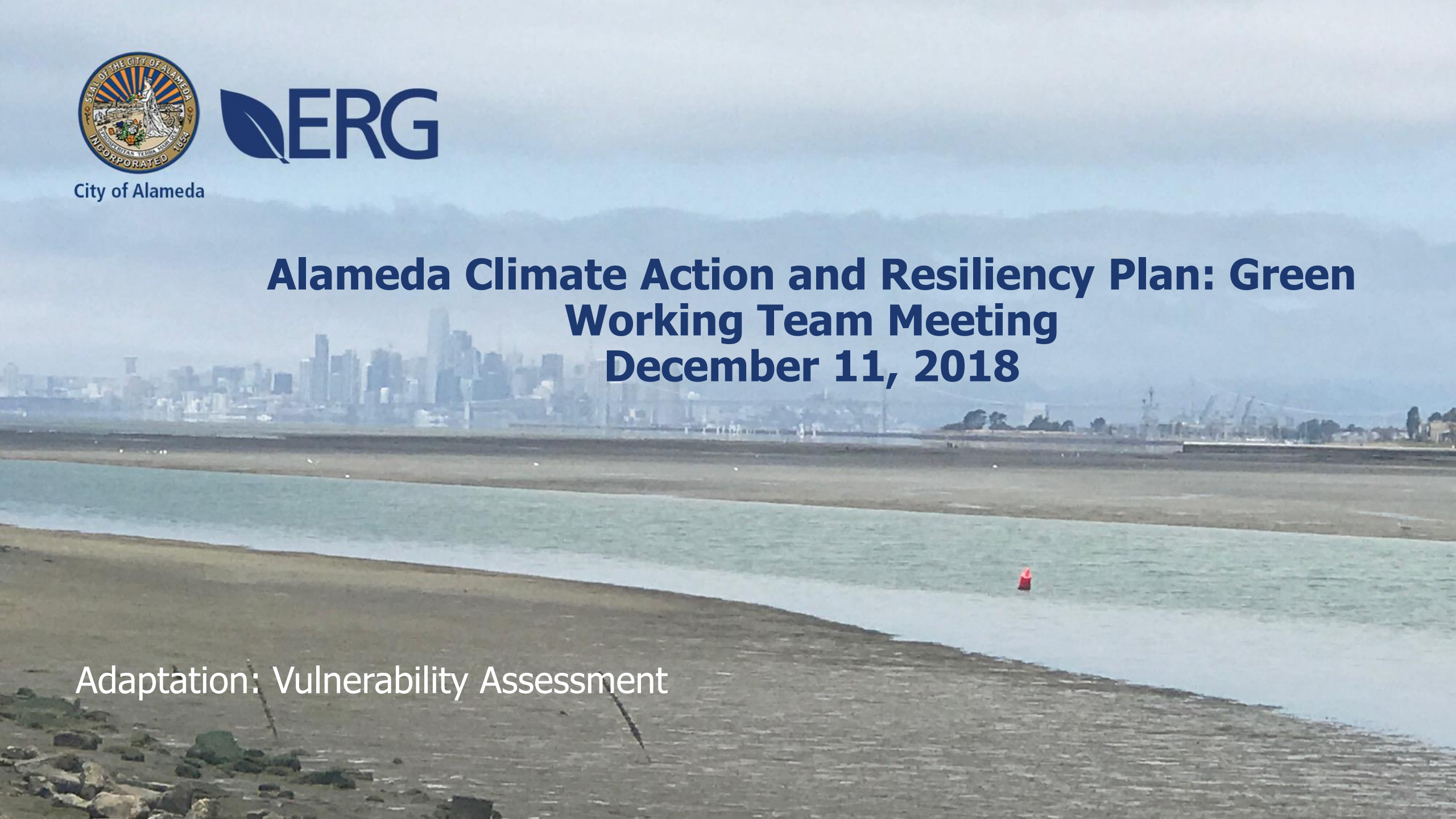


City of Alameda

Alameda Climate Action and Resiliency Plan: Green Working Team Meeting
December 11, 2018

Adaptation: Vulnerability Assessment

AGENDA

Time	Agenda Item
3:00 – 3:10 pm	Introductions
3:10 – 3:20 pm	Meeting Goals and Project Timeline
3:20 – 3:40 pm	Vulnerability Assessment Methodology and Results
3:40 – 4:30 pm	Discussion of Priority Assets for Adaptation
4:30 – 4:50 pm	Priority Assets for Discussion at Community Meeting in January
4:50 – 5:00 pm	Wrap up and Next Steps

Goals of this Meeting

(1) Input on the Draft Vulnerability Assessment

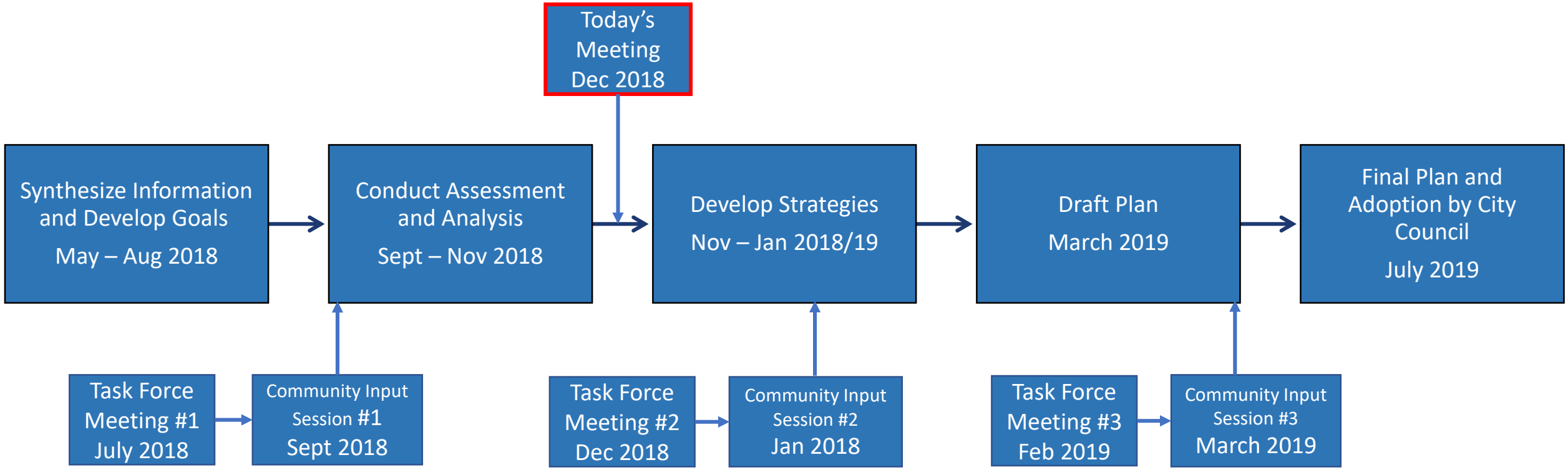
- Have we accurately captured the city's high priority assets?
- What ideas do you have for adaptation strategies?

(2) Input on the January Public Workshop

- What subset of priority assets should we get public input on at the January workshop?

City of Alameda ERG

Project Timeline



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Methodology: Adaptation Planning Process

City-wide Vulnerability Assessment

- Consider All Hazards
- Consider All Assets

Identify Subset of Assets

- High, Early Exposure
- High Consequence & Sensitivity

Prioritize Actions

- Key Planning Gaps
- Actions with Multiple Benefits
- Community Support
- Other Criteria

Methodology: Identify Alameda's Priority Climate Hazards

Hazard	Priority	Potential Impacts
Sea Level Rise	**Critical**	Coastal erosion and coastal flooding; rising groundwater levels; damage to submerged structures; permanent inundation; **very high community interest**
Inland Flooding	High	Coupled flooding risk with SLR; overwhelmed stormwater management system; damage to assets from temporary flooding
Liquefaction*	Moderate	Liquefaction risk from earthquakes is heightened by SLR and rising groundwater
Drought	Moderate	Stress to EBMUD water supply (water use in Alameda)
Extreme Heat	Low	Public health impacts; damage to transportation infrastructure
Wildfire Smoke	Low - Evolving	Public health impacts from smoke

*Earthquakes are addressed as they relate to SLR and its impact on liquefaction – see LHMP for more information on earthquakes more broadly.

Methodology: Define Asset Categories

- **Critical Services**
- **Utilities**
- **Transportation**
- **Other (Waste)**
- **Buildings**
- **Land Use**
- **Shoreline & Natural Environment**

Methodology: Priority Assets for Specific Assessments

Exposure	+	Sensitivity	+	Consequence	+	Adapt.Capacity	-	In Plan	=	Priority Ranking
<u>Flooding:</u> Sea level Rise Storm surge Precipitation		The degree to which assets are affected by climate change impacts		The effect of impacts to the asset on the surrounding community and beyond.		(Adaptive Capacity) The ability of assets, systems or people to adjust to an adverse impact.		City has already committed to adaptation action.		Rankings of High, Moderate, Low will be used to prioritize actions among assets with each asset category.

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Results: Focus on Subset of Vulnerability Assessment

1. Statement of Climate Change Risks: Current & Future Conditions

2. Vulnerability Assessment Methodology

3. City-wide Vulnerabilities: Summary of Key Vulnerabilities by Asset Category

- Buildings
- Transportation
- Critical Services
- Natural Areas and Shoreline
- Land Use

4. Priority Asset Vulnerabilities: Focus on SLR/flooding

- Priority Ranking Table for High Priority Assets
- In Plan and Secondary Priority Asset Lists
- Profile Sheets for High-Priority Assets

5. Citywide Special Vulnerability Statements

- Utilities
- Contaminated Lands & Hazardous Waste
- Wildfire Smoke
- Heat
- Drought
- Social Vulnerability
- Cross-cutting Issues

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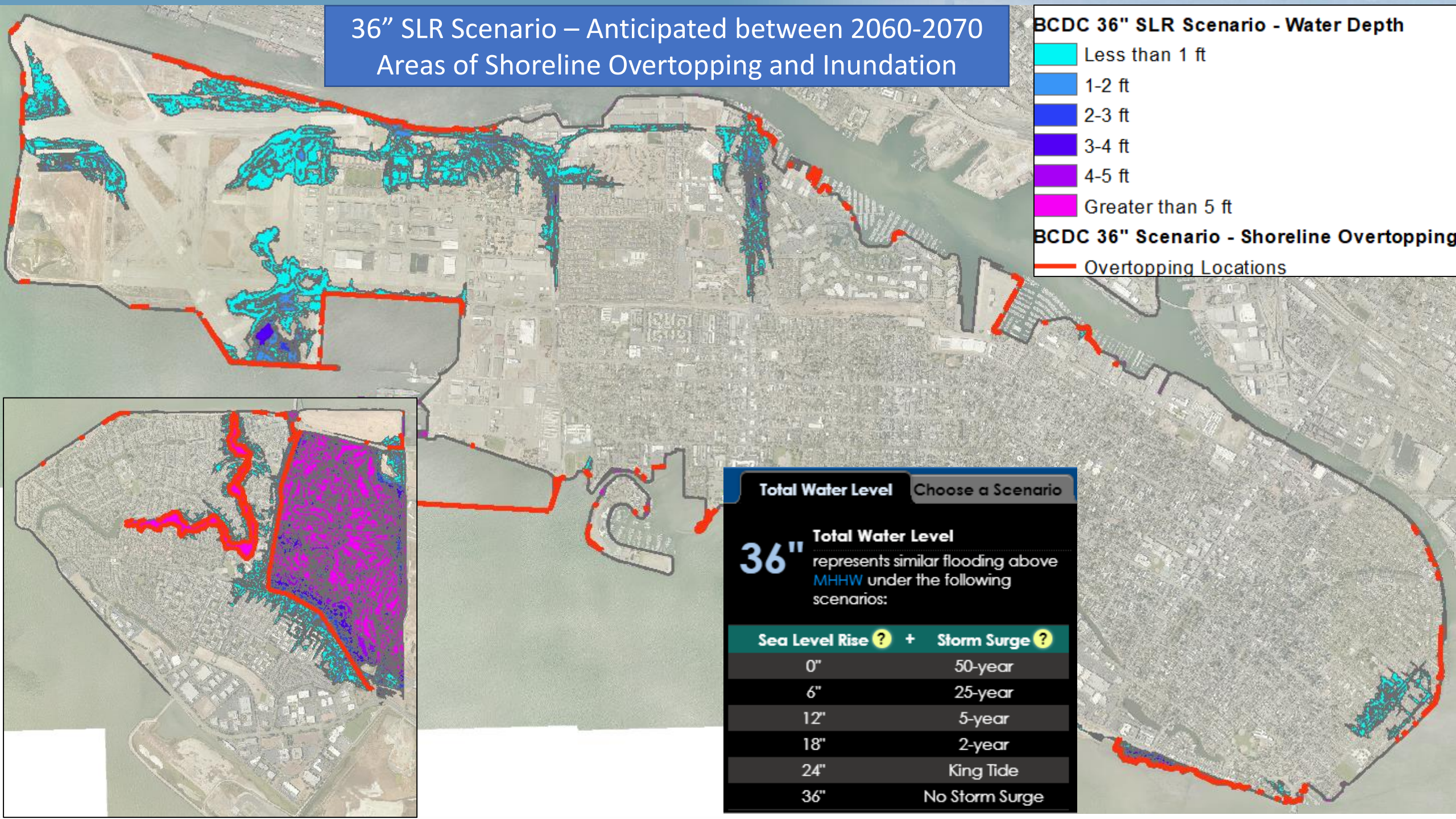
RESULTS: LEVEL OF ANALYSIS

VULNERABILITY CATEGORY	LEVEL OF ANALYSIS
➢ High-Priority Asset	➢ Asset-specific assessment and adaptation strategies
➢ Secondary Priority Asset	➢ Apply city-wide asset assessment & adaptation strategies; recommended for further analysis
➢ "In Plan" Assets	➢ Addressed in existing plans; recommendations for consistency with CARP as needed

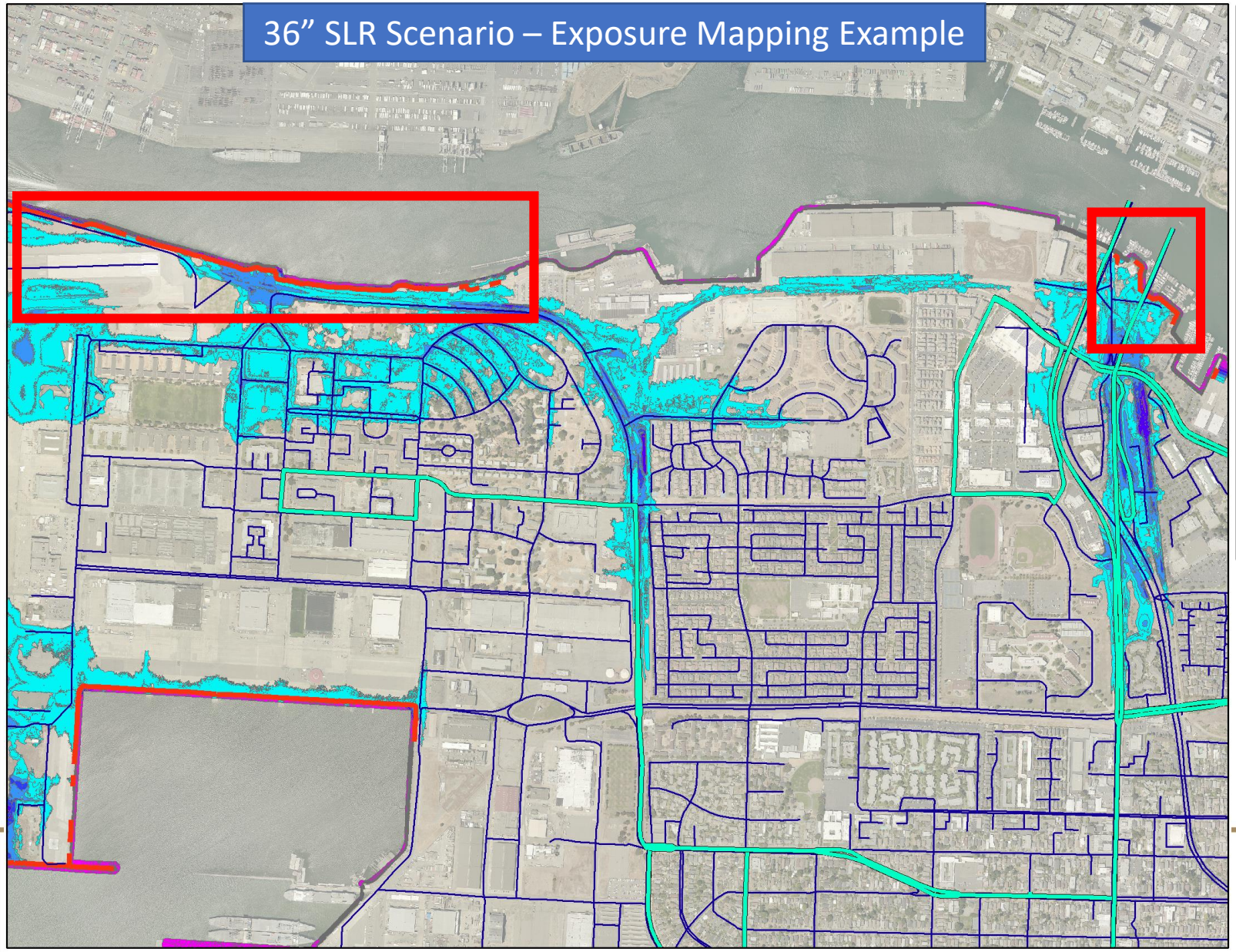
RESULTS: DATA LAYERS USED IN THE VULNERABILITY ASSESSMENT

- More than 15 Data Layers used for the Vulnerability Assessment
- Focus on Sea Level Rise and Flooding
- Examples Shown for this meeting:
  - Areas of shoreline overtopping and inundation with 36" sea level rise
  - Zoom-in of shoreline overtopping to show analysis of assets impacted
  - Storm drain modeling results (flood depth above street level)
  - Social vulnerability areas

36” SLR Scenario – Anticipated between 2060-2070
Areas of Shoreline Overtopping and Inundation



36” SLR Scenario – Exposure Mapping Example



Alameda Roads (TIGER Dataset)

AC Transit Bus Routes

BCDC 36" SLR Scenario - Water Depth

- Less than 1 ft
- 1-2 ft
- 2-3 ft
- 3-4 ft
- 4-5 ft
- Greater than 5 ft

BCDC 36" Scenario - Shoreline Overtopping

- Overtopping Locations

- Also analyzed exposure of critical buildings and other infrastructure
  - Data from 2016 Local Hazard Mitigation Plan

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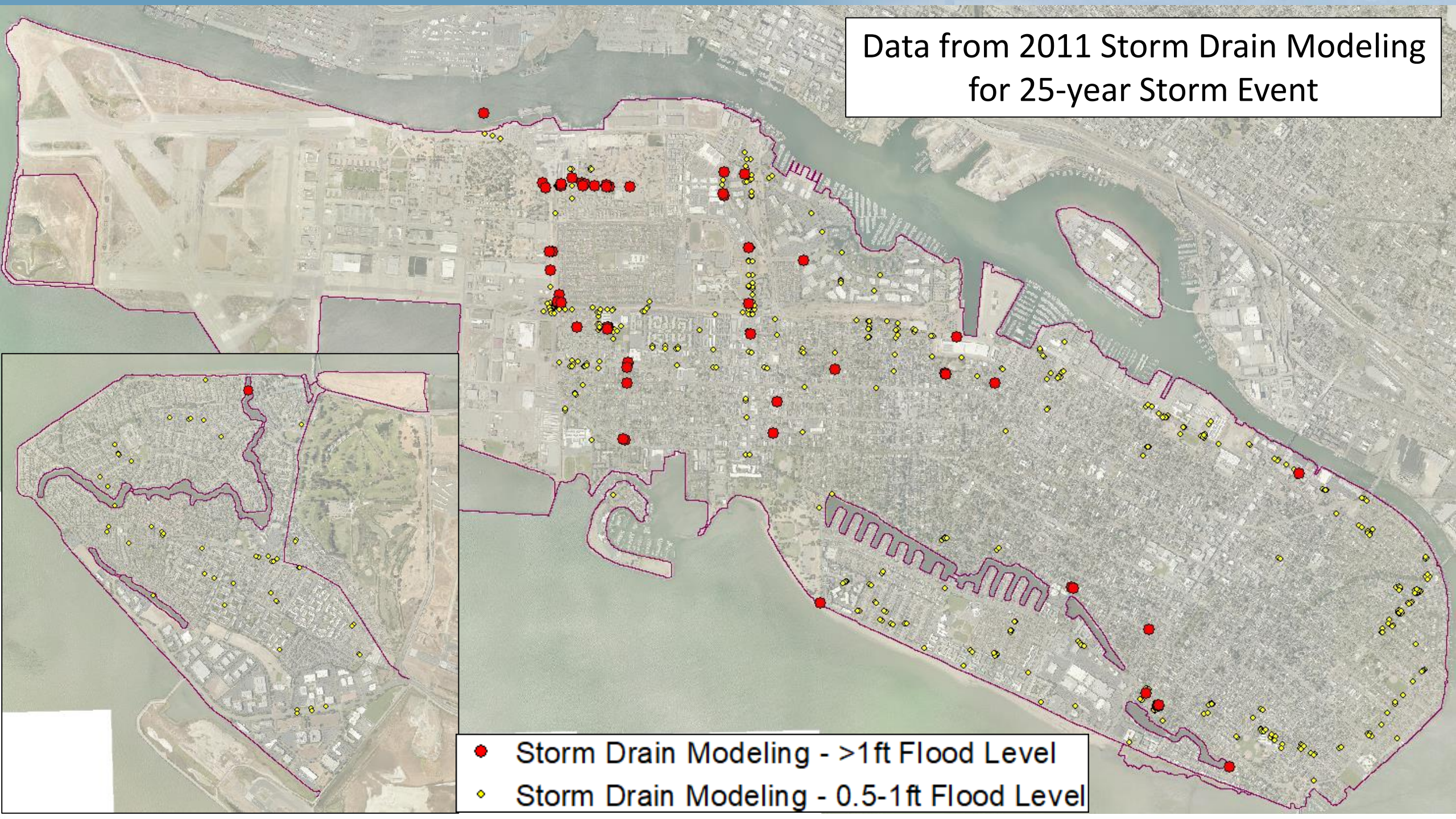
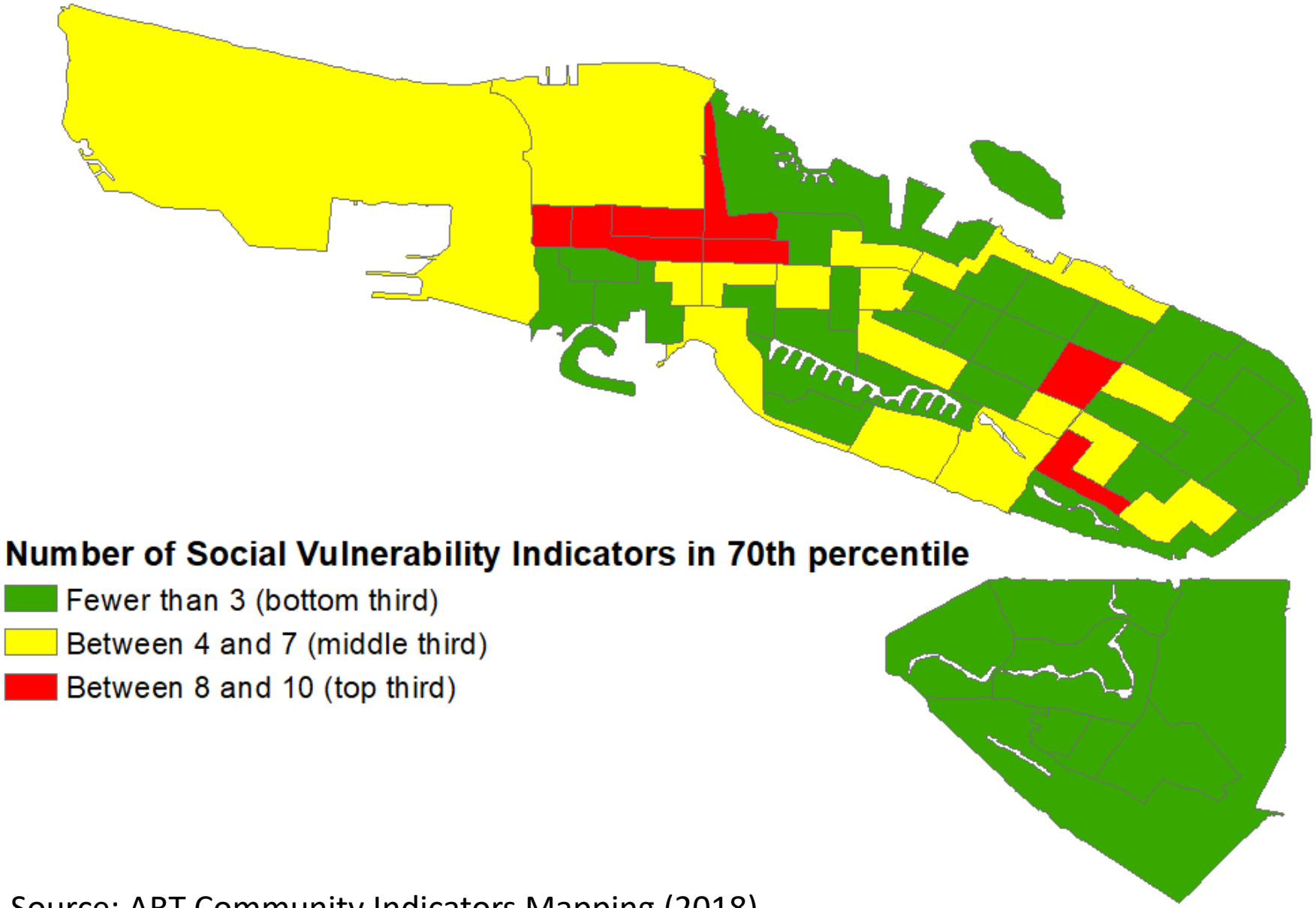

Data from 2011 Storm Drain Modeling for 25-year Storm Event
Storm Drain Modeling - >1ft Flood Level
Storm Drain Modeling - 0.5-1ft Flood Level

Consequence: Social Vulnerability Indicators



Social Vulnerability Indicators

- Language
- Vehicle access
- Housing cost burden
- Race/ethnicity
- Education
- Housing tenure
- Transportation cost burden
- Income
- Age (under 5 and over 75)

Source: ART Community Indicators Mapping (2018)

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Results: Identification of Priority Assets Not Already Addressed In Plans

Asset Category	Asset Name	Exposure (SLR)	Exposure (25-Year Flood)	Sensitivity	Consequence	Adaptive Capacity
Shoreline and Natural Areas	Shoreline adjacent to Webster and Posey Tubes	Moderate (36" SLR)	None	Low	High	Moderate
	Veteran's Court Seawall	Moderate (36" SLR)	None	High	Moderate	Moderate
	Crown Beach and Bird Sanctuary	High (12" SLR)	None	High	Moderate	Moderate
	Bay Farm Island Bridge Touch Down Area (Alameda Island side)	Low (>48" SLR)	None	Moderate	Moderate	Moderate
	Eastshore Dr.	Moderate (36" SLR)	None	Moderate	High	High
	Harbor Bay Lagoon System tide gate structure and dike	Moderate (36" SLR)	None	Moderate	Moderate	Moderate
Utilities	Storm Drain Pump Stations	Moderate (36" SLR)	Varies	High	Moderate	Moderate
	Bayview outfall	High (24" SLR)	None	High	High	High
Transportation	SR260 and Posey/Webster Tubes	Moderate (36" SLR)	High (1ft+ flood)	High	High	Low
	Key Roadways Utilized by AC Transit (including Webster St. and Otis Dr.)	Low (>48" SLR)	High (1ft+ flood)	Moderate	High	Moderate
	State Route 61	Moderate (36" SLR)	High (1ft+ flood)	Low	High	Moderate

RESULTS: DISCUSSION

Have We Appropriately Captured High-Priority Assets?

(Refer to back to the table)

Crown Beach
Photo credit:
Trisha Fawyer

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TRANSITIONING TO ADAPTATION STRATEGIES

- **What Ideas Do You Have for Adaptation Strategies?**
- **What Did We Hear About Adaptation Strategies at the September Community Workshop?**
- **What Subset of Priority Assets Should be the Focus of the January Community Workshop?**

Adaptation Strategies: Top 10 Themes from Workshop #1

Shoreline and Natural Environments:

- Create/restore wetlands, dunes & other coastal habitat*
- Construct and rebuild levees and sea walls

Land Use:

- Increase green space/open space/green infrastructure*
- More mixed-use development, sustainable development patterns, and housing density*
- Increase requirements/ incentives for permeable surfaces and remove unnecessary pavement
- Encourage urban farming*
- Plan for managed retreat
- Prohibit building in the flood zone

Buildings:

- Require cost-effective resilient retrofits for existing buildings and design standards for new buildings, including elevating structures
- Consider floating houses

**Co-benefits with GHG Reduction*

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Adaptation Strategies: Other Themes from Workshop #1

Transportation:

- White pavement to reduce heat island effect
- Evacuation planning
- Expand water transit including for evacuation*

Other (Utilities & Public Safety):

- Clean/upgrade storm drains and expand capacity of drainage system
- Emergency preparedness education & investment in CERT (Community Emergency Response Team)
- Flooding alert system

**Co-benefits with GHG Reduction*

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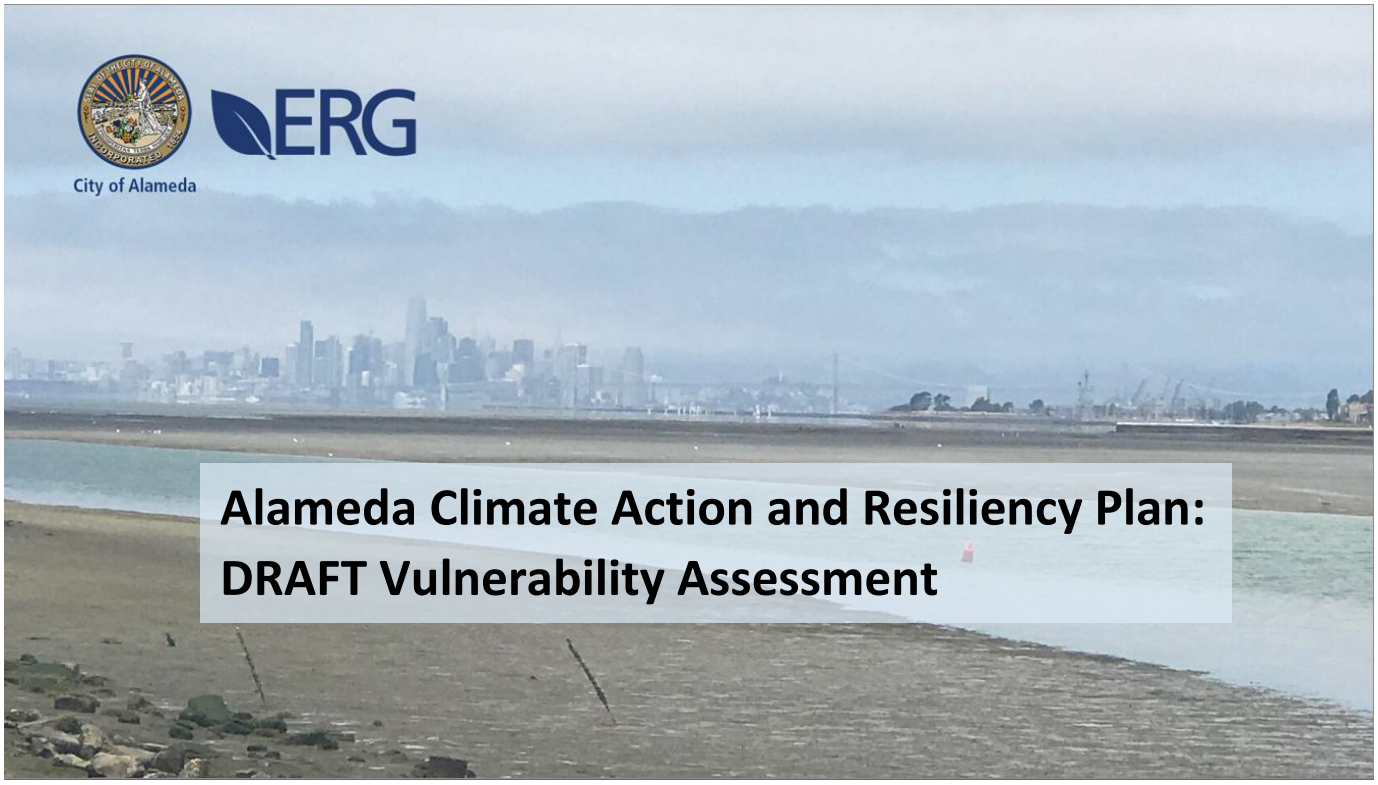

Draft findings of the Climate Change Vulnerability Assessment for the City of Alameda:

Shared with the Green Working Team in preparation for its 12/11/18 meeting

Assessment is a major component of the resiliency portion of the Climate Action and Resiliency Plan

Contents

Criteria for Identifying Priority Assets through the Vulnerability Assessment

Assets that are identified as priority assets will receive a more detailed vulnerability summary, in addition to the asset category-level adaptation strategies developed for the City. ERG will conduct a targeted process of developing adaptation strategies for those prioritized assets. This process and criteria summarized below are consistent with the methodology used in Adapting to Rising Tides (Bay Area Conservation and Development Commission).

We consider assets within the following categories:

1. Shoreline and Natural Areas
2. Critical Services
3. Utilities
4. Transportation
    a. Note: Key assets flagged by the City were automatically pulled onto the priority list, such as: Doolittle Drive, Alameda Point, Veteran's Court Seawall. Heat, air quality, and groundwater impacts and liquefaction risk will be discussed in the final vulnerability assessment but are not part of the prioritization.

1. Exposure Assessment: extent to which an asset experiences an impact. This includes total or % of asset impacted as well as probability of occurrence.

a. Exposure to inundation from sea level rise and storm surges

i. The following categories were applied:
    1. High=exposed to flooding at a total water level of 12-24"
    2. Moderate= exposed to flooding at a total water level of 36"
    3. Low= exposed to flooding at a total water level of 48"

ii. Note: While our exposure analysis looked at higher levels of SLR exposure and these risks will be discussed more broadly in the plan, higher water levels were not used as part of the prioritization for the 10-year CARP

iii. Exposure to tidal flooding from sea level rise and storm surges is considered in terms of "total water level" above today's mean higher high-water level or MHHW (e.g. MHHW + 36"). This language and approach allow us to look at a map of a single total water level (TWL) and see flooding resulting from a range of different scenarios. For example, a TWL of 36-inches above today's high tide can result from scenarios such as:

- 50-year storm today,
- 6-inches of sea level rise plus a 25-year storm in the short term, or
- 36-inches of sea level rise in the long-term.

This approach allows us to plan actions to address temporary impacts of today's winter storm while simultaneously planning to address permanent flooding from sea level rise.

b. Exposure to precipitation flooding (25-year storm)
   i. High= 1+ft flood levels (above surface flooding)
   ii. Moderate= 0.5-1ft flood levels
   iii. Low= <0.5 flood levels

2. **Sensitivity Assessment:** the degree to which assets are affected by climate change impacts.
   a. Sensitivity may be influenced by governance and other factors.
   b. For shoreline assets, "sensitivity" of the shoreline asset/protection structure itself was considered, whereas "consequence" was considered in terms of impacts to surrounding areas if shoreline protection failed.
   c. A ranking of high, moderate or low was applied as defined below:
      i. High
         1. Existing studies indicate the asset is damaged or failing, or otherwise making it highly susceptible to flood damage.
         2. The asset (natural areas) provides sensitive habitat to protected species.
         3. The asset contains sensitive equipment (e.g. hospital) that is not protected from flooding.
         4. The asset is located on lands known to contain contaminants or hazardous waste that may be at risk of mobilizing if flooded.
      ii. Moderate
         1. Asset will be damaged by flooding (e.g. office), but equipment is not highly sensitive
      iii. Low
         1. Flood waters will recede without major damage (e.g. some roads)

3. **Consequence Assessment:** the effect of impacts to the asset on the surrounding community and beyond.
   a. A ranking of high, moderate or low was applied.
      i. High
         1. Restricts movement of emergency responders
         2. Restricts access and egress to critical services (e.g., hospitals)
         3. Flooding of disadvantaged community
         4. Flooding of routes heavily used by transit-dependent community
      ii. Moderate
         1. Limited access to public services (e.g., grocery stores, drug stores)
      iii. Low
         1. Minor/temporary precipitation-based flooding of residential neighborhood

4. **Adaptive Capacity Assessment:** the ability of assets, systems or people to adjust to an adverse impact.
   a. A ranking of high, medium or low was applied.
      i. High: Asset can adapt to new impacts given changes in operations and/or minor physical improvements
      ii. Moderate: Major changes or replacement of existing asset is required
      iii. Low: Cannot adjust in place. Asset must be relocated or elevated

5. **In Plan:** This notation indicates that the City has already made a commitment to adaptation for these assets.
   a. Plans considered commitments include:
      i. Alameda Point Master Infrastructure Plan

   ii. Storm Drain Capital Improvement Plan
   iii. Sewer Master Plan
   iv. Development Projects on the Northern Waterfront
b. We are identifying City commitments so that we can document them, identify the gaps where no commitment or action has been made and prioritize work on those gaps through the CARP.
c. Note: We are documenting where suggestions for adaptation have been developed under other plans and processes, however, these are not being treated as commitments.

6. Aggregate Vulnerability Ranking

a. Sum of results of: Exposure + Sensitivity + Consequence + Adaptive Capacity - In Plan
b. Result is an overall High, Moderate or Low vulnerability ranking for the asset that equates to a primary or secondary priority in moving the asset forward for additional focus in the CARP adaptation planning process.

Priority Asset Vulnerabilities

Assets in the table below have been identified as priority asset vulnerabilities through the process outlined above. Following the table, there is a detailed vulnerability summary for each of these assets. These vulnerability summaries follow the adaptation planning framework developed by the Adapting to Rising Tides (ART) Program. The ART framework calls for considering vulnerability in terms of exposure, consequence, sensitivity and adaptive capacity. The summaries below consider the physical, functional, governance, and informational components of an asset (or asset-management) that contribute to its sensitivities to climate impacts.

Please note that in cases where informational sensitives are listed (e.g. lack of information on pump condition), this means that the project team has been informed that the data is not collected or is very challenging to access. While we are happy to be corrected if the information does exist, we do not expect reviewers to solve this kind of information gap.

Spots where the project team still needs help filling gaps are flagged in italics. Corrections or additional details are welcome.

Summaries of shoreline vulnerabilities are accompanied by two maps:

1. Map 1 = shoreline segment and extent of inundation for 24, 36, and 48 inches of SLR
2. Map 2 = shoreline segment and depth of inundation for 36” SLR scenario

Priority Assets Table

Asset Category	Asset Name	Exposure (SLR)	Exposure (25-Year Flood)	Sensitivity	Consequence	Adaptive Capacity
Shoreline and Natural Areas	Shoreline adjacent to Webster and Posey Tubes	Moderate (36" SLR)	None	Low	High	Moderate
	Veteran's Court Seawall	Moderate (36" SLR)	None	High	Moderate	Moderate
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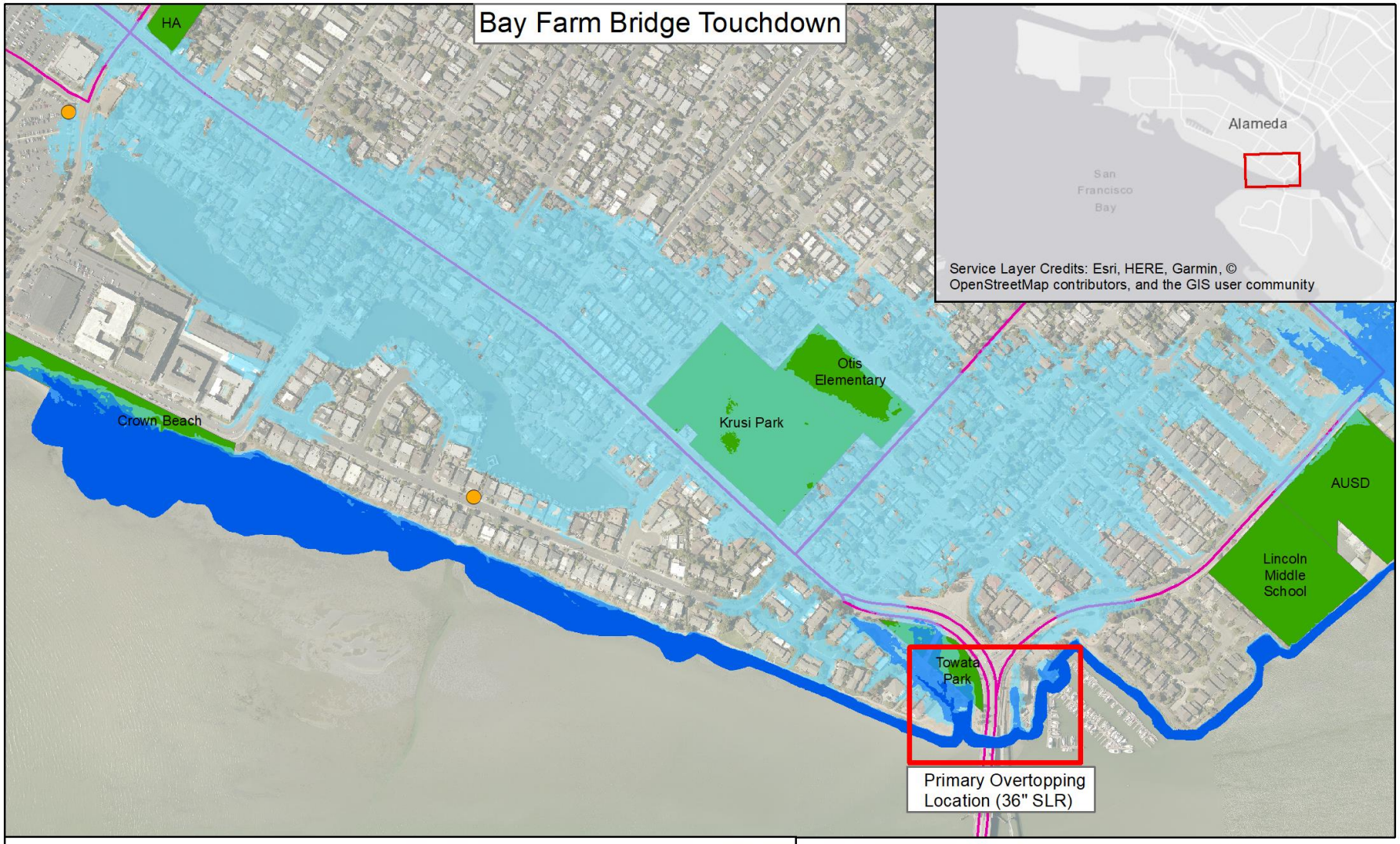
	State Route 61	Moderate (36" SLR)	High (1ft+ flood)	Low	High	Moderate

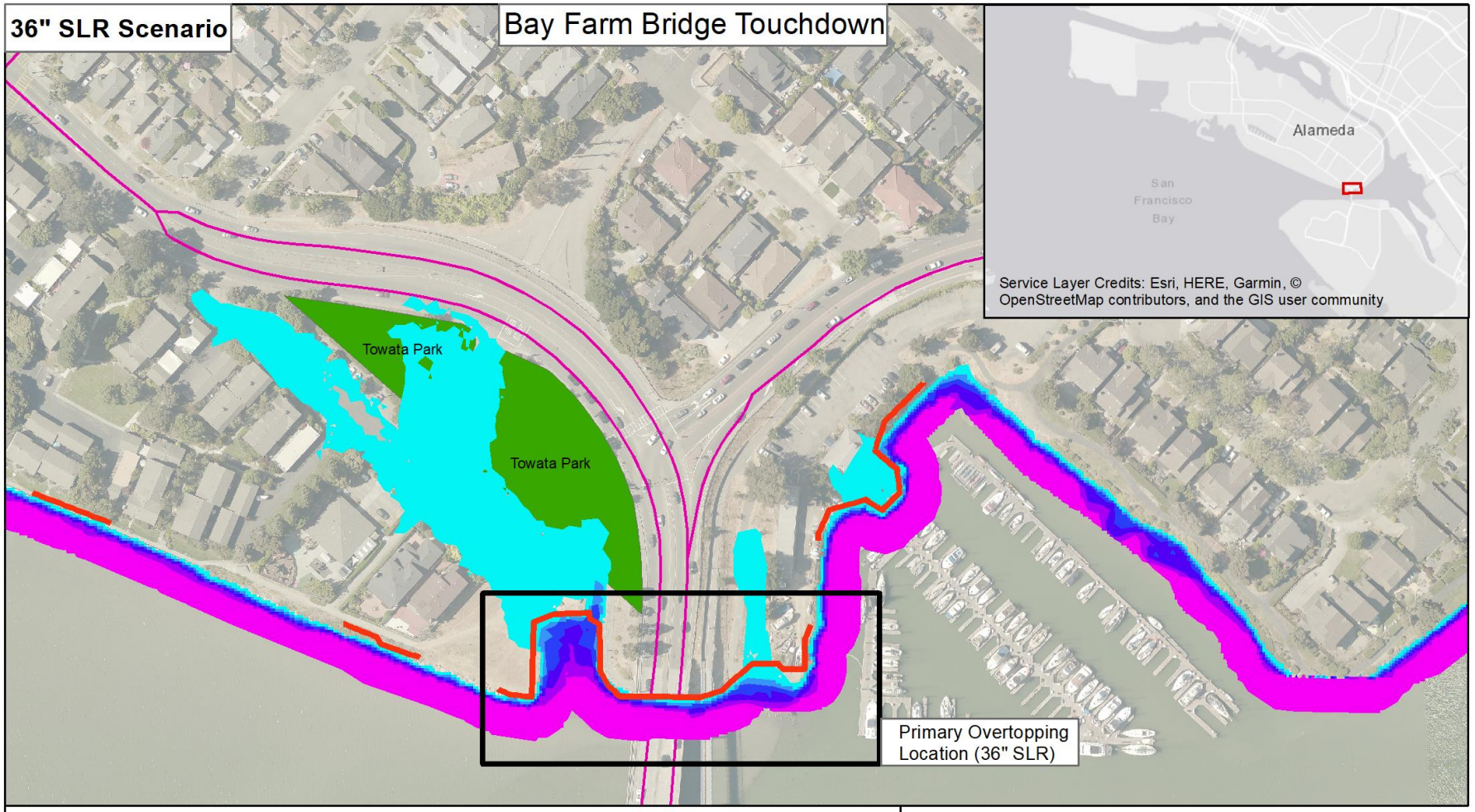
Bay Farm Island Bridge Touchdown	
Description: The area of concern is the shoreline protection along the northern Bay Farm Island Bridge Touchdown area. The shoreline provides flood protection to the adjacent residential area, Bridgeview Isle, and Krusi Park.	
Key Issue(s)	• Shoreline protection structures along the Bay Farm Island Bridge Touchdown currently provide flood protection up to a total water level of about 48." At this point, overtopping occurs at several other spots along the southeastern and eastern shoreline of Alameda Island, failing to provide flood protection for residential areas and community assets.
Exposure	• Overtopping of the shoreline directly to the west of the bridge (on the Alameda Island side) begins at a total water level of 24." At a total water level of 36" Bridgeview Isle and some nearby houses are impacted. At 48," Otis Dr., Krusi Park, and surrounding streets are inundated, with flooding extending northwest towards lagoons and northeast along High St and Peach St. At a total water level of 48," flood waters are coming from several sources in this area.
Sensitivity	Governance: • The bridge is within Caltrans' Right of Way (and Caltrans conducts large-scale repairs). The bridge approaches are protected from flooding by shoreline protection under the jurisdiction of the City of Alameda. Coordination among multiple agencies is necessary to increase resilience. Informational • At a total water level of 48," there is a risk of flooding large neighborhoods in southeastern and eastern Alameda Island. Because the shoreline overtops at several locations in this general vicinity, it is not clear which overtopping location is likely to lead to the most flooding, making it challenging to prioritize actions and thus suggesting an integrated approach along the entire area. Functional: • Overtopping of this section of shoreline leads to flooding of Otis Dr, Fernside Dr, and High Street, which connect to the Bay Farm Island Bridge, thus serving as important connections between Alameda and Bay Farm Island.
Consequence	• Bay Farm Island Bridge carries over *xx* vehicles daily, including commuters, goods movement, residents, and emergency response, as well as bus routes. The main bridge and the bike / pedestrian bridge, which runs parallel, are the only bridges connecting Bay Farm Island and Alameda Island. Bay Farm Island (which is not actually an Island) would remain connected to the mainland through Oakland. • Flooding of residential neighborhoods, Otis Elementary, and Krusi Park.

Shoreline and Natural Areas



Produced for: City of Alameda
Produced by: ERG
Date: December 2018
Source Credits: City of Alameda, AC Transit, BCDC

Shoreline and Natural Areas



BCDC 36" SLR Scenario - Water Depth

- Less than 1 ft
- 1-2 ft
- 2-3 ft
- 3-4 ft
- 4-5 ft
- Greater than 5 ft
- Overtopping Locations

- AC Transit Bus Routes - Alameda Only
- Storm Drain Pump Stations
- Sewer Pump Stations

Asset Inventory (from 2016 LHMP)

- Critical Recovery Priority (from LHMP)
- Other Recovery Priority (from LHMP)

0 0.05 0.1 Miles

N

S

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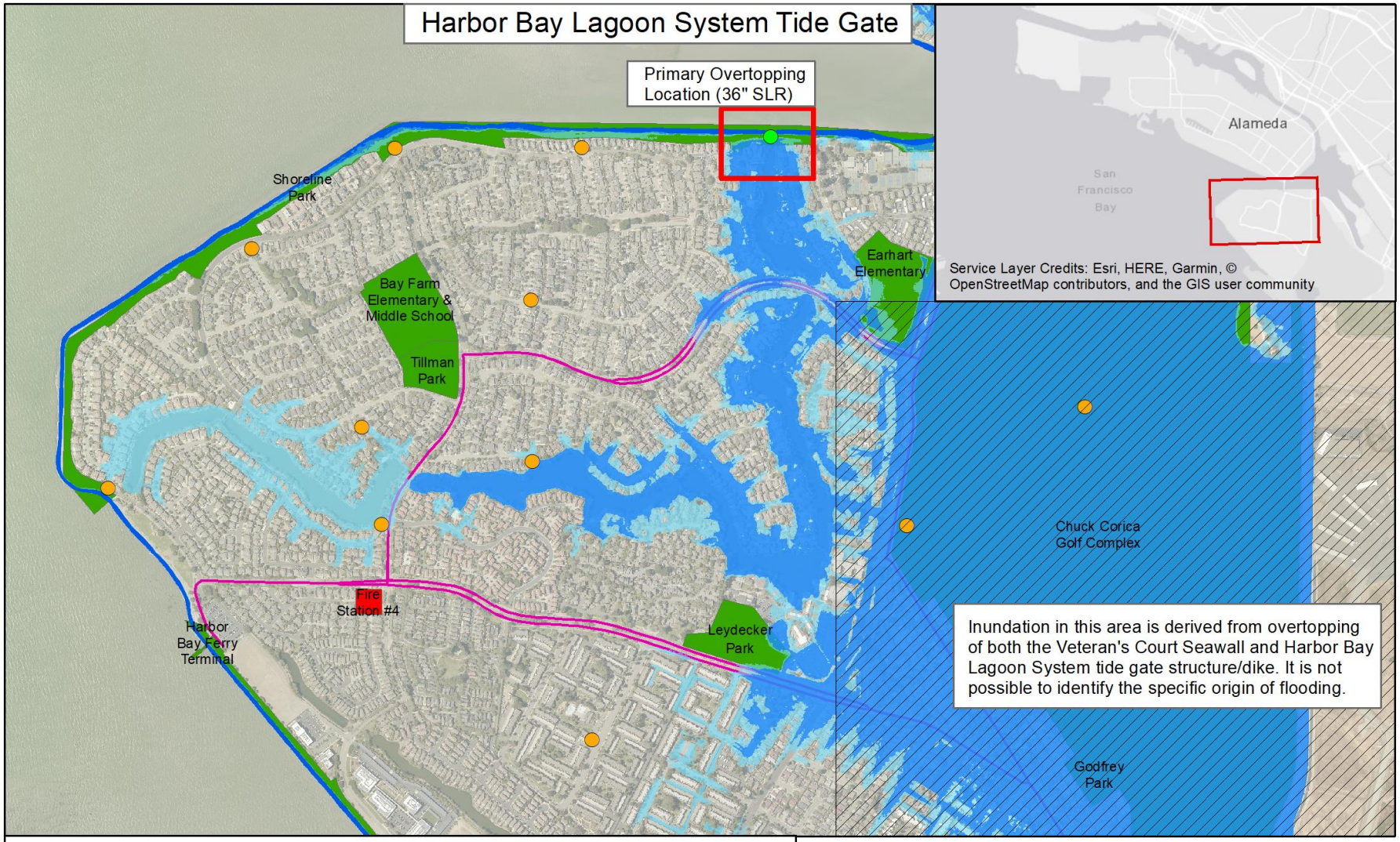
Bay Farm Island Lagoon System 1 North Outlet Gate and Dike	
Description: Bay Farm Island has two lagoon systems. System 1, built is 1979, is on the north end of Bay Farm. The system draws water in through an intake pipe located at the south-western side of the system (just beyond where Creedon Circle turns into Adelphian Way). The system routes water out through its North Outlet Gate, located just west of the Harbor Bay Club. The North Outlet Gate and the adjacent shoreline are priority areas of concern. There is a narrow, 100-ft long isthmus of land between the end of the lagoon system and San Leandro Bay (where the outlet gate is located) that can be considered a dike. The dike is not a certified levee. Lagoon operations are carried out by the City Maintenance Department in accordance with a 1994 Operation and Maintenance Agreement for Harbor Bay Lagoon. Operations are carried out from the lagoon maintenance yard, with maintenance staff lowering water levels to maintain enough freeboard to account for additional inputs in the winter and expected storms.	
Key Issue(s)	• The lagoon system as a whole is at risk of flooding from sea level, storm surges, and major rainfall events due to a poorly maintained outlet gate, a slow pump for lowering water levels, and inaccurate system for monitoring water levels. The dike separates the lagoon from San Leandro Bay, is quite low and is not a certified levee. This makes it vulnerable to overtopping and potentially earthquake damage. Adaptation action will require coordination among the City, HOAs, and private property owners who are involved in system ownership and management in different capacities.
Exposure	• The dike is vulnerable to overtopping at total water level of 36”. This leads to overtopping of the banks of the lagoon and flooding of surrounding areas.
Sensitivity	Governance: • While gate and pump operations are the responsibility of the City, responsibility for maintaining the lagoon retailing walls is shared among homeowners’ associations, private property owners, and the City (based on who owns the adjacent property). This impacts health of the dike and the lagoon system. The tide gates and pumps are owned and managed by the Harbor Bay Island Homeowners’ Association and the City of Alameda so decisions on changes in management are made collectively. Informational: • No information on condition of outlet pipe at North Gate. • No information on condition of culverts that feed into lagoons. Functional: • The pressure transducers used to measure water levels in the lagoon (and determine when water must be pumped out) are inaccurate and unreliable.

Bay Farm Island Lagoon System 1 North Outlet Gate and Dike	
	• Lagoon water levels are not being measured and tracked to a single datum. Physical: • The dike's is built on fill and its risk of failure during an earthquake is unknown. • The North Gate is made up two electrically-drive tide gates. Since the outer gate is broken, the city has permanently closed it and instead relies on a pump to get water out of the lagoons. In addition, the gates show signs of wear due to wave damage.1 • The pump used to drain the lagoon is undersized and it takes several hours for the lagoon water level to drop several inches. Maintenance staff do not always have enough warning that pumping is needed. Pumping needs will accelerate with sea level rise. • No secondary sensor to tell if a gate has failed (and to auto-close gates). • Lagoon retaining walls are severely low in some spots.
Adaptive Capacity	• There are many operational and physical changes that can made to this site to increase its resilience to flooding issues.
Consequence	• If the dike were to breach or the lagoon system were to fail to drain during a storm, homes, businesses, and roads adjacent to the lagoons could flood.

Ideas already generated for adaptation (for review during development of adaption strategies): The 2015 "Bay Farm Island Lagoon Operations Study" calls for many measures to adapt the lagoon system and dike. *Have some of these measures been implemented? ERG to discuss with Public Works.*

[1] Schaaf and Wheeler. "Bay Farm Island Lagoon Operations." 2015.



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.

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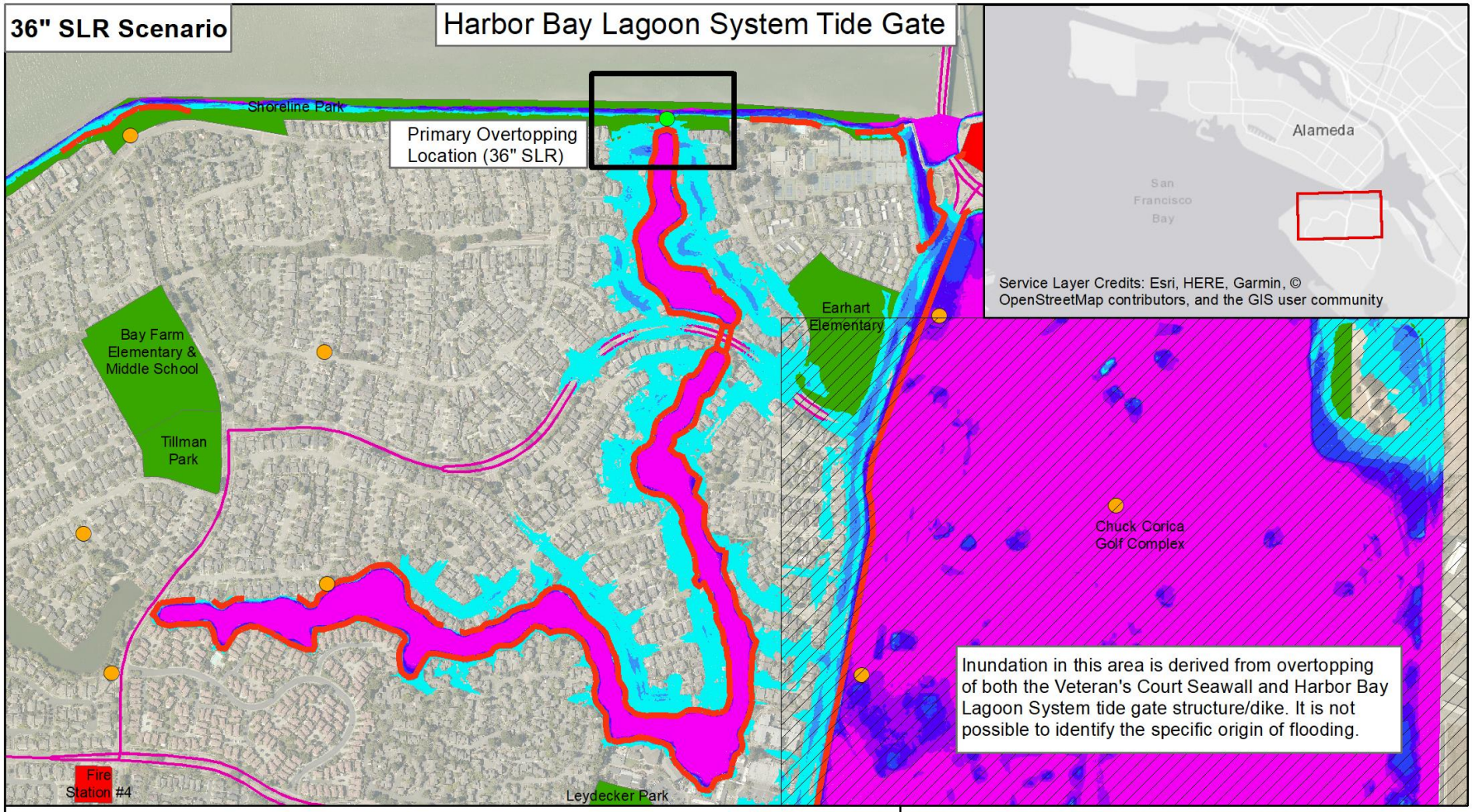
Shoreline and Natural Areas



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- AC Transit Bus Routes - Alameda Only
- Storm Drain Pump Stations
- Sewer Pump Stations

Asset Inventory (from 2016 LHMP)

- Critical Recovery Priority (from LHMP)
- Other Recovery Priority (from LHMP)

0 0.225 0.45 Miles

N S

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.

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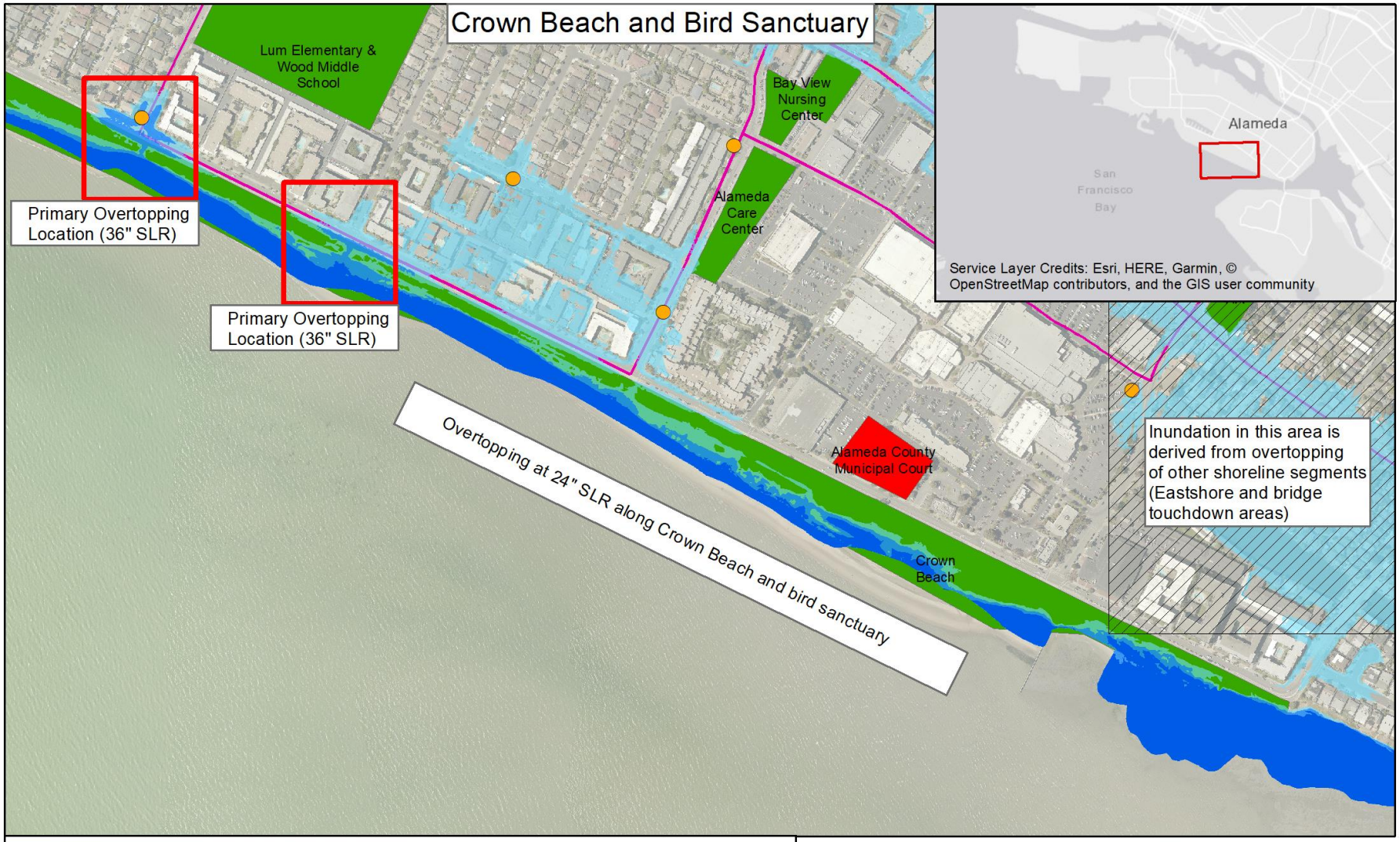
Crown Memorial State Beach	
Description: Crown Memorial State Beach is a popular spot for recreation and education in Alameda. It also provides wildlife habitat with a pickleweed saltmarsh providing bird habitat in the Elsie Roemer Bird Sanctuary to the east end of the beach and an eel grass bed just offshore of the beach that provides juvenile fish habitat.	
Key Issue(s)	• The narrow beach is vulnerable to sea level rise and storm surge flooding and erosion. It is backed by a road, housing, and shopping centers, giving it little capacity to migrate inland. Decisions on adaptation will involve the City (which owns the lands), East Bay Regional Parks District (which manages the beach), and the community which is very invested in this asset.
Exposure	• Lower portions of the sandy beach are susceptible to King Tide flooding today. Large portions of the beach are inundated at a total water level of 36," at which point small segments of Shoreline Dr. begin to overtop. At a total water level of 48," flooding of the adjacent neighborhoods begins, including the apartment on Shoreline Dr. (between Kitty Hawk Rd. and Willow St). There is also overtopping at Broadway and Shoreline Drive, which may contribute to flooding around the larger lagoon system.
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. East Bay Regional Park District has operating agreements and manages both areas as one park. Informational • Unknown whether groins have proven effective in controlling beach erosion. *See if EBRPD can speak to erosion control.* • EBRPD has plans for a Crown Beach Master Plan update (to include sea level rise consideration), however this work is currently on hold and it is unknown when it will proceed. Functional: • Beach provides shoreline protection to Shoreline Dr. and the residential areas behind Shoreline Dr.

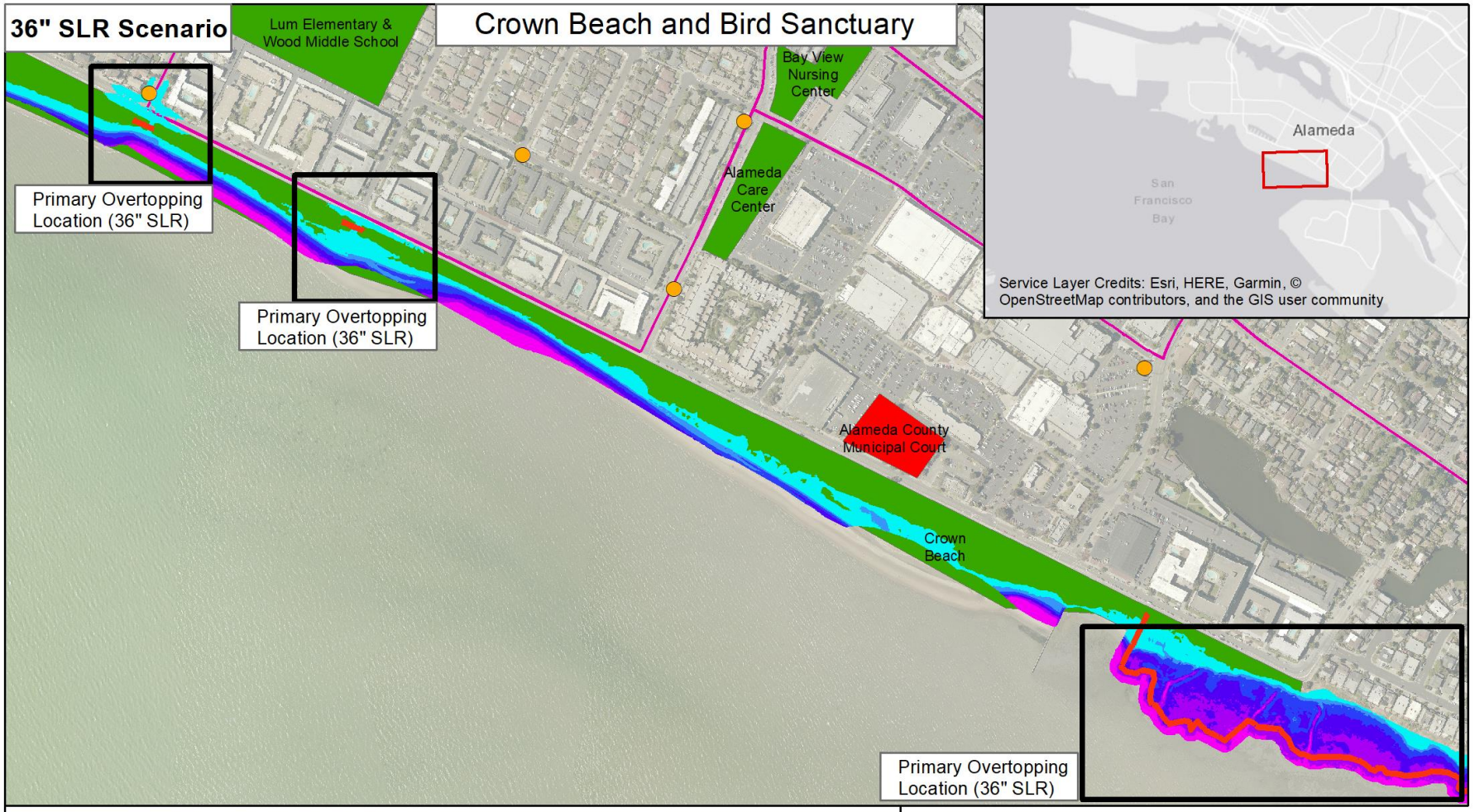
Crown Memorial State Beach	
	Physical: • Crown Memorial State Beach, comprised of approximately 70 acres of sandy beach, stretches 2.5 miles. The sand was pumped onto the beach in 2013 after the beach had become heavily eroded. Groins are used to keep the sand in place. • Just offshore is an eelgrass bed, a sensitive resource that provides nursery habitat for a variety of juvenile fish and a food source for aquatic birds.
Adaptive Capacity	• The beach is very narrow and backed by a road so there is limited space to move inland as the beach erodes or lower portions are flooded.
Consequence	• Elsie Roemer Bird Sanctuary is within the eastern boundary of Crown Beach. This pickleweed salt marsh provides habitat to local and migrating shorebirds. This important habitat could be lost. • 1.5 million people visit the beach annually and naturalists run nearly 450 programs per year about the Bay environment out of the Beach and its Crab Cove Visitor Center (as of 2016). The beach is a popular spot for kiteboarding, windsurfing, walking, and other forms of beachside recreation. It is one of a small number of sandy beaches in the east bay.

Ideas already generated for adaptation (for review during development of adaption strategies: Shoreline Dr. Bike path enhancements were included in in 2011 Bicycle Master Plan. EBRPD planned to increase the width of the bike path (2.13 miles south of Shoreline Dr) and resurface the path. Under EBRPD, a Crown Beach Master Plan Update is planned, however, the work is currently on hold. *Request update from EBRPD.*

Shoreline and Natural Areas



Shoreline and Natural Areas



BCDC 36" SLR Scenario - Water Depth

- Less than 1 ft
- 1-2 ft
- 2-3 ft
- 3-4 ft
- 4-5 ft
- Greater than 5 ft
- Overtopping Locations

- AC Transit Bus Routes - Alameda Only
- Storm Drain Pump Stations
- Sewer Pump Stations

Asset Inventory (from 2016 LHMP)

- Critical Recovery Priority (from LHMP)
- Other Recovery Priority (from LHMP)

0 0.175 0.35 Miles

N

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Produced for: City of Alameda
Produced by: ERG
Date: December 2018
Source Credits: City of Alameda, AC Transit, BCDC

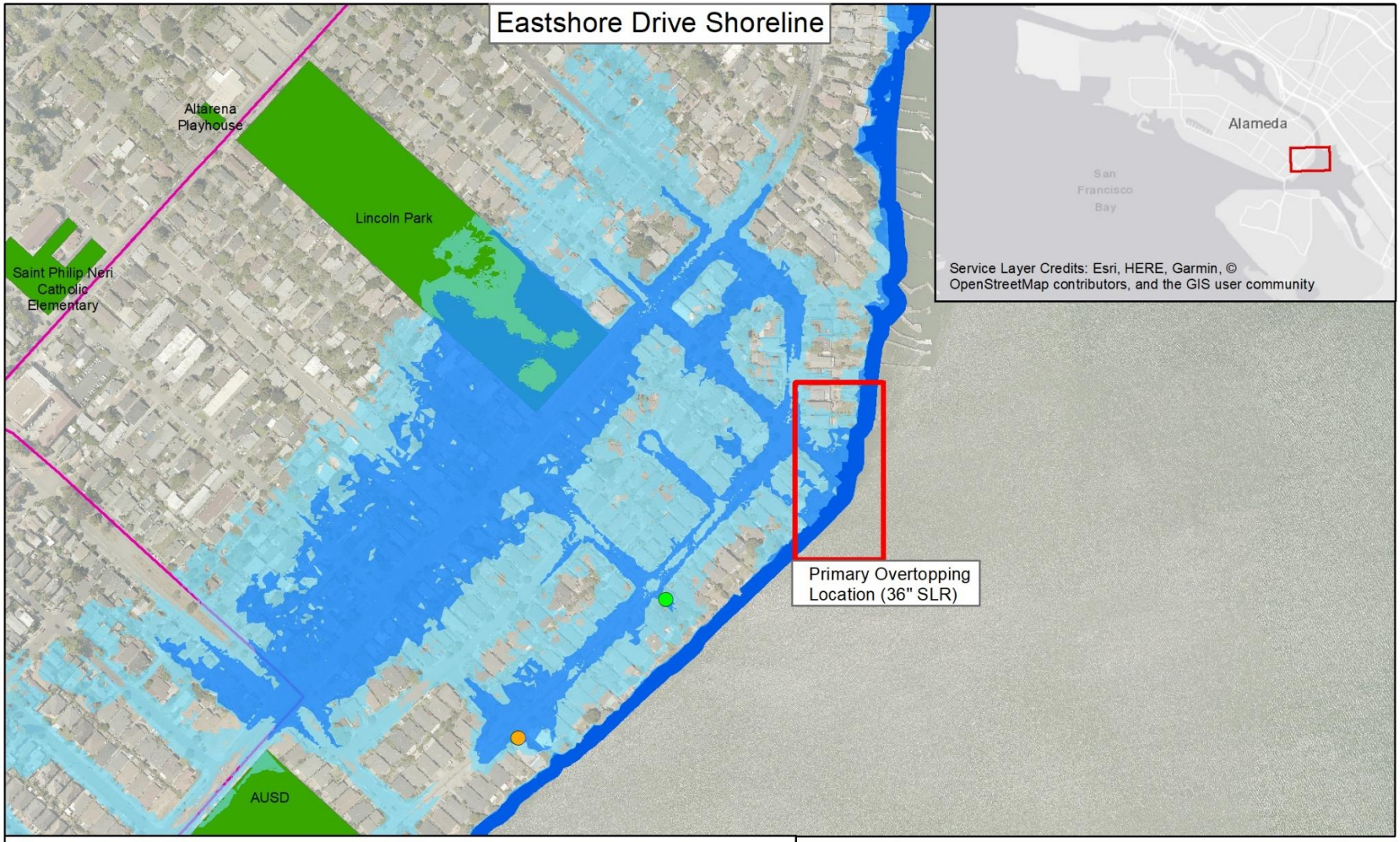
Eastshore Drive (adjacent shoreline)	
Description: Eastshore Drive is the easternmost road running east-south in Alameda, providing access to the Eastshore and Fernside residential neighborhoods. These neighborhoods have homes with private docks directly on San Leandro Bay. Though there is are several designated points of public access along Eastshore Drive (and the city is working to improve them), there are no extensive public trails or parks running along the water (in juxtaposition to the southern waterfront)[2]. The eastern waterfront is dominated by private homes. FEMA recently determined that sections of the Eastshore neighborhood are within the 100-year flood zone.	
Key Issue(s)	• This is a low-lying section of the city and shoreline and a large residential area (and the stormwater pump serving the area) is vulnerable to flooding from sea level, storm surges, and major rainfall events. There is limited space available for adaptation since homes are built out close to the waterfront. • A potentially complex collaboration with homeowners will be needed to agree upon shoreline protection measures since waterfront homeowners own their segment of shoreline.
Exposure	• When water overtops the shoreline protection structures at a total water level of 36”, it moves inland, inundating stretches of Fernside Blvd, the stormwater pump station serving the area, and moving as far inland as the baseball field by Harrison Recreation Center.
Sensitivity	Governance: • In 2005, the Army Corps transferred ownership over submerged lands under the estuary to the City of Alameda, which in turn sold the land to property owners at the sites allowing them to get permits to make repairs on docks and other waterfront structures.[3] Individual property rights over these submerged lands may mean that may property owners need to buy in to potential shoreline protection solutions proposed. • Reliance on individual property owner's management of their segment of shoreline protection. Informational • No known inventory of condition of current shoreline protection structures (beyond basic shoreline elevation data).

[2] https://www.eastbaytimes.com/2017/06/07/around-the-island-alameda-is-improving-east-end-public-access-to-the-water/
[3] https://alamedasun.com/news/city-update-east-end-public-access
https://www.eastbaytimes.com/2017/06/07/around-the-island-alameda-is-improving-east-end-public-access-to-the-water/

Eastshore Drive (adjacent shoreline)	
	Functional: • Shoreline provides protection to broader residential community and residential streets.
Adaptive Capacity	• Space available for building shoreline protection is constrained, given location of homes.
Consequence	• Overtopping of shoreline may lead to flooding of large residential neighborhood.

Ideas already generated for adaptation (for review during development of adaption strategies): Resilient by Design project envisions "tidal cities" for this area over the long term.

Shoreline and Natural Areas



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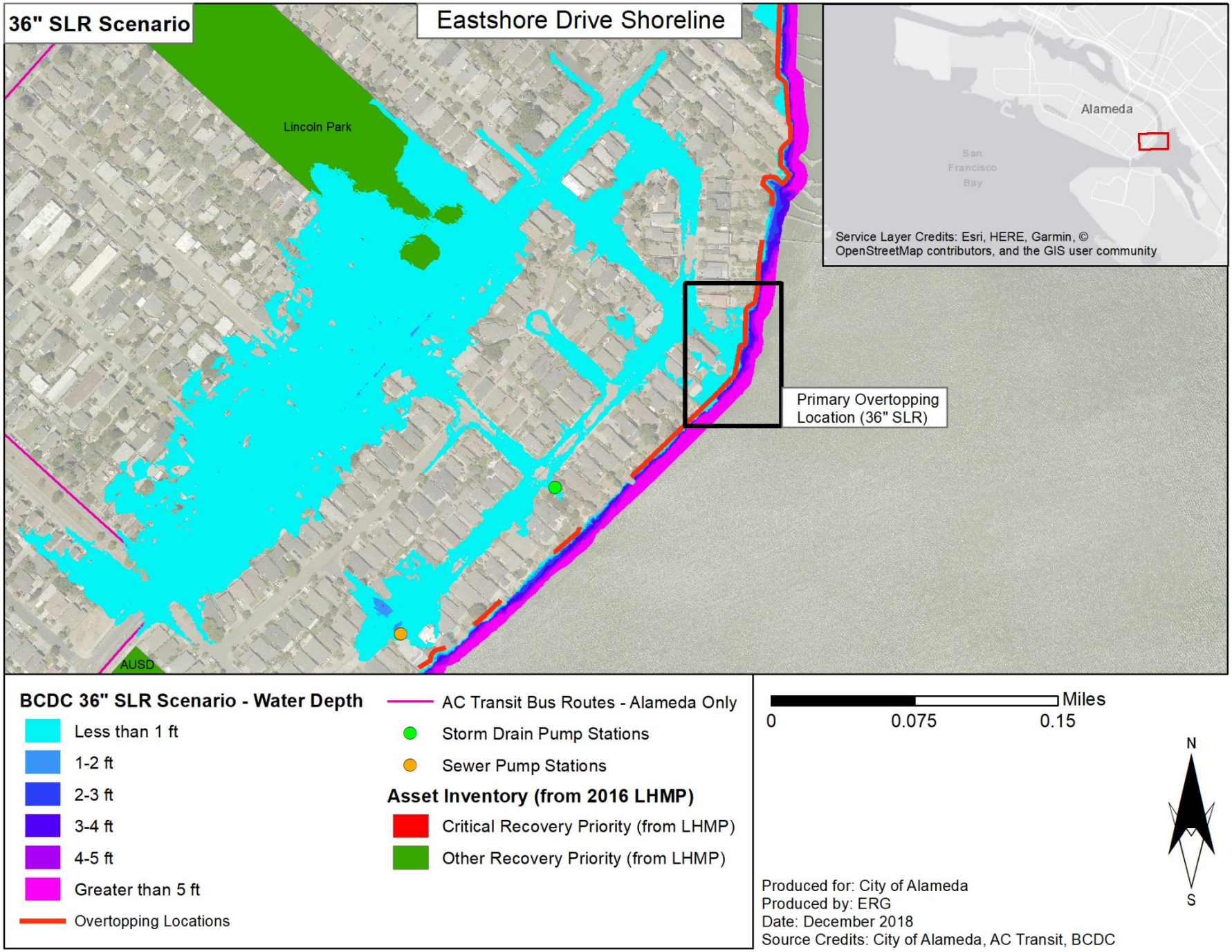
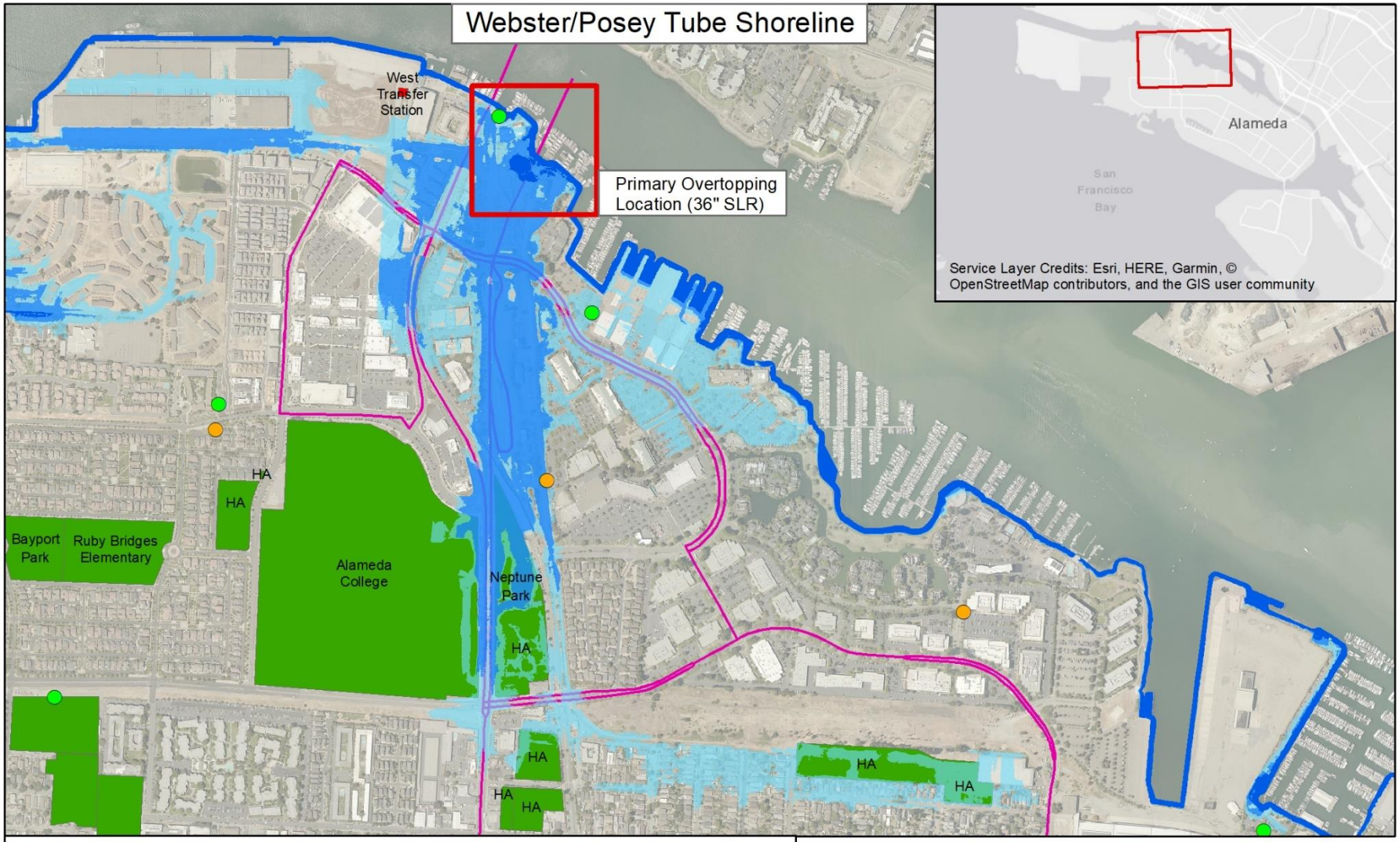
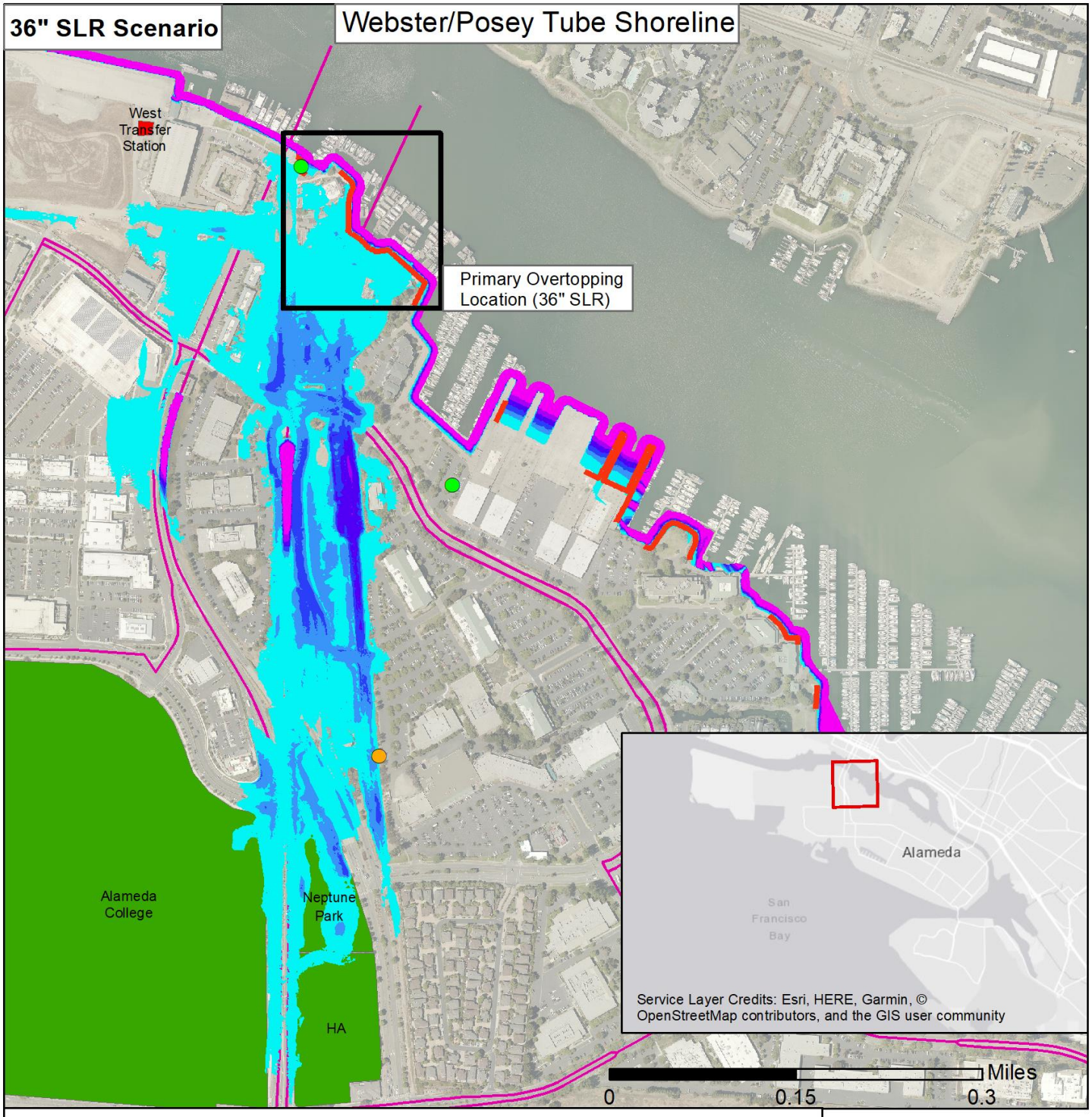

36" SLR Scenario
Eastshore Drive Shoreline
Lincoln Park
AUSD
Alameda
San Francisco Bay
Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Primary Overtopping Location (36" SLR)
BCDC 36" SLR Scenario - Water Depth
Less than 1 ft
1-2 ft
2-3 ft
3-4 ft
4-5 ft
Greater than 5 ft
Overtopping Locations
AC Transit Bus Routes - Alameda Only
Storm Drain Pump Stations
Sewer Pump Stations
Asset Inventory (from 2016 LHMP)
Critical Recovery Priority (from LHMP)
Other Recovery Priority (from LHMP)
Miles
0
0.075
0.15
N
S
Produced for: City of Alameda
Produced by: ERG
Date: December 2018
Source Credits: City of Alameda, AC Transit, BCDC

Posey and Webster Tubes (adjacent shoreline)	
Description: The area of concern is the shoreline protection lined with yacht clubs, docks, and public trails near Oakmont of Mariner Point. If the shoreline here is overtopped, the Webster tube entrance and Posey tube exit may flood.	
Key Issue(s)	• Overtopping of a stretch of shoreline lined with yacht clubs, docks, and a public trail leads to inundation of one of the tubes, among the most critical transportation assets on the Island. Confined space will pose design challenges for securing the shoreline while maintaining public access to the waterfront.
Exposure	• At a total water level of 36", the shoreline near Oakmont of Mariner Point overtops leading to inundation of the Webster Tube entrance, the Posey Tube exit, Webster Street, Mariner Square Dr., and the Mariner Square Shopping Center.
Sensitivity	Governance: • The immediate shoreline is lined with yacht clubs and docks, so these yacht club owners are likely involved in management of the shoreline protection at these sites. *More information needed on governance, ownership of shoreline protection along this stretch of shoreline.* • There is a public access along the shoreline that needs to be maintained in accordance with BCDC requirements. Physical: • The shoreline protection structures, in some cases fronted with riprap, suffer from erosion due to deferred maintenance (reference: 427 Alameda Report).
Adaptive Capacity	• The site may be able to be adapted through engineered structures (e.g., construction of a seawall and levee) between the public path and the water. While the City has considered concept plans for structures that would provide enough protection to raise the area out of the FEMA 100-year flood zone, it is not clear if these structures could be easily adapted for sea level rise.
Consequence	• Interruptions to the Posey and Webster tubes would severely impact the entire city, as the tubes provide critical access between the City of Alameda and surrounding areas. It would not be possible for the bridges and ferry service to entirely make up for this loss in movement of people, goods, and services. • Shoreline overtopping leads to inundation of Oakmont of Mariner Point Assisted Living and Memory Care.

Shoreline and Natural Areas





BCDC 36" SLR Scenario - Water Depth

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- 4-5 ft
- Greater than 5 ft
- Overtopping Locations
- AC Transit Bus Routes - Alameda Only
- Storm Drain Pump Stations
- Sewer Pump Stations

Asset Inventory (from 2016 LHMP)

- Critical Recovery Priority (from LHMP)
- Other Recovery Priority (from LHMP)

N

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Produced for: City of Alameda
Produced by: ERG
Date: December 2018
Source Credits: City of Alameda, AC Transit, BCDC

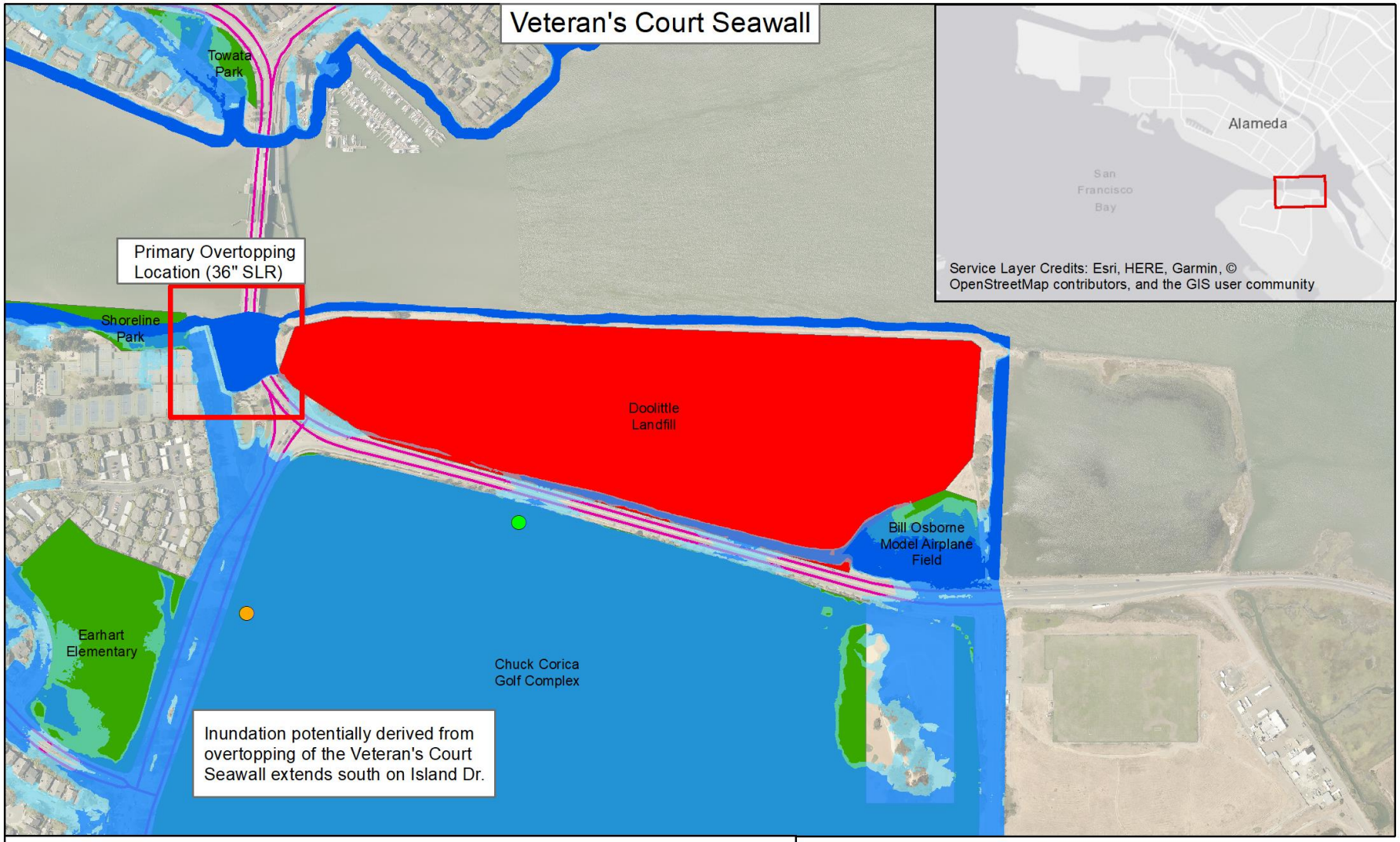
Veteran's Court Seawall	
Description: The Veteran's Court Seawall is non-FEMA accredited seawall providing shoreline flood protection to the Veteran's Court, the Doolittle Drive-Island Drive interchange, and Veteran's Memorial Park.	
Key Issue Statement	• The Veteran's Court Seawall is located within FEMA's 100-year flood zone. Overtopping of the seawall during a 100-year event or at a total water level of 36" will flood a major intersection of Bay Farm Island (Doolittle and Island Drives). While there are options for adapting this low stretch of shoreline, nearby stretches of shoreline will overtop at similar water levels, so a coordinated strategy is needed.
Exposure	• The Veteran's Court overtops at a total water level of 36", which is below the height of a 100-year storm. • This shoreline is within the FEMA 100-year floodplain. • Overtopping leads to inundation of Doolittle and Island Drives.
Sensitivity	Governance: • Seawall is owned by the City. • The seawall is not FEMA accredited. Functional: • Given that there are other low and vulnerable spots along this stretch of shoreline, fixing the seawall alone will not solve all local flood risk. Overtopping would also need to be addressed at the lagoon outlet, the banks of the lagoon, Doolittle Drive, and Island Drive to address tidal flood risk in this general area. Physical: • Alameda's 2008 Storm Drain Master Plan indicates that seepage is observed along the seawall during high tides.
Adaptive Capacity	• Roadway could be elevated, or a floodgate installed to reduce flood risk (as described in 2017 Storm Drain Master Plan Update). Additional measures may be needed to prevent flooding of intersection.

Veteran's Court Seawall	
Consequence	• If the seawall fails or overtops, the Veteran's Court Area, including the Island Drive and Doolittle Drive intersection, is expected to flood. These are essential access roads on Bay Farm Island so interruptions will have major impacts to the community.

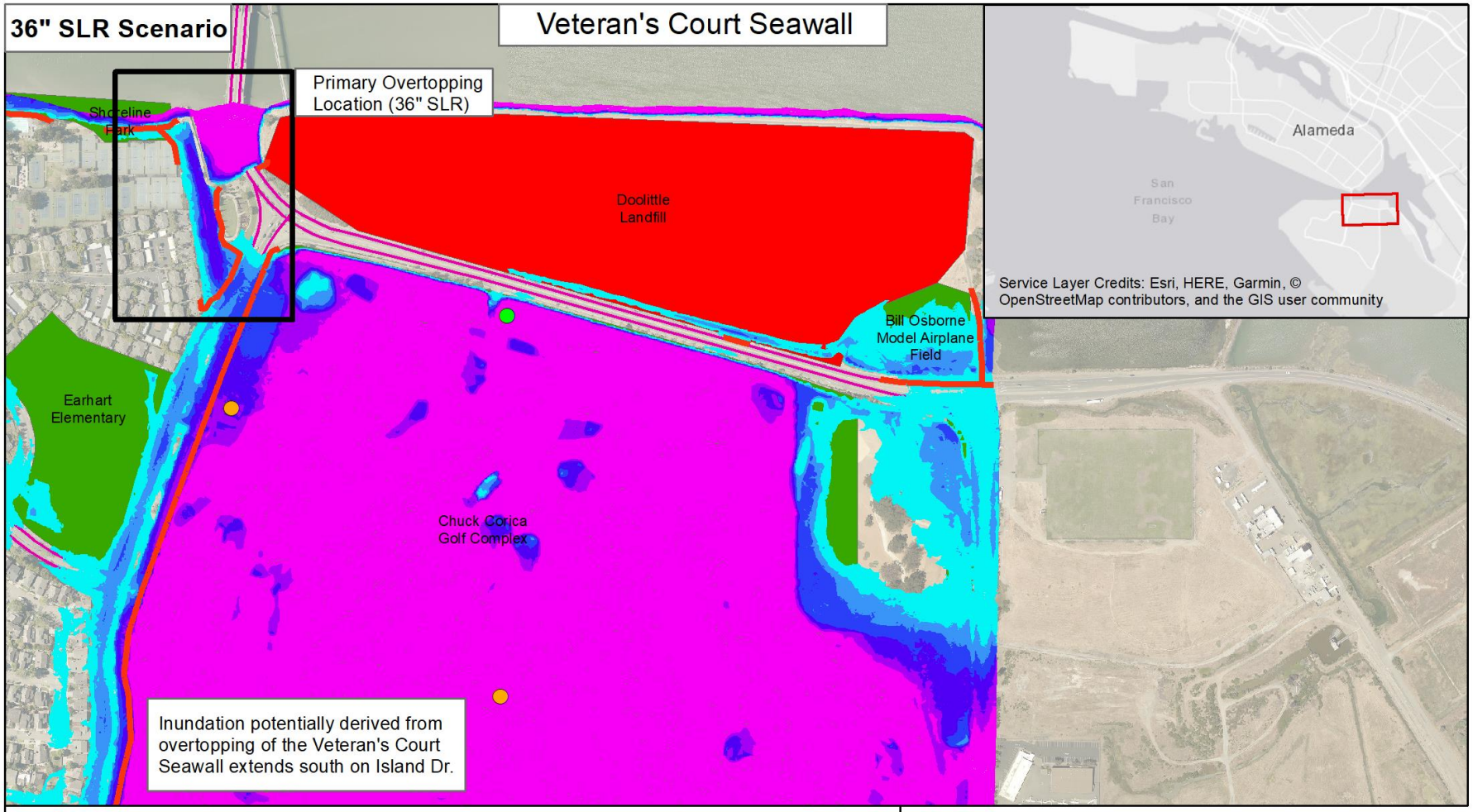
Ideas already generated for adaptation (for review during development of adaption strategies): The 2017 Storm Drain Master Plan Update memo calls for raising roadway or installing a floodgate to address some of this flood risk. Adaptation strategies were proposed in the ART case study memo: http://www.adaptingtorisingtides.org/wp-content/uploads/2014/12/BayFarmIslandTechnicalMemo.pdf

Resilient by Design, All Bay Collective Team work proposed work in this area.

Shoreline and Natural Areas



Shoreline and Natural Areas



BCDC 36" SLR Scenario - Water Depth

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- 3-4 ft
- 4-5 ft
- Greater than 5 ft
- Overtopping Locations

- AC Transit Bus Routes - Alameda Only
- Storm Drain Pump Stations
- Sewer Pump Stations

Asset Inventory (from 2016 LHMP)

- Critical Recovery Priority (from LHMP)
- Other Recovery Priority (from LHMP)

0 0.15 0.3 Miles

N

S

Produced for: City of Alameda
Produced by: ERG
Date: December 2018
Source Credits: City of Alameda, AC Transit, BCDC

Roadways Utilized by AC Transit	
Description: AC Transit bus routes serves transit-dependent or socially vulnerable communities and provide critical connections between Alameda and the mainland.	
Key Issue(s)	• There are multiple roads and specific road segments in Alameda that are exposed to flooding from sea level, storm surges, and major rainfall events. Those roads utilized by AC Transit bus routes serving transit-dependent or socially vulnerable communities are considered high priority due to their importance to commuters. Given the limited number of connections between Alameda and the mainland, disruptions to key roads like Webster St. can have large impacts on the flow of traffic around the city. Many of the road segments used by AC Transit are also high-use roadways for commuter and commercial traffic. Adjacent connecting streets were not designed to handle the additional traffic volume that could occur if these key roads and road segments were closed or restricted.

Exposure	• Majority of exposure to key roadway segments utilized by AC Transit is due to storm drain flooding – some segments are exposed to SLR in isolated locations
	• <u>AC Transit Route 96 (Alameda Point)</u>:
	  ○ Exposed at 24" SLR along Main St. near Midway Ave. Water depth at this scenario is generally less than 1 ft. Inundation is derived from overtopping of the north shoreline near the end of the Alameda Point runway.
	  ○ Additional flooding from SLR along Marina Village Pkwy and Mariner Square Loop at 36" of SLR due to overtopping of the shoreline near the Webster and Posey Tubes. Water depths at this scenario of 1-3 ft.
	  ○ Higher SLR scenarios result in more extensive and deeper flooding along route, primarily due to overtopping of shoreline near Webster and Posey Tubes.
	  ○ Substantial exposure to storm drain flooding from a modeled 25-year event. Flooding greater than 1 ft above the street could occur at multiple locations along the route including: sections of Main St. between Stargell Ave. and Atlantic Ave., along Webster St. near approach to tubes, and along Pacific Ave.
	• <u>AC Transit Route 51A (major trunk route)</u>:
	  ○ Exposed at 36" of SLR along Webster St. near Webster/Posey Tubes. No other areas of exposure to SLR.
	  ○ Substantial exposure to storm drain flooding along Webster St. near approach to tubes. Minor storm drain flooding (<0.5ft) near Fernside Ave. bridge and along Santa Clara Ave.
	• List of priority affected roadway segments for key AC Transit routes (more details in bullets above):
	  ○ Main St. between Stargell Ave., and Atlantic Ave.
	  ○ Pacific Ave. near intersection with 4th St.
	  ○ Corner of Atlantic Ave., and Webster St.
	  ○ Mariner Square Loop
	  ○ Webster St. (segment owned by City of Alameda)

Roadways Utilized by AC Transit	
	○ Otis Dr. between Park St. and Broadway (used by Routes 20, 21, 314, 356, O, W, OX)
Sensitivity	Governance: • City of Alameda is responsible for maintenance and upgrades to most roadways utilized by AC Transit with the exception of Caltrans-owned SR260 and SR61. • Decisions on changes to route alignment or upgrades to transit services (e.g., creation of Bus Rapid Transit corridors) are made by AC Transit, a special district with an elected governing board. The City of Alameda is part of a voting ward with approximately 285,000 residents that includes portions of Oakland and San Leandro – Alameda accounts for approximately 28% of the ward population. • Alameda is a relatively minor component of the AC Transit system, which has most of its riders in Oakland, Berkeley and elsewhere. The City is part of the Northern Alameda County planning area (one of 4 planning areas for AC Transit) that includes a total population of 616,000. This could lead to less attention being paid to the transit system within Alameda except when it is part of a major transit corridor (e.g., AC Transit Route 51A). Informational • City of Alameda is required to conduct a condition assessment of roadways on a regular basis. This assessment considers pavement condition as well as other important components like culverts. Functional: • AC Transit routes have multiple connections with regional transit services, primarily BART, and are heavily utilized by commuters that travel around the Bay Area. • AC Transit Route 51A is one of the highest volume routes in the system, with an average daily ridership of greater than 20,000. It is unclear what portion of that ridership is within the City of Alameda. • AC Transit Route 96 is a relatively low-use route but serves highly transit-dependent and socially vulnerable communities on 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 indicators evaluated by the ART program. Specific indicators include: ○ Percent households with very low income – greater than 50% in Alameda Point, some adjacent tracts also greater than 50%

Roadways Utilized by AC Transit	
	○ Percent households with no vehicle – between 15-20% in Alameda Point (relatively high for Alameda); greater than 25% is tracts just east of and adjacent to Webster St. ○ Percent households with rental housing cost burden (HCB) – highest along Atlantic Ave. (30-40%) and east of/adjacent to Webster St. (30-40%) Physical: • Several highly exposed roads are critical transportation corridors in Alameda, including Webster St. and Otis Dr. Both roads have substantial daily traffic and known issues with congestion currently. Disruptions to the roadways that restrict traffic flow could have large impacts on congestion citywide. • Flooding issues during precipitation events along Mariner Square Dr. (used by AC Transit Route 96) due to road sections being higher than storm system catch basin inlets. • Details for specific key roadway segments: ○ Webster St. – road is slated for resurfacing in upcoming years; no known issues with ponding, but substantial exposure to storm drain flooding during a modeled 25-year storm event; few details on culvert condition. ○ Otis Dr. – Alameda Street Master Plan indicates many segments of Otis Dr. need "urgent" attention; the segment of Otis Dr. between Park St. and Broadway was last reconstructed in 1986 (other segments reconstructed in 2010/2011 timeframe).
Adaptive Capacity	• Almost all segments of Otis Dr. are candidates for the Complete Streets program. • A current Caltrans-funded project will address the segment of Otis Dr. between Park St. and Broadway, which is the segment with the highest exposure to storm drain flooding. • Modifications to roadways are often expensive and require long environmental review and other permitting processes. It may be difficult to identify short-term strategies that allow rapid response to threats.
Consequence	• Multiple AC Transit bus routes serve transit-dependent or disadvantaged communities in Alameda. Closure or disruptions to roads on these routes would limit the ability of these residents to commute to work. • Substantial impacts to the transport of goods around Alameda and on/off the islands could occur if key roads like Webster St. and Otis Dr. were closed or disrupted. Webster St. specifically is a heavily-utilized roadway with substantial commercial traffic.

Transportation

Ideas already generated for adaptation (for review during development of adaption strategies): Transportation Choices Plan includes a new Bus Rapid Transit (BRT) route for Alameda Point. Street Master Plan specifies resurfacing and other improvements to roadway segments but generally related to routine maintenance and not adaptations to future conditions.

Questions:

- *What is the level of collaboration between AC Transit and the City of Alameda for maintaining and upgrading bus routes and bus stops?*
- *What is the status of the segments of Otis Drive as candidates for the Complete Streets Program?*

SR260 including Posey and Webster Tubes	
Description: SR260 is a critical transportation corridor connecting Alameda and Oakland – the tunnels are one of three ways on or off Alameda Island (others are Park St. Bridge and Bay Farm Island Bridge). The historical average annual daily traffic at the Webster and Posey tubes is approximately 31,500. The route is also a major commercial corridor connecting the Port of Oakland with container storage facilities in Alameda - ~2.5% of the daily traffic is commercial in nature. The Posey Tube is the second oldest underwater tunnel in the United State, built in 1928. Although seismic retrofits were completed in 2004, the age of the tunnel 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, including the Posey and Webster tube are essential to movement of people, goods, and emergency services. However, the tubes are vulnerable due to overtopping risk of the adjacent shoreline. • Mixed jurisdictional oversight of the asset(s) could pose a barrier to implementation of adaptation measures. SR260 is owned and maintained by Caltrans, but the City of Alameda also bears some responsibility and oversight.
Exposure	• SR260 overall and the Webster and Posey Tubes specifically are exposed to flooding due to sea level rise at 36” (BCDC scenario). Inundation likely originates at the northside shoreline near the Oakmont of Mariner Point. At higher SLR scenarios, overtopping of the shoreline near the Main Street Ferry Terminal also impacts access to the tubes and may contribute to flooding within them. • Due to their nature, the tubes are exposed to seismic impacts, although seismic retrofits in 2004 reduced some of this risk. Immersed tubes like the Webster and Posey Tubes are often not anchored in bedrock and are therefore particularly susceptible to liquefaction during seismic events. • There is a high risk of overland flooding near Posey and Webster Tube entrance/exit. Storm drain modeling indicates multiple locations of potential flooding greater than 1 ft above road level immediately adjacent to the tube access points.
Sensitivity	Governance: • SR260 is owned and maintained by Caltrans, but the City of Alameda also has maintenance responsibilities and oversight. Informational • Unclear what the current condition of the Posey Tube is (and the Webster Tube to a lesser degree) and the extent of age-related deterioration to the tube itself (waterproofing) and elements within (electrical systems, ventilation system, roadway).

SR260 including Posey and Webster Tubes	
	• Long-term improvement plans for the tubes are limited in nature or mainly conceptual. There are some planned improvements to SR260 to reduce traffic volume on adjacent roads outside the tubes, but limited information on improvements to the tubes themselves. Functional: • SR260 is a critical transportation corridor for the City of Alameda. Average daily traffic at the tubes is approximately 31,500, including many commercial vehicles transporting materials between the Port of Oakland and container storage facilities in Alameda. • The Posey Tube portal buildings are historic landmarks with art deco styling that are important cultural sites for residents and tourists on both sides of the tube. Physical: • Underground and submerged hazardous waste sites are located along SR260 including adjacent to the tubes. The walls of the tubes are impacted by soot buildup that is a chronic maintenance issue. • Both the Posey and Webster Tubes are “immersed tubes” – precast concrete placed in trenches and sealed. This type of tunnel construction requires careful waterproofing. • The Posey Tube is approaching 100 years old and there is insufficient space in the Webster Tube to accommodate the increase in volume were the Posey Tube to be damaged and closed. • Both tubes rely on functioning ventilation systems to remove exhaust from the tunnels and ensure public safety. • Pedestrian and bicycle access through the tubes (specifically the Posey Tube) is restricted despite recent modifications to the sidewalk in the tunnel.
Adaptive Capacity	• Adaptations to the entrance and exit from the tubes are possible to reduce the potential for the tubes to flood due to SLR inundation or overland flooding. These types of adaptations (e.g., walls near the entrance/exit) would likely not convey long-term resilience to SLR inundation due to the large-scale access impacts indicated by higher SLR scenarios. • Due to their nature, the Posey and Webster Tubes themselves have relatively limited adaptive capacity. Some modifications to the tubes are possible to extend their lifespan but the age of the Posey Tube, is an issue.

SR260 including Posey and Webster Tubes	
	• There is known underground and submerged hazardous waste sites along SR260 including adjacent to tubes. The risk of this waste being mobilized with flooding has not been assessed.
Consequence	• SR260 and the Webster and Posey Tubes are a critical connection between Alameda and the mainland. Multiple bus routes utilize the tubes and transport Alameda residents that are highly transit-dependent. The route is also very important for emergency services and serves as a key evacuation route from Alameda. • Posey Tube was designated to the National Register of Historic Places in 2000. • Flooding at the surface due to sea level rise or overland flooding rapidly impacts the tunnels and makes them impassible. Water draining into the tubes can damage the roadways, metal hardware, and other components including electrical equipment and ventilation systems. • The addition of new water overburden due to sea level rise could potentially compromise the waterproofing of the tubes, especially the Posey Tube due to its age.

Ideas already generated for adaptation (for review during development of adaption strategies): Caltrans State Route 260 Transportation Concept Report (TCR) – signed in 2011 and reaffirmed in 2017.

Questions:

- *Is there a more specific capital improvement plan for SR 260 or does the TCR serve that purpose?*
- *Did the Posey Tube Retrofit (slated for completion in 2016) address restrictions to bi-directional pedestrian/bicycle traffic?*
- *Can you clarify the arrangement between the City and Caltrans for maintenance of and capital improvements to both the tubes and SR260?*

Note: Given SR 260 is primarily composed of the tubes, with small road segments on the Alameda and Oakland sides of the channel, combining these assets into one seemed appropriate. SR260 would be unable to function as a state route is the tubes were compromised.

SR61	
Description: SR61 is a state highway owned and maintained by Caltrans. The route runs from the intersection with SR112 near Oakland Airport across Alameda and terminates at the intersection of Webster St. in Alameda, operating as an important corridor out of the City to Oakland and the airport. The route includes the Bay Farm Island Bridge connecting Alameda Island and Bay Farm Island. Multiple AC Transit bus routes, including several serving transit-dependent or disadvantaged communities, utilize SR61. The City of Alameda has designated SR61 south of Otis Dr. as a primary evacuation route, and the segment on Alameda Island as critical access to the evacuation route.	
Key Issue(s)	• The importance of SR61 as a critical route connecting Alameda and Oakland heightens its vulnerabilities because damage to the road or other disruptions to its operation could have substantial impacts on the flow of commuters and goods on and off of the islands. Although the roadway itself is not exposed to flooding from SLR until mid-century or later, storm events could lead to street flooding along the route that disrupts vehicle travel including AC Transit bus routes that bring commuters from Alameda to Oakland. Existing traffic issues in Alameda would be exacerbated if SR61 were closed or flow was restricted due to flooding, forcing vehicles onto adjacent connecting streets that do not have comparable capacity. Similarly, more frequent disruptions to routes in Oakland like I-880 could lead to increased traffic on SR61, which was not designed to handle that volume of traffic.

Exposure	• Exposure is the result of overtopping at multiple shoreline segments:
	  ○ Veteran's Court Seawall
	  ○ Doolittle Drive
	  ○ Bay Farm Island Bridge Touch Down Area (Alameda Island side)
	• First instance of exposure at 36" SLR
	• Overland flooding exposure due to storm drain flooding (25-year storm event) – modeled flood levels of more than 0.5 ft above the street at multiple locations along route.
	• Storm drain flooding along route primarily on Otis Dr. and near intersection with Webster St.

Sensitivity	Governance: • Caltrans owns and maintains SR61 within the City of Alameda. The Webster St. segment was relinquished to City control in 2014. Caltrans has discussed relinquishing the entirety of SR61 on Alameda Island due to its primary use as a local artery. Informational • There is limited information on the condition of SR61 (roadway, culverts, etc.).

SR61	

	Functional:
	
	• High average daily traffic – 43,600 at Island Dr., and 10,400 at Broadway.
	• Segment of SR61 along Doolittle Dr. south of Otis Dr. is designated as a primary evacuation route by the City of Alameda. Other segments of SR61 within the City are designated as access routes to these primary evacuation routes.
	• Several emergency operations staging areas are located along SR61.
	• Issues with major congestion along SR61 in Alameda during peak hours, primarily the PM commute (southbound). Locations with the largest congestion issues are at the junction of Webster St. and Central Ave. and at Doolittle Dr. and Island Dr.
	• SR61 operations are affected by local Alameda surface streets connecting to SR61, traffic from other adjacent state routes (SR260 and SR112) and diversion of traffic from I-880 due to congestion, construction, or accidents.
	
	Physical:
	
	• Multiple environmental vulnerabilities along SR61 in and around Alameda:
	  ○ Several species of concern found along the corridor including the California Tiger Salamander (ambystoma tigrinum), Western Snowy Plover (Charadrius Alexandrinni Nivosuss), California Seablite (Suaeda Californica), Robust Spineflower (Choriazanther Robusta) and Adobe Sanicle (Sanicula maritime).
	  ○ Several priority development or priority conservation areas within the SR61 area of influence.
	  ○ Known concentrations of underground or submerged hazardous waste sites along the southern end of SR61 and just north of the route in the City of Alameda.

Adaptive Capacity	• Modifications to roadways are often expensive and require long environmental review and other permitting processes. It may be difficult to identify short-term strategies that allow rapid response to threats. • Alterations to SR61 that increase the routes resilience to flooding and other climate threats could have impacts on adjacent connecting streets in Alameda. Careful attention would be needed to ensure strategies to address SR61 do not increase vulnerabilities or consequences elsewhere.
Consequence	• SR61 is a critical arterial roadway connecting Alameda to Oakland. The southern portion of SR61 (Doolittle Dr. on Bay Farm Island) is one of the primary egresses from Alameda to Oakland, and a major route to the Oakland Airport. • Multiple AC Transit bus routes utilize SR61 and several serve transit-dependent or disadvantaged communities in Alameda. Closure or disruptions to SR61 would lead to major congestion issues across Alameda and would require substantial rerouting of the bus system. Congestion could result in major delays to all AC Transit routes in Alameda.

SR61	
	• SR61 is a priority evacuation route from Alameda – closure or disruptions (especially along Doolittle Dr.) would require all evacuations to occur through the Webster/Posey Tubes or over the Park St. or Fruitvale Ave. bridges. • Substantial impacts to the transport of goods between Alameda and Oakland could occur if SR61 were closed or disrupted.

Ideas already generated for adaptation (for review during development of adaption strategies): Some conceptual planning in the Caltrans 2012 Transportation Concept Report for SR61

Question:

- *Is additional information on road status available to better understand physical vulnerabilities along the route?*

Notes: Summary refers to CalTrans-owned roadway only. City-owned section of Webster Street is discussed elsewhere

<table>
<tr><th colspan="2">Stormwater: Storm Drain Pump Stations</th></tr>
<tr><td colspan="2">Description: Storm drain pump stations are a critical part of the storm water system in Alameda and are expected to become even more important as sea rise. The pump stations are located in areas where water is likely to pond following storms and where we cannot rely on gravity to drain water from those sites. Instead pumps provide the additional pressure needed to move the water to a discharge point and avoid flooding our neighborhoods.</td></tr>
<tr><td>Key Issue(s)</td><td>• Alameda’s pump station already face capacity and operational issues (e.g., flap gate failures, sedimentation issues, lack of backup power). While necessary upgrades and fixes have already been identified, an additional consideration is the need to raise and flood-proof a number of these station because several of them are at risk of being submerged by sea level rise or major storm surge events.</td></tr>
<tr><td>Exposure</td><td>• Shoreline overtopping due to sea level rise or storm surges at multiple locations could lead to temporary flooding or permanent inundation at several storm drain pump stations in Alameda. The degree of flooding varies from station to station. The following table summarizes the SLR scenario at which each station is first exposed to inundation or direct access is restricted:
<table>
<tr><th>Station Name</th><th>First Exposure to Flooding (SLR-derived)</th><th>Water Depth at First Exposure</th><th>SLR Resulting in Greater than 3 Feet of Flooding*</th></tr>
<tr><td>Main Street</td><td>24” SLR</td><td>None – access restricted</td><td>77” SLR</td></tr>
<tr><td>Webster</td><td>36” SLR</td><td>< 1 ft</td><td>77” SLR</td></tr>
<tr><td>Eastshore</td><td>36” SLR</td><td>< 1 ft</td><td>84” SLR</td></tr>
<tr><td>Golf Course</td><td>36” SLR</td><td>11 ft</td><td>36” SLR</td></tr>
<tr><td>HBI System I</td><td>36” SLR</td><td>1-2 ft</td><td>66” SLR</td></tr>
<tr><td>HBI System II</td><td>> 48” SLR</td><td>< 1ft</td><td>84” SLR</td></tr>
<tr><td>Northside/Marina Village</td><td>> 48” SLR</td><td>1-2 ft</td><td>77” SLR</td></tr>
<tr><td>Southshore Lagoon</td><td>> 48” SLR</td><td>< 1 ft</td><td>>108” SLR</td></tr>
</table>
• Initial exposure to flooding or inundation due to SLR is primarily related to access to pumps stations. Due to minimal water depth at initial exposure (see table above) direct impacts are not likely until higher sea levels.
• Several pump stations could be impacted by overland flooding from the storm drain system.</td></tr>
<tr><td>Sensitivity</td><td>Governance:

• No governance issues for most storm drain stations – the City of Alameda owns and maintains most.</td></tr>
</table>

Stormwater: Storm Drain Pump Stations	

	• For stations not owned by the City – Harbor Bay Island stations, Southshore Lagoon inlet pump – clear division of responsibility for the stations exists. However, rising sea levels could exacerbate issues at these stations and non-City ownership could delay action.
	
	Informational
	
	• None – regular inspections and maintenance of equipment result in substantial information related to station condition.
	
	Functional:
	
	• Known capacity issues with overall stormwater system (upgrades planned) that result in overland flooding across Alameda during heavy precipitation events.
	• 2008 Storm Drain Master Plan identified 5 stations that have a lower design capacity than the modeled operating discharge.
	• Sea level rise is likely to block stormwater outfalls, increasing strain on pumps or resulting in pump failure.
	
	Physical:
	
	• Pumps stations contain both electrical and mechanical equipment that could be damaged by floodwaters (all pumps are electric-motor driven). Temporary flooding could lead to shorted electrical systems and permanent inundation or frequent seawater flooding could corrode mechanical equipment.
	• Historical issues with sedimentation at pump stations and outfalls.
	• Most pump stations have multiple pumps that provide some inherent redundancy, but stations were not designed with built-in excess capacity.
	• Pump stations have a wide range of ages (Webster station was built in 1947) and designs. Lack of consistency in design requires more maintenance knowledge and introduces a range of station-specific vulnerabilities.
	• Various known vulnerabilities with the pump stations (note that not all stations have these issues – see Storm Drain Master Plan for more details):
	  ○ No on-site standby power generator
	  ○ No automatic transfer switch
	  ○ No back-up power supply (relies on portable generators during power outages)
	  ○ Flap gate failures

Stormwater: Storm Drain Pump Stations	
	○ Malfunctioning ("frozen") gravity bypass systems (designed to let floodwater exit during low tide during power failure)
Adaptive Capacity	• Submersible pump technology exists that could reduce the impact of flooding on the pump stations. • City ownership and maintenance responsibility for most storm drain pump stations increases the adaptive capacity by removing barriers to action.
Consequence	• Malfunctioning storm drain pump stations could lead to street flooding across Alameda. The extent of impacts depends on the individual station, which drain catchment areas ranging from 30 acres (Main Street station) to >450 acres (Northside/Marina Village and Golf Course). • Impacts from malfunctioning pump stations have ripple effects throughout the stormwater management system, with flooding possible at locations far from the station itself.

Ideas already generated for adaptation (for review during development of adaption strategies): Yes – Capital Improvement Plan specifies stormwater upgrades (primarily capacity)

Question:

- *Is it valuable to determine the water level that would result in direct impacts to the station? If so, we should discuss how best to determine that threshold.*

Notes: (*exposure) - We selected 3' as an estimate of the water depth at which the station might experience issues (varies from station to station based on visual inspection of photos from Storm Drain Master Plan). Actual threshold of impacts would depend on individual station design.

Stormwater: Bayview Weir and Outfall	
Description: The weirs and water levels in South Shore Lagoons are managed and maintained by the City's Maintenance Department. Water is pumped into the upstream West Lagoon at high tide and released from the Bayview outfall at low tide in order to move water through the lagoon system at a rate that prevents stagnation and water quality issues.[4] The Bayview weir functions as a barrier between lagoon waters and the Bay. The weir connects to the outfall which functions as gravity-fed drainage when it is time to lower lagoon water levels.	
Key Issue(s)	• The Bayview Weir and Outfall are an important component of the lagoon system. An operational lagoon system is important not only to water quality in the lagoon, but also to providing flood protection to the communities adjacent to the lagoons. The weir and outfalls are in need of major repairs and/or replacement of system components. As seas rise, a gravity-fed outfall will no longer be possible.
Exposure	• Bayview weir and outfall structures are not directly exposed to flooding from sea level, storm surges, and major rainfall events. Operation of the weir and outfall system are compromised by rising sea levels due to the current system's reliance on a gravity flow system during low tide. • Based on engineering drawings from 1989, the outfall is approximately 2-3 feet below mean high water, roughly equivalent to mean sea level (MSL), or approximately 2' above mean low water. • 12" of SLR (over MHHW) is roughly equivalent to a king tide event – this amount of SLR would result in the outfall being below sea level for a longer portion of each day. • 24" of SLR (not including storm surge) would likely result in the outfall structure being regularly below water level except for a short window around low tide. By 36" of SLR (not including storm surge) the outfall structure would likely be permanently below low tide levels.
Sensitivity	Governance: • Lagoon system is owned by a homeowner's association, 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 outfall structure are older (late 1959 and 1989) and may not accurately reflect current water levels and mean high tide levels, making it difficult to compare this information against current sea level and future projections.

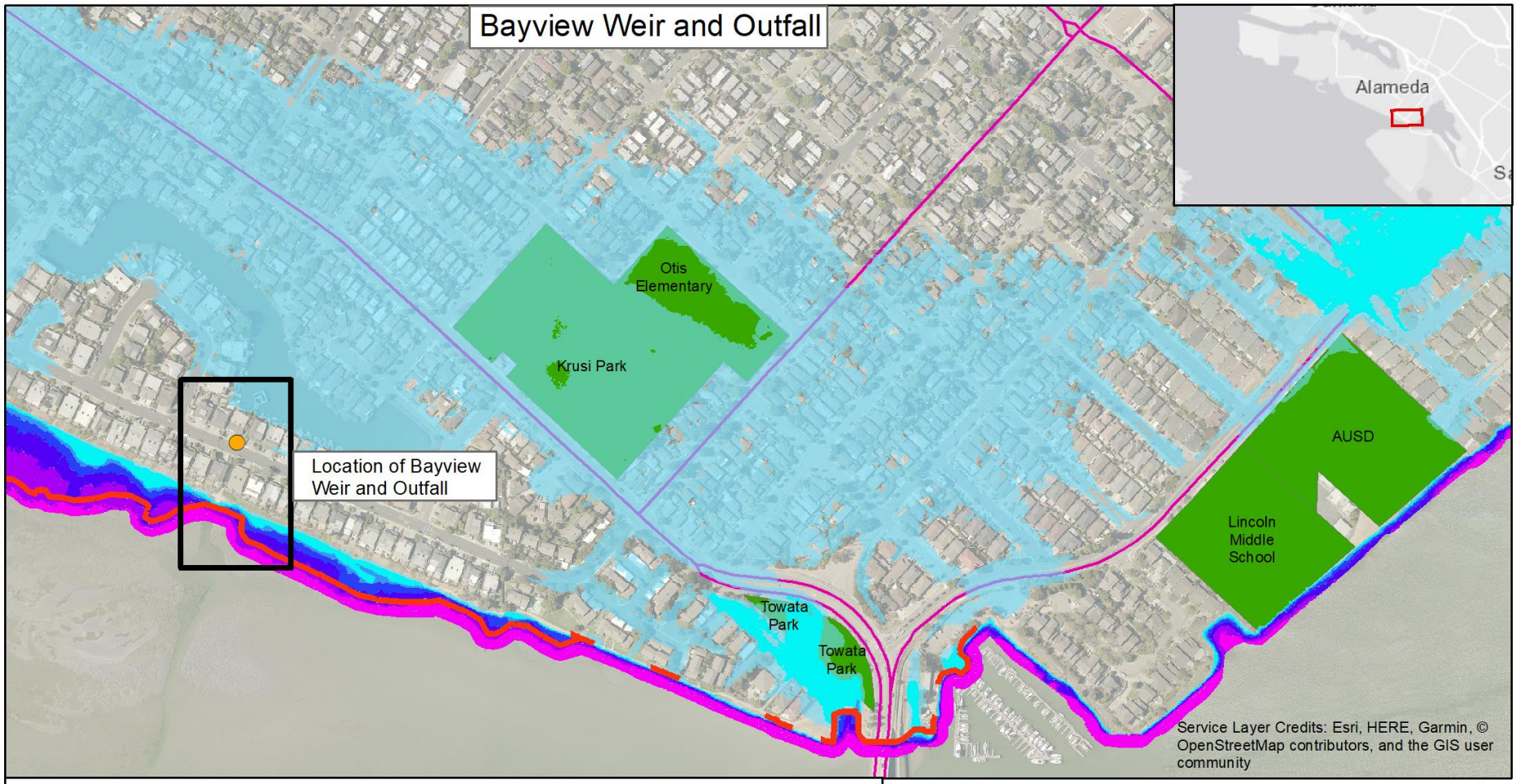
[4] Schaaf and Wheeler. "Draft South Shore Lagoon Operation." 2015.

Stormwater: Bayview Weir and Outfall	
	Functional: • System designed to discharge water from the South Shore Lagoon system at low tide – requires the water level to be lower than the outfall to function. • Even if the outfall remains exposed at low tide in the coming years, rising water levels will reduce the amount of time it is possible to discharge water from the lagoons. • Current system design could expose the lagoon system to the threat of precipitation events and overland flooding if ocean levels are too high to allow for discharge. Increased storm intensity in the future could exacerbate this, and rising ocean levels will decrease the amount of time available to discharge from the outfall, exacerbating the threat of lagoon overtopping. • The weir is manually controlled by the Maintenance Department Physical: • BCDC inundation maps indicate the South Shore Lagoon system could eventually be directly connected to ocean water at higher SLR scenarios due to overtopping along the shoreline in other areas. • Outfall is in a dredged channel that may be vulnerable to sedimentation issues. • In the past, high water levels in the East and East-Central lagoon during large storms have caused property damage. • The last time a study was conducted in the Bayview Outfall (in 2015), the flapgate was not operating correctly (it was stuck open), presumably impacting lagoon water elevations.[5] It is unknown whether or not the flapgate is now functioning correctly. • When the weir was studied in 2015, platform columns were severely damaged, many gates were leaking, and one gate could not be opened. It is unknown whether or not the needed repairs have been made. • Current lagoon infrastructure (built in the 1960s) is close to end of life expectancy.[5]
Adaptive Capacity	• The existing outfall structure has limited adaptive capacity because it relies on a gravity flow system. Raising the outfall to accommodate rising ocean levels would not be feasible.

[5] Schaaf and Wheeler. “Draft South Shore Lagoon Operations.” 2015.

Stormwater: Bayview Weir and Outfall	
	• The existing weir system requires upgrades and the City has the ability to install a pump station to replace the existing gravity flow system. Installation of a pump station would decrease the vulnerability of the system because it could operate at higher ocean levels.
Consequence	• Failure of the weir and outfall system could result in flooding near the lagoons, threatening adjacent neighborhoods. Many of the adjacent properties are residential, but there are also other critical assets or important commercial areas that could be impacted including Alameda Hospital and the South Shore Center. • Flooding from the lagoons could heavily impact vehicle travel on major roadways including Otis Dr., Park St., and Broadway.

Ideas already generated for adaptation (for review during development of adaption strategies): Yes – plans for upgrades/repairs to weir structure. Could be expanded to include installation of a pump station. Recommendations made in "Draft South Shore Lagoon Operations".



BCDC 36" SLR Scenario - Water Depth

- Less than 1 ft
- 1-2 ft
- 2-3 ft
- 3-4 ft
- 4-5 ft
- Greater than 5 ft
- Overtopping Locations

BCDC 48" SLR Scenario - Extent

- AC Transit Bus Routes - Alameda Only
- Storm Drain Pump Stations
- Sewer Pump Stations

Asset Inventory (from 2016 LHMP)

- Critical Recovery Priority (from LHMP)
- Other Recovery Priority (from LHMP)

0 0.125 0.25 Miles

NOTE: This map shows water depth for the 36" SLR scenario as well as the extent of inundation for the 48" SLR scenario to highlight the potential for inundation due to overtopping at other shoreline segments (Eastshore and bridge touchdown) to directly connect with the South Shore Lagoon System. The lagoons will likely require active pumping prior to this scenario due to greater water depths at the outfall.

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Produced by: ERG
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Vulnerable Assets Addressed in Existing City Plans and Commitments

The project team reviewed existing City commitments to adaptation in order to document them, identify the gaps where no commitment or action has been made, and prioritize work on those gaps through the CARP. The list below summarizes some of the key vulnerable assets addressed in existing city plans and commitments:

Asset	Plan
Alameda Point Shoreline	Alameda Point Master Infrastructure Plan
City Hall West	Alameda Point Master Infrastructure Plan
Main Street Ferry Terminal	Alameda Point Master Infrastructure Plan
Shoreline along Main Street Ferry Terminal	Alameda Point Master Infrastructure Plan
Northern Waterfront	Northern Waterfront Development Plans
Shoreline Drive	City's 2017-2019 Capital Budget
Veteran's Court Seawall	Storm Drain Master Plan 2008 (focus on capacity upgrades)
Storm Drain Pump Stations	Storm Drain Master Plan 2008
Multiple Sewer Pump Stations	Sewer System Management Plan 2017
SR260 (including Posey and Webster Tubes)	Caltrans State Route 260 Transportation Concept Report (TCR) (signed 2011, reaffirmed 2017)

Assets Considered Secondary Priorities for Adaptation Action

Some of these assets have been identified as secondary priority assets because they are exposed to flooding at higher water levels (MHHW + 48" or higher). Others are considered secondary priorities because we expect that much of their current risk to tidal flooding will be addressed through shoreline modifications taken to address the initial set of priority asset vulnerabilities.

- Fire Station #4 (Bay Farm Island)
- Encinal High School
- Alameda Hospital
- Building 2 - Alameda Point (telecom switch station)
- 2000 Grand St. - Garage, Storage Center (AMP and Public Works)
- Maintenance Service and Animal Shelter
- Main Street Ferry Terminal Harbor Bay Ferry Terminal (tentative: may be adequately covered in Master Infrastructure Plan)
- Roads: additional roads flooded at a total water level of 48" (of sea level rise or storm surge flooding) or under a 25-year precipitation event due to drainage issues).