BELVEDERE

Community Profile: Belvedere

Belvedere is a unique shoreline community, because it used to be an island before fill was used to create the lagoon, or flats, neighborhood. The primary impacts here are to housing. In the near-term, 24 acres could be exposed to sea level rise. By the long-term, 169 acres could be exposed to sea level rise and 180 acres could be exposed with an additional 100-year storm surge. Key sea level rise vulnerabilities include:

- San Rafael Avenue could be impacted after the medium-term, cutting off the first access point to the community.
- Shoreline homes along West Shore and Beach Roads could expect impacts to utilities in the near and medium-terms, and potential structural impacts to any in water structures during storms, especially in the long-term.
- Homes in the flats would be vulnerable to sea level rise flooding if the levees are overtopped. Note that the homes on the lagoon could also flood, however the model may overestimate the flooding intensity. These homes are also vulnerable to worsening subsidence.
- The Belvedere Corp Yard could be vulnerable to storm surge flooding in the near-term and tidal flooding in the long-term.
- The City Hall, Community Center, and Police Department share the same buildings that could expect impacts in the long-term, especially during storms. The park facility and roads fronting the building could expect flood waters sooner, creating potential access issues.

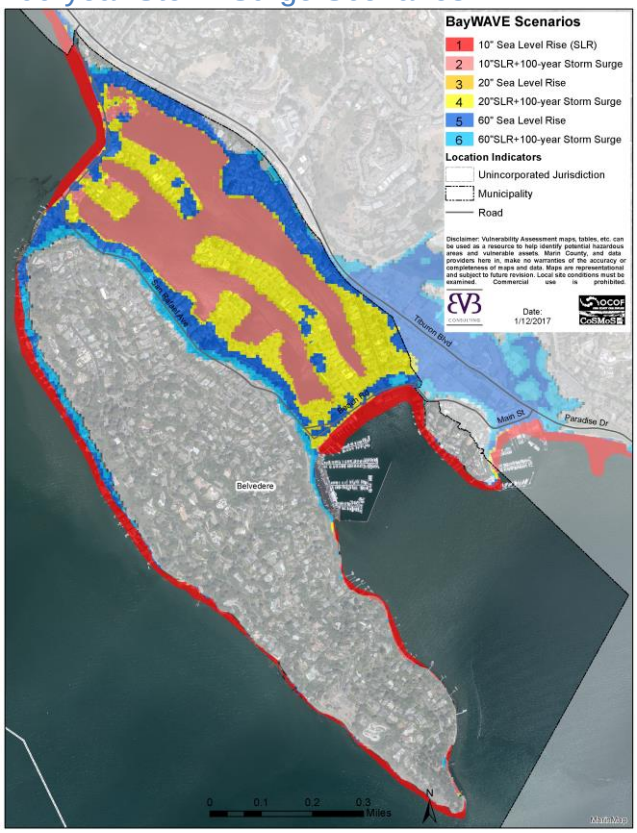
Vulnerable Assets

The assets most vulnerable to sea level rise and storm surges in Belvedere are single-family residential homes and San Rafael Avenue. With respect to the impacts to lagoon side homes, it is important to note that the CoSMoS model treats the tide gate closing the lagoon from incoming tide waters as open. This assumption may overestimate flooding levels and prematurely estimate onset of flooding. The following sections detail these vulnerabilities.

IMPACTS AT-A-GLANCE: SCENARIO 6

550 living units	2,000+ people
180 acres exposed	4 commercial parcels
3.7 miles of roads	
Seasonal storm flooding already occurs	
$8.6 million in assessed property; $1.4 billion in single-family housing market value[177]	Property Owners City of Belvedere

Map 63. Belvedere Sea Level Rise and 100-year Storm Surge Scenarios



Source: MarinMap, CoSMoS. Credit: BVB Consulting LLC

[177] 2016 dollars

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Belvedere Lagoon homes. Credit: Wiki Commons

Table 66. Belvedere Exposed Acres

Scenarios		Acres	
		#	%
Near-term	1	24	2
	2	85	6
Medium-term	3	24	2
	4	130	9
Long-term	5	169	12
	6	180	12

Source: MarinMap, CoSMoS

Table 67. Belvedere Vulnerable Parcels

Scenarios		Parcels	
		#	%
Near-term	1	51	5
	2	56	6
Medium-term	3	52	5
	4	210	21
Long-term	5	356	36
	6	495	50

Source: MarinMap, CoSMoS

Land

Belvedere was an island until it was connected to Tiburon with fill on bay mud. Because of this several homes in the lagoon neighborhood could be vulnerable to subsidence and several have sunk below mean sea level. Much of this area is protected from the Bay by a levee wall on the north and a wall with tides gates to the south. The tide gates allow water into a central lagoon. Note that the CoSMoS model treats these gates open, when city engineers have the ability to close the gates to reduce tidal influences on the internal lagoon.

Acres

Belvedere is essentially two hill side and top neighborhoods and a lagoon neighborhood. The first acreages claimed by tidal waters are those along the bluff side of Belvedere Island. In time, the lagoon area and the area extending into Tiburon could face tidal and storm surge flooding.

In near-term scenario 1, two percent, or 24 acres of Belvedere could face tidal flooding at MHHW. Flooded acreage could more than triple with the onset of a 100-year storm surge. The same acreage could be vulnerable in the medium-term as the near-term due to sea level rise alone. A 100-year storm surge could impact almost ten percent of the acre sin Belvedere. In long-term scenario 5 and 6, less than 200 acres, or 12 percent of Belvedere could be vulnerable to sea level rise and a 100-year storm surge, including the entire lagoon neighborhood.

Parcels

This land area is divided into parcels. Most parcels in the community are residential in use; however, a few commercial and public parcels are also vulnerable. As shown in Table 67, in the near-term, 51 water's edge parcels on Belvedere and Corinthian Islands could be vulnerable to sea level rise, as are a few on the southern end of the Belvedere lagoon. A significant jump in parcels could flood in the medium-term with a 100-year storm surge, when levee protecting the lagoon neighborhood are overtopped. In long-term scenario 5, sea levels are high enough at mean higher high water to over top the levee walls and flood most of the lagoon area, amounting to more than 30 percent of the parcels there. With a 100-year storm nearly every parcel in low-lying Belvedere could flood, accounting for a striking half of all parcels in the community.

BELVEDERE

Table 68 shows that over 30 percent of residential and commercial parcels in Belvedere could be vulnerable to sea level rise. The majority of these properties are in the low lying lagoon area. Thirty percent of residential parcels would be a considerable loss of over 300 parcels. Most of these parcels are single family residential. Some multi-family parcels could be vulnerable as well.

Table 68. Belvedere Vulnerable Residential and Commercial Parcels

Land Use	Scenarios					
	Near-term		Medium-term		Long-term	
	1		3		5	
	#	%	#	%	#	%
Residential	46	5	47	5	324	37
Commercial					4	33

Source: MarinMap, CoSMoS

Table 69. Belvedere Vulnerable Parcels by Land Use

Land Use	Scenarios					
	1		3		5	
	Near-term		Medium-term		Long-term	
	#	Ac.	#	Ac.	#	Ac.
Commercial Improved					4	3
Common Area					10	64
Exemption Improved					2	0.4
Residential	46	10	47	10	324	70
Multi-Family Improved	3	2	3	2	14	12
Single Family Attached					4	0.1
Single Family Improved	40	8	41	8	303	57
Single Family Unimproved	3	0.3	3	0.4	3	0.5
Tax Exempt	5	1	5	1	16	3

Source: MarinMap, CoSMoS

Buildings

The most vulnerable buildings are in the flats, or lagoon area, and those directly above the bay on the bluff edge on West Shore Road and Beach Road. Some may extend over the water on piers or feature overhanging decks. According to Belvedere managers, some of these homes have vents and other utility lines under the homes that could be vulnerable to increased saltwater exposure. In the low-lying areas, homes in the area could be vulnerable in the medium to long-term time horizon if the levees are overtopped and the lagoon is left under tidal influence. Even if the lagoon is managed well enough to keep those homes bordering it dry, these homes may become isolated if tidewaters overtop the levees lining San Rafael Avenue and Beach Road, or Tiburon's downtown streets. Looking at the CoSMoS model interactive map, the levees surrounding the lagoon area are topped at 3 feet of sea level rise, though significant impacts could occur between scenarios 3 and 5. In the lagoon area, many of the original homes were, or are being, replaced with newer construction.

In addition, the city corporation yard is vulnerable in the medium-term to low levels of flooding and over one foot of flooding at MHHW in the long-term. The remaining community center, police department, and city hall, which share a building, could expect impacts during storms to the surrounding property, face access issues in the medium-term, and flood with up to four feet of tide waters by scenario 5.

As seen in Table 70, in the near-term, 32 buildings could be compromised. The number of buildings impacted by 20 inches of sea level rise doubles, and nearly three times as many are impacted by the 100-year storm surge in scenarios 2 and 4. In the long-term, from sea level rise alone, around 400 buildings could be vulnerable to sea level rise.[178] Table 71 divides the vulnerable buildings by flood depth in one-foot intervals, showing how many buildings could flood with one, two, or ten feet of salt water at MHHW. A 100-year storm surge would add 1 to 3 feet of water.

[178] The CoSMoS model may over predict flooding in the lagoon system. The model treats the lagoon as tidal, when, in fact, the lagoon water levels are managed through tide gates for seasonal water fluctuations.

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Table 70. Belvedere Vulnerable Buildings

Scenarios		Buildings	
		#	%
Near-term	1	32	2
	2	84	5
Medium-term	3	65	4
	4	90	5
Long-term	5	423	24
	6	470	27

Source: MarinMap, CoSMoS

Table 71. Belvedere Tidal MHHW Flood Depth* Estimates for Vulnerable Buildings

Flood Depth (feet)	Scenarios		
	Near-term	Medium-term	Long-term
	1	3	5
0.1-1	10	6	8
1.1-2	14	16	31
2.1-3	13	14	65
3.1-4	5	10	52
4.1-5	3	2	89
5.1-6	2	3	124
6.1-7		1	46
7.1-8			5
8.1-9			1
9.1-10			1

**Flood depth data is not available for all exposed assets.*
Source: MarinMap, CoSMoS

Table 72. Belvedere Vulnerable Buildings FEMA Hazus Damage Cost Estimates in Long-term Scenario 6

Buildings Scenario 6	470
Yellow Tag-Minor Damage **$5,000 minimum**	$2,350,000
Orange Tag: Moderate Damage **$17,001 minimum**	$7,990,470
Red Tag-Destroyed **Assessed structural value**	$356,209,805

Source: MarinMap, CoSMoS
**2016 dollars*

In near-term scenario 1, of the buildings with an associated flood depth, ten buildings could expect 1 foot of flooding. If a building is elevated from the ground by more than this amount the floor boards of the building may remain dry, however, any equipment, and the property in general, would be wet and could be damaged on a regular basis. Thirty buildings could face flood levels of over one to three feet, and an addition al ten could experience up to six feet of flood water. In the medium-term, most buildings could flood with more than 1 foot to three feet of salt water, with 20 buildings experiencing flooding deeper than three feet up to seven feet. In long-term scenario 5, flooding could exceed seven feet and reach up to 10 feet at MHHW. Roughly 300 buildings could expect saltwater flooding over three feet up to seven feet. About 100 buildings could anticipate less than three feet of saltwater flooding at MHHW. Tidal flooding at these levels may require a dramatic shift in use and design is use of the properties is still desired moving forward.

Applying the FEMA post-storm damage tagging levels described in the Buildings Profile reveals that minor damage to all of the buildings flooded in scenario 6, the worst case scenario, could add to $8 million.[179,180] If total destruction were to occur for each building vulnerable to five feet of sea level rise and a 100-year storm, over $356 million in assessed building value[181,182] could be lost in a storm. Reality will likely reflect a mix of these damage levels. These figures are summarized in Table 72.

If sea level rise occurs at these levels much a Belvedere's lagoon area could be lost to sea. This would also present major complications for those who travel through the lagoon neighborhood on San Rafael Avenue to get to their homes or jobs on Belvedere Island. The maps on the following pages illustrate vulnerable buildings by scenario. The areas in the call out circles enable the reader the see areas that are difficult to see on the large scale map. The circles do not indicate that these areas are more vulnerable than others along the shoreline.

179 ArcGIS. FEMA Modeling Task Force (MOTF)-Superstorm Sandy Impact Analysis. Last update June 22, 2015. http://www.arcgis.com/home/item.html?id=307dd522499d4a44a33d7296a5da5ea0
180 2016 dollars
181 Market value is typically higher than assessed value.
182 2016 dollars

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Map 64. Belvedere Vulnerable Buildings

Vulnerable Assets

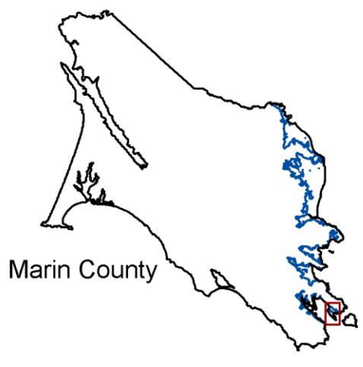
- City Hall
- Fire Station
- Post Office

Vulnerable Buildings

- Scen. 1: 10" Sea Level Rise (SLR)
- Scen. 2: 10" SLR+Storm Surge
- Scen. 3: 20" Sea Level Rise
- Scen. 4: 20"SLR+Storm Surge
- Scen 5: 60" Sea Level Rise
- Scen. 6: 60"SLR+Storm Surge

Location Indicators

- Unincorporated
- Municipality
- Road
- Inland Extent: Sea Level @ 60"+100-year Storm



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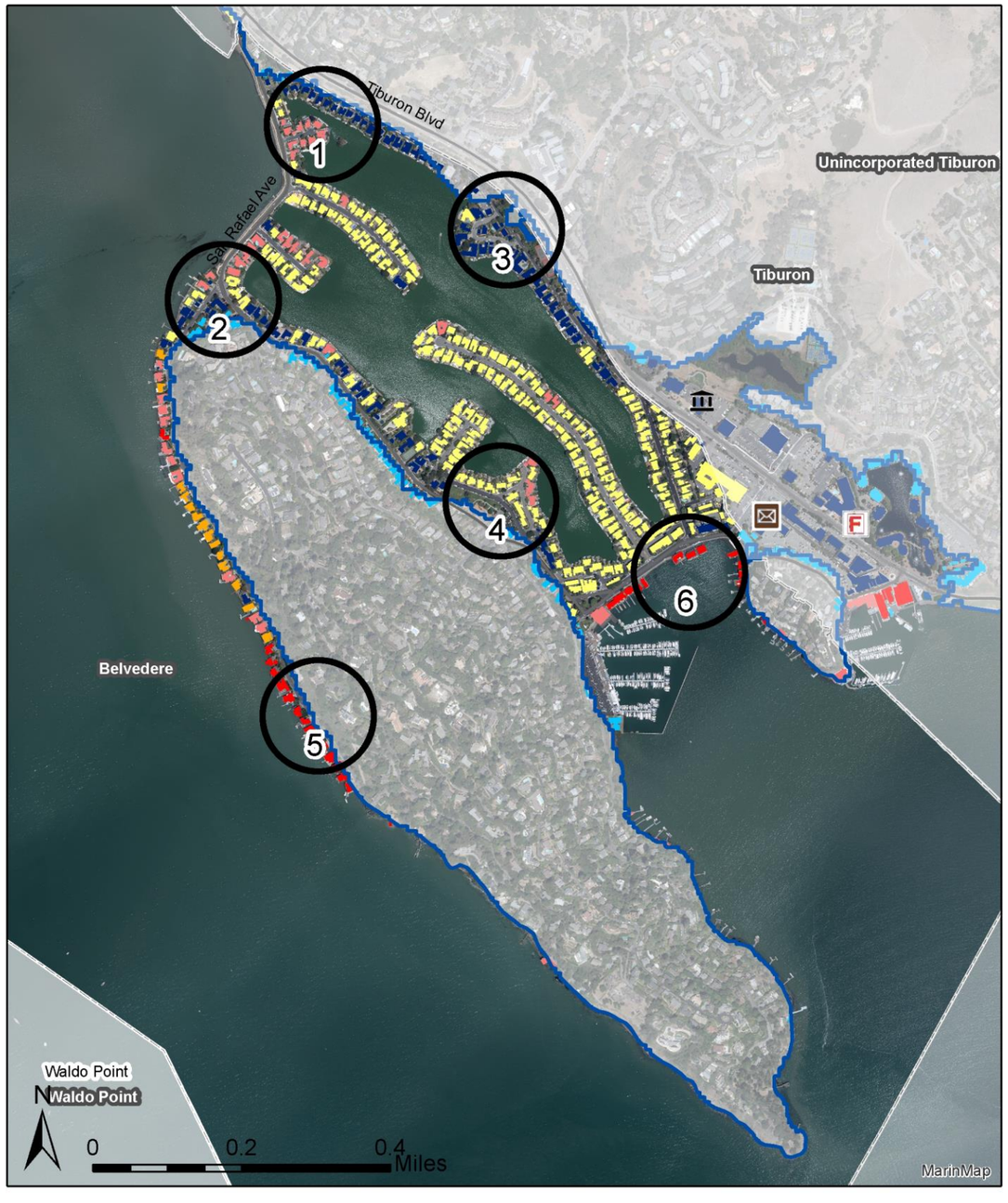
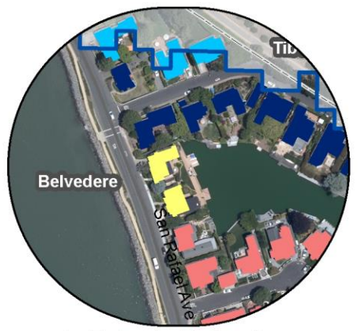
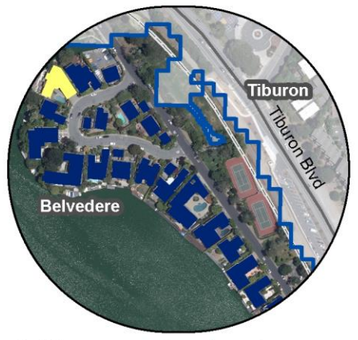


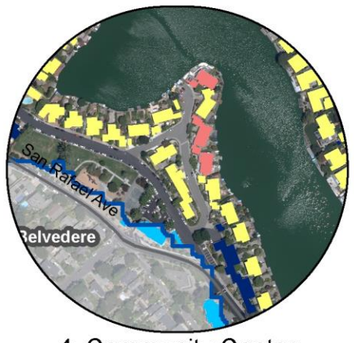


1: Entry to Belvedere

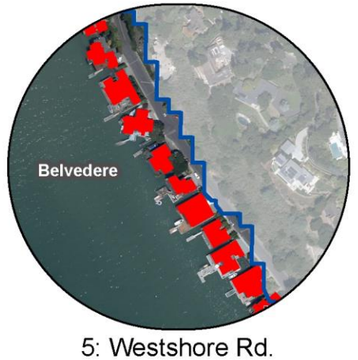
2: San Rafael Ave. @ Westshore Rd.



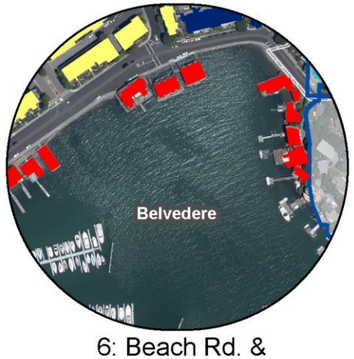
3: Homes on Eastern Lagoon



4: Community Center & Park



5: Westshore Rd.



6: Beach Rd. & Corinthian Hill

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

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Transportation

The primary access road to Belvedere, San Rafael Avenue, is vulnerable to overland flooding after three feet of sea level rise. The levee lining the shoreline here may protect the avenue from sea level rise for a couple decades; however, when combined with storm surges, the armoring could be compromised sooner. The lagoon area roads may experience increasing subsidence issues in addition to, and even before, flooding. In time, several additional roads in the lagoon area could be impacted by high tides on a regular basis. If the low lying roads are compromised, people who live in the homes on Belvedere Island could become isolated or prevented through travel for several hours several days a month.

Table 73 lists roads and trails that could be vulnerable to sea level rise and a 100-year storm surge. Golden Gate Transit route 8 along Beach Road, and along its route connecting to Belvedere, could experience service reductions during high tides and/or a 100-year storm at the following stops:

- Beach Rd. and San Rafael Ave, and
- Beach Rd. and Juanita Ln.

If public transportation gets cut off because roads are inundated, people who travel through or to the area for work would be cut off. Similarly, people with mobility or health constraints will be affected.

Water transportation for recreational purposes is a major use of the San Francisco Yacht Club Marina off Belvedere Island. As sea level rises, the facility may need to make some adjustments or relocate. Several private piers and docks could also be damaged in storms and/or may need to be elevated.

The maps on the following pages illustrate vulnerable transportation features. The areas in the call out circles enable the reader the see areas that are difficult to see on the large scale map. The circles do not indicate that these areas are more vulnerable than others along the shoreline.

San Francisco Yacht Club facing Corinthian Hill in Belvedere. Credit: F .Higgins

Table 73. Belvedere Roads Vulnerable to Sea Level Rise and a 100-year Storm Surge

Near-term		Medium-term		Long-term	
Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**	**Scenario 6**
None	**0.1** miles	**None**	**1.5** miles	**3** miles	**4** miles
	San Rafael Ave [L] Hilarita Cir [L] Edgewater Rd [L]		Roads in Scenario 2 Barn Rd [P] Beach Rd [L] Community Rd Cove Rd [L] Cove Road Pl [L] Leeward Rd [L] Mallard Rd [P] Peninsula Rd [L] Teal Rd [P] Windward Rd [L]	Roads in scenarios 2 and 4 Embarcadero Dr [P] Lagoon Rd [L] Maybridge Rd [L] West Shore Rd [L]	Roads in scenarios 2, 4, and 5 Bellevue Ave [L] Golden Gate Ave [L]

M = Marin County; C = State of California; L = Local Municipality; P = Private.
Source: MarinMap, CoSMoS

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Map 65. Belvedere Vulnerable Transportation Assets

Vulnerable Assets

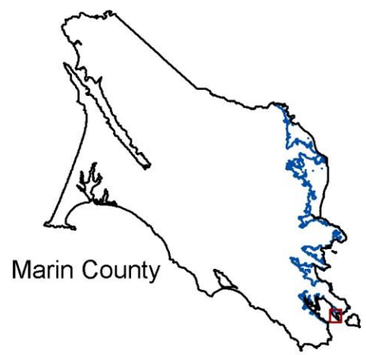
- Bike path
- Bay Trail
- GGT Bus Stop
- Marina
- Ferry

Vulnerable Roads

- @10" Sea Level Rise (SLR)
- @10"SLR+ 100-year Storm Surge
- @20" Sea Level Rise
- @20"SLR+ 100-year Storm Surge
- @60" Sea Level Rise
- @60"SLR+ 100-year Storm Surge

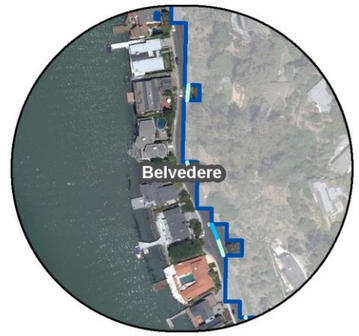
Location Indicators

- Unincorporated
- Municipality
- Road
- Inland Extent: Sea Level @ 60"+100-year Storm

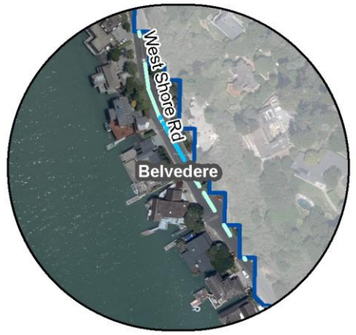


1: San Rafael Ave.

2: San Rafael Ave. @ Westshore Rd.



3: Upper Westshore Rd.



4: Lower Westshore Rd.

5: Beach Rd. @ San Rafael Ave.

6: Beach Rd.

Date: 1/15/2017

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

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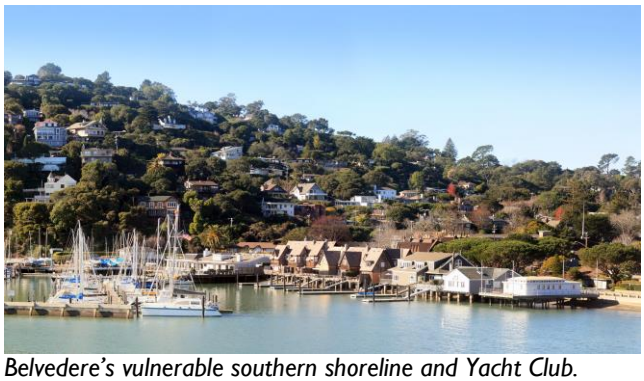


Belvedere's vulnerable southern shoreline and Yacht Club. Credit: WikiMedia

Utilities
Primary concerns include those common to other communities in the study area such as:

- Underground pipes face compounding pressure forces from water and the road,
- Road erosion and collapse with underlain pipes,
- Saltwater inflow and infiltration causing inefficiencies in wastewater treatment,
- Continuously subsiding soils or fill, and
- Escalating activity, capacity demands, energy consumption, and wear and tear on pump stations in stormwater and wastewater systems,
- Aging individual site connections for water, sewer, and electrical, and
- Flood waters interrupting access for employees to reach work sites.

Natural Resources
Much of Belvedere is developed with housing and boating facilities. Nevertheless, the Belvedere lagoon and Corinthian Bay provide ample bird and marine life habitat.

Just off the shores of Belvedere Island is a relatively large patch of eelgrass that serves as critical shallower water habitat. Eelgrass beds are recognized by both federal and state agencies as sensitive and highly valuable habitat for a suite of species. They are managed under the Magnuson-Stevens Fishery Conservation and Management Act. Eelgrass beds are listed as a Habitat Area of Particular Concern because they are susceptible to degradation, especially ecologically important, and/or located in an environmentally stressed area. As mean low tide rises, creating deeper waters in the bay, these plants could be denied the sunlight required to generate energy and sustain them. The loss of eelgrass beds would have significant ripple effects on other species in the Bay eco-system. Eelgrass beds are much larger and closer to shore than the mapped habitats on Map 69.

The longfin smelt is the only listed species recorded in this area. The smelt is list as threated on the California species list and a candidate for the federal list. The San Pablo Song sparrow, though not listed, is unique to the area, and has potential habitat in the vulnerable area.

Recreation
Access to the water could be compromised at the yacht club and private residential facilities. Trails around and leading to the area could also be compromised by flooding and erosion. Finally the Belvedere Community Center and Park could be vulnerable to sea level rise alone in the long-term, especially if the tide gates managing the lagoon water level fail.

Cultural Resources
Vulnerable resources: *1 California Register of Historic Places site, 4 additional locally registered historic sites*
Scenarios: All
Flood Depths: 6''- 3'2'' + 100-year storm surge
Primary Building Materials: Wood

Belvedere was first settled in the late 19th century as a fishing community, and incorporated in 1896.[183] Vulnerable historic resources in Belvedere include:

- Properties on Beach Road, along the northwest edge of Belvedere Cove are exposed, including several in the near term. A handful of these properties were designed by well-known architect Albert Farr including the Farr cottages/Farr apartments and the Belvedere Land Company. Additionally the China Cabin lies along this vulnerable waterfront stretch. This saloon was once housed by the S.S. China, built in 1866 to carry passengers from San Francisco to Asia, though the rest of the ship was burned for scrap metal.[184]
- The Belvedere Presbyterian Church/City Hall/Community Center.

[183] Belvedere, CA. Last updated January 9, 2017. en.wikipedia.org/wiki/Belvedere,_California
[184] Belvedere-Tiburon Landmarks Society, China Cabin. Accessed January 18, 2017. landmarkssociety.com/landmarks/china-cabin/

BELVEDERE

The 1905 Belvedere Land Company building reflects designer Albert Farr's signature style.[185] *Credit: Wikipedia*

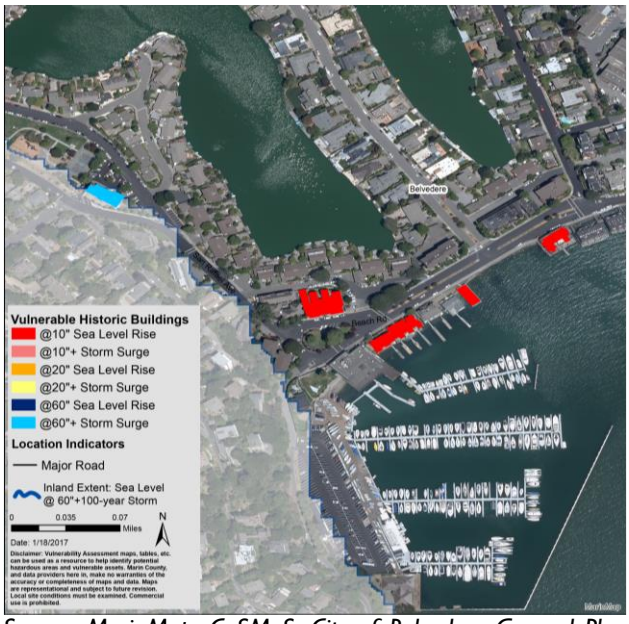
Emergency Services

The largest threat to emergency services is lost emergency vehicle access to the community. High tides and storms could flood the roads in front of the police department and, in the long-term, up to four feet of flooding could impact the property and the vehicles. In addition, though technically in Tiburon, the Tiburon Fire Department serves Belvedere and could be blocked from providing service if roads are severely flooded or if the station itself is flooded.

Select assets are presented in Table 74. A 100-year storm surge would add an additional one to three feet of water to these properties. Note also, above average high tides could impact more properties than accounted for in this analysis. The maps on the following pages illustrate vulnerable utility, natural resource, recreation, emergency and historic features. The areas in the call out circles enable the reader the see areas that are difficult to see on the large scale map. The circles do not indicate that these areas are more vulnerable than others along the shoreline.

[185] Albert L. Farr. Last updated October 10, 2016. <en.wikipedia.org/wiki/Albert_L._Farr>

Map 66. Belvedere Vulnerable Cultural Resource Assets



Source: MarinMap, CoSMoS, City of Belvedere General Plan Update. Credit: Marin County CDA

Table 74. Example Belvedere Vulnerable Assets by Sea Level Rise Onset and Flooding at MHHW

Asset	Scenarios		
	Near-term	Medium-term	Long-term
	1	3	5
Corinthian Hill homes	2'10'	3'2"	4'7"
West Shore Rd. homes	0-2'4"	2"-3'6"	5"-8'11"
SF Yacht Club	2'2"	3'6"	8'10"
Beach Rd. homes	6"	2'2"	4'
Lagoon homes		2"-3'	5"-7'9"
Corp Yard		4"	1'5"
San Rafael Ave.		0-3"	2"-4'3"
West Shore Rd.			2'3"-5'5"
Mini Park			5'3"
Beach Rd.			11"-5'
Community center city hall, & police			4'4"
Belvedere Lagoon	Saltwater resource		

Source: MarinMap, CoSMoS

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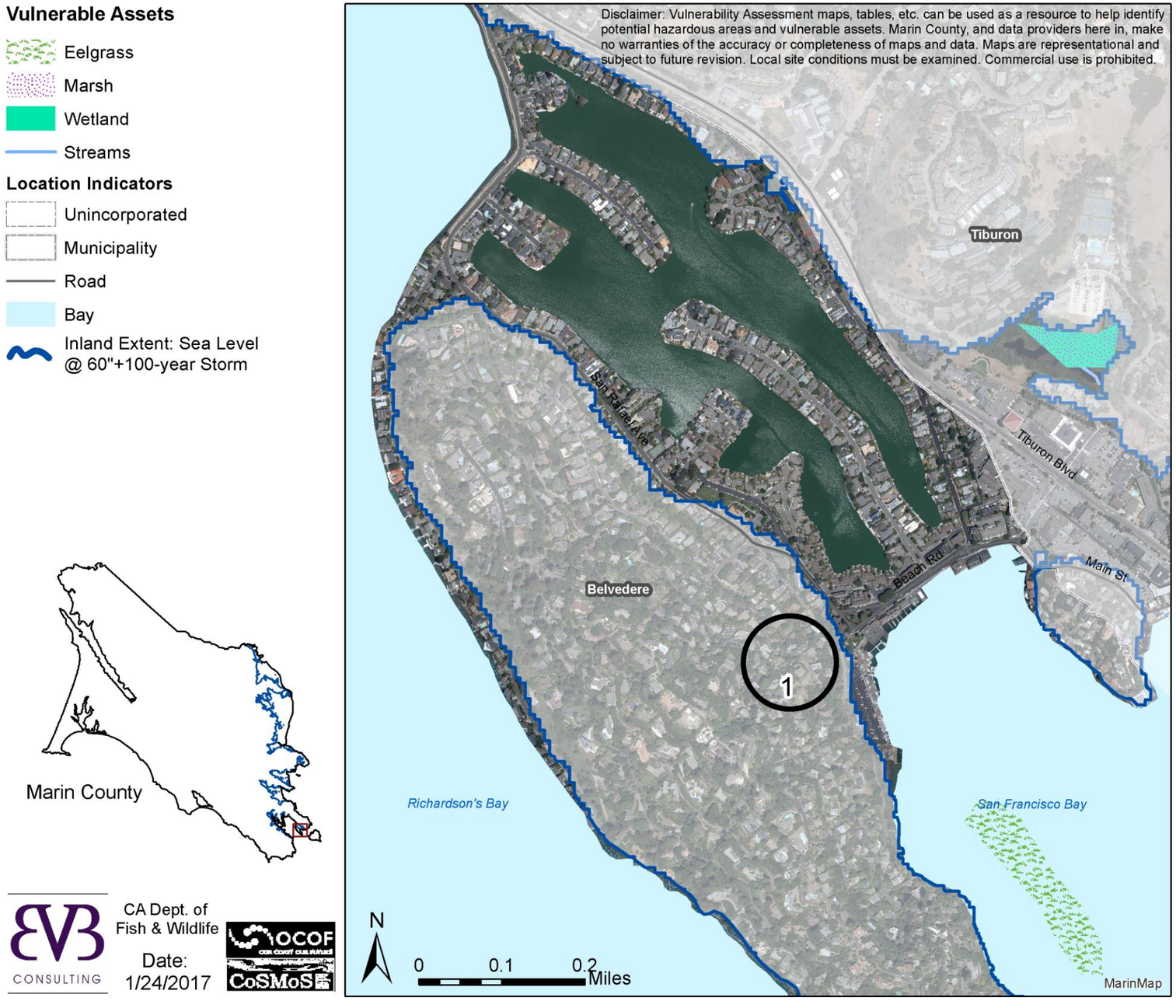
Map 67. Belvedere Vulnerable Natural Resource Assets



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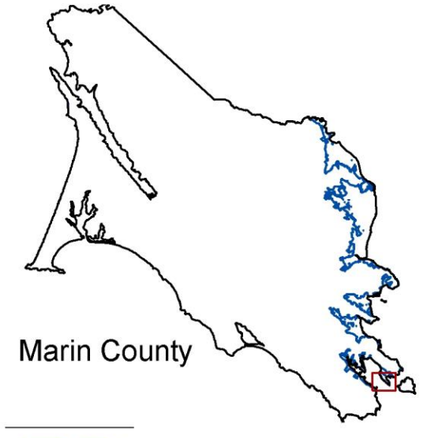
Map 68. Belvedere Vulnerable Recreation Assets

Vulnerable Assets

- Bay Trail
- Trail
- Bikeway
- Park
- Ferry
- Marina

Location Indicators

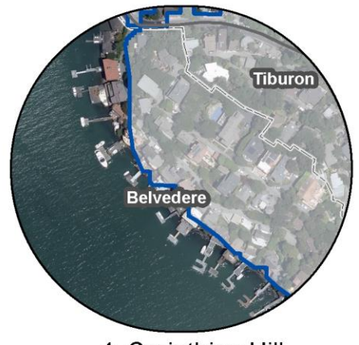
- Unincorporated
- Municipality
- Road
- Bay
- Inland Extent: Sea Level @ 60"+100-year Storm



1: West Shore Rd. Home Docks

2: Belvedere Community Park

3: San Francisco Yatch Club



4: Corinthian Hill Home Docks

EVB CONSULTING

Date: 1/25/2017

OCOF CoSMoS

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

Map 69. Belvedere Cultural Resource Assets

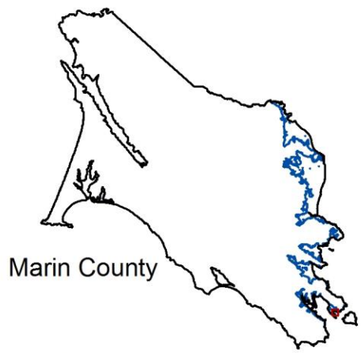
Vulnerable Historic Buildings

- @10" Sea Level Rise
- @10"+ Storm Surge
- @20" Sea Level Rise
- @20"+ Storm Surge
- @60" Sea Level Rise
- @60"+ Storm Surge

Location Indicators

- Municipality
- Major Road
- Inland Extent: Sea Level @ 60"+100-year Storm

Source: Marin Map, CoSMoS, Belvedere General Plan Update



Date: 2/17/2017

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