# Adaptation Responses

## ADAPTING TO RISING TIDES PROJECT

JULY 2013

In considering how to best address the vulnerabilities identified in the ART subregion, the project team and working group determined the need for comprehensive approach that went beyond a simple list of strategy names. The result was the development of the ART subregional adaptation responses that clearly link actions to the vulnerability(s) that they would reduce, identify when it is important to take a phased or sequential approach, and acknowledge alternative actions that will require considering trade-offs and costs/benefits. For the cross-sector, cross-jurisdictional issues identified in the ART project, the adaptation responses are a springboard for participating agencies, organizations and communities to collectively begin to take action together. For the issues identified that affect a single jurisdiction or agency, the subregional adaptation responses are the foundation from which an adaptation plan can be developed or individual actions can be selected, refined and initiated.

The ART adaptation response contains three core elements: (1) a key vulnerability; (2) actions to directly address the vulnerability; and (3) the likely steps, partners, and processes necessary to initiate and administer the actions. Additionally, each action was characterized by its type and priority, and the scale(s) at which it would be implemented.

The ART **adaptation responses** consist of three elements:

A **key vulnerability** provides a direct link to the outcomes of the assessment so that the most critical issues identified are addressed. Including the key vulnerability is a clear and transparent means to ensure that each action is connected to an identified planning issue.

One or more **actions**. While some vulnerabilities can be addressed by a single action most require multiple actions. Many actions can be taken at the same time, while others act as a series of sequential steps that incrementally build towards resilience.

**Implementation options** are a guide for those that want to initiate actions. The options identify the possible actors that will need to be at the table, whether actions could be incorporated into existing planning or collaborative processes, or if new initiatives will be needed.

# Components of an Adaptation Response

Assessment findings for the ART subregion were summarized within and across the twelve asset categories evaluated. This organization allowed the project team to identify asset categories that had similar vulnerabilities identified relationships and dependencies among the assets, eliminated redundancies, and highlighted the unique vulnerabilities of specific asset categories.

Five broader asset categories were developed from the original 12 asset categories assessed within the subregion:

- Overarching – Vulnerabilities that cut across many or all asset categories.
- Community Land Use – Community Land Use, Facilities and Services, Contaminated Lands and Hazardous Material Sites
- Transportation – Ground Transportation, Airport and Seaport
- Utilities – Energy, Pipelines & Telecommunications, Stormwater and Wastewater
- Shorelines – Natural Shorelines, Structural Shorelines and Parks and Recreation Areas

Key vulnerabilities were identified for these broader categories and this formed the basis of subregional scale adaptation responses.

## Key Vulnerability

The ART subregional adaptation responses start with a key vulnerability that had been classified using the system developed by the ART project to characterize and communicate vulnerabilities and risks[1]. The vulnerability classifications – information, management, physical and functional – classifications make it easier to identify specific and appropriate actions, the potential actors to be involved, and the processes and scales at which to implement the actions.

For example, "information vulnerabilities" describe assets and issues where a lack of information or inadequate access to information makes it difficult to assess the problem and develop an appropriate response. Information vulnerabilities that were identified during the ART assessment include a lack of information on the condition of shoreline protection; difficulty in obtaining access to information regarding the elevations and condition of ground transportation; and a lack of analysis and data on how ground water will be affected by rising sea levels. These kinds of vulnerabilities are more economically and effectively

[1] See Chapter 3 of the ART Vulnerability and Risk Assessment Report for a description of the classification system (*www.adaptingtorisingtides.org/vulnerability-and-risk-report/*).

addressed through evaluations or assessments conducted at a regional or system-wide scales. Informational vulnerabilities are often the necessary first step before more refined assessments can be conducted or actions prioritized and implemented.

Understanding the type of vulnerability can more quickly lead to a targeted and appropriate response to resolve the real issues faced, avoiding potentially costly and unnecessary actions.

# Action

Each action in the adaptation responses is described and identified by action types[2] - evaluation, policy development, coordination, program/operation, and education/outreach. These action types communicate the activities and processes required, and provide a means to identify actions requiring similar kind of efforts.

# Implementation Options, Possible

The adaptation responses include implementation options that highlight the potential actors –the agencies, organizations, individuals or groups – who should be involved and the processes into which the actions could be integrated.

## Possible Actors in the ART Subregion

Possible actors are identifies in the ART subregional adaptation responses that will likely be involved in action initiation and administration. Actors include those that are likely to lead action implementation (often asset owners or operators), as well as potential decision-making or funding partners, regulatory or permitting agencies, non-profit and community organizations, the private sector, landowners, and the owners and operators of adjacent properties or interconnected infrastructure.

Not all of the actors identified will either choose or need to be engaged in implementation. In other cases, the list of possible actors is not comprehensive and it will be necessary to seek a broad range of participation from all levels of governance[3] – from the private sector, to community organizations, to surrounding neighborhoods, organizations and agencies, as well as others with adjacent or interconnected assets.

| Acronym | Full Name |
|---|---|
| ACEH | Alameda County Environmental Health |
| ACFCWCD | Alameda County Flood Control & Water Conservation District |
| ACPHD | Alameda County Public Health Department |
| AT&T | American Telephone and Telegraph Company |
| ABAG | Association of Bay Area Governments |
| BAAQMD | Bay Area Air Quality Management District |
| BART | Bay Area Rapid Transit |

[2] Action Type was adapted from the Association of Bay Area Government's (ABAG) Regional Resilience Initiative Action Plan, available at http://quake.abag.ca.gov/resilience_initiative/.

[3] For information on issues regarding governance and adaptation, see the *Adapting Governance to Rising Tides Issue Paper* available at http://www.adaptingtorisingtides.org/governance/.

| | |
|---|---|
| Caltrans | California Department of Transportation |
| CalEMA | California Emergency Management Agency |
| CPUC | California Public Utilities Commission |
| CTC | California Transportation Commission |
| CCJPA | Capital Corridor Joint Powers Authority |
| CUPA | Certified Unified Program Agency |
| CBO | Community Based Organization |
| CMA | Congestion Management Agency |
| CDPH | California Department of Public Health |
| DBW | Department of Boating and Waterways |
| DFW | Department of Fish and Wildlife |
| DPW | Department of public works |
| DTSC | Department of Toxic Substances Control |
| DWR | Department of Water Resources |
| EBDA | East Bay Dischargers Authority |
| EBMUD | East Bay Municipal Utility District |
| FAA | Federal Aviation Administration |
| FEMA | Federal Emergency Management Agency |
| FERC | Federal Energy Regulatory Commission |
| FHWA | Federal Highway Administration |
| FRA | Federal Railroad Administration |
| FTA | Federal Transit Administration |
| HARD | Hayward Area Recreation and Park District |
| JPC | Joint Policy Committee |
| MTC | Metropolitan Transportation Commission |
| NOAA | National Oceanic and Atmospheric Administration |
| NPO | Non Profit Organization |
| OPR | Office of Planning and Research |
| OLSD | Oro Loma Sanitary District |
| PG&E | Pacific Gas & Electric |
| PHMSA | Pipeline and Hazardous Materials Safety Administration |
| RAPC | Regional Airport Planning Committee |
| RASPA | Regional Airport Systems Planning Analysis |
| RDA | Regional Development Agency |
| RWQCB | Regional Water Quality Control Board |
| BCDC | San Francisco Bay Conservation and Development Commission |
| SFBRA | San Francisco Bay Restoration Authority |
| SFEP | San Francisco Estuary Partnership |
| SWRCB | State Water Resources Control Board |
| UP | Union Pacific Railroad |
| USD | Union Sanitary District |
| USEPA | United States Environmental Protection Agency |
| USFWS | United States Fish and Wildlife Service |
| USGS | United States Geological Survey |
| USACE | US Army Corps of Engineers |
| DOT | US Department of Transportation |
| WETA | Water Emergency Transportation Authority |

## Possible Processes

For the ART subregional adaptation responses, the possible planning mechanisms, governance structures or collaborative approaches that could be used to implement adaptation actions were grouped into eight broad categories. These include most of mechanisms, structures and approaches that agencies, organizations and stakeholders in the ART subregion currently use, as well as a new initiative category that indicates the possible need for changes to existing laws and policies, other organizational shifts, or a need for new funding sources.

| Capital Planning | Project Planning and Design |
|---|---|
| Capital improvement plans<br>Caltrans Project in Development (PID) | Private and public development projects<br>Restoration project planning and permits |
| **Codes and Standards** | **Long-Range Planning** |
| Building codes and standards<br>City ordinances<br>Construction codes<br>Design standards<br>State and federal standards<br>Other standards, e.g., professional organizations or committees | Agency or facility master plan<br>Climate Action Plan<br>Community-based planning<br>Regional Airport Sustainability Plan (RASP)<br>Regional Transportation Plan (RTP)<br>Sustainable Communities Strategy (SCC)<br>Integrated Water Resource Management Plan (IRWMP) |
| **Emergency and Hazard Planning** | **Land-Use Planning** |
| State or local hazard mitigation plans<br>Emergency response and recovery plans<br>Standardized Emergency Management Systems (SEMS)<br>National Incident Management System | General plan<br>Specific plan<br>Land use plan |
| **Operations** | **New Initiatives** |
| Annual budgeting<br>Continuity of Operations Plans (COOP)<br>State Highway Operation and Protection Program (SHOPP) | Partnerships and collaborations<br>Ballot measures<br>Legislation |

# Action Implementation

Actions are also characterized according to potential priority, phasing, and scale of action implementation. Four of the action characterizations – Unlocking, Do It Yourself, Multi-Benefit, and Long Lead Time – indicate the potential timing or priority of action initiation, while one – Scale – indicates the possible geographic scales at which an action could be implemented.

| Action Characterization | Description |
|---|---|
| Unlocking | Actions that can enable other actions. Some unlocking actions contribute independently to resilience, while others serve primarily as stepping stones to other actions. Unlocking actions are generally high priority for implementation as they are often the foundation on which many other actions depend. However, depending on the vulnerability the action addresses and the potential magnitude of the consequences, not all unlocking actions will be taken first as other actions may be higher priority or provide multiple benefits and therefore would be easier to gain support and funding for. |
| Do it Yourself (DIY) | Actions that an asset owner or operator could take on independently without the formation of new partnerships or collaborations. DIY does not imply a 'go it alone' approach, as owners and operator will need to comply with existing regulations and it may be beneficial to seek participation from other entities. DIY does indicate the actions that can be taken without changes to existing regulations, possibly using existing funding streams or operational processes such as regular maintenance or upgrades tied to asset lifecycle |
| Multi-benefit | Actions that will improve asset performance or provide community benefits beyond improving the resilience to climate change. These benefits may including addressing other hazards such as earthquakes, improving the local quality of life, for example through new recreational opportunities, or encouraging the local economy. Investments in actions that provide multiple benefits that in near term can improve sustainability and help to address address existing challenges. |
| Long Lead Time | Actions that should be implemented early as they generally require the coordination of many partners, will result in formal agreements, joint planning or funding decisions, require difficult decision making or are controversial, include a number of different assets, or require collaborative regional planning or research. |
| Scale | Indicates the geographic scale at which an action could be carried out. Local actions are those that would be taken at the city or county level; regional actions across the entire nine county Bay Area by the agencies, organizations or entities that operate at this scale; state actions by state agencies or state-wide organizations or entities; or at the federal level by national agencies or partners |

The elements of each adaptation response are presented together in the **ART Subregional Adaptation Response Cards**, organized according to the five broader categories. A **Guide** that explains each element presented on the adaptation response cards follows

# The ART Subregional Adaptation Responses

## Guide to the Adaptation Response Cards

Vulnerability Classification: Indicates whether the vulnerability is related to lack of information, management control challenges, physical qualities or functional qualities.

**Vulnerability:** A brief description of the subregional vulnerability addressed in the adaptation response. Vulnerabilities are numbered for navigation only and number does not indicate priority.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| Actions are numbered to assist with navigation. They do not to indicate ranking or priority. For actions that can be taken sequentially the numbers indicate that order. | The action or actions to address the identified vulnerability. Some responses include a series of related actions that could or should be taken together. | The type of action, categorized into one of five general themes. | The mechanism(s) through which the action could be implemented. Some processes are existing and possibly ongoing, while others will be new initiatives. There can be more than one process by which to implement any given action. | Agencies and organizations that could be involved in implementing the action. Actors include lead agencies (often asset owners or operators), as well as regulators, funders, and other potential partners. | Guidance for selecting and prioritizing actions. |

### Action Types

- Evaluation – actions to improve data and information or conduct new analyses
- Program/Operation – actions to update plans, procedures or management activities
- Policy development – actions to develop or revise policies and guidelines
- Coordination – actions to initiate or expand partnerships
- Education/ outreach – actions to communicate information and build awareness

### Processes

- Long–range planning, e.g., master plan, climate action plan
- Land use planning, e.g., general plan, specific plan
- Capital planning, e.g., capital improvement plan
- Operations, e.g., annual budgeting
- Codes and Standards, e.g., city ordinance, design standards
- Emergency & hazard planning e.g., hazard mitigation plans
- Project planning & design, e.g., private and public development projects
- New Initiatives e.g., legislation, ballot measure

### Action Characterization

- Local, Regional, State, Federal: scale(s) of implementation
- Unlocking: enables other actions
- Do it Yourself: land owner or manager could implement within existing laws and policies and with existing funding sources
- Multi-Benefit: confers benefits beyond sea level rise and storm event resilience
- Long Lead Time: Urgent due to long implementation timeframe, near-term impacts, complex planning process, or large number of actors

Information Vulnerability

**Vulnerability O1:** Information about the effects of sea level rise on groundwater levels and salinity intrusion is insufficient for assessing vulnerability and risk, supporting identification of priority issues, and developing adaptation responses.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **O1.1** | Coordinate with local, regional, state, and federal agencies, academic researchers, and the private sector to improve the region's understanding of how sea level rise will affect groundwater levels | Evaluation, Coordination | Long-range Planning, New Initiative | USGS, FEMA, NOAA, USACE, RWQCB, ABAG, Regional Agencies, DTSC, Cities, County, Water Districts, Academic Institutions, Private Sector | Unlocking, Multi-benefit, Regional, Long Lead Time |
| **O1.2** | Develop a collaborative monitoring program to measure groundwater levels and salinity intrusion through cost-sharing or other agreements, and make the data publically available through a centralized database | Evaluation, Coordination | Long-range Planning, Operations, New Initiative | USGS, FEMA, NOAA, USACE, RWQCB, ABAG, DTSC, Cities, County, Water Districts, Private Sector | Unlocking, Multi-benefit, Regional, Long Lead Time |

Information Vulnerability

**Vulnerability O2:** There is limited availability of and access to regionally relevant, current and historic weather data needed to understand flood risk.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **O2.1** | Develop agreements with state and federal agencies to make historic weather observations easily accessible, improve collection of current weather and water condition data, and provide summarized weather data through a centralized coordinated database | Coordination | New Initiative | NOAA, USGS, USACE, FEMA, DWR, BCDC, SCC, RWQCB | Multi-benefit, Unlocking, Regional, State, Long Lead Time |

Information Vulnerability

**Vulnerability O3:** Flood risk maps rely on historic flooding to determine coastal hazard zones and do not factor in sea level rise. Additionally, many communities do not have access to recent coastal hazard (100-year flood) maps or the underlying data that could support shoreline adaptation planning.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **O3.1** | Engage federal agencies including FEMA, NOAA and USGS in a regional coordination effort to ensure the timely update of flood maps and access to data, studies, and models to help the region better understand future risks as sea level rises | Coordination | Long-range Planning, New Initiative | NOAA, USGS, USACE, FEMA, OPR, DWR, ABAG, BCDC, SCC, RWQCB, Cities, County, Flood Control Districts | Unlocking, Multi-benefit, Regional, Long Lead Time |

Information Vulnerability

**Vulnerability O4:** There is a limited understanding of how dynamic baylands habitats such as tidal marshes, intertidal mudflats, and subtidal areas will respond to accelerating sea level rise, or how these habitats will be affected by shoreline adaptation responses (e.g., structural solutions such as levees) that may change tide, wave or sediment conditions.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **O4.1** | Establish and support a regional research agenda to advance the understanding of how baylands will respond to accelerating sea level rise in light of declining sediment supply and limited space to migrate inland | Evaluation, Coordination | Long-range Planning, New Initiative | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, City, County, CBOs, Private Sector, SFBRA | Unlocking, Regional, Long Lead Time |
| **O4.2** | Research and test restoration and management actions that will improve baylands resilience | Evaluation | Project Planning and Design | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, City, County, CBOs, Private Sector, SFBRA | Unlocking, Regional, Long Lead Time |
| **O4.3** | Develop and implement a Regional Sediment Management Plan for the Bay | Coordination, Policy Development | Long-range Planning, New Initiative | CSMW, BCDC, USEPA, USACE, RWQCB, LTMS stakeholders, USFWS, NOAA, City DPW, Flood Control Agencies, Private Sector | Unlocking, Multi-benefit, Regional, Long Lead Time |

Information Vulnerability

**Vulnerability O4 (continued):** There is a limited understanding of how dynamic baylands habitats such as tidal marshes, intertidal mudflats, and subtidal areas will respond to accelerating sea level rise, or how these habitats will be affected by shoreline adaptation responses (e.g., structural solutions such as levees) that may change tide, wave or sediment conditions.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **O4.4** | Develop a decision-making framework for selecting resilient, multi-objective shoreline adaptation responses given economic, environmental and social equity trade-offs | Policy Development | New Initiative | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, City, County, CBOs, Private sector, SFBRA | Unlocking, Regional, Long Lead Time |

Information Vulnerability

**Vulnerability O5:** Proactive management of baylands to improve their resilience to sea level rise and storm events involves confronting regulatory requirements related to state and federal threatened, endangered, and special status species. Maintenance, upgrade, repair and restoration of baylands require review and authorization from multiple state and federal agencies, often with limited work windows and restrictions on the type of actions that can be taken.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **O5.1** | Research the potential benefits or conflicts of various types of potential baylands adaptation responses to better quantify potential impacts to habitat values and ecosystem services in the short and long term and at the local and regional scale | Evaluation | New Initiative | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, City, County, CBOs, Private Sector, SFBRA | Unlocking, Regional, Long Lead Time |

Management Control Vulnerability

**Vulnerability O6:** Capital investment planning, design, and funding for new infrastructure or for substantial repairs and improvements to existing infrastructure do not consider sea level rise impacts. Infrastructure designed to remain in place for longer spans of time and that is not built or rebuilt to be resilient to flooding and salt-water exposure will need to be protected or retrofitted long before the end of the expected life of the infrastructure. Resources to maintain or improve existing infrastructure are limited, and investments needed in the future to address sea level rise will affect financial resources, economic opportunities, and communities.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **O6.1** | Develop policies or incentives to require or encourage the consideration of sea level rise and storm events in developing, planning, and funding capital investments | Policy Development | Long-range Planning, Land Use Planning, Capital Planning, Codes and Standards | DWR, BCDC, ABAG, MTC, CPUC, Caltrans, CMAs, County, Cities | Do It Yourself, Unlocking, Local, Regional, State |
| **O6.2** | Prioritize capital investments and new infrastructure in low-risk areas; in particular, plan and construct new public infrastructure in areas not projected to be at risk of sea level rise or storm events | Policy Development, Program/Operation | Long-range Planning, Land Use Planning, Capital Planning | DWR, BCDC, ABAG, MTC, CPUC, Caltrans, CMAs, County, Cities | Do It Yourself, Local, Regional, State |
| **O6.3** | Develop a decision-making framework for determining if substantial repairs or improvements to protect existing infrastructure from sea level and groundwater rise should be made, or if it should be located or relocated in an area not at risk | Policy Development | Long-range Planning, Capital Planning, New Initiative | DWR, BCDC, ABAG, MTC, CPUC, Caltrans, CMAs, County, Cities | Do It Yourself, Unlocking, Local, Regional, State, Long Lead Time |

Management Control Vulnerability

**Vulnerability O7:** Many of the plans, policies, and practices that guide community development, land use planning, emergency planning, and capital investments do not consider sea level rise or the adaptation responses that will be necessary to reduce the vulnerabilities and risks to both natural and built environments associated with sea level rise.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **O7.1** | Qualify for and maintain the highest feasible rating under the Community Rating System of the National Flood Insurance Program to reduce flood risks and the cost of private property insurance | Policy Development, Program/Operation | Emergency and Hazard Planning | ABAG, FEMA, CalOES, Cities, County | Do It Yourself, Local |
| **O7.2** | Prepare, adopt, implement, and update comprehensive recovery plans to direct how and where state or federal disaster recovery funds are used to rebuild resilient communities after storm events | Policy Development | Emergency and Hazard Planning | ABAG, FEMA, CalOES, Cities, County | Do It Yourself, Multi-benefit, Local, Regional, State, Long Lead Time |
| **O7.3** | Require the consideration of sea level rise in land use plans and project designs, e.g., General Plan Safety Elements | Policy Development | Land Use Planning, Codes and Standards | Cities, Counties, OPR | Do It Yourself, Unlocking, Local, Regional, State |
| **O7.4** | Evaluate the feasibility of applying adaptive management to Land Use Planning and decision making | Evaluation | New Initiative | BCDC, ABAG, MTC, OPR | Regional, State |

Management Control Vulnerability

**Vulnerability O7 (continued):** Many of the plans, policies, and practices that guide community development, land use planning, emergency planning, and capital investments do not consider sea level rise or the adaptation responses that will be necessary to reduce the vulnerabilities and risks to both natural and built environments associated with sea level rise.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **O7.5** | Improve coordination among agencies to ensure consistent regulatory and planning approaches to sea level rise adaptation, and to reduce programmatic or legislative barriers to assessing and addressing future risks | Coordination, Policy Development | Long-range Planning | BCDC, ABAG, MTC, Cities, County | Unlocking, Regional, Long Lead Time |
| **O7.6** | Develop incentives for clustered development in low-risk areas using density bonuses, reduced impact fees, tax incentives and streamlined permitting | Policy Development | Long-range Planning, Land Use Planning | BCDC, ABAG, MTC, OPR, Cities, County, California Natural Resources Agency | Do It Yourself, Local, Regional, State |
| **O7.7** | Create a voluntary transfer of development rights program to allow property owners to sell development rights in high-risk areas in exchange for rights in a low-risk areas | Policy Development | Land Use Planning, Codes and Standards | Cities, County, State | Do It Yourself, Local, Regional, State |
| **O7.8** | Use rolling easements to establish a boundary that moves inward as sea level rises along the Bay shoreline | Policy Development | Long-range Planning, Land Use Planning, Legislation | Cities, County, Special Districts, State | Do It Yourself, Local, Regional, State |

Management Control Vulnerability

**Vulnerability O8:** Non-profit, faith, and community-based organizations play a critical role in building and maintaining community resilience. Many of these organizations do not have the capacity to fully participate in climate planning efforts. Government agencies and organizations also lack the capacity and processes to engage non-governmental organizations in planning and decision-making to ensure the robust, sustained partnerships that will be necessary to address climate change in an equitable, environmentally conscientious, and economically feasible manner.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **O8.1** | Conduct community-led campaigns to build public support for community groups and leaders to participate in collaborative efforts to address current and future climate stressors, including sea level rise and storm events | Education/ Outreach | Long-range Planning, New Initiative | BCDC, ABAG, MTC, BAAQMD, Cities, Counties, NPOs, CBOs, CDPH | Unlocking, Local, Regional |
| **O8.2** | Work with decision-makers to provide public funds for community groups to participate in local climate resilience building efforts, for example in developing and implementing local climate adaptation plans or conducting public education on local climate impacts and emergency response in multiple languages | Policy Development | New Initiative | BCDC, ABAG, MTC, BAAQMD, Cities, Counties, NPOs, CBOs, CDPH, State, Federal | Unlocking, Regional, State, Federal, Long Lead Time |
| **O8.3** | Create and implement a framework that government agencies, organizations and community partners can use to engage in open, transparent, and well publicized planning and decision making processes | Education/ Outreach, Program/ Operation | New Initiative | BCDC, ABAG, MTC, BAAQMD, Cities, Counties, NPOs, CBOs, CDPH | Multi-benefit, Local, Regional, Long Lead Time |

Functional Vulnerability

**Vulnerability O9:** Proper functioning of utilities, which themselves are vulnerable to sea level rise and storm events, is essential for communities to effectively respond during a disaster, and for communities, businesses, the airport, seaport, parks and recreation areas, and natural shorelines to function on a day-to-day basis.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **O9.1** | Reduce downstream flood risk and stress on stormwater and flood control systems by minimizing runoff volumes and peak flow rates from new developments and substantial redevelopments using site-specific low impact design (LID) and source control techniques | Policy Development | Land Use Planning, Codes and Standards | Cities, County, RWQCB, SFEP | Do It Yourself, Multi-benefit, Local, Regional |
| **O9.2** | Avoid new development and substantial redevelopments that will require expanding the capacity of utilities and infrastructure in areas at risk | Policy Development | Land Use Planning, Codes and Standards | Cities, County, RWQCB, CPUC, City DPW, ACFCWCD | Local, Regional |

Functional Vulnerability

**Vulnerability O10:** Some assets along the Bay shoreline function as a continuous corridor, or as a series of linked segments, and impacts to one segment of the Bay shoreline can compromise the function of the other segments. This is especially true of the system of natural and structural shorelines along the Bay edge; energy, gas, and pipelines infrastructure; and for long, linear ground transportation assets such as the Bay Trail and the regional rail network.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **O10.1** | Conduct a regional evaluation of transportation and utility networks that are vulnerable to sea level rise to determine hot spots or weak links that would cause significant disruption to the regional economy and quality of life | Evaluation | Long-range Planning, Operations, Capital Planning | Caltrans, BART, CCJPA, UP, PG&E, Kinder Morgan, EBMUD, EBDA, Cities, County, MTC, Private Sector, Regional Agencies | Do It Yourself, Unlocking, Regional |
| **O10.2** | Conduct a regional evaluation of structural shorelines and determine how they are connected/interconnected to natural shorelines in providing flood risk reduction benefits | Evaluation | New Initiative | Cities, County, USACE, EBRPD, HARD, ABAG (Bay Trail), DFW, USFWS, BCDC, City DPW, ACFCWCD, SCC, Regional Agencies | Unlocking, Regional |

Physical Vulnerability

**Vulnerability O11:** Changes in groundwater levels due to sea level rise may increase the risk of liquefaction during an earthquake. Residences, utilities and other infrastructures that are not designed for these conditions are likely to be damaged during an earthquake. Long, linear infrastructure such as utility pipelines, surface roads, and rail lines are highly susceptible to damage during earthquakes, particularly due to liquefaction. Much of the airport is built on Bay fill, which has a high liquefaction potential. During an earthquake, liquefaction could cause damage to runways and other infrastructure, and could cause the perimeter levee to fail.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **O11.1** | Conduct a regional study on the impacts of rising sea level on groundwater elevations, and on the potential for increased liquefaction potential | Evaluation | New Initiative | USGS, FEMA, NOAA, USACE, RWQCB, Regional Agencies, ABAG, DTSC, Cities, County, Water Districts, MTC, Caltrans, BCDC, Private Sector | Unlocking, Multi-benefit, Regional |
| **O11.2** | Conduct vulnerability assessments of critical infrastructure and land uses in areas exposed to sea level rise and liquefaction to identify strategies that can improve resilience to both hazards | Evaluation | Long-range Planning, New Initiative | ABAG, Caltrans, MTC, BCDC, ABAG, Special Districts, Cities, County, Private Sector | Do It Yourself, Unlocking, Multi-benefit, Local, Regional |

Physical Vulnerability

**Vulnerability O12:** Public health, safety, and welfare are at risk from sea level rise and storm events, particularly where the land uses are predominately residential, e.g., single-family, multi-family, and senior housing. These communities were developed in a manner that makes protecting them from future flood risks extremely challenging. It is likely that planning for future growth in the region will follow this past pattern without consideration of future flooding, increasing the number of people at risk.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **O12.1** | Initiate a regional collaboration to discuss and analyze approaches to improve the resilience of current vulnerable communities and how to plan future growth to avoid placing more of the region's population at risk | Evaluation, Coordination | New Initiative | Local, Regional, State, Federal, Private sector, NPOs, CBOs | Unlocking, Regional, Long Lead Time |
| **O12.2** | Improve regional coordination on policies targeted at improving Bay Area resilience to climate change | Coordination | Long-range Planning, New Initiative | JPC Agencies | Unlocking, Regional, Long Lead Time |

Information Vulnerability

**Vulnerability C1:** Up-to-date information regarding the characteristics of communities, including the locations and specific needs of certain populations, is generally not available or easily accessible when needed for emergency response. Collecting and maintaining this type of information requires coordination with non-profit, community, and faith based groups to ensure accuracy of information and to provide a trusted partner to help communities understand the importance of these efforts.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C1.1** | Develop and maintain a centralized database of non-profit, community, and faith-based organizations, equipment and service providers, and others that can communicate with communities at risk | Program/operation | Emergency and Hazard Planning, New Initiative | Cities, County, ACPHD, NPOs, CBOs, Private Sector | Unlocking, Multi-benefit, Local |
| **C1.2** | Develop and maintain a voluntary database that includes specific needs within each community related to emergency response | Program/operation | Emergency and Hazard Planning, New Initiative | Cities, County, ACPHD, NPOs, CBOs, Private Sector | Unlocking, Multi-benefit, Local |
| **C1.3** | Develop and maintain an emergency communication protocol for city, county, regional, and state agencies; local, community and faith-based organizations; and facilities that serve communities and that can be activated during a flood or storm event | Program/operation | Emergency and Hazard Planning, New Initiative | CalOES, FEMA, ABAG, Cities, County, ACPHD, NPOs, CBOs, Private Sector | Multi-benefit, Local, Regional, State |

Information Vulnerability

**Vulnerability C2:** There is a lack of centrally coordinated information systems for contaminated lands and hazardous material sites, which is needed for effective emergency and adaptation planning and for setting remediation, monitoring, and enforcement priorities to reduce risks.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C2.1** | Review existing information systems to identify gaps in completeness, quality, and accessibility, and to determine if they contain the information needed to plan for emergencies, sea level rise, storm events, and elevated groundwater levels | Evaluation | New Initiative | DTSC, RWQCB, CUPAs, USEPA, ACEH | Do It Yourself, Unlocking, Multi-benefit, Local, Regional |
| **C2.2** | Coordinate the information in existing data repositories using cross-referencing or geo-referencing | Coordination, Program/operation | New Initiative | DTSC, RWQCB, CUPAs, USEPA, ACEH | Multi-benefit, Local, Regional |
| **C2.3** | Establish agreements among agencies and organizations that regulate or manage contaminated lands and hazardous material sites to use consistent data collection, management, and sharing methods | Policy Development | New Initiative | DTSC, RWQCB, CUPAs, USEPA, ACEH | Multi-benefit, Local, Regional, State, Long Lead Time |
| **C2.4** | Develop and keep current a centralized information system that has key emergency and adaptation planning information about contaminated lands and hazardous materials sites | Program/operation | New Initiative | DTSC, RWQCB, CUPAs, USEPA, ACEH | Multi-benefit, Local, Regional, Long Lead Time |

Management Control Vulnerability

**Vulnerability C3:** There are no effective regulatory or financing mechanisms to prioritize the remediation of contaminated lands that will be affected by sea level rise. Additionally, these sites may not provide the most appropriate redevelopment opportunities, further diminishing any incentive to conduct cleanup activities.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C3.1** | Conduct studies of contaminated lands to gather critical information needed to assess vulnerability and risk from sea level rise, storm events, and elevated groundwater | Evaluation | New Initiative | DTSC, RWQCB, USEPA, ACEH, Cities, County, Private Sector | Do It Yourself, Unlocking, Local, Regional |
| **C3.2** | Address potential increased risks due to sea level rise, storm events, and elevated groundwater in designing, funding, and permitting new remediation efforts | Policy Development, Program/operation | Codes and Standards, Project Planning and Design | DTSC, RWQCB, USEPA, ACEH, Cities, County, Private Sector | Do It Yourself, Local, Regional |
| **C3.3** | Prioritize the remediation of contaminated sites based on the timing of exposure to sea level rise, storm events, and elevated groundwater, degree of vulnerability, and extent of the consequences | Policy Development, Program/operation | Long-range Planning, Codes and Standards, New Initiative | DTSC, RWQCB, USEPA, ACEH, Cities, County, Private Sector | Do It Yourself, Local, Regional |

Management Control Vulnerability

**Vulnerability C4:** Neighborhoods are informal networks whose function depends on the relationship among the individuals and services within them. These informal connections are easily severed during disasters and are often difficult to rebuild once disrupted. Neighborhoods without a strong social network, where residents do not know each other, or are not invested in the overall community good, are especially vulnerable to sea level rise and storm events.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C4.1** | Provide expanded Community Emergency Response Team (CERT) trainings, refresher classes, and annual exercises that include flooding preparedness and response | Education/outreach | Emergency and Hazard Planning | ABAG, CalOES, FEMA, Cities, County, ACPHD, CBOs, NPOs | Multi-benefit, Local, Regional |
| **C4.2** | Coordinate with non-profit, community, and faith-based organizations to build strong social networks in neighborhoods, in particular those with certain characteristics such as less mobile or medically dependent residents | Coordination | Emergency and Hazard Planning, New Initiative | CalOES, FEMA, Cities, County, ACPHD, CBOs, NPOs, Private Sector | Multi-benefit, Local |
| **C4.3** | Provide technical assistance to neighborhoods to support the development and maintenance of disaster plans, including storm evacuation procedures and shelter-in-place guidelines | Education/outreach, Program/operation | Emergency and Hazard Planning | ABAG, CalOES, FEMA, Cities, County, ACPHD | Multi-benefit, Local |

Management Control Vulnerability

**Vulnerability C4 (continued):** Neighborhoods are informal networks whose function depends on the relationship among the individuals and services within them. These informal connections are easily severed during disasters and are often difficult to rebuild once disrupted. Neighborhoods without a strong social network, where residents do not know each other, or are not invested in the overall community good, are especially vulnerable to sea level rise and storm events.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C4.4** | Develop and support neighborhood and community-based response centers to distribute information and supplies after a disaster | Education/outreach, Program/operation | Emergency and Hazard Planning | CalOES, FEMA, Cities, County, ACPHD, CBOs, NPOs, Private Sector | Multi-benefit, Local, Regional |
| **C4.5** | Develop a "Maintain-a-Drain" program that encourages neighborhoods to keep storm drains free of debris, reducing potential flood risks | Education/outreach, Program/operation | Long-range Planning, New Initiative | City DPW, ACFCD, ACPHD, ACEH, CBOs, RWQCD, Private Sector | Do It Yourself, Multi-benefit, Local |

Management Control Vulnerability

**Vulnerability C5:** Certain populations within the subregion are especially vulnerable to sea level rise and storm events. These include young children, the elderly, people with mobility or medical needs, people without automobiles, renters, people without insurance, the linguistically isolated, people at or below poverty level and caretakers of young children, the elderly and animals.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C5.1** | At community or neighborhood-scales, assess how sea level rise and storm events will affect vulnerable populations | Evaluation | Long-range Planning, New Initiative | ABAG, BCDC, MTC, Cities, County, CBOs, NPOs | Do It Yourself, Unlocking, Local |
| **C5.2** | Through a multi-agency effort, develop policies or guidance on improving resilience to sea level rise through appropriate community development, land use and infrastructure planning, and project design | Coordination, Policy Development | Long-range Planning, New Initiative | ABAG, BCDC, MTC, Cities, County, CBOs, NPOs | Local, Regional, Long Lead Time |
| **C5.3** | Identify and research critical gaps in information needed by decision-makers to understand and respond to the needs of all of those in their communities, including the level of financial and technical assistance needed to minimize impacts from job loss and potential relocation | Evaluation | Long-range Planning, Land Use Planning | ABAG, BCDC, MTC, ACPHD, Cities, County, CBOs, NPOs, Private Sector | Unlocking, Local, Regional |

Management Control Vulnerability

**Vulnerability C5 (continued):** Certain populations within the subregion are especially vulnerable to sea level rise and storm events. These include young children, the elderly, people with mobility or medical needs, people without automobiles, renters, people without insurance, the linguistically isolated, people at or below poverty level and caretakers of young children, the elderly and animals.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C5.4** | Develop community-led education and outreach campaigns designed for specific local populations on the risks of sea level rise and storm events | Education/outreach | Long-range Planning, Land Use Planning, Emergency and Hazard Planning | ABAG, BCDC, MTC, ACPHD, Cities, County, CBOs, NPOs | Do It Yourself, Multi-benefit, Local |
| **C5.5** | Identify the specific needs and characteristics of the community being served and, if necessary, revise emergency response policies, procedures, and trainings, including strategies for managing those needs such as providing specialized equipment or evacuation procedures, e.g., for those that care for animals (shelters, zoos, pet owners) | Policy Development, Program/operation | Long-range Planning, Land Use Planning, Emergency and Hazard Planning | ABAG, BCDC, MTC, ACPHD, Cities, County, CBOs, NPOs, Private Sector | Do It Yourself, Multi-benefit, Local, Regional |

Management Control Vulnerability

**Vulnerability C6:** Planning and resources are inadequate to address contingencies and secondary impacts associated with widespread or long-lasting sea level rise or storm event impacts, especially if residential neighborhoods, elder care facilities, or similar land uses are affected. In addition, out-of-date emergency plans, lack of compliance with existing plans, and poor coordination among local, regional, and state authorities increases vulnerability of populations, facilities, and services.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C6.1** | Review and update emergency plans to address sea level rise and storm event contingencies and secondary impacts that are broad-scale (e.g., county or Bay Area-wide) and/or severe (e.g., long-lasting and/or deep inundation) | Program/operation | Emergency and Hazard Planning | ABAG, BCDC, MTC, CalOES, FEMA, ACPHD, Cities, County, CBOs, NPOs, Private Sector | Do It Yourself, Local, Regional |
| **C6.2** | Expand or form multi-agency and cross-jurisdictional partnerships (including community-based organizations) to improve the capacity to address the needs of people in the community, particularly those with special mobility, care, or medical needs, during a disaster or emergency | Coordination | Emergency and Hazard Planning, New Initiative | ABAG, BCDC, MTC, ACPHD, Cities, County, CBOs, NPOs, Private Sector | Multi-benefit, Local, Regional, Long Lead Time |
| **C6.3** | Develop and keep current hazard mitigation plans meeting established standards to ensure eligibility for state and federal emergency funds | Program/operation | Emergency and Hazard Planning | ABAG, CalOES, FEMA, Cities, Counties, Special Districts | Do It Yourself, Multi-benefit, Local, Regional |

Management Control Vulnerability

**Vulnerability C6 (continued):** Planning and resources are inadequate to address contingencies and secondary impacts associated with widespread or long-lasting sea level rise or storm event impacts, especially if residential neighborhoods, elder care facilities or similar land uses are affected. In addition, out-of-date emergency plans, lack of compliance with existing plans, and poor coordination among local, regional, and state authorities increases vulnerability of populations, facilities, and services.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C6.4** | Develop contingency plans and procedures to address the need for short-term sheltering and long-term housing for displaced residents, with particular attention to certain populations and those with specific needs such as animal caretakers | Program/operation | Emergency and Hazard Planning | ABAG, CalOES, FEMA, ACPHD, Cities, County, CBOs, NPOs, Private Sector | Do It Yourself, Multi-benefit, Local, Regional |
| **C6.5** | Coordinate emergency plans and information sharing among individual facilities, neighborhoods, Special Districts, utilities, cities, counties and regional and state authorities, including establishing protocols for responding to NOAA weather forecasts (e.g., when to close, shelter-in-place, or evacuate) | Coordination, Program/operation | Emergency and Hazard Planning | ABAG, MTC, ACTC, Caltrans, BART, Port, CCJPA, WETA, UP, CalOES, FEMA, NOAA, Cities, County, Special Districts, Utilities, CBOs, NPOs, Private Sector | Multi-benefit, Local, Regional, State, Long Lead Time |
| **C6.6** | Establish mutual aid agreements and initiate or strengthen joint protocols with adjoining jurisdictions for cooperative disaster response | Coordination, Policy Development | Emergency and Hazard Planning | Cities, Counties, CalOES. FEMA | Do It Yourself, Multi-benefit, Regional |

Management Control Vulnerability

**Vulnerability C6 (continued):** Planning and resources are inadequate to address contingencies and secondary impacts associated with widespread or long-lasting sea level rise or storm event impacts, especially if residential neighborhoods, elder care facilities or similar land uses are affected. In addition, out-of-date emergency plans, lack of compliance with existing plans, and poor coordination among local, regional, and state authorities increases vulnerability of populations, facilities, and services.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C6.7** | Develop and maintain a multi-disciplinary communication interoperability plan to facilitate emergency communications among first responders from different cities, counties, Special Districts, state and federal agencies | Program/operation, Policy Development | Emergency and Hazard Planning | ABAG, MTC, CalOES, FEMA, Cities, County, CBOs, NPOs, Private Sector | Multi-benefit, Local, Regional, State |
| **C6.8** | Work with national organizations, e.g., Humane Society of the United States and the American Humane Association, to develop preparedness, response, and recovery plans for facilities housing animals | Coordination, Program/operation | Emergency and Hazard Planning, New Initiative | ABAG, CalOES, Cities, County, CBOs, NPOs, Private Sector | Do It Yourself, Multi-benefit, Local, Regional |
| **C6.9** | Require facilities that generate, transport, and/or store hazardous materials to consider vulnerability and risks of sea level rise, storm events, and elevated groundwater in emergency plans, facility operations plans, and capital improvement plans | Policy Development, Program/operation | Capital Planning, Operations, Emergency and Hazard Planning | CalOES, DTSC, RWQCB, USEPA, ACEH, Cities, County, Private Sector | Local, Regional, High Priority |

Functional Vulnerability

**Vulnerability C7:** Certain land uses and facility types within the subregion are particularly difficult to protect, evacuate, and rebuild due to the critical functions they serve. These include residences, elder care facilities, hospitals, childcare facilities, schools, and animal shelters.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C7.1** | Evaluate the continued siting of of certain land uses (schools, hospitals, childcare facilities, animal shelters, and residential development) in high risk areas that are difficult or expensive to protect, and in many cases cannot be protected, evacuated, or rebuilt in a manner ensuring public health, safety and welfare | Evaluation | Long-range Planning, Land Use Planning | ABAG, MTC, Cities, County | Unlocking, Local, Regional |
| **C7.2** | Prioritize buyout of properties with certain land uses that are damaged or at high risk of damage from sea level rise or storm events | Program/operation | Emergency and Hazard Planning, Long-range Planning | FEMA, CalOES, Cities, County, Special Districts, Private Sector | Local, Regional, State, Federal |
| **C7.3** | Develop and implement a community outreach process to educate a broad audience including facility owners, asset managers, private business owners, and the general public on the risks, costs, and benefits of hazard reduction strategies in comparison to relocation of vulnerable land uses | Education/outreach | Emergency and Hazard Planning, New Initiative | FEMA, CalOES, ABAG, Cities, County, Special Districts, CBOs, NPOs, Private Sector | Unlocking, Local, Regional |

Functional Vulnerability

**Vulnerability C8:** Community facilities such as hospitals, long-term care facilities, and those that serve at-risk, less mobile or medically dependent populations, are vulnerable since the individuals they serve cannot easily be evacuated or sheltered and require on-site care, specialized equipment, and a high level of coordination.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C8.1** | Develop plans and procedures to obtain or distribute specialized equipment needed to either shelter-in-place or evacuate at-risk, less mobile, or medically dependent populations | Program/operation | Emergency and Hazard Planning | Cities, ACPHD, County, CBOs, NPOs, Private Sector | Do It Yourself, Local |
| **C8.2** | For facilities that provide key community services, develop and communicate to staff, emergency personnel, elected officials, and the public the expected standards for levels of service during and after a storm event | Policy Development, Education/outreach | Emergency and Hazard Planning | Cities, ACPHD, County, CBOs, NPOs | Do It Yourself, Local |
| **C8.3** | Reduce dependency on facilities that provide critical community services that are vulnerable to sea level rise by building alternative facilities or by increasing the capacity of existing facilities in areas not at risk from sea level rise | Policy Development | Long-range Planning, Land Use Planning | Cities, ACPHD, County, CBOs, NPOs | Local, Long Lead Time |

Functional Vulnerability

**Vulnerability C9:** Facilities that provide key community services are vulnerable if they cannot maintain operations, if connections to services such as power, clean water, and safe food supplies are not available, or if they cannot be easily accessed. This is of particular concern for facilities that play a role in emergency response and recovery such as schools, hospitals, shelters, and nursing homes.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C9.1** | Conduct vulnerability and risk assessments of individual facilities that provide key community services and develop site-specific strategies to reduce service disruptions or closures | Program/operations | Long-range Planning, New Initiative | Cities, ACPHD, County, CBOs, NPOs, Private Sector | Do It Yourself, Unlocking, Local |
| **C9.2** | Develop policies or incentives to encourage/require facilities providing key community services to implement changes to facility structures or operations that would reduce potential for disruption or closure due to sea level rise or storm events | Policy Development | Long-range Planning, Land Use Planning, Emergency and Hazard Planning | ABAG, CalOES, FEMA, Cities, ACPHD, County, CBOs, NPOs, Private Sector | Do It Yourself, Local, Regional |
| **C9.3** | Develop policies or incentives to encourage/require access to auxiliary water and power sources, e.g., on-site power generators with sufficient fuel for several days, portable generators, or pre-negotiated rental or leasing agreements for portable sources | Policy Development | Long-range Planning, Land Use Planning, Emergency and Hazard Planning | ABAG, CalOES, FEMA, Cities, ACPHD, County, CBOs, NPOs, Private Sector | Do It Yourself, Multi-benefit, Local, Regional |

Functional Vulnerability

**Vulnerability C9 (continued):** Facilities that provide key community services are vulnerable if they cannot maintain operations, if connections to services such as power, clean water, and safe food supplies are not available, or if they cannot be easily accessed. This is of particular concern for facilities that play a role in emergency response and recovery such as schools, hospitals, shelters, and nursing homes.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C9.4** | Develop policies or incentives to encourage/require emergency response plans and procedures to consider how power, water, and food necessary to maintain the function of key community services during a flood emergency, will be delivered given that many access routes and transportation modes may also be disrupted | Policy Development | Long-range Planning, Land Use Planning, Emergency and Hazard Planning | ABAG, CalOES, FEMA, Cities, ACPHD, County, CBOs, NPOs, Private Sector | Do It Yourself, Multi-benefit, Local, Regional |
| **C9.5** | Develop policies or incentives to encourage/require the establishment of facilities providing key community services in locations that are not at risk of flooding, restrict the development of new key community services in such areas, and relocate existing facilities that are damaged by flooding and need to be substantially rebuilt to areas not at risk | Policy Development | Long-range Planning, Land Use Planning | ABAG, CalOES, FEMA, Cities, ACPHD, County, CBOs, NPOs, Private Sector | Local, Regional, Long Lead Time |

Physical Vulnerability

**Vulnerability C10:** Most residences, employment sites, and community facilities are highly susceptible to damage from sea level and groundwater rise because of their construction methods or materials. When flooding damages these structures, the release of hazardous materials including paints, cleaners, oils, batteries, pesticides, asbestos, and medical waste can occur.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C10.1** | Develop and implement requirements for real estate agents and lessors of residential and commercial properties to disclose the risk of sea level rise | Policy Development | Codes and Standards | Cities, County, CA Department of Insurance, CalOES, FEMA, HUD, NPOs, Private Sector | Local, Regional, State, Federal |
| **C10.2** | Work with building industry to develop and distribute guidelines for reducing damages by designing or retrofitting structures to accommodate saltwater exposure and periodic low levels of flooding | Policy Development | Codes and Standards | Cities, County, FEMA, HUD, NPOs, Private Sector | Unlocking, Local, Regional, State, Federal |
| **C10.3** | Provide incentives or require that structures be retrofitted using waterproof shutters, shields or doors and salt-resistant materials to reduce flood damage, with a particular focus on retrofitting critical community facilities | Program/operation, Policy Development | Codes and Standards, New Initiative | Cities, County, FEMA, HUD, NPOs, Private Sector | Do It Yourself, Local, Regional, State, Federal |

Physical Vulnerability

**Vulnerability C10 (continued):** Most residences, employment sites, and community facilities are highly susceptible to damage from sea level and groundwater rise because of their construction methods or materials. When flooding damages these structures, the release of hazardous materials including paints, cleaners, oils, batteries, pesticides, asbestos, and medical waste can occur.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C10.4** | Provide incentives or require that entrances, windows and foundations be raised above future flood elevations for all new construction or substantial reconstruction in areas likely to be at risk from sea level rise | Program/operation, Policy Development | Codes and Standards, New Initiative | Cities, County, FEMA, HUD, CalOES, NPOs, Private Sector | Do It Yourself, Local, Regional, State, Federal |
| **C10.5** | Provide flood protection assistance to community residents, e.g., technical advice and materials such as sand bags and plastic sheeting, and ensure vulnerable populations have access to these materials at low or no cost | Program/operation | Emergency and Hazard Planning | Cities, County, FEMA, HUD, CalOES, NPOs, Private Sector | Do It Yourself, Local, Regional, State, Federal |
| **C10.6** | Encourage owners of property in floodplains to purchase flood insurance and educate the public that most homeowner insurance policies do not cover a property that is flood damaged | Education/outreach | New Initiative | Cities, County, FEMA, HUD, CalOES, NPOs, Private Sector | Do It Yourself, Local, Regional, State, Federal |

Physical Vulnerability

**Vulnerability C10 (continued):** Most residences, employment sites, and community facilities are highly susceptible to damage from sea level and groundwater rise because of their construction methods or materials. When flooding damages these structures, the release of hazardous materials including paints, cleaners, oils, batteries, pesticides, asbestos, and medical waste can occur.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C10.7** | Participate in and seek to qualify for the highest feasible rating of the Community Rating System of the National Flood Insurance Program to reduce flood risks and private property insurance costs | Program/operation | Land Use Planning, Emergency and Hazard Planning | Cities, County, FEMA | Do It Yourself, Local |
| **C10.8** | Encourage residents and landowners to use hazardous waste disposal and drop off locations to reduce the amount of potentially hazardous materials released during a flood event. | Education/outreach, Program/operation | Land Use Planning, Emergency and Hazard Planning | Cities, County, ACEH, CBOs, NPOs, Private Sector | Do It Yourself, Local |

Physical Vulnerability

**Vulnerability C11:** Sites that generate, treat, store, or transport hazardous materials are particularly vulnerable since flood damage could cause a release of potentially harmful materials.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C11.1** | Require that hazardous materials are stored above projected flood levels or are protected from flood damage | Policy Development | Codes and Standards | DTSC, RWQCB, Cities, County, ACEH, CUPAs, CBOs, NPOs, Private Sector | Do It Yourself, Local, Regional |
| **C11.2** | Enforce compliance with all state hazardous materials requirements | Program/operation | Operations | DTSC, RWQCB, CalOES, Cities, County, ACEH, CUPAs | Local, Regional, State |

Physical Vulnerability

**Vulnerability C12:** Essential mechanical and electrical equipment in buildings are highly water and salt sensitive, and are often located below-grade or on the ground floor.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C12.1** | Monitor groundwater and salinity levels near vulnerable infrastructure by leveraging existing data or collecting site-specific data as necessary | Program/operation | Operations, New Initiative | City, County, Special Districts, Private Sector | Do It Yourself, Unlocking, Local |
| **C12.2** | Increase inspection and maintenance of infrastructure that that is sensitive to water or salt in areas at risk from sea level rise, storm events, or elevated groundwater levels | Program/operation | Operations | City, County, Special Districts, Private Sector | Do It Yourself, Multi-benefit, Local |
| **C12.3** | Review and update standards, codes, and regulations for the construction and placement of new facilities and infrastructure to avoid or address sea level rise, storm events, and elevated groundwater levels | Policy Development | Codes and Standards | City, County, Special Districts, Private Sector | Unlocking, Do It Yourself, Local |
| **C12.4** | Follow existing or develop new standards requiring that waterproof materials be used in the construction of new infrastructure and in the repair or protection of existing infrastructure | Policy Development, Program/operation | Operations, Project Planning and Design, Codes and Standards | City, County, Special Districts, Private Sector | Do It Yourself, Local |
| **C12.5** | Follow existing or develop new standards to ensure corrosion-resistant materials or cathodic coatings are used when installing new or upgrading existing cables and pipelines | Policy Development, Program/operation | Capital Planning, Project Planning and Design, Codes and Standards | City, County, Special Districts, Private Sector | Do It Yourself, Local |

Physical Vulnerability

**Vulnerability C12:** Essential mechanical and electrical equipment in buildings are highly water and salt sensitive, and are often located below-grade or on the ground floor.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C12.6** | Follow existing or develop new standards to ensure sensitive components are elevated above anticipated flood levels | Policy Development, Program/operation | Operations, Project Planning and Design, Codes and Standards | City, County, Special Districts, Private Sector | Do It Yourself, Local |

Physical Vulnerability

**Vulnerability C13:** Structures with habitable space below grade are vulnerable to sea level rise, storm events, and elevated groundwater.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **C13.1** | Develop and implement disclosure requirements for real estate agents and lessors for residential and commercial properties with regard to future flood and groundwater exposure due to sea level rise and the particularly high vulnerability of habitable below-grade space | Policy Development, Program/operation | Codes and Standards | Cities, County, CA Department of Insurance, CalOES, FEMA, HUD, NPOs, Private Sector | Unlocking, Do It Yourself, Local, Regional, State |
| **C13.2** | Evaluate eligibility and rates of required insurance and FEMA flood insurance for structures that have habitable below-grade space in areas likely to be affected by sea level and groundwater rise | Evaluation | New Initiative | Cities, County, CA Department of Insurance, CalOES, FEMA, HUD, NPOs, Private Sector | Unlocking, Local, Regional, State |
| **C13.3** | Create incentives for property owners to repurpose below-grade space to less vulnerable or temporary uses | Program/operation | Codes and Standards | CA Department of Insurance, CalOES, FEMA, HUD, NPOs, Private Sector | Do It Yourself, Local, Regional, State |
| **C13.4** | Prohibit below-grade habitable space in new development that will be exposed to sea level rise, storm events, and elevated groundwater | Policy Development | Land Use Planning, Codes and Standards | Cities, County, CA Department of Insurance, CalOES, FEMA, HUD, Private Sector | Do It Yourself, Local, Regional, State |
| **C13.5** | Develop and enforce policies for repair and reconstruction to eliminate below-grade habitable space that is damaged by sea level and groundwater rise | Policy Development, Program/operation | Codes and Standards | Cities, County, CA Department of Insurance, CalOES, FEMA, HUD | Do It Yourself, Local, Regional, State |

Information Vulnerability

**Vulnerability T1:** There is a lack of detailed, easily accessible, and well-coordinated transportation infrastructure information, which is necessary for vulnerability and risk assessments.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T1.1** | Review existing transportation asset management plans to identify gaps in completeness, quality and accessibility of information most relevant to emergency response, adaptation planning, and federal funding | Evaluation | New Initiative | ABAG, BCDC, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, FTA, FHWA | Do It Yourself, Unlocking, Multi-benefit, Local, Regional |
| **T1.2** | Develop and maintain transportation asset management plans with information on structures, including age, condition, expected useful life, replacement cost, rehabilitation schedule and costs, location, elevation, etc. | Program/operation | New Initiative, Long-range Planning, Capital Planning, Project Planning and Design | MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, FTA, FHWA | Do It Yourself, Multi-benefit, Local, Regional |
| **T1.3** | Adopt data management and sharing agreements among transportation asset managers to ensure that complete and high quality asset information is available and accessible | Policy Development | New Initiative | MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA | Multi-benefit, Regional, State, Federal |

Information Vulnerability

**Vulnerability T1 (continued):** There is a lack of detailed, easily accessible, and well-coordinated transportation infrastructure information, which is necessary for vulnerability and risk assessments.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T1.4** | Develop and maintain a centralized database of key transportation asset information that non-transportation agencies and organizations can use in planning for sea level rise and storm events | Program/operation | New Initiative | ABAG, BCDC, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, CBOs | Multi-benefit, Local, Regional, Long Lead Time |

## Management Control Vulnerability

**Vulnerability T2:** The number and relationships of public agencies and private entities that own and operate transportation assets complicates planning and implementing improvements or use changes. Due to the function and physical characteristics of these assets, numerous agencies and organizations will be affected by the temporary disruption and permanent loss, or adaptation responses for, transportation assets.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T2.1** | Develop multi-agency agreements that result in shared transportation management objectives and identify decision-making and funding responsibilities related to maintenance, repair, or upgrade | Coordination, Policy Development | New Initiative | MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA | Unlocking, Multi-benefit, Local, Regional, Long Lead Time |
| **T2.2** | Expand or form broad public-private partnerships (multi-sector/agency) to guide the planning and implementation of multi-objective transportation improvements and new investments that are resilient to sea level rise and storm events | Coordination | Long-range Planning, New Initiative | ABAG, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, CBOs, Private Sector | Unlocking, Local, Regional |
| **T2.3** | Work with adjacent communities, regions, and states to develop and jointly implement transportation adaptation strategies that address changes in transportation system condition and use due to sea level rise and storm events | Coordination | New Initiative, Emergency and Hazard Planning | ABAG, BCDC, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Adjacent Regions and States | Multi-benefit, Regional, State, Federal, Long Lead Time |

Management Control Vulnerability

**Vulnerability T3:** The capacity to plan for sea level rise and storm event impacts on transportation infrastructure in a timely manner is limited due to the current lack of financing and regulatory mechanisms.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T3.1** | Expand or form multi-agency partnerships to facilitate cost-sharing in planning for multi-objective transportation improvements and new investments that avoid or address sea level rise and storm events | Coordination, Policy Development | Long-range Planning, New Initiative | MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA | Local, Regional, Long Lead Time |
| **T3.2** | Review and update existing policies, procedures, and practices, particularly weather-related planning and management, to support the planning, design, or redesign of transportation assets to reduce vulnerabilities to sea level rise and storm events | Evaluation, Policy Development | Operations, Codes and Standards, Project Planning and Design | MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, FTA, FHWA | Do It Yourself, Local, Regional, State, Federal |
| **T3.3** | Require an evaluation of sea level rise and storm events in planning capital improvements and infrastructure investments, including an evaluation of whether an alternative location or design would reduce future risks and lifecycle costs | Policy Development, Program/operation | Long-range Planning, Codes and Standards, Capital Planning, Project Planning and Design | MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, FTA, FHWA | Do It Yourself, Local, Regional, State, Federal |

Management Control Vulnerability

**Vulnerability T4:** Public agencies and private entities that own or manage transportation assets do not have control over the surrounding land, road, or transit that provide access to their facilities or services, or in some cases provide protection against flooding. Ensuring that access to these facilities remains viable and that current levels of flood protection are maintained will require cooperation that goes beyond the agencies operating the transportation infrastructure. This is of particular importance to regionally and nationally significant infrastructure such as the Oakland International Airport, the Port of Oakland seaport, the interstate system, and lifeline facilities.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T4.1** | Form partnerships among public agencies and private entities to engage in collaborative multi-objective planning to improve the resilience of vulnerable transportation assets, the populations and facilities they serve, and the inland areas they protect as the first line of defense against flooding | Coordination | Long-range Planning, New Initiative | ABAG, BCDC, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, CBOs, Private Sector, USACE, FEMA | Unlocking, Local, Regional, Long Lead Time |
| **T4.2** | Develop a framework for regional transportation planning (particularly transit-oriented development plans) and for the acquisition of easements and access agreements that incorporates sea level rise and storm events | Policy Development | Long-range Planning | ABAG, BCDC, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, CBOs, Private Sector, USACE, FEMA | Unlocking, Regional |

Functional Vulnerability

**Vulnerability T5:** Alternative routes have limited additional capacity to accommodate re-routed commuter traffic (e.g., buses or carpools) or goods movement. If significant roadways or nodes are disrupted, re-routing would result in heavy congestion that could overwhelm the region's roadways and interstates as well as non-motorized transportation corridors (bike and pedestrian).

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T5.1** | Conduct a "hot spot" analysis to identify key routes and nodes critical to traffic flow, assess their vulnerability and risk, and develop actions to improve their resilience to sea level rise and storm events | Evaluation | Long-range Planning, Operations, Emergency and Hazard Planning, New Initiative | ABAG, MTC, Caltrans, AC Transit, County, Cities, CMA | Do It Yourself, Unlocking, Multi-benefit, Local, Regional |
| **T5.2** | Identify and invest in non-motorized transportation corridors (bike and pedestrian) that will provide alternatives if significant roadways and interstates are disrupted | Program/operation | Long-range Planning, Operations, Capital Planning, Emergency and Hazard Planning, Project Planning and Design | ABAG, MTC, Caltrans, AC Transit, County, Cities, CMA | Multi-benefit, Local, Regional |
| **T5.3** | Increase the capacity to accommodate re-routed traffic on alternative routes, or build new routes, in areas not at risk from sea level rise and storm events | Program/operation | Long-range Planning, Capital Planning | MTC, Caltrans, AC Transit, County, Cities, CMA | Local, Regional, Long Lead Time |
| **T5.4** | Develop currently underused, unused, or new pedestrian rights-of-way as non-motorized emergency evacuation alternative routes | Program/operation | Capital Planning, Operations, Codes and Standards, Project Planning and Design, Emergency and Hazard Planning | MTC, Caltrans, AC Transit, County, Cities, CMA | Multi-benefit, Local, Regional |

Functional Vulnerability

**Vulnerability T5 (continued):** Alternative routes have limited additional capacity to accommodate re-routed commuter traffic (e.g., buses or carpools) or goods movement. If significant roadways or nodes are disrupted, re-routing would result in heavy congestion that could overwhelm the region's roadways and interstates as well as non-motorized transportation corridors (bike and pedestrian).

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T5.5** | Prioritize funding to improve alternative ground transportation routes, enhance or develop public transportation, bike and pedestrian options, and replace or retrofit vulnerable critical lifeline infrastructure | Policy Development | Long-range Planning, Capital Planning | MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA | Multi-benefit, Local, Regional, State, Federal |

Functional Vulnerability

**Vulnerability T6:** The temporary disruption or permanent loss of public transportation assets due to sea level rise and storm events, and the lack of sufficient alternatives, could leave residents in some communities unable to travel on a day-to-day basis, compounding evacuation challenges during an emergency.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T6.1** | Identify public transportation assets at-risk of flooding that serve transit-dependent populations | Evaluation | Long-range Planning, Operations, New Initiative | MTC, Caltrans, BART, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, County Health, CBOs | Do It Yourself, Unlocking, Local, Regional |
| **T6.2** | Proactively protect public transportation assets that serve transit-dependent populations, or prioritize development of alternative transit options to serve these populations | Program/ operation | Capital Planning, Operations, Codes and Standards, Project Planning and Design | MTC, Caltrans, BART, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, County Health, CBOs | Local, Regional |
| **T6.3** | Include strategies that ensure the safe evacuation of transit-dependent populations in emergency response plans, e.g., designate evacuation routes and bus assignments, coordinate with local school bus fleets, transportation service providers, and wheelchair accessible vehicles to expand the pool of available vehicles for evacuation | Program/ operation | Emergency and Hazard Planning | ABAG, MTC, Caltrans, BART, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, County Health, CBOs, CalEMA | Multi-benefit, Local, Regional |

Functional Vulnerability

**Vulnerability T7:** The rail system lacks redundancy, and fixed stations and maintenance yards serve long, linear lengths of track. The interconnected nature of rail and the lack of redundancy mean that damage at any point in the system can disrupt commuter and goods movement system-wide, causing significant economic effects in the region, particularly if there is a loss of service to the seaport or airport. Repair or relocation of rail infrastructure may require significant investment to ensure public safety and security.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T7.1** | Conduct an assessment to identify hot spots or weak links in the regional rail system (fixed facilities and track) that are vulnerable to sea level rise and storm events (in particular, assets along the shoreline, in low-lying areas, on levees, or across tidal streams or the Bay) and to identify areas of potential conflict where other infrastructure is either above or below the rail line, or where the line or facilities are in or adjacent to high value natural areas | Evaluation | Long-range Planning, Operations, Emergency and Hazard Planning, New Initiative | MTC, BART, UP, Amtrak, CCJPA, Caltrans, Transportation Authorities, Cities, Counties, CPUC, FRA | Do It Yourself, Unlocking, Regional |
| **T7.2** | Prioritize maintenance, repair, and retrofit of bridges and levees vulnerable to damage from sea level rise and storm events | Program/operation | Capital Planning, Operations | BCDC, USACE, RWQCB, MTC, UP, Caltrans, CCJPA, Cities, Counties | Do It Yourself, Regional |

Functional Vulnerability

**Vulnerability T7 (continued):** The rail system lacks redundancy, and fixed stations and maintenance yards serve long, linear lengths of track. The interconnected nature of rail and the lack of redundancy mean that damage at any point in the system can disrupt commuter and goods movement system-wide, causing significant economic effects in the region, particularly if there is a loss of service to the seaport or airport. Repair or relocation of rail infrastructure may require significant investment to ensure public safety and security.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T7.3** | Develop or update Continuity of Operations Plans (COOPs) to include sea level rise and storm events, and work with other regional transportation providers to identify alternative facilities and services to provide continuity of operations during an emergency | Program/operation | Emergency and Hazard Planning, Operations | MTC, Caltrans, BART, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Private Sector, CBOs | Multi-benefit, Regional, Long Lead Time |
| **T7.4** | Develop design standards for new infrastructure and capital improvements investments that will protect critical elements from sea level and groundwater rise | Policy Development | Codes and Standards, Capital Planning, Long range Planning | UP, Amtrak, Caltrans, CCJPA, Cities, Counties | Do It Yourself, Unlocking, Regional |
| **T7.5** | Install manual, remote control, or automatic temporary barriers or waterproof closures to protect at- or below-grade critical elements such as station entrances, tunnels, maintenance facilities, asset storage areas, and rail alignments | Program/operation | Capital Planning, Operations, Codes and Standards, Project Planning and Design | UP, Amtrak, Caltrans, CCJPA, Cities, Counties | Do It Yourself, Unlocking, Regional |

Functional Vulnerability

**Vulnerability T7 (continued):** The rail system lacks redundancy, and fixed stations and maintenance yards serve long, linear lengths of track. The interconnected nature of rail and the lack of redundancy mean that damage at any point in the system can disrupt commuter and goods movement system-wide, causing significant economic effects in the region, particularly if there is a loss of service to the seaport or airport. Repair or relocation of rail infrastructure may require significant investment to ensure public safety and security.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T7.6** | Construct permanent structures to protect at- or below-grade critical elements such as station entrances, tunnels, maintenance facilities, and asset storage areas | Program/operation | Capital Planning, Operations, Codes and Standards, Project Planning and Design | UP, Amtrak, Caltrans, CCJPA, Cities, Counties | Do It Yourself, Unlocking, Regional |
| **T7.7** | Raise the elevation of at- or below-grade critical elements such as station entrances, maintenance yards, and rail alignments | Program/operation | Capital Planning, Operations, Codes and Standards, Project Planning and Design | UP, Amtrak, Caltrans, CCJPA, Cities, Counties | Do It Yourself, Unlocking, Regional |
| **T7.8** | Relocate critical elements that are necessary to ensure regional rail system function to areas that are not at risk from sea level rise and storm events | Program/operation | Capital Planning, Land use planning, Project Planning and Design | UP, Amtrak, Caltrans, CCJPA, Cities, Counties | Regional, Long Lead Time |
| **T7.9** | Develop a decision-making framework for determining if new infrastructure and capital improvements should be protected from sea level and groundwater rise, or if the infrastructure should be located/relocated in an area not at risk from sea level rise and storm events | Policy Development | Long-range Planning, New Initiative | UP, Amtrak, CCJPA, CPUC, FRA, Private Sector, CBOs, BCDC, ABAG, MTC | Unlocking, Regional, Long Lead Time |

Functional Vulnerability

**Vulnerability T8:** Certain communities or facilities are linked by only one or two access-ways (e.g., road, rail, or transit) and could become isolated during disasters. For example, the majority of access roads to the Port of Oakland's seaport and Oakland International Airport are vulnerable, and if they flood they could isolate these regionally significant facilities.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T8.1** | Identify specific communities and facilities served by limited or sole access-ways that are vulnerable to sea level rise and storm events | Evaluation | New Initiative | MTC, Caltrans, BART, AC Transit, County, Cities, CMA, CCJPA, Port, UP, WETA, County Health, CBOs | Do It Yourself, Unlocking, Local, Regional |
| **T8.2** | Prioritize protection of sole or limited access to communities or facilities, and/or develop alternative access to these communities and facilities | Program/operation | Long-range Planning, Capital Planning | MTC, Caltrans, BART, AC Transit, County, Cities, CMA, CCJPA, Port, UP, WETA, County Health, CBOs | Local, Regional, Long Lead Time |
| **T8.3** | Develop and adopt plans for future relocation of people, uses, and services that are at risk of becoming isolated where sole or limited access-ways cannot be improved or protected, and where no other alternative means of access is feasible | Program/operation | Long-range Planning | ABAG, MTC, Caltrans, BART, AC Transit, County, Cities, CMA, CCJPA, Port, UP, WETA, County Health, Private Sector, CBOs | Local, Regional, Long Lead Time |

Functional Vulnerability

**Vulnerability T9:** The Port of Oakland seaport exports a significant amount of perishable goods, such as agricultural products. Sea level rise and storm events could delay and disrupt the movement and delivery of these goods.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T9.1** | Review and improve understanding of critical partners, timelines, and pathways for perishable goods movement, using past disruptions at the Port of Oakland as a source | Evaluation | Operations | Port, Private Sector | Do It Yourself, Unlocking, Local |
| **T9.2** | Conduct an economic analysis of the consequences of perishable goods not being delivered, using past disruptions at the Port of Oakland to inform understanding of the types of products that would perish if delivery is delayed and the length of time within which a delivery would have to be made | Evaluation | Long-range Planning, New Initiative | Port, Private Sector | Do It Yourself, Multi-benefit, Local |
| **T9.3** | Develop contingency plans for perishable goods if seaport operations are disrupted, including developing secondary markets and alternative transportation options | Program/operation | Long-range Planning, New Initiative | Port, Private Sector | Do It Yourself, Local |
| **T9.4** | Identify other seaport facilities in the Bay Area that may serve as a backup to the Port of Oakland for perishable goods export | Evaluation | Long-range Planning, New Initiative | Northern California Ports | Regional, State |

Functional Vulnerability

**Vulnerability T10:** The seaport facilities in the San Francisco Bay region do not have sufficient capacity to handle additional cargo if operations at the Port of Oakland seaport were disrupted by sea level rise and storm events.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T10.1** | Update plans that evaluate the capacity for handling different types of cargo at the region's seaports, e.g., the Cargo Monitoring Report, Seaport Plan, and seaport Master Plans to factor in sea level rise and storm events | Policy Development, Program/operation | Long-range Planning | Port, BCDC, MTC | Do It Yourself, Unlocking, Local, Regional |
| **T10.2** | Develop contingency plans for using other port facilities within or outside of the region in the event of temporary or permanent disruption at the Port of Oakland | Policy Development | Long-range Planning, New Initiative | Northern California Ports | Multi-benefit, Regional, State |

Functional Vulnerability

**Vulnerability T11:** There is not sufficient commercial airport runway capacity in the San Francisco Bay Area to serve as a short- or long-term alternative to Oakland International Airport if it were damaged or disrupted due to sea level rise or storm events.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T11.1** | Update the San Francisco Bay Area's Regional Airport Systems Planning Analysis (RASPA) to consider sea level rise, storm events, earthquakes, and other hazards | Evaluation | Long-range Planning | RAPC, ABAG, BCDC, MTC, Regional Airports, FAA | Unlocking, Regional |
| **T11.2** | Analyze sea level rise, storm events, earthquakes, and other hazards in updating the Master Plans of the region's airports | Evaluation | Long-range Planning | Regional Airports, FAA | Unlocking, Local, Regional |
| **T11.3** | Consider sea level rise and storm event impacts when developing passenger and cargo demand projections for the region's runway capacity | Program/operation | Long-range Planning | Regional Airports, FAA | Regional |
| **T11.4** | Develop a stakeholder group to identify sea level rise and storm event adaption options for the Oakland International Airport that considers airport assets, key infrastructure that the airport relies on (transportation, power, water, etc.), and opportunities to benefit adjacent, non-airport vulnerable assets | Coordination | New Initiative | Port, FAA, RAPC, ABAG, BCDC, MTC, Cities, Counties, CBOs, Private Sector | Local, Regional, High Priority |

Physical Vulnerability

**Vulnerability T12:** Many high-cost and critical elements of transportation infrastructure are highly vulnerable to flooding because they are located at or below grade (tubes, tunnels, ventilation), in low-lying areas (airport runways, storage and maintenance facilities), or on top of levees (rail alignments).

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T12.1** | Manage stormwater at or near critical facilities and transportation elements by prioritizing regular maintenance, investing in drainage improvements (under or cross drains, backflow or flex valves, perimeter walls or pile/column foundations), and using low impact development (LID) techniques | Program/operation | Capital Planning, Operations, Codes and Standards | RWQCB, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Private Sector | Do It Yourself, Local, Regional |
| **T12.2** | Prepare for recovery from flooding by stockpiling materials, establishing turn-key agreements for equipment rental, and pre-positioning emergency power generation capacity, portable pumps, and debris removal equipment | Program/operation | Emergency and Hazard Planning | MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Private Sector | Do It Yourself, Multi-benefit, Local, Regional |
| **T12.3** | Identify locations that are not at risk of flooding to temporarily store mobile equipment, rolling stock, or other assets (may require agreements or permission from private property owners), and develop clear procedures for how and when to use these sites when flooding is predicted | Program/operation | Emergency and Hazard Planning | MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Private Sector | Do It Yourself, Local, Regional |

Physical Vulnerability

**Vulnerability T12 (continued):** Many high-cost and critical elements of transportation infrastructure are highly vulnerable to flooding because they are located at or below grade (tubes, tunnels, ventilation), in low-lying areas (airport runways, storage and maintenance facilities), or on top of levees (rail alignments).

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T12.4** | Install manual, remote control, or automatic temporary barriers or waterproof closures to protect at- or below-grade critical elements such as roadways, tube and tunnel openings, ventilation grates, switchgears, maintenance facilities, and asset storage areas | Program/operation | Capital Planning, Project Design and Planning | Caltrans, BART, Port, County, Cities, CMA, CCJPA, UP, WETA, Private Sector | Do It Yourself, Local, Regional |
| **T12.5** | Construct permanent structures to protect at- or below-grade critical elements such as roadways, tube and tunnel openings, ventilation grates, switchgears, maintenance facilities, and asset storage areas | Program/operation | Capital Planning, Project Design and Planning | Caltrans, BART, Port, County, Cities, CMA, CCJPA, UP, WETA, Private Sector | Do It Yourself, Local, Regional |
| **T12.6** | Raise the elevation of at- or below-grade critical elements such as entrances, mechanical or electrical equipment, and ventilation grates | Program/operation | Capital Planning, Project Design and Planning | Caltrans, BART, Port, County, Cities, CMA, CCJPA, UP, WETA, Private Sector | Do It Yourself, Local, Regional |
| **T12.7** | Develop or improve design standards to require protection of new infrastructure and capital improvement investments from sea level rise, storm events, and elevated groundwater levels | Policy Development | Codes and Standards | MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Private Sector | Do It Yourself, Local, Regional, Long Lead Time |

Physical Vulnerability

**Vulnerability T12 (continued):** Many high-cost and critical elements of transportation infrastructure are highly vulnerable to flooding because they are located at or below grade (tubes, tunnels, ventilation), in low-lying areas (airport runways, storage and maintenance facilities), or on top of levees (rail alignments).

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T12.8** | Relocate critical transportation system components to areas that are not at risk from sea level rise or storm events | Program/operation | Capital Planning, Project Design and Planning | MTC, Caltrans, BART, Port, County, Cities, CMA, CCJPA, UP, WETA, Private Sector, CBOs | Local, Regional, Long Lead Time |

Physical Vulnerability

**Vulnerability T13**: Water and salt-sensitive electronic and mechanical components and power supplies critical to the continued function of transportation infrastructure are often at or below grade and therefore are vulnerable to sea level rise, storm events, and elevated groundwater levels.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T13.1** | Monitor groundwater and salinity levels near vulnerable infrastructure by leveraging existing data or collecting site-specific data as necessary | Evaluation | Operations, New Initiative | MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Private Sector | Do It Yourself, Unlocking, Local, Regional |
| **T13.2** | Increase inspection and maintenance of infrastructure that is sensitive to water or salt in areas at risk from sea level rise, storm events, or elevated groundwater levels | Program/operation | Operations | MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Private Sector | Do It Yourself, Multi-benefit, Local, Regional |
| **T13.3** | Review and update standards, codes, and regulations for the construction and placement of transportation infrastructure to avoid or address sea level rise, storm events, and elevated groundwater levels | Policy Development | Codes and Standards | MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Private Sector | Do It Yourself, Unlocking, Local, Regional, Long Lead Time |
| **T13.4** | Follow existing or develop new standards requiring that waterproof materials be used in the construction of new infrastructure and in the repair or protection of existing infrastructure | Policy Development, Program/operation | Operations, Project Planning and Design, Codes and Standards | MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, FEMA, CalEMA, Private Sector | Do It Yourself, Local, Regional, State, Federal |

Physical Vulnerability

**Vulnerability T13 (continued):** Water and salt-sensitive electronic and mechanical components and power supplies critical to the continued function of transportation infrastructure are often at or below grade and therefore are vulnerable to sea level rise, storm events, and elevated groundwater levels.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T13.5** | Follow existing or develop new standards to ensure corrosion-resistant materials or cathodic coatings are used when installing new or upgrading existing cables and pipelines | Policy Development, Program/operation | Operations, Project Planning and Design, Codes and Standards | MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, FEMA, CalEMA, Private Sector | Do It Yourself, Local, Regional, State, Federal |
| **T13.6** | Follow existing or develop new standards requiring elevation of sensitive components above anticipated flood levels | Policy Development, Program/operation | Operations, Project Planning and Design, Codes and Standards | MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, FEMA, CalEMA, Private Sector | Do It Yourself, Local, Regional, State, Federal |
| **T13.7** | Require adequate backup power to minimize interruptions to critical facilities, including lifeline facilities, e.g., on-site power generators with sufficient fuel for several days, portable backup power generators, or pre-position access through rental or leasing agreement | Policy Development, Program/operation | Operations, Codes and Standards | MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Private Sector | Do It Yourself, Multi-benefit, Local, Regional |

Physical Vulnerability

**Vulnerability T14:** Certain assets such as bridges across tidal streams or in the Bay, and infrastructure located under the wharves at the Port of Oakland seaport, may be increasingly vulnerable to high water levels and wave erosion during storm events, which can disrupt asset function, cause scour, require additional maintenance, and potentially shorten asset life span.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **T14.1** | Conduct analyses of critical infrastructure to identify the potential for increased erosion, scour and wear due to increased tide and wave energy | Evaluation | New Initiative, Operations | BART, Caltrans, Port, County, Cities, UP, CCJPA, WETA, CMA | Do It Yourself, Unlocking, Local, Regional |
| **T14.2** | Require and implement improvements to, and new investments in, existing infrastructure across tidal streams or in the Bay to increase resilience to sea level rise and storm events | Policy Development, Program/operation | Codes and Standards, Capital Planning | BCDC, RWQCB, USACE, FEMA, NOAA, BART, Caltrans, Port, County, Cities, UP, CCJPA, WETA, CMA | Local, Regional |

Information Vulnerability

**Vulnerability U1:** There is a lack of detailed, easily accessible, and well-coordinated information about the ownership, location, and condition of energy, pipeline, telecommunication, and stormwater infrastructure, which is needed for site- and asset-specific vulnerability and risk assessments.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U1.1** | Review existing asset management systems or information sources to identify gaps in completeness, quality, and accessibility, and to identify the types of information most relevant to adaptation planning | Evaluation | Long-range Planning, New Initiative | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Unlocking, Multi-benefit, Do It Yourself, Local, Regional |
| **U1.2** | Address challenges and gaps in information most relevant to adaptation planning by developing new or updating existing asset management systems | Program/ operation | Long-range Planning, New Initiative, Operations | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Multi-benefit, Do It Yourself, Local, Regional |
| **U1.3** | Adopt data management and sharing agreements among utilities in similar sectors, e.g., wastewater, power, pipelines, telecommunications, to ensure there is complete, high quality, and accessible asset information available for vulnerability and risk assessments | Policy Development | New Initiative | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Multi-benefit, Local, Regional, Long Lead Time |

Information Vulnerability

**Vulnerability U1 (continued):** There is a lack of detailed, easily accessible, and well-coordinated information about the ownership, location, and condition of energy, pipeline, telecommunication, and stormwater infrastructure, which is needed for site- and asset-specific vulnerability and risk assessments.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U1.4** | Develop and maintain a centralized database of unrestricted utility information that can support non-utility agencies and organizations in shoreline planning for sea level rise and storm events | Program/ operation | New Initiative | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Multi-benefit, Local, Regional, Long Lead Time |

Management Control Vulnerability

**Vulnerability U2:** The infrastructure that comprises wastewater, stormwater, and flood control systems is either interconnected (e.g., stormwater pipes connect to flood control channels) or affected by other systems (e.g., stormwater contributes to wet weather flows to wastewater treatment plants), but is owned and managed by different public and private entities. Even within a single utility, different departments are often responsible for interdependent functions (e.g., reducing versus handling wet weather flows). Due to these interdependencies, many assets will be affected by the temporary disruption or permanent loss of, or adaptation responses for, other assets that are owned and operated by different departments or entirely separate agencies.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U2.1** | Improve communication, education, and coordination across departments within individual agencies | Coordination | Long-range Planning, Operations, New Initiative | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD | Unlocking , Multi-benefit, Do It Yourself, Local, Regional |
| **U2.2** | Consolidate management of interconnected infrastructure either by creating a single entity or establishing inter-agency agreements to guide capital investment, management, and operations decisions | Coordination, Policy Development | Long-range Planning, New Initiative | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD | Multi-benefit, Local, Regional, Long Lead Time |

Management Control Vulnerability

**Vulnerability U2 (continued):** The infrastructure that comprises wastewater, stormwater, and flood control systems is either interconnected (e.g., stormwater pipes connect to flood control channels) or affected by other systems (e.g., stormwater contributes to wet weather flows to wastewater treatment plants), but is owned and managed by different public and private entities. Even within a single utility, different departments are often responsible for interdependent functions (e.g., reducing versus handling wet weather flows). Due to these interdependencies, many assets will be affected by the temporary disruption or permanent loss of, or adaptation responses for, other assets that are owned and operated by different departments or entirely separate agencies.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U2.3** | Coordinate with owners and operators of interdependent infrastructure to articulate and advocate for shared objectives (e.g., reducing runoff through low impact development (LID), addressing wet weather flows), and to develop frameworks for decision-making and funding related to infrastructure maintenance and new investments | Coordination, Policy Development | Long-range Planning, New Initiative | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD | Unlocking, Multi-benefit, Local, Long Lead Time |
| **U2.4** | Establish inter-agency mutual aid agreements to provide assistance with inspection and repair of damaged or compromised facilities, and mobile or alternative facilities (e.g., portable pumps, generators) during emergency response and recovery | Coordination | Long-range Planning, Emergency and Hazard Planning | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD | Multi-benefit, Local, Regional |

Management Control Vulnerability

**Vulnerability U3:** Existing operations, maintenance, and emergency response plans and procedures for utility infrastructure may be inadequate to address contingencies associated with storm events.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U3.1** | Review existing operations and maintenance plans to determine where preparation is inadequate for sea level rise and storm events | Evaluation | New Initiative | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Unlocking, Do It Yourself, Local, Regional |
| **U3.2** | Require shut-off, overflow, and re-routing mechanisms to be designed and installed to function during an emergency, e.g., enable remote access or place them in easily accessible locations | Policy Development, Program/operation | Long-range Planning, Capital Planning, Codes and Standards, Project Planning and Design | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast, State and Federal | Multi-benefit, Do It Yourself, Local, Regional |
| **U3.3** | For power plants and substations, develop procedures for the shutdown of sensitive infrastructure in advance of flooding and for the restoration of power afterwards | Program/operation | Operations, Codes and Standards, Emergency and Hazard Planning | PG&E, Kinder Morgan, Shell | Do It Yourself, Local, Regional |

Management Control Vulnerability

**Vulnerability U3 (continued):** Existing operations, maintenance, and emergency response plans and procedures for utility infrastructure may be inadequate to address contingencies associated with storm events.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U3.4** | For electricity transmission and telecommunications assets, develop a load transfer and re-routing plan for networked systems to maintain service when part of the system is jeopardized | Program/operation | Long-range Planning, Operations, Emergency and Hazard Planning | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional |
| **U3.5** | Prepare for recovery from flooding by stockpiling materials, establishing turn-key agreements for equipment rental, and pre-positioning emergency power generation capacity, portable pumps, and debris removal equipment | Program/operation | Emergency and Hazard Planning, New Initiative | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional |

Management Control Vulnerability

**Vulnerability U4:** Cities and flood control districts have limited ability to increase revenues to address current stormwater and flood management needs, and sea level rise impacts will create a need for additional funding.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U4.1** | Pursue IRWMP and other state/federal funding for repair or improvement of stormwater management and flood control infrastructure | Program/operation | Capital Planning | City DPW, ACFCWCD, BCDC, ABAG, SFEP, RWQCB | Do It Yourself, Multi-benefit, Local, Regional |
| **U4.2** | Conduct public outreach to educate property owners about the importance of stormwater management and flood control so they support bond initiatives and increases in assessments for infrastructure repair and improvement | Education/outreach | New Initiative | City DPW, ACFCWCD, Landowners, Private Sector, NPOs, CBOs | Multi-benefit, Do It Yourself, Local |
| **U4.3** | Investigate and pursue alternative funding mechanisms, e.g., taxes, fee-based mechanism, assessment districts, or leveraging private sector resources | Program/operation | Long-range Planning, New Initiative | City DPW, ACFCWCD, Landowners, Private Sector | Multi-benefit, Do It Yourself, Local, Regional |

Functional Vulnerability

**Vulnerability U5:** Wastewater treatment systems are large, expensive, and complex, and there is little to no redundancy within each system or the ability to connect across systems, making them highly vulnerable to sea level rise and storm events.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U5.1** | Add redundancy or increase capacity to re-route around compromised wastewater system components | Program/operation | Long-range Planning, Capital Planning, Project Planning and Design | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, RWQCB | Multi-benefit, Do It Yourself, Local |
| **U5.2** | Reduce the vulnerability of components by improving the ability to operate remotely, ensuring access to backup power or portable pumps, or by redesigning (e.g., restrict pump station design capacity to be operable with portable pumps) | Program/operation | Capital Planning, Project Planning and Design | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, RWQCB | Multi-benefit, Do It Yourself, Local |
| **U5.3** | Institute operational changes to reduce system complexity, eliminate key vulnerable components, or minimize cost to maintain and repair the system | Program/operation, Policy Development | Operations, Codes and Standards | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD | Multi-benefit, Do It Yourself, Local, Long Lead Time |
| **U5.4** | Redesign or relocate wastewater treatment systems to areas not at risk using alternative strategies such as distributed wastewater treatment networks | Program/operation | Long-range Planning, Capital Planning, Project Planning and Design, New Initiative | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, RWQCB | Multi-benefit, Local, Regional, Long Lead Time |

Functional Vulnerability

**Vulnerability U6:** Stormwater and flood control infrastructure is vulnerable to higher Bay water levels and rising groundwater levels that will reduce the capacity of these systems to collect, convey, and discharge flows.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U6.1** | Identify stormwater and flood control system components that have insufficient capacity to accommodate sea level and groundwater rise, e.g., existing pipe and channel sizes, outfall elevations, etc. | Evaluation | Long-range Planning, New Initiative | City DPW, ACFCWCD | Do It Yourself, Unlocking, Local |
| **U6.2** | Increase system capacity by increasing pipe size, installing backflow prevention devices, elevating outfalls, installing forced mains, installing new pump stations, or increasing existing pump station capacity | Program/operation | Long-range Planning, Capital Planning, Project Planning and Design | City DPW, ACFCWCD | Do It Yourself, Multi-benefit, Local |
| **U6.3** | Enforce creek protection, stormwater management, and discharge control ordinances, following the RWQCB Best Management Practices (BMPs), to keep watercourses free of obstructions and protect drainage facilities | Program/operation | Operations, Project Planning and Design | City DPW, ACFCWCD, CBOs, RWQCB, SFEP | Multi-benefit, Do It Yourself, Local, Regional |

Functional Vulnerability

**Vulnerability U6 (continued):** Stormwater and flood control infrastructure is vulnerable to higher Bay water levels and rising groundwater levels that will reduce the capacity of these systems to collect, convey, and discharge flows.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U6.4** | Conduct watershed analyses to identify opportunity sites for green infrastructure or low impact development (LID) techniques to improve stormwater and flood control system capacity to accommodate sea level and groundwater rise | Evaluation | Long-range Planning, New Initiative | Cities, ACFCWCD, CBOs, SFEP | Unlocking, Multi-benefit, Local |
| **U6.5** | Require new developments and redevelopments to reduce and manage stormwater through on-site capture and retention, low impact development (LID), green infrastructure, and other means | Policy Development | Long-range Planning, Codes and Standards | City, ACFCWCD, RWQCB | Multi-benefit, Local, Regional |

Physical Vulnerability

**Vulnerability U7:** Many mechanical and electrical components of utility infrastructure are vulnerable to groundwater rise and/or salinity intrusion due to water- and salt-sensitivity.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U7.1** | Monitor groundwater and salinity levels near vulnerable infrastructure by leveraging existing data or collecting site-specific data as necessary | Program/operation | Operations, New Initiative | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Unlocking, Do It Yourself, Local, Regional |
| **U7.2** | Increase inspection and maintenance of infrastructure that is sensitive to water or salt in areas at risk from sea level rise, storm events, or elevated groundwater levels | Program/operation | Operations | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional |
| **U7.3** | Review and update standards, codes, and regulations for the construction and placement of utility infrastructure to avoid or address sea level rise, storm events, and elevated groundwater levels | Policy Development | Codes and Standards | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast, CPUC, FERC, RWQCB | Unlocking, Do It Yourself, Local, Regional, State, Federal, Long Lead Time |

Physical Vulnerability

**Vulnerability U7 (continued):** Many mechanical and electrical components of utility infrastructure are vulnerable to groundwater rise and/or salinity intrusion due to water- and salt-sensitivity.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U7.4** | Follow existing or develop new standards requiring that waterproof materials be used in the construction of new infrastructure and in the repair or protection of existing infrastructure | Program/operation, Policy Development | Operations, Project Planning and Design, Codes and Standards | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional |
| **U7.5** | Follow existing or develop new standards to ensure corrosion-resistant materials or cathodic coatings are used when installing new or upgrading existing cables and pipelines | Program/operation, Policy Development | Operations, Project Planning and Design, Codes and Standards | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional |
| **U7.6** | Follow existing or develop new standards requiring elevation of sensitive components above anticipated flood levels | Program/operation, Policy Development | Capital Planning, Project Planning and Design, Codes and Standards | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional |

Physical Vulnerability

**Vulnerability U8:** Certain critical utility infrastructure (e.g., cell towers, wastewater and stormwater pump stations) requires an uninterrupted power supply to function.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U8.1** | Establish plans to deliver fuel to backup power generation systems | Program/operation | Operations, Emergency and Hazard Planning | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Do It Yourself, Multi-benefit, Local, Regional |
| **U8.2** | Review cell tower records to identify which ones do not have backup power generation systems | Evaluation | Long-range Planning, New Initiative | Verizon, AT&T, Comcast, County | Do It Yourself, Unlocking, Multi-benefit, Local, Regional |
| **U8.3** | Develop emergency alternate power supplies for cell towers that do not have a backup power supply, e.g., obtain portable backup power generators or ensure quick access through rental agreements; keep power generators with sufficient fuel for several days on site | Program/operation | Emergency and Hazard Planning | Verizon, AT&T, Comcast | Do It Yourself, Multi-benefit, Local, Regional |
| **U8.4** | Ensure access to Cells on Wheels (COWs) through rental or leasing agreements or by creating a county-wide fund through conditions on permits, which can provide service when permanent cellular towers are insufficient or non-operational | Program/operation | Emergency and Hazard Planning | Verizon, AT&T, Comcast, County | Do It Yourself, Multi-benefit, Local, Regional |

Physical Vulnerability

**Vulnerability U9:** Infrastructure such as pipelines, cables, and utility poles that are exposed to storm events are susceptible to damage. Scour and erosion can expose pipelines and cables, and pipelines can become buoyant when flooded, while high winds can topple utility poles and damage electrical wires, especially in flooded areas.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U9.1** | Inspect underground infrastructure, particularly after storm events and extreme tides, and improve cover as necessary to ensure it is sufficient to withstand scour and flooding | Program/operation | Operations, Emergency and Hazard Planning | PG&E, Kinder Morgan, Shell, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional, |
| **U9.2** | Improve existing and install new underground infrastructure to ensure pipelines and cables are adequately weighted and secure enough to remain in place even if cover is removed | Program/operation | Long-range Planning, Capital Planning, Operations | PG&E, Kinder Morgan, Shell, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional |
| **U9.3** | Reinforce aboveground infrastructure to reduce the risk of erosion, undermining, and toppling | Program/operation | Capital Planning, Operations, Project Planning and Design | PG&E, Kinder Morgan, Shell, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional |
| **U9.4** | Consider relocating critical elements that are necessary to continuity of utility services to areas that are not at risk from sea level rise and storm events | Policy Development | Long-range Planning, Capital Planning | PG&E, Kinder Morgan, Shell, Verizon, AT&T, Comcast | Local, Regional, Long Lead Time |

## Information Vulnerability

**Vulnerability S1:** Publicly available information about the ownership, elevation, and condition of structural shorelines is insufficient for conducting vulnerability and risk assessments and developing adaptation responses.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **S1.1** | Review and improve existing structural shoreline asset information to identify and address gaps in completeness, quality and accessibility | Evaluation | New Initiative | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, City, County, CBOs, Private Sector | Do It Yourself, Unlocking, Multi-benefit, Local, Regional |
| **S1.2** | Develop and keep current a centralized structural shoreline asset management database that includes ownership, location, elevation, condition and management status | Program/operation | New Initiative | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, City, County, NPOs, CBOs, Private Sector | Multi-benefit Local, Regional, Long Lead Time |

Management Control Vulnerability

**Vulnerability S2:** Landowners, agencies and facility managers do not always have control over the shorelines (structural and natural) that protect their vulnerable assets from flooding or storm event impacts.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **S2.1** | Improve communication and coordination between those that own and manage the shoreline (levees, marsh, beach) and those that own and manage the assets that are protected by these shorelines | Coordination | New Initiative | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, City, County, CBOs, Private Sector | Unlocking, Local, Regional |
| **S2.2** | Expand or form partnerships among agencies, organizations and community members to facilitate decision-making regarding shoreline improvements and new investments | Coordination, Program/operation | New Initiative | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, City, County, CBOs, Private Sector | Unlocking, Local, Regional, Long Lead Time |

Management Control Vulnerability

**Vulnerability S3:** Structural shorelines that lack dedicated funding and permit authorizations for maintenance and improvements, and which are not included in long-range capital improvement planning, are particularly vulnerable because shoreline managers cannot easily maintain or make repairs to address sea level rise and storm event impacts for these "at risk" structural shorelines.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **S3.1** | Prioritize the inspection, maintenance, upgrade, and repair of vulnerable, at-risk structural shorelines | Program/operation | Capital Planning, Operations | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, Private Sector | Do It Yourself, Local, Regional |
| **S3.2** | Dedicate funding and resources to inspect, maintain, upgrade, and repair vulnerable, at-risk structural shorelines | Program/operation | Capital Planning | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, Private Sector | Do It Yourself, Local, Regional |
| **S3.3** | Develop and implement a regional permit authorization program to expedite the ongoing maintenance, minor repair, or upgrade of structural shorelines | Policy Development, Program/operation | New Initiative | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, NOAA, Private Sector | Multi-benefit, Regional, State, Federal, Long Lead Time |

Management Control Vulnerability

**Vulnerability S4:** Existing inter-agency coordination, governance structures, and financing strategies are insufficient for planning and implementing the types of large-scale, phased, structural and/or natural shoreline projects that will be needed to address sea level rise and storm events.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **S4.1** | Establish a working group of agencies and organizations, including community-based organizations and private landowners, to develop a shoreline project decision-making framework that considers existing policies, procedures, and practices as well as the value of ecosystem services, public access and recreation, and social equity | Coordination, Policy Development | New Initiative | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, SFEP, RWQCB, Port, USACE, USFWS, FEMA, NPOs, CBOs, Private Sector | Unlocking, Regional, Long Lead Time |
| **S4.2** | Expand or form partnerships among agencies, organizations, and private shoreline landowners to facilitate cost-sharing for planning, implementing, and monitoring multi-objective shoreline improvements and new investments | Coordination, Program/operation | Capital Planning, New Initiative | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, SFEP, RWQCB, Port, USACE, USFWS, FEMA, NPOs, CBOs, Private Sector | Local, Regional, Long Lead Time |

Management Control Vulnerability

**Vulnerability S5:** Planning and implementing improvements or changes in use at shoreline parks is complicated because parks are often owned and managed by different agencies. Some parks have multiple managers and owners, adding complexity to funding and decision-making.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **S5.1** | Develop agreements among park managers and park landowners that articulate shared objectives, decision-making, and funding responsibilities for sea level rise and storm event adaptation planning and response | Policy Development | New Initiative | EBRPD, HARD, DFW, State Parks, City, County | Unlocking, Local Regional |
| **S5.2** | Expand or form partnerships among agencies, organizations, and community members to facilitate decision-making regarding park improvements and new investments in light of sea level rise and storm event flooding | Coordination | New Initiative | EBRPD, HARD, DFW, State Parks, City, County, CBOs, Private Sector | Unlocking, Local, Regional, Long Lead Time |

Functional Vulnerability

**Vulnerability S6:** Many Bay Trail segments are vulnerable because they are situated on shoreline levees, cannot be used when flooded, and often have surface materials that erode easily. Because of the interconnected nature of the Bay Trail, disruption of one segment can affect the function of the entire Bay Trail.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **S6.1** | Develop and maintain a Bay Trail asset management database that includes ownership, location, elevation, condition, and management status | Evaluation | New Initiative | ABAG, SCC, BCDC, EBRPD, HARD, NPOs, Private Sector | Unlocking, Regional |
| **S6.2** | Prioritize resurfacing vulnerable trail segments with erosion-resistant materials | Program/operation | Capital Planning, Project Planning and Design | EBRPD, HARD, State Parks, City DPW or Parks, County, NPOs, Private Sector | Do It Yourself, Local, Regional |
| **S6.3** | Establish agreements among shoreline managers to maintain, repair, and upgrade shoreline levees in a manner that best preserves the Bay Trail and connected shoreline access | Policy Development | Long-range Planning | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA | Multi-benefit, Local, Regional |

Functional Vulnerability

**Vulnerability S7:** Shoreline access for people with limited mobility is especially vulnerable to sea level rise and storm events.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **S7.1** | Prioritize maintenance and repair of barrier-free access to the shoreline and recreation facilities in order to minimize re-routing or closure | Policy Development, Program/operation | Operations | ABAG, EBRPD, HARD, State Parks, CBOs, Private Sector | Do It Yourself, Local, Regional |
| **S7.2** | Stockpile materials to create temporary bridges, ramps or pathways to maintain safe access for those with limited mobility | Program/operation | Operations, Emergency and Hazard Planning | ABAG, EBRPD, HARD, State Parks, NPOs, Private Sector | Multi-benefit, Do It Yourself, Local, Regional |
| **S7.3** | Effectively communicate trail closures, e.g., establish specific notification practices | Education/Outreach | Long-range Planning, Operations, Emergency and Hazard Planning | ABAG, EBRPD, HARD, State Parks, CBOs, Private Sector | Do It Yourself, Local, Regional |
| **S7.4** | Develop a public outreach and education campaign to inform and engage the public in maintaining shoreline access for all | Education/Outreach | Operations | ABAG, EBRPD, HARD, State Parks, NPOs, CBOs, BCDC, SCC, Private Sector | Unlocking, Local, Regional |

Functional Vulnerability

**Vulnerability S8:** Shoreline recreation areas with activities that depend on grass (sports fields, golf) are vulnerable to coastal flooding and saltwater intrusion.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **S8.1** | Plant salinity-resistant grass species in areas exposed to flooding and saltwater intrusion | Program/operation | Capital Planning, Project Planning and Design | EBRPD, HARD, State Parks, City DPW, City Parks Department, County | Do It Yourself, Local, Regional |
| **S8.2** | Install artificial turf, if appropriate, at sports fields exposed to flooding and saltwater intrusion | Program/operation | Capital Planning, Project Planning and Design | EBRPD, HARD, State Parks, City DPW, City Parks Department, County | Do It Yourself, Local, Regional |
| **S8.3** | Develop new or enhance existing venues for grass-dependent recreation activities (sports fields, golf) in areas not exposed to flooding and saltwater intrusion | Policy Development, Program/operation | Capital Planning, Project Planning and Design | EBRPD, HARD, State Parks, City DPW, City Parks Department, County | Do It Yourself, Local, Regional |

Functional Vulnerability

**Vulnerability S9:** Loss of sandy beaches due to sea level rise and storm events will diminish access to the Bay for certain water recreation activities (swimming, boardsailing, paddle boating).

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **S9.1** | Implement strategies to preserve sandy beaches, e.g., nourish, construct groins, setbacks, and buffers | Program/operation | Capital Planning, Project Planning and Design | EBRPD, State Parks, City of Alameda | Multi-benefit, Local |
| **S9.2** | Enhance existing boardsailing and paddle boat launch areas | Program/operation | Capital Planning, Project Planning and Design | EBRPD, State Parks, SCC, Water Trail, City, County, DFW, BCDC, DBW | Do It Yourself, Local, Regional |
| **S9.3** | Improve the capacity of existing boardsailing and paddle boat launch areas, or develop new areas, in locations not at risk | Policy Development, Program/operation | Long-range Planning | EBRPD, State Parks, SCC, Water Trail, City, County, DFW, BCDC, DBW | Do It Yourself, Local, Regional |

Functional Vulnerability

**Vulnerability S10:** Birds and wildlife that rely on tidal marshes will be displaced by changing (i.e., downshifting) habitat and more frequent or permanent inundation. These changes will force them to forage and nest closer to people and infrastructure, such as roads and highways, and will reduce the amount of available high tide refugia.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **S10.1** | Develop policies, guidance or incentives to encourage setbacks and buffers adjacent to tidal marshes that protect sensitive species and allow appropriate types of public access and recreation uses | Policy Development | Long-range Planning, Land Use Planning | EBRPD, HARD, SCC, DFW, BCDC, State Parks, RWQCB, USFWS, NOAA, City, County, Private Sector, NPOs | Do It Yourself, Unlocking, Multi-benefit, Local, Regional |
| **S10.2** | Improve or protect high tide refugia where it is already limited and vulnerable to increased inundation, e.g., install artificial refugia | Program/operation | Capital Planning, Project Planning and Design | EBRPD, HARD, SCC, DFW, BCDC, State Parks, USFWS, NOAA, Private Sector, NPOs | Do It Yourself, Local, Regional |
| **S10.3** | Protect existing, or create new, corridors that facilitate the movement of birds and wildlife to viable adjacent or nearby habitats | Program/operation | Long-range Planning, Land Use Planning | EBRPD, HARD, SCC, DFW, BCDC, State Parks, USFWS, NOAA, NPOs | Do It Yourself, Multi-benefit, Local, Regional, Long Lead Time |

Physical Vulnerability

**Vulnerability S11:** Depending on the type and design, structural shorelines will have varying sensitivity to sea level rise and storm events. Daily tides can cause wear and tear of varying degrees depending on type and design of shoreline, while overtopping during larger storm events can cause destabilization and failure.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **S11.1** | Protect, enhance, or restore baylands outboard of structural shorelines to preserve wave attenuation benefits, thereby reducing wave erosion, the likelihood of overtopping, and maintenance needs of structures such as non-engineered berms and levees | Program/operation | Capital Planning, Project Planning and Design | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, SFEP, RWQCB, USACE, USFWS, NOAA, SFBRA | Multi-benefit, Local, Regional, Long Lead Time |
| **S11.2** | Increase the size or amount of armor on structural shorelines to reduce erosion and scour | Program/operation | Capital Planning, Project Planning and Design | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA | Do It Yourself, Local |
| **S11.3** | Enhance or reinforce non-engineered berms, e.g., armor to protect from erosion | Program/operation | Capital Planning, Project Planning and Design | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA | Do It Yourself, Local |

Physical Vulnerability

**Vulnerability S11 (continued):** Depending on the type and design, structural shorelines will have varying sensitivity to sea level rise and storm events. Daily tides can cause wear and tear of varying degrees depending on type and design of shoreline, while overtopping during larger storm events can cause destabilization and failure.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **S11.4** | Increase the height of structural shorelines, if technically feasible and if physical and environmental constraints allow, to reduce potential overtopping | Program/operation | Capital Planning, Project Planning and Design | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA | Do It Yourself, Local |
| **S11.5** | Combine different types of structural shorelines, e.g., construct a flood wall on top of a levee | Program/operation | Capital Planning, Project Planning and Design | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA | Do It Yourself, Local |
| **S11.6** | Reinforce bulkheads and relocate any infrastructure that is located underneath them | Program/operation | Capital Planning, Project Planning and Design | Port, BCDC | Do It Yourself, Local |
| **S11.7** | Relocate or re-align structural shorelines to a landward location | Program/operation | Long-range Planning | EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, NOAA, Counties, Cities | Local, Long Lead Time |

Physical Vulnerability

**Vulnerability S12:** Natural, non-wetland shorelines (e.g., sandy beaches, bluffs, and cliffs) are vulnerable to sea level rise and storm events, which cause erosion and land loss.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **S12.1** | Nourish beaches to replenish sand | Program/ operation | Capital Planning, Project Planning and Design | EBRPD, State Parks, City of Alameda | Multi-benefit, Local |
| **S12.2** | Construct sand trapping structures such as groins | Program/ operation | Capital Planning, Project Planning and Design | EBRPD, State Parks, City of Alameda | Multi-benefit, Local |
| **S12.3** | Establish setbacks and buffers that will allow beaches to migrate landward | Program/ operation | Long-range Planning, Codes and Standards | EBRPD, State Parks, City of Alameda | Multi-benefit, Local |

Physical Vulnerability

**Vulnerability S13:** Tidal marshes will not keep up with sea level rise solely through vertical accretion, especially in light of the Bay's declining suspended sediment supply and the lack of space to shift landward.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **S13.1** | Establish a monitoring program to obtain baseline information to track changes in tidal marsh habitat and identify when it is approaching key thresholds, e.g., measure vertical accretion, observe changes in vegetation and indicator species, document marsh edge erosion (photo-points/surveys) | Program/operation Evaluation | Long-range Planning, Operations | EBRPD, HARD, SCC, DFW, BCDC, RWQCB, USFWS, NOAA, SFBRA, SFEP | Unlocking, Multi-benefit, Local, Regional |
| **S13.2** | Factor sea level rise into ongoing management of tidal marsh restorations to address potential higher water levels and larger waves | Policy Development, Program/operation | Long-range Planning, Capital Planning, Project Planning and Design | EBRPD, HARD, SCC, SFEP, DFW, BCDC, RWQCB, USFWS, NOAA, SFBRA, Counties, Cities | Do It Yourself, Local, Regional |
| **S13.3** | Factor sea level rise into design of new tidal marsh restorations, e.g., consider marsh future capacity to build upward and move landward | Policy Development, Program/operation | Long-range Planning, Capital Planning, Project Planning and Design | EBRPD, HARD, SCC, DFW, BCDC, SFEP, RWQCB, USFWS, NOAA, SFBRA, Counties, Cities | Do It Yourself, Local, Regional |

Physical Vulnerability

**Vulnerability S13 (continued):** Tidal marshes will not keep up with sea level rise solely through vertical accretion, especially in light of the Bay's declining suspended sediment supply and the lack of space to shift landward.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **S13.4** | Develop strategic plan to acquire and conserve upland areas that are appropriate to support marsh landward migration | Policy Development | Long-range Planning, Capital Planning | EBRPD, HARD, SCC, DFW, BCDC, SFEP, USFWS, Counties, Cities | Do It Yourself, Local, Regional |
| **S13.5** | Establish rolling easements to prevent shoreline armoring that would foreclose options for the landward migration of tidal marshes | Policy Development | Long-range Planning, Capital Planning, Ordinances, regulations, codes | EBRPD, HARD, DFW, Counties, Cities | Local, Regional, State |

Physical Vulnerability

**Vulnerability S14:** Managed marsh systems are particularly sensitive to sea level rise and storm events because they rely on water level control structures (tide gates, berms, and levees), some of which are already in need of repair.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **S14.1** | Prioritize the inspection, maintenance, and repair of control structures such as tide gates, berms, and levees, especially after large storm events | Policy Development, Program/operation | Operations | EBRPD, HARD, DFW | Do It Yourself, Local |
| **S14.2** | Enhance or improve control structures such as tide gates, berms, and levees, especially those in need of repair | Program/operation | Long-range Planning, Capital Planning, Project Planning and Design | EBRPD, HARD, DFW, BCDC, USACE, EPA, RWQCB, SCC, USFWS | Do It Yourself, Local |
| **S14.3** | Restore managed marshes to tidal action | Program/operation | Long-range Planning, Capital Planning, Project Planning and Design | EBRPD, HARD, DFW, BCDC, USACE, EPA, RWQCB, SCC, USFWS | Multi-benefit, Local, Regional, Long Lead Time |

Physical Vulnerability

**Vulnerability S15:** Stormwater drainage at shoreline parks and golf courses in low-lying areas will worsen with sea level and groundwater rise.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **S15.1** | Improve drainage by installing under-drains, cross-drains, backflow or flex valves, or perimeter drains | Program/operation | Capital Planning, Operations, Project Planning and Design | EBRPD, HARD, City DPW or City Parks | Do It Yourself, Multi-benefit, Local |
| **S15.2** | Elevate the surface or grade of facilities in low-lying areas with poor drainage, or relocate them to higher areas | Program/operation | Long-range Planning, Capital Planning, Project Planning and Design | EBRPD, HARD, City DPW or City Parks, CBOs | Do It Yourself, Local |
| **S15.3** | Convert active use areas to passive uses and re-purpose low-lying areas for uses that can be temporarily flooded | Program/operation | Long-range Planning, Capital Planning, Project Planning and Design | EBRPD, HARD, City DPW or City Parks, CBOs | Do It Yourself, Local |

# Sources Used to Develop the ART Subregional Adaptation Responses


Input from Subregional ART Working Group
Working Group Meeting #9, March 26, 2013
http://www.adaptingtorisingtides.org/news-events/

Adapting to Climate Change: A Planning Guide for State Coastal Managers
NOAA Ocean and Coastal Resources Management Center for Climate Strategies
http://coastalmanagement.noaa.gov/climate/adaptation.html

Synthesis of Adaptation Options for Coastal Areas
EPA Climate Ready Estuaries
http://www.epa.gov/climatereadyestuaries/downloads/CRE_Synthesis_1.09.pdf

Flood Damage Reduction Measures
US Army Corps of Engineers
http://www.nwo.usace.army.mil/nfpc/NFPC_Measures_Matrix.pdf

Center for Climate Strategies Adaptation Guidebook: Comprehensive Climate Action
Center for Climate Action
http://www.climatechange.ca.gov/ecrcf/docs/CCSAdaptationGuidebook2011.pdf

California Climate Adaptation Planning Guide
California Natural Resources Agency and California Emergency Management Agency
http://resources.ca.gov/climate_adaptation/local_government/adaptation_policy_guide.html

Climate Ready Water Utilities Updated Adaptation Strategies Guide for Water Utilities
U.S. Environmental Protection Agency
http://water.epa.gov/infrastructure/watersecurity/climate/upload/epa817k13001.pdf

Flooded Bus Barns and Buckled Rails: Public Transportation and Climate Change Adaptation
Federal Transit Administration Office of Research, Demonstration and Innovation
http://www.fta.dot.gov/research

Taming Natural Disasters: ABAG Multi-Jurisdictional Local Hazard Mitigation Plan for the San Francisco Bay Area (2010 Update of 2005 Plan)
Association of Bay Area Governments
http://quake.abag.ca.gov/mitigation/

Adapting to Climate Change Project Summary Report and Action Plan
City of Castlegar and Colombia Basin Trust
http://www.cbt.org/Initiatives/Climate_Change