DRAFT
ADAPTATION SUMMARIES

28 AUGUST 2024

SEA LEVEL RISE ADAPTATION PLANNING FOR MARIN COUNTY'S TRANSPORTATION SYSTEM

TRANSPORTATION AUTHORITY OF MARIN

FOCUS AREA:

SAUSALITO

VULNERABILITY OVERVIEW

Sausalito's ideal location along Richardson Bay makes it highly susceptible to coastal flooding and sea level rise. Gate 5 road and Gate 6 road are already experiencing quasi-permanent flooding issues, highlighting the immediate impact of rising waters. Bridgeway, the main downtown thoroughfare, is exposed to intermittent storm flooding and shallow groundwater, posing significant risks during extreme weather events.

Bridgeway is a vital component for Sausalito's transportation network, featuring 16 stops that serve the community. However, the southern end of Bridgeway is projected to face permanent inundation with 49 inches of sea level rise. Other areas of this road are expected to experience temporary flooding at 30 inches of sea level rise during a 100-year coastal storm event. Additionally, emergent groundwater on Bridgeway is anticipated at 36 inches of sea level rise. The ferry terminal, another key transportation hub, along with its parking lot, also face permanent inundation without significant interventions.

Sausalito's economy, heavily reliant on tourism, waterfront businesses, and the maritime industry, faces risks from sea level rise. Flooding and erosion may damage key tourist attractions, marinas, and commercial areas, leading to economic losses and reduced revenue. The impact on Bridgeway, a vital transportation artery for locals and visitors alike, could further exacerbate these economic challenges by disrupting the flow of goods, services, and tourists into and out of the city.

Rising sea levels also threaten local ecosystems, including wetlands and tidal marshes, which provide natural flood protection and critical habitat for wildlife. The loss of these ecosystems would not only impact biodiversity but also reduce the natural resilience of Sausalito's coastline against future sea level rise. For example, Old Town Swede's Beach is already experiencing frequent flooding, and with just a 20-inch rise in sea levels, surrounding properties will likely see more severe and regular flooding. Shoreline erosion is a growing concern at Dunphy Park and Galilee Harbor. With a 36-inch rise in sea level, the area will face both more regular and impactful coastal flooding and routine shallow groundwater issues. As these natural barriers degrade, the city's vulnerability to coastal impacts will increase.

SUMMARY OF VULNERABLE ASSETS

TRANSIT ASSETS

16 BUS STOPS

1 PARK AND RIDE HUB AREA

3 ARTERIAL- BRIDGEWAY, RICHARDSON STREET, AND SAN CARLOS AVENUE

7 COLLECTORS, & NETWORK OF LOCAL STREETS

1 INGRESS/EGRESS ROUTE

ONGOING ADAPTATION PLANNING

- Dunphy Park – Multiple Restoration Projects
- Sausalito Marine - Eelgrass Preserve

A royal tide event floods Gate 5 Road, January 2024. Photo by WRT

APPROACH

In developing strategies at the focus area level, we emphasized several key themes critical to success. First, we initiated a dialogue with Marin's transportation agencies and neighboring communities to align on shared goals and opportunities—a conversation that continues with this adaptation summary for Mill Valley. Recognizing that TAM does not own assets and must rely on strong partnerships, we prioritized the inclusion of nature-based solutions, ensuring they remain a focal point in the planning process. We also conducted a thorough analysis of TAM's role, adopting a 'control, collaborate, and advocate' approach. Additionally, we acknowledge the importance of balancing protection with risk, working towards adaptation strategies that integrate both elements. Finally, we are committed to finding a balance between near-term actions and long-term planning, guided by the 'adaptation pathways' approach.


SAUSALITO
1" = 1200'
N
Adaptation Strategies
Nature Based Adaptation Strategies
Existing Culverts
Existing Pump Stations
City Boundary
Roads
Floating Piers
Green Open Space
Parks / School Playgrounds
Streams
Flooding on Roads / Trails / Transit
Temporary Flooding
10 20 30 39 49 59
Permanent Flooding
10 20 30 39 49 59
Emergent/Shallow Groundwater
0 12 24 36 48 52 66
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SEE TAM JUNCTION / MARIN CITY
GATE 5 ROAD
MARINSHIP PARK
GALILEE HARBOR
DUNPHY PARK
FERRY TERMINAL
BRIDGEWAY
RICHARDSON BAY
SAUSALITO
US 101
1
2
3
4
5
6

FOCUS AREA:

SAUSALITO

KEY ADAPTATION CHALLENGES & POTENTIAL STRATEGIES

The following challenges have been identified for the Sausalito area and correspond to the adjacent map.

1 INUNDATION OF ACCESS AND INFRASTRUCTURE

Strategy: Elevate Roads and Utilities, Breakwater, Eelgrass

2 SUBSIDENCE AND FLOODING

Strategy: Complete Green & Elevated Streets, Levee/Seawall, Pump Station(s)

3 SHORELINE EROSION

Strategy: Breakwaters, Eelgrass, Cobble Berm/ Coarse Beach

4 BRIDGEWAY FLOODING

Strategy: Complete Green & Elevated Streets

5 FERRY TERMINAL & PARKING LOT FLOODING

Strategy: Complete Green & Elevated Streets/Paths

6 FLOODING OF OLD TOWN SWEDE'S BEACH

Strategy: Coarse Grain Beach, Breakwater

ADAPTATION OPPORTUNITY DESCRIPTIONS

1 INUNDATION OF ACCESS AND INFRASTRUCTURE

Location: Gate 6 Road

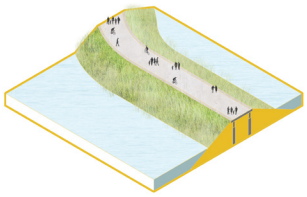
Potential Adaptation Strategy: Elevate Roads and Utilities, Breakwater, Eelgrass

Near-term, proactive elevation of key road, parking, utilities, and dock connections in the Gate 6 area could improve and maintain ingress/egress to docks and houseboats. Longer-term subtidal and intertidal habitat restoration for eelgrass, oysters, cord grass, and other species could help attenuate wave energy, and reduce shoreline erosion.

2 SUBSIDENCE AND FLOODING

Location: Gate 5 Road

Potential Adaptation Strategy: Complete Green & Elevated Streets, Levee/Seawall, Pump Station(s)



Levee

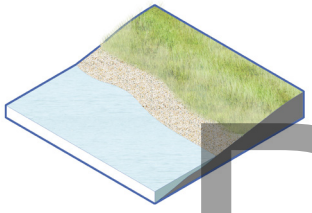
A district-scale adaptation plan for Marinship is needed to develop a long- term perimeter protection and interior drainage strategy, likely involving levees, seawalls, and/or bulkheads as well as culverts and pump

stations. Near-term roadway elevation projects with natural stormwater detention features (e.g., bioswales, vegetated basins) would alleviate some existing flooding issues affecting roads and parking areas, providing time to implement longer-term strategies.

3 SHORELINE EROSION

Location: Dunphy Park, Galilee Harbor

Potential Adaptation Strategy: Breakwaters, Eelgrass, Cobble Berm/Coarse Beach



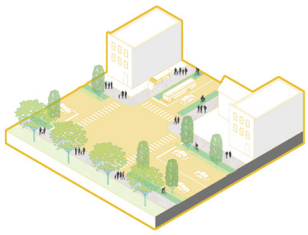
Coarse Grain Beach

Subtidal and intertidal habitat restoration efforts for eelgrass, oysters, cord grass, and other species are already underway in this area. Continuing with these strategies, adjusting based on observations, can help attenuate wave energy, reduce erosion, and maintain a favorable shoreline profile. Cobble berms or coarse grain beach nourishment can be utilized in concert with habitat improvements as needed.

4 BRIDGEWAY FLOODING

Location: Bridgeway

Potential Adaptation Strategy: Complete Green & Elevated Streets



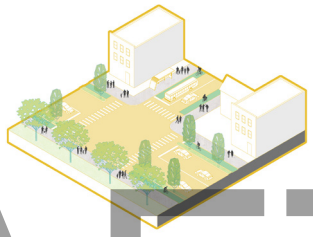
Complete Green

Near-term, proactive elevation of low-lying sections of Bridgeway along with associated underground utilities would improve and maintain critical ingress/egress throughout Sausalito. Inclusion of stormwater detention features (e.g., bioswales, vegetated basins) would provide additional time to plan and implement longer-term, city-scale flood protection infrastructure.

5 FERRY TERMINAL & PARKING LOT FLOODING

Location: Sausalito Ferry Terminal

Potential Adaptation Strategy: Complete Green & Elevated Streets/Paths



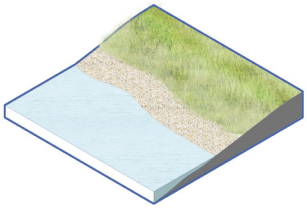
Complete Green

A district-scale adaptation plan for downtown is needed to develop a long- term perimeter protection and stormwater drainage strategy, likely involving seawalls and/or bulkheads as well as culverts and pump stations. Near-term roadway elevation projects along low-lying sections of the Ferry terminal parking area with stormwater detention features (e.g., bioswales, vegetated basins would improve and maintain critical access to ferry service, providing additional time to implement longer-term strategies.

6 FLOODING OF OLD TOWN SWEDE'S BEACH

Location: Swede's Beach

Adaptation Strategy: Coarse Grain Beach, Breakwater



Coarse Grain Beach

Offshore measures, such as a breakwater structure, can help attenuate wave energy, reduce erosion, and preserve the shoreline profile at

Swede's Beach, particularly when sediment loss reaches critical levels. Additionally, cobble berms or coarse grain beach nourishment can be employed to support the beach profile, providing further protection as sea level rise progresses.

FOCUS AREA:

TAM JUNCTION / MARIN CITY

VULNERABILITY OVERVIEW

Tam Junction and Marin City possess key transportation networks and natural areas. With both SR-1 and US-101 running through this focus area, it makes it highly vulnerable to coastal hazards. The Sausalito Canal and the Bothin Marsh Preserve, an important wetland for fishing and bird watching, are also at risk. These areas are susceptible to flooding, erosion, and other impacts from sea level rise and severe storms, posing threats to infrastructure, ecosystems, and communities.

The transportation infrastructure in Tam Junction and Marin City faces significant risks from flooding and inundation. US-101 and its ramps, especially Exit 445B (Mill Valley; Stinson Beach), are prone to frequent flooding, which can lead to temporary shutdowns and disrupt commuter traffic. Moreover, Donahue access is susceptible to temporary flooding with 30 inches of sea level rise coupled with a 100-year storm, obstructing access to the Gateway Shopping Center in Marin City. Coyote Creek's potential for overtopping and the inundation of Tam Junction pose further threats to the transportation network.

The Bay Trail, a popular route for running, walking, and biking, is already experiencing notable flooding issues. This is particularly evident along the stretch near Highway 101 and Tam Junction, where permanent flooding is anticipated with 20 inches of sea level rise. Similarly, The Charles F. McGlashan Pathway, which runs along Coyote Creek, faces the risk of permanent inundation with a rise of 10 inches in sea level. These trails suffer from marsh subsidence, lack of sediment, and emergent groundwater, even without sea level rise. Ongoing erosion and overtopping of the marsh and trail are making the area increasingly difficult to navigate.

SUMMARY OF VULNERABLE ASSETS

TRANSIT ASSETS

HIGHWAY 101

24 BUS STOPS

2 INGRESS/EGRESS ROUTES

1 HUB, PARK, AND RIDE AREA

LIFELINES

1 POLICE STATION

COMMUNITY ASSETS

1 LIBRARY

1 SCHOOL

1 COMMERCIAL SHOPPING CENTER

COMMUNITY ASSETS

3 PUMP STATIONS

ONGOING ADAPTATION PLANNING

- Transforming Marin City's Urban Wetland
- Mill Valley Flood Management and Storm Drain Master Plan

A man walks to a car stuck in a flooded section of the Highway 101 onramp in Marin City, October 2021. Photo by Sherry LaVars/Marin Independent Journal.

APPROACH

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US 101
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COYOTE CREEK
CALIFORNIA 1
6
5
4
RIDGEVIEW CT.
VILLA GARDEN DR.
MANZANITA PARK & RIDE LOT
MILL VALLEY - SAUSALITO PATH
MARIN CITY STORMWATER POND
1
MARIN GATEWAY SHOPPING CENTER
2
DR. MARTIN LUTHER KING JR. ACADEMY
MARIN CITY
DONAHUE ST
3
DRAKE AVE
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FOCUS AREA:

TAM JUNCTION / MARIN CITY

KEY ADAPTATION CHALLENGES & POTENTIAL STRATEGIES

The following challenges have been identified for the TAM Junction / Marin City area and correspond to the adjacent map.

1 FLOODING OF 101 & BAY TRAIL

Strategy:

- A: Elevate on Causeway / Viaduct
- B: Elevate on Embankment, Coarse Beach, Breakwater, Pump Station
- C: Sea Wall / Bulkhead, Coarse Beach, Breakwater, Pump Station

2 STORMWATER FLOODING

Strategy: Detention Pond Improvement

3 FLOODING OF DONAHUE ACCESS

Strategy: Complete Green & Elevated Streets

4 LIMITED EVACUATION ROUTES/ CONNECTIVITY

Strategy: Evacuation route gap closure

5 INUNDATION OF 101 & HWY 1 RAMPS

Strategy: Complete Green and Elevated Streets

6 COYOTE CREEK OVERTOPPING / TAM JUNCTION INUNDATION

Strategy: Levee, Tide Gate

7 MARSH / TRAIL SUBSIDENCE AND LACK OF SEDIMENT

Strategy: Breaching Creek Channels

8 MARSH / TRAIL EROSION & OVERTOPPING

Strategy: Coarse Grain Beach, Trail Relocation "Ring the Marsh"

ADAPTATION OPPORTUNITY DESCRIPTIONS

1 FLOODING OF 101 & BAY TRAIL

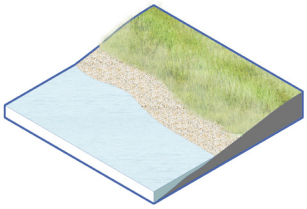
Location: Highway 101, Bay Trail

Potential Adaptation Strategy:

- Strategy A: Elevate on Causeway / Viaduct
  - Elevating SR-101 on a causeway or viaduct would involve raising the infrastructure above the anticipated future sea levels with storm scenarios considered. This approach would allow water to flow beneath the structure, minimizing flood risk to the highway while maintaining transportation and access. However, this approach would not

provide flood protection for the surrounding community.

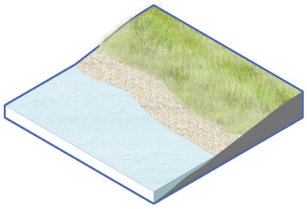
- Strategy B: Elevate on Embankment, Coarse Beach, Breakwater -



Coarse Grain Beach

This strategy involves elevating the shoreline on an embankment, complemented by a coarse grain beach and offshore breakwater either using natural or man-made features (e.g., oyster reef or rubble-mound). The embankment would raise the SR-101 and the Bay Trail above the anticipated future sea levels with storm scenarios considered, while the beach and breakwater would absorb wave energy and reduce shoreline erosion. This strategy would provide flood protection for the surrounding community and would also require stormwater drainage improvements including culverts and a pump station.

- Strategy C: Seawall / Bulkhead, Coarse Beach, Breakwater -



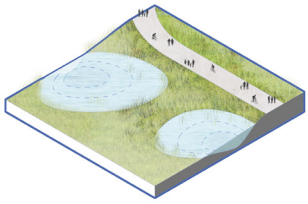
Coarse Grain Beach

Constructing a seawall or bulkhead, in combination with an offshore breakwater either using natural or man-made features (e.g., oyster reef or rubble-mound). The seawall or bulkhead would act as a vertical barrier to protect SR-101, the Bay Trail, and the surrounding community from anticipated future sea levels with storm scenarios considered, while the beach and breakwater would absorb wave energy and reduce shoreline erosion. This strategy would also require stormwater drainage improvements including culverts and a pump station.

2 STORMWATER FLOODING

Locaton: Marin City Stormwater Pond

Potential Adaptation Strategy: Detention Pond Improvement



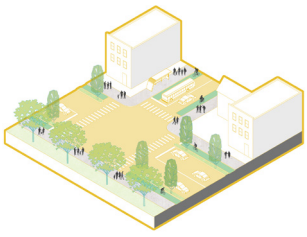
Detention Basin

This option focuses on enhancing the Marin City Stormwater Pond to improve its capacity and functionality as a detention pond. By upgrading the pond, it can better manage stormwater runoff, reducing the risk of flooding during heavy rainfall and accommodating higher water levels associated with sea level rise. The improvements would help protect the surrounding area by effectively controlling stormwater and mitigating the impacts of future flood events. To address sea level rise, a future pump station needs to be considered to control water levels in the pond when the outfall location is inundated.

3 FLOODING OF DONAHUE ACCESS

Location: Donahue Street

Potential Adaptation Strategy: Complete Green & Elevated Streets



Complete Green

A district-scale adaptation plan for Marin City is needed to develop a long- term perimeter protection and interior drainage strategy, likely involving levees, seawalls, and/or bulkheads as well as culverts and pump stations. A near-term roadway

elevation project focused on Donahue Street with natural stormwater detention features (e.g., bioswales, vegetated basins) would alleviate some existing flooding issues affecting critical ingress/egress, providing time to implement longer-term strategies.

4 LIMITED EVACUATION ROUTES/ CONNECTIVITY

Location: Connection between Ridgeview Ct. and Villa Garden Dr.

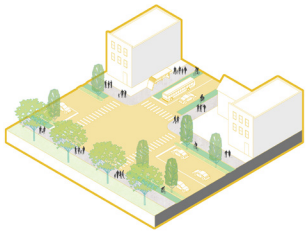
Potential Adaptation Strategy: Evacuation route gap closure

There exists a 500-foot gap between Ridgeview Court and Villa Garden Drive, which if connected, would create an additional evacuation and ingress/egress route for the Marin City community as well as Tam Valley. This gap closure could be permanently open to all vehicles or open to bus, bikes, and pedestrians only on a daily basis and then opened for vehicles during emergencies.

5 INUNDATION OF 101 & HWY 1 RAMPS

Location: Highway 101, Highway 1

Potential Adaptation Strategy: Complete Green and Elevated Streets



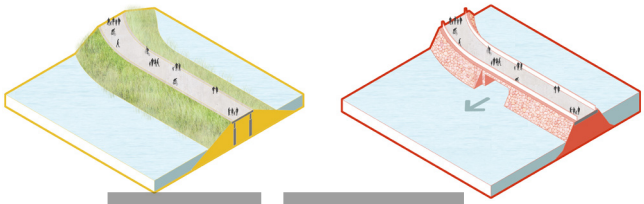
Complete Green

Near-term, proactive elevation of low-lying sections of Highway 101 and Highway 1 on/off ramps along with associated underground utilities could improve and maintain critical ingress/egress and transit throughout southern Marin. Vertical clearance issues beneath SR-101 could limit the feasibility of this strategy. Inclusion of stormwater detention features (e.g., bioswales, vegetated basins) would provide additional time to plan and implement longer-term flood protection strategies like those listed above.

6 COYOTE CREEK OVERTOPPING / TAM JUNCTION INUNDATION

Location: Coyote Creek

Potential Adaptation Strategy: Levee, Tide Gate



Levee Tide Gate

A levee improvement and tide gate solution for Coyote Creek would involve enhancing the existing levee system to better protect the Tam Junction area from flooding, particularly during high tides and storm events. The levee improvements would include raising and reinforcing the levees to ensure they can withstand higher water levels and increased storm surges anticipated with sea level rise. In the long-term, installing a tide gate at the mouth of Coyote Creek would help regulate the flow of tidal waters, preventing saltwater from flowing upstream during high tides thereby reducing the risk of tidal flooding in the surrounding areas. The tide gate would allow freshwater to flow out during low tide, which eventually would require pumping after sea level rise reached a critical point. Together, these measures would provide robust protection against both storm-driven and tidal flooding, albeit with substantial environmental tradeoffs requiring thorough consideration.

7 MARSH / TRAIL SUBSIDENCE AND LACK OF SEDIMENT

Location: Bothin Marsh, next to Coyote Creek

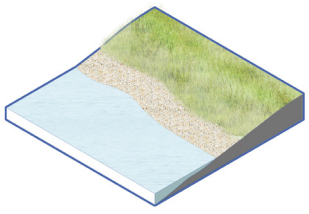
Potential Adaptation Strategy: Breaching Creek Channels

Intentionally breaching the north side levee of Coyote Creek would restore the natural hydrological connection to Bothin Marsh, allowing high flow events to flood the marsh and deposit sediment. This sediment replenishment would mitigate marsh subsidence, helping maintain the marsh's elevation relative to rising sea levels and enhancing the longevity of the Bay Trail's current alignment. By reintroducing these natural processes, the marsh would restore a portion of its role as a dynamic, ecologically diverse system, while also serving as a natural buffer that provides flood protection to the surrounding area through wave and surge attenuation.

8 MARSH / TRAIL EROSION & OVERTOPPING

Location: Bothin Marsh, along Mill Valley-Sausalito Path

Potential Adaptation Strategy: Coarse Grain Beach, Trail Relocation "Ring the Marsh"



Coarse Grain Beach

Relocating the Mill Valley-Sausalito Path involves creating a coarse-grain beach and redesigning the Bay Trail to encircle the marsh ("Ring the Marsh"). The coarse-grain beach at the backshore of the marsh would act as a natural barrier to reduce erosion and protect Tam Junction from wave action and overtopping during storm events. Relocating the trail to a higher elevation around the marsh would ensure continued access while reducing the risk of damage from flooding. This approach not only preserves the marsh's ecological function but also enhances the resilience of the trail and surrounding community against sea level rise and erosion.

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FOCUS AREA:

MILL VALLEY

VULNERABILITY OVERVIEW

The City of Mill Valley touches Richardson Bay, part of San Francisco Bay, and extends upland towards Mount Tamalpais. The coastal areas of the city include Bothin Marsh, contain transit centers, commercial districts, and residences, among other assets and services. Onramps to US-101 corridor and key ingress/egress routes are vulnerable to flooding and sea level rise due to elevation, existing drainage capacity, and proximity to creeks and Richardson Bay.

The local transportation network includes 18 bus stops but faces significant challenges due to drainage issues along E Blithedale Ave. Particularly, the section following the US-101 exit already experiences shallow groundwater. If not addressed with proper adaptation strategies, stormwater will continue to lead to frequent flooding and disruptions. Miller Ave is also vulnerable to shallow groundwater and permanent inundation with 10 inches of sea level rise, impacting students commuting to Tamalpais High School.

Flooding along Arroyo Corte Madera del Presidio is increasingly affecting local homes, restaurants, and retail stores that lie parallel to it. Similarly, Bothin Marsh is experiencing erosion and trail overtopping, affecting habitat and recreational areas. Just north of the Marsh is Bayfront Park, which already faces challenges from coastal flooding. As Mill Valley's multiple schools and large outdoor spaces see many individuals daily, effective flood management is crucial to protect both residential areas and community resources.

SUMMARY OF VULNERABLE ASSETS

TRANSIT ASSETS

18 BUS STOPS

LIFELINES

2 SCHOOLS

UTILITIES

2 PUMP STATIONS

1 WASTEWATER TREATMENT PLANT

1 POWER SUBSTATION

ONGOING ADAPTATION PLANNING

- Mill Valley Flood Management and Storm Drain Master Plan
- Evolving Shorelines Project at Bothin Marsh

A king tide event in January 2022 floods Miller Avenue and the Bay Trail. Photo by: Josh Edelson AFP.

APPROACH

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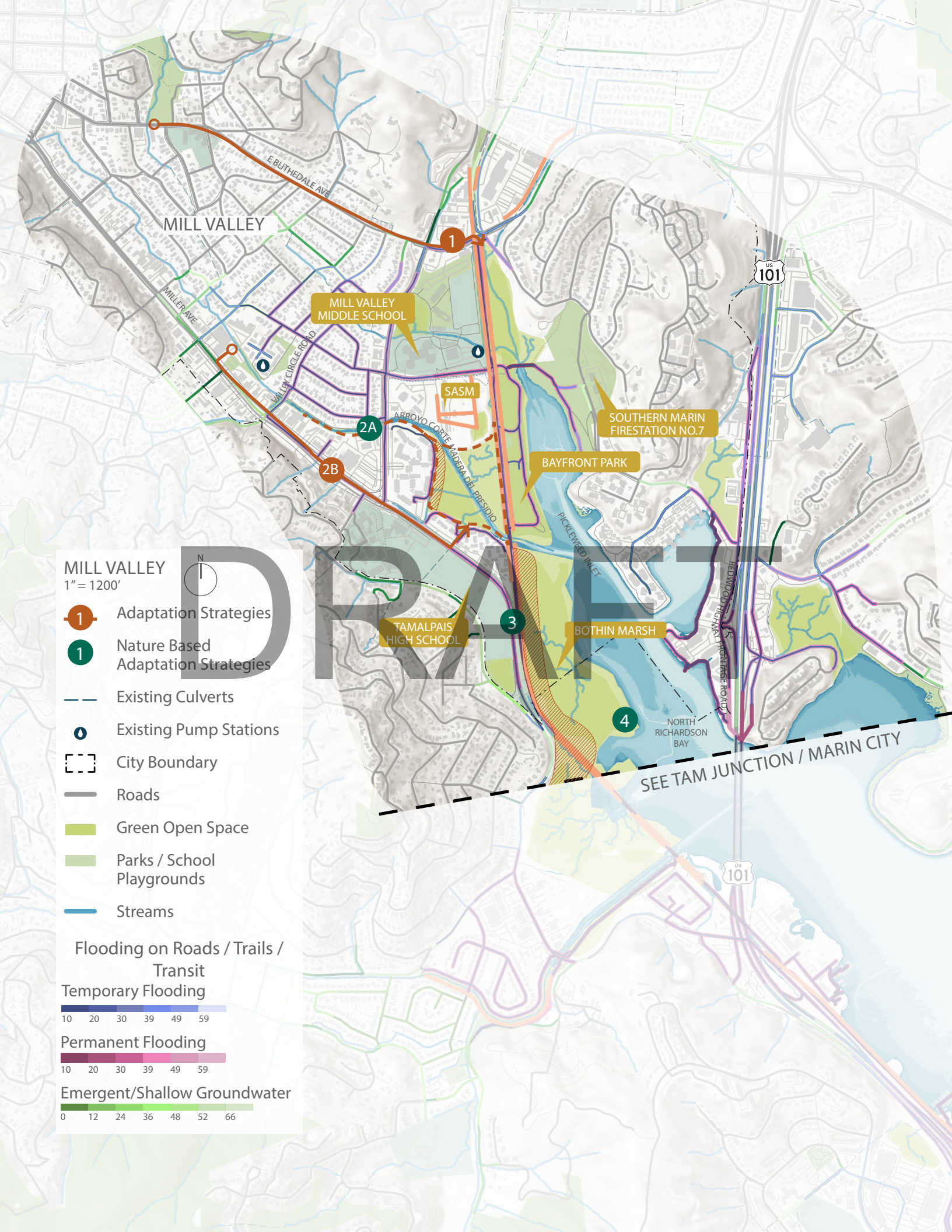
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E BLITHEDALE AVE
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VALLEY CIRCLE ROAD
MILL VALLEY MIDDLE SCHOOL
SASM
ARROYO CORTE MADERA DEL PRESIDIO
SOUTHERN MARIN FIRESTATION NO.7
BAYFRONT PARK
PICKLEWEED INLET
TAMALPAIS HIGH SCHOOL
BOTHIN MARSH
REDWOOD HIGHWAY FRONTAGE ROAD
NORTH RICHARDSON BAY
US 101
SEE TAM JUNCTION / MARIN CITY
1
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FOCUS AREA:

MILL VALLEY

KEY ADAPTATION CHALLENGES & POTENTIAL STRATEGIES

The following challenges have been identified for the Mill Valley area and correspond to the adjacent map.

1 DRAINAGE ISSUES ALONG BLITHEDALE

Strategy: Culvert & Pump Station

2 FLOODING ALONG ARROYO CORTE MADERA DEL PRESIDIO

Strategy:

- A: Levee, Horizontal Levee/Ecotone Slope
- B: Culvert and Pump Station

3 MILLER AVENUE / BOTHIN MARSH / TRAIL FLOODING & OVERTOPPING

Strategy: Complete Green & Elevated Streets, Horizontal Levee

4 BOTHIN MARSH OPEN SPACE PRESERVE HABITAT LOSS

Strategy: Coarse Grain Beaches

ADAPTATION OPPORTUNITY DESCRIPTIONS

1 DRAINAGE ISSUES ALONG BLITHEDALE

Location: Arroyo Corte Madera del Presidio, along Blithedale, to Pickleweed Inlet / Richardson Bay

Potential Adaptation Strategy: Culvert and Pump Station

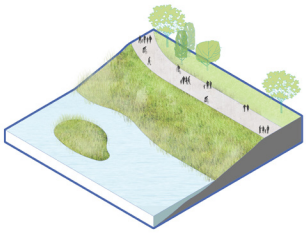
This solution includes near-term upgrades to culverts along Blithedale Avenue to enhance stormwater drainage, improving ingress, egress, and evacuation routes for Mill Valley. In the longer term, a pump station would need to be installed to manage water levels during high tides. As sea levels rise, the pump station will become essential for conveying stormwater to Richardson Bay, as a gravity-based system will no longer reliably function with future tidal inundation of the outfall.

2 FLOODING ALONG ARROYO CORTE MADERA DEL PRESIDIO

Location: Connecting from pump station near Valley Circle Road along Arroyo Corte Madera del Presidio

Potential Adaptation Strategy:

- Strategy A: Levee, Horizontal Levee/Ecotone Slope -



Ecotone Slope

This strategy involves constructing a levee along the creek to provide a physical barrier against both inland and coastal flooding. A horizontal levee, or ecotone slope, could be integrated into the design to create a gradual transition from the aquatic

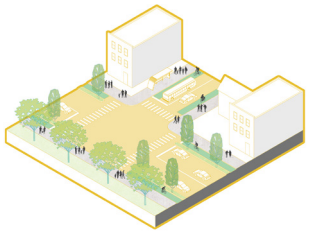
environment to upland areas. This approach enhances flood protection, supports habitat restoration, and allows species to migrate upslope as the high tide line shifts with sea level rise. The horizontal levee would also help reduce erosion and maintain natural floodplain functions.

- Strategy B: Culvert and Pump Station
  This approach focuses on enhancing the existing drainage infrastructure by upgrading culverts to re-route stormwater coming from the southern tributaries of the Arroyo Corte Madera Del Presidio drainage area and installing a pump station. The improved culverts would divert stormwater flow during heavy rainfall events to alleviate pluvial and fluvial flooding issues in the low-lying areas surrounding the existing creek alignment. he pump station would actively manage water levels, particularly during high tide or storm surge events. As sea levels rise, the pump station will become essential for conveying stormwater to Richardson Bay, as a gravity-based system will no longer reliably function with future tidal inundation of the outfall.

3 MILLER AVENUE / BOTHIN MARSH / TRAIL FLOODING & OVERTOPPING

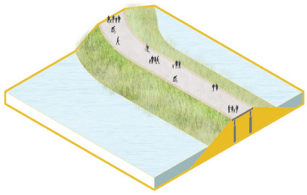
Location: Miller Avene, next to TAM High School and Bothin Marsh

Potential Adaptation Strategy: Complete Green & Elevated Streets, Horizontal Levee



Complete Green

This solution involves transforming Miller Avenue into a "Complete Green & Elevated Street" by elevating the roadway and integrating green infrastructure elements. The elevated street would be designed to remain above future flood levels, ensuring continued accessibility including during emergency evacuations. Green infrastructure, such as permeable surfaces and bio-swales, would help manage stormwater runoff.



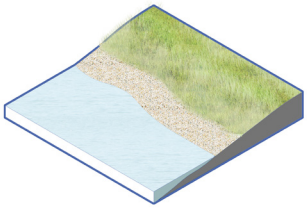
Levee

Additionally, a horizontal levee would be incorporated alongside Bothin Marsh, creating a gradual slope that transitions from the marsh to the upland areas. This horizontal levee would provide flood protection, support ecological diversity, and allow species to migrate as sea levels rise.

4 BOTHIN MARSH OPEN SPACE PRESERVE HABITAT LOSS

Location: North Richardson Bay along Redwood Highway Frontage Road

Potential Adaptation Strategy: Coarse Grain Beaches



Coarse Grain Beach

Implementing coarse grain beaches along the shoreline of Bothin Marsh would help protect and restore habitat. These beaches would be composed of larger, more stable sediments that can better withstand wave action and erosion, providing a natural buffer against sea level rise and storm surges. The coarse grain beaches would help reduce the rate of habitat loss by stabilizing the shoreline, preventing further erosion, and maintaining the marsh's ecological integrity. This approach also supports the resilience of the marsh to provide vital habitat for wildlife and other ecological functions as environmental conditions change.

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FOCUS AREA:

CORTE MADERA / LARKSPUR

VULNERABILITY OVERVIEW

The Town of Corte Madera is located on San Francisco Bay in central Marin County, along the US-101 Corridor on the San Francisco Bay. Approximately 10,000 people live in this low-lying coastal town. Historically, much of this area was marshland, which leaves most lower elevation residential and commercial areas in the Town vulnerable to coastal flooding. The City of Larkspur, located in central Marin, encompasses Corte Madera Creek and touches San Francisco Bay, exposing it to coastal and riverine flood hazards.

US-101 is critical for the region, but it faces permanent inundation with 10 inches of sea level rise. The highway connects key locations such as homes, schools, and the Town Center at Corte Madera. It is also crucial for commuters, linking to the Larkspur Ferry Terminal that connects the area to San Francisco. Moreover, 42 bus stops—both local and Golden Gate Transit—serve the area. Roadways in Larkspur also provide vital connectivity to Marin General Hospital.

Flooding along Corte Madera Creek poses a serious threat to numerous homes bordering the Creek and Larkspur Lagoon. Despite the attractive waterfront locations, these communities are highly prone to coastal flooding. Similarly, the houses in Mariner Cove and Marina Village face flooding from a 100-year storm, even without sea level rise. The current levee along the old railroad tracks has proved insufficient. With 11 schools in this focus area, any flooding would lead to significant disruptions and inconveniences, highlighting the urgent need for improved flood management.

SUMMARY OF VULNERABLE ASSETS

TRANSIT ASSETS

3 HUB, PARK, AND RIDE AREAS

2 FERRY STOPS

42 BUS STOPS

HIGHWAY 101

1 SMART STATION

LIFELINES

3 FIRE STATIONS

3 POLICE STATIONS

1 MUNICIPAL

1 HOSPITAL

COMMUNITY ASSETS

11 SCHOOLS

1 LIBRARY

UTILITIES

1 POWER SUBSTATION

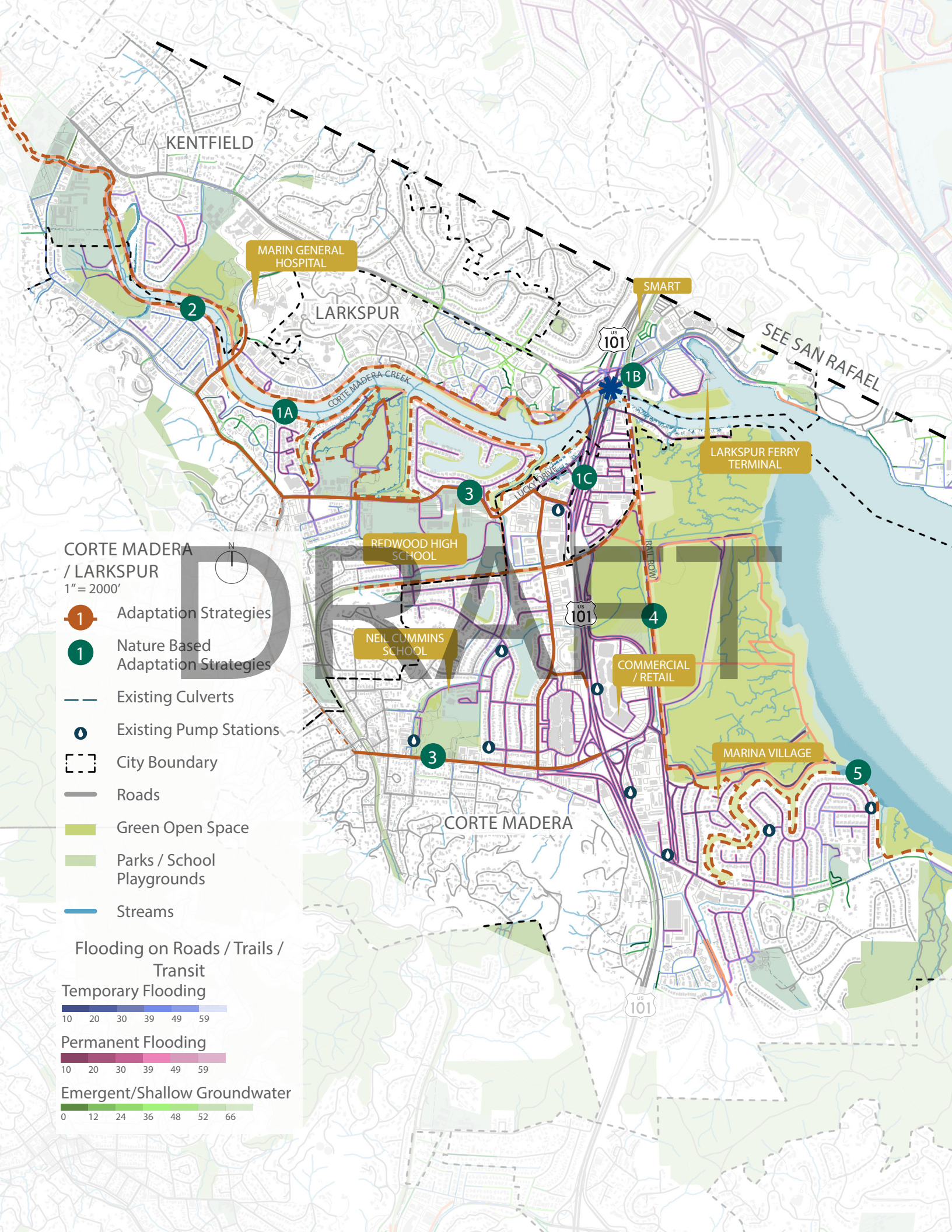
Community Flooding. Photo from Town of Corte Madera Climate Adaptation Plan

ONGOING ADAPTATION PLANNING

- The Corte Madera Climate Adaptation Assessment
- Mariner Cove & Marina Village
- Corte Madera Ecological Reserve Expansion and Restoration
- Corte Madera Creek - College of Marin "Dog Park" Habitat Restoration
- Corte Madera Creek - College of Marin Ecology Study Area Habitat Enhancement
- Corte Madera Creek - College of Marin Lot 13 Habitat Restoration
- Corte Madera Creek - Southeastern Creekside Marsh Culvert Replacement and Habitat Enhancement

APPROACH

In developing strategies at the focus area level, we emphasized several key themes critical to success. First, we initiated a dialogue with Marin's transportation agencies and neighboring communities to align on shared goals and opportunities—a conversation that continues with this adaptation summary for Mill Valley. Recognizing that TAM does not own assets and must rely on strong partnerships, we prioritized the inclusion of nature-based solutions, ensuring they remain a focal point in the planning process. We also conducted a thorough analysis of TAM's role, adopting a 'control, collaborate, and advocate' approach. Additionally, we acknowledge the importance of balancing protection with risk, working towards adaptation strategies that integrate both elements. Finally, we are committed to finding a balance between near-term actions and long-term planning, guided by the 'adaptation pathways' approach.


KENTFIELD
MARIN GENERAL HOSPITAL
LARKSPUR
SMART
SEE SAN RAFAEL
CORTE MADERA CREEK
LUCKY DRIVE
LARKSPUR FERRY TERMINAL
REDWOOD HIGH SCHOOL
RAILROW
NEIL CUMMINS SCHOOL
COMMERCIAL / RETAIL
MARINA VILLAGE
CORTE MADERA
US 101
2
1A
1B
1C
3
4
5
DRAFT
CORTE MADERA / LARKSPUR
1" = 2000'
Adaptation Strategies
Nature Based Adaptation Strategies
Existing Culverts
Existing Pump Stations
City Boundary
Roads
Green Open Space
Parks / School Playgrounds
Streams
Flooding on Roads / Trails / Transit
Temporary Flooding
10 20 30 39 49 59
Permanent Flooding
10 20 30 39 49 59
Emergent/Shallow Groundwater
0 12 24 36 48 52 66

FOCUS AREA:

CORTE MADERA / LARKSPUR

KEY ADAPTATION CHALLENGES & POTENTIAL STRATEGIES

The following challenges have been identified for the Corte Madera / Larkspur area and correspond to the adjacent map.

1 101 FLOODING

Strategy:

- A: Levee along Corte Madera Creek, Levee along Rail Alignment
- B: Tide Gate at 101, Levee along rail alignment
- C: Elevate 101, Complete Green & Elevated Streets

2 FLOODING ALONG CORTE MADERA CREEK

Strategy: Levee / Embankment, Tide Gate, Detention Ponds Upstream

3 COMMUNITY / EVACUATION ROUTE FLOODING

Strategy: Complete Green & Elevated Streets, Green Schoolyard Detention Basins

4 FLOODING ON CURRENT LEVEE ALIGNMENT

Strategy: Levee / Embankment, Horizontal Levee

5 EROSION, WAVE OVERTOPPING

Strategy: Coarse Grain Beaches, Bulkhead, Breakwater

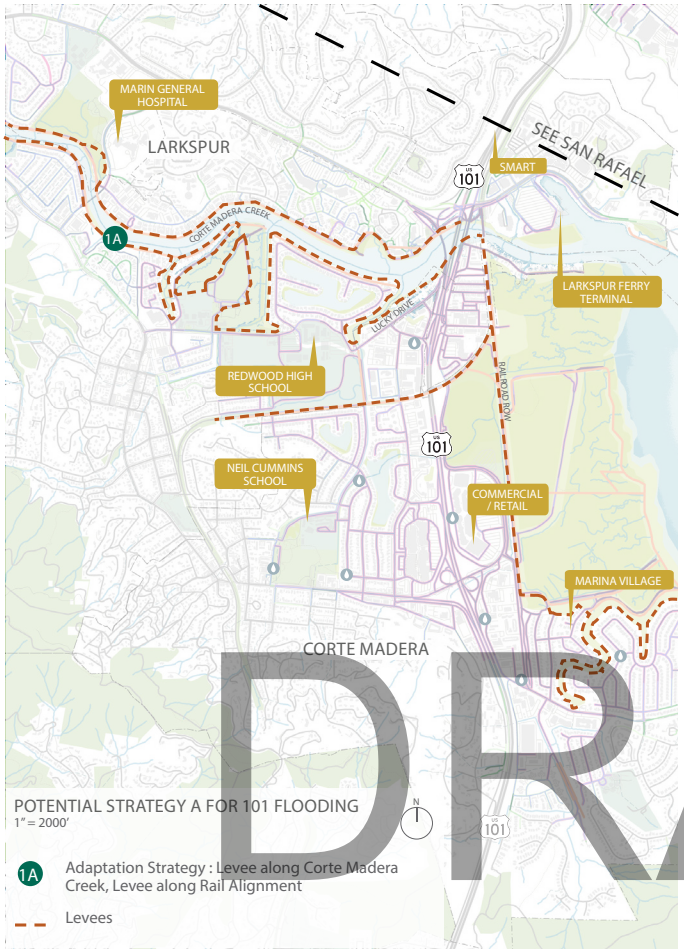
ADAPTATION OPPORTUNITY DESCRIPTIONS

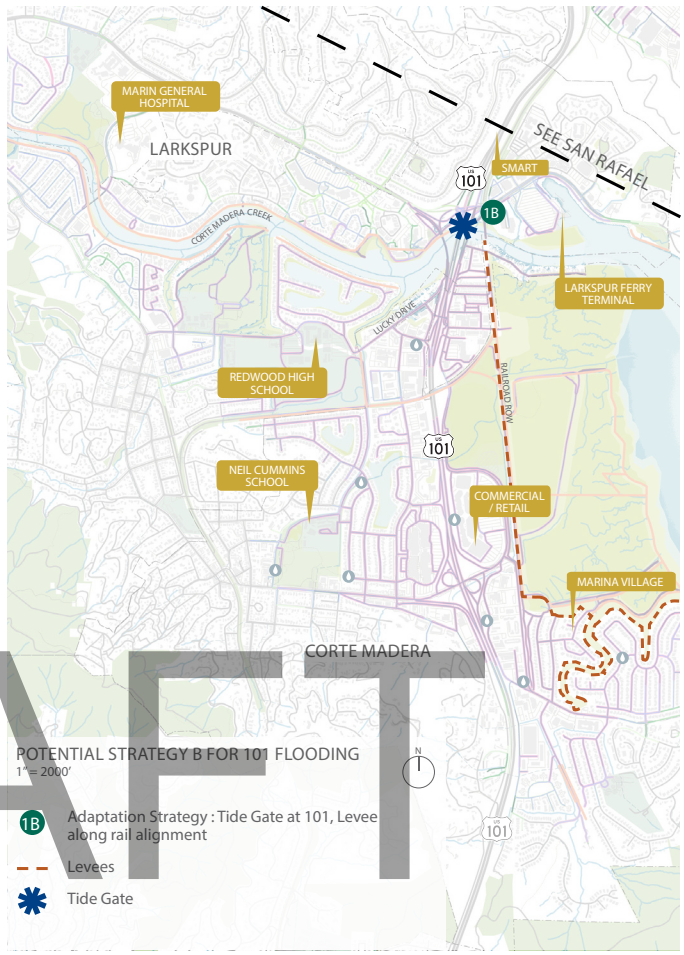
1 101 FLOODING

Location: Highway 101

Potential Adaptation Strategy:

- Strategy A: Levee along Corte Madera Creek, Levee along Rail Alignment – Constructing a large system of levees along Corte Madera Creek and the former rail alignment would protect Highway 101, Corte Madera, Larkspur, as well as portions of Greenbrae and Kentfield from flooding by creating a continuous line of defense against coastal and riverine flooding. These levees would ensure the highway and nearby infrastructure remain safe and operational during storm events and high tides, while providing comprehensive flood protection for the surrounding communities. Interior drainage improvements would also be necessary to convey stormwater across levees to the creek or the bay.

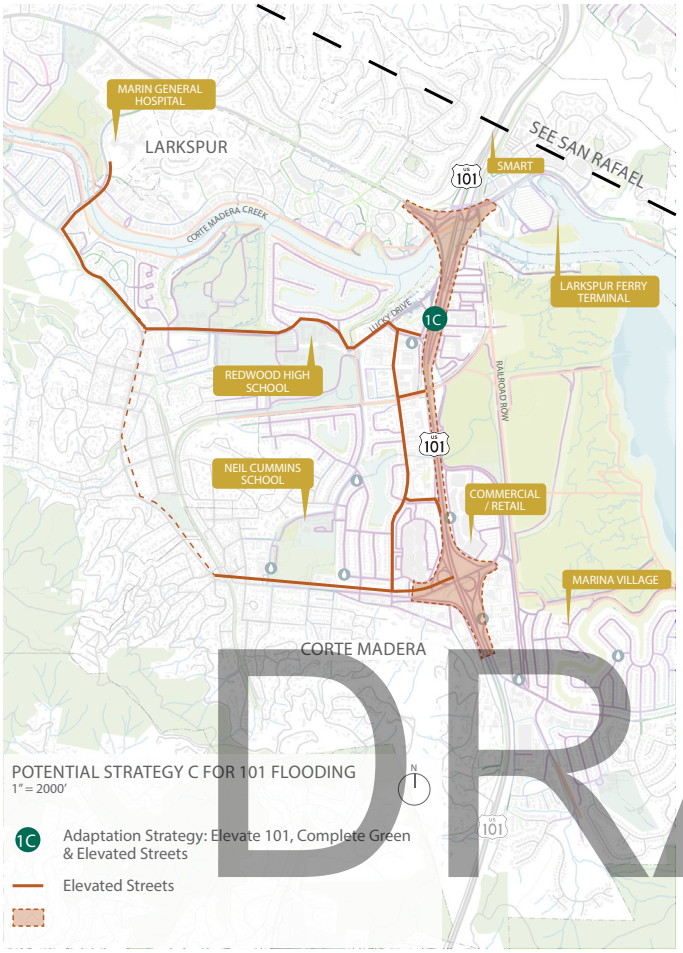




Strategy A: Levee along Corte Madera Creek, Levee along Rail Alignment

Strategy B: Tide Gate at 101, levee along rail alignment

- Strategy B: Tide Gate at 101, Levee along rail alignment – Installing a tide gate at Hwy 101 and constructing a levee along the former rail alignment would protect Highway 101, Corte Madera, Larkspur, as well as portions of Greenbrae and Kentfield from flooding and shorten the line of defense compared to extending levees along Corte Madera Creek. Some levee improvements would likely be required upstream of the tide gate to reinforce both sides of the creek to ensure they can withstand inland flood events. In the long-term, installing a tide gate would help regulate the flow of tidal waters up Corte Madera Creek, thereby reducing the risk of tidal and coastal flooding in the surrounding areas. The tide gate would allow freshwater to flow out during low tide, which eventually would require pumping after sea level rise reached a critical point. These measures could have substantial environmental tradeoffs requiring thorough consideration.
- Strategy C: Elevate 101, Complete Green & Elevated Streets – Elevating Hwy 101 above anticipated flood levels using either an embankment or viaduct would provide



Strategy C: Elevate 101, Complete Green & Elevated Streets

long-term protection for the highway against sea level rise and storm surges. Elevating Tamalpais Dr, Doherty Dr, and Lucky Dr on embankments would mitigate the flooding of key evacuation routes, ensuring that these critical roadways remain accessible during flood events. Incorporating green infrastructure, such as permeable surfaces and bio-swales, would help manage stormwater runoff. Interior drainage improvements would also be necessary to convey stormwater across elevated roadways to the creek or the bay. This strategy would not protect portions of the community outboard of the elevated roadways.

2 FLOODING ALONG CORTE MADERA CREEK

Location: Corte Madera Creek

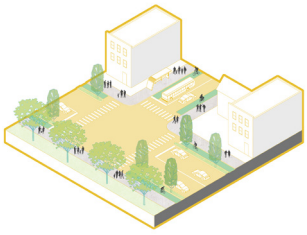
Potential Adaptation Strategy: Levee / Embankment, Tide Gate, Detention Ponds upstream

To address flooding along Corte Madera Creek, see strategies 1A and 1B to consider flood protection through levees along the creek and potentially a tide gate. To further manage riverine flooding, areas for detention ponds upstream could be identified to store water and prevent significant overland flow.

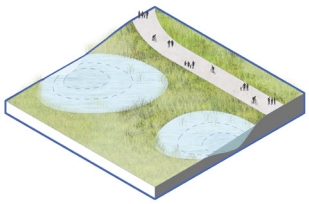
3 COMMUNITY / EVACUATION ROUTE FLOODING

Location: Redwood High School, Neil Cummins School

Potential Adaptation Strategy: Complete Green & Elevated Streets, Green Schoolyard Detention Basins



Complete Green



Detention Basin

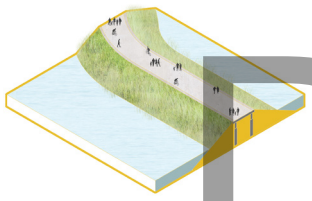
Elevating Tamalpais Dr, Doherty Dr, and Lucky Dr on embankments would mitigate the flooding of key evacuation routes, ensuring that these critical roadways remain accessible during flood events. Incorporating green infrastructure, such as permeable surfaces and bio-swales, would help manage stormwater runoff. Interior drainage improvements would also be necessary to convey

stormwater across elevated roadways to the creek or the bay. Constructing detention basins on public property, such as recreational areas or school ballfields, could temporarily capture and store excess stormwater during heavy rainfall, reducing flood risks in surrounding areas.

4 FLOODING ON CURRENT LEVEE ALIGNMENT

Location: SMART Route, Corte Madera Marsh

Potential Adaptation Strategy: Levee / Embankment, Horizontal Levee



Levee

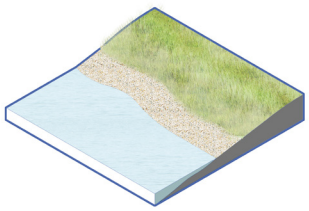
Constructing a horizontal levee along the former rail alignment would provide effective flood protection for some of the surrounding developed areas and sections of the 101 freeway. The horizontal levee would create a gradual transition from wetland to upland, providing flood protection and allowing habitat migration as sea levels rise. This strategy only provides long-term protection if tied into a district-scale flood protection system.

5 EROSION, WAVE OVERTOPPING

Location: San Clemente Creek, Corte Madera Marsh

Potential Adaptation Strategy: Coarse Grain Beaches, Bulkhead, Breakwater

Implementing coarse grain beaches along the bay facing shoreline of San Clemente Creek would help protect and restore habitat.



Coarse Grain Beach

These beaches would be composed of larger, more stable sediments that can better withstand wave action and erosion, providing a natural buffer against sea level rise and storm surges. Offshore measures, such as a breakwater structure, can help attenuate wave energy, reduce erosion, and preserve the shoreline profile. Additionally, floodwall or bulkhead structures can be used on the backshore of beaches to protect surrounding properties from flooding and overtopping.

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FOCUS AREA:

SAN RAFAEL - CANAL

VULNERABILITY OVERVIEW

The City of San Rafael is situated on San Rafael Bay, part of the San Francisco Bay. Approximately 60,000 people reside in the city, which contains wetlands and rivers (Gallinas Creek, South Fork Gallinas Creek, and San Rafael Creek) that border or cross important infrastructure. US-101 and I-580 converge in San Rafael, and this interchange is a critical asset due to it being a low-lying asset susceptible to flooding and a key connection point for regional traffic.

Flooding represents a severe threat to essential evacuation routes such as Bellam Blvd, which is expected to experience permanent inundation at 10 inches of sea level rise. US-101 and I-580 are also at risk, with I-580 facing permanent flooding under the same sea level scenario. As I-580 leads into the Richmond-San Rafael Bridge, it is crucial for maintaining connectivity between Marin County and the East Bay.

Developed areas along Kerner Blvd and Shoreline Pkwy will see temporary inundation with 10 inches of sea level rise. On the other hand, shoreline erosion is leading to noticeable trail overtopping, which impacts the key recreational spot San Rafael Bay Shoreline Path. Jean and John Starkweather Shoreline Park also experiences stormwater flooding, which is further exacerbated by 10 inches of sea level rise and emergent groundwater.

SUMMARY OF VULNERABLE ASSETS:

TRANSIT ASSETS

HIGHWAY 101 & HIGHWAY 580

RICHMOND-SAN RAFAEL BRIDGE

71 BUS STOPS

1 SMART STATION

4 HUB & PARK LOCATIONS

ONGOING ADAPTATION PLANNING

- San Quentin Pump Station Reconstruction
- Spinnaker Marsh Restoration
- Tiscornia Marsh Restoration and Sea Level Rise Adaptation Project
- Sea Level Rise Adaptation Transportation Infrastructure (US-101)

A king tide event in the San Rafael Canal neighborhood. Photo by George Alfaro/Kneedeep Times.

APPROACH

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TRANSIT CENTER
SAN RAFAEL HIGH SCHOOL
MARIN YACHT CLUB
LOWRIE YACHT HARBOR
PICKLEWEED COMMUNITY CENTER
JAMES B DAVIDSON MIDDLE SCHOOL
SAN RAFAEL
HOME DEPOT
SEE CORTE MADERA/ LARKSPUR
DRAFT
SAN RAFAEL
1" = 1800'
Adaptation Strategies
Nature Based Adaptation Strategies
Existing Culverts
Existing Pump Stations
City Boundary
Roads
Green Open Space
Parks / School Playgrounds
Streams
Flooding on Roads / Trails / Transit
Temporary Flooding
10 20 30 39 49 59
Permanent Flooding
10 20 30 39 49 59
Emergent/Shallow Groundwater
0 12 24 36 48 52 66

FOCUS AREA:

SAN RAFAEL - CANAL

KEY ADAPTATION CHALLENGES & POTENTIAL STRATEGIES

The following challenges have been identified for the San Rafael area and correspond to the adjacent map.

1 FLOODING OF DEVELOPED AREAS

Strategy: Horizontal Levee, Detention Pond

2 SHORELINE EROSION & TRAIL OVERTOPPING

Strategy: Levee, Coarse Beach, Breakwater

3 FLOODING OF EVACUATION ROUTES

Strategy: Elevate on Embankment

4 101 & 580 FLOOD HAZARD

Strategy:

- A: Elevate Transportation Assets (Highways, SMART rail, major roads)
- B: Tide Gate Upstream (Grand Ave OR Ped Crossing) + floodwalls along San Rafael Creek
- C: Tide Gate Downstream (Pickleweed Park)

5 STORMWATER FLOODING

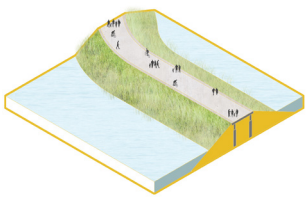
Strategy: Green Schoolyard Detention Ponds/Basins

ADAPTATION OPPORTUNITY DESCRIPTIONS

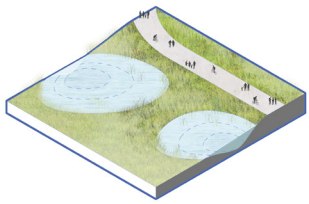
1 FLOODING OF DEVELOPED AREAS

Location: Marsh north of Home Depot

Potential Adaptation Strategy: Horizontal Levee, Detention Pond



Levee



Detention Basin

Constructing a horizontal levee and detention pond improvements north of the Home Depot property would provide effective flood protection for some of the surrounding developed areas and sections of the 580 freeway. The horizontal levee would create a gradual transition from wetland to upland, providing flood protection and allowing habitat migration as sea levels rise. The detention pond would capture and store stormwater runoff, reducing flooding risks by managing peak flows during heavy rainfall or high tides. These strategies only provide long-term protection if tied into a district-scale flood protection system.

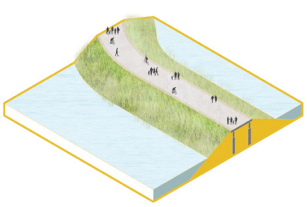
2 SHORELINE EROSION AND TRAIL OVERTOPPING

Location: Along the SF Bay Trail Shoreline

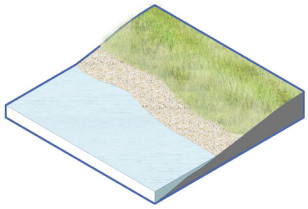
Potential Adaptation Strategy: Levee, Coarse Beach, Breakwater

A district-scale adaptation plan for the canal district

is needed to develop a long- term perimeter protection and interior drainage strategy, likely involving levees and seawalls as well as culverts and pump stations.



Levee



Coarse Grain Beach

Constructing a levee, coarse beach, and breakwater along the existing Bay Trail alignment offers a solution to address shoreline erosion and coastal storm overtopping. The levee would act as a barrier against rising sea levels and storm surges, protecting the trail and the community, if tied into a districtwide flood protection system. A coarse beach in front of the levee would help absorb wave energy and reduce erosion, while an offshore breakwater would further dissipate wave forces before they reach the shore, enhancing some subtidal habitat areas.

3 FLOODING OF EVACUATION ROUTES

Location: Bellam Blvd, Canal St, Kerner Blvd

Potential Adaptation Strategy: Elevate on Embankment

Elevating Bellam Blvd, Canal St, and Kerner Blvd on an embankment would mitigate the flooding of key evacuation routes, ensuring that these critical roadways remain accessible during flood events, including those caused by heavy rainfall, storm surges, or sea level rise. While this strategy is best exemplified by Bellam Blvd, it can be adapted to other vulnerable evacuation routes in the area, enhancing overall community resilience. Incorporating green infrastructure, such as permeable surfaces and bio-swales, would help manage stormwater runoff.

4 101 & 580 FLOOD HAZARD

Location:

- A. San Rafael creek - Grand Ave,
- B. San Rafael creek,
- C. Marin Yacht club- levee improvement along bay trail

Potential Adaptation Strategy:

- Strategy A: Elevate Transportation Assets (Highways, SMART rail, major roads) - Elevating key transportation infrastructure, such as Hwy 101 and 580, the SMART rail, the San Rafael Transit Hub and major roads would protect the assets themselves from flooding. By raising these assets above anticipated flood levels, this strategy ensures continued operation and connectivity during extreme weather events or rising sea levels, reducing the risk of closures and disruptions and safeguarding access and mobility for the community. However, this approach would not provide flood protection for the surrounding community.
- Strategy B: Tide Gate Upstream (Grand Ave, Ped Crossing) + floodwalls along San Rafael Creek - Installing a tide gate upstream on the San Rafael Canal near Grand Ave and constructing floodwalls along San Rafael Creek up to Pickleweed Park, would better protect central San Rafael and the Canal District from flooding, particularly during high tides and storm events. The floodwall improvements would include raising and reinforcing both sides of the canal to ensure they can withstand higher water levels and increased storm surges anticipated with sea level rise. In the long-term, installing a tide gate would help regulate the flow of tidal

Strategy A, B & C for 101 & 580 Flooding

- waters up San Rafael Creek, thereby reducing the risk of tidal flooding in the surrounding areas. The tide gate would allow freshwater to flow out during low tide, which eventually would require pumping after sea level rise reached a critical point. These measures could have substantial environmental tradeoffs requiring thorough consideration.
- Strategy C: Tide Gate Downstream (Pickleweed Park) - Installing a tide gate downstream on the San Rafael Canal near Pickleweed Park, would better protect central San Rafael and the Canal District from flooding, particularly during high tides and storm events. Some floodwall improvements would likely be required upstream of the tide gate to reinforce both sides of the canal to ensure they can withstand inland flood events. In the long-term, installing a tide gate would help regulate the flow of tidal waters up San Rafael Creek, thereby reducing the risk of tidal flooding in the surrounding areas. The tide gate would allow freshwater to flow out during low tide, which eventually would require pumping after sea level rise reached a critical point. These measures could have substantial environmental tradeoffs requiring thorough consideration.

5 STORMWATER FLOODING

Location: San Rafael High School, James B Davidson Middle School

Potential Adaptation Strategy: Green Schoolyard Detention Ponds/Basins

Constructing detention basins on public property, such as recreational areas or school ballfields, could temporarily capture and store excess stormwater during heavy rainfall, reducing flood risks in surrounding areas. By integrating green infrastructure into these spaces, the basins would not only manage stormwater effectively but also offer educational and ecological benefits, as well as water quality improvements.

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FOCUS AREA:

SANTA VENETIA

VULNERABILITY OVERVIEW

Santa Venetia, situated in Eastern Marin along San Pablo Bay, is home to approximately 4,200 residents. Gallinas Creek—which connects to San Pablo Bay and branches out through Santa Venetia—poses a significant risk of overtopping, impacting surrounding communities. The area is particularly vulnerable to flooding due to its historical development on marshland, leading to challenges with both groundwater emergence and creek-related inundation.

The 2-mile stretch of US-101 running through Santa Venetia and its access roads are affected by shallow groundwater, even in the absence of sea level rise. This poses a challenge for maintaining road integrity and safety. Additionally, essential transportation assets—the SMART route, 19 bus stops, and the San Rafael Airport—are vulnerable to both groundwater and permanent flooding, which can disrupt transportation and daily commutes. Flooding of evacuation routes and surrounding communities further complicates emergency response and accessibility.

Community impacts are exacerbated by the overtopping of Gallinas Creek, causing frequent flooding in neighborhoods and roads. With a 20-inch rise in sea level, the area is anticipated to face permanent flooding, significantly affecting residential properties and infrastructure. The community must prepare for these changes by implementing flood mitigation measures and improving drainage systems to protect homes and roads from frequent and severe flooding events.

SUMMARY OF VULNERABLE ASSETS

TRANSIT ASSETS

HIGHWAY 101

19 BUS STOPS

1 AIRPORT

1 INGRESS/EGRESS ROUTE

LIFELINES

1 FIRESTATION

2 POLICE STATIONS

UTILITIES

9 PUMP STATIONS

ONGOING ADAPTATION PLANNING

- McInnis Marsh Habitat Restoration
- Proposed Santa Venetia Levee Upgrade

Water in Las Gallinas Creek approaches homes in the Santa Venetia November, 2020. Photo by Alan Dep/ Marin Independent Journal.

APPROACH

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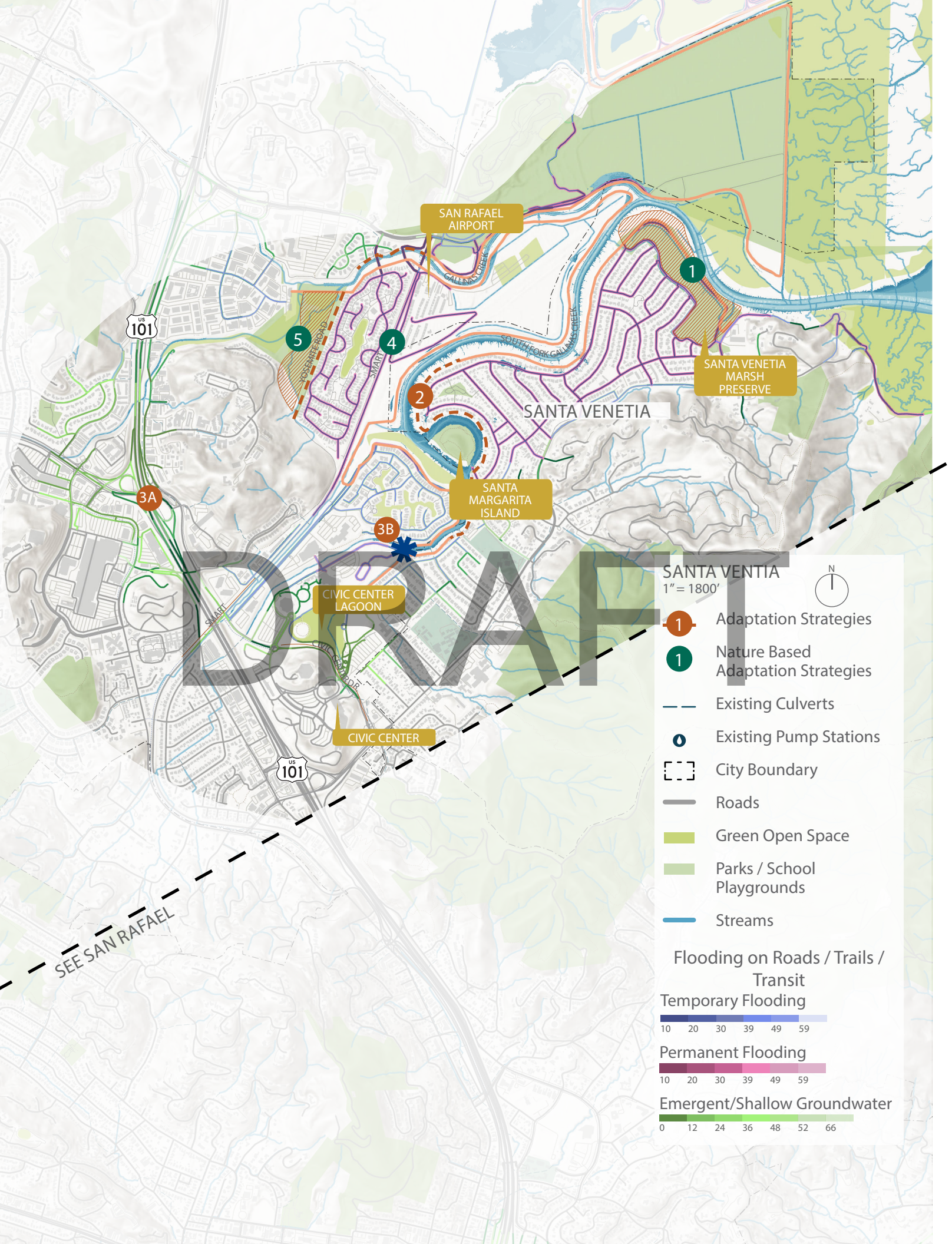
SAN RAFAEL AIRPORT
GALLINAS CREEK
SOUTH FORK GALLINAS CREEK
SANTA VENETIA MARSH PRESERVE
SANTA VENETIA
SANTA MARGARITA ISLAND
CIVIC CENTER LAGOON
CIVIC CENTER
YOSEMITE ROAD
SMART
SAN RAFAEL
CIVIC CENTER DR
US 101
1
2
3A
3B
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5
SEE SAN RAFAEL
DRAFT
SANTA VENTIA
1" = 1800'
N
Adaptation Strategies
Nature Based Adaptation Strategies
Existing Culverts
Existing Pump Stations
City Boundary
Roads
Green Open Space
Parks / School Playgrounds
Streams
Flooding on Roads / Trails / Transit
Temporary Flooding
10 20 30 39 49 59
Permanent Flooding
10 20 30 39 49 59
Emergent/Shallow Groundwater
0 12 24 36 48 52 66

FOCUS AREA:

SANTA VENETIA

KEY ADAPTATION CHALLENGES & POTENTIAL STRATEGIES

The following challenges have been identified for the Santa Venetia area and correspond to the adjacent map.

1 CREEK OVERTOPPING

Strategy: Horizontal Levee

2 NEIGHBORHOOD / ROAD FLOODING

Strategy: Bulkhead / Sheet Pile

3 GROUNDWATER EMERGENCE AT 101 AND ACCESS ROADS

Strategy:

- A: Complete Green & Elevated Streets, Pump Station
- B: Tide Gate

4 FLOOD HAZARDS ON SMART ROUTE & COMMUNITY

Strategy: Elevate Transit on Embankment, Horizontal Levee

5 FLOODING OF EVACUATION ROUTE & COMMUNITY

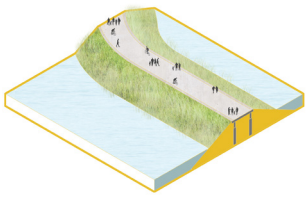
Strategy: Horizontal Levee, Elevation of Roads on Embankment

ADAPTATION OPPORTUNITY DESCRIPTIONS

1 CREEK OVERTOPPING

Location: Along Santa Venetia marsh preserve and Yosemite Road

Potential Adaptation Strategy: Horizontal Levee



Levee

Constructing a horizontal levee along the eastern perimeter of the Santa Venetia neighborhood would provide flood protection if connected into perimeter defenses along the South Fork Gallinas Creek. The horizontal levee would create a gradual transition from wetland to upland, allowing habitat migration as sea levels rise. A horizontal levee could also be used to protect the neighborhood between North Fork Gallinas Creek and the SMART rail alignment (accessed by Yosemite Rd.). This levee would have similar benefits if tied into a complete perimeter defense systems for this neighborhood.

2 NEIGHBORHOOD / ROAD FLOODING

Location: San Rafael Runway, along the South Fork Gallinas Greek

Potential Adaptation Strategy: Bulkhead / Sheet Pile

Installing a sheet pile wall would increase flood protection along the South Fork Gallinas Creek, benefitting much of the Santa Venetia neighborhood if tied into a complete perimeter protection system. Sheet pile walls are recommended due to space

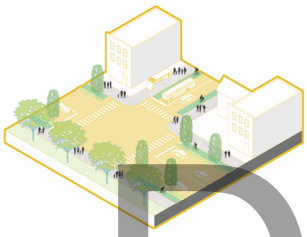
constraints between private property boundaries and the creek. Existing plans are in development considering a similar concept for this location.

3 GROUNDWATER EMERGENCE AT 101 AND ACCESS ROADS

Location: Civic Center Dr, near Duck Pond and on 101

Potential Adaptation Strategy:

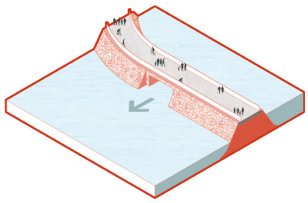
- Strategy A: Complete Green & Elevated Streets, Pump Station -



Complete Green

Elevating low-lying segments of Civic Center Dr between Freitas Pkwy and N San Pedro Rd would mitigate some flood risk for Highway 101 in this area and protect key evacuation routes, ensuring that these critical roadways remain accessible during flood events, including those caused by heavy rainfall, storm surges, or sea level rise. While this strategy is best exemplified by Civic Center Dr, it can be adapted to other vulnerable evacuation routes in the area, enhancing overall community resilience. Incorporating green infrastructure, such as permeable surfaces and bio-swales, would help manage stormwater runoff. This strategy also require stormwater drainage improvements including culverts and a pump station to convey stormwater from upland areas to the bay during intense rainfall events.

- Strategy B: Tide Gate -



Tide Gate

Installing a tide gate upstream on the South Fork Gallinas Creek near Civic Center Dr and constructing floodwalls and levees along the creek up to its connection with the bay, would better protect Highway 101 and the Civic Center and Santa Venetia district from flooding, particularly during high tides and storm events. The floodwall/levee improvements would include raising and reinforcing both sides of the creek to ensure they can withstand higher water levels and increased storm surges anticipated with sea level rise. In the long-term, installing a tide gate would help regulate the flow of tidal waters up the creek into Terra Linda, thereby reducing the risk of tidal flooding in the surrounding areas. The tide gate would allow freshwater to flow out during low tide, which eventually would require pumping after sea level rise reached a critical point. These measures could have substantial environmental tradeoffs requiring thorough consideration.

4 FLOOD HAZARDS ON SMART ROUTE & COMMUNITY

Location: SMART Route

Potential Adaptation Strategy: Elevate Transit on Embankment, Horizontal Levee

Elevate Transit on Embankment, Horizontal Levee

In the long-term, low-lying sections of the SMART rail alignment may need to be elevated onto an enhanced embankment or protected with floodwalls. Augmenting the existing embankment to create a horizontal levee can also be considered in sections

where space between the alignment and nearby properties and waterways would allow for this. The horizontal levee would create a gradual transition from wetland to upland, allowing habitat migration as sea levels rise.

5 FLOODING OF EVACUATION ROUTE & COMMUNITY

Location: Yosemite Road

Potential Adaptation Strategy: Horizontal Levee, Elevation of Roads on Embankment

Yosemite Road is currently the only ingress/egress route for daily traffic or emergency evacuation from the neighborhood here adjacent to the San Rafael Airport. Elevating Yosemite Rd and installing perimeter flood protection for this community would provide life safety and property protection benefits. Utilizing an embankment would mitigate the flooding of this evacuation route, ensuring that the community's critical roadway and bridge remain accessible during flood events, including those caused by heavy rainfall, storm surges, or sea level rise. While this strategy is best exemplified by Yosemite Dr, it can be adapted to other low-lying sections of evacuation routes in the area, enhancing overall community resilience. Bridge replacement should also be considered for Yosemite Road.

FOCUS AREA:

NOVATO

VULNERABILITY OVERVIEW

The northernmost city in Marin, Novato sits on San Pablo Bay, part of San Francisco Bay. The city includes wetland areas and Novato Creek, which runs through the main commercial district. SR-37 and US-101 meet in the city. This interchange is a critical transportation asset vulnerable to sea level rise.

The transportation network in Novato is widely impacted by flooding, particularly affecting the SMART route. Rush Creek, which drains along the SMART rail alignment, is poorly maintained and contributes to frequent flooding. Additionally, groundwater emergence on US-101 complicates travel and infrastructure stability. The area is served by 27 bus stops, which are crucial for local transit. However, the combined issues of flooding and groundwater emergence highlight the urgent need for enhanced drainage and maintenance to ensure reliable transportation throughout the region.

Marsh subsidence and a lack of sediment east of US-101 contribute to the vulnerability of the extensive marshlands, including those surrounding Deer Island. Groundwater emergence around Scottsdale Marsh affects key community locations such as Lynwood Elementary School and Vintage Oaks Shopping Center. Mitigation efforts are essential to protect these vital community assets and ensure the resilience of the local environment and infrastructure.

SUMMARY OF VULNERABLE ASSETS

TRANSIT ASSETS

27 BUS STOPS

LIFELINES

1 HOSPITAL / HEALTHCENTER

COMMUNITY ASSETS

1 LIBRARY

6 SCHOOLS

ONGOING ADAPTATION PLANNING

- Novato Baylands and Flood Protection
- Deer Island Basin Complex Tidal Wetlands Restoration
- Sea Level Rise Adaptation Transportation Infrastructure | SR-37
- Hamilton Levee
- Novato Creek Sediment Removal and Wetland Enhancement Project

A truck sits in flood water along westbound Highway 37 near Highway 101 in Novato, February 2019. Photo by Alan Dep/Marin Independent Journal.

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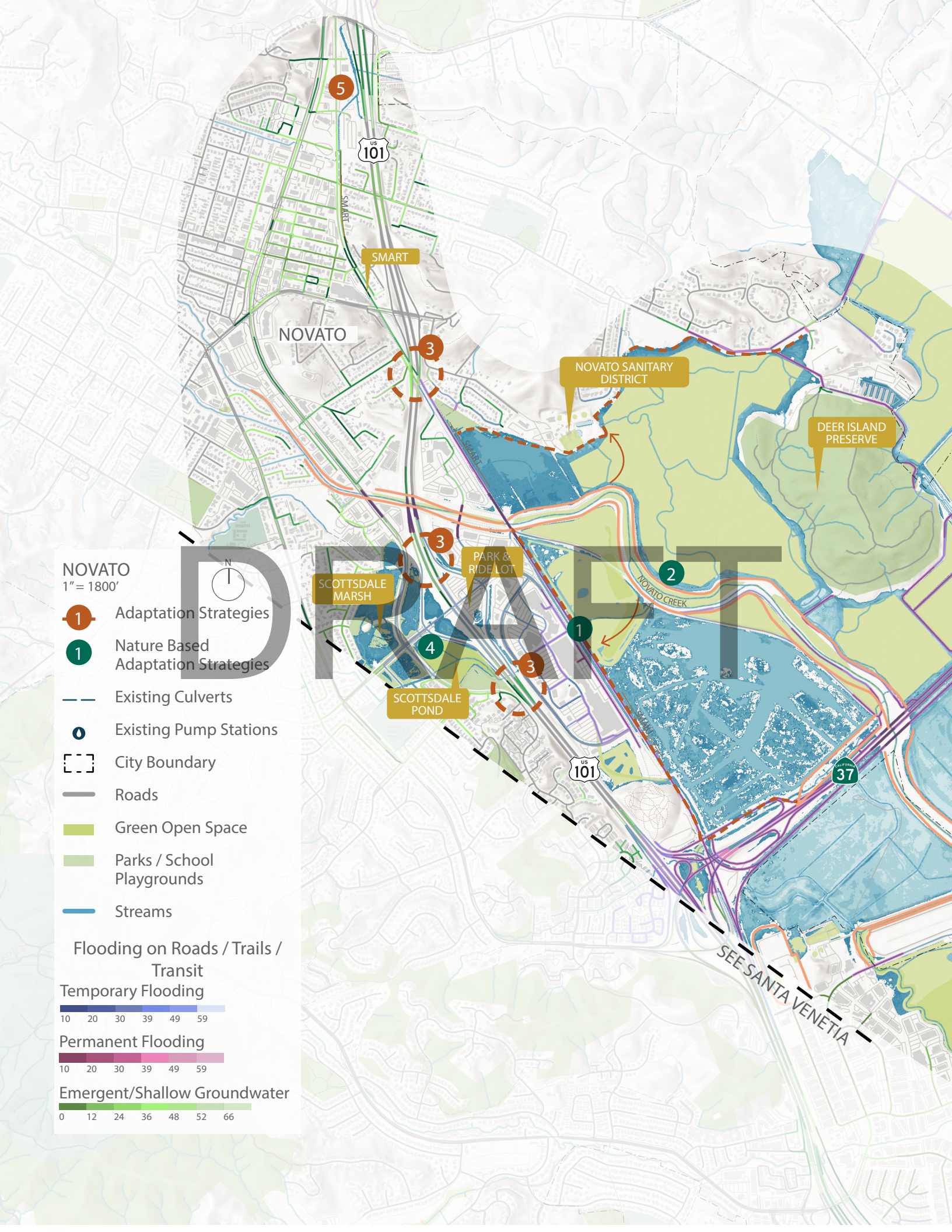
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SMART
NOVATO
NOVATO SANITARY DISTRICT
DEER ISLAND PRESERVE
PARK & RIDE LOT
SCOTTSDALE MARSH
SCOTTSDALE POND
NOVATO CREEK
US 101
37
SEE SANTA VENETIA
DRAFT

FOCUS AREA:

NOVATO

KEY ADAPTATION CHALLENGES & POTENTIAL STRATEGIES

The following challenges have been identified for the Novato area and correspond to the adjacent map.

1 FLOODING OF SMART ROUTE

Strategy: Elevate Transit on Embankment, Horizontal Levee, Relocation of levees along the perimeter of Novato Creek Marsh

2 MARSH SUBSIDENCE & LACK OF SEDIMENT

Strategy: Breaching Creek Channels

3 GROUNDWATER EMERGENCE ON 101

Strategy: Pump Station, Levee / Embankment

4 GROUNDWATER EMERGENCE AROUND SCOTTSDALE MARSH

Strategy: Detention Ponds, Pump Station / Culvert

5 FLOODING OF SMART ROUTE ALONG RUSH CREEK

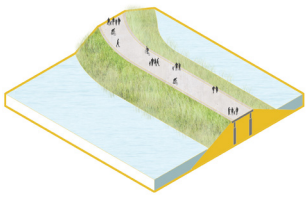
Strategy: Improve Drainage Capacity via Detention Ponds, Pump Station / Culvert

ADAPTATION OPPORTUNITY DESCRIPTIONS

1 FLOODING OF SMART ROUTE

Location: SMART Route

Potential Adaptation Strategy: Elevate Transit on Embankment, Horizontal Levee, Relocation of levees along the perimeter of Novato Creek Marsh



Levee

In the long-term, low-lying sections of the SMART rail alignment may need to be elevated onto an enhanced embankment or protected with floodwalls or levees. Augmenting the existing embankment to create a horizontal levee can also be considered in sections where space between the alignment and nearby properties and waterways would allow for this. The horizontal levee would create a gradual transition from wetland to upland, allowing habitat migration as sea levels rise. Relocating the existing levees along the south side of Novato Creek to adjacent the SMART rail alignment will open up substantial wetland restoration opportunities in the Novato Creek Unit of the Petaluma Marsh Wildlife Area. This strategy would require protection of Highway 37, likely utilizing levees, in the segment between Highway 101 and the bridge across Novato Creek.

2 MARSH SUBSIDENCE & LACK OF SEDIMENT

Location: Along Novato Creek

Potential Adaptation Strategy: Breaching Creek Channels

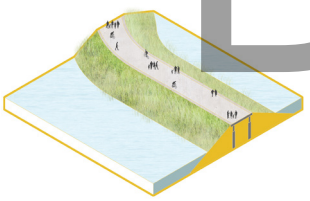
Strategically breaching the existing levees along the

north side of Novato Creek in the areas west and south of the Deer Island Preserve would allow for floodplain and wetland restoration opportunities. This strategy could require additional levees around the perimeter of the existing open space area to protect the Novato Sanitary District property as well as other adjacent properties with existing development. Reconnecting the creek and tidal flows to this area of open space would bring both brackish water and sediment which could help improve habitat for certain native species. Adaptive management practices could be used to monitor improvements over time and augment restoration efforts as needed.

3 GROUNDWATER EMERGENCE ON 101

Location: Along 101

Potential Adaptation Strategy: Pump Station, Levee / Embankment



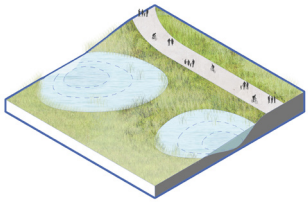
Levee

Elevating Highway 101 on an embankment in the areas surrounding Novato Creek could mitigate risks from future emergent groundwater. Impermeable cutoff walls, if located strategically, combined with pumps could also help to manage emergent groundwater issues in problem areas. This strategy would require more robust investigation.

4 GROUNDWATER EMERGENCE AROUND SCOTTSDALE MARSH

Location: Scottsdale Pond

Potential Adaptation Strategy: Detention Ponds, Pump Station / Culvert



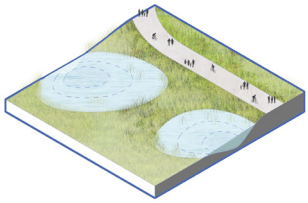
Detention Basin

A groundwater management strategy is likely required for mitigating future roadway flooding from emergent groundwater and stormwater accumulation in the area surrounding the current Scottsdale Pond. Enhancing this area's ability to function as a stormwater detention pond could alleviate flood risks during intense rainfall events. Considering cutoff walls along with pumps and culverts could also be investigated to help manage emergent groundwater.

5 FLOODING OF SMART ROUTE ALONG RUSH CREEK

Location: Along Rush Creek

Potential Adaptation Strategy: Improve Drainage Capacity via Detention Ponds, Pump Station / Culvert



Detention Basin

Improving drainage capacity along the SMART route at Rush Creek could mitigate flood risk, particularly with respect to emergent groundwater. Strategies to manage drainage may include a combination of identifying areas to detain water and building a series of pump stations and culverts to move water.

DRAFT

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