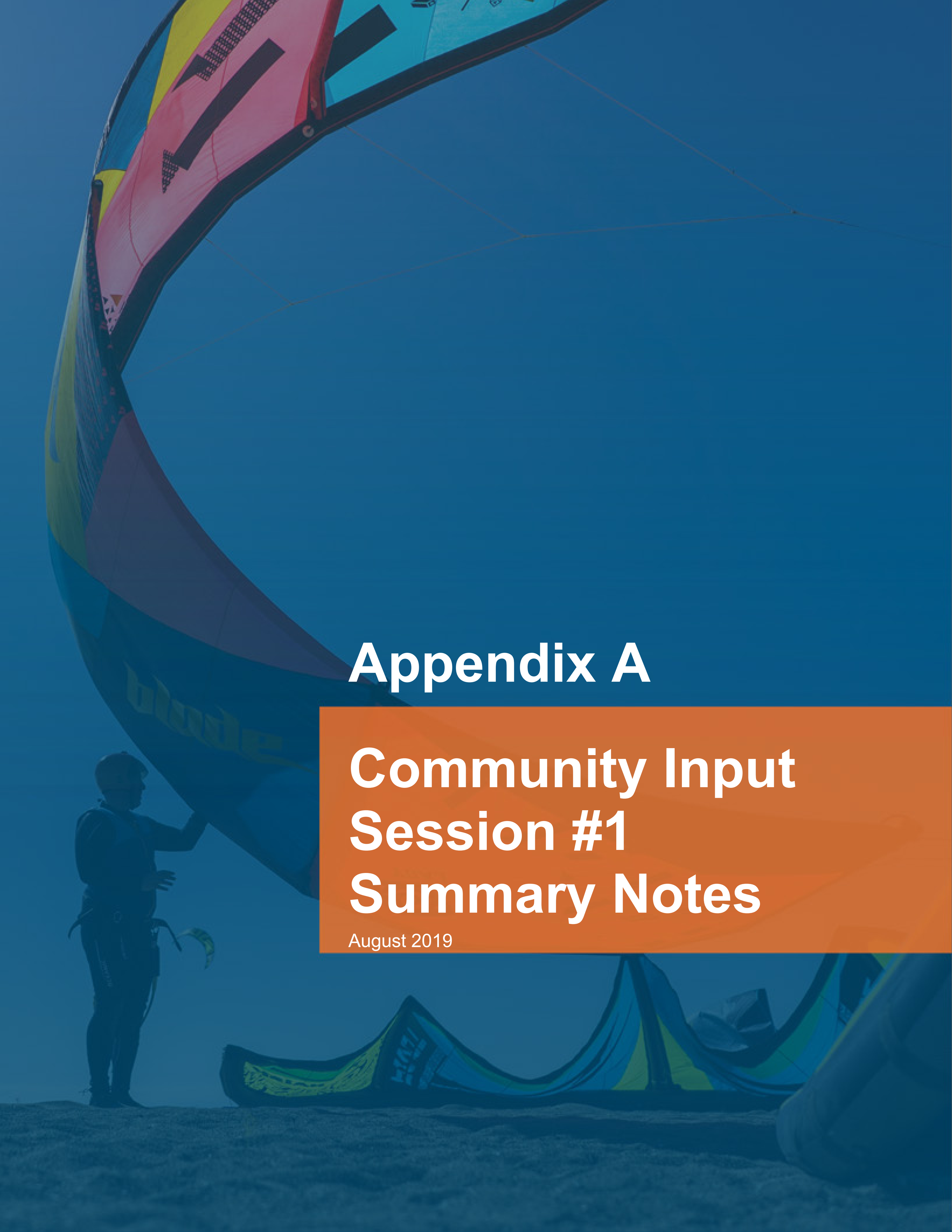


Appendix A

Community Input Session #1 Summary Notes

August 2019

City of Alameda Climate Action and Resiliency Plan Update

September 24, 25, 26, 2018, 6:30–8:00 p.m. PT

LOCATIONS

9/24: Lincoln Park Harrison Recreation Center, 1450 High Street, Alameda, CA 94501

9/25: Harbor Bay Isle HOA, 3195 Mecartney Road, Alameda, CA 94502

9/26: Albert H. DeWitt O Club, 641 W Red Line Avenue, Alameda, CA 94501

PARTICIPANTS

122 attendees across all three locations

SUMMARY

Kicking Off Climate Action and Resiliency Plan (CARP)

- Erin Smith (City of Alameda) welcomed participants and shared introductory remarks on the importance of the Community Input Session and why the City is taking action to address climate change and greenhouse gas (GHG) emissions. She explained the need for the City to adapt and become resilient to these climate-related threats. She noted the CARP will build on past work and accomplishments, including previous plans and reports, town hall forums, public input surveys, and stakeholder engagement. She highlighted the CARP process and timeline and that Community Input Session #1 was focused on gathering priority ideas. Following these sessions, Ms. Smith explained, the City and Eastern Research Group, Inc. (ERG) would assess and analyze all the ideas gathered throughout the process and recommend priority GHG mitigation measures and climate adaptation strategies for implementation. These recommendations would be further vetted by the Green Working Team, Task Force, and community. Ms. Smith also noted details for two Federal Emergency Management Agency public outreach meetings.

- Tegan Hoffmann (ERG) shared Community Input Session #1's objectives:
  - Increase mutual understanding between City and community about the vision and goals for the CARP;
  - Solicit ideas for actual actions, both to increase resilience (adaptation) and for mitigation, that both the City and community can take to achieve those goals; and
  - Learn about community priorities.

  The outcomes that the City hopes for are: proposed strategies from community members for reducing our GHG emissions, increasing our resilience to climate change impacts, and becoming more sustainable overall.

Community Input Session Activity

- Tegan Hoffmann (ERG) gave an overview of the session's Ketso activity, in which participants would work in groups to do active learning and sharing to catalyze action. The Ketso process included three stages of creative thinking:

— **Stage 1—future shared vision:** In the context of the CARP and setting 10-year goals, what is your aspirational vision for Alameda?
— **Stage 2—GHG reduction strategies to achieve vision:** What are key GHG strategies to achieve this vision?
— **Stage 3—adaptation strategies to achieve vision:** What are key adaptation strategies to achieve this vision?

- The center of this activity's Ketso tree was the CARP. All questions for each stage were framed in the context of five branches:

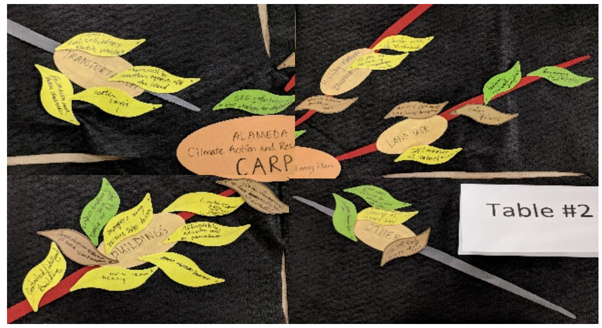
— **Transportation** includes all modes of transportation such as bicycles, pedestrians, cars/trucks, ferries, transit (buses/trains), and the systems that support these modes of transportation.
— **Land use** includes existing and future land use planning, ordinances, rules, regulations, land use policies, city master plans, and major development opportunities such as Alameda Point.

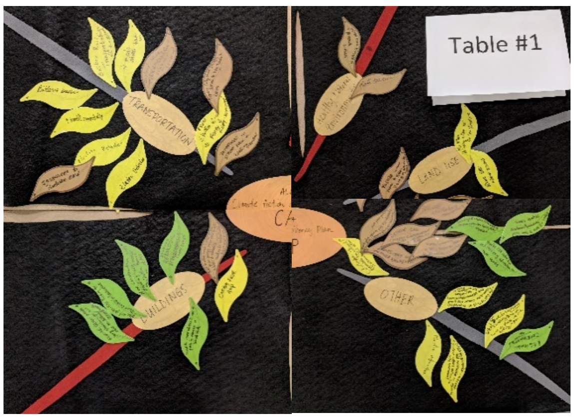
— **Buildings** includes residential/commercial/government buildings, new development and re-development of buildings, energy efficiency, alternative energy use in buildings, building codes, and standards.
— **Healthy natural environments** includes shorelines, wetlands, parks, open space, air quality, and water quality.
— **Other** includes waste (waste management, landfills, hazardous waste sites, and storage facilities), energy sources and use, earthquakes, utilities (energy and communication infrastructure), and utilities (water, wastewater, and stormwater infrastructure).

- Within each group, each participant wrote their ideas down for each stage on leaves, shared their ideas, and placed the leaves on relevant branches. For Stages 2 and 3, participants reviewed handouts on example GHG strategies and adaptation strategies for their reference.

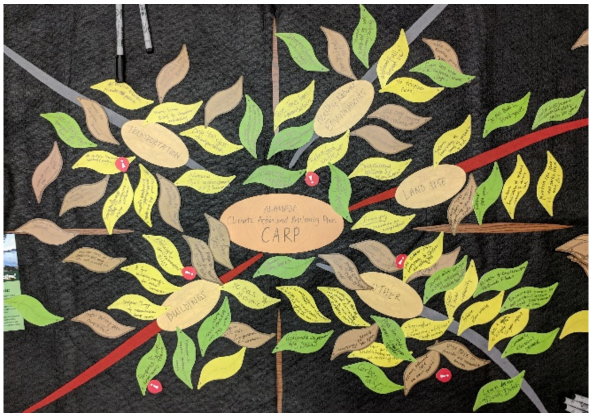
- After the Ketso activity, Tegan Hoffmann (ERG) asked participants to share what they liked about the exercise with their groups and called on volunteers to share back with the larger group. Some of the thoughts shared by participants included generally positive reviews of the highly interactive activity, an appreciation for the opportunity to engage with others in their community who share common concerns, disappointment that there was limited time and opportunity to dive into specific topics in more depth, and a desire to make Alameda a leader on climate action. All participants were invited to look at other groups' Ketso trees.

9/24 Community Input Session Activity–Ketso Trees





9/25 Community Input Session Activity—Ketso Trees



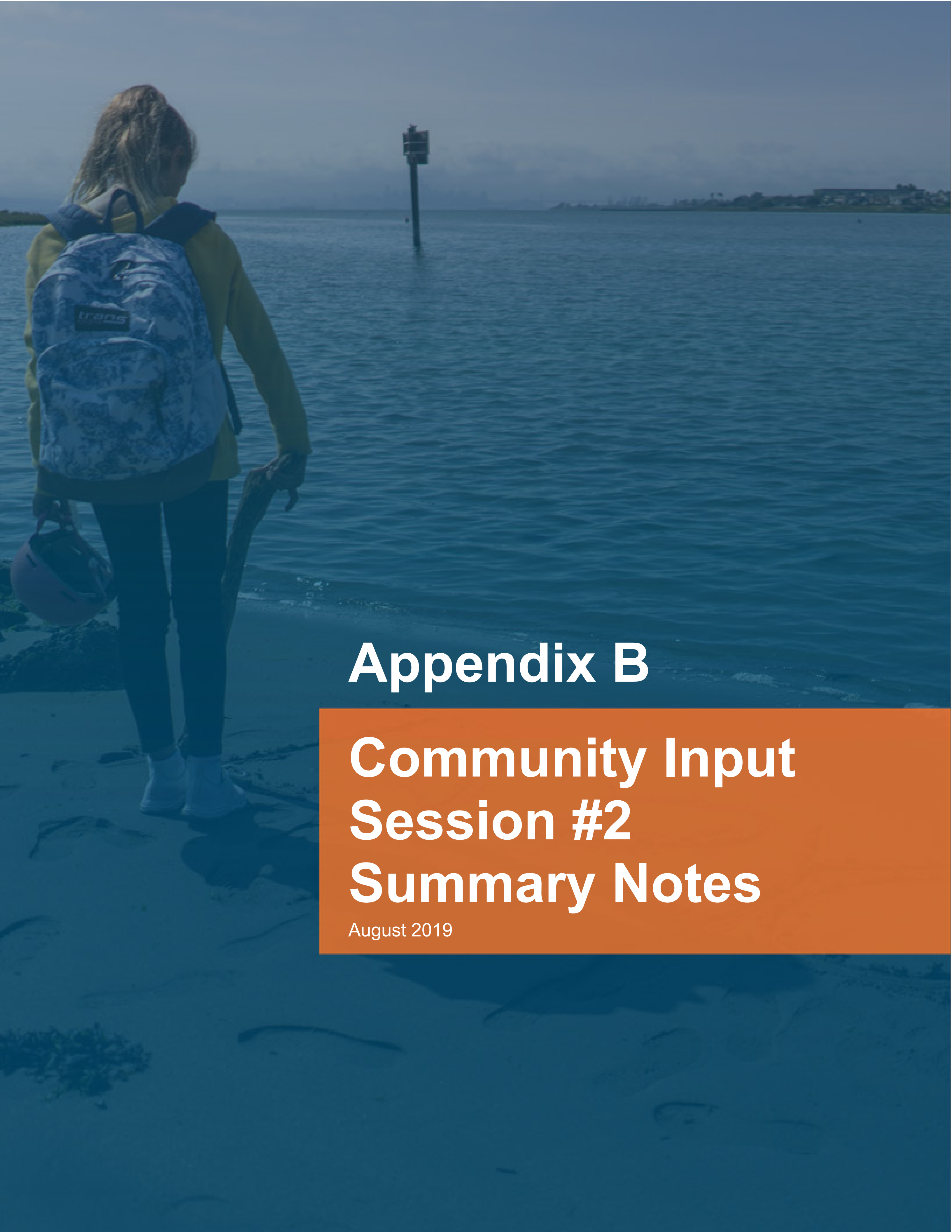
9/26 Community Input Session Activity—Ketso Trees

Parking Lot Items: Community Input Session #1, All Three Locations

- Making transportation more accessible for non-car drivers, tunnels one-way in, one-way out.
- Sequestration quantification of wetland conversion square feet = how much GHG reduced and/or sequestered.
- Find room with better acoustics; hard to hear.
- What has Alameda done well when it comes to reducing GHG emissions since the initial 2008 plan (and not done so well)?
- Thinking about how we're defining vulnerability, what constitutes someone being vulnerable, must go beyond sea level rise. Who's being left out of the conversation (e.g., homeowners vs. renters) and who's being impacted differently?
- Should be having discussions on water (access to clean water, drought).

CARP Next Steps and Fill Out Evaluation Survey

- Tegan Hoffmann (ERG) noted that Community Input Session #1 would meet three times; participants who had further thoughts to share, or people could not attend Community Input Session #1, could share their thoughts on the digital workshop until 10/15/18 via www.opentownhall.com/portals/198/Issue_6744. Community Input Session #2, she said, would be held in December 2018; Community Input Session #3 (public comment) would be held in March 2019.
- Finally, Tegan Hoffmann (ERG) asked all participants to evaluate Community Input Session #1 via www.surveymonkey.com/r/sep26eval. She added that participants who were interested in more information or had more questions could visit www.alamedaca.gov/climateplan or e-mail climateaction@alamedaca.gov.



Appendix B

Community Input Session #2 Summary Notes

August 2019

City of Alameda—Climate Action and Resiliency Plan (CARP) Update
January 26, 2019, 9:00 a.m.–12:00 p.m. PT

LOCATIONS
Alameda High School (Cafeteria), 2201 Encinal Avenue, Alameda, CA 94501

PARTICIPANTS
70 attendees

SUMMARY

Welcome and Main Session Overview

- Erin Smith (City of Alameda) welcomed participants and shared introductory remarks on the importance of the Community Input Session and why the City is taking action to address climate change and greenhouse gas (GHG) emissions. She explained the need for the City to adapt and become resilient to these climate-related threats. She highlighted the CARP process and timeline and that Community Input Session #2 was focused on gathering additional priority ideas. Ms. Smith explained that following these sessions, the City and Eastern Research Group, Inc. (ERG) would assess and analyze all the ideas gathered throughout the process and recommend priority GHG mitigation measures and climate adaptation strategies for implementation. These recommendations would be further vetted by the Green Working Team, Task Force, and community. Ms. Smith went over the Climate-Safe Path, which describes different GHG emissions pathways. She noted the vision for the CARP, which was based on input from Community Input Session #1: *Alameda will be an innovative leader in achieving carbon neutrality and community resilience to climate change impacts, with community members actively involved in this work.*[1]

[1] Note: Alameda later revised the CARP vision based on the City Council's March 2019 declaration of a climate emergency. The new vision states that "Alameda will be an innovative leader in achieving net zero carbon emissions and community resilience as soon as possible, and serve as an example that inspires similarly impacted cities to do the same. Our community members will be a vital part of this ongoing process."

- Tegan Hoffmann (ERG) shared the Community Input Session #2 objectives:
  - Share CARP vision and recap outcomes from Session #1;
  - Ensure residents understand climate risks and hazards, as well as options to address them; and
  - Solicit feedback on priority adaptation strategies and GHG reduction actions that both the City and community can adopt.
- The outcomes that the City hopes for include input from community members on reducing Alameda's GHG emissions and implementing adaptation actions, increasing the City's resilience to climate change impacts, and becoming more sustainable overall.

Overview of Community Input Session Activity

- Tegan Hoffmann (ERG) gave an overview of the three breakout groups:
  - Group 1: GHG Reduction Actions;
  - Group 2: Adaptation Strategies—Sea Level Rise and Flooding; and
  - Group 3: Adaptation Strategies—Other Climate Risks (drought, fire, wildfire smoke).
- Participants had the opportunity to rotate and participate in each of the three different groups.

BREAKOUT GROUP 1	
GHG Reduction Actions	**Facilitator:** Paula Fields (ERG) **Notetaker:** Patrick Pelegri-O'Day (City)

Overview

- Paula Fields (ERG) presented an overview of the GHG reduction analysis process and reviewed the top 40 measures identified for detailed analysis. These include new actions and some current actions to be expanded upon (e.g., Transportation Choices Plan, Zero Waste Management Plan). The original 160 actions included Community Input Session #1 suggestions. We combined and reduced these to 40 actions for detailed analysis. Ms. Fields noted other actions not on this list will be addressed in the CARP, but not discussed at this time (e.g., building density, consumption-based emissions). GHG reductions were estimated using the same approach used in the 2015 GHG inventory, with best data available. Costs were estimated for capital and recurring annual maintenance/operation costs (costs to the City, costs to homeowners, etc.).
- The breakout group discussed the following questions:
  - What other issues should be considered when selecting an action to reduce GHGs?
  - What are suggestions of specific actions to implement to help achieve the goals?
  - Can Alameda establish a visionary reduction goal?
  - Which actions are most desirable and why?
- Prioritized strategies (by number of votes) are listed below. Participants voted for their top five strategies.
  - Standardize electric vehicle (EV) charging (at least 31 out of 70 people voted for this strategy):
    - Residents are concerned about equity in promoting EVs and incentivizing car culture; otherwise, this strategy should be the top priority.

- Promote EVs/light EVs and charging stations (25):
  - Work with Alameda Municipal Power (AMP) programs to promote zero emission vehicles.
  - Provide free travel for EV drivers during congestion pricing.
  - Work with sellers to provide credit to buyers.
- Natural gas ban (17):
  - Start with a surcharge on gas.
- Increase rooftop solar on buildings (19):
  - Look into implementing this on Bay Farm, where the Home Owners Association has odd rules about this practice.
  - Solar bond.
- Incentivize EV ownership (18):
  - Allow curbside charging.
  - Require Uber/Lyft to be EV.

- Compost in Alameda parks (18):
  - Great idea that can be used to potentially encourage community gardens/nurseries.
  - Compost and sequestration on no-till areas.
- Urban forest (15):
  - Give trees away for self-planting.
- 100 percent carbon neutral electricity (15).
- Convert existing buildings to all-electric (16).
- Congestion pricing (16):
  - And transportation alternatives.
- More bike lanes (11):
  - In addition to bike lanes, we need more bike and pedestrian-friendly corridors.
- New BART tube (2050) (11).
- Zero waste culture (11):
  - Include food production and consumption as contributing 1/3 of GHG emissions.
  - Increase awareness in schools—change behavior through education.
- Citywide *EasyPass* (11):
  - Free bus passes.
- Electrify City fleet (5):
  - Should be one of the easier strategies to implement.
  - Consider downsizing police cars. They constantly idle–do not need 100 miles per hour speeds on an island—must have gas option because an earthquake disaster may make electricity unattainable.
- EV-only lanes (8).
- Ban two stroke engines (8).
- Traffic signal synchronization (7).
- Promote telecommuting (6).
- Net zero energy for new construction (3).
- Green roofs (3):
  - Should be low cost. Simply needs ordinance to require light-colored roof shingles. There are many kinds of green roofs, and some are cheap.

- AMP incentives for electrification (1).
- Incentivize weatherization (1).
- Value of wetland sequestration (1).
- Multi-family housing (1).
- Substantial increase in housing production (1).
- Density and mass transit (1).

Group Discussion

Land Use and Transportation

- If we don't have a climate action plan that adds housing, it is a joke. If we want to be actual innovative leaders, then we need to add housing.
- Along the same lines, is the plan going to talk about how to get Alamedans on and off the island? Ferry service without bus service, as the last mile is a problem.
- It is important to link together housing, land use, and transportation in the plan and to show how we support the Transportation Choices Plan, etc.
- People want to know about the disaster preparedness aspect of all this—they are worried that adding housing will make it more difficult for people to get off the island.
- Participant has looked at smart spotlight technologies—synchronization in multiple directions.
- There's a difference between super ultra-low emission vehicles and EVs that needs to be clearly distinguished in the plan.
- Congestion pricing is regressive—we should be wary of it for equity reasons.
- Why is congestion pricing put off until 2050?

Methodology of Projections, Discussion of Costs, Benefits, Co-Benefits

- How do we weigh total GHG emissions vs. per capita?
- We show things for homeowners to implement as costs, but there are also long-term benefits to homeowners for implementing many of those measures.
- Make sure that 95 percent carbon neutral is switched to 100 percent carbon neutral.
- Need to reconcile the electrification numbers—why is it only 16,000 instead of the full 70,000, if we're stating that all buildings would be converted to electric-only? What does a phase-in of banning natural gas look like?
- Think about cool roofs, not green roofs; it can be cheaper to just have light-colored shingles.
- Some people want a lot of detail on the assumptions used in the calculations.
- Pursue multi-benefit actions; don't just go for EVs.
- Uber/Lyft as EVs and make sure to figure out curbside charging.

Workshop Feedback

- Note that on the quadrant, it's confusing that the "best" option is on the top left instead of the top right.

Parks and Urban Forest

- On the application of compost to parklands, differentiate between municipal compost and compost with biochar.
- People want more trees and want to understand why there aren't trees planted in the medians between the curb and sidewalk.
- We need to listen to this input about trees! Can we get grants to expand our urban forest and close the budget gap that is causing challenges right now?
- Get the right trees planted—ones that won't die.

Co-Benefits That Should Be Considered

- Amount that can be reduced in metric tons of carbon dioxide equivalent (MTCO2e);
- Cost to implement;
- Equity;
- Helps with climate resilience (e.g., green roofs);
- Externalities;
- Health costs;
- Cost of materials;
- Traffic congestion;
- Quality of life and desirability of community;
- Community acceptance of action; and
- Fossil fuel independence.

BREAKOUT GROUP 2	
Adaptation Strategies: Sea Level Rise and Flooding	**Facilitator:** Eliza Berry (ERG) **Notetaker:** Jennifer Lam (ERG)

Overview

- Eliza Berry (ERG) gave an overview of the Bay Shoreline Flood Explorer, https://explorer.adaptingtorisingtides.org/home, noting that the sea level rise view shows high tide lines and is based on data from 2017. Ms. Berry noted with the timeline for sea level rise that there is a range of uncertainty for when we experience this type of impact. Considering the more conservative end of the range, we should be prepared for 36 inches of sea level rise by the 2060–2070 decade. She added the CARP focuses on areas where there is more immediate risk and where current plans are not in place to address sea level rise. Ms. Berry explained that ERG was developing strategies that can be integrated into citywide strategies for the whole shoreline over time. She also noted that ERG was working with City staff to develop strategies and shoreline protection around Alameda and to address all the vulnerabilities around the shoreline. For the breakout sessions (and due to limited timing), the groups focused on Crown Beach and Eastshore Drive as example shoreline segments for discussion and explored the value of nature-based shoreline at these segments. The CARP covers other segments beyond these two examples.

- The Flood Explorer map does not include a model for groundwater. There is a significant data gap in regard to the interaction between sea level rise and groundwater in the region currently.
  - A participant shared that the data are different from Federal Emergency Management Agency 100-year flood estimates (e.g., Liberty Park)—lots of technical things to look at.
  - Another participant shared that the maps make it look like most flooding is at Alameda Point—good area to build up that point. In the northwest territories and deep A point (sea plane lagoon), the City already has plans for wetland restoration and a perimeter levy to develop the historic area.

- The breakout groups assessed the following questions for each site:
  - Which strategy (or combination of strategies) has the strongest alignment with the community vision for resiliency?
  - What are the trade-offs you considered? What changes or special considerations need to be taken with each strategy and/or site?

SITE: CROWN BEACH			
Strategy or Combo Strategies	**Criteria**	**Tradeoffs**	**Site-Specific Considerations**
1. Strategy 5—increase dune management. 2. Strategy 4—widen shoreline (goes with Strategy 5). 3. Strategies 1, 2, 6—need research and to know long-term benefits. 4. Too focused on a beach; could let go of it as a beach in the future (look at wetlands, oyster beds, dunes).	1. Least disruptive (politically, currently doing it already). 2. *Not assessed in meeting.* 3. Outputs for research will inform other strategies and maximize success. 4. *Not assessed in meeting*.	1. But we have to do it every 20 years so increase $. Might reduce recreational value of beach. 2. Kite borders; may be challenging to get approval by Bay Conservation and Development Commission (BCDC). 3. *Not assessed in meeting.* 4. Purchasing, repurposing.	1. How it affects beach on bay side, but could increasing dune space encroach in built environment? Vegetative network of dunes gets stronger and reduces strong erosion. Not enough barrier wetland sediment and protection. 2. Add marsh barrier wetland for mitigation of wave and wind impacts and limit runoff.

SITE: EASTSHORE DRIVE		
Strategy or Combo Strategies	**Tradeoffs**	**Site-Specific Considerations**
1. (new) Add wetland and living breakwater. 2. (new) Natural revetment. 3. As much natural solutions as possible; some hard barriers will be needed though. 4. More emphasis on addressing groundwater flooding, City groundwater collection in terms of greywater flooding (city/individual sub-pump system so residents can have access to water during drought seasons). 5. Disconnect in strategies (studies vs. implementation)—groundwater integration. 6. Look at Delta for solutions to groundwater. 7. Add clarity to discussion on interconnection between vegetation and wave energy attenuation.	1. *Not assessed in meeting.* 2. Eastshore becomes garbage collection site. 3. 3–7. *Not assessed in meeting.*	1. *Not assessed in meeting.* 2. Tidepools, fractals. 3. 3–7. *Not assessed in meeting.*

Group Discussion

- Is strategic retreat an option today? For Crown Beach, how it can be part of the bay?
- There is no cost information on the handout. What is strategy 3 vs. 4 vs. 5 cost in comparison? Need cost estimates to assess cost criteria.
- Is it safe to assume redistributing sand is most costly? Not that expensive but harvesting more sand out of bay is expensive.
- Do any strategies replace that as a strategy or complement? Evaluate future costs and how strategies can complement each other.
- Is there any consideration of a big event (e.g., earthquake) and its impact on the resiliency of measures and strategies? Any major infrastructure that the City builds has to meet seismic regulations.
- How has anyone looked at regular dredging? It's about stopping water but also diverting the water—wetlands work great in flooding events.
- What lessons can we learn from the Netherlands on how to keep water out? Leverage their knowledge on sea water practices. We can also look at the California Delta locally.
  - — Holland is dealing with natural environment and building up (dunes, holistic strategy), instead of insuring people for homes being trashed.
- There is legislation on future buildings, green roofs, etc. Are we taking future flooding into consideration for future buildings? Currently yes, and looking into the future, consider floating homes as an example.
- In terms of geomorphic ideas and working with land as is (instead of building own structures), what emphasis do you put in plans that make sure it aligns with the bay as a natural ecosystem

and not disrupting that? How to integrate our ideas with how the environment is currently with the least disruption to natural environment? There are basic laws that prevent us from impacting endangered species, etc. Anything proposed needs to look at impacts to the natural environment.

- City of Davis is not dealing with sea level rise but dealt with a huge storm event in the city. One neighborhood used bioswales and saved that area of the city.
- How closely are you looking at Resilient by Design Challenge, Adapting to Rising Tides, and BCDC work? Looked at both and working closely with BCDC. Design Challenge is focused on floating homes—hard to implement in the next year; it also did not really involve Alameda community members (a good idea, but a lot of conflicts).
- Likely need research to inform infrastructure development strategies.
  - San Francisco Bay Sponge: create more mudflats and augment them to be more porous (e.g., biorock used for coral reefs, carbon negative concrete).
  - Reinforced dune: use dead trees to reinforce dunes (Dutch are doing this) to deal with sea level rise and act as natural habitat.
- Mudflats will not help with sea level rise, but they reduce wave size so lower bulkheads or seawalls are needed. Wetland creation takes a lot of space.
- Water wheel track project as an example for natural revetment.
- Manhattan bulkhead project: build a 20- to 30-foot bulkhead to first ridge/tunnel to prevent water from coming in. This costs a lot of money, but the City could build parks and bike paths on top of it. East End—proponent of hard and natural solutions.
- How does the Marin Army Corps Bay Model compare to these maps? Very old (1940s)—a good educational tool, but we have better models today.
- The highest point in Alameda is 13 feet.

BREAKOUT GROUP 3	
ADAPTATION STRATEGIES: OTHER CLIMATE RISKS (fire, drought, wildfire smoke)	**Facilitator:** Arleen O'Donnell (ERG) **Notetaker:** Marisa Johnson (City)

Overview

- Arleen O'Donnell (ERG) presented an overview of other climate risk topics (heat, drought, wildfire smoke), selection criteria, and definitions of vulnerability and adaptation strategies. The group discussed the following questions:
  - Which adaptation strategy ranks most highly against the evaluation criteria?
  - How should this strategy be implemented?
  - For strategies that need to be sited, where should they be located?

- The adaptation strategies for heat, drought, and wildfire smoke are as follows:

HEAT	
1.	Identify heat islands and implement ways to make those locations cooler (increase street trees, green infrastructure, white pavement, cool/green roofs).
2.	Implement neighborhood-specific, visible green infrastructure and open space projects to test new ideas and communicate benefits.
3.	Plant heat-tolerant landscaping citywide.
4.	Establish adequate number of accessible, well-publicized cooling centers.
5.	Integrate cooling methods into energy-efficient building requirements (operable windows, green/cool roofs).
6.	Adopt shade tree codes (restrict tree removal/require replacement).
7.	Integrate wetland restoration and living shorelines to provide cooling for birds, wildlife, and people.
8.	Establish a heat alert system and "hot" line to warn vulnerable populations and provide emergency assistance as needed.
9.	Ensure communications address language barriers for non-English speaking populations.
10.	Establish temperature thresholds for restricting outdoor work hours for City employees and outdoor events.

DROUGHT	
1.	Implement a citywide water conservation program with a water use reduction goal (e.g., gallons per capita/day).
2.	Plant drought-resistant landscaping citywide.
3.	Implement a program to reduce outdoor water use.
4.	Increase public awareness of Alameda's water supply: where it comes from, status of the supply, water use, how to conserve, and benefits of conservation.
5.	Provide incentives (e.g., reduced or no-cost devices) to residents/businesses to encourage water conservation.
6.	Publicize and enforce water use restrictions (outdoor water restrictions, water upon request at restaurants, option to reuse towels/linens at hotels).
7.	Promote a system for rapid detection, reporting, and repair of water leaks.
8.	Work with East Bay Municipal Utility District (EBMUD) to improve the effectiveness of water conservation programs and increase drought awareness.
9.	Explore recycled water and use of local groundwater sources for non-potable water supplies.

WILDFIRE SMOKE
1. Implement an alert system to warn residents of smoke hazards and inform them of actions they should take during an event (ensure communications reach non-English-speaking people).
2. Issue easy-to-understand, daily notices of air quality in Alameda via social media, websites, cable TV, reverse 911, etc., with associated health advice (ensure communications reach non-English-speaking people).
a. Provide masks (with instructions on how to use them and their limitations) at accessible locations citywide.
b. Provide well-publicized and accessible smoke-free centers (cooling centers could be used) with air filtering.
c. Adopt thresholds for restricting certain activities (outdoor sporting events, outdoor worker exposure).
d. Involve hospitals/nursing homes and other critical care facilities in planning, outreach and communication.

- Below are the adaptation strategies Community Input Session #2 participants identified that most strongly align with the community vision for resiliency and meet the selection criteria (note: voting for workshop purposes; the City is exploring all strategies).

<table>
<tr><th colspan="2">HEAT</th></tr>
<tr><th>Session Round</th><th>Top Strategy and Implementation Approach</th></tr>
<tr><td>Round 1</td><td>Strategy 1: Require climate-appropriate tree planting, cool roofs, lighter streets, open pavement.

Strategy 8: Nixle promotion, promote neighborhood watch/community emergency response teams, emergency transportation to cooling centers, establish real cooling centers in addition to Mastick Senior Center, add pavilions around the island.

Strategy 5: More insulation, passive solar building retrofits, earth-bermed homes. Program proposal: Use public spaces as case study venues for successful heat-abatement strategies and use such venues for future workshops to access loans/incentives for retrofitting to building codes. Pass building codes for existing buildings/retrofits that are heat-mitigating objectives.</td></tr>
<tr><td>Round 2</td><td>Strategies 1, 3, and 6: Planting trees/landscaping wetlands, more greenery, etc.
- Cost: probably low
- Benefits: environmental—carbon dioxide sequestration, groundwater, heat reduction, and shade
- Economic: increases value, more customers
- Social: pleasant, adds value to houses, people more likely to stay around trees
- Implementation: schools and other public buildings need to be evaluated and fixed, rebate for planting trees, city provides trees, new roof/bathroom on older buildings must follow new rules, education on new environmental requirements, rebate on other environmental improvements on your house
Strategies 1 and 5: Infrastructure requirements for new buildings (must be green)
- Cost: low
- Implementation: light-colored roof requirements (green roofs), street trees requirements, # trees per square feet, less impervious ground covering, specify brightness of asphalt/concrete, etc.; all new building and new construction must follow stricter rules</td></tr>
<tr><td>Round 3</td><td>Strategies 1 and 3: Cool landscaping—trees, ground cover, permeable surface, urban permaculture. Visible to whole community.
- Implementation: establish building codes on new and existing buildings, neighborhood-specific, and give out trees.
- Where: buildings codes citywide, at a neighborhood level in public spaces and business districts, Residential Resource Center</td></tr>
<tr><td>Additional Comments from Report Back</td><td>- Plant trees;
- Require cool roofs;
- Focus on better landscaping, more trees in schools especially—kids will be happier, healthier;
- Initiate community tree planting; and
- Implement community landscaping starting with business districts and more tree planting, ensuring it is all citizen-led.</td></tr>
</table>

DROUGHT	
Session Round	**Top Strategy and Implementation Approach**
Round 1	**Strategy 8:** Work with EBMUD **plus** promote the use of greywater and groundwater. **Strategy 9**: Reduce the use of potable water for outdoor use. - Costs: mostly in case of new construction projects. Rain barrels are cheap. - Benefits: significant reduction of potable water use, maintain green biomass and shade. - How: ordinance on new construction and remodel projects to incorporate greywater reuse and runoff capture. Free rain barrels. Incentivize greywater and sump pumps for existing homes and businesses.
Round 2	**Strategy 8**: To improve effectiveness of water conservation. A more effective rate structuring that rewards water conservation. Metering to identify leaks and identify water wasting. - How to address in housing boards: citywide policy and transparency of billing **New Strategy:** carbon farming on public lands and parks. - Main cost: labor—City staff, volunteers where possible - Materials: wood waste, dead trees, agricultural waste, compost tea
Round 3	**Strategies 7 and 9:** Preserve water supplies and reuse water. Consider cisterns for rainwater capture—can be set up so not open, standing water. Storm-line permitting process/regulations for greywater/recycled water systems. Set a citywide goal for water conservation. Investigate recycled water storage. Work with EBMUD to get access to greywater/purple pipe water. Conduct studies to find sources of leaks. Survey other municipalities and find out what strategies work best to address aging infrastructure. Consider setting up systems to rapidly detect and address leaks.
Additional Comments from Report Back	- Could we develop and install smart meters for water? - Distaste for strategies 2 and 3 because they do not promote urban forest, which has many benefits. - Rain barrels can promote water reuse among residents and rainwater capture. - Incentives for greywater capture. - Rapid detection system for leaks. - Increase organic farming practices and urban farming. - Water conservation and incentives to reduce water use.

WILDFIRE SMOKE	
Session Round	**Top Strategy and Implementation Approach**
Round 1	**Strategy 5:** Bay Area Air Quality Management District might be a good source for standards regarding outdoor activities vis-a-vis air quality. Conduct an ongoing awareness campaign so people understand hazards and where to find information during an event. Ask City Council to direct City management to make a proactive effort. For example, Alameda's public information officer (Sarah Henry) could make quarterly articles/reports in the newspaper, newspaper website, sound media, etc., or discuss climate-related issues, like details on air masks, home air filter systems, where to find info in an event, etc.
Round 2	**Strategy 3**: City bulk purchases air purifiers and masks, giving away masks for free and selling air purifiers at a cost. City creates a lending library of air purifiers for those that don't want/can't purchase them. **Strategies 1 and 2**: Educate the public about the severity of risks, establish "clean air" buildings that are safe to go to (movies, library, etc.), and publicize programs the City offers (such as free masks and air purifier lending library). Leverage City website to publicize such programs; use third-party apps and potentially an alarm system.
Round 3	**Strategy 1 (with 2 as an extension):** Establish a citywide trigger system that creates a domino effect to synthesize different communities and disseminate information. Aside from spreading information/education around proper use of masks (don't use a mask for longer than a certain number of hours, etc.), set up an action plan to distribute masks, institute (partial) driving bans, etc., as emissions exacerbate poor air quality of wildfire smoke.
Additional Comments from Report Back	■ Set up an air quality station in Alameda. ■ Air quality visual. ■ Use citywide emergency alarm system for thresholds. ■ City to adopt thresholds that restrict outdoor activities/work/school. ■ Needs to be ongoing awareness so people know in advance how to use masks and air purifiers, where to get them, and how to be proactive rather than reactive. ■ Communications and emergency alert systems should be able to reach those without cell phones. ■ Educate people on the severity of smoke—communicate by comparative risk (e.g., how many packs of cigarettes a day the smoke amounts to, how the quality compares to other cities like Beijing, Calcutta, etc.). ■ Provide education around risks and how to get resources to be safe. ■ Understand the crossover with reducing GHGs and staying off the road on poor air quality days. ■ Provide masks that fit children and people with beards, as well as education on how to properly use them. ■ EDUCATION—emergency system that links to a "things to know" during smoke days tab on website. ■ Alert system and accessible language for non-English-speaking people.

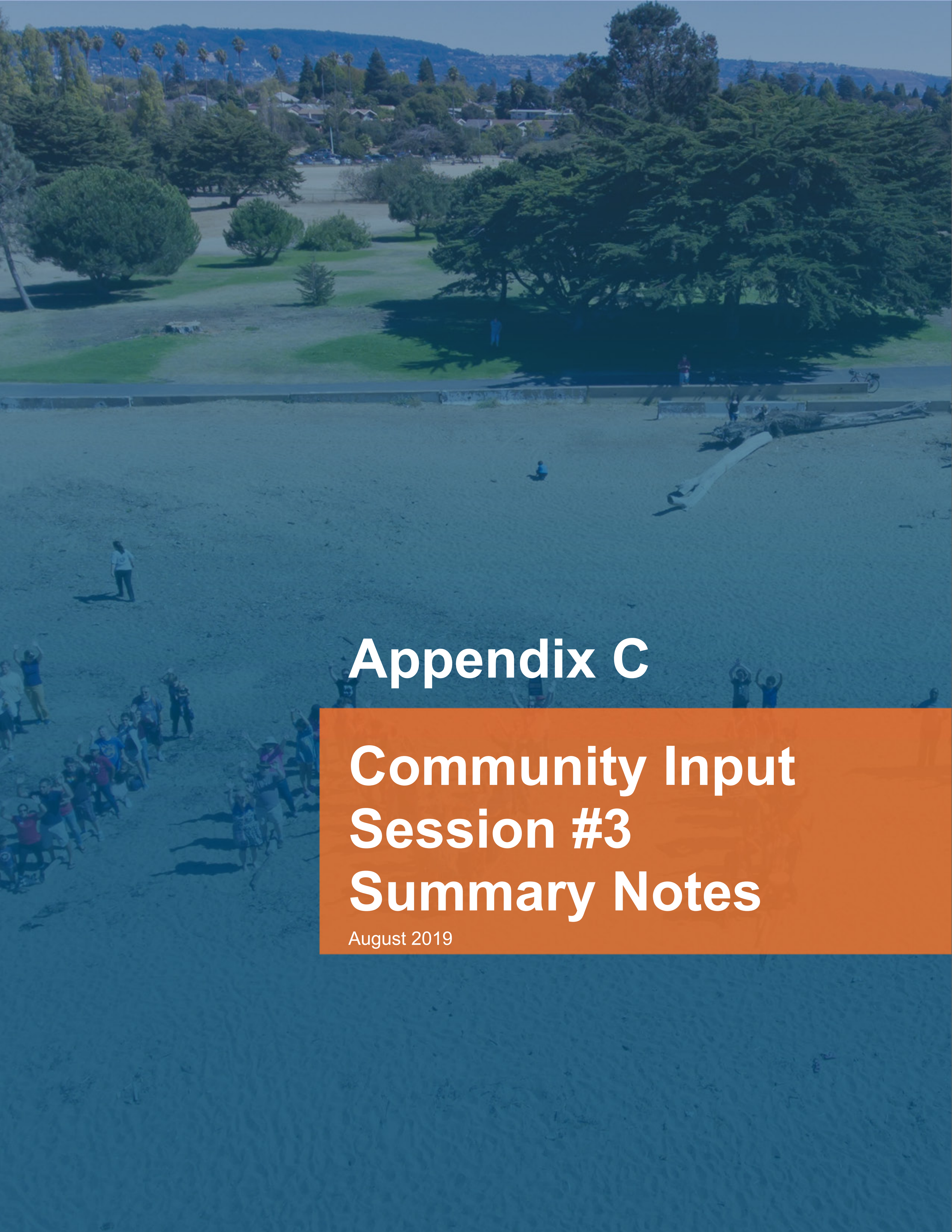
Main Session—Report Back

The breakout group facilitators reported back key themes that arose from the sessions:

- **Group 1: GHG Reduction Actions**
  - Talked about process, new actions in addition to actions already implemented, and goals to meet.
  - Highlighted priority actions: applying compost to Alameda parks, standardizing EV stations, improving urban forests, all actions involving EVs (high reduction, low cost).
  - Identified visionary goal: achievable through implementation of actions.
- **Group 2: Adaptation Strategies—Sea Level Rise and Flooding**
  - Pursue natural shoreline solutions and integrating harder solutions where needed.
  - Consider layered barriers and solutions (e.g., options for beach, layering wetlands, dunes) before looking at harder barriers.
  - Reconsider whether Crown Beach for Alameda is needed in the future; may not need all segments.
  - Conduct more research to understand groundwater and how the beach will respond to sea level rise, as well as to fill information gaps.
  - Conduct more research on new natural shoreline solutions.
- **Group 3: Adaptation Strategies—Other Climate Risks (drought, fire, wildfire smoke)**
  - Talked about priority strategies and how to implement them.
  - Focus on water conservation and incentives to use less water, recycling and reuse, better use of the water we have for better irrigation, and leak detection (need full accounting system) (Drought).
  - Plant trees and identify heat communities and incentives to buy trees at cost and plant them, community involvement, carbon sequestration (Heat).
  - Continue ongoing awareness campaign since cannot just wait for next smoke event, alert people in place, masks and air purifiers readily available (at cost or free or loaners). People don’t understand the hazards of smoke – use point of reference (1 pack of cigarettes/day) and raise awareness) (Wildfire smoke).

CARP Next Steps and Fill Out Evaluation Survey

- Tegan Hoffmann (ERG) stated that participants who had additional thoughts or people who were unable to attend Community Input Session #2 could share their thoughts on the digital workshop until 2/8/19 via https://www.opentownhall.com/7127. She said Community Input Session #3 would occur in April 2019.
- Finally, Tegan Hoffmann (ERG) asked all participants to evaluate Community Input Session #2 via www.surveymonkey.com/r/jan2019eval. She added that those who want more information on the Bay Shoreline Flood Explorer could visit https://explorer.adaptingtorisingtides.org/home.



Appendix C

Community Input Session #3 Summary Notes

August 2019

City of Alameda Climate Action and Resiliency Plan Update
May 20, 2019, 6:00–8:00 p.m. PT

LOCATION
Elks Lodge, 2255 Santa Clara Ave, Alameda, CA 94501

PARTICIPANTS
44 attendees

SUMMARY

Welcome and Overview of the DRAFT Climate Action and Resiliency Plan (CARP)

- Erin Smith (City of Alameda) welcomed participants and shared an overview of Community Input Session #3, which had the following objectives:
  - Provide overview of DRAFT CARP and next steps to finalize CARP;
  - Residents provide feedback on the DRAFT CARP; and
  - Share and explain web-based systems for continued public feedback on DRAFT CARP.

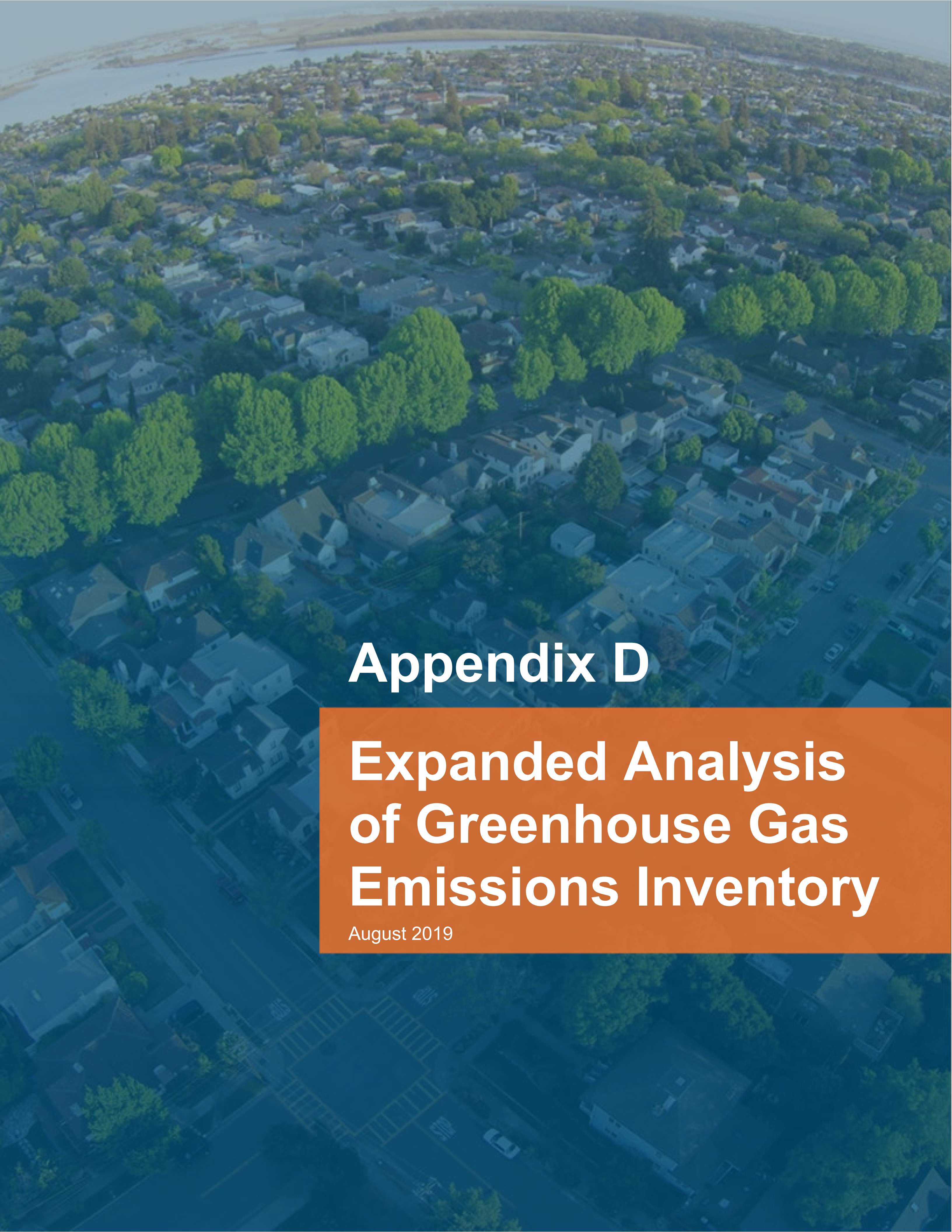
  The outcomes that the City hopes for are: input on the DRAFT CARP, GHG reduction and adaptation actions from community members for reducing Alameda's GHG emissions, increasing the city's resilience to climate change impacts, and becoming more sustainable overall. Erin Smith shared an overview on the DRAFT CARP chapters, including:
  - Background
  - How We Developed the Plan
  - Reducing Alameda's GHG Emissions
  - Adapting to Climate Change
  - Making Economically Informed Climate Change Decisions
  - From Plan to Action
  - Appendices

Public Comment

- Attendees had the opportunity to provide public comment during Community Input Session #3. Participants had two minutes maximum to comment on the DRAFT CARP. A total of 33 people provided public comment during the session.
- Some example public comments included:
  - **GHG:** Public transportation is a necessity, but fares need to be lowered for students and more steps must be taken toward hydrogen fuel cells in public transportation vehicles.
  - **Adaptation**: Would like to see more done to address sea level rise on Alameda Point where there is more development, rewilding, and wetland mitigation.
  - **Implementation**: The sustainability position is highly important, as Alameda needs someone who can be a leader and have gravitas to go to Washington, D.C., and meet with other agencies.

Process to Provide Online Feedback, Next Steps, and Evaluation Survey

- Tegan Hoffmann (ERG) shared the process to provide online feedback on the DRAFT CARP through OpenGov (open through May 31, 2019). The next steps included:
  - — Revise CARP based on public comment;
  - — Present FINAL DRAFT CARP to City Council on July 16, 2019;
  - — Finalize CARP based on City Council feedback, as needed; and
  - — Present FINAL CARP for adoption by City Council—September 2019.



Appendix D

Expanded Analysis of Greenhouse Gas Emissions Inventory

August 2019

2015 Community-Wide Greenhouse Gas Emissions Inventory and Projections to 2020 and 2030

The 2015 greenhouse gas (GHG) emissions inventory contains three main sectors of GHG emissions: transportation (e.g., passenger, commercial, and off-road vehicles); building energy (i.e., residential, commercial, and industrial use of electricity and natural gas); and waste, water, and wastewater (i.e., landfill and water treatment operations) (COA, 2017). The inventory, completed in 2017 and revised in 2018, uses the International Council for Local Environmental Initiative U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions.

The 2015 inventory also contains projections of emissions for years 2020 and 2030 based on business as usual (BAU) assumptions. The BAU projections include reductions attributable to the following state initiatives: Pavley fuel efficiency standards, energy efficiency improvements from Title 24 standards, and California Air Resources Board estimates on increased electric vehicle (EV) adoption.

As part of the CARP development, the City evaluated and identified opportunities to improve the 2015 inventory and the 2020/2030 BAU projections and updated them in January 2019. Revisions to the 2030 BAU scenario included updates to some calculations and methodologies, as well as the addition of the 2019 updates to state-mandated building energy efficiency improvements (Title 24, to be implemented in 2020). Table D-1 shows the original and updated 2015 inventory and 2020/2030 BAU projections. Note that the emissions shown in the table include the carbon sequestration impact from the city's existing tree canopy as part of the inventory and BAU estimates. All BAU emissions discussed from this point forward in the CARP are the updated BAU emissions for 2020 and 2030.

Table D-1. Summary of Updates to 2015 GHG Emissions and Projections

Emissions Category	MTCO2e [a]		
	2015 Inventory	2020 BAU	2030 BAU
2015 Community-Wide GHG Inventory and Projections (December 2018 update)	409,978	414,734	382,280
2015 Inventory and Projections with Updates (January 2019)	409,461	413,377	376,118

[a] Metric tons of carbon dioxide equivalent

The most significant difference between Alameda's 2015 GHG inventory and the updated BAU emissions projections for 2030 is the shift from transportation to building energy as the primary source of emissions. While total BAU emissions in 2030 are expected to decrease slightly from the 2015 and 2020 BAU projections, emissions from building energy are forecasted to increase despite state-mandated building energy efficiency requirements (Title 24). The primary driver behind this increase is the projected shift to EVs, which produce zero transportation emissions but require building-based energy to charge. Another important factor affecting the 2030 BAU projections are the expected improvements in conventional vehicle fuel efficiency and the increased number of EVs, both of which drive down the transportation emissions predicted for 2030.

GHG Emissions Projection to 2050

The Association of Bay Area Governments (ABAG) provided the current population and job projections that the City used to develop the 2050 BAU projection. Population and jobs are the two primary forecast drivers for emissions. As current ABAG projections only extend to 2040, the 2050 projections assumed the same growth rate from 2040 to 2050 that is forecasted to occur between 2030 and 2040. The ABAG data and projections to 2050 are presented in Figure D-1.

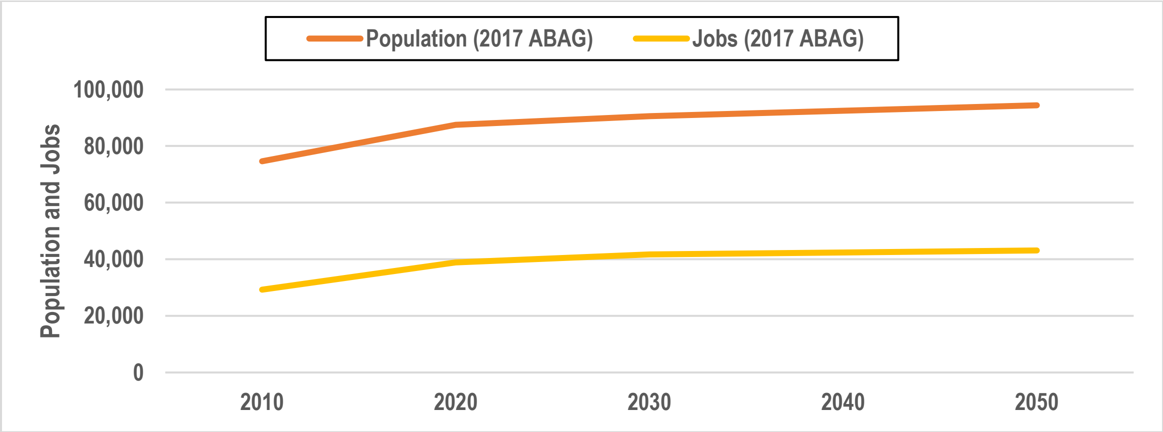


Figure D-1. Population and job projections for Alameda County (Source: ABAG, 2019).

The resulting population and jobs growth from 2030 to 2050 were then applied to 2030 BAU inventory projections to forecast increases in BAU emissions to all categories in 2050. Table D-2 presents the application of the population and jobs data as forecast drivers across all emissions categories.

Table D-2. Application of Forecast Drivers to Emissions Categories

Emissions Category	Forecast Driver
Transportation	
Passenger Vehicles	Population
Commercial Vehicles	Jobs
Off-Road Vehicles	Jobs
Ferries, Buses, BART	Population
Building Energy Use	
Residential Buildings	Population
Commercial, Industrial, Public	Jobs
Waste, Water, Wastewater	
Landfill	Population
Doolittle Landfill	LandGEM[a]
East Bay Municipal Utility District Operations	Population

[a] U.S. Environmental Protection Agency Landfill Gas Emissions Model

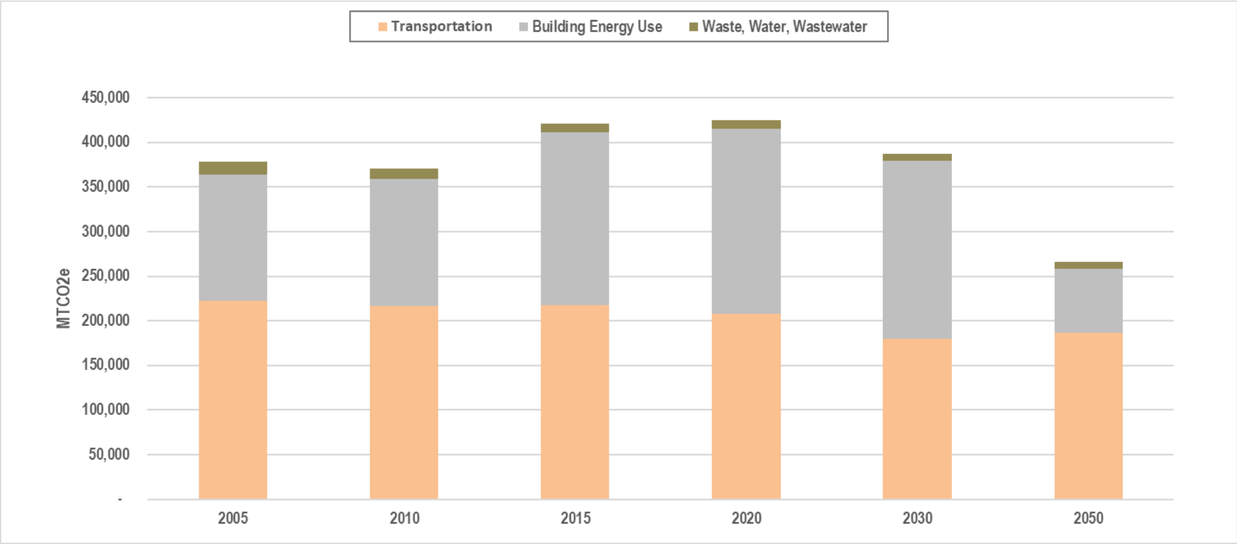
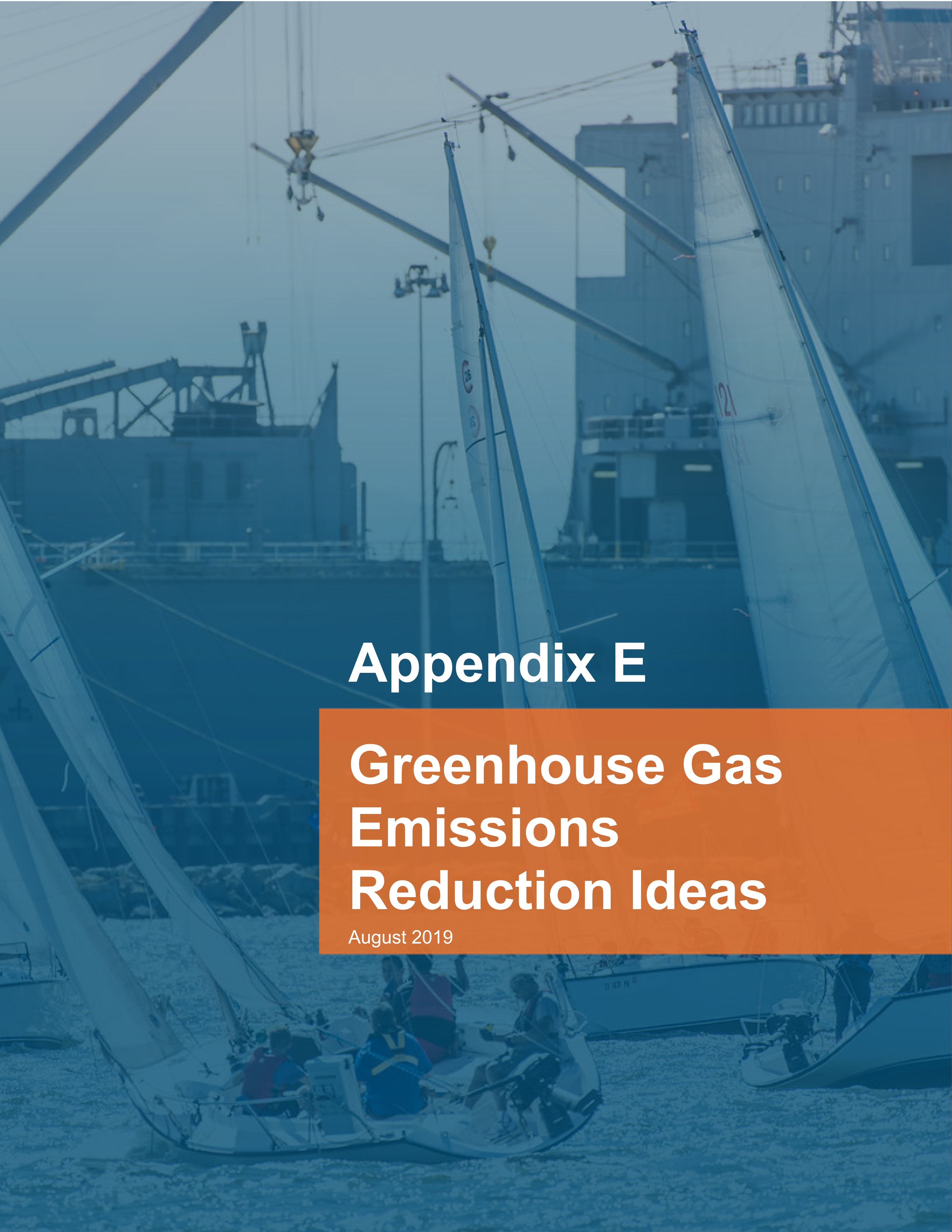


Figure D-2. Alameda's historical and BAU GHG emissions projections.

Figure D-2 shows the resulting GHG BAU emissions projections for 2050, with other years going back to 2005 for comparison and reference. This trend reflects the longer-term effects of forecasted population and jobs growth through 2050. Also, the 2050 BAU projection includes the effect of Senate Bill 100, which requires the state's electric grid to provide 100 percent zero-carbon electricity to end-users by 2045.



Appendix E

Greenhouse Gas Emissions Reduction Ideas

August 2019

Master List of Greenhouse Gas Emissions Reduction Ideas

Sector	Reduction Idea	Source[a]
Transportation	Promote low and zero emission vehicles, including electric vehicles (EVs).	SOW/City
	Standardize EV charging stations in new developments.	SOW/City
	Electrify City's fleet; include police cars.	SOW/City
	Incentivize ownership through tax credits.	SOW/City
	Continue to provide incentives for EV owners through electricity rate discounts.	SS
	Explore relationship between large support of free/low-cost parking, vehicle miles traveled (VMT), and greenhouse gas (GHG) emissions.	SOW/City
	Charge tolls on in-coming bridges and tunnels (into Alameda), then use funding for new EV charging stations.	SOW/City
	Continue to expand bike lanes and make pedestrian/bikeway improvements that increase safety and make it easier for people to use them. Build West End bike bridge (reduces VMT, provides emergency bridge during flooding). Build bike station near Park Street and Central Street. Keep Limebikes available.	SS
	Sponsor long-term visional transportation projects such as congestion pricing.	SOW/City
	New/replacement multi-modal crossing.	
	Citywide *EasyPass* program.	
	Plan for renewable, geothermal, electricity-powered hydrogen fuel station.	SOW/City
	Reduce VMT through parking restrictions: • Parking meter pricing; • No parking minimums for new development parking requirements; • Maximum parking requirements for residential and retail; • No parking requirements for retail on Park Street, Webster Street, and stations; and • No free parking on Sundays.	SOW/City
	Continue to encourage businesses to install EV charging stations.	SS
	Continue to encourage community solar and community storage (e.g., blockwide or regional "ecodistrict" approach) that allows residents to buy into storage facilities (e.g., microgrids) for use in EV charging.	GWT
	Ban unnecessary vehicle idling.	SS
	Buy garbage trucks with reversible can grabbers to allow pickup on both sides of the street in a single pass.	SS
	Install more stop signs (St. Clara/Sherman) to slow speeds; change traffic flow by timing green lights to slow vehicle speeds and reduce idling when no traffic is coming.	SOW/City
	Improve bus connectivity to Alameda ferry.	SOW/City
	Build more ferry stations.	SOW/City
	Provide public education on how buying factory-farmed meat, driving to the store for one item, etc., is affecting GHG emissions.	SOW/City
	Provide 10-minute free shuttle from end to end of island and to BART, modeled off of Emery-go-Round.	CIS #1
	New BART tube.	CIS #1

Sector	Reduction Idea	Source[a]
	Better public transit to BART and ferry.	CIS #1
	Calm traffic, keep enforcing 25 miles per hour (mph) limit, improve timing of traffic lights to maintain 25 mph speed.	CIS #1
	Gondola access from Alameda Point to 12th Street BART and Jack London Square.	CIS #1
	Water taxis to Oakland.	CIS #1
	Reduce airplane exhaust—soot.	CIS #1
	Ban cars from city centers.	CIS #1
	Increase gas tax.	CIS #1
	Transport mode following age demographics.	CIS #1
	Vehicle to grid program.	CIS #1
	Voting on measures that de-prioritize cars.	CIS #1
	More live/work development.	CIS #1
	Water taxis.	CIS #1
	Enforce noise limits on cars.	CIS #1
	Parking policy = one parking space per bedroom.	CIS #1
	Re-do Transportation Choices Plan with realistic assumptions.	CIS #1
	Better public transit to and from Bay Farm Island.	CIS #1
	More frequent ferry service.	CIS #1
	"Green vehicle" parking spots.	CIS #1
	Free bus passes for students.	CIS #1
	Promote working from home.	CIS #1
	Tax parking/charge more for parking.	CIS #1
	Zone to promote transit use.	CIS #1
	Bus rapid transit to BART stations.	CIS #1
	Bike-only, EV-only, and carpool-only lanes.	CIS #1
	Require EVs for Uber/Lyft vehicles	CIS #2
Land Use	Evaluate impact of citywide 21-dwelling unit/acre residential density restriction on Alameda's ability to reduce GHG emissions.	SOW/City
	Encourage midrise, mixed-use, and multifamily housing along Park Street, Webster Street, and Alameda Point.	SOW/City
	Encourage affordable housing to make it easier for local workers to live in Alameda.	SOW/City
	Identify and evaluate land use policies and biological resource management policies that could reduce GHG emissions and increase carbon sequestration, resiliency, and economic development—biochar, use of goat grazers.	SOW/City
	Promote Climate Victory Gardens.	CIS #1
	Build cohousing projects.	CIS #1
	Continue to limit multi-unit housing growth.	CIS #1
	More building reuse rather than teardowns.	CIS #1

Sector	Reduction Idea	Source[a]
Energy and Buildings	Build on California Building Energy Efficiency Standards by considering City-specific requirements for the following: • Outreach and advocacy plan that promotes installation of reflective/green roofs with pump water heaters; • Solar and EV charger requirements for new developments; • Energy efficiency measures that reduce the need for mechanical cooling; • Electrification of natural gas appliances (e.g., electric water heating using heat pump water heaters); • Capture and use of rainwater for non-consumptive purposes in new and remodeled housing; • Smart building design and meters to monitor usage patterns, including water usage; • Use of natural systems or systems designed to mimic natural systems such as biomimicry and living machines; • Action plan to decarbonize buildings and infrastructure; and • Emerging sustainable technologies and practices for building construction, and development of an inventory and appraisal of existing infrastructure conditions.	SOW/City
	Implement feed-in tariff program for solar installation (e.g., Palo Alto).	SS
	Educate contractors on improved construction techniques.	SS
	Electrify buildings during new construction.	SOW/City
	Consider City implementation of U.S. Passive House Standard, Net Zero Building Standard, Living Building Challenge.	GWT
	Maintain compliance with statewide renewable power requirements.	SOW/City
	Encourage the Public Utilities Board (PUB) to continue promoting and providing innovative energy efficiency opportunities and incentives to residential and non-residential customers.	SOW/City
	Encourage PUB to explore opportunities for promoting and incentivizing electrification and fuel switching.	SOW/City
	Encourage PUB to develop interconnection policies for battery storage systems.	SOW/City
	Consider clean alternatives to natural gas.	SOW/City
	Work with Pacific Gas and Electric (PG&E) Company to promote natural gas energy efficiency opportunities to residents and non-residential entities.	SOW/City
	Expand solar for new and existing buildings, offer incentives/rebates, and install panels on roofs and parking lots, solar road beds, and pavement.	CIS #1
	Provide incentives for solar, including fast-tracking permits.	CIS #1
	Require solar for new buildings.	CIS #1
	Achieve total energy independence, urge PG&E to provide all renewable energy, and consider installing solar panels and battery storage arrays at Alameda Point as well as generating wind energy.	CIS #1
	Require solar heating in new buildings.	CIS #1
	Create a special solar zone at Alameda Point with incentives.	CIS #1
	Totally regulate PG&E for public benefit.	CIS #1
	Float bonds for public-engaged Property Assessed Clean Energy (PACE) program.	CIS #1
	Have a “go carbon-free neighborhood” competition via phone app, sponsored by the Bay Area Air Quality Management District.	CIS #1

Sector	Reduction Idea	Source[a]
	Update building codes to reduce GHG emissions; require high energy efficiency standards for new development—potentially net zero or beyond.	CIS #1
	Establish green roofs—City regulations for green roofs on small buildings, City grants for school facility green roofs. Include cool shingles.	CIS #1, CIS #2
	Energy from waste generated on the island.	CIS #1
	Attract green businesses to Alameda to reduce commute.	CIS #1
	Smart buildings.	CIS #1
	Time-of-use electric metering.	CIS #1
	Local grants for home retrofits.	CIS #1
	Educate contractors about energy savings potential in retrofits.	CIS #1
	On-bill financing from Alameda Municipal Power for solar and storage so everyone wins.	CIS #1
	Fix deficient cooling systems.	CIS #1
Waste, Water, Wastewater	Update construction and demolition debris ordinance.	SOW/City
	Clarify residential recycling and composting as mandatory.	SOW/City
	Increase composting at home and in public spaces and restaurants using individual and municipal worm composting bins for food wastes and local shredded dry leaves.	TF
	Prioritize the reduction of toxic or harmful waste such as plastics.	SOW/City
	Consider additional landfill bans for, or more regulation of, specific materials.	SOW/City
	Explore mixed waste processing.	SOW/City
	Consider food rescue program.	SOW/City
	Decrease use of plastics (e.g., encourage alternatives to plastic straw use in restaurants).	SS
	Consider new organic gardening techniques on compost application to parks, which could yield up to 11 tons per acre per year.	GWT
	Encourage purchase of locally grown food to reduce transport of out-of-season and non-local food.	CIS #1
	Require greywater plumbing installation in new buildings and citywide recycling of greywater.	CIS #1
	No plastic/non-reusable packaging in stores.	CIS #1
	Recycling bins for bottles, as in Germany.	CIS #1
	Help large housing reuse and reduce waste.	CIS #1
	Delegate space for commercial agriculture—from farm to local table to dump sites.	CIS #1
	Ocean cleanups.	CIS #1
	Invest in on-site recycling and sell plastic back to company.	CIS #1
	Require manufacturers to be responsible for their packaging; must recycle waste.	CIS #1
	Provide reuse facility in town.	CIS #1
	Recycling bins in every department.	CIS #1
	City tax on plastic bottles.	CIS #1
	Better education for recycling.	CIS #1
	Zero waste culture established through community-based social marketing.	CIS #1
	Ban/discourage single-use containers.	CIS #1
	Use fungus to decompose toxics, plastics, and waste.	CIS #1

Sector	Reduction Idea	Source[a]
	Discount homes and businesses that produce less waste.	CIS #1
Sequestration	Encourage/facilitate urban forest (e.g., increase tree cover to one tree per resident, move trees displaced by development to a new location, create landscaped islands and bulb-outs to streets, repair damaged water systems watering existing trees).	SOW/City
	Develop living shorelines to benefit marine environments and promote kelp and oyster shoals along areas of high erosion.	GWT
	Encourage urban farming as a means of sequestration and resiliency (e.g., create rooftop and vertical gardens, convert vacant lots to community gardens).	SOW/City
	Capture and convert methane to hydrogen.	CIS #1
	Protect ocean plants that sequester carbon.	CIS #1
	Capture carbon dioxide from seawater via bio-rock.	CIS #1
	Harvest methane from landfills.	CIS #1
	Pulse grazing of goats for silvopasture.	CIS #1
	Give trees away for self-planting.	CIS #2
Other	Consider restrictions on wood smoke; ban wood burning fireplaces.	SOW/City
	Ban gas-powered leaf blowers, lawn mowers, and other two-stroke engine lawn equipment (e.g., Berkeley).	SOW/City
	Provide education—all residents are knowledgeable on climate change. Host walking tours and invest in more outreach to the community on the WHY, provide perspective on the global problem, describe how to practice sustainability, explain water scarcity, discuss impacts on Alameda (in earthquakes), and provide interpretative signage in natural areas.	CIS #1
	Promote vegetarian/vegan diets.	CIS #1
	Implement a carbon tax.	CIS #1
	Float a bond to pay for citywide sea level rise protection.	CIS #1
	Reduce outdoor cooking.	CIS #1
	Engage with the power authority to the water utility to facilitate desalinization options.	CIS #1
	Develop a GHG civilian conservation corps.	CIS #1

[a] SOW/City = ERG's scope of work as developed by City

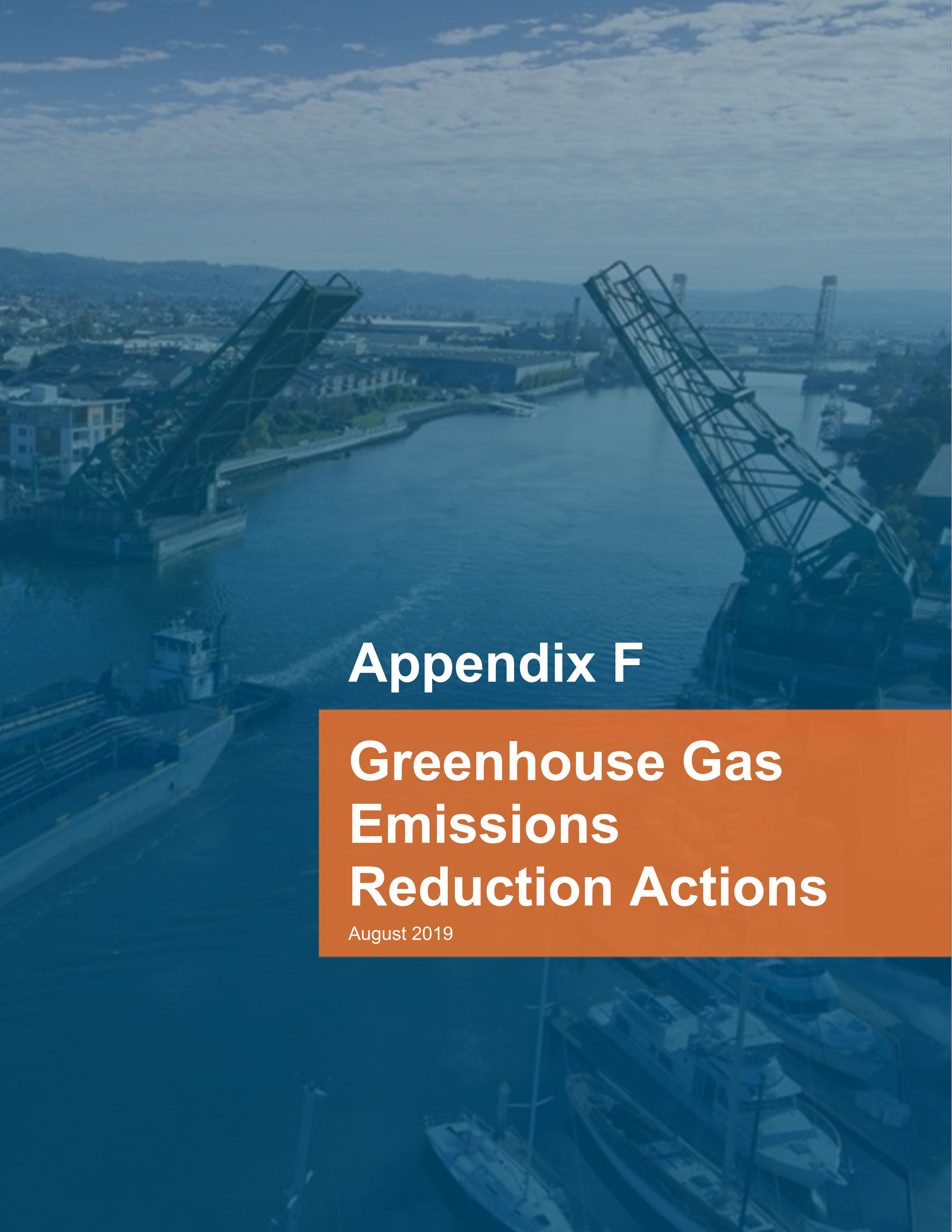
TF = Task Force

GWT = Green Working Team

SS = Summer (2018) survey sponsored by City Public Works Department

CIS #1 = Community Input Session #1 (September 2018)

CIS #2 = Community Input Session #2 (January 2019)



Appendix F

Greenhouse Gas Emissions Reduction Actions

August 2019

T1. Reduce Commute VMTs

2,968 2030

Value in MTCO2e

$10.44/MT

Abatement Cost

Implementation Time Frame

2020–2030

Description

Encourage employee and employer participation in commute trip reduction through telecommuting. Develop outreach program and take steps to overcome barriers to implementation (e.g., eliminate double taxing, employer tax incentives, etc.).

Key Assumptions & Data

- Based on California Air Pollution Control Officers Association (CAPCOA) Quantification Report (Measure TRT-6), average telecommuting of 1.5 days per week adopted with 25% employee participation would result in a 5.5% reduction in commute vehicle miles traveled (VMT).
- Employee participation capped at 25% (per CAPCOA Measure TRT-6) because roughly 50% of workforce could participate in telecommuting/alternative work schedules (based on specific job requirements) and about 50% of those would choose to participate.
- Outreach efforts should promote telecommuting and also strive to overcome barriers associated with the implementation of telecommuting. Some examples include:
    - Telecommuters living in a state with a “convenience of the employer” rule can be double taxed on their income. State and local tax codes should be updated to eliminate this penalty.
    - Provide employer goals and tax incentives for the offering and adoption of telecommuting.
    - Provide funding/subsidies for the private provision of regional telework centers and shared satellite offices.

Costs

Capital cost: $25,000 (consultant program design)
Avoided capital cost: N/A
Annual operating cost: $30,000 (0.25 full-time equivalent [FTE] at $120,000)

References

- CAPCOA: http://capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf
- Moving Cooler: http://www.reconnectingamerica.org/assets/Uploads/2009movingcoolerexecsumandappend.pdf
- 2017 State of Telecommuting in the U.S. Employee Workforce

T2. Build more bike lanes

962 2030

Value in $MTCO_2e$

$10.85/MT

Abatement Cost

Implementation Time Frame

2025–2030

Description

Expand on Transportation Choices Plan (TCP) Project/Programs 39 and 13 by adding more bike lanes and making pedestrian/bike way improvements that increase safety and make it easier for people to use. Increase dedicated and protected bike lanes; connect residential neighborhoods with commercial centers and work places.

Key Assumptions & Data

- Greenhouse gas (GHG) reductions and costs estimated for bike lane expansion beyond what is already included in the TCP.
- West-end bike bridge included in TCP Project/Program 39. Continued availability of Limebikes included in TCP Project/Program 13.
- Based on CAPCOA Quantification Report (Measure SDT-5), 1st alternative, each additional mile of bike lanes per square mile will generate a 1% increase in the share of workers commuting by bicycle. Assumed a similar reduction for Alameda-only non-worker trips.
- Based on city of Alameda land area (10.44 square miles), an increment of 1 additional mile of bike lane per square mile (i.e., 10.44 miles of bike lane) was considered.
- Reductions based upon 1% decrease of work travel and Alameda-only non-work travel (disaggregated from inventory VMT calculations) assuming light-duty auto travel.
- Bike lane costs were assumed to be $25,000 per mile of bike lane on existing streets (2009 $), including signage and striping. Costs for overall reconfiguration of all lanes would be more.

Costs

Capital cost: $261,000 (at $25,000/mile)
Avoided capital cost: N/A
Annual incremental operating cost: $0

References

- TCP (January 2018)
- CAPCOA: http://capcoa.org/wpcontent/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf
- Moving Cooler: http://www.reconnectingamerica.org/assets/Uploads/2009movingcoolerexecsumandappend.pdf

T3. Traffic signal synchronization

779 2030

Value in MTCO2e

$164.10/MT

Abatement Cost

Implementation Time Frame

2020–2030

Description

Improve synchronized timing of traffic lights. Change traffic flow by timing green lights to slow vehicle speeds and reduce idling when traffic is not coming. Alameda will continue to analyze and implement best practices to ensure improved traffic flow. Traffic management technologies are constantly improving, which may allow for traffic flow improvements with limited resources.

Key Assumptions & Data

- Based on Metropolitan Transportation Commission (MTC) Program for Arterial System Synchronization (PASS) FY 16/17 cycle fact sheets, comparable signal synchronization projects could be implemented in Alameda based on Community of Antioch, Corte Madera, Fremont, Livermore, Oakley, Pleasanton, San Jose, San Mateo, Santa Clara, and Santa Rosa.
    - Co-sponsored with Caltrans in Antioch, Corte Madera, Fremont, Livermore, San Mateo, Santa Clara, and Santa Rosa.
    - Projects varied from nine to 48 signals.
    - Total project cost varied from $43,130 to $282,150.
    - Per signal cost varied from $918 to $7,838, with an average cost of $4,812.
    - Annual total gasoline savings varied from 5,880 gallons to 318,720 gallons.
    - Annual per signal gasoline savings varied from 535 gallons to 10,990 gallons, with an average of 3,551 gallons.
    - For Alameda, assume synchronization of 25 of 86 signals at maximum cost of $7,838/signal.

Costs

Capital cost: $195,938
Avoided capital cost: Fuel savings to consumers
Annual operating cost: Assume one FTE at $120,000/year for maintenance to signals

References

MTC PASS: https://mtc.ca.gov/our-work/operate-coordinate/arterial-operations/program-arterial-system-synchronization-pass

T4. Citywide *EasyPass* program

Implementation Time Frame
2025–2030

339 (2030)
Value in MTCO2e

$115.04/MT
Abatement Cost

Description

Expand on TCP Project/Program 4 by expanding *EasyPass* program citywide to include an additional 5,000 passes to Alameda residents by 2030.

Key Assumptions & Data

- Assumed that 100% of Alameda city residents would be eligible for pass (minus assumed 5% under the age of 5 and 5,000 passes already issued under the TCP).
- Based on CAPCOA Quantification Report (Measure TRT-4), between 0.3 and 20.0% reduction of VMT and commute trip GHG emissions due to subsidized/discounted daily or monthly public transit passes. Based on 100% eligibility in an urban area, the capped reduction value of 20.0% was adjusted by the ratio of actual passes issued relative to the number of eligible residents for 2030.
- If all Alameda residents were to receive pass, then reduction value should be capped at 20.0% per CAPCOA guidance. (Costs to provide passes for this number of residences would be ~$5 million/year.)
- Assumed to apply to travel of Alameda residents either working in Alameda or non-working. *EasyPass* costs were estimated to be $70/person-year based on TCP Project/Program 4. Administrative costs were estimated to be $25,000/year based on TCP Project/Program 4.

Costs

Capital cost: $350,000 (2030 cost of passes)
Avoided capital cost: $0
Annual operating cost: $25,000

References

CAPCOA: http://capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf

T5. Ban gas-powered leaf blowers

76 2030

Value in MTCO2e

$1,647/MT

Abatement Cost

Implementation Time Frame

2025–2030

Description

Ban gas-powered leaf blowers in the City of Alameda. Anticipate City ordinance in effect by 2025.

Assumptions and Key Data

- Equipment population: 25% of single-family units own gas leaf blowers; 50% convert to electric; 50% cease operation. This would result in the replacement of approximately 2,327 gas leaf blowers with electric leaf blowers.
- Average electric leaf blower from Home Depot.
- Electric equipment replaces gas-powered equipment; associated GHG emissions are eliminated based on zero-carbon electricity.

Costs

Cost to the public:

- **Capital cost:** for replacement of leaf blowers: $129,000
- **Avoided annual cost:** Gasoline savings is offset by increased electricity costs
- **Annual operating cost:** 1 FTE for enforcement ($120,000/year)

References

- *Alameda Magazine,* November 2018
- Home Depot: www.homedepot.com

T6. Increase availability of EV charging stations citywide

8,209 (2030) Value in MTCO2e	$22.41/MT Abatement Cost

Implementation Time Frame

2020–2030

Description

Standardize the design and installation requirements for new electric vehicle (EV) charging stations. The standardization of charging stations for new development supports future charger network consistency in terms of station design and density requirements, potentially allowing for faster permitting and installation and lower costs for installers. Faster permitting and installation timeframes would expedite the implementation of a charger network and support greater EV growth in the city.

Assumptions and Key Data

- Assume EV charging space requirements based on Cal Green Building Code for new residential and non-residential developments. For residential: mandatory EV space requirements of one space per single family and 10% of total parking spaces for multi-family units greater than 17. For non-residential: Tier I voluntary measures in terms of required EV spaces for number of total parking spaces.
- Assume EV rate of usage of EV spaces per required EV growth to meet zero emission vehicle (ZEV) mandate in 2025.
- 50/50 split between plug-in hybrid electric vehicle (PHEV) and battery-electric vehicle (BEV) for future EV purchases.
- Carbon dioxide equivalent (CO_2e) reductions from this action have been adjusted to reflect the offsetting emissions from battery recycling based on typical EV battery weights and 1.0 kg CO_2/kg battery recycled data from Sullivan & Gaines (2010).
- Alameda Municipal Power (AMP) survey information, when available, may result in adjustment of some assumptions for this action.
- Total of 2,061 new EV charger spaces estimated for this 12-year program.
- Action impact diminishes after 10 years when new EVs purchased as a result of the program are replaced by similar vehicles.

Costs

Costs to the City:

- **Capital cost:** First year development of EV station design and pre-wiring standardization for permitting; outreach and education; contractor ($100,000)
- **Annual cost:** 1.5 FTE/year ($180,000)

Cost savings: to EV installers from streamlined permitting and lower future installation costs

References and Documents Used

- CEC (2018): https://www.nrel.gov/docs/fy18osti/70893.pdf
- COA (2014): https://www.alamedaca.gov/files/sharedassets/public/alameda/building-planning-transportation/general-plan/he-background-report.pdf
- California Green Building Code
- U.S. EPA: www.fueleconomy.gov
- Sullivan & Gaines (2010): https://greet.es.anl.gov/publication-batteries_lca

T7. Promote purchase of low and zero emission vehicles

Value in MTCO2e (2030)	Abatement Cost
6,125	$19.98/MT

Implementation Time Frame

2020–2025

Description

Implement communications and outreach activities to promote the acquisition of light-duty low emission vehicles (LEVs) and ZEVs. The five-year program should focus on super ultra-low emission vehicles (SULEVs) that are PHEVs and ZEVs that are BEVs to achieve the greatest CO_2 reductions. The program should be modeled after California-based or federal Clean Cities program in terms of promotional activities and structure. A five-year program is adequate for supporting early SULEV and ZEV market liftoff locally.

Assumptions and Key Data

- Assume promotes SULEV and ZEV for lowest GHG, and SULEVs should be PHEVs and ZEVs should be BEVs to support electric infrastructure development.
- Apply one-third of federal Clean Cities program promotional EV success rate (2011 thru 2016) to similar City promotional effort.
- Assume new annual PHEV and BEV purchases split 50/50.
- Assume new EVs accrue 7,500 miles/year.
- CO_2e reductions from this action have been adjusted to reflect the offsetting emissions from battery recycling based on typical EV battery weights and 1.0 kg CO_2/kg battery recycled data from Sullivan & Gaines (2010).
- The five-year program is estimated to deploy 1,950 new EVs.

Costs

Costs to the City:

- **Initial cost** for designing and implementing outreach program (one-time, 0.5 FTE): $60,000
- **Annual costs** for staffing dedicated outreach program, events (workshops, conferences, OEM/dealer), materials, website maintenance, charger station grand openings, etc. (1 FTE/year): $120,000

References

- U.S. EPA (2012): https://nepis.ep.gov/Exe/ZyPDF.cgi?Dockey=P100EZ7C.PDF
- U.S. EPA: www.fueleconomy.gov
- U.S. Department of Energy (DOE) Alternative Fuels Data Center (AFDC) website
- Electric Drive Transportation Association website market data
- Sullivan & Gaines (2010): https://greet.es.anl.gov/publication-batteries_lca

T8. Continue programs to encourage new EV purchases

2030 Value in MTCO2e	Abatement Cost
5,314	$11.74/MT

Implementation Time Frame

2020–2025

Description

Encourage EV ownership through manufacturer's suggested retail price (MSRP) rebate from the City at time of purchase, and continued electricity rate discounts through AMP. Assume MSRP discount of $2,000 per new EV registration and continued AMP discounted rate for light-duty EVs of $0.06/kilowatt-hour (kWh).

Assumptions and Key Data

- Per Jack Faucett Associates (2015), assume $2,000 rebate value associated with 20.6% change in EV registrations.
- Assume current AMP rate discount program has produced one-third of the 2.2% registered EVs over its 13-year existence; continue program for another five years assuming that rate of success. AMP may opt for a time-of-use rate structure in future, which would require this measure to be adjusted accordingly.
- Assume new BEV each year since AMP data suggests PHEVs do not plug in.
- Reduces upfront capital cost and cost of ownership issues for purchase decisions on BEVs. Especially important in early EV market for improving market growth.
- CO_2e reductions from this action have been adjusted to reflect the offsetting emissions from battery recycling based on typical EV battery weights and 1.0 kg CO_2/kg battery recycled data from Sullivan & Gaines (2010).
- Assume 1,047 EVs by 2030 × $2,000 each = $2.094 million to City for rebates, plus program administration costs.
- Estimate 821 new EVs due to continuing AMP discount rate.
- Total new EVs of 1,863, or 374 per year, due to combined rebate and AMP discounted rate program.

Costs

Costs to the City:

- **First year/one-time cost to negotiate with car dealers** (assume 0.5 FTE at $120,000): $60,000
- **Annual cost:** Program administration (assume 0.5 FTE/year at $120,000): $60,000

AMP cost impacts (not estimated): Lost revenues from discounted electricity rate and program administration costs; increased revenue from new EV ownership

References

- Jack Faucett Associates (2015): http://www.caletc.com/wp-content/uploads/2016/08/New-Study-Shows-State-Investment-in-Zero-Emission-Vehicle-Incentives-Pays-Off.pdf
- *California Auto Outlook,* Electric and Plug In Hybrid Vehicle Gain Ground in 2018", Volume 14, Number 3, August 2018
- DOE AFDC website
- Sullivan & Gaines (2010): https://greet.es.anl.gov/publication-batteries_lca

T9. Continue to encourage businesses to install EV charging stations

691 (2030)
Value in MTCO2e

$90.30/MT
Abatement Cost

Implementation Time Frame

2020–2025

Description

Implement communications and outreach activities to encourage workplaces and businesses to install EV charging systems. This will provide more destination charging options for EV owners, thereby addressing range anxiety fears for current and prospective EV owners.

Assumptions and Key Data

- Assume same rate of growth of workplace/public charging organizations as DOE Workplace Charging Program partner growth for first four years, then 50% growth thereafter.
- Assume one workplace per organization and one station per workplace for small city location.
- Assume mix of new Level 1 and Level 2 chargers at 10/90.
- Assume 10 kWh/station/day; same as DOE Workplace Charging Program average.
- Assume average new EV energy consumption of 0.30 kWh/mile, 7,500 miles/year.
- CO_2e reductions from this action have been adjusted to reflect the offsetting emissions from battery recycling based on typical EV battery weights and 1.0 kg CO_2/kg battery recycled data from Sullivan & Gaines (2010).
- Program estimated to create 52 new stations (one charger per station) per year for five-year program.

Costs

Costs to the City:

- **First year cost:** Designing and implementing outreach program (one-time, 0.5 FTE) = $60,000
- **Annual cost:** Staffing dedicated outreach program, outreach events (workshops, conferences), outreach materials, public relations, and website maintenance (annual 0.5 FTE) = $60,000

References

- DOE (2016): https://www.energy.gov/sites/prod/files/2017/01/f34/WPCC_2016%20Annual%20Progress%20Report.pdf
- Plugshare and DOE AFDC websites
- U.S. EPA: www.fueleconomy.gov
- Sullivan & Gaines (2010): https://greet.es.anl.gov/publication-batteries_lca

T10. Electrify City's fleet

145 (2030)	$23.09/MT
Value in MTCO2e	Abatement Cost

Implementation Time Frame

2020–2030

Description

Convert the light-duty portion of the City's fleet to EVs: BEVs and PHEVs. Also, right-size the fleet.

Assumptions and Key Data

- Conversion of the heavy-duty portion of the City's fleet was not considered due to duty cycle, mission, and market availability issues for heavy-duty EVs.
- Assume total fleet of 235 vehicles, including six light-duty EVs per City's Public Works Fleet Supervisor; police patrol vehicle (PPV) vs. non-PPV fleet.
- Assume City's fleet grows at same rate as city population, about 1%/year based on GHG inventory figures.
- Assume City's light-duty PPVs replaced by PHEVs and non-PPVs by BEVs.
- Assume City fleet light-duty PPV turnover at five years, non-PPV at 12 years.
- Assume average City fleet light-duty PPV at 6,300 miles/year, non-PPV at 3,000 miles/year.
- CO2e reductions from this action have been adjusted to reflect the offsetting emissions from battery recycling based on typical EV battery weights and 1.0 kg CO2/kg battery recycled data from Sullivan & Gaines (2010).
- Cost assumptions: 28, L2 stations required at $6,000/unit installed.
- Ten-year program assumed to produce an estimated 208 new EVs.

Costs

Cost to the City:

- **Capital cost** (total EV purchases): $979,905
- **L2 station costs:** $168,000
- **Lifetime PEV operating <u>savings</u>** (fuel + maintenance): $1,064,194

References

- City Fleet Supervisor fleet inventory and data
- U.S. EPA: www.fueleconomy.gov
- DOE AFDC website
- CEC (2018): https://efiling.energy.ca.gov/GetDocument.aspx?tn=223241
- Sullivan & Gaines (2010): https://greet.es.anl.gov/publication-batteries_lca

100% clean energy from AMP (already committed to action; CARP Table 3-3)	134,189 2030 Value in MTCO2e

Description

AMP will provide electricity from 100% clean energy sources to all residential and commercial users in Alameda by 2020. Because Alameda's *2015 community-wide GHG emissions inventory* assumed that 95% of AMP's power portfolio is sourced from clean energy, it is necessary to estimate the GHG reduction that will be achieved from 100% clean energy and, thus, the reductions achievable in 2030. Below is a description of the calculation approach applied:

- **Step 1:** Determine 2030 BAU emissions associated with fossil-fuel-generated residential and commercial building electricity consumption originally developed in the 2015 inventory with some adjustments:
    - Made minor calculational corrections
    - Applied an updated grid loss factor of 4.87%, as provided by AMP

2030 BAU (original plus adjustments): 141,635.4 MTCO2e

- **Step 2:** Account for impacts from 2019 Building Energy Efficiency Standards (effective January 1, 2020):
    - Residential buildings:
        - Efficiency gains compared to those built based on 2016 standards: 7%
        - Efficiency gains compared to those built based on the 2016 standards with rooftop solar impact: 53%
    - Non-residential buildings:
        - Efficiency gains compared to those built based on the 2016 standards: 30%

2030 BAU (with impacts from 2019 Building Energy Efficiency Standards): 134,189.4 MTCO2e

GHG emissions reductions from AMP's supply of 100% clean electricity is equivalent to the value of the estimated BAU emissions from fossil-fuel-generated electricity.

References

- Alameda 2015 Community-Wide GHG Emissions Inventory (CoA, 2018a)
- 2019 Building Energy Efficiency Standards, California Energy Commission (adopted as Title 24, Part 6, California Code of Regulations)
- February 27, 2019 email correspondence with AMP's Vidhi Chawla

E1. Fuel switch in existing buildings

7,836 [2030]	$622.46/MT
Value in MTCO2e	Abatement Cost

Implementation Time Frame

2020–2030

Description

With the State of California aggressively pursuing the first portion of the nation's electric grid that provides 100% clean energy, there is a significant motivation to increasingly electrify buildings and shift from the use of fossil fuels to electricity for all building functions, including space heating, water heating, pools, spas, clothes dryers, and cooking. Under this action, the City of Alameda will support programs that encourage homeowners/commercial building owners to implement electrification retrofits.

Assumptions and Key Data

Measure applies to existing residential and commercial buildings.

- Building owners that implement electrification retrofits replace 100% of their existing natural gas use with electricity.
- **12% of residential and commercial** natural gas is replaced with electricity by 2030.
- Emissions reductions resulting from this measure are discrete and above and beyond emissions reductions associated with the "Programs to Encourage Fuel Switch in Certain Appliances" measure (E3).

Costs

Capital cost: $119 million
O&M cost: Assume one FTE at $120,000/year to administer program

References and Documents Used

- City of Berkeley Climate Action Plan update, 12/6/18 work session
- Building Electrification Initiative: https://www.beicities.org/
- SMUD Home Performance Program: https://www.smud.org/en/Rebates-and-Savings-Tips/Improve-Home-Efficiency
- Billimoria, Henchen, Guccione, & Louis-Prescott (2018): https://rmi.org/wp-content/uploads/2018/06/RMI_Economics_of_Electrifying_Buildings_2018.pdf

E2. Electrification of new residential construction

1,887 (2030)

Value in MTCO2e

$355.17/MT

Abatement Cost

Implementation Time Frame

2025–2030

Description

To supplement other actions targeting electrification of buildings, under this action Alameda will ensure all future residential construction is 100% electric-powered.

Assumptions and Key Data

- Applies to all new residential construction.
- Alameda will enforce 2019 Building Energy Efficiency Standards in its Building Codes.
- Sacramento Municipal Utility District offers a $5,000 rebate for new construction of all-electric homes. Assume this is representative of the cost premium for all-electric.

Costs

Capital cost: $13,755,000
O&M cost: Assume one FTE at $120,000/year to administer program

References and Documents Used

- SMUD All-Electric Smart Homes Program: https://www.smud.org/en/Going-Green/Smart-Homes

E3. Programs to encourage fuel switch in certain appliances

447 (2030) Value in MTCO2e	$520.28/MT Abatement Cost

Implementation Time Frame

2020–2030

Description

AMP offers numerous rebate programs, including programs incentivizing residential customers to install ENERGY STAR–labeled electric clothes dryers and ENERGY STAR–labeled electric heat pump water heaters. This action assumes AMP's continued implementation of these two rebate programs.

Assumptions and Key Data

- Measure applies to existing residential buildings only.
- Since it is assumed that AMP will provide 100% clean power by 2020, there are no further emissions reductions associated with programs that reduce electricity consumption; this measure only accounts for the scenarios whereby residential customers replace existing natural gas-powered clothes dryers and water heaters with electric-powered alternatives (i.e., perform fuel-switching).
- Cumulative percentage of AMP's total residential customers replacing existing natural gas clothes dryers with new electric clothes dryers: **2030= 10%.**
- Cumulative percentage of AMP's total residential customers replacing existing natural gas water heaters with new electric water heaters: **2030= 1%.**

Costs

Capital cost: ~$2.8 million
O&M cost: Assume one FTE at $120,000/year to administer program

References and Documents Used

- ENERGY STAR® Certified Products: https://www.energystar.gov/products

E4. Green roof installation on new development at Alameda Point

Implementation Time Frame 2025–2030	6 (2030) Value in MTCO2e	$45,750/MT Abatement Cost

Description

This action aligns with the Alameda Point Stormwater Management Plan in requiring green roofs for a minimum of 10% of the roof area in Development Areas. In most instances, the primary motivation for installing green roofs is to subscribe to "green infrastructure" practices, which act to mimic natural drainage patterns to reduce stormwater runoff, improve water quality, and replenish groundwater. As an additional co-benefit, green roofs reduce the energy required to both cool and heat buildings, thereby contributing to reduced GHG emissions associated with building energy consumption. To further enhance the energy efficiency of newly constructed buildings, the City will also encourage/incentivize the implementation of cool shingles.

Assumptions and Key Data

- Assumed heating load reduction resulting from green roof: 5%.
- Assumed green roof implementation on 10% of roof area of new development of residential and commercial units in Alameda Point. Equivalent to 10% of roof area on 1,909 residential units by 2030.
- Emissions reductions associated with reduced electric load not accounted for; assumed emissions reductions associated with building electricity already fully exhausted via zero-carbon electricity supply.

Costs

Capital cost: ~$4 million
O&M cost: Assume one FTE at $120,000/year to administer program

References and Documents Used

- Ganguly et al. (2016): https://www.sciencedirect.com/science/article/pii/S1876610216313960
- 2015 Residential Energy Consumption Survey, Table CE4.5: https://www.eia.gov/consumption/residential/data/2015/index.php?view=consumption#by%20End%20uses%20by%20fuel
- 2012 Commercial Building Energy Consumption Survey, Table E8: https://www.eia.gov/consumption/commercial/data/2012/
- ARUP (2016): http://default.sfplanning.org/Citywide/livingroof/SFLivingRoofCost-BenefitStudyReport_060816.pdf

S1. Apply compost in Alameda parks and open spaces

5,560 (2030)
Values in MTCO2e

$93.53/MT
Abatement Cost

Implementation Time Frame

2025–2030

Description

Alameda's 2018 update to the Zero Waste Implementation Plan (ZWIP) sets a goal of 89% diversion of waste from landfills by 2030. Based on this goal and the amount of organic waste that may be available for compost in those years (as estimated in the 2015 GHG Inventory), additional GHG reduction in the form of carbon sequestration may be attainable through land application of compost produced from diverted organic waste—potentially in parks, open space, and no-till areas controlled by Alameda. Alameda owns and/or controls significant open space, including parks covering over 180 acres of land. Although not all of that park land is available to compost application, landscaped areas throughout the city and other open spaces such as the closed Doolittle landfill may also provide area for compost application.

Assumptions and Key Data

- Alameda's 2015 GHG inventory estimated that 30,988 tons of waste will be disposed of in 2030. Using the waste type data from the 2015 inventory, and assuming 89% diversion in 2030, 13,238 tons of organic material and yard waste may be available for composting.
- Assume 100% of compost provided from this waste will be available for land application
- Based on CARB (2011), the net compost emission reduction factor (CERF) for composting in California is 0.42 MTCO2e/ton organic feedstock. The CERF includes emissions from transportation, processing, and fugitive emissions from composting as well as reductions from reduced water use, fertilizer use, herbicide use, and soil erosion.
- 13,238 tons of organic waste × 0.42 MTCO2e/ton organic feedstock = 5,560 MTCO2e soil carbon sequestration in 2030.
- Although these amounts of organic waste will be generated by the City, the City will have to pay for processing into compost as estimated below.

Costs

Capital cost: Estimate $500,000 for truck and spreader equipment
Annual operating cost: $500,000 per year

- Purchase compost: ~13,000 CY × ~$15/CY = ~$200,000/year
- Two FTEs ($240,000 per year)
- $60,000 per year in fuel and maintenance costs

References and Documents Used

- 2015 community-wide GHG inventory and projections (January 2019 version with ERG updates)
- CARB (2011): https://www.arb.ca.gov/cc/protocols/localgov/pubs/compost_method.pdf
- Verma, Badole, Deewan, & Meena (2014): https://www.researchgate.net/publication/286191585_Carbon_and_weight_loss_during_composting_of_wheat_straw_by_different_methods

S2. Further develop urban forest

356 (2030) Value in MTCO2e	$330.76/MT Abatement Cost

Implementation Time Frame

2020, 2025, 2030

Description

Encourage/facilitate urban forest. Plant more trees in Alameda, increase landscaped islands, replace damaged trees, make carbon sequestration a higher priority for the landscape maintenance contract. This action estimates the sequestration potential of planting 1,500 new trees in Alameda, in addition to the 2,000 new trees by 2030 that are already part of current City actions. The 1,500 new trees will be planted by the City and the public. The public will be incentivized by a volume discount to be negotiated by the City with local nurseries. Vouchers for the trees may also be available.

Assumptions and Key Data

- Current GHG inventory action includes 2,000 new trees by 2030; Master Street Tree Plan (2010) includes level 4 planting to achieve full stock of 350 trees/year for 10 years (total of 3,500 trees in 10 years). Therefore, 1,500 new trees will achieve full stock.
- Method based on iTree model, assuming 500 new trees are planted by each year: 2020, 2025, and 2030.
- Tree species to be planted selected from iTree model for those in Alameda's tree inventory (limited number of species in iTree): *Platanus acerifolia, Pyrus* species, *Gingko biloba, Fraxinus americana.* However, in the future, the City should choose to plant the tree species with the greatest sequestration rates.
- Current annual operating costs (for ~12,000 trees) are $750,000. 1,500 new trees is 12.5% increase in stock.

Costs

Capital cost: $600,000
Annual operating cost: $93,750 (12.5% over current budget)

References and Documents Used

- Current inventory of trees and Alameda urban forest webpage and 2010 Master Street Tree Plan: https://alamedaca.gov/go-green/street-trees; https://alamedaca.gov/public-works/trees
- Method used: https://planting.itreetools.org/

Appendix G

Social Vulnerability Assessment

August 2019

Prepared by Marisa Johnson, Sustainability and Equity Fellow, Alameda Public Works

Introduction

The objective of this study is to assess the social vulnerability of the City of Alameda to natural hazards such as flooding, reduced air quality, extreme heat, drought, and earthquakes. Social vulnerability can be defined as "the ways individuals, households and neighborhoods may be disproportionately harmed by a hazard" (Nutters, 2012, p. 5). Distinct from the physical vulnerabilities of assets like roads, infrastructure, and the built environment, social vulnerability focuses on the social and economic factors of individuals and communities that affect an individual's ability to prepare for, respond to, and recover from a natural hazard.

Each of these elements is influenced by factors such as race, age, income, historic patterns of exclusion, and government policy and implementation. For instance, families living in low-income neighborhoods during 2017's Hurricane Harvey were historically segregated to a part of the city that was racially homogenous and the most flood-prone. These communities were hit hardest by the storm and, because they had less disposable income, could not relocate or recover as easily as their more affluent neighbors (Krause & Reeves, 2017). This proves to be a pattern across the states, in the case of Hurricane Katrina, and beyond.

When thinking about sensitivity, seniors, children, and people with cardiovascular or chronic respiratory diseases are most susceptible to wildfire smoke (Allen, Cooley, Heberger, & Moore, 2012, p. 8). Although climate change impacts everyone, the intensity of the effects and ability of impacted individuals to respond are influenced by pre-established social variables. Social vulnerability is important to consider as it draws our attention to communities that will bear the heaviest burden in the face of climate change. By considering these communities, we can create the most effective strategies for adaptation and mitigation efforts.

Table G-1. Social Vulnerability Indicators and Measurement Index

Populations or Households That Are:	Measure	70th Percentile Rate	90th Percentile Rate
Renters	% renter-occupied households	58%	81%
Under 5	% people under 5	7%	10%
Very Low-Income	% people under 200% poverty rate; % households with income less than 50% of area median income	30%; 35%	50%; 52%
Not U.S. Citizens	% people not U.S. citizens	17%	26%
Without a Vehicle	% households without a vehicle	9%	22%
People with Disability	% households with one or more persons with a disability	26%	35%
Single-Parent Families	% single-parent families	11%	21%
Communities of Color	% people of color	70%	91%
65 and Over Living Alone	% households with one or more people 65 years and over	11%	19%
Limited English Proficiency	% limited English speaking household	11%	21%

Populations or Households That Are:	Measure	70th Percentile Rate	90th Percentile Rate
Without a High School Degree	% people 25 years and older without a high school degree	15%	30%
Severely Housing Cost Burdened	% renter-occupied households spending greater than 50% income on housing; % owner-occupied households spending greater than 50% income on housing	32% ; 20%	47% ; 33%

The City of Alameda's *Climate Action and Resiliency Plan* (CARP) applies a social vulnerability index, a block group's compounded vulnerability, to better inform strategies to boost community resilience to climate change impacts. The index is based on social vulnerability indicators determined by the San Francisco Bay Conservation and Development Commission (BCDC) Adapting to Rising Tides (ART) Program. BCDC consulted with an advisory committee comprising community members and working professionals to choose indicators that are measurable, publicly accessible, and relevant in a Bay Area context, and that capture heightened vulnerability. A more detailed description of the indicators used in this report can be accessed through the ART Program (Community Indicators for Flood Risk User Guide) and Housing and Community Risk Multiple Hazard Risk Assessment on the Association of Bay Area Governments (ABAG) website. Data for these indicators come from the American Community Survey five-year estimates and were compiled by ABAG. The metric used in this assessment is a block group, which is a census unit that is between 600 and 3,000 people. This assessment analyzes individual indicators as well as their compounded impact. Table G-1 shows the individual indicators, the measure used to represent them, and the threshold for vulnerability.

Social Vulnerability in Alameda, General Trends

Social vulnerability indicators are viewed at the census block group level. For each indicator, each block group in Alameda is ranked relative to all other block groups in the nine-county Bay Area region. To take the indicator for "percentage of households that are renters" as an example, a block group in the 70th percentile for the renter indicator has a higher percentage of renters than 70 percent of block groups in the Bay Area. A block group in the 90th percentile for the renter indicator has a higher percentage of renters than 90 percent of block groups in the Bay Area.

Individual indicators are useful for gaining a better sense of demographic patterns. For example, residents with limited English proficiency will need access to multilingual communication and educational resources. Knowing where these communities are concentrated and what services are nearby can adequately address this barrier. Figure G-1 shows a general picture of characteristics that occur in the 70th and 90th percentile in Alameda. Since it can cannot be determined whether one indicator contributes more to vulnerability than another, viewing indicators in conjunction provides a more accurate picture of social vulnerability. In addition to analyzing social vulnerability indicators individually and two to three at a time, this assessment uses a social vulnerability index to examine the cumulative effect of all indicators at once. Table G-2 describes how the social vulnerability index is determined.

Table G-2. Social Vulnerability Index

Social Vulnerability Level	Number of Indicators
Highest	8 or more in the 70th percentile 6 or more in the 90th percentile
High	6 to 7 in the 70th percentile 4 to 5 in the 90th percentile
Moderate	4 to 5 in the 70th percentile 3 in the 90th percentile
Low	Does not meet any of the above criteria

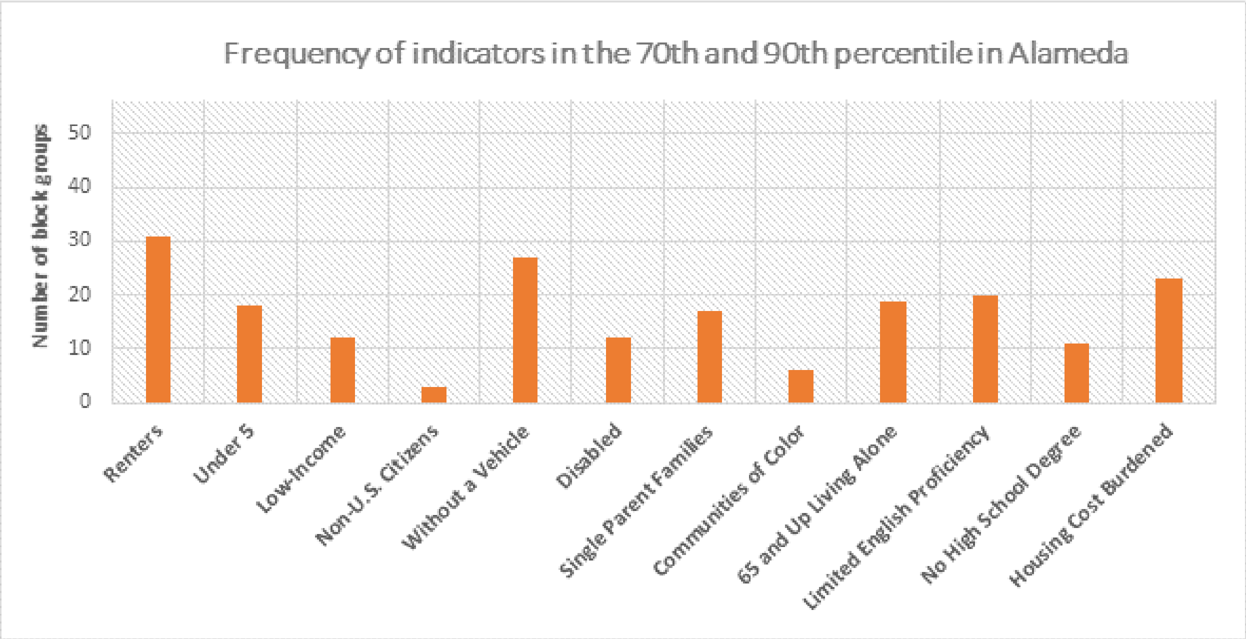


Figure G-1. Individual indicators in 70th and 90th percentile in the City of Alameda.

Renters

Significantly, nearly half of all residents in Alameda are renters. Renters have less autonomy over housing upgrades and typically do not have insurance in the case of flooding, earthquakes, and other hazards, making them much more susceptible to instability during climate disasters (Brechwald, Goodfriend, Kroll, & Lowe, 2015, p. 19). The maps below illustrate that the renter population is spread throughout the city. When overlain with the low-income indicator, however, we see that low-income renters become concentrated west of Constitution Way, near Alameda Landing, and in parts of the Downtown Alameda business district. This is significant, as low-income renters have the additional stressor of poverty on top of stressors driven by climate change. Low-income renters face challenges in preparing for and responding to climate change impacts due to the financial burdens of insurance costs, relocation costs, and recovery costs. Low-income renters are especially at risk of displacement due to damaged housing (Brechwald, Goodfriend, Kroll, & Lowe, 2015, p. 17). Coordinated efforts to provide renters with temporary housing and assist them during post-disaster relocation and recovery will be essential to promoting resilience and mitigating displacement.

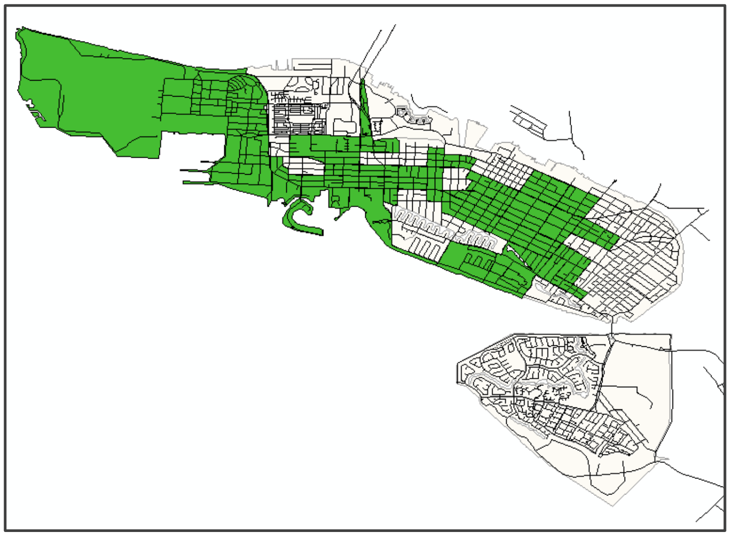


Figure G-2. Renters (green).

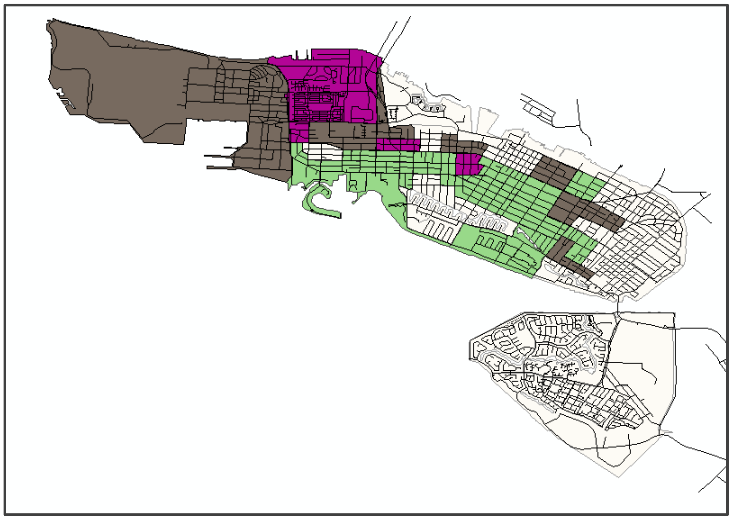


Figure G-3. Renters (green); very low-income (purple); renters x very low-income (gray).

Households Without a Vehicle/Transit-Dependent

Many households in Alameda are transit-dependent. This means that many households do not have a vehicle and rely on the bus, shuttles, car-share services, or other modes of transportation to reach a destination. In Alameda, more than 10 percent of households in most parts of the city do not have a car, making them dependent on the bus, walking, or other modes of transportation. The parts of Alameda that have higher rates of car ownership include Bay Farm Island, the East End, Ballena Bay, and South Shore.

Transit dependence can make it harder for economically strained households to respond in times of emergency, and insufficient transit options then make transportation an accessibility issue. Lack of mobility inhibits one’s quality of life and productivity and also makes it harder to respond in emergency situations (Federal Transit Administration, 2013, p. 72). When the individuals who are transit-dependent are children, seniors, disabled residents, and low-income residents, these impacts can be more extreme. Transportation resilience would ensure services are accessible and reliable under all circumstances, particularly for the vulnerable populations mentioned above.

Transit dependence can make one increasingly vulnerable when high transportation costs are combined with high housing costs. The average combined housing and transportation costs for an individual in the United States is 60 percent of monthly income (Federal Transit Administration, 2013, p. 14). Given that in Alameda around 33 percent of households spend over half their income on housing, that 60 percent for housing and transportation costs could be even higher (U.S. Census Bureau, 2016). Expanding on this nexus between income and vulnerability, the average American spends around 18 percent of their income on transportation costs, while the average American in a low-income bracket spends around 33 percent (Federal Transit Administration, 2013, p. 14).

In Alameda, residents on the West End are in a particularly vulnerable place, as the only bus line that serves them is the 96. This lack of service becomes an accessibility issue as public transit offers access to work, shopping, and school. Access to only one bus line limits transit options and can push individuals to rely on alternative transportation services such as car-shares. However, low-income, transit-reliant residents in areas serviced by one bus line like on the West End might find alternative modes of transportation such as car-shares a less reliable option. A Pew Research Center study states that “about one-third of American adults do not have a smartphone [and many of them tend to be] poorer and older” (Pacific Standard Staff, 2016). A different study conducted by the American Public Transportation Association “surveyed frequent ride-sharing users in seven cities [and] found the average household income of those users was about $91,000” (Pacific Standard Staff, 2016). One strategy for reducing the burden on households with high combined transportation and housing costs is to build and expand transit lines near affordable housing. This could help alleviate the stresses of transit-reliant individuals while simultaneously designing solutions to reduce earthquake and flood risks (Brechwald, Goodfriend, Kroll, & Lowe, 2015, p. 22).

People with disabilities who are transit-dependent can face additional accessibility challenges. In the United States, “adults with disabilities are twice as likely as those without disabilities to have inadequate transportation (31 percent vs. 13 percent)” (American Association of People with Disabilities, n.d.). Alameda offers a number of transportation services, including a free shuttle service designed for seniors and disabled riders that functions three days a week at hourly intervals, a reduced taxi ride program that transports riders home after a medical appointment, and East Bay Paratransit. Still, paratransit users in many cities similarly feel that “problems with service quality and capacity limitations” inhibit their mobility (American Association of People with Disabilities, n.d.). In the case of emergency and evacuation situations, residents with disabilities who frequently use or rely on these services will be highly vulnerable due to the above factors.

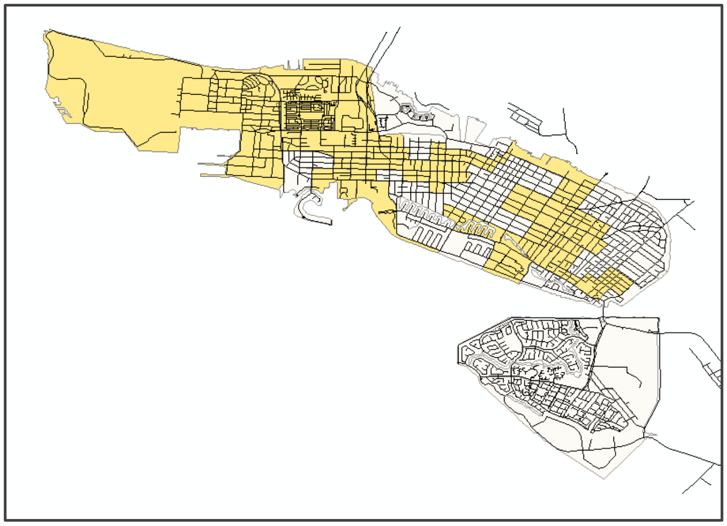


Figure G-4. Transit-dependent (yellow).

Figure G-5. Transit-dependent (yellow); low-income (purple); transit-dependent x low-income (orange).

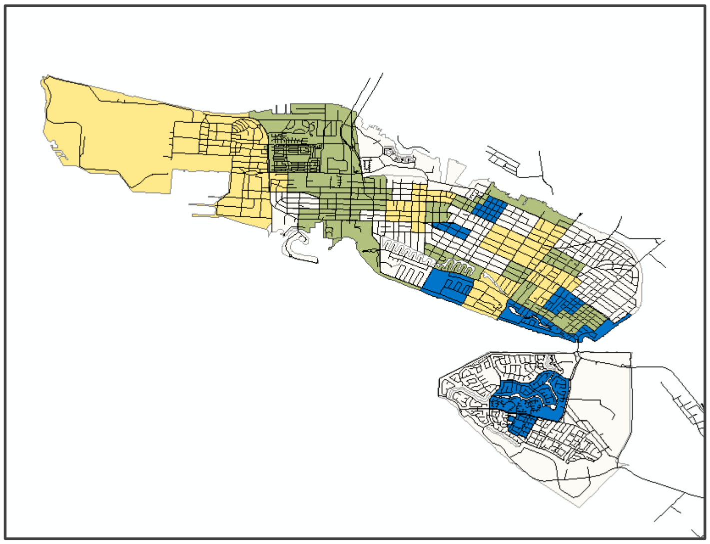


Figure G-6. Transit-dependent (yellow); housing cost burdened (blue); transit-dependent x housing cost burdened (green).

Housing Cost Burdened

Households spending more than 50 percent of their income on housing are considered housing cost burdened. Many Alamedans fall into this category. Housing cost burdened block groups are concentrated on the West End, between Main Street and Constitution Way in central Alameda, and along Shoreline Drive and Clement Avenue in eastern Alameda. Lack of affordable housing can exacerbate the number of residents who become displaced after a natural disaster. If units are lost during a disaster, housing costs can rise, making the remaining housing stock even more difficult to afford (Brechwald, Goodfriend, Kroll, & Lowe, 2015, p.17). For example, in the weeks following the 2017 Sonoma County fires, "median monthly rent… jumped 35 percent to $3,224, in response to new demand from displaced residents" (Miller, 2017). These steep price increases prompted cities in Sonoma County to center affordable housing and tenant protection in rebuilding efforts (Miller, 2017).

In Figure G-8, block groups with a high percentage of housing cost burdened households are overlain with the indicator for low-income to further analyze the vulnerability of the block groups. Low-income households that spend more than half their income on housing live mostly near Alameda Landing, along Lincoln Avenue and Park Street. Due to limited resources and added stressors, these low-income households will face more challenges in adapting to climate impacts than higher-income households that also spend more than half their paycheck on housing. Stable housing is important for community resilience, and high housing costs can decrease an individual's ability to adapt to a climate impact like flooding. Ensuring an ample supply of affordable housing in Alameda can mitigate displacement after disasters and increase a household's economic ability to prepare for natural hazards. It will be important to consider affordable housing as an adaptation strategy that contributes to individual and community resilience.

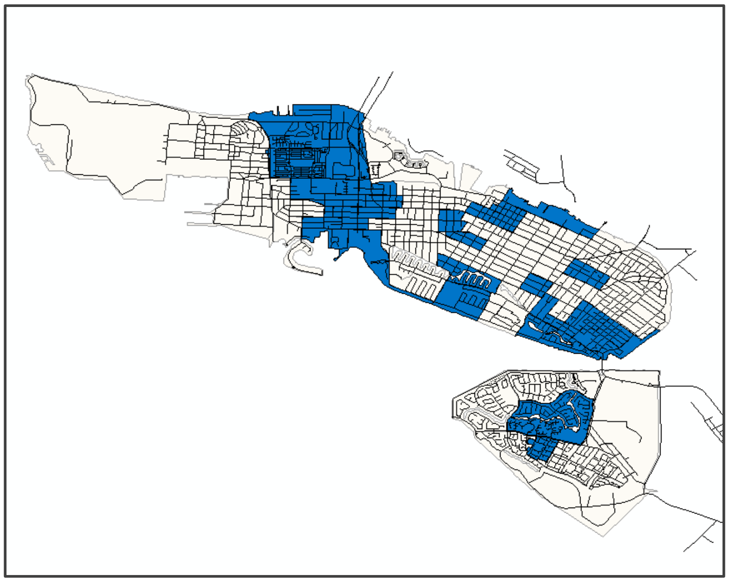


Figure G-7. Housing cost burdened (blue).

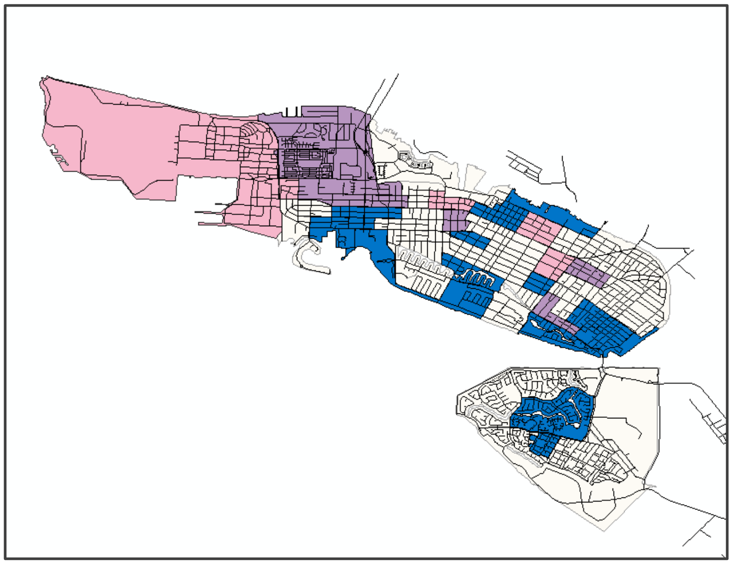


Figure G-8. Housing cost burdened (blue); very low-income (pink); housing cost burdened x very low-income (purple).

Limited English-Language Proficiency

Block groups with significant numbers of limited English-language-proficient households are more concentrated in Alameda Landing, along Buena Vista and Clement Avenues, in South Shore, along Broadway, and on parts of Bay Farm Island and Eastshore. In those block groups, 1 to 4 percent speak Spanish, 1 to 14 percent speak Chinese, 1 to 4 percent speak Vietnamese, and 0 to 4 percent speak Tagalog. Lack of communication and miscommunication make neighborhoods with higher concentrations of non-English speakers highly vulnerable to climate hazards because they may not receive important information about preparing for and responding to disaster events. Many of these residents are immigrants, refugees, and communities of color who are often left out of conversations or are hesitant to engage because of the language barrier and not feeling welcome (Nelson, Spokane, Ross, & Deng, 2015, p. 51). In the case of emergencies and disaster response situations, people who are most vulnerable are often impacted the most, and families with limited English can become overwhelmed if they were never spoken to about how to respond in an emergency.

In Alameda, there is a larger percentage of Chinese speakers overall, meaning that communications materials should prioritize translation into Chinese (though outreach and communications efforts should always offer translations in the four non-English languages) and conduct targeted outreach to these areas. Translated communications builds trust and enhances the reach of public information. Working with community organizations and services that reach non-English speakers to disseminate information can help the City move toward building community resilience while working collaboratively with residents (Nutters, 2012, p. 22).

Figure G-9. Limited English-language proficiency (brown).

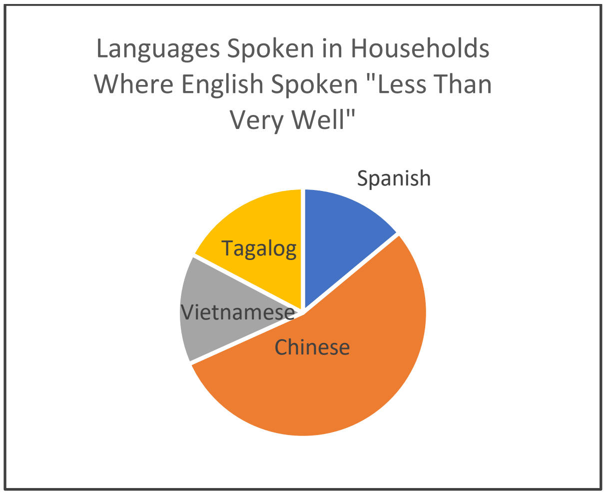


Figure G-10. The above pie chart calculates languages for all non-English-proficient households in Alameda, not just households in highly vulnerable block groups.

Social Vulnerability Index

The social vulnerability index is used in the CARP to identify the best strategies for the populations most vulnerable to climate change. Alameda contains 57 census block groups, and 14 of those read as having high or highest vulnerability. The compounded vulnerability of each block group directs our attention to areas that need more targeted community resilience strategies. This level of analysis is key for developing the most effective and holistic climate change adaptation strategies and policies.

The social vulnerability index (Figure G-11) captures concentrated populations of vulnerability, though it is important to note that there are highly vulnerable people in the low and moderate vulnerability block groups. People experiencing homelessness also need to be considered. While they cannot be physically "mapped" by block group, adaptation strategies should consider how they will receive emergency communications and how they will be sheltered. Proper, safe housing for all is an adaptation and resilience strategy. Planning strategies should always consider these vulnerable populations in adaptation efforts.

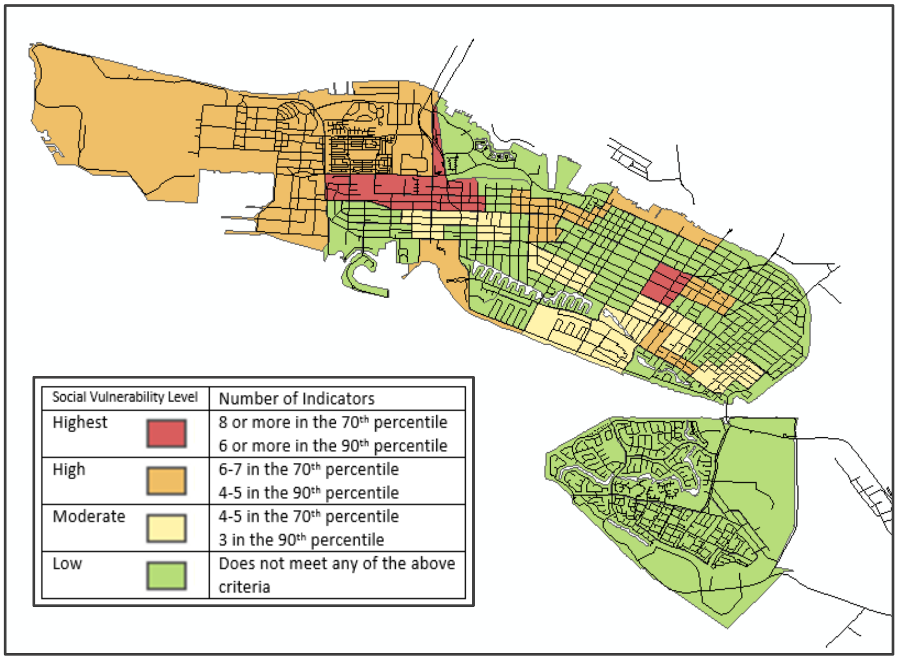


Figure G-11. Social vulnerability index in Alameda.

Block Group Level

Figure G-12 captures the block groups with highest vulnerability. Within these 14 block groups, an inventory of community assets and bus lines was taken (Table G-3), which can be used to inform outreach practices and gaps in equitable greenhouse gas and adaptation strategies. Here, assets are defined as sites and places residents might frequent, receive information, or congregate in search of community. These include schools, places of worship, parks, community centers, childcare centers, community gardens, libraries, and recreational centers.

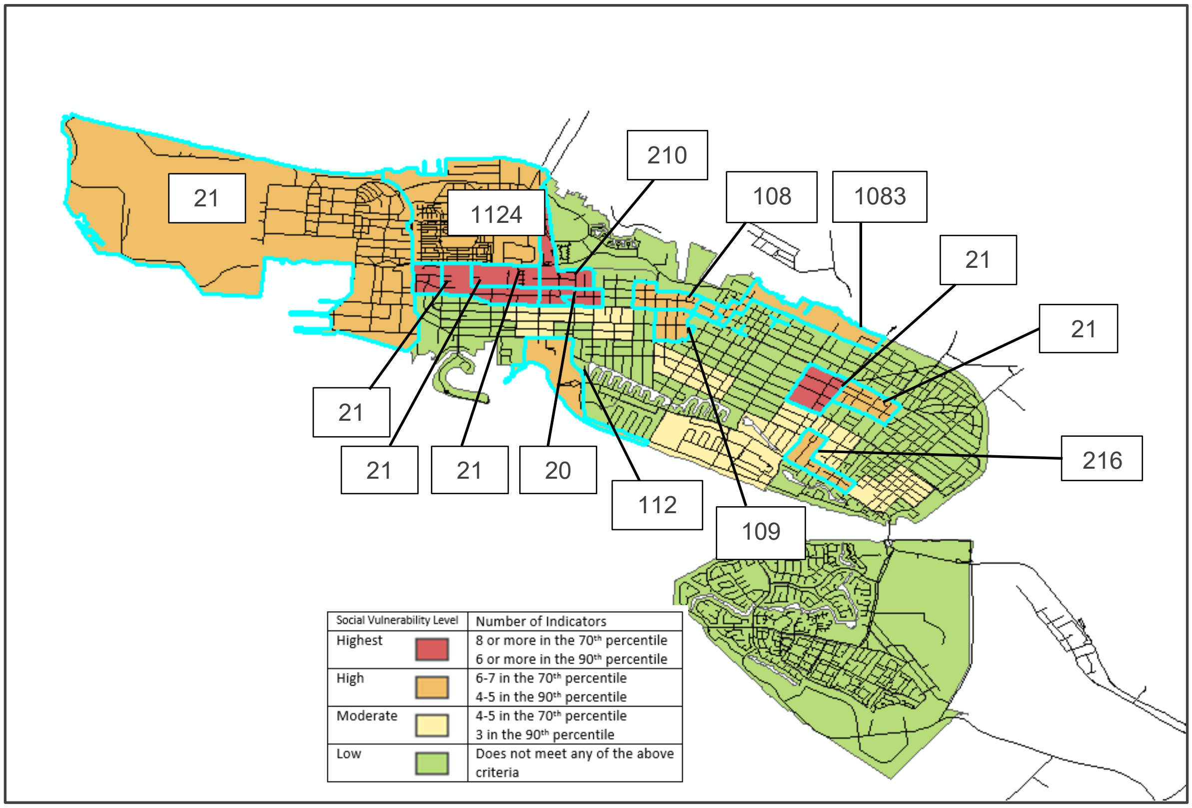


Figure G-12. Social vulnerability index in Alameda distinguishing highly vulnerable block groups.

Table G-3. Block Group Inventory

Object ID	Bordering Streets	Indicators in 70th or 90th Percentile	Assets Within or in Adjacent* Block Group	Bus Lines Within
217	Main St	Renters, low-income, without a vehicle, people with disability, single-parent households	Changing Gears Bike Shop, Ploughshares Nursery, Farm2Market community garden and event space, Alameda Point Collaborative Career Center, Encinal High School*	96
1124	Main St, Ralph Appezzato Memorial Pkwy, Webster St	Under 5, low-income, without a vehicle, 65 and over living alone, limited English proficiency, severely housing cost burdened	Ruby Bridges Elementary School, College of Alameda, Island High School	96
213	Main St, Ralph Appezzato Memorial Pkwy, 3rd St, Pacific Ave	Low-income, not U.S. citizens, without a vehicle, people with disability, single-parent households, communities of color, limited English proficiency, without a high school degree	Kiddie Kampus Co-Op Nursery	96
212	Ralph Appezzato Memorial Pkwy, 3rd St, Pacific Ave, Marshall Way, Lincoln Ave, Webster St, Buena Vista Ave, Poggi Ave	Renters, low-income, not U.S. citizens, without a vehicle, people with disability, single-parent households, communities of color, limited English proficiency, without a high school degree, severely housing cost burdened	Nea Community Learning Center, The Academy of Alameda Elementary School, Woodstock Park, Longfellow Park,* Boys and Girls Club, Alameda Adult School	631, 663, 96
211	Ralph Appezzato Memorial Pkwy, Webster St, Poggi Ave, Buena Vista Ave	Renters, under 5, low-income, not U.S. citizens, without a vehicle, single-parent households, without a high school degree, severely housing cost burdened	N/A	20, 314, 51A, 851, O, W
210	Webster St, Constitution Way, 9th St, Buena Vista Ave, Stewart Ct	Renters, low-income, without a vehicle, people with disability, communities of color, 65 and over living alone, limited English proficiency, without a high school degree, severely housing cost burdened	N/A	19, 20, 314, 51A, 851, O, W, 96
209	Webster St, Lincoln Ave, Wood St, Buena Vista Ave	Low-income, without a vehicle, people with disability, single-parent households, communities of color, limited English proficiency, without a high school degree, severely housing cost burdened	N/A	

Object ID	Bordering Streets	Indicators in 70th or 90th Percentile	Assets Within or in Adjacent* Block Group	Bus Lines Within
1122	Central Ave, Westline Dr, Shoreline Dr, Grand St, McKay Ave	Renters, without a vehicle, people with disability, single-parent households, 65 and over living alone, severely housing cost burdened	Washington Park, Crown Memorial State Beach, Alameda Free Library-West End Branch,* Blue Moon Learning Center	20, 631, 663, W
1083	Clement Ave, Park St, Grand St, Eagle Ave, Hibbard St, Buena Vista Ave, Stanton St, Lincoln Ave, Mintrum St	Without a vehicle, people with disability, single-parent households, limited English proficiency, without a high school degree, severely housing cost burdened	Frank Bette Center for the Arts	19
1084	Buena Vista Ave, Lincoln Ave, St Charles St, Stanton St, Lincoln Ave	Renters, low-income, without a vehicle, single-parent households, limited English proficiency, without a high school degree	Bay Eagle Community Garden, Littlejohn Park	19
1099	Stanton St, Sherman St, Lincoln Ave, Cottage St	Low-income, without a vehicle, single-parent households, limited English proficiency, without a high school degree, severely housing cost burdened	Mastick Senior Center,* Franklin Park Pool,* Franklin Park,* Fuzzy Caterpillar Preschool*	314, 51A, 851, O
214	Park St, Lincoln Ave, Encinal Ave, Walnut St	Renters, under 5, low-income, without a vehicle, single-parent households, communities of color, 65 and over living alone, limited English proficiency, without a high school degree	Alameda High School, Alameda Christian School,* The Child Unique Montessori School,* Alameda Free Library*	631
215	Park St, Central Ave, Encinal Ave, Versailles Ave	Renters, low-income, without a vehicle, 65 and over living alone, without a high school degree, severely housing cost burdened	Edison Elementary School,* Downtown Alameda Business District, Bay Area Music Project-Alameda	631, 663, O, OX
216	San Jose Ave, Park St, Regent St, Calhoun St, Mound St, Otis Dr,	Renters, under 5, low-income, without a vehicle, 65 and over living alone, limited English proficiency, severely housing cost burdened	Jackson Park, Frank Otis Elementary School,* Krusi Park,* St Philip Neri School,* Otis Preschool,* Luna's Montessori Bilingual School,* Bay Language Academy,* Alameda School of Music*	21, 314, 356, W

*asset is located in adjacent block group

Climate-Specific Vulnerabilities

The social vulnerability index can show how populations will be impacted differently in climate events. In this section, sea level rise and contaminated lands are highlighted because these hazards are geographically situated, whereas hazards like wildfire smoke, drought, and heat will be distributed across the city.

Sea Level Rise and Flooding

Alameda's geography as an island makes it especially vulnerable to sea level rise and flooding. Figure G-13 captures sea level rise at 36 inches, which is projected to significantly impact residents living on Bay Farm Island, at Alameda Point, and near Alameda Landing. Flooding can force people out of their homes, "as even short duration flooding can undermine building structures or create unsafe living conditions due to mold growth and contamination," making community resilience harder to attain (Brechwald, Goodfriend, Kroll, & Lowe, 2015, pg. 8). Flood risk at 36 inches of sea level rise shows how the most vulnerable are often impacted first. During a 100-year storm event under these same conditions, a larger portion of the city faces flood risk, yet the implications of sea level rise on western Alameda residents in highly vulnerable block groups remain. Those who are most vulnerable will have greater difficulty responding if preventative actions such as the aforementioned strategies (e.g., climate-resilient housing) and safe, affordable housing are not implemented. Table G-4 and Table G-5 identify household characteristics that appear in the 70th or 90th percentile of the block groups that will be directly impacted by water inundation in the two respective scenarios.

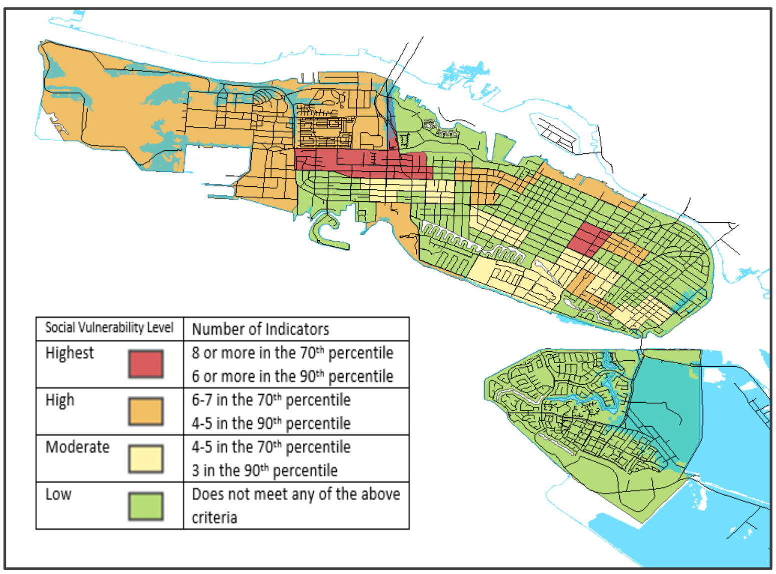


Figure G-13. Blue indicates water inundation, or flooding, at 36 inches of sea level rise.

Table G-4. Impacted Populations

Impacted Populations
Renters
Low Income
Under 5
65 and Over Living Alone
Single Parent Households
People with a Disability
Households without a Vehicle
Severely Housing Cost Burdened
Without a High School Degree
Communities of Color

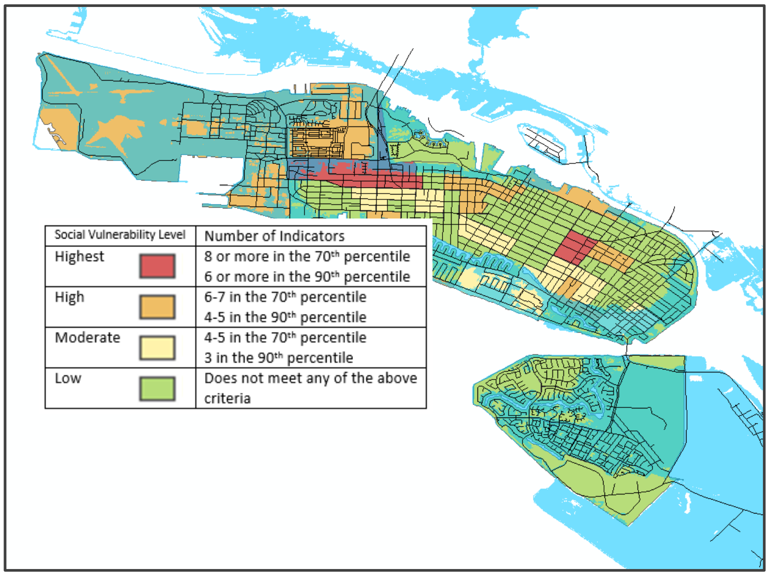


Figure G-14. Blue indicates water inundation, or flooding, during a 100-year storm at 36 inches of sea level rise.

Table G-5. Impacted Populations

Impacted Populations
Renters
Low Income
Under 5
65 and Over Living Alone
Single Parent Households
People with a Disability
Households without a Vehicle
Severely Housing Cost Burdened
Without a High School Degree
Communities of Color
Non-U.S. Citizen

Contaminated Lands and Waste

Figure G-15 captures the block groups that contain cleanup sites at or above the 90th percentile. Cleanup sites are defined by the California Office of Environmental Health Hazard Assessment as places “contaminated with harmful chemicals [that] need to be cleaned up by the property owners or government” (OEHHA, 2019). These contaminants can come from old buildings, toxic spills, the dumping of toxic waste, national defense activities, and pesticides, among many others (U.S. EPA, 2017). Cleanup sites in Alameda are primarily a result of industrial activities that occurred at the Alameda Naval Air Station from 1939 until its closure in 1997. Cleanup of the contaminated sites at Alameda Point are ongoing (Clearwater Revival Company, 1999).

Residents living at Alameda Point, around Alameda Landing, in Marina Village, and along Lincoln Avenue facing the harbor are situated directly in these contamination-vulnerable block groups. The health impacts on people living close to contaminated lands vary by level of contamination but can be acute (e.g., rashes and skin irritation) or chronic (e.g., cancer). Six block groups with high and highest social vulnerability are also the sites of cleanups as identified by the CalEnviroScreen tool (OEHHA, 2018). Future development plans should account for this hazard and current residents should be given full transparency as to their risks and the current process to remove toxins.

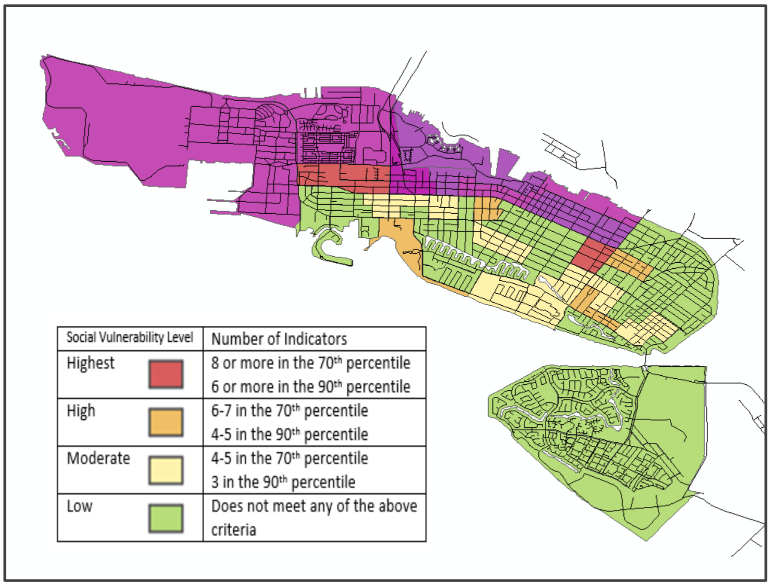


Figure G-15. Purple indicates block groups with number of cleanup sites exceeding the 90th percentile.

In addition to the indicators described above, there are additional social and economic indicators of vulnerability to be aware of. It is important to remember that these are indicators, meant to be used together to identify locations where community members may be at greater risk.

Communities of Color

Of the six total block groups that meet the 70th or 90th percentile for communities of color, five of those are in block groups with high or highest social vulnerability. Across the United States and California, communities of color are disproportionately burdened by several factors contributing to increased vulnerability. According to the Ocean Protection Council, the author of California's official 2018 sea level rise adaptation guidance, "Adaptation strategies should prioritize protection of vulnerable communities and take into consideration social equity and environmental justice" (OPC, 2018, pg. 6). Alameda's planning is in accordance with this state guidance, meaning it is crucial to understand the disparate impacts climate change might have on communities of color. Doing so will ensure further harm is prevented in communities of color. California's Fourth Climate Change Assessment attributes social vulnerability to a combination of personal demographic attributes, the physical environment, and historic underinvestment and marginalization. The uneven distribution of vulnerability to climate impacts can be partly traced to patterns of exclusion in the early 20th century by means of redlining and restrictions on black, Chinese, and other non-white home ownership. Without this awareness and deliberate planning, certain groups and individuals will continue experiencing the impacts of harmful systems. Centering communities of color in climate change adaptation planning bridges equity and environment, a key component of sustainable climate action planning.

Figure G-16. Communities of color (green).

Age

Alameda is a city with a large population of families and seniors. The vulnerabilities to climate-related issues that young children and seniors face will be especially important to consider for climate action planning. Lack of mobility, dependence on others, and health sensitivities make these populations particularly vulnerable.

For children, proper protection and care services should be a focus. Children are more sensitive to their environment as their immune systems are still developing, “leaving their rapidly growing bodies more sensitive to disease and environmental pollutants” (Climate Reality Project, 2018). They spend more time outdoors than adults, meaning they are more directly exposed to poor air quality in wildfire events and extreme heat, which poses another threat as children are less able to regulate their body temperature (U.S. EPA, 2016a, pg. 2). They are also dependent, meaning they are especially vulnerable if they are separated from a caregiver. In Alameda, children under 5 are fairly dispersed throughout the city.

Like children, elders are more sensitive to poor environmental quality. Pre-existing health conditions can be exacerbated by wildfire smoke and rising temperatures. Educational materials for seniors on how to reduce their risk to such conditions can be an effective resilience strategy. This should be distributed through a number of ways—online media, newspaper, e-mail, landline and cell phone—to adequately meet the needs of older residents. Connecting with local senior centers and senior living centers can also provide a space to distribute information, and they might serve as places for seniors to gather on high heat and poor air days. Mobility is also a point of concern, as some seniors might rely on transportation services. As Alameda is a city with a sizable proportion of people over 65 living alone, preparation and proper education can go a long way.

Figure G-17. Households with children under 5 (gray).

Figure G-18. Seniors over 65 living alone (orange).

People with Disabilities

The disabled community is varied and diverse, though they generally face “barriers in accessing healthcare services and in receiving timely public health or emergency information in an accessible format” (U.S. EPA, 2016b, pg. 2). They also often face added social stressors such as poverty, unemployment, and health conditions. People with disabilities have consistently been hard hit in emergency situations. Thus, it would be essential to “meet demand for wheelchair-accessible transportation,” as well as to “maintain adequate supplies of prescription medication[,] access to necessary medical equipment like oxygen, and [proper] evacuation shelters with appropriate facilities, equipment, and trained staff to meet the various needs of people with disabilities” (U.S. EPA, 2016b, pg. 3). Proper health services and informational services will be important when preparing for projected climate change impacts—such as wildfire events, flooding, and heat—and reducing the burden on people with disabilities.

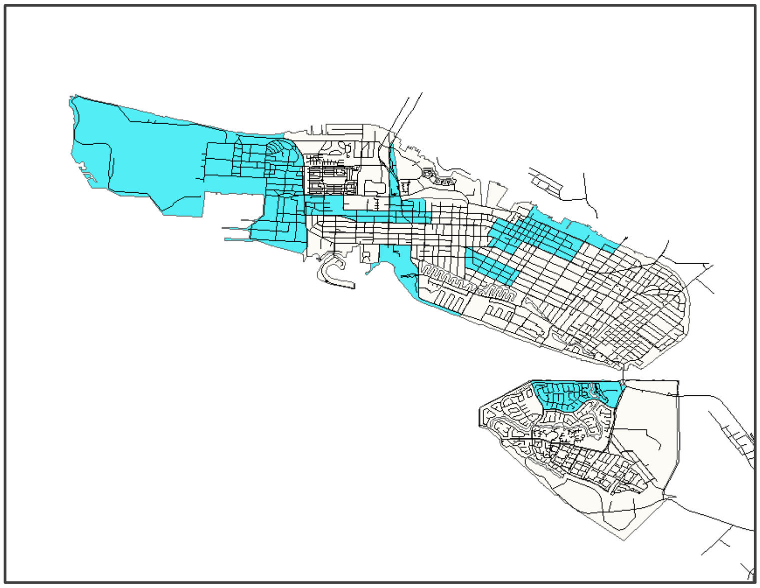


Figure G-19. People with disabilities.

Alamedans Experiencing Homelessness

Combined housing prices and living costs in the Bay Area and consequently, the City of Alameda, have exacerbated the prevalence of families and individuals experiencing homelessness. The City of Alameda’s 2018 Homelessness Report emphasizes the importance of physical space to provide services more reliably and accessibly. While unhoused individuals cannot be geographically situated on a map, the best indicator for this is the City of Alameda’s Point-in-Time counts, first done in 2015 to quantify the number of homeless Alamedans. A January 2017 count found that there were 204 homeless individuals in the city (COA, 2018). Adequate services for these individuals are important now and can help prevent future harm regarding climate impacts.

Lack of shelter dramatically increases an individual’s risk to climate impacts, as constant exposure to disparate weather patterns and flooding becomes a health risk when one does not have immediate shelter. For instance, “cumulative exposure to heat over numerous days can lead to serious health conditions including heat stress, and severe heat stroke” (Hanson-Easey, Every, Tehan, Richardson, & Krackowizer, 2016, p. 7). Inadequate healthcare and medical services further place unhoused individuals at such risks. Additional stressors such as "higher rates of chronic disease, smoking, respiratory disease, mental illness and substance abuse than the general population" mean that unhoused Alamedans will have a more difficult time adequately responding and adapting to climate threats, considering the additional social barriers impacting their daily lives (Hanson-Easey, Every, Tehan, Richardson, & Krackowizer, 2016, p. 2). Lack of mobility among the homeless population can also increase vulnerability in emergency and flooding situations. Expanding and streamlining services by local means, such as the Homeless Outreach Team, can ensure proper education, awareness and pre-disaster planning. Ultimately, safe and stable housing would help ameliorate many of the risks homeless individuals face.

Summary of Potential Impacts

The social vulnerability assessment adds another layer to climate change vulnerability by considering human impact. A cornerstone of sustainable planning is equity, where the needs of communities who have been continually marginalized are properly addressed. This assessment draws connections between equity and environment and offers the City a chance to build equity into projects and programs. It can inform more tailored greenhouse gas and adaptation strategies that address the disproportionate impacts of climate change hazards on certain residents while promoting resilience and adaptation to climate change.

References

Allen, L., Cooley, H., Heberger, M., & Moore, E. (2012). *Social vulnerability to climate change in* California. California Energy Commission. Retrieved from https://www.energy.ca.gov/2012publications/CEC-500-2012-013/CEC-500-2012-013.pdf

American Association of People with Disabilities. (n.d.). *Equity in Transportation for People with Disabilities*. Retrieved from http://www.civilrightsdocs.info/pdf/transportation/final-transportation-equity-disability.pdf

Brechwald, D., Goodfriend, W., Kroll. C., & Lowe, L. (2015). *Stronger housing, safer communities: Strategies for seismic and flood risks.* Association of Bay Area Governments. Retrieved from http://resilience.abag.ca.gov/wp-content/documents/housing/Final%20Report/StrongHousingSaferCommunities_Strategies_3.16.15.pdf

Clearwater Revival Company. (1999). *Military: Alameda Point Naval Air Station*. Retrieved from http://www.toxicspot.com/military/alameda/

Climate Reality Project. (2018). *Climate change and health: Children.* Retrieved from https://www.climaterealityproject.org/blog/climate-change-and-health-children

COA (City of Alameda). (2018). *Homelessness report*. Retrieved from https://www.alamedaca.gov/files/assets/public/alameda-homelessness-report.pdf

Federal Transit Administration. (2013). *Transportation needs of disadvantaged populations: Where, when, and how?* (Report No. 0030). https://www.transit.dot.gov/sites/fta.dot.gov/files/FTA_Report_No._0030.pdf

Hanson-Easey, S., Every, D., Tehan, B., Richardson, J., & Krackowizer, A. (2016). *Climate Change, Housing and Homelessness: Report on the homelessness and climate change forum*. National Climate Change Adaptation Research Facility. Retrieved from https://www.nccarf.edu.au/sites/default/files/Forum%20report%20on%20homelessness%20and%20climate%20change%20final.pdf

Krause, E., & Reeves, R. (2017, September). *Hurricanes hit the poor the hardest.* Retrieved from https://www.brookings.edu/blog/social-mobility-memos/2017/09/18/hurricanes-hit-the-poor-the-hardest/

Miller, S. R. (2017, November 28). Wildfires have worsened the Bay Area's housing crisis. *CityLab*. Retrieved from https://www.citylab.com/equity/2017/11/wildfires-have-worsened-the-bay-areas-housing-crisis/546647/

Nelson, J., Spokane, L., Ross, L., & Deng, N. (2015). Advancing racial equity and transforming government: A resource guide to put ideas into action. Government Alliance on Race and Equity. Retrieved from https://www.racialequityalliance.org/wp-content/uploads/2015/02/GARE-Resource_Guide.pdf

Nutters, H. (2012). *Addressing social vulnerability and equity in climate change adaptation planning.* San Francisco Bay Conservation and Development Commission. Retrieved from http://www.adaptingtorisingtides.org/wp-content/uploads/2015/04/ART_Equity_WhitePaper.pdf

OEHHA (Office of Environmental Health Hazard Assessment). (2018). *CalEnviroScreen 3.0.* Retrieved from https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30

OEHHA. (2019). *Cleanup sites.* Retrieved from https://oehha.ca.gov/calenviroscreen/indicator/cleanup-sites

OPC (Ocean Protection Council). (2018). *State of California sea-level rise guidance.* Retrieved from http://www.opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_Exhibit-A_OPC_SLR_Guidance-rd3.pdf

Pacific Standard Staff. (2016, May). How Lyft and Uber are ignoring the poor. *Pacific Standard Magazine.* Retrieved from https://psmag.com/news/how-lyft-and-uber-are-ignoring-the-poor

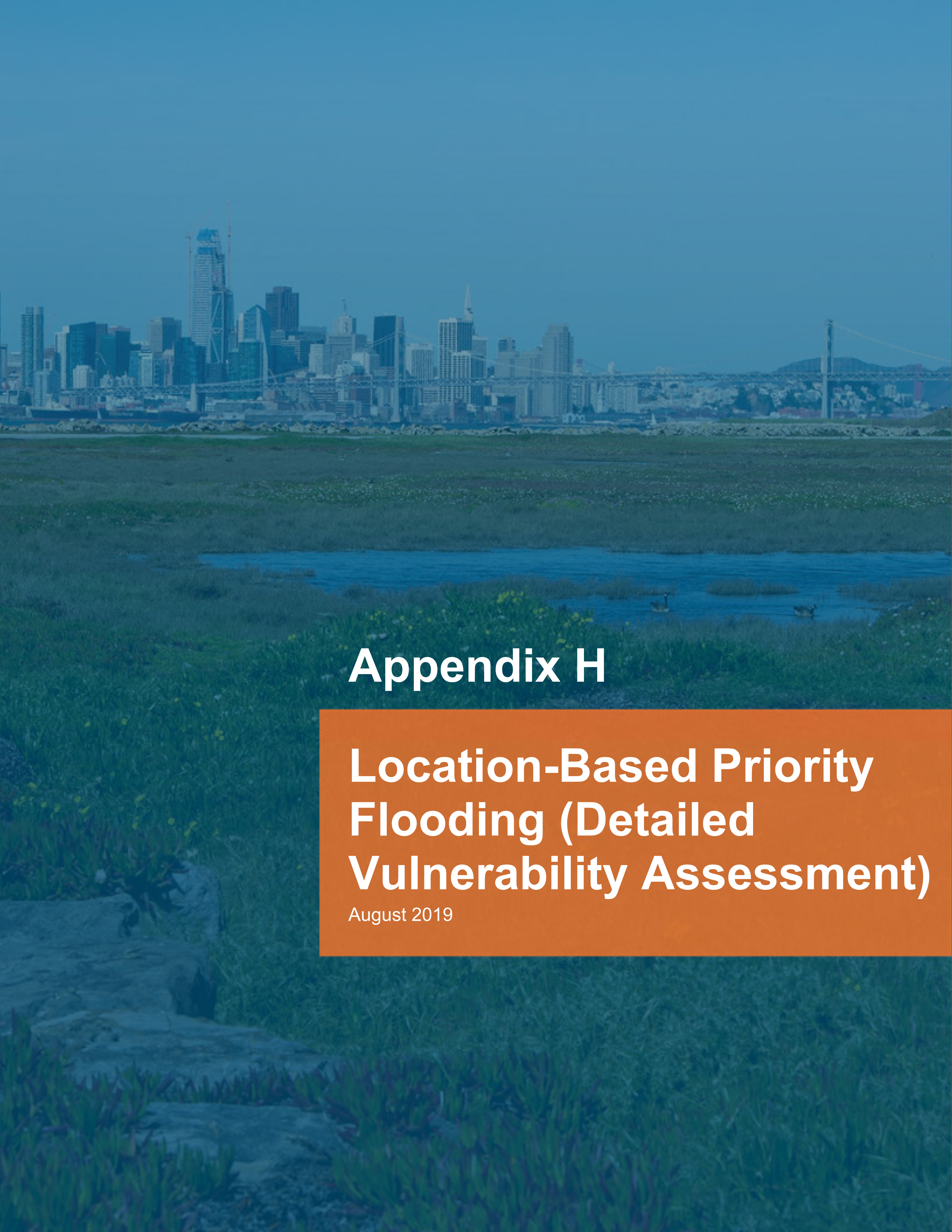
Resource Innovation Group. (n.d.) *Transformational resilience.* Retrieved from http://www.theresourceinnovationgroup.org/transformational-resilience/

U.S. Census Bureau. (2016). *2016, American Community Survey 5-year estimates.* Retrieved from https://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2016/

U.S. EPA (U.S. Environmental Protection Agency). (2016a). *Climate Change and the Health of Children.* United States Environmental Protection Agency (EPA 430-F-16-055). Retrieved from https://www.aap.org/en-us/Documents/Climate_Change_Health_of_Children.pdf

U.S. EPA. (2016b). *Climate Change and the Health of People with Disabilities* (EPA 430-F-16-060). Retrieved from https://cerch.berkeley.edu/sites/default/files/climate_change_and_the_health_of_people_with_disabilities.pdf

U.S. EPA. (2017). *Report on the environment: Contaminated land*. Retrieved from https://www.epa.gov/report-environment/contaminated-land



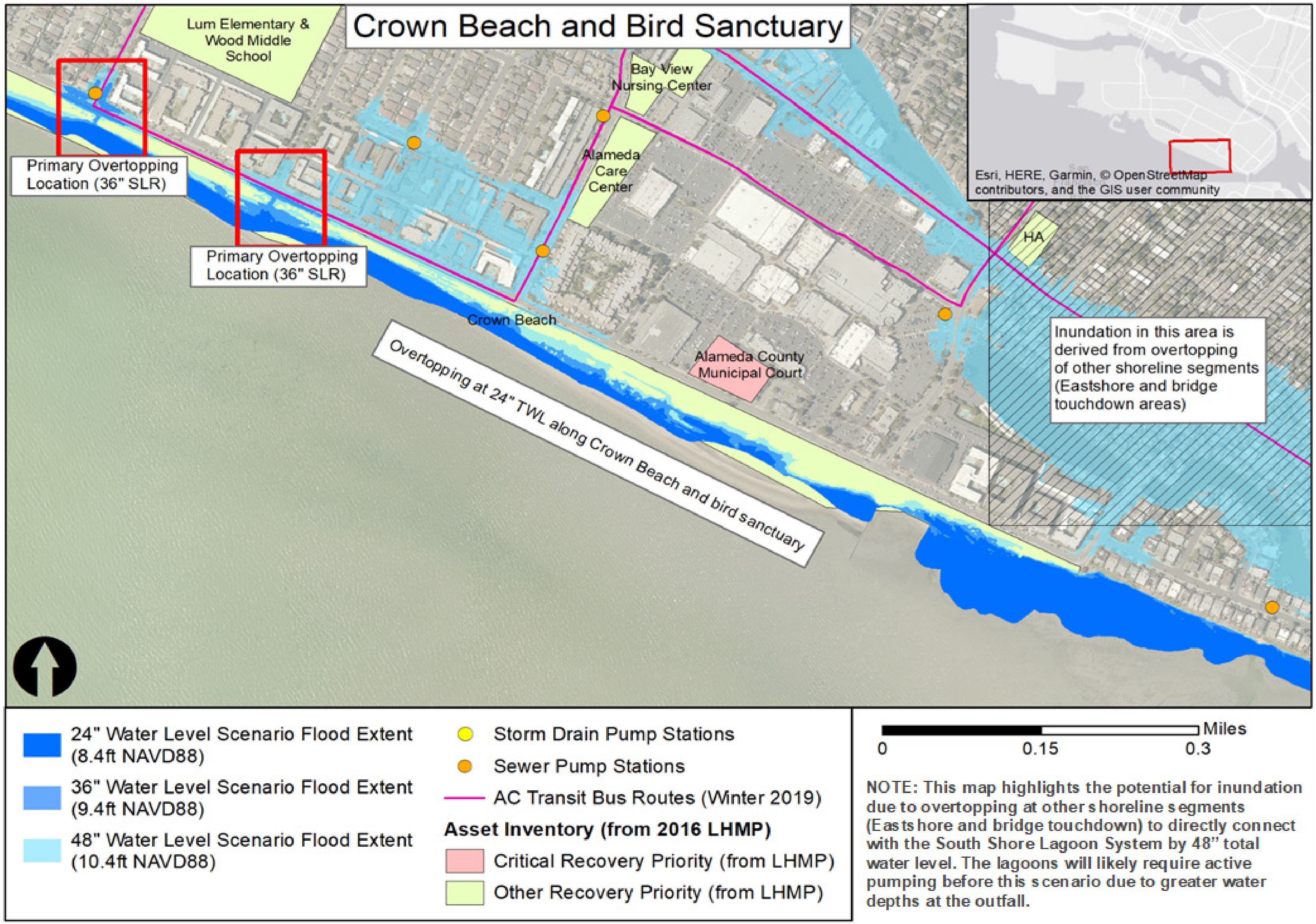
Appendix H

Location-Based Priority Flooding (Detailed Vulnerability Assessment)

August 2019

Table H-1. Crown Memorial State Beach Vulnerability Summary

Crown Memorial State Beach is a popular spot for recreation and education in Alameda. It has a pickleweed salt marsh that provides bird habitat in the Elsie Roemer Bird Sanctuary at the east end of the beach, as well as an eelgrass bed just offshore of the beach that provides juvenile fish habitat. Crown Beach and the bird sanctuary make up the majority of the natural shoreline on Alameda Island and are at substantial risk of erosion due to wave action and inundation from sea level rise.	
Key Issue(s)	■ The narrow beach is vulnerable to sea level rise and storm surge flooding, as well as erosion due to wave action. It is backed by a road, housing, and shopping centers, giving it little capacity to migrate inland. Decisions on adaptation will involve the City (owns the land), East Bay Regional Parks District (EBRPD; manages the beach), and the community at large.
Exposure	■ Lower elevation portions of the sandy beach are currently susceptible to flooding at king tides. Large portions of the beach and bird sanctuary are inundated at 36” total water level, at which point small segments of Shoreline Drive also experience flooding originating at this location. At 48” total water level, nearly all of the beach and bird sanctuary are overtopped, leading to flooding of adjacent neighborhoods.
Sensitivity	**Governance** ■ The northern portion of the park is owned by California State Parks; the narrow southern part, including the beach and trail along Shoreline Drive, is owned by the City of Alameda. EBRPD has operating agreements and manages the entire area (bird sanctuary and beach) as one park. **Informational** ■ There is limited information on the efficacy of existing groins to prevent beach erosion. ■ EBRPD is working on a Crown Beach Master Plan update that will consider sea level rise; however, this work is currently on hold and it is unknown when it will proceed. **Functional** ■ The beach and bird sanctuary provide flood protection to important roads (e.g., Shoreline Drive), residential neighborhoods, and commercial areas (e.g., South Shore Shopping Center). **Physical** ■ The beach is not a natural structure and regular nourishment is needed. In 2013, sand was pumped in due to heavy erosion, and groins are used to keep sand in place. ■ Several sensitive resources are present in this area, such as an eelgrass bed and salt marsh that provide nursery habitat and a food source for aquatic birds, including some threatened and endangered species.
Adaptive Capacity	■ The beach is very narrow and backed by a road, so there is limited capacity to migrate inland as the beach erodes and lower-elevation portions become permanently inundated. The sloping character of the beach and tidal flats offshore provide opportunities to adapt the shoreline through living or nature-based features.
Conse-quences	■ **Social:** The beach is very popular for recreation and educational programs, and it is one of only a small number of sandy beaches in the East Bay. ■ **Economic:** Crown Beach is an important tourist destination. Although no fees are collected, tourism brings money to businesses in the area. ■ **Environment:** Habitat in this area could be lost if the Elsie Roemer Bird Sanctuary is inundated and no adaptation action is taken.



NOTE: This map highlights the potential for inundation due to overtopping at other shoreline segments (Eastshore and bridge touchdown) to directly connect with the South Shore Lagoon System by 48" total water level. The lagoons will likely require active pumping before this scenario due to greater water depths at the outfall.

Table H-2. Eastshore Drive (Adjacent Shoreline) Vulnerability Summary

Eastshore Drive is the easternmost, north-south-oriented road on Alameda Island, providing access to the Eastshore and Fernside neighborhoods. These residential neighborhoods have many homes with private docks in San Leandro Bay. Although there are several designated points of public access along Eastshore Drive, there are no extensive public trails or parks along the shoreline. Private homes dominate the eastern waterfront. The Federal Emergency Management Agency (FEMA) recently determined that sections of the Eastshore neighborhood are within the 1 percent annual chance floodplain.	
Key Issue(s)	■ The Eastshore area is a low-lying section of the city with a large residential area vulnerable to flooding from sea level rise and storm events. There is limited space for adaptation because homes are built out very close to the waterfront. A potentially complex collaboration with homeowners and related groups (e.g., homeowners' associations [HOAs]) will be necessary to agree upon shoreline protection measures due to ownership in this area.
Exposure	■ Overtopping of existing shoreline structures in this area begins at 36" total water level, at which point floodwaters extend inland, inundating portions of Fernside Boulevard, the stormwater pump station serving this area, and areas as far inland as the fields near the Harrison Recreation Center. Initial shoreline overtopping is likely restricted to small sections of the shoreline (e.g., at the end of Liberty Drive), but more substantial shoreline overtopping occurs along the east shore at higher water levels, beginning as early as 48" total water level.
Sensitivity	**Governance** ■ Substantial portions of the east shoreline are privately owned. Beginning in 2005, ownership transfers between the U.S. Army Corps of Engineers (USACE) and the City of Alameda, and then between the City and private landowners, resulted in individual property rights over submerged lands along the shore. Property owners will likely need to buy in to potential shoreline protection solutions, although the actual concrete seawall along properties in this area is part of City-owned parcels that are leased to homeowners. **Informational** ■ There is no known inventory of the condition of shoreline protection structures in this area beyond basic shoreline elevation data. **Functional** ■ Shoreline in this area protects residential communities and streets. **Physical** ■ Nearly all of the east shoreline of Alameda Island is heavily armored with engineered flood protection structures like seawalls and levees. The condition and quality of these structures determines their vulnerability to sea level rise and storm surge. ■ Environmental resources like submerged aquatic vegetation (SAV) are present throughout San Leandro Bay, including near the east shoreline of Alameda Island. These resources provide important habitat for aquatic species and some level of wave attenuation.
Adaptive Capacity	■ There is very limited available space for constructing new shoreline structures, especially nature-based shorelines like living levees, which generally require a much larger footprint. Tidal flats along this stretch of shoreline may provide opportunities for some nature-based adaptation strategies. FEMA floodplain designation in this area may open funding opportunities to address shoreline issues.
Conse-quences	■ **Social:** Overtopping of this shoreline may lead to flooding of the Eastshore and Fernside neighborhoods, where few homes are flood-proofed. ■ **Environmental:** Flooding of large residential areas could lead to the release of debris and invasive species into San Leandro Bay, where restoration of sensitive habitats is currently underway.

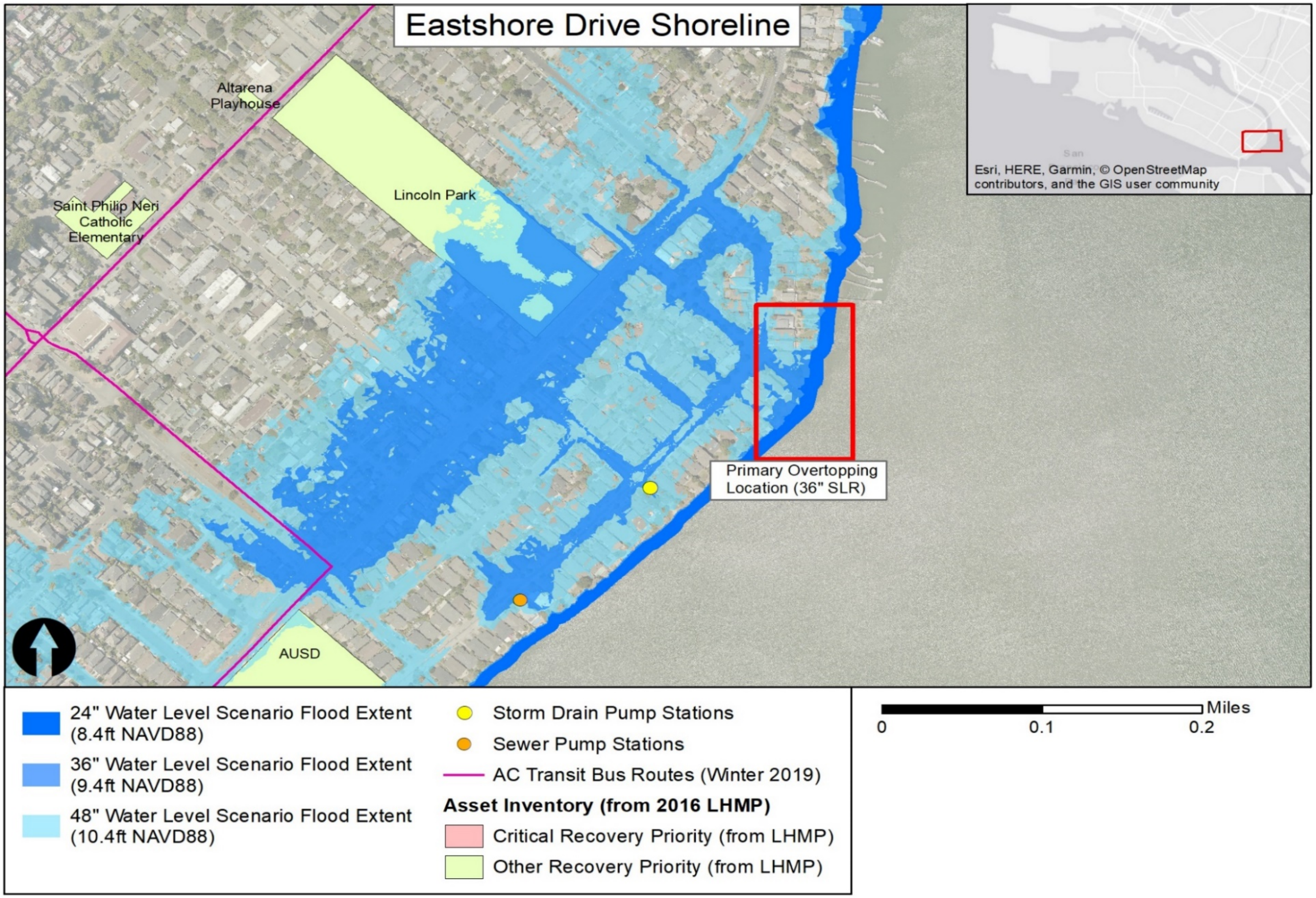

Eastshore Drive Shoreline
Altarena Playhouse
Lincoln Park
Saint Philip Neri Catholic Elementary
AUSD
Primary Overtopping Location (36" SLR)
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
24" Water Level Scenario Flood Extent (8.4ft NAVD88)
36" Water Level Scenario Flood Extent (9.4ft NAVD88)
48" Water Level Scenario Flood Extent (10.4ft NAVD88)
Storm Drain Pump Stations
Sewer Pump Stations
AC Transit Bus Routes (Winter 2019)
Asset Inventory (from 2016 LHMP)
Critical Recovery Priority (from LHMP)
Other Recovery Priority (from LHMP)
0
0.1
0.2
Miles

Table H-3. Shoreline Adjacent to Webster and Posey Tubes Vulnerability Summary

The area of concern is the shoreline immediately adjacent to the Webster and Posey Tubes along the northern shore of Alameda Island. Numerous development projects are in the planning stage along the northern waterfront, and any long-term strategy to address flooding along the northern waterfront requires a coordinated approach across all new development projects and areas between. The shoreline in this area is lined with marinas, yacht brokerages, houseboats, and some shoreline public trails, and it is composed of a combination of levees and seawalls.	
Key Issue(s)	■ Overtopping of the shoreline near the tubes leads to inundation of one of the most critical transportation corridors in Alameda, including Webster Street and the tubes themselves. The proximity of businesses along the northern shoreline will pose design challenges for shoreline modifications, which must maintain public access to the waterfront. Numerous sensitive assets in this area would be inundated if the shoreline overtops; many assets were recently added to the FEMA 1 percent annual chance floodplain.
Exposure	■ Shoreline overtopping begins at 36" total water level, at which point several buildings—such as the Oakmont of Mariner Point and Mariner Square Shopping Center—are at risk of inundation, as well as key assets like the Webster and Posey portals. Webster Street initial overtopping is restricted to a small (< 1,000-foot) section of shoreline in the immediate area, but more substantial shoreline overtopping occurs at higher water levels.
Sensitivity	**Governance** ■ The shoreline area is lined with private businesses that should be involved in managing shoreline protection at this site. There is limited City ownership of shoreline except public trails and open space, which are owned and managed by the Alameda Recreation and Parks Department. Any changes to shoreline public access would need to be designed in accordance with Bay Conservation and Development Commission (BCDC) requirements. **Informational** ■ There is no known inventory of the condition of shoreline protection structures in this area beyond basic shoreline elevation data. **Functional** ■ Shoreline protection in this area protects sensitive assets that house vulnerable populations, including several senior care centers and a daycare center. In addition, shoreline protection is needed to keep floodwaters from impacting Bay Ship and Yacht and the Hazardous Materials Transfer Station, which are both locations where hazardous materials could be mobilized. **Physical** ■ Shoreline protection structures in this area suffer from erosion due to deferred maintenance.
Adaptive Capacity	■ There is opportunity to adapt this site by enhancing engineered structures (seawalls and levees) between the public path and the water. It is not clear if engineered structures can be adapted over time to provide sufficient protection for sea level rise beyond mid-century due to the characteristics of this shoreline and the height required to address end-of-century water levels (> 15 feet NAVD88).
Conse-quences	■ **Social:** Flooding near the tubes could disproportionately impact vulnerable communities, including many transit-dependent residents that live on and around Webster Street. Many AC Transit bus routes use the roads in this area, placing substantial burden on low-income and other vulnerable populations. ■ **Economic:** Interruptions to the tubes would severely hamper goods movement from Alameda to the mainland. ■ **Environmental:** Flooding of the Hazardous Materials Transfer Station and industrial facilities in this area could mobilize harmful substances.

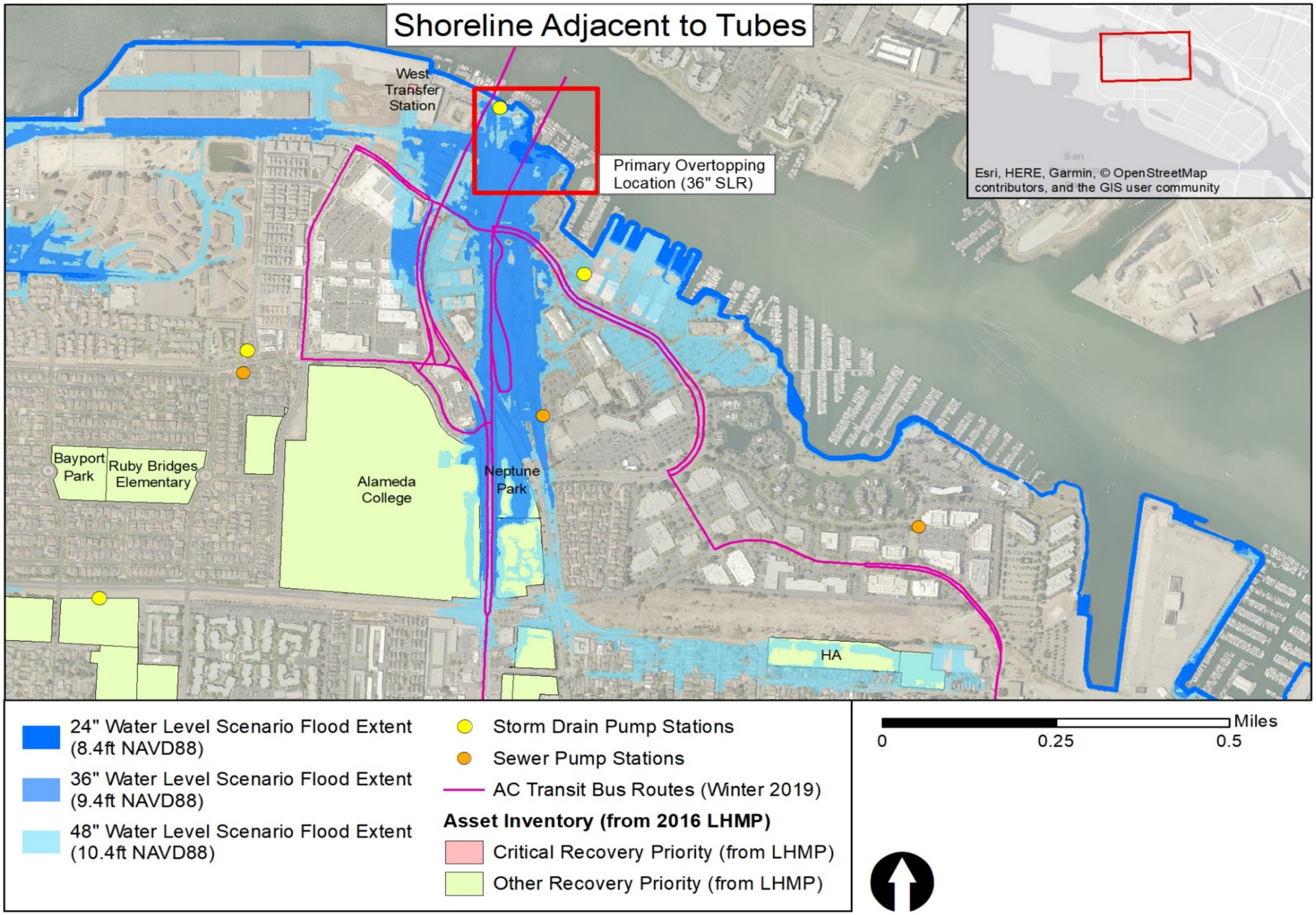

Shoreline Adjacent to Tubes
West Transfer Station
Primary Overtopping Location (36" SLR)
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Bayport Park
Ruby Bridges Elementary
Alameda College
Neptune Park
HA
24" Water Level Scenario Flood Extent (8.4ft NAVD88)
36" Water Level Scenario Flood Extent (9.4ft NAVD88)
48" Water Level Scenario Flood Extent (10.4ft NAVD88)
Storm Drain Pump Stations
Sewer Pump Stations
AC Transit Bus Routes (Winter 2019)
Asset Inventory (from 2016 LHMP)
Critical Recovery Priority (from LHMP)
Other Recovery Priority (from LHMP)
0
0.25
0.5
Miles

Table H-4. Bay Farm Island Bridge Touchdown and Towata Park Vulnerability Summary

<table>
<tr><td colspan="2">The stretch of shoreline near the Bay Farm Island Bridge touchdown on Alameda Island provides flood protection to the adjacent residential area, Bridgeview Isle, and Krusi Park. Overtopping at this location begins at 24” total water level but does not impact residential areas until 36” total water level. The current shoreline is composed of seawalls and riprap with a mix of City and Raven’s Cove HOA ownership. The City owns and maintains Towata Park at this location, which is impacted by flooding at 36” total water level.</td></tr>
<tr><td>Key Issue(s)</td><td>▪ Shoreline protection structures in this area currently provide flood protection for surrounding roads, residential neighborhoods, and Krusi and Towata Parks. Floodwater originating in this area may merge with water derived from overtopping in other areas at higher water levels, leading to substantial inundation that is only addressed with shoreline modifications in several locations.</td></tr>
<tr><td>Exposure</td><td>▪ Minor overtopping of the shoreline directly west of the bridge touchdown on Alameda Island begins at 24” total water level. At 36” total water level, Bridgeview Isle and some nearby houses are impacted. At 48” total water level and higher, the flood area expands significantly with several important streets and other assets impacted. Flooding at higher water levels could connect with the lagoons, leading to more widespread inundation.</td></tr>
<tr><td>Sensitivity</td><td>Governance
▪ Several jurisdictions have oversight of assets near the Bay Farm Island Bridge. The bridge itself is within the Caltrans Right of Way. The shoreline west of Towata Park is owned by the California Department of Parks and Recreation, while Towata Park is owned by the City. Information also suggests that the Raven’s Cove HOA may own parts of the shoreline in this area. Coordination among multiple agencies is necessary to address shoreline deficiencies in this area.
Informational
▪ Beyond 48” total water level, multiple areas of shoreline overtopping could lead to flooding of large segments in southeastern Alameda Island, including around the South Shore Lagoons. Because the shoreline overtops at several locations in the same general area, it is not clear where the majority of floodwaters originate, making it challenging to prioritize actions. The lack of clear information on floodwater source suggests an integrated approach is necessary for this entire area.
Functional
▪ Shoreline overtopping in this area leads to flooding along Otis Drive, Fernside Drive, and High Street, which all connect to the Bay Farm Island Bridge and are important connections between Alameda and Bay Farm Island. The bridge is also part of official evacuation routes in Alameda.
Physical
▪ Eelgrass beds are present in the San Leandro Bay Inlet immediately near the Bay Farm Island Bridge. Any adaptation actions in this area need to avoid or mitigate impacts to eelgrass and should seek to enhance eelgrass habitat where possible.</td></tr>
<tr><td>Adaptive Capacity</td><td>▪ Adaptation in this area will likely require strategies to be integrated and coordinated across multiple landowners and agencies because flooding over the longer term originates from multiple areas of shoreline overtopping.</td></tr>
<tr><td>Conse-quences</td><td>▪ Social: Bay Farm Island Bridge is an important corridor for commuters, businesses, and emergency response. It is the only direct connection between the islands and blocked access would greatly disrupt daily life.
▪ Economic: Approximately 40,000 vehicles cross the bridge daily and disruptions would greatly impact the movement of goods and services.
▪ Environmental: Degradation of the adjacent tidal flat and marsh panne could negatively impact nearby SAV.</td></tr>
</table>

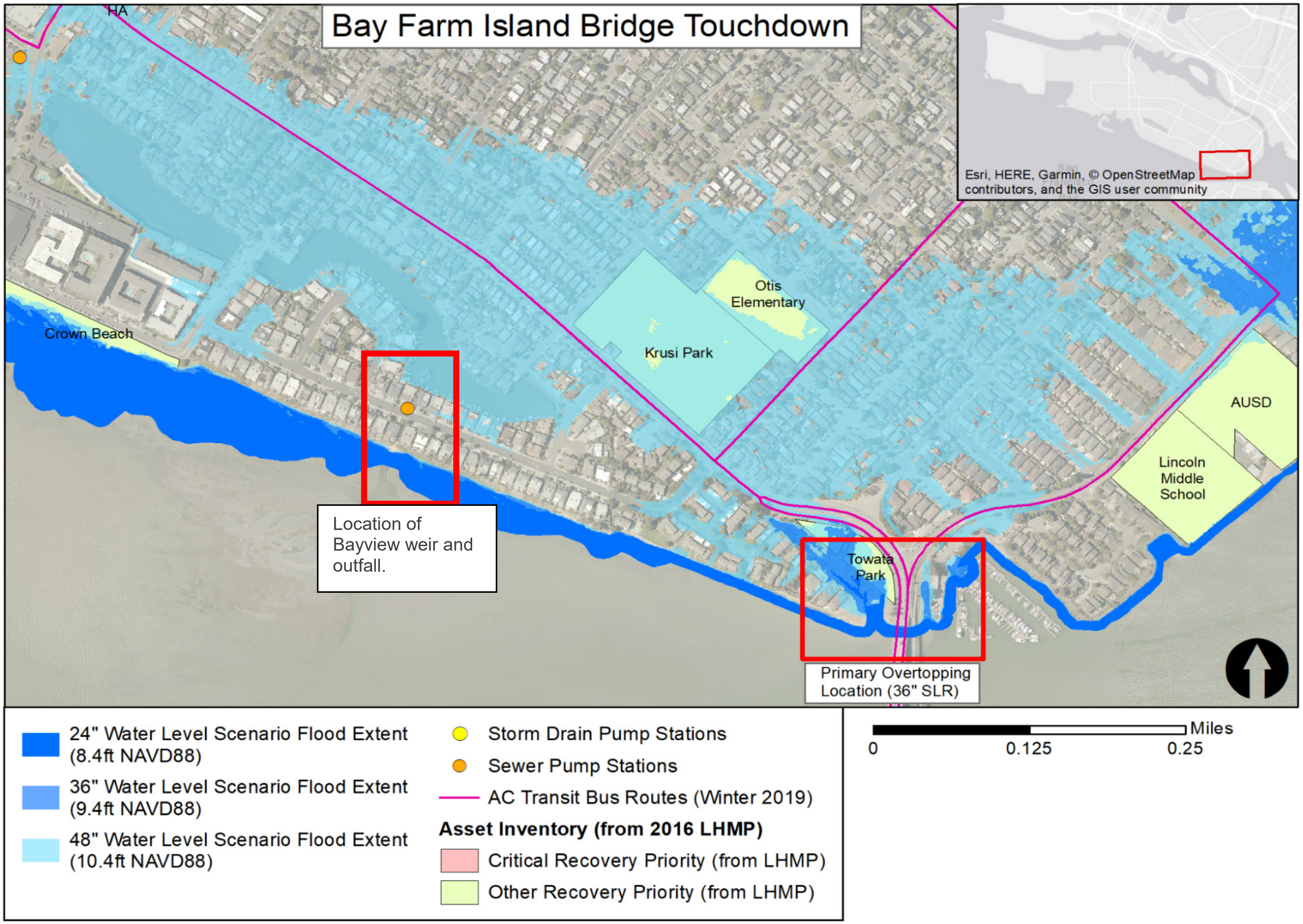

Bay Farm Island Bridge Touchdown
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Crown Beach
Otis Elementary
Krusi Park
AUSD
Lincoln Middle School
Towata Park
Location of Bayview weir and outfall.
Primary Overtopping Location (36" SLR)
24" Water Level Scenario Flood Extent (8.4ft NAVD88)
36" Water Level Scenario Flood Extent (9.4ft NAVD88)
48" Water Level Scenario Flood Extent (10.4ft NAVD88)
Storm Drain Pump Stations
Sewer Pump Stations
AC Transit Bus Routes (Winter 2019)
Asset Inventory (from 2016 LHMP)
Critical Recovery Priority (from LHMP)
Other Recovery Priority (from LHMP)
0
0.125
0.25
Miles

Table H-5. Bay Farm Island Lagoon System 1 North Outlet Gate and Seawall Vulnerability Summary

The Bay Farm Island lagoon system draws water at the southern end and discharges it at the North Outlet Gate, located just west of Bay Farm Island Bridge. The shoreline at the outlet gate is a narrow isthmus of land that provides flood protection but is not a certified seawall or levee. The outlet gate is used to manage water levels in the lagoon through a passive tide gate system (currently inoperable) and an active pump. The shoreline in this area is a critical point of protection for the lagoon system and the homes that surround it.	
Key Issue(s)	▪ The lagoon system is at risk of flooding due to issues at the outlet gate, including a slow pump that cannot rapidly lower water levels, an inoperable tide gate, and deficiencies in the seawall at that location. Overtopping of the shoreline in this area could inundate the lagoon system and lead to substantial flooding in surrounding neighborhoods.
Exposure	▪ Overtopping at the outlet gate seawall is likely at 36” total water level, potentially leading to overtopping of the banks of the lagoon and flooding of adjacent neighborhoods. Beyond 36” total water level, floodwaters originating at this location merge with floodwaters from elsewhere on Bay Farm Island, leading to substantial inundation across the island.
Sensitivity	**Governance** ▪ The City of Alameda assumed maintenance responsibility in 1993 for the dike at the outlet gate, although other entities—including the Harbor Bay Isle Owner’s Association—own the lagoon retaining walls and tide gate/pump structure. The City can modify the outlet gate and seawall to protect the lagoon system from flooding. Coordination with relevant Bay Farm Island organizations, including HOAs, is necessary to ensure the lagoon systems are resilient to climate change in the long term. Replacement of the seawall at this location will likely require permits or coordination with BCDC, USACE, and the California Department of Fish and Wildlife. **Informational** ▪ There is limited information on the structural condition of the outlet pipe or the dike, including the structural makeup of the dike itself, which is partially built on sunken ships and dredged material. ▪ Flooding on Bay Farm Island is connected to several sources of overtopping, making it challenging to identify a primary source. More detailed assessment could help determine the source of flooding, but a coordinated approach to adaptation across Bay Farm Island is warranted. **Functional** ▪ Some equipment at the outlet gate and pump is deficient, including the tide gate itself, which is currently inoperable—a pump drains the lagoon. The pump is undersized to drain the lagoons rapidly, which may be necessary if there is a large storm event on top of sea level rise. Compounding this, pressure transducers used to measure water levels in the lagoons are inaccurate and unreliable. **Physical** ▪ The structural condition of the dike is unknown, and the seawall built on it may be at risk of failure during a large event like an earthquake. Deficiencies along the interior lagoon retaining walls could also contribute to flooding next to the lagoons.
Adaptive Capacity	▪ Operational and physical changes at this site could increase its resilience to sea level rise and storm surge. Relatively minor modifications to the seawall could provide short-term protection from storm events and remove substantial areas from the FEMA 1 percent annual chance floodplain.
Conse-quences	▪ **Social:** If the seawall breaches or the lagoon system fails to drain during a storm, many homes and businesses could be flooded. ▪ **Economic:** Flooding next to the lagoon system would impact important roads and cut off access to some neighborhoods on the island.

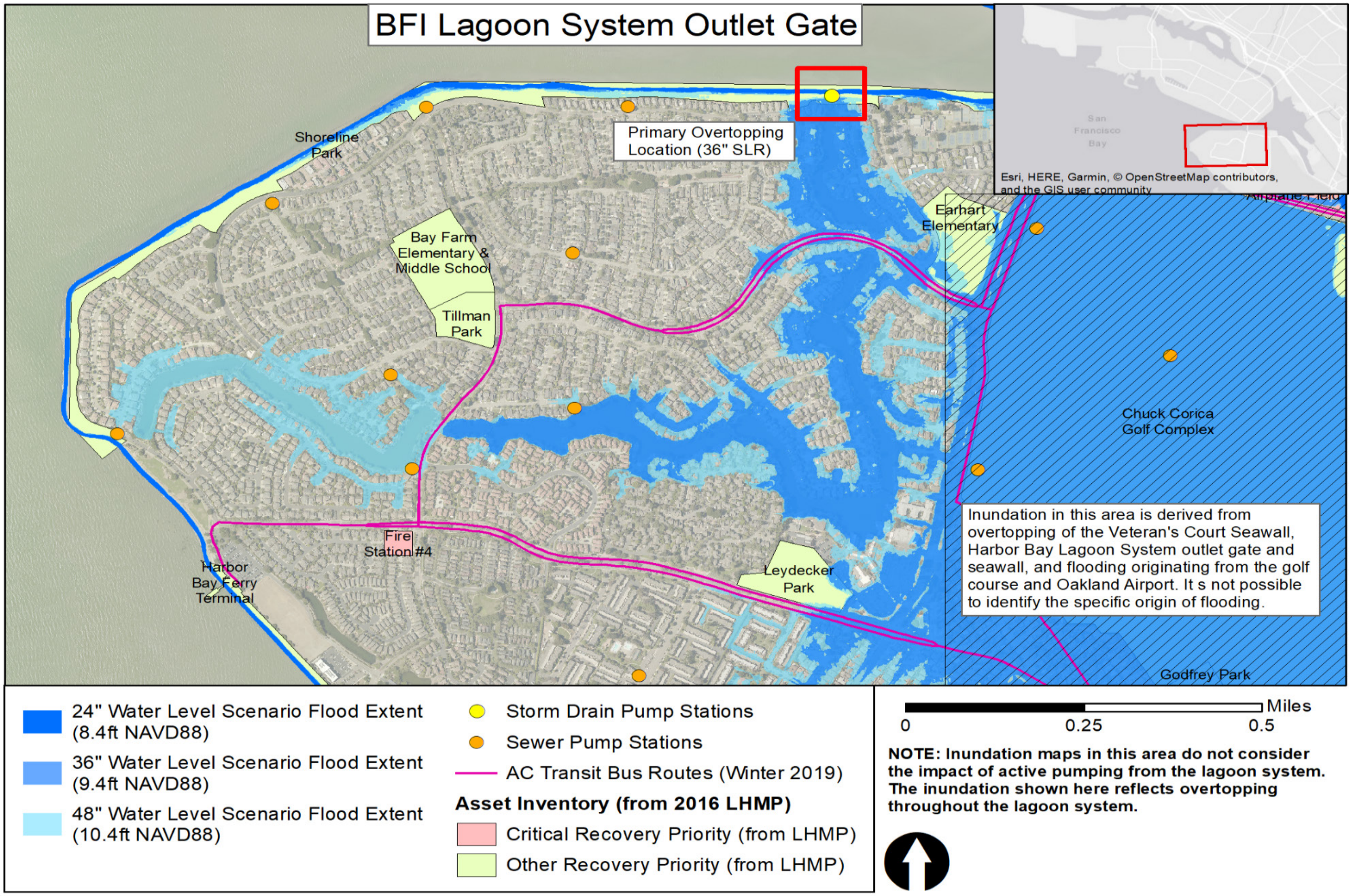

BFI Lagoon System Outlet Gate
Primary Overtopping Location (36" SLR)
Shoreline Park
Bay Farm Elementary & Middle School
Tillman Park
Earhart Elementary
Chuck Corica Golf Complex
Fire Station #4
Harbor Bay Ferry Terminal
Leydecker Park
Godfrey Park
San Francisco Bay
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Inundation in this area is derived from overtopping of the Veteran's Court Seawall, Harbor Bay Lagoon System outlet gate and seawall, and flooding originating from the golf course and Oakland Airport. It s not possible to identify the specific origin of flooding.
24" Water Level Scenario Flood Extent (8.4ft NAVD88)
36" Water Level Scenario Flood Extent (9.4ft NAVD88)
48" Water Level Scenario Flood Extent (10.4ft NAVD88)
Storm Drain Pump Stations
Sewer Pump Stations
AC Transit Bus Routes (Winter 2019)
Asset Inventory (from 2016 LHMP)
Critical Recovery Priority (from LHMP)
Other Recovery Priority (from LHMP)
0
0.25
0.5
Miles
NOTE: Inundation maps in this area do not consider the impact of active pumping from the lagoon system. The inundation shown here reflects overtopping throughout the lagoon system.

Table H-6. Veteran's Court Seawall Vulnerability Summary

Veteran's Court is a small road near the Bay Farm Island Bridge touchdown on Bay Farm Island. It connects to Island Drive and serves primarily as an access road to the shore for maintenance or recreation. Veteran's Memorial Park is also considered part of this priority shoreline area due to its importance to flood mitigation strategies. Veteran's Court itself serves as a conduit for floodwaters if the seawall in this area is breached, potentially contributing to substantial inundation along Island Drive and adjacent neighborhoods.	
Key Issue(s)	▪ The Veteran's Court area is located within the FEMA 1 percent annual chance floodplain. Overtopping of this shoreline results in flooding at a major intersection on Bay Farm Island (Doolittle and Island Drives). While there are options for adapting this specific section of low-elevation shoreline, other shoreline areas across Bay Farm Island also overtop at similar water levels. Beyond 36" total water level, a coordinated response to shoreline overtopping on Bay Farm Island is needed to prevent flooding.
Exposure	▪ The Veteran's Court seawall overtops at 36" total water level, below the FEMA base flood elevation (10' NAVD88). At 48" total water level, inundation from Veteran's Court merges with inundation from other overtopped shorelines on Bay Farm Island, making it difficult to determine the exact source of floodwaters. The Veteran's Court area is likely responsible for some component of flooding at the intersection of Island Drive and Doolittle Drive.
Sensitivity	**Governance** ▪ The seawall itself is owned by the City but is not accredited by FEMA. Addressing vulnerabilities in this immediate area, especially over the longer term as water levels continue to rise, would likely require coordination with adjacent private landowners, including the Harbor Bay Club and adjacent neighborhoods. ▪ Flooding on Bay Farm Island, derived from Veteran's Court and other locations, impacts State Route (SR) 61 (Doolittle Drive), which Caltrans owns. Coordination with Caltrans is important to maintain traffic flow along this critical road, one of the primary evacuation routes from Alameda. **Informational** ▪ It is very difficult to determine the exact source of flooding on Bay Farm Island beyond 36" total water level due to overtopping at multiple locations. **Functional** ▪ The presence of other vulnerable spots along the shoreline in this immediate area and more broadly across Bay Farm Island means that fixing the Veteran's Court seawall alone will not reduce all local flood vulnerability. **Physical** ▪ Alameda's 2008 Storm Drain Master Plan indicates that seepage is observed along the seawall at high tide.
Adaptive Capacity	▪ There are multiple options for enhancing flood protection along Veteran's Court, but construction and engineering of some sort is required; however, no immediate or simple modifications to this location could address sea level rise and storm surge.
Conse-quences	▪ **Social:** Community impacts are likely if major transportation routes on Bay Farm Island are blocked. Flooding is also likely to directly impact residences and businesses. ▪ **Economic:** Substantial disruption to commuter and commercial transit is likely if Island Drive and/or Doolittle Drive flood. ▪ **Environmental:** SAV is present immediately adjacent to Veteran's Court and should be protected.

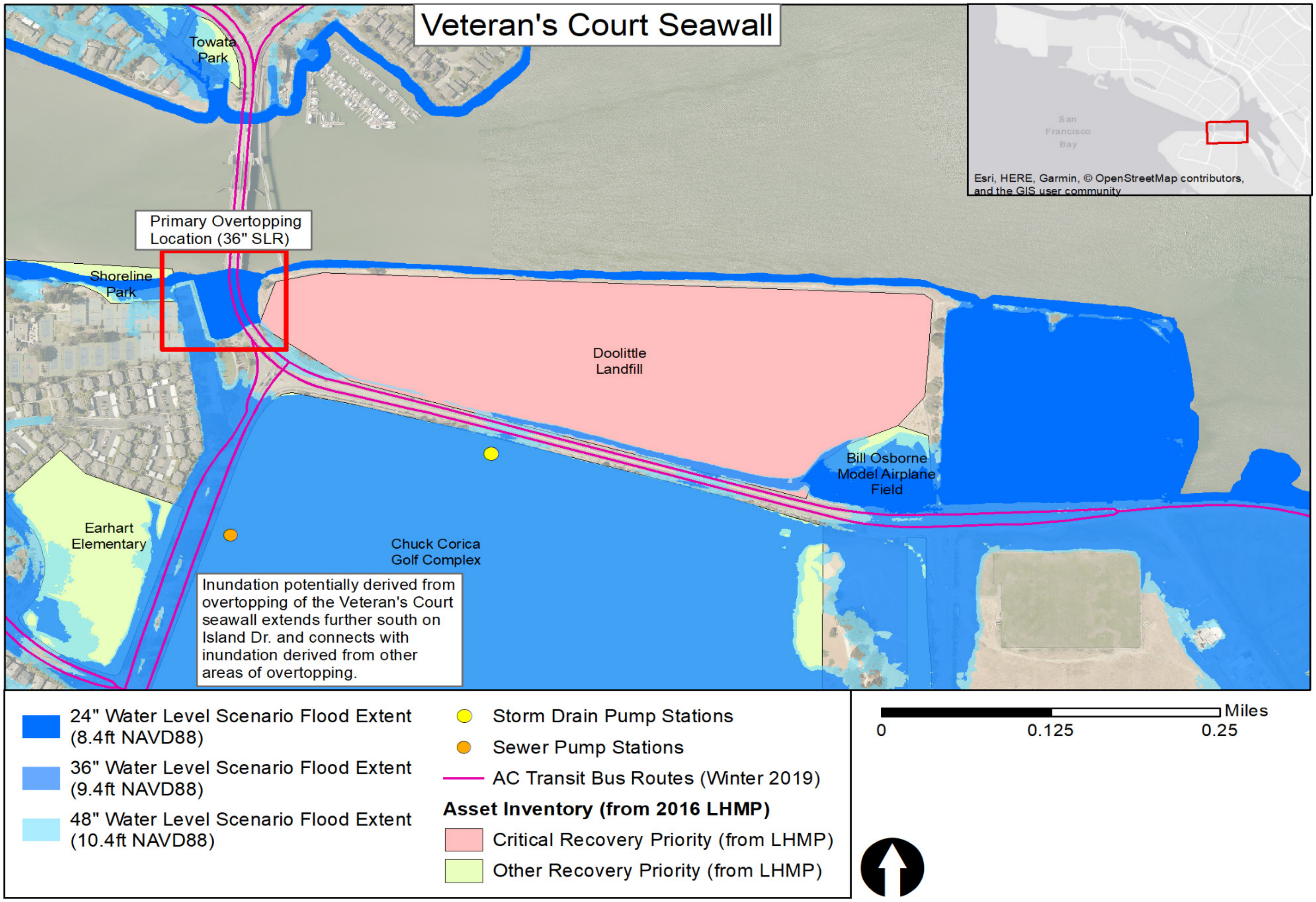
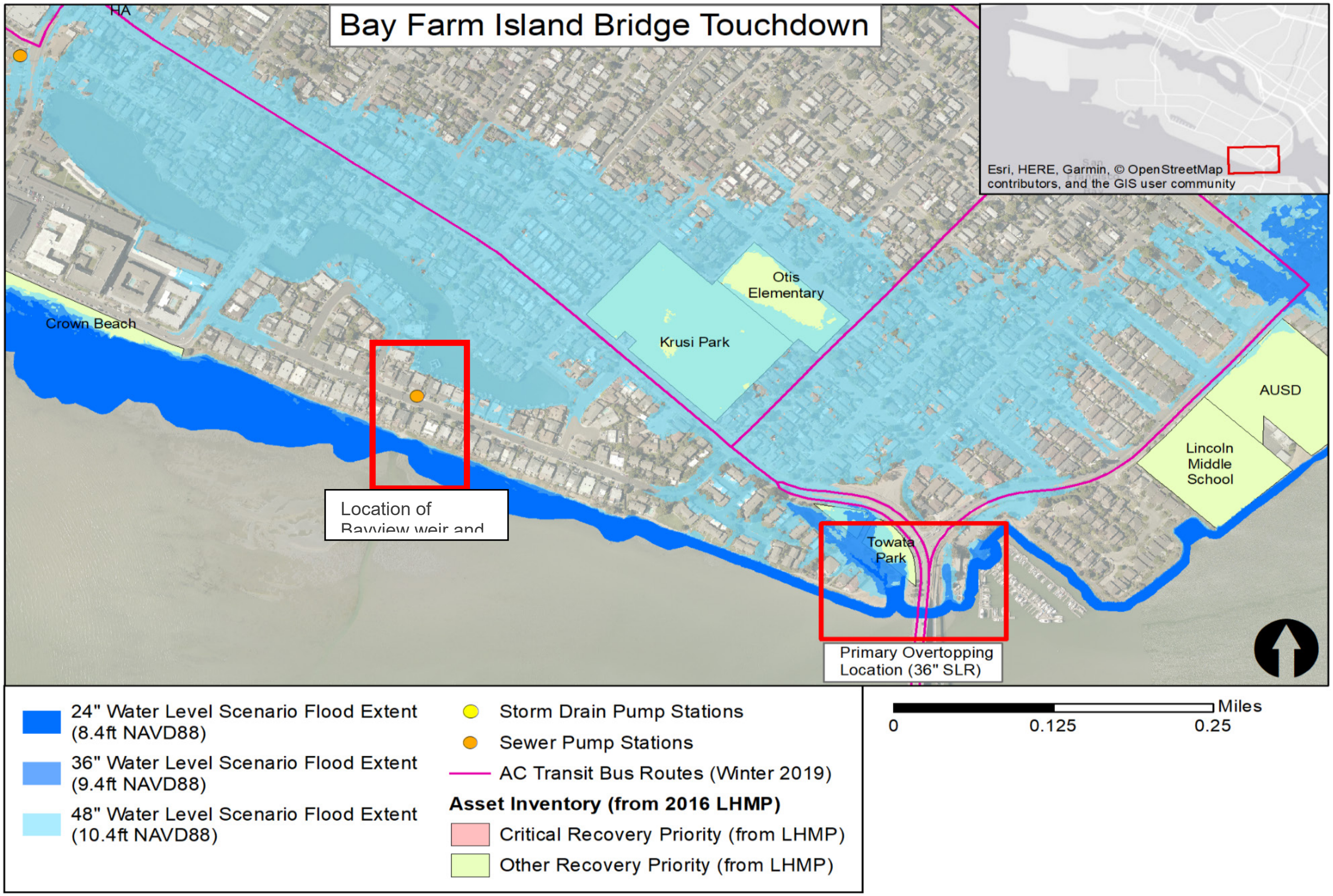

Veteran's Court Seawall
Towata Park
Primary Overtopping Location (36" SLR)
Shoreline Park
Doolittle Landfill
Bill Osborne Model Airplane Field
Earhart Elementary
Chuck Corica Golf Complex
Inundation potentially derived from overtopping of the Veteran's Court seawall extends further south on Island Dr. and connects with inundation derived from other areas of overtopping.
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
24" Water Level Scenario Flood Extent (8.4ft NAVD88)
36" Water Level Scenario Flood Extent (9.4ft NAVD88)
48" Water Level Scenario Flood Extent (10.4ft NAVD88)
Storm Drain Pump Stations
Sewer Pump Stations
AC Transit Bus Routes (Winter 2019)
Asset Inventory (from 2016 LHMP)
Critical Recovery Priority (from LHMP)
Other Recovery Priority (from LHMP)
0
0.125
0.25
Miles

Table H-7. Bay Farm Island Bridge Touchdown and Towata Park Vulnerability Summary

The stretch of shoreline near the Bay Farm Island Bridge touchdown on Alameda Island provides flood protection to the adjacent residential area, Bridgeview Isle, and Krusi Park. Overtopping at this location begins at 24" total water level but does not impact residential areas until a total water level of 36". The current shoreline is composed of seawalls and riprap with a mix of City and Raven's Cove HOA ownership. Towata Park at this location is owned and maintained by the City and is impacted by flooding by 36" total water level.	
Key Issue(s)	■ Shoreline protection structures in this area currently provide flood protection for surrounding roads, residential neighborhoods, and Krusi and Towata Parks. Floodwater originating in this area may merge with water derived from overtopping in other areas at higher water levels, leading to substantial inundation that is only addressed with shoreline modifications in several locations.
Exposure	■ Minor overtopping of the shoreline directly west of the bridge touchdown on Alameda Island begins at 24" total water level. At 36" total water level, Bridgeview Isle and some nearby houses are impacted. At 48" total water level and higher, the flood area expands significantly with several important streets and other assets impacted. Flooding at higher water levels could connect with the lagoons, leading to more widespread inundation.
Sensitivity	**Governance** ■ Several jurisdictions have oversight of assets near the Bay Farm Island Bridge. The bridge itself is within the Caltrans Right of Way. The shoreline west of Towata Park is owned by the California Department of Parks and Recreation, while Towata Park is owned by the City. There is also information suggesting the Raven's Cove HOA may own parts of the shoreline in this area. Coordination among multiple agencies is necessary to address shoreline deficiencies in this area. **Informational** ■ Beyond 48" total water level, multiple areas of shoreline overtopping could lead to flooding of large segments in southeastern Alameda Island, including around the South Shore Lagoons. Because the shoreline overtops at several locations in the same general area, it is not clear where the majority of floodwaters originate, making it challenging to prioritize actions. The lack of clear information on floodwater source suggests an integrated approach is necessary for this entire area. **Functional** ■ Shoreline overtopping in this area leads to flooding along Otis Drive, Fernside Drive, and High Street, which all connect to the Bay Farm Island Bridge and are important connections between Alameda and Bay Farm Island. The bridge is also part of official evacuation routes in Alameda. **Physical** ■ There are eelgrass beds present in the San Leandro Bay Inlet immediately near the Bay Farm Island Bridge. Any adaptation actions in this area need to avoid or mitigate impacts to eelgrass and should seek to enhance eelgrass habitat where possible.
Adaptive Capacity	■ Adaptation in this area will likely require strategies to be integrated and coordinated across multiple landowners and agencies because flooding over the longer term originates from multiple areas of shoreline overtopping.
Conse-quences	■ **Social:** Bay Farm Island Bridge is an important corridor for commuters, businesses, and emergency response. It is the only direct connection between the islands and blocked access would greatly disrupt daily life. ■ **Economic:** Approximately 40,000 vehicles cross the bridge daily and disruptions would greatly impact the movement of goods and services. ■ **Environmental:** Degradation of the adjacent tidal flat and marsh panne could negatively impact nearby SAV.



Bay Farm Island Bridge Touchdown
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Otis Elementary
Krusi Park
Crown Beach
AUSD
Lincoln Middle School
Location of Bayview weir and
Towata Park
Primary Overtopping Location (36" SLR)
24" Water Level Scenario Flood Extent (8.4ft NAVD88)
36" Water Level Scenario Flood Extent (9.4ft NAVD88)
48" Water Level Scenario Flood Extent (10.4ft NAVD88)
Storm Drain Pump Stations
Sewer Pump Stations
AC Transit Bus Routes (Winter 2019)
Asset Inventory (from 2016 LHMP)
Critical Recovery Priority (from LHMP)
Other Recovery Priority (from LHMP)
0
0.125
0.25
Miles

Table H-8. SR260, Including Webster and Posey Tubes, Vulnerability Summary

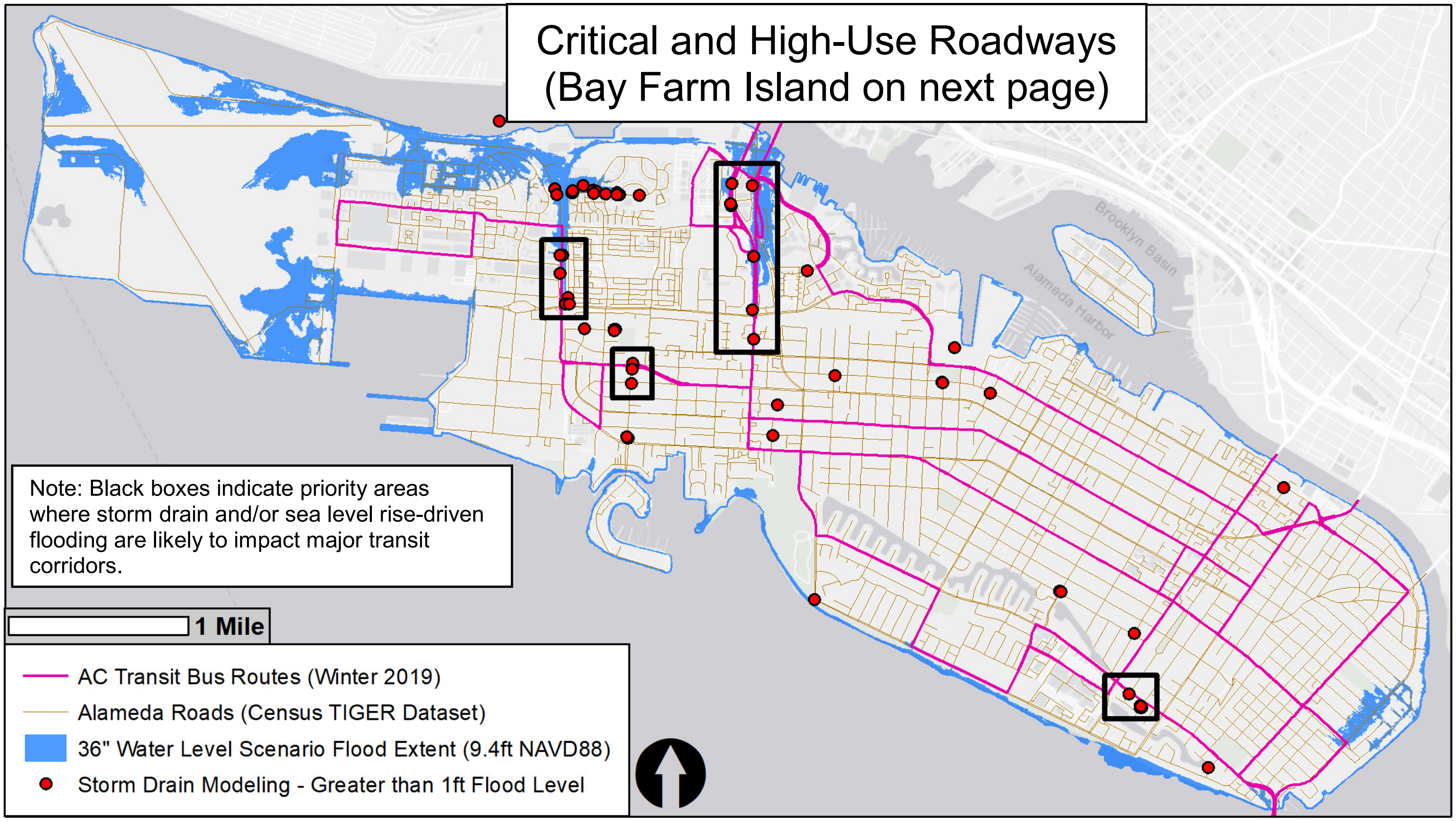
SR260 is a critical transportation corridor connecting Alameda and Oakland—the tubes are one of four ways on or off Alameda Island. The historic average annual daily traffic at the tubes is approximately 31,500, including numerous commercial vehicles, which account for approximately 2.5 percent of daily traffic. The Posey Tube is the second oldest underwater tunnel in the United States (built in 1928) and was added to the National Register of Historic Places in 2000. Although seismic retrofits were completed in 2004, the age of the tube may increase its vulnerability to climate impacts. Webster Tube, built in 1963 to ease traffic volume in Posey Tube, is at lower risk of age-related deterioration.	
Key Issue(s)	■ SR260 is essential to the movement of people, goods, and emergency services. However, the tubes are vulnerable to flooding derived from both shoreline overtopping and precipitation events. Mixed jurisdictional oversight of the asset(s) could also pose a barrier to the implementation of adaptation measures, primarily because Caltrans is not specifically authorized to implement resilience/adaptation projects (but can incorporate adaptation/resilience into larger transportation projects).
Exposure	■ SR260 and the tubes are exposed to sea level rise and storm surge flooding at 36” total water level. Inundation likely originates along the northern shoreline adjacent to the tubes (as described in the summary for that shoreline area). Overtopping near the Main Street Ferry Terminal may also contribute to flooding at the tubes. There is also substantial exposure to storm drain flooding driven by precipitation events near the entrance to the tubes, with storm drain modeling indicating multiple locations of potential flooding greater than 1 foot above street level.
Sensitivity	**Governance** ■ Caltrans owns and maintains SR260 and the tubes. The City of Alameda also has some maintenance responsibility and oversight, particularly along streets that lead to the tubes. **Informational** ■ The extent of age-related deterioration of the Posey Tube and elements within it (electrical/ventilation systems) is not clear. **Functional** ■ SR260 is a very high-use transportation corridor that is highly sensitive to disruptions. Traffic rerouting would be incredibly difficult if the tubes are blocked due to floodwaters, as vehicles would need to be redirected to one of the bridges leading to Alameda. **Physical** ■ Many physical vulnerabilities are associated with the tubes. Notable issues include stormwater pumps that are not corrosion-resistant, and therefore could become inoperable if saltwater enters the tubes. The tubes themselves are also “immersed” and rely on careful waterproofing to maintain their function.
Adaptive Capacity	■ Short-term modifications at the ramps to the tubes could reduce the potential for flooding in the tubes; however, new structures would be required (elevated roadway, floodwalls, etc.). The tubes themselves have very limited adaptive capacity because modifications would be very complicated and require closure during construction.
Conse-quences	■ **Social:** SR260 and the tubes are critically important to traffic flow on and off Alameda Island. Multiple AC Transit bus routes use the tubes, and disruptions could disproportionately impact transit-dependent communities that don’t have alternative transportation options. ■ **Economic:** Major economic impacts are likely if access to the tubes is blocked. ■ **Environmental:** There are known underground and submerged hazardous waste sites along SR260 and adjacent to the tubes.

Table H-9. SR61 (Doolittle Drive and Other Segments) Vulnerability Summary

SR61 is a state highway owned and maintained by Caltrans. The route runs from the intersection with SR112 near Oakland Airport and terminates on Alameda Island at the intersection of Webster Street and Central Avenue. The road connects Bay Farm Island and Alameda Island across the Bay Farm Island Bridge. Multiple AC Transit bus routes use SR61, including several that serve transit-dependent or disadvantaged communities. The City of Alameda has designated SR61 south of Otis Drive as a primary evacuation route and the segment on Alameda Island as critical access for the evacuation route.	
Key Issue(s)	■ Disruptions to SR61 could have substantial impacts on the flow of commuters and goods within Alameda and to Oakland, including several important bus routes. Existing traffic issues in Alameda would be exacerbated if the City closes SR61 or restricts traffic flow. Overtopping of Doolittle Drive on Bay Farm Island also contributes to broad flooding across the island, with the road serving as a conduit for floodwaters.
Exposure	■ SR61 is exposed to flooding from multiple sources of overtopping, including Veteran's Court seawall, along Doolittle Drive, and at the Bay Farm Island Bridge touchdown on Alameda Island. Shoreline overtopping begins at around 36" total water level. Precipitation-driven storm drain flooding also impacts SR61—the modeled 25-year storm event results in several areas with water levels greater than 0.5 feet above street level.
Sensitivity	**Governance** ■ Caltrans owns and maintains SR61, both in Alameda and Oakland. Flooding along SR61 is also a concern for the City of Oakland and Port of Oakland, and a coordinated approach to address vulnerabilities is warranted. **Informational** ■ It is very difficult to determine the exact source of flooding on Bay Farm Island beyond 36" total water level due to overtopping at multiple locations. **Functional** ■ SR61 has very high average daily traffic, and it is very important for travel between the islands and for emergency services. Several emergency operations staging areas are along SR61. ■ Major congestion issues exist along SR61 during peak hours, primarily at the junction of Webster Street and Central Avenue, and at Doolittle Drive and Island Drive. Traffic flow on SR61 is affected by local Alameda surface streets, traffic from SR112, and traffic diverted from I-880 in Oakland due to construction or accidents. GPS systems like Google Maps and Waze often redirect people onto SR61 if major congestion is on I-880. **Physical** ■ Overtopping in this area could impact Doolittle Landfill, which is protected by a perimeter levee that has known seepage concerns. Groundwater impacts to the landfill are also likely.
Adaptive Capacity	■ There are multiple options for enhancing flood protection along SR61, but construction and engineering of some sort is required. No immediate or simple modifications to this location could address sea level rise and storm surge.
Conse-quences	■ **Social:** SR61 is used by several AC Transit bus routes that serve transit-dependent communities, and disruptions could result in major delays to most bus routes in Alameda. SR61 is also a priority evacuation route from Alameda. ■ **Economic:** Substantial disruption to commuter and commercial transit is likely if SR61 floods. ■ **Environmental:** Several species of concern are found along SR61. There are also known underground hazardous waste sites along the southern end of SR61 and just north of the route on Alameda Island. Contamination could impact Arrowhead Marsh and other sensitive areas.

Table H-10. Critical and High-Use Roadways (Excluding Caltrans Roads) Vulnerability Summary

Many major and minor roads in Alameda are expected to be impacted by flooding and inundation associated with both sea level rise and storm events. To analyze and present vulnerabilities, key roadways were bundled into a single priority asset group. The common theme for roadways in this asset group is that they are heavily used by multiple AC Transit bus routes, specifically those that serve transit-dependent or socially vulnerable communities and provide critical connections between Alameda and the mainland. Although roadways other than those described here are at risk of damage due to flooding, this assessment prioritized roads that serve as key transit corridors because of their importance to transit-dependent communities.	
Key Issue(s)	▪ Entire roads and specific road segments or intersections in Alameda are exposed to flooding from sea level rise, storm surge, and major rainfall events. Given the limited number of connections between Alameda and the mainland, disruptions to key roads like Webster Street can have large impacts on transit-dependent residents and commerce. One key vulnerability is the inability of connecting streets in Alameda to handle additional traffic volume if key roads are closed or restricted and major traffic rerouting is necessary.
Exposure	▪ Most of the exposure to key roadway segments is due to precipitation-driven, storm drain flooding—some segments are exposed to sea level rise and storm surge flooding in isolated locations. There is substantial exposure to storm drain flooding as modeled for a 25-year storm event. Flooding greater than 1 foot above street level could occur at multiple locations along key roadways. Heavily impacted roads include Main Street, Webster Street, Stargell Avenue, Atlantic Avenue, Pacific Avenue, and Otis Drive.
Sensitivity	**Governance** ▪ The City of Alameda is responsible for maintenance and upgrades of almost all roadways except Caltrans-owned SR260 and SR61. However, the City has very limited control over operational conditions like route alignments for AC Transit. Any route adjustments would be made by AC Transit in collaboration with the City. ▪ Alameda is a relatively minor component of the AC Transit system, which also serves Oakland, Berkeley, and other cities in Alameda and Contra Costa counties. AC Transit has four planning districts—Alameda is part of the Northern Alameda County planning area, with a total population of 616,000, potentially resulting in less attention being paid to the transit system within Alameda except where it is part of a major transit route like AC Transit Route 51A. **Functional** ▪ AC Transit routes have multiple connections with regional transit services (primarily BART) and are heavily used by commuters. The bus system serves highly transit-dependent and socially vulnerable communities in Alameda Point and adjacent neighborhoods. The entirety of Route 96 runs through census tracts with high social vulnerability, as defined by a composite of several economic and demographic indicators. **Physical** ▪ Location-specific issues on roads contribute to overall vulnerability. For example, stormwater catch basin inlets along Mariner Square Drive (used by AC Transit Route 96) are lower in elevation than surrounding road sections, leading to flooding during precipitation events.
Adaptive Capacity	▪ Modifications to roadways are often very expensive and require long environmental review and permitting processes. It may be difficult to identify shore-term strategies that allow rapid response to threats.
Conse-quences	▪ **Social:** Multiple AC Transit bus routes serve transit-dependent and disadvantaged communities. Closures or disruptions to roads along these routes would limit the ability of these residents to commute to work and go about daily activities. ▪ **Economic:** Substantial impacts to the transport of goods around Alameda and on/off the islands could occur if key roads are closed/disrupted.


Critical and High-Use Roadways
(Bay Farm Island on next page)
Brooklyn Basin
Alameda Harbor
Note: Black boxes indicate priority areas where storm drain and/or sea level rise-driven flooding are likely to impact major transit corridors.
1 Mile
AC Transit Bus Routes (Winter 2019)
Alameda Roads (Census TIGER Dataset)
36" Water Level Scenario Flood Extent (9.4ft NAVD88)
Storm Drain Modeling - Greater than 1ft Flood Level

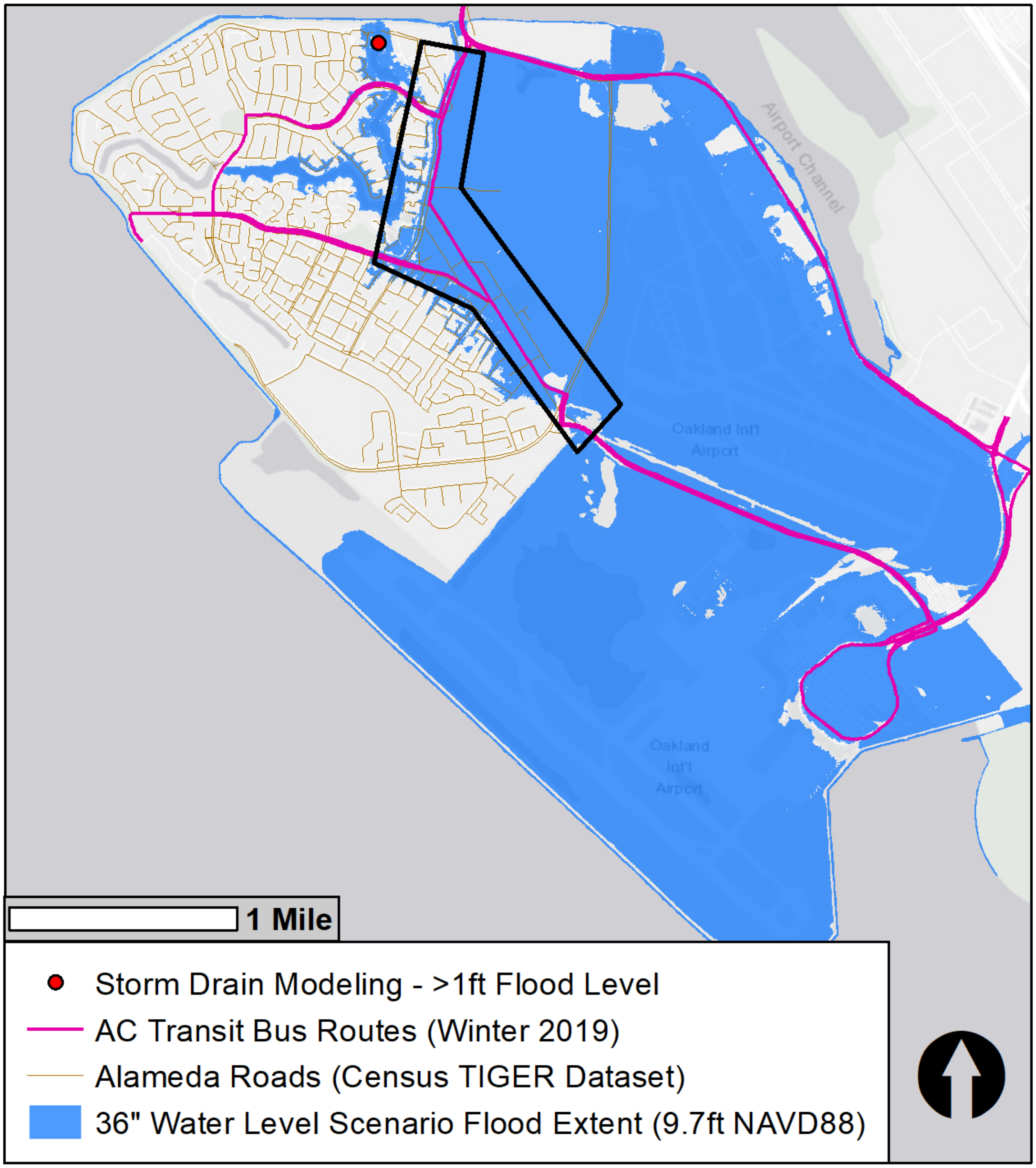
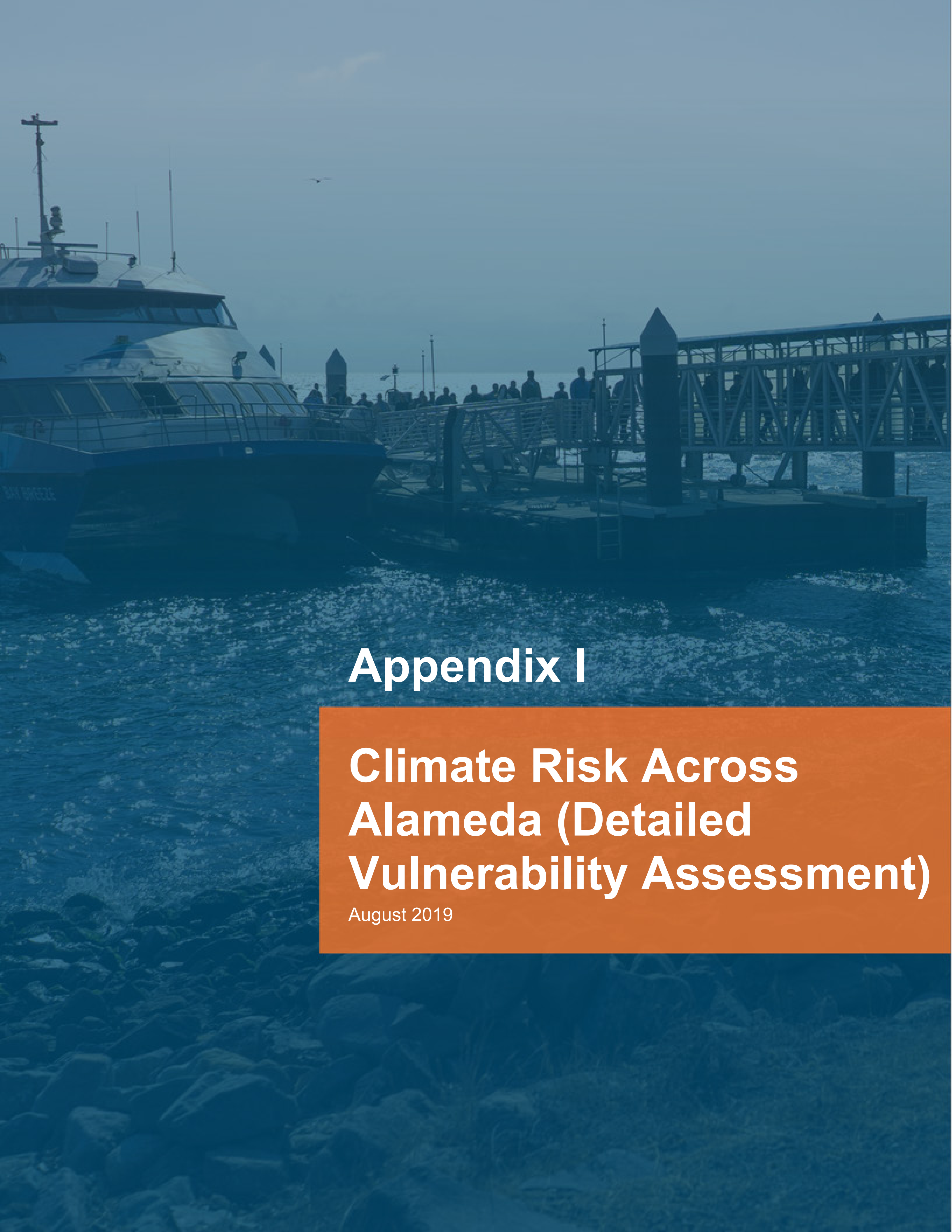

Airport Channel
Oakland Int'l Airport
Oakland Int'l Airport
1 Mile
Storm Drain Modeling - >1ft Flood Level
AC Transit Bus Routes (Winter 2019)
Alameda Roads (Census TIGER Dataset)
36" Water Level Scenario Flood Extent (9.7ft NAVD88)

Table H-11. Storm Drain Pipes and Pump Stations Vulnerability Summary

Storm drain pump stations across Alameda are a critical component of the stormwater system and are expected to become even more important as water levels rise. The pump stations operate in areas that cannot drain through a gravity system, although it is likely that most of the gravity-fed components of Alameda's stormwater system will become obsolete as outfalls are submerged and rising groundwater impacts hydraulic conditions.	
Key Issue(s)	■ Alameda's storm drain pump stations are already subject to capacity and operational issues, including flap gate failures, sedimentation, and lack of backup power. While capacity upgrades have already been identified, the City must consider other modifications at the pump stations to increase the resilience of the station infrastructure to floodwater.
Exposure	■ Shoreline overtopping due to sea level rise and storm surge at multiple locations could lead to temporary flooding or permanent inundation at storm drain pump stations. Precipitation-driven storm drain flooding could also impact the pump stations. The degree of flooding varies from station to station. Initial exposure at the storm drain pump stations is primarily related to access; direct impacts to infrastructure are not likely until higher water levels.
Sensitivity	**Governance** ■ The City of Alameda owns and maintains most of the storm drain pump stations. For those that are not owned by the City (Harbor Bay Lagoon System stations and Southshore Lagoon inlet pump), there is a clear division of responsibility for station maintenance. **Informational** ■ None—regular inspections and maintenance result in substantial information related to station condition. **Functional** ■ Operating storm drain pump stations are a vital component of Alameda's stormwater system and their failure would have wide-ranging ripple effects throughout the system. ■ There are known capacity issues with the overall stormwater system (upgrades planned) that result in overland flooding across Alameda during heavy precipitation events. ■ Sea level rise is likely to block some stormwater outfalls, increasing the strain on storm drain pumps or resulting in pump failure. **Physical** ■ Pump stations contain both electrical and mechanical equipment that floodwaters could damage (electric motors drive all pumps). The primary risks are for shorted electrical systems or corroded mechanical equipment. ■ There are known issues with sedimentation at several pump stations and outfalls, further reducing their capacity and functionality. ■ Pump stations were not designed with built-in excess capacity (backup pumps), and several lack backup power systems.
Adaptive Capacity	■ City ownership of most storm drain pump stations increases their adaptive capacity by removing barriers to action. The City can take (and is currently taking) some immediate steps to increase the resilience of the stations, including elevating electrical panels.
Conse-quences	■ **Social:** Malfunctioning storm drain pump stations could lead to flooding across Alameda with broad impacts even far from the station itself. ■ **Economic:** City resources are used to prepare for, handle, and recover from flood events. Flood damage is also a major economic impact. ■ **Environmental:** The stormwater system conveys water directly to the Bay. Failure of individual pump stations could lead to greater overland flow and mobilization of contaminants from the land surface.

Table H-12. Bayview Weir and Outfall Vulnerability Summary

Water levels in the South Shore Lagoons are maintained by the Bayview weir and outfall, located near the Elsie Roemer Bird Sanctuary. Water is pumped into the lagoon system at the west end at high tide and released from the Bayview outfall at low tide to move water through the lagoon system at a rate that prevents stagnation and water quality issues. The Bayview weir functions as a barrier between lagoon waters and the Bay. The location of the weir and outfall is shown on the map for Crown Beach and the bird sanctuary earlier in this appendix.	
Key Issue(s)	■ The Bayview weir and outfall system is an important component of the South Shore Lagoons. An operational lagoon system is important to maintain water quality and to prevent flooding in communities adjacent to the lagoons. The current weir and outfall are at high risk of sea level rise and storm surge, and they need major repairs and/or replacement. The greatest vulnerability to the weir and outfall system is from sea level rise, which will eventually prevent the gravity-fed system from operating, necessitating an active pump.
Exposure	■ The Bayview weir and outfall are directly exposed to flooding from sea level rise, storm surge, and major rainfall events. Sea level rise compromises the operation of the weir and outfall system due to its current reliance on gravity flow during low tide. Based on engineering drawings, the outfall is roughly equivalent in elevation to mean sea level, or approximately 2 feet above mean low tide. As a result, 24" of sea level rise (not including storm surge) would likely result in the outfall structure being regularly submerged except for a short window around low tide. By 36" total water level, the outfall structure is likely permanently below low tide levels.
Sensitivity	**Governance** ■ The local HOA owns the lagoon system, but the City of Alameda is responsible for maintaining water levels. Residents with homes along the lagoon shoreline have a vested interest in a functioning water level management system. **Informational** ■ Engineering drawings for the outfall structure are old (1959 and 1989) and may not accurately reflect current water levels and mean tide levels. **Functional** ■ The gravity-fed system relies on low tide to drain water from the lagoons. Sea level rise poses a direct and imminent risk to this system as currently designed. Even if the outfall was exposed at low tide in the coming years, rising water levels will reduce the amount of time the City can discharge water from the lagoons, greatly restricting the flood management capacity of this system. ■ The current system design could expose homes surrounding the lagoon system to precipitation-driven overland flooding if water levels at the outfall are too high to allow for discharge. Increased storm intensity in the future could exacerbate the risk of overland flooding. **Physical** ■ BCDC inundation maps indicate the South Shore Lagoon system could eventually be directly connected to the Bay at higher water levels if steps are not taken to protect critical shoreline segments and improve the weir and outfall system. ■ Multiple components of the weir are damaged, including an inoperable flap gate and platform columns.
Adaptive Capacity	■ The existing outfall structure has very limited adaptive capacity because it relies on a gravity flow system. Raising the outfall to accommodate higher water levels would not be feasible. Installation of a pump station at the weir would greatly decrease the vulnerability of the lagoons.
Conse-quences	■ **Social:** There is a small chance that the failure of the weir and outfall system could result in flooding adjacent to the lagoons, threatening residential neighborhoods and critical assets, including Alameda Hospital. ■ **Environmental:** There is known contaminated sediment in the east lagoon (where the weir is located).



Appendix I

Climate Risk Across Alameda (Detailed Vulnerability Assessment)

August 2019

Table I-1. Summary of Citywide Buildings Vulnerability

Alameda has an extensive inventory of buildings that are vulnerable to flooding from sea level rise, storm surge, and major rainfall events. Damage to homes, businesses, community facilities, and their associated infrastructure represents a serious socioeconomic threat to the city. Buildings constructed in Alameda are not generally designed to withstand projected levels of flooding or saltwater exposure. Furthermore, liquefaction risk is high.	
Key Issue(s)	▪ Home damage or destruction can result in significant social and financial costs, potentially displacing entire populations. Most buildings in Alameda are not flood-proofed and are very sensitive to both temporary flooding and permanent inundation. ▪ Damage to community services like shelters, hospitals, and elder care facilities can disproportionately impact vulnerable populations, including those who are ill, immobile, elderly, or economically disadvantaged.
Exposure	▪ Buildings across Alameda are highly exposed to flooding beginning as early as 36" total water level. Before that, precipitation-driven storm drain flooding can also damage buildings, particularly basements where mechanical and electrical equipment are often located. As water levels rise, the number of buildings exposed, and the degree of exposure, increases rapidly. Some critical facilities serve important functions during heat events (healthcare centers, cooling centers), yet many buildings lack cooling systems to address future heat extremes.
Sensitivity	**Governance** ▪ The City of Alameda is responsible for defining the majority of building-related policies in Alameda, including those related to redevelopment and new development. City land use policies and building codes apply to all buildings in Alameda, regardless of ownership. **Informational** ▪ Accurate and up-to-date information on the location and needs of socially vulnerable populations is important to determine the vulnerability of specific buildings or neighborhoods, but that information is difficult to collect and maintain. **Functional** ▪ Critical buildings like schools, hospitals, care facilities, and community centers are an integral part of a healthy and vibrant city. Flooding can restrict access to key buildings or make them uninhabitable. Two of the four priority emergency shelters in the city are at risk of flooding (Encinal Middle and High School, Earhart Elementary School). ▪ Ensuring the resilience of shelters and emergency response facilities is critical for reducing the impacts of climate change. **Physical** ▪ Electrical and mechanical systems are often located in basements and are at risk of damage from even small amounts of flooding. ▪ Most homes and businesses are not currently resilient to flooding or saltwater impacts like corrosion.
Adaptive Capacity	▪ The adaptive capacity of buildings in Alameda varies greatly depending on factors like building age, use, design, and ownership. The greatest adaptive capacity is for new development or redevelopment because building codes and other policies can dictate adaptation measures.
Conse-quences	▪ **Social:** Displaced residents face severe challenges, especially among socially vulnerable populations. There is an extra burden on renters, who have limited capacity to address deficiencies in their buildings and rely on landlords to make changes. ▪ **Economic:** The economic impacts of building damage depend on the building use but include the cost to repair/replace buildings and equipment as well as the cost to the local economy (tax revenue, retail sales, etc.). ▪ **Environmental:** Flooded buildings can be a source of debris and contamination when waters recede.

Table I-2. Summary of Citywide Critical Services Vulnerability

Alameda's critical services—fire, police, emergency medical services, schools, hospitals—are vulnerable to flooding from sea level rise, storm surge, and major rainfall events, primarily due to access issues created by flood events and the resulting inability to provide services. Disruption of and damage to Alameda's critical facilities can exacerbate climate impacts because the public depends on these services most during emergencies. Schools are especially important to disadvantaged and vulnerable communities because they rely on these services for child care and meals.	
Key Issue(s)	■ Maintaining critical services as climate change impacts Alameda is crucial to the city's long-term resilience. Critical services are vital to residents impacted by a range of climate hazards, including extreme heat and decreased air quality from wildfires. Public services are especially important to particularly vulnerable populations like the elderly, disabled, sick, and low-income. During emergencies, transit-dependent populations will rely on emergency services to get them to safety, emphasizing the importance of a resilient critical services sector.
Exposure	■ Most critical facilities in Alameda are not directly exposed to flooding until after 48" total water level (Oakmont Senior Center is exposed at 36" total water level). However, the provision of critical services is exposed to a greater degree due to inundation of key roadways and access restrictions that begin at 36" total water level. Critical services rely on assets and systems that are also vulnerable to climate change, including transportation and telecommunications systems. ■ Emergency personnel are exposed to other hazards, most notably extreme heat and wildfire smoke, which threaten outdoor workers while also placing increased stress on emergency and healthcare services.
Sensitivity	**Governance** ■ The City is responsible for most critical services in Alameda except private facilities (daycares, senior centers, etc.) and Alameda Hospital. Coordination with regional emergency services is necessary for large-scale emergency planning and evacuations. **Informational** ■ Detailed information on the location and needs of vulnerable populations is important for effective emergency response but is difficult to collect and maintain. The social vulnerability assessment (SVA) in Appendix G presents a baseline that can be revisited periodically. **Functional** ■ Critical facilities that serve the elderly or infirm will need significantly longer response times to relocate during flood events. These facilities also house sensitive equipment that is necessary for effective care and may be impacted by flooding. ■ The reliance of critical services on other vulnerable assets like roads and tunnels increases the likelihood of their disruption from flooding. **Physical** ■ Critical facilities often contain equipment that is especially vulnerable to flooding but also crucial to patient well-being.
Adaptive Capacity	■ City departments like fire and police can adjust protocols to increase their resilience to climate change. ■ Addressing shoreline deficiencies and adapting transportation assets could greatly reduce the risk critical services face.
Conse-quences	■ **Social:** Disadvantaged and vulnerable populations often rely more on critical services than other groups. Disruptions to these services could disproportionately impact these groups, especially those that are transit-dependent. ■ **Economic:** Disruptions to emergency services would likely increase the economic impact of flood events. Residents and businesses also rely on these services every day, and their loss could have far-reaching effects on economic well-being.

Table I-3. Summary of Citywide Land Use Vulnerability

Given Alameda's exposure to a wide range of climate hazards, most notably flooding due to sea level rise and storm surge, the City's existing and future land use planning must incorporate adaptation strategies to keep residents and businesses out of harm's way. This involves important decisions about how to modify existing land use, where development opportunities still exist, and how to design new development and redevelopment to be adaptable to future climate conditions. Land use policies are an important avenue to creating a resilient Alameda.	
Key Issue(s)	■ Many existing plans, policies, and practices that guide land use planning, decisions, and subsequent capital investments do not consider sea level rise and flooding from intensifying storm events. Such plans need to be tailored to specific land uses while considering cross-cutting issues and interdependencies. Future land use decisions regarding development, redevelopment, open space, shoreline protection, and possible retreat will require balancing existing and future social and economic interests.
Exposure	■ All land use types (commercial, transportation/utilities, residential, open space, shoreline, municipal, institutional) are projected to be exposed to flooding and inundation from sea level rise, storm surge, and heavy precipitation events. Of particular concern are shoreline areas where land use policies are directly related to the City's ability to implement shoreline adaptation strategies and encourage flood-proofing.
Sensitivity	**Governance** ■ Land use plans that fully consider sea level rise and flooding will require coordination and communication with other entities that control and manage land uses within and surrounding the city. **Informational** ■ Public knowledge of and involvement in land use decisions will raise public awareness about trade-offs and inform the City going forward about social and behavioral changes that the community is prepared to make. The City must consider the interests of vulnerable populations (see the SVA in Appendix G) and engage with those groups to ensure that land use policies are equitable. **Functional** ■ Land use policies that allow development close to existing shoreline elevate the risk that buildings and infrastructure face. **Physical** ■ Current land use policies that do not adequately consider the impacts of climate change may heighten the sensitivity of buildings and infrastructure that are exposed to those impacts. Incorporating flooding adaptation measures into building and land use regulations can reduce the impact to residents and critical assets.
Adaptive Capacity	■ Alameda's adaptive capacity for future land use depends on whether climate change is adequately considered in plans and mandated in new projects, and hinges largely on Alameda Point land use decisions, where much of the new development is occurring.
Conse-quences	■ **Social:** Land use decisions often impact disadvantaged communities, especially renters that rely on landlords to ensure their homes are safe and protected from hazards. Failing to incorporate climate change into land use planning increases the vulnerability of all residents. ■ **Economic:** Land use decisions are critical to an economically vibrant city, and failing to consider climate change could be costly. ■ **Environment:** Poor land use planning can lead to issues like the mobilization of hazardous materials during flooding near the shoreline.

Table I-4. Summary of Citywide Shoreline and Natural Areas Vulnerability

Alameda has both engineered shorelines (primarily seawalls or levees and associated riprap and other armoring) and a variety of natural shoreline habitats. These natural shorelines attenuate waves and mitigate the impacts of sea level rise and storms. They also provide ecosystem service benefits, including open space, water quality, air quality, carbon sequestration, and habitats. Shoreline areas include wetlands, tidal flats, and marshes.	
Key Issue(s)	■ Sources of sediments into the Bay are decreasing while water levels are rising, increasing the vulnerability of natural areas to erosion. At the same time, inland barriers (roads, structures) restrict the ability of natural areas such as wetlands to migrate landward. ■ Deferred maintenance on existing shoreline protection structures makes it necessary to both repair and enhance shoreline structures to provide adequate flood protection as water levels rise, but a complex ownership system along the shoreline is a barrier to adaptation.
Exposure	■ Shorelines with the potential to overtop in the near term from storm events or small amounts of sea level rise represent the highest priority for adaptation strategies and are reflected in the list of priority assets. ■ Alameda relies on natural shorelines to protect some developed areas. Because they are unable to adjust to sea level rise, a significant portion of these shorelines may be eroded and/or flooded, severely reducing their ability to protect inland areas.
Sensitivity	**Governance** ■ Shoreline resilience projects will need to be coordinated across jurisdictions and may require complex permitting considerations. Private ownership of portions of the shoreline will require the City to engage landowners and discuss long-term options to enhance the shoreline. **Informational** ■ There is limited information on the existing condition of both engineered and natural shoreline structures in Alameda. **Physical** ■ Rising water levels increase shoreline erosion and damage from waves, making it more important to maintain existing structures.
Adaptive Capacity	■ Natural shorelines with room to expand landward have the most adaptive capacity; however, land use policies must be changed to allow this landward migration. Existing engineered shorelines can be elevated to adapt to sea level rise and, in some cases, integrated with living shoreline designs.
Conse-quences	■ **Social:** Natural areas are important to residents and provide substantial value for recreation and general well-being. ■ **Economic:** Major economic impacts are likely if engineered or natural shoreline features fail. ■ **Environment:** Habitat loss is likely for many species, including some threatened or endangered species.

Table I-5. Summary of Citywide Transportation Vulnerability

The transportation sector contains a vast network of assets that are critical to social, economic, and physical well-being, as well as emergency response, connecting Alameda to other services around the region and beyond. Transportation assets include those supporting vehicular movement (roads, bridges, tunnels), public transit (bus and passenger ferries), boats, and bicycle/pedestrian paths. The transportation sector's vulnerability to sea level rise and flooding from intensifying storm events not only puts these assets at risk but also affects other sectors, amplifying socioeconomic and public health risks.	
Key Issue(s)	■ Alameda's island location and transportation assets (which often lack alternatives) make it extremely vulnerable to transportation disruptions, with serious social, economic, and environmental consequences. Transit-dependent populations are especially vulnerable to impacts along bus routes, and other vulnerable groups like the elderly, infirm, and disabled rely on critical services to reach them. ■ Transportation planning is often a very lengthy process with numerous regulatory hurdles. The City must also pay careful attention to the needs of disadvantaged and vulnerable populations, as these groups are often overlooked during planning efforts or unable to attend public meetings or engage in the planning process due to barriers like language, work schedules, and child care needs.
Exposure	■ Many transportation assets are located along the shoreline or in areas likely to be inundated as water levels rise. Roads also serve as conduits for floodwaters, so even small amounts of shoreline overtopping during a storm event could lead to extensive flooding in some areas. ■ Many road segments are also vulnerable to precipitation-driven storm drain flooding and extreme heat, which can cause issues such as overheated engines and disabled A/C systems in buses, as well as pavement softening.
Sensitivity	**Governance** ■ Resilience planning will require close coordination with Caltrans and other transportation planning entities, including AC Transit, which is responsible for all bus transit on Alameda. **Informational** ■ There are limited centralized data to identify and prioritize transportation assets at greatest risk, considering physical, social, economic, and operation and maintenance aspects as well as interdependencies within the regional transportation system. **Functional** ■ Overland flooding across Alameda could greatly impact the provision of emergency services during storm events. This is a concern both in areas impacted by sea level rise and storm surge flooding as well as inland areas where storm drains could overflow. **Physical** ■ Some transportation system components are especially sensitive to flooding and inundation, including culverts that may not be large enough to accommodate projected future precipitation events or at elevations that would be flooded regularly at higher water levels. ■ Bridges in Alameda are vulnerable to sea level rise and storm surge, specifically mechanical rooms that are closer to existing mean higher high water. Sea level rise may also reduce clearance under bridges.
Adaptive Capacity	■ Adaptive capacity varies among transportation assets depending on the use of the asset, exposure, and whether there are feasible alternatives.
Conse-quences	■ **Social:** Key transit-dependent communities, including those on Alameda Point and in neighborhoods near Webster Street, are likely to experience substantial disruptions due to flooding along roadways. Citywide flooding of transportation assets impacts commuters and services. ■ **Economic:** Alameda's location and dependence on deliveries from the mainland make it heavily reliant on passable roads. ■ **Environment:** Damages or delays to public transit may result in more single-occupancy vehicular traffic, increasing emissions.

Appendix J

Adaptation Strategies and Actions

August 2019

Adaptation Planning: Crown Beach

Site-Specific Considerations

All future adaptation will need to be carried out in close collaboration with East Bay Regional Park District (EBRPD), which has a management agreement with the City of Alameda. EBRPD has plans to conduct a Master Plan Update for the beach, which could further adaptation planning for the site; however, a date has not been set for initiating the master planning process. Future community engagement in planning for the site should evaluate how much the community values maintaining the entire stretch of beach as a beach environment into the future. A geomorphology study will be an important initial step in determining if the beach is likely to keep pace with sea level rise in some spots and erode in others.

There is strong support for integrating the San Francisco Bay Trail into all future plans for the area.

Case Studies and Examples

As EBRPD and the City of Alameda clarify the vision for the future of Crown Beach (through the Crown Beach Master Planning process) and learn more about the geomorphology of the site with additional studies, it will be useful to examine other beach adaptation projects for guidance, such as the Cardiff Living Shoreline Project (OPC, 2016). This project, conducted by the San Ellijo Lagoon Conservancy, California State Coastal Conservancy, and California State Parks in Encinitas, is building a 0.5-mile dune system on Cardiff State Beach to protect Highway 101 from sea level rise.

The San Francisco Bay Living Shorelines Project provides a local example of lessons learned on integrating eelgrass restoration and oyster reefs offshore (San Francisco Bay Living Shorelines Project, 2015).

Limitations and Barriers to Implementation

In the near term, with continuation of dune management and annual sand redistribution, the beach will likely continue to provide a range of services to the community. Over the coming decades, these benefits may degrade without a clear vision established among EBRPD, the City, and the community for the future of the beach. Key questions include:

- How much of Crown Beach must be maintained as beach to continue providing recreational benefits?
- Can the ecosystem services that the beach, dunes, and marsh provide be quantified and a system established to pay for their maintenance?

Adaptation strategies that include expanding the beach or marsh into the Bay will encounter permitting challenges related to the Bay Conservation and Development Commission's (BCDC's) policies, which limit fill in the Bay. The City of Alameda may wish to consider getting involved in regional conversations encouraging the BCDC to re-evaluate these policies as the Bay adapts to sea level rise.

Costs and Benefits of Proposed Strategies

Protecting this stretch of shoreline will benefit the nearby residential areas and businesses that receive direct flood protection from the beach. Larger segments of the Alameda community will benefit from ongoing use of a main thoroughfare and protection of major infrastructure, such as stormwater outfalls serving larger portions of the city. Strategies that protect the salt marsh, tidal pools, beach, dune, and eelgrass habitats in this area would maintain the city's biodiversity into the future. If these ecosystems are lost, they would represent a major loss to the city's biodiversity.

Adaptation Planning: Eastshore Drive

Site-Specific Considerations

All work in this area will require close collaboration between the City and local homeowners, given that the shoreline protection abuts backyards. Some homeowners have received permits from the City to build decks and ramps beyond the seawalls.

Adaptation measures along the shoreline should be integrated with projects to improve public pathways leading to the water in the area. It may be important to consider some of the sensitivities around public access in the neighborhood. Unlike other parts of the Alameda shoreline, this area is primarily private without a public trail extension running parallel to the shoreline. Residents would need to be involved in any plans for public access along this stretch of shoreline.

As described in the strategies for shorelines and natural areas (see page 100 of the CARP), the City should explore opportunities to incorporate ecologically friendly features into any bulkheads and barriers built along this shoreline.

Case Studies and Examples

The Seal Beach Salt Marsh Sediment Augmentation Project in Orange County—an 8-acre U.S. Fish and Wildlife Service project—is a good resource on implementing a mudflat augmentation project (USFWS, n.d.).

Limitations and Barriers to Implementation

Given that private homes are built directly along the shoreline, there is limited space for adaptation without use of bulkheads and similar barriers (which are well-suited for small spaces). These hard structures may not have to be built as high if combined with the natural shoreline protections proposed in the CARP.

Costs and Benefits of Proposed Strategies

Protecting this stretch of shoreline will protect primarily residential areas, Lincoln Park, and local roads and infrastructure. Strategies that build on benefits provided by mudflats have potential to support the biodiversity of San Leandro Bay. Without public access improvements built into major City investments in the shoreline, the benefits may be felt primarily in the immediate neighborhoods. As sea levels rise higher than mean higher high water (MHHW) + 36 inches, the City must protect the shoreline near Lincoln Middle School—such protections will serve the community more broadly.

Adaptation Planning: Shoreline Near Webster and Posey Tubes

Site-Specific Considerations

The character of the Northern Waterfront in general limits the options for nature-based shoreline infrastructure. All the existing shoreline is hardened, and there is limited space to encroach into the estuary or migrate the shoreline inland. Long-term strategies for the Northern Waterfront could involve either full armoring to address end-of-century sea level rise projections, or a combination of policy/zoning changes and land acquisition to increase the buffer between private parcels and the water, allowing the City to implement larger-scale, nature-based features. Should the City move toward hardening the shoreline here, they should explore opportunities to incorporate ecologically friendly features into the levees and seawalls (gray-green infrastructure as described in the strategies for shorelines and natural areas on page 100.

Initial City conceptual drawings for shoreline enhancements in this area identify modifications needed to remove adjacent land from the Federal Emergency Management Agency (FEMA) 1 percent annual chance floodplain (approximately 100-year storm). A design elevation of approximately 13 feet NAVD88 (approximately 5 feet above current shoreline elevation) is recommended to account for a 100-year storm, a projection of approximately 24 inches sea level rise at mid-century, and freeboard. It is also recommended that the City consider adaptation options available in the future to address higher water levels and higher flood risk levels.

If the City moves to address mid-century projections with shoreline modifications in this area, the proposed seawall would likely need to be extended several hundred feet to the northwest beyond the City's initial conceptual drawings to provide protection from shoreline overtopping in this location at higher water levels.

Case Studies and Examples

Elevating levees and seawalls to provide shoreline protection is a common practice. Inland, flood-resistant shoreline design options that accommodate flooding and inundation, such as those outlined in the Alameda Point Master Infrastructure Plan (MIP) and other Northern Waterfront development plans, may apply in this area. The City of Seattle provides an example of hard flood protection integrating ecologically friendly features.

Limitations and Barriers to Implementation

Due to extensive private ownership of shoreline along the Northern Waterfront, and the proximity of buildings and impervious surfaces to the existing shoreline, any flood protection actions in this area require coordination with private landowners. The City must maintain multiple points of access to docks along this section of shoreline if levees and seawalls are elevated, including docks for semi-permanent houseboats.

Several buildings in this immediate shoreline area are very close to the existing shoreline. As a result, options for inland parks and green infrastructure are limited. The City could consider establishing zoning overlays that identify high-risk zones and require flood-proofing and other retrofits, while limiting expansion of buildings and impervious surfaces within a specified distance from the shoreline.

Costs and Benefits of Proposed Strategies

Benefits of shoreline protection in this area will be felt citywide, as overtopping of the shoreline here could lead to flooding of the tubes, which are critical for resident, commuter, goods movement, and emergency access to Alameda Island. The tubes are also essential to AC Transit bus routes. Flooding of this area could impact the Hazardous Materials Transfer Station, creating risks for local residents (and beyond if hazardous materials are mobilized in water). The immediate community will feel the costs of inaction and benefits of adaption. The social vulnerability assessment (Appendix G) identified the Alameda Landing and College of Alameda block groups as having residents with socioeconomic characteristics that make it harder for them to respond to and recover from flood events—critical information for the City to keep in mind as they prioritize projects and action. For example, it is important for the City to support adaptation actions in collaboration with Oakmont of Mariner Point (a retirement community), located right on the shoreline.

Adaptation Planning: Bay Farm Island Lagoon System 1 Outlet Gate and Seawall

Site-Specific Considerations

Elevating the existing seawall to be level with adjacent levees can provide short-term protection and reduce the extent of the FEMA 1 percent floodplain. Due to the elevation of the levee along the northern shoreline of Bay Farm Island, the City must investigate larger-scale shoreline alternatives to provide flood protection to 77 inches total water level, at which point most of the shoreline is overtopped. Examples of options for longer-term protections include:

- Elevating the existing levee and shoreline park to accommodate higher water levels. The entire levee would need to be elevated by approximately 5 feet to provide protection beyond 77 inches total water level.
- Redesigning Shoreline Park to be a more effective flood management feature by incorporating green infrastructure and using permeable and flood-resistant materials in construction.
- Considering buyouts to expand the shoreline area inland or encroachment into the Bay.
- Converting the existing levee into a horizontal levee to help reduce erosion and provide more space for submerged aquatic vegetation (SAV) growth.

Habitat modifications may be necessary to expand SAV in this area depending on characteristics at this location. The *San Francisco Bay Shoreline Adaptation Atlas* report identifies design criteria for SAV habitats that should be considered (SFEI & SPUR, 2019).

Future changes to the seawall and shoreline should aim to maintain the existing public waterfront trail.

Case Studies and Examples

Few case studies demonstrate conversion of existing hardened shorelines into nature-based features at the scale of the northern Bay Farm Island shoreline. An example of this type of project is the Surfer's Point Managed Shoreline Retreat Project in Ventura, California (Judge et al., 2017).

Limitations and Barriers to Implementation

The proximity of homes to the existing levee limits the scale of shoreline modifications in this area and prevents the shoreline area from migrating inland without property buyouts. However, the presence of a park along the length of this shoreline makes mixed gray/green infrastructure and flood-tolerant landscaping design feasible. Encroachment into the Bay may be feasible but would require substantial coordination with permitting agencies and other stakeholders.

The City's Local Hazard Mitigation Plan indicates that there is limited understanding of the structural condition of the isthmus at this site. Additional information on structural integrity is needed to design larger-scale shoreline projects that remain competent in the event of large storms or earthquakes.

Costs and Benefits of Proposed Strategies

Improved shoreline protection in this area will reduce flood risk to the Harbor Bay Island community, surrounding residential areas, and Elsie Roemer Elementary School.

Adaptation Planning: Veteran’s Court Seawall

Site-Specific Considerations

Inundation maps suggest overtopping at the Veteran’s Court seawall could contribute to flooding along Island Drive and adjacent neighborhoods. However, it is difficult to determine the exact source of overtopping (when Bay water levels reach MHHW + 36 inches) because of contributions from other areas, including the golf course and Doolittle Drive. The City should integrate any long-term strategy to address flooding in this area into a broader approach to flood control on Bay Farm Island. Short-term activities at this location can provide flood protection from storm events and extreme tides.

The initial design elevation of the City’s preliminary concept to regrade and elevate Veteran’s Court is 13 feet NAVD88, equivalent to approximately 24 inches of sea level rise, plus a 100-year storm, plus 1 foot of freeboard (adding up to 78 inches total water level). At these higher water levels, flooding on Bay Farm Island is derived from multiple areas of shoreline overtopping. Local modification to the shoreline at Veteran’s Court could protect the immediate area from temporary flooding during storms but would not provide protection from permanent inundation and larger-scale flooding unless other sections of shoreline in Alameda and Oakland are addressed (see State Route [SR] 61/Doolittle Drive priority asset write-up).

Providing full sea level rise protection for Veteran’s Court and downstream areas to an elevation of 13 feet NAVD88 may involve future elevation of the existing Harbor Bay Club retaining walls, depending on the results of as-built survey data. Once redesigned and elevated, the Veteran’s Court right-of-way will serve as the primary shoreline protection measure for this area, and the existing seawall will remain in place, serving as a secondary level of protection for the area of retreat (the area between the shoreline and future cul-de-sac/berm).

Plans for the Veteran’s Court adaptation include replacing the existing bicycle and pedestrian path to allow continued access to the bicycle bridge from Island Drive. Adaptation in the area should consider the feasibility of efforts to integrate with long-term car and bicycle bridge adaptation efforts and plans to make the bicycle bridge comply with the Americans with Disabilities Act.

Case Studies and Examples

Although it has not been constructed yet, De-Pave Park in the Seaplane Lagoon on Alameda Point is an example of the type of shoreline reclamation and conversion project that might be applicable at Veteran’s Court. If conversion to a living levee is the desired approach, pilot studies underway in California (e.g., in Palo Alto) may provide lessons learned.

Limitations and Barriers to Implementation

The proximity of private property to Veteran’s Court limits but does not prohibit conversion of impervious surface in this area into more nature-based features like the De-Pave Park concept on Alameda Point. Longer-term strategies to address higher water levels will require coordination with private landowners to promote retreat or greatly enhance flood protection structures (retaining walls) along the private property boundary.

The City must consider the structural stability of the bridge when investigating major modifications to the Veteran’s Court area to ensure waves and storm surge are not unintentionally redirected toward bridge support structures.

Converting the Veteran’s Court area into a nature-based shoreline like a living levee—as identified in the Bay Farm Island Focus Area Technical Study—would require inland land acquisition (buyouts) or encroachment into San Leandro Canal (AECOM, 2014). A living levee also requires a long-term management plan to maintain adequate elevation as water levels rise.

Costs and Benefits of Proposed Strategies

Improved shoreline protection in this area will reduce flood risk to the Harbor Bay Island community, surrounding residential areas, and Elsie Roemer Elementary School. In addition, it will protect a key access route on and off Bay Farm Island, as it connects to the Bay Farm Island Bridge.

Adaptation Planning: Bay Farm Island Touchdown and Towata Park

Site-Specific Considerations

Homes are very close to the shoreline, limiting options to adapt the shoreline without use of gray infrastructure (seawalls, berms, levees). Should additional hardened structures be added to this area, there may be opportunities to incorporate ecologically friendly features into the retaining walls and flood protection structures (as described in the strategies for shorelines and natural areas on page 100). The size of these structures may be reduced with use of beaches or subtidal vegetation, which reduce wave size and stress on walls (the *San Francisco Bay Shoreline Adaptation Atlas* work suggests these approaches are worthy of further exploration in this area) (SFEI & SPUR, 2019).

It should be noted that this stretch of shoreline has been flagged for San Francisco Bay Trail extension, so Bay Trail staff and partners should engage with future planning for this area.

Case Studies and Examples

Elevating seawalls and revetments to protect shoreline is a common practice. Adaptive management plans, such as those outlined in the Alameda Point MIP and other Northern Waterfront development plans, may apply to this area.

Limitations and Barriers to Implementation

The first step in identifying adaptation options for the site will be collaboration among the City, Ravens Cove Homeowners' Association (HOA), and other shoreline homeowners outside of the HOA to determine ownership and management responsibilities for the shoreline path and existing shoreline protection structures. The City will also need to consult the East Bay Municipal Utility District, which has an easement in the area. Strategies to adapt Towata Park will need to meet the goals of the Recreation and Parks Department.

Longer-term strategies to address higher water levels may require coordination with private landowners to promote retreat or greatly enhance flood protection structures (retaining walls) along the private property boundary.

Costs and Benefits of Proposed Strategies

While homeowners in the immediate vicinity experience the near-term costs of flooding in this area, the costs will be felt across the community as seas rise. Impacts to the broader transportation system (flooding of Otis Drive and Fernside Boulevard) will impede movement between Alameda Island and Bay Farm Island.

Adaptation Planning: SR260, Including Webster and Posey Tubes

Limitations and Barriers to Implementation

Caltrans must use transportation funds to plan, build, design, and construct transportation improvement projects. While these projects can include design elements to improve a transportation asset's resiliency to sea level rise, adaptation actions that Caltrans funds and implements must be components of broader transportation improvement projects or safety-based repairs. Caltrans can implement projects that are only focused on adaptation. The City can help address this limitation by taking the lead in designing and installing floodwalls and flood gates (if necessary) at the entrance and exit of the tubes.

Site-Specific Considerations

Multiple feasibility and preliminary design studies are included in the City's Transportation Choices Plan to increase redundancy in the west end of Alameda for on/off island access, including: 1) BART to Alameda, 2) New Transit/Bike/Pedestrian Lifeline Tube, and 3) West End Bicycle/Pedestrian Crossing. The City should continue to participate in studies and planning efforts related to providing expanded access for vehicle alternatives.

There is known contaminated sediment and/or waste located near the existing tubes. Projects in this area should take care to prevent contamination from affecting nearby communities.

Case Studies and Examples

Ongoing and planned modifications to the New York City (NYC) subway system as a result of Hurricane Sandy provide the best example of the types of flood-proofing actions relevant to tunnels. Strategies to address flooding in NYC include floodwalls and floodgates at tunnel entrances and exits and elevation of tunnel ramps. The scale and unique characteristics of the NYC system make it an imperfect example for Alameda, but lessons could be applied. In general, flood-proofing activities such as those in NYC are extremely expensive and disruptive to transit networks. A long lead time for planning, community engagement, and design is necessary for any major tunnel projects.

Costs and Benefits of Proposed Strategies

As discussed in the social vulnerability assessment (Appendix G), the Alameda Landing and College of Alameda areas would be impacted by flooding in the vicinity of the tubes. These neighborhoods are located in block groups that have residents with socioeconomic characteristics that make it harder for them to respond to and recover from flood events. Protecting these vulnerable neighborhoods is a major benefit of these strategies.

Furthermore, given the importance of SR260 and the tubes to AC Transit routes, projects in this area provide citywide benefits to the long-term functionality of transit systems that are critical to transit-dependent residents across Alameda. Access to/from Alameda on public transit is a fundamental part of a thriving economy and community, and it must be maintained.

Adaptation Planning: SR61/Doolittle Drive

Site-Specific Considerations

To address flood risk at the intersection of Harbor Bay Parkway and Doolittle Drive, the City may be able to work with the model airplane field on steps to provide flood control. In addition, the City may wish to reach outside of its boundaries to engage with EBRPD on managing Doolittle Pond to provide flood protection. The pond is currently managed as a wildlife sanctuary—its management will need to be reconsidered as the Bay rises.

A key component of the area is Doolittle Dump, known locally as “Mt. Trashmore,” a closed landfill between Doolittle Drive and Doolittle Pond. The Regional Water Quality Board requires that the management and water quality monitoring requirements at the site be updated every 10 to 15 years to meet current site conditions and ensure wastes do not seep into surface or groundwater (ART, 2017). This includes updating flood protection plans.

Corica Golf Course, located in this area, is in the midst of renovations that include updates to its drainage and stormwater system. Once renovations are complete, Greenway Golf, the company renovating and operating the course, expects a 2,418 percent increase in stored acres/feet of water within the property ponds, lakes, wetlands, and sand. The surface area of ponds, lakes, and wetlands for water storage will be 525 percent greater than before the course renovations. Marc Logan, Chief Agronomist/Principal for Greenway Golf, explains that the courses are engineered to use a 4-inch advanced drainage system pipe on all turf areas to ensure the water can back up on the golf course and avoid moving water too quickly within the property. The water is directed to internal ponds and wetlands. As such, the golf course renovation is likely to reduce flood risks for adjacent communities by absorbing stormwater and slowing water that may originate from the MLK shoreline area. Additional modeling will be needed to look in depth at impacts to adjacent communities.

Limitations and Barriers to Implementation

While there are some steps the City of Alameda can take within its jurisdiction to address overtopping of Doolittle Drive (such as addressing flooding risk at Veteran’s Court and at the model airplane field), the largest flood risk comes from the Oakland end of Doolittle Drive along the MLK shoreline. Caltrans and the Oakland Airport are in discussions about opportunities to address flood risk in this area (as it also impacts the north field of the airport). The City of Alameda may find ways to leverage support from these efforts to collaborate and move work forward.

If Doolittle Drive’s flooding risk is not addressed in a timely enough matter, the City of Alameda may choose to pursue other adaptation options within their jurisdiction, such as collaborating with the golf course to improve its flood control system and/or converting local roads (within the city) into an inland levee/barrier.

Case Studies and Examples

In considering expansion of Arrowhead Marsh, the City can look to Giant Marsh, Sonoma Baylands, and many other wetlands projects around the Bay as examples (Judge et al., 2017). In considering management of the golf course for flood protection, the Palo Alto Flood Basin and Hamilton Wetlands Restoration Project can serve as examples. While each of these projects serve unique needs and habitats, they may have relevant lessons learned in terms of polder management.

Costs and Benefits of Proposed Strategies

Actions taken within Alameda alone may be effective at protecting the city, but they are likely to be costly and challenging without collaboration from neighboring jurisdictions. It may prove more cost-effective for the City to pay into collaborative solutions.

References

AECOM. (2014). *Bay Farm Island focus area*. Retrieved from http://www.adaptingtorisingtides.org/wp-content/uploads/2014/12/BayFarmIslandTechnicalMemo.pdf

ART (Adapting to Rising Tides). (2017). *Adapting to Rising Tides: Contra Costa County Assessment and Adaptation Project.* Retrieved from http://www.adaptingtorisingtides.org/wp-content/uploads/2017/03/Contra-Costa-ART-Project-Report_Final.pdf

Judge, J., Newkirk, S., Leo, K., Heady, W., Hayden, M., Veloz, S., Cheng, T., Battalio, B., Ursell, T., & Small, M. (2017). *Case studies of natural shoreline infrastructure in coastal California: A component of* Identification of natural infrastructure options for adapting to sea level rise (California's Fourth Climate Change Assessment). Arlington, VA: The Nature Conservancy. Retrieved from http://scc.ca.gov/files/2017/11/tnc_Natural-Shoreline-Case-Study_hi.pdf

OPC (Ocean Protection Council). (2016). *Cardiff Beach Living Shoreline Project*. Retrieved from http://www.opc.ca.gov/webmaster/ftp/pdf/agenda_items/20160629/4h_Cardiff_Beach/4h_Staff%20Rec%20for%20SCC%20Cardiff%20Beach_final.pdf

San Francisco Bay Living Shorelines Project. (2015). Retrieved from http://www.sfbaylivingshorelines.org/sf_shorelines_about.html

San Francisco Estuary Institute (SFEI) and SPUR. (2019). *San Francisco Bay shoreline adaptation atlas: Working with nature to plan for sea level rise using operational landscape units* (Publication #915). Richmond, CA: San Francisco Estuary Institute.

USFWS (U.S. Fish and Wildlife Service). (n.d.). *Salt marsh sediment augmentation project.* Retrieved from https://www.fws.gov/refuge/seal_beach/what_we_do/resource_management/Sediment_Pilot_Project.html

Appendix K

Recommendations for Tracking System Dashboard

August 2019

Introduction

An interactive and engaging dashboard to highlight the City of Alameda's efforts to address climate change will help galvanize the community, build public support for ongoing work, and track progress transparently. Effective dashboards for measuring progress are easy to navigate, easy to understand, show a limited number of parameters that resonate with community values, and track results of investments made to implement the plan. The dashboard should emphasize engaging graphics and minimize text. It will visualize the key greenhouse gas (GHG) reduction and adaptation metrics described in Chapter 6: "From Plan to Action." The final list of metrics the City selects will partially dictate the design of the *Climate Action and Resiliency Plan* (CARP) dashboard. In addition, the following guidance should be kept in mind when designing the dashboard:

- **Flexibility to present diverse data sets:** A dashboard should be flexible enough to accommodate both quantitative data and qualitative information to integrate tracking of GHG reduction and adaptation efforts into a single platform.
- **Opportunities to pair data with case studies and narrative text:** A dashboard should include components that help identify the impact of actions—for example, by including narrative text or case studies (success stories) that supplement a graphic and help describe the outcomes.

This appendix presents several examples of dashboards from other municipalities. The examples range from relatively simple to very complex and illustrate different ways of reporting data and engaging the community. The examples were drawn from approximately one dozen other municipal websites related to climate action that could be adapted for use in Alameda. The final CARP dashboard will use these examples as inspiration to develop an attractive and informative platform for tracking progress toward GHG reduction and adaptation goals.

Dashboard Concept Without Enhanced Data Visualization Capabilities

The current City website and associated tools, including OpenGov, do not have advanced data visualization capabilities like those provided by the Open Data system, an add-on to OpenGov. The lack of advanced visualization capabilities does not prevent us from developing a dashboard but does restrict the types of interactive data features, including charts, graphs, and maps, that could be included. This section presents recommendations and examples for a dashboard built with existing City capabilities. It is important to note that we would likely need to design a new dashboard if enhanced data visualization capabilities were purchased to incorporate those features.

A basic dashboard built with existing capabilities would contain the following important elements:

- Narrative text describing CARP goals, implementation timeline, actions, and other information;
- Static graphs, maps, and other graphics created using tools like spreadsheet-based graphing systems (e.g., Microsoft Excel) as well as traditional geographic information system (GIS) mapping platforms, including Esri products like ArcMap or open-source products like QGIS; and
- Links to other pages containing infographics or other information.

If purchasing enhanced data visualization capabilities is a longer-term goal, we could develop a basic CARP website that incorporates these elements, taking care to design it in a way that allows for incorporation of new capabilities as they become available. The City will first consider when they should purchase new visualizations tools and then decide on the best approach. If it will be several years before those capabilities are available, then we will move forward with a basic dashboard that relies on existing systems. Overall, based on the initial list of metrics provided in Chapter 6, “From Plan to Action,” we will consider purchasing a new data system to facilitate our development of an attractive and interactive dashboard to display CARP progress and engage with the community. This capability can be used for other purposes as well.

The examples presented below—from the City of Berkeley, California, and King County, Washington—are relatively basic systems that do not include interactive data visualizations. We can take inspiration from these examples in developing a dashboard using existing City capabilities.

City of Berkeley

The Berkeley website presents Climate Action Plan Core Strategies Goals & Metrics for Climate Adaptation. This is a basic web-based interface with PDF fact sheets available by strategy and goal area. See Figure K-1 and Figure K-2 for visualizations of the Climate Action Plan Core Strategies and Goals home page, as well as an example of a strategy and goal area. Berkeley’s website is a good example of how to connect metrics to CARP goals and provide informative narrative text (see Figure K-2). Furthermore, the Berkeley page does not require enhanced data visualization capabilities; the charts, graphs, and other visualizations tracking Berkeley’s progress (see Figure K-3) are not interactive and can be produced using traditional spreadsheet-based graphing tools.

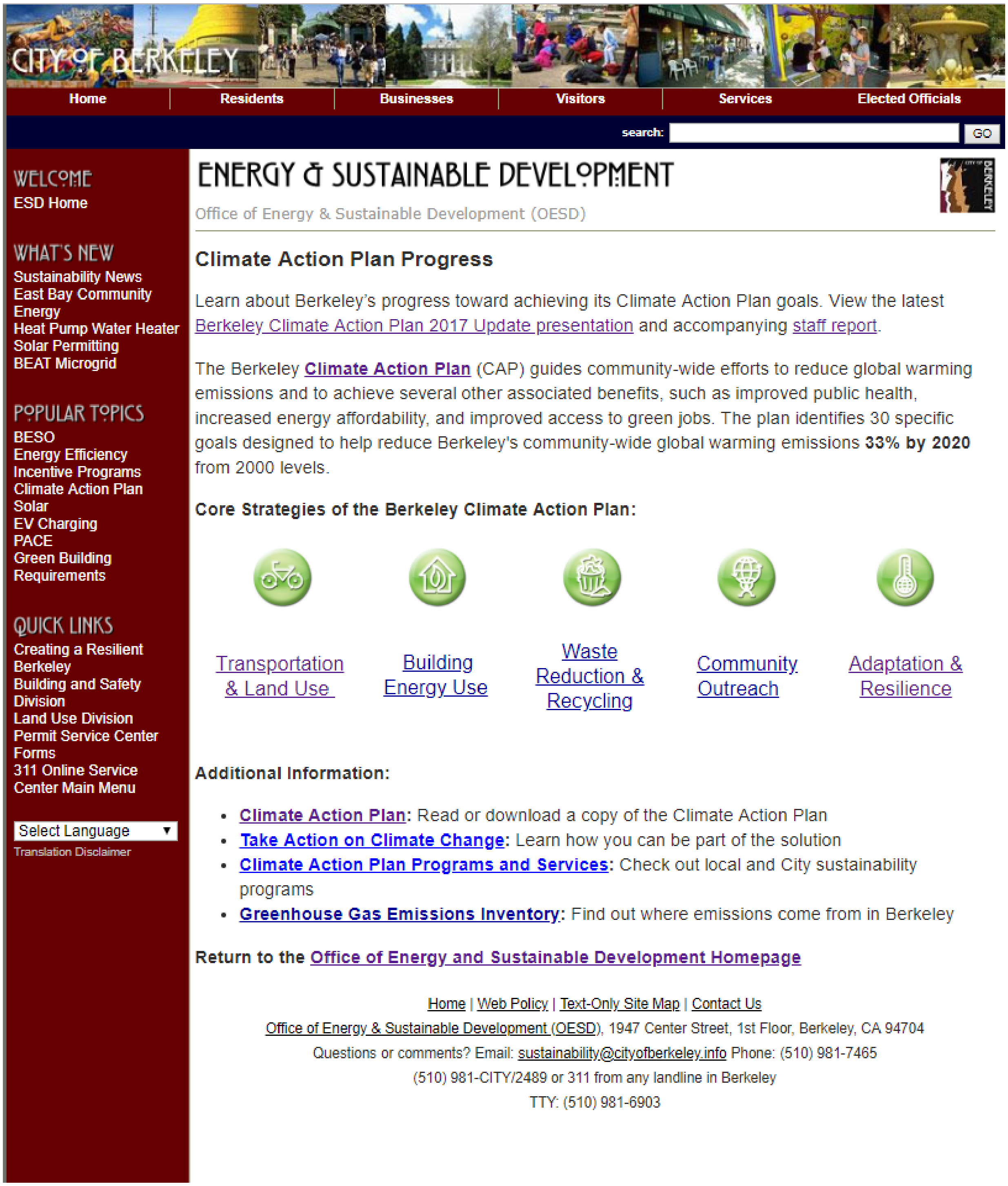
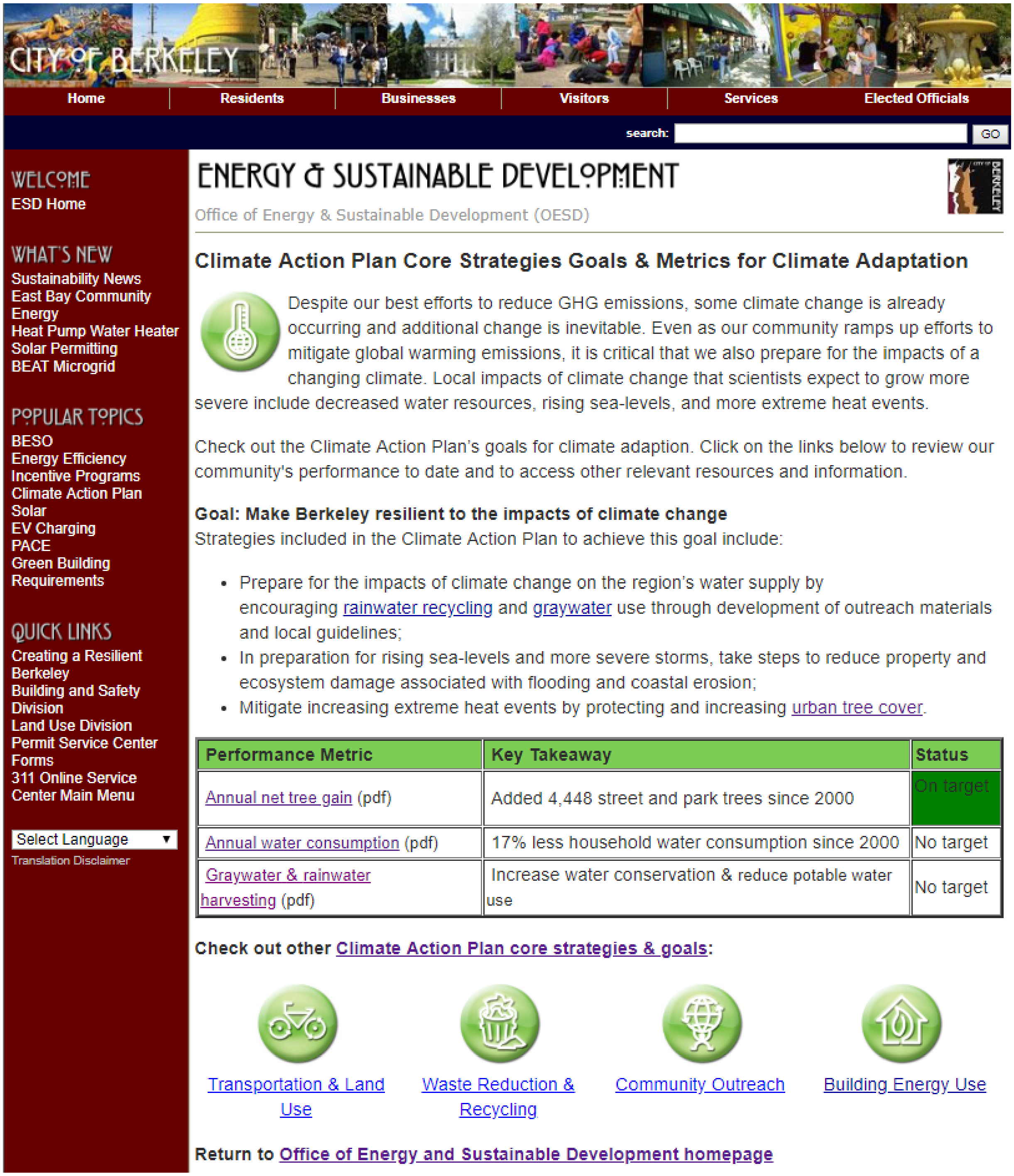


Figure K-1. City of Berkeley Climate Action Plan Progress website.


CITY OF BERKELEY

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search: GO

WELCOME
ESD Home

WHAT'S NEW
Sustainability News
East Bay Community Energy
Heat Pump Water Heater
Solar Permitting
BEAT Microgrid

POPULAR TOPICS
BESO
Energy Efficiency
Incentive Programs
Climate Action Plan
Solar
EV Charging
PACE
Green Building Requirements

QUICK LINKS
Creating a Resilient Berkeley
Building and Safety Division
Land Use Division
Permit Service Center
Forms
311 Online Service Center Main Menu

Select Language
Translation Disclaimer

ENERGY & SUSTAINABLE DEVELOPMENT

Office of Energy & Sustainable Development (OESD)

Climate Action Plan Core Strategies Goals & Metrics for Climate Adaptation

Despite our best efforts to reduce GHG emissions, some climate change is already occurring and additional change is inevitable. Even as our community ramps up efforts to mitigate global warming emissions, it is critical that we also prepare for the impacts of a changing climate. Local impacts of climate change that scientists expect to grow more severe include decreased water resources, rising sea-levels, and more extreme heat events.

Check out the Climate Action Plan's goals for climate adaption. Click on the links below to review our community's performance to date and to access other relevant resources and information.

Goal: Make Berkeley resilient to the impacts of climate change
Strategies included in the Climate Action Plan to achieve this goal include:

- Prepare for the impacts of climate change on the region's water supply by encouraging rainwater recycling and graywater use through development of outreach materials and local guidelines;
- In preparation for rising sea-levels and more severe storms, take steps to reduce property and ecosystem damage associated with flooding and coastal erosion;
- Mitigate increasing extreme heat events by protecting and increasing urban tree cover.

Performance Metric	Key Takeaway	Status
Annual net tree gain (pdf)	Added 4,448 street and park trees since 2000	On target
Annual water consumption (pdf)	17% less household water consumption since 2000	No target
Graywater & rainwater harvesting (pdf)	Increase water conservation & reduce potable water use	No target

Check out other Climate Action Plan core strategies & goals:

Transportation & Land Use | Waste Reduction & Recycling | Community Outreach | Building Energy Use

Return to Office of Energy and Sustainable Development homepage

Figure K-2. Climate Action Plan Core Strategies Goals & Metrics for Climate Adaptation webpage.

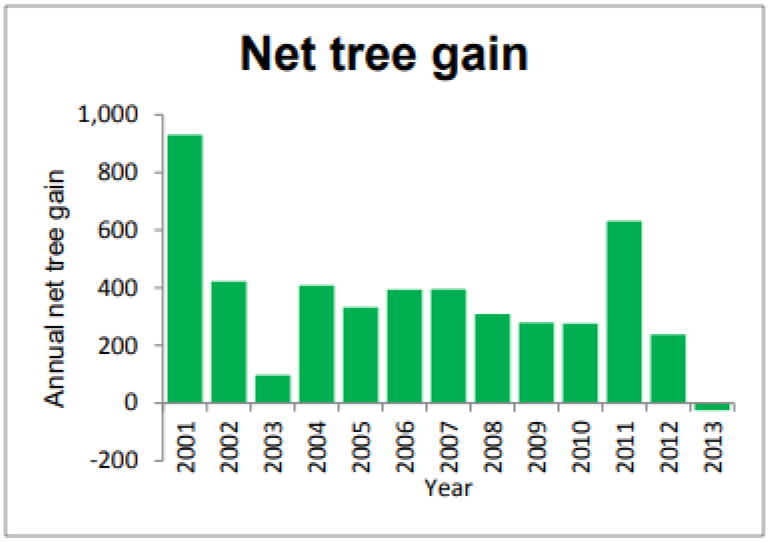
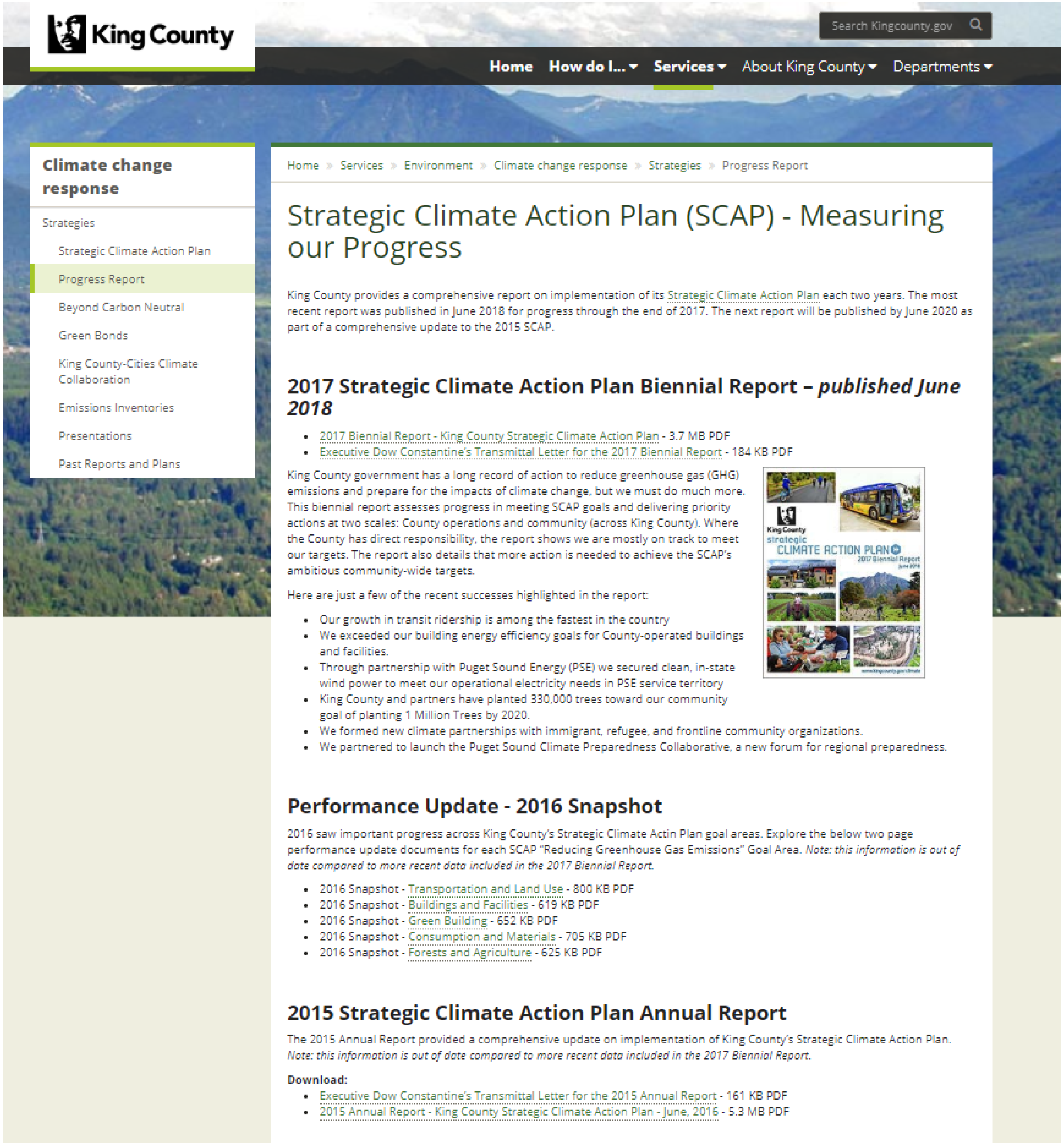


Figure K-3. City of Berkeley is "on target" to meet their net tree gain goal of trees planted since 2000.

King County

King County's Strategic Climate Action Plan (SCAP), like the City of Berkeley's Climate Action Plan Core Strategies Goals & Metrics for Climate Adaptation plan, is a web-based dashboard presenting PDFs with summary statistics and indicators of progress using the "stoplight" approach (green, yellow, red). SCAP uses slightly more summary statistics and more disaggregated measures of progress. Figure K-4 and Figure K-5 are snapshots of the SCAP main page and one of their PDF infographics. King County's home page is very text-heavy with few graphics (see Figure K-4), but clicking on a sector "snapshot" takes you to an appealing infographic that is very informative (see Figure K-5). However, producing similar infographics for the CARP would be very time-consuming. If we move forward with expanding our visualization capabilities with Open Data or a similar system, infographics like these would be replaced by more interactive graphics and maps.



King County

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Strategic Climate Action Plan (SCAP) - Measuring our Progress

King County provides a comprehensive report on implementation of its Strategic Climate Action Plan each two years. The most recent report was published in June 2018 for progress through the end of 2017. The next report will be published by June 2020 as part of a comprehensive update to the 2015 SCAP.

2017 Strategic Climate Action Plan Biennial Report – *published June 2018*

- 2017 Biennial Report - King County Strategic Climate Action Plan - 3.7 MB PDF
- Executive Dow Constantine's Transmittal Letter for the 2017 Biennial Report - 184 KB PDF

King County government has a long record of action to reduce greenhouse gas (GHG) emissions and prepare for the impacts of climate change, but we must do much more. This biennial report assesses progress in meeting SCAP goals and delivering priority actions at two scales: County operations and community (across King County). Where the County has direct responsibility, the report shows we are mostly on track to meet our targets. The report also details that more action is needed to achieve the SCAP's ambitious community-wide targets.

King County strategic CLIMATE ACTION PLAN 2017 Biennial Report

Here are just a few of the recent successes highlighted in the report:

- Our growth in transit ridership is among the fastest in the country
- We exceeded our building energy efficiency goals for County-operated buildings and facilities.
- Through partnership with Puget Sound Energy (PSE) we secured clean, in-state wind power to meet our operational electricity needs in PSE service territory
- King County and partners have planted 330,000 trees toward our community goal of planting 1 Million Trees by 2020.
- We formed new climate partnerships with immigrant, refugee, and frontline community organizations.
- We partnered to launch the Puget Sound Climate Preparedness Collaborative, a new forum for regional preparedness.

Performance Update - 2016 Snapshot

2016 saw important progress across King County's Strategic Climate Actin Plan goal areas. Explore the below two page performance update documents for each SCAP "Reducing Greenhouse Gas Emissions" Goal Area. *Note: this information is out of date compared to more recent data included in the 2017 Biennial Report.*

- 2016 Snapshot - Transportation and Land Use - 800 KB PDF
- 2016 Snapshot - Buildings and Facilities - 619 KB PDF
- 2016 Snapshot - Green Building - 652 KB PDF
- 2016 Snapshot - Consumption and Materials - 705 KB PDF
- 2016 Snapshot - Forests and Agriculture - 625 KB PDF

2015 Strategic Climate Action Plan Annual Report

The 2015 Annual Report provided a comprehensive update on implementation of King County's Strategic Climate Action Plan. *Note: this information is out of date compared to more recent data included in the 2017 Biennial Report.*

Download:

- Executive Dow Constantine's Transmittal Letter for the 2015 Annual Report - 161 KB PDF
- 2015 Annual Report - King County Strategic Climate Action Plan - June, 2016 - 5.3 MB PDF

Figure K-4. King County home page.

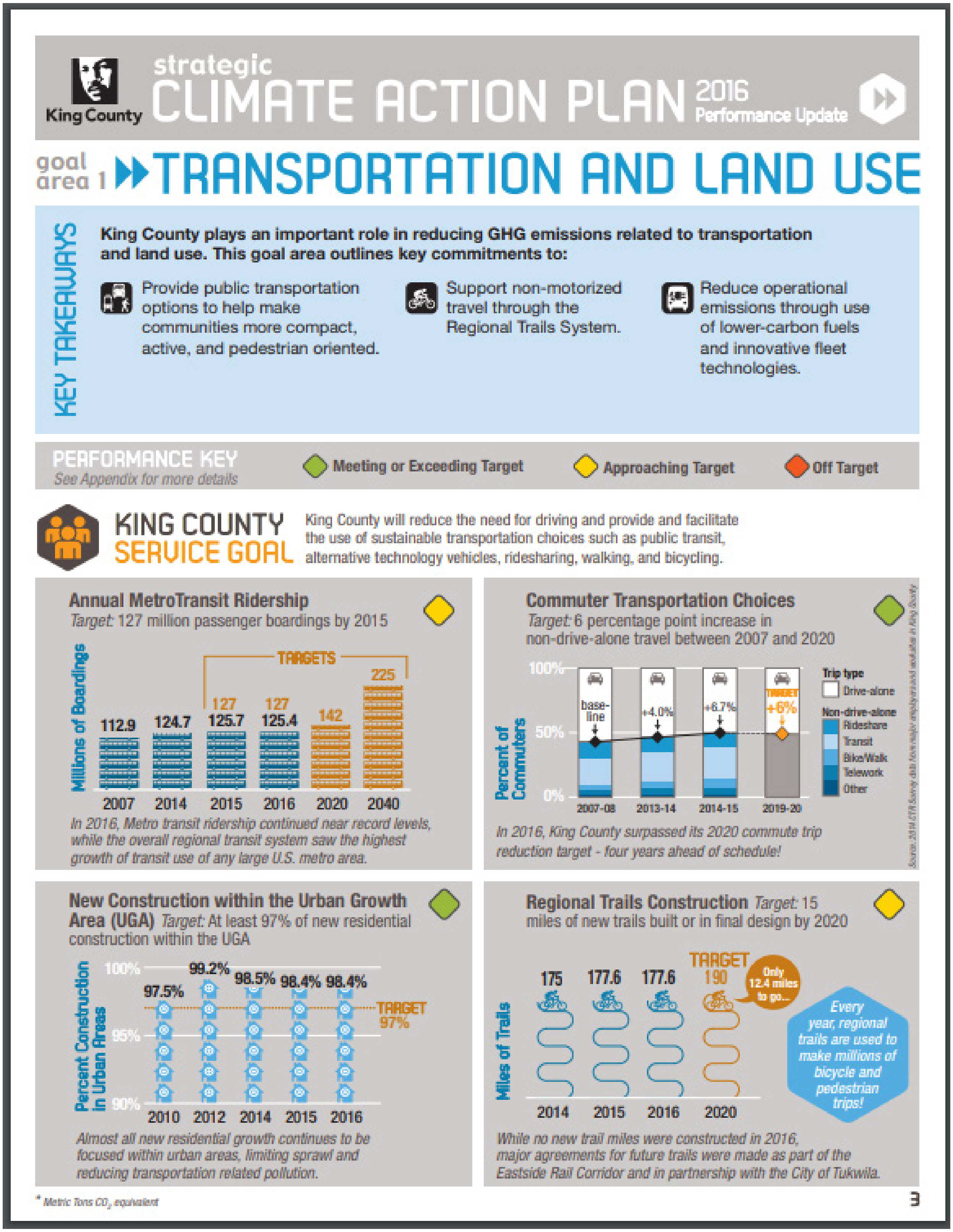


Figure K-5. King County "Transportation and Land Use" infographic.

Dashboard Concept with Enhanced Data Visualization Capabilities

Interactive dashboards and similar products can run the gamut from relatively simple text-based websites that include some interactive graphics (e.g., maps, interactive charts/graphs) to complex and comprehensive data-driven platforms with enhanced graphical visualizations and detailed interactive maps. To maximize resources and align the CARP dashboard with an adaptive management approach, we suggest a relatively simple system that can be deployed quickly but that allows for future enhancements as new data are collected, needs change, or the community provides suggestions. If more resources are available, a more comprehensive system could be produced, but it would require more development time and would likely require City staff to regularly update and manage the platform. We will consider that type of more substantial system as a longer-term objective for tracking CARP progress.

Recommendation 1: Modular Dashboard Approach

If we adopt an Open Data system with enhanced data visualization capabilities, a "modular" dashboard approach would be feasible, allowing us to add content to the CARP website as data availability or needs change. Figure K-6 shows an example landing page from the City of Richmond, California, which uses the Open Data system (and other components). Richmond's dashboard is a good example of a modular approach with multiple topic-area pages that each contain text, graphs, maps, and other information for specific tracking metrics and survey results. This climate website includes elements that are not feasible with our existing system and that would require some enhanced data visualization capabilities. Many of the City of Richmond elements also require maintenance of underlying spreadsheets or databases, as described below.

A modular approach like the City of Richmond's climate website will allow for ongoing enhancements as resources and technical capacity grow. The dashboard should include narrative text surrounding graphics and maps that help describe key objectives and the implementation approach.

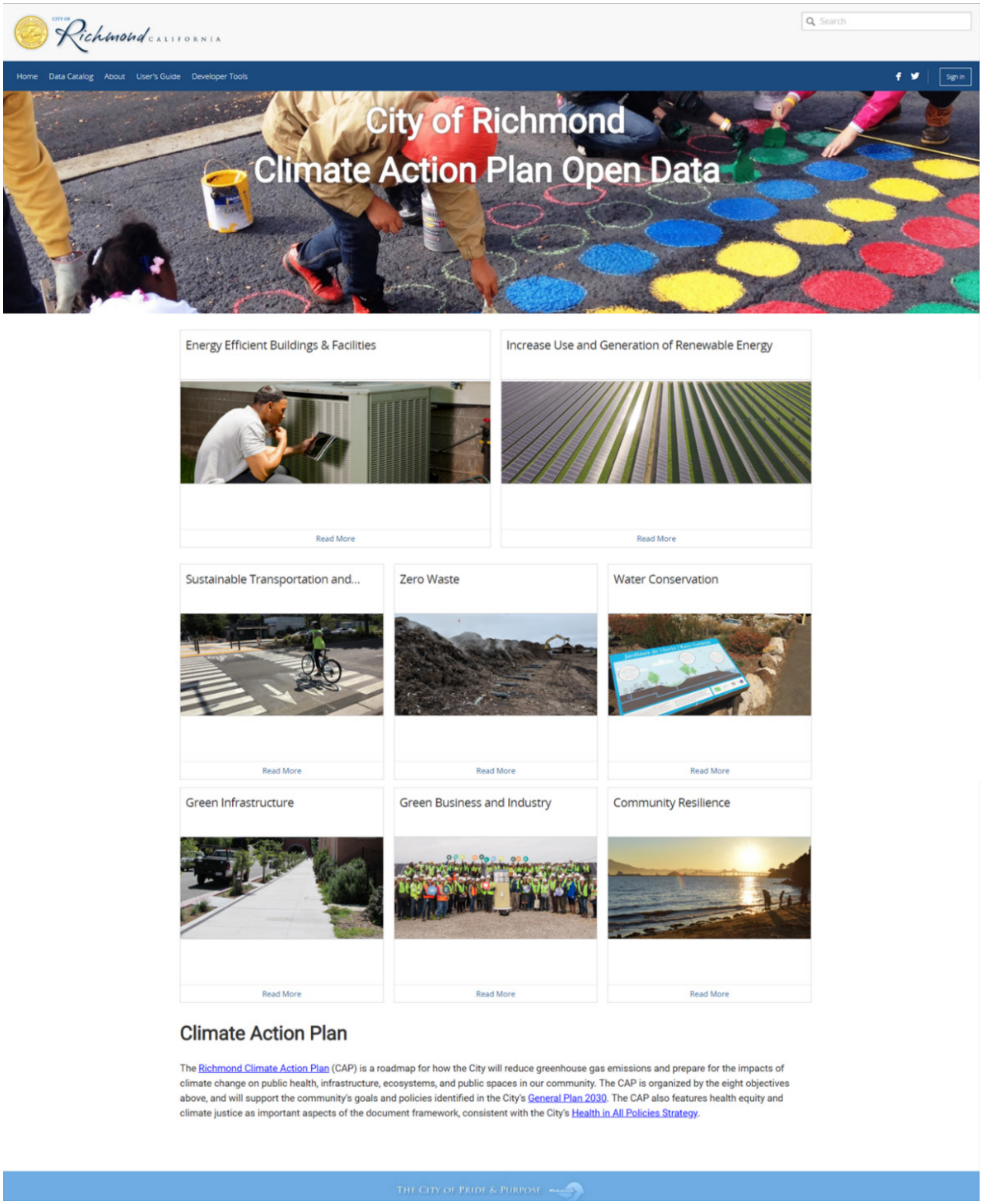


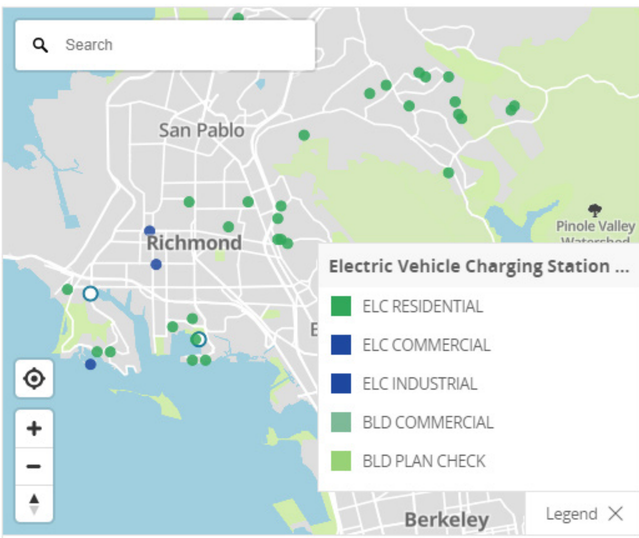
Figure K-6. City of Richmond, California, home page.

Recommendation 2: Flexible Data Visualization

In designing and developing the dashboard, we will consider three primary types of information that differ in their visualization needs. The metrics described in Chapter 6, "From Plan to Action," all fall into one of these categories.

Spatially Discrete Metrics

Several metrics in Chapter 6 could be tracked spatially with GPS data, including monitoring data and project locations. Metrics related to adaptation are more likely to be spatial because they are often connected to activities at specific locations. Simple maps are a good way to display spatial metrics, especially if the spatial data are connected to attributes that can be displayed in map pop-ups. Figure K-7 below shows a simple map interface using the Open Data system that tracks the location of activities (credit to City of Richmond, California). Collecting spatial data for CARP metrics is relatively simple to operationalize into existing protocols for City departments such as Public Works that already track their activities in some spatial format.



Example of a Simple Map to Track Projects

- The map was developed using the Open Data platform.
- The map links to a database that tracks the location of electric vehicle charging stations and associated attributes (date of installation, owner, type, etc.).
- It can be easily updated by adding rows to the underlying database.
- A simple map like this could also display monitoring locations (e.g., to track water levels or flood frequency) and link to results that are updated periodically.

Figure K-7. City of Richmond's Open Data map interface.

Tracking spatial metrics is an important part of committing to social equity in the distribution of climate-related activities citywide. Vulnerable communities that are disproportionately impacted by climate change are often overlooked when implementing actions to address climate threats, or they are disproportionately burdened by the costs associated with new GHG reduction or adaptation actions. Tracking the location of CARP projects and the benefits that result can help demonstrate the equitable distribution of activities and investments across the city and to all residents.

Non-Spatial Metrics

In many cases, it is not feasible or appropriate to connect GHG reduction or adaptation actions to spatial data, like when we track the total square footage of green roofs or the number of new trees planted annually. In these cases, the dashboard could present metrics in a semi-interactive way using the Open Data system, as shown in Figure K-8. Non-spatial visualizations are also useful for presenting survey results.

Example of a Chart for Non-Spatial Metrics

- This chart was developed using the Open Data platform.
- The graph links to a spreadsheet that tracks annual residential energy use in kilowatt-hours (kWh).
- In this example, new data are added each year to the underlying spreadsheet that tracks annual kWh electricity usage.
- Other chart styles (pie, scatter, etc.) could be displayed using a similar platform based on a tracking spreadsheet.

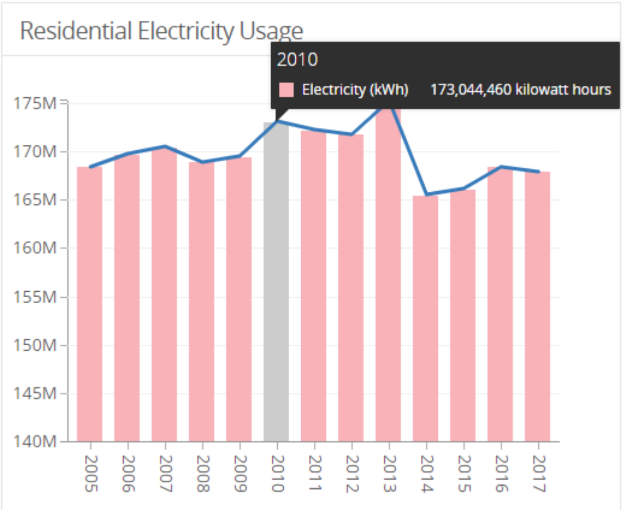


Figure K-8. City of Richmond—example of a chart to display metrics.

Supporting Information

Narrative text provides context and is an important part of a dashboard that enables us to communicate successes to the community. Text should provide details about GHG reduction and adaptation actions throughout Alameda and help explain those actions through the lens of people's daily lives in a healthy and vibrant city. The Open Data system allows for narrative text to accompany maps, charts, and other visualizations. Another option is a more traditional website style with embedded, semi-interactive Open Data-based visualizations, as shown in Figure K-9 (example from City of Portland, Oregon).

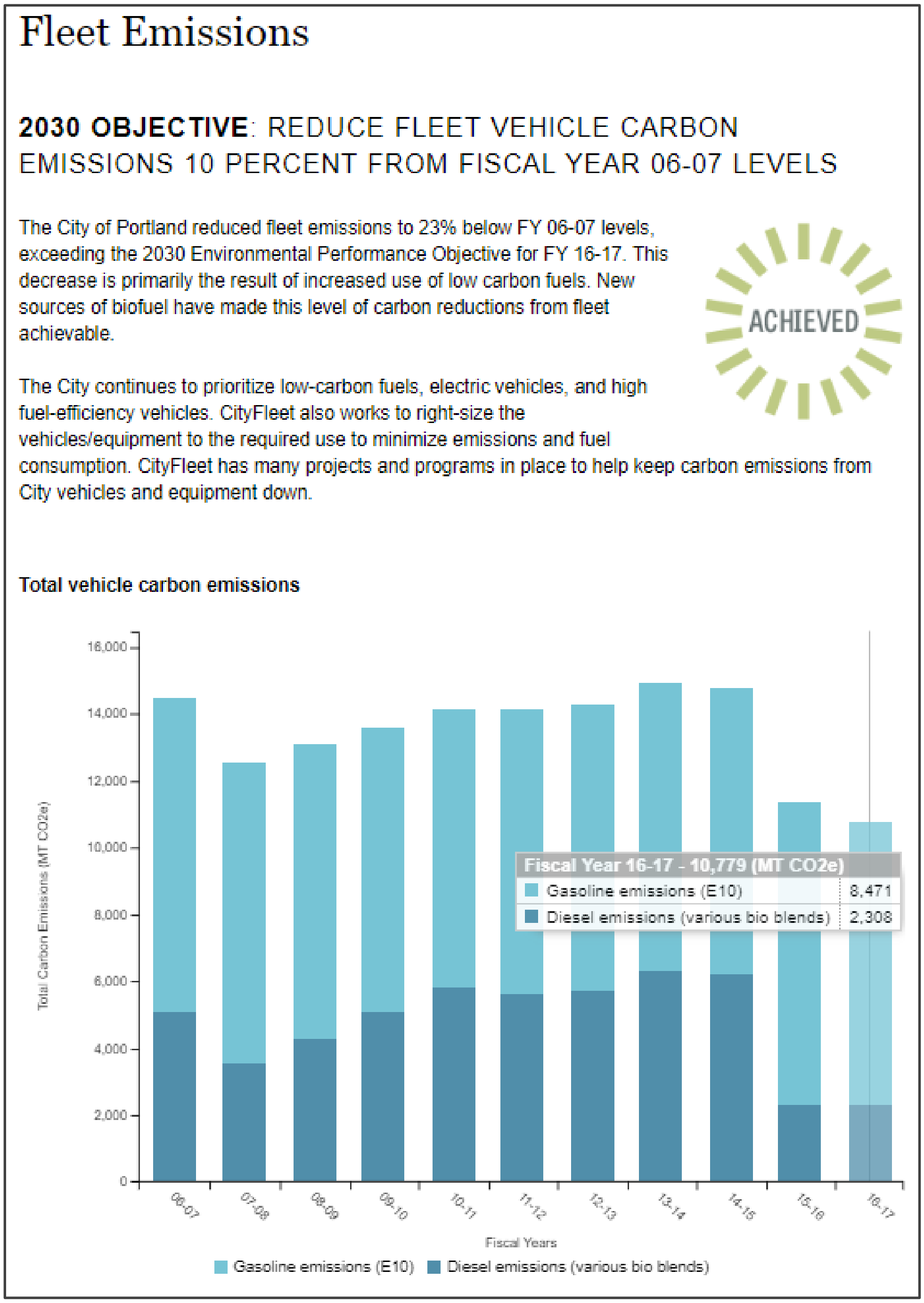


Figure K-9. City of Portland—example of a traditional website with embedded visuals.

Example of Map-Based Dashboard—New York City

New York City's OneNYC Resiliency Map supplements a larger OneNYC website that provides information on New York City's large-scale resiliency and sustainability plan. The screenshot in Figure K-10 shows this map. Individual projects are identified based on either their scheduled phase (planning, design, construction, completed) or the relevant OneNYC initiative (buildings, coastal defense, infrastructure, neighborhoods). Pop-ups for each project provide other information like cost, responsible entity, and funding source(s), as well as a link to a detailed project-specific website. This type of map-based system requires more effort—both to develop the map and to populate the content and additional resources necessary to make the map functional. Furthermore, a map-based platform would not work well for tracking GHG reduction progress because GHG actions are not necessarily place-based. To incorporate a GHG reduction component, we would need to develop a website that contains charts/graphs and text for GHG reduction and links to a place-based resiliency projects map.

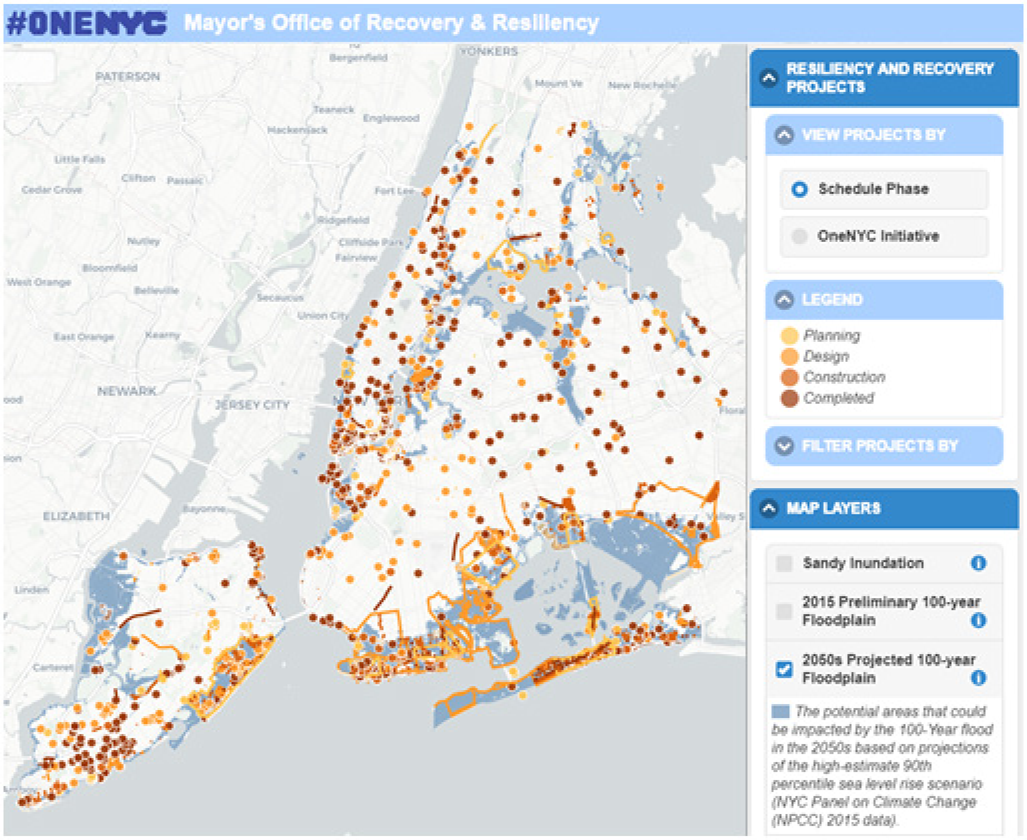


Figure K-10. NYC Resiliency and Recovery Projects map.

Recommended Next Steps for Dashboard

This appendix outlines the range of options available for a CARP dashboard and provides a blueprint for the City of Alameda to develop a progress tracking and community engagement platform. As part of CARP implementation, we will determine the best approach based on available resources and how likely we are to expand our data visualization capabilities. Some key next steps in designing and implementing the dashboard include the following:

1. Select "final" list of metrics based on recommendations in Chapter 6, "From Plan to Action," of the CARP. The metrics we select will help inform the best dashboard approach—for example, if we plan to track multiple spatially discrete metrics, then we need to design the dashboard to accommodate maps, which are much more powerful when they include interactive components.
2. Determine available resources to expand the City's data visualization capabilities. We will consider the added benefit of more interactive visualizations as community engagement and empowerment tools. We will explore options for grants and other funding sources to help support these enhanced capabilities.
    a. If new data visualization systems are not likely within one to two years of CARP adoption, then we will develop a basic CARP dashboard using existing capabilities and incorporate them into the City website, as described earlier in this appendix. It is important to implement a public-facing system to foster transparency and engage interested community members; waiting several years for new data visualization capabilities is not ideal.
    b. If new capabilities are likely within the next year or so, then we will proceed with designing and implementing a more interactive product like the City of Richmond's Open Data-based platform.
3. Proceed with design and implementation of a CARP dashboard that includes substantial narrative text on CARP goals, actions, and implementation plan.

Appendix L

Assembly Bill 691 Compliance

August 2019

Introduction

Alameda's character is defined by its unique location on an island and peninsula in the middle of San Francisco Bay. The city has historically hosted maritime industry and a naval air station; it continues to house marinas and houseboats and serve as a popular spot for boaters, kite surfers, and beachgoers. Traffic on and off the island is by tunnels and bridges, limited and at times inconvenient—but this separation from the surrounding cities is part of the charm for many residents.

The extensive waterfront, which makes Alameda such a desirable place to live, also makes it vulnerable to sea level rise, and will necessitate smart growth into the future to keep the community safe and vibrant. Many acres of the city are built on wetlands filled with bay mud to enable development; large areas of the city are relatively low-lying and their shorelines will need to be adapted to avoid flooding as sea levels rise in the future.

City officials and community members are aware of the need to start planning and acting now to address flood risks from current storm surge and future sea level rise impacts. As such, beginning in summer 2018, the City initiated the *Climate Action and Resiliency Plan* (CARP) development process to address Alameda's goals for greenhouse gas emissions reduction and increased resiliency to climate change impacts. The CARP process built on past work investigating the city's vulnerability to sea level rise—and looked at vulnerability in greater detail.

The CARP process developed a wide range of adaptation strategies to address flood risk across the city as well as strategies to address location-based priority flooding at 11 key shoreline segments, transportation assets, and storm utilities. These discrete locations were selected because adaptation strategies undertaken there could significantly reduce flood risk that threatens residents, businesses, and key assets. These locations along the shoreline overtop at lower sea level rise scenarios (mean higher high water [MHHW] + 24 or 36 inches). Therefore, they should be addressed first to help protect other assets and to increase the resilience of the shoreline for higher sea levels. The CARP focuses first on protecting assets that are likely to be compromised soonest and with greatest consequences, while accommodating longer-term solutions. This approach recognizes that the City has a greater understanding of nearer-term risks and allows time to take advantage of technologies and science that will evolve to better address long-term impacts, which are less certain today.

Work under the CARP and accompanying work on Assembly Bill (AB) 691 indicate that significant sea level rise impacts can be expected to the public trust within Alameda, especially given that the public trust lands are extensive within the city. By MHHW + 36 inches of sea level rise, we can expect that flood impacts to public trust resources will include the following: 1) parcels in the Eastshore Drive neighborhood, 2) Crown Beach and adjacent properties near Shoreline Apartments, 3) Towata Park, 4) shoreline adjacent to the Posey and Webster Tubes, and 5) large areas of Alameda Point Naval Air Station. It should be noted that the City, developers, and the U.S. Department of Veterans Affairs have extensive plans to redevelop Alameda Point and these plans include flood adaptation measures. As Bay water levels rise to MHHW + 52 inches (and higher), additional impacts to the public trust will occur to parcels at the western and southern ends of Bay Farm Island. At MHHW + 66 inches, there is minor flooding of the Northern Waterfront parcel by Encinal Basin.

Developing a Public Trust Map

A map of public trust boundaries in Alameda was developed for the purpose of the sea level rise economic analysis and review for AB 691. Much of Alameda is built on Bay fill over historic baylands, making the delineation of tidelands and public trust boundaries more difficult. The engineered nature of Alameda's shoreline prevented the City from using MHHW as an estimate for tidelands extent, for AB 691 compliance purposes. We used a simplified methodology detailed in the steps below:

1. Apply boundaries from an existing map of tidelands boundaries in the Alameda Point area.[1] This map was developed by the City's Base Reuse Department to identify state lands in Alameda Point after a formal exchange occurred.
2. Use public trust leases with the City for private property in the Eastshore Drive neighborhood to identify parcels that are not considered part of the public trust.
3. Define the location of historic baylands and areas that are developed Bay fill using the San Francisco Estuary Institute (SFEI) data set of historic and modern baylands. This step accounted for historic tidelands that are now developed fill and still considered part of the public trust.
4. Use a 1931 map of public trust sales in Alameda (Figure L-1) to identify land removed from the public trust. This map was digitized using a California Public Land Survey System data set, and the public trust boundary was adjusted accordingly.
5. To the extent possible, cross-check the resulting map with City of Alameda granting statutes related to public trust lands and make revisions as needed. These granting statutes often contain very detailed survey information that is difficult to interpret without field work. In many cases, it was not possible to verify boundaries specifically.

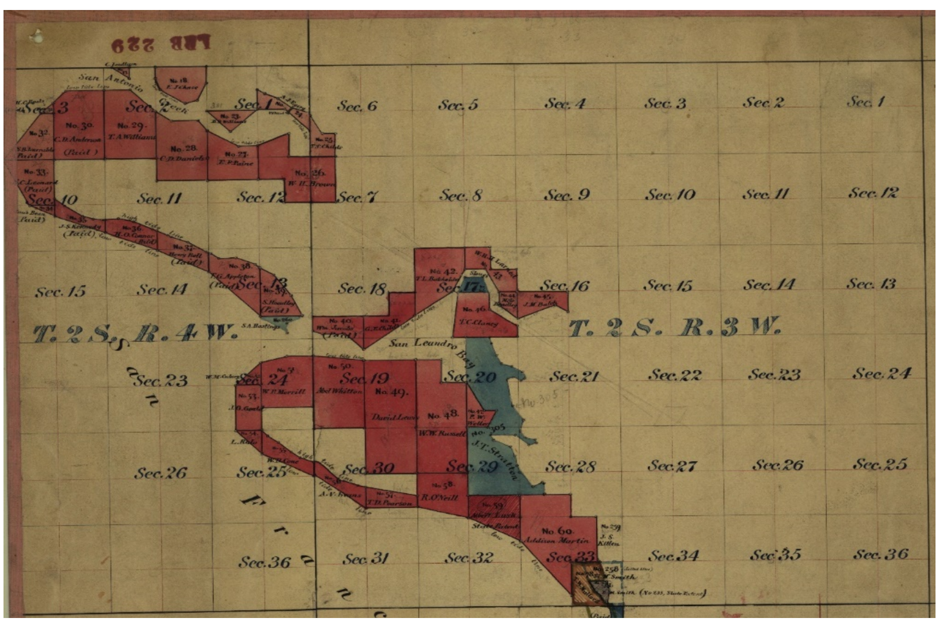


Figure L-1. 1931 map from the Division of State Lands showing parcels sold. (Map file index numbers: Drawer 6, Folio 1, Map 5.)

[1] Map available here: https://www.alamedaca.gov/files/sharedassets/public/alameda/base-reuse/navy/tidelands_post-exchange-2.pdf. Note: clicking link may not work, so you may need to copy and paste link directly into browser.

Approximate Boundary of Public Trust Land in Alameda

Figure L-2 shows the map produced from the methodology above. This map is an approximation only, and the assumptions and limitations listed above should be considered when interpreting this map or using it for other purposes. The boundary shown here also determined what parcels in the city were considered part of the public trust in the economic analysis. The next section presents more information on how we used this map.

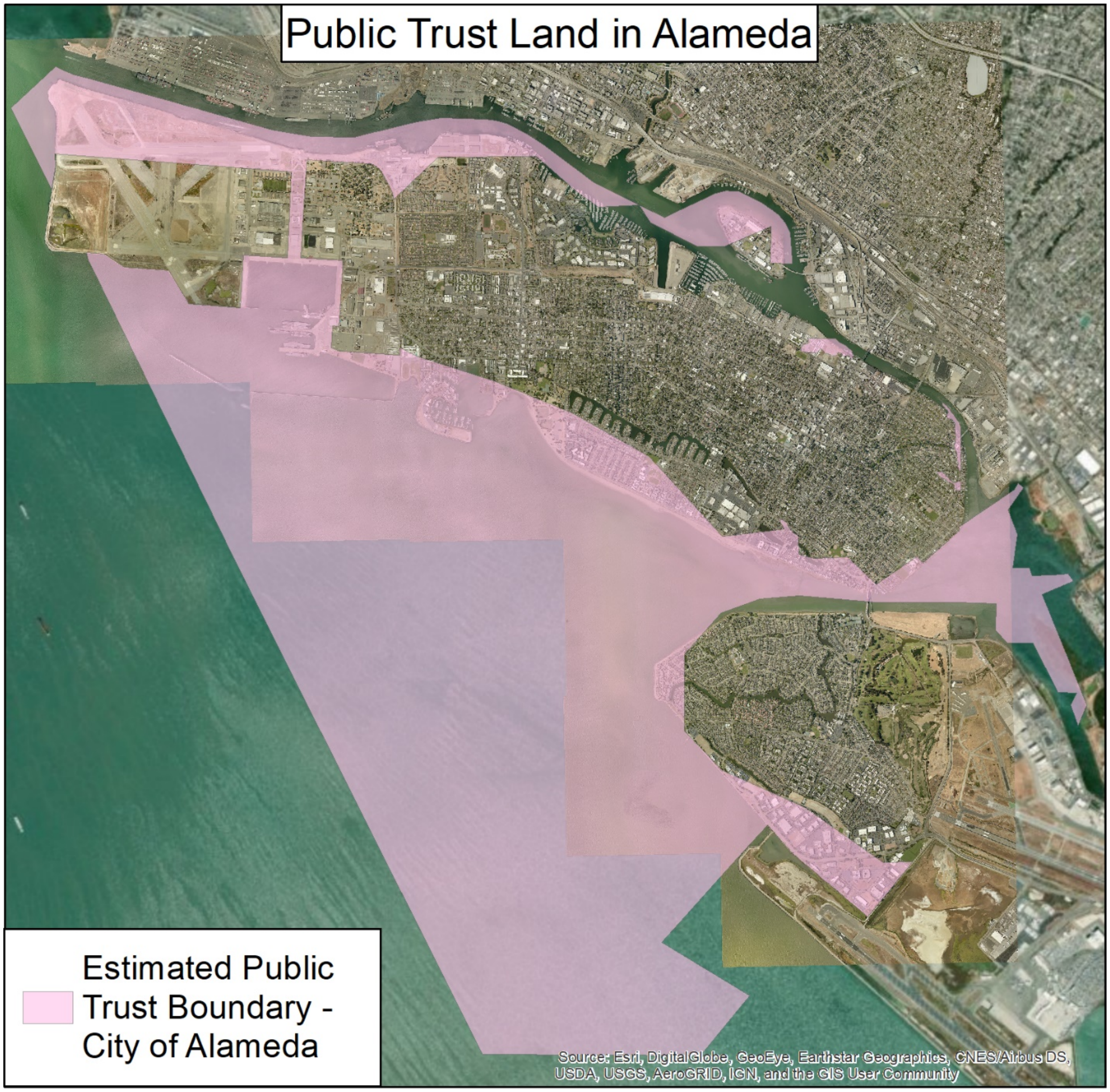


Figure L-2. Estimated public trust boundary for the City of Alameda.

State Lands Economic Analysis

As part of the CARP, we conducted an economic analysis at a citywide scale to determine the potential cost associated with projected sea level rise and storm surge. This was then compared to the cost of adaptation (see CARP Chapter 5). To meet the objectives and requirements of AB 691, the City conducted a second analysis on the subset of land that is within the estimated public trust boundaries in Figure L-2. We determined this subset spatially by using a geographic information system software to select all parcels that intersect the public trust boundary at any point. A more thorough survey of public trust lands could determine how much of each parcel is within the public trust, but the relatively limited accuracy of the public trust map in Figure L-2 prevented this type of analysis. Furthermore, the "value" of each parcel would need to be distributed across the parcel using survey information that identified building locations.

In some cases, parcels include substantial amounts of water, without an assessed value in the county parcel data set. Applying a blanket $/acre value to these parcels would be misleading because the value is only derived from part of the parcel. To address this, we used the LOTSIZE attribute in the parcels data set to estimate the amount of developable land for which the blanket costs should be applied.

Guiding Assumptions

The economic analysis for AB 691 compliance required several assumptions and contained limited data sets. These assumptions and data limitations should be considered when interpreting the results of this analysis. A more robust economic analysis of individual projects will be necessary as part of implementation, as described in Chapter 6, "From Plan to Action."

The guiding assumptions are listed below:

- The Division of State Lands map from 1931 depicting "sold" parcels was interpreted to indicate parcels removed from the public trust. As a result, these areas were removed as a final step to produce the map in Figure L-2.
- All historic baylands that were converted to developed land by adding fill were considered part of the "original" public trust. Additional details on the methodology SFEI employed to produce the historic and modern baylands map is available in the report linked above.
- A parcel was considered to be within the public trust if any portion of it intersected the boundary in Figure L-2 at any point.
- The entire Alameda shoreline was included when developing cost estimates for addressing coastal flooding, even if the land behind the shoreline protection feature is not within the public trust. The relatively limited accuracy of the map in Figure L-2 made it difficult to determine what portions of the shoreline are within the public trust with confidence.
- Due to limited information, this analysis did not consider Coast Guard Island. Based on our estimated public trust boundary, the island may be partially or fully located within the public trust.
- Additional limitations are explained at the end of this appendix.

Section I: Flooding Extents—2030, 2050, and 2100

This section provides basic maps depicting the extent of inundation for each of the scenarios required by AB 691 in this analysis. Where possible, the maps show both sea level rise and a 100-year storm on top of projected sea level rise. The estimated tidelands boundary is also shown for reference on each map.

Note that the San Francisco Bay Conservation and Development Commission (BCDC) developed the scenarios shown in these maps, and only a select group of scenarios are available. The Coastal Adaptation to Sea Level Rise Tool (COAST) analysis used the specific projections referenced in the California Ocean Protection Council's (OPC's) Sea Level Rise Policy Guidance. The maps below show the closest available BCDC scenario for each timestep.

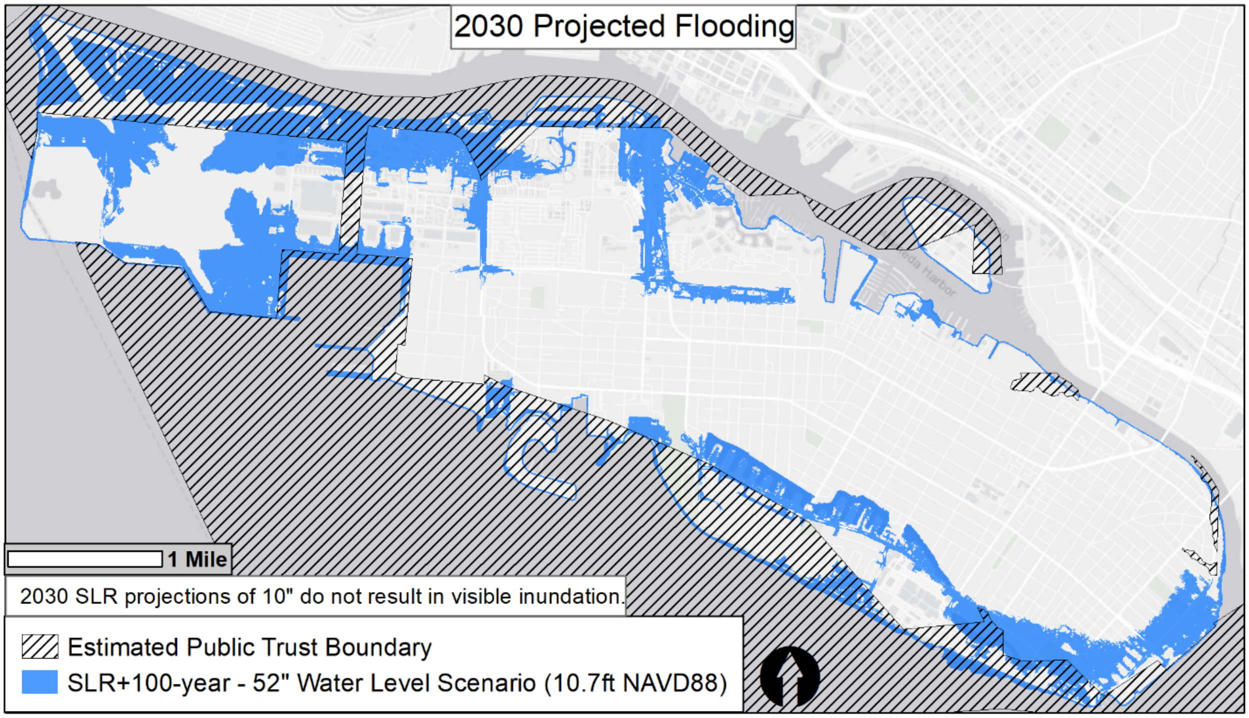


Figure L-3. Flooding at a total water level of 52 inches, which can be expected in 2030 due to sea level rise (10 inches) plus a 100-year storm (42 inches).

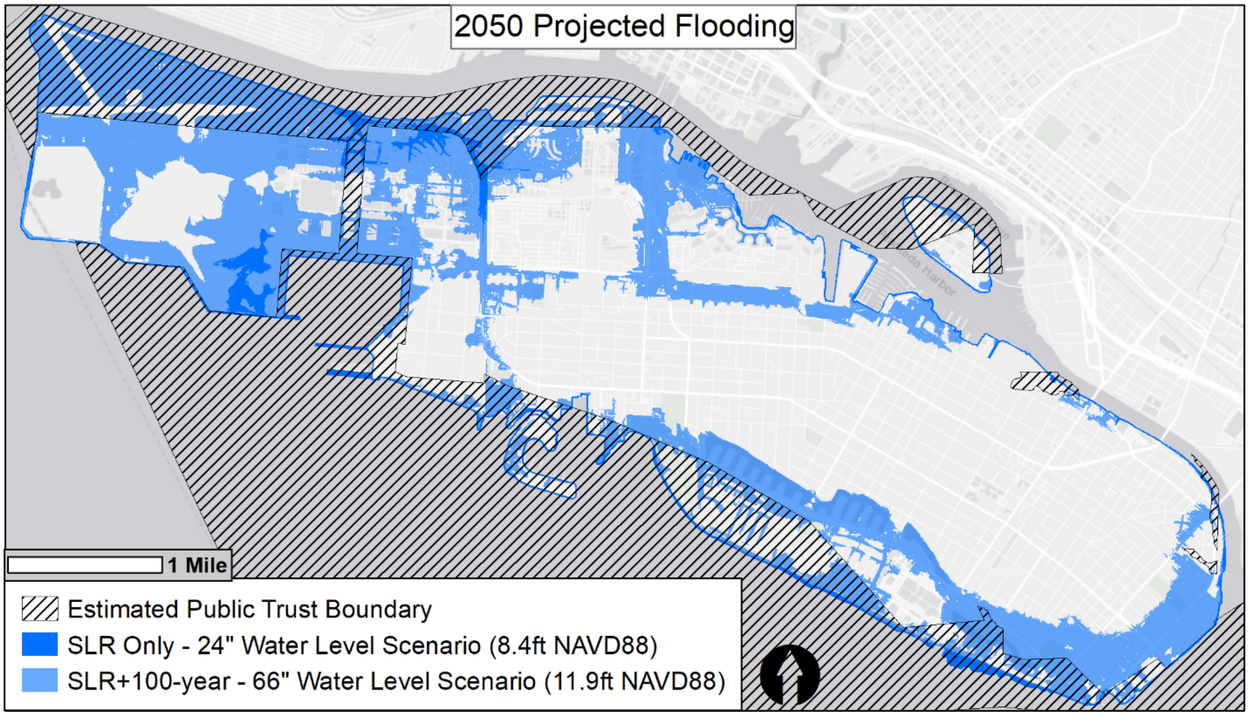


Figure L-4. Flooding at a total water level of 66 inches, which can be expected in 2050 due to sea level rise (24 inches) plus a 100-year storm (42 inches).

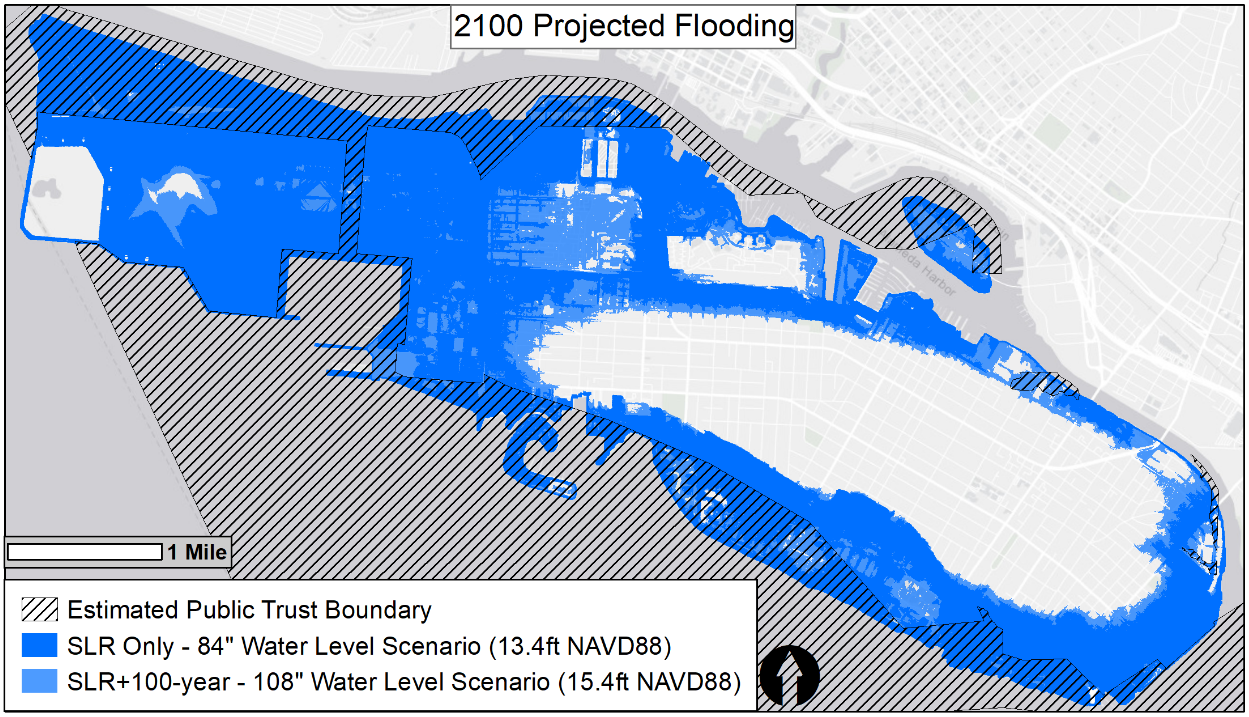


Figure L-5. Flooding at a total water level of 84 inches, which can be expected in 2100. Additional storm surge is also mapped to show a total water level of 108 inches (the highest BCDC inundation maps). The COAST modeling includes up to a total water level of 125 inches.

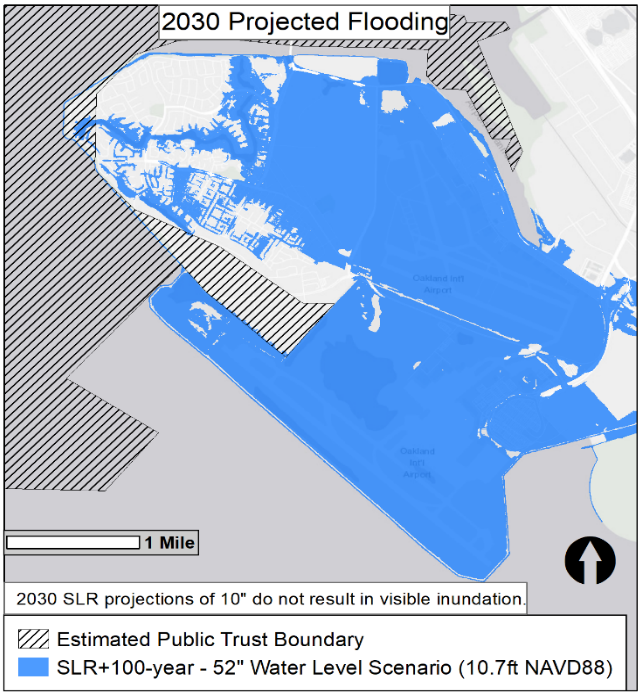


Figure L-6. Flooding at a total water level of 52 inches, which can be expected in 2030 due to sea level rise (10 inches) plus a 100-year storm (42 inches).

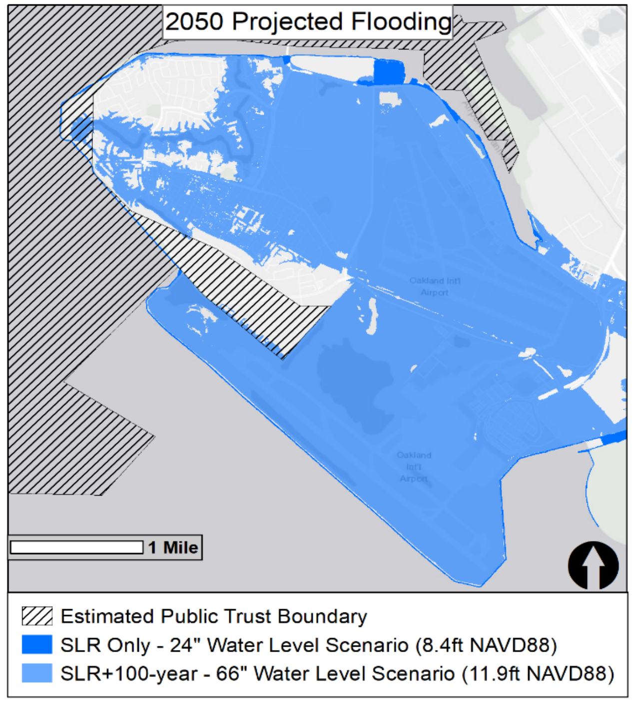


Figure L-7. Flooding at a total water level of 66 inches, which can be expected in 2050 due to sea level rise (24 inches) plus a 100-year storm (42 inches).

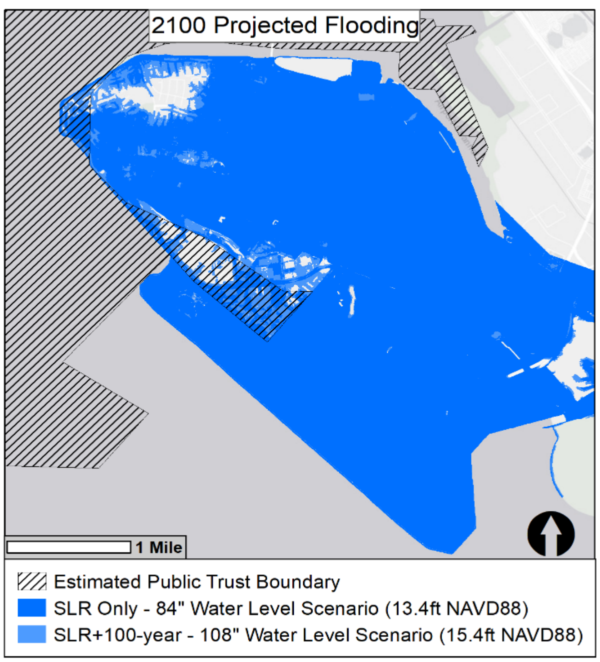


Figure L-8. Flooding at a total water level of 84 inches, which can be expected in 2100. Additional storm surge is also mapped to show a total water level of 108 inches (the highest BCDC inundation maps). The COAST modeling includes up to a total water level of 125 inches.

Several coastal flooding scenarios were considered that account for sea level rise alone, as well as the combined impact of sea level rise and a 100-year storm surge. OPC's Sea Level Rise Policy Guidance provides a range of sea level rise projections with differing probabilities of exceedance (OPC, 2018). Table L-1 below presents OPC projections for key planning horizons of 2030, 2050, and 2100.

Table L-1. California OPC Sea Level Rise (SLR) Projections in Inches (Adapted)

Year[a]	Likely Range (66% Chance)[b]	1-in-20 Chance SLR Exceeds	1-in-200 Chance SLR Exceeds[c]	H++ Single Scenario[d]
2030	4 – 6	7	10	12
2050	7 – 13	17	23	32
2100	19 – 41	53	83	122

a All projections are for the high emissions (RCP 8.5) scenario. Projections for low emissions (RCP 2.6) can be found in the OPC sea level rise guidance. The low emissions scenario is considered extremely unlikely given current global emissions trends.

b OPC considers the top end of the "likely range" to be equivalent to a low risk aversion decision.

c OPC considers the 1-in-200 chance to be equivalent to a medium-high risk aversion decision.

d OPC considers the H++ single scenario to be equivalent to an extreme risk aversion decision.

e Most climate models do not extend past 2100. These longer-range projections have greater uncertainty.

Based on State Lands Commission criteria for AB 691, the 2030, 2050, and 2100 planning horizons are important targets to consider. Consistent with the overall approach to the CARP, the City opts to use the medium-high level of risk aversion, equivalent to the 1-in-200 chance of exceedance. On top of sea level rise, which leads to permanent inundation, there is a risk of storm surge that would result in more extensive temporary flooding. State guidance in California recommends considering the risk of a 100-year storm event, approximately equal to 42 inches above MHHW, in addition to sea level rise. Based on state guidance, the following scenarios were selected for the AB 691 economic analysis:

- 2030 sea level rise only = 10 inches;
- 2030 sea level rise + 100-year storm = 52 inches;
- 2050 sea level rise only = 23 inches;
- 2050 sea level rise + 100-year storm = 65 inches;
- 2100 sea level rise = 83 inches; and
- 2100 sea level rise + 100-year storm = 125 inches.

Section II: Public Trust Resources

The results of the economic analysis, presented in Section III, describe the financial cost of damage caused by sea level rise and storm surge. Other impacts like changing shorelines, loss of access, and habitat loss are described below. We considered sea level rise that results in permanent inundation and loss of an impacted parcel equivalent to the assessed or estimated value of that parcel currently. Storm events are more likely to cause temporary flooding, damaging buildings and reducing access but not resulting in a total loss. Storm event impacts were therefore quantified in COAST using a depth-damage relationship, whereby greater water levels result in greater damage from storms. Section III of this AB 691 report presents the COAST methodology in more detail.

Changing Shorelines

A significant portion of the shoreline change over time in Alameda is expected as a result of erosion, storm surge, and tidal forcing of hardened or semi-hardened shoreline. Of the approximately 23.5 miles of shoreline that surround Alameda Island and Bay Farm Island, about 20.9 miles are lined with riprap, bulkheads, and seawalls.

Changing natural shoreline can be expected along the 2.5-mile-long Crown Beach and Elsie Roemer Bird Sanctuary, where additional studies are needed to determine how the beach and marsh will respond to rising seas. At present, sand is annually redistributed down Crown Beach because it collects at groins at either end of the beach throughout the year. In 2013, the beach underwent a large restoration effort of replenishing sand that had been lost during storms. That said, the slope of the beach and its orientation to waves varies along its length—additional study may reveal that some spots along the beach are well positioned to keep pace with rising seas (to a point). There have been limited studies on Elsie Roemer Bird Sanctuary to date. However, it is well understood that marshes need adequate sediment and space to migrate upland with sea level rise—this issue needs to be studied specifically at this site.

The mudflats that back the residential seawalls along Eastshore Drive can be expected to change as Bay water levels rise. Further analysis is required to see if they are expected to receive enough sediment to allow them to keep pace with sea level rise. Ideally, these mudflats can be maintained (perhaps through active management) at an elevation and width that enables them to attenuate waves.

Public Trust Resources, Including Public Access, Commerce, Recreation, Coastal Habitats, and Navigability

Public Access, Parks, Beaches, and Other Recreation

Table L-2 presents public access areas within the public trust that offer recreational opportunities. Many of these areas are especially prone to sea level rise because of their proximity to the shoreline. “X” marks mean that sea level rise breaches the parcel of land at the level indicated. “/” means that surrounding parcels are breached.

Table L-2. Public Trust Areas: Parks, Beaches, and Access Impacted by Sea Level Rise

Public Trust Area	Address (Coordinates)	Year 2030 SLR: 10''	Year 2050 SLR: 23''	Year 2100 SLR: 83''
Crown Beach	8th Street, Otis Drive (37.7663851,-122.2755575)	X	X	X
Elsie Roemer	Shore Line Drive, Broadway (37.753048,-122.247131)	X	X	X
Alameda Beach	2351 Shore Line Drive (37.754310, -122.251728)	X	X	X
Hornet Field	250 W Hornet Avenue		X	X
Multipurpose field	W Red Line Avenue (37.789567, -122.304169)			X
Main Street dog park	2990 Main Street, Alameda			X
Wind River Park	Wind River Park (37.782406, -122.261186)			X
Lincoln Middle School Field	1250 Fernside Boulevard			X
Public boardwalk	Bayview Drive (37.7520627,-122.2440812)	X	X	X
Shoreline Park	37.7450789,-122.257393	/	/	X
City View Skate Park	1177 West Redline Avenue			X
Encinal Boat Ramp	Central Avenue behind Encinal High School		X	X
Krusi Park	900 Mount Street			X
Rittler Park	1400 Otis Drive			X
Towata Park	3315 Brideway Isle		X	X
Washington Park	740 Central Avenue			X

Key: X = at least some of parcel flooded by sea level rise; / = surrounding parcels flooded; [Blank] = no flooding
Note: We approximated impacts using a viewer with sea level rise at 12, 24, and 84 inches.

Impacts to Crown Beach, San Francisco Bay Trail, and San Francisco Water Trail are likely to be felt broadly across the community. Crown Beach is a 2.5-mile-long sandy beach, one of the few beaches in the East Bay. It draws 1.5 million beachgoers, kite surfers, picnickers, walkers, and other visitors every year. In addition, the beach protects adjacent Shoreline Drive and the Bay Trail. The Bay Trail running along the beach is commonly used for recreation and commuting. Bike connectivity is important given the City's goals to reduce car traffic. As such, disruptions to the Bay Trail would prove challenging.

Marinas

The marinas in Alameda extend into the public trust, and the analysis of impacts included the following public and private marinas:

- Aeolian Yacht Club, 980 Fernside Boulevard;
- Alameda Marina, 1815 Clement Avenue;
- Alameda Yacht Club, 1535 Clement Avenue;
- Ballena Isle Marina, 1150 Ballena Boulevard # 111;

- Carefree Boat Club, 1070 Marina Village Parkway;
- Encinal Yacht Club, 1251 Pacific Marina;
- Fortman Marina, 1535 Clement Avenue;
- Grand Marina, 2099 Grand Street;
- Island Yacht Club, 1853 Clement Avenue;
- Marina Village Yacht Harbor, 1030 Marina Village Pkwy;
- Mariner Square, 1251 Pacific Marina; and
- Oakland Yacht Club, 1101 Pacific Marina.

Marinas serve as a key point of access for boating-related recreation. This analysis assumes that sea level rise does not impact boating-related recreation (i.e., this recreation will not be lost due to rising seas) because Alameda has existing flexible floating docks or can add flexible floating docks. However, much of the marina infrastructure is constructed on land and will not rise with the seas; thus, Section III incorporates the assessed value of marinas into the COAST analysis to better understand the total impact of each sea level rise and 100-year storm scenario.

Museum

The USS Hornet Museum draws 80,000 visitors annually. The museum would be impacted at 84 inches of sea level rise. We have accounted for the building losses to the museum in our COAST analysis in Section III. Additionally, there is a revenue loss, as people can no longer access the museum when flooded. We estimated the lost revenue in Section III based on the price per visitor.

Coastal Habitat

Table L-3. Coastal Habitats in Public Trust Impacted by Sea Level Rise

Public Trust Area	Address (Coordinates)	Year 2030 SLR: 10''	Year 2050 SLR: 23''	Year 2100 SLR: 83''
Elsie Roemer	Shore Line Drive, Broadway (37.753048,-122.247131)	X	X	X
Crab Cove	1231 McKay Avenue, Alameda, CA 94501	X	X	X

Key: X = at least some of parcel flooded by sea level rise; / = surrounding parcels flooded; [Blank] = no flooding
Note: We approximated impacts using a viewer with sea level rise at 12, 24, and 84 inches.

Recreation will be negatively affected in the form of lost habitat. Key areas of natural habitat in Alameda, including the Elsie Roemer Bird Sanctuary and Crab Cove near Crown Beach, are threatened by 2030 levels of sea rise. Elsie Roemer Bird Sanctuary (at the east end of Crown Beach) has a pickleweed salt marsh that provides bird habitat, as well as an eelgrass bed just offshore of the beach that provides juvenile fish habitat. In addition, the public trust includes bayside properties along Eastshore Drive and the adjacent mudflat parcels in San Leandro Bay. Mudflats provide foraging habitat for shorebirds, wading birds, and dabbling ducks. Further study is needed to determine if there is risk of losing these mudflats as seas rise, given sediment supply and erosive forces.

Alameda also provides habitat for eelgrass beds. Eelgrass is a marine plant that provides habitat for juvenile fish and is a food source for aquatic birds and fish in the Bay. These beds filter out excess nutrients; they also help prevent shoreline flooding and erosion by stabilizing sediment and acting as natural wave buffers (Rhode Island Habitat Restoration Team, n.d.). Eelgrass beds require a specific amount of light and clean water. Sea level rise threatens this valuable species in the ecosystem because a higher and more turbid water column allows less light to reach the beds.

Ferry Terminals

This analysis includes the following ferry terminals:

- Alameda Main Street Terminal: 2990 Main Street on the North Part of Alameda; and
- Harbor Bay Ferry Terminal: Harbor Bay Parkway on Bay Farm Island.

This analysis considers how sea level rise and 100-year storm scenarios could 1) damage the infrastructure and 2) lead to lost revenue if the ferry is unable to operate. While the docks themselves change with changing water levels, the buildings and parking lots will be impacted without adaptation strategies. The main island terminal would lose all access with about 48 inches of sea level rise, and the Bay Farm Island terminal would lose access with about 52 to 66 inches of sea level rise, in the absence of any storm surge. In addition to the lost revenue from lost ridership, this would negatively impact traffic in Alameda as commuters heavily rely on these terminals. About 4,000 commuters ride the ferry daily to San Francisco from the main island and Bay Farm Island combined (WETA, 2018).

Commerce

Above and beyond damage to buildings, commerce will be impacted in terms of lost employment and wages as commercial and industrial building space is lost to sea level rise. In Section III of this report, we estimate the commerce loss based on the percent of commercial and industrial space that is flooded relative to the entire city. We only assess this damage for sea level rise impact (and not surge) because sea level rise will lead to a permanent loss of commercial or industrial space, whereas surge impacts are a temporary loss.

Section III: Impacts of Sea Level Rise Within the Public Trust

The following analysis assesses the value of the built environment and infrastructure exposed to coastal flooding from sea level rise and storm surge in Alameda's public trust lands. In separate subsections that follow, we include impacts to commerce in public trust lands, ecosystem services related to recreation at Crown Beach, and planning level costs for raising the shoreline to mitigate the impacts of sea level rise and surge.

Building and Infrastructure Damage

The City of Alameda used COAST to estimate the impacts of sea level rise and 100-year storms for various scenarios. COAST overlays the value of parcels with flooding data to estimate the value of land and property exposed to flooding. This analysis used the county assessor's parcel data, including assessed values. For public parcels and a small number of private parcels without assessed values, the estimated values of the parcel are $16.07 per square foot for open space and parks and $45.91 million per square foot for school, residential, commercial, and other public buildings. Table L-4 presents the results of this COAST analysis. "Value of buildings and land exposed" includes the total value of all buildings and land (and infrastructure in the case of the right four columns) the water touches in that scenario. The table also presents "Damage," which is the sum of 1) 100 percent of any land or building impacted by sea level rise to estimate the value permanently lost and 2) a portion of (based on the depth-damage relationship in COAST) the value of any building flooded only by storm surge to estimate the cost to repair the impacted building.

COAST does not incorporate infrastructure such as roads into the calculations, so Alameda separately estimated the impacts to roads, storm pipes, and City-owned sewer mains as part of Table L-4. We include impacts to commerce and non-market values for these scenarios in subsequent sections.

Table L-4. Property and Infrastructure Damage in Public Trust—Cost of Inaction for Selected Sea Level Rise Scenarios (All Values in $Million)

Scenario	Total Water Level (above MHHW) [a]	Damage [b]	Value of Buildings and Land Exposed [b]	Length and Value of Sewer Mains Exposed [c]	Length and Value of Storm Pipes Exposed [c]	Length and Value of Roads Exposed [c]	Total Infrastructure Exposed
2030 sea level rise	10”	$490.4	$490.4	2,409 feet, $1	2,263 feet $1.4	0 feet $0	$2.3
2050 sea level rise	23”	$492.6	$492.6	4,579 feet $1.8	8,792 feet, $5.3	12,247 feet $3.4	$10.5
2030 sea level rise plus 100-year storm	52” (10” + 42”)	$620.4 ($130.0 more than sea level rise only)	$985.4				
2050 sea level rise plus 100-year storm	65” (23” + 42”)	$789.3 ($296.7 more than sea level rise only)	$1,596.3				
2100 sea level rise	83”	$2,348.9	$2,348.9	73,048 feet, $29.2	94,178 feet, $56.5	150,417 feet, $42.1	$127.8
2100 sea level rise plus 100-year storm	125” (83” + 42”)	$2,704.8 ($355.9 more than sea level rise only)	$3,497.2				

[a] All “sea level rise” projections are under medium-high risk aversion level in OPC sea level rise guidance.

[b] Exposed building and land value and damage are all based on current value of property with no discounting or increased property values.

[c] Values per linear foot for infrastructure were taken from the City of Santa Cruz AB 691 Sea Level Rise Assessment: $400/linear foot for sewer mains, $600/linear foot for storm pipes, and $280/linear foot for roads (City of Santa Cruz, 2018).

Below are COAST's visual outputs, with blue representing flooded parcels. Note: The light blue values in Alameda Point for the 2050 and 2100 scenarios represent flooded property with no dollar value assigned to the parcel; thus, these scenarios slightly under-represent the total exposed value and damage from each scenario.

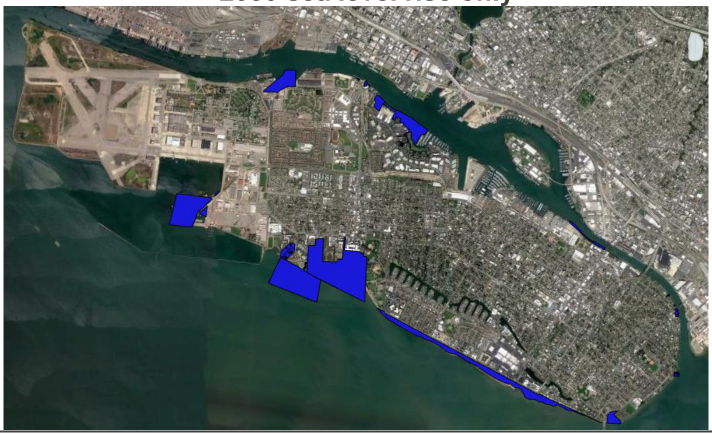
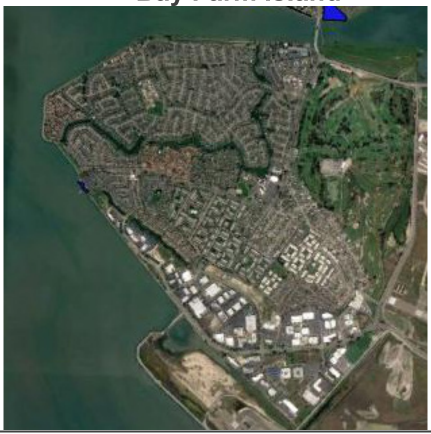
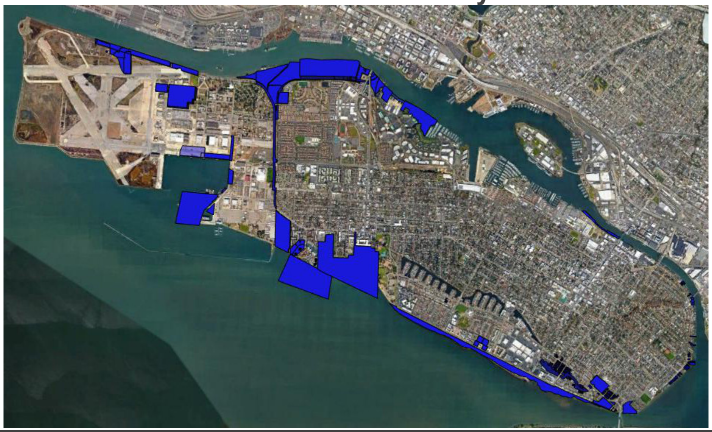
2030 sea level rise only	Bay Farm Island
	
2030 sea level rise with 100-year storm	**Bay Farm Island**
	

Figure L-9. 2030 sea level rise only ($490.4 million) with a 100-year storm ($985.4 million) in public trust.

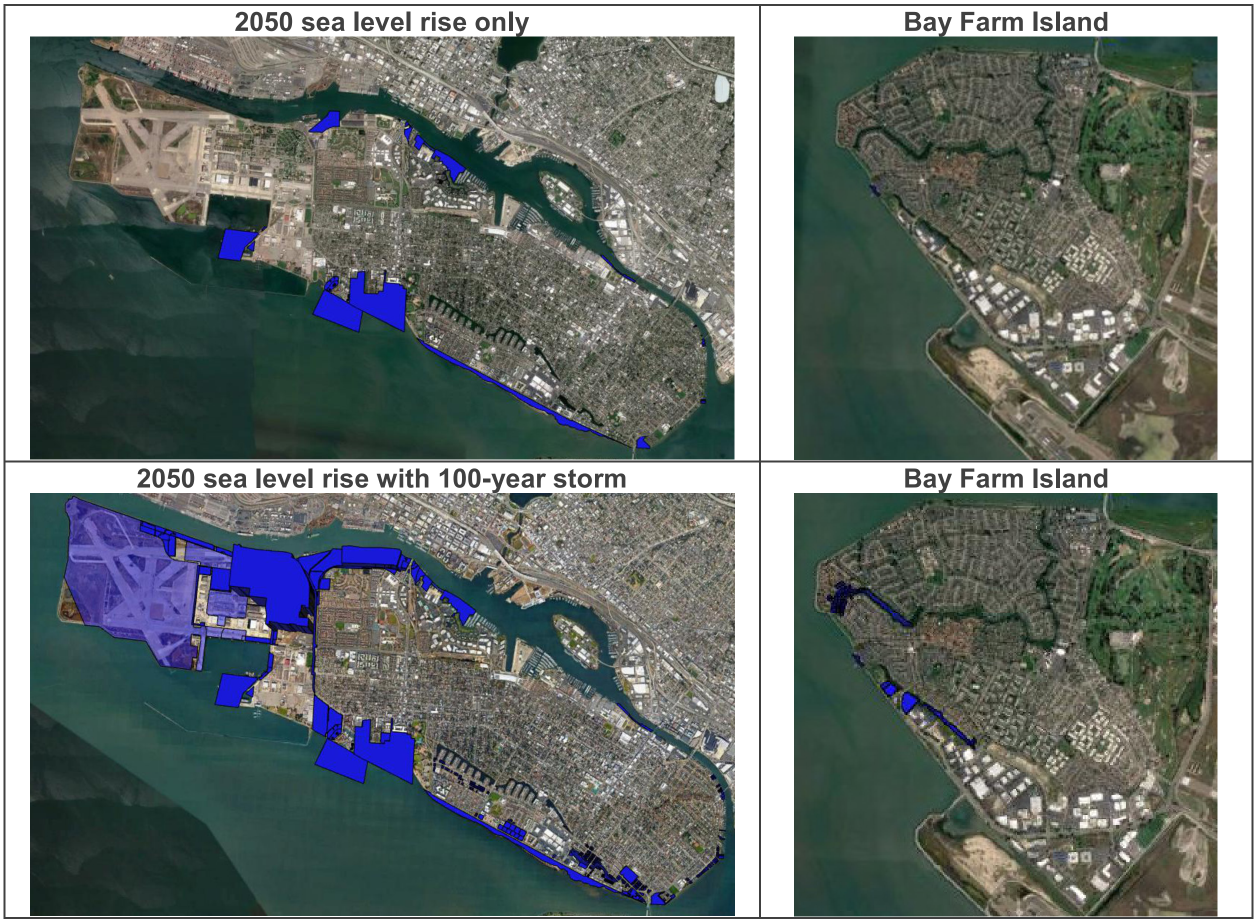


Figure L-10. 2050 sea level rise only ($492.6 million) with 100-year storm ($1,596.3 million) in public trust.

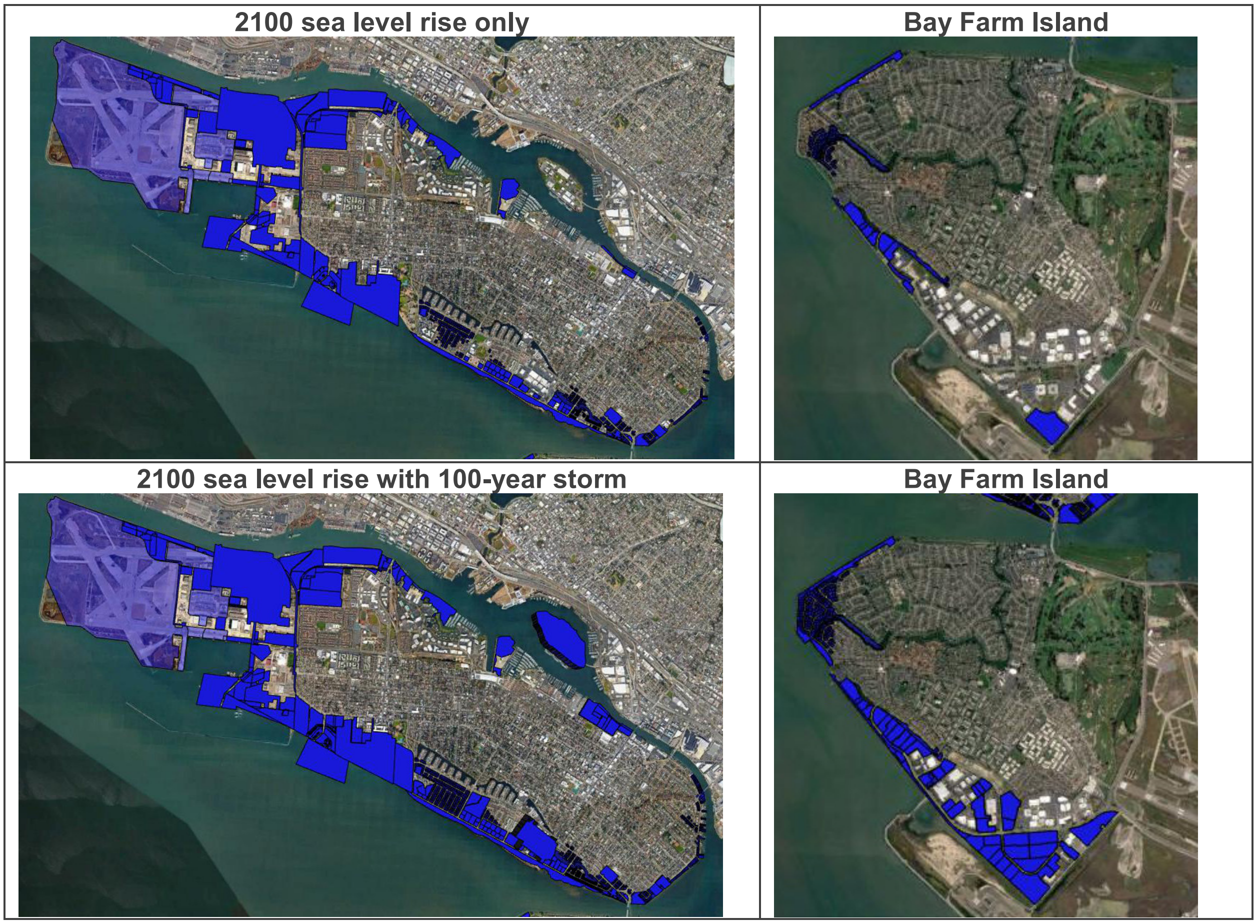


Figure L-11. 2100 sea level rise only ($2,348.9 million) with 100-year storm ($3,497.2 million) in public trust.

Commerce Impacts

In addition to the built environment, infrastructure, and value of open space and parks that we assessed above, we considered the impacts to commerce within the public trust lands. Specifically, we are including the impact on the ferry as well as business disruption. Alameda's estimates of lost revenue and wages associated with ferries and other commerce are described below.

Ferry

The ferry takes an average of over 4,000 daily commuters from Alameda Island and Bay Farm Island to San Francisco (WETA, 2018). The main island terminal would lose all access with about 48 inches of sea level rise, and the Bay Farm Island terminal would lose access with about 52 to 66 inches of sea level rise. The 3,000 daily weekday commuters who take the ferry from Alameda, the 2,000 daily weekend ticket sales, and the 1,000 daily weekday commuters who take the ferry from Bay Farm Island generate an annual revenue of over $20 million. In addition to this revenue loss, there would be an additional loss because people would not be able to use the ferry. This could lead to more vehicle traffic or people choosing to work or live in another location outside of Alameda.

Museum

The USS Hornet Museum draws in 80,000 visitors per year and charges an admissions price of $20 for adults. This is a revenue loss of $1.6 million per year. Although the museum is on a decommissioned aircraft carrier and would not be impacted directly by sea level rise and storm surge, access would be blocked completely by 2100 if no adaptation actions are implemented along the shoreline.

Other Commerce

Table L-5 presents the number of establishments, employees, and annual payroll in Alameda in 2016 based on ZIP code business pattern data (U.S. Census Bureau, n.d.).

Table L-5. Commerce in Alameda

Area	Establishments*	Employees*	Annual Payroll*
Alameda ZIP 94501 (Main Island)	1,461	18,729	$1,113,051,000
Alameda ZIP 94502 (Bay Farm Island)	271	8,323	$895,781,000
Alameda Total	1,732	27,052	$2,008,832,000

* Excludes self-employed individuals, employees of private households, railroad employees, agricultural production employees, and most government employees.

Using the approximately $2 billion annual payroll for Alameda businesses, we calculated the impacted portion of that payroll based on the portion of commercial parcel value flooded in each scenario. For this analysis, we considered scenarios for sea level rise only, as those would lead to a permanent commerce loss. A 100-year storm would lead to a temporary loss of commerce depending on the extent of the devastation. We have not included that in this analysis, so we are underestimating the loss of commerce in the public trust areas by a small fraction.

The total value of buildings in the entire city is $1,937.5 million. Comparatively, the values of commercial and industrial buildings within Alameda's public trust areas lost under each scenario are:

- 2030 sea level rise: $38.2 million;
- 2050 sea level rise: $38.2 million; and
- 2100 sea level rise: $60.3 million.

Thus, about 2 percent of commerce is impacted in 2030 and 2050, and about 3.1 percent is impacted in 2100. This percent of overall commerce reflects approximately $39.4 million lost in annual wages in 2030 and 2050, as well as $62.2 million lost in 2100.

Non-market Values, Including Recreation and Ecosystem Services

Parks, beaches, and natural areas in Alameda provide ecosystem services ranging from recreational value to shoreline protection. This section describes the range of provisioning, regulating, habitat, and cultural services provided by public trust ecosystems. It then seeks to assign a dollar value to these services, where possible, and assesses expected impacts on those services due to sea level rise. As outlined below, a lack of data on visitors or users in many cases limited our ability to make defensible estimates of the economic benefit.

Cultural Services

Recreation

A diverse set of parks, beaches, and public access areas located within Alameda's public trust (listed on Table L-2) undoubtedly provide important cultural services to the community. Recreational opportunities to run and play at the beach, go boating and kite surfing, and simply experience views of San Francisco Bay are an important part of the city's character. While some of these benefits are emotional and spiritual and not easily quantified, many resources are available to help approximate the dollar value of recreation benefits.

This section estimates the recreational value of those areas based on number of visitors and approximate recreational values from other studies. We begin with a focus on Crown Beach because it has the highest visitor numbers of recreational areas in the public trust. We estimate that the overall economic value associated with recreation at Crown Beach is between $52 and $78 million annually. We base this on data from the number of annual visitors and approximate economic benefit per visitor.

To value the non-market recreational opportunities for Crown Beach, as well as create a range of potential impacts associated with sea level rise, we reviewed expenditure surveys from the region. The most applicable survey outlined median expenditure at San Diego beaches at $30.29 with a standard error of $6.05 in 2000 dollars, which results in an expenditure range of $34.79 to $51.16 for most visitors after converting to current dollars and considering the standard deviation (Lew & Larson, 2005). The CARP estimates Crown Beach has 1.5 million visitors, which means Crown Beach generates an economic benefit of $52 to $78 million annually (i.e., 1.5 million x $34.79 for low range and 1.5 million x $51.16 for high range). This benefit is threatened by sea level rise in the 2050 scenario and beyond.

Other parks (outside of Crown Beach) and trails also provide recreational value to users. Studies suggest the value of a park is between $2.50 and $25 per user (Harnik & Crompton, 2014, p. 10). In Section II of this appendix, we identified major parks, open space fields, and trails impacted by flooding for each sea level rise and storm surge scenario. We attempted to estimate visitor use by park using InVEST; however, the City did not have visitor estimates. Therefore, we could not defensibly estimate the annual benefit associated with recreation. Counting visitors at parks that would be impacted by sea level rise and storm surge is an important future step to estimate the economic benefits of these important resources. A future study that estimates the number of users and type of use at each park could help the City better understand the economic benefits associated with these parks threatened by sea level rise.

In addition, trips taken to the Elsie Roemer Bird Sanctuary provide value to users. Many studies have tried to capture the value derived from birding through the travel-cost method (TCM). This measures what people spend to go on a birdwatching trip to estimate the economic value to that person. TCM studies of birding vary by the populations they study and the types of trips they measure. Myers et al. (2010) found that birdwatching trips to wetlands in the eastern United States have a value of $66 to $90 for day trips and $200 to $425 for overnight stays. Loomis et al. (2018) found that birding trips have a total surplus between $211 and $259. Kolstoe and Cameron (2017) found users have derived $239 to $272 value through travel cost estimations. Myers et al. (2010) found lower values than the other two studies referenced, which is attributable to the methods they used to conduct their study. Myers et al. conducted their surveys on site, getting a representative sample of the public. Loomis et al. and Kolstoe and Cameron conducted their studies through online birding sites (Duck Unlimited and eBird, respectively); because they did not include a survey, they were unable to discern between the lower-cost day trips that casual birders (who are less likely to make a birding online profile) take and overnight trips.

The Elsie Roemer Bird Sanctuary likely sees more day trippers than overnight stays, and so most users may derive an economic value in the range of $66 to $90. However, the dedicated birders who derive these much higher values are present in Alameda. eBird, which Kolstoe and Cameron used to conduct their study, lists the Elsie Roemer Bird Sanctuary site, and its webpage is quite active, with 184 total species spotted. Additionally, Kolstoe and Cameron found that the presence of an endangered species raises the value of a trip to a birding site; the California clapper rail, an endangered bird, is native to the Elsie Roemer Bird Sanctuary. While a precise value of the bird sanctuary is not measurable, its presence provides value to residents and outside visitors. Future studies to estimate the number of birders and determine their profile (i.e., day trip or overnight visitor) could help provide an estimate of the economic benefit of birding in the Elsie Roemer Bird Sanctuary.

Provisioning Services

Fishing opportunities provide recreational value to users. The rock wall at the former naval base is a staple of recreational fishing for Alameda residents (Rutledge, 2018). The City does not estimate visitor numbers. However, the rock wall lies just above sea level and is heavily susceptible to sea level rise. Grand Marina, San Leandro Marina, and the shoreline behind Encinal High School are also popular fishing spots that are susceptible to sea level rise. As with parks and trails, fishing provides recreation (and, for some, nutrition) and is thus another source of economic value that could be further explored if the number of visitors is tracked. Recreational fishing also brings in commerce to the local economy; in 2011, anglers spent $70 per shore fishing trip in California (Lovell et al., 2013). Sea level rise also impacts the rate at which anglers fish and the consumer surplus that they derive. A study of shore anglers in North Carolina found that 2030 and 2080 sea levels decreased shore anglers' trips by 6.7 percent and 7.5 percent, respectively. Researchers found additional reductions in consumer surplus due to disappearing beach width, which brought losses to 39 percent of total value (Whitehead et al., 2009). Sea level rise has a demonstrable effect on shore angling, and Alameda's fishing locations are especially vulnerable to sea level rise.

Habitat and Supporting Services

The public trust includes important coastal habitats that provide nursery grounds for fish and add biodiversity to the city. As noted above, eBird identifies 184 bird species at Elsie Roemer marsh, including the endangered California clapper rail. Along Elsie Roemer and San Leandro Bay, tidal mudflats and eelgrass beds support shorebirds and invertebrates. Eelgrass provides spawning and nursery habitat for Pacific herring, the primary commercial fishery in the San Francisco Bay **(California State Coastal Commission and Ocean Protection Council, 2010). As noted throughout this report, additional study will be needed to determine how the marsh and mudflat habitat and biodiversity will respond to sea level rise. Additional study is also needed to determine how eelgrass will migrate or increase/decline with sea level rise.**

Regulating Services

The salt marshes of Alameda regulate the environment by sequestering carbon. As a highly productive ecosystem, salt marshes sequester carbon in their accumulated sediment. While a more site-specific analysis of marsh response to sea level rise at Elsie Roemer will be required in the future, a Point Blue Conservation Science (n.d.) review of a regional analysis of marsh migration in response to sea level rise provides a good starting point for estimating future migration and changing benefits (Veloz et al., 2014). Applying a 1.65 meter per century rate of sea level rise in the model (and high sedimentation rates), we can expect to begin seeing a shift from marsh to mudflat when Bay water levels reach approximately MHHW + 12 inches to 24 inches (which could occur by 2030).

Under this scenario, the salt marshes of Elsie Roemer are expected to decrease from 7 acres to 5.5 acres (Veloz et al., 2014). Salt marshes store roughly 3.24 tons of carbon per year and per acre (Murray et al., 2011), so approximately 22 tons are stored in these salt marshes. The value of carbon sequestration can be estimated using the market price of California's cap-and-trade system. As of March 29, 2019, carbon dioxide emissions in California were trading at $15.10 per ton (Climate Policy Initiative, n.d.). This amounts to an annual deadweight loss of $73.33 due to lost carbon sequestration. A portion of that loss will be recovered as the marsh transitions to mudflats. Mudflats also sequester carbon, though at a much lower rate (Herr et al., 2010). Later in the century at high water levels, these mudflats may transition to subtidal areas with limited sequestration value.

In addition to carbon sequestration, Alameda's natural shoreline provides regulating services in terms of shoreline protection. Though challenging to quantify without site-specific studies, the existing eelgrass beds likely provide wave dampening to the adjacent shoreline. The marsh and mudflats reduce erosive forces on adjacent shoreline structures. In addition, Crown Beach provides coastal shoreline protection to Shoreline Drive and adjacent neighborhoods. In the 2100 sea level rise plus 100-year storm scenario, our COAST analysis showed several hundred million dollars of property that is flooded behind Crown Beach (most of which is not flooded in the 2050 sea level rise plus 100-year storm scenario)—demonstrating its important economic benefit through flood protection.

Overall

Crown Beach likely provides very substantial economic benefits in terms of value to people using the beach as well as the substantial flood protection benefits mentioned above—these services together may sum to several hundred million dollars in economic benefits. Other substantial benefits threatened by sea level rise may include the loss of other parks and birding in the Elsie Roemer Bird Sanctuary. While we do not have visitor data for those parks and the bird sanctuary, these could easily contribute tens of millions in economic value. Because of the lack of visitor data and resulting uncertainty in associated economic value, we have decided to not sum these non-market impacts together with the avoided costs of adapting to sea level rise.

Costs of Adaptation/Mitigation

Figure L-2 presents a map of the public trust lands, which are included to at least some degree around most of the island's perimeter. Thus, for simplicity, we have included the entire perimeter of the island when assessing the costs of adaptation strategies. Table L-6 presents the length of overtopped shoreline in Alameda.

Table L-6. Infrastructure Overtopped at Different Levels of Sea Level Rise (Linear Feet)

Structure Type	2030 SLR (10")	2050 SLR (23")	2030 SLR + 100-Year Storm Surge (52")	2050 SLR + 100-Year Storm Surge (65")	2100 SLR (83")	2100 SLR + 100-Year Storm Surge (125")
Berm	1,191	1,918	3,610	4,159	4,429	4,725
Channel or opening	122	122	229	229	229	229
Embankment	0	0	19,841	20,891	21,744	22,354
Engineered levee	0	79	926	1,786	3,277	3,886
Natural shoreline	0	61	914	1,984	3,020	3,386

Structure Type	2030 SLR (10”)	2050 SLR (23”)	2030 SLR + 100-Year Storm Surge (52”)	2050 SLR + 100-Year Storm Surge (65”)	2100 SLR (83”)	2100 SLR + 100-Year Storm Surge (125”)
Shoreline protection structure	1,067	3,289	17,136	24,131	30,441	32,188
Transportation structure	0	61	624	807	878	878
Water control structure	0	0	32	32	32	32
Wetland	985	1,016	1,030	1,030	1,030	1,030

The types of infrastructure included in the table above make up most of the Alameda shoreline. Over 90 percent of the linear feet of overtopped shoreline includes berms, embankments, engineered levees, and shoreline protection structures (primarily seawalls). A planning level cost estimate was developed, assuming each of these four shoreline types must be raised enough to prevent flooding under each scenario.

Costs for infrastructure are derived from *The Impacts of Sea Level Rise on the California Coast,* (Herberger et al., 2009). A reasonable low-end, average estimate, and high-end price per linear foot of shoreline protection structure was determined based on the referenced studies in this report. Table L-7 presents this range of costs.

Table L-7. Derived Costs of Infrastructure

Shoreline Type	Low-End Estimate ($/meter)	Average Estimate ($/meter)	High-End Estimate ($/meter)
Berm	$1,057	$2,250	$3,249
Levee	$1,057	$2,250	$3,249
Seawall	$3,858	$7,729	$11,780

Because different parts of the shoreline need to be raised by varying amounts, we weighted the cost based on how high the shoreline type needed to be built to protect against a certain scenario. For example, for the 3,610 feet of berm in Table L-6 that are overtopped, we estimated the length that needed to be raised 1 foot, 2 feet, 3 feet, and 4 feet. The cost per linear foot of shoreline infrastructure was scaled using a study prepared for the town of Weymouth, Massachusetts (Bourne Consulting Engineering, 2011). This study presented the costs of building seawalls and other forms of infrastructure to different heights. From this study, we developed weights to estimate how much more each additional foot of raising a structure would cost. Using the length of each shoreline type and the height needed to be raised, we calculated a range of costs for increasing the shoreline height to protect against each sea level rise and storm scenario. These costs are presented in in Table L-8.

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Table L-8. Costs to Raise Shoreline to Protect Against Sea Level Rise and Surge

Scenario (Total Water Level)	Low-End Estimate ($Million)	Average Estimate ($Million)	High-End Estimate ($Million)
2030 sea level rise (10")	$5	$11	$16
2050 sea level rise (23")	$17	$34	$51
2030 sea level rise + 100-year storm surge (52")	$93	$188	$285
2050 sea level rise + 100-year storm surge (65")	$183	$368	$559
2100 sea level rise (83")	$245	$493	$748
2100 sea level rise + 100-year storm surge (125")	$346	$696	$1,056

Natural shoreline alternatives. The analysis described in this appendix primarily considered in-kind modifications to Alameda's shoreline. For example, existing levees would be elevated to address future water levels. Although much of Alameda's existing shoreline is hardened, there are several natural alternatives to hardened shorelines that could be considered across the island. For example, existing traditional engineered levees could be replaced with or supplemented by horizontal or living levees that provide similar or better flood protection, as well as habitat and erosion reduction. Some of these natural alternatives are described in CARP Chapter 4. Another resource for considering potential nature-based shoreline adaptation measures for Alameda and the Bay more broadly is the *San Francisco Bay Shoreline Adaptation Atlas* (Beagle et al., 2019). The atlas identifies locations where a variety of nature-based adaptation approaches may be applicable given a variety of geophysical characteristics.

The CARP economic analysis did not explicitly cost out natural alternatives at a citywide scale because of the highly site-specific nature of designing living shorelines. Many factors come into play when determining whether natural alternatives are feasible, including available space and the proximity of existing buildings to the water. Often, natural shoreline alternatives are more expensive than traditional options, particularly when converting hardened shorelines to living shorelines. However, natural shorelines also offer substantial non-market value and are likely necessary in Alameda to ensure a sustainable and resilient city in the long term. In addition, the substantial avoided cost from shoreline adaptation in Alameda makes a higher-cost design economically feasible, as described in the next section.

CARP Chapter 5 provides cost estimates for recommended shoreline adaptation strategies (both hardened and nature-based) at the areas of location-based priority flooding.

Section IV: Alameda's Plans to Protect and Preserve Resources and Structures

Alameda's CARP provides guidance to address the city's public trust vulnerabilities in the face of sea level rise. Many of the assets highlighted for adaptation in the near term are part of the public trust. The CARP highlights the need to prioritize adaptation of Crown Beach, the Eastshore Drive neighborhood, and the Towata Park area to protect resources from sea level rise and storm surge resources.

Chapter 4 provides details on specific adaptation strategies for these locations as well as strategies to implement citywide.

Chapter 6 includes the City's plan to enhance staffing for CARP implementation. In addition, a monitoring and evaluation program will be established to track progress and respond accordingly.

While Alameda will be taking strong action at the local level to address sea level rise impacts, the City cannot operate effectively without participating in state, regional, and other cross-jurisdictional entities charged with addressing sea level rise. Alameda has an especially urgent need to raise "its voice" in advocating at all these levels. The City was recently a founding member of the Bay Area Climate Adaptation Network, a new collaborative network of local government staff helping the Bay Area region respond effectively and equitably to the impacts of climate change. The City also collaborates with BCDC's Adapting to Rising Tides (ART) Program. The City's existing regional partnerships and plans for growing them to support regional resilience are further elaborated in the CARP (Chapter 6). All City efforts to support regional resilience feed into their efforts to protect the public trust from sea level rise impacts.

Limitations of This Analysis

This economic valuation of sea level rise impacts on the public trust demonstrates the importance of the public trust lands at risk of flooding. This awareness can help the City and other stakeholders advocate for adaptation financing and push for action.

This analysis is based on best available data, but there are several limitations to be aware of:

- Many parcels in Alameda are "exempt" from tax assessments and, as a result, appear in the City's parcels data set as land with no net total value. To address this gap, blanket costs of $700,000/acre and $2,000,000/acre for recreation/open space and residential/commercial land were applied. The large parcel making up most of Alameda Point was not given this blanket cost because it is a very large area and the resulting value would greatly skew the analysis.
- Applying current cost estimates to undeveloped land does not necessarily capture the potential future value of that land if development continues. The values in this analysis reflect best estimates of current parcel value, including both land and buildings. Those undeveloped areas where developments are planned are not treated differently in this analysis.
- The tool used for the economic analysis, COAST, employs its own methodology for determining inundation extent based on an underlying elevation model. The elevation model used for this analysis was the same as that used by BCDC/ART to develop inundation maps, but the methodologies differ somewhat. As a result, the BCDC and COAST inundation maps are not

aligned for the same total water level scenarios. This analysis relied on COAST, which generally underestimates inundation extent when compared with the BCDC maps. Care should be taken when comparing inundation maps from different sources.

- BCDC inundation maps are shown in this report for reference. However, the BCDC scenarios do not align perfectly with California OPC guidance. The COAST analysis used the specific projections referenced by the OPC guidance.

References

Beagle, J., Lowe, J., McKnight, K., Safran, S. M., Tam, L., & Szambelan, S. Jo. (2019). *San Francisco Bay shoreline adaptation atlas: Working with nature to plan for sea level rise using operational landscape units* (SFEI Contribution No. 915). Richmond, CA: San Francisco Estuary Institute.

Bourne Consulting Engineering. (2011). *Fore River Avenue/Fort Point Road seawall evaluation.* Prepared for the Town of Weymouth. Retrieved from https://www.weymouth.ma.us/sites/weymouthma/files/file/file/seawall_report_043013.pdf

California State Coastal Commission and Ocean Protection Council. (2010). Appendix 8-1: Eelgrass Conservation and Restoration in San Francisco Bay: Opportunities and Constraints. In *San Francisco Bay Subtidal Habitat Goals Report*.

City of Santa Cruz (2018). *AB 691 Sea-level rise assessment city of Santa Cruz tide and submerged lands 1969 grant Santa Cruz Municipal Wharf*. Retrieved from https://www.slc.ca.gov/wp-content/uploads/2018/11/CityofSantaCruz.pdf

Climate Policy Initiative. (n.d.). California carbon dashboard. Retrieved from http://calcarbondash.org/

Harnik, P., & Crompton, J. (2014). Measuring the total economic value of a park system to a community. *Managing Leisure, 19*(3), 188–211.

Herberger, M., Cooley, H., Herrera, P., Gleick, P. H., & Moore, E. (2009). *Impacts of sea-level rise on the California coast.* Prepared by the California Climate Change Center for the State of California. Retrieved from https://pacinst.org/wp-content/uploads/2014/04/sea-level-rise.pdf

Herr, D., Laffoley, D., Tamelander, J., & Vandever, J. (2010). *Capturing and conserving natural coastal carbon: Building mitigation, advancing adaptation*. World Bank, International Union for Conservation of Nature, Environmental Science Associates (ESA) Philip Williams & Associates (PWA).

Kolstoe, S., & Cameron, T. A. (2017). The non-market value of birding sites and the marginal value of additional species: Biodiversity in a random utility model of site choice by eBird members. *Ecological Economics*, *137*, 1–12.

Lew, D. K., & Larson, D. M. (2005). Valuing recreation and amenities at San Diego County beaches. *Coastal Management, 33,* 71–86.

Loomis, J., Haefele, M., Dubovsky, J., Lien, A. M., Thogmartin, W. E., Diffendorfer, J., Humburg, D., Mattsson, B. J., Bagstad, K., Semmens, D., Lopez-Hoffman, L., & Merideth, R. (2018). Do economic values and expenditures for viewing waterfowl in the U.S. differ among species? *Human Dimensions of Wildlife, 23*(6), 587–596.

Lovell, S. J., Steinback, S., & Hilger, J. (2013). *The economic contribution of marine angler expenditures in the United States, 2011* (NOAA Technical Memorandum NMFS-F/SPO-134).

Murray, B. C., Pendleton, L., Jenkins, W. A., & Sifleet, S. (2011). Green payments for blue carbon: Economic incentives for protecting threatened coastal habitats. Retrieved from https://nicholasinstitute.duke.edu/sites/default/files/publications/blue-carbon-report-paper.pdf

Myers, K. H., Parsons, G. R., & Edwards, P. E. T. (2010). Measuring the recreational use value of migratory shorebirds on the Delaware Bay. Marine Resource Economics, 25(3), 247–264. Retrieved from: https://www.researchgate.net/publication/42831392_Measuring_the_Recreational_Use_Value_of_Migratory_Shorebirds_A_Stated_Preference_Study_of_Birdwatching_on_the_Delaware_Bay

OPC (Ocean Protection Council). (2018). *Rising seas in California: An update on sea-level rise.* Retrieved from http://www.opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_Exhibit-A_OPC_SLR_Guidance-rd3.pdf

Point Blue Conservation Science. (n.d.). San Francisco Bay Future Marshes Report. Retrieved from http://data.prbo.org/maps/sfbayReport/docs/web_report_Elsie_Roemer.pdf

Rhode Island Habitat Restoration Team. (n.d.). *Eelgrass* (Zostera marina). Retrieved from https://www.edc.uri.edu/restoration/html/gallery/plants/eel.htm

Rutledge, R. M. (2018, February 7). Alameda's real rock wall. *Alameda Magazine.* Retrieved from http://www.alamedamagazine.com/February-2018/Alamedas-Real-Rock-Wall/

U.S. Census Bureau (n.d.). 2016 ZIP code business patterns. Retrieved from https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t

Veloz, S., Fitzgibbon, M., Stralberg, D., Michaile, S., Jongsomjit, D., Moody, D., Nur, N., Salas, L., Wood, J., Elrod, M., & Ballard, G. (2014). Future San Francisco Bay tidal marshes: A climate-smart planning tool. [Web application]. Petaluma, California. Retrieved from www.pointblue.org/sfbayslr

WETA (Water Emergency Transit Authority). (2018). *Summary report: 2017 On-board passenger survey: San Francisco Bay Ferry.* Retrieved from https://weta.sanfranciscobayferry.com/sites/default/files/weta/publications/2017PassengerSurveyRept.pdf

Whitehead, J. C., Poulter, B., Dumas, C. F., & Bin, O. (2009). Measuring the economic effects of sea level rise on shore fishing. *Mitigation and Adaptation Strategies for Global Change, 14*(8), 777–792. Retrieved from https://www.researchgate.net/profile/Benjamin_Poulter/publication/226944340_Measuring_the_economic_effects_of_sea_level_rise_on_shore_fishing/links/09e415118b5ae0ed70000000/Measuring-the-economic-effects-of-sea-level-rise-on-shore-fishing.pdf