IV. FLOOD PROTECTION AND SITE GRADING

A. Sea Level Rise and Adaptive Management

1. Sea Level Rise Criteria

Development sites along the San Francisco Bay shoreline are susceptible to future inundation with sea level rise. These sites shall develop strategies and design solutions to provide protection from the expected impacts of climate change. To assist the planning of these projects, the Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT) issued a Sea-Level Rise Guidance Document in March 2013. This document provides guidance for incorporating sea-level rise projections into planning for projects within California. The CO-CAT projections are generally recognized as the best science-based sea level rise projections for California. The CO-CAT sea level rise projections are as follows:

Table 3 - CO-CAT Sea Level Rise Projections (March 2013)

Time Period	Amount of Sea Level Rise
2000 - 2030	1.5 - 12 inches
2000 - 2050	5 - 24 inches
2000 - 2100	17 - 66 inches

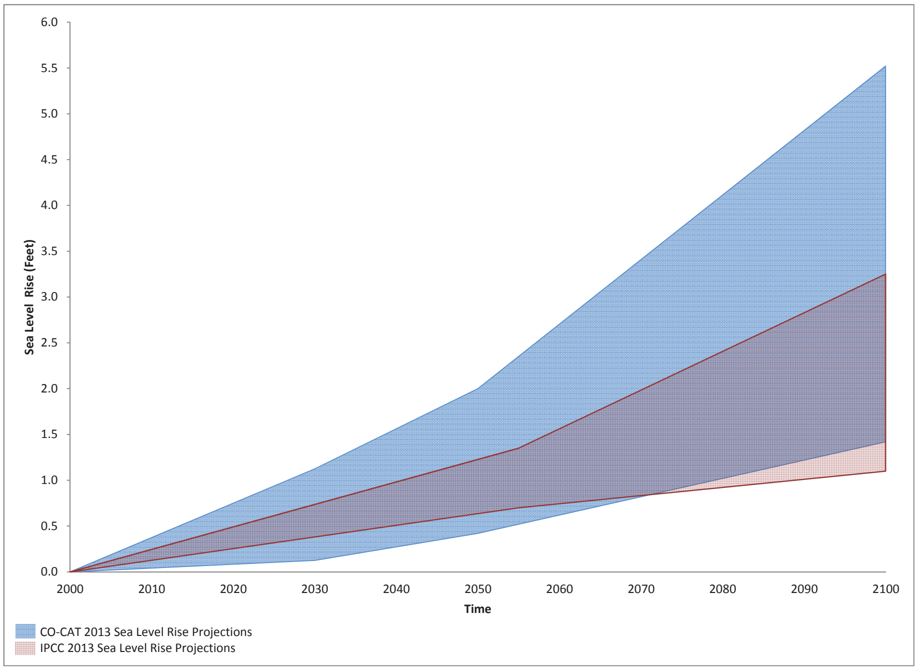
Also, recently in September 2013, the Intergovernmental Panel on Climate Change (IPCC) issued a Fifth Assessment Report on climate change. This report is an update to their Fourth Assessment Report (2007) and reflects advancements in methodologies and understandings of the various components of sea level rise, such as loss of continental ice, thermal expansion of ocean water and past sea level changes. The IPCC report concludes that the global sea level is rising and predicts a global rise between 11 and 38 inches will occur by 2100.

Identifiably, there still remains variability of sea level rise projections within the scientific community. See Graph 1 summarizing the CO-CAT and IPCC sea level rise projections through to the end of the century. Generally, up to 2050 there is agreement among the various climate models for the amount of sea level rise that is likely to occur within that timeframe (i.e., 5 to 24 inches). However after mid-century, the projections of sea level rise become more uncertain and variable, primarily due to the uncertainties associated with future global greenhouse gas emissions and land ice melting rates. Therefore, for projects with timeframes beyond 2050, such as Alameda Point, it is recommended to consider adaptive capacity and adaptive flood protection measures that provide the ability to adapt to increased amounts of sea level rise and ensure long term protection.

In addition, the San Francisco Bay Conservation and Development Commission (BCDC) updated the San Francisco Bay Plan in October 2011 to address the expected impacts of climate change in San Francisco Bay. In order to understand the potential impacts of sea level rise to the shoreline communities around the San Francisco Bay, BCDC conducted a vulnerability assessment. BCDC selected two sea level rise projections to complete this assessment, 16-inches by 2050 and 55-inches by 2100. These projections are within the range of CO-CAT sea level rise predictions. The assessment provides an understanding of the areas susceptible to inundation at these various amounts of sea level rise. From this assessment, BCDC adopted policies within the Bay Plan Amendment that include guidance for addressing future sea level rise when planning projects along the Bay shoreline. BCDC's policies require projects within their jurisdiction to evaluate the potential risks associated with sea level rise, based on the most current science. Additionally, BCDC's policies indicate that projects with a life beyond the mid-century shall have flood protection measures that can be adapted to address additional sea level rise that is projected to occur by the end of the century.

Specific to Alameda Point, the MIP recommends an Adaptive Management Plan for the flood protection system. The flood protection measures constructed in the near term, with initial development, shall be constructed with built-in protection against 18-inches of sea level rise. The 18-inches of sea level rise protection shall be in addition (added to) to other flood protection criteria, including the 100-year tidal elevation and wave/wind run-up. 18-inches is within the ranges of sea level rise predicted by CO-CAT and IPCC to occur by the end of the century.

Graph 1 - 2013 Sea Level Rise Projection



The 18-inch initial protection criteria was selected because it balanced a number of important development considerations:

- **Science and Regional Policies.** Is consistent with latest scientific projections and BCDC policies;
- **Phasing.** Allows initial phases in Development Areas to commence without costly major perimeter improvements that are very difficult for the first initial phases to implement up front;
- **Geotechnical.** Addresses geotechnical soil conditions associated with the compressible Young Bay Mud in a feasible and cost effective manner; and
- **Financial Feasibility.** Recognizes that flood protection improvements are expensive and must be phased and adaptable to balance financial feasibility and near-term development with sea-level rise protection.

2. Benchmarking Sea Level Rise Criteria

For planning of flood protection measures and shoreline improvements, the projected amount of sea level rise will be benchmarked (added to) the design flood criteria of each specific improvement.

At Alameda Point, the shoreline improvements and flood protection measures within the Development and Reuse Areas will be designed to comply with FEMA's flood protection criteria. This flood criteria includes protection from the 100-year tidal event, wave/wind run-up and storm surge. Levees will also require an additional 2-feet of protection above this criteria, as freeboard, providing additional factor of safety and protection. This is further outlined in the Section 6 - Site Grading Criteria. Accordingly, the flood protection measures for Alameda Point are planned based on this FEMA criteria plus an additional 18-inches of sea level rise added. In summary, the MIP recommends 18-inches of sea level rise protection be in addition to the flood criteria of 100-year tidal elevation, wave/wind run-up and storm surge.

There are other shoreline improvements that may have less stringent design flood criteria. For example, the Bay Trail planned in the Northwest Territories does not need to be designed to comply with FEMA's flood protection criteria. This facility may be designed to provide protection from the mean high tide and wave/wind run-up only. The mean high tide elevation is approximately 4-feet lower than the 100-year tidal elevation. In fact, BCDC's vulnerability assessment benchmarked the projected sea level rise on the mean high tide to provide an understanding of risks associated with potential more frequent flooding with sea level rise, not the very infrequent 100-year tidal event. Figure 10.2 is from BCDC's assessment and depicts the areas within Alameda Point that would be inundated by 16-inches of sea level rise and 55-inches of sea level rise, both added to current mean high tide.

Therefore, it is important to note the proposed flood protection measures at Alameda Point will have built-in sea level rise protection above the mean high tide of 66-inches (18-inches plus 4-feet) with the near term measures.

3. Proposed Sea Level Rise Protection

There are a number of flood protection strategies that can be implemented with adaptive capacities to address sea level rise. These include:

- Raise the elevations of the site to be at or above the expected flood levels and projected amount of sea level rise within the life of the project.
- Construct perimeter measures, such as floodwalls and levees, above the expected flood levels and projected amount of sea level rise.
- Set back from the shoreline and develop on areas with existing elevations above the expected flood levels and projected amount of sea level rise.

The MIP recommends a hybrid of these strategies for Alameda Point, implementing the strategy that is most appropriate for each portion of the site. Accordingly, the Development Areas are proposed to be raised to establish minimum elevations at or above the expected flood levels plus 18-inches of sea level rise. The finish floors of all new structures will be constructed 24-inches above the 100-year tidal elevation, providing an additional 6-inches above the initial 18-inches amount of sea level rise. For the Reuse Areas where preservation goals of the Historic District preclude interior elevations from being raised, perimeter measures will be constructed. Lastly, there are opportunities within the Project Site for future tidal wetlands to be created as sea levels rise. These areas are along the western shore of the Seaplane Lagoon and within the Northwest Territories.

With the scientific uncertainties regarding the pace and amount of future sea level rise, CO-CAT and IPCC are committed to continue to periodically update their projections to reflect the most accurate available data and theories. Therefore a sea level rise monitoring program will be established at Alameda Point to periodically review actual sea level rise amounts, trajectories, and updated projections.

If future sea level rise amounts are anticipated to exceed 18-inches, additional flood protection measures will be implemented. The flood protection system will be adaptively designed to address sea level rise in excess of 18-inches. The adaptive measures will include preserving inland land and right of way along the perimeter of the site such that existing shorelines and floodwalls could be elevated to manage sea level rise. The perimeter improvements shall be designed to allow for the future flood protection measures to be widened and support additional height such that no fill is placed in the Bay. Other adaptive measures that may be implemented include a flexible perimeter protection measure that shifts inland and allows the out board land to be converted to tidal wetlands. This type of solution is only anticipated as an option for the western shoreline of the Seaplane Lagoon and Northwest Territories. A funding mechanism to implement these future adaptive measures will be established for the Alameda Point area. A Geologic Hazard Abatement District (GHAD) will be established at Alameda Point to serve as the mechanism to monitor, maintain and implement the adaptive flood protection measures.

The near term and future perimeter flood protection measures shall be designed in accordance with the National Flood Protection Insurance Program (NFIP), as described in Title 4, Chapter 1, Section 65.10 of the Code of Federal Regulations.

4. Existing Conditions

a. Existing Topography

The existing topography of Alameda Point is generally flat and has gradients ranging between 0.2 and 0.75 percent. The existing elevations throughout the Project Site range between 0.5 and 9.0 (City Datum).

There is an existing slight ridge in the middle of the Project Site, near Midway Avenue. The elevations of this ridge are approximately 7.0. The existing ground slopes away from this ridge either to north or the south. The existing elevations of the southeast quadrant are also elevated, an average elevation of 7.0. This portion of the Project Site includes the existing piers, which are at elevation 9.0.

The low lying areas include the northern entrance to the Project Site at the Main Gate, where the elevation is approximately 1.0. Also, the areas in the northwest corner of the Seaplane Lagoon are at elevations ranging in between 2.0 and 3.4.

The existing elevations of Main Street adjacent to the northeastern portion of the Project Site are also low. The lowest point of Main Street is located at the Main Street / Ferry Terminal Parking Lot intersection, which is at elevation 0.5. This portion of Main Street is drained by an existing storm drain pump station.

The existing topography of the Northwest Territories generally drains northerly to the Oakland-Alameda Estuary. The existing runways are elevated and crowned, approximately at elevation 7.5, and the surrounding areas are depressed, approximately at elevations 1.5 – 5.0.

b. Existing Areas of Potential Flooding

Currently, Federal Emergency Management Agency (FEMA) has not included Alameda Point within a Flood Insurance Study or Flood Insurance Rate Map, since it was a federal facility. The existing areas of potential inundation will need to be mapped and adopted by FEMA. This process is currently underway through FEMA's California Coastal Analysis and Mapping Project. This study will include the shorelines of Alameda Point and define the coastal flood hazards within the project site based on regional-scale storm surge and wave models of the San Francisco Bay. The flood hazards affecting portions of the Project Site include areas subject to flooding in the 100-year tidal event and the perimeter shoreline that is subject to flooding in the 100-year tidal event and wave/wind run up. See Figure 10.1 depicting the approximate existing areas that are subject to the current 100-year flood hazards within Alameda Point.

The portion of Main Street adjacent to the northeastern portion of the Project Site is identified as within "Zone A", areas subject to flooding in the 100-year event, on FEMA's FIRM panel, dated 2009.

As part of BCDC's Bay Plan Amendment, BCDC conducted a vulnerability assessment. This assessment indicates the low-lying areas surrounding the San Francisco Bay that would be inundated by 16-inches of sea level rise assumed to occur by 2050 and 55-inches of sea level rise assumed to occur by 2100. See Figure 10.2 depicting the areas within Alameda Point that would be inundated at these two amounts of sea level rise. It is important to note that this figure represents that areas inundated by comparing the projected amount of sea level rise to the mean high tide. As previously stated, the 100-year tidal elevation is approximately 4-feet above the mean high tide. Accordingly, the areas depicted as inundated by the 100-year tidal event on Figure 10.1 are similar to those areas depicted as inundated by sea level rise added to the mean high tide as depicted on Figure 10.2

i. 100-Year Tide

The 100-year tidal elevation is established by the flood frequency analysis prepared by the U.S. Army Corp of Engineers in October 1984. This study, titled "San Francisco Bay – Tidal Stage versus Frequency Study" analyzed the flood frequency based upon tidal data throughout the Bay Area for a 129-year period. One of the tidal gauges utilized in this analysis in located near the piers at the southeastern portion of Alameda Point. The 100-year tidal elevation at the Alameda Point tidal gauge presented in this study is elevation 3.4. In order to account for the increased mean sea level represented between the old and new tidal epochs, the 100-year tidal elevation is increased by 0.2-feet to elevation 3.6 for the MIP.

ii. Wave/Wind Run-Up

The perimeter coastal areas within Alameda Point will be designed to account for wave/wind run up. The prevailing winds at the Project Site are from the west, with typical speeds up to approximately 25 knots. Extreme wind conditions for the Project Site were previously calculated in the Alameda Point Golf Course EIR and are summarized in Table 4.

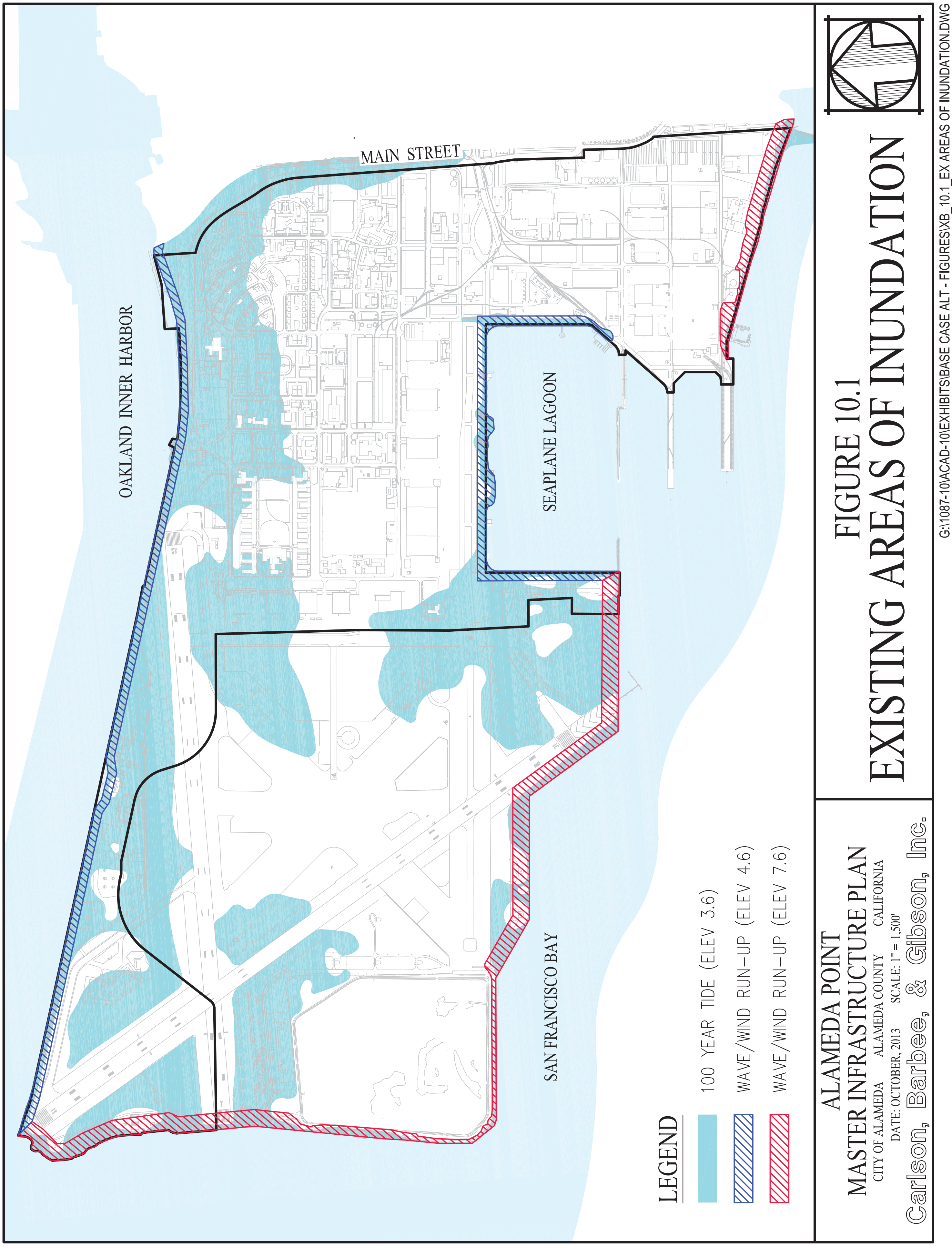

MAIN STREET
OAKLAND INNER HARBOR
SEAPLANE LAGOON
SAN FRANCISCO BAY
LEGEND
100 YEAR TIDE (ELEV 3.6)
WAVE/WIND RUN-UP (ELEV 4.6)
WAVE/WIND RUN-UP (ELEV 7.6)
ALAMEDA POINT
MASTER INFRASTRUCTURE PLAN
CITY OF ALAMEDA ALAMEDA COUNTY CALIFORNIA
DATE: OCTOBER, 2013 SCALE: 1" = 1,500'
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FIGURE 10.1
EXISTING AREAS OF INUNDATION
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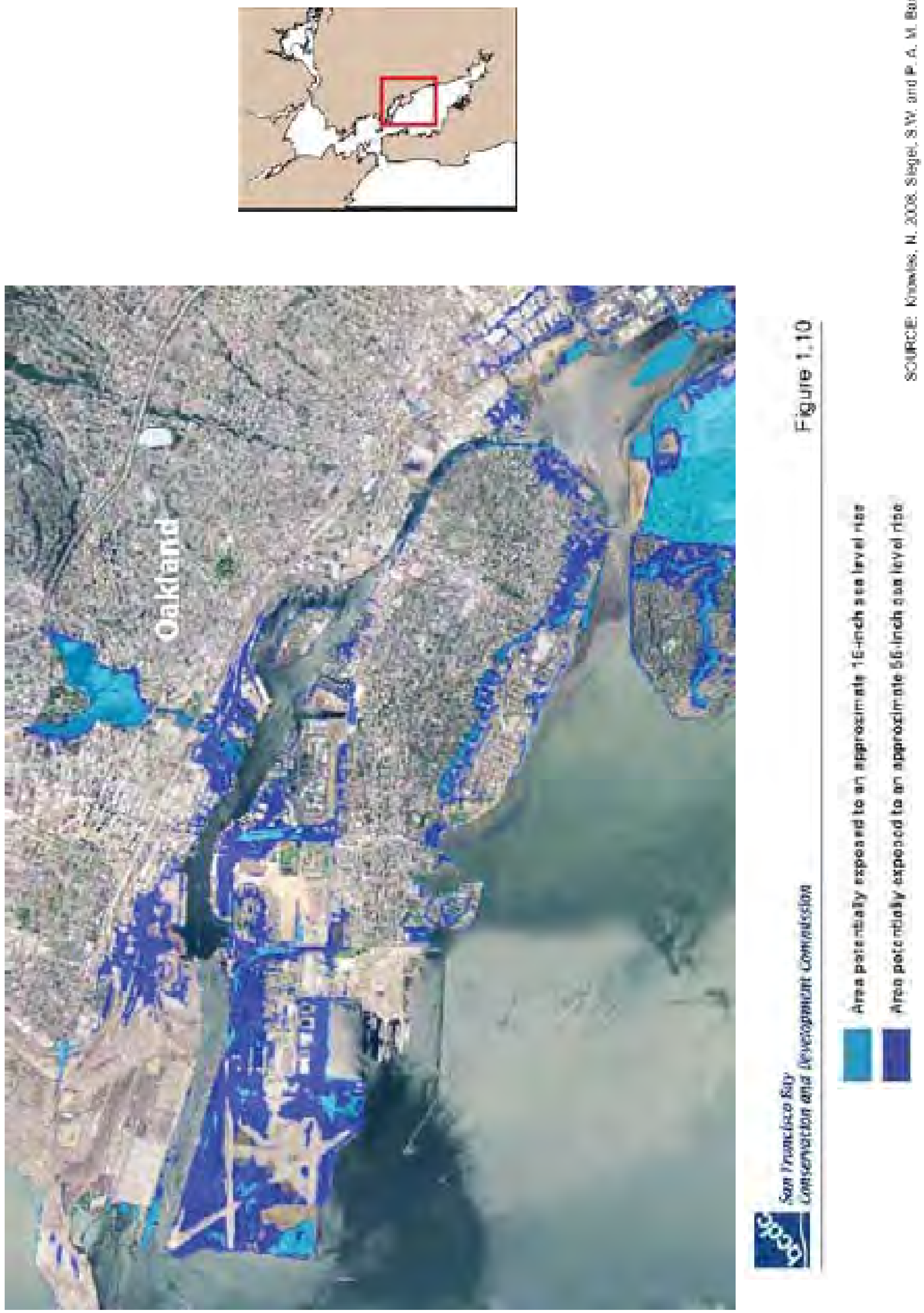

FIGURE 10.2
SEA LEVEL RISE

ALAMEDA POINT
MASTER INFRASTRUCTURE PLAN
CITY OF ALAMEDA ALAMEDA COUNTY CALIFORNIA
DATE: OCTOBER, 2013 NOT TO SCALE
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Table 4 - Wind Conditions

Return Period (Years)	Wind Speed (Knots)
2	29.7
10	36.8
25	40.3
50	43.0
100	45.6

The majority of the shoreline within with Project Site is well protected from wind generated waves and from swell. The northern shoreline along the Oakland-Alameda Estuary and the Seaplane Lagoon shoreline are sheltered from the wind waves. Wave/wind run-up for these shorelines is estimated to be a maximum of 1-foot.

The shorelines along the southern edge of the Project Site, east of the Seaplane Lagoon, are directly exposed to the wind generated waves. The 100-year wind wave heights estimated for these shorelines are approximately 4-feet.

iii. Tsunamis

The Golden Gate limits the propagation of tsunamis through the San Francisco Bay providing sheltering of Alameda Point from the majority of potential tsunami damage. San Francisco Bay has had a tidal gauge, in various locations, recording data since 1854 to present. Over this period of time, there have been approximately 50 creditable tsunamis recorded or observed in the San Francisco Bay region. Of these, only 5 produced run up that exceeded 1.6 ft. (-1.8 City Datum) within the Bay. The best-documented tsunami events are the 1946, 1960 and 1964 tsunamis generated by distant earthquakes in Aleutian Islands, Southern Chile and Prince William Sound, Alaska respectively. The highest recorded wave height associated with a tsunami event at the Alameda tidal gauge was associated with the 1964 Alaskan tsunami event. The tidal gauge recorded a maximum wave height during this event of approximately 2.3 ft. (-0.8 City Datum). Based on the available records from tidal gauges within the San Francisco Bay Area, this maximum event is representative of a 100-year tsunami event. The approximate maximum wave height associated with this event is less than the 100-year tidal elevation and therefore is below the elevation of the proposed flood protection measures at Alameda Point.

Additionally, the US Geologic Survey (USGS) recently issued a report, “Community Exposure to Tsunami Hazards in California” dated March 2013, which evaluated the potential community exposure to tsunami hazards along the California coastline, including San Francisco Bay. USGS completed simulation modeling of tsunami generation, propagation and run up to determine and investigate the “worst case” type scenario. USGS determined that large ruptures along the Aleutian subduction zone is the most likely to generate the strongest tsunami within the San Francisco Bay and presents the greatest hazard, larger than any other modeled potential source either locally or in the Pacific. Specific to Alameda, this type of modeled tsunami event presented in this USGS report indicates that the maximum onshore run up elevation is 10.6 (City Datum). While this event is an extreme case with a low probability of occurrence, the majority of Alameda Point would be inundated by a tsunami event of this magnitude. This report concludes that because of the City of Alameda's high percentage of people and businesses within the tsunami prone area, the City has high potential for losses related to this significant tsunami event. Accordingly, proposed developments within the Project Site shall work with the City of Alameda emergency services to establish emergency preparedness plans and evacuation routes for Alameda Point in the case of this extreme event.

iv. Wakes

Large vessels associated with the Port of Oakland's activities commonly travel along the northern shoreline. Additionally, ferry vessels may enter the Seaplane Lagoon as part of the transit solutions for Alameda Point. This shipping traffic may generate wakes up to approximately 1-foot.

5. Initial Flood Protection System

a. Flood Protection Criteria

The flood protection criteria for Alameda Point combine those outlined by the FEMA with additional consideration for sea level rise. The FEMA guidelines for establishing the flood elevations vary for shoreline areas and for inland areas. FEMA's design criteria for shoreline areas require that the flood protection measures be established above the 100-year tidal elevation plus consideration for wave / wind run-up. If the flood protection measure is a perimeter levee, the crest elevation must include the greater of either 2-feet above the 100-year tidal elevation or 1-foot above the 100-year tidal elevation plus wave / wind run up. The FEMA design criteria for the inland areas consider only the 100-year tidal elevation. The minimum elevations of the initial flood protection system for Alameda Point will adhere to FEMA's guidelines plus an additional 18-inches of sea level rise.

b. Development Areas

The Development Areas will be elevated to achieve the initial flood protection criteria. The minimum elevations of the inland Development Areas will be designed to be at or above the 100-year tidal elevation plus 18-inches of sea level rise. The finish floors of all new structures will be constructed 24-inches above the 100-year tidal elevation, providing an additional 6-inches above the initial 18-inches amount of sea level rise. The minimum elevations of the perimeter of the Development Areas will be designed to be at or above the 100-year tidal elevation, plus consideration for wave/wind run up and 18-inches of sea level rise. The flood protection measures within the Development Areas will be phased consistent with the development phasing.

The shorelines will be designed to dedicate the necessary right-of-way and land for the future adaptive measures that will be employed as part of Alameda Point's Adaptive Management Plan for future sea level rise in excess of 18-inches. Typically, a 50 to 90-foot wide corridor shall be reserved along the Development Area shorelines. This future adaptive measures corridor is anticipated to encompass the Bay Trail alignment. This corridor will accommodate a future levee or floodwall elevated to provide protection from future sea level rise.

c. Reuse Areas

The Reuse Areas include historic structures and landscapes that will be preserved. Generally, many of the existing structures are elevated relative to the street elevations. A sample of the existing structures was field surveyed. The majority of these structures had an existing finish floor elevation above the 100-year tidal elevation plus sea level rise. However, there were some existing structures in the northwest and southwest portions of the Project Site that have existing finish floor elevations below the 100-year tidal elevation plus 18-inches of sea level rise. Additionally, the majority of the existing streets within the Reuse Areas are at an elevation below the 100-year tide. Therefore, the initial flood protection system for the Reuse Areas will be comprised of a perimeter system of levees and floodwalls. These perimeter measures will be designed to have a crest elevation that meets FEMA's guidelines, which include 100-year tidal elevation, plus wave / wind run up, 18-inches of sea level rise plus 2-feet of additional protection (freeboard). The construction of the initial flood protection system for the Reuse Areas will be completed over time as described in the Phasing and Implementation Section XIII.

The levees and floodwalls will be designed to be adapted if the amount of future sea level rise exceeds 18-inches. Typically, a 50-foot wide corridor shall be reserved along the Reuse Area shorelines. This future adaptive measures corridor is anticipated to encompass the Bay Trail alignment. This corridor will accommodate further elevating the initial construction levee or floodwall to provide increased protection from future sea level rise.

See Figure 11 depicting the initial flood protection system and minimum elevations throughout Alameda Point.

d. Bay Trail - NW Territories and VA Property

In general, the Bay Trail outside of the Development and Reuse Areas within the NW Territories and VA Property will be constructed along the shoreline. The minimum elevation of the Bay Trail shall be in accordance with BCDC's design guidelines for public use areas along the Bay shoreline. Generally, the Bay Trail will be constructed at an elevation above the anticipated amount of sea level rise within the design life of this facility. However, the Bay Trail within the NW Territories and VA Property are not expected to be constructed to the FEMA standards of a flood protection berm / levee and therefore not providing flood protection for the VA Property. Additionally, the segment of the Bay Trail along the perimeter of the VA Property is subject to review and approval by the United States Fish and Wildlife Service, if open all year outside the breeding season of the endangered California Least Tern. Other design measures for the Bay Trail may be necessary to ensure the protection of endangered and sensitive species within the VA Property.

e. Stormwater System

A new stormwater collection system will be constructed in phases within the Project Site. The stormwater system will include the construction of new outfall structures that include tide valves to prevent tidal influences in the system. For the low lying watersheds, pump stations will be constructed to minimize the depth of the stormwater pipelines and ensure stormwater discharge during extreme tides and 18-inches of sea level rise. The new stormwater system will be designed to convey the 25-year design storm with 6-inches of minimum freeboard. Additionally, the system will accommodate the 100-year storm with a maximum ponding in the streets of up to the top of curb at low points in the street profiles.

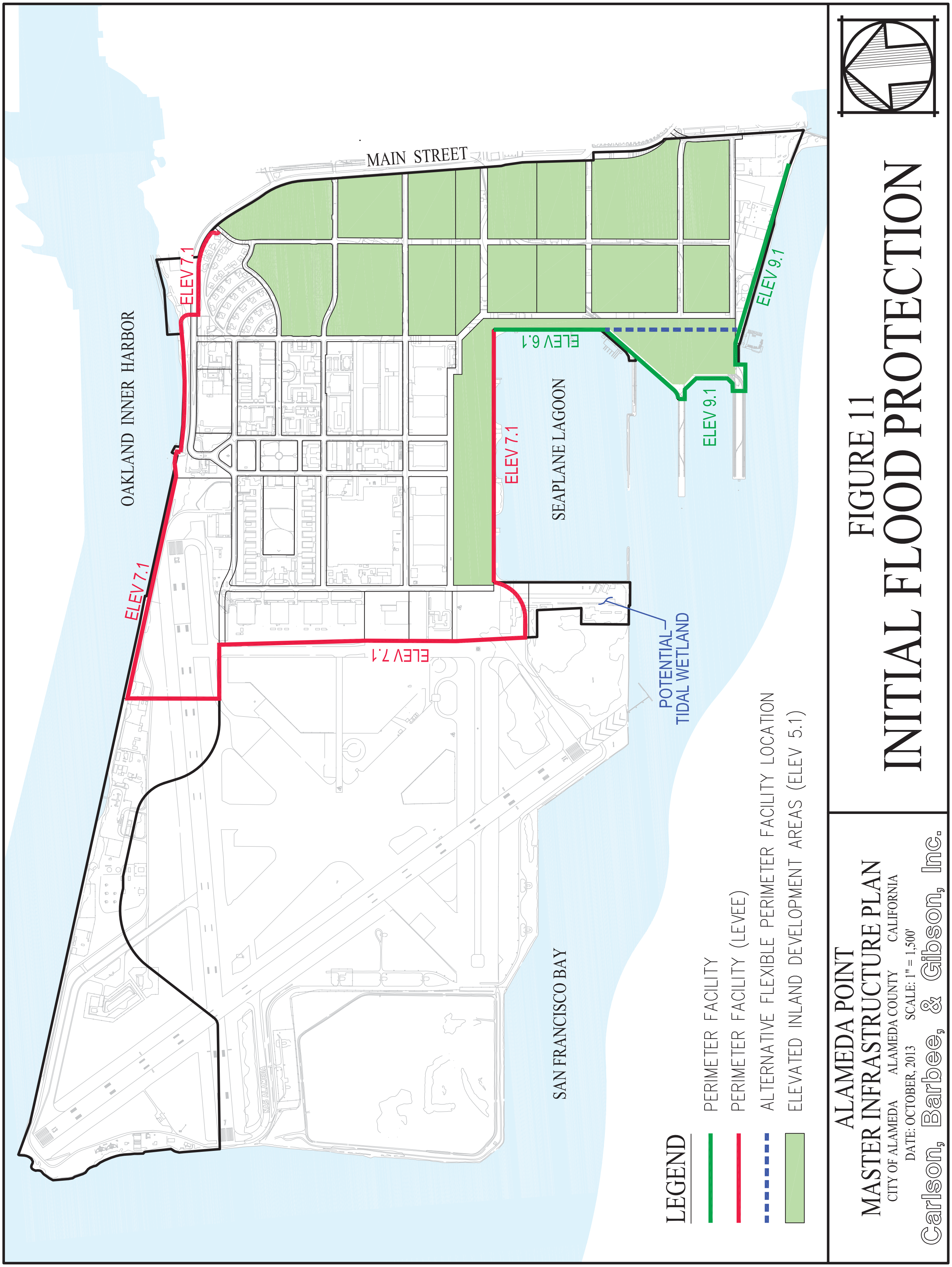
FIGURE 11
INITIAL FLOOD PROTECTION
MAIN STREET
OAKLAND INNER HARBOR
SEAPLANE LAGOON
SAN FRANCISCO BAY
ELEV 7.1
ELEV 7.1
ELEV 7.1
ELEV 7.1
ELEV 6.1
ELEV 9.1
ELEV 9.1
POTENTIAL TIDAL WETLAND
LEGEND
PERIMETER FACILITY
PERIMETER FACILITY (LEVEE)
ALTERNATIVE FLEXIBLE PERIMETER FACILITY LOCATION
ELEVATED INLAND DEVELOPMENT AREAS (ELEV 5.1)
ALAMEDA POINT
MASTER INFRASTRUCTURE PLAN
CITY OF ALAMEDA ALAMEDA COUNTY CALIFORNIA
DATE: OCTOBER, 2013 SCALE: 1" = 1,500'
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6. Site Grading Design Criteria

The site grading design criteria for the various flood protection measures presented above are summarized in Table 5.

Table 5 - Site Grading Design Criteria

	Location	Improvements	Min. Elev. (City Datum)	Design Criteria
Development Areas (New Construction)				
Perimeter	Eastern Seaplane Lagoon	Raise Ex Revetment	6.1	100-Year Tide +18” Sea Level Rise +1’ Wind/Wave
	West & North Project Boundary	Raise Ex Headwall or Revetment	7.1	100-Year Tide +18” Sea Level Rise +2’ Wind/Wave
	Existing Piers	Raise Ex Floodwall	9.1	100-Year Tide +18” Sea Level Rise +4’ Wind/Wave
	Southeast Project Boundary	Raise Ex Revetment	9.1	100-Year Tide +18” Sea Level Rise +4’ Wind/Wave
Inland	Areas Adjacent to Main Street	Raise Finish Grade	5.1	100-Year Tide +18” Sea Level Rise
	Areas Adjacent to Seaplane Lagoon	Raise Finish Grade	6.1	100-Year Tide +18” Sea Level Rise +1’ Wind/Wave
Reuse Areas				
Perimeter	West & North Project Boundary	Construct Berm or Raise Ex Revetment	7.1	100-Year Tide +18” Sea Level Rise +1’ Wind/Wave
Inland	Existing Areas to Remain	Existing Elevations to Remain	-	Existing Elevations to Remain As Is
Main Street				
Reconstruction	NW Alameda Ferry Terminal Parking Lot Entrance to Atlantic Ave.	Raise Main Street	3.6	

7. Flood Protection System Adaptations for Future Sea Level Rise

a. Adaptive Measure Criteria

As previously described, the initial flood protection system will provide flood protection for up to 18-inches of sea level rise. These initial flood protection measures will be designed to be adapted if the amount of future sea level rise exceeds 18-inches. The adaptive measures for the Development Areas will include constructing a perimeter system of levees and floodwalls. The adaptive measures for the Reuse Areas will include elevating the initially constructed perimeter levees and floodwalls. The adapted perimeter measures will be elevated to meet FEMA's guidelines with the necessary amount of sea level rise. The inland edge along the eastern boundary of Alameda Point will rely on protection from sea level rise in excess of 18-inches by regional flood protection measures along the perimeter of the remainder of Alameda.

In some locations, the location of the perimeter system may be shifted inland as part of the implementation of adaptive measures. This would allow for the creation of tidal wetlands as part of the Project's response to climate change.

A funding mechanism will need to be established to generate long term funding from the Alameda Point residents and businesses to monitor sea level rise and implement the phased construction of the adaptive flood protection measures to meet future projections. This mechanism may be GHAD. The funding and financing mechanisms will be evaluated as part of future development and financing discussions for Alameda Point.

See Figure 12 through Figure 14 depicting the future flood protection system and how the adaptive measures will be implemented for future sea level rise in excess of 18-inches.

b. Stormwater System

The proposed stormwater system at Alameda Point can continue to collect and convey the required design storms regardless of the amount of future sea level rise. For those watersheds that do not include pump stations with the initial flood protection system, the adaptive measures will include the construction of a pump station, such that all watersheds within Alameda Point have pump stations as part of the stormwater collection systems. The pump stations will ensure stormwater discharge to the surrounding waters in extreme tides and with any amount of sea level rise.

8. Sea Level Rise Monitoring Program

An on-going sea level rise monitoring and financing program will be established for Alameda Point. This program may be managed through a GHAD. It will be administered through the City of Alameda and funded through the residents and businesses at Alameda Point. The program will review the sea level rise estimates prepared for the San Francisco Bay by the National Oceanic Atmospheric Administration, as well as other relevant publications regarding updated sea level rise estimates that are available at that time. The review will estimate when improvements to the initial flood protection system will need to be implemented, confirm that sufficient funds will be available to construct the improvements when needed, and, if necessary, accelerate the construction schedule and/or funding of improvements. Initially, it is anticipated that these reviews will be conducted every 5 years, however, more frequent reviews will occur over time, especially if new regulatory requirements are created to address sea level rise or the rate of sea level rise projections increases.

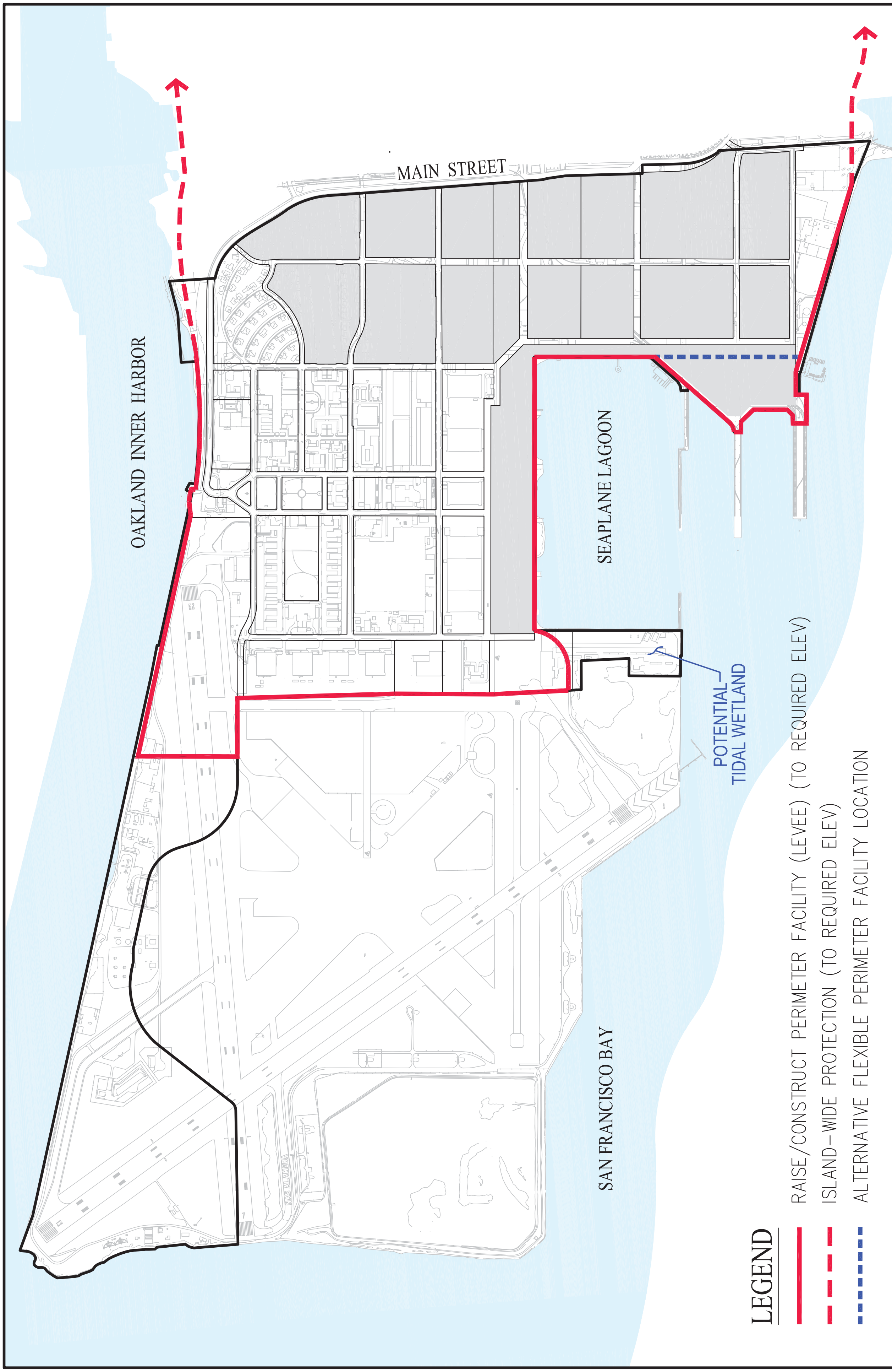

FIGURE 12
ADAPTED FLOOD PROTECTION

ALAMEDA POINT
MASTER INFRASTRUCTURE PLAN
CITY OF ALAMEDA ALAMEDA COUNTY CALIFORNIA
DATE: OCTOBER, 2013 SCALE: 1" = 1,500'
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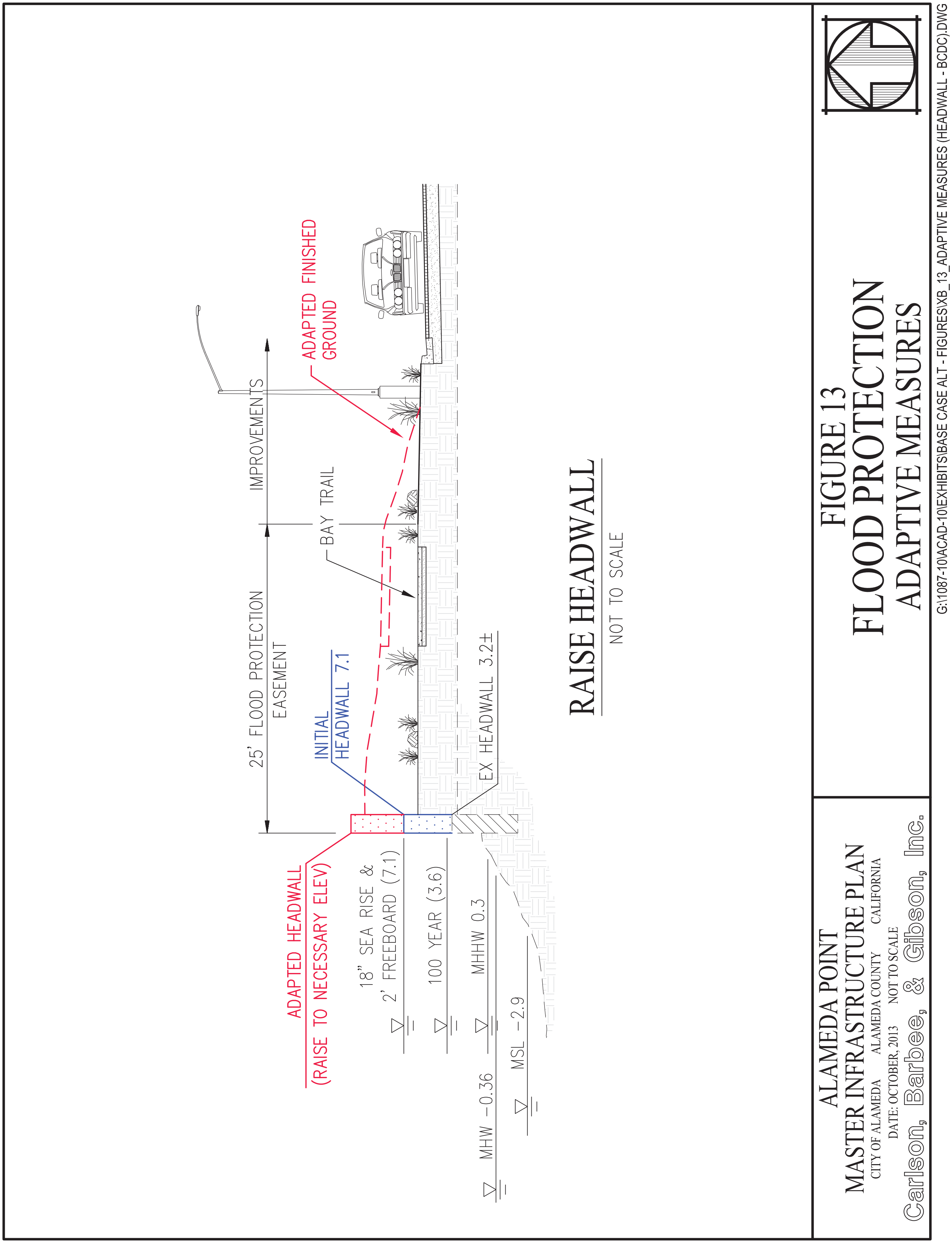

ADAPTED FINISHED GROUND
IMPROVEMENTS
BAY TRAIL
25' FLOOD PROTECTION EASEMENT
INITIAL HEADWALL 7.1
EX HEADWALL 3.2±
ADAPTED HEADWALL (RAISE TO NECESSARY ELEV)
18" SEA RISE & 2' FREEBOARD (7.1)
100 YEAR (3.6)
MHHW 0.3
MHW -0.36
MSL -2.9
RAISE HEADWALL
NOT TO SCALE
FIGURE 13
FLOOD PROTECTION
ADAPTIVE MEASURES
ALAMEDA POINT
MASTER INFRASTRUCTURE PLAN
CITY OF ALAMEDA ALAMEDA COUNTY CALIFORNIA
DATE: OCTOBER, 2013 NOT TO SCALE
Carlson, Barbee, & Gibson, Inc.
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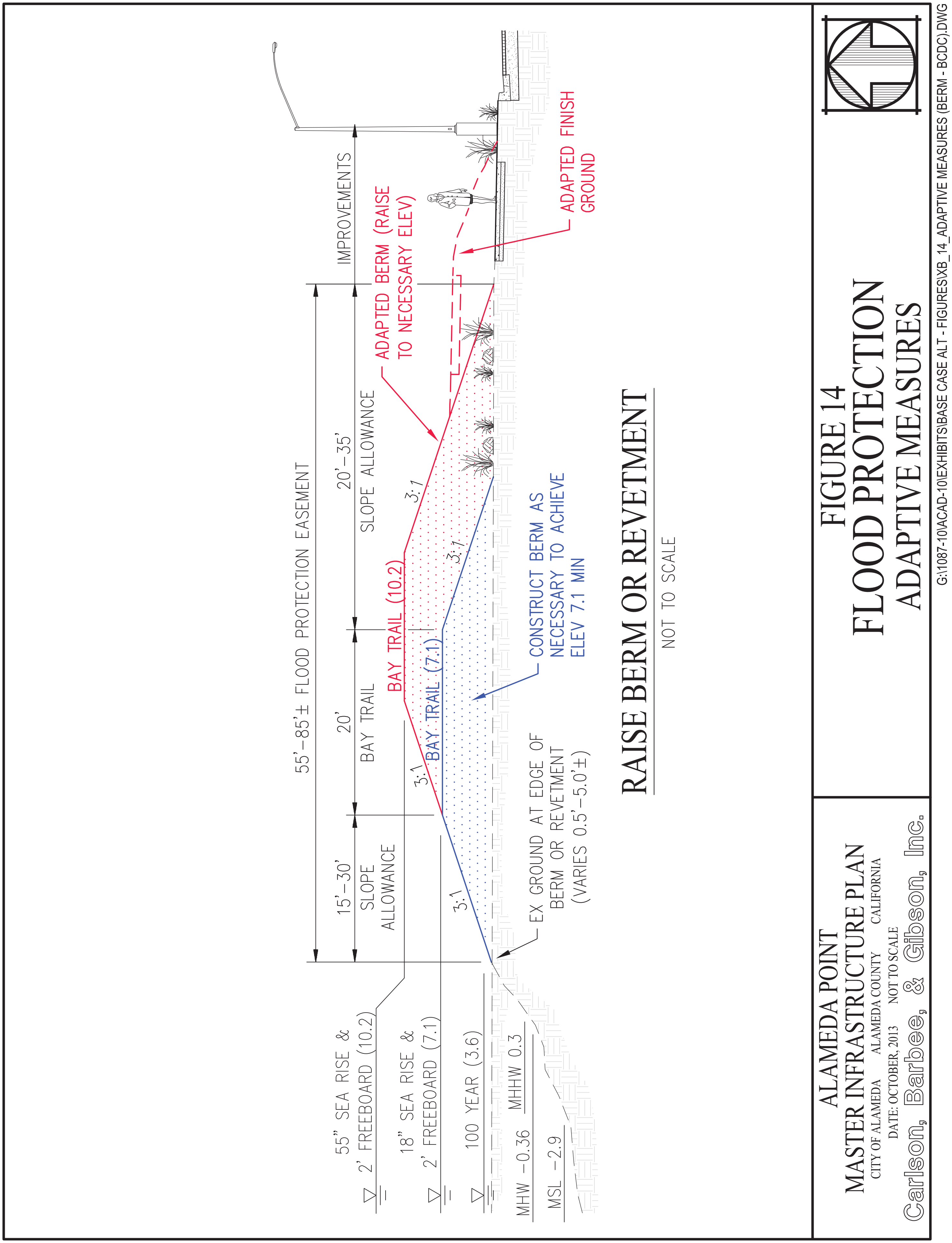

55" SEA RISE &
2' FREEBOARD (10.2)
18" SEA RISE &
2' FREEBOARD (7.1)
100 YEAR (3.6)
MHHW 0.3
MHW -0.36
MSL -2.9
55'-85'± FLOOD PROTECTION EASEMENT
15'-30'
SLOPE ALLOWANCE
20'
BAY TRAIL
20'-35'
SLOPE ALLOWANCE
IMPROVEMENTS
3:1
3:1
3:1
3:1
BAY TRAIL (10.2)
BAY TRAIL (7.1)
ADAPTED BERM (RAISE TO NECESSARY ELEV)
ADAPTED FINISH GROUND
CONSTRUCT BERM AS NECESSARY TO ACHIEVE ELEV 7.1 MIN
EX GROUND AT EDGE OF BERM OR REVETMENT (VARIES 0.5'-5.0'±)
RAISE BERM OR REVETMENT
NOT TO SCALE
ALAMEDA POINT
MASTER INFRASTRUCTURE PLAN
CITY OF ALAMEDA
ALAMEDA COUNTY
CALIFORNIA
DATE: OCTOBER, 2013
NOT TO SCALE
Carlson, Barbee, & Gibson, Inc.
FIGURE 14
FLOOD PROTECTION
ADAPTIVE MEASURES
G:\1087-10\ACAD-10\EXHIBITS\BASE CASE ALT - FIGURES\XB_14_ADAPTIVE MEASURES (BERM - BCDC).DWG

9. FEMA Floodplain

Initially, the existing areas of potential inundation within Alameda Point will need to be mapped and adopted by FEMA. As previously stated, this process is currently underway through FEMA's California Coastal Analysis and Mapping Project. At the time that design of flood protection measures is being completed, a Conditional Letter of Map Revision (CLOMR) shall be processed and approved by FEMA. The CLOMR will demonstrate FEMA's concurrence that design of the flood protection measures will remove the proposed development areas from the flood zones. Once the flood protection measures have been constructed, a field survey can be completed to document the as-built elevations of these facilities. This information will be used to process a final Letter of Map Revisions (LOMR). Once the LOMR is approved by FEMA, the FIRM panel will be revised to depict the constructed flood protection measures and remove the protected areas from the floodplain. The CLOMR and LOMR can be prepared and processed in phases with the development phasing.

10. Earthwork Quantities

The site grading activities will include the geotechnical corrective measures to stabilize the site and site grading to achieve minimum elevations described above. The estimated earthwork quantities of these activities is approximately 25,000 cubic yards of cut and 1,800,000 cubic yards of fill. Therefore, it is estimated that approximately 1,775,000 cubic yards of import material will be required in order to complete the necessary site grading including a surcharge operation discussed in SectionIV.B.2.c. The import materials may be either trucked or barged to the Project Site, depending on available sources. See Figure 15 depicting the areas where fill material is required in order to achieve the minimum elevations specified in the site grading design criteria. This does not include the fill material that may be required for the Bay Trail outside of the Development and Reuse Areas.

The geotechnical corrective measures and site grading will be phased with the development phasing. The surcharge operation will likely include additional sub-phases in order to optimize and minimize the amount of import and export of materials for this operation.

B. Geotechnical Conditions

1. Subsurface Conditions

The subsurface conditions at Alameda Point generally consist of artificial fill of varying thickness. Young Bay Mud exists beneath the fill in the portions of the site to the north of the Seaplane Lagoon with the greatest thickness of approximately 130 feet. Merritt Sand and the San Antonio formation sand exist directly beneath the fill in the southeastern portion of the site, approximately 60 to 70 feet in thickness, and dipping beneath the Young Bay Mud to the north and the west. Yerba Buena Mud, also commonly called Old Bay Mud, lies beneath the San Antonio formation.

Due to site elevations and proximity to the San Francisco Bay, the site has relatively shallow groundwater. Based on historic groundwater measurements, the groundwater is approximately 4 to 6 feet below existing grade of the site.

Much of the existing fill and some of the Merritt Sand deposits are potentially liquefiable. The Young Bay Mud deposits are highly compressible under loads associated with fill and buildings. The Young Bay Mud is also soft, typically leading to relatively low stability of cuts and slopes as well as low bearing capacity.


OAKLAND INNER HARBOR
SEAPLANE LAGOON
MAIN STREET
LEGEND
0'–1' PROPOSED FILL
1'–2' PROPOSED FILL
2'+ PROPOSED FILL
ALAMEDA POINT
MASTER INFRASTRUCTURE PLAN
CITY OF ALAMEDA ALAMEDA COUNTY CALIFORNIA
DATE: OCTOBER, 2013 SCALE: 1" = 1,000'
Carlson, Barbee, & Gibson, Inc.
FIGURE 15
FILL AREAS MAP
G:\1087-10\ACAD-10\EXHIBITS\BASE CASE ALT - FIGURES\X9_15_FILL AREAS MAP.DWG

2. Geotechnical Considerations

The main geotechnical considerations for Alameda Point are commonly encountered at waterfront development sites throughout the Bay Area. The considerations include:

- Shoreline Slope Stability
- Liquefaction
- Compressible Soils
- Underground Utility Construction

These considerations and proposed corrective measures are discussed below. A design-level geotechnical analysis to confirm the necessary corrective measures shall be prepared as part of the design process of proposed improvements.

a. North Shoreline

i. Slope Stability

The northern shoreline of Alameda Point is adjacent to a portion of the Port of Oakland's shipping channel. The historical dredging of the shipping channel has resulted in the northern shoreline having a steep slope below the water surface, down to the bottom of the channel. In 2009, the Port of Oakland completed a project deepening and widening the Inner and Outer Harbor shipping channels. This project included deepening of the shipping channel along the northern shoreline of Alameda Point. The static slope stability and seismic performance of the northern shoreline was evaluated through the permitting process of the Port's recent project.

The Port analyzed the slope stability of various locations along the northern shoreline of Alameda Point. The locations of the cross sections the Port analyzed are shown on Figure 16. The Port's analysis concluded that the static stability of cross section I-I' was marginal and the seismic performance was poor with potential deformations at all seismic levels. The seismic performance of cross section J-J' was concluded to be good at the channel limit but poor at the shoreline. The additional cross sections adjacent to the Northwest Territories , F-F', G-G', and H-H', were found to be stable under static conditions. But, the seismic conditions were also predicted to experience deformations at these cross sections. In summary, the Port's analysis indicated that the northern shoreline was marginally stable in static conditions, but had predicted deformations to occur in seismic conditions.

As part of the MIP, additional analyses of the slope stability of cross sections I-I' and J-J' have been conducted to verify the Port's conclusions. The MIP slope stability calculations confirm that the northern shoreline slopes adjacent to the Development and Reuse Areas are marginally stable under current conditions. Any new loads from fill placement or buildings within 50 feet of the northern shoreline would likely have an impact on static slope stability. Additionally, the MIP calculations also predict deformations under seismic conditions, ranging from 6-inches to over 3-feet, which are considered seismically "unstable" under the California Geological Survey presented in Special Publication 117A (SP117A). According to these guidelines, such deformation "may be sufficient to cause serious ground cracking or enough strength loss to result in continuing (post seismic) failure."

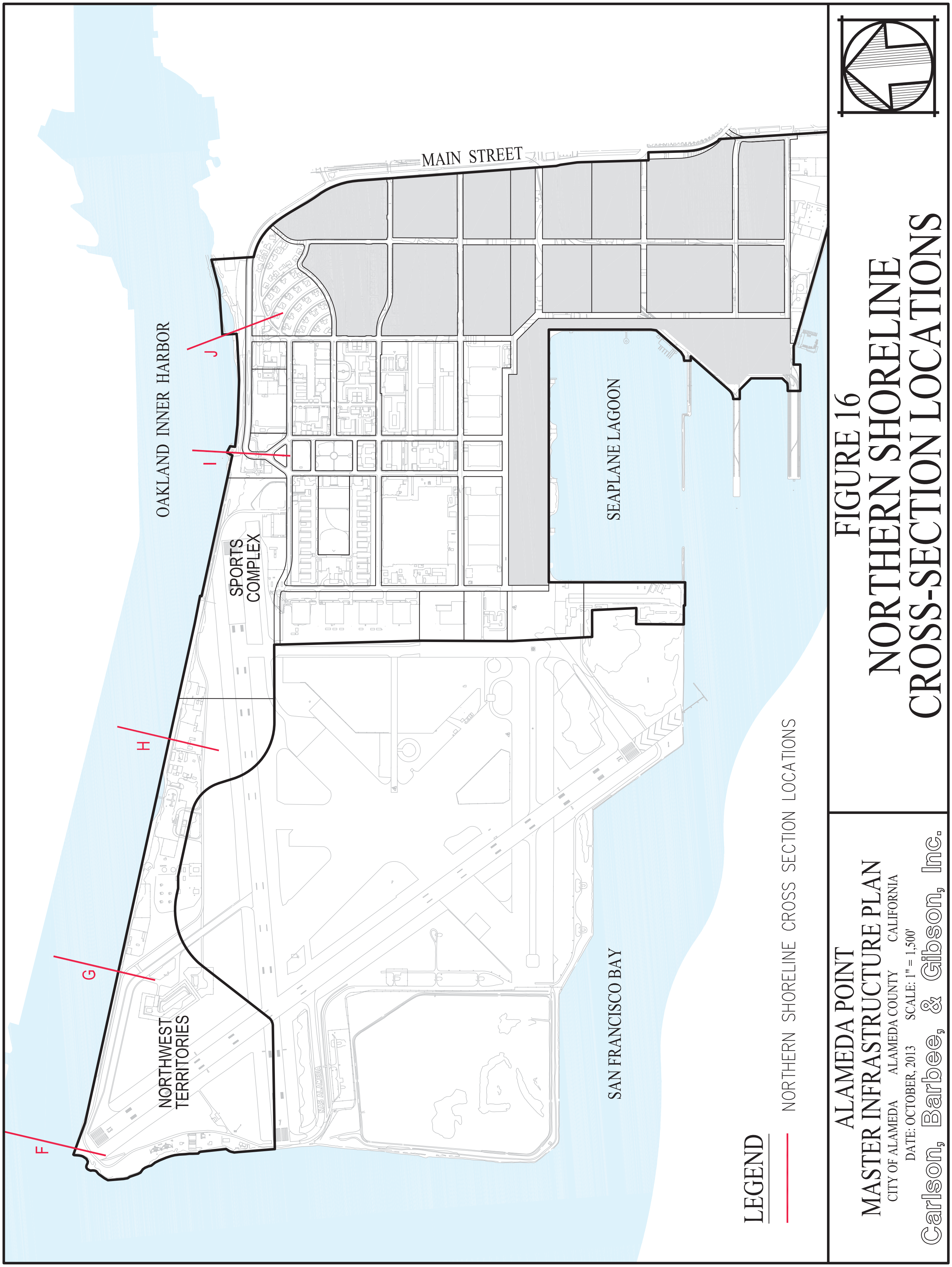


FIGURE 16
NORTHERN SHORELINE
CROSS-SECTION LOCATIONS
MAIN STREET
OAKLAND INNER HARBOR
SEAPLANE LAGOON
SPORTS COMPLEX
NORTHWEST TERRITORIES
SAN FRANCISCO BAY
J
I
H
G
F
LEGEND
NORTHERN SHORELINE CROSS SECTION LOCATIONS
ALAMEDA POINT
MASTER INFRASTRUCTURE PLAN
CITY OF ALAMEDA ALAMEDA COUNTY CALIFORNIA
DATE: OCTOBER, 2013 SCALE: 1" = 1,500'
Carlson, Barbee, & Gibson, Inc.
G:\1087-10\ACAD-10\EXHIBITS\BASE CASE ALT - FIGURES\XB_16_N SHORELINE (CROSS-SECTIONS).DWG

Deformations could extend more than 1,000-feet from the shore at cross section I-I' and approximately 200-feet at cross section J-J'. The distance of potential deformation for the portion of the northern shoreline adjacent to the Northwest Territories is approximately 200-feet.

Lateral stability issues at the shoreline are not unique to this site and are found in other sites with similar subsurface conditions along the border of the San Francisco Bay. The amount of potential displacement and potential distance from the shoreline are exacerbated by the adjacent dredge cut in the channel. The amount of displacement and distance from the shoreline can be refined as part of the project design by performing additional field exploration and soil testing along with using more advanced analytical methods, such as numerical modeling.

See Figure 17 depicting the approximate zones of deformation along the northern shoreline in seismic activities.

ii. Corrective Measures

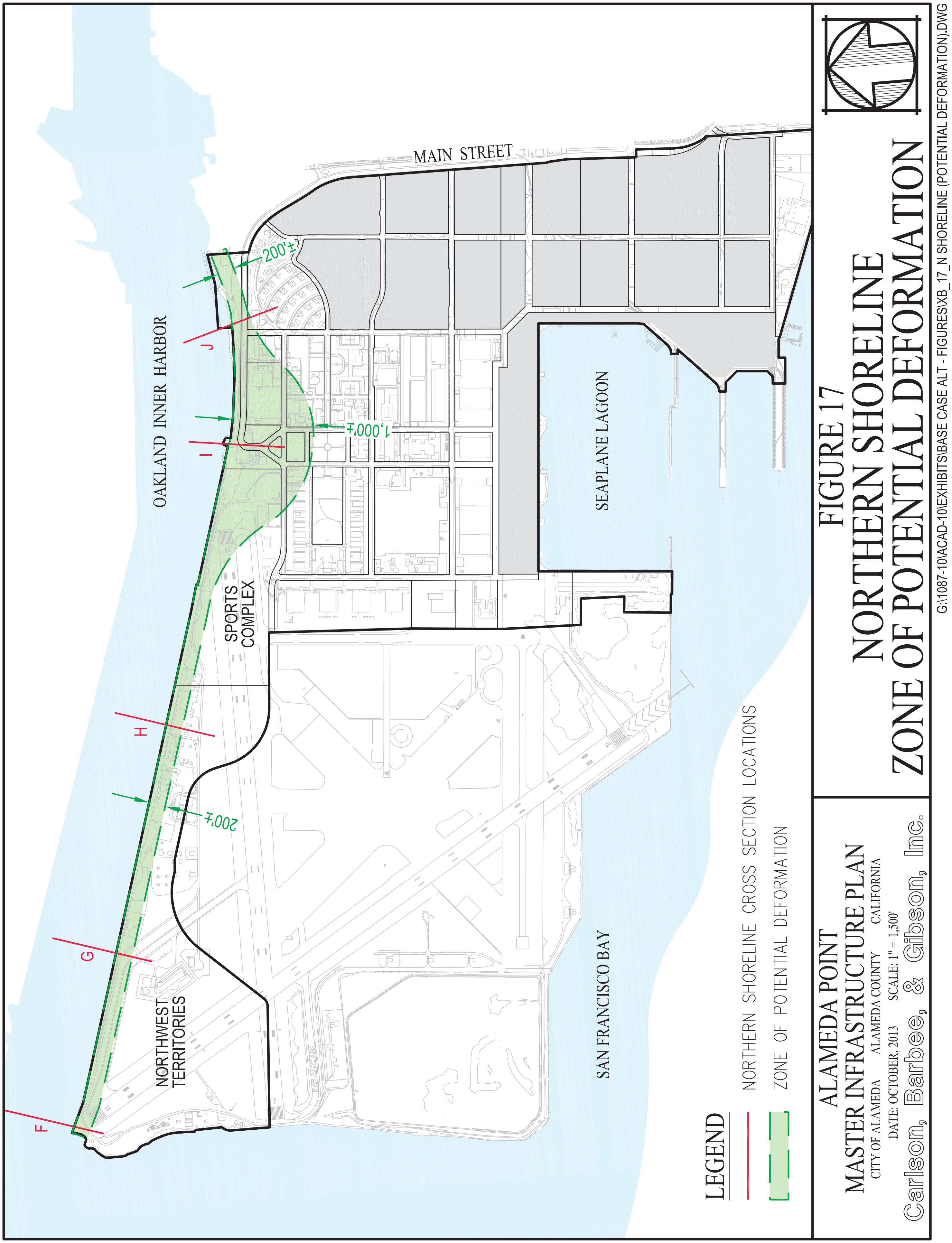
For the portion of the northern shoreline adjacent to the Reuse and Development Areas and the Sports Complex a significant setback from the shoreline is not feasible. Also, options have been evaluated to minimize the length of the northern shoreline that will be stabilized, including limiting the improvements to only adjacent to Pump Station R. However, there are multiple existing critical components of infrastructure, such as Main Street for site access, Pump Station R and the 20-inch force main, within the zone of potential deformation. Therefore, strengthening of the shoreline will be necessary in these areas to reduce the loss or damage of these facilities in a seismic event. The most cost effective shoreline stabilization measure is anticipated to be performing ground improvement such as soil/cement mixing. Because both the liquefiable fill and Young Bay Mud impact the seismic slope stability, the soil/cement mixing will need to extend about 40 feet below the ground surface to the bottom of the Young Bay Mud layer. To appropriately improve shoreline stability it is estimated that the soil treatment may need to be performed on 15 to 30 percent of the soil volume over an area between 20 to 30 feet wide. Other shoreline improvement measures, such as a levee and flood protection system could be constructed in conjunction with the improvement area. An alternative to soil/cement mixing would be construction of a structure, such as a deep bulkhead wall.

There are no corrective measures proposed for the remainder of the northern shoreline adjacent to the Northwest Territories. This area is generally planned for passive open space uses that can accommodate the potential deformations in a seismic event. Any critical or important improvements or amenities planned within the Northwest Territories shall be located outside of the zone of deformation. Otherwise, additional shoreline stability measures will be required in these areas.

b. Liquefaction

i. Liquefiable Soils

Soil liquefaction results from loss of strength during cyclic loading, such as imposed by earthquakes. The previous explorations at the site encountered sand and silty sand deposits that could potentially liquefy under seismic loading. Shallow liquefiable soil is most likely


MAIN STREET
OAKLAND INNER HARBOR
SEAPLANE LAGOON
SPORTS COMPLEX
NORTHWEST TERRITORIES
SAN FRANCISCO BAY
200'±
1,000'±
200'±
F
G
H
I
J
LEGEND
NORTHERN SHORELINE CROSS SECTION LOCATIONS
ZONE OF POTENTIAL DEFORMATION
FIGURE 17
NORTHERN SHORELINE
ZONE OF POTENTIAL DEFORMATION
ALAMEDA POINT
MASTER INFRASTRUCTURE PLAN
CITY OF ALAMEDA ALAMEDA COUNTY CALIFORNIA
DATE: OCTOBER, 2013 SCALE: 1" = 1,500'
Carlson, Barbee, & Gibson, Inc.
G:\1087-10\ACAD-10\EXHIBITS\BASE CASE ALT - FIGURES\XB_17_N SHORELINE (POTENTIAL DEFORMATION).DWG

to vent to the surface in the form of sand boils. Sand boils were observed in portions of the Naval Air Station Alameda in the 1989 Loma Prieta Earthquake.

An evaluation of liquefaction potential was performed for the Project Site. The results indicate that sand and silty sand fill material and native deposits are potentially liquefiable down to 40 feet below existing grades. These analyses also indicate that the potentially liquefiable soil could settle as much as 11 inches. A plan showing the depth of liquefiable soil material within the Project Site is provided as Figure 18.

ii. Corrective Measures

The amount of potential liquefaction settlement and lateral spreading are greater than typical structures and infrastructure can tolerate without corrective measures. Ground improvement techniques will likely be necessary to reduce the liquefaction potential of the sandy deposits at the Project Site to levels that improvements can be designed to tolerate. Liquefiable soil can be addressed by either dynamic impact/vibration to densify the soil or mixing with cement to create zones of non-liquefiable soil. The success of dynamic impact methods depends on the fines content of the sand and the depth of the liquefiable material. The following are 4 methods of corrective measures that may be implemented to address liquefiable soils (See detailed descriptions of each of these measures in Appendix A):

- Deep Dynamic Compaction (DDC)
- Rapid Impact Compaction (RIC)
- Vibratory Replacement
- Soil / Cement Mixing

In the Development Areas, DDC will be the most applicable and cost effective liquefaction mitigation method. DDC results in relatively large noise and vibration impacts, so a buffer zone of up to 100 feet will be necessary from any existing structures to minimize impacts. Inside this buffer zone, other ground improvement methods such as rapid impact compaction, vibratory replacement or soil/cement mixing will be implemented.

In the Reuse Areas, liquefaction mitigation measures will be constrained by existing structures and utilities. Ground improvement techniques are not possible for existing buildings; therefore, potential liquefaction induced settlement must be mitigated structurally. Where new utilities are to be installed, RIC could be used to densify the top 15- feet of liquefiable material, and the utilities could be designed to withstand settlement up to 8-inches and differential settlement up to 4-inches. Alternatively, vibratory replacement or soil/cement mixing could be used in these areas to reduce settlement of utilities and other improvements; total and differential settlement using these approaches would be less than using RIC. Based on typical construction costs, ground improvement using RIC will likely be the most cost efficient solution though other ground improvement methods would be more effective in decreasing potential settlement where liquefiable soil is deeper than 15-feet. Existing utilities that will remain in place can be supported by grouting underneath the utility.

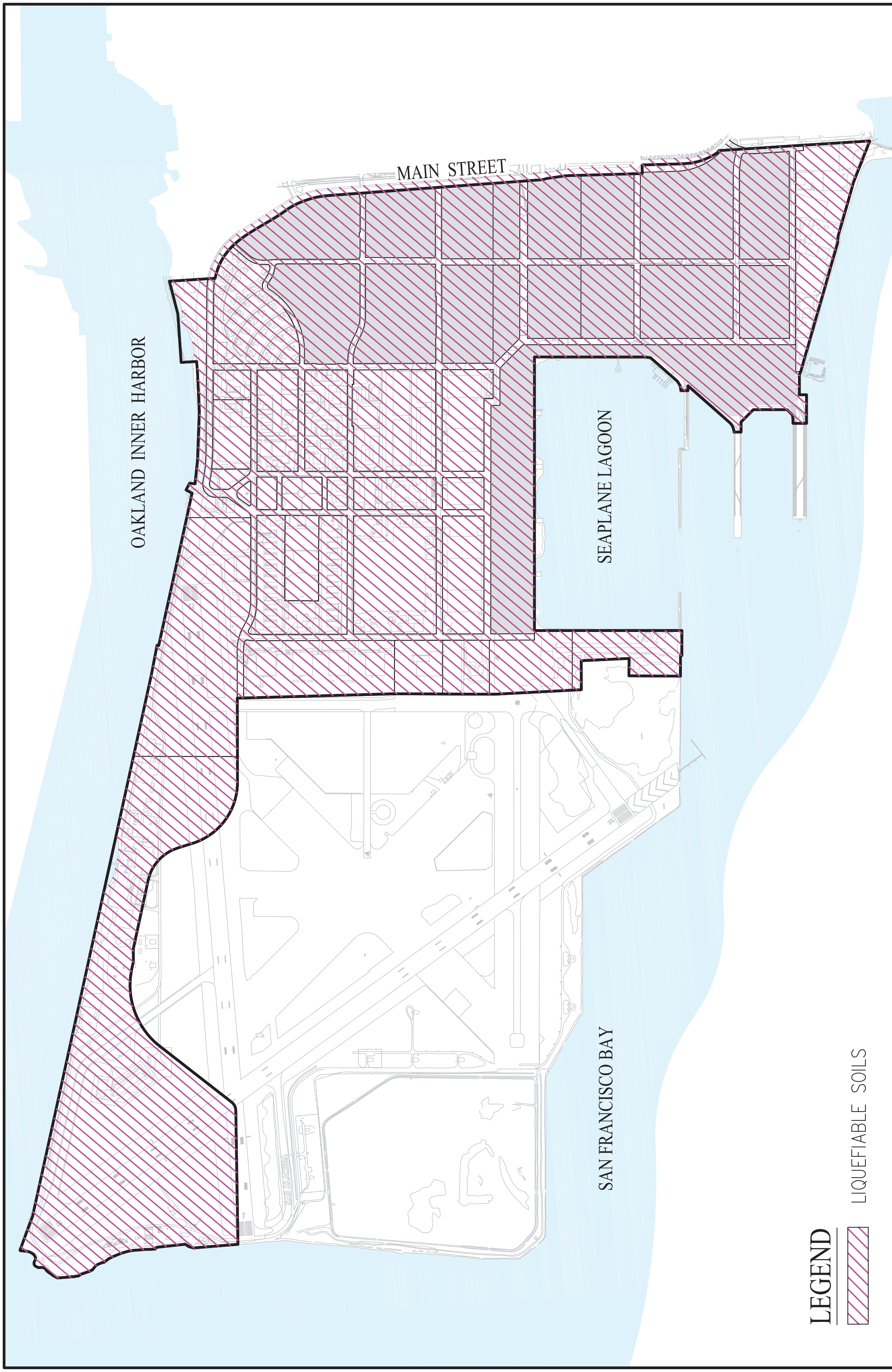


FIGURE 18
LIQUEFIABLE SOILS

ALAMEDA POINT
MASTER INFRASTRUCTURE PLAN
CITY OF ALAMEDA ALAMEDA COUNTY CALIFORNIA
DATE: OCTOBER, 2013 SCALE: 1" = 1,500'

Carlson, Barbee, & Gibson, Inc.

G:\1087-10\ACAD-10\EXHIBITS\BASE CASE ALT - FIGURES\XB_18_LIQUEFIABLE SOILS.DWG

c. Compressible Soil

i. Young Bay Mud

Soft, highly compressible Young Bay Mud deposits were encountered in the previous explorations at the Project Site. See Figure 19 depicting the depth of the base of the Young Bay Mud throughout the Project Site. The locations and thicknesses of these deposits are variable, ranging from nil to over 130-feet in thickness. The Young Bay Mud can settle due to loading from any new fill or from new structures constructed at the site. The amount of settlement is a factor of load and thickness of Young Bay Mud. Assuming the Young Bay Mud is normally consolidated, settlement can be as great a ½-foot for each foot of fill placed over the thickest areas of Young Bay Mud. While the majority of settlement from new loads will happen in the first 1 to 2 years after construction, in the areas of the thickest Young Bay Mud, settlement can continue for a period of 50 years or more.

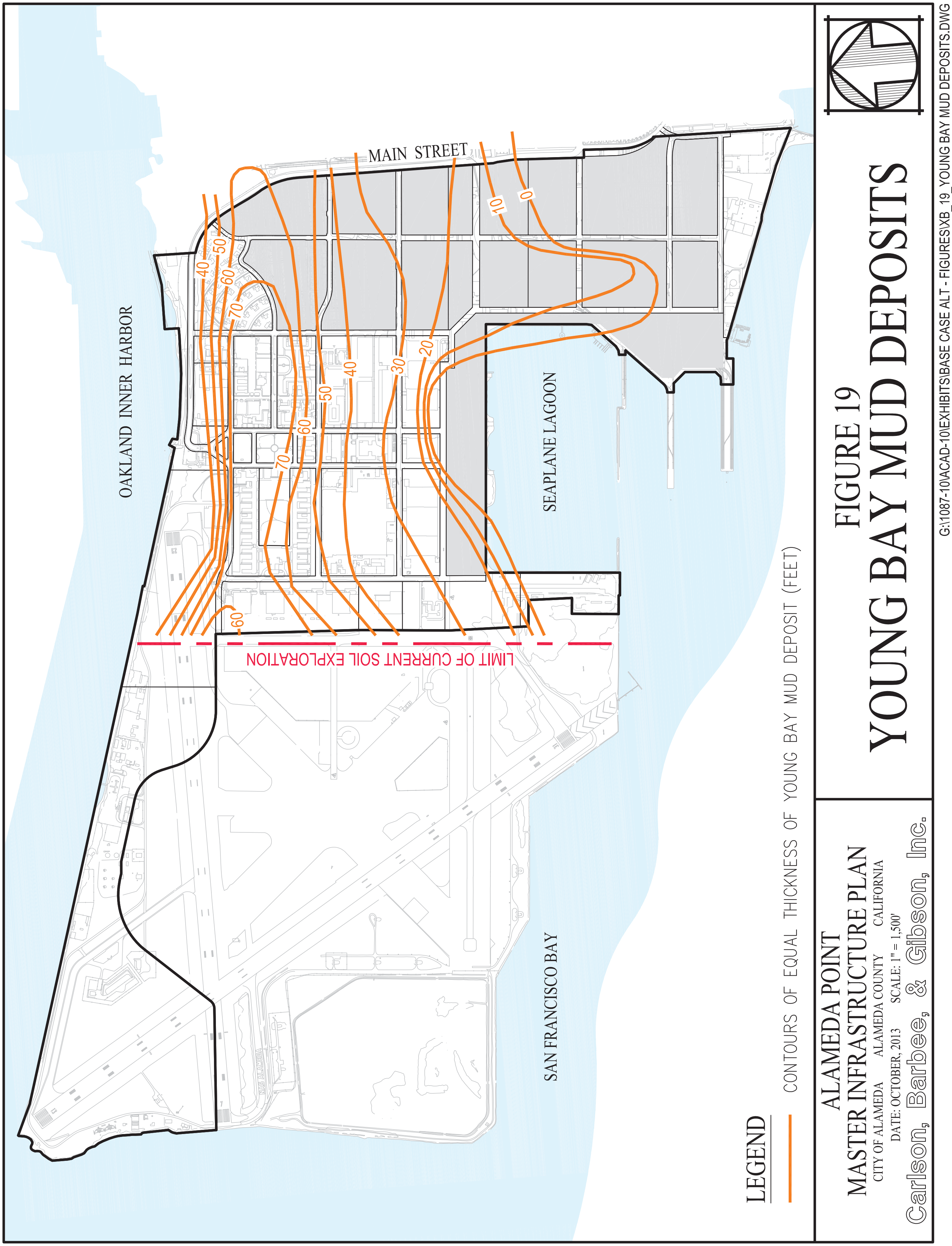
ii. Corrective Measures

Depending on the type of buildings planned at the Project Site, corrective measures of the compressible Young Bay Mud deposits may be feasible. One measure that can be used to mitigate the loading from small, relatively lightweight structures is pre-consolidation of compressible material through a surcharge program. Surcharge fill is placed above design grade elevations in areas of the site where pre-consolidation measures are necessary to reduce settlement. The surcharge fill remains in place for a period sufficient to allow the desired degree of consolidation to be achieved, such that the risk of settlement is sufficiently reduced for the planned structure. Surcharging will induce some settlement in adjacent areas; therefore, it may not be feasible to use surcharge as a compressible soil corrective measure in areas near existing structures and utilities. Likewise, surcharging of initial phases of construction should be placed wider than the footprint of the construction area so that subsequent phases of surcharge do not cause settlement of already constructed areas. Accordingly, surcharge areas of initial phases should be overbuilt by at least 20 feet laterally from the improvement area.

The amount of time necessary to effectively mitigate compressible soil through surcharge is directly related to the thickness of the compressible soil deposit. Where the Young Bay Mud is thicker than about 20 feet, it is likely that wick drains may be desired to shorten the drainage path of the compressible deposits and accelerate the surcharge program. Wick drains are small drain lines that provide a conduit for the water to escape the Young Bay Mud layer. By doing so, the voids created by the removed water accelerate the consolidation process.

The typical time frames that the surcharge fill is required to be left in place without wick drains can range from 1 to 2 years. Whereas, with the use of wick drains this time frame can be reduced to approximately 6 to 9 months.

A surcharge program is generally not efficient for structures with bearing pressures over 750 to 1,000 pounds per square foot. In these cases deep foundation systems deriving support from below the Young Bay Mud could be suitable at the Project Site. Where deep foundations are used, utilities should incorporate flexible connections as the building will not settle with the surrounding soil.


MAIN STREET
OAKLAND INNER HARBOR
SEAPLANE LAGOON
SAN FRANCISCO BAY
LIMIT OF CURRENT SOIL EXPLORATION
0
10
20
30
40
50
60
70
LEGEND
CONTOURS OF EQUAL THICKNESS OF YOUNG BAY MUD DEPOSIT (FEET)
FIGURE 19
YOUNG BAY MUD DEPOSITS
ALAMEDA POINT
MASTER INFRASTRUCTURE PLAN
CITY OF ALAMEDA ALAMEDA COUNTY CALIFORNIA
DATE: OCTOBER, 2013 SCALE: 1" = 1,500'
Carlson, Barbee, & Gibson, Inc.
G:\1087-10\ACAD-10\EXHIBITS\BASE CASE ALT - FIGURES\XB_19_YOUNG BAY MUD DEPOSITS.DWG

Outside of the building areas, additional fill from grading to raise the areas above the flooding elevations will also induce consolidation settlement of the Young Bay Mud, and other measures may be necessary to mitigate potential settlement that could adversely affect site improvements (i.e., streets, parking areas, drainage, underground utilities, concrete flatwork, etc.). The selected mitigation will partly depend on what level of risk is acceptable, and could range from:

- Acceptance of settlement risk and periodic maintenance,
- Implementation of a surcharge program to pre-consolidate the soil and Reduce long term settlements,
- Use of lightweight fill as compensation load to reduce settlement or
- Critical utilities could be supported on cement/soil mixed columns.

A surcharge program is anticipated to be implemented in the Development Areas. The surcharge will achieve the amount of pre-consolidation to reduce the risk of settlement associated with the structures and fill material planned for these areas. The surcharge program will include both the building areas, street areas and perimeter flood protection measure areas. This program is intended to eliminate the potential for long term settlement within the Development Areas. Wick drains will be implemented as part of the surcharge program for areas with Young Bay Mud thicker than 20 feet or when surcharge time frames are desired to be accelerated.

New structures proposed within the Reuse Areas will be constructed on a deep foundation system. New utilities will be designed to accommodate the anticipated remaining amount of potential long-term settlement. The design considerations for utilities within these areas include providing flexible joints and/or increased pipe slopes to maintain positive gradients for gravity pipelines should settlement occur. The perimeter flood protection measures surrounding the Reuse Areas will either be surcharged or be supported on a soil/cement mixed corridor.

d. Underground Utilities

i. Utility Trench Shoring & Bedding

Due to the soft nature of the Young Bay Mud, excavations that extend into Young Bay Mud deposits may become unstable. Installation of temporary sheet piles or the use of a shield or continuous hydraulic skeleton shoring should be anticipated for excavations that extend below a depth of about 3 to 5 feet. Additionally, increased pipeline bedding measures will be required in order to achieve a stable foundation for installing the pipeline. This may include a thickened section of base below the pipeline with fabric or other measures as recommended by a geotechnical engineer.

ii. Trench Dewatering

Shallow groundwater is expected at the site and trench excavations may encounter perched groundwater. Therefore, utility trench excavations may require temporary dewatering during construction to keep the excavation and working areas reasonably dry. In general, excavations should be dewatered such that water levels are maintained at least 2 feet below the bottom of the excavation prior to and continuously during shoring installation and the backfill process to control the tendency for the bottom of the excavation to heave under hydrostatic pressures and to reduce inflow of soil or water from beneath temporary shoring. Dewatering for underground utility construction will likely be accomplished by pumping from sumps.

Utility trenches adjacent to existing improvements should include a low permeability cutoff to reduce the risk of inadvertent groundwater flow along permeable bedding or backfill. In these areas dewatering may not be an option; therefore, a relatively impervious shoring system of tight interlocking sheet piles, or other impervious wall type, can be utilized to reduce infiltration during construction.

In addition, possibility of encountering contaminated soil and groundwater should be considered during underground construction and addressed in accordance with the SMP developed for Alameda Point.

C. Value Engineering Opportunities

A value engineering opportunity that could be implemented for the proposed flood protection measures is to minimize the length of the northern shoreline that is proposed to be stabilized to only those areas necessary to protect the critical components of infrastructure. These areas to be stabilized would be from Pump Station R, near Main Gate, and easterly along Main Street to protect the 20-inch force main and site access. The portion of the northern shoreline adjacent to the Sports Complex where the potential zone of deformation is only 200-foot wide could be maintained in its existing condition and not stabilized. The proposed perimeter flood protection measures would be setback from the zone of potential deformation, approximately 200-feet from the shoreline. Areas exterior to the perimeter flood protection measure will be subject to flooding in high tidal events or with future sea level rise. The improvements of these exterior areas would be passive landscaping that could be converted to tidal wetlands if future sea level rise inundates these areas. Effectively, this would reduce the active areas of the Sports Complex from 44 acres to approximately 25 to 30 acres. Assuming that the length of the Northern Shoreline Stabilization is decreased by 1,500 feet, the backbone infrastructure construction costs would be reduced by approximately $5.5 million.