

Developing an Adaptation Response: The Plan Step

ADAPTING TO RISING TIDES PROJECT

DECEMBER 2013

The Adapting to Rising Tides (ART) project is a collaborative effort to understand how sea level rise and storm events will affect San Francisco Bay Area communities, infrastructure, ecosystems and economy. Led by the San Francisco Bay Conservation and Development Commission in partnership with the NOAA Coastal Services Center the ART project engaged communities in a subregion of the Bay Area in an adaptation planning process (see Figure 1) that resulted in strategies that can be pursued both locally and regionally to reduce and manage the risks of rising Bay water levels.

The ART project began by defining the extent of the area to be studied. A subregion of the Bay Area that includes a portion of the Alameda County shoreline extending from Emeryville to Union City was selected based on local interest, capacity, and the mix of natural and built shoreline assets potentially at risk. Next the project convened a working group comprised of representatives from local, county, regional, state and federal agencies as well as private entities that work in the subregion. The working group helped the ART project team to define broad resilience goals and project objectives, develop communications strategies, identify important assets along the shoreline, select climate scenarios and identify impacts associated with sea level rise and storm events to be considered.

Next the project assessed the subregion's vulnerability and risk to sea level rise and storm event impacts using an approach developed by project staff with input from the working group. The assessment began by characterizing the existing conditions of assets within the subregion. This set the stage for a comprehensive evaluation of the vulnerability of assets based on exposure, sensitivity, and capacity to accommodate or adjust to potential sea level rise and storm event impacts. Staff also broadly evaluated the societal, economic, environmental and governance consequences of sea level rise and storm event impacts in the subregion based on input from the working group and other experts.

FIGURE 1. ART Planning Process



Once the assessment was complete the results were organized both within and across asset categories in a manner that clearly communicated the key issues and outcomes of the assessment. This process facilitated the transition from assessing into response planning.

With the summarized subregional assessment findings in hand, project staff and the working group began the process of developing adaptation responses to address the key planning issues identified. The report that follows describes the approach and outcomes of this effort. It also presents information about the other components of the Plan step that were investigated by the project team but not taken up in a comprehensive manner by the project's working group.

The Plan Step

Adaptation planning is a process that evaluates vulnerabilities and risks and then identifies ways to increase community, organizational and asset resilience. The Plan step is the culmination of the adaptation planning process, and thus builds on, synthesizes, and benefits from the outcomes of the previous steps. There are five components of the Plan step, starting with refining resilience goals and ending with integrating adaptation responses into plans and processes that will lead to implementation. In the ART project, staff and the working group considered each component of the Plan step, but focused most deeply on the third step – developing adaptation responses for the subregion. The other components of the Plan step will be considered further and applied directly in follow-up ART project efforts at more refined scales.

The ART resilience goal was developed at the start of the project with input from the working group. A broad resilience goal was appropriate for a project of this geographic scale, involving numerous agencies and organizations, and addressing different types of assets.

Increase the preparedness and resilience of Bay Area communities to sea level rise and storm events while protecting critical ecosystem and community services.

Refining Resilience Goals

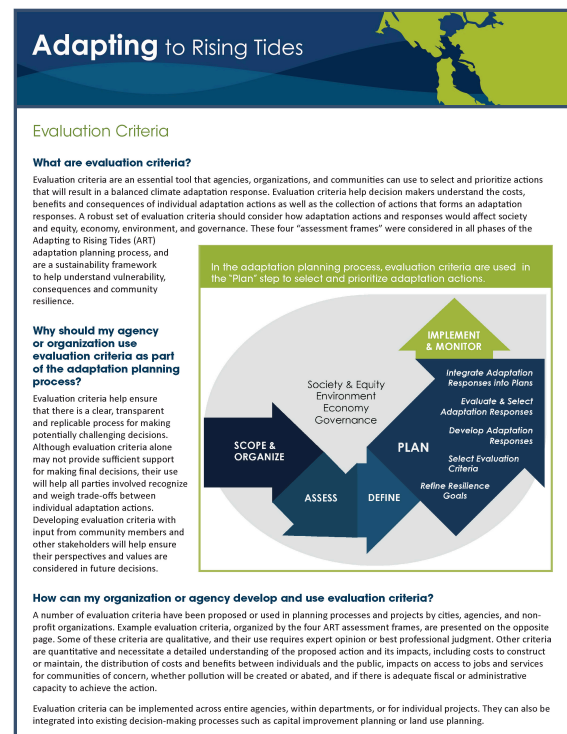
Resilience goals are a statement or series of statements defining the desired outcomes and primary focus of a climate adaptation planning effort¹. Depending on the purpose and scale of the project, the goals can either be broad or specific and focused. The ART resilience goal was broad due to the nature of the project, including the geographic scale, number of agencies and organizations, and number of different types of assets evaluated. The ART resilience goal was developed at the initiation of the project with input from the working group. Throughout the project it served as a guide. At the start of the Plan step, the goal was revisited to ensure that the outcomes of the assessment were grounded in the principles stated in the resilience goal.

¹ More information on refining resilience goals is available on the ART project website at www.adaptingtorisingtides.org/plan/.

Selecting Evaluation Criteria

Evaluation criteria are an essential tool that agencies, organizations, and communities can use to develop a balanced climate adaptation response that helps meet established resilience goals. Due to the geographic scale of the ART subregion and the number of asset categories that were included, evaluation criteria were not developed for the project. Staff did research how evaluation criteria have been used at different jurisdictional scales in different types of planning efforts. The findings of this research are presented in a 2-page guidance document available at the ART project website (www.adaptingtorisingtides.org/plan/).

Developing and selecting evaluation criteria will be a focus of future ART planning efforts at smaller geographic scales and within single asset categories. The criteria will help project participants refine, select and prioritize adaptation actions for implementation, but will also lay the groundwork for the ART project to develop additional resource materials and recommendations for developing and selecting evaluation criteria for climate adaptation planning efforts in the Bay Area.



Developing and Adaptation Response

In considering how to best address the vulnerabilities identified in the ART subregion, project staff and the working group quickly determined that a comprehensive approach that went beyond a list of actions or strategies was needed. The resulting adaptation responses, which are discussed in more detail below, connect actions directly to the findings of the vulnerability and risk assessment, and provide a path towards action implementation.

The ART subregional adaptation responses start with a **key vulnerability** classified using the system developed by the project to sort, characterize and communicate vulnerabilities and risks². The vulnerability classifications make it easier to identify specific and appropriate actions, the potential actors to be involved, and the processes and scales at which the actions could be implemented. For example, information vulnerabilities can be addressed through evaluations or assessments that are often most economical and

² 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/).

feasible at larger geographic scales, in particular for regionally significant assets. 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.

Each **action** in the adaptation responses is described in narrative and is labeled with a type. The action types³ - evaluation, policy development, coordination, program/operation, and education/outreach - communicate the kind of activities that might be required, and provide a means to identify actions requiring similar kind of efforts.

Each action is also labeled with action characterizations that indicate the potential priority, phasing, and scale of action implementation. As such, the characterizations can be used by agencies, organizations or communities screen actions to help select those that might be most feasible, timely, or politically and financially supportable.

The action characterizations – **Unlocking**, **Do It Yourself**, **Multi-Benefit**, and **Long Lead Time** – indicate the potential timing or priority of action initiation (see Appendix A for a complete description). **Unlocking** actions can serve as a stepping-stone to further action or can be the foundation upon which other actions depend, and are generally a priority for early implementation. **Do it Yourself** actions can be taken by an asset owner or manager without new partnerships or collaborations. Do It Yourself actions generally can be implemented during regularly planned maintenance connected to asset lifecycle using existing funding streams and through existing regulatory processes. **Multi-benefit** actions can improve asset performance or provide community benefits beyond addressing future sea level rise and storm events, and may more easily gain political support for early initiation. In addition, there may be existing funding sources that can be used for these actions. **Long Lead Time** actions generally require the coordination of many possible actors, require difficult decision-making, are controversial, or require collaborative planning, decision-making, funding or regional research. The benefits of most Long Lead Time actions will likely require more time and resources.

The ART subregional **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.

³ 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/.

For example, community planning processes that engage public, nonprofit, and private sector interests in consensus decision-making will take dedicated time and resources. The ultimate outcomes of Long Lead Time actions are significant improvements in local and regional resilience, and therefore should be implemented early to capitalize on the benefits they provide.

The last action characterization – **Scale** – indicates the possible geographic scales at which an action could be implemented. Depending on the agencies and organizations involved, some actions can be implemented locally, regionally, state-wide, or even nationally, while others are most appropriate for implementation at one specific scale. For example, developing an asset management system for transportation infrastructure may be most appropriate at the local scale for city streets and roads, however the California Department of Transportation could consider implementing this action regionally, for example within each District, or even state-wide.

The adaptation responses also include **implementation options** that highlight the potential actors – that is the agencies, organizations, individuals or groups – who should likely be involved and the processes that the actions could be integrated into (see Appendix B for a description of possible actors and processes in the ART subregion).

The elements of each adaptation response are presented together in the “ART Subregional Adaptation Response Cards” in Appendix E. A quick guide that explains each element presented on the adaptation response cards is provided in Appendix D. By keeping the three elements of the adaptation response together – the key vulnerability, actions, and implementation options – the ART project has developed a useful tool that can serve to communicate or jump start adaptation planning in the subregion and beyond.

Evaluating, Selecting and Integrating Adaptation Responses into Plans

The evaluation and selection of adaptation responses brings together the first three components of the Plan step – refining resilience goals, selecting evaluation criteria, and developing adaptation responses. The outcome is a suite of adaptation responses that have been selected and prioritized in a clear and transparent manner that can then be integrated into existing plans such as hazard mitigation plans, general plans, capital improvement plans, or operations and maintenance plans, or into a stand alone climate adaptation plan. Integrating the adaptation responses into existing or stand-alone plans will require consideration of how best to implement each action. This will include identifying the agencies, organizations, units, departments, or individuals responsible for initiating and administering the various actions, the timing to initiate them, the sources of funding that will be used, and any regulatory requirements that will need to be met before the action can be fully implemented.



As described above, the ART subregional project was a cross-sector, cross-jurisdictional, collaborative effort to investigate sea level rise and storm event vulnerability and risk and determine how best to improve shoreline and community resilience. The ultimate goal of this project was not a consensus adaptation plan for the subregion, as this was neither feasible nor practical. Rather, key outcomes are a vulnerability and risk assessment and subregional adaptation responses that can be used by the ART working group members and other stakeholders from the subregion to begin addressing the key climate issues identified either independently or collectively. Additionally, the project is providing a “road tested” portfolio of adaptation tools, processes, and frameworks that can be used in the subregion and by others to plan for and respond to sea level rise and storm events. This report, and the process and efforts used to develop the content within it, is an important part of this ART adaptation planning portfolio.

Summary of ART Subregional Adaptation Responses

The ART project developed possible adaptation responses to address the subregional vulnerabilities identified in the assessment using published resources, best professional judgment, and input from the working group (see Appendix C). The complete set of subregional adaptation responses are presented in Appendix E, along with a quick guide that defines and describes the elements of the responses (see Appendix D). Below is a summary of the adaptation responses based on the key issues revealed in the ART assessment that affect the entire subregion and are pertinent to most, if not all, of the asset categories.

The key issues identified in the ART assessment fell into five main themes: information gaps, emergency preparedness and response, population characteristics, certain land uses, and networked infrastructure. The subregional adaptation responses reflect the prominence of these issues, and highlight how similar actions will be necessary for all types of assets and jurisdictions to improve local and regional resilience to sea level rise and storm events. The summary that follows describes some of the fundamental actions that can be taken to address these key issues that are relevant both within and beyond the ART subregion. The actions and implementation options exemplified are drawn from both the asset category and overarching adaptation responses. In this way, the summary is both a guide to how the subregion can seek efficiencies in implementation, and an indicator of the most pressing actions needed to address the challenges the subregion faces as the Bay rises.

Information Gaps

Within the ART subregion and beyond there are significant gaps in the quality and availability of information necessary to understand the vulnerabilities associated with sea level rise and storm events. Publicly available information is often insufficient to support the type of collaborative planning that is required to conduct comprehensive vulnerability and risk assessments, or identify broad solutions to issues that cut across asset sectors or jurisdictions.

Many of the adaptation responses that address information gaps are most appropriately implemented at a regional scale. These efforts will likely only be successful if there is full participation from all of the relevant organizations, from local to regional, state to federal. Evaluation actions that address information gaps can be Unlocking as they provide the information needed or serve as the foundation for understanding the issues that need to be addressed in future actions.



Photo: M. Brennan

Example actions to address information gaps that can **Unlock** future action:

- Develop agreements to improve the collection and dissemination of historic and current weather data
- Establish and support regional research on impacts of sea level rise on marshes & mudflats
- Engage Federal agencies in leveraging regional flood mapping data, studies, and models that will help inform future flood risk

Some Unlocking evaluation actions can be implemented locally. For example, improving the understanding of the shoreline can start with a review of existing conditions information. This action should be implemented early as it is the first step in understanding shoreline vulnerability and will facilitate the next action – creating a high quality, centralized, shoreline asset management database. Improving the quality of shoreline information and developing mechanisms to manage and share this information are Multi-benefit actions that help asset owners and managers become better prepared to respond to hazards such as earthquakes and address existing stressors that currently impact shoreline recreation and access.

Many information gaps can be addressed through Do It Yourself actions. For example, improving the quality and accessibility of the data needed to assess and plan for transportation, utility, and shoreline vulnerability and risk is an action that can be taken up by the asset owner or manager, independent of whether they are at the local or regional scale. These evaluation actions are also Multi-benefit because they can improve the capacity to plan for, and respond to, multiple hazards. These actions can also improve the efficiency of day-to-day planning and operations activities.

Some of the Multi-benefit actions to address information gaps may also require a Long Lead Time as there are many possible actors that will need to participate. For example, developing and



Photo: ART project

Example actions to address information gaps that are **Do It Yourself**:

- Review existing asset information
- Collect / improve asset information
- Develop an easily accessible asset information database
- Share high quality asset information in a centralized

maintaining centralized databases, adopting agreements for managing and sharing information, or developing platforms to share unrestricted information broadly, will require coordination and the decision-making of numerous possible actors. Due to the need for significant coordination, the time between initiation and results may be long. Because these types of coordination actions will broadly benefit communities, agencies and organizations both locally and regionally, they should be prioritized for early implementation.

Emergency Preparedness and Response

Most of the plans, policies and practices that guide emergency planning in the ART subregion or elsewhere are not adequate to address the contingencies and secondary impacts associated with widespread or long-lasting flooding and inundation due to sea level rise or storm events. This is especially true for residential areas that are not currently at risk of flooding. Additionally, emergency plans do not always identify the specific needs of community members or include strategies for managing those needs. For example, responders may need specialized equipment or evacuation procedures for less mobile or medically dependent individuals, and for facilities and individuals that care for animals (shelters, zoos, pet owners). In addition, “real time” information about the status of hazardous material sites, contaminated lands, and shoreline protection infrastructure is generally not available or is hard to obtain when it is most needed.

Similar to other evaluation actions, improving local and regional information about the community members and facilities at greatest risk can Unlock further actions such as improving or updating plans, policies and practices to address sea level rise and future storm events. Addressing inadequacies in current emergency plans generally will require coordination, policy, program, or operational actions that are Multi-benefit as they will improve preparedness and response capacity for other types of emergencies and disasters. Some of these actions can be Do It Yourself, in particular when an individual agency or organization already has

emergency plans, policies or practices, while others will require broader coordination. For example, establishing mutual aid agreements or strengthening joint protocols with adjoining jurisdictions for cooperative disaster response will require the active participation of more than one agency or organization.

Many of the actions to improve emergency preparedness and response can be implemented either locally or regionally, by communities, agencies, and organizations individually or collectively through multi-agency or cross-jurisdictional partnerships. Coordination efforts aimed at better addressing the needs of those most at risk during an emergency, for example by improving information sharing between public and private agencies and organizations, will generally require a number of partners, and will take time to achieve tangible outcomes. These actions therefore will have a Long Lead Time, and

Example actions to address emergency preparedness and response that are **Multi-benefit** include:

- Develop community-led campaigns to educate the public about the specific needs of those most at risk
- Revise plans, policies, and practices to improve the capacity for emergency responders to address the specific needs of community members most at risk
- Require facilities that generate, transport, and/or store hazardous materials to consider the risk of flooding or elevated groundwater in emergency, facility operations, and capital improvement plans

because they will improve the capacity to prepare for and respond to all types of emergencies, including sea level rise and storm event flooding, local communities, the region, and their partners should begin investing in these efforts sooner rather than later.

Population Characteristics

Certain community members tend to be especially vulnerable to flooding and storm events because they are more likely to lack access to information and services, or the financial means or the physical capacity to prepare for or respond to flooding or other hazards. There are many Unlocking actions that can help to address this vulnerability including:

- Improve the understanding of the location and needs of community members most at risk by conducting neighborhood scale assessments
- Evaluate the facilities and services these community members rely on
- Provide critical information about these community members to decision-makers so they can address specific financial and technical needs during an emergency and the recovery from an emergency to minimize relocation and lost jobs

Characteristics of community members most likely to be at risk during flood events:

- Elderly
- Very young
- Caretakers of the elderly or very young
- Linguistically isolated
- Low income
- Mobility limited
- Medically dependent
- Without a car
- Without insurance
- Renters
- Pet owners and other caretakers of animals



There are also a number of Multi-benefit actions that can reduce the vulnerability of at-risk community members by improving neighborhood and community resilience. These education, outreach, program, and operational actions should be locally implemented and focused on improving the strength of neighborhood social networks that can reduce the impacts of storm events and other hazards such as earthquakes, wildfires, and heat waves. Neighborhood social networks are informal and built on the relationships of those that live, work, and use the services within them. These networks can easily be severed, in particular if homes are not habitable or services not available soon after an event occurs. Once disrupted, neighborhood social networks are difficult, if not impossible, to rebuild. Actions to improve the strength and capacity of neighborhood social networks to prepare for and address emergencies and disasters will focus on training, coordination, and technical assistance.

The risk that certain community members will be affected by sea level rise and storm events can also be reduced through policy development actions that result in land use planning and design practices or policies that create resilient neighborhoods and communities. Making changes to land use, community development, infrastructure and facility design practices, whether through guidance, policy, or financial incentives, will require a Long Lead Time. These actions can be implemented locally, but will have a greater affect if implemented regionally and if they are based on a clear understanding of the specific characteristics and needs of communities, neighborhoods and individuals. Initiating an Unlocking evaluation action before developing new plans or policies is essential to making decisions with the best information available about how to reduce risks. As an example, it would be prudent to identify the specific planning and design changes needed, such as limiting the types of land uses that can be built in at risk locations, before engaging in policy discussions.



Example **Multi-benefit** actions to address neighborhood resilience include:

- **Build community capacity by offering emergency response training and providing technical assistance to create neighborhood response plans**
- **Improve coordination between public agencies and organizations and community, faith-based, and non-profit organizations**
- **Develop and support neighborhood response centers**

Certain Land Uses

Because of the functions they serve, certain types of land uses are particularly difficult to protect, evacuate, or rebuild in a manner ensuring public health, safety and welfare. For example, in the ART subregion there are a number of elder care, long-term care, and skilled nursing facilities, an animal shelter, and many residences that are at risk of flooding from sea level rise and storm events. These land uses, and the many public and private facilities that support them, are vulnerable because of reliance on an uninterrupted power supply, access to clean water and food, and safe access. This vulnerability is of particular concern for

facilities that are intended to play a role in emergency response and recovery, such as sheltering locations or coordination and communication centers.

Example actions to address certain land uses that can **Unlock future action:**

- **Initiate a regional collaboration to investigate and recommend approaches for addressing sea level rise a storm event impacts**
- **Coordinate regionally to develop policies to improve the Bay Area's ability to plan for, respond to, and recover from all shoreline hazards**
- **Plan for future growth in a manner that does not place additional people in harm's way**

Most of the plans, policies and practices that guide land use and community development in the ART subregion and elsewhere do not consider that there are certain land uses that are more at risk from sea level rise or storm event impacts than others. If growth in the region follows past practices without considering future flooding, the number of people at risk will increase considerably. Regional evaluation and coordination actions are needed to address this challenge. These actions are Unlocking and will have a Long Lead Time as the number of possible actors and the scale of potential action could be quite broad. Because the outcome of these actions will be important to protecting public health and safety and ensuring the economic health of the region, they should be high priority for early initiation at the regional scale.

Ensuring that critical community services are maintained, in particular those that support the land uses most at risk, is critical if significant consequences to public health, safety and welfare are to be avoided. There are a number of Do It Yourself actions to address this issue, including evaluating individual facilities that provide key community services, developing site-specific strategies to reduce service disruptions or closures, and improving access to auxiliary water and power. These actions are also Multi-benefit and could be locally or regionally implemented depending on the agencies and organizations that own and operate the facilities. Additionally, actions to reduce dependence on critical facilities that are vulnerable will also improve resilience. This can be achieved by increasing capacity at facilities not at risk, and by developing policies or incentives to encourage or require that new facilities are not located in areas at risk. Both of these actions will require a Long Lead Time and should be prioritized for early implementation as they have the potential to greatly improve community resilience.

Many land uses, including residential, commercial and industrial employment sites, and community facilities are vulnerable to sea level rise because they were not designed to withstand flooding, rising groundwater or saltwater intrusion. Essential mechanical and electrical equipment, such as fans, boilers, and pumps are highly sensitive to water and salt and are often located at or below grade. Many of these structures also have habitable, below-grade spaces that are vulnerable in particular to rising groundwater. When flooding damages residences, employment sites, and community facilities there is an additional risk that hazardous materials will be released.

Actions to address these physical vulnerabilities include a mixture of "carrot and stick" options that either provide incentives or require that potential impacts are avoided or reduced. These Unlocking actions include developing and distributing guidelines on how to design or retrofit structures to accommodate periodic

flooding; reviewing codes, standards and regulations for the construction and placement of structures in areas at risk; and evaluating the flood insurance eligibility of structures with habitable below grade space in high risk areas. These actions can be implemented locally, regionally, statewide, or nationally, and should be prioritized for early initiation as they can provide the foundation for future beneficial actions that will help ensure resilient community design.

There are many Do It Yourself actions that can be implemented by agencies or organizations responsible for structures or facilities. For example, retrofitting with waterproof and corrosion proof materials; raising or protecting entrances, windows, or foundations; or elevating sensitive equipment or hazardous materials above projected flood levels. Other Do It Yourself actions focus on education and outreach to improve communities and neighborhoods capacity to prepare for and respond to storm events or floods. These include providing information and resources to community members to help them improve their level of flood protection, encouraging property owners to purchase flood insurance and educating them about what the policies do and do not cover, and encouraging residents to reduce the amount of hazardous household wastes they store by taking advantage of disposal and drop off options. There are also Do It Yourself policy development actions such as creating incentives for property owners to repurpose below grade spaces to less vulnerable or temporary uses; prohibiting below-grade living spaces in new developments; and eliminating below-grade habitable space that could be damaged by sea level, storm events and groundwater rise.

Building and maintaining neighborhood and community capacity to accommodate and respond to storm events, sea level rise, and other hazards will require the active engagement and participation of community, faith-based, private industry and non-profit organizations in addition to government agencies and organizations. Unfortunately, many non-governmental organizations do not have the capacity to fully participate in resilience efforts, nor do the governmental agencies that often lead these efforts have the processes in place to fully engage these groups in planning and decision-making. Actions to address this vulnerability are aimed at education, outreach, policy and programmatic changes that foster engagement and participation. This includes Unlocking actions to build community support for community, faith-based, private industry and non-profit groups and their leaders to participate in collaborative climate planning efforts, and encouraging decision-makers to provide public funds to support the participation of these groups in



Example **Do It Yourself** actions to address certain land uses include:

- **Retrofit, raise, or protect sensitive equipment to avoid or accommodate flooding during storm events**
- **Educate property owners about flood insurance, costs, benefits, and coverage limitations**
- **Develop policies that require or create incentives to re-purpose below grade habitable space that is at risk of flooding**

local resilience efforts. Additionally, creating and implementing a framework that governmental and non-governmental agencies and organizations can use to engage in open and transparent processes is a Multi-benefit action that will also provide a means for involvement and input in other planning and decision-making efforts. Lastly, efforts to obtain public funding or develop planning and decision-making frameworks will have a Long Lead Time, as there will likely be a large number of partners and potentially controversial issues to be resolved.

Networked Infrastructure

Networked infrastructure is particularly susceptible because disruptions to one segment of a network can cause cascading, secondary impacts in adjoining segments or even farther away. Most of the networked infrastructure in the Bay Area is essential to day-to-day community and economic function, and is critical during an emergency or disaster for an effective and timely response. Actions to address networked infrastructure vulnerability focus on conducting evaluations to pinpoint key issue areas, reducing physical sensitivity of critical components, seeking alternatives to reduce or avoid potential disruptions, and increasing organizational capacity. The goal of these actions is to reduce existing stressors, both physical and organizational, undertake improvements or new investments wisely, and broaden the discussion of resilience beyond the asset owner or manager to those that are protected by, or rely on, the asset.

Because networked infrastructure is as resilient as its weakest link, evaluation actions that identify sensitive components can help to prioritize future assessments or investments. “Hot spots” analyses can identify particular network components and segments that are most at risk due to their function, type, elevation or location. For example, some network components and segments are located at or below grade, in low-lying areas, across tidal streams or the Bay, or sit under wharves. The vulnerability of these components and segments may depend on whether they are water or salt sensitive, or if they rely on an uninterrupted power supply. For some networked infrastructure owners, hot spot or weak link analyses are Do It Yourself actions that they can initiate independently. For others, such as structural and natural shorelines, interconnected utility networks, and transportation assets owned and operated by more than one



Networked infrastructure includes:

- **Transportation assets, such as heavy and light rail, bike and pedestrian routes, that provide access to goods, services, jobs, schools, family, friends, and recreation opportunities**
- **Utilities that provide communities water, power, and a means of communication**
- **The shoreline, both natural and structural, that provides access to the Bay and protects inland communities and job centers from flooding during extreme water levels that occur during storms**

agency, evaluation actions require coordination and are not likely to be conducted independently.

Evaluation actions that identify the weakest link of a network can be Unlocking as they can lead to further actions that reduce the vulnerability such as retrofitting sensitive components with water or corrosion resistant materials, elevating or relocating sensitive components, or constructing temporary or permanent protection barriers. These Do It Yourself actions could be incorporated into annual operations or maintenance plans, initiated when assets are undergoing repair or upgrade, or as funding becomes available.

The resilience of networked infrastructure can also be improved by increasing the system's capacity to accommodate or adjust to an impact. This can generally be accomplished by first initiating Unlocking actions such as identifying undersized components or conducting studies to identify where capacity is currently limited. The actions that follow are generally Do It Yourself and Multi-benefit actions that increase capacity or redundancy where possible, improve the ability of critical components to accommodate impacts and enforce existing policies or practices to minimize stressors and avoid future challenges. For particular assets, such as the Oakland International Airport and the Port of Oakland Seaport, it is very difficult if not impossible to increase capacity and there are no adequate alternatives with sufficient capacity in the region to replace their function. In these cases, it will be necessary to seek creative solutions to address potential operational disruptions.

For some networked infrastructure it may ultimately become necessary to relocate it to areas not at risk. Developing policies, incentives and decision-making frameworks to determine if new infrastructure should be built in areas at-risk, or if existing infrastructure should be protected or relocated to areas not at-risk, are Unlocking actions that will support many future actions. These actions also require a Long Lead Time because of the numerous agencies and organizations that will need to participate, and because moving or building infrastructure in new locations can be both highly controversial and resource intensive. Evaluation actions will be necessary before these policy actions are initiated, and should be implemented early as the results will take time, but will help to avoid capital investments that could result in placing additional communities and individuals at risk.

There are also a number of actions that can build the capacity of agencies and organizations that own or operate networked infrastructure so they can more efficiently work together. These include improving communication and coordination, forming or expanding partnerships, and developing multi-agency agreements to guide collaborative planning and decision-making. Many of these actions are Unlocking as they will lead to further, refined actions. For example, expanding or forming broad public-private partnerships or developing shared decision-making frameworks are often necessary first steps of a complex planning effort. Many of the actions are also Multi-benefit, and will improve capacity to response to other hazards such as earthquakes, landslides or fire.

Summary and Conclusions

The set of adaptation responses developed for the ART project are a resource that agencies, communities and asset managers in the subregion can use to develop an adaptation plan to increase resilience to sea level rise and storm events. The adaptation responses can also help agencies, organizations and communities beyond the subregion move quickly and efficiently through the Plan step. They can be used as presented, or be refined and customized to best achieve the project's agreed upon goals and objectives. Lastly, for those initiating an adaptation planning effort, gaining an understanding of the types of responses that were developed for the ART subregion can help determine the appropriate scope and scale of effort needed early in the project during the scoping and organizing step. This will save time and reduce efforts wasted on assessing issues, asset or geographic scales that will not address the vulnerabilities and risks that will be faced as the climate continues to change.



Appendix A.

Action Characterizations in the ART Subregional Adaptation Responses

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

Appendix B.

Implementation Options, Possible Actors and Processes

Possible Actors in the ART Subregion

Possible actors are identified 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 governance⁴ – 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
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

⁴ For information on issues regarding governance and adaptation, see the *Adapting Governance to Rising Tides Issue Paper* available at <http://www.adaptingtorisingtides.org/governance/>.

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

Appendix C.

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

Appendix D.

ART Subregional Adaptation Responses