Sea Change Burlingame Proposed Sea Level Rise Adaptation Strategies

October 16, 2019









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- Adaptation Strategies
- Screening Criteria
- Next Steps



Overview







Over 400 volunteers at Bayfront Clean-Up September 21, 2019



Strategy Selection Process





Takeaways

- Burlingame's shoreline is at risk from SLR, particularly starting at 100-year/ 1% flood
- 2. Burlingame will need to decide what to protect and to what level
- 3. Adaptation strategies recommended for Burlingame include raising levees at low points, managing creeks and sediment, and maintaining seawalls
- Next steps include evaluating the adaptation strategies through a decision-making framework



Adaptation Solutions for Burlingame





- Process description (reports used, scenarios analyzed)
- Flow paths
- Map for existing base flood conditions
- Map for mid-level SLR



- Planning Documents:
 - SeaChange San Mateo County Study
 - The City of Burlingame General Plan
 - Stanford Study of Economic and Social Impacts
- Flood Predictions: FEMA
- Flood Predictions + Sea Level Rise:
 - Our Coast Our Future (OCOF)
 - Adapting to Rising Tides (ART)
- **'Ground-Truthing':** Discussions with stakeholders and city engineering and planning staff.

ESA 5 years

SeaChange San Mateo County Study







Maximum Monthly Water Levels, San Francisco

ESA







Source: OPC (2018)

YEARS



Present & Projected Bay Water Levels

		Water Level (ft NAVD88)			
Scenario	Scenario/Source	MHHW ⁴	1-year flood	10-year flood	100-year flood
Present-Day	AECOM (2016)	7	8	9	10
3.3 feet of SLR by 2100	'Medium' SLR scenario applied by County of San Mateo et al. 2018	10	11	12	13
6.6 feet of SLR by 2100	'High' SLR scenario applied by County of San Mateo et al. 2018	13	15	16	17



- Existing Base Flood (1% Annual Chance Flood) Maps
- 'Medium' SLR Scenario: 3.3 feet of SLR + 1% Annual Chance Flood
- 'High' SLR Scenario: 3.3 feet of SLR + 1% Annual Chance Flood

Approach

- No single source has all the information we need
- Used different tools to get:
 - Flood pathways
 - Flood extents and depths
 - Expected frequency of major floods

Compare to vulnerable asset locations



1% Annual Chance Flood

Western Burlingame



- 1% annual chance flood ('Base Flood') is roughly same as MHHW + 3.5 feet
- Overtopping at Bay shoreline, Hwy 101, and spilling along creeks

Eastern Burlingame



- 1% annual chance flood ('Base Flood') is roughly same as MHHW + 3.5 feet
- Overtopping at Bay shoreline, Hwy 101, and spilling along creeks
- Overtopping along east shore of Burlingame Lagoon

ESAFEMA SFHA Map 2019 – Role of Waves on BaseImage: Description of the second second



Flood Hazard Zones

1% Annual Chance Flood Hazard

0.2% Annual Chance Flood Hazard

Political Jurisdictions

Levees

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Flood Pathways: Western Burlingame



0"-24" of SLR

 Limited flooding from levee overtopping at Bay shoreline

24"-36" of SLR:

- Overtopping at Bay shoreline
- High tide backing up creeks
- Banks spilling along El Portal, Easton, Mills Creeks

36+" of SLR:

 Add'l overtopping over Highway 101

Flood Pathways: Eastern Burlingame

0"-24" of SLR: Limited flooding from levee overtopping at Bay shoreline



Source: ART

- 36" to 72" of SLR: •
 - Overtopping along east shore of Burlingame Lagoon
 - Flooding from San Mateo enters Eastern Burlingame
 - Potential overtopping at Hwy 101 and Caltrain



Depth of Flooding: 1% Annual Chance Flood + 3.3' of SLR





- 1% Annual Chance Flood expected to flood:
 - Hwy 101 and adjacent neighborhoods, west of Broadway
 - Areas adjacent to Burlingame Lagoon
- 1% Annual Chance Flood + 3.3' SLR expected to expand flood area to portion of Caltrain tracks
- Bay shoreline and Creek levees are the most likely pathway for flood waters
- Results suggest significant flooding could occur at less than 100-year (1% annual chance) flood event





Vision

 An inclusive, transparent process for the selection of SLR adaptation strategies which solicits and includes feedback from all stakeholders







Goals

- Protect people and buildings from flooding
- Provide recreational opportunities in the project area



 Provide continued access to businesses for employees and patrons



 Educate stakeholders about how to prepare and react in the event of a flood





Approaches to Adaptation

INTERVENTION OPTIONS

ACCOMMODATE



CCC SLR Guidance



Approaches to Adaptation

Accommodate



Protect - Engineered



Protect - Natural



Protect - Realignment





Definitions

- Embankment: An earthen bank built to provide flood protection
- Floodwall: A concrete or vinyl wall erected to provide flood protection
- Horizontal Levee: A levee built at a gradual slope to provide habitat and recreation benefits in addition to flood protection
- Mean Higher High Water (MHHW): A tidal datum that is the average of the higher of the two high water heights of each tidal day



Study Goals & Objectives

<u>Goal</u>

 Develop an implementable sea-level rise adaptation plan for City of Burlingame shoreline and residents

Objectives

- Assess baseline flood risk that includes future sea-level rise projections
- Develop reasonable & feasible sea level rise adaptations appropriate to Burlingame's setting
- Evaluate range of adaptation measures to inform the selection of recommended measures
- Integrate recommended measures into phased adaptation plan to guide implementation



Developing Adaptation Approaches

Vulnerability Study

Understand the Flood Risks

Incorporate Studies

- existing flood maps
- future SLR flood maps
- ground-truthing of known trouble spots with City and stakeholders
- regional and ongoing studies

Find Specific Flood Information

- sources of flooding
- pathways of spreading
- total extents
- total depths
- frequency
- types of infrastructure that would be impacted



Developing Adaptation Approaches

Look for Regional Solutions

- Look at Burlingame as series of reaches
- For each reach, hone in on key sources of flooding
- Consider community/stakeholder inputs
 - Outreach meetings
 - Incorporate previous planning efforts (OLUs and Countywide study
- Consider ways to use hybrid green/grey methods
- Consider ways to tie into neighboring efforts: Foster City, SFO, San Mateo

Find Opportunities to Address Flooding

Develop and Present Approaches

Towards A Flood Management Plan





Raise Levees



Source: USACE (2000)

Install Sheet Pile Floodwalls





Tide Gates and Active Barriers

Palo Alto Flood Basin









Operational Landscape Units for Shoreline Adaptation

Legend

CONDITIONS SUITABLE FOR*:





Updates Since July Meeting

Conceptual Approaches Reviewed and Refined

- For each reach, conceptual alternatives screened
- Considered
 - Flood Management
 - Economics
 - Environmental Impact
 - Governance Issues
 - General Plan Policies

Burlingame Shoreline Reaches

ESA



Reach 1 – Existing Shoreline Section



ESA
SourceReach 1Coordinate with County and City ofSan Francisco Bay

Millbrae to perform study of combined

appropriate adaptation measures along

runoff and high tide design flood

elevation along El Portal Creek

El Portal Creek/Canal

Coordinate with City of Millbrae on

Coordinate with City of Millbrae on

Hwy 1 and Bayshore crossings

placing tide gate and pump station at

- Raise low-lying portions of the levee & Bay Trail to 13' NAVD88
- Where space allows, reduce slope and vegetate Bay side of levee

Ground Surface Elevation (feet NAVD88)



Maintain-enhance concrete flood wall in areas where room for levee raising is currently limited

Consider placing seepage-cutoff along old Bayshore Rd

Feet



Reach 1 Strategies – Criteria Screening

		Raise Shoreline		Address Flooding on El Portal Canal		Seepage	
	Implications of Strategy	Raise to 11 ft NAVD88	Raise to 13 ft NAVD88	Install tide gate	Raise canal levees	barrier along Bayshore Rd	
Flood Mgmt	Flood Hazard	-Removes most of Reach 1 from 100- year floodplain -At risk to 100-	-Removes most of Reach 1 from 100- year floodplain -At risk to 100-	-Limit flooding upstream of Hwy 101	Limit flooding upstream of	Potential to limit groundwater inundation of	
		year flood with 1 ft SLR (c. 2035- 2075)	year flood with 3 ft SLR (c. 2075- 2150)	-Less effective as SLR increases	Hwy 101	low-laying areas with SLR	
	Engineering competence for erosion, geotechnical, and seismic	High	High	Med	High	Med	
	Parcel-to-reach scalability	High	Med	High	Med	High	
	Adaptive capacity to sea-level rise	Med	High	Low	Med	High	
Economic	Potential to reduce the risk of asset damages	High	High	Med	High	Low	
	Protection for econ. vulnerable groups working or living in the project area	Med	High	Med	Med	Low	
	Protection for public infrastructure in the project area (e.g. wastewater mains)	High	High	Med	Med	Med	
	Cost	\$\$\$	\$\$\$\$	\$\$\$	\$\$\$	\$\$\$	
Environmental	Does strategy protect existing habitat?	Yes	Yes	No	Yes	Yes	
	Does strategy create new habitat?	No	No	No	No	No	
Governance	Does this provide benefits beyond the project area?	Yes	Yes	Yes	Yes	Yes	
	Ease of implementation using existing authorities or policies?	Med	Med	Low	Med	High	
General Plan Considerations	Aesthetics: protects views to the waterfront	Med	Med	Low	Low	No Effect	
	Recreation: encourages walking and biking	High	High	No Effect	Low	No Effect	







24

10 3

100

Reach 2

	San Francisco Bay	Ground Surface Elevation (feet NAVD88)
Consider installing tide gate & pump station at Mills, Easton Creek crossings	Maintain-enhance concrete flood wall in areas where room for levee asing is currently limited • Raise low-lying portions of the evee/Bay Trail • Where space allows, reduce slope and vegetate Bay side of evee	Ground Surrace Elevation (reet NAVD88) Streams 6.01 - 7 14.01 - 15 Streets 7.01 - 8 15.01 - 16 0.24 - 1 8.01 - 9 16.01 - 17 1.01 - 2 9.01 - 10 17.01 - 18 2.01 - 3 10.01 - 11 18.01 - 19 3.01 - 4 11.01 - 12 19.01 - 20 4.01 - 5 12.01 - 13 Pump Stn 5.01 - 6 13.01 - 14
Consider raising banks of Mills and Easton Creeks based on findings of County study of combined watershed runoff and Bay flooding	Case of the second seco	actions upstream on Easton and Mills at would increase sediment delivery to the oport Bay front mudflats otential for creating beach fronting levee



Reach 2 Strategies – Criteria Screening

		Raise Shoreline		Address Flooding on Mills and Easton Creeks		Environmental Approaches	
	Implications of Strategy		Raise to 14 ft NAVD88	Install tide gates	Raise canal levees	Bay Beach fronting levee	Improve Creek Sediment Delivery
Flood Management	Flood Hazard	-Removes most of Reach 2 from 100- year floodplain -At risk to 100-year flood with 1 ft SLR (c. 2035-2075)	-Removes most of Reach 2 from 100- year floodplain -At risk to 100-year flood with 3 ft SLR (c. 2075-2150)	-Limit flooding upstream of Hwy 101 -Less effective as SLR increases	Limit flooding upstream of Hwy 101	Potential to limit wave runup on shoreline levee	Limited impact
	Engineering competence for erosion, geotechnical, and seismic	High	High	Med	High	Low	Low
	Parcel-to-reach scalability	High	Med	High	Med	High	Med
	Adaptive capacity to sea-level rise	Med	High	Low	Med	Med	Med
	Potential to reduce the risk of asset damages	High	High	Med	High	Low	No Effect
	Protection for econ. vulnerable groups working or living in the project area	Med	High	Med	Med	Low	No Effect
Economic	Protection for public infrastructure in the project area (e.g. wastewater mains)	High	High	Med	Med	Low	No Effect
	Cost	\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$
	Does strategy protect existing habitat?	Yes	Yes	No	Yes	No	Yes
Environmental	Does strategy create new habitat?	No	No	No	No	Yes	No
Governance	Does this provide benefits beyond the project area?	Yes	Yes	Yes	Yes	No	No
	Ease of implementation using existing authorities or policies?	Med	Med	Low	Med	Low	Med
General Plan Considerations	Aesthetics: protects views to the waterfront	Med	Med	Low	Low	High	No Effect
	Recreation: encourages walking and biking	High	High	No Effect	Low	High	No Effect
	Impacts to water recreation and ferry service	Low	Low	No Effect	No Effect	Low	Low









Reach 3 Strategies – Criteria Screening

		Raise Anza Lagoon Shoreline		Environmental Approaches	
	Implications of Strategy	Raise to 11 ft NAVD88	Raise to 13 ft NAVD88	Bay Beach fronting levee	Consider more in-depth assessment of wastewater treatment plant (WWTP)
Flood Management	Flood Hazard	-Removes most of Reach 3 from 100- year floodplain -At risk to 100-year flood with 1 ft SLR (c. 2035-2075)	-Removes most of Reach 3 from 100- year floodplain -At risk to 100-year flood with 3 ft SLR (c. 2075-2150)	Potential to limit wave runup on shoreline levee	Flood protection studies should take place to explore ways of providing add'l protection for WWTP. This should include wastewater mains
	Engineering competence for erosion, geotechnical, and seismic	High	High	Low	
	Parcel-to-reach scalability	High	Med	High	
	Adaptive capacity to sea-level rise	Med	High	Med	
Economic	Potential to reduce the risk of asset damages	High	High	Low	Yes
	Protection for econ. vulnerable groups working or living in the project area	Med	High	Low	
	Protection for public infrastructure in the project area (e.g. wastewater mains)	High	High	Low	Yes
	Cost	\$\$	\$\$\$	\$\$\$\$	\$
Environmental	Does strategy protect existing habitat?	Yes	Yes	No	
	Does strategy create new habitat?	No	No	Yes	
Governance	Does this provide benefits beyond the project area?	Yes	Yes	No	Yes
	Ease of implementation using existing authorities or policies?	Med	Med	Low	
General Plan Considerations	Aesthetics: protects views to the waterfront	Med	Med	High	
	Recreation: encourages walking and biking	High	High	High	
	Impacts to water recreation and ferry service	Low	Low	Low	









Reach 4 Strategies – Criteria Screening

		Raise SI	horeline	Environmental Approaches	
	Implications of Strategy	Raise to 11 ft NAVD88	Raise to 13 ft NAVD88	Living Shoreline Enhancements on west shore of Burlingame Lagoon	Improve Sanchez Creek Sediment Delivery
Flood Management	Flood Hazard	-Removes most of Reach 4 from 100- year floodplain -At risk to 100-year flood with 1 ft SLR (c. 2035-2075)	-Removes most of Reach 4 from 100- year floodplain -At risk to 100-year flood with 3 ft SLR (c. 2075-2150)	Potential to limit wave runup on shoreline levee protecting Hwy 101	Limited potential to limit wave runup on shoreline levee protecting Hwy 101
	Engineering competence for erosion, geotechnical, and seismic	High	High	Med	Low
	Parcel-to-reach scalability	High	Med	High	Med
	Adaptive capacity to sea-level rise	Med	High	High	Med
	Potential to reduce the risk of asset damages	High	High	Low/Med	No Effect
	Protection for econ. vulnerable groups working or living in the project area	Med	High	Low	No Effect
Economic	Protection for public infrastructure in the project area (e.g. wastewater mains)	High	High	Low	No Effect
	Cost	\$\$\$	\$\$\$\$	\$\$\$	\$\$\$
Environmental	Does strategy protect existing habitat?	Yes	Yes	Yes	Yes
	Does strategy create new habitat?	No	No	Yes	No
Governance	Does this provide benefits beyond the project area?	Yes	Yes	Yes	No
	Ease of implementation using existing authorities or policies?	Med	Med	Med	Med
General Plan Considerations	Aesthetics: protects views to the waterfront	Med	Med	High	No Effect
	Recreation: encourages walking and biking	High	High	High	No Effect
	Impacts to water recreation and ferry service	No Effect	No Effect	No Effect	Low







Reach 5 Strategies – Criteria Screening

		Rai	Environmental Approaches	
	Implications of Strategy	Raise to 12 ft NAVD88	Raise to 14 ft NAVD88	Consider Creating Bay Beach that ties into western edge of Coyote Point Beach
Flood Management	Flood Hazard	-Removes most of Reach 5 from 100- year floodplain -At risk to 100-year flood with 1 ft SLR (c. 2035-2075)	-Removes most of Reach 5 from 100-year floodplain -At risk to 100-year flood with 3 ft SLR (c. 2075-2150)	Potential to limit wave runup on shoreline levee protecting Hwy 101 and Airport Drive
	Engineering competence for erosion, geotechnical, and seismic	High	High	Med
	Parcel-to-reach scalability	High	Med	Med
	Adaptive capacity to sea-level rise	Med	High	Med
Economic	Potential to reduce the risk of asset damages	High	High	No Effect
	Protection for econ. vulnerable groups working or living in the project area	Med	High	No Effect
	Protection for public infrastructure in the project area (e.g. wastewater mains)	High	High	No Effect
	Cost	\$\$\$	\$\$\$\$	\$\$
Environmontal	Does strategy protect existing habitat?	Yes	Yes	Yes
Environmental	Does strategy create new habitat?	No	No	Yes
Governance	Does this provide benefits beyond the project area?	Yes	Yes	No
	Ease of implementation using existing authorities or policies?	Med	Med	Low
	Aesthetics: protects views to the waterfront	Med Med		High
General Plan Considerations	Recreation: encourages walking and biking	High	High	High
	Impacts to water recreation and ferry service	Low	Low	Low

- Raising the shoreline in Reaches 1 and 2 (from Millbrae boundary to Broadway Ave) would have substantial benefits
- In the short-term, raising the shoreline will likely require a combination of raising or building new levees and improving existing flood walls
- aesthetic and recreational impacts of raising the shoreline can be mitigated by integrating the Bay Trail on the improved shoreline.
- Raising the shoreline should be combined with a similar effort raising low-lying portions of the banks of El Portal, Mills, and Easton Creeks
- Just offshore along parts of Reaches 2, 3, and 5, there are opportunities to create or enhance Bay habitats (e.g. 'living shorelines'). Where feasible, they should be combined with an improved flood barrier system along the shoreline.

Included in Final

Included in Final

Included in Final

Reach Specific Questions

- For each reach, do you see any other opportunities or challenges in the study area as well that have not been identified?
- Are there any evaluation criteria answers that you'd like more information on? Do they provide a full enough picture of the adaptation strategies?

General Adaptation Questions

- What coordination with Burlingame's neighbors is needed for the City's adaptation strategy?
- Which next steps do you see as priorities?
- What additional information would you like to see to adequately evaluate these strategies?

Discussion Questions

General Adaptation Questions

- What coordination with Burlingame's neighbors is needed for the City's adaptation strategy? What water levels are you planning to?
- Which next steps do you see as priorities?
- What additional information would you like to see to adequately evaluate and endorse these strategies?

- Incorporate stakeholder feedback on conceptual measures
- Develop a "Next Steps" memo to highlight knowledge gaps to get to implementation

• Next Steps include recommendations for:

- Cost-Benefit Study
- Feasibility Study
- Fluvial-Bay Interaction Study

Thank you