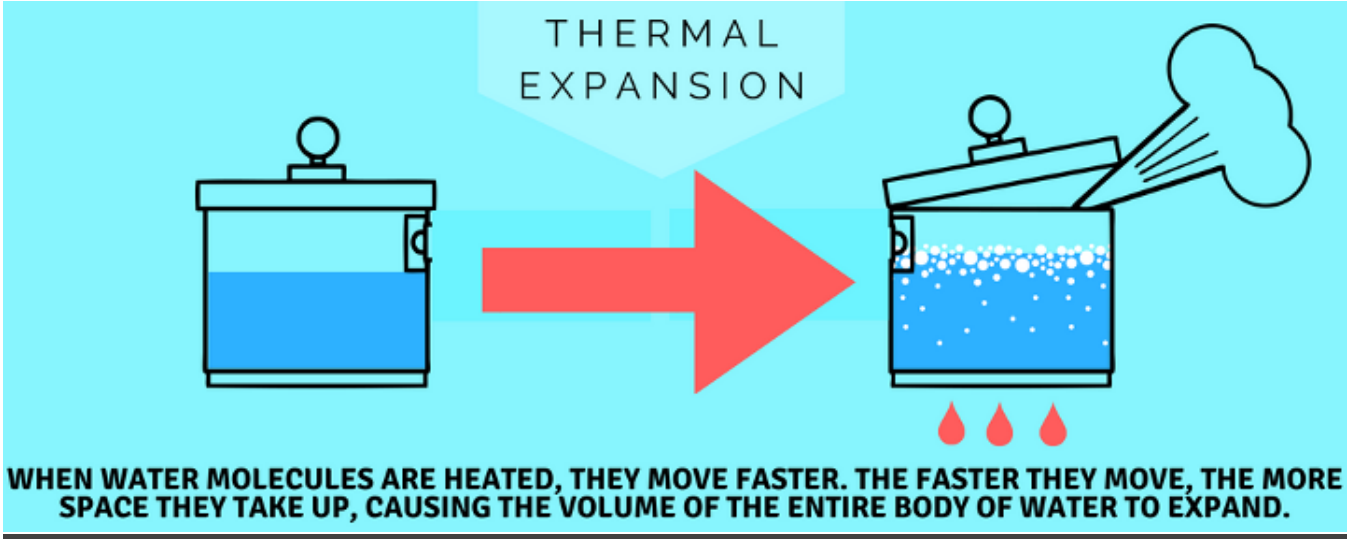

Figure A-2. Process of thermal expansion graphic. Source: City of Hayward.

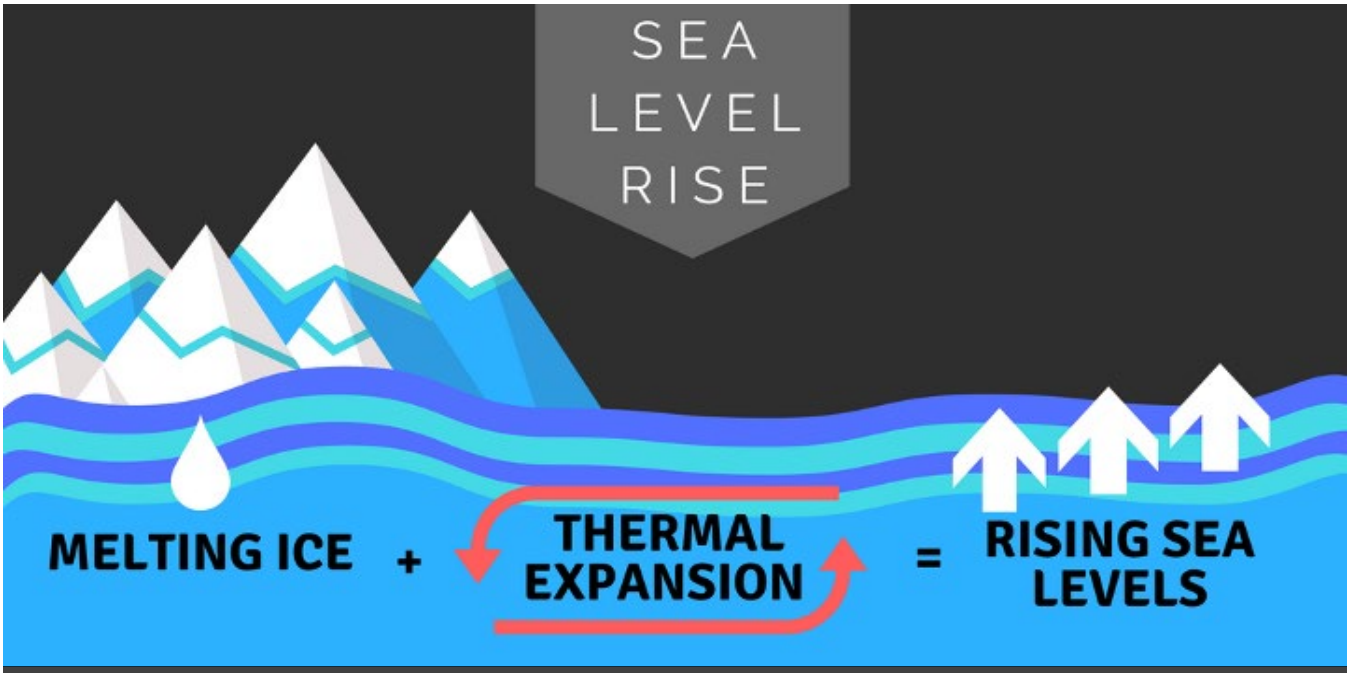

Figure A-3. Key contributors to global mean sea level rise. Source: City of Hayward.

Local divergences from global mean sea level rise

Local rates of sea level rise can diverge from global mean sea level rise. The relative sea level is the local difference in elevation between the height of the sea surface and the height of the land surface at any particular location. Changes to relative sea levels can result from: vertical land motion; changes in the height of the geoid, which is the shape that the ocean surface would take under the influence of the gravity and rotation of Earth alone if other influences such as winds and tides were absent; and changes in the height of the sea surface relative to the geoid. These changes are not the same across the globe or even along California's coastline.

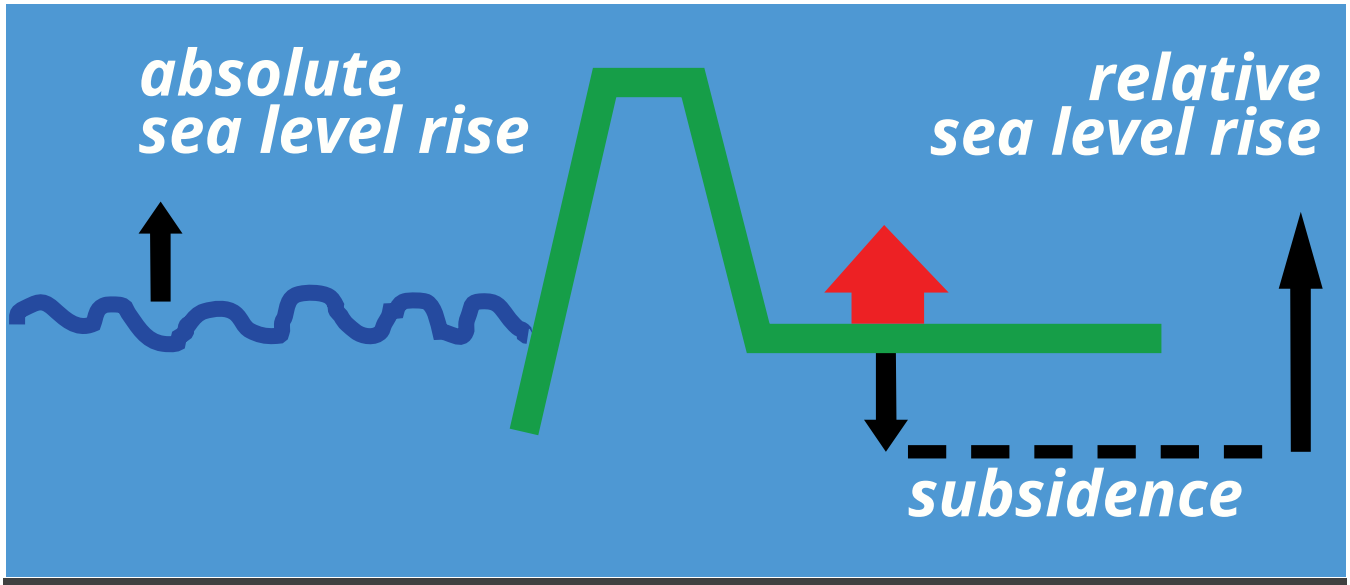

Figure A-4. Absolute (mean) sea level rise versus relative sea level rise. Source: BCDC.

Vertical land motion can be caused by plate tectonics, sediment compaction, withdrawal of groundwater and fossil fuels, and isostatic adjustments, which are the ongoing movements of land in response to the redistributions of ice and ocean mass after the last ice age (see **Section 5.2.4** for more information regarding vertical land motion in the Bay Area). Substantial changes in wind and ocean currents can also have local to regional scale impacts on sea levels, but these changes are not projected to have a significant effect on the California coast. However, the future redistributions of ice and water caused by the retreat of the polar ice sheets, specifically on Antarctica, are of particular concern for California.

The mass redistribution of the retreating polar ice sheets affects Earth's gravitational field and the orientation and rate of Earth's rotation, and it deforms the Earth's crust and mantle. As an ice sheet loses mass, its gravitational pull on the surrounding ocean is reduced, causing relative sea levels within a certain distance to drop, even though volume has increased. Farther from the ice sheet, this change causes relative sea levels to rise more than expected from the extra volume of water added. This is particularly concerning for coastlines of the Northern Hemisphere, as they generally experience the enhanced effects of losses of the Antarctic ice sheet, the larger of the two polar ice sheets. For every foot of global sea level rise resulting from loss of ice on West Antarctica, sea levels along California's coastline are expected to rise approximately 1.25 feet.

An Alaskan Glacier. Source: BCDC Staff.

Background of the State of California Sea-Level Rise Guidance

In response to Governor Schwarzenegger's Executive Order S-13-08, issued on November 14, 2008, which directed state agencies to plan for sea level rise and other climate change impacts, the Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT) completed the State of California Sea-Level Rise Interim Guidance (Interim State Guidance) in 2010, to help state agencies incorporate future sea level rise impacts into planning decisions. In 2013, the Interim State Guidance was updated and expanded by the Ocean Protection Council (OPC) to reflect scientific advancements in understanding and modeling of future sea level rise, becoming the State of California Sea-Level Rise Guidance (State Guidance).

In 2017, in response to scientific advancements, such as those included in the IPCC's Fifth Assessment Report, and to Governor Brown's Executive Order B-30-15, issued on April 29, 2015, which called for state agencies to take climate change into account in planning and investment decisions and to use adaptable approaches to prepare for uncertain impacts, the State of California began the process of updating the State Guidance for the second time. The State first requested the development of a report summarizing recent scientific advancements on which to base the update to the State Guidance, which resulted in the production of Rising Seas in California: An Update on Sea Level Rise (Rising Seas Report), finalized in 2017.

The development of the Rising Seas Report was led by OPC in partnership with the California Ocean Science Trust. They convened a Science Advisory Team Working Group, consisting of some of the nation's leading experts in coastal processes, climate science, modeling science, and decision-making under uncertainty, who synthesized advances in modeling and improved understanding of scientific processes, particularly of the dynamics of ice loss from the Greenland and Antarctic ice sheets, into the report.

The 2018 update to the State Guidance, based on the Rising Seas Report, was produced by OPC, in close coordination with a Policy Advisory Committee with representation from the California Natural Resources Agency, the Governor's Office of Planning and Research, and the California Energy Commission, as well as with input from the member agencies of the State's CO-CAT and various coastal stakeholders.

In addition to assisting state agencies as they incorporate sea level rise into their planning, permitting, and investment decisions, the update was expanded to also incorporate the needs of local governments by helping cities and counties comply with climate change legislation, such as SB 379 (Jackson, 2015), which requires all cities and counties to include climate adaptation and resiliency strategies in the safety elements of their general plans. The 2018 update provides: 1) a synthesis of the best available science on sea-level rise projections and rates for California; 2) a stepwise approach for state agencies and local governments to evaluate those projections and related hazard information in decision-making; and 3) preferred coastal adaptation approaches.

Currently, BCDC considers the best estimates of future sea level rise for use in its permitting and planning programs to be the projections included in the 2018 update to the State Guidance.

The science is rapidly evolving

Currently, BCDC considers the best estimates of future sea level rise for use in its permitting and planning programs to be the projections included in the 2018 update to the State Guidance. BCDC will periodically update this section of the Bay Plan Climate Change Policy Guidance as appropriate, particularly with future updates to the State Guidance, expected in 2023.

Scientific understanding and modeling of sea level rise continues to evolve, and the projections of sea level rise will change with future updates to the State Guidance and other sources, as they have with the previous updates. The upper limits of projections of sea level rise have been increasing on average with releases and updates to guidance documents over time, primarily due to new and improved understanding of mass loss from continental ice sheets, and recent scientific advances suggest we may experience higher rates of sea level rise than previously anticipated. Additionally, although it is a planning goal rather than a projection, OPC's Strategic Plan for 2020-2025, approved in February 2020, includes the objective of ensuring California's coast is resilient to a minimum of 3.5 feet of sea level rise by 2050. The target of resilience by 2050 to a value projected for 2100 is based on a 50-year margin of safety, as outlined in OPC's Frequently Asked Questions document. OPC's Strategic Plan states that this target will be updated periodically based on the best available science and updates to the State Guidance.

In response to rapidly evolving scientific understanding and modeling of sea level rise, the State Guidance will be updated at a minimum of every 5 years. A report summarizing the most recent scientific advancements is expected in 2022, followed by an update to the State Guidance in 2023.

Scientific approaches to and advancements in projecting sea level rise

Scientific statements about the probability or likelihood of different future pathways, such as those made by probabilistic sea-level rise projections, are Bayesian probabilities, which are based upon a synthesis of multiple lines of evidence and represent an assessment of the strength of the observational, modeling, and theoretical evidence supporting different future outcomes. Probabilistic projections differ from frequentist probabilities, which are based on the historical frequency of occurrence.

While the scientific literature offers different approaches to projecting future sea level rise, the authors of the Rising Seas in California report concluded that this comprehensive probabilistic approach would be best for a policy setting in California as it can be used to support various scenarios of decision-making and different levels of risk aversion.

After 2014, new research highlighted the sensitivity of projections to Antarctic ice sheet instability and the potential for extreme sea level rise as a result, particularly under a high global emissions trajectory similar to the one we are currently following. This suggested that existing probabilistic projections may have underestimated the rate and total amount of sea level rise that may occur. In response to various assessments of the 'maximum physically plausible' global mean sea level rise and new scientific reports concerning the dynamics of ice loss, such as that of DeConto and Pollard (2016), an extreme scenario of 8 feet of global mean sea level rise in 2100, developed by Sweet et al. (2017), was also included in the State Guidance. This scenario, which the State Guidance refers to as the "H++" scenario, was provided alongside the probabilistic projections in the State Guidance, however without an associated probability as one cannot be accurately estimated at this time.

Although projections and their associated probabilities will likely evolve as scientific understanding and modeling advances, and as the range of potential emissions trajectories becomes more refined, it is critical that decision-makers not wait for scientific certainty to take action. As there is relatively high confidence in the sea level rise projections up until 2050, these projections can inform hazard preparation, adaptation, and mitigation efforts undertaken today and can prevent more significant damage and risks to public safety that might otherwise occur if action is not taken now. The H++ scenario is provided to account for the potential for extreme sea level rise that could be considered in long-term planning and decision-making. While it is unclear when high sea level rise scenarios will occur, there is scientific consensus* that sea levels will continue rising beyond 2100 even in optimistic projections, eventually reaching the values in the H++ scenario or beyond.

Sea level rise mapping and visualization tools

Inundation maps and sea level rise visualization tools can be useful resources for identifying vulnerable areas and supporting adaptation planning and the design of flood protection projects, among other uses. The various geospatial and visualization tools available differ in their target uses and audiences and have different strengths and limitations. The State Guidance recommends using the tool that contains the most locally-specific details for a planning location and, in some cases, overlaying the results of multiple tools to gain a more complete idea of the range of potential risks.

As mentioned in **Section 2.3.2,** BCDC staff often use BCDC's Adapting to Rising Tides (ART) Bay Shoreline Flood Explorer (Flood Explorer) to aid in visualizing potential overtopping and flood risks to a proposed project at existing conditions from different combinations of storm surge and sea level rise. BCDC permit applicants may consider using the Flood Explorer when appropriate as well, although it is not detailed enough at the parcel-scale to replace a coastal engineering survey of local flood risk. BCDC's ART Program developed this regional sea level rise visualization tool to support regional and local adaptation planning with assistance from the San Francisco Estuary Institute and AECOM.

The Flood Explorer maps low points along the Bay's shoreline where overtopping, or water

* IPCC, 2019: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. In press.

pouring over the shoreline, may occur in the future, utilizes a "Total Water Level" approach to depict flooding from various combinations of storm surge and sea level rise, and provides high-quality spatial information reviewed by local stakeholders. The Flood Explorer depicts flood scenarios without an associated time frame or emissions scenario so that the information remains relevant as sea level rise projections are updated (I.e., "One Map, Many Futures"). The ART Program also produced a separate East Contra Costa Shoreline Flood Explorer in collaboration with the Delta Stewardship Council, to account for differences in the modeling of current and future flooding around the Delta, compared with the Bay.

The Flood Explorer maps utilize water level outputs from the comprehensive San Francisco Bay Tidal Datums and Extreme Tides Study (2016), leveraging work done for FEMA's San Francisco Bay Coastal Study, which modeled tidal datums and extreme tides for over 900 locations around

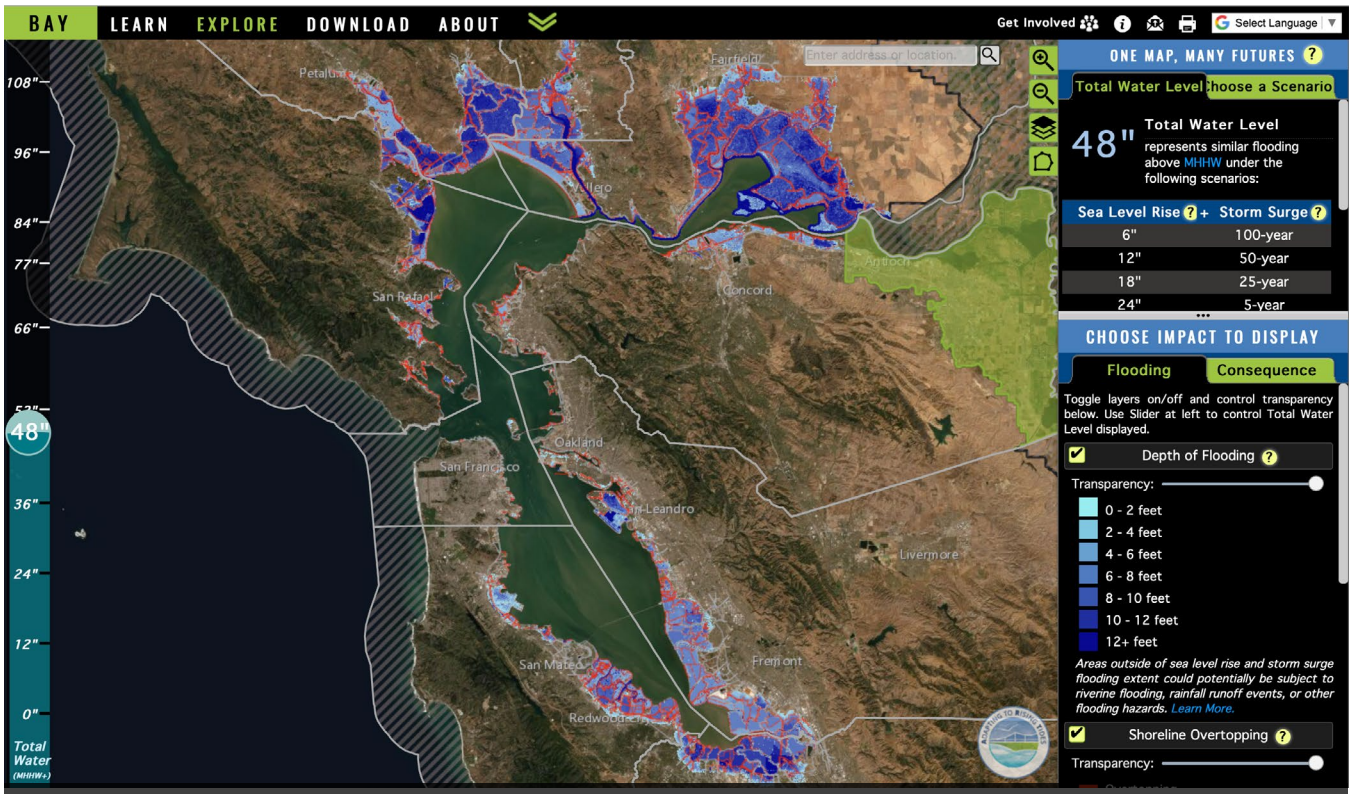

Figure A-5. BCDC's ART Bay Shoreline Flood Explorer. Source: BCDC.

the Bay, as well as LiDAR topographic data collected and refined through a stakeholder review process. Limitations of the Flood Explorer include that riverine, groundwater, and surface water flooding from rainfall-runoff events, as well as erosion, subsidence, and local wind and wave effects are not modeled. For the Flood Explorer's full mapping and sea level rise analysis methods, see the Adapting to Rising Tides Bay Area Sea Level Rise Analysis and Mapping Project technical study.

In Summer 2020, the ART Bay Shoreline Flood Explorer was updated to include consequence data resulting from the regional vulnerability analysis, ART Bay Area, which was published in March 2020. ART Bay Area is the first ever regional comparison of the impacts of sea level rise

on communities, habitats, and infrastructure. ART Bay Area conducted an analysis on factors of "regional significance," or impacts that would create rippling negative effects felt throughout the region. These factors, called consequences, vary across each regional system but provide a measure of impact not captured by flood exposure alone, revealing the impacts of flooding on transportation, vulnerable communities, job centers, housing, recreation, and tidal wetlands. The Bay Shoreline Flood Explorer now includes a representative selection of consequence analysis results from across the regional systems.

Since the Flood Explorer depicts future water levels without an associated timeframe and utilizes a Total Water Level approach, as described above, the table shown in Figure A-6 provides information on which combination of factors (i.e., amount of sea level rise and storm scenario) in the Flood Explorer corresponds to certain projections of sea level rise from the State Guidance.

For a comparison of the Flood Explorer and other available sea level rise viewing tools, the California State Coastal Conservancy developed the online tool Sea the Future, in partnership with the San Francisco Sentinel Site Cooperative and with funding and support provided by NOAA's Office for Coastal Management. The website provides information and comparisons on the features and functionality of select tools.

It is important to note that scientific understanding and modeling of shallow groundwater rise in coastal areas as a result of sea level rise is still advancing and that the impacts of groundwater rise are expected to be significant, with some areas expected to flood as much or more as a result of groundwater rise than directly from overland flooding as sea level rises. Currently the ART Flood Explorer and, to the best of BCDC's knowledge, similar tools for the Bay Area do not include groundwater rise in their modeling. However, a team from the University of California, Berkeley, and Silvestrum Climate Associates has generated a map of depth to the water table around San Francisco Bay to reveal areas that are vulnerable to the impacts of groundwater rise. Additionally, efforts are underway to add groundwater rise modeling into the ART Flood Explorer as well as Point Blue Conservation Science's Our Coast our Future flood hazard viewer, which utilizes United States Geological Survey (USGS) Coastal Storm Modeling System (CoSMoS) data.

COMPARING CALIFORNIA STATE GUIDANCE ON SEA LEVEL RISE TO ART TOTAL WATER LEVELS

			Likely Range*	1-200 Chance*	Extreme Risk*
2030	State Guidance (High Emissions)		6"	9.6"	12"
	ART Maps Equivalent	*MHHW+*	**	*12"*	*12"*
	Sea Level Rise + 5-Year Storm	MHHW+	**	36"	36"
	Sea Level Rise + 50-Year Storm	MHHW+	**	48"	48"
	Sea Level Rise + 100-Year Storm	MHHW+	48"	52"	52"
2040	State Guidance (High Emissions)		9.6"	15.6"	21.6
	ART Maps Equivalent	*MHHW+*	*12"*	**	*24"*
	Sea Level Rise + 5-Year Storm	MHHW+	36"	36"	48"
	Sea Level Rise + 50-Year Storm	MHHW+	48"	52"	**
	Sea Level Rise + 100-Year Storm	MHHW+	52"	**	66"
2050	State Guidance (High Emissions)		13.2"	22.8	32.4
	ART Maps Equivalent	*MHHW+*	*12"*	*24"*	*36"*
	Sea Level Rise + 5-Year Storm	MHHW+	36"	48"	**
	Sea Level Rise + 50-Year Storm	MHHW+	48"	**	**
	Sea Level Rise + 100-Year Storm	MHHW+	52"	66"	77"
2060	State Guidance (High Emissions)		18"	31.2"	46.8"
	ART Maps Equivalent	*MHHW+*	**	**	*48"*
	Sea Level Rise + 5-Year Storm	MHHW+	**	52"	**
	Sea Level Rise + 50-Year Storm	MHHW+	52"	66"	84"
	Sea Level Rise + 100-Year Storm	MHHW+	**	**	**
2070	State Guidance (High Emissions)		22.8"	42"	62.4"
	ART Maps Equivalent	*MHHW+*	*24"*	**	*66"*
	Sea Level Rise + 5-Year Storm	MHHW+	48"	66"	84"
	Sea Level Rise + 50-Year Storm	MHHW+	**	77"	96"
	Sea Level Rise + 100-Year Storm	MHHW+	66"	84"	108"
2100	State Guidance (High Emissions)		40.8"	82.8"	122.4"
	ART Maps Equivalent	*MHHW+*	**	*84"*	**
	Sea Level Rise + 5-Year Storm	MHHW+	66"	108"	**
	Sea Level Rise + 50-Year Storm	MHHW+	77"	**	**
	Sea Level Rise + 100-Year Storm	MHHW+	84"	**	**

Figure A-6. Table comparing sea level rise projections from the State Guidance to total water levels in the ART Bay Shoreline Flood Explorer. Source: BCDC.

Appendix B. How the Bay Plan Climate Change Policies Relate to BCDC's Adapting to Rising Tides (ART) Program

The ART Program is a non-regulatory, collaborative, and inclusive program that provides support for sea level rise vulnerability assessment and adaptation planning to be implemented by local governments. ART projects are co-led by the ART team at BCDC and local governments, as well as other partners, and use the ART Portfolio, an online database of how-to guides, templates, and worksheets that walk users through the ART Approach, a five-stage planning process to assess vulnerability and develop responsive adaptation strategies. Local governments may also use the ART Portfolio on their own to develop a local assessment. Utilizing the ART Approach is not a requirement of BCDC's Climate Change Policies, yet it can serve as a useful and important planning tool that may support a more comprehensive integration of BCDC's Climate Change Policies for individual projects into a larger-scale adaptation planning process to meet local and regional resilience goals. The ART Program has also produced a sea level rise mapping and visualization tool, the ART Bay Shoreline Flood Explorer, which is discussed in **Appendix A**.

There are many differences between the way that BCDC analyzes and permits proposed projects and the ART Program's collaborative planning process. In particular, each has different intended goals and, therefore, each examines vulnerability on a different scale and with a different scope. Additionally, unlike BCDC permits, the outcomes of ART projects are non-binding, thus encouraging the involvement of multiple stakeholders in a collaborative planning project without legal commitments to implementing any of the outcomes identified in the project.

Key Differences between BCDC Permitting and the ART Program

	BCDC Permitting	ART Program
Authority	Regulatory	Non-regulatory; voluntary
Scale	Individual projects (parcels).	Varies: city-wide to regional (cross-jurisdictional, cross-sectoral).
Scope	Determined by BCDC's jurisdiction and authority. Often confined to individual land-owner(s).	Can be comprehensive (cross-jurisdictional, cross-sectoral assets and infrastructure) and developed by multiple stakeholders. ART project areas are not confined to BCDC's permitting jurisdiction.
Lead	Project proponents(s) who have direct authority over project area outcomes.	ART Program and local jurisdiction partner(s), in collaboration with project proponents who have direct, limited, shared, or no authority over project area outcomes (e.g., local governments, residents, service providers, landowners, etc.)

Although there are significant differences between BCDC permitting and the ART Program, individual projects seeking BCDC permits could consider utilizing the ART Planning Process in one of the following two ways:

1. To the extent feasible, if an existing ART (or similar) project exists, align the individual project's risk assessment, resilience measures, and adaptive management efforts with the existing ART project, as appropriate; or
2. If no existing ART (or similar) project exists, utilize the principles of the ART Planning Process and adapt the steps to meet the needs of an individual project to assess risk and identify appropriate resilience measures and adaptation responses. The ART Planning Process can also be utilized in a wider area than an individual project to help understand the project's context and how it contributes to larger resilience goals.

In both cases, the ART Planning Process may further support improved communication of shared risks, catalyze the development of larger-scale sea level rise planning efforts, and help facilitate understanding of how individual-scale projects align with overarching shoreline strategies and goals.

Most recently, the ART Program published a comprehensive regional vulnerability analysis, ART Bay Area (2020). It has also completed other regional and sector-specific vulnerability assessments, as well as the following local-scale vulnerability assessments:

- Alameda County ART Project
- Contra Costa County ART Project
- ART East Contra Costa County
- Hayward Shoreline Resilience Study
- Oakland / Alameda Resilience Study

Some local jurisdictions have conducted vulnerability assessments and developed adaptation plans that reflect the ART Approach but are not ART-led projects. If those exist locally, project proponents could consider adapting the information provided in this section to align with those projects as well.

The following section explains each of the stages of the ART Planning Process and how they relate to or differ from BCDC's permitting process for individual projects, as well as potential areas of integration between the two.

ART Approach: Introduction

The ART Approach is intended to guide local jurisdictions through the process of conducting a vulnerability assessment to identify and define key issues and develop strategic responses for adaptation. The ART Approach uses a planning process for climate change adaptation to sea level rise and flooding through five overarching stages (Figure B-1): Scope and Organize; Assess; Define; Plan; and Implement. Within these stages, a step-wise process lays out how vulnerability is assessed and findings are synthesized and communicated in a way that emphasizes collaboration, transparency, and sustainability as factors for successful adaptation. Sustainability is framed through the lenses of impacts from sea level rise to society and equity, environment, economy, and governance.

Figure B-1. The ART Approach. Source: BCDC.

ART Approach: Scope and Organize Stage

The first major departure of individually permitted projects on the Bay shoreline from the ART planning occurs in the "Scope and Organize" stage when determining the project area. Typically, a project seeking a BCDC permit will reside on one or a few parcels and have one or a small consortium of owners. In the ART Planning Process, project areas can include entire cities, counties or watersheds and include assets, infrastructure, neighborhoods, and services that allow the assessment of various and interconnected consequences on the four sustainability frames.

Another key difference is who leads the process. While a BCDC permit applicant or their representative/consultant might lead the risk assessment and adaptive management plan for an individual project, the ART Planning Process could be led by a local government, nonprofit, or community group and is meant to include input from a wide variety of stakeholders. The Scope and Organize stage of the ART Planning Process also includes setting project resilience goals, which are goals that define desired outcomes of a climate change planning effort and provide a foundation upon which future project decisions can be made.

If an ART project exists in the proposed project area: Review the existing ART project and determine if the project's resilience goals are applicable or helpful for the individual project. If so, check that the goals are consistent with Bay Plan policies, then align the individual project's resilience and adaptation goals with the larger ART project's goals, if appropriate.

If not, adapt the ART Approach to an individual project: If no ART project or similar scale project exists, apply elements of the ART Planning Process to the individual project. As the project area is already set, define what to address, convene stakeholders, and set the individual project's resilience and adaptation goals.

ART Approach: Assess Stage

Although Bay Plan Climate Change Policy 2 prescribes certain elements to be included in risk assessments (see **Section 2.3.2**), the ART Approach's "Assess" stage views vulnerability more holistically. The ART assessment questions were developed to guide the collection of data and information about existing conditions, vulnerabilities, and consequences. The questions are grouped into classifications, including existing conditions, observed vulnerabilities (functional, information, physical, and governance), and consequences (to people, ecosystem services, and the economy). Given their small scale, it might not be feasible and/or practical for an individual project to answer all of the ART assessment questions. However, the risk assessments for individual projects will likely be a piece of the vulnerability story of the larger geography in which it is situated.

If an ART project exists in the proposed project area: Individual projects can review vulnerabilities and consequences uncovered in the existing ART project that are applicable to their project areas and improve and build upon the findings in the completion of a parcel-scale risk assessment, as stipulated in Bay Plan Climate Change Policy 2.

If not, adapt the ART Approach to an individual project: Plan out the assessment methods and select climate scenarios that align with Bay Plan Climate Change Policies 2 and 3. Conduct a parcel-scale risk assessment that is consistent with Bay Plan Climate Change Policy 2. The assessment is likely to be smaller and more specific to the individual parcel than implied by the ART guidance for this stage, but the ART assessment questions may help to uncover wider shoreline vulnerabilities.

ART Approach: Define Stage

The next stage of the ART Approach, "Define", entails 1) summarizing answers to the assessment questions (mentioned above) into clear, outcome-oriented vulnerability and consequence statements; 2) writing asset-specific issue statements; and 3) defining key planning issues. An issue statement clearly describes how the climate impacts affect the asset, including the primary reason for the vulnerabilities and what the likely consequences would be. Key planning issues are often caused by vulnerabilities that cut across multiple assets, geographies, and/or jurisdictions; have significant and/or early consequences; require coordinated decision-making or funding; and/or require changes in laws, regulations, policies, or other processes that will have significant consequences on people, the economy, and/or the environment. To the extent feasible, individual shoreline projects could benefit from defining key issues impacting the site; however, it may be infeasible or impractical to complete this stage fully as defined by the ART Planning Process.

If an ART project exists in the proposed project area: Review the individual project's risk assessment findings, per Climate Change Policy 2, and determine their relationship to the ART project's vulnerability findings. Review the ART project's issue statements and key planning issues to identify which, if any, are relevant to the individual project. Use them as a starting point to summarize the individual project's asset-specific issues and identify key planning issues. It is important that individual projects and their larger jurisdictions coordinate in this step as solutions to key planning issues are likely to require coordinated decision-making or funding, and/or process and policy changes.

If not, adapt the ART Approach to an individual project: Summarize project-scale issues and identify findings that are within the project scale and those that are outside of the project area, but could impact functioning of the project, and share them with stakeholders and local community members.

ART Approach: Plan Stage

The next stage of the ART Approach, "Plan", includes reviewing resilience goals, developing adaptation responses, and developing evaluation criteria to help select and prioritize responses. Adaptation responses have three main components: 1) the key vulnerability being addressed, 2) adaptation action(s), and 3) implementation options. The ART Approach emphasizes adaptation responses over strategies to address the vulnerabilities comprehensively. Responses help to present a number of possible stand-alone or sequenced actions; connect actions to the vulnerability assessment outcomes; characterize actions by type, priority, and implementation scale; identify possible implementation partners and processes; provide greater transparency to project decision-making overall; and ensure that responses address sustainability.

While Climate Change Policy 3 requires certain projects be resilient to mid-century and adaptable to the end of the century, the ART Approach Plan stage does not specifically require adaptation to mid- or end of century. This stage is a more comprehensive approach to adaptation planning that is not necessarily tied to a certain planning horizon. Depending on the scale and scope of an individual project seeking a permit, aspects of the ART Approach's Plan stage may be applicable. If the project is large in scale or contains multiple phases of development over time, evaluating various adaptation responses could be possible. With smaller projects, it may not be possible to address vulnerabilities in the same way.

At the time of publishing this guidance, the ART Program is currently updating the "Plan" stage of the ART Planning Process by developing an Adaptation Guidance document, co-produced in partnership with numerous entities in the Bay Area. The updated Adaptation Guidance will

build upon existing ART resources and include additional guidance to support local jurisdictions in making the transition from vulnerability assessment to inclusive, equity-driven, integrated adaptation planning.

If an ART project exists in the proposed project area: Similar to crafting risk assessments, individual projects can review the existing ART project's adaptation responses and evaluate or refine the responses using the ART evaluation criteria along with results of the parcel-scale risk assessment and in alignment with Bay Plan Climate Change Policy 3 and other Bay Plan policies applicable to the project. To the extent feasible, aligning with larger-scale goals can ensure individual projects fit into a comprehensive vision for resilience and adaptation and can help the individual project leverage resources and avoid unintended consequences. This could also relate to Climate Change Policy 7, to help justify and contextualize projects within a larger regional or subregional framework.

If not, adapt the ART Approach to an individual project: Develop resilience measures and adaptation responses that address each of the individual project's key planning issues, evaluate their implementation options and identify benefits and trade-offs using the ART evaluation criteria, in alignment with Bay Plan Climate Change Policy 3 and other applicable Bay Plan policies.

ART Approach: Implement Stage

In the ART Approach, the purpose of this final step, "Implement" is to support the implementation of adaptation responses. This includes identifying resources to assist with implementation, conducting feasibility studies as needed for specific actions, and continuing to convene the appropriate actors in collaborative planning. Specific tasks in this step include: 1) developing recommendations for advancing high priority adaptation responses that require shared and/or coordinated action; 2) communicating project outcomes to stakeholders, including boards, commissions, committees, and other decision-making bodies; 3) implementing adaptation responses identified by the project, including actions such as initiating further studies, advancing physical interventions, making legislative changes, and improving the information necessary to increase resilience; and 4) integrating sustainability into governance, capital investment, and management. Individual projects will also undertake an implementation phase, whether it be advancing physical interventions, changing designs, or initiating monitoring programs, among others, but will likely be at a smaller scale than implementation on the local jurisdiction or sectoral scale.

If an ART project exists in the proposed project area: Share the individual project's outcomes with the ART project proponents, explore options, and develop recommendations for taking action. Ideally, both local jurisdictions and individual project proponents should seek out areas where entities can coordinate on implementation, including leveraging resources and information.

If not, adapt the ART Approach to an individual project: Share outcomes with stakeholders and local community members, explore options, and develop a project-scale adaptation plan for taking action to address vulnerabilities in accordance with BCDC permit conditions.

Appendix C. Example Risk Assessments and Adaptive Management Plans

The following risk assessments and adaptive management plans are listed here as non-exhaustive examples and not as models for consistency with Climate Change Policies 2 and 3. The required components of a risk assessment are stipulated in Climate Change Policy 2 and are discussed in **Section 2.3.2** of this guidance. Adaptive management plans, which are required for certain projects under Climate Change Policy 3, are discussed in **Section 2.3.3**.

These example risk assessments and adaptive management plans are available from BCDC staff upon request. Select language from certain plans listed below and from approved permits accompanying these documents are provided in **Section 3.**

Foster City Levee Protection Planning and Improvements Project (BCDC Permit No. 2018.005.00)

The City of Foster City prepared the Risk Assessment and Adaptive Management Plan for Future Sea Level Rise in part due to the requirements of Climate Change Policies 2 and 3.

Alameda Landing Development (BCDC Permit No. 2018.004.00)

The City of Alameda prepared the Evaluation of Alameda Landing Waterfront due to the requirements of Climate Change Policy 2.

Oyster Point Development (BCDC Permit No. 2017.007.00)

The Investigative study into future sea level rise for the development of Oyster Point is a risk assessment and includes a step-by-step process of sea level rise scenario selection. Please note this risk assessment was prepared before the latest update to OPC's Sea Level Rise Guidance.

Mission Rock Development (BCDC Permit No. 2017.004.00)

The Coastal Flooding and Sea Level Rise Risk Assessment and Adaptation Strategy was prepared to satisfy requirements in Climate Change Policy 2. Please note this risk assessment was prepared before the latest update to OPC's Sea Level Rise Guidance.

Treasure Island Redevelopment Project (BCDC Permit No. 2016.005.00)

The Sea Level Rise Risk Assessment and Adaptation Strategy for Rising Sea Levels was prepared for Treasure Island Community Development in part due to the requirements of Climate Change Policies 2 and 3. Please note this risk assessment was prepared before the latest update to OPC's Sea Level Rise Guidance.