

Appendix A: Oakland/Alameda Asset and Sector Profile Sheets

These “snap-shots” capture the key issues, vulnerabilities, and consequences identified for each asset in the Oakland/Alameda Resilience Study. The profile sheets also identify priority management issues, present proposed adaptation strategies, and identify next steps for individual agencies and the study area.

Asset and Sector Profile Sheets (arranged by asset owner)

Scale of assessment	Asset or Sector Name	Asset Owner
Sector	Schools	Alameda, Oakland, Private
	Childcare Facilities	Private
	Senior Care Facilities	Private
	Communities	Alameda, Oakland
Asset	Control Tower	Port of Oakland
	Fire Station #22	Port of Oakland
	Terminal 1	Port of Oakland
	Terminal 2	Port of Oakland
	Tank Farm	Port of Oakland
	North Field	Port of Oakland
	South Field	Port of Oakland
	Perimeter Dike	Port of Oakland
	98th Avenue	City of Oakland
	Airport Drive	City of Oakland
	Hegenberger Drive	City of Oakland
	San Leandro Street	City of Oakland
	Harbor Bay Parkway	City of Alameda
	Doolittle Drive	Caltrans
	Bay Farm Island Bridge	Caltrans
	Bay Farm Island Bike/Ped Bridge	Caltrans
	Coliseum Amtrak Station	Amtrak
	Coliseum BART Station	BART
	Oakland Airport Connector	BART
	Harbor Bay Ferry Terminal	WETA
	Otis Bridge	City of Alameda
	Fire Station #27	City of Oakland
	Fire Station #29	City of Oakland
	Pump Station G	EBMUD
	Bay Trail	EBRPD
	MLK Jr. Regional Shoreline	EBRPD
	Bay Farm Island Lagoon	City of Alameda/Bay Farm Island Homeowner's Association

Schools Vulnerability and Risk Profile

The Oakland/Alameda Resilience Study area contains 16 schools including elementary through high school, public and private, including portions of the Oakland Unified School District and the Alameda Unified School District. Schools were constructed at various times from 1959 (James Madison Middle School) to 2006 (Oakland Aviation High School). All of the schools have at-grade facilities that could be damaged in a flood event and the schools have varying levels of earthquake safety depending on their construction date and retrofit status. Schools serve children, and this function makes them both difficult and important during disasters and emergency response. Some schools also serve as temporary shelters during disaster response. Schools in OUSD are also overcrowded, so there is limited capacity to reassign students if one school is damaged temporarily or permanently closed.

Key Issue

Schools are vulnerable to sea level rise and storm event impacts because of their physical construction and because of their functions. Schools in the current or future flood plain are vulnerable to flood damage because of their at-grade entrances and equipment. Young children, or limited-mobility or special education students, are particularly difficult to evacuate in the event of an emergency. Schools may not have sufficient staff or transportation to manage an evacuation. Evacuating schools and childcare centers will require careful coordination so that there is adequate supervision of young people and safe locations identified where family members can be reunited. Schools are funded and governed at the local level and may not have adequate resources to improve their buildings or plan for future relocation.

Assets Considered

Oakland Unified School District:

James Madison Middle School

New Highland/Rise Academy

Brookfield Elementary

Oakland Aviation High School

Lockwood Elementary School

Esperanza and Stonehurst Elementary

Greenleaf Elementary

Encompass / Acorn Woodland Academy

Havenscourt MS / Community United / Futures / Roots / Coliseum HS

Sobrante Park Elementary

Rudsdale Continuation School

Lighthouse Community Charter HS

Alameda Unified School District:

Amelia Earhart Elementary

Bay Farm Elementary

Private:

Chinese Christian School

ACTS Christian Academy

Vulnerabilities:

INFO1: Many schools have not been evaluated for earthquake safety, a necessary first step for receiving state funding for earthquake retrofits.

GOV1: Public schools constructed before 1978, and private schools constructed before 1986, may not meet current earthquake safety standards.

GOV2: There is no central database for the condition of buildings that house charter schools.

FUNC1: Schools in the study area are overcrowded. If schools need to close for disaster preparation or response, finding adequate alternative classrooms could be difficult.

FUNC2: Schools rely on roads, transit, electricity, water, wastewater, and telecom utilities to function. Even short term disruptions in utility service could disrupt school activities and require school cancellations, e.g., school closures during 12/11/14 storm).

FUNC3: Schools need teachers and support staff to function. If school staff cannot access the school because of disruptions within or outside the study area, the school cannot operate as intended.

PHYS1: Schools are at-grade and vulnerable to sea level rise and storm event impacts. Due to their construction and use, waterproofing is not practicable.

PHYS2: Public schools constructed prior to 1978 and private schools constructed prior to 1986 may be in building vulnerable to seismic impacts.

PHYS3: Schools are at risk during seismic events due to their contents. Unsecured bookcases, furniture and equipment caused four of the deaths in the Northridge earthquake and improved building standards cannot address building contents brought in after inspection. Bracing and other management techniques need to be implemented at both old and new construction buildings.

Consequences

Schools provide a critical community function and contribute to the overall well being of the community. They also provide shelter during emergencies for students and community members. Damage to school buildings could result in education disruptions for students and financial burdens for school districts. These effects could be exacerbated in already stressed schools and districts. Oakland Unified School District faces budget shortfalls and overcrowding that seismic or flood damage would exacerbate. Schools that serve low-income, transit-dependent, or linguistically-isolated students are even vulnerable because of the populations they serve. Schools rely on communities for staff, access, funding, and, most importantly, students. If the neighborhoods where students and teachers live are damaged, schools will not be able to fully function.

Adaptation Responses

Vulnerabilities	Action	Action Type	Process	Possible Actors	Action Characterization
INFO1: Many schools have not been evaluated for earthquake safety, a necessary first step for receiving state funding for earthquake retrofits.	Provide funding and technical assistance to support the evaluation of school facilities for earthquake safety	Program/operation	Emergency and Hazard Planning, New Initiative	ABAG, CalOES, City of Oakland, City of Alameda	Unlocking, Multi-benefit, Regional
GOV1: Public schools constructed before 1978, and private schools constructed before 1986, may not meet current earthquake safety standards.	Bring schools up to current earthquake safety standards through retrofits	Program/operation	Emergency and Hazard Planning, New Initiative	ABAG, CalOES, City of Oakland, OUSD, City of Alameda, AUSD	Multi-benefit, Regional
GOV2: There is no central database for the condition of buildings that house charter schools.	Develop and maintain a voluntary database that includes specific information on charter schools related to building safety and emergency response	Program/operation	Emergency and Hazard Planning, New Initiative	City of Oakland, Oakland Unified School District, private charter school owners	Unlocking, Multi-benefit, Local
	Coordinate the information in any existing data repositories using cross-	Coordination, Program/operation	New Initiative	City of Oakland, Oakland Unified School District,	Multi-benefit, Local

	referencing or geo-referencing			private charter school owners	
FUNC1: Schools in the study area are overcrowded. If schools need to close for disaster preparation or response, finding adequate alternative classrooms could be difficult.	Develop contingency plans and procedures to address the need for short-term accommodation and long-term relocation for displaced students in other schools and classrooms	Program/operation	Emergency and Hazard Planning	City of Oakland, OUSD, City of Alameda, AUSD, private schools	Do It Yourself, Multi-benefit, Local, Regional
	Establish mutual aid agreements and initiate or strengthen joint protocols with adjoining school districts for cooperative disaster response	Coordination, Policy Development	Emergency and Hazard Planning	City of Oakland, OUSD, City of Alameda, AUSD, private schools	Do It Yourself, Multi-benefit, Regional
	Reduce dependency on school buildings that are vulnerable to sea level rise by building alternative facilities or by increasing the capacity of existing schools in areas not at risk from sea level rise	Policy Development	Long-range Planning, Land Use Planning	City of Oakland, OUSD, City of Alameda, AUSD, private schools, Alameda County	Local, Long Lead Time
FUNC2: Schools rely on roads, transit, electricity, water, wastewater, and telecom utilities to function. Even short term	Develop policies or incentives to encourage/require emergency response plans and procedures to consider how power, water, and food	Policy Development	Long-range Planning, Land Use Planning, Emergency and Hazard Planning	City of Oakland, OUSD, City of Alameda, AUSD, private schools, Alameda County	Do It Yourself, Multi-benefit, Local, Regional

<p>disruptions in utility service could disrupt school activities and require school cancellations, e.g., school closures during 12/11/14 storm).</p>	<p>necessary to maintain the function of schools during a flood emergency, will be delivered given that many access routes and transportation modes may also be disrupted</p>				
	<p>Develop policies or incentives to encourage/require access to auxiliary water and power sources at schools, e.g., on-site power generators with sufficient fuel for several days, portable generators, or pre-negotiated rental or leasing agreements for portable sources</p>	<p>Policy Development</p>	<p>Long-range Planning, Land Use Planning, Emergency and Hazard Planning</p>	<p>City of Oakland, OUSD, City of Alameda, AUSD, private schools, Alameda County</p>	<p>Do It Yourself, Multi-benefit, Local, Regional</p>
<p>PHYS1: Schools are at-grade and vulnerable to sea level rise and storm event impacts. Due to their construction and use, waterproofing is not practicable.</p>	<p>Conduct vulnerability and risk assessments of individual schools and develop site-specific strategies to reduce service disruptions or closures</p>	<p>Program/operations</p>	<p>Long-range Planning, New Initiative</p>	<p>City of Oakland, OUSD, City of Alameda, AUSD, private schools</p>	<p>Do It Yourself, Unlocking, Local</p>
	<p>Develop policies or incentives to encourage/require at-risk schools to implement changes to facility structures or operations that would reduce potential for</p>	<p>Policy Development</p>	<p>Long-range Planning, Land Use Planning, Emergency and Hazard Planning</p>	<p>City of Oakland, City of Alameda, County of Alameda</p>	<p>Do It Yourself, Local, Regional</p>

	disruption or closure due to sea level rise or storm events				
PHYS2: Public schools constructed prior to 1978 and private schools constructed prior to 1986 may be in building vulnerable to seismic impacts.	Evaluate schools for earthquake safety in order to help obtain funding for retrofits and other earthquake safety measures	Program/operation	Emergency and Hazard Planning, New Initiative	City of Oakland, City of Alameda, OUSD, AUSD	Unlocking, Multi-benefit, Local, Regional
PHYS3: Schools are at risk during seismic events due to their contents. Unsecured bookcases, furniture and equipment caused four of the deaths in the Northridge earthquake and improved building standards cannot address building contents brought in after inspection. Bracing and other management techniques need to be implemented at both old and new construction buildings.	Provide funding and assistance to schools for bracing and other management techniques that can help reduce risk from building contents during seismic events	Program/operation	Emergency and Hazard Planning, New Initiative	ABAG, CalOES, City of Oakland, City of Alameda	Unlocking, Multi-benefit, Local, Regional

Vulnerabilities also addressed under Key Planning Issue 1: FUNC2, FUNC3

Vulnerabilities also addressed under Key Planning Issue 2: GOV1, FUNC2, PHYS1

Oakland/Alameda Childcare Centers Vulnerability and Risk Profile

The Oakland/Alameda Resilience Study area contains 19 registered childcare centers, comprised of 13 centers in Oakland and 6 centers in Alameda. These childcare facilities are primarily day care centers serving children from 2-5 years old. Two childcare centers in Alameda have co-located infant care centers for ages 0-2: Peter Pan Academy and Kindercare Learning Center. All of these facilities are licensed through the Community Care Licensing Division of the California Department of Social Services, and were licensed between 1982 (OUSD – Highland) and 2011 (Dr. Herbert Guice Christian Academy).

The day care centers range from a registered capacity of 24 children to 174 children, with an average capacity of 55 children. The two infant care centers have a lower capacity than their associated preschools. The total licensed capacity within the study area is 974 children under the age of 5. Childcare centers are generally located in commercial buildings, and may have at-grade entrances or equipment that can be damaged in a flood event. These centers also have varying levels of earthquake safety depending on their construction date and retrofit status. Childcare centers serve young children, requiring special consideration of needs for assistance and supplies during disasters and emergency response. Smaller, in-home childcare facilities are not included in this assessment, but share similar vulnerabilities.

Key Issues

Childcare centers are vulnerable to sea level rise and storm event impacts because of their physical construction and because of their functions. At-grade childcare centers in the current or future flood plain are vulnerable to direct damage in a flood event. Centers that are not at grade may rely on equipment or other services that are at- or below-grade. Childcare centers are dependent on outside services, including transportation, electricity, and food and water supplies. Young children rely on others for basic needs and assistance, which increases their vulnerability to disaster events and makes them more challenging to evacuate and care for during an emergency.

Assets Considered

Oakland

Acts Full Gospel Christian Academy (1127 62nd Ave)

Acts Full Gospel Christian Academy (1034 66th Ave)

Dr. Herbert Guice Christian Academy

Live, Learn, and Laugh

Oakland Head Start – Brookfield

Oakland Head Start – Lion Creek Crossings

Oakland Head Start – Tassafaronga

OUSD – Acorn/Woodland

OUSD – Brookfield CDC

OUSD – Highland

OUSD – Lockwood (1125 69th Ave)

OUSD – Lockwood School (6701 International Blvd)

Supporting Future Growth – Site III

Alameda

Kindercare Learning Center, #1335 (co-located day care and infant care)

Garner Preschool Learning Center

Seedling Child Montessori School

Peter Pan Academy (co-located day care and infant care)

Vulnerabilities

GOV1: Childcare centers with out-of-date or inadequate emergency preparedness and response plans, or that do not implement plan action items, are more vulnerable to storm event and earthquake hazards.

FUNC1: Young children – particularly those that are not yet mobile, unable to follow instructions, or have medical needs – are challenging to evacuate in case of an emergency, especially if the childcare center does not have sufficient staff or transportation to manage the evacuation.

FUNC2: Childcare centers need to maintain their connection to outside infrastructure and services, including transportation, electricity, clean water, and safe food supplies, to maintain function, which is particularly important if other functioning facilities are not available.

FUNC3: If access to outside infrastructure and services is disrupted due to an emergency, childcare centers may not have the ability to contact or coordinate with parents and guardians to make pick-up arrangements. On-site staff, equipment, and supplies (e.g. diapers, food and formula, and prescription medications) may not be adequate to care for children long term.

FUNC4: The closure of childcare centers due to disaster response could result in parents or other caregivers taking time off work to care for small children, resulting in lost wages.

FUNC5: Many childcare centers have limited capacity to take on more children, given available space, staff, and other resources. This could be a concern if temporary or permanent reassignment of children is needed due to emergency closure of another center.

PHYS1: Most buildings, including the commercial buildings where many childcare centers are located, are vulnerable because they are not designed to withstand flooding and may have equipment or habitable space at- or below-grade.

Consequences

Childcare centers provide an important function, caring for and supervising young children in the community on a daily basis. Loss of access to childcare services can result in hardships for parents and caregivers, who may need to take time off work or arrange for alternative childcare. Because childcare centers serve young children, they are particularly vulnerable to emergency events that take place while children are onsite.

Damage to childcare centers can also result in financial burdens for private owners or school districts. Childcare centers that serve low-income, transit-dependent, or linguistically-isolated students are more vulnerable because of the populations they serve. Childcare centers rely on communities for staff, access, funding, and, most importantly, children. If the neighborhoods where children and staff live are damaged, childcare centers will not be able to fully function.

Adaptation Responses

Vulnerabilities	Action	Action Type	Process	Possible Actors	Action Characterization
GOV1: Childcare centers with out-of-date or inadequate emergency preparedness and response plans, or that do not implement plan action items, are more vulnerable to storm event and earthquake hazards.	Review and update childcare center emergency preparedness and response plans to address sea level rise and storm event contingencies	Program/operation	Emergency and Hazard Planning	Childcare centers	Do It Yourself, Local, Regional
	Provide technical assistance to childcare centers to support the development and maintenance of emergency response plans, including storm evacuation procedures and shelter-in-place guidelines	Education/outreach, Program/operation	Emergency and Hazard Planning	City of Oakland, City of Alameda, DSS	Multi-benefit, Local
FUNC1: Young children – particularly those that are not yet mobile, unable to follow instructions, or have medical needs – are challenging to evacuate in case of an emergency, especially if the childcare center does not have sufficient staff or transportation to manage the evacuation.	Review, update, and train staff on evacuation protocols that take into account flooding and storm events	Program/operation	Emergency and Hazard Planning	Childcare centers	Do It Yourself, Local

<p>FUNC2: Childcare centers need to maintain their connection to outside infrastructure and services, including transportation, electricity, clean water, and safe food supplies, to maintain function, which is particularly important if other functioning facilities are not available.</p>	<p>Develop policies or incentives to encourage/require emergency response plans and procedures to consider how power, water, and food necessary to maintain the function of childcare facilities during a flood emergency, will be delivered given that many access routes and transportation modes may also be disrupted</p>	<p>Policy Development</p>	<p>Long-range Planning, Land Use Planning, Emergency and Hazard Planning</p>	<p>ABAG, CalOES, City of Oakland, City of Alameda, DSS</p>	<p>Do It Yourself, Multi-benefit, Local, Regional</p>
<p>FUNC3: If access to outside infrastructure and services is disrupted due to an emergency, childcare centers may not have the ability to contact or coordinate with parents and guardians to make pick-up arrangements. On-site staff, equipment, and supplies (e.g. diapers, food and formula, and prescription medications) may not be adequate to care for children long term.</p>	<p>Develop plans and procedures to obtain or distribute specialized supplies needed to either shelter-in-place or evacuate children and staff at childcare centers</p>	<p>Program/operation</p>	<p>Emergency and Hazard Planning</p>	<p>City of Oakland, City of Alameda, Emergency Services (fire, police)</p>	<p>Do It Yourself, Local</p>
	<p>Expand or form multi-agency and cross-jurisdictional partnerships (including community-based organizations) to improve the capacity to address the needs of children and their caregivers during a disaster or emergency</p>	<p>Coordination</p>	<p>Emergency and Hazard Planning, New Initiative</p>	<p>ABAG, BCDC, MTC, ACPHD, Cities, County, CBOs, NPOs, Private Sector</p>	<p>Multi-benefit, Local, Regional, Long Lead Time</p>

<p>FUNC5: Many childcare centers have limited capacity to take on more children, given available space, staff, and other resources. This could be a concern if temporary or permanent reassignment of children is needed due to emergency closure of another center.</p>	<p>Develop contingency plans and procedures to address the need for short-term accommodation and long-term relocation for displaced children in other childcare centers</p>	<p>Program/operation</p>	<p>Emergency and Hazard Planning</p>	<p>City of Oakland, OUSD, City of Alameda, AUSD, private childcare centers</p>	<p>Do It Yourself, Multi-benefit, Local, Regional</p>
	<p>Establish mutual aid agreements and initiate or strengthen joint protocols with adjoining school districts for cooperative disaster response (for public childcare centers), as well as strengthening partnerships between public and private childcare centers</p>	<p>Coordination, Policy Development</p>	<p>Emergency and Hazard Planning</p>	<p>City of Oakland, OUSD, City of Alameda, AUSD, private childcare centers</p>	<p>Do It Yourself, Multi-benefit, Regional</p>
	<p>Reduce dependency on childcare facilities that are vulnerable to sea level rise by building alternative facilities or by increasing the capacity of existing facilities in areas not at risk from sea level rise or by providing relocation assistance for private childcare facilities</p>	<p>Policy Development</p>	<p>Long-range Planning, Land Use Planning</p>	<p>City of Oakland, OUSD, City of Alameda, AUSD, private childcare centers, Alameda County</p>	<p>Local, Long Lead Time</p>

PHYS1: Most buildings, including the commercial buildings where many childcare centers are located, are vulnerable because they are not designed to withstand flooding and may have equipment or habitable space at- or below-grade.	Conduct vulnerability and risk assessments of individual childcare centers and develop site-specific strategies to reduce service disruptions or closures	Program/operations	Long-range Planning, New Initiative	City of Oakland, OUSD, City of Alameda, AUSD, private childcare centers	Do It Yourself, Unlocking, Local
	Develop policies or incentives to encourage/require at-risk schools to implement changes to facility structures or operations that would reduce potential for disruption or closure due to sea level rise or storm events	Policy Development	Long-range Planning, Land Use Planning, Emergency and Hazard Planning	City of Oakland, City of Alameda, County of Alameda, DSS	Do It Yourself, Local, Regional

Vulnerabilities also addressed under Key Planning Issue 1: FUNC2

Vulnerabilities also addressed under Key Planning Issue 2: FUNC2, FUNC3, FUNC4, PHYS1

Oakland/Alameda Senior and Healthcare Facilities Vulnerability and Risk Profile

There are six assisted living Residential Care Facilities for the Elderly (RCFEs) in the project area. These are typically small facilities, with 6-8 beds each; Waters Edge Lodge is larger in capacity, with 120 licensed beds. RCFEs have staff onsite 24-hours per day for non-medical care and to assist residents with daily tasks such as hygiene, meals, and housekeeping. They are designed for elderly residents who are no longer able to live independently, but do not require the full-time health care provided by a nursing home. Additionally, several home and hospice health care providers serve the project area. These provide services to clients in their own homes, and thus the community members they serve are not located at a single physical location, although the providers have an office location within the project area. There is also an outpatient healthcare facility, the East Oakland Health Center, located within the project area, which provides general clinical, pharmacy, laboratory, and other services. While patients are not limited to the elderly, individuals with ongoing medical needs are more likely to be vulnerable in a disaster event.

Key Issues

Senior and healthcare facilities serve populations that are more vulnerable and less mobile, putting them at greater risk in the event of an emergency. RCFEs, with seniors living onsite, require special consideration in case of evacuation due to mobility, medical needs, and other concerns. These facilities also rely on outside services, including transportation, 24-hour staff and visiting medical personnel, utilities, and supplies, which can be compromised in a disaster. Healthcare facilities, while not serving residential patients, still need to ensure continuity and quality of care for community members and clients, and similarly rely on outside infrastructure, staff, and services to function.

Assets Considered

Senior Housing

Waters Edge Lodge

Golden Age of Sweet Road

Villa Milano of Sweet Road

Golden Age of Channing II

Goldencare Assisted Living, Inc. #2

Golden Age Bayside II

Healthcare Facilities

Affiliated Home Calls

Health Service Solutions

Pathways Home Health & Hospice

East Oakland Health Center

Vulnerabilities

GOV1: Senior or healthcare facilities with out-of-date or inadequate emergency preparedness and response plans, or that do not implement plan action items, are more vulnerable to storm event and earthquake hazards.

FUNC1: Although home and hospice healthcare offices do not have seniors living onsite, flooding or other disasters could disrupt service and coordination of assistance for clients.

FUNC2: Emergency evacuation of community members with limited mobility, or who have medical needs, will require special equipment, sufficient trained staff, greater coordination, and an appropriate location to shelter displaced individuals who are hard to move and relocate.

FUNC3: The closure of facilities serving senior citizens – either residential facilities or offices providing coordination for in-home care – can result in a lack of available caretakers. This may require family members or other alternate caretakers to take time off work, resulting in lost wages.

FUNC4: Senior citizens and individuals with medical needs may be particularly vulnerable if they are additionally limited in economic resources or education or are not proficient in English.

FUNC5: Senior and healthcare facilities rely on outside infrastructure and services to function, such as roads, electricity, clean water, telecommunications, and deliveries of specialized supplies.

PHYS1: Most buildings, including senior residences and healthcare facilities, are vulnerable because they are not designed to withstand flooding and may have equipment or habitable space at- or below-grade.

Consequences

Senior and healthcare facilities serve community members who rely on these services for care and quality of life. Disruption of facilities can result in significant hardships for these community members and their families, who may not have access to alternative care that is equivalent, affordable, and in an easily accessible location. Damage to facilities can also result in financial burdens for building owners and operators, as well as staff that may end up out of work. Damage to neighborhoods where staff and clients live may also result in access issues and disconnection from healthcare services, and senior and healthcare facilities may not be able to function.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
GOV1: Senior or healthcare facilities with out-of-date or inadequate emergency preparedness and response plans, or that do not implement plan action items, are more vulnerable to storm event and earthquake hazards.	Review and update emergency preparedness and response plans to address sea level rise and storm event contingencies	Program/operation	Emergency and Hazard Planning	Senior facilities, healthcare facilities	Do It Yourself, Local, Regional
	Provide technical assistance to senior and healthcare facilities to support the development and maintenance of emergency response plans, including storm evacuation procedures and shelter-in-place guidelines	Education/outreach, Program/operation	Emergency and Hazard Planning	City of Oakland, City of Alameda, DSS, Alameda County Health services, ABAG	Multi-benefit, Local
FUNC2: Emergency evacuation of community members with limited mobility, or who have medical needs, will require special equipment, sufficient trained staff, greater coordination, and an appropriate location to shelter displaced individuals who are hard to move and relocate.	Review, update, and train staff on evacuation protocols that take into account flooding and storm events	Program/operation	Emergency and Hazard Planning	Senior and healthcare facilities	Do It Yourself, Local
	Develop plans and procedures to obtain or distribute specialized equipment needed to either	Program/operation	Emergency and Hazard Planning	City of Oakland, City of Alameda, ABAG, Alameda County Health Services	Multi-benefit, Local

	shelter-in-place or evacuate at-risk, less mobile, or medically dependent populations				
FUNC5: Senior and healthcare facilities rely on outside infrastructure and services to function, such as roads, electricity, clean water, telecommunications, and deliveries of specialized supplies.	Develop policies or incentives to encourage/require emergency response plans and procedures to consider how power, water, and food necessary to maintain the function of senior and healthcare facilities during a flood emergency, will be delivered given that many access routes and transportation modes may also be disrupted	Policy Development	Long-range Planning, Land Use Planning, Emergency and Hazard Planning	City of Oakland, City of Alameda, emergency response (police and fire)	Do It Yourself, Multi-benefit, Local, Regional
	Develop policies or incentives to encourage/require access to auxiliary water and power sources at senior and healthcare facilities, e.g., on-site power generators with sufficient fuel for several days, portable generators, or pre-negotiated rental or leasing agreements for portable sources; provide assistance for smaller facilities where needed	Policy Development	Long-range Planning, Land Use Planning, Emergency and Hazard Planning	City of Oakland, City of Alameda, Alameda County, DSS	Do It Yourself, Multi-benefit, Local, Regional

PHYS1: Most buildings, including senior residences and healthcare facilities, are vulnerable because they are not designed to withstand flooding and may have equipment or habitable space at- or below-grade.	Conduct vulnerability and risk assessments of individual senior and healthcare facilities and develop site-specific strategies to reduce service disruptions or closures	Program/operations	Long-range Planning, New Initiative	City of Oakland, City of Alameda, Alameda County Health Services	Do It Yourself, Unlocking, Local
	Develop policies or incentives to encourage/require at-risk senior and healthcare facilities to implement changes to facility structures or operations that would reduce potential for disruption or closure due to sea level rise or storm events	Policy Development	Long-range Planning, Land Use Planning, Emergency and Hazard Planning	City of Oakland, City of Alameda, Alameda County, ABAG	Do It Yourself, Local, Regional

Vulnerabilities also addressed under Key Planning Issue 1: GOV1

Vulnerabilities also addressed under Key Planning Issue 2: GOV1, FUNC3, FUNC4, FUNC5, PHYS1

Regional Housing and Community Multiple Hazard Assessment Community Profile Data Collection Framework: Summary of the Oakland/Alameda Community Profile Area

Description of the Profile Area

The Oakland/Alameda community profile area includes the peninsula formed by Bay Farm Island and Oakland International Airport, as well as portions of East Oakland and a small part of the City of San Leandro. The focus area is bounded loosely by the Bay to west, 54th Ave. to the north, 185 (International) to the east, and 112 (Davis St.) to the south. The dominant land uses are low-to-medium density residential development, commercial, industrial and retail. The profile area includes portions of the Oakland Transit Oriented Development Corridor, the Coliseum BART Station Area Priority Development Areas and the Coliseum Transit Village specific plan area. It includes the East Oakland neighborhoods of Coliseum Industrial, Lockwood Gardens, Fitchburg, Woodland Fremont. Bay Farm Island neighborhoods include the housing development of Bay Harbor Isle, which is comprised of the Crowne Pointe, The Headlands, Freeport, and Cantamar subdivisions. The eastern portion of the island, called Bay Farm, is the older section of the island. There are three southern townhome developments – Islandia, Casitas and Garden Isle.

Transportation routes include Interstate 880, which runs roughly north/south through the center of the East Oakland portion of the profile area and is the primary means of access to the Oakland Airport, the Port of Oakland, and the Oakland Coliseum. Doolittle Drive connects Alameda to Bay Farm Island (via Bay Farm Island Bridge) and the Oakland Airport. It runs along the northeast shore of Bay Farm Island, from the bridge to the island of Alameda southeast to Oakland, onto the mainland and into San Leandro. Hegenberger Road runs northeast through the profile area, from Doolittle Dr. under I-880, past the Coliseum to San Leandro Street, bending northeast before it turns into Hegenberger Expressway. South of Doolittle Dr., Hegenberger turns into Airport Dr., which leads to the airport.

The profile area is served by a number of transit providers, including BART, Amtrak and several AC Transit lines and AC Transbay lines. The Oakland Coliseum BART station and the Amtrak station are located in the middle of the profile area. Bay Farm Island is also served by the Harbor Bay Ferry, which provides commuter service to the San Francisco Ferry Building.

The area is generally heavily urbanized, but natural areas within the profile area include the San Leandro Bay, the body of water that lies between the western shore of Oakland, the Bay Farm Island/OAK peninsula and the island City of Alameda to the north. Bay Farm Island has several lagoons, as well as several community parks, including Shoreline Park. A green belt also encompasses the entire perimeter of the peninsula. In East Oakland, open space and park uses include the Martin Luther King Regional Shoreline, Arrowhead Marsh, MLK Junior Regional Shoreline, Coliseum Gardens Park and Greenman Field. There is a city-owned Rec

center, Rainbow Rec Center. Parts of the Bay Trail also run through the profile area along the MLK Jr. Shoreline and around the Bay Farm Island community.

Key Issues

The Oakland/Alameda profile area includes a peninsula that is susceptible to future flooding. At 12" of sea level rise, much of the eastern portion of Bay Farm Island may be flooded. All of the Oakland International Airport area may be flooded at 36", and there are inland areas of Oakland that may be flooded at 48", especially along I-880 near the Coliseum. However, there is minimal housing within the current 100-year floodplain. Because the profile area is less than 1.5 miles from the Hayward fault, the entire area is within a liquefaction hazard zone, meaning that the soil types are susceptible to liquefaction and the area is likely to be shaken long and hard enough to trigger liquefaction. The project's regional screening analysis found the presence of single-family cripple wall housing in East Oakland, and one block group on Bay Farm Island that may have a high percentage of single family homes over garage; however, no other fragile ground shaking housing types were flagged. Nearly all of the residential structures within the profile area are less than 10 stories and unlikely to have a foundation that is able to withstand liquefaction. In general, those that live in East Oakland are very low income, housing and transportation cost burdened, and transit dependent. There are also significant numbers of non-English speaking households. This combination of characteristics suggests that the established community in the profile area has limited ability or resources to invest in improving the housing they live in, and will either need to shelter in place or rely on public transportation to evacuate. These characteristics also mean that residents are more likely to be displaced if their homes are damaged, and may struggle to find affordable housing elsewhere. Conversely, the project's regional screening analysis did not identify a significant presence of community indicators for the residents living on Bay Farm Island, except that much of Bay Farm Island's community is housing cost burdened. Though its community members may not be transit dependent, only a few transportation assets serve the island, which may complicate evacuation and recovery.

Existing Housing Characteristics

The project's regional screening analysis found twenty block groups that have been flagged as having 30% or more housing units that may be single-family homes with a cripple wall. There is one block group on Bay Farm Island that was flagged as having 30% or more housing units that may be single family home over garage. No other fragile ground shaking types were flagged. Thirty-three block groups have been flagged as having 30% or more housing units are likely to have a foundation insufficient to withstand liquefaction (<10 stories). There is one block group on Bay Farm Island that has been identified as having 30% or more housing units vulnerable to flooding hazard.

The City of Oakland has conducted a soft-story inventory and made its map available online, however none of the identified homes are within the profile area. The City of Oakland also has a grant program designed to incentivize seismic safety improvements. This program provides matching grants to owner-occupied low-income households for the completion of seismic retrofit repairs. Homes located within this area are eligible for participation in this program, and the applicant's annual family income cannot exceed 80% of the established HUD area median income for the area. This program is open to 1-4 unit properties, of which many residential properties located in this area are. Several block groups in this area were identified as having high renter occupancy, which would disqualify them from this program.

On Bay Farm Island, housing development started in the 1970's. The western part, called Harbor Bay Isle, was built in the 1970's and 1980's. Since the 1990's, numerous subdivisions have been completed, including Crowne Pointe, The Headlands, Freeport, and Cantamar. These subdivisions consist of single-family detached units, duplexes and townhouses. There are no affordable housing units in Harbor Bay. Bay Farm, the older eastern section of the island, is characterized by single-family 1950's ranch-style homes.

Community Characteristics

The project's regional screening analysis identified 45 block groups within or partially within the profile area. Two of these block groups have a Community Indicator score of 3-4. Eight have a score of 5-6, and twenty have a score of 7-10.

There is one block group within the profile area (on Bay Farm Island) where 10% or more of the population is over the age of 75. There are also block groups near the community profile boundary where the population of those over the age of 75 is over 10 percent. There are two block groups in the profile area with a high percentage of children under the age of five.

Three block groups have 30% or more households that are very low income. Two block groups have households with low high school graduation rates. Twenty-seven block groups have low high school graduation rates and also 30% or more of households that are very low income. There are 35 block groups where the households contain 70% or more non-white. Fifteen block groups also contain 20% or more households who are non-English speakers. Twenty block groups have 10% or more households with no vehicle. Eight block groups also contain a high percentage of renter households. Forty-one block groups have 15% or more of households that are housing cost burdened. Twenty-seven are also transportation cost burdened. Three block groups are transportation cost burdened only.

Within the City of Oakland, the number of homeowners and the numbers of renters varies based on income level. Based on information from the 2000 census, the majority of Oakland households rent, with 58.6% rental households and 41.4% own.

Approximately 22% of Oakland's population is extremely low income and most of Oakland's extremely low income households are renters. Of those renters, 80% have housing problems, which include 56% with severe cost burden and a number of renters in extreme overcrowding. Of the small number of extremely low income households who own a home, 3/4s of those households are severely cost burdened.

For low income households, which are over 14% of Oakland's population, 73% are renters and 27% are owners. Sixty percent of the renters are cost burdened and 29% experience overcrowding. In almost every income group, large families experience overcrowding most commonly and there is a lack of affordable housing that is three or more bedrooms. The owners in this group have experienced high levels of foreclosures in recent years and are also cost burdened.

Moderate income households make up 15% of Oakland's population and two-thirds are renters, one third are owners. Cost burden affects 41% of the renters in this group and 24% experience overcrowding, with large families experiencing this phenomena the most. For owners, 46% are cost burdened, 8% experience overcrowding and foreclosures have been an issue for moderate income households in Oakland in recent years.

Middle income households make up approximately 70,362 people in Oakland and 41% rent, 59% own. Only a small number of renting households in this group are cost burdened, but large families still experience overcrowding. Approximately 20% of middle income households are cost burdened and foreclosures have affected this group as well in recent years.

The existing population density for the neighborhoods within and adjacent to the profile area is higher than the city as whole. For example, the Coliseum neighborhood, with a population of approximately 3,634 people in 2008, had 14,492 people per square mile in contrast to the City of Oakland with 7,061 people per square mile. The City of Oakland, as of 2008, had 164,053 housing units. Approximately 7,257 Oakland residents live in group quarters such as dormitories, nursing homes, correctional facilities and other group shelter facilities.

ACCORDING TO THE 2000 CENSUS:

Elderly households made up 14% of renters in Oakland and 24% of owners. Elderly households experience high rates of housing problems, most commonly for seniors is severe cost burden.

Oakland identifies large families in this category and states that overcrowding is severe for large families regardless of income.

Approximately 21% of people five and older reported a disability. Approximately 29,428 households reported mobility and self care limitations. Of the 21% of households that reported a disability, 69% are very low income and 81% are low income. 50% of households that reported mobility or self care limitations are very low income.

The Oakland Housing Authority is responsible for the operation, management and maintenance of 1,606 public housing units and also operates the Section 8 Rental Assistance Program. Both waiting lists for public housing and Section 8 assistance are closed and the waiting list is lengthy. On the waiting list, 49.9% are families with children, 19.36% are people requesting reasonable accommodations and 67.50% are female head of household.

The City of Alameda's 2007-2014 Housing Element states that in 2000, Bay Farm Island Census Tract 4283.1 had the highest median income of any neighborhood in Alameda, while Bay Farm Island Census Tract 4283.2 had the third highest median income of Alameda neighborhoods. It also had the second highest percentage of children and the second lowest percentage of senior citizen residents. Population density on Bay Farm Island is significantly lower at 2,259 people per square mile as compared to the rest of the City of Alameda (6,926 people per square mile). Median household income in 2011 was \$110,844, which is significantly higher than the rest of Alameda, at \$66,781. Median rent in 2011 was \$1,759, which was higher than the rest of Alameda at \$1,242. Percent of family households is 57.4%, higher than the rest of Alameda at 47.5%. Percent of non-English speaking is 7%, which is nearly consistent with the rest of Alameda, at 8.6%.

Community serving facilities

Community services in the profile area include: four fire stations (Oakland: Station 20, 29 and 27. Bay Farm Island: Station 4) and two police departments (Bay Farm Island: Alameda County Sheriff's Office and Sector 4). There are no hospitals or medical facilities, except for one clinic (East Oakland Health Center), and five hospices/assisted living facilities (Oakland: Premier Healthcare Services, Crossroads Home Health Care and

Hospice, Pathways Home Health and Hospice. Bay Farm Island: Villa Milano of Sweet Road Assisted Living, Water's Edge Lodge Elder Community).

Community facilities or public spaces that could serve as gathering locations or sources of emergency information or assistance include: five food distribution centers (Oakland: Elmhurst Presbyterian Church, Elmhurst Food Panty, Unity Outreach, True Holiness/Watson Memorial, Alameda County Community Food Bank), five private schools (Oakland: Dr. Herbert Guice Christian Academy, ACTS Christian Academy, Roots Middle School, Greenleaf Elementary School, Oakland Aviation High School) seventeen public schools (Oakland: Sobrante Park Elementary, James Madison Middle School, Coliseum College Prep Academy, Community United Elementary, Rudsdale Continuation, Aspire Golden State College Preparatory Academy, Encompass Academy Elementary, Lockwood Elementary, Lighthouse Community Charter High School, New Highland/Rise School, Brookfield Elementary, Esperanza at Stonehurst Elementary, Havenscourt Middle School/Coliseum College Prep Academy. Bay Farm Island: Bay Farm Elementary School, Amelia Earhart Elementary School, Peter Pan Academy, Chinese Christian School), thirteen churches (Oakland: East Oakland Faith Deliverance Center, Allen Temple Baptist Church, East Oakland Church of Christ, Cosmopolitan Baptist Church, Love Center Ministries, St. Louis Bertrand Parish, Acts Full Gospel, Shiloh Church, Amos Temple CME Church, Paradise Baptist Church, Community Reformed Church, St. Benedict's Church. Bay Farm Island: Bay Farm Community Church), one city run senior center (East Oakland Senior Center), four groceries (Oakland: Safeway and two convenience markets. Bay Farm Island: Safeway), four branch libraries (Oakland: Brookfield, 81st Street, Martin Luther King Jr., Bay Farm Island Library) and sixteen parks (Oakland: Oakport Field, Rainbow Park Recreation Center, Coliseum Gardens, Dolphin Mini Park, Tassafaronga Park, Greenman Field, Elmhurst Plaza Tennis, Brookfield Village Park, MLK Jr. Regional Shoreline. Bay Farm Island: Chuck Corica Golf Complex, Godfrey Park, Harrington Park, Metropolitan Golf Links, Leydecker Park, Tillman Park, Shoreline Park).

Hazards

Because it is less than 1.5 miles from the Hayward Fault, all of the profile area is within a liquefaction hazard zone, meaning that the soil types are susceptible to liquefaction and the area is likely to be shaken long and hard enough to trigger liquefaction. The profile area may be vulnerable to other hazards triggered by a flood or seismic event, such as fire following an earthquake, dam or levee failure, or flooding due to pipe breakage. Some flood control measures such as levees are located in this area. More information is needed to better understand secondary hazards, including pipe location and condition, prevalence of gas shutoff valves, and status of any dams or levees within the area. A significant portion of Bay Farm Island is susceptible to future flooding, starting at 12" of sea level rise. All of the airport area may be flooded at 36". Inland portions of the area may be flooded at 48", which could affect regionally significant transportation routes, such as 1-880, as well as local streets and roads and other critical community infrastructure.

Community Adaptation Responses

Action	Action Type	Process	Possible Actors	Action Characterization
Develop and maintain a centralized database of non-profit, community, and faith-based organizations, equipment and service providers, and others that can communicate with communities at risk	Program/operation	Emergency and Hazard Planning, New Initiative	City of Oakland, City of Alameda, Alameda County, NPOs	Unlocking, Multi-benefit, Local
Develop and maintain a voluntary database that includes specific needs within the Bay Farm Island and Oakland communities related to emergency response	Program/operation	Emergency and Hazard Planning, New Initiative	City of Oakland, City of Alameda, ACPHD, NPOs	Unlocking, Multi-benefit, Local
Develop and maintain an emergency communication protocol for city, county, regional, and state agencies; local, community and faith-based organizations; and facilities that serve communities and that can be activated during a flood or storm event	Program/operation	Emergency and Hazard Planning, New Initiative	CalOES, FEMA, ABAG, City of Oakland, City of Alameda, ACPHD, NPOs, CBOs, Private Sector	Multi-benefit, Local, Regional, State
Coordinate with non-profit, community, and faith-based organizations to build strong social networks in neighborhoods, in particular those with certain characteristics such as less mobile or medically dependent residents	Coordination	Emergency and Hazard Planning, New Initiative	CalOES, FEMA, City of Oakland, City of Alameda, ACPHD, CBOs, NPOs, Private Sector	Multi-benefit, Local
Provide technical assistance to neighborhoods to support the development and maintenance of disaster plans, including storm evacuation procedures and shelter-in-place guidelines	Education/outreach, Program/operation	Emergency and Hazard Planning	ABAG, CalOES, FEMA, City of Oakland, City of Alameda, Alameda County, ACPHD	Multi-benefit, Local

Develop and support neighborhood and community-based response centers to distribute information and supplies after a disaster	Education/outreach, Program/operation	Emergency and Hazard Planning	CalOES, FEMA, City of Oakland, City of Alameda, Alameda County, ACPHD, CBOs, NPOs, Private Sector	Multi-benefit, Local, Regional
Develop a "Maintain-a-Drain" program that encourages neighborhoods to keep storm drains free of debris, reducing potential flood risks	Education/outreach, Program/operation	Long-range Planning, New Initiative	City of Oakland DPW, City of Alameda DPW, ACFCD, ACPHD, RWQCD, Private Sector	Do It Yourself, Multi-benefit, Local
Identify and research critical gaps in information needed by decision-makers to understand and respond to the needs of all of those in their communities, including the level of financial and technical assistance needed to minimize impacts from job loss and potential relocation	Evaluation	Long-range Planning, Land Use Planning	ABAG, BCDC, MTC, ACPHD, City of Oakland, City of Alameda, CBOs, NPOs, Private Sector	Unlocking, Local, Regional
Develop community-led education and outreach campaigns designed for specific local populations on the risks of sea level rise and storm events	Education/outreach	Long-range Planning, Land Use Planning, Emergency and Hazard Planning	ABAG, BCDC, MTC, ACPHD, City of Oakland, City of Alameda, CBOs, NPOs	Do It Yourself, Multi-benefit, Local
Revise emergency response policies, procedures, and trainings, including strategies for managing community needs such as providing specialized equipment or evacuation procedures	Policy Development, Program/operation	Long-range Planning, Land Use Planning, Emergency and Hazard Planning	ABAG, City of Oakland, City of Alameda, ACPHD, CBOs, NPOs, Private Sector	Do It Yourself, Multi-benefit, Local, Regional
Expand or form multi-agency and cross-jurisdictional partnerships (including community-based organizations) to improve the capacity to address the needs of people in the community, particularly those with special mobility, care, or medical needs,	Coordination	Emergency and Hazard Planning, New Initiative	ABAG, BCDC, MTC, ACPHD, City of Oakland, City of Alameda, CBOs, NPOs, Private Sector	Multi-benefit, Local, Regional, Long Lead Time

during a disaster or emergency				
Develop and keep current hazard mitigation plans meeting established standards to ensure eligibility for state and federal emergency funds	Program/operation	Emergency and Hazard Planning	ABAG, CalOES, FEMA, City of Oakland, City of Alameda, Alameda County	Do It Yourself, Multi-benefit, Local, Regional
Develop contingency plans and procedures to address the need for short-term sheltering and long-term housing for displaced residents, with particular attention to certain populations and those with specific needs such as animal caretakers	Program/operation	Emergency and Hazard Planning	ABAG, CalOES, FEMA, ACPHD, City of Oakland, City of Alameda, CBOs, NPOs, Private Sector	Do It Yourself, Multi-benefit, Local, Regional
Coordinate emergency plans and information sharing among individual facilities, neighborhoods, utilities, cities, counties and regional and state authorities, including establishing protocols for responding to NOAA weather forecasts (e.g., when to close, shelter-in-place, or evacuate)	Coordination, Program/operation	Emergency and Hazard Planning	ABAG, MTC, Caltrans, BART, Port, UP, CalOES, FEMA, NOAA, City of Oakland, City of Alameda, Alameda County, PG&E	Multi-benefit, Local, Regional, State, Long Lead Time
Establish mutual aid agreements and initiate or strengthen joint protocols with adjoining jurisdictions for cooperative disaster response	Coordination, Policy Development	Emergency and Hazard Planning	City of Alameda, City of Oakland, CalOES, FEMA	Do It Yourself, Multi-benefit, Regional
Develop and maintain a multi-disciplinary communication interoperability plan to facilitate emergency communications among first responders from different cities, counties, Special Districts, state and federal agencies	Program/operation, Policy Development	Emergency and Hazard Planning	ABAG, MTC, CalOES, FEMA, Cities, County, CBOs, NPOs, Private Sector	Multi-benefit, Local, Regional, State

Evaluate the continued siting of certain land uses (schools, hospitals, childcare facilities, animal shelters, and residential development) in high risk areas that are difficult or expensive to protect, and in many cases cannot be protected, evacuated, or rebuilt in a manner ensuring public health, safety and welfare	Evaluation	Long-range Planning, Land Use Planning	ABAG, MTC, City of Oakland, City of Alameda, Alameda County	Unlocking, Local, Regional
Prioritize buyout of properties with certain land uses that are damaged or at high risk of damage from sea level rise or storm events	Program/operation	Emergency and Hazard Planning, Long-range Planning	FEMA, CalOES, City of Oakland, City of Alameda, Private Sector	Local, Regional, State, Federal
Develop and implement a community outreach process to educate a broad audience including facility owners, asset managers, private business owners, and the general public on the risks, costs, and benefits of hazard reduction strategies in comparison to relocation of vulnerable land uses	Education/outreach	Emergency and Hazard Planning, New Initiative	FEMA, CalOES, ABAG, City of Oakland, City of Alameda, Alameda County, CBOs, NPOs, Private Sector	Unlocking, Local, Regional
For facilities that provide key community services, develop and communicate to staff, emergency personnel, elected officials, and the public the expected standards for levels of service during and after a storm event	Policy Development, Education/outreach	Emergency and Hazard Planning	City of Oakland, City of Alameda, ACPHD, CBOs, NPOs	Do It Yourself, Local
Reduce dependency on facilities that provide critical community services that are vulnerable to sea level rise by building alternative facilities or by increasing the capacity of existing facilities in areas not at risk from sea level rise	Policy Development	Long-range Planning, Land Use Planning	City of Oakland, City of Alameda, ACPHD, Alameda County, CBOs, NPOs	Local, Long Lead Time

Develop policies or incentives to encourage/require the establishment of facilities providing key community services in locations that are not at risk of flooding, restrict the development of new key community services in such areas, and relocate existing facilities that are damaged by flooding and need to be substantially rebuilt to areas not at risk	Policy Development	Long-range Planning, Land Use Planning	ABAG, CalOES, FEMA, City of Oakland, City of Alameda, ACPHD, Alameda County, CBOs, NPOs, Private Sector	Local, Regional, Long Lead Time
Develop and implement requirements for real estate agents and lessors of residential and commercial properties to disclose the risk of sea level rise	Policy Development	Codes and Standards	City of Oakland, City of Alameda, Alameda County, CA Department of Insurance, CalOES, FEMA, HUD, NPOs, Private Sector	Local, Regional, State, Federal
Work with building industry to develop and distribute guidelines for reducing damages by designing or retrofitting structures to accommodate saltwater exposure and periodic low levels of flooding	Policy Development	Codes and Standards	City of Oakland, City of Alameda, Alameda County, FEMA, HUD, NPOs, Private Sector	Unlocking, Local, Regional, State, Federal
Provide flood protection assistance to community residents, e.g., technical advice and materials such as sand bags and plastic sheeting, and ensure vulnerable populations have access to these materials at low or no cost	Program/operation	Emergency and Hazard Planning	City of Oakland, City of Alameda, Alameda County, FEMA, HUD, CalOES, NPOs, Private Sector	Do It Yourself, Local, Regional, State, Federal
Encourage owners of property in floodplains to purchase flood insurance and educate the public that most homeowner insurance policies do not cover a property that is flood damaged	Education/outreach	New Initiative	City of Oakland, City of Alameda, Alameda County, FEMA, HUD, CalOES, NPOs, Private Sector	Do It Yourself, Local, Regional, State, Federal

Participate in and seek to qualify for the highest feasible rating of the Community Rating System of the National Flood Insurance Program to reduce flood risks and private property insurance costs	Program/operation	Land Use Planning, Emergency and Hazard Planning	City of Oakland, City of Alameda, Alameda County, FEMA	Do It Yourself, Local
Review and update standards, codes, and regulations for the construction and placement of new facilities and infrastructure to avoid or address sea level rise, storm events, and elevated groundwater levels	Policy Development	Codes and Standards	City of Oakland, City of Alameda, Alameda County, Special Districts, Private Sector	Unlocking, Do It Yourself, Local
Follow existing or develop new standards requiring that waterproof materials be used in the construction of new infrastructure and in the repair or protection of existing infrastructure	Policy Development, Program/operation	Operations, Project Planning and Design, Codes and Standards	City of Oakland, City of Alameda, Alameda County, Special Districts, Private Sector	Do It Yourself, Local
Follow existing or develop new standards to ensure corrosion-resistant materials or cathodic coatings are used when installing new or upgrading existing cables and pipelines	Policy Development, Program/operation	Capital Planning, Project Planning and Design, Codes and Standards	City of Oakland, City of Alameda, Alameda County, Special Districts, Private Sector	Do It Yourself, Local
Develop and implement disclosure requirements for real estate agents and lessors for residential and commercial properties with regard to future flood and groundwater exposure due to sea level rise and the particularly high vulnerability of habitable below-grade space	Policy Development, Program/operation	Codes and Standards	City of Oakland, City of Alameda, Alameda County, CA Department of Insurance, CalOES, FEMA, HUD, NPOs, Private Sector	Unlocking, Do It Yourself, Local, Regional, State
Evaluate eligibility and rates of required insurance and FEMA flood insurance for structures that have habitable below-grade space in areas likely to be affected by sea level and groundwater rise	Evaluation	New Initiative	City of Oakland, City of Alameda, Alameda County, CA Department of Insurance, CalOES, FEMA, HUD, NPOs, Private Sector	Unlocking, Local, Regional, State

Create incentives for property owners to repurpose below-grade space to less vulnerable or temporary uses	Program/operation	Codes and Standards	CA Department of Insurance, CalOES, FEMA, HUD, NPOs, Private Sector	Do It Yourself, Local, Regional, State
Prohibit below-grade habitable space in new development that will be exposed to sea level rise, storm events, and elevated groundwater	Policy Development	Land Use Planning, Codes and Standards	City of Oakland, City of Alameda, Alameda County, CA Department of Insurance, CalOES, FEMA, HUD, Private Sector	Do It Yourself, Local, Regional, State
Develop and enforce policies for repair and reconstruction to eliminate below-grade habitable space that is damaged by sea level and groundwater rise	Policy Development, Program/operation	Codes and Standards	City of Oakland, City of Alameda, Alameda County, CA Department of Insurance, CalOES, FEMA, HUD	Do It Yourself, Local, Regional, State

Oakland International Airport – Control Tower

The control tower at Oakland International Airport is part of a public airport located five miles south of downtown Oakland. The control tower cab is 236 feet above ground level with an accompanying 14,000 square-foot base building. The control tower handles all takeoff, landing, and movement area traffic at OAK, making it critical to the airport's function. The control tower is brand new (opened in 2013) and LEED gold-certified. It is built atop a pre-engineered fill base on piles and is adjacent to but high above a wetland. The FAA constructed a seawall on this side of the building's footprint. The air traffic control tower and system is owned and operated by the FAA.

Key Issue Statement

The OAK Control Tower is vulnerable to flooding and seismic events because it relies on sensitive utilities, roadways, and employees to function. The control tower is critical to the safe operation of OAK but if OAK suffers a major disruption due to flooding or seismic impacts, the control tower would no longer function. The control tower needs to be considered as OAK plans for overall resilience to seismic and flooding impacts.

Vulnerabilities

GOV1: The control tower is owned and operated by the FAA and is located within the footprint of the Oakland International Airport, which is owned and operated by the Port of Oakland. Any changes to the Control Tower would require the cooperation of both entities as well as the airlines. It would also have to meet all standards and regulations – including federal and local regulations – which could mean that a long lead time will be required for structural or operational changes to increase resilience.

GOV2: The Control Tower is protected by a dike around South Field, which is owned and maintained by the Port of Oakland (See Perimeter Dike profile sheet). The access route to and from the tower is also owned and maintained by the Port but is protected by EBRPD, Caltrans, and Port shoreline property. Therefore, FAA coordination with the Port will be required to maintain the tower's protection and access.

PHYS1: The control tower cab is well above grade, but there are offices, parking at grade and other supporting facilities such as utilities below grade. The below grade utilities are protected from flooding but the at-grade entrances and offices are vulnerable to flooding.

FUNC1: The facility relies on power to function; there are solar panels that generate 30% of the facility's needs. Backup electrical generation is by an on-site diesel generator that can operate for 72 hours.

FUNC2: The airport is part of an international network of airports with coordinated arriving and departing flights. A disruption to one part of the network can disrupt the entire system for a period of time until passengers are accommodated on alternate flights. The arrival and departure of flights depends on the control tower being operational.

FUNC3: The airport is a lifeline facility and needs to be operable in the event of an emergency (e.g., bringing in supplies, personnel, etc.). If the control tower isn't functioning, the airport won't be able to perform this service.

Consequences

Society: The control tower handles all takeoff, landing, and ground traffic at OAK, making it critical to the airport's function. Disruptions to service of the control tower due to a climate impact or seismic event would delay or cancel air service out of Oakland International Airport, which could have a negative impact on the transportation of cargo and passengers, with potential cascading effects on jobs at and associated with the airport.

Economy: The control tower serves the airport, which is a large contributor to the local and regional economy. Disruptions to service of the control tower due to a climate impact or seismic event would delay or cancel air service out of Oakland International Airport, which could have a negative impact on the transportation of cargo and passengers, with potential cascading effects on the surrounding economy.

Environment: The control tower is near a wetland and a seawall is between the tower and the wetland. If changes to the tower are necessary, there could be impacts on the wetland. In addition, generator fuel exists on site and could foul floodwaters if the waters covered the vented tank.

Adaptation Response

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
GOV1: The control tower is owned and operated by the FAA and is located within the footprint of the Oakland International Airport, which is owned and operated by the Port of Oakland. Any changes to the Control Tower would require the cooperation of both entities as well as the airlines. It would also have to meet all standards and regulations – including federal and local regulations – which could mean that a long lead time will be required for structural or operational changes to increase resilience.	Review FAA regulations (on design, maintenance and operations) that apply to the control tower and other regulated airport infrastructure and services in light of the vulnerability and consequence findings from the ART Oakland Alameda Focus Area Project to identify potential constraints and/or requirements that would apply to adaptation responses.	Evaluation, Policy Development	Operations, Codes and Standards, Project Planning and Design	Port, FAA	Do It Yourself, Unlocking
PHYS1: The control tower cab is well above grade, but there are offices, parking at grade and other supporting facilities such as utilities below grade. The below grade utilities are protected from flooding but the at-grade entrances and offices are vulnerable to flooding.	In advance of storm events, install temporary barriers or waterproof closures to protect at-grade station entrances and offices from flooding	Program/ operation	Emergency and Hazard Planning	FAA, Port	Do It Yourself
FUNC1: The facility relies on power to function; there are solar panels that generate 30% of the facility's needs. Backup electrical generation is by an on-site diesel generator that can operate for 72 hours.	Establish plans to deliver fuel to backup power generation systems to increase backup generator operation	Program/ operation	Operations, Emergency and Hazard Planning	FAA, Port	Do It Yourself,

Vulnerabilities also addressed under Key Planning Issue 1: GOV1, GOV2, FUNC3

Vulnerabilities also addressed under Key Planning Issue 6: GOV2

Oakland International Airport – Fire Station #22

Fire Station #22 is located at 751 Air Cargo Road, Oakland CA 94621, within the Oakland International Airport footprint. It is northeast of Runway 12/30 (formerly 11/29), northwest of Terminals 1 and 2, and inland of the runway. The station's role is firefighting and fire prevention services, as well as first aid and emergency medical technician services, throughout the airport. Fire Station #22 is a 33,000-square-foot facility with equipment bays that hold four airport fire trucks, other rescue vehicles, and equipment. A storage room for fire-retardant foam tanks, a personnel decontamination facility, and breathing apparatus fill room also are included in the facility. In addition, the station holds living quarters and offices. The station houses a crew of six, which is composed of a captain and five firefighters. The station was built in 1998. It is owned by the Port of Oakland and operated by the Oakland Fire Department.

Key Issue Statement

Fire Station #22 is vulnerable to future flooding because the building is at grade and firefighters rely on vulnerable roads to perform their emergency response function. Building resilience into emergency and disaster response will require adaptation on site of the fire station and coordination with transportation agencies to maintain road access. Fire Station #22 has a unique function in fire response for OAK that must be maintained to safely operate the airport.

Vulnerabilities

GOV1: The fire station is owned by the Port but operated by the City, and is subject to rules promulgated by the FAA. Given the multiple entities involved in regulating the fire station, any changes to increase resilience would require coordination and communication.

PHYS1: Electrical components and fuel components, including a backup generator, exist at the site at and below grade. They are protected from rainfall but not from floodwaters.

FUNC1: In order to carry out its function, Fire Station #22 needs vehicle access, which is at grade. It also requires electricity and fuel.

Consequences

Society: The fire station responds to fire and other emergencies at the airport, benefitting travelers and airport employees. The airport is a critical facility and is part of emergency response for the region; keeping it operational benefits communities in the region in the event of an emergency (see profile sheets for South and North Field, Terminals 1 and 2).

Economy: The fire station responds to fire and other emergencies at the airport, helping it maintain the services that benefit the local and regional economy (see profile sheets for South and North Field, Terminals 1 and 2).

Environment: The fire station contains fire retardant and possibly other chemicals used to fight fires. It is not immediately adjacent to the Bay or wetlands, but if floodwaters reached the fire station, they could potentially be polluted by these substances.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
PHYS1: Electrical components and fuel components, including a backup generator, exist at the site at and below grade. They are protected from rainfall but not from floodwaters.	Waterproof and/or raise the elevation of at- or below-grade electrical and fuel components at the fire station, including the backup generator, to protect against flooding and allow for continued function during a flood event	Program/ operation	Capital Planning, Project Design and Planning	Port, (City of Oakland Fire Department)	Do It Yourself
FUNC1: In order to carry out its function, Fire Station #22 needs vehicle access, which is at grade. It also requires electricity and fuel.	Identify and assess vulnerability of key routes used by fire fighters for access to the station, and emergency response at OAK, and ensure that this informs broader adaptation planning and prioritization for transportation assets for Bay Farm Island.	Evaluation	Long-range Planning, Operations, Emergency and Hazard Planning, New Initiative	Port, City of Oakland Fire Department	Do It Yourself, Unlocking, Multi-benefit

Vulnerabilities also addressed under Key Planning Issue 1: FUNC1

Oakland International Airport – Terminal 1

Terminal 1 is part of Oakland International Airport, a public airport owned and operated by the Port of Oakland, located five miles south of downtown Oakland. The terminal was opened in 1962 and is located between the South Field runway and Airport Drive, close to San Francisco Bay. Terminal 1 has 16 gates for commercial air travel, including three international gates. It is used by ten different airlines. There are also unscheduled charter flights and airlines that are contracted by other airlines (i.e., Horizon Air passengers are customers from Alaska Airlines). Terminal 1 serves commercial airlines and passengers and includes passenger check-in, airport security, customs, baggage claim, boarding gates, concessions, airline offices, heating and ventilation, and passenger amenities.

Key Issue Statement

Terminal 1 supports the commuter movement function of OAK. The terminal is vulnerable to flood events because of its construction and function; it has extensive at-grade entrances and equipment and needs to remain accessible to all visitors. The terminal also relies on many vulnerable outside services including local roads, overall airport operations, and power, wastewater, and water supply. If the terminal is damaged or disrupted, the airport cannot function in its commercial air travel capacity and Oakland and the region would suffer economic losses due to impaired commuter movement.

Vulnerabilities

GOV1: Terminal 1 is subject to safety, seismic, and ADA regulations, as well as City of Oakland building codes. The number of regulations and possible need for permits mean that coordination and communication between the airport and regulatory agencies will be required for structural or operational changes to increase resilience.

GOV2: The Port of Oakland owns some of the access roads critical to function of the airport – and therefore the Terminal (Airport Drive, Ron Cowan Parkway). Other access roads are owned by other entities such as Caltrans and the Cities of Oakland and Alameda (Interstate 880, 98th Avenue, Hegenberger Road, Doolittle Drive, Harbor Bay Parkway). The Port will need to work with these entities to ensure that access roads are resilient to sea level rise and earthquakes.

GOV3: While the Port of Oakland owns and operates Terminal 1, several other entities – such as TSA and the airlines – have a role in its operations and management and will likely need to be involved in any changes to operations to adapt to sea level rise.

PHYS1: The terminal buildings are at grade. There is some mechanical and electrical equipment located on the first floor of Terminal 1 (M102 and M103), including security computer equipment. Such equipment is sensitive to water and saltwater.

FUNC1: The terminal relies on access roads being open and runways being operational in order to carry out its function of handling arriving and departing passengers. Some of these roads and runways are low-lying and more exposed to flooding than Terminal 1. If these roads or runways are not operational, Terminal 1 cannot serve its function even if it is not directly affected by a climate or seismic impact.

FUNC2: The airport is part of an international network of airports with coordinated arriving and departing flights. A disruption to one part of the network can disrupt the entire system for a period of time until passengers are accommodated on alternate flights.

FUNC3: The terminal building relies on utilities to perform its basic functions (e.g., lighting, cooking at restaurants, heating/cooling) as well as specialized functions (e.g., conveyor belts for luggage, security screening equipment, secured doors). OAK is served by PGE for power and EBMUD for water supply and wastewater treatment.

FUNC4: The airport is a lifeline facility and needs to be operable in the event of an emergency (e.g., bringing in supplies, personnel, etc.). If the terminal is flooded or damaged by an earthquake it may not be able to serve this function.

FUNC5: There is another terminal at Oakland International Airport, but there may not be room to accommodate passengers and flights from Terminal 1. The other terminal may also be affected by the same event that has disrupted service at Terminal 1. There are other airports in the region that may be able to absorb some, but probably not all, of the traffic at Terminal 1.

Consequences

Society: OAK served approximately 9.7 million commercial passengers in 2013 (Terminal 1 and Terminal 2 combined). Interruptions to operations would affect people's ability to travel to and from the Bay Area and create pressures at other airports. In addition, the disruption of operations could have an effect on local employment, at the airport and at facilities associated with the airport (hotels, car rental companies). The airport is a lifeline facility and needs to be operable in the event of an emergency (e.g., bringing in supplies, personnel, etc.). If the terminals are flooded or damaged, it may not be able to fulfill its role in emergency response, which would reduce the resilience of local communities.

Economy: OAK generates thousands of jobs and brings money into the local economy. In 2013, there were approximately 14,000 on-airport jobs. Airlines/businesses would leave and passengers would fly at other Bay Area airports if Terminal 1 had to be rebuilt or relocated.

Environment: Asbestos-containing material, lead-based paint, solvents, oil, waste oil, and paints are present at Terminal 1. The airport borders San Francisco Bay, and there is the potential for these materials to be washed out to San Francisco Bay with floodwaters. This could affect San Francisco Bay itself, as well as the 500 acres of wetlands and other waters of the US around the airport.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
GOV3: While the Port of Oakland owns and operates Terminal 1, several other entities – such as TSA and the airlines – have a role in its operations and management and will likely need to be involved in any changes to operations to adapt to sea level rise.	In coordination with entities involved in operations and management at the terminal, assess vulnerabilities, plan for and facilitating cost-sharing in making on-site improvements to increase the resilience of the terminal to sea level rise, storm and earthquake impacts	Coordination	Long-range Planning, New Initiative	Port, private entities	Unlocking, Long Lead Time
PHYS1: The terminal buildings are at grade. There is some mechanical and electrical equipment located on the first floor of Terminal 1 (M102 and M103), including security computer equipment. Such equipment is sensitive to water and saltwater.	Waterproof and/or raise the elevation of at-grade electrical equipment above anticipated flood levels	Program/operation	Capital Planning, Project Design and Planning	Port, private entities	Do It Yourself
FUNC5: There is another terminal at Oakland International Airport, but there may not be room to accommodate passengers and flights from Terminal 1. The other terminal may also be affected by the same event that has disrupted service at Terminal 1. There are other airports in the region that may be able to absorb some, but probably not all, of the traffic at Terminal 1.	Review existing operations and maintenance plans, and emergency response plans to determine where preparation is inadequate for flooding impacts to one or both Terminals.	Evaluation	New Initiative	Port	Unlocking

Vulnerabilities also addressed under Key Planning Issue 1: GOV2, FUNC1

Vulnerabilities also addressed under Key Planning Issue 2: FUNC3

Vulnerabilities also addressed under Key Planning Issue 6: GOV1

Oakland International Airport – Terminal 2

Terminal 2 is part of Oakland International Airport, a public airport owned and operated by the Port of Oakland, located five miles south of downtown Oakland. The terminal is located between the South Field runway and Airport Drive, next to San Francisco Bay. Terminal 2 has 13 passenger gates and is used by Southwest Airlines for commercial flights. Terminal 2 includes baggage claim, airport security, passenger check-in/ticket counters, restrooms, airline offices, concessions, passenger boarding, and passenger amenities. It was opened in 1985 and expanded in 2007.

Key Issue Statement

Terminal 2 supports the commuter movement function of OAK. The terminal is vulnerable to flood events because of its construction and function; it has extensive at-grade entrances and equipment and needs to remain accessible to all visitors. The terminal also relies on many vulnerable outside services including local roads, overall airport operations, wastewater treatment, and power and water supply. If the terminal is damaged or disrupted, the airport cannot function in its commercial air travel capacity and Oakland and the region would suffer economic losses due to impaired commuter movement.

Vulnerabilities

GOV1: Terminal 2 is subject to safety, seismic, and ADA regulations, as well as City of Oakland building codes. The number of regulations and possible need for permits mean coordination and communication between the airport and regulatory agencies will be required for structural or operational changes to increase resilience.

GOV2: The Port of Oakland owns some of the access roads critical to function of the airport – and therefore the Terminal (Airport Drive, Ron Cowan Parkway). Other access roads are owned by other entities such as Caltrans and the Cities of Oakland and Alameda (Interstate 880, 98th Avenue, Hegenberger Road, Doolittle Drive, Harbor Bay Parkway). The Port will need to work with these entities to ensure that access roads are resilient to sea level rise and earthquakes.

GOV3: While the Port of Oakland owns and operates Terminal 2, other entities – such as TSA and Southwest Airlines – have a role in its operations and management and will likely need to be involved in any changes to operations to adapt to sea level rise.

PHYS1: The terminal buildings are at grade. There is some mechanical and electrical equipment located at grade that is sensitive to water and saltwater.

FUNC1: The terminal relies on access roads being open and runways being operational in order to carry out its function of handling arriving and departing passengers. Some of these roads and runways are low-lying and more exposed to flooding than Terminal 2. If these roads or runways are not operational, Terminal 1 cannot serve its function even if it is not directly affected by a climate or seismic impact.

FUNC2: The airport is part of an international network of airports with coordinated arriving and departing flights. A disruption to one part of the network can disrupt the entire system for a period of time until passengers are accommodated on alternate flights.

FUNC3: The terminal building relies on utilities to perform its basic functions (e.g., lighting, cooking at restaurants, heating/cooling) as well as specialized functions (e.g., conveyor belts for luggage, security screening equipment, secured doors). OAK is served by PGE for power and EBMUD for water supply and wastewater treatment.

FUNC4: The airport is a lifeline facility and needs to be operable in the event of an emergency (e.g., bringing in supplies, personnel, etc.). If the terminal is flooded or damaged by an earthquake it may not be able to serve this function.

FUNC5: There is another terminal at Oakland International Airport, but there may not be room to accommodate passengers and flights from Terminal 2. The other terminal may also be affected by the same event that has disrupted service at Terminal 2. There are other airports in the region that may be able to absorb some, but probably not all, of the traffic at Terminal 2.

Consequences

Society: OAK served approximately 9.7 million commercial passengers in 2013 (Terminal 1 and Terminal 2 combined). Interruptions to operations would affect people's ability to travel to and from the Bay Area and create pressures at other airports. Terminal 2 is used exclusively by the budget airline Southwest, so lower-income travelers could be disproportionately affected by an impact to this terminal. In addition, the disruption of operations could have an effect on local employment, at the airport and at facilities associated with the airport (hotels, car rental companies). The airport is a lifeline facility and needs to be operable in the event of an emergency (e.g., bringing in supplies, personnel, etc.). If the terminals are flooded or damaged, it may not be able to fulfill its role in emergencies, which could reduce the resilience of local communities.

Economy: OAK generates thousands of jobs and brings money into the local economy. In 2013, there were approximately 14,000 on-airport jobs. Airlines/businesses would leave and passengers would fly at other Bay Area airports if Terminal 2 had to be rebuilt or relocated.

Environment: Asbestos-containing material, lead-based paint, solvents, oil, waste oil, and paints are present at Terminal 2. The airport borders San Francisco Bay, and there is the potential for these materials to be washed out to the San Francisco Bay with floodwaters. This could affect San Francisco Bay itself, as well as the 500 acres of wetlands and other waters of the U.S. around the airport.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
GOV3: While the Port of Oakland owns and operates Terminal 2, other entities – such as TSA and Southwest Airlines – have a role in its operations and management and will likely need to be involved in any changes to operations to adapt to sea level rise.	In coordination with entities involved in operations and management at the terminal, assess vulnerabilities, plan for and facilitating cost-sharing in making on-site improvements to increase the resilience of the terminal to sea level rise, storm and earthquake impacts	Coordination	Long-range Planning, New Initiative	Port, private entities	Unlocking, Long Lead Time
PHYS1: The terminal buildings are at grade. There is some mechanical and electrical equipment located at grade that is sensitive to water and saltwater.	Waterproof and/or raise the elevation of at-grade electrical equipment above anticipated flood levels	Program/ operation	Capital Planning, Project Design and Planning	Port, private entities	Do It Yourself
FUNC5: There is another terminal at Oakland International Airport, but there may not be room to accommodate passengers and flights from Terminal 2. The other terminal may also be affected by the same event that has disrupted service at Terminal 2. There are other airports in the region that may be able to absorb some, but probably not all, of the traffic at Terminal 2.	Review existing operations and maintenance plans, and emergency response plans to determine where preparation is inadequate for flooding impacts to one or both Terminals.	Evaluation	New Initiative	Port	Unlocking

Vulnerabilities also addressed under Key Planning Issue 1: GOV2, FUNC1

Vulnerabilities also addressed under Key Planning Issue 2: FUNC2

Vulnerabilities also addressed under Key Planning Issue 4: FUNC4

Vulnerabilities also addressed under Key Planning Issue 6: GOV1

Oakland International Airport – South Field Tank Farm

Oakland International Airport's Tank Farm is located along the southeastern edge of the airport next to the San Francisco Bay. The Tank Farm has three primary components – Tank Farm C, the Oakland Airport Transfer Station, and underground piping to the fuel hydrant system – and has three aboveground storage tanks. It is owned by a consortium of airlines, Oakland Fuel Facilities Corporation (OFFC), and managed by Swissport Fueling. Fuel is supplied by Kinder Morgan Energy Partners. Tank Farm C and the underground piping to the fuel hydrant system were completely rebuilt in 2010 to comply with seismic regulations. The Fuel Transfer Station has operated since the 1970s and is currently active.

Key Issue Statement

The South Field Tank Farm is vulnerable to seismic impacts both onsite (despite upgrades) and through the pipelines it relies on for resupply. The tank farm is critical to the operation of the airport for both daily operations and emergency response. If the tank farm is damaged or disrupted, there would be both economic consequences due to lost airport activity and environmental and public health consequences if fuel and other materials are released from the site.

Vulnerabilities

GOV1: The land where the Tank Farm is located is owned by the Port of Oakland; OFFC is the tenant, Swissport Fueling is the manager, and Kinder Morgan supplies the fuel. All of these entities would likely need to be involved in any changes necessary to increase resilience.

GOV2: The Tank Farm is subject to State Fire Marshal regulations, and contamination from historic releases is subject to a cleanup plan overseen by the RWQCB.

PHYS1: Underground piping could be vulnerable to ground shaking and liquefaction. However, this site was stabilized during the 2010 improvements through cement and soil mixing.

FUNC1: The airport depends on the Tank Farm being operational in order to provide Jet fuel to aircraft. The Tank Farm can store approximately 100,000 barrels of fuel, which should provide commercial aircraft with fuel for at least one week.

FUNC2: The pipeline network that connects to the tank farm is vulnerable to liquefaction and ground shaking. Higher groundwater due to sea level rise may exacerbate liquefaction risk in the pipeline network.

Consequences

Society: The asset is critical to the function of the airport, which transports passengers and cargo. Interruptions beyond about a week would have impacts for surrounding communities and those who wish to travel to and from the area, or have cargo delivered through Oakland airport (see profile sheets for South and North Field, Terminals 1 and 2).

Economy: The tank farm serves the airport, which is a large contributor to the local and regional economy. Disruptions to service of the Tank Farm due to a climate impact could delay or cancel air service out of Oakland International Airport, which could have a negative impact on the transportation of cargo and passengers, with potential cascading effects on the surrounding economy (see profile sheets for South and North Field, Terminals 1 and 2).

Environment: Sensitive receptors, including wetlands and the Bay, are immediately adjacent to the facility and at least one pipeline goes underneath a wetland. The facility stores and transports jet fuel and diesel fuel.

If a storage container or pipeline were to break and leak due to a climate or seismic event, it could harm the Bay and wetlands.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
GOV1: The land where the Tank Farm is located is owned by the Port of Oakland; OFFC is the tenant, Swissport Fueling is the manager, and Kinder Morgan supplies the fuel. All of these entities would likely need to be involved in any changes necessary to increase resilience.	Form or expand existing coordination with Tank Farm private partners to engage in collaborative, multi-objective planning and facilitate cost-sharing in making improvements to increase the resilience of the tank farm, transfer station and pipelines to sea level rise, storm and earthquake impacts	Coordination	Long-range Planning, New Initiative	Port, OFFC, Kinder Morgan, Swissport	Unlocking, Long Lead Time
PHYS1: Underground piping could be vulnerable to ground shaking and liquefaction. However, this site was stabilized during the 2010 improvements through cement and soil mixing.	Require and install (if not already in place) shut-off, overflow, and re-routing and/or other mechanisms to function during an emergency to both prevent fuel release and restore fuel supply	Policy Development, Program/operation	Long-range Planning, Capital Planning, Codes and Standards, Project Planning and Design	Port, OFFC, Kinder Morgan, Swissport	Multi-benefit,

Vulnerabilities also addressed under Key Planning Issue 6: GOV2

Oakland International Airport – North Field

North Field is part of Oakland International Airport, a public airport located five miles south of downtown Oakland. North Field is used for general aviation. Facilities include aircraft hangars, ramps, two fixed base operators, including jet fuel storage, and some air cargo facilities (approximately 30 acres). Three runways (Runway 10R-28L, formerly 9R-27L; Runway 10L-28R, formerly 9L-27R; and Runway 15-33) provide service to smaller aircraft, including general aviation and air cargo. The oldest buildings at North Field were built in the 1930's, with the oldest apron built in 1932. Oakland International Airport is owned and operated by the Port of Oakland. Various ground and building leases exist that place differing levels of responsibilities on lessees. North Field is protected by levees owned by EBRPD.

Key Issue Statement

North Field provides critical goods movement functions to OAK and the region. North Field is directly vulnerable to flooding impacts due to its low elevation and insufficient shoreline protection. It is also vulnerable to secondary impacts such as disrupted ground transportation networks and power outages. As OAK plans for resilience, they will need to consider the onsite structures and operations of North Field as well as its place in the transportation and utility systems.

Vulnerabilities

GOV1: North Field, as part of an international airport, is subject to many standards and regulations including those of the FAA and city and county zoning, as well as natural resources agencies – RWQCB Section 404 for any discharges, BCDC for any work in its jurisdiction, USFWS, CDFW if endangered species are present, etc. Portions of North Field are in the jurisdiction of Army Corp of Engineers (ACOE) as tidal and non-tidal wetlands. The number of regulations and possible need for permits mean that a long lead time will be required for structural or operational changes to increase resilience, along with coordination and communication between the airport and regulatory agencies.

GOV2: A number of other entities have contracts to use land and facilities at North Field, meaning that coordination with them would be necessary for access in the event of an emergency, and for the development and implementation of adaptation strategies.

GOV3: North Field is protected by dikes and riprap owned and managed by the Cities of Oakland and Alameda, Caltrans, and EBRPD. In order to improve the shoreline protection, the Port will need to coordinate very closely with these entities.

GOV4: The access roads critical to the airport's function are mostly owned by other entities (Caltrans, Cities of Oakland and Alameda). The Port will need to work with these entities to ensure functionality of these roads.

PHYS2: North Field is at grade and is protected by a riprap and dikes (not owned by the Port). If any of this shoreline protection were to fail, flooding of North Field and its facilities could be extensive (see FUNC1).

PHYS3: Numerous communication and electrical components below grade. These are constantly wet and are engineered to resist corrosion. At-grade electrical transformers on the North field, however, are sensitive to standing water.

PHYS4: Some parts of North Field have settled due to groundwater withdrawal; these include a building (is this building important?) that is being monitored, and paved surfaces.

PHYS5: Stormwater control at North Field involves pumps and gate valves that require technical staff and professional scuba divers to maintain and repair.

FUNC1: Runways that are flooded or that have significant earthquake damage, such as sand boils and cracks, cannot operate. The San Francisco Bay Area does not have sufficient commercial airport runway

capacity to serve as a short- or long-term alternative to Oakland International Airport if it were damaged or disrupted due to sea level rise, storm events, or an earthquake. (See Key Planning Issue 4. OAK)

FUNC2: The airport relies on access roads that are low-lying and are vulnerable to flooding in events similar to – and even less severe than – those that threaten North Field. Without vehicle access to the airport, it cannot serve its function.

FUNC3: The airport is a lifeline facility and needs to be operable in the event of an emergency (e.g., bringing in supplies, personnel, etc.). If its runways are flooded it cannot serve this function.

FUNC4: Some utility items in North Field are on generator power, but most are not. If the main source of power were interrupted, these utilities would cease to function.

Consequences

Society: Interruptions to operations could have an effect on local employment. The airport is a lifeline facility and needs to be operable in the event of an emergency (e.g., bringing in supplies, personnel, etc.). If its runways are flooded it cannot fulfill this role, which reduces the resilience of local communities.

Economy: North Field includes some cargo facilities for Oakland International Airport, which serves as the West Coast hub for FedEx and also has a large UPS presence. The airport ranks 12th in the country in terms of tons of cargo handled, and interruptions to cargo facilities could slow the exchange of goods in the region and also affect employment.

Environment: North Field borders San Francisco Bay, including parks and marshes that are part of MLK Regional Shoreline and which provide habitat for many species, including several endangered ones. Any hazardous materials at the site could be washed out to the Bay with floodwaters. In addition, changes to the dikes and riprap that protect North Field could have an environmental impact.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
GOV2: A number of other entities have contracts to use land and facilities at North Field, meaning that coordination with them would be necessary for access in the event of an emergency, and for the development and implementation of adaptation strategies.	Form or expand existing coordination with Tank Farm private partners to engage in collaborative, multi-objective planning and facilitate cost-sharing in making improvements to increase the resilience of the tank farm, transfer station and pipelines to sea level rise, storm and earthquake impacts	Coordination	Long-range Planning, New Initiative	Port, OFFC, Kinder Morgan, Swissport	Unlocking, Long Lead Time
PHYS3: Numerous communication and electrical components below grade. These are constantly wet and are engineered to resist corrosion. At-grade electrical transformers on the North field, however, are sensitive to standing water.	Waterproof and/or raise the elevation of below-grade electrical transformers above anticipated flood levels	Program/operation	Capital Planning, Project Design and Planning	Port	Do It Yourself
PHYS5: Stormwater control at North Field involves pumps and gate valves that require technical staff and professional scuba divers to maintain and repair.	Review existing operations and maintenance plans for stormwater control at North Field to determine where preparation is inadequate for sea level rise and storm events	Evaluation	New Initiative	Port	Unlocking, Do It Yourself
	Manage stormwater at or near critical facilities and transportation elements on North Field by prioritizing regular maintenance, investing in drainage improvements.	Program/operation	Capital Planning, Operations, Codes and Standards	Port	Do It Yourself

	Institute operational changes to reduce system complexity, eliminate key vulnerable components, or minimize cost to maintain and repair the system	Program/ operation, Policy Development	Operations, Codes and Standards	Port	Multi-benefit, Do It Yourself
	Reduce the vulnerability of components by improving the ability to operate remotely, ensuring access to backup power or portable pumps, or by redesigning (e.g., restrict pump station design capacity to be operable with portable pumps)	Program/ operation	Capital Planning, Project Planning and Design	Port	Multi-benefit, Do It Yourself
FUNC4: Some utility items in North Field are on generator power, but most are not. If the main source of power were interrupted, these utilities would cease to function.	Provide adequate backup power to minimize interruptions to critical facilities at North Field, including lifeline facilities, e.g., on-site power generators with sufficient fuel for several days, portable backup power generators, or pre-position access through rental or leasing agreement	Policy Development, Program/ operation	Operations, Codes and Standards, Emergency and Hazard Planning	Port	Do It Yourself, Multi-benefit

Vulnerabilities also addressed under Key Planning Issue 1: GOV4, FUNC1

Vulnerabilities also addressed under Key Planning Issue 6: GOV1

Oakland International Airport – South Field

South Field is part of Oakland International Airport, a public airport located five miles south of downtown Oakland. It is used by commercial airline service and air cargo and contains 208 acres of passenger facilities, including Terminals 1 and 2, and 104 acres of air cargo facilities. Runway 12/30 (recently changed from 11/29) is the South Field's primary runway that provides service to large commercial aircraft. South Field was constructed in the early 60's and will continue to be operated, improved and maintained for the foreseeable future. The Port of Oakland manages Oakland International Airport. The land and infrastructure surrounding OAK is owned or regulated by a number of agencies, including the Cities of Oakland and Alameda. South Field consists of multiple components – see profile sheets for Terminals 1 and 2, Fire Station #22, the Tank Farm, and the Perimeter Dike.

Key Issue Statement

South Field is vulnerable to both seismic and flooding events and relies on many other vulnerable services both within and outside OAK. The Port of Oakland has planned improvements to the perimeter dike at South Field but will need to coordinate across its own departments and with outside agencies to maintain full airport function including control tower, terminal, fuel supply, and access road operations. If South Field is disrupted due to a seismic or flood event, there would be economic disruptions due to lost airport activity and public safety consequences because OAK provides a critical link in regional emergency response efforts.

Vulnerabilities

GOV1: South Field, as part of an international airport, is subject to many standards and regulations including those of the FAA (Part 139) and city and county zoning, as well as natural resources agencies – RWQCB Section 404 for any discharges, BCDC for any work in its jurisdiction, USFWS, CDFW if endangered species are present, etc. The number of regulations and possible need for permits mean that coordination and communication between the airport and regulatory agencies will be required for structural or operational changes to increase resilience.

GOV2: The access roads critical to the airport's function are mostly owned by other entities (Caltrans, Cities of Oakland and Alameda). The Port will need to work with these entities to ensure functionality of these roads. (See Key Planning Issue 1. Access)

PHYS1: There are two active fuel pipelines within the dike (see Perimeter Dike profile sheet), and underground utility runs – including hydrant fueling of aircraft – crisscross South Field and are subject to water incursion. They were placed with the high water table in mind and are protected to varying degrees based on this. However, the presence of utilities means that any repairs or improvements to South Field will require extra caution, and the utilities themselves may be vulnerable to liquefaction and ground shaking.

PHYS2: South Field is at grade and is protected by a single levee that currently does not meet standards (see Perimeter Dike profile sheet). If this levee were to fail, flooding of South Field, including the runway, could be extensive (see FUNC1).

FUNC1: Runways that are flooded or that have significant earthquake damage, such as sand boils and cracks, cannot operate. The San Francisco Bay Area does not have sufficient commercial airport runway capacity to serve as a short- or long-term alternative to Oakland International Airport if it were damaged or disrupted due to sea level rise, storm events, or an earthquake.

FUNC2: The airport relies on access roads that are low-lying and are vulnerable to flooding in events similar to – and even less severe than – those that threaten South Field. Without vehicle access to the airport, it cannot serve its function.

FUNC3: The airport is a lifeline facility and needs to be operable in the event of an emergency (e.g., bringing in supplies, personnel, etc.). If its runways are flooded it cannot serve this function.

Consequences

Society: Interruptions to operations could have an effect on local employment. See Terminals 1 and 2 profile sheets for travel /passenger information. The airport is a lifeline facility and needs to be operable in the event of an emergency (e.g., bringing in supplies, personnel, etc.). If its runways are flooded it cannot fulfill this role, which reduces the resilience of local communities.

Economy: South Field includes the primary cargo facilities for Oakland International Airport, which serves as the West Coast hub for FedEx and also has a large UPS presence. The airport ranks 12th in the country in terms of tons of cargo handled, and interruptions to cargo facilities could slow the exchange of goods in the region and also affect employment. See Terminals 1 and 2 profile sheets for passenger information.

Environment: South Field borders San Francisco Bay; any hazardous materials at the site could be washed out to the Bay with floodwaters. In addition, changes to the dike that protects South Field could have an environmental impact (See Perimeter Dike profile sheet).

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
<p>PHYS1: There are two active fuel pipelines within the dike (see Perimeter Dike profile sheet), and underground utility runs – including hydrant fueling of aircraft – crisscross South Field and are subject to water incursion. They were placed with the high water table in mind and are protected to varying degrees based on this. However, the presence of utilities means that any repairs or improvements to South Field will require extra caution, and the utilities themselves may be vulnerable to liquefaction and ground shaking.</p>	<p>Increase inspection and maintenance of infrastructure that is sensitive to water or salt in areas at risk from sea level rise, storm events, or elevated groundwater levels</p>	<p>Program/ operation</p>	<p>Operations</p>	<p>Port, Kinder Morgan</p>	<p>Do It Yourself</p>
	<p>Monitor groundwater and salinity levels near vulnerable infrastructure by leveraging existing data or collecting site-specific data as necessary</p>	<p>Program/ operation</p>	<p>Operations, New Initiative</p>	<p>Port</p>	<p>Unlocking, Do It Yourself</p>

Vulnerabilities also addressed under Key Planning Issue 1: GOV2, FUNC2

Vulnerabilities also addressed under Key Planning Issue 4: FUNC1

Vulnerabilities also addressed under Key Planning Issue 6: GOV1, PHYS2

Oakland International Airport – South Field

Perimeter Dike

The perimeter dike forms the southwestern shoreline of the Oakland International Airport property and protects the South Airport from flooding. The dike, which is owned by the Port of Oakland, was initially built in the late 1950s; it was built in phases using dredged materials (Bay Mud and Merritt Sand). It is 4.5 miles long, 18 to 28 feet wide, and its crest is 9 to 17.5 feet above the Bay. The dike is currently functional but it needs to be improved for FEMA certification and to withstand seismic events.

Key Issue Statement

The perimeter dike at OAK provides flood protection for the south airport and is critical to the commercial functions of the airport. Planned improvements to raise and stabilize the dike will only accommodate storm events plus one foot of sea level rise so the dike will not be resilient past mid-century. The dike's importance and the cost and governance challenges surrounding any changes to its structure mean OAK will need to carefully consider the long term use and safety of the dike.

Vulnerabilities

GOV1: While OAK owns most of the dike, the first 1500 feet of it are in and owned by the City of San Leandro, where it protects the wastewater treatment plant and Metrolinks Golf Course. Coordination with the City and golf course may therefore be necessary for any improvements. In addition, there are 2 active pipelines within the dike, so coordination with Kinder Morgan would be necessary, primarily for seismic improvements.

GOV2: The perimeter dike improvement project is subject to regulation by a number of agencies. Changes to the asset that affect jurisdictional wetlands could require permits from the ACOE (Section 10, Section 404); RWQCB (401 Water Quality Certification); and USFWS/NMFS consultation. Furthermore, the dike is within BCDC's jurisdiction. These regulations mean that time-consuming coordination and permitting will be required for any changes.

PHYS1: The riprap along the dike was not engineered and is in need of repairs to prevent erosion of the crest structure.

PHYS2: There are two active fuel pipelines within the dike, meaning that any repairs or improvements will require extra caution, and the pipelines themselves may be vulnerable to liquefaction and ground shaking.

PHYS3: The dike was partially damaged during the 1989 Loma Prieta earthquake, including seepage and erosion of the crest structure. It is still vulnerable to this type of damage.

FUNC1: The dike is 4.5 miles long and protects a commercial airport; if it is breached in one point, any assets in the path of the water are at risk, not just those directly behind the breach.

Consequences

Society: The dike protects the airport, which provides travel services and employment throughout the focus area and beyond. If the dike were to fail, it could disrupt operations at South Field (commercial runway). See South Field profile sheet for consequences.

Economy: The dike protects the airport, which is a source of employment and commercial hub for the focus area and beyond. If the dike were to fail, it could disrupt operations at South Field (commercial runway). See South Field profile sheet for consequences.

Environment: Due to the presence of pipelines in the perimeter dike, a catastrophic failure of the dike could cause environmental damage if the pipelines were to break and release fuel into the Bay.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
<p>GOV1: While OAK owns most of the dike, the first 1500 feet of it are in and owned by the City of San Leandro, where it protects the wastewater treatment plant and Metrolinks Golf Course. Coordination with the City and golf course may therefore be necessary for any improvements. In addition, there are 2 active pipelines within the dike, so coordination with Kinder Morgan would be necessary, primarily for seismic improvements.</p>	<p>Develop agreements with the City of San Leandro and Kinder Morgan to set shared management objectives for the perimeter dike. Identify decision-making and funding responsibilities, as well as requirements (e.g., FAA regulations) related to maintenance, repair, or upgrade.</p>	<p>Coordination, Policy Development</p>	<p>New Initiative</p>	<p>Port, City of San Leandro, Kinder Morgan</p>	<p>Unlocking, Multi-benefit, Long Lead Time</p>
	<p>Coordinate planning and decision-making regarding emergency response, repairs and improvements to the dike to address sea level rise, storm and earthquake impacts.</p>	<p>Coordination, Policy Development</p>	<p>New Initiative</p>	<p>Port, City of San Leandro, Kinder Morgan</p>	<p>Multi-benefit, Long Lead Time</p>
<p>PHYS1: The riprap along the dike was not engineered and is in need of repairs to prevent erosion of the crest structure.</p>	<p>Dedicate funding and resources (if not already done) to inspect, maintain, upgrade, and repair vulnerable, at-risk portions of the perimeter dike – particularly after seismic or storm events.</p>	<p>Program/operation</p>	<p>Capital Planning</p>	<p>Port</p>	<p>Do It Yourself</p>
<p>PHYS2: There are two active fuel pipelines within the dike, meaning that any repairs or improvements will require extra caution, and the pipelines themselves may be vulnerable to liquefaction and ground shaking.</p>	<p>If not already in place, install shut-off, overflow, and/or re-routing mechanisms for the pipelines in the event that they are damaged during an earthquake,</p>	<p>Policy Development, Program/operation</p>	<p>Long-range Planning, Capital Planning, Codes and Standards, Project Planning and Design</p>	<p>Port, Kinder Morgan</p>	<p>Multi-benefit, Do It Yourself, Local, Regional</p>

FUNC1: The dike is 4.5 miles long and protects a commercial airport; if it is breached in one point, any assets in the path of the water are at risk, not just those directly behind the breach.	Review existing operations and maintenance plans, and emergency response plans to determine where preparation is inadequate for flooding and seismic events that damage the perimeter dike and/or pipelines within the dike.	Evaluation	New Initiative	Port, City of San Leandro, Kinder Morgan	Unlocking,
--	--	------------	----------------	--	------------

Vulnerabilities also addressed under Key Planning Issue 6: Gov2

98th Avenue

98th Avenue is a six-lane surface street that connects Oakland to Hegenberger Road, Bay Farm Island, and the Oakland International Airport. It is a major arterial in south Oakland. It runs northeast from Doolittle Drive on Bay Farm Island through southern Oakland, running under I-880 and intersecting with San Leandro Street in the focus area. It was constructed in 1960 and is owned and maintained by the City of Oakland's Public Works Department.

Key Issue Statement

98th Avenue is vulnerable to sea level rise and storm event impacts through direct inundation, especially in the underpass on Bay Farm Island. Addressing this vulnerability will be complicated because 98th Avenue is co-located with utilities, sewers and the Oakland Airport Connector and crosses over San Leandro Creek. 98th Avenue provides vehicle access between OAK and the city of Oakland. Any disruption in its function could impact the local and regional economy as well as goods and commuter movement.

Vulnerabilities

GOV1: A number of entities have permitting authority over 98th Ave; if improvements are necessary to increase resilience, permits from the following agencies could be necessary, which would increase the time needed to implement changes: USACE (Section 404), RWQCB (401 Certification), USFWS (Biological Opinion), and CDFW (CESA compliance).

GOV2, PHYS1: 98th Avenue is co-located with utilities and sewers, and crosses over San Leandro Creek, a flood control channel owned and operated by Alameda County. If changes to the road were required, the City of Oakland would need to coordinate with public and private utilities such as PG&E and EBMUD, as well as Alameda County.

PHYS2: 98th Ave's Pavement Condition Index ranges from 50-78; areas with low PCIs may suffer more extensive damage from a climate or seismic event than if they were in good shape.

PHYS3: Some components of the road are below-grade, sensitive to water or saltwater, and not protected. The structural integrity of the street itself is sensitive to wave action and susceptible to erosion.

FUNC1: 98th Ave. is one of very few roads that connect Bay Farm Island and the airport with Oakland. While surface roads generally have high redundancy with the ability to re-route traffic, other arterial routes in the area do not have the capacity to accommodate traffic and Bay Farm Island has limited access points. In addition, these alternate routes may be exposed to the same impacts. Therefore, if 98th Ave. were not operational due to a climate or seismic impact, access between the mainland and Bay Farm Island / OAK would be limited. 98th Ave is also used by public transit agencies for several different routes, which would be cut off or forced to detour if it were inoperable.

FUNC2: Hegenberger Road is an Oakland Evacuation Route. It cannot serve the function of safely evacuating people if it is not operational due to a climate or seismic event.

Consequences

Society: 98th Ave. connects Bay Farm Island and the airport with Oakland and beyond. It is a local arterial for Southern Oakland, carrying goods, residents, commuters, and emergency response. It carries several transit routes and may serve transit-dependent communities. If 98th Ave. were out of service, it would have a serious effect on residents and commuters and could disrupt access to the airport for workers and travelers.

Economy: 98th Ave. is a local arterial and provides access to the airport. Interruptions to commuters and goods movement could have a local to regional economic effect, and disruption of airport operations could have a national to international effect.

Environment: 98th Ave. crosses San Leandro Creek. Pollutants on the road could wash into the Bay with floodwaters, and any construction on the road could threaten habitat and water quality in San Leandro Creek.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
GOV2, PHYS1: 98th Avenue is co-located with utilities and sewers, and crosses over San Leandro Creek, a flood control channel owned and operated by Alameda County. If changes to the road were required, the City of Oakland would need to coordinate with public and private utilities such as PG&E and EBMUD, as well as Alameda County.	Develop multi-agency agreements that result in shared transportation management objectives and identify decision-making and funding responsibilities related to maintenance, repair, or upgrade	Coordination, Policy Development	New Initiative	MTC, Caltrans, BART, Port, AC Transit, County, Oakland,	Unlocking, Multi-benefit, Local, Regional, Long Lead Time
	Expand or form broad public-private partnerships (multi-sector/agency) to guide the planning and implementation of multi-objective transportation improvements and new investments that are resilient to sea level rise and storm events	Coordination	Long-range Planning, New Initiative	ABAG, MTC, Caltrans, BART, Port, AC Transit, Oakland, CBO's, Private Sector (OAK tenants?)	Unlocking, Local, Regional
	Work with adjacent communities, regions, and the state to develop and jointly implement transportation adaptation strategies that address changes in transportation system condition and use due to sea level rise and storm events	Coordination	New Initiative, Emergency and Hazard Planning	ABAG, BCDC, MTC, Caltrans, BART, Port, AC Transit, Alameda County, Oakland and Alameda, CCJPA, UP, WETA,	Multi-benefit, Regional, State, Federal, Long Lead Time
	Expand or form multi-agency partnerships to facilitate cost-sharing in planning for multi-objective transportation improvements and new investments that avoid or address sea level rise and storm	Coordination, Policy Development	Long-range Planning, New Initiative	MTC, Caltrans, BART, Port, AC Transit, County, Oakland, Alameda	Local, Regional, Long Lead Time

	events				
<p>FUNC1: 98th Ave. is one of very few roads that connect Bay Farm Island and the airport with Oakland. While surface roads generally have high redundancy with the ability to re-route traffic, other arterial routes in the area do not have the capacity to accommodate traffic and Bay Farm Island has limited access points. In addition, these alternate routes may be exposed to the same impacts. Therefore, if 98th Ave. were not operational due to a climate or seismic impact, access between the mainland and Bay Farm Island / OAK would be limited. 98th Ave is also used by public transit agencies for several different routes, which would be cut off or forced to detour if it were inoperable.</p>	Develop design standards for new infrastructure and capital improvements investments that will protect critical elements from sea level and groundwater rise	Policy Development	Codes and Standards, Capital Planning, Long range Planning	Caltrans, MTC	Do It Yourself, Unlocking, Regional
	Install manual, remote control, or automatic temporary barriers or waterproof closures to protect at- or below-grade critical elements such as station entrances, tunnels, maintenance facilities, asset storage areas, and rail alignments	Program/operation	Capital Planning, Operations, Codes and Standards, Project Planning and Design	Caltrans, Oakland	Do It Yourself, Unlocking, Regional
<p>FUNC2: Hegenberger Road is an Oakland Evacuation Route. It cannot serve the function of safely evacuating people if it is not operational due to a climate or seismic event.</p>	Develop a framework for regional transportation planning (particularly transit-oriented development plans) and for the acquisition of easements and access agreements that incorporates sea level rise and storm events	Policy Development	Long-range Planning	ABAG, BCDC, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, CBOs, Private Sector, USACE, FEMA	Unlocking, Regional
	Conduct a "hot spot" analysis to identify key routes and nodes critical to traffic flow, assess their vulnerability and risk, and develop actions to improve their resilience to	Evaluation	Long-range Planning, Operations, Emergency and Hazard	MTC, Caltrans, AC Transit, Oakland, Alameda	Do It Yourself, Unlocking, Multi-benefit, Local, Regional

	sea level rise and storm events		Planning, New Initiative		
	Increase the capacity to accommodate re-routed traffic on alternative routes, or build new routes, in areas not at risk from sea level rise and storm events	Program/operation	Long-range Planning, Capital Planning	MTC, Caltrans, AC Transit, Oakland, Alameda, CMA	Local, Regional, Long Lead Time
	Develop currently underused, unused, or new pedestrian rights-of-way as non-motorized emergency evacuation alternative routes	Program/operation	Capital Planning, Operations, Codes and Standards, Project Planning and Design, Emergency and Hazard Planning	MTC, Caltrans, AC Transit, Bay Trail, Oakland, Alameda, CMA	Multi-benefit, Local, Regional
	Include strategies that ensure the safe evacuation of transit-dependent populations in emergency response plans, e.g., designate evacuation routes and bus assignments, coordinate with local school bus fleets, transportation service providers, and wheelchair accessible vehicles to expand the pool of available vehicles for evacuation	Program/ operation	Emergency and Hazard Planning	ABAG, MTC, Caltrans, BART, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, County Health, CBOs, CalEMA, County OES	Multi-benefit, Local, Regional

Vulnerabilities also addressed under Key Planning Issue 6: GOV1

Airport Drive (Airport Access Road)

Airport Drive is a six-lane surface street that connects Oakland to Bay Farm Island and the Oakland International Airport. It forms a loop in front of Oakland International Airport and then runs northeast across the southern end of Bay Farm Island to where it intersects with Doolittle Drive and splits in to Hegenberger Road and 98th Ave. It was constructed in 1960 and is owned and maintained by the City of Oakland's Public Works Department. Its PCI is 59.

Key Issue Statement

Airport Drive is the sole roadway to access the OAK airport terminals. It is vulnerable to sea level rise and storm event impacts and could not function if flooded or damaged. Airport Drive relies on vulnerable shoreline protection owned by East Bay Regional Park District. Airport drive also relies on connections with other vulnerable transportation assets including Doolittle Drive, 98th Avenue and Hegenberger Road to function. Making Airport Drive more resilient will require coordination with other Bay Farm Island property owners and other transportation agencies.

Vulnerabilities

GOV1: Airport Drive is protected by levees owned by EBRPD around MLK Jr. Regional Shoreline and the perimeter dike owned by the Port of Oakland.

GOV3, PHYS1: Airport Drive is co-located with utilities and sewers; if changes to the road were required, the City of Oakland would need to coordinate with public and private utilities such as PG&E and EBMUD.

PHYS2: Some components of the road are below-grade, sensitive to water or saltwater, and not protected. The structural integrity of the street itself is sensitive to wave action and susceptible to erosion.

FUNC1: Airport Drive is the only street connecting Oakland with the airport. If the northeastern portion were disrupted, traffic would have to re-route along Doolittle Drive, Harbor Bay Pkwy, and Ron Cowan Pkwy; if the southwestern portion were disrupted, the airport would not be accessible.

Consequences

Society: Airport Drive connects Bay Farm Island and the airport with Oakland and beyond, and has several transit routes. It provides access to the airport for travelers and workers at the airport and related facilities. If it were inoperable due to a climate impact, travelers and workers would be unable to access the airport. There is also at least one transit route and a section of Bay Trail on Airport Drive, which would be disrupted.

Environment: None

Economy: Connects workers and travelers to the Oakland airport. Given this, disruption could have impacts at the local and regional, as well as state and national level.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
GOV3, PHYS1: Airport Drive is co-located with utilities and sewers; if changes to the road were required, the City of Oakland would need to coordinate with public and private utilities such as PG&E and EBMUD.	Form partnerships among public agencies and private entities to engage in collaborative multi-objective planning to improve the resilience of vulnerable transportation assets, the populations and facilities they serve, and the inland areas they protect as the first line of defense against flooding	Coordination	Long-range Planning, New Initiative	ABAG, BCDC, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, CBOs, Private Sector, USACE, FEMA	Unlocking, Local, Regional, Long Lead Time
PHYS2: Some components of the road are below-grade, sensitive to water or saltwater, and not protected. The structural integrity of the street itself is sensitive to wave action and susceptible to erosion.	Develop or improve design standards to require protection of new infrastructure and capital improvement investments from sea level rise, storm events, and elevated groundwater levels	Policy Development	Codes and Standards	MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Private Sector	Do It Yourself, Local, Regional, Long Lead Time
FUNC1: Airport Drive is the only street connecting Oakland with the airport. If the northeastern portion were disrupted, traffic would have to re-route along Doolittle Drive, Harbor Bay Pkwy, and Ron Cowan Pkwy; if the southwestern portion were disrupted, the airport would not be accessible.	Increase the capacity to accommodate re-routed traffic on alternative routes, or build new routes, in areas not at risk from sea level rise and storm events	Program/operation	Long-range Planning, Capital Planning	MTC, Caltrans, AC Transit, County, Cities, CMA	Local, Regional, Long Lead Time

Vulnerabilities also addressed under Key Planning Issue 6: GOV1

Hegenberger Road

Hegenberger Road is a six-lane surface street that connects Oakland to Bay Farm Island and the Oakland International Airport. It runs north from Doolittle Dr. under I-880 and past the Coliseum to San Leandro Street, where it bends northeast before turning into Hegenberger Expressway. South of Doolittle Dr., Hegenberger turns into Airport Dr., which leads to Oakland International Airport. Hegenberger Road was originally built in 1960 and is owned and maintained by the City of Oakland's Public Works Department.

Key Issue Statement

Hegenberger road provides goods and commuter movement between Bay Farm Island and the region. Hegenberger road is vulnerable because of its low elevation and because the City of Oakland owns and maintains the roadway, but not its shoreline protection. If Hegenberger road was damaged or closed due to a flood or seismic event, there could be economic and public safety consequences due to lost access to and from the airport and communities on Bay Farm Island.

Vulnerabilities

GOV1: Part of Hegenberger is protected by dikes and riprap owned by EBRPD as part of the MLK Shoreline (near bridge over San Leandro Channel – dikes/riprap are perpendicular to bridge; if overtopped, water could flood road south and north of bridge). If the road is threatened by overtopping of this shoreline protection, the City of Oakland will need to work with EBRPD to make the necessary improvements. Hegenberger also crosses over Elmhurst Creek.

GOV2, PHYS1: Hegenberger Road is co-located with utilities and sewers; if changes to the road were required, the City of Oakland would need to coordinate with public and private utilities such as PG&E and EBMUD.

PHYS2: Hegenberger's Pavement Condition Index ranges from 62-91; areas on the lower end of the range may suffer more extensive damage from a flood event than if it were in good shape.

PHYS3: The road is at grade and the structural integrity of the street itself is sensitive to wave action and susceptible to erosion.

FUNC1: Hegenberger is one of very few roads that connect Bay Farm Island and the airport with the mainland (other roads running from the mainland towards Bay Farm Island feed Doolittle Dr., which intersects with Hegenberger where it merges with 98th Ave and becomes Airport Drive; another alternate route would go through the Island of Alameda and across the Bay Farm Island Bridge onto Doolittle). Therefore, if Hegenberger were not operational due to a climate or seismic impact, access between the mainland and Bay Farm Island / OAK would be nearly cut off. Hegenberger Rd. is also used by public transit agencies for several different routes, which would be cut off or forced to detour if Hegenberger were inoperable.

FUNC2: Hegenberger Road is an Oakland Evacuation Route. It cannot serve the function of safely evacuating people if it is not operational due to a climate or seismic event.

Consequences

Society: Hegenberger Road connects Bay Farm Island and the airport with Oakland and beyond. It carries 18,000 riders per day as well as several transit routes. It may serve transit-dependent communities. It provides access to the airport for travelers and workers (at the airport and related facilities), as well as the movement of cargo and supplies necessary to serve the airport. It is also an Oakland evacuation route and could be used for emergency response. If Hegenberger Road were out of service, it would have a serious effect on travelers and commuters and could disrupt the operation of the airport, as well as the safety of nearby communities.

Economy: Hegenberger Road provides arterial access for commuter movement, goods movement, residents and emergency response between Oakland and Bay Farm Island. It also provides access to the Coliseum. Interruptions to commuters and goods movement could have a local to regional economic effect, and disruption of airport operations could have a national to international effect.

Environment: Hegenberger Road Crosses San Leandro Creek near MLK shoreline, and has part of the Bay Trail on it. Pollutants on the road could wash into the Bay with floodwaters, and construction could threaten habitat and water quality in San Leandro Creek.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
GOV2, PHYS1: Hegenberger Road is co-located with utilities and sewers; if changes to the road were required, the City of Oakland would need to coordinate with public and private utilities such as PG&E and EBMUD.	Expand or form broad public-private partnerships (multi-sector/agency) to guide the planning and implementation of multi-objective transportation improvements and new investments that are resilient to sea level rise and storm events	Coordination	Long-range Planning, New Initiative	ABAG, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, CBOs, Private Sector	Unlocking, Local, Regional
	Work with adjacent communities, regions, and states to develop and jointly implement transportation adaptation strategies that address changes in transportation system condition and use due to sea level rise and storm events	Coordination	New Initiative, Emergency and Hazard Planning	ABAG, BCDC, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Adjacent Regions and States	Multi-benefit, Regional, State, Federal, Long Lead Time
	Expand or form multi-agency partnerships to facilitate cost-sharing in planning for multi-objective transportation improvements and new investments that avoid or address sea level rise and storm events	Coordination, Policy Development	Long-range Planning, New Initiative	MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA	Local, Regional, Long Lead Time

PHYS3: The road is at grade and the structural integrity of the street itself is sensitive to wave action and susceptible to erosion.	Conduct analyses of critical infrastructure to identify the potential for increased erosion, scour and wear due to increased tide and wave energy	Evaluation	New Initiative, Operations	BART, Caltrans, Port, County, Cities, UP, CCJPA, WETA, CMA	Do It Yourself, Unlocking, Local, Regional
FUNC2: Hegenberger Road is an Oakland Evacuation Route. It cannot serve the function of safely evacuating people if it is not operational due to a climate or seismic event.	Conduct a "hot spot" analysis to identify key routes and nodes critical to traffic flow, assess their vulnerability and risk, and develop actions to improve their resilience to sea level rise and storm events	Evaluation	Long-range Planning, Operations, Emergency and Hazard Planning, New Initiative	ABAG, MTC, Caltrans, AC Transit, County, Cities, CMA	Do It Yourself, Unlocking, Multi-benefit, Local, Regional
	Increase the capacity to accommodate re-routed traffic on alternative routes, or build new routes, in areas not at risk from sea level rise and storm events	Program/operation	Long-range Planning, Capital Planning	MTC, Caltrans, AC Transit, County, Cities, CMA	Local, Regional, Long Lead Time

Vulnerabilities also addressed under Key Planning Issue 1: FUNC1

Vulnerabilities also addressed under Key Planning Issue 6: GOV1

San Leandro Street – 54th Ave to 98th Ave

San Leandro St. is a four lane surface road that provides access to the Coliseum BART and Amtrak stations and I-880. It is owned and managed by City of Oakland Public Works.

Key Issue Statement

San Leandro Street is vulnerable to future flooding because of its low elevation and its location near flood control channels. If the street were flooded, commuter movement and transit lines would be disrupted. Although San Leandro street is owned and managed by the City of Oakland, the city does not own and maintain the flood protection around the street or the transit lines that serve the area. In order to preserve access within and around San Leandro street, the city will need to coordinate with Alameda County Flood Control and Water Conservation District, the Alameda-Contra Costa Transit District, and neighboring landowners.

Vulnerabilities

GOV1: San Leandro St. is owned and operated by the City of Oakland. Oakland is on an 85-year repaving schedule (standard is 25), and the city's streets score low (56/100) on MTC's Pavement Condition Index (Bay Area average is 66/100).

FUNC1: San Leandro Street serves several transit lines: AC Transit Lines 98, 73, and 45 all run on San Leandro St. past Coliseum BART.

FUNC2: San Leandro Street is part of a network of roads; if other roads are disrupted, traffic may be re-routed to San Leandro Street, which may not have sufficient capacity. In addition, San Leandro St. provides access to BART and Amtrak (Coliseum Station) and I-880. An interruption of any of these elements of the network could have an effect on other elements.

Consequences

Society: San Leandro St. connects the road network to Coliseum BART and Amtrak trains so any disruptions would disproportionately affect transit-dependent households.

Economy: Disruptions in access to the Coliseum BART and Amtrak stations (on San Leandro St.) would negatively affect commuter movement and goods movement and could lead to cascading economic effects within the region.

Environment: None

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
<p>FUNC2: San Leandro Street is part of a network of roads; if other roads are disrupted, traffic may be re-routed to San Leandro Street, which may not have sufficient capacity. In addition, San Leandro St. provides access to BART and Amtrak (Coliseum Station) and I-880. An interruption of any of these elements of the network could have an effect on other elements.</p>	<p>Conduct a "hot spot" analysis to identify key routes and nodes critical to traffic flow, assess their vulnerability and risk, and develop actions to improve their resilience to sea level rise and storm events</p>	<p>Evaluation</p>	<p>Long-range Planning, Operations, Emergency and Hazard Planning, New Initiative</p>	<p>ABAG, MTC, Caltrans, AC Transit, County, Cities, CMA</p>	<p>Do It Yourself, Unlocking, Multi-benefit, Local, Regional</p>

Vulnerabilities also addressed under Key Planning Issue 1: FUNC1

Harbor Bay Parkway

Harbor Bay Parkway is a four-lane surface street that runs along the boundary between the cities of Alameda and Oakland. It was built to provide access to the Harbor Bay industrial park, ferry terminal, and Oakland International Airport. It also acts as a bypass to the residential areas of Bay Farm, connecting State Route 61 (Doolittle Drive), the main island of Alameda, and Oakland, to the north, with Ron Cowan Parkway and Oakland International Airport to the south, and Maitland Drive to the west. It runs along the shoreline of the San Francisco Bay. Harbor Bay Parkway is owned and maintained by the City of Alameda. The first mile of Harbor Bay Parkway was the former unpaved City Line Road. It was incrementally reconstructed and extended to its current length and width in the 1980s. Portions have been periodically resurfaced since then, and it is in need of resurfacing now.

Key Issue Statement

Harbor Bay Parkway provides access to residential areas on Bay Farm Island and OAK. The roadway is also co-located with utility alignments, which may complicate necessary adaptation actions. Improving the resilience of the parkway will require coordination with other transportation agencies to maintain access to, from and within Bay Farm Island.

Vulnerabilities

GOV1: A number of permits would be required to make any physical changes to Harbor Bay Parkway: City of Alameda Right of Way permit; BCDC permit for portion within 100 feet of the Bay; and Caltrans Encroachment Permit for work in the Doolittle intersection.

GOV2, PHYS1: The parkway has water lines owned by EBMUD, sewerage and power owned by the City of Alameda, and various telecom franchises. The parkway ties into State Route 61 (Doolittle Drive) and Ron Cowan Parkway (Port of Oakland), and two private streets at its western end - Bay Edge Road (Harbor Bay Village Five Associates) and Adelphian Way (Harbor Bay Waterfront Investors), and the Harbor Bay Ferry Terminal (run by WETA). Storm drainpipes cross under Harbor Bay Parkway. There is sanitary sewer and water co-located with portions of the street. The multiple assets within or adjacent to the road mean that more owners, managers, and regulators (e.g., RWQCB in the case of stormwater and wastewater) will need to be involved if any construction is needed to increase the resilience of Harbor Bay parkway, which would increase the degree of coordination necessary and possibly delay adaptation actions.

FUNC1: Harbor Bay Parkway relies on local and regional roads and highways to function for goods and commuter movement. If other roadways are damaged or closed due to flooding or seismic impacts, Harbor Bay Parkway will be impaired as well.

Consequences

Society: Harbor Bay Parkway contributes to the circulation of goods and people; in addition to approximately 10,000 vehicles per day, including workers, ferry users, airport passengers, and delivery trucks, the separated multiuse trail along side the Parkway is part of the Bay Trail and is used by joggers and cyclists (actual volume unknown). There are alternate access routes to the airport, ferry terminal, and industrial park;

loss of this asset could make alternate routes more congested and would make it more difficult for Fire Station 4 to respond to Oakland International Airport requests for mutual aide.

Economy: Harbor Bay Parkway is used for commuting to jobs, goods movement, and getting to the airport. There are alternate routes, but closure or loss of the asset could slow the movement of traffic, and there would be costs associated with any required repairs.

Environment: Harbor Bay Parkway is built over the old City Line Road, from Doolittle Drive to Ron Cowan Parkway. City Line Road was built on unregulated solid waste that was dumped there to fill in the tidelands and create Chuck Corica Golf Course to the west, and Oakland Metropolitan Airport to the east. Any hazardous material below the road fill has been encapsulated for many years and is unlikely to pose a health or environmental risk as it is now, or if it was flooded. Major liquefaction damage could expose the material.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
<p>GOV2, PHYS1: The parkway has water lines owned by EBMUD, sewerage and power owned by the City of Alameda, and various telecom franchises. The parkway ties into State Route 61 (Doolittle Drive) and Ron Cowan Parkway (Port of Oakland), and two private streets at its western end - Bay Edge Road (Harbor Bay Village Five Associates) and Adelphian Way (Harbor Bay Waterfront Investors), and the Harbor Bay Ferry Terminal (run by WETA). Storm drainpipes cross under Harbor Bay Parkway. There is sanitary sewer and water co-located with portions of the street. The multiple assets within or adjacent to the road mean that more owners, managers, and regulators (e.g., RWQCB in the case of stormwater and wastewater) will need to be involved if any construction is needed to increase the resilience of Harbor Bay parkway, which would increase the degree of coordination necessary and possibly delay adaptation actions.</p>	<p>Develop multi-agency agreements that result in shared transportation management objectives and identify decision-making and funding responsibilities related to maintenance, repair, or upgrade</p>	<p>Coordination, Policy Development</p>	<p>New Initiative</p>	<p>MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA</p>	<p>Unlocking, Multi-benefit, Local, Regional, Long Lead Time</p>
	<p>Expand or form broad public-private partnerships (multi-sector/agency) to guide the planning and implementation of multi-objective transportation improvements and new investments that are resilient to sea level rise and storm events</p>	<p>Coordination</p>	<p>Long-range Planning, New Initiative</p>	<p>ABAG, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, CBOs, Private Sector</p>	<p>Unlocking, Local, Regional</p>
	<p>Work with adjacent communities, regions, and states to develop and jointly implement transportation adaptation strategies that address changes in transportation system condition and use due to sea level rise and storm events</p>	<p>Coordination</p>	<p>New Initiative, Emergency and Hazard Planning</p>	<p>ABAG, BCDC, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Adjacent Regions and States</p>	<p>Multi-benefit, Regional, State, Federal, Long Lead Time</p>

<p>FUNC1: Harbor Bay Parkway relies on local and regional roads and highways to function for goods and commuter movement. If other roadways are damaged or closed due to flooding or seismic impacts, Harbor Bay Parkway will be impaired as well.</p>	<p>Increase the capacity to accommodate re-routed traffic on alternative routes, or build new routes, in areas not at risk from sea level rise and storm events</p>	<p>Program/operation</p>	<p>Long-range Planning, Capital Planning</p>	<p>MTC, Caltrans, AC Transit, County, Cities, CMA</p>	<p>Local, Regional, Long Lead Time</p>
--	---	--------------------------	--	---	--

Vulnerabilities also addressed under Key Planning Issue 6: GOV1

Doolittle Drive (SR-61)

State Route 61/Doolittle Drive is a 2-lane and 4-lane surface road that connects Alameda to Bay Farm Island and the Oakland International Airport. It runs along the northeast shore of Bay Farm Island, from the bridge to the island of Alameda southeast to Oakland, onto the mainland, and into San Leandro. SR-61 provides access for commuter movement, goods movement, residents and emergency response between Alameda and Bay Farm Island. Most of SR-61 was built prior to 1964. Significant changes and upgrades were made to the section adjacent to the airport in 1982. Caltrans is the owner and operator of state route 61. The road is in generally good condition, according to the most recent pavement condition survey, and is maintained regularly.

Key Issue Statement

Doolittle Drive provides goods and commuter movement access for Bay Farm Island and OAK. Doolittle Drive is vulnerable to flooding impacts and culverts under the roadway may create near term flooding for Bay Farm Island. Improving the culverts and the resilience of Doolittle Drive will require extensive coordination between the Port of Oakland, Caltrans, EBRPD, and the cities of Alameda and Oakland.

Vulnerabilities

GOV1: The ownership structure of the shoreline that Doolittle Drive runs along is complicated; the Port of Oakland owns the land, while EBRPD may be responsible for the levees. Doolittle Drive is on top of and / or inland of some of these levees. If the levees need to be raised in order to protect Doolittle Drive or other assets, Caltrans, EBRPD, and the Port of Oakland would all need to work together. Other relevant protective structures may fall under the jurisdiction of other entities such as the Cities of Oakland and Alameda.

GOV2: A number of entities have permitting authority over Doolittle Drive; if improvements are necessary to increase resilience, permits from the following agencies could be necessary, which would increase the time needed to implement changes: BCDC, USACE (Section 404), RWQCB (401 Certification), USFWS (Biological Opinion), and CDFW (CESA compliance).

GOV3, PHYS1: There are likely buried utilities within the right of way, which would require coordination with public and private utility companies. The road is located within the jurisdictions of the cities of Oakland and Alameda, so close coordination would be required in operating and maintaining electrical devices (traffic signals) and roadway drainage systems.

PHYS2: Some portions of the road are on levees; these may be erodible, which could cause undercutting of the road.

PHYS3: SR-61/Doolittle Drive is at-grade in this section. Most seismic assessment and retrofit work has been done for state-owned bridge structures, but not necessarily for at-grade facilities.

FUNC1: There are other, local streets connecting the residential area in northwest Bay Farm Island and areas to the southeast in Oakland and San Leandro, but there is no other access across San Leandro Bay between Bay Farm Island and Alameda other than the Doolittle Drive/Route 61 Bridge (see profile sheet for Bay Farm Island Bridges).

FUNC3: While there are alternative routes to the airport and mainland (Harbor Bay Parkway, Ron Cowan Parkway, Airport Drive), they face similar exposure and vulnerability, meaning that the function of moving people and goods between the airport and the mainland may not be served in the event of a climate or seismic impact.

Consequences

Society: Doolittle Drive provides access for commuter movement, goods movement, residents and emergency response between Alameda and Bay Farm Island, with average annual daily traffic of 21,2000 trips and peak hour traffic of 2,251 trips. It serves portions of the Fruitvale and Alameda Communities of Concern, as identified by MTC and is an emergency route between Alameda and Bay Farm Islands. If it were inoperable due to a climate impact, commuters, residents of Alameda, and goods would not be able to reach their destination, or would need to re-route; within Bay Farm Island this would not be too cumbersome, but movement between the islands would require a lengthy detour.

Environment: SR-61 is near marshes along the shore of Bay Farm Island – any construction to improve resilience will need to take this into account.

Economy: Connects residential neighborhoods to major job centers in Oakland and San Leandro, as well as serves the Oakland airport. Given this, disruption could have impacts at the local and regional, as well as state and national level.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
GOV3, PHYS1: There are likely buried utilities within the right of way, which would require coordination with public and private utility companies. The road is located within the jurisdictions of the cities of Oakland and Alameda, so close coordination would be required in operating and maintaining electrical devices (traffic signals) and roadway drainage systems.	Expand or form broad public-private partnerships (multi-sector/agency) to guide the planning and implementation of multi-objective transportation improvements and new investments that are resilient to sea level rise and storm events	Coordination	Long-range Planning, New Initiative	ABAG, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, CBOs, Private Sector	Unlocking, Local, Regional
	Work with adjacent communities, regions, and states to develop and jointly implement transportation adaptation strategies that address changes in transportation system condition and use due to sea level rise and storm events	Coordination	New Initiative, Emergency and Hazard Planning	ABAG, BCDC, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Adjacent Regions and States	Multi-benefit, Regional, State, Federal, Long Lead Time
PHYS2: Some portions of the road are on levees; these may be erodible, which could cause undercutting of the road.	Prioritize maintenance, repair, and retrofit of bridges and levees vulnerable to damage from sea level rise and storm events	Program/operation	Capital Planning, Operations	BCDC, USACE, RWQCB, MTC, UP, Caltrans, CCJPA, Cities, Counties	Do It Yourself, Regional

FUNC3: While there are alternative routes to the airport and mainland (Harbor Bay Parkway, Ron Cowan Parkway, Airport Drive), they face similar exposure and vulnerability, meaning that the function of moving people and goods between the airport and the mainland may not be served in the event of a climate or seismic impact.	Increase the capacity to accommodate re-routed traffic on alternative routes, or build new routes, in areas not at risk from sea level rise and storm events	Program/operation	Long-range Planning, Capital Planning	MTC, Caltrans, AC Transit, County, Cities, CMA	Local, Regional, Long Lead Time
--	--	-------------------	---------------------------------------	--	---------------------------------

Vulnerabilities also addressed under Key Planning Issue 1: FUNC1

Vulnerabilities also addressed under Key Planning Issue 6: GOV1, GOV2

Bay Farm Island Vehicle Bridge

Bay Farm Island Bridge is a drawbridge over the San Leandro Bay inlet to the Oakland Estuary that connects Alameda to Bay Farm Island and the Oakland International Airport at Otis Drive. It is owned by the State of California and operated by the Alameda County Public Works Agency by contract (maintenance agreement) with the State. The bridge was built in 1953. The bridge is in relatively good condition. Regular, routine maintenance is performed, and the bridge is inspected every 24 months. Various types of corrosion protection were added to the column casings in 2005.

Key Issue Statement

Bay Farm Island Bridge provides an important connection between Alameda and Bay Farm islands for commuter movement. The drawbridge contains sensitive electronic equipment, which could be damaged by future flooding. If the bridge was disrupted due to flooding or seismic events, access to and from Bay Farm Island would be impaired. Improving resilience of this bridge is complex due to the interconnectedness of local roads and highways and different landowners along the San Leandro Bay inlet.

Vulnerabilities

GOV1: Bay Farm Island Bridge is owned by the State of California and operated by the Alameda County Public Works Agency by contract with the State. The Public Works Agency provides preventive maintenance to the bridge, but large-scale repairs are done by the California Department of Transportation, District 4. While the bridge is within Caltrans' Right of Way, the bridge approaches are protected from flooding by shoreline protection under the jurisdiction of the City of Alameda. The multiple agencies involved means that coordination is necessary to make any changes to increase resilience, which could delay adaptation measures.

GOV2: The bridge is permitted by multiple agencies; physical changes to the bridge could require permits from BCDC, USACE (Section 404), RWQCB (401 certification), USFWS (BO), and CDFW (CESA compliance). This could add to the lead-time necessary to implement improvements to the bridge.

PHYS1: The drawbridge system includes an electrical system, and the bridge also contains the operating console for the bike / pedestrian bridge; if these components are at or below grade and are not waterproofed, they could be flooded and probably cannot operate when wet. In addition, saltwater would corrode them.

FUNC1: The bridge needs power to operate lighting and the drawbridge system; however, unless the bridge is stuck in the 'up' position, a loss of power to the drawbridge system would not affect operation of the roadway (though it could affect boat traffic).

FUNC2: The bridge connects to highway 61 (Doolittle Drive) and local roads on both sides. The bridge cannot function if those roads are disrupted due to future flooding or seismic events.

Consequences

Society: Bay Farm Island Bridge carries over 40,000 vehicles every day, including commuters, goods movement, residents, and emergency response, as well as multiple transit routes. This and the bike / pedestrian bridge parallel to it are the only bridges connecting Bay Farm Island with the island of Alameda; it

is the main way to travel between Bay Farm Island and the Island of Alameda. If it were inoperable, it would hamper movement between the two 'islands' that comprise the City of Alameda, including emergency response. However, Alameda Island has access to the mainland via 3 other bridges and a pair of tubes, and Bay Farm Island is not actually an island – it is connected to the mainland by surface streets – so it would not be completely cut off.

Economy: Commuter traffic and goods movement could be cut off or delayed if the bridge is inoperable, which could have a local to regional economic effect.

Environment: The bridge crosses the Bay and is next to Shoreline Park. The hydraulic operating system of the bike / pedestrian bridge, which is housed in the vehicle bridge, includes a 150-gallon tank of oil. If this were broken or spilled due to a climate or seismic impact, it could affect the nearby park and Bay.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
GOV2: The bridge is permitted by multiple agencies; physical changes to the bridge could require permits from BCDC, USACE (Section 404), RWQCB (401 certification), USFWS (BO), and CDFW (CESA compliance). This could add to the lead-time necessary to implement improvements to the bridge.	Develop multi-agency agreements that result in shared transportation management objectives and identify decision-making and funding responsibilities related to maintenance, repair, or upgrade	Coordination, Policy Development	New Initiative	MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA	Unlocking, Multi-benefit, Local, Regional, Long Lead Time
	Expand or form broad public-private partnerships (multi-sector/agency) to guide the planning and implementation of multi-objective transportation improvements and new investments that are resilient to sea level rise and storm events	Coordination	Long-range Planning, New Initiative	ABAG, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, CBOs, Private Sector	Unlocking, Local, Regional
	Work with adjacent communities, regions, and states to develop and jointly implement transportation adaptation strategies that address changes in transportation system condition and use due to sea level rise and storm events	Coordination	New Initiative, Emergency and Hazard Planning	ABAG, BCDC, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Adjacent Regions and States	Multi-benefit, Regional, State, Federal, Long Lead Time

PHYS1: The drawbridge system includes an electrical system, and the bridge also contains the operating console for the bike / pedestrian bridge; if these components are at or below grade and are not waterproofed, they could be flooded and probably cannot operate when wet. In addition, saltwater would corrode them.	Install manual, remote control, or automatic temporary barriers or waterproof closures to protect at- or below-grade critical elements such as motors and electronics.	Program/operation	Capital Planning, Operations, Codes and Standards, Project Planning and Design	UP, Amtrak, Caltrans, CCJPA, Cities, Counties	Do It Yourself, Unlocking, Regional
FUNC1: The bridge needs power to operate lighting and the drawbridge system; however, unless the bridge is stuck in the 'up' position, a loss of power to the drawbridge system would not affect operation of the roadway (though it could affect boat traffic).	Require adequate backup power to minimize interruptions to critical facilities, including lifeline facilities, e.g., on-site power generators with sufficient fuel for several days, portable backup power generators, or pre-position access through rental or leasing agreement	Policy Development, Program/operation	Operations, Codes and Standards	MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Private Sector	Do It Yourself, Multi-benefit, Local, Regional
FUNC2: The bridge connects to highway 61 (Doolittle Drive) and local roads on both sides. The bridge cannot function if those roads are disrupted due to future flooding or seismic events.	Conduct a "hot spot" analysis to identify key routes and nodes critical to traffic flow, assess their vulnerability and risk, and develop actions to improve their resilience to sea level rise and storm events	Evaluation	Long-range Planning, Operations, Emergency and Hazard Planning, New Initiative	ABAG, MTC, Caltrans, AC Transit, County, Cities, CMA	Do It Yourself, Unlocking, Multi-benefit, Local, Regional

Vulnerabilities also addressed under Key Planning Issue 6: GOV1

Bay Farm Island Bike / Pedestrian Bridge

Bay Farm Island Bicycle/Pedestrian Bridge connects the bike paths on Bay Farm Island to the Fernside Boulevard shoreline path on the Island of Alameda. The bridge is adjacent to the Bay Farm Island Bridge, spanning the San Leandro Bay inlet to the Oakland Estuary at Otis Drive. It also ties into the Otis Wooden Bridge. It has a 10.75-foot roadway that carries bicycles and pedestrians and provides access for the handicapped. Clearance between fenders is approximately 130 Feet. The bridge width is 14 feet, length is approximately 750 feet, and the roadway, curb to curb, is 11 feet. Construction on the Bay Farm Island Bicycle Bridge began in 1993 and was completed in 1995. It is owned and maintained by Caltrans and operated by Alameda County.

Key Issue Statement

The Bay Farm Island Bicycle/Pedestrian Bridge provides an important non-motorized transportation connection between Bay Farm Island and Alameda Island. If future flooding damages the bridge's mechanical equipment or surface, pedestrians and bicyclists would need to use the highway bridge which would be less safe and comfortable for some users. Making this bridge more resilient and maintaining bike/pedestrian access between the islands will require coordination between Caltrans, the Bay Trail, and neighboring landowners.

Vulnerabilities

GOV1: Bay Farm Island Bike/Pedestrian Bridge is owned by Caltrans and operated and maintained by the City of Alameda. It is also part of the Bay Trail. Because more than one agency is involved with the management of this asset, extra coordination and time may be necessary if any changes are needed to increase resilience.

GOV2: The bridge is permitted by multiple agencies; physical changes to the bridge could require permits from BCDC, USACE (Section 404), RWQCB (401 certification), USFWS (BO), and CDFW (CESA compliance). This could add to the lead time necessary to implement improvements to the bridge.

PHYS1: The Bridge uses an electrical hydraulic system to move the span. The hydraulic system is powered by two 50 HP motors. A 150-gallon tank and supplies the hydraulic oil used in the bridge operation. The hydraulic system is controlled by an electrical system of limit, pressure, and flow switches. The switches control the flow of oil and pressure, which then control the speed of the bridge span. Power is necessary for lighting and drawbridge operation, and possibly for communication between bridge operator and boats. The hydraulic system is housed in the Vehicle Bridge (see profile sheet for vehicle bridge).

FUNC1: The bridge is part of the Bay Trail, which is used by commuters and for recreation; the bridge is an important part of the north-south connectivity of the Bay Trail, and if it is inoperable, people will have to take lengthy detours or use the vehicle bridge, which may be affected by the same event(s).

Consequences

Society: The bridge serves bikers and walkers in Alameda – including students commuting to school – and links the Bay Trail on Bay Farm Island and the Island of Alameda. It also provides disabled access. If the bridge were to be damaged, access for all of these groups would be reduced; alternative access is available on the highway bridge for pedestrians.

Economy: The bridge cost approximately \$3.5M to build about 20 years ago.

Environment: The bridge crosses the Bay and is next to Shoreline Park. The hydraulic operating system of the bike / pedestrian bridge, which is housed in the vehicle bridge, includes a 150-gallon tank of oil. If this were broken or spilled due to a climate or seismic impact, it could affect the nearby park and Bay.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
<p>GOV2: The bridge is permitted by multiple agencies; physical changes to the bridge could require permits from BCDC, USACE (Section 404), RWQCB (401 certification), USFWS (BO), and CDFW (CESA compliance). This could add to the lead time necessary to implement improvements to the bridge.</p>	<p>Expand or form broad public-private partnerships (multi-sector/agency) to guide the planning and implementation of multi-objective transportation improvements and new investments that are resilient to sea level rise and storm events</p>	Coordination	Long-range Planning, New Initiative	ABAG, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, CBOs, Private Sector	Unlocking, Local, Regional
	<p>Work with adjacent communities, regions, and states to develop and jointly implement transportation adaptation strategies that address changes in transportation system condition and use due to sea level rise and storm events</p>	Coordination	New Initiative, Emergency and Hazard Planning	ABAG, BCDC, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Adjacent Regions and States	Multi-benefit, Regional, State, Federal, Long Lead Time
<p>PHYS1: The Bridge uses an electrical hydraulic system to move the span. The hydraulic system is powered by two 50 HP motors. A 150-gallon tank and supplies the hydraulic oil used in the bridge operation. The hydraulic system is controlled by an electrical system of limit, pressure, and flow switches. The switches control the flow of oil and pressure, which</p>	<p>Install manual, remote control, or automatic temporary barriers or waterproof closures to protect at- or below-grade critical elements such as motors and electronics.</p>	Program/operation	Capital Planning, Operations, Codes and Standards, Project Planning and Design	UP, Amtrak, Caltrans, CCJPA, Cities, Counties	Do It Yourself, Unlocking, Regional

then control the speed of the bridge span. Power is necessary for lighting and drawbridge operation, and possibly for communication between bridge operator and boats. The hydraulic system is housed in the Vehicle Bridge (see profile sheet for vehicle bridge).					
FUNC1: The bridge is part of the Bay Trail, which is used by commuters and for recreation; the bridge is an important part of the north-south connectivity of the Bay Trail, and if it is inoperable, people will have to take lengthy detours or use the vehicle bridge, which may be affected by the same event(s).	Conduct a "hot spot" analysis to identify key routes and nodes critical to bicycle and pedestrian flow, assess their vulnerability and risk, and develop actions to improve their resilience to sea level rise and storm events	Evaluation	Long-range Planning, Operations, Emergency and Hazard Planning, New Initiative	ABAG, MTC, Caltrans, AC Transit, County, Cities, CMA, BayTrail	Do It Yourself, Unlocking, Multi-benefit, Local, Regional

Vulnerabilities also addressed under Key Planning Issue 1: GOV1

Oakland Coliseum Amtrak Station

Amtrak Capitol Corridor's Oakland Coliseum station and Bay Area Rapid Transit (BART)'s Coliseum/Oakland Airport (OAK) station are within 600 feet of each other and part of the Oakland Coliseum complex located in East Oakland. The two stations are connected to each other, and to the O.co Coliseum and the Oracle Arena by a pedestrian bridge. The Coliseum Amtrak Station is part of a larger passenger rail system. The station is part of the Capitol Corridor intercity passenger rail service. Capitol Corridor Joint Powers Authority (CCJPA) manages the train service while the City of Oakland owns and maintains the station. City of Oakland also owns the parking lot and the ramp leading to the walkway between the Coliseum BART station and the Coliseum. Union Pacific owns the railroad and the right of way (ROW), which includes the station platform. Capitol Corridor JPA manages the operations of the station platform. The station has a platform with a shelter but no other services are provided. The station has no enclosed waiting area, ticket office, restrooms, lounge, payphone, or elevator.

Key Issue Statement

The Coliseum Amtrak Station is vulnerable to direct and indirect flooding impacts. The station includes electrical and mechanical equipment that could be damaged by flooding. Although the station could be made resilient to on-site flooding, the station can only function if other, more vulnerable, segments of the UP rail alignment are made resilient. This will require extensive coordination between CCJPA, UP and neighboring landowners.

Vulnerabilities

INFO1: There is a lack of detailed, easily accessible, and well-coordinated information about the Oakland Coliseum Amtrak Station components, which are owned and managed by different entities. For example, information about the condition and elevation of the station, parking lot, and ramp leading to a pedestrian bridge may be available to the City of Oakland but is not shared with Capitol Corridor Joint Powers Authority (CCJPA) who manages the intercity passenger rail service.

INFO2: Detailed information on the type, condition and elevation of the railroad may be available from Union Pacific Rail Road (UP) who own and operate the rail track and right of way (ROW), however the accessibility, easy of use, and quality of this data is unknown as UP does not have a practice of openly sharing information on its assets.

INFO3: The City of Oakland and/or the Alameda County Water Conservation and Flood Control District (ACWCFCDD) may have information on the capacity and condition of the stormwater and flood control systems that are in place near the station, however this information is not publically available and can be challenging to obtain.

GOV1: The number and relationships of public agencies and private entities that own and operate the station, rolling stock, rail track and ROW, and the passenger rail service complicates planning and implementing improvements or use changes. The Coliseum Amtrak station, the parking lot, and the ramp leading to the walkway between the Coliseum BART station and the Coliseum are owned and maintained by the City of Oakland. The Capitol Corridor Joint Powers Authority (CCJPA) manages the Capitol Corridor intercity

passenger rail service, while Union Pacific owns the railroad and the right of way (ROW), which includes the station platform.

GOV2: CCJPA does not have control over the surrounding land, road, or transit that provides access to the station or services or those that provide flooding protection. Ensuring that access to the station remains viable and that current levels of flood protection are maintained will require cooperation between CCJPA, City of Oakland, Alameda County Flood Control and Water Conservation District (ACFCWCD). Any changes to the station would need to comply with local land use plans, codes and standards, while changes to the boarding platform, which is in the UP ROW and subject to a lease agreement, would need to be coordinated with UP and CCJPA and could be more challenging.

GOV3: There is an Alameda County Flood Control and Water Conservation District (ACFCWCD) pump station exists near the end of the cul-de-sac on 73rd Avenue, which is the road that provides access to the station and the adjacent parking lot. ACFCWCD coordinates with the City of Oakland on stormwater and flood control management, but has no direct relationship with CCJPA. Disruption of this pump station, which sits below grade, could cause local flooding that disrupts passenger or maintenance crew access to the station and parking lot.

PHYS1: The station was built as slab-on-grade of materials not intended to withstand flooding of any duration. Mechanical and electrical equipment (e.g. ticket machines, lighting, electronic notification system) that are essential to the safe operation of the station will be damaged by exposure to water and/or salinity.

PHYS2: The safe operation of the station relies on utilities that are below-grade. Specifically, the underground pump station managed by ACWCFCD and utilities owned by PG&E, Comcast, and AT&T that are located in the area along San Leandro Street from 75th to 66th Avenue including 73rd Avenue. Electrical and mechanical equipment are generally not water or saltwater proof, even if located below-grade, and rising groundwater or overland flooding could disrupt these elements.

PHYS3: The station is located in an area with high liquefaction potential if there was a seismic event. Neither the station nor the rail track will be able to withstand high levels of liquefaction, which could be of increasing risk as groundwater levels rise in this area.

FUNC1: Station is served by a free parking lot and there are few alternative locations to park and leave cars aside from limited on-street parking. If 73rd Avenue is closed due to flooding, pedestrians can still access the station via the pedestrian overhead bridge from the Coliseum BART station. However, parking for those using the passenger rail service may be limited at the Coliseum BART station.

FUNC2: The function of the station will be affected by a disruption to commercial power supplies as the electronic notification system, lighting, and monitoring cameras that are part of the operations of this station will be disrupted, making the station unsafe for users at night and inconvenient in general due to lack of train information and status updates.

FUNC3: Service to and from the station would be affected by a disruption to commercial power supplies, as the signal system is critical to the safe operation of the rail service. Although the signal system has battery backups that can last a few hours, and then there are protocols in place for manual signally by railroad staff, these are only short-term solutions.

FUNC4: If the rail track in the vicinity of the Coliseum is flooded or damaged the intercity passenger rail service will be disrupted and the Coliseum Amtrak station will not be in service. An alternative bus bridge

service could be set up to get passengers around the disrupted rail track and station, however this is only a short-term solution.

FUNC5: Due to the linear connectivity of rail track, a disruption to any rail segment within the Capitol Corridor would impact passenger service. There is no realistic alternative route for the service, or in fact for goods movement, if this segment of rail track is damaged or disrupted.

FUNC6: There are no alternative rail transit options providing intercity service from San Jose to Sacramento, and the state highway I-880 that could provide an alternative route for car or bus service is vulnerable to the same sea level rise and storm event impacts as this segment of rail track.

Consequences

Equity: NONE

Environment: NONE

Economy: Loss of the Capitol Corridor intercity passenger rail service would affect commuters that use the service to access jobs, goods or services in the cities and metro areas of the Bay Area and Sacramento regions. Loss of the Coliseum Station would not interrupt Capitol Corridor rail service, however disruption of this station would affect passengers that use this station, and would be a significant impediment to using the rail system to travel to events held at the Coliseum venues. Disruption of the rail track in the vicinity of the Coliseum Amtrak station would not only significantly affect passenger service, it would also disrupt freight operations and affect goods movement as there are not alternative rail alignments along this portion of the East Bay shoreline. Disruption of goods movement, and in particular perishable goods moving to or from the Port of Oakland Seaport, would have significant economic impacts.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
INFO1: There is a lack of detailed, easily accessible, and well-coordinated information about the Oakland Coliseum Amtrak Station components, which are owned and managed by different entities. For example, information about the condition and elevation of the station, parking lot, and ramp leading to a pedestrian bridge may be available to the City of Oakland but is not shared with Capitol Corridor Joint Powers Authority (CCJPA) who manages the intercity passenger rail service.	Review existing transportation asset management plans to identify gaps in completeness, quality and accessibility of information most relevant to emergency response, adaptation planning, and federal funding	Evaluation	New Initiative	MTC, Caltrans, BART, AC Transit, CCJPA, UP	Do It Yourself, Unlocking, Multi-benefit, Local, Regional
INFO2: Detailed information on the type, condition and elevation of the railroad may be available from Union Pacific Rail Road (UP) who own and operate the rail track and right of way (ROW), however the accessibility, easy of use, and quality of this data is unknown as UP does not have a practice of openly sharing information on its assets.	Adopt data management and sharing agreements among transportation asset managers to ensure that complete and high quality asset information is available and accessible	Policy Development	New Initiative	MTC, Caltrans, BART, CCJPA, UP,	Multi-benefit, Regional, State, Federal

<p>PHYS1: The station was built as slab-on-grade of materials not intended to withstand flooding of any duration. Mechanical and electrical equipment (e.g. ticket machines, lighting, electronic notification system) that are essential to the safe operation of the station will be damaged by exposure to water and/or salinity.</p>	<p>Install manual, remote control, or automatic temporary barriers or waterproof closures to protect at- or below-grade critical elements such as station entrances, tunnels, maintenance facilities, asset storage areas, and rail alignments</p>	<p>Program/operation</p>	<p>Capital Planning, Operations, Codes and Standards, Project Planning and Design</p>	<p>UP, Amtrak, Caltrans, CCJPA, Cities, Counties</p>	<p>Do It Yourself, Unlocking, Regional</p>
	<p>Construct permanent structures to protect at- or below-grade critical elements such as station entrances, tunnels, maintenance facilities, and asset storage areas</p>	<p>Program/operation</p>	<p>Capital Planning, Operations, Codes and Standards, Project Planning and Design</p>	<p>UP, Amtrak, Caltrans, CCJPA, Cities, Counties</p>	<p>Do It Yourself, Unlocking, Regional</p>

Vulnerabilities also addressed under Key Planning Issue 1: FUNC4, FUNC5, FUNC6

Vulnerabilities also addressed under Key Planning Issue 2: PHYS2, FUNC2, FUNC3

Vulnerabilities also addressed under Key Planning Issue 6: GOV1, GOV2, GOV3

Coliseum BART Station

Coliseum station consists of a track, elevated platform, ground level concourse, automatic fare collection, station booths, train control, and traction power. The station also contains or is linked to adjacent track and aerial structures, pedestrian pathways, roadways, and parking lots. The station contains electrical, mechanical, and communication infrastructure. BART owns the station and surrounding property, which extends from 75th avenue to Hegenberger road. The station serves the Coliseum neighborhood and is a major access point for events in the Coliseum Complex and Oakland International Airport via the Oakland Airport Connector.

Key Issue Statement

The BART Coliseum station is vulnerable to direct and indirect sea level rise and storm event impacts. Future flooding could damage electrical and mechanical equipment at the station and necessitate costly and lengthy repairs. Flooding on surround tracks and local roads could affect the function of the Coliseum station. If commuters cannot access the station or make connections between BART, OAC, and AC Transit, the station cannot fully function. Coliseum station serves OAK, the coliseum complex, and the surrounding communities and there are not sufficient alternative transit routes so any disruption would affect people where they live and work, travel to and from OAK, and the economic value and function of the coliseum complex.

Vulnerabilities

GOV1: BART Facility Standards (BFS) requires that facility design accounts for the 100-year storm event and 500-year flood stage for critical assets, but does not require the consideration of changes to extreme tides due to sea level rise.

PHYS1: The traction power substation is at-grade with some protective curbing. It is not resilient to salt or freshwater flooding.

PHYS2: Train control equipment is at-grade and housed, but not resilient to salt or freshwater flooding.

PHYS3: The Automatic fare collection (AFC) stations are at grade and were not constructed to be exposed to water or salinity and therefore not flood resistant.

PHYS4: The A30 tunnel (pedestrian bridge) is below-grade; there is a sump pump that helps keep the tunnel dry, however this pump system was not designed for major overland flooding events and may be taxed by consistently high groundwater.

PHYS5: The station's access at grade will be affected by flooding of adjacent local streets and roads.

FUNC1: BART has ongoing communication with Coliseum event coordinators to plan for increased level of service during scheduled events but not to coordinate on disruption of service.

FUNC2: The connection to AC Transit at the station could be disrupted if local streets and roads are flooded.

FUNC3: BART has an existing agreement with AC Transit to provide a bus bridge if there is a service disruption, however AC Transit does not have the ability to replace the full level of service BART provides

to/from this station. AC Transit is a sufficient alternative for short-term disruptions (e.g., off load people already on trains) but not for long-term disruptions.

FUNC4: This station provides the sole connection via a transfer platform to the Oakland Airport Connector. Disruption of this station would functionally disable the OAC.

FUNC5: The A30 tunnel (pedestrian bridge) connects directly to the Coliseum station parking lot and provides the most direct access to the station. Alternate pedestrian routes to the station are not as direct or safe.

Consequences

Equity: Surrounding neighborhoods of Fruitvale and East Oakland are MTC community of concern and rely on this BART station for transit service. Disruption of this station could affect local riders, but could also affect BART's ability to serve transit dependent populations throughout the rest of the system.

Economy: Disruption of service will cause significant economic losses to BART (revenue loss) and to the greater region, as BART is a major transit provider that allows people to access jobs, goods and services. Due to the high cost of BART assets, replacement or repair of damaged assets could be costly for taxpayers, and time to restore the asset could easily be months or years depending on the damage. Disruption of this station will affect connecting commuters between the A (to Fremont), L (to Dublin/Pleasanton) line, and rest of the system.

Environment: Hazardous materials (oil transformer at the substation is 1200 gallons; biohazard waste pail) from station could be released/exposed during flooding. Alternative modes of transportation, such as personal car, may be less environmentally friendly.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
GOV1: BART Facility Standards (BFS) requires that facility design accounts for the 100-year storm event and 500-year flood stage for critical assets, but does not require the consideration of changes to extreme tides due to sea level rise.	Review and update existing policies, procedures, and practices, particularly weather-related planning and management, to support the planning, design, or redesign of transportation assets to reduce vulnerabilities to sea level rise and storm events	Evaluation, Policy Development	Operations, Codes and Standards, Project Planning and Design	MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, FTA, FHWA	Do It Yourself, Local, Regional, State, Federal
PHYS4: The A30 tunnel (pedestrian bridge) is below-grade; there is a sump pump that helps keep the tunnel dry, however this pump system was not designed for major overland flooding events and may be taxed by consistently high groundwater.	Install manual, remote control, or automatic temporary barriers or waterproof closures to protect at- or below-grade critical elements such as station entrances, tunnels, maintenance facilities, asset storage areas, and rail alignments	Program/operation	Capital Planning, Operations, Codes and Standards, Project Planning and Design	UP, Amtrak, Caltrans, CCJPA, Cities, Counties	Do It Yourself, Unlocking, Regional
	Construct permanent structures to protect at- or below-grade critical elements such as station entrances, tunnels, maintenance facilities, and asset storage areas	Program/operation	Capital Planning, Operations, Codes and Standards, Project Planning and Design	UP, Amtrak, Caltrans, CCJPA, Cities, Counties	Do It Yourself, Unlocking, Regional

<p>FUNC5: The A30 tunnel (pedestrian bridge) connects directly to the Coliseum station parking lot and provides the most direct access to the station. Alternate pedestrian routes to the station are not as direct or safe.</p>	<p>Form partnerships among public agencies and private entities to engage in collaborative multi-objective planning to improve the resilience of vulnerable transportation assets, the populations and facilities they serve, and the inland areas they protect as the first line of defense against flooding</p>	<p>Coordination</p>	<p>Long-range Planning, New Initiative</p>	<p>ABAG, BCDC, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, CBOs, Private Sector, USACE, FEMA</p>	<p>Unlocking, Local, Regional, Long Lead Time</p>
	<p>Work with adjacent communities, regions, and states to develop and jointly implement transportation adaptation strategies that address changes in transportation system condition and use due to sea level rise and storm events</p>	<p>Coordination</p>	<p>New Initiative, Emergency and Hazard Planning</p>	<p>ABAG, BCDC, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Adjacent Regions and States</p>	<p>Multi-benefit, Regional, State, Federal, Long Lead Time</p>
	<p>Develop multi-agency agreements that result in shared transportation management objectives and identify decision-making and funding responsibilities related to maintenance, repair, or upgrade</p>	<p>Coordination, Policy Development</p>	<p>New Initiative</p>	<p>MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA</p>	<p>Unlocking, Multi-benefit, Local, Regional, Long Lead Time</p>

Vulnerabilities also addressed under Key Planning Issue 1: PHYS5

BART Oakland Airport Connector (OAC)

Oakland Airport Connector includes the OAC airport station, the BART Coliseum station, 3.2 miles of guideway and aerial structures, and the wheelhouse. The OAC connects the BART Coliseum station to a new station at the airport, roughly following the course of Hegenberger road. It was built in 2014.

Key Issue Statement

The OAC is vulnerable to direct and indirect sea level rise and storm event impacts. The OAC has sensitive electrical and mechanical equipment at or below-grade that could be damaged by future flooding, especially in the Hegenberger road underpass. OAC is also vulnerable because it relies on OAK and the Coliseum BART station, which have their own vulnerabilities to future flooding. OAC sole function is to provide transportation to and from OAK for travelers and staff. If the OAC is disrupted due to future flooding, there would be economic consequences due to impaired commuter movement and travel.

Vulnerabilities

GOV1: BART owns the OAC, but Dopple-Mayer will manage operations and maintenance, including sump pumps to provide drainage during storm events. The Dopple-Mayer Management Plan is in progress, but is only a 20-year contract and is not incentivized to consider more frequent storm events due to sea level rise. Adaptation may require coordination with Dopple-Mayer, which may be out of the scope of their contract.

GOV2: The design of OAC is highly unlikely to have considered sea level rise impacts, as high-level State guidance is not yet routinely applied to project design. The lack of new design standards can potentially jeopardize the useful project lifetime.

PHYS1: A portion of the OAC is in a tunnel below grade and is vulnerable to increased flooding due to storm events and sea level rise. The sump pump in the tunnel was designed to manage current groundwater intrusion or rainfall runoff and will not have the capacity to handle flows during significant flooding events.

PHYS2: The OAC has a diesel emergency generator that is located at grade in the wheelhouse.

PHYS3: The wheelhouse substation is at grade and was not designed to be water or salt tolerant.

PHYS4: The switchgear cabinets at the airport station are at grade and are not designed to be water or salt tolerant.

FUNC1: The OAC extends from the BART Coliseum Station to the Oakland International Airport and relies on existing structural shoreline protection, owned and managed by others. The system of structural shoreline protection was not designed for future storm event water levels that will occur as sea level rises.

FUNC2: Flooding of the track that passes through the tunnel would disrupt services of the OAC.

FUNC3: There are no good alternatives to access the airport if the OAC flooded because the local streets and roads that lead to the airport will also be flooded and impassible in particular near the OAC tunnel location.

FUNC4: The sole function of the OAC is to provide transit access to the Oakland International Airport. If operations of the airport are disrupted the OAC will not have a purpose.

FUNC5: Access to the OAC relies on the ongoing operation of the Coliseum BART station. Disruption to this station or the adjacent local streets and roads would inhibit passenger access to the OAC.

Consequences

Equity: Disruption may inhibit BART's ability to serve transit dependent populations making trips to and from the airport.

Economy: Loss of the OAC will affect BART through loss of revenue and the cost to repair damage to asset. Loss of the OAC will have consequences on the business at the airport and possibly on passenger use of the airport.

Environment: Hazardous materials (diesel in emergency generator) could be released/exposed during flooding. Alternative modes of transportation, such as personal car, may be less environmentally friendly.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
PHYS4: The switchgear cabinets at the airport station are at grade and are not designed to be water or salt tolerant.	Install manual, remote control, or automatic temporary barriers or waterproof closures to protect at- or below-grade critical elements such as station entrances, tunnels, maintenance facilities, asset storage areas, and rail alignments	Program/operation	Capital Planning, Operations, Codes and Standards, Project Planning and Design	UP, Amtrak, Caltrans, CCJPA, Cities, Counties	Do It Yourself, Unlocking, Regional
	Construct permanent structures to protect at- or below-grade critical elements such as station entrances, tunnels, maintenance facilities, and asset storage areas	Program/operation	Capital Planning, Operations, Codes and Standards, Project Planning and Design	UP, Amtrak, Caltrans, CCJPA, Cities, Counties	Do It Yourself, Unlocking, Regional
	Raise the elevation of at- or below-grade critical elements such as station entrances, maintenance yards, and rail alignments	Program/operation	Capital Planning, Operations, Codes and Standards, Project Planning and Design	UP, Amtrak, Caltrans, CCJPA, Cities, Counties	Do It Yourself, Unlocking, Regional

Vulnerabilities also addressed under Key Planning Issue 1: FUNC3, FUNC5

Vulnerabilities also addressed under Key Planning Issue 6: GOV1, FUNC1

Harbor Bay Ferry Terminal

The ferry terminal is located at Adelphian Way and Mecartney Road, just south of the northwestern tip of Bay Farm Island. It has weekday service to and from San Francisco's Ferry Building. Components of the terminal include shoreline protection (rip rap), parking lot, lighting, landscaping, bus stop, bike storage lockers, signage, covered waiting area, restrooms, NextBus reader board, gate and fencing, gangplank, and float. The Blue & Gold Fleet operates ferries for the Water Emergency Transportation Authority (WETA). WETA is the owner/operator of the float and gangway that are in the waters of the SF Bay and provides security landside. The Harbor Bay Isle Associates and Harbor Bay Village Five Associates own the land where the parking lot and waiting areas are located. The City of Alameda owns the coastal strip where the restrooms, bike lockers, and shore protection are located. The City performs major upgrades with funds provided by WETA. Harbor Bay Business Park provides ongoing maintenance for the restrooms. Harbor Bay Isle Associates maintains the landscaping. The land was reclaimed by first placing a dike, then infilling behind it in 1982. The terminal, restroom, and pathway were built in 1990. The bike lockers were installed in 2008. The parking lot was slurry sealed in 2011. The bathrooms were upgraded for ADA deficiencies in 2013. The assets are in good condition, are regularly maintained, and are not currently affected by flooding or groundwater.

Key Issue Statement

The Harbor Bay Ferry Terminal is vulnerable to future flooding because of its at-grade components and its reliance on local roads and services to function. The multiple ownership and management arrangements between Alameda, WETA, Blue & Gold Fleet, and private landowners may delay adaptation actions due to the need for coordination and advance, joint planning.

Vulnerabilities

GOV1: Changes to the terminal would require a City of Alameda building permit. Anything within 100 feet of shoreline would require a BCDC permit. Work in the Bay would require Water Quality Board, Corps of Engineers, and Coast Guard involvement. The involvement of multiple agencies would require coordination, which may complicate or delay adaptation actions.

GOV2: The Corps of Engineers is currently studying storm hazards for the shore protection. However, sea level rise is not included.

PHYS1: All landside components are at grade. The restroom plumbing and sewer lateral could be affected by saltwater flooding.

PHYS2: The terminal or riprap along shore could be damaged by strong waves.

PHYS3: The sewer lateral and power for lighting are under parking lot, meaning these assets must be considered if any physical changes to the parking lot are necessary to improve resilience.

FUNC1: The ability of the ferries to perform their function depends on passengers being able to get to and from the terminals; this dependence makes the ferries vulnerable to flooding of nearby access roads.

Consequences

Society: Harbor Bay Ferry is a commute route that carries residents of Bay Farm Island and Oakland to jobs in San Francisco (and beyond). If it were inoperable, commuters would need to use alternate routes such as ferries from the Island of Alameda (using transit, biking, or driving to get to the terminal) or taking transit or driving all the way to their destination. In addition, WETA plays a role in emergency response. Ferry service is an alternative transportation when vehicular traffic is impaired.

Economy: As a commuter route, the disruption of the Harbor Bay Ferry service would make it more difficult for people to get to work, but there are alternatives (bus, car, BART). The disruption could result in some regional costs.

Environment: The terminal is near Shoreline Park and the Bay. There is no fueling at the site, but the ferry or a parked car could potentially leak petroleum products.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
GOV2: The Corps of Engineers is currently studying storm hazards for the shore protection. However, sea level rise is not included.	Conduct analyses of critical infrastructure to identify the potential for increased erosion, scour and wear due to increased tide and wave energy	Evaluation	New Initiative, Operations	BART, Caltrans, Port, County, Cities, UP, CCJPA, WETA, CMA	Do It Yourself, Unlocking, Local, Regional
	Require and implement improvements to, and new investments in, existing infrastructure across tidal streams or in the Bay to increase resilience to sea level rise and storm events	Policy Development, Program/operation	Codes and Standards, Capital Planning	BCDC, RWQCB, USACE, FEMA, NOAA, BART, Caltrans, Port, County, Cities, UP, CCJPA, WETA, CMA	Local, Regional
PHYS1: All landside components are at grade. The restroom plumbing and sewer lateral could be affected by saltwater flooding.	Increase inspection and maintenance of infrastructure that is sensitive to water or salt in areas at risk from sea level rise, storm events, or elevated groundwater levels	Program/operation	Operations	MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Private Sector	Do It Yourself, Multi-benefit, Local, Regional
PHYS2: The terminal or riprap along shore could be damaged by strong waves.	Conduct analyses of critical infrastructure to identify the potential for increased erosion, scour and wear due to increased tide and wave energy	Evaluation	New Initiative, Operations	BART, Caltrans, Port, County, Cities, UP, CCJPA, WETA, CMA	Do It Yourself, Unlocking, Local, Regional

PHYS3: The sewer lateral and power for lighting are under parking lot, meaning these assets must be considered if any physical changes to the parking lot are necessary to improve resilience.	Raise the elevation of at- or below-grade critical elements such as entrances, mechanical or electrical equipment, and ventilation grates	Program/operation	Capital Planning, Project Design and Planning	Caltrans, BART, Port, County, Cities, CMA, CCJPA, UP, WETA, Private Sector	Do It Yourself, Local, Regional
	Develop or improve design standards to require protection of new infrastructure and capital improvement investments from sea level rise, storm events, and elevated groundwater levels	Policy Development	Codes and Standards	MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Private Sector	Do It Yourself, Local, Regional, Long Lead Time
FUNC1: The ability of the ferries to perform their function depends on passengers being able to get to and from the terminals; this dependence makes the ferries vulnerable to flooding of nearby access roads.	Increase the capacity to accommodate re-routed traffic on alternative routes, or build new routes, in areas not at risk from sea level rise and storm events	Program/operation	Long-range Planning, Capital Planning	MTC, Caltrans, AC Transit, County, Cities, CMA	Local, Regional, Long Lead Time

Vulnerabilities also addressed under Key Planning Issue 6: GOV1

Otis Wooden Bridge

The Otis Wooden Bridge runs beneath the Bay Farm Island Vehicle and Bike / Pedestrian bridges along the northern shore of Bay Farm Island where they cross over the San Leandro Channel. It was built in 1984 through mitigation for the Harbor Bay Island development in the City of Alameda. Ownership is unclear; the bridge is part of the Bay Trail and EBRPD has an agreement with the City of Alameda and BCDC to maintain it.

Key Issue Statement

Otis Wooden Bridge provides access for pedestrians and bicyclists. Its unclear ownership status will make any necessary adaptation measures difficult to implement.

Vulnerabilities

INFO1: Ownership is unknown.

(Ownership and permitting issues – addressed under Key Planning Issue #6)

GOV1: Ownership is unknown; EBRPD is responsible for minor maintenance.

PHYS1: The Bridge is made out of wood, which doesn't have the life span of, e.g., a steel bridge. The tread on the bridge path has to be replaced often, and could deteriorate with frequent or prolonged flooding.

FUNC1: The Bridge provides continuity of the Bay Trail on Bay Farm Island. If this section were damaged or inoperable, people would need to find alternate routes.

Consequences

Society: The Bridge is used by commuters, pedestrians, and bikers, including middle school students who use the bridge to get to and from school and as part of their mile course during PE classes. If the bridge were damaged, commuters, pedestrians, and bikers would need to find a new route – e.g., Doolittle Dr. to Veteran's Court, which may be less safe as it is not intended for bikes and pedestrians.

Economy: None

Environment: None

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
GOV1: Ownership is unknown; EBRPD is responsible for minor maintenance.	Expand or form broad public-private partnerships (multi-sector/agency) to guide the planning and implementation of multi-objective transportation improvements and new investments that are resilient to sea level rise and storm events	Coordination	Long-range Planning, New Initiative	ABAG, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, CBOs, Private Sector	Unlocking, Local, Regional
	Work with adjacent communities, regions, and states to develop and jointly implement transportation adaptation strategies that address changes in transportation system condition and use due to sea level rise and storm events	Coordination	New Initiative, Emergency and Hazard Planning	ABAG, BCDC, MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, Adjacent Regions and States	Multi-benefit, Regional, State, Federal, Long Lead Time
PHYS1: The Bridge is made out of wood, which doesn't have the life span of, e.g., a steel bridge. The tread on the bridge path has to be replaced often, and could deteriorate with frequent or prolonged flooding.	Follow existing or develop new standards requiring that waterproof materials be used in the construction of new infrastructure and in the repair or protection of existing infrastructure	Policy Development, Program/operation	Operations, Project Planning and Design, Codes and Standards	MTC, Caltrans, BART, Port, AC Transit, County, Cities, CMA, CCJPA, UP, WETA, FEMA, CalEMA, Private Sector	Do It Yourself, Local, Regional, State, Federal

FUNC1: The Bridge provides continuity of the Bay Trail on Bay Farm Island. If this section were damaged or inoperable, people would need to find alternate routes.	Conduct a "hot spot" analysis to identify key routes and nodes critical to bicycle and pedestrian flow, assess their vulnerability and risk, and develop actions to improve their resilience to sea level rise and storm events	Evaluation	Long-range Planning, Operations, Emergency and Hazard Planning, New Initiative	ABAG, MTC, Caltrans, AC Transit, County, Cities, CMA, BayTrail	Do It Yourself, Unlocking, Multi-benefit, Local, Regional
--	---	------------	--	--	---

Vulnerabilities also addressed under Key Planning Issue 6: INFO1

Fire Station #27

Fire Station #27 is located at 8501 Pardee Drive, Oakland. It includes accommodations for one officer and 3 crew members, 2 apparatus bay house, 1 triple combination pumper and 1 spare aerial apparatus. The station also has a kitchen and break area for use by the assigned crew. In addition, to firefighting and fire prevention services, the crews provide first aid/emergency medical response. The station was built in 1966 and was retrofitted after the Loma Prieta earthquake. It is owned by the City of Oakland, staffed by the Oakland Fire Department, and managed by the Oakland Public Works Department.

Key Issue Statement

Fire Station #27 is vulnerable to future flooding because the building is at grade and firefighters rely on vulnerable roads to perform their emergency response function. Building resilience into emergency and disaster response will require adaptation on site of the fire station and coordination with transportation agencies to maintain road access.

Vulnerabilities

GOV1: While there are CORE trained residents in the residential area, there isn't an organized, active team.

PHYS1: The building is at grade.

FUNC1: In order to carry out its function, Fire Station #27 needs vehicle access, which is at grade. Not only is the access important at the station itself, but also between the station and any emergency to which the station is responding. The major streets near Fire Station #27 are Hegenberger Rd. and Doolittle St. (See profile sheets for these assets). The fire station also requires electricity and fuel. Information on the source of electricity is currently unavailable; the station has a fuel storage tank with a capacity of 95 gallons, which is sufficient for 21 hours of operation.

Consequences

Society: The fire station responds to fire and other emergencies in the community, benefitting residents and those who work in the area. The station serves a low-income community adjacent to I-80, and responds to emergencies at the airport if needed.

Economy: By protecting the local community, the fire station has an indirect value to the local economy; if it were damaged or otherwise inoperable, it could cause an increase in insurance rates, fire loss, and loss of life.

Environment: The fire station is within a couple of blocks of a wetland, but there are no hazardous materials on site other than diesel carried by apparatus (100 gallons).

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
GOV1: While there are CORE trained residents in the residential area, there isn't an organized, active team.	Provide expanded Communities of Oakland Respond to Emergencies (CORE) trainings, refresher classes, and annual exercises that include flooding preparedness and response	Education/outreach	Emergency and Hazard Planning	City of Oakland, Oakland Fire Department, Oakland Police Department	Multi-benefit, Local, Regional
PHYS1: The building is at grade.	Increase inspection and maintenance of infrastructure that is sensitive to water or salt in areas at risk from sea level rise, storm events, or elevated groundwater levels	Program/operation	Operations	City of Oakland, Oakland Public Works Department	Do It Yourself, Multi-benefit, Local
	Provide incentives or require that Fire Station #27 be retrofitted using waterproof shutters, shields or doors and salt-resistant materials to reduce flood damage	Program/operation, Policy Development	Codes and Standards, New Initiative	City of Oakland, Oakland Public Works Department, Alameda County	Do It Yourself, Local, Regional, State, Federal
	Waterproof and/or raise the elevation of at- or below-grade electrical and fuel components at the fire station to protect against flooding and allow for continued function during a flood event	Program/ operation	Capital Planning, Project Design and Planning	Oakland Public Works Department, City of Oakland	Do It Yourself

<p>FUNC1: In order to carry out its function, Fire Station #27 needs vehicle access, which is at grade. Not only is the access important at the station itself, but also between the station and any emergency to which the station is responding. The major streets near Fire Station #27 are Hegenberger Rd. and Doolittle St. (See profile sheets for these assets). The fire station also requires electricity and fuel. Information on the source of electricity is currently unavailable; the station has a fuel storage tank with a capacity of 95 gallons, which is sufficient for 21 hours of operation.</p>	<p>Develop policies or incentives to expand access to auxiliary water and power sources, e.g., on-site power generators with sufficient fuel for several days, portable generators, or pre-negotiated rental or leasing agreements for portable sources</p>	Policy Development	Long-range Planning, Land Use Planning, Emergency and Hazard Planning	City of Oakland, Oakland Fire Department, Oakland Public Works Department, County of Alameda, ABAG, CalOES	Do It Yourself, Multi-benefit, Local, Regional
	<p>Develop policies or incentives to encourage/require emergency response plans and procedures to consider how power, water, and supplies necessary to maintain the function of Fire Station #27 during a flood emergency, will be delivered given that many access routes and transportation modes may also be disrupted</p>	Policy Development	Long-range Planning, Land Use Planning, Emergency and Hazard Planning	City of Oakland, Oakland Fire Department, Oakland Public Works Department, County of Alameda, ABAG, CalOES	Do It Yourself, Multi-benefit, Local, Regional

Vulnerabilities also addressed under Key Planning Issue 1: FUNC1

Fire Station #29

Fire Station #29 is located at 1016 66th Avenue, Oakland, CA. It includes accommodations for one officer and 3 crew members, 2 apparatus bay house, 1 triple combination pumper. The station also has a kitchen and break area for use by the assigned crew. In addition, to firefighting and fire prevention services, the crews provide first aid/emergency medical response. The station was built in 1950 and was retrofitted after the Loma Prieta earthquake. It is owned by the City of Oakland, staffed by the Oakland Fire Department, and managed by the Oakland Public Works Department.

Key Issue Statement

Fire Station #29 is vulnerable to future flooding because the building is at grade and firefighters rely on vulnerable roads to perform their emergency response function. Building resilience into emergency and disaster response will require adaptation on site of the fire station and coordination with transportation agencies to maintain road access.

Vulnerabilities

GOV1: While there are CORE trained residents in the residential area, there isn't an organized, active team.

PHYS1: The building is at grade and therefore could be vulnerable if the area is flooded.

FUNC1: In order to carry out its function, Fire Station #29 needs vehicle access, which is at grade. Not only is the access important at the station itself, but also between the station and any emergency to which the station is responding. The major streets near Fire Station #29 are San Leandro St. and International Blvd. (See San Leandro St. profile sheet). The fire station also requires electricity and fuel. Information on the source of electricity is currently unavailable; the station has a fuel storage tank with a capacity of 60 gallons, which is sufficient for 20 hours of operation.

Consequences

Society: The fire station responds to fire and other emergencies in the community, benefitting residents and those who work in the area. The station serves a low-income community adjacent to I-80, and responds to emergencies at the airport if needed.

Economy: By protecting the local community, the fire station has an indirect value to the local economy; if it were damaged or otherwise inoperable, it could cause an increase in insurance rates, fire loss, and loss of life.

Environment: The fire station is close to Leona Creek, but there are no hazardous materials on site other than diesel carried by apparatus (100 gallons).

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
GOV1: While there are CORE trained residents in the residential area, there isn't an organized, active team.	Provide expanded Communities of Oakland Respond to Emergencies (CORE) trainings, refresher classes, and annual exercises that include flooding preparedness and response	Education/outreach	Emergency and Hazard Planning	City of Oakland, Oakland Fire Department, Oakland Police Department	Multi-benefit, Local, Regional
PHYS1: The building is at grade and therefore could be vulnerable if the area is flooded.	Increase inspection and maintenance of infrastructure that that is sensitive to water or salt in areas at risk from sea level rise, storm events, or elevated groundwater levels	Program/operation	Operations	City of Oakland, Oakland Public Works Department	Do It Yourself, Multi-benefit, Local
	Provide incentives or require that Fire Station #29 be retrofitted using waterproof shutters, shields or doors and salt-resistant materials to reduce flood damage	Program/operation, Policy Development	Codes and Standards, New Initiative	City of Oakland, Oakland Public Works Department, Alameda County	Do It Yourself, Local, Regional, State, Federal
	Waterproof and/or raise the elevation of at- or below-grade electrical and fuel components at the fire station to protect against flooding and allow for continued function during a flood event	Program/ operation	Capital Planning, Project Design and Planning	Oakland Public Works Department, City of Oakland	Do It Yourself
FUNC1: In order to carry out its function, Fire Station #29 needs vehicle access, which is at grade. Not only is the access important at the station itself, but also between	Develop policies or incentives to encourage/require access to auxiliary water and power sources, e.g., on-site power generators with sufficient fuel for	Policy Development	Long-range Planning, Land Use Planning, Emergency and	City of Oakland, Oakland Fire Department, Oakland Public Works Department, County of	Do It Yourself, Multi-benefit, Local, Regional

the station and any emergency to which the station is responding. The major streets near Fire Station #29 are San Leandro St. and International Blvd. (See San Leandro St. profile sheet). The fire station also requires electricity and fuel. Information on the source of electricity is currently unavailable; the station has a fuel storage tank with a capacity of 60 gallons, which is sufficient for 20 hours of operation.	several days, portable generators, or pre-negotiated rental or leasing agreements for portable sources		Hazard Planning	Alameda, ABAG, CalOES	
	Develop policies or incentives to encourage/require emergency response plans and procedures to consider how power, water, and supplies necessary to maintain the function of Fire Station #29 during a flood emergency, will be delivered given that many access routes and transportation modes may also be disrupted	Policy Development	Long-range Planning, Land Use Planning, Emergency and Hazard Planning	City of Oakland, Oakland Fire Department, Oakland Public Works Department, County of Alameda, ABAG, CalOES	Do It Yourself, Multi-benefit, Local, Regional

Vulnerabilities also addressed under Key Planning Issue 1: FUNC1

EBMUD Pump Station G

EBMUD's Pump Station G is located at 9301 Doolittle Drive, Oakland CA 94614. It carries wastewater from the Oakland International Airport and is designed to lift water via a force main to the South Interceptor, which ultimately flows to the main wastewater treatment plant before discharging into the Bay. Pump Station G was constructed in 1953 and last improved in 1995; the 1998 Pump Station Master Plan reported that the pump station and associated electrical equipment had an estimated remaining 20 years of useful life. The pump station is part of a system that consists of nearly 29 miles of gravity pipelines, in addition to 15 pump stations, over 8 miles of pressure pipeline, 5 emergency overflow structures, and storage facilities at 1 pump station and 2 of EBMUD's 3 wet weather facilities.

Key Issue Statement

Pump Station G provides a critical wastewater function for OAK and has no redundancy. The pump station already uses its full capacity and has limited remaining service life. Improvements to the pump station and interceptor system will need to be coordinated with Caltrans, OAK, and the city of Oakland to minimize disruptions and costs for wastewater and transportation.

Vulnerabilities

GOV1: While EBMUD owns and operates its entire infrastructure, Doolittle Drive and the associated road embankment, which are owned and maintained by Caltrans and EBRPD, protect Pump Station G. In addition, the interceptor and force main for this pump station extends across public and private property then follows Hegenberger Road. If changes to the shoreline are necessary in order to protect the pump station, EBMUD will have to work closely with Caltrans and EBRPD. Likewise, EBMUD will need to work with transportation agencies where the interceptor is located if changes are necessary to increase resilience. This level of coordination could complicate and delay adaptation actions.

GOV2: There are several adjacent assets owned by other entities, such as Caltrans and the Oakland International Airport; if flooding became frequent or lasted longer than usual, EBMUD would need to coordinate with these asset owners to protect the pump station.

PHYS1: Currently, wet weather events add to sewer flow due to inflow and infiltration (I/I).

PHYS2: The facility has components at and below grade that could be damaged by flooding.

FUNC1: The pump station relies on power in order to function; there is a generator for backup power.

FUNC2: There is no redundancy in the system that could provide the services of Pump Station G if it is out of service. However, the station does have a bypass connection, and operators are prepared with all of the equipment that they need to pump around the station. EBMUD conducts drills for bypass procedures. In the event that Pump Station G fails and a bypass operation is not successful, wastewater will back up into the Port of Oakland's collection system and eventually overflow into a stormwater detention pond located north of Pump Station G. From there, the water would be pumped into the San Leandro Bay.

Consequences

Society: Disruption of service could result in discharge of wastewater into the Bay and surrounding properties, which could have health impacts.

Economy: None

Environment: Disruption of service could result in discharge of wastewater into the Bay and nearby MLK Shoreline. The generator diesel could also be released into floodwaters.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
PHYS1: Currently, wet weather events add to sewer flow due to inflow and infiltration (I/I).	Pursue IRWMP and other state/federal funding for repair or improvement of stormwater management and flood control infrastructure	Program/operation	Capital Planning	City DPW, ACFCWCD, BCDC, ABAG, SFEP, RWQCB	Do It Yourself, Multi-benefit, Local, Regional
PHYS2: The facility has components at and below grade that could be damaged by flooding.	Pursue IRWMP and other state/federal funding for repair or improvement of stormwater management and flood control infrastructure	Program/operation	Capital Planning	City DPW, ACFCWCD, BCDC, ABAG, SFEP, RWQCB	Do It Yourself, Multi-benefit, Local, Regional
FUNC2: There is no redundancy in the system that could provide the services of Pump Station G if it is out of service. However, the station does have a bypass connection, and operators are prepared with all of the equipment that they need to pump around the station. EBMUD conducts drills for bypass procedures. In the event that Pump Station G fails and a bypass operation is not successful, wastewater will back up into the Port of Oakland's collection system and eventually overflow into a stormwater detention pond located north of Pump Station G. From there, the water would be pumped into the San Leandro Bay.	Pursue IRWMP and other state/federal funding for repair or improvement of stormwater management and flood control infrastructure	Program/operation	Capital Planning	City DPW, ACFCWCD, BCDC, ABAG, SFEP, RWQCB	Do It Yourself, Multi-benefit, Local, Regional
	Add redundancy or increase capacity to re-route around compromised wastewater system components	Program/operation	Long-range Planning, Capital Planning, Project Planning and Design	EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, RWQCB	Multi-benefit, Do It Yourself, Local

Vulnerabilities also addressed under Key Planning Issue 6: GOV1, GOV2

Martin Luther King Jr. Regional Shoreline / Arrowhead Marsh

Martin Luther King Jr. Regional Shoreline is a popular, 717-acre park located along the shoreline around San Leandro Bay from Tidewater Boating Center to Doolittle Pond. It provides a diversity of recreation opportunities, including 3.7 miles of Bay Trail with six bridges, the Tidewater Boating Center with facilities and launches for rowing and paddleboats, a boat launch ramp, the Shoreline Center (meeting facility), 16 acres of grass turf, nine staging areas providing parking, picnic tables and restrooms, a staff office, the Arrowhead Marsh Overlook ramp and boardwalk, interpretive signage, wildlife viewing opportunities, and three marshes – Arrowhead, New, and Damon – which provide habitat for endangered species.

Key Issue Statement

MLK Jr. Regional Shoreline is vulnerable to sea level rise due to its low elevation, especially in Arrowhead Marsh, and its complex relationships with neighboring landowners and partner agencies. In order to preserve public access, recreation, and shoreline habitat around San Leandro Bay, EBRPD and its partners will need to coordinate and proactively plan to adapt to sea level rise.

Vulnerabilities

INFO1: There is a database with the condition and elevation of Bay Trail available to owners and managers. However, this database is not geo-referenced or very high quality. There is no publicly available database with, for example, the owners and managers of Bay Trail segments.

GOV1: MLK Jr. Shoreline and Arrowhead Marsh are owned by the Port of Oakland and managed by EBRPD. Many sections of Bay Trail, managed by EBRPD, are on levees owned by ACFCWCD, with a land use agreement between the agencies. Because of these multiple owners and managers, coordination will be required in order to make changes to adapt to sea level rise.

GOV2: Many agencies have regulatory authority over MLK Jr. Shoreline: USACE San Francisco District (Section 404 permit); USFWS and NOAA (Section 7 consultations for the endangered species act); RWQCB (Section 401 certification); some projects require permits from BCDC or a review under CEQA/NEPA. The many agencies involved and permits required means that a lengthy process may be required to make changes to adapt to sea level rise.

FUNC1: The Bay Trail connects over 300 miles of trails. If one part of the system is not operational, some of the overall functionality could suffer. In particular, this section is an important north-south commuting corridor both on the mainland and on Bay Farm Island.

FUNC2: Arrowhead Marsh is mapped as mid marsh with very little high tide refugia. It is projected to downshift to low marsh by midcentury and to mudflat by end-of-century. The federally endangered clapper rail rely on the high-tide refugia that currently exists; in the future, the marsh may not be able to serve this function for this species and others.

FUNC3: Damon Slough seasonal wetlands will be increasingly inundated by rising sea level and over time downshift to marsh habitat. Vertical accretion modeling indicates that Damon Marsh will not keep pace with

sea level rise through this century. Its downshifting trajectory depends on the sea level rise rate and sediment supply. The wetlands currently provide habitat for the federally endangered clapper rail. This function could diminish with sea level rise.

PHYS1: Although the Bay Trail is paved in MLK Shoreline, some of it is on top of poorly maintained levees that are vulnerable to erosion, which undercuts the trail.

PHYS2: Some of the levees may have fiber optic cables or tidegates located under, within, or adjacent to them. This could complicate any work necessary to repair or protect against the effects of sea level rise.

Consequences

Society: MLK Jr. Shoreline provides commuting options, recreation, access to the shoreline, and wildlife viewing; these opportunities are free to the public, including several underserved / low-income communities in the vicinity. The shoreline also provides school programs and volunteer programs. If the shoreline is eroded or flooded, or the Bay Trail undercut, these recreational and program opportunities would be lost for the local communities.

Economy: MLK Jr. Shoreline provides \$4.8M in recreation value per year, which would be reduced or lost as sea level rise changes and diminishes shoreline and habitat. It also provides commuting options via the Bay Trail that could be lost or disrupted.

Environment: The Shoreline provides habitat for at least one endangered species, which could be lost due to sea level rise. In addition, various types of ecosystems (high marsh, mid marsh, seasonal wetlands) could be lost as sea level rise causes them to downshift to low marsh and mudflat.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
<p>PHYS1: Although the Bay Trail is paved in MLK Shoreline, some of it is on top of poorly maintained levees that are vulnerable to erosion, which undercuts the trail.</p>	Prioritize resurfacing vulnerable trail segments with erosion-resistant materials	Program/ operation	Capital Planning, Project Planning and Design	EBRPD	Do It Yourself, Local, Regional
	Prioritize maintenance and repair of barrier-free access to the shoreline and recreation facilities in order to minimize re-routing or closure	Policy Development, Program/ operation	Operations	EBRPD	Do It Yourself, Local, Regional
	Stockpile materials to create ramps or pathways to maintain safe access for those with limited mobility during and after flooding events	Program/ operation	Operations, Emergency and Hazard Planning	EBRPD	Multi-benefit, Do It Yourself, Local, Regional
	Stockpile and use sandbags to minimize flood damage to vulnerable structures (e.g., boat house, meeting space)	Program/ operation	Operations, Emergency and Hazard Planning	EBRPD	Multi-benefit, Do It Yourself, Local, Regional
	Effectively communicate trail closures, e.g., establish specific notification practices	Education/ Outreach	Long-range Planning, Operations, Emergency and Hazard Planning	EBRPD	Do It Yourself, Local, Regional

Vulnerabilities also addressed under Key Planning Issue 5: FUNC2, FUNC3

Vulnerabilities also addressed under Key Planning Issue 6: GOV1, GOV2, FUNC1

Harbor Bay Isle Lagoon System

The Harbor Bay Isle Lagoon is located on the Bay Farm Island peninsula in Alameda, on the east bay shoreline north of the Oakland International Airport. Harbor Bay Isle Lagoon Systems I and II form the major component of the Harbor Bay Isle Master Plan Community, providing open space, wildlife habitat, aesthetic and recreational enjoyment for the residents of the Community. The lagoons also accept storm water drainage from the adjacent developed areas. System I has an intake weir from San Francisco Bay at the west end of the lagoon system and an outfall weir and pump station at San Leandro channel at the north. System II is along the south edge of Bay Farm Island, parallel to the Bay, with an outlet weir and pump station at the southeast end. The lagoons are narrow river-like waterways about 3 miles long. The basic operation of the Lagoon Systems is dependent upon the normal San Francisco Bay tidal action, which through a series of sluice gates at each end of the lagoon, provide a degree of flushing from west to east while maintaining a calibrated water level 2 to 4 inches below the top of the structure. During normal operation, the anticipated average water retention time is approximately four days. When it is necessary to remove some of the lagoon waters while the tides are not favorably low, the pump stations are used. Harbor Bay Isle Community Water Quality Division (HBICWQD) owns and maintains the asset. The City of Alameda Public Works Department provides some major capital improvements for the weir structures and pump stations. Harbor Bay Isle began development in 1978. The area was filled in by 1982, and the lagoons were built simultaneously with tideland reclamation, in 1980.

Key Issue Statement

The Harbor Bay Island Lagoon provides critical stormwater storage for residential areas on the island. The tide gate that protects the lagoon cannot maintain its function during future flood events and will need to be improved or redesigned. The lagoon operates under many different regulatory structures and provides multiple benefits including recreation, habitat, and stormwater management. Improving the resilience of the lagoon will require coordination among user groups and with regulatory agencies.

Vulnerabilities

GOV1: In order to make changes to the asset, a City building permit is required, and the Corps of Engineers and RWQCB have jurisdiction over the lagoons. While BCDC does not have jurisdiction over the lagoons, it has jurisdiction over the Bay into which the lagoons discharge, so if modifications of the outfalls were necessary, a BCDC permit could be required. Since multiple entities have jurisdiction and / or require permits, any changes will require coordination and may take a long time to plan, permit, and implement.

PHYS1: System II pump is undersized and takes a while to affect the lagoon elevation. It is recommended for upgrade.

FUNC1: Weirs can be operated manually. In the event that pumping is needed during a power outage, there is a receptacle for a portable generator for System I, but not System II.

FUNC2: The lagoon system is part of a network that includes the stormwater system for Bay Farm Island. A master plan of the storm water system identified several outfalls into the lagoon systems that are undersized and cause flooding in neighborhoods due to backwater conditions and undersized storm drains.

Consequences

Society: The lagoons provide recreational opportunities to residents, along with storm water storage for water quality treatment. If these systems were damaged, it could cause stormwater management problems and lower the quality of life for local residents.

Economy: The lagoon system is seen as desirable neighborhood element; its damage or loss could potentially hurt home prices, and repairs would need to be financed through assessments and city stormwater fees.

Environment: Problems caused by climate or seismic impact could potentially cause water to overtop, where it could pick up pollutants from surrounding properties; however, these properties are largely residential rather than, e.g., hazardous waste sites. Another possibility is that stormwater stuck in the lagoon due to high Bay water levels could potentially be reduced in quality.

Adaptation Responses

Vulnerability	Action	Action Type	Process	Possible Actors	Action Characterization
<p>GOV1: In order to make changes to the asset, a City building permit is required, and the Corps of Engineers and RWQCB have jurisdiction over the lagoons. While BCDC does not have jurisdiction over the lagoons, it has jurisdiction over the Bay into which the lagoons discharge, so if modifications of the outfalls were necessary, a BCDC permit could be required. Since multiple entities have jurisdiction and / or require permits, any changes will require coordination and may take a long time to plan, permit, and implement.</p>	<p>If not already done, consolidate management of the interconnected stormwater infrastructure on Bay Farm Island either by creating a single entity or establishing inter-agency agreements to guide capital investment, management, and operations decisions.</p>	<p>Coordination, Policy Development</p>	<p>Long-range Planning, New Initiative</p>	<p>HBICWQD, City of Alameda</p>	<p>Multi-benefit, Long Lead Time</p>
	<p>Establish or strengthen coordination of owners and managers of the interconnected stormwater infrastructure on Bay Farm Island, to articulate and advocate for shared objectives (e.g., reducing runoff through low impact development (LID), addressing wet weather flows), and to develop frameworks for decision-making and funding related to infrastructure maintenance and new investments</p>	<p>Coordination, Policy Development</p>	<p>Long-range Planning, New Initiative</p>	<p>HBICWQD, City of Alameda</p>	<p>Unlocking, Multi-benefit, Long Lead Time</p>

<p>FUNC1: Weirs can be operated manually. In the event that pumping is needed during a power outage, there is a receptacle for a portable generator for System I, but not System II.</p>	<p>Upgrade Lagoon System II to increase resilience to sea level rise and storm events. (1) Ensure that the upgraded System II pump is properly sized to accommodate increasing Bay tidal levels projected to occur over the expected useful life of the pump. (2) Install a receptacle for a portable generator.</p>	<p>Program/ operation</p>	<p>Long-range Planning, Capital Planning, Project Planning and Design</p>	<p>HBICWQD City of Alameda</p>	<p>Do It Yourself, Multi-benefit, Local</p>
	<p>Prepare for flooding by pre-positioning emergency power generators and other necessary equipment (e.g., portable pumps, and debris removal equipment)</p>	<p>Program/ operation</p>	<p>Emergency and Hazard Planning, New Initiative</p>	<p>HBICWQD</p>	<p>Do It Yourself, Local</p>
	<p>Establish inter-agency mutual aid agreements to provide assistance with inspection and repair of damaged or compromised facilities, and mobile or alternative facilities (e.g., portable pumps, generators) during emergency response and recovery</p>	<p>Coordination</p>	<p>Long-range Planning, Emergency and Hazard Planning</p>	<p>HBICWQD, City of Alameda, Port</p>	<p>Multi-benefit, Local</p>

<p>FUNC2: The lagoon system is part of a network that includes the stormwater system for Bay Farm Island. A master plan of the storm water system identified several outfalls into the lagoon systems that are undersized and cause flooding in neighborhoods due to backwater conditions and undersized storm drains.</p>	<p>Upgrade the system outfalls to accommodate storm water flows. Add sufficient capacity to accommodate future increases in storm water flows.</p>	<p>Program/ operation</p>	<p>Capital Planning, Project Planning and Design</p>	<p>City of Alameda, HBICWQD</p>	<p>Do It Yourself, Multi-benefit, Local</p>
--	--	-------------------------------	--	-------------------------------------	---

Vulnerabilities also addressed under Key Planning Issue 6: GOV1