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

FINAL REPORT - MAY 2025

TRANSPORTATION AUTHORITY OF MARIN

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SECTION 1

EXECUTIVE SUMMARY

The Transportation Authority of Marin (TAM) has developed a comprehensive Sea Level Rise Adaptation Planning Study (Study) to address the critical challenges posed by rising sea levels and coastal flooding to Marin County's transportation infrastructure.

Sea level rise (SLR) affects everyone in Marin County, from those living close to the shoreline to those living in the hills. Even those with property outside of inundation zones will be affected by service disruptions due to the flooding of emergency services and hospitals, and, most relevant to TAM's interests, delays and congestion on local roads when flooding disrupts key transportation routes such as Highway 101 and State Route 37. The impacts are likely to be felt most acutely by community members with fewer resources and historically underserved communities.

Marin County has been a leader in California and across the nation in understanding and preparing for SLR. To date, there have been several important efforts to identify exposure and hazards, as well as begin to map solutions, including countywide projects such as Marin SLR (previously known as BayWave and C-SMART), in combination with existing and burgeoning localized efforts in Sausalito, Mill Valley, Corte Madera, San Rafael, and elsewhere.

With the passage of Measure AA, TAM has dedicated, on-going funds for SLR protection, estimated at $250,000 annually based on the current revenue projections. These funds have a wide array of eligibility and potential application and were used to develop this study.

Even with this dedicated funding, the overall landscape to implement SLR resilience projects remains complicated, especially given the estimated cost to adapt: $17B for the county, according to MTC/ABAG and BCDC estimates. Many areas rely on haphazard measures and aging infrastructure to remain dry today, and SLR adaptation presents an opportunity for an intentional, coordinated effort to address vulnerabilities and improve community infrastructure.

In addition to funding, public engagement is crucial to implementation of SLR adaptation work in Marin. Success hinges on outreach and incorporation of community needs into resilience projects.

This Study identified a diverse set of adaptation strategies tailored to the county's unique landscape, including:

- **Physical Infrastructure Enhancements**: Elevating roads, constructing horizontal levees, and installing pump stations and tide gates.
- **Nature-Based Strategies**: Restoring marshlands, creating coarse grain beaches, and expanding green infrastructure.
- **Policy and Governance Initiatives**: Establishing a cohesive Subregional Plan network, adopting climate-resilient transportation design principles, and developing a Voluntary SLR Adaptation Policy to align local jurisdictions with TAM's goals.

This Study reflects TAM's commitment to protecting Marin County's transportation network while fostering equity and enhancing nature. By leveraging partnerships and innovative solutions, TAM is positioning Marin County to adapt to the challenges of SLR and show what is possible to other coastal communities in California and beyond.

SECTION 2

INTRODUCTION / CONTEXT

This Study is intended to provide a clear, actionable framework for TAM and its partner agencies to address SLR impacts in the Marin County through identifying vulnerabilities, evaluating strategies, and implementing practical solutions to ensure the resilience of critical transportation infrastructure. The Study is intended to be a:

- Practical tool to inform policy decisions, project planning, and resource allocation.
- Guide for implementing SLR adaptation strategies
- Collaborative framework for countywide action
- Resource for funding and project prioritization

This Study is not intended to be:

- A one-size-fits-all solution
- A replacement for local planning efforts
- A static document—adaptation is ongoing

As the County Transportation Agency, TAM acts as a leader, funder, and partner in advancing SLR adaptation. TAM coordinates regional efforts, facilitates collaboration, and secures funding for critical projects. The primary audience for this Study includes TAM, local and regional agencies, and policymakers. The work aims to progress SLR adaptation planning in the county, including feeding into local RSAPs, from a transportation lens. While TAM led this effort, the Study provides valuable insights for local governments, public works and transportation departments, and community-based organizations (CBOs) seeking to enhance their resilience efforts to address sea level rise and coastal flooding.

2.1 STUDY APPROACH

This Study included the following process to move TAM and its partners toward implementation:

- Baseline Analysis: A review of existing studies and GIS datasets to establish a foundation for planning.
- Vulnerability Assessment: Identification of high-risk areas and vulnerability to transportation assets.
- Engagement: Active collaboration with local jurisdictions, focus groups, and a Technical Advisory Committee (TAC).
- Adaptation Strategy Development: Evaluation of the ongoing projects and vulnerabilities for all focus areas with an in-depth investigation into focus areas with a high concentration of vulnerable transportation assets, critical infrastructure, and equity communities, integrating nature-based and engineered approaches.
- Implementation Roadmap: A phased strategy for advancing ongoing and emerging adaptation projects and policies.

2.2 ONGOING EFFORTS

This Study complements several ongoing initiatives, leveraging their insights while filling critical gaps in transportation resilience planning. Some of the efforts that are happening in parallel to this Study are described below. Their implications for this work are detailed further in the implementation section:

1. Marin SLR: Marin SLR, a Marin County-led initiative previously called BayWave, assesses SLR impacts across Marin County. The Study builds on Marin SLR's findings by focusing specifically on transportation infrastructure.
2. SLR Governance Project: A Marin County-led governance study aims to establish a coordinated approach to SLR adaptation countywide. This Study aligns with the governance project's goals, offering actionable strategies for transportation assets.
3. Senate Bill 272: Senate Bill (SB) 272 requires coastal jurisdictions to develop Regional Shoreline Adaptation Plans by 2034. This Study aligns with and informs this legislative requirement, providing a foundation for local jurisdictions to meet their obligations effectively.
4. Caltrans Adaptation Planning: Caltrans is currently working on a study to analyze Highway 101 from Marin City to San Rafael for adaptation to sea level rise. Like the work underway on other Caltrans facilities in the County (US-1 and SR-37), it is expected that Caltrans will continue to advance adaptation solutions for their facilities within Marin County. These adaptation solutions may provide co-benefits to other communities and assets in Marin County.

Bringing together vulnerability and hazard analysis with actionable strategies for implementation positions TAM and its partners to deliver adaptation projects at a scale and pace to match levels of expected risk, making Marin County a model for resilience.

Bel Marin Keys Wetland Restoration, 2020. Photo by WRT Environmental Consultants.

Marin County timber-reinforced levee system, August 2021. Photo by Marin County Public Works.

SECTION 3

SUMMARY OF RELEVANT PLANS

In the first phase of the project, TAM reviewed existing plans and GIS datasets to establish a baseline dataset and understanding of relevant previous and ongoing work in Marin County to guide this Study.

3.1 PURPOSE

The goals of the Existing Plan Review were threefold:

1. Establish a baseline level of awareness and understanding of the breadth and depth of existing work related to SLR adaptation regionally and in Marin County. Much work has been done to understand and plan for the impact of SLR in the Bay Area and in Marin County. In this project and related efforts, it is critical to avoid, to the extent possible, duplication of previous work. Reviewing prior work also allows TAM to develop an up-to-date familiarity with studies completed by local and regional partners to benefit collaboration.
2. Create a shortlist of potentially viable SLR adaptation strategies that are compatible with the Marin context and pre-identify (i.e., before GIS analysis) known vulnerability "focus areas" from prior works; accomplish this through broad review of:
   - Existing or planned projects in Marin
   - Vulnerable sites / areas in Marin (as identified from previous studies)
   - Adaptation strategies from national/international precedents

   The focus on projects, vulnerable areas, and precedent strategies prepared TAM to develop concept-level adaptation measures for potential implementation in Marin County, discussed in Section 6.
2. Develop a GIS geodatabase from prior efforts to be used in this project and held by TAM for future planning efforts. As a companion deliverable of this Existing Plan Review, a geospatial inventory of assets and projects has been provided to TAM in the form of a geodatabase. This baseline GIS dataset builds the foundation for the first technical task of this project, in which vulnerable assets and locations will be identified from the dataset.

3.2 FINDINGS

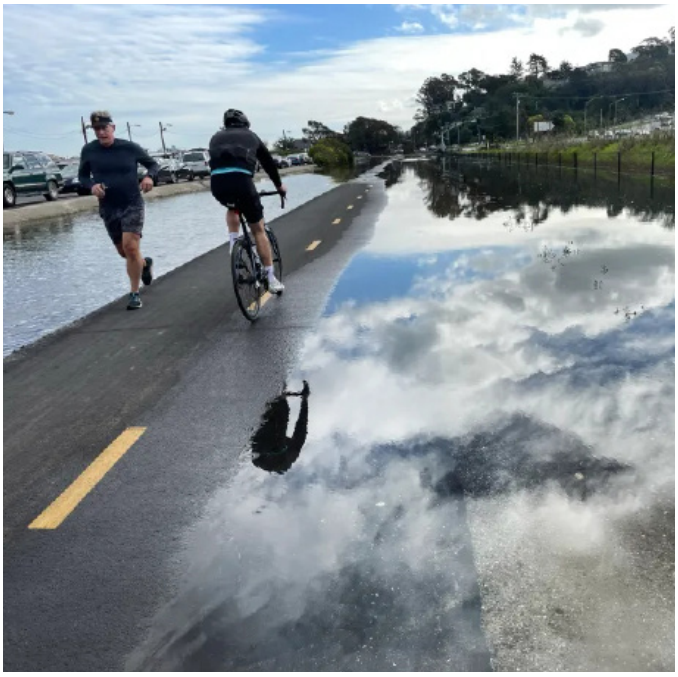
The key findings from the Existing Plan Review set the foundation the Study. Those findings included are summarized below:

- Significant effort has gone into evaluating SLR exposure to transportation assets in the Bay Area and Marin County. This previous work provides a solid foundation upon which to build this Study. There is consensus on many vulnerable transportation assets and broader areas in the county, such as the US101/580 interchange, US 101/Lucky Drive, State Route 37, Highway 1, and the Manzanita Park & Ride.
- Much of the Bay Area's critical transportation assets are located along the bay and ocean coast, and this is particularly true in Marin County. This means that transportation assets, and the network more broadly, are highly vulnerable to SLR based on low elevation, subsidence, and a lack of regional shoreline flood defense infrastructure.
- Estimated costs for adaptation solutions are extremely high. For Marin County, the total cost of protecting against two feet (2') of SLR is estimated to be $17B. Regional documents acknowledge that there is a major gap in funding between what is needed and what is potentially available from existing sources.

- A focus on the transportation system can be an effective strategy at moving the needle on SLR adaptation. More funding has become available to address coastal resilience and transportation needs, including the state level Caltrans SB1 grants.
- There is strong interest and support for adaptation solutions that complement or enhance the natural environment, as documented in the Living Shorelines study in Tomales Bay, dune restoration study in Stinson Beach, and permaculture concepts in Resilient by Design project, The Peoples Plan. These proposals align with the high value placed on nature and open space areas by residents and political leaders. A robust discussion of tradeoffs is still needed to better understand the limitations of nature-based solutions and the effectiveness of these strategies compared to others.
- Larger-scale flood and SLR adaptation work crosses jurisdictional boundaries which complicates implementation and calls for Marin County to play a key role in helping guide or facilitate action. Understanding the work completed or planned to date, and the near- and long-term needs, will support decision-making at the county level to implement appropriate adaptation solutions.

The documents that TAM reviewed were developed by local and regional bodies and include plans, studies, and projects with a focus on transportation and information about SLR vulnerability and adaptation in Marin County. The list has been summarized below by geographic scope: regional, county, and community/project.

Highway 37, August 2022. Photo by John Burgess/The Press Democrat.



Cyclist and Jogger on a flooded path, January 2024. Photo by Sherry LaVars/Marin Independent Journal.

Table 1: Regional, county, and local plans, studies, and project reports reviewed

REGIONAL

- Adapting to Rising Tides (ART) Bay Area (BCDC, 2020)
- BARC Raising the Bar on Regional Resilience (BARC, 2018)
- BARC Shared Workplan for Regional Climate Adaptation (BARC, 2022)
- Bay Adapt Joint Platform Regional Strategy for a Rising Bay Implementation Brief (BCDC, 2021)
- CalOES California Adaptation Planning Guide (CalOES, 2020)
- Caltrans District 4 Climate Change Vulnerability Assessment (Caltrans, 2019)
- Capital Corridor Joint Powers Authority SLR Vulnerability Assessment (CCJPA, 2014)
- Plan Bay Area 2050 (MTC/ABAG, 2021)
- Plan Bay Area 2050+ Final Blueprint (MTC/ABAG, 2025)
- San Francisco Bay Shoreline Adaptation Atlas (SFEI/SPUR, 2019)

COUNTY

- Marin County Multi-Jurisdictional Local Hazard Mitigation Plan (MCM LHMP)
- Marin Ocean Coast Sea Level Rise Adaptation Report (C-SMART, 2018)
- Marin Ocean Coast SLR Vulnerability Assessment (C-SMART, 2016)
- Marin Shoreline Sea Level Rise Vulnerability Assessment (BayWAVE, 2017)
- Safety Element Update to the Countywide Plan Draft (Marin County, 2023)

COMMUNITY/PROJECT

- ART Richardson Local Assessment (BCDC, 2020)
- ART San Rafael Local Assessment (BCDC, 2020)
- Corte Madera Climate Adaptation Assessment (Town of Corte Madera, 2021)
- Corte Madera Creek Flood Risk Management Project – Phase 1 Components (2020)
- Lower Corte Madera Creek Improvement Study (2020)
- Marin City Pond Flood Reduction Project – Drainage Study (2018)
- Miller Avenue Streetscape Project (2017)
- Mill Valley Flood Management and Drainage Master Plan (2021)
- Resilient by Design Bay Area Challenge The People's Plan by Permaculture + Social Equity Team (P+SET, 2018)
- Santa Venetia Floodwall Basis of Design and Project Alternatives (2023)
- Sausalito General Plan (City of Sausalito, 2021)
- Shallow Groundwater Response to Sea Level Rise (2022)
- State Route 37 Corridor Planning and Environmental Linkages Study (SR 37 PEL Study) Draft (Caltrans, 2022)
- Stinson Adaptation and Resilience Collaboration (Stinson ARC, 2022)
- Stinson Beach Nature-based Adaptation Study (Coastal Conservancy/ County of Marin/ESA, 2021)
- TAM Annual Report 2022 (TAM, 2022)
- Tomales Bay Living Shorelines Feasibility Project (ESA, 2022)

SECTION 4

ENGAGEMENT AND FEEDBACK

TAM engaged with key agency and local partners throughout the study process to guide and co-create the Study. This section provides a summary of those activities.

Technical Advisory Committee: TAM invited representatives from the County of Marin, local cities within Marin County, Caltrans, MTC, and BCDC to serve on the TAC. The role of the TAC was to provide thought leadership and feedback throughout the course of the project through a series of six meetings. The TAC meetings focused on reviewing adaptation strategies for addressing vulnerabilities such as sea-level rise and groundwater emergence, presenting case studies like Corte Madera, and gathering feedback on the adaptation framework and implementation plans. The final meeting is expected to review and finalize the report with TAC input. Summaries of each TAC meeting can be found in Appendix C.

Focus groups: TAM convened an environmental focus group, and an equity focus group (comprised of advocates, community groups, and local agency staff) to solicit perspective and guidance on specific issues. Key take-aways from those conversations included the following:

- **Environmental Focus Group**: The meeting attendees highlighted the importance of comprehensive approaches and community involvement. Participants noted the value of high-level cost estimates to guide funding applications, refining map legends for clarity, and considering a range of SLR projections based on greenhouse gas (GHG) scenarios. Participants emphasized the immediate threat of fluvial flooding, the need for watershed-level planning, and prioritizing nature-based solutions. Action items included improving map clarity, incorporating historical photos, evaluating the financial impacts of flooding, and ensuring partner collaboration.
- **Equity Focus Group**: The meeting highlighted the importance of community engagement and clear communication in planning efforts. Key points included ensuring presentations are easily understandable and avoid technical jargon when connecting with the community. The meeting attendees suggested that TAM work with its Community Based Organization (CBO) and Non-Government Organization (NGO) partners to help train residents to share information and involve technical experts as needed, emphasizing community-first principles. The group discussed infrastructure resilience to protect people, not just physical structures, with a focus on collaboration, efficiency, and avoiding redundant efforts. Recommendations from this outreach are incorporated in the Implementation Strategy in Section 7.
- **Local Jurisdictions**: TAM engaged with local agency staff representing various Public Works, Sustainability, and Planning departments from San Rafael, Mill Valley, Corte Madera, Larkspur, Novato, Sausalito, Tiburon, Belvedere, and Marin County throughout the course of the study to solicit perspective and guidance on the applicability, feasibility of different adaptation strategies, and to better understand community vulnerabilities from those who live and work in these specific geographies. Input from these sessions was incorporated into the Adaptation Summaries described in Section 6.

SECTION 5

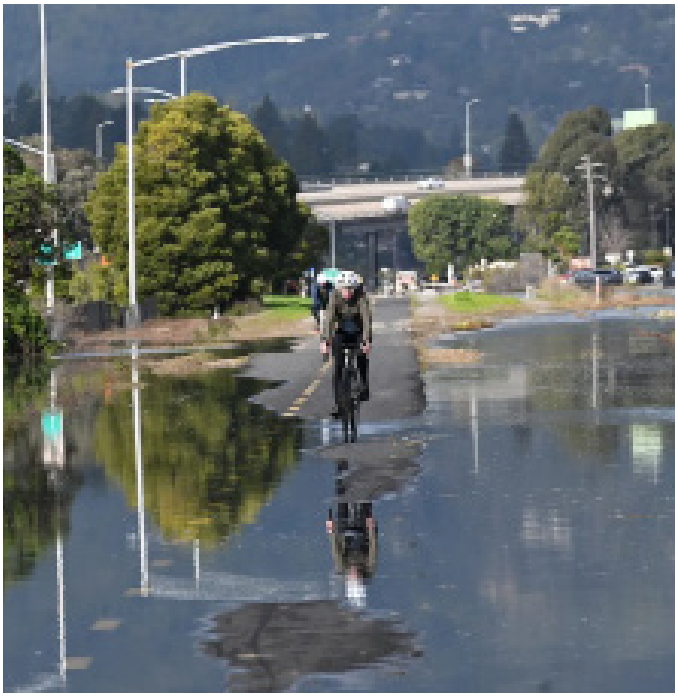
VULNERABILITY ASSESSMENT

Following a review of existing work in and around Marin County, TAM updated the analysis of coastal flood vulnerability in Marin County, with a focus on the transportation system. Since BayWAVE (now Marin SLR) conducted the last countywide assessments almost nine years ago (2016), and since BCDC developed the regional assessment four years ago through ART 2020, SFEI and Pathways Climate Institute released information on how SLR will also impact shallow groundwater tables, commonly referred to as groundwater rise. FEMA floodplain mapping assesses groundwater rise projections in combination with permanent overland inundation from rising sea levels and analyzes current and future temporary 100-year flood exposure from both coastal storm surge and waves, as well as coastal and fluvial impacts. Please see the Vulnerability Assessment Memo in Appendix D for discussion of sources.

One important goal of this flood hazard analysis was to use the latest science to both reaffirm known locations of current and future coastal flood vulnerability and identify any new potential flood hazard locations. TAM refers to the locations where such vulnerability exists as, 'Focus Areas.' The Focus Areas are intended to be used to spur discussion and identify ongoing or planned transportation improvements and adaptation plans and increase coordination among agencies and partners to implement measures that reduce the Marin County's transportation system's vulnerability to flooding.

Through this analysis, TAM identified Focus Areas and provided information on the flood-related hazards for each, the timing of impact on roads, impacts to transit and bicycle routes, and identification of key community and lifeline assets within each focus area to connect the transportation system to the communities they serve. For a summary of the Focus Areas, please see the summary table and Vulnerability Assessment Memo in Appendix D.

Drivers on flooded Simmons Lane, February2025. Photo by Sherry LaVars/Marin Independent Journal.



Cyclist on flooded path, January 2024. Photo by Sherry LaVars/Marin Independent Journal.

Figure 1: Vulnerability focus areas

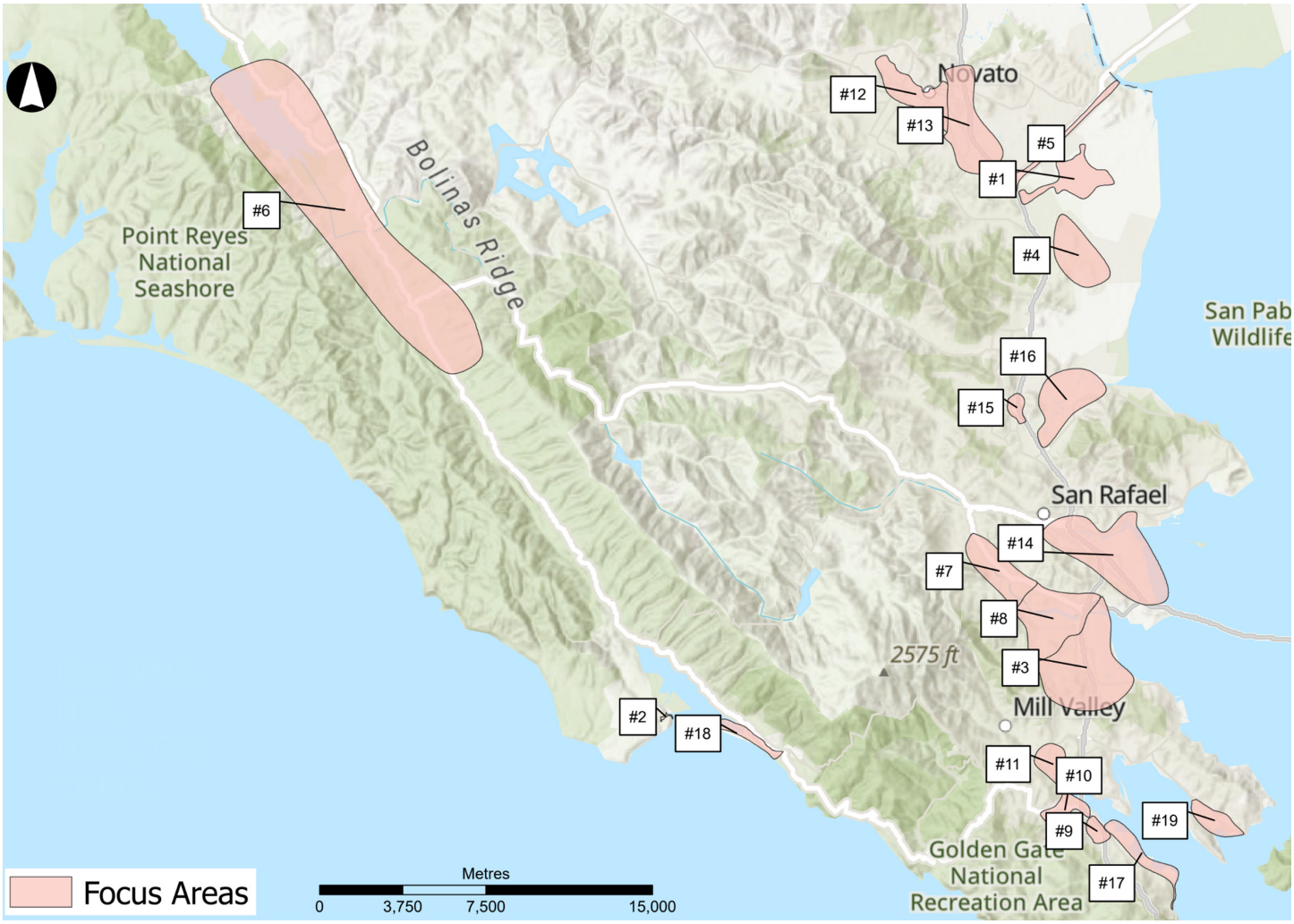


Table 2: Focus area names

Focus Area By Identifier Number on Map			
1	Bel Marin Keys	11	Mill Valley – Miller Ave
2	Bolinas	12	Novato – Downtown
3	Corte Madera	13	Novato – West
4	Hamilton Wetlands	14	San Rafael – Canal Neighborhood
5	Highway 37 / Highway 101	15	San Rafael – North
6	Inverness	16	Santa Venetia
7	Kentfield	17	Sausalito
8	Larkspur	18	Stinson Beach
9	Marin City	19	Tiburon / Belvedere
10	Manzanita / Tam Junction		

5.1 PURPOSE

The goal of the vulnerability assessment was to identify key areas of coastal flooding and relevant risk to the county's transportation system and assets. This section describes the methodology and findings of the assessment.

5.2 APPROACH & OUTCOMES

In recognition of the extensive work that has been done to map and understand Marin County's vulnerability to coastal flood hazards, the goal of the vulnerability assessment was to update known vulnerabilities, refine with the latest scientific information, and propose a suite of focus areas that will support future discussions for adaptation planning, with a focus on transportation assets.

TAM provided the exposure analysis, including the delineated Focus Areas, in GIS geodatabases and through an online Web Map to increase uptake across the entire county. The Focus Areas aim to spur future discussions on shared coastal flood hazard exposure, guide conversations about ongoing and planned transportation and adaptation projects and encourage multi-partner and multi-jurisdiction coordination to prepare and implement flood hazard adaptation measures. The key vulnerabilities by Focus Area have been summarized in the Chapter 6 Adaptation Summaries and can be found in more detail in Appendix D: Vulnerability Assessment Memo.

In coordination with the TAC, TAM refined the Focus Areas from the 19 initially identified to a smaller set of seven (7) areas to bring into the adaptation phase and develop detailed Adaptation Summaries, included in Section 6. TAM grouped several Focus Areas due to proximity, such as those in the Corte Madera Creek watershed, and removed others where extensive work was already underway, such as the Highway 101 / Highway 37 interchange, to not be duplicative with ongoing efforts. The Focus Areas that have detailed Adaptation Summaries (from south to north) are:

- Sausalito
- Tam Junction / Marin City
- Mill Valley
- Corte Madera Creek Watershed
- San Rafael – Canal Neighborhood
- Santa Venetia
- Novato

This report also includes one-page vulnerability summaries for the remaining Focus Areas in Section 6.

> For this project, TAM defined **Focus Areas** as locations that are vulnerable to SLR coastal hazards and fluvial/pluvial flood exposure, with implications to both Marin County's transportation assets, as well as to important community and lifeline assets.

SECTION 6

ADAPTATION SUMMARIES

TAM developed an Adaptation Summary for each of these seven Focus Areas comprised of specific adaptation strategies to address near- and long-term impacts from SLR. The process that TAM used to develop the Adaptation Summaries included the following steps:

1. Initiated a dialogue with Marin's local transportation agencies and neighboring communities to align on shared goals and opportunities. A central theme raised and reemphasized throughout these engagements was the importance of prioritizing nature-based solutions as well as hybrid green-grey solutions, which was incorporated into the Adaptation Summaries, ensuring that this remains a focal point in the next phases of project planning.
2. Analyzed TAM's functions, which led to a framework that enabled the agency to consider for each adaptation strategy how involved TAM would need to be to drive projects forward. In this assessment, TAM recognized that it does not own assets and therefore relies heavily on partnership, both in leadership and supporting roles to initiate, coordinate, and delivery projects across Marin County. Additionally, TAM acknowledged the importance of balancing protection with adaptive risk management, working towards strategies that integrate both elements.
3. Employed an 'adaptation pathways' approach to identify near-term actions and long-term plans that create community benefits today while planning for climate impacts down the road. Tipping points and timelines for action were developed for each Focus Area as a continuation of the adaptation planning process. This work can feed into an adaptation pathways approach for each Focus Area.

TAM'S FUNCTIONS

TAM's functions in future implementation efforts will vary depending on the type and stage of the project. Here are some specific examples of TAM's anticipated functions as it relates to implementation:

Facilitator	Partner
• Transportation planning and project delivery support • Implement county-wide transportation policies, i.e., complete, green, and elevated streets • Identify opportunities for collaboration across agencies and flag duplicative efforts • Identifying partnerships and convening agencies	• Coordinate with Caltrans, USACE, Public Works, and other agencies as needed on SLR adaptation project planning and implementation • Support grant administration needs for SLR-related projects on behalf of lead delivery agencies • Help identify and support funding for projects that align with SLR adaptation goals (i.e., matching funds)

Within each of the seven Adaptation Summaries, the project team identified several challenge areas (e.g., near-term storm flooding on an evacuation route) and a suite of applicable adaptation strategies mapped to each location. As the project team evaluated the adaptation strategies, they noted the following recurring themes and tailored the evaluation process to identify measures for each challenge area.

Fostering communication to transportation agencies and adjacent communities related to shared goals and opportunities

Ensuring nature-based opportunities

Understanding TAM's role in sea level rise adaptation

Weighing relationship between protection and risk; moving towards

Balancing near-term and long-term

ADAPTATION PATHWAYS TIMELINES

To build towards an Implementation Strategy, the project team assigned timelines to each adaptation strategy. These timelines were developed to inform planning-level understanding of how these potential projects might be implemented over time.

The timelines incorporate **tipping points** at which an asset becomes permanently inundated by SLR, **project development time** that includes financing, planning, design, and construction, and an **effective time** to consider design lifetime, ranging from permanent (e.g., trail relocation) to ongoing, incremental projects (e.g., elevating roads in cycles).

The decision to use permanent inundation as the tipping point supports the high-level mapping of timelines for major projects, but temporary flooding and closures are anticipated sooner along impacted routes. The timing of permanent inundation from follows the Intermediate-High SLR Scenario as recommended by BCDC guidelines. These timelines lay the foundation of an adaptation pathways approach to implementation over time, which will also serve to help navigate decision-making under the uncertainty of SLR.

Adaptation pathways support decision-makers in the selection of viable adaptation strategies over time. An adaptation pathways approach would build upon the timelines presented here by grouping complementary strategies and outlining the options as plans that TAM and its partners can consider and prioritize based on resources and urgency. For example, two adaptation pathways could be to protect the perimeter (strategies may include pumps and levees) or to elevate key transportation assets. The building blocks for this approach are included here, but the strategies intentionally have not been prioritized for TAM and its partner agencies.

The challenge areas, adaptation strategies, and adaptation pathways development can be found for each Focus Area in the Adaptation Summaries on the following pages.

FOCUS AREA:

SAUSALITO

VULNERABILITY OVERVIEW

Sausalito's 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 and vulnerability of Sausalito's unique floating homes communities. 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 bus stops that serve the community and providing vital ingress/egress for evacuation. 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. As these natural barriers degrade, the city's vulnerability to coastal impacts will increase.

SUMMARY OF VULNERABLE ASSETS

TRANSPORTATION ASSETS

16 BUS STOPS

1 PARK AND RIDE HUB AREA

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

7 COLLECTORS & NETWORK OF LOCAL STREETS

1 INGRESS/EGRESS ROUTE

1 FERRY TERMINAL

ONGOING ADAPTATION PLANNING

- Sausalito Shoreline Adaptation Plan
- New Life for Eroding Shorelines: Dunphy Park
- Dunphy Park Phase 2 Restoration
- Dunphy Park Breakwater
- Eelgrass Restoration
- Sausalito Ferry Terminal Improvements

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 Sausalito. 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 evaluated TAM's role to facilitate or partner on adaptation efforts. 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.

For this focus area, several of the proposed adaptation solutions align with projects currently underway.


SAUSALITO
1" = 1200'
N
1 Adaptation Strategies
Existing Culverts
Existing Pump Stations
City Boundary
Roads
Floating Piers
Green Open Space
Parks / School Playgrounds
Streams
Existing Levee
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
SEE TAM JUNCTION / MARIN CITY
GATE 5 ROAD
GATE 5 ROAD
MARINSHIP PARK
GALILEE HARBOR
DUNPHY PARK
FERRY TERMINAL
BRIDGEWAY
RICHARDSON BAY
SAUSALITO
US 101
1
2
3
4
5
6
P

FOCUS AREA:

SAUSALITO

KEY ADAPTATION CHALLENGES & POTENTIAL STRATEGIES

The following challenges have been identified for the Sausalito area and coorespond 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 SAUSALITO FERRY LANDING & 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

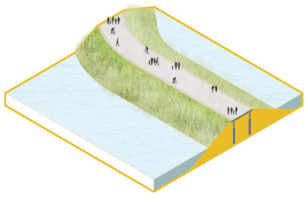
Potential Adaptation Strategy: Elevate Roads and Utilities, Breakwater, Eelgrass

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

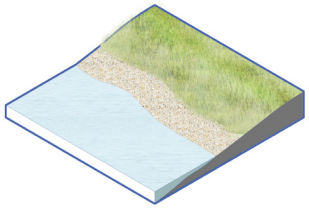
A district-scale adaptation plan for Marinship is needed to develop a long- term perimeter protection and interior drainage strategy, likely involving levees, seawalls, and/or bulkheads as well as culverts and pump

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



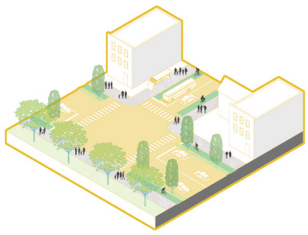
Coarse Grain Beach

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



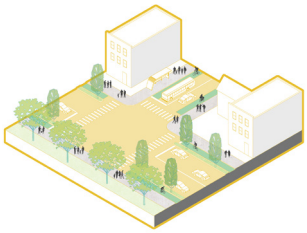
Complete Green

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 SAUSALITO FERRY LANDING & PARKING LOT FLOODING

Location: Sausalito Ferry Landing

Potential Adaptation Strategy: Complete Green & Elevated Streets/Paths



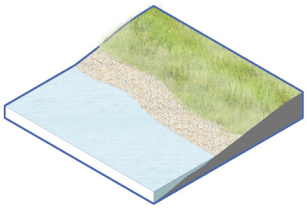
Complete Green

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 Sausalito Ferry Landing parking area with stormwater detention features (e.g., bioswales, vegetated basins) would improve and maintain critical access to ferry service (along with necessary improvements to docking facilities), providing additional time to implement longer-term strategies.

6 FLOODING OF OLD TOWN SWEDE'S BEACH

Location: Swede's Beach

Potential 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

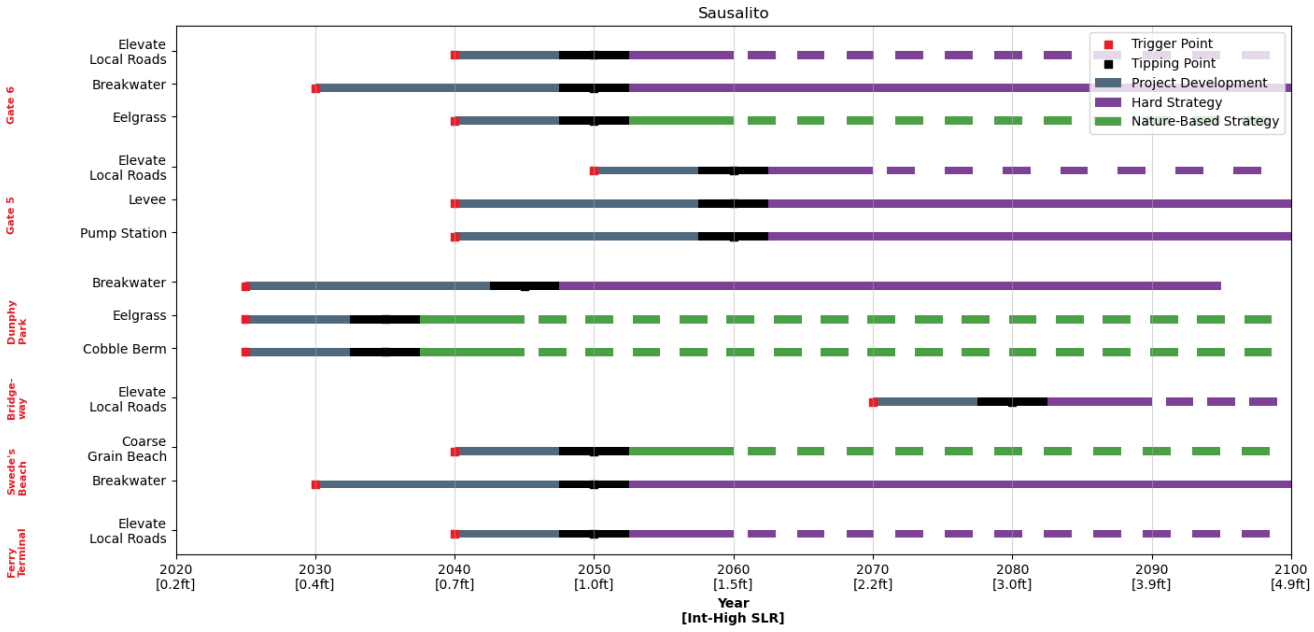
shoreline profile at Swede's Beach, particularly when sediment loss reaches critical levels. Additionally, cobble berms or coarse grain beach nourishment can be employed to support the beach profile, providing further protection as sea level rise progresses.

ADAPTATION PATHWAYS

Timelines are estimated for the strategies identified for each challenge area, as seen in the diagram below. This work can feed into an adaptation pathways framework for the Focus Area.

Built into the Project Development is a minimum time to secure funding, conduct detailed planning and design, obtain permitting, and construct each strategy. The Tipping Point aligns with permanent inundation impacts due to SLR for each challenge area, though temporary flooding and closures are anticipated sooner. The Trigger Point for action is identified given the Project Development time, unless impacts occur in present day, in which case the Trigger Point was set to 2025. Dotted lines on the strategies indicate incremental or ongoing strategies.

Most of the challenge areas identified in Sausalito will see inundation from SLR in approximately 25-35 years (2050-2060). Many strategies involve incremental strategies, such as Complete Green & Elevated Streets/Paths, and ongoing work, such as beach nourishment or habitat management.



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 both local and 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 Mill Valley-Sausalito Path (part of 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

TRANSPORTATION ASSETS

HIGHWAY 101

24 BUS STOPS

2 INGRESS/EGRESS ROUTES

1 PARK AND RIDE AREA

LIFELINES

1 POLICE STATION

COMMUNITY ASSETS

1 LIBRARY

1 SCHOOL

1 COMMERCIAL SHOPPING CENTER

3 PUMP STATIONS

ONGOING ADAPTATION PLANNING

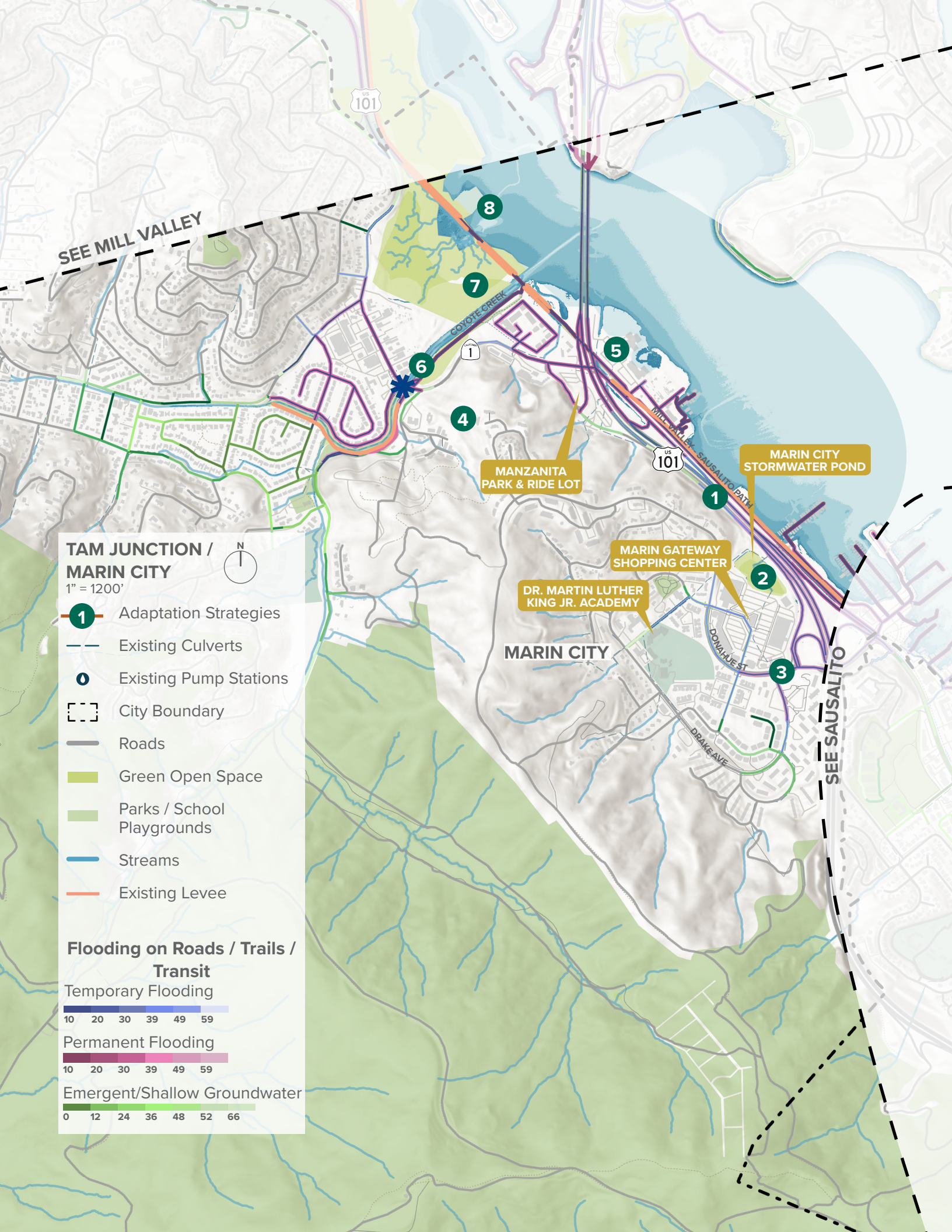
- Transforming Marin City's Urban Wetland
- Manzanita Sea Level Rise
- Marin City Stormwater Plan
- New Life for Eroding Shorelines
- Caltrans US-101, SR-1 Sea-Level Rise Project

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

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 Tam Junction / Marin City. Strategies from ongoing adaptation planning projects have been incorporated in an effort to avoid duplicating work and to build on strategies for this area.

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 evaluated TAM's role to facilitate or partner on adaptation efforts. 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.


SEE MILL VALLEY
8
7
COYOTE CREEK
6
5
4
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
SEE SAUSALITO
US 101
CALIFORNIA 1
TAM JUNCTION / MARIN CITY
1" = 1200'
N
Adaptation Strategies
Existing Culverts
Existing Pump Stations
City Boundary
Roads
Green Open Space
Parks / School Playgrounds
Streams
Existing Levee
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:

TAM JUNCTION / MARIN CITY

KEY ADAPTATION CHALLENGES & POTENTIAL STRATEGIES

The following challenges have been identified for the Tam Junction / Marin City area and coorespond 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

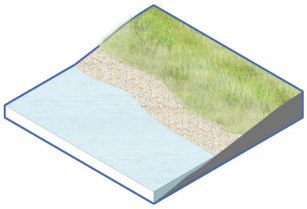
Location: Highway 101, Bay Trail

Potential Adaptation Strategy:

- Strategy A: Elevate on Causeway / Viaduct
  - Elevating US-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.

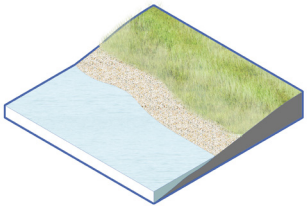
- Strategy B: Elevate on Embankment, Coarse Beach, Breakwater -



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 -



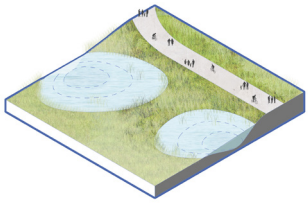
Coarse Grain Beach

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



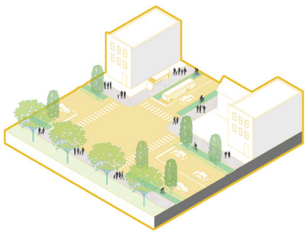
Detention Basin

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: Between Marin City and Tam Valley

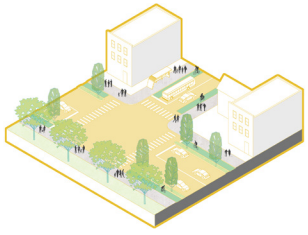
Potential Adaptation Strategy: Evacuation route gap closure

A secondary evacuation route for Marin City should be considered given the critical importance of multiple ingress/egress routes during emergencies. Though exact location should be determined in future effort, the recommended area is between Marin City and Tam Valley, and it could provide ingress/egress for both communities. The connection 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

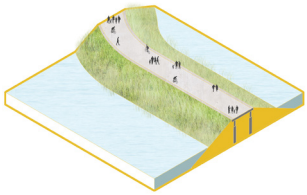
Near-term, proactive elevation of low-lying sections of Highway 101 and Highway 1 on/off ramps along with associated underground utilities could improve and maintain critical ingress/egress and transit throughout southern Marin.

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. Strategies in this area are being evaluated as part of the active Caltrans sea level rise project for US-101 / SR-1 here.

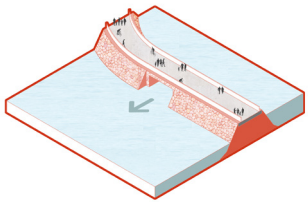
6 COYOTE CREEK OVERTOPPING / TAM JUNCTION INUNDATION

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

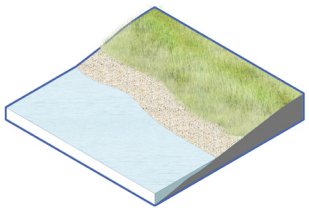
Potential Adaptation Strategy: Breaching Creek Channels

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

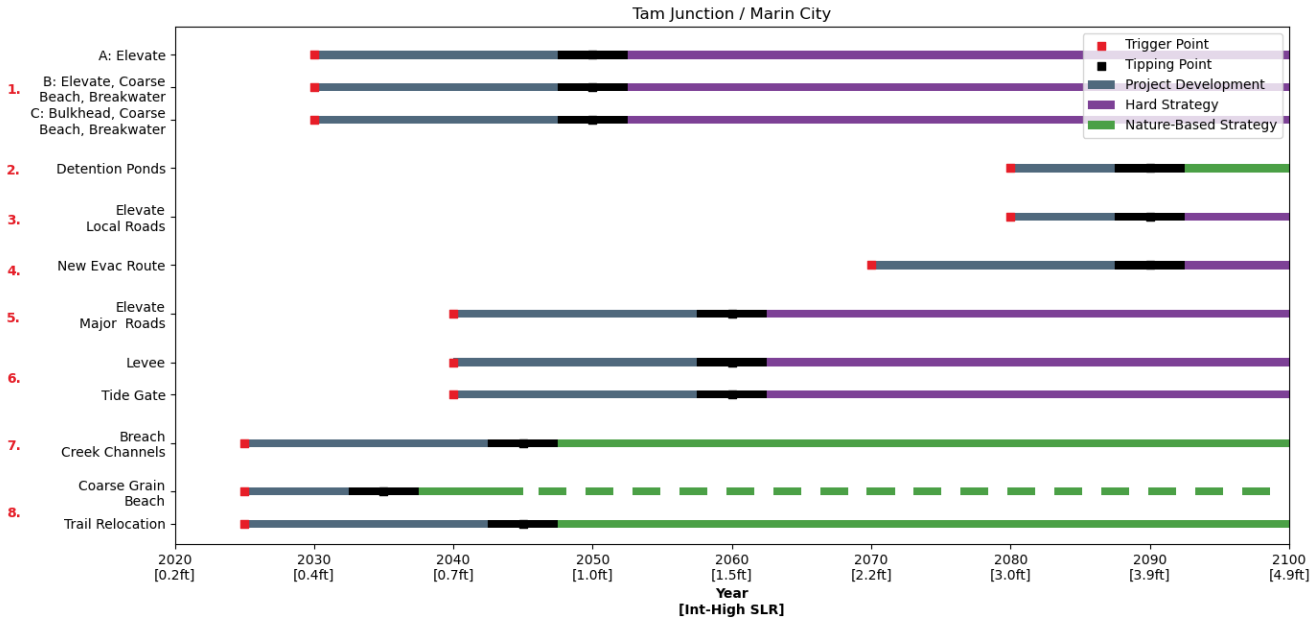
Relocating the Mill Valley-Sausalito Path involves creating a coarse-grain beach and redesigning the Bay Trail to encircle the marsh ("Ring the Marsh"). The coarse-grain beach at the backshore of the marsh would act as a natural barrier to reduce erosion and protect Tam Junction from wave action and 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.

ADAPTATION PATHWAYS

Timelines are estimated for the strategies identified for each challenge area, as seen in the diagram below. This work can feed into an adaptation pathways framework for the Focus Area.

Built into the Project Development is a minimum time to secure funding, conduct detailed planning and design, obtain permitting, and construct each strategy. The Tipping Point aligns with permanent inundation impacts due to SLR for each challenge area, though temporary flooding and closures are anticipated sooner. The Trigger Point for action is identified given the Project Development time, unless impacts occur in present day, in which case the Trigger Point was set to 2025. Dotted lines on the strategies indicate incremental or ongoing strategies.

The challenge areas identified in Tam Junction / Marin City see impacts in the next 25-35 years, and the trigger point to begin action is crossed within the next 10 years (#1 Flooding of 101 & Bay Trail) to 15 years (#5 and #6). The marsh areas experience erosion and subsidence issues already, so their timelines begin in 2025. Later challenges see permanent inundation impacts from SLR around 2090.



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

TRANSPORTATION ASSETS

18 BUS STOPS

COMMUNITY ASSETS

2 SCHOOLS

UTILITIES

2 PUMP STATIONS

1 WASTEWATER TREATMENT PLANT

1 POWER SUBSTATION

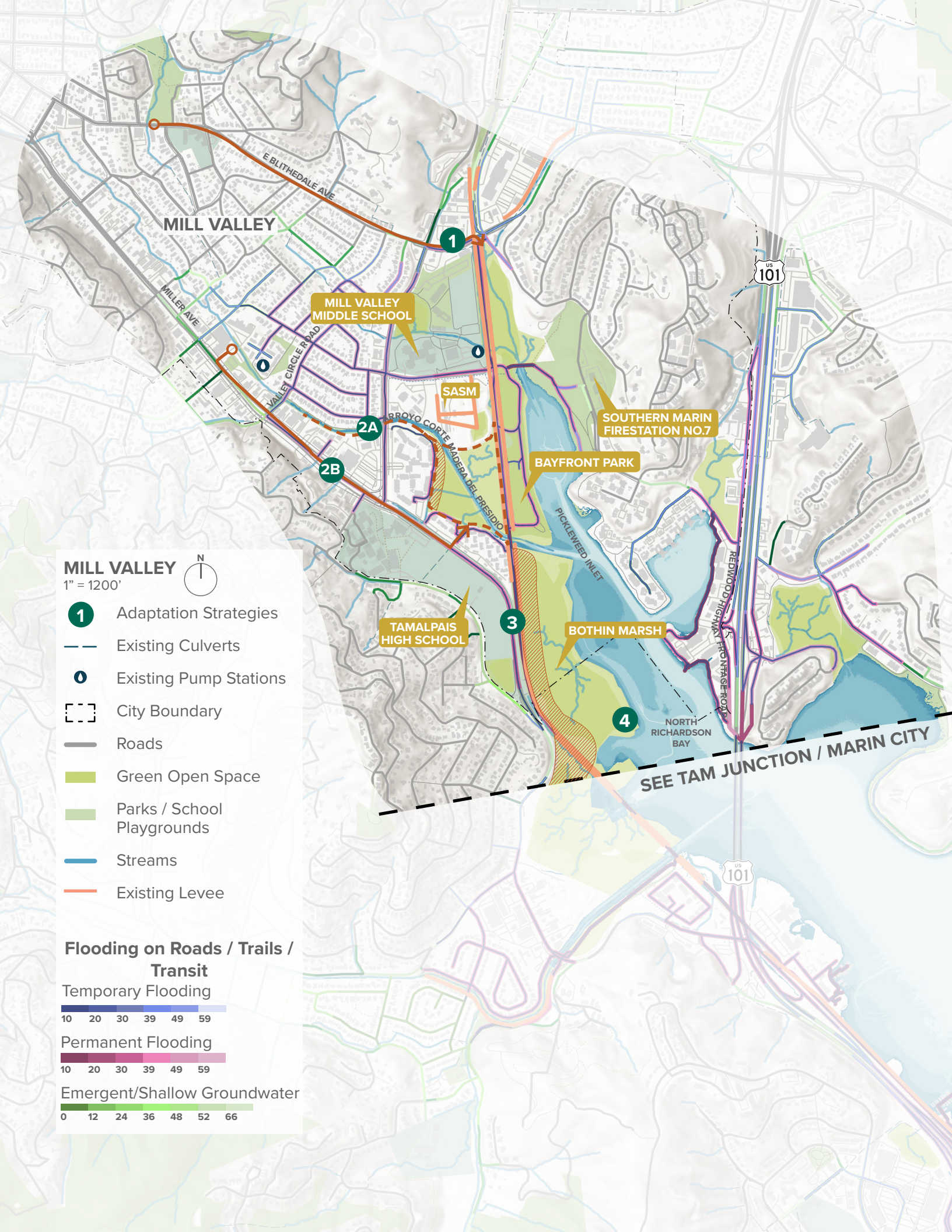
ONGOING ADAPTATION PLANNING

- Mill Valley Flood Management and Storm Drain Master Plan
- Cardinal Road Levee Upgrade Project
- Evolving Shorelines Project at Bothin Marsh
- New Life for Eroding Shorelines: Seminary Drive Beach
- Shoreline Adaptation | Mill Valley, CA

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

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 evaluated TAM's role to facilitate or partner on adaptation efforts. 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.


MILL VALLEY
E BLITHEDALE AVE
MILLER AVE
VALLEY CIRCLE ROAD
MILL VALLEY MIDDLE SCHOOL
SASM
ARROYO CORTE MADERA DEL PRESIDIO
SOUTHERN MARIN FIRESTATION NO.7
BAYFRONT PARK
PICKLEWEED INLET
REDWOOD HIGHWAY FRONTAGE ROAD
TAMALPAIS HIGH SCHOOL
BOTHIN MARSH
NORTH RICHARDSON BAY
SEE TAM JUNCTION / MARIN CITY
US 101
1
2A
2B
3
4
MILL VALLEY
1" = 1200'
N
Adaptation Strategies
Existing Culverts
Existing Pump Stations
City Boundary
Roads
Green Open Space
Parks / School Playgrounds
Streams
Existing Levee
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:

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

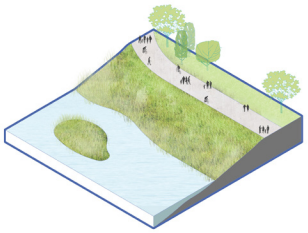
This solution includes near-term upgrades to culverts along Blithedale Avenue to enhance stormwater drainage, improving ingress, egress, and evacuation routes for Mill Valley during storms today and the future. In the longer term, a pump station would need to be installed to manage water levels during 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

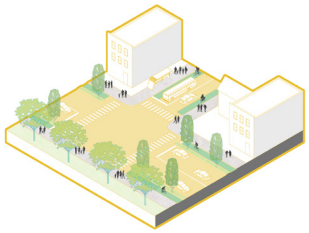
environment to upland areas. This approach enhances flood protection, supports habitat restoration, and allows species to migrate upslope as the high tide line shifts with sea level rise. The horizontal levee would also help reduce erosion and maintain natural floodplain functions.

- 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. The 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

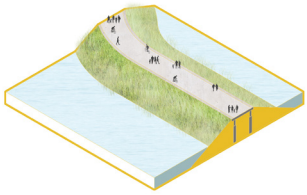
Location: Miller Avene, next to TAM High School and Bothin Marsh

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.



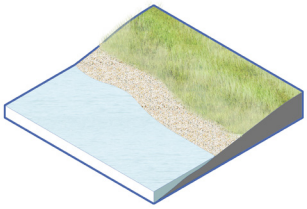
Levee

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

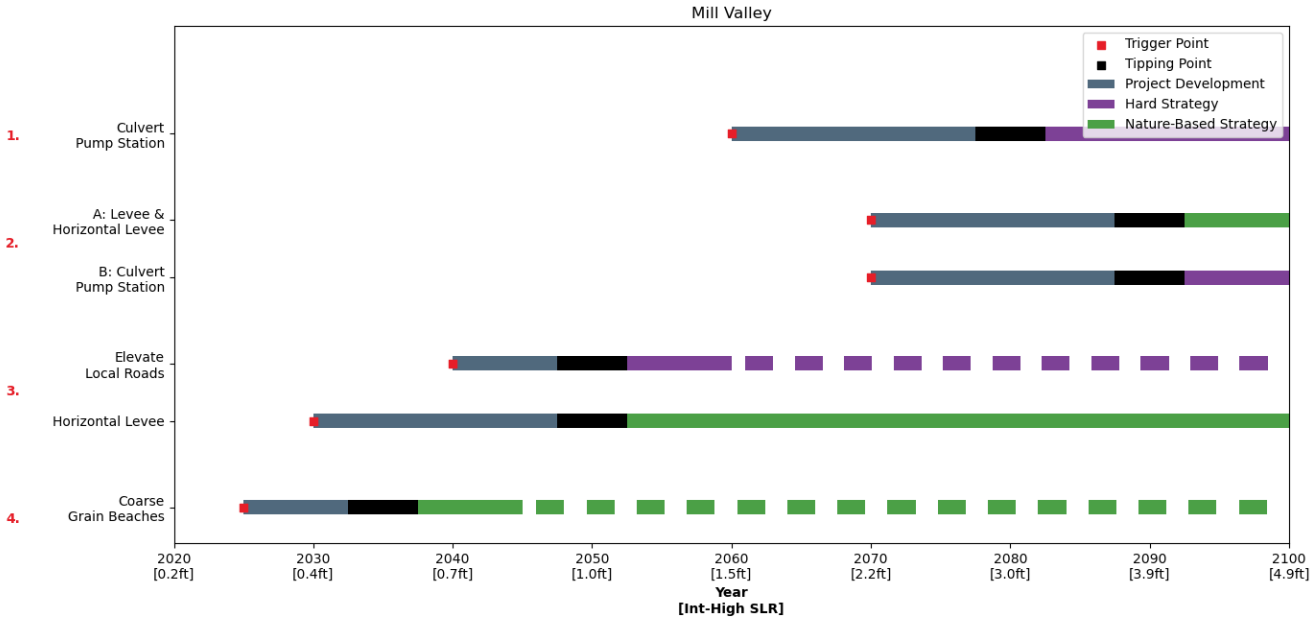
Implementing coarse grain beaches along the shoreline of Bothin Marsh would help protect and restore habitat. These beaches would be composed of larger, more stable sediments that can better withstand wave action and erosion, providing a natural buffer against sea level rise and storm surges. The coarse 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.

ADAPTATION PATHWAYS

Timelines are estimated for the strategies identified for each challenge area, as seen in the diagram below. This work can feed into an adaptation pathways framework for the Focus Area.

Built into the Project Development is a minimum time to secure funding, conduct detailed planning and design, obtain permitting, and construct each strategy. The Tipping Point aligns with permanent inundation impacts due to SLR for each challenge area, though temporary flooding and closures are anticipated sooner. The Trigger Point for action is identified given the Project Development time, unless impacts occur in present day, in which case the Trigger Point was set to 2025. Dotted lines on the strategies indicate incremental or ongoing strategies.

The challenge areas identified in Mill Valley see impacts today (#4), mid-century (#3), and near the end of century (#1 and #2). The near-term trigger points are for the habitat loss at Bothin Marsh (ongoing work) and overtopping of Miller Ave and Bay Trail.



FOCUS AREA:

CORTE MADERA CREEK WATERSHED

VULNERABILITY OVERVIEW

The Corte Madera Creek watershed includes the towns of Larkspur, Corte Madera, Kentfield, among others. Historically, much of this area was marshland, which leaves most lower elevation residential and commercial areas vulnerable to coastal flooding. Parts of the watershed touch 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, 53 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. Kentfield is connected to US-101 via the short corridor known as Lucky Drive which floods during present-day king tide events and is also susceptible to riverine flooding from Corte Madera Creek. This short corridor represents an essential connection for the town to a vital transportation corridor.

With 15 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

TRANSPORTATION ASSETS

3 PARK AND RIDE AREAS

1 FERRY TERMINAL

53 BUS STOPS

1 SMART STATION

HIGHWAY 101

LIFELINES

6 POLICE STATIONS

5 FIRE STATIONS

2 MUNICIPAL BUILDING

2 HOSPITAL/ HEALTHCARE CENTER

COMMUNITY ASSETS

15 SCHOOLS

1 LIBRARY

UTILITIES

1 POWER SUBSTATION

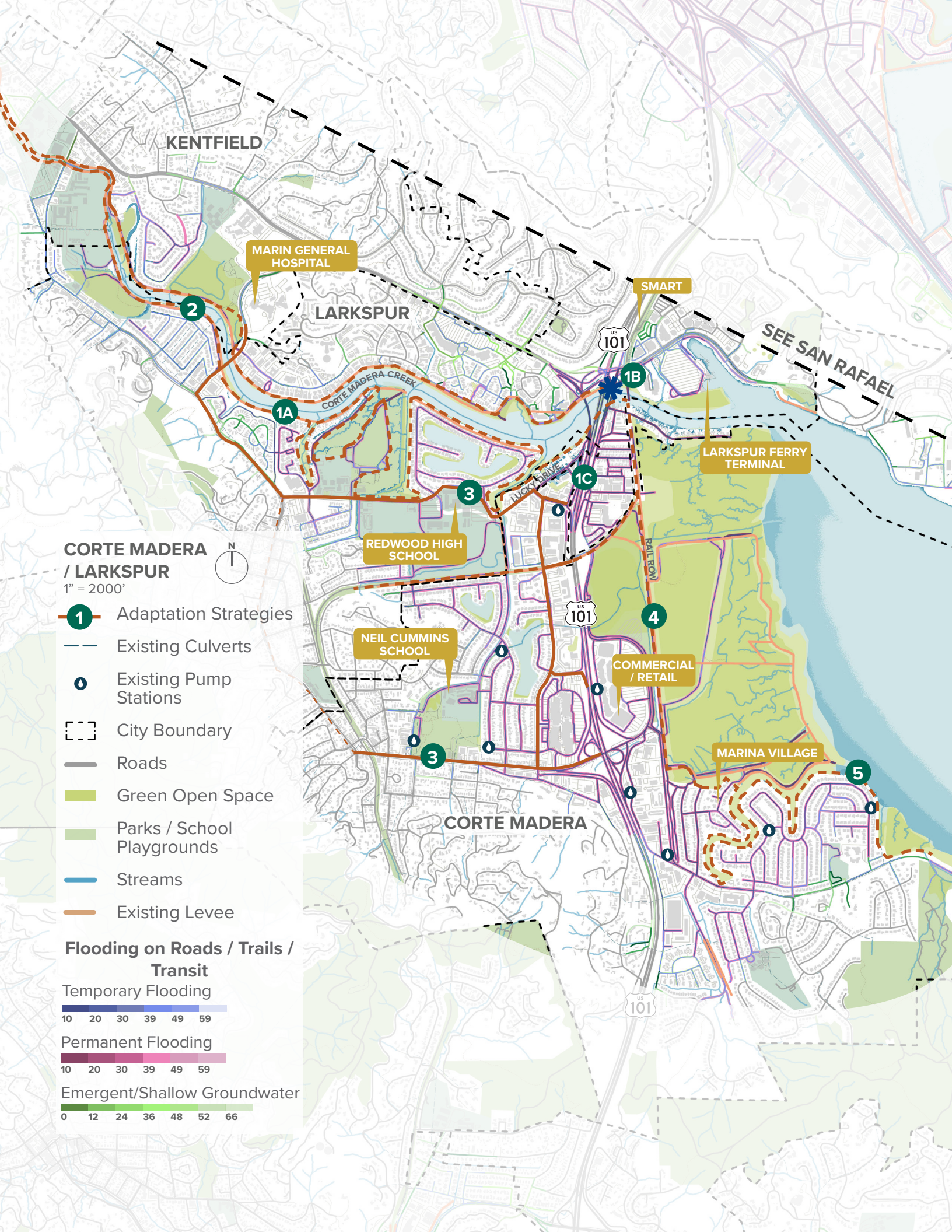
Community Flooding. Photo from Town of Corte Madera Climate Adaptation Plan

ONGOING ADAPTATION PLANNING

- The Corte Madera Climate Adaptation Assessment
- Mariner Cove & Marina Village Berm Upgrade
- Corte Madera Ecological Reserve 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 - Lot 13 Habitat Restoration
- Corte Madera Creek - SE Creekside Marsh Culvert Replacement and Habitat Enhancement
- New Life for Eroding Shorelines
- SLR Adaptation Transportation Infrastructure (I-580/US-101/SMART)
- Corte Madera Creek Flood Risk Management Project
- Lower Corte Madera Creek Improvement Study
- Larkspur Service Expansion and Parking Study

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 the Corte Madera Creek Watershed. 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 evaluated TAM’s role to facilitate or partner on adaptation efforts. 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
1A
1B
1C
2
3
4
5
CORTE MADERA / LARKSPUR
1" = 2000'
N
Adaptation Strategies
Existing Culverts
Existing Pump Stations
City Boundary
Roads
Green Open Space
Parks / School Playgrounds
Streams
Existing Levee
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 CREEK WATERSHED

KEY ADAPTATION CHALLENGES & POTENTIAL STRATEGIES

The following challenges have been identified for the Corte Madera Creek Watershed 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

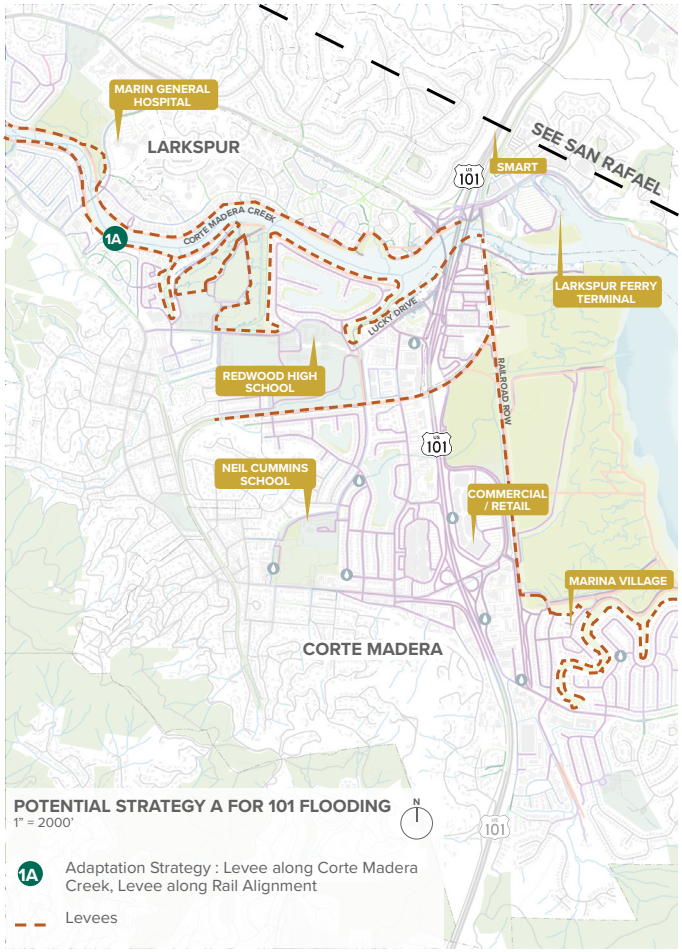
ADAPTATION OPPORTUNITY DESCRIPTIONS

1 101 FLOODING

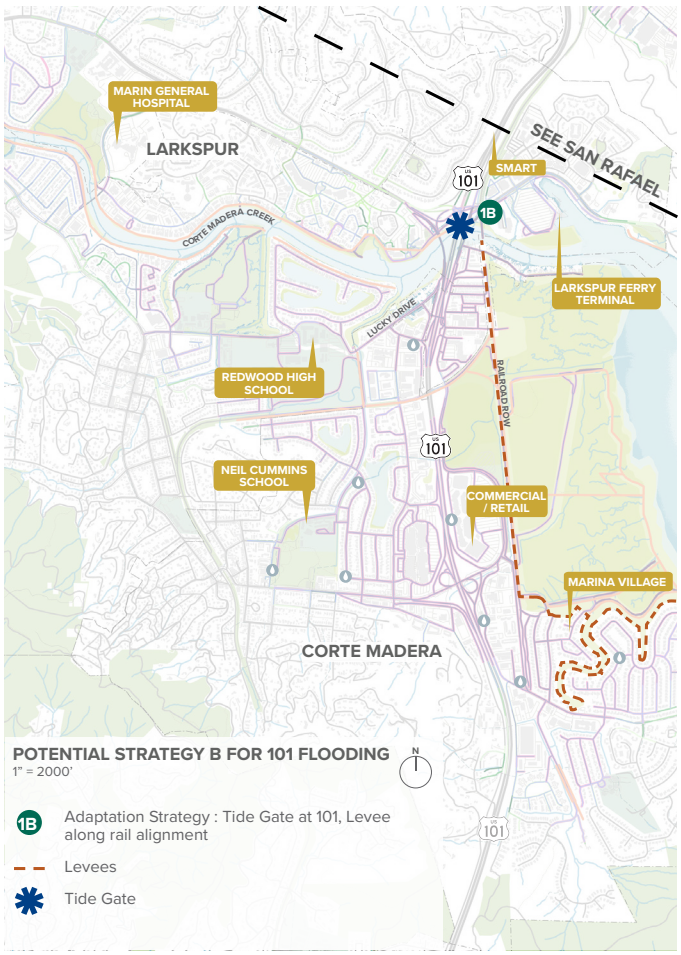
Location: Highway 101

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.

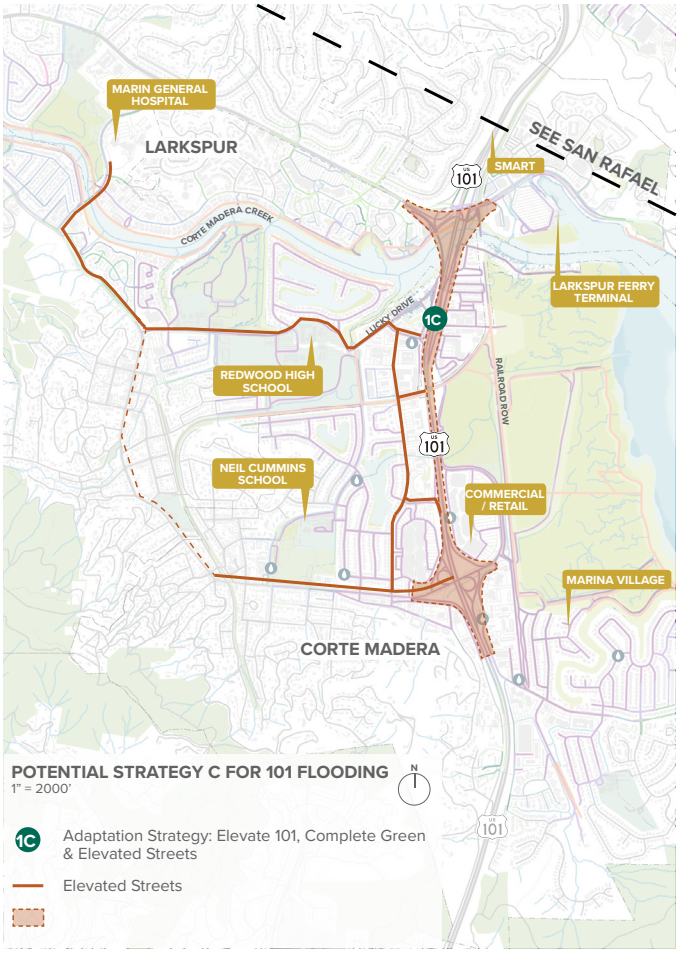


Strategy A: Levee along Corte Madera Creek, Levee along Rail Alignment



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

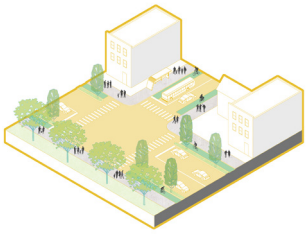
Potential Adaptation Strategy: Levee / Embankment, Tide Gate, Detention Ponds upstream

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.

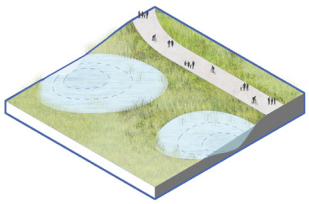
3 COMMUNITY / EVACUATION ROUTE FLOODING

Location: Redwood High School, Neil Cummins School

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



Complete Green



Detention Basin

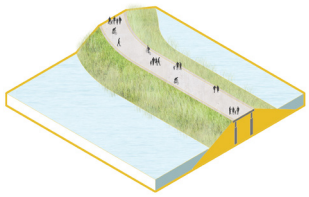
Elevating Tamalpais Dr, Doherty Dr, and Lucky Dr on embankments would mitigate the flooding of key evacuation routes, ensuring that these critical roadways remain accessible during flood events. Incorporating green infrastructure, such as permeable surfaces and bio-swales, would help manage stormwater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

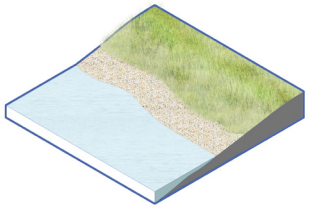


Levee

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. Permits from BCDC and GGBHTD, which maintains Corte Madera Marsh, would be required.

5 EROSION, WAVE OVERTOPPING

Location: San Clemente Creek, Corte Madera Marsh



Coarse Grain Beach

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.

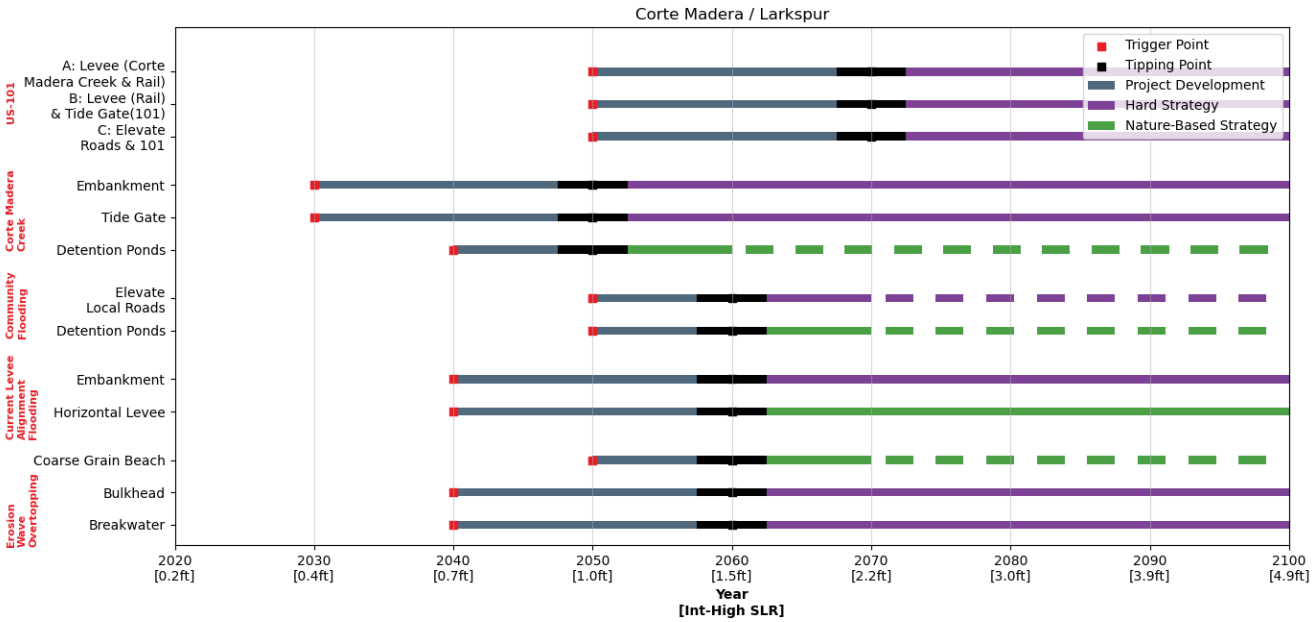
These beaches would be composed of larger, more stable sediments that can better withstand wave action and erosion, providing a natural buffer against sea level rise and storm surges. Offshore measures, such as a breakwater structure, can help attenuate wave energy, reduce erosion, and preserve the shoreline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

ADAPTATION PATHWAYS

Timelines are estimated for the strategies identified for each challenge area, as seen in the diagram below. This work can feed into an adaptation pathways framework for the Focus Area.

Built into the Project Development is a minimum time to secure funding, conduct detailed planning and design, obtain permitting, and construct each strategy. The Tipping Point aligns with permanent inundation impacts due to SLR for each challenge area, though temporary flooding and closures are anticipated sooner. The Trigger Point for action is identified given the Project Development time, unless impacts occur in present day, in which case the Trigger Point was set to 2025. Dotted lines on the strategies indicate incremental or ongoing strategies.

The trigger points for two long-term strategies for #2 Corte Madera Creek are expected to occur in the next 5 years to address permanent inundation by 2050 under about one foot of SLR. The remaining challenge areas see tipping points in the next 15-25 years to address SLR inundation up to about two feet SLR.



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.

Even without additional sea level rise, these transportation assets are vulnerable to flooding under current conditions. Maintaining the current pumps and shoreline barriers is necessary to keep transportation routes passable, including I-580.

SUMMARY OF VULNERABLE ASSETS:

TRANSPORTATION ASSETS

71 BUS STOPS

1 SMART STATION

4 PARK AND RIDE AREAS

HIGHWAYS 101 AND 580

RICHMOND-SAN RAFAEL BRIDGE

ONGOING ADAPTATION PLANNING

- New Life for Eroding Shorelines
- San Quentin Pump Station Reconstruction
- Spinnaker Marsh Restoration
- Tiscornia Marsh Restoration and Sea Level Rise Adaptation Project
- Sea Level Rise Adaptation Transportation Infrastructure (I-580/US-101/SMART)

A royal tide event in December 2024 showing high water level near San Rafael Transit Center. Photo from California King Tides Project 2018-2025 by California Coastal Commission.

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 San Rafael. 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 evaluated TAM's role to facilitate or partner on adaptation efforts. 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.

SAN RAFAEL
1" = 1800'

N

- 1 Adaptation Strategies
- Existing Culverts
- Existing Pump Stations
- City Boundary
- Roads
- Green Open Space
- Parks / School Playgrounds
- Streams
- Existing Levee

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 coorespond 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

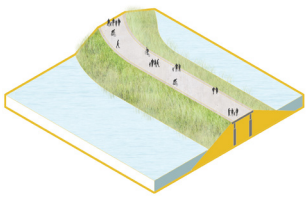
Strategy: Green Schoolyard Detention Ponds/Basins

ADAPTATION OPPORTUNITY DESCRIPTIONS

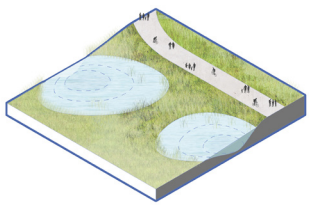
1 FLOODING OF DEVELOPED AREAS

Location: Marsh north of Home Depot

Potential Adaptation Strategy: Horizontal Levee, Detention Pond



Levee



Detention Basin

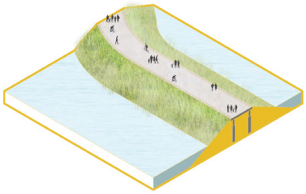
Constructing a horizontal levee and detention pond improvements north of the Home Depot property would provide effective flood protection for some of the surrounding developed areas and sections of the 580 freeway. The horizontal levee would create a gradual transition from wetland to upland, providing 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. At a minimum, existing shoreline path and pumps need to be maintained to keep 580 passable.

2 SHORELINE EROSION AND TRAIL OVERTOPPING

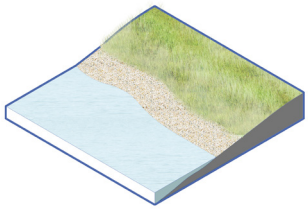
Location: Along the SF Bay Trail Shoreline

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.

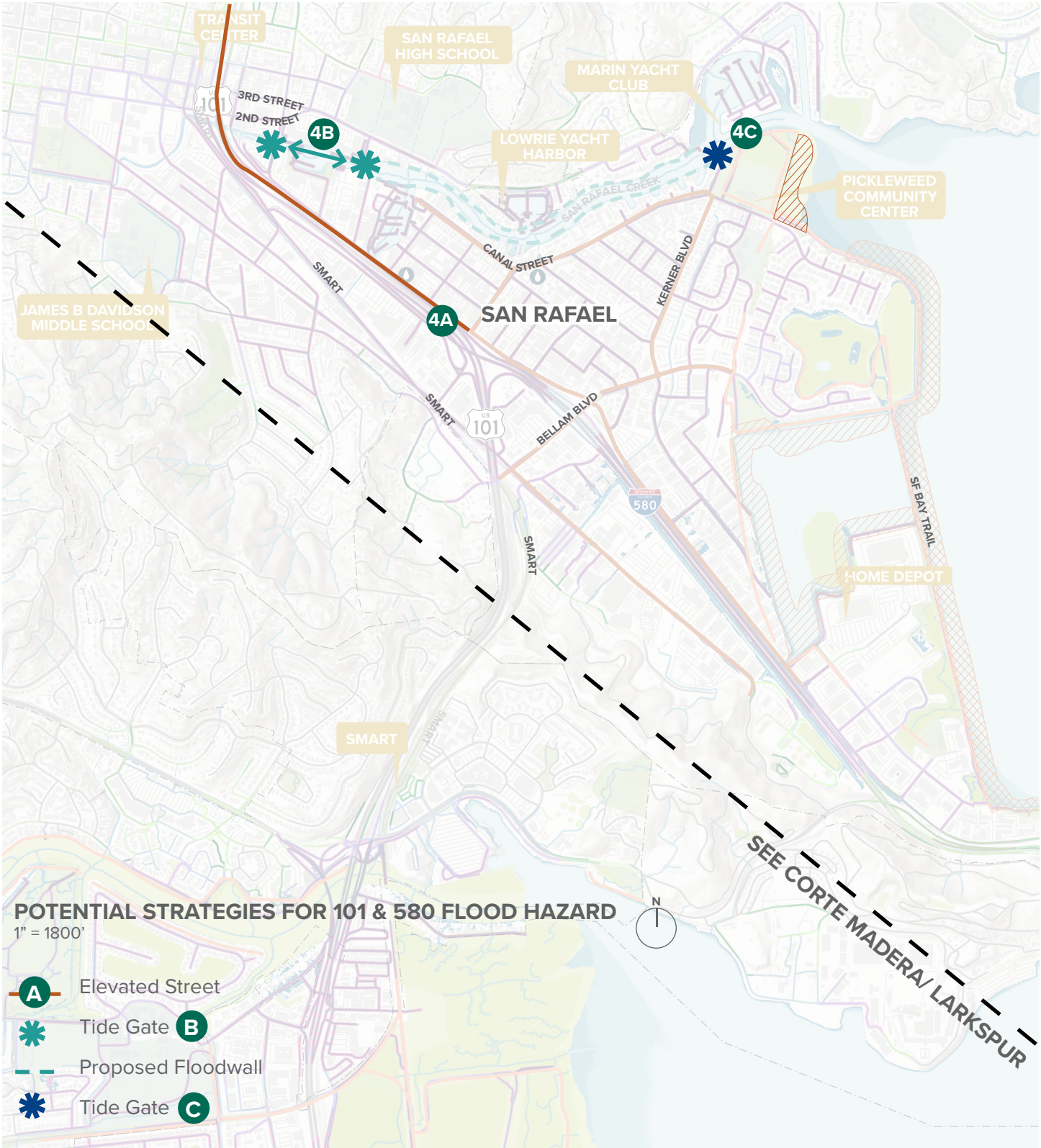
4 101 & 580 FLOOD HAZARD

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 weather events or rising sea levels, reducing the risk of closures and disruptions and safeguarding emergency access and evacuation 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



Strategy A, B & C for 101 & 580 Flooding

- 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 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 and housing tradeoffs requiring thorough consideration, particularly given lack of public space for such measures.
- 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

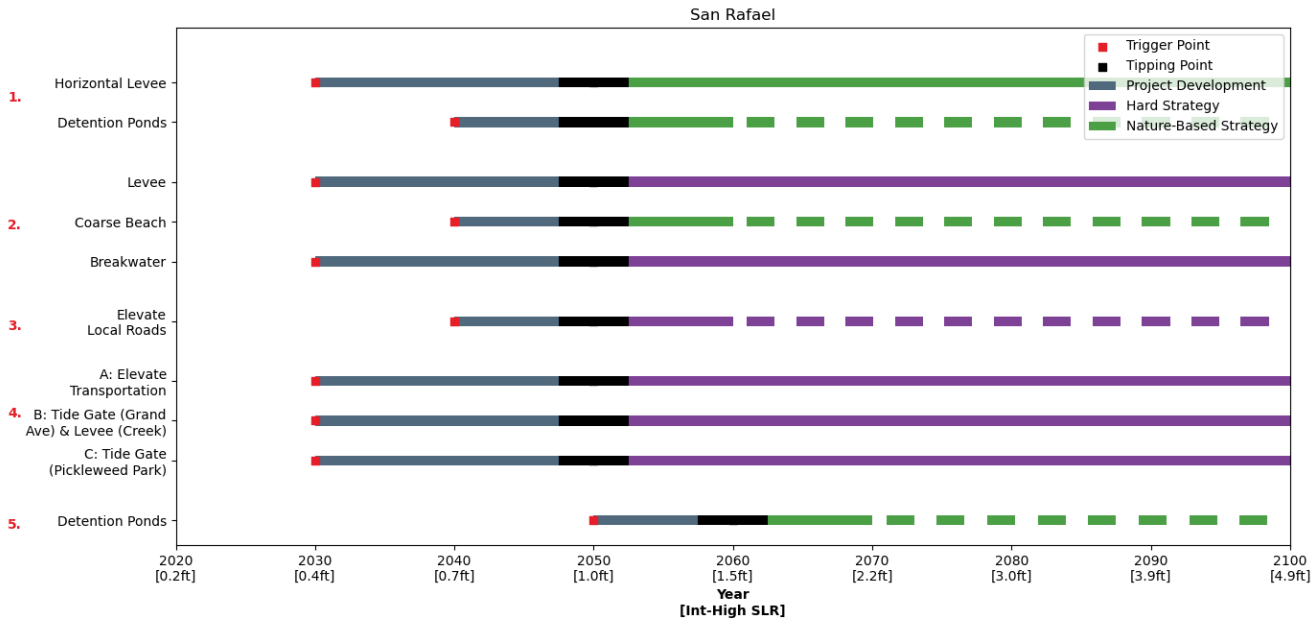
Constructing detention basins on public property, such as recreational areas or school ballfields, could temporarily capture and store excess stormwater during heavy rainfall, reducing flood risks in surrounding areas. By integrating green infrastructure into these spaces, the basins would not only manage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

ADAPTATION PATHWAYS

Timelines are estimated for the strategies identified for each challenge area, as seen in the diagram below. This work can feed into an adaptation pathways framework for the Focus Area.

Built into the Project Development is a minimum time to secure funding, conduct detailed planning and design, obtain permitting, and construct each strategy. The Tipping Point aligns with permanent inundation impacts due to SLR for each challenge area, though temporary flooding and closures are anticipated sooner. The Trigger Point for action is identified given the Project Development time, unless impacts occur in present day, in which case the Trigger Point was set to 2025. Dotted lines on the strategies indicate incremental or ongoing strategies.

The tipping points in San Rafael are concentrated in 2050, when about 1ft of SLR is expected to cause permanent inundation of key transportation assets. Significant adaptation planning for this Focus Area is underway.



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 in near-future SLR scenarios, where more frequent flooding may impact 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

TRANSPORTATION ASSETS

19 BUS STOPS

1 AIRPORT

1 INGRESS/EGRESS ROUTE

HIGHWAY 101

LIFELINES

1 FIRE STATION

2 POLICE STATIONS

UTILITIES

9 PUMP STATIONS

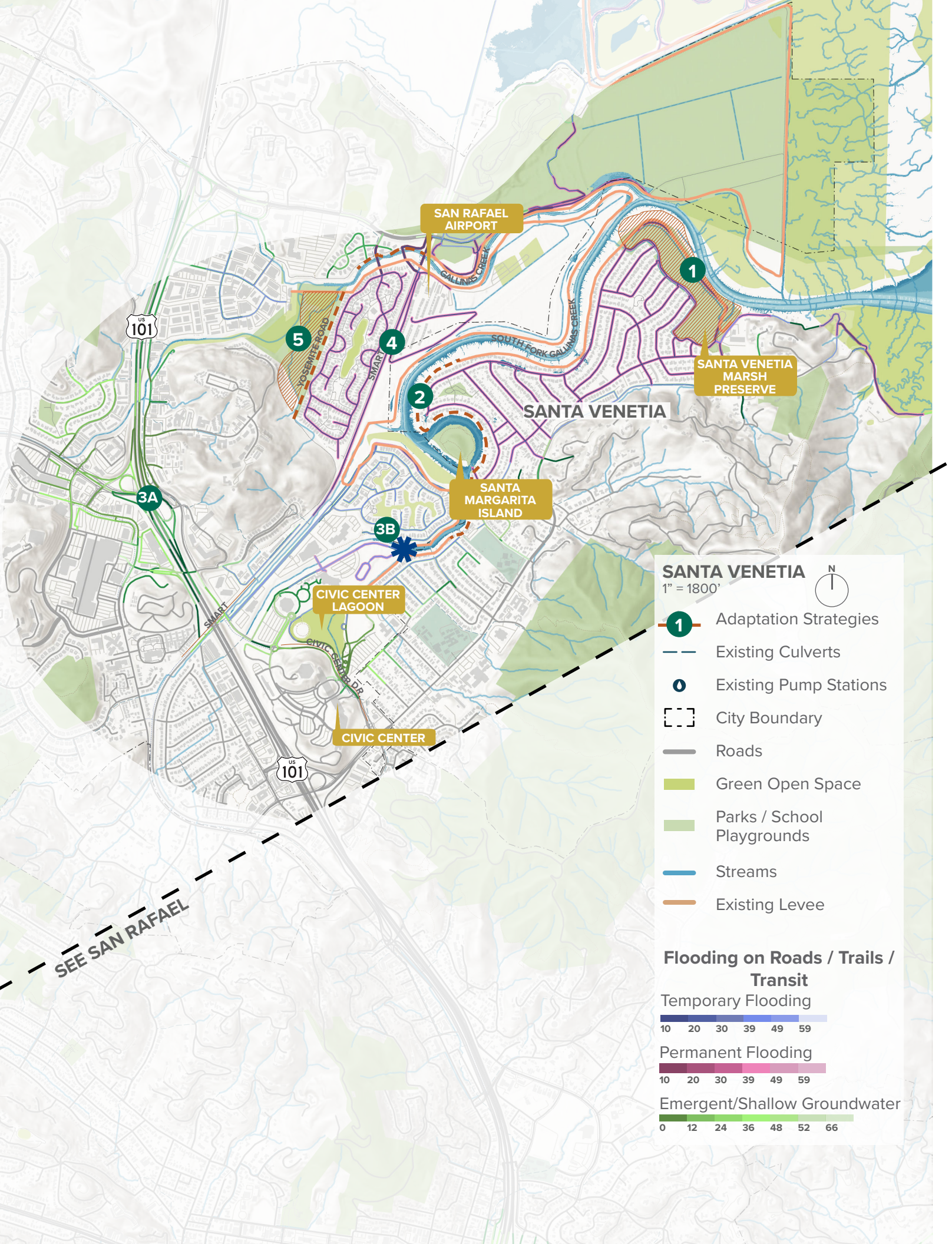
ONGOING ADAPTATION PLANNING

- Las Gallinas Creek Dredge and McInnis Marsh Restoration Project
- New Life for Eroding Shorelines
- Proposed Santa Venetia Levee Upgrade
- Santa Venetia Levee Upgrade Project (South Fork Gallinas Creek)
- Sea Level Rise Adaptation Transportation Infrastructure (I-580/US-101/SMART)

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

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 Santa Venetia. 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 evaluated TAM's role to facilitate or partner on adaptation efforts. 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.


SAN RAFAEL AIRPORT
GALLINAS CREEK
SOUTH FORK GALLINAS CREEK
SANTA VENETIA MARSH PRESERVE
SANTA VENETIA
SANTA MARGARITA ISLAND
CIVIC CENTER LAGOON
CIVIC CENTER DR
CIVIC CENTER
YOSEMITE ROAD
SMART
US 101
1
2
3A
3B
4
5
SEE SAN RAFAEL
SANTA VENETIA
1" = 1800'
N
Adaptation Strategies
Existing Culverts
Existing Pump Stations
City Boundary
Roads
Green Open Space
Parks / School Playgrounds
Streams
Existing Levee
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 coorespond 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

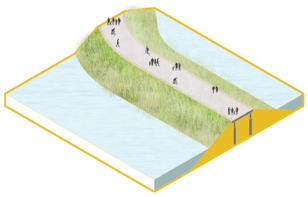
Strategy: Horizontal Levee, Elevation of Roads on Embankment

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

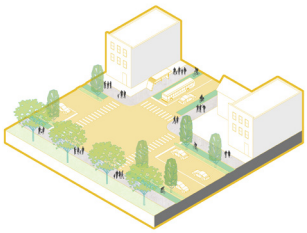
if tied into a complete perimeter protection system. Sheet pile walls are recommended due to space constraints between private property boundaries and the creek. Existing plans are in development considering a similar concept for this location.

3 GROUNDWATER EMERGENCE AT 101 AND ACCESS ROADS

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

Potential Adaptation Strategy:

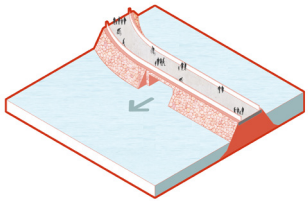
- Strategy A: Complete Green & Elevated Streets, Pump Station -



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

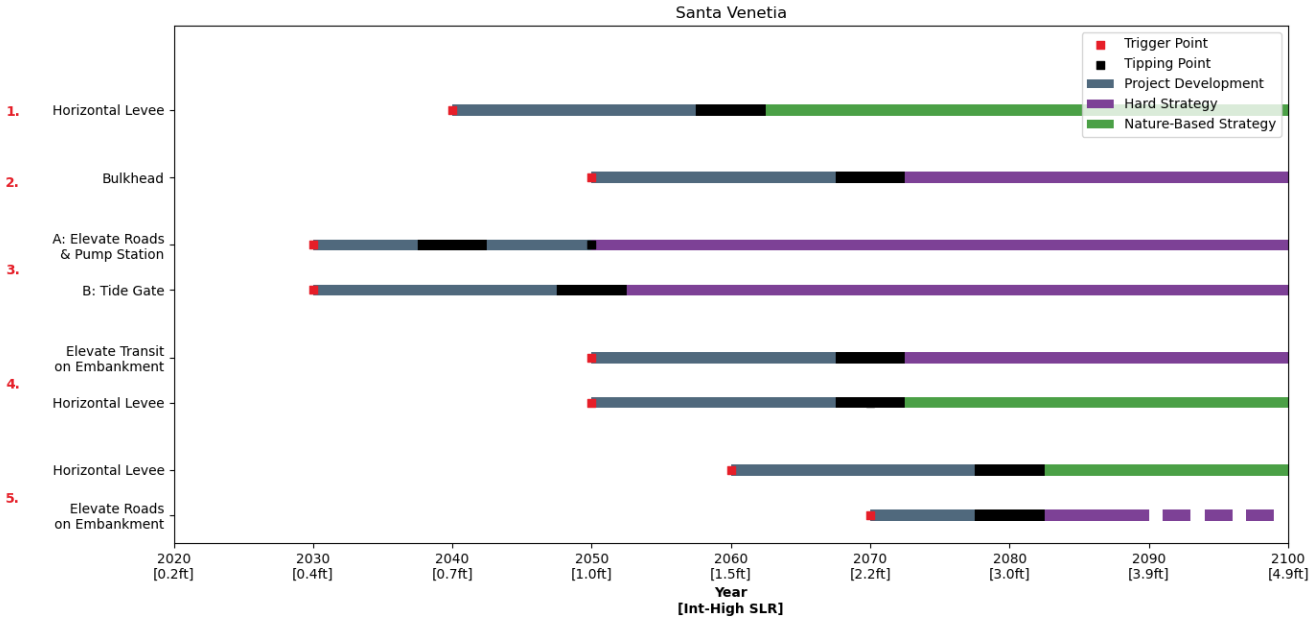
Yosemite Road is currently the only ingress/egress route for daily traffic or emergency evacuation from the neighborhood here adjacent to the San Rafael Airport. Elevating Yosemite Rd and installing perimeter flood protection for this community would provide life safety and property protection benefits. 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.

ADAPTATION PATHWAYS

Timelines are estimated for the strategies identified for each challenge area, as seen in the diagram below. This work can feed into an adaptation pathways framework for the Focus Area.

Built into the Project Development is a minimum time to secure funding, conduct detailed planning and design, obtain permitting, and construct each strategy. The Tipping Point aligns with permanent inundation impacts due to SLR for each challenge area, though temporary flooding and closures are anticipated sooner. The Trigger Point for action is identified given the Project Development time, unless impacts occur in present day, in which case the Trigger Point was set to 2025. Dotted lines on the strategies indicate incremental or ongoing strategies.

The challenge areas identified in Santa Venetia are temporally spread out, where inundation from SLR is expected in the years 2050-2080 under 1-3ft SLR. The earliest trigger point is in 2030 to address #3 Groundwater Emergence at 101 and Access Roads.



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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

TRANSPORTATION ASSETS

1 INGRESS/ENGRESS ROUTE

HIGHWAY 101

1 SMART STATION

1 PARK AND RIDE AREA

40 BUS STOPS

LIFELINES

1 HOSPITAL / HEALTHCARE CENTER

COMMUNITY ASSETS

1 LIBRARY

6 SCHOOLS

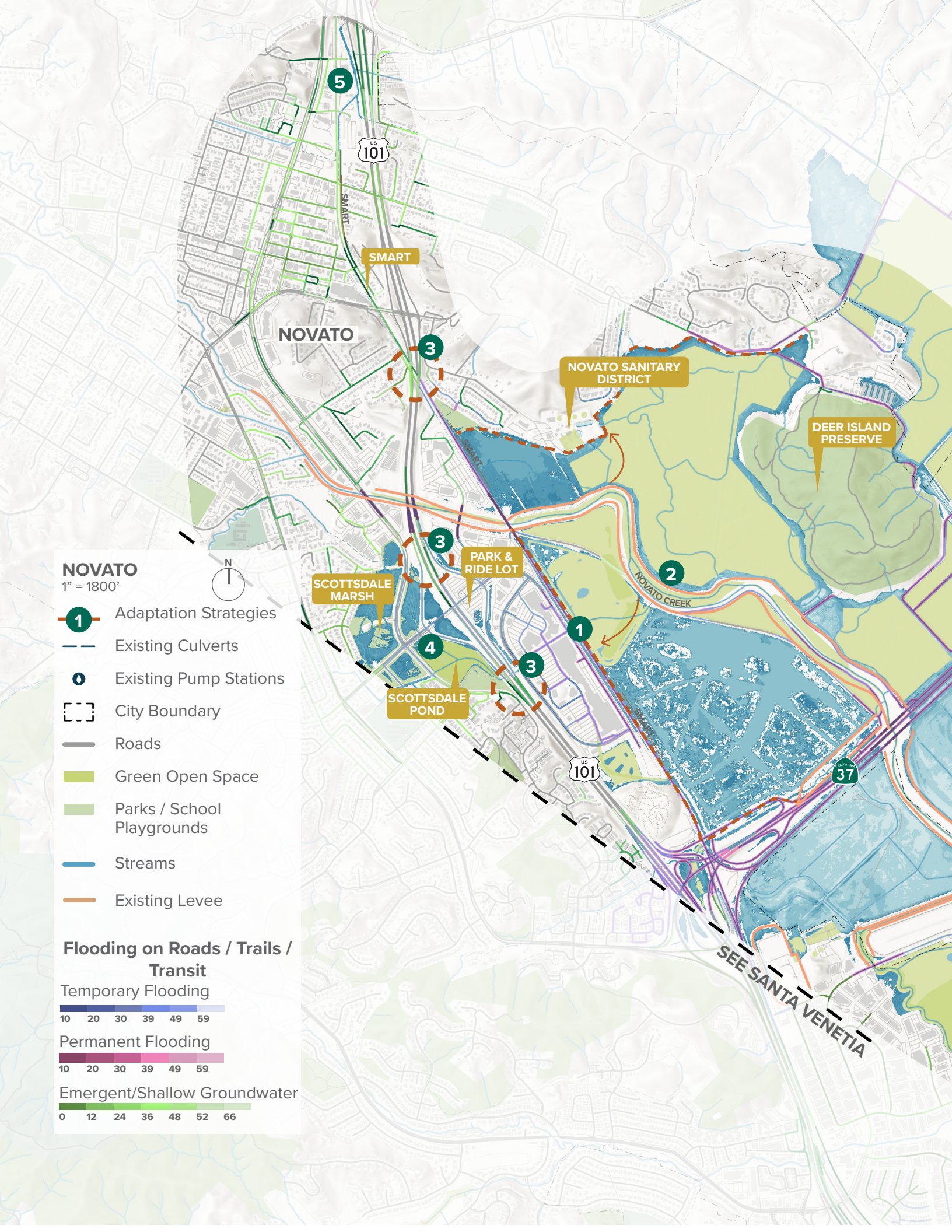
ONGOING ADAPTATION PLANNING

- Novato Baylands and Flood Protection
- Deer Island Basin Complex Tidal Wetlands Restoration
- Sea Level Rise Adaptation Transportation Infrastructure (SR-37)
- Sea Level Rise Adaptation Transportation Infrastructure (I-580/US-101/SMART)
- Hamilton Levee
- Novato Creek Sediment Removal and Wetland Enhancement Project
- SMART Track Raise at Hanna Ranch Rd.

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

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 Novato. 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 evaluated TAM's role to facilitate or partner on adaptation efforts. 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.


NOVATO
1" = 1800'
N
Adaptation Strategies
Existing Culverts
Existing Pump Stations
City Boundary
Roads
Green Open Space
Parks / School Playgrounds
Streams
Existing Levee
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
NOVATO
SMART
NOVATO SANITARY DISTRICT
DEER ISLAND PRESERVE
PARK & RIDE LOT
SCOTTSDALE MARSH
SCOTTSDALE POND
NOVATO CREEK
US 101
37
SEE SANTA VENETIA

FOCUS AREA:

NOVATO

KEY ADAPTATION CHALLENGES & POTENTIAL STRATEGIES

The following challenges have been identified for the Novato area and coorespond 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

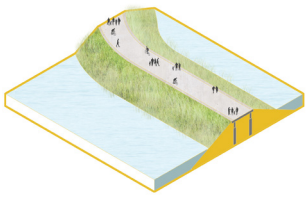
Strategy: Improve Drainage Capacity via Detention Ponds, Pump Station / Culvert

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

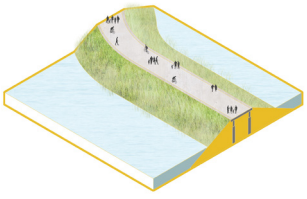
Potential Adaptation Strategy: Breaching Creek Channels

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 (as in ongoing Deer Island Basin Complex Tidal Wetlands Restoration project). 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



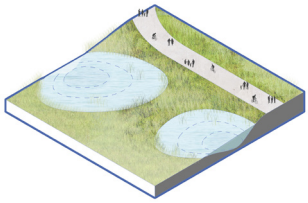
Levee

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



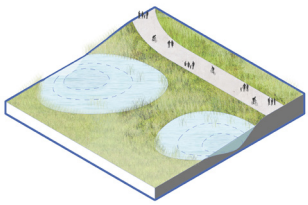
Detention Basin

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.

ADAPTATION PATHWAYS

Timelines are estimated for the strategies identified for each challenge area, as seen in the diagram below. This work can feed into an adaptation pathways framework for the Focus Area.

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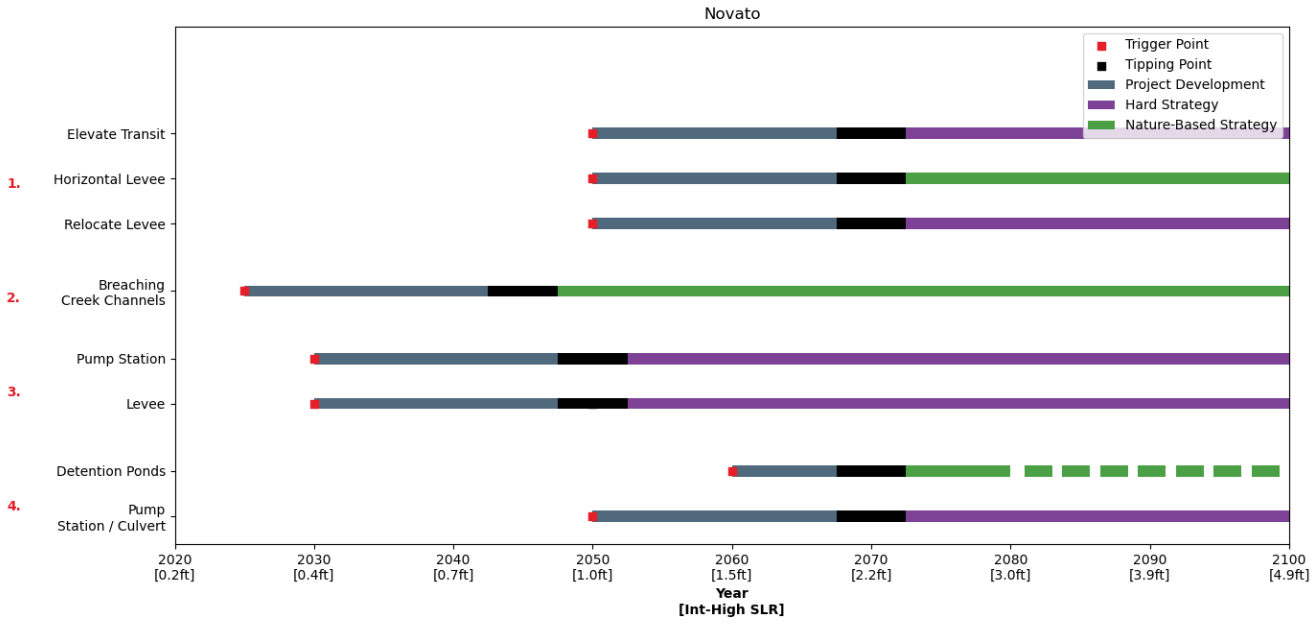
The Novato Focus Area reflects ongoing work along Novato Creek (#2) and near-term trigger points to address emerging groundwater on 101 (#3) anticipated around 2050 under one foot of SLR. Permanent inundation of the SMART route due to SLR is shown around 2070, where the tipping points are located for #1 and #5.



FOCUS AREA:

BEL MARIN KEYS

VULNERABILITY OVERVIEW

Bel Marin Keys is a small waterfront community located in an unincorporated part of Marin County, just east of Novato. Most of the homes sit either on one of the many lagoons or on Novato Creek. This area is highly vulnerable to the impacts of sea level rise as it is largely surrounded by water, bounded by tidal wetlands to the south, Novato Creek to the east and west, and farmland on the north and northeast. All of the lagoons have access to San Pablo Bay through navigational locks.

This area includes several key vulnerable utilities: two power substations and one pump station. Bel Marin Keys experiences present-day exposure to hazards, including shallow and emergent groundwater and flooding from 100-year coastal storms (CoSMoS). This area also includes Equity Priority Community members, with 21-36% of residents characterized as low income.

Levee breach in Bel Marin Keys, October 2022.
Photo by San Rafael Rock Quarry.

SUMMARY OF VULNERABLE ASSETS

TRANSPORTATION ASSETS

1 INGRESS/EGRESS ROUTE

UTILITIES

2 POWER SUBSTATIONS

1 PUMP STATION

ONGOING ADAPTATION PLANNING

- Bel Marin Keys Unit V Wetland Restoration Project
- New Life for Eroding Shorelines

FOCUS AREA:

BOLINAS

VULNERABILITY OVERVIEW

Bolinas is a small, unincorporated coastal community in Marin County, known for its rugged shoreline, and which faces climate adaptation challenges such as coastal erosion and sea level rise. Bolinas is connected to the rest of Marin County and the region via SR-1, a critical asset that already experiences flooding during present-day storms. Several portions of SR-1 are vulnerable to inundation under future 10" (0.8ft or 0.25m) sea level rise conditions. Particularly exposed sections of SR-1 can be found in Bolinas, Stinson Beach, and Point Reyes Station (C-SMART, 2018).

Bolinas includes several community assets like a library and school, as well as one bus stop. Bolinas experiences present-day exposure to hazards, including shallow groundwater. It is also located in a 100-year FEMA floodplain, threatening community assets noted above, as well as local food systems and recreation.

Pacific Storm brings heavy rain to Bolinas, January 2024. Photo by Carlos Barria/Reuters.

SUMMARY OF VULNERABLE ASSETS

TRANSPORTATION ASSETS

1 BUS STOP

1 INGRESS/EGRESS ROUTE

COMMUNITY ASSETS

1 LIBRARY

1 SCHOOL

ONGOING ADAPTATION PLANNING

- Bolinas Lagoon Wye Wetlands Resiliency Project
- Bolinas Lagoon North End Wetland Enhancement/SLR Adaptation Project
- Highway 1 Sea Level Rise Adaptation Planning Study

FOCUS AREA:

HAMILTON WETLANDS

VULNERABILITY OVERVIEW

Hamilton Wetlands are a restored tidal marsh complex that provides critical habitat for wildlife while acting as a natural buffer against sea level rise and coastal flooding. As sea levels rise, the wetlands will require ongoing sediment replenishment and adaptive management to maintain their ecological functions and flood protection benefits for nearby communities.

The area contains several key transit and transportation assets, including three bus stops, one SMART station, as well as Highway 101 running through it. It also has a library and a schooo. The Hamitlon Wetlands experience present-day exposure to hazards, including shallow and emergent groundwater.

Aerial View of Hamilton Wetlands with nearby houses, September 2024. Photo by USACE San Francisco District.

SUMMARY OF VULNERABLE ASSETS

TRANSPORTATION ASSETS

3 BUS STOPS

1 SMART STATION

1 INGRESS/EGRESS ROUTE

HIGHWAY 101

COMMUNITY ASSETS

1 LIBRARY

1 SCHOOL

ONGOING ADAPTATION PLANNING

- Sediment for Wetlands Adaptation Project (SWAP)
- Hamilton Wetlands Restoration Project
- Hamilton Levee
- New Life for Eroding Shorelines

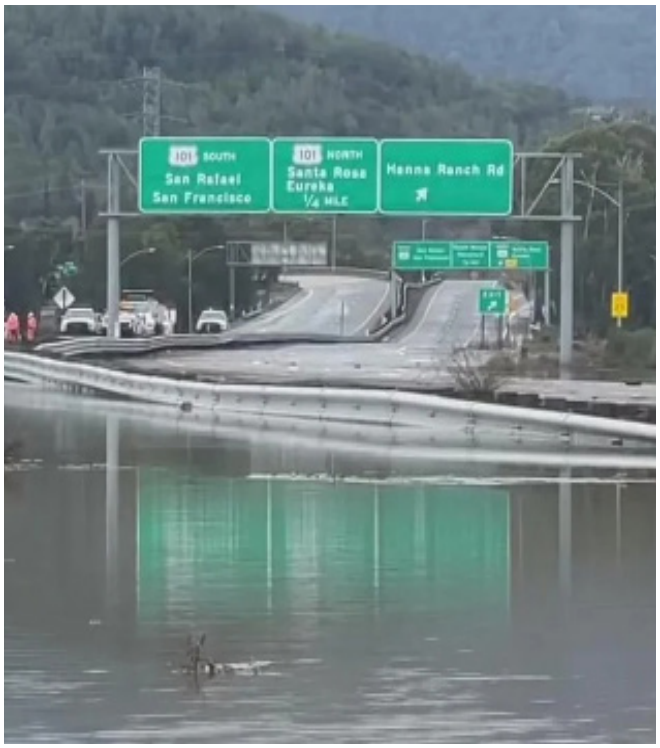
FOCUS AREA:

HIGHWAY 37 / HIGHWAY 101

VULNERABILITY OVERVIEW

This area is where Highways 101 and 37 meet, traversing through a sensitive, low-lying wetland, making it highly susceptible to flooding and sea-level rise. This corridor is a vital transportation route connecting Solano County with Napa, Marin, and Sonoma Counties.

This area includes one park and ride area as well as two pump stations. This area experiences present-day exposure to hazards including shallow and emergent groundwater. It is also located in a 100-year FEMA floodplain.



Flooding on Highway 37 near the Highway 101 interchange, January 2023. Photo by CBS.

SUMMARY OF VULNERABLE ASSETS

TRANSPORTATION ASSETS

1 PARK AND RIDE AREA

1 INGRESS/EGRESS ROUTE

HIGHWAYS 37 AND 101

UTILITIES

2 PUMP STATIONS

ONGOING ADAPTATION PLANNING

- Sea Level Rise Adaptation Transportation Infrastructure (SR-37)

FOCUS AREA:

INVERNESS

VULNERABILITY OVERVIEW

Inverness is a small coastal community situated along Tomales Bay. With rising sea levels, the community faces increasing risks from tidal flooding, necessitating adaptive strategies such as nature-based solutions and resilient infrastructure planning.

Inverness hosts many important community assets and lifeline services, including one hostpial/ healthcare center, one police station, one fire station, two libraries, and one school. It also has six bus stops. There is only one road into and out of the town, Sir Francis Drake Boulevard which is subject to present-day risk to flooding during storm events, which are expected to worsen with climate change. Living shoreline solutions are being explored for this community and others along Tomales Bay (Tomales Bay Living Shoreline Feasibility Study, 2022).

Inverness experiences present-day exposure to hazards as it sits within the 100-year FEMA floodplain. 18-23% of the community is characterized as low income.

Flooding on Sir Francisc Drake Boulevard at Vision Road, December 2024. Photo by The West Marin Feed.

SUMMARY OF VULNERABLE ASSETS

TRANSPORTATION ASSETS

6 BUS STOPS

1 INGRESS/EGRESS ROUTE

LIFELINES

1 HOSPITAL / HEALTHCARE CENTER

1 POLICE STATION

1 FIRE STATION

COMMUNITY ASSETS

2 LIBRARIES

1 SCHOOL

UTILITIES

1 POWER SUBSTATION

ONGOING ADAPTATION PLANNING

- Tomales Bay Living Shoreline Feasibility Study, 2022
- Tomales Bay (Bulkheads)
- Marin Ocean Coast Sea Level Rise Adaptation Report, 2018

FOCUS AREA:

NOVATO - WEST

VULNERABILITY OVERVIEW

The west side of Novato is generally at a higher elevation and less directly vulnerable to sea level rise compared to the low-lying eastern areas. However parts of the area do fall within the FEMA 100-year floodplain.

The area is vitally important to the city and county overall from a transportation perspective as it includes 40 bus stops, one park and ride area, and one SMART station. It also includes several lifeline services like a hospital/healthcare center, police station, fire station, and municpal building as well as community assets, including one library, four schools, and one commercial center. There is one power substation in the area, too. While the exposure to hazards in this area is relatively low, the number of vulnerable assets is high.

Fallen tree during storm blocks driveway to dental office, February 2025. Photo by Sherry LaVars/ Marin Independent Journal.

SUMMARY OF VULNERABLE ASSETS

TRANSPORTATION ASSETS

40 BUS STOPS

1 PARK AND RIDE AREA

1 SMART STATION

1 INGRESS/EGRESS ROUTE

LIFELINES

1 HOSPITAL / HEALTHCARE CENTER

1 POLICE STATION

1 FIRE STATION

1 MUNICIPAL BUILDING

COMMUNITY ASSETS

1 LIBRARY

4 SCHOOLS

1 COMMERCIAL CENTER

UTILITIES

1 POWER SUBSTATION

FOCUS AREA:

STINSON BEACH

VULNERABILITY OVERVIEW

Stinson Beach is a small, low-lying community with an iconic shoreline that faces significant risks from sea level rise, coastal erosion, and flooding due to its proximity to the Pacific Ocean.

Stinson Beach has three bus stops, one fire station, and one library. It is located directly on SR-1 which is a key corridor, connecting the community to the rest of the county and the region and it is vulnerable to inundation during storm events with as little as 10” (0.8ft or 0.25m) SLR (C-SMART, 2018). Relatedly, Stinson Beach’s roads will be under water by the time the broader region reaches 10” of sea level rise.

Stinson Beach experiences present-day exposure to hazards, including shallow groundwater. Low-lying parts of Stinson Beach are located in FEMA VE zones, which is a 100-year flood zone exposed to tsunamis and/or wave action (MCM LHMP). Stinson Beach has a low-income population of 37-66%.

Debris and water on a street in Stinson Beach after a severe storm, January 2023. Photo by David Shalchter.

SUMMARY OF VULNERABLE ASSETS

TRANSPORTATION ASSETS

3 BUS STOPS

2 INGRESS/EGRESS ROUTES

LIFELINES

1 FIRE STATION

COMMUNITY ASSETS

1 LIBRARY

ONGOING ADAPTATION PLANNING

- The Stinson Beach Adaptation and Resilience Project
- Stinson Beach Nature-Based Adaptation Study
- Stinson Beach & Bolinas Lagoon Coastal Resilience Projects
- Marin County Multi-Jurisdiction Local Hazard MitigationPlan

FOCUS AREA:

TIBURON/BELVEDERE

VULNERABILITY OVERVIEW

Tiburon and Belvedere comprise a peninsula and island respectively that extend from mainland Marin into the San Francisco Bay. Tiburon Boulevard (CA-131), which connects them to US-101 and the mainland, is a key transportation asset exposed to coastal hazards. Beach Rd and San Rafael Ave are critical connectors between Belvedere and Tiburon and they're vulnerable to 10-20" of sea level rise and experience inundation during present-day storm events, depicted in the figure below.

Tiburon and Belvedere experience exposure to shallow and emergent groundwater and both are located in the 100-year FEMA floodplain. The cities include several other vulnerable transportation assets including eight bus stops, one park and ride area, and one ferry terminal. It also includes critical lifeline services including one police station, one fire station, and two municipal buildings. Many of these assets are located in low-lying areas exposed to sea level rise, groundwater rise, and storm flooding.

Flooding on Tiburon Boulevard during second day of storm, November 2024. Photo by Ted McDonnel/The Ark.

SUMMARY OF VULNERABLE ASSETS

TRANSPORTATION ASSETS

8 BUS STOPS

1 PARK AND RIDE AREA

1 FERRY TERMINAL

1 INGRESS/EGRESS ROUTE

LIFELINES

1 POLICE STATION

1 FIRE STATION

2 MUNICIPAL BUILDINGS

ONGOING ADAPTATION PLANNING

- Sea Level Rise Vulnerability Assessment (BayWAVE, 2017)
- New Life for Eroding Shorelines: Greenwood and Brunini Beaches
- Protect Belvedere (Belvedere Critical Infrastructure Project)
- Beach Road Stabilization Project (Belvedere Critical Infrastructure Project)

SECTION 7

IMPLEMENTATION STRATEGY

This Implementation Strategy provides a road map for TAM and its partners to advance a coordinated and strategic SLR adaptation program for transportation assets in Marin County. This section outlines three key elements to implementation.

- **Influences and Assumptions**: Acknowledges the broader context, including other county, regional, state, and federal-level activities that may impact implementation, as well as the key assumptions made in areas where uncertainty or dependencies exist.
- **Priority Policies and Programs**: Focuses on high-priority programs and policy recommendations that are both achievable and critical to the success of this Study.
- **Advancing Physical Infrastructure Projects**: Summarizes the primary considerations for implementing the physical SLR adaptation strategies proposed in this Study.

7.1 IMPLEMENTATION INFLUENCES

At the time of writing, there are several concurrent and related efforts happening that will have implementation implications.

SLR GOVERNANCE STUDY

The County of Marin is conducting a study to recommend a new county-level governance structure to respond to SLR adaptation and resilience planning and project delivery in a coordinated way. The study recommendations may directly inform the ways in which the adaptation strategies are implemented and by whom. While it is expected that a recommendation for an SLR governing body could be established through that study's effort, for the purposes of this plan, the current governing structures are assumed to remain unchanged while also maintaining flexibility for future governance changes.

NEW LEGISLATION

The recent approval of Senate Bill 272 requires all coastal jurisdictions in the Bay Area to develop a Regional Shoreline Adaptation Plan (RSAP) by 2034. The Bay Conservation and Development Commission (BCDC) is the governing agency that will provide oversight for the legislation; BCDC recently established guidelines for developing Subregional Shoreline Adaptation Plans (Subregional Plan). This Study precedes those guidelines and legislation, however, there is an intentional overlap between the requirements of the Subregional Plans and what is included in this report. Coastal jurisdictions in Marin who are required to develop a Subregional Plan by 2034 under SB 272 can pull heavily from this document, including the Adaptation Summaries section. It is contemplated that this Study and the Subregional Plans will inform one another over time and be updated as new funding, data, or implementation opportunities arise.

CALTRANS COASTAL RESILIENCE EFFORTS

Caltrans is actively advancing coastal resilience efforts in Marin County to address the growing challenges of SLR, flooding, and coastal erosion. Through the State Highway Operation and Protection Program (SHOPP), Caltrans has prioritized several resilience-focused projects, including improvements to vulnerable locations along the Highway 101 and Highway 1 corridors, which frequently experience tidal flooding. These

enhancements aim to maintain critical access and improve safety along key transportation corridors. Additionally, Caltrans is proceeding with efforts for State Route 37 to adapt the highway to present day flooding conditions as well as rising sea levels and increasing storm impacts that interfere with operations and maintenance of the facility. Collaborative studies and investments are underway to explore adaptive designs, such as elevating roadways, improving drainage, and incorporating nature-based solutions. These initiatives underscore Caltrans's commitment to enhancing the resilience of Marin County's transportation network while supporting regional mobility and ecological health. These efforts are highly relevant for the TAM, who plays a vital role in coordinating and implementing SLR adaptation projects across Marin's transportation system, ensuring alignment with regional priorities, emphasizing local needs, and securing funding for resilient infrastructure solutions.

COUNTYWIDE TRANSPORTATION PLAN UPDATE

TAM's recently adopted Countywide Transportation Plan (CTP) emphasizes resilience as a core priority, providing a framework for addressing the challenges of climate change and SLR in Marin County. By highlighting the importance of sustainable and adaptive infrastructure, the CTP aligns closely with regional and state efforts to implement transportation solutions that enhance long-term reliability and safety. This Study serves as further refinement to the CTP in terms of identifying locations of SLR vulnerabilities, potential projects to advance, and development of a coordinated process across TAM's planning efforts. This strategic focus ensures that Marin's transportation network can support community needs while promoting environmental stewardship and resilience in the face of increasing climate impacts.

7.2 ASSUMPTIONS

The implementation strategy is informed by the following six assumptions.

1. **Marin County's transportation system is to be protected in its current form and function**: The transportation system exists to serve the community and facilitate movement of people throughout Marin. The Study and TAM's program focus actions on protection of that system as is the responsibility of the agency.

2. **Agencies and governing structures are unchanged**: Existing agencies are those who would be on-point for implementation, largely through partnerships. As the County of Marin SLR Governance Study progresses, a new or adapted governing body is expected to be established to aid in the leadership and delivery of SLR adaptation projects. TAM may revisit the implementation strategy in this Study to reflect any changes to the County's governance structure upon completion of the Governance Study.

3. **Regulations related to shoreline infrastructure may be updated in the future**: SLR has led several regulatory agencies to commit to updating regulations. Although the timeline and scale of updates is unknown, it is assumed that new regulations could be in place at a future date.

4. **Funding availability is unchanged**: For the purposes of anticipating future fundings streams, TAM assumes that current grant funding opportunities will remain intact and consistent with recent amounts and availability, recognizing that the funding landscape is dynamic and will most certainly change in the coming years.

5. **No cost escalation or inflation incorporated**: The planning-level cost estimates provided for the adaptation strategies are provided in current dollars and do not reflect future cost escalation or estimate of inflation. More detailed cost estimates will be required in future phases of work.

6. **Partner agencies will have staff who are willing and available to lead specific adaptation strategies**: Partner agencies identified in the implementation strategy have the interest and capacity to perform these activities.

For the purposes of this Study, these informed assumptions were necessary to draw conclusions and provide direction to TAM and its SLR Program. The landscape of climate adaptation and SLR planning is evolving and it is understood that these assumptions are subject to change as conditions do.

7.3 POLICY-LEVEL SLR ADAPTATION STRATEGIES

Achieving SLR goals requires policies and programs that not only align adaptation action across jurisdictions within Marin County, but also support physical SLR strategies and create opportunities for new or additional funding. This section outlines priority policies and programs that TAM identified through a review of best practices and input from agency partners.

These strategies aim to ensure resilience of critical transportation assets; integrate nature-based and engineered solutions; foster regional collaboration and shared accountability; and align with emerging legislation and governance structures. TAM can influence SLR adaptation strategy implementation through policy level interventions in addition to physical interventions on the landscape.

VOLUNTARY SLR ADAPTATION POLICY

One of the key implementation tools that TAM has available is the Voluntary SLR Adaptation Policy (Appendix B) which is currently under development. This policy is intended to be adopted at the jurisdictional level as a resolution by city councils or other special district boards to commit jurisdictions to alignment with the SLR adaptation goals adopted by TAM's Marin CTP. Adoption of the policy will position jurisdictions for Measure AA sales tax funding available within the agency's SLR Program as well as project development including outreach and engagement assistance, grant writing support, and other technical assistance from TAM.

CLIMATE-RESILIENT TRANSPORTATION DESIGN PRINCIPLES

Develop guidelines for infrastructure that incorporate SLR projections, extreme weather, and groundwater emergence into the design of roads, bridges, and transit facilities, prioritizing facilities that have been identified as priority evacuation routes. An early example of such a design guideline or principle that the project team recommends is a 'Complete, Green, and Elevated Streets' Policy that would require any planned maintenance or updates to the county's roadways within the evacuation network to include evaluating the roadway segment for potential integration of green infrastructure components, multimodal infrastructure, and elevation to a certain height depending on its criticality and current SLR projections.

This type of approach ensures that resilience upgrades are seamlessly integrated into routine maintenance and capital projects. By aligning adaptation efforts with planned infrastructure

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

improvements, agencies can maximize cost efficiency and minimize disruption, addressing resilience needs without requiring entirely new standalone projects. This opportunistic strategy mirrors "Complete Streets" practices, where repaving or roadway improvement projects are frequently leveraged to incorporate bike and pedestrian safety upgrades, stormwater management features like bioswales or rain gardens, and other multimodal enhancements. Similarly, incorporating green infrastructure, multimodal facilities, and elevation standards into roadway upgrades ensures that local projects contribute meaningfully to long-term SLR resilience while addressing immediate needs. This integrated approach provides a practical pathway to incrementally enhance resilience across Marin County's transportation network.

To implement this policy, TAM—and/or the SLR governing agency in the County—would need to develop and publish a map identifying roads in Marin County that are eligible or compatible, starting with the evacuation route network and expanding to include additional critical roadways identified in this project's vulnerability assessment, ensuring a targeted and strategic approach to resilience upgrades. It is important to note that these adaptation measures would not replace the longer-term, larger-scale protection or perimeter defense adaptation projects, but would aid in making Marin's transportation infrastructure more resilient in the near term. Near term adaptations as mentioned above could provide meaningful improvements to the roadways, extending the efficacy of the evacuation routes in the event of an emergency.

CONTINUE COHESIVE SUBREGIONAL PLANNING EFFORT AT COUNTY LEVEL

This Study can be employed as an organizing tool for coastal jurisdictions to create a shared understanding around vulnerability in the county and to advance consistent adaptation strategies as they develop their Subregional Plans under SB 272; TAM might support and/or collaborate with working groups to seek alignment and define triggers or thresholds for implementing additional measures, such as elevating roads or retrofitting flood-prone assets.

The new requirements under SB 272 have highlighted the critical need for County-level entities to convene and coordinate the key partners and agencies involved in developing Subregional Plans. TAM is well-positioned to aid local jurisdictions and the County in the transportation sections of these plans, leveraging its established relationships with local jurisdictions, regional agencies, and

community organizations to foster collaboration and ensure consistency in adaptation plans that involve Marin County's transportation system. TAM could serve as a facilitator for regular meetings and working groups to align priorities, share data, and help to establish uniform standards for adaptation strategies, such as thresholds for implementing measures like roadway elevation. By providing planning support, guidance, and a platform for dialogue, TAM can help ensure consistency in the development of Subregional Plans, supporting more effective and efficient implementation of SLR adaptation measures across Marin County.

LEVERAGE LEGISLATIVE AND FUNDING OPPORTUNITIES

Use the TAM state and federal lobbyists to advocate for policies that expand or secure funding for SLR adaptation, focusing on opportunities like federal infrastructure resilience grants, Caltrans adaptation planning funds, and other emerging sources of funding. This includes actions such as advocating for protecting and leveraging funding allocations from initiatives like the Water Resources Development Act of 2024 (WRDA). Additionally, TAM can build on its Voluntary Adaptation Policy framework to further build out the TAM Measure AA SLR Program that encourages local jurisdictions to advance implementation of adaptation measures aligned with TAM priorities as identified in the Study as well as regional and state priorities.

To implement this strategy, TAM should begin by looking more closely at the funding opportunities outlined in the implementation strategy and identify sources for matching funds and resources for grant development, acknowledging the potential for change in funding landscape over time.

Concurrently, TAM's lobbyists can initiate outreach to state and federal representatives, presenting Marin County's adaptation needs and success stories to build support for funding allocations. Internally, TAM should create a partner engagement plan to coordinate with local jurisdictions, ensuring readiness to apply for and utilize new funding sources efficiently. Establishing metrics to evaluate the effectiveness of advocacy efforts and providing regular updates to TAM's board and partners will help maintain transparency and demonstrate progress toward securing resources for resilience projects. These actions will enable TAM to play a transportation-focused lead role for Marin County in addressing the challenges of SLR while strengthening the region's ability to secure long-term funding for adaptation.

CONSISTENT MESSAGING THROUGH PUBLIC OUTREACH

Communicating risk and building public understanding and trust is one of the most significant challenges in SLR adaptation planning. Messaging must inspire people to care now about projects they may never see built or impacts they may not experience in their lifetime. Given Marin County's vulnerability, it is crucial to communicate SLR risks effectively through workshops, in-person events, and other engagement tools that not only educate but also gather public feedback on goals and priorities to guide agencies' decision-making processes. Engaging the community in this way helps build the support necessary for increasing funding measures and fostering the political will required for long-term implementation. These efforts should prioritize Equity Priority Communities, such as Marin City, San Rafael's Canal Neighborhood, and Novato, to ensure that historically underserved areas have a voice in shaping adaptation strategies and receive equitable benefits from future investments.

The relationships that the local jurisdictions and the County have with the CBOs and other NGOs within Marin position them well to facilitate these conversations with the community. As a part of the external engagement within this Plan, TAM held a focus group with CBOs and NGOs in Marin to gather feedback on effective public engagement strategies recommended for future outreach pertaining to sea level rise in Marin. The group provided the following recommendations:

1. Ensure presentations are easily understandable and avoid technical jargon when connecting with the community.
2. Work with CBOs and NGOs to train residents to share information and involve technical experts as needed, emphasizing community-first principles.
3. Focus on collaboration, efficiency, and avoiding redundant efforts within the County.

To amplify these efforts, a County-level public education campaign could be developed to deliver consistent messaging and provide support to local jurisdictions, many of which may lack the resources for robust community outreach. Such a campaign could include visual tools like interactive maps, clear summaries of SLR risks, and success stories of adaptation measures, alongside accessible workshops tailored to specific community needs. These policy-level strategies complement the physical SLR adaptation strategies it will lead or partner on, ensuring a holistic approach to managing risks and fostering resilience. These physical strategies are detailed in the following section, forming a critical counterpart to the public engagement and policy initiatives.

7.4 PHYSICAL SLR ADAPTATION STRATEGIES

Physical SLR adaptation strategies involve interventions designed to reduce the impacts on transportation infrastructure in coastal areas. TAM will play a critical role as a partner in implementing these landscape-level strategies, ensuring they are executed in a coordinated and efficient manner. The strategies outlined in the accompanying table focus on those within TAM's purview or that of its public infrastructure partners. Strategies such as eelgrass or marshland restoration and coarse grain beach nourishment, while vital for mitigating SLR impacts, fall outside TAM's jurisdiction and are typically managed by natural resource agencies.

The table of physical SLR adaptation strategies includes key details to guide TAM in planning and coordinating implementation with its partners. This information is tailored to help TAM align its efforts with other agencies, prioritize projects, and address vulnerabilities within Marin County's transportation network.

Strategy detail	Description
Rough Order of Magnitude (ROM) Costs	The cost ranges are intended to provide TAM with a reference point as they consider the level of funding required to bring any one of these adaptation strategies to fruition. For the purpose of this study, the costs are bucketed as follows: • Low costs: $1M-$10M per project • Medium costs: $10M-$100M per project • High costs: >$100M per project
Timeframe	The timeframe captures the project team's recommendations for initiating construction of adaptation strategies given SLR projections and level of vulnerability. For the purpose of this study, the timeframes are bucketed as follows: • Near-term: 5-10 years • Medium-term: 10-25 years • Long-term: >25 years
Focus Areas	The focus areas are the locations identified in the Adaptation Summaries where these adaptation strategies touch down.
Transportation Assets	Captures the transportation assets intended to be defended by the adaptation strategy.
Partners	Identifies partners with whom TAM should initiate conversations about project development, funding, and planning.
Funding Sources	Existing funding from Federal, State, regional, and local sources for which adaptation strategies might be eligible. All funding sources noted here should be explored in further detail.
Near-Term Actions	Any one of these adaptation strategies will require multi-year planning efforts, jurisdictional and agency coordination and formal partnerships, and sustained funding for planning and construction. The near-term actions are intended to help TAM, and its partners take first steps to move the strategies forward into reality after the they have determined feasibility (discussed in Section 7.8). Community engagement is a vital near-term action related to each of these strategies and should be one of the first actions to occur, with an eye toward Equity Priority Communities and their needs.

The detailed adaptation strategies are included in the following table followed by a discussion on feasibility and project delivery.

Adaptation Strategy	ROM Cost	Timeframe	Example Areas for Application	Transportation Assets	Partners	Funding Sources	Near-Term Actions	Regional precedents
TAM Facilitates								
Elevate Roads and Utilities	Medium to High	Near- to Long-term	• Gate 5 Road • Civic Center Drive • Donahue Street • Yosemite Road	• Roadways • Ingress/egress routes • Parking facilities	• Caltrans • County and local public works departments • Local transportation departments	• FHWA grants • Caltrans adaptation planning grants • Local government public works CIP • Local transportation CIP	• Develop project level engineering plan • Initiate permitting process for top priority project	• SR-37 (in progress)
Green Infrastructure	Low to Medium	Medium-term	• Bridgeway • Miller Avenue • Donahue Access • Lucky Drive	• Streetscapes • Transit routes • Adjacent bus stops	• USACE • SFEP • Caltrans • County and local public works departments • Local transportation departments • Local water management districts	• EPA Green Infrastructure Funding • MTC OBAG 3 Grants • Municipal stormwater fees (potentially)	• Develop green street master plans • Adopt Complete, Green, and Elevated Streets policy • Identify locations and pilot projects (bioswales, permeable pavements) • Train local staff on green infrastructure functions and maintenance	• San Pablo Ave Green Stormwater Spine, East Bay • San Mateo Sustainable Streets Plan • SFPUC Urban Watershed Planning
TAM Partners								
Horizontal Levees	Medium	Long-term	• Santa Venetia • Bothin Marsh • Corte Madera Creek • San Rafael Canal	• Transit hubs • Key transportation corridors	• USACE • Environmental groups like SFEP • County and local public works departments • Special districts	• FEMA Hazard Mitigation Grants, Coastal Conservancy grants, local taxation measures	• Identify pilot levee project • Develop project level engineering plan • Initiate construction process in priority areas	• Oro Loma Horizontal Levee, San Lorenzo • Palo Alto Horizontal Levee, Palo Alto • First Mile Horizontal Levee, Hayward
Pump Stations and Detention Basins	Low	Medium-term	• Marin City Stormwater Pond • Scottsdale Marsh • Gallinas Creek • Corte Madera Creek	• Adjacent transit assets • Vulnerable transportation infrastructure	• Local flood control districts • Local public works departments • Private developers	• California State Water Resources Control Board grants • FEMA infrastructure resilience funds • Local bond measures	• Conduct gap analysis between SLR vulnerability assessment and County flood management plan • Assess pump/basin capacity • Update flood management plan accordingly	• Bayfront Canal & Atherton Channel Watershed Flood Management Plan, San Mateo County • Central Avenue, Fremont
Tide Gates and Floodwalls	Medium	Medium-term	• San Rafael Canal • Corte Madera Creek • Gallinas Creek	• Low-lying roadways • Transit routes	• USACE • Local water management districts	• FEMA Pre-Disaster Mitigation Program • Federal infrastructure grants • Local water districts CIP • Local public works department CIP	• Conduct environmental studies • Identify project lead	• Palo Alto Tide Gate Structure • Lake Merritt Tide Gate
Embankments and Causeways	High	Long-term	• Highway 101 • Highway 37 • SMART rail • Bellam Blvd	• Highways • SMART • Major transit routes	• Caltrans • Local transportation departments • Local public works departments	• FHWA grants • Local Transportation Climate Adaptation Program (LTCAP) • Regional transportation funds • Public-private partnerships	• Prioritize project based on evacuation utility • Identify initial pilot project • Conduct geotechnical assessment	• Mills Creek Embankment and Wingwall Repairs Project, San Mateo

These physical adaption strategies are unconstrained, encompassing the full suite of defenses that will help the address impacts from SLR, including projects that could require change in right of way or need for acquisition of private property. While many of the near-term actions detailed above are specific to the respective adaptation strategy, it is recommended that TAM and its partners convene to discuss project next steps including what partners should be involved in various projects, the roles and responsibilities of each agency, and the project feasibility before any of the above noted near-term actions can move forward, the steps for which are described in Figure 2. TAM would not be on-point for all the steps included in this process to determine feasibility but would help identify and convene the right people, facilitate the process, and support on funding efforts, like grant writing.

Workers diverting water into drain, October 2021. Photo by Justin Sullivan/Getty Images.

The process to determine feasibility is aimed at generating a set of discrete priority projects that are ready to receive funding and advance into subsequent project delivery phases. TAM will follow the below guiding principles throughout this process:

- **Adopt an adaptation pathways approach**: To the extent possible, seek opportunities for phased implementation for adaptation strategies. The Adaptation Summaries in this report serve as a starting point. The pathways should provide benefit to Marin County today while putting it on the path to resilience in the coming century. This approach allows projects to flex over time as different priorities emerge and as SLR impacts potentially change.
- **Reflect SLR as a cross-jurisdictional and cross-department priority**: Departments and jurisdictions outside of TAM should earmark budget for SLR projects in their CIPs and annual programs. Seek increased funding from Measure AA as this Study advances.
- **Prioritize projects with multiple benefits**: Examples could include flood protection and congestion mitigation.
- **Focus on what is essential**: Prioritize those strategies that are most cost efficient, but that also protect the most vulnerable assets. This could include near-term projects that come at a high cost and long-term projects that may have lower costs as they are implemented slowly over time.

Working groups

- Determine roster for adaptation strategy-specific working groups and solicit participation.
- Convene groups consisting of staff who can move the strategies forward and director-level representatives who can make key decisions on behalf of their agency.
- Identify strategy leads.
- Flag any implementation challenges expected based on professional and local knowledge.

Detailed cost estimates

- Develop detailed cost estimates for each adaptation strategy by pricing out the associated projects in each.
- Seek opportunities to bundle projects to the extent possible to better leverage funding sources.
- Consider cost escalation to support cost-benefit analyses and planning timelines.

Funding sources and availability

- Assess funding landscape across agencies and departments.
- Identify funding shortfalls between budget required for implementation and budget available from current and potential grants and local department CIPs.
- Research funding opportunities and develop a grant strategy and grantwriting plan.
- Determine which projects lend themselves to PPP and initiate discussions with developers.

Project prioritization

- Collaborate across agencies to develop detailed information about strategies, including:
- Cost-benefit analyses
- Equity benefits
- Cost and funding availability
- Vulnerability and criticality of assets
- Adaptation pathways and sequencing of projects
- Evaluate project's ability to generate near-term benefits as well as long-term defense and to maintain options over time.
- Evaluate opportunities for leveraged funding.

SECTION 8

NEXT STEPS

This Study underscores the critical importance of integrating policy-level initiatives, nature-based solutions, and physical infrastructure enhancements to safeguard vital transportation assets against impacts from climate change while advancing equity goals. The findings reaffirm the need for coordinated efforts across agencies, prioritization of adaptation strategies, and the incorporation of community feedback into decision-making processes. TAM's functions as both a lead and a partner are pivotal in advancing SLR adaptation strategies in Marin County. Next steps coming from this Study include the following:

Next steps	Description
Finalize and share the Plan	Secure approval and formalize the Study as a guiding framework for SLR adaptation in Marin County. Share with local, regional, and state agencies.
Find project champions and key partners	Identify key staff at agencies identified in Focus Area jurisdiction to initiate feasibility exploration for strategies.
Promote community involvement	Use consistent messaging through public outreach. Enhance outreach to ensure inclusivity for all historically underserved communities, vulnerable road users, and non-drivers (as identified through the TAM CTP process) in project development and implementation.
Support cohesive subregional planning efforts	Integrate the findings and strategies of this Study with forthcoming Subregional Plans as mandated by SB 272. Leverage existing and new sources of funding to support adaptation work in the county.
Develop and implement priority policies and programs	Outline implementation of Measure AA SLR Program via Voluntary SLR Adaptation Policy, including funding call for projects/project nomination processes for jurisdictions. Explore development of Climate Resilient Transportation Design Principles.

SECTION 9

APPENDICES

APPENDIX A

GLOSSARY

APPENDIX A

GLOSSARY

Abbreviation	Definition
ABAG	Association of Bay Area Governments
ABC Waters	Active, Beautiful, Clean Waters
AGOL	ArcGIS Online
ARC	Adaptation and Resilience Collaboration
ART	Adapting to Rising Tides
BARC	Bay Area Regional Collaborative
BayWAVE	Bay Waterfront Adaptation and Vulnerability Evaluation
BCDC	San Francisco Bay Conservation and Development Commission
BOD	Basis of Design
CA	California
CalOES	California Office of Emergency Services
Caltrans	California Department of Transportation
CCJPA	Capital Corridor Joint Powers Authority
CMA	Congestion Management Agency
C-SMART	Collaboration: Sea level Marin Adaptation Response Team
D4	District 4 (Caltrans)
DFE	Design Flood Elevation (DFE)
ESA	Environmental Science Associates
FEMA	Federal Emergency Management Agency
FL	Florida
FME	Feature Manipulation Engine
GGBHTD	Golden Gate Bridge, Highway and Transportation District
GIS	Geographic Information System
HOV	High-occupancy vehicle
I-580	Interstate 580

LA	Louisiana
LHMP	Local Hazard Mitigation Plan
MA	Massachusetts
MCM	Marin County Multi-Jurisdictional
MTC	Metropolitan Transportation Commission
NY / NYC	New York / New York City
OBAG	One Bay Area Grant (MTC)
OLU	Operational Landscape Unit
OPC	Ocean Protection Council
PEL	Planning and Environmental Linkages
PM	Postmile
RFI	Request For Information
P+SET	Permaculture + Social Equity Team (Resilient by Design Bay Area Challenge)
SF	San Francisco
SFEI	San Francisco Estuary Institute
SLR	Sea level rise
SPUR	San Francisco Bay Area Planning and Urban Research Association
SR-37	State Route 37
TAM	Transportation Authority of Marin
TIP	Transportation Improvement Program
TX	Texas
UK	United Kingdom
US-101	US Highway 101
USA	United States of America
VA	Virginia
VE	High-risk coastal flood zone with at least 1-in-4 chance of flooding over 30 years (FEMA)

APPENDIX B

VOLUNTARY ADAPTATION POLICY

[JURISDICTION]

RESOLUTION NO. [INSERT NUMBER]

ADOPTION OF THE TRANSPORTATION AUTHORITY OF MARIN VOLUNTARY SEA LEVEL RISE ADAPTATION POLICY

WHEREAS, the [insert local jurisdiction] is responsible for [local jurisdiction tasks]; and

WHEREAS, the Transportation Authority of Marin (TAM) is responsible for implementing voter approved transportation expenditure plans including 2018's voter approved Measure AA Sales Tax and supporting transportation projects and programs that align with the Marin Countywide Transportation Plan (CTP) adopted in December 2024, including multi-modal network solutions, safety, equity and affordability, and community resilience; and

WHEREAS, TAM's voter approved Measure AA Sales Tax includes a 1% set aside through Category 2.3 to develop projects to address transportation impacts from sea level rise; and

WHEREAS, sea level rise poses significant risks to Marin County's transportation infrastructure, public utilities, and lifeline and community facilities; and

WHEREAS, public support for funding and planning to adapt to sea level rise is included in local and county plans including but not limited to the list identified in TAM's Sea Level Rise Adaptation Planning Study's Existing Plan Review Chapter; and

WHEREAS, Multi-jurisdictional and organizational collaboration is needed to improve and adapt the transportation system to sea level rise and flooding; and

WHEREAS, TAM has developed a comprehensive Sea Level Rise Adaptation Plan (the "Plan") to guide local jurisdictions in advancing solutions for and mitigating the impacts of sea level rise; and

WHEREAS, the Plan promotes proactive measures to protect critical infrastructure and communities from flooding, erosion, and other climate-related hazards; and

WHEREAS, adoption of the Plan's goals by local jurisdictions is essential to achieving regional resilience and securing the necessary resources to implement adaptation strategies; and

WHEREAS, TAM recognizes the limited financial resources local jurisdictions to integrate the Plan's goals into their planning and implementation efforts; and

NOW, THEREFORE, BE IT RESOLVED THAT:

[Jurisdiction] agrees to work collaboratively with TAM and other local jurisdictions to address sea level rise and the impacts it poses on Marin County's transportation system should adaptation planning and project implementation not move forward cohesively.

In alignment with the goals of the TAM Measure AA Sales Tax Category 2.3 Sea Level Rise Program, [Jurisdiction] is formally adopting Resolution No: XXX to incorporate the goals and strategies outlined in TAM's Sea Level Rise Adaptation Program. [Jurisdiction] commits to integrating sea level rise adaptation into transportation planning, land use decisions, and infrastructure investments.

Adoption of Resolution No. XXXX positions [Jurisdiction] for potential funding from TAM to support:

- **Project Development:** Development of concepts for adaptation solutions including engagement, planning, design, and construction. Includes a focus on multi-benefit

projects that incorporate additional elements of TAM's programs including active transportation, transit, and other infrastructure.

- **Grant Writing Assistance:** Financial or technical assistance to secure additional funding for transportation adaptation projects.
- **Other:** Additional funding opportunities may be made available to [Jurisdiction] by demonstrating exceptional progress or innovation in implementing adaptation strategies.

Implementation and Monitoring: TAM staff will work collaboratively with [Jurisdiction] to:

- Support funding strategy development, including coordination on countywide priorities for transportation and adaptation funding as well as incorporation into regional and state plans and programs as applicable.
- Assist in facilitation of collaboration with regional and state agency partners.
- Provide guidance on incorporating the Program's goals into local plans, capital improvement programs, and other planning programs.
- Monitor and evaluate progress in achieving adaptation objectives.
- TAM will establish an annual reporting framework for [Jurisdiction] to document their implementation efforts and outcomes.

Regional Collaboration: TAM will coordinate with regional and state agencies to align funding opportunities and technical resources, ensuring consistency and efficiency in addressing sea level rise across Marin County.

BE IT FURTHER RESOLVED THAT:

[Jurisdiction] will support the goals of the Sea Level Rise Adaptation Program and ensure the long-term resilience of Marin County's transportation network.

PASSED AND ADOPTED this [INSERT DATE] by the following vote:

AYES: [LIST]

NOES: [LIST]

ABSENT: [LIST]

ATTEST:

[NAME],

Jurisdictional signatory

APPENDIX C

TAC MEETING SUMMARIES

APPENDIX C

TAC MEETING SUMMARIES

TAC Member Agencies
• California Department of Transportation (Caltrans Planning Team) • Metropolitan Transportation Commission (MTC) • San Francisco Bay Conservation and Development Commission (BCDC) • Local Jurisdiction Sustainability Coordinators • County of Marin (BayWAVE / MarinSLR) • Marin Public Works Association (MPWA)

TAC Meeting	Meeting Content
1	Key takeaways from existing plan review, data availability, national and global precedents, and initial adaptations concepts.
2	Vulnerability issues like SLR and groundwater emergence, adaptation strategy development process, and three geographic focus areas examples.
3	Moving from vulnerability to adaptation. Shared screening exercise to get feedback. Catalog ongoing planning projects as part of TAC input.
4	Adaptation summaries approach and Corte Madera case study, including addressing 101 flooding and employing an adaptation pathways framework.
5	Implementation approach for TAC feedback. The discussion included topics related to the adaptation strategies as well as TAM's role in advancing said strategies.
6	The final meeting solicited TAC feedback on the final report, including the estimated timelines as part of the adaptation pathways work, and on TAM's next steps, discussing roles on RSAPs, voluntary policies, and design guidelines.

APPENDIX D

EXISTING PLAN REVIEW MEMO

ARUP

Transportation Authority of Marin

Sea Level Rise Adaptation Planning for Marin County's Transportation System

Existing Plan Review Memo

V2 | May 19, 2025
V1 | October 18, 2023

Job number 295823-00

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Contents

Appendices

Abbreviations

Abbreviation	Definition
ABAG	Association of Bay Area Governments
ABC Waters	Active, Beautiful, Clean Waters
AGOL	ArcGIS Online
ARC	Adaptation and Resilience Collaboration
ART	Adapting to Rising Tides
BARC	Bay Area Regional Collaborative
BayWAVE	Bay Waterfront Adaptation and Vulnerability Evaluation
BCDC	Bay Conservation and Development Commission
BOD	Basis of Design
CA	California
CalOES	California Office of Emergency Services
Caltrans	California Department of Transportation
CCJPA	Capital Corridor Joint Powers Authority
CMA	Congestion Management Agency
C-SMART	Collaboration: Sea level Marin Adaptation Response Team
D4	District 4 (Caltrans)
DFE	Design Flood Elevation (DFE)
ESA	Environmental Science Associates
FEMA	Federal Emergency Management Agency
FL	Florida
FME	Feature Manipulation Engine
GGBHTD	Golden Gate Bridge, Highway and Transportation District
GIS	Geographic Information System
HOV	High-occupancy vehicle
I-580	Interstate 580
LA	Louisiana
LHMP	Local Hazard Mitigation Plan
MA	Massachusetts
MCM	Marin County Multi-Jurisdictional
MTC	Metropolitan Transportation Commission
NY / NYC	New York / New York City
OBAG	One Bay Area Grant (MTC)
OLU	Operational Landscape Unit
PEL	Planning and Environmental Linkages
PM	Postmile
RFI	Request For Information
P+SET	Permaculture + Social Equity Team (Resilient by Design Bay Area Challenge)
SF	San Francisco
SFEI	San Francisco Estuary Institute
SLR	Sea level rise
SPUR	San Francisco Bay Area Planning and Urban Research Association
SR-37	State Route 37
TAM	Transportation Authority of Marin

Abbreviation	Definition
TIP	Transportation Improvement Program
TX	Texas
UK	United Kingdom
US-101	US Highway 101
USA	United States of America
VA	Virginia
VE	High-risk coastal flood zone with at least 1-in-4 chance of flooding over 30 years (FEMA)

1. Executive Summary

As the County Transportation Agency (CTA) for Marin County, TAM works closely with local jurisdictions as well as other partners in the region and state to plan, coordinate and deliver a wide range of transportation projects and programs, including sea level rise planning for the countywide transportation system. This project, the "Sea Level Rise Adaptation Planning for Marin County's Transportation System Project", will deliver an implementation plan to address sea level rise and flooding for transportation assets in the county. In the first phase of the project, a review of existing plans and GIS datasets was completed to establish a baseline dataset and understanding of relevant previous and ongoing work in the county to guide this project, inform later phases of work, and help avoid duplicating prior efforts.

1.1 Purpose

The goals of the Existing Plan Review were threefold:

1. Establish a baseline level of awareness and understanding of the breadth and depth of existing work related to sea level rise adaptation regionally and in Marin County.
   Much work has been done to understand and plan for the impact of sea level rise in the Bay Area and in Marin County. In this project and related efforts, it is critical to avoid, to the extent possible, duplication of previous work. Reviewing prior work also allows TAM and its project team to develop an up-to-date familiarity with studies completed by local and regional partners to benefit collaboration.

2. Create a shortlist of potentially viable sea level rise adaptation strategies that are compatible with the Marin context and pre-identify (i.e., before GIS analysis) known vulnerability "hotspots" from prior works; accomplish this through broad review of:
   - Existing or planned projects in Marin
   - Vulnerable sites / areas in Marin (as identified from previous studies)
   - Adaptation strategies from national/international precedents

   The focus on projects, vulnerable areas, and precedent strategies prepares the team for later tasks of this project, in which concept-level adaptation measures will be identified for potential implementation in the county.

3. Develop a GIS geodatabase from prior efforts to be used in this project and held by TAM for future planning efforts.
   As a companion deliverable of this Existing Plan Review, a geospatial inventory of assets and projects has been provided to TAM in the form of a geodatabase. This baseline GIS dataset builds the foundation for the first technical task of this project, in which vulnerable assets and locations will be identified from the dataset.

1.2 Approach

The approach to this work followed these steps.

- **Request for Information (RFI):** Relevant data, plans, and studies were identified by name. The list was shared with TAM and was used in collecting documents from local and regional partners.
- **Existing Plan Inventory Review**: The collected data, plans, and studies were then reviewed for the following information:
  - Near and long-term solutions developed from previous work
  - Critical assets and communities identified by previous work

- **Precedents Review:** A high-level review of national and global precedents was undertaken to obtain examples of strategies potentially relevant to the Marin context.
- **Baseline GIS Dataset:** Geospatial information was collected through TAM and public sources online; this data was cleaned and added to a project database.
- **Existing Plan Review Memo:** The preceding work was summarized in this memo.

1.3 Outcomes

The five outcomes of this plan review set the foundation for upcoming work in this project.

1. **Existing Plan Review Memo**: Synthesis of plans, projects, and studies conducted in Marin or relevant to the county. This document summarized previously completed work to build project understanding.
2. **Shortlist of Adaptation Strategies**: Categorized as near- or long-term, this list of strategies is a starting toolkit for measures to consider in Marin.
3. **Pre-identified Critical Assets and Communities**: Cataloging vulnerable communities and transportation assets previously identified informs TAM where ongoing or completed work has been directed.
4. **National and International Precedents**: Examples of other regions globally, and the strategies they've implemented helps inform the project team about what could be possible in Marin.
5. **GIS Geodatabase and Inventory**: Geospatial data is critical to seeing where projects and studies have occurred, where vulnerable communities are located, and where SLR will reach in the future.

2. Plans and Studies

The documents reviewed were developed by local and regional bodies and include plans, studies, and projects with a bias towards transportation. These documents were examined for information about SLR vulnerability and adaptation in Marin County. The list has been summarized by scale: Regional, County, and Community/Project.

Given that local knowledge cannot be fully absorbed from a plan review, this exercise aimed to capture the landscape of SLR adaptation projects and planning at the regional, county and sub-county levels. More detail will be woven into this study through the engagement process with the Technical Advisory Committee and the Focus Groups.

2.1 Regional, County, and Community/Project Review

Table 1: Plans, studies, and project reports reviewed at the regional level, covering the San Francisco Bay Area.

Regional
• Adapting to Rising Tides (ART) Bay Area (BCDC, 2020) • BARC Raising the Bar on Regional Resilience (BARC, 2018) • BARC Shared Workplan for Regional Climate Adaptation (BARC, 2022) • Bay Adapt Joint Platform Regional Strategy for a Rising Bay Implementation Brief (BCDC, 2021) • CalOES California Adaptation Planning Guide (CalOES, 2020) • Caltrans District 4 Climate Change Vulnerability Assessment (Caltrans, 2019) • Capital Corridor Joint Powers Authority SLR Vulnerability Assessment (CCJPA, 2014) • Plan Bay Area 2050 (MTC/ABAG, 2021) • San Francisco Bay Shoreline Adaptation Atlas (SFEI/SPUR, 2019)

Takeaways relevant to Marin from the review of regional documents include:

1. There is significant agreement on where SLR impacts will occur, but there is low agreement on when impacts will occur and specifically what tipping points may exist. There are several projection timelines used with specific SLR levels which differ by climate scenario. For implementing SLR adaptation projects in Marin, it would be important to have consistency in the defined projection scenarios for practitioners to use for specific applications (e.g., transportation infrastructure planning).
2. Significant effort has gone into evaluating transportation assets in the Bay Area and their exposure to SLR. Examples include the vulnerability assessments by Caltrans and by Capital Corridor Joint Powers Authority. In Marin, this previous work provides a solid foundation upon which to build the present study. Identifying tipping points is one area of potential improvement.
3. Much of the Bay Area's critical transportation assets are located along the bay and ocean coast, particularly in Marin. This means that transportation assets, and the network more broadly, is highly vulnerable to SLR based on elevation and a lack of regional shoreline flood defense infrastructure, as identified and discussed in these regional documents.
4. Adaptation cost estimates are significant. For Marin, the total cost of protecting against two feet (2') of SLR is estimated to be $1.75B according to Plan Bay Area 2050. Regional documents acknowledge that

there is a major gap in funding between what is needed and what is potentially available from existing sources.

5. A focus on the transportation system can be an effective strategy at moving the needle on SLR adaptation. More funding has become available to address coastal resilience and transportation needs, including the state level Caltrans SB1 grants and the PROTECT program at the federal level.

Table 2: Plans, studies, and project reports reviewed at the county and community levels.

County
• Marin County Multi-Jurisdictional Local Hazard Mitigation Plan (MCM LHMP) • Marin Ocean Coast Sea Level Rise Adaptation Report (C-SMART, 2018) • Marin Ocean Coast SLR Vulnerability Assessment (C-SMART, 2016) • Marin Shoreline Sea Level Rise Vulnerability Assessment (BayWAVE, 2017) • Safety Element Update to the Countywide Plan Draft (Marin County, 2023)
Community/Project
• ART Richardson Local Assessment (BCDC, 2020) • ART San Rafael Local Assessment (BCDC, 2020) • Corte Madera Climate Adaptation Assessment (Town of Corte Madera, 2021) • Corte Madera Creek Flood Risk Management Project – Phase 1 Components (2020) • Lower Corte Madera Creek Improvement Study (2020) • Marin City Pond Flood Reduction Project – Drainage Study (2018) • Miller Avenue Streetscape Project (2017) • Mill Valley Flood Management and Drainage Master Plan (2021) • Resilient by Design Bay Area Challenge The People's Plan by Permaculture + Social Equity Team (P+SET, 2018) • Santa Venetia Floodwall Basis of Design and Project Alternatives (2023) • Sausalito General Plan (City of Sausalito, 2021) • Shallow Groundwater Response to Sea Level Rise (2022) • State Route 37 Corridor Planning and Environmental Linkages Study (SR 37 PEL Study) Draft (Caltrans, 2022) • Stinson Adaptation and Resilience Collaboration (Stinson ARC, 2022) • Stinson Beach Nature-based Adaptation Study (Coastal Conservancy/ County of Marin/ESA, 2021) • TAM Annual Report 2022 (TAM, 2022) • Tomales Bay Living Shorelines Feasibility Project (ESA, 2022)

Takeaways relevant to Marin from review of local reports, biased towards transportation, include:

1. Much effort has been spent to study and identify the exposed assets and communities in the county, and there is considerable consensus on vulnerable areas in the county, such as US101/580 interchange, State Route 37, Highway 1, and the Manzanita Park & Ride.
2. Strong interest exists for adaptation solutions that complement or enhance the natural environment, such as the Living Shorelines study in Tomales Bay, dune restoration study in Stinson Beach, and permaculture concepts in Resilient by Design project The Peoples Plan. These proposals align with the high value placed on nature and open space areas by Marin residents and political leaders. A robust discussion of tradeoffs is still needed to better understand the limitations of nature-based solutions and the effectiveness of these strategies compared to others.
3. Larger-scale flood and SLR adaptation work crosses jurisdictional boundaries which complicates implementation and calls for the county to play a key role in helping guide or facilitate action. Understanding the work completed or planned to date, and the near- and long-term needs, will support decision-making at the county level to implement appropriate adaptation solutions.
4. Still needed is a shortlist of potential project types and locations, a further understanding of processes and program cycles that agencies are obligated to follow, and crucial potential implementation roadblocks. These are all focus areas for TAM sea level rise planning.

2.2 Critical Vulnerable Assets

Appendix A.2 provides an overview of critical vulnerable assets and communities in Marin County. Assets and communities are categorized by City, Town, and Unincorporated Marin County. Below is a summary of high-level considerations for each jurisdiction in Marin County with respect to sea level rise.

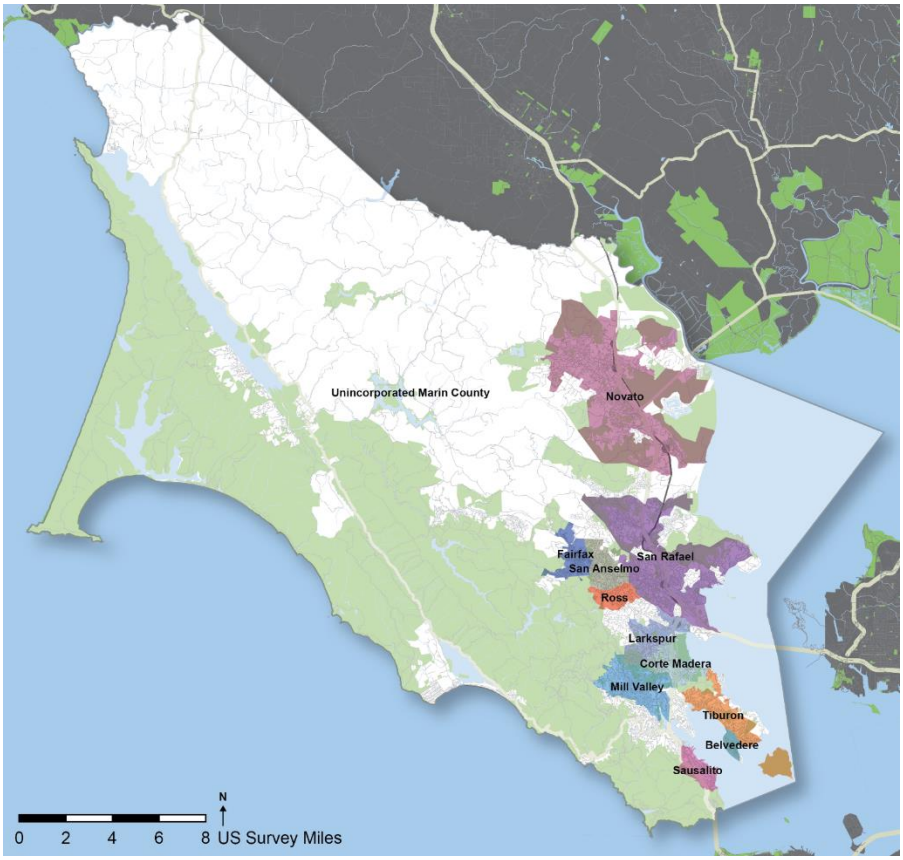

Figure 1: Incorporated Cities, Towns, and Unincorporated Marin County

Belvedere

The City of Belvedere is located in southeastern Marin County on San Francisco Bay (and offshoot Richardson Bay) and includes Belvedere Island, Belvedere Lagoon, and Corinthian Island. Access to Belvedere is dependent on low-lying roads exposed to inundation under future SLR conditions.

Corte Madera

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. Key roadways have been identified in regional documents as vulnerable to flooding, like Lucky Drive and the US-101 corridor through downtown.

Fairfax

The Town of Fairfax sits over 100ft above sea level in inland Marin. Residents rely on the road network to access other communities in Marin and the greater Bay Area. Though none of the infrastructure in the town is exposed to coastal hazards, the essential roadways that connect Fairfax to the region may be impacted by sea level rise. Additionally, Fairfax Creek, San Anselmo Creek, and their tributaries run through the town, which may expose the town to riverine flooding.

Larkspur

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. The Larkspur Ferry Terminal connects the area to San Francisco via ferry while US-101, which runs through the city, provides vital connection to other communities in Marin and the Bay Area. Roadways in Larkspur also provide vital connectivity to Marin General Hospital.

Mill Valley

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 SLR due to elevation, existing drainage capacity, and proximity to creeks and Richardson Bay.

Novato

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 has been identified as a critical transportation asset vulnerable to sea level rise from previous studies, discussed in Appendix A.2.

Ross

The town of Ross is a small, inland community of roughly 2,000 residents. It is located along the Corte Madera Creek, upstream of Larkspur. It is connected to nearby communities via Sir Francis Drake Boulevard, a major corridor that connects to US-101. Though none of the infrastructure in Ross is directly exposed to coastal hazards, the tidal influence from the San Francisco Bay is expected to extend upstream in Corte Madera Creek as a result of future sea level rise which could worsen the existing riverine flood issues along this creek during future extreme rainfall and high tide events. The essential roadways that connect Ross to the region may also be impacted by sea level rise.

San Anselmo

The Town of San Anselmo sits about 50ft above sea level in inland Marin. Residents rely on the road network to access other communities in Marin and the greater Bay Area. Though none of the infrastructure in the town is exposed to coastal hazards, the essential roadways that connect San Anselmo to the region may also be impacted by sea level rise. San Anselmo Creek and its tributaries run through the town, which expose the town to riverine flooding. The tidal influence from the San Francisco Bay is expected to extend upstream in Corte Madera Creek as a result of future sea level rise which could worsen the existing riverine flood issues in San Anselmo during future extreme rainfall and high tide events.

San Rafael

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 has been identified as a critical asset in previous studies (discussed in Appendix A.2) due to it being a low-lying asset susceptible to flooding and a key connection point for regional traffic.

Sausalito

The City of Sausalito is located along the coastline of San Francisco Bay into Richardson Bay in southern Marin. The Sausalito Ferry Terminal and the main downtown thoroughfare, Bridgeway, are key infrastructure assets that connect the city to the region and are vulnerable to SLR. US-101 forms the western border of Sausalito, bypassing the downtown area, but onramps and offramps to the highway may be vulnerable to flooding due to elevation, existing drainage infrastructure, creek crossings, and proximity to Richardson Bay.

Tiburon

The Town of Tiburon comprises a peninsula that extends from main Marin into the San Francisco Bay. Tiburon Boulevard (CA-131), which connects the town (and adjacent Belvedere) to the mainland, is a key transportation asset exposed to coastal hazards like sea level rise.

Unincorporated Communities

Unincorporated communities in the County of Marin include Greenbrae, Kentfield, Marin City, Bolinas, Dillon Beach, Forest Knolls, Inverness, Lagunitas, Marshall, Nicasio, Olema, Point Reyes, San Geronimo, Stinson Beach, and Tomales.[1] Many of these communities are connected via vulnerable roadways, like SR-37, Shoreline Highway (SR-1), Lucky Drive, Sir Francis Drake Boulevard (Inverness), US-101, and Donahue Street (Marin City) as key examples. See the following figure for network link volumes in the county for a typical weekday, noting significant number of trips that pass through the eastern half of Marin.

[1] Marin Communities - County of Marin (marincounty.org)

3. National and Global Adaptation Precedents

This high-level review of national and global SLR adaptation precedents aimed to identify areas outside of the county that have implemented strategies relevant to the Project. The goal was to identify additional adaptation solutions that might be compatible with the Marin context despite not being included in existing plans or studies present in the region. Their strategies have been grouped by theme in this section.

The areas evaluated included coastal cities in the USA with bays and estuaries, like New York City, New Orleans, and Boston, and international cities that have implemented unique solutions to address SLR, including Singapore, Hamburg, Rotterdam, and the United Kingdom. The locations and the plans reviewed can be found in the following table, along with a description of governance structures that support implementation of the plans.

Table 3: National and global precedents reviewed for this project.

City / Region	Plans Reviewed	Governance Structures
Singapore, Singapore	ABC Waters	The Public Utility Board developed references for developers and professionals on how to implement resilience solutions.[2]
Hamburg, Germany	Hamburg HafenCity Master Plan	A private company that is a subsidiary wholly owned by the city oversees development.
North Atlantic (USA) -Boston, MA -New York City, NY -Norfolk, VA	Climate Ready Boston (2016) Boston Coastal Flood Resilience Design Guidelines NYC Climate Resilience Design Guidelines North Atlantic Coast Comprehensive Study Report Norfolk Coastal Storm Risk Management	- Climate Ready Boston was an initiative led by the City of Boston Planning Department. They developed Coastal Flood Resilience Design Guidelines and recommended that the City of Boston implement initiatives. - New York City Council passed Local Law 41 requiring public projects to follow the established guidelines.[3] - Collaboration between the City of Norfolk and the USACE identified vulnerable assets and the City of Norfolk undertook planning and implementation of strategies.
South Atlantic / Gulf of Mexico (USA) -Miami Beach, FL -New Orleans, LA	Resilient 305 – Greater Miami & The Beaches (2010) New Orleans Masterplan (2018)	- Greater Miami & the Beaches is a partnership of Miami-Dade County, the City of Miami, and the City of Miami Beach. Resilient 305 prioritizes intergovernmental and community collaboration to achieve shared goals.

[2] https://www.pub.gov.sg/abcwaters/designguidelines

[3] https://climate.cityofnewyork.us/initiatives/climate-resiliency-design-guidelines/

		- New Orleans's Masterplan is a planning and policy document for the use of elected officials who will adopt it and fund its implementation.
Rotterdam, Netherlands	Rotterdam Masterplan (2019)	Planning document by the city to align development with vision.
United Kingdom	Managing the Coast in a Changing Climate	An independent climate change committee published the document to provide guidance to communities facing sea level rise challenges.

Figure 2: Map showing areas explored for national and international case studies with strong SLR adaptation strategies.

These regions have implemented overlapping strategies, which have been collected into the following themes.

3.1 Short-Term Safety Procedures

Cities can implement near-term safety solutions while long-term projects are identified and developed. As one example, in Hamburg, evacuation routes are posted and prioritized in coastal areas as road elevation (a long-term solution) is planned. Communication modes, incident management, and response measures would need to be evaluated and developed (perhaps coordinated with local emergency responders), but they can be implemented in shorter timelines than SLR adaptation projects.

The United Kingdom (UK National Flood and Coastal Erosion Program, 2018) has partnered with Google to alert people of flooding. Flood warnings now appear on Google Search and through Google Maps with live alerts becoming visible seconds after they have been issued. The warnings include vital information on steps people can take to keep themselves and their property safe when flooding is expected.

Safety measures may be a compelling immediate measure for Marin to prioritize road elevation projects and prevent traffic delays, miscommunication, and potential loss of life during flood events.

3.2 Coastal Zoning Ordinances

Zoning can be a powerful tool to manage and guide SLR adaptation. Coastal Zoning Ordinances, such as limiting the areas of development or requiring flood protection measures, have been implemented in various places globally.

In Hamburg, Germany, building development has been restricted within 66ft (20m) of the water. The shoreline area has been zoned as public open space and moves the city closer to its goal of having interconnected green spaces throughout its jurisdiction. Restricting development at the waterfront can be a compelling strategy for areas of high vulnerability while allowing the potential addition of public spaces or new transportation corridors such as bike trails.

In Singapore, minimum crest levels for certain properties may be 5 feet or more above adjacent street levels. Designs require sizing setback distances as well as ramps, stairs, and landscaping to enhance this feature of the property and benefit the public realm. Additionally, new developments are permitted to consider deployable flood barriers only when elevating the building platform is cost prohibitive or otherwise infeasible. Barriers can be static like concrete walls or deployable like gates. In applications of this strategy, new buildings see reduced flood risk while surface streets are temporarily left at existing elevations.

3.3 Living Shorelines

Living shorelines rely on natural features, like vegetated marshes and dunes, to address coastal erosion. This approach differs from traditional grey infrastructure strategies, like concrete seawalls, by working with the natural environment and depending on local ecosystem functions to prevent erosion.

In 2006, Singapore set an ambitious goal to become the City of Gardens and Water and launched its Active, Beautiful, Clean Waters (ABC Waters) program. Through ABC Waters, Singapore seeks to provide a "transition zone" between public waterways and amenities. The following figure shows a cross-section of this transition zone, which gently slopes upward away from the water and contains significant vegetation and public walkways before reaching city infrastructure and buildings. The transition zone includes a deep landscape setback that provide enough horizontal space for gradual slope up to building entry with amenities including plantings, walking paths, seating, and other amenities. Planters with integrated seating soften the transition between elevated hardscape and vegetated public areas along the shoreline.

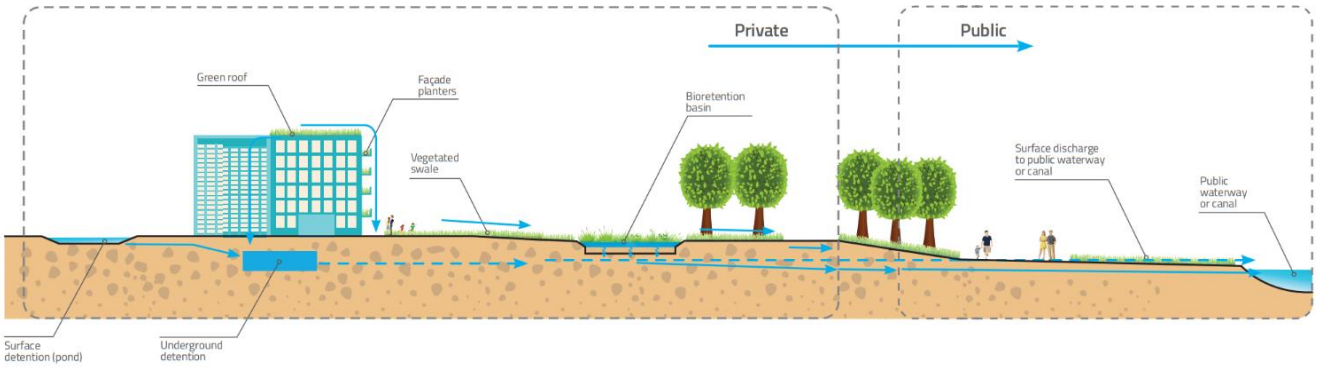

Figure 3: Strategies implemented as part of Singapore's ABC Waters program.

In Miami Beach, FL, high groundwater and saltwater intrusion affect what vegetation can be planted along the shoreline and throughout the city. Outdoor spaces are required to have flood-resistant, saltwater-tolerant species. This requirement enhances resilience to both coastal and stormwater flooding. Trees with high evapotranspiration rates also help mitigate extreme heat events.

Another living shoreline strategy is called managed realignment, which has the goal to set back the shoreline and restore coastal environments. This strategy usually involves (1) removing or deliberately breaching flood defenses to allow flooding up to higher ground or create a new defense line or (2) realigning coastal cliff frontages to allow cliff erosion. It has advantages in removing long-term financial commitments to maintain

defenses and in restoring natural environments and processes. Managed realignment can create new habitat area that acts as a natural buffer to coastal waves and is much cheaper to maintain over the long-term. This was applied to the Twitchell Marsh area in the UK by creating a breach in the sea wall to connect existing salt marsh creeks. Seawater was able to enter the brackish marsh and flood it with the tide, turning it into a tidal salt marsh. This new habitat, along with new associated mudflats, is attractive to many coastal bird species, and it also serves as a better natural defense against coastal erosion when combined with the sea wall (Managing the Coast in a Changing Climate, 2018).

3.4 Hybrid Elevate-in-Place and Retreat

In Germany, the HafenCity neighborhood within the city of Hamburg has begun making its climate-ready vision a reality from its 2000 Masterplan. Similar to Marin, the area is connected to the surrounding region via bridges, an established road network, and public transportation (including regional rail and buses). Areas of HafenCity are already subject to regular flooding, particularly along the canals.

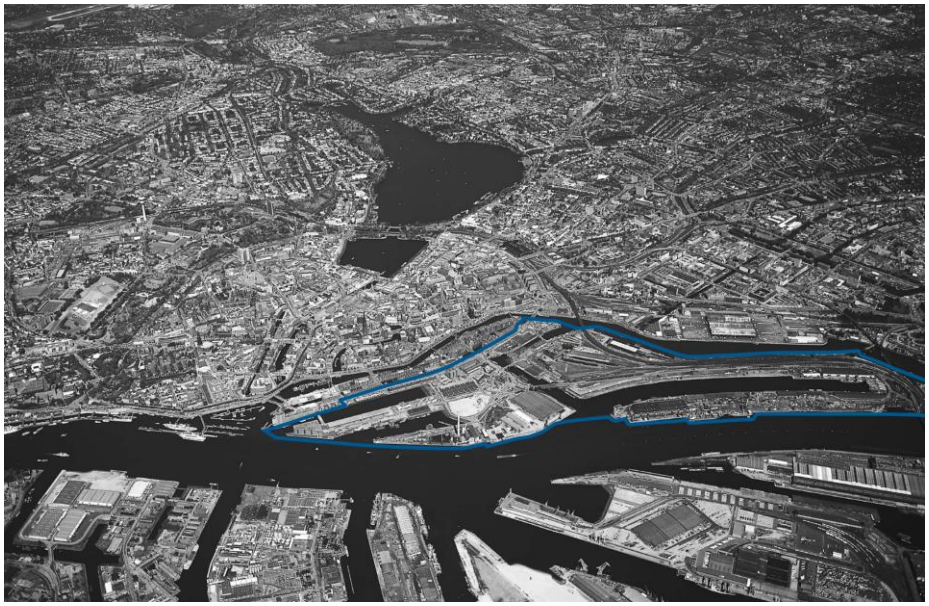

Figure 4: HafenCity area along Elbe River (HafenCity Masterplan).

Hamburg is Europe's largest inner-city urban development area and is seen as a blueprint for the new European city on the waterfront. Due to the dynamic interplay of the water and buildings, Hamburg has identified an innovative set of practices including the use of ground floors in buildings as flood barriers.

Strategies include elevating new structures, including buildings, 25ft (7.6m) above ground (which is the expected storm surge elevation under future SLR levels), constructing elevated roadways to ensure access for emergency services during high tides or storm events, and hardening existing assets to prevent potential damage from future storm surges under higher sea levels. A setback of 66ft (20m) from the water edge has created public open space along the water and interconnected green spaces.

Figure 5: View of development happening in HafenCity. Note elevation of area above water level (Miguel Ferraz, hafencity.com).

The development of the area has been managed by a port and location development company called HafenCity Hamburg GmbH, a wholly owned subsidiary of Hamburg ("Free and Hanseatic City of Hamburg"). Its supervisory board is comprised of city officials, who oversee the development of HafenCity. As described on HafenCity's website[4],

> By concentrating non-official functions in a dedicated development company of its own, Hamburg can ensure the integrated planning and realization of the district and the efficiency and quality of the urban development project. It also creates the conditions for a strong focus on innovation while guaranteeing a high degree of public accountability.

3.5 Sponge Cities

Resilience-focused stormwater management is referenced in guidelines for many cities. The goal of stormwater management with an emphasis on resilience is to absorb runoff and allow water to circulate as naturally as possible to prevent or significantly reduce overland flooding. Several strategies focus on buildings, which might be appropriate for transportation-affiliated buildings, such as maintenance facilities or transit stops.

Copenhagen's Cloudburst program shows how beneficial it can be to prioritize rainwater capture. To address runoff during short storm events (i.e., cloudburst), adaptation strategies include designing blue/green roofs and other appropriate landscape elements to maximize onsite rainwater capture and reuse.

In Rotterdam, green roofs help absorb rainfall and reduce heat stress on the city. Rotterdam also serves as a prominent example for utilizing public spaces as water storage basins during extreme rainfall. The "Water Square" in Benthemplein holds three large rainwater collection ponds which, when the weather is dry, can be used as amphitheaters, basketball and volleyball courts, or skateboarding rinks.

[4] HafenCity Hamburg GmbH - Hafencity

Figure 6: Submerged features in the public square can act as stormwater retention basins during flood events.

Singapore's ABC Waters program has implemented many Sponge City concepts through their stormwater management practices. The program aims to reduce stormwater flooding and filter runoff before it enters Singapore's waterways. Rain gardens (bioretention basins), vegetated swales, and sedimentation basins help collect rainwater, slow runoff, and filter the water.

Figure 7: Natural drainage basins in Sg Ulu Pandan (left) and Kallang River at Potong Pasir (right) (ABC Waters).

An example strategy for roads is shown below, in which water collected from roads moves through green and blue features into the stormwater drainage pipes. The dual action of collecting excess flow and slowing runoff into the stormwater system help reduce flooding and prevent overwhelm of the drainage system.

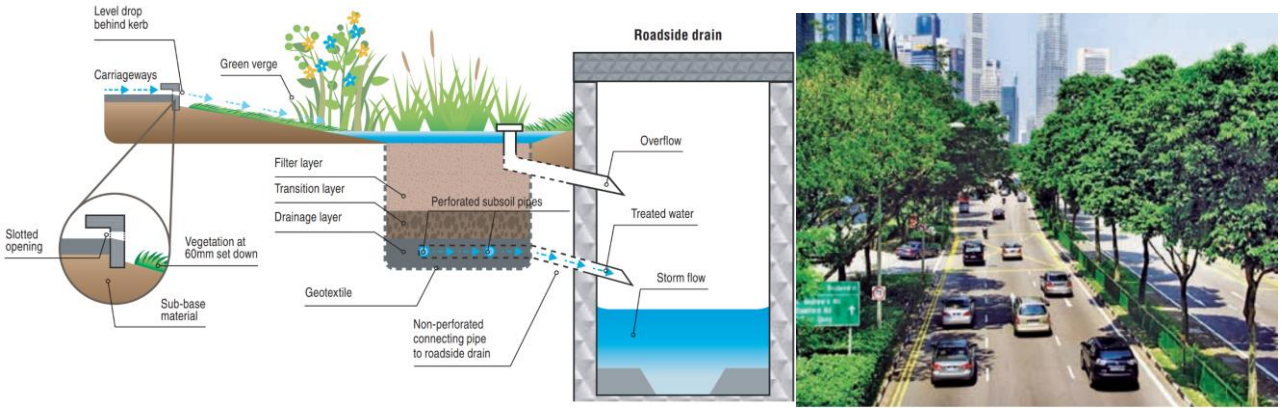

Figure 8: Bioretention system that slows runoff from roads, depicted schematically (left) and along expressway (right) (ABC Waters).

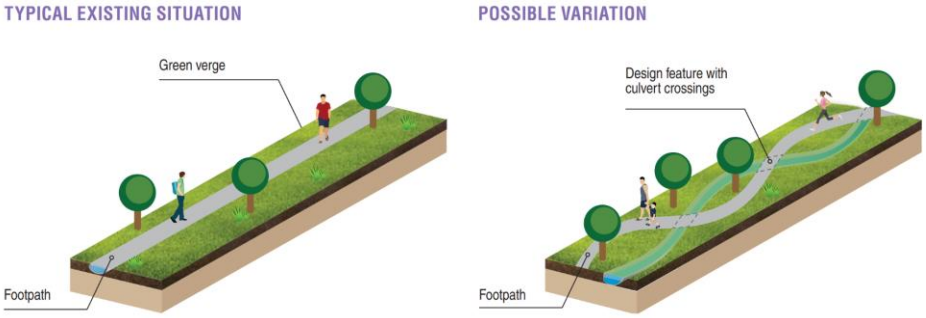

Figure 9: Strategy for incorporating water features along pedestrian walkways proposed by Singapore's ABC Waters.

3.6 Hold the Line

Some regions have employed protective strategies, like hardening buildings and armoring their coastlines, to prevent water from reaching their people and buildings. In conjunction with the other overarching themes described in this section, holding the line can be a viable option for areas of Marin County. These types of strategies have even been proposed for Corte Madera OLU and Novato OLU in the Marin County SLR Adaptation Framework report.

In New Orleans, LA, an extensive pump system maintains livability in the city, much of which lies below today's mean sea level. The system's buildings, power supply, and mechanical and electrical equipment should be submergible or otherwise proven to be operable in significant future flood events (i.e., including SLR) in order to protect the city. The pump strategy works in coordination with the levee system. The pumps address groundwater and stormwater flood issues, while the levees prevent coastal hazards (e.g., storm surge) from inundating the city. Other cities like New York (Urban Waterfront Adaptive Strategies, 2013), Boston (Climate Ready Boston, 2019), and Norfolk, VA (Resilient Norfolk, 2020) also reference the use of pumps as a key part of dry proofing buildings.

Norfolk, VA has identified a number of hold the line measures that includes construction new seawalls, levees, and gates. Specifically, phase 1 of the Norfolk plan identifies replacing an existing flood wall and increasing its height as well as a proposed storm surge barrier for highly sensitive areas.

During Hurricane Harvey, the Mayor of Houston, TX issued an order for all residents to shelter-in-place during the flood. Analysis after this event found that an evacuation order could have led to a significantly higher death

toll[5]. As a result, Miami Beach recommends residential units should be above the first floor of a building, designed to safely accommodate shelter-in-place orders. This strategy could also be employed for buildings that act as emergency community shelters.

4. Initial Adaptation Concepts

This section distills the near- and long-term adaptation strategies collected from the review of previous studies and global precedents research into a shortlist of initial adaptation concepts that will be used in the Task 4 planning and design efforts. Here "near-term" refers to strategies that could be implemented within ten years, while "long-term" refers to strategies that take decades to implement.

Climate change adaptation strategies have typically been grouped into three categories: Protect, Accommodate, and Retreat (or Avoid). "Protect" strategies aim to reinforce existing assets against future sea levels, whereas "Accommodate" strategies allow water to move where it intends and work with the changing shoreline. When people move from flood-prone areas or assets are relocated to higher ground, the "Retreat" strategy is employed. Typically these strategies are combined into "Hybrid" approaches best suited to local conditions and community needs. The following image depicts the three strategies.

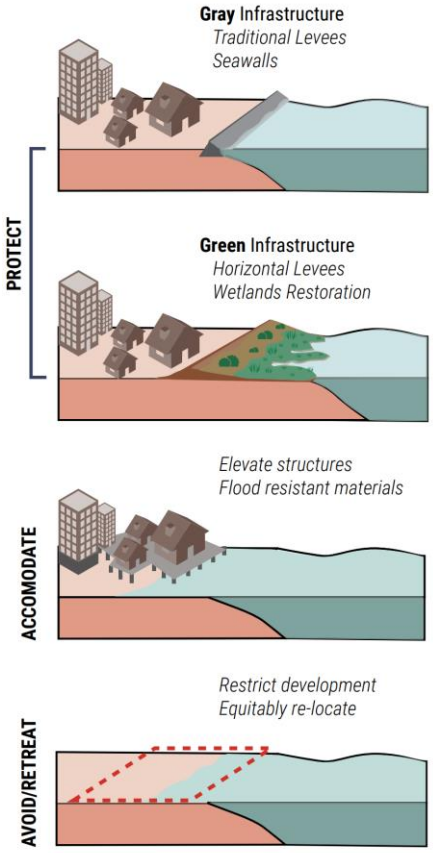

Figure 10: Three categories of adaptation strategies, as depicted in Bay Adapt (BCDC, 2021).

[5] https://www.npr.org/sections/thetwo-way/2017/08/28/546721363/why-didn-t-officials-order-the-evacuation-of-houston

The following table shows strategies categorized as near- or long-term solutions and whether they are structural (physical) or non-structural (policy). These strategies fall into a blend of the three categories of Protect, Accommodate, and Avoid/Retreat. The full list of strategies can be found in Appendix A.1.

Table 4: Adaptation strategies summarized as near- or long-term and as structural (physical) or non-structural (policy) solutions.

	Near-term	**Long-term**
Structural / Physical	• Elevate key assets – utility connections, mechanical equipment, etc. • Backup power – for pumps, electrical/mechanical systems, etc. • Rooftop landscaping for stormwater management • Enhance drainage, for example by upsizing pumps and pipes • Design new structures to withstand future hydrostatic, hydrodynamic, and impact loads • Plant flood-resistant vegetation (and saltwater-tolerant where applicable) • Seal utility connections • Submergible pump systems • Design pedestrian access routes to be flood-resistant • Build flood-resistant landscaping • Anchor movable components that could cause damage if moved by water (e.g., tanks, gates, ramps) • Incorporate mold-resistant, water-resistant, and corrosion-resistant materials into exposed assets • Ensure vents, drains, conduit boxes, utility manholes, and access openings are sealed or sealable and include backflow prevention • Install backflow valves in buildings at sewer lines • Dry and wet flood-proof stairs, elevators, doors, and other ingress/egress to remain operable during flood event	• Maximize infiltration and detention to delay drainage and manage stormwater runoff (sedimentation basins, bioswales, etc.) • Use parking lots and plazas for stormwater detention • Build new seawalls and revetments • Raise existing levees • Elevate key corridors and assets – roads, rail, ferry terminals, trails, etc. • Floodproof marinas to adjust to fluctuations of water level • Land reclamation or waterfront bulkheads to raise levels above future SLR • Retrofit existing buildings and structures to withstand hydrostatic, hydrodynamic, and impact loads • Realign shoreline areas with new waterfront protection features, i.e., levees • Install flood gates on tidally influenced canals or creeks to control water levels • Install new pump stations to evacuate stormwater during high tide events • Living shorelines incorporating habitat enhancement with waterfront protection • Enhance offstream detention areas along creeks to reduce peak flow events

	Near-term	Long-term
Non-Structural / Policy	• Designate shelter-in-place locations • Temporary closures and reroute traffic or provide alternative means of transportation • Public flood notices via warnings and alerts • Establish risk-based criteria for selecting projections • Determine credible climate hazards and identify climate change projections to inform design • Coastal flood zone ordinances restricting new development or requiring new flood protection for properties	• Designate all residential units to be located above first floor of buildings for shelter-in-place • Develop climate resilient design guidelines • Managed realignment or relocation and buyouts in high-risk areas

This list of strategies is by no means exhaustive, especially because areas for adaptation concept development (Task 4) will not be selected by the project team until the vulnerability study has been completed (Task 3). This initial list will help guide the project team without limiting them to the strategies herein.

5. Baseline GIS Dataset

Arup developed a baseline GIS dataset that aggregates existing transportation asset information, including data on road, transit, and bike/ped infrastructure. This baseline GIS dataset is intended to identify previously studied transportation infrastructure in previous sea level rise studies conducted throughout Marin County, including BayWAVE and C-SMART.

5.1 Approach

Arup submitted a request for information (RFI) to TAM which included a list of transportation infrastructure assets, proposed projects, right-of-way information, and other asset information that would be considered within this analysis. Data was aggregated from previous planning and GIS databasing efforts from a variety of sources including Marin County, the Metropolitan Transportation Commission (MTC), and Caltrans. Data linked or received through the RFI was downloaded and reviewed utilizing a GIS log and GIS project standards.

The GIS log included review parameters including whether the initial request had been adequately met, if the dataset covered the required extent, if the spatial accuracy of the dataset met project requirements, if the terms of the dataset were fully understood and if they permit the project to use the data, if the dataset contains attributes which meet the project requirements, if the dataset requires any processing prior to usage, if the data have a coordinate system which is correctly assigned, if the dataset naming convention has been followed correctly, if the dataset metadata had been populated correctly, and if it meets basic sense checks, spot checks, or similar.

Utilizing the Feature Manipulation Engine (FME), Arup cleaned the downloaded geospatial data, reprojected to a NAD_1983_HARN_StatePlane_California_III_FIPS_0403_Feet coordinate system, clipped to Marin County Boundary, and added attribute information related to the date.

The geospatial data was compiled into a geodatabase and shared with TAM and the project team. Data can also be viewed on the project ArcGIS Online (AGOL) site. It is recommended that TAM maintains a copy of the GIS data in a format that allows TAM to view, manipulate, and analyze the data. This analysis can be done via online GIS service, such as AGOL, or other enterprise GIS platform.

5.2 Limitations

Some documents and data were not obtained through the RFI process, but they will be incorporated into the next phase of this project. Outstanding reports include San Rafael Flood Risk and Sea Level Rise Adaptation Report, Canal Community Resilience Project, I-580/US-101 Direct Connector, Local Coastal Program Environmental Hazards Update, and Richardson Bay Shoreline Study.

Similarly, geospatial data for the following items have not been incorporated into the GIS Baseline Dataset, but will likely be incorporated as TAM identifies of vulnerability hotspots and develops initial adaptation concepts:

- Existing coastal protection infrastructure, including available information on location, asset type, performance standards & condition
- Right-of-way information for transportation infrastructure
- Facilities for service and maintenance for Bus, Ferry, and Rail lines
- Rail yards and depots
- Toll, interstate, and state bridges
- Management centers for traffic/transportation
- Sidewalk network

Asset data from the BayWAVE project was available and generously shared with the team. Vulnerability information, which connect previously used SLR scenarios to assets, was unfortunately not available at the time of this report. This data may need to be recreated in Task 3.

6. Key Take-aways

Key take-aways from the plan review include the following:

- There is a need for consistency between sea level rise scenarios and projections used within Marin County for SLR adaptation planning. Furthermore, clarity around potential tipping points (i.e., when will SLR trigger the need for local-scale and larger-scale improvements) is lacking across the various studies and plans that have been commissioned to-date.
- The protect, accommodate, and retreat framework does provide a consistent categorization of SLR interventions. In more detailed studies, many intervention concepts do fall between categories into a “hybrid” classification which is often overlooked.
- Many of Marin’s most significant flooding and SLR vulnerabilities surround existing tidally influenced creeks including Coyote Creek, Corte Madera Creek, San Rafeal Canal, Novato Creek and others; there is no clear consensus among the plans and studies reviewed with regards to the set of interventions that could reduce flood risk and address sea level rise long-term.
- Some areas in Marin County have been studied extensively and already begun SLR adaptation work. These areas include key interchanges in the county along US-101 (with SR-37 and I-580) and on/off-ramps to these corridors. Concept designs have been proposed in other areas, such as dune restoration in Stinson Beach. There does not appear to be a consistent approach to the design of interventions, as some

efforts focus on engineering upgrades to an existing system (e.g., upgrading flood protection infrastructure along Lower Corte Madera Creek) and others involve a more holistic approach with significant community feedback and larger scope (e.g., the design concept approach in The People's Plan for Resilient by Design team P+SET).

- A significant gap exists in the lack of vulnerability data in geospatial form. Individual asset layers were downloaded from publicly available sites maintained by the County of Marin, MTC, Caltrans, and others, including shared by the BayWAVE project team. Unfortunately, vulnerability data (such as inundation depth at a road asset under 3ft SLR) from the BayWAVE analysis or data from previous SLR or flood assessments were not available.
- It is recommended that TAM obtains a GIS license for viewing and analyzing the data collected from this project. The geodatabase format cannot be viewed easily without GIS software or custom scripts developed by a geospatial professional.

In the next task, hazard data will be layered onto the asset data. This hazard data will add to analysis from previous studies, and it includes layers for present-day and future groundwater, pluvial and riverine flood, coastal flood, and sea level rise hazard scenarios. Assets and communities will be evaluated for vulnerability and identified for the next scope of work, building towards an implementation plan to address these hazards and support the communities on the road to adaptation and resilience.

A.1 Adaptation Strategies

See below for excerpt of adaptation strategies identified, along with their categorization by scale (County/City/Asset) and time horizon (near- or long-term).

Scale			Time Horizon		Guideline / Solution	Commentary
County	City	Asset	Near-term	Long-term		
	X	X	X		Backup power - pumping	Consider backup power systems specifically for stormwater pumping systems, enabling the building to continue pumping operations through power outages of up to 12 hours
		X	X		Elevate mechanical equipment	All mechanical equipment and critical utility connections shall elevated to at least the minimum platform level.
		X	X		Rooftop landscaping - stormwater	Design green/blue roofs and/or other appropriate landscape elements that maximize onsite rainwater capture and reuse.
		X	X		Enhanced drainage	Design roof and site drainage to remain outside of the façade and prevent ponding and overflow into protected areas. All structures with dry-floodproofed areas should be equipped with the appropriate size sump pump. Ensure there are overflow pathways from the roof to mitigate floods caused by drains clogging.
X	X	X		X	Establish risk-based criteria for selecting projections	The selection of climate change projections depends on risk tolerance. Projects with a high risk tolerance can opt for less conservative climate change projections and those with a low tolerance would select more conservative projections. It is recommended that criteria be established to outline how risk tolerance can be assessed and how climate change projections can be appropriately matched to various tolerance levels.
		X	X		Hydrostatic, hydrodynamic, and impact loads	The structure should be designed to withstand the forces imposed by hydrostatic bodies, hydrodynamic loads, and loads delivered by objects carried by flood waters with climate change and sea level rise taken into account.
		X	X		Shelter-in-place	All residential units should be above first floor of building and designed to safely accommodate shelter-in-place orders.
X	X	X	X		Flood resistant vegetation	All outdoor spaces below the platform level will be designed with flood resistant vegetation including saltwater tolerate planting. Include high evapotranspiration-rate tree species to mitigate heat and stormwater events.
		X	X		Utility Connections	The structure should have all utility connections sealed in accordance with guidelines in Floodproofing Non-Residential Buildings (FEMA 2013). This includes utility chases on the exterior of walls for electrical lines, plumbing, gas, communications, or ductwork.
X	X	X	X		Temporary closure / rerouting traffic	A nonstructural/management option during extreme events A nonstructural/management option during extreme events could be to close part or all parts of select roadways. Planning alternative routes, or providing additional means of transportation (ferries instead of bridges) would be required
		X	X		Submersible pumps	Mechanical and electrical pumps, back-up systems, or any other mission-critical components which are needed to maintain pump functionality, including those located in other buildings, should be submergible or otherwise proved to remain operable up to the DFE+SLR.
		X	X		Below grade flood protection	Protect areas below grade from groundwater flooding
X	X	X	X	X	Maximize infiltration and detention	Minimize increases in impervious surface; Utilize strategies that infiltrate, evaporate, or reuse rainwater to achieve stormwater volume reductions; choose low impact development strategies that detain (delay drainage) to manage the rate of the stormwater flow into the utility drainage system; Install stormwater infiltration, detention, and storage
		X	X		Interior water management	When implementing perimeter protections, ensure that interior water management is also accounted for
		X	X		Underground utility protection	Explore interventions to protect underground utility and telecommunications infrastructure from water damage
		X	X		Flood resistant access ways	Any stairs, ramps or walkways in the transition zone up to platform level should be designed to resist flood loads.
		X	X		Floodproofing basements	All indoor spaces within the building below the platform level (basements) will be wet and dry floodproofed.
	X	X	X	X	Parking and/or Plazas as detention	Explore opportunities for designing underground parking garages and/or outside plazas for stormwater detention.
X	X		X	X	Public flood notices	Provide flood warnings and alerts
	X	X		X	Develop climate resiliency design guidelines	Develop climate resiliency design guidelines for design elements at the building and district scale.
		X		X	Determine minimum platform level	Platform level refers to the general ground level of a proposed development. The platform level of new developments will not be lower than the DFE+SLR elevation.
X	X	X		X	Elevate roads	Construct elevated roadways to provide access for fire and ambulance services in the event of king tides or storm tides.

Scale			Time Horizon		Guideline / Solution	Commentary
County	City	Asset	Near-term	Long-term		
X	X	X	X		Flood resistant landscaping (e.g., bioswales, sedimentation basins)	All outdoor spaces below the platform level will be designed with flood resistant landscaping with publicly accessible plaza where possible. Public spaces or temporary programmable space is acceptable below the platform level. If sited above the platform level, public spaces must provide context-sensitive, visually accessible, and gradual vertical transition up to platform level.
	X			X	Flood proof marinas	In marinas also watercrafts can be allowed to adjust to fluctuations of water level.
X	X			X	Land claim	The main objective of land claim is neither erosion nor storm reduction. The aim of land claim is to create new land from areas that were previously below high tide. These measures can be taken to reduce the exposure of these areas to coastal flooding.
X	X			X	Managed realignment	Looks to set back the shoreline and restore coastal environments. This strategy usually involves removing or deliberately breaching flood defenses to allow flooding up to higher ground or a new defense line; or realigning coastal cliff frontages to allow cliff erosion. It has advantages in removing long-term financial commitments to maintain defenses and in restoring natural environments and processes. Managed realignment can create new habitat area that acts as a natural buffer to coastal waves and is much cheaper to maintain over the long-term.
		X		X	Foundation	Design foundation elements, including mat slabs, shallow footings, and piles for the hydrostatic uplift forces corresponding to the DFE+SLR.
		X		X	Wall Systems	Wall systems below the DFE+SLR should be constructed to withstand all hydrostatic and hydrodynamic forces imposed on the wall by the DFE.
	X	X		X	Build revetments	Revetments are onshore structures with the principal function of protecting the shoreline from erosion. Revetments typically consist of a cladding of stone, concrete, or asphalt to armor sloping natural shoreline profiles.
X	X	X		X	Determine credible climate hazards	A multi-hazard assessment will be applied to an individual site in order to determine the credible threats influenced by climate. Hazards to be considered should include, but not be limited to, extreme heat, precipitation, wind, storm surge, stormwater flooding, fluvial flooding, tidal flooding, waves, sea level rise inundation, groundwater flooding.
X	X	X		X	Identify climate change projections	For each credible climate hazard, appropriate climate change projections will be collected to inform design.
		X		X	Anchor movable contents	Anchor any submersible content located below the DFE+SLR that could cause damage to the structure if moved by water. Includes tanks, ramps and gates.
		X		X	Mold resistant materials	The structure should include high strength, non-organic materials with no potential for deterioration, corrosion or warping for all structural and core elements.
		X		X	Water resistant materials (Wall Sealants)	Select waterproof exterior materials that prevent entry of water into any essential area of the building. Use sealed membranes in areas within 5ft of the DFE+SLR, including door and window openings.
		X		X	Windows and doors	On the ground floor, windows and doors should be sealed, watertight and designed to withstand high water pressures.
		X		X	Gaskets and Seals	Ensure that all vents, drains, conduit boxes, utility manholes and access openings are also sealed or sealable and include backflow prevention. Self-sealing compression seals should be utilized as they are more reliable and can be used in conjunction with pneumatic seals for a redundant configuration, which provides more protection.
		X		X	Electrical Outlets	Install electrical outlets above DFE+SLR and wire ground floor system independently to prevent short out of other building areas.
		X		X	Backflow Valves	Install check valve or similar back flow device at the point of entry into the building on the main discharge sewer line to prevent sewage from potentially flowing back into the building during a flood event.
		X		X	Envelope	Ensure building envelope is protected against any water intrusion through use of waterproofing membranes in areas within 5ft of the DFE+SLR and essential facades sealed, without openings to rainfall or wind driven rain.
		X		X	Stairs	Stair framing elements and their connections are designed and detailed to maintain support of the design dead and live loads during flooded conditions of the primary structure and external access is achievable on the second-floor level or above the DFE.
		X		X	Doors	Egress doors and first floor windows are designed to accommodate surges such that they remain operable following the design level flood.
		X		X	Elevators	Elevators that operate below the platform level will be dry and wet floodproofed to ensure resilience against flooding up to the DFE+SLR.
X	X	X		X	Categorize climate change projections based on project type	For each type of project, appropriate climate change projections should be pre-identified and recommended. Project types include infrastructure improvements, mixed use development, utility upgrades, etc.
X	X	X		X	Design based on future climate data	Identify appropriate basis of design (BOD) requirements for each credible climate hazard and incorporate climate change projections. The credibility of specific hazards will trigger hazard-specific design requirements using existing Federal, State, and Local guidance. Hazard-specific design guidelines will be combined with climate change projections to determine appropriate climate-resilience design levels.
X	X	X		X	Design for critical loads - stormwater	Increase capacity of stormwater drainage systems by designing for critical loads that incorporate future extreme climate projections for rainfall-runoff.

Scale			Time Horizon		Guideline / Solution	Commentary
County	City	Asset	Near-term	Long-term		
X	X	X		X	Build/update barriers	Construct a moveable or permanent barrier (tidal gates). Tide gates can potentially protect a significant length of upstream shoreline relative to the length of the tide gate. May be the only viable solution where right of way for other solutions cannot be obtained. These can have negative environmental impacts.
X	X	X		X	Build levees	Raise, strengthen, or build levees. Levees are not a great option on the open coast due to high wave energy environment, need to armor levee slope. Levees could be used in tidally influenced creeks and rivers though.
X	X	X	X	X	Build walls	Build new sea walls or raise the height of existing ones; can also incorporate buildings as flood protection features. Both seawalls and revetments were found to have a negative net cost benefit as a result of high construction cost in past erosion mitigation
	X	X		X	Determine minimum crest level	Crest level refers to the bottom level of any openings (including ventilation and services openings) or summit level of a ramp or accessway leading into or away from an underground or basement structure or facility, including the summit level of any exits from the underground facilities. The crest level of new developments will not be lower than the platform level plus a to-be-determined amount of freeboard.
X	X	X		X	Flood Barrier	New developments will raise the platform level and/or crest level to the highest possible levels before considering flood barriers. Where flood barriers are used, they must be designed to provide at least the same level of protection that minimum platform and/or crest levels would provide for the building.
X	X	X			Transition zone	Provide "transition zone" between the back of sidewalk up to the crest level, with deep landscape setback to provide enough horizontal space for gradual slope up to building entry with amenities including plantings, walking paths, seating and other amenities. Use planters with integrated seating to soften the transition between elevated hardscape and sidewalk
X	X			X	Land reclamation	Develop an extension of the land, natural or unnatural (port), to provide wave energy dissipation

A.2 Critical Transportation Assets and Communities by Jurisdiction

6.1.1 City of Belvedere

The City of Belvedere is located in southeastern Marin County on San Francisco Bay (and offshoot Richardson Bay) and includes Belvedere Island, Belvedere Lagoon, and Corinthian Island.

Asset	
Airports	0
Golden Gate Transit Stops	0
Golden Gate Ferry Terminals	0
Marin Transit Stops	1
SMART Stations	0
Caltrans Maintenance Facilities	0
Park and Ride	0
OBAG Projects	0
Plan Bay Area Projects	0
TIP Projects	0
State Highway Bridges	0
Road Tunnels	0
Bikeways (Existing and Proposed)	<1 mile
HOV Lanes	0 miles
Trails	<1 mile
Roadways	26 miles

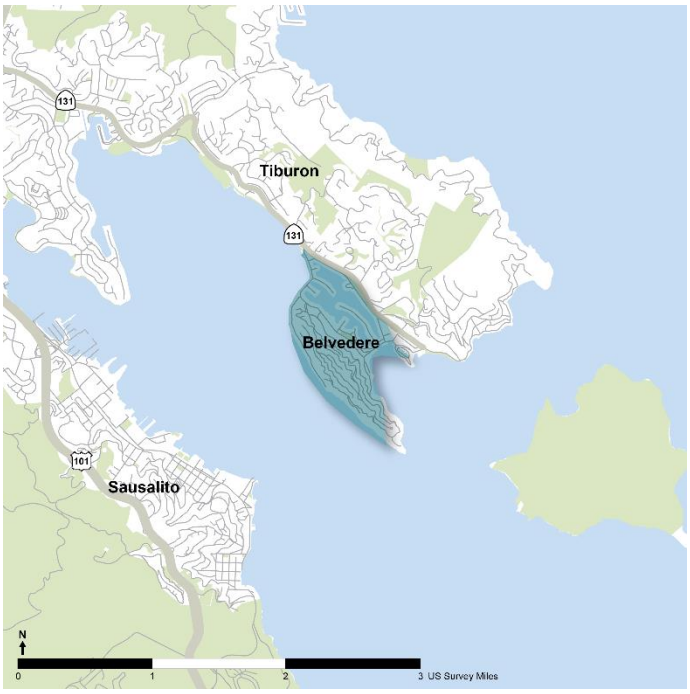

Figure 11 Belvedere City Boundary

Key focus areas, highlighting vulnerable communities or assets:

- San Rafael Ave. and Beach Rd. are the two primary ingress/egress routes connecting Belvedere Island to the Tiburon peninsula, both of which are waterfront roads on the west and east sides of the Lagoon respectively; these roads represent key vulnerable assets for Belvedere with respect to sea level rise. They are exposed to inundation under 24" (2.0ft or 0.6m) SLR (ART Bay Area, BCDC, 2020). The Protect Belvedere (Belvedere Critical Infrastructure Project) seeks to address improvements to these roads and the levees they sit atop (MTC/ABAG & BCDC Sea Level Rise Framework Shoreline Project Inventory, 2021).

6.1.2 City of Larkspur

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. The Larkspur Ferry Terminal connects the area to San Francisco via ferry while US-101, which runs through the city, provides vital connection to other communities in Marin and the Bay Area. Roadways in Larkspur also provide vital connectivity to Marin General Hospital.

Asset	
Airports	0
Golden Gate Transit Stops	2
Ferry Terminals	1
Marin Transit Stops	34
SMART Stations	1
Caltrans Maintenance Facilities	0
Park and Ride	3
OBAG Projects	0
Plan Bay Area Projects	-Larkspur Ferry Parking Garage
TIP Projects	-Old Redwood Highway Multi-Use Path -Ferry Channel and Berth Dredging -Golden Gate Transit Ferry Upgrades
Transit Hubs	1
State Highway Bridges	3
Road Tunnels	0
Bikeways (Existing and Proposed)	30 miles
HOV Lanes	5 miles
Trails	21 miles
Roadways	134 miles

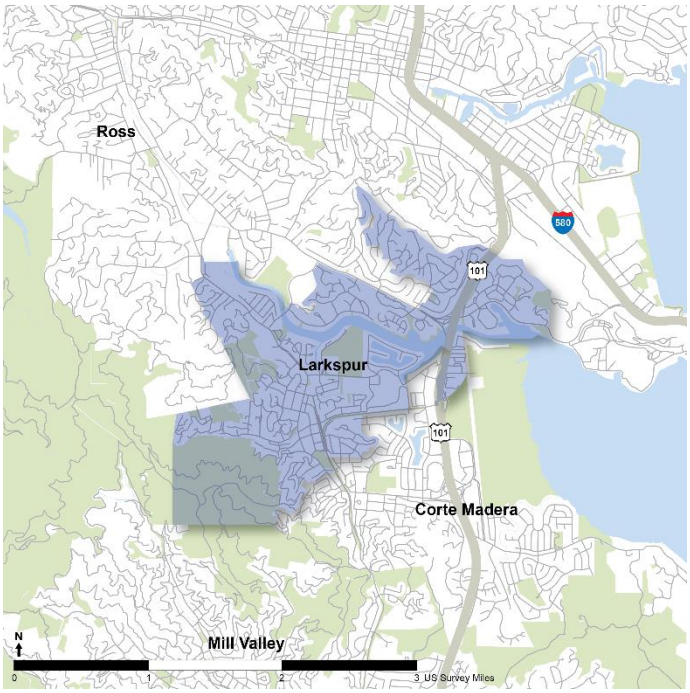

Figure 12 Larkspur City Boundary

Key focus areas, highlighting vulnerable communities or assets:

- The Larkspur Ferry Terminal was identified in the Marin Shoreline Sea Level Rise Vulnerability Assessment as vulnerable to coastal flooding. There are plans to improve the site, parking capacity, and dock operating systems in response to SLR. Identified in Marin Shoreline Sea Level Rise Vulnerability Assessment (BayWAVE, 2017).

- Lucky Drive floods during present-day king tide events and is also susceptible to riverine flooding from Corte Madera Creek. This relatively short stretch is an essential connector between Corte Madera, Larkspur, Kentfield, and other Central Marin communities to US-101 (Corte Madera Climate Adaptation Assessment, 2021) (BayWAVE, 2017).
- The US-101 corridor is known to be vulnerable to sea level rise and flooding in Marin; the section through Larkspur is mostly elevated but on/off ramps are low-lying and flood prone.

6.1.3 City of Mill Valley

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.

Asset	
Airports	0
Golden Gate Transit Stops	26
Golden Gate Ferry Terminals	0
Marin Transit Stops	27
SMART Stations	0
Caltrans Maintenance Facilities	0
Park and Ride	0
OBAG Projects	0
Plan Bay Area Projects	-Golden Gate Transit Bus Upgrades
TIP Projects	0
State Highway Bridges	0
Road Tunnels	0
Bikeways (Existing and Proposed)	34 miles
HOV Lanes	0 miles
Trails	28 miles
Roadways	191 miles

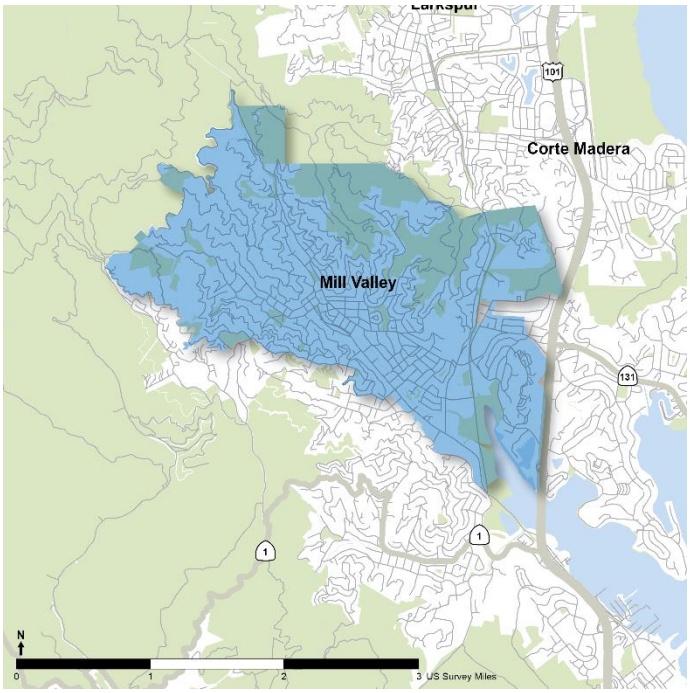

Figure 13 Mill Valley City Boundary

Key focus areas, highlighting vulnerable communities or assets:

- The US-101 corridor is known to be vulnerable to sea level rise and flooding in Marin; the section through Mill Valley is mostly elevated but on/off ramps and frontage roads are low-lying and flood prone.
- Extreme precipitation combined with drainage capacity issues, rising shallow groundwater tables, and high tides is a known issue in Mill Valley; this impacts several local roads, bridges and bus routes/stops, particularly those nearby creeks and the Richardson Bay (Shallow Groundwater Response to Sea Level Rise, 2022).
- East Blithedale Ave., Miller Ave., and Camino Alto are all key roadways for ingress/egress to and from many of Mill Valley's main commercial and residential areas; due to elevation, existing drainage capacity, and proximity to creeks and Richardson Bay, these roads are all vulnerable to flooding and sea level rise.

- Bothin Marsh restoration work includes strategies such as ecotone levees, sediment management, and enhancement of the natural tidal marsh ecosystem (MTC/ABAG & BCDC Sea Level Rise Framework Shoreline Project Inventory, 2021).

6.1.4 City of Novato

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 has been identified as a critical transportation asset vulnerable to sea level rise from previous studies, discussed below.

Asset	
Airports	0
Golden Gate Transit Stops	29
Golden Gate Ferry Terminals	0
Marin Transit Stops	126
SMART Stations	3
Caltrans Maintenance Facilities	0
Park and Ride	2
OBAG Projects	Great Redwood Trail – Novato, Transit Corridor Improvements
Plan Bay Area Projects	Golden Gate Transit Bus Upgrades, SR-37 Long Term Project, Marin Sonoma Narrows, Bus on Shoulder on Highway 101, Novato Boulevard
TIP Projects	Novato Boulevard Widening – Diablo to Grant
Transit Hubs	4
State Highway Bridges	26
Road Tunnels	0
Bikeways (Existing and Proposed)	118 miles
HOV Lanes	22 miles
Trails	118 miles
Roadways	564 miles

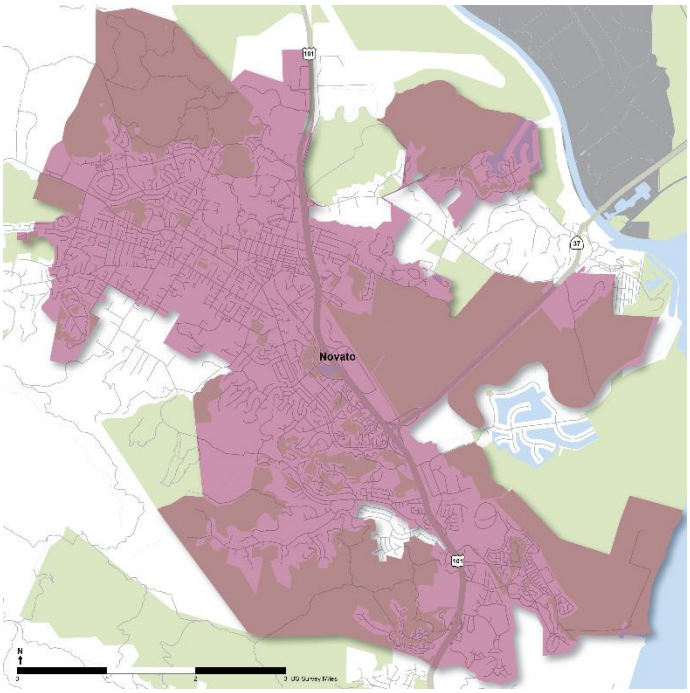

Figure 14 Novato City Boundary

Key focus areas, highlighting vulnerable communities or assets:

- The US-101 corridor is known to be vulnerable to sea level rise and flooding in Marin; the section through Novato is mostly elevated but many on/off ramps are low-lying and flood prone. Additionally, the section of US-101 passing the Gnoss Field Airport is vulnerable to flooding due to elevation and proximity to nearby wetlands and creeks.
- SR-37 connecting Novato and Vallejo was expected to be permanently submerged by 39in (3.3ft or 1.0m) SLR, according to Caltrans D4 Vulnerability Assessment (Caltrans, 2019) and SR 37 PEL Study (Caltrans, 2022). Near-term maintenance projects include SR 37 Pavement Rehabilitation between US-

101/SR-37 interchange and Petaluma River and SR 37 Bridge Preservation project at Petaluma River Bridge at the border of Marin and Sonoma counties. Long-term implementation plan includes elevating SR-37 on a raised facility between US-101 and Atherton Avenue, where it meets the already elevated SR-37. Improvements to on- and off-ramps and bicycle and pedestrian facilities are also planned along the SR-37 corridor through Novato and Marin County (TAM Annual Report, 2022).

- The SMART train is vulnerable to flood issues in Novato as about 4-5mi of track is vulnerable to inundation in future SLR, as identified in Marin Shoreline Sea Level Rise Vulnerability Assessment (BayWAVE, 2017). SMART has identified opportunities along SR-37 to align rail infrastructure with the highway between Novato and Sears Point, according to SR 37 PEL Study (Caltrans, 2022); extending SMART along the SR 37 corridor will require SMART to address known flooding and sea level rise vulnerabilities.
- The Novato Creek Flood Control Project was completed in 2006, and the Novato-Hamilton levee system is the only FEMA-accredited system in Marin, but extensive damage to the levees and stormwater pumping systems was experienced in 2014 and 2017 flood events. (Marin LHMP)
- Novato OLU Case Study in Marin County SLR Adaptation Framework (2019) calls out low-lying Highway 37 and rail lines and the Bel Marin Keys neighborhood as vulnerable. Eroding marshlands may cause issue because they protect the bayside of the levees.

6.1.5 City of San Rafael

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 has been identified as a critical asset in previous studies (discussed below) due to it being a low-lying asset susceptible to flooding and a key connection point for regional traffic.

Asset	
Airports	Smith Ranch
Golden Gate Transit Stops	55
Golden Gate Ferry Terminals	0
Marin Transit Stops	117
SMART Stations	2
Caltrans Maintenance Facilities	-San Rafael Landscape Storage
Park and Ride	5
OBAG Projects	-2nd and 4th Street Intersection Improvements
Plan Bay Area Projects	-Transit Center Relocations -US-101/I-580 multimodal local access improvement project -Richmond-San Rafael Forward -Golden Gate Transit Bus Upgrades -Bus on Shoulder on Highway 101
TIP Projects	-Toll Bridge Rehabilitation Program -SMART Rail and Pathway Phase 2
Transit Hubs	1
State Highway Bridges	21
Road Tunnels	0
Bikeways (Existing and Proposed)	119 miles
HOV Lanes	22 miles
Trails	57 miles
Roadways	540 miles

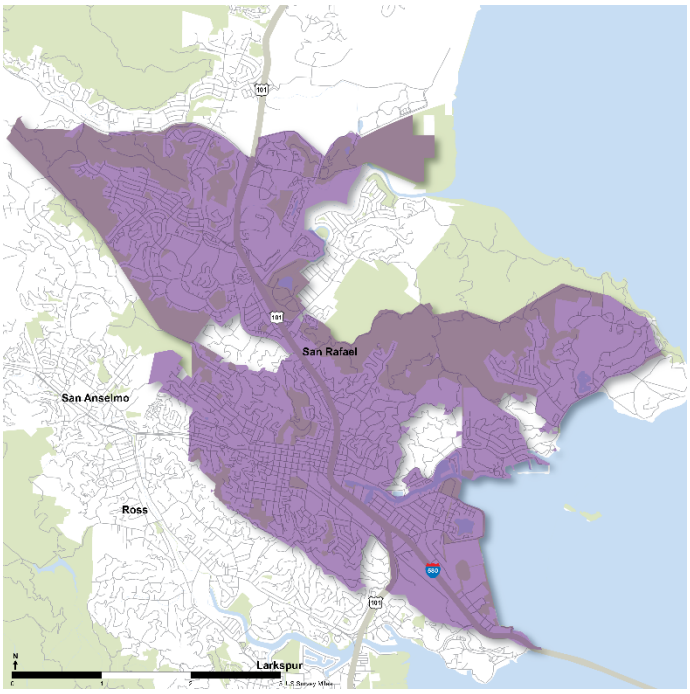

Figure 15 San Rafael City Boundary

Key focus areas, highlighting vulnerable communities or assets:

- TAM is leading project development for the US-101/I-580 interchange, which has been identified as a critical regional transportation asset vulnerable to climate hazards in the BARC Raising the Bar on Regional Resilience report, ART Bay Area (BCDC, 2020), and other studies. Though sections are elevated, many ramps and feeder roads could flood and impede travel through the city and county, and they become vulnerable to inundation by 12" (1.0ft or 0.3m) SLR (ART Bay Area, BCDC, 2020).

- The Canal District is exposed to flooding and sea level rise from the canal and bay and has been identified as a socially vulnerable neighborhood in the BARC Raising the Bar on Regional Resilience report. The Gerstle Park/Bret Harte neighborhood and Montecito/Happy Valley neighborhood are also exposed to flooding, as identified in the BARC Raising the Bar on Regional Resilience report. Portions of downtown San Rafael currently experience flooding in extreme rainfall plus high tide events.
- The SMART train may experience flood issues in San Rafael along mile posts 15.9-16.9 (San Rafael/Santa Venetia) and 19.8-20.9 (Central San Rafael). The San Rafael Transit Center was identified as the only SMART stop vulnerable to tidal flooding at 60" (5ft or 1.5m) SLR. Identified in Marin Shoreline Sea Level Rise Vulnerability Assessment (BayWAVE, 2017).
- The Golden Gate Bridge, Highway and Transportation District (GGBHTD) headquarters and depot, multiple yacht harbors, and parts of the Bay Trail in San Rafael are vulnerable to inundation under 10" (0.8ft or 0.25m) SLR, as identified in the Marin Shoreline Sea level Rise Vulnerability Assessment (BayWAVE, 2017).
- The San Rafael Airport and Loch Lomond Marina were also identified in the Marin Shoreline Sea Level Rise Vulnerability Assessment as vulnerable to medium-term SLR, experience inundation in 20" (1.7ft or 0.5m) SLR (BayWAVE, 2017).
- The San Francisco Bay Trail and Water Trail are vulnerable to flood under 12" (1.0ft or 0.3m) SLR (ART Bay Area, BCDC, 2020).
- The Irwin Street Bridge crossing San Rafael Creek/Canal, which was recently replaced and connects northbound vehicles from US-101 to downtown San Rafael currently has minimal freeboard during high tide events.
- The San Rafael Transit Center is vulnerable to flooding from extreme precipitation, existing drainage capacity and proximity to the tidally influenced sections of San Rafael Creek/Canal. This is a key transit hub for the region, including multiple bus stops and the SMART downtown San Rafael station. It is the highest ridership station in the North Bay. Note that FEIR has been completed, and design is underway.
- Key connector roads in San Rafael that are known to be vulnerable to flooding and sea level rise due to elevation, existing drainage infrastructure, and proximity to creeks and the San Francisco Bay include N. San Pedro Rd., Point San Pedro Rd., Irwin St., Grand Ave., Second St., Lincoln Ave., Anderson Dr., Francisco Blvd. E., Francisco Blvd. W., and Bellam Blvd.

6.1.6 City of Sausalito

The City of Sausalito is located along the coastline of San Francisco Bay into Richardson Bay in southern Marin. The Sausalito Ferry Terminal and the main downtown thoroughfare, Bridgeway, are key infrastructure assets that connect the city to the region. US-101 forms the western border of Sausalito, bypassing the downtown area.

Asset	
Airports	0
Golden Gate Transit Stops	1
Golden Gate Ferry Terminals	20
Marin Transit Stops	14
SMART Stations	0
Caltrans Maintenance Facilities	0
Park and Ride	1
OBAG Projects	Bridgeway Bike Lane Project – Princess Street to Richardson
Plan Bay Area Projects	Golden Gate Transit Bus Upgrades
TIP Projects	0
Transit Hubs	1
State Highway Bridges	5
Road Tunnels	Waldo Tunnel
Bikeways (Existing and Proposed)	11 miles
HOV Lanes	0 miles
Trails	16 miles
Roadways	98 miles

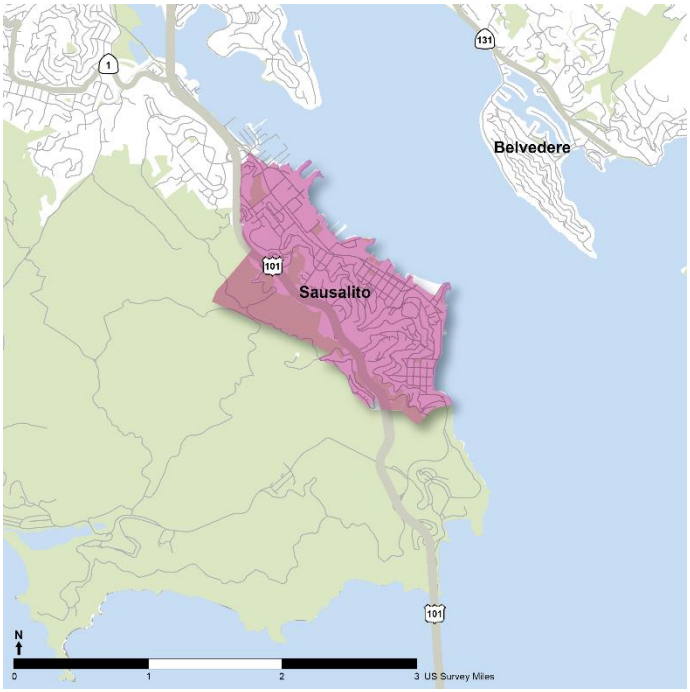

Figure 16 Sausalito City Boundary

Key focus areas, highlighting vulnerable communities or assets:

- The San Francisco Bay Trail and Water Trail are vulnerable to flood under 12” (1ft or 0.3m) SLR (Richardson Bay ART).
- The City of Sausalito is aware of flooding, land subsidence and associated impacts to infrastructure along Gate 5 Road that will only increase with further SLR.
- Bridgeway is the main connector road through Sausalito that provides a vital ingress/egress route; this roadway is vulnerable to flooding due to elevation, existing drainage infrastructure, multiple creek crossings, and proximity to Richardson Bay. On/offramps to US-101 as well as N Bridge Blvd on the north end of Sausalito are known to be vulnerable to flooding for many of these same reasons.
- The Sausalito Ferry Plaza and several waterfront marinas are also known to be vulnerable to future flooding as a result of sea level rise.
- Stormwater pump stations are also known to be vulnerable to coastal flooding in Sausalito due to elevation and proximity to Richardson Bay.

- Mill Valley to Sausalito Path and the North-South Greenway Path contain the highest usage of Marin's Active Transportation facilities.

6.1.7 Town of Corte Madera

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.

Asset	
Airports	0
Golden Gate Transit Stops	2
Golden Gate Ferry Terminals	0
Marin Transit Stops	32
SMART Stations	0
Caltrans Maintenance Facilities	0
Park and Ride	1
OBAG Projects	-Paradise Drive
Plan Bay Area Projects	-Golden Gate Transit Bus Upgrades
TIP Projects	0
Transit Hubs	0
State Highway Bridges	3
Road Tunnels	0
Bikeways (Existing and Proposed)	39 miles
HOV Lanes	8 miles
Trails	12 miles
Roadways	123 miles

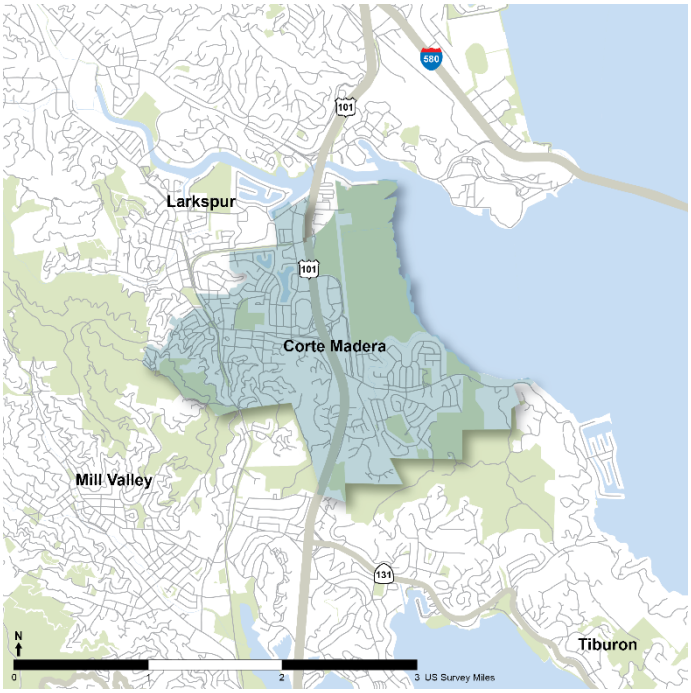

Figure 17 Corte Madera City Boundary

Key focus areas, highlighting vulnerable communities or assets:

- Wornum Drive Bridge (US-101 PM 8.02) and Tamalpais Drive Overcrossing (US-101 PM 7.37) may be exposed to scour starting in 20" (1.6ft or 0.5m) SLR and may require protection measures. Identified in Caltrans D4 Vulnerability Assessment.
- US-101 through downtown Corte Madera, extending north outside of city boundaries, has been identified as a regional "hot spot" in Bay Adapt Regional Strategy, using data from ART Bay Area Regional Sea Level Rise Vulnerability and Adaptation Study with 108" (9.0ft or 2.7m) SLR. US-101 has been identified as vulnerable in the Marin County SLR Adaptation Framework (2019) and BayWAVE (2017).
- Lucky Drive floods during present-day king tide events and is also susceptible to riverine flooding from Corte Madera Creek. This short corridor represents an essential connection between Corte Madera, Larkspur, Kentfield, and other Central Marin communities to US-101 (Corte Madera Climate Adaptation Assessment, 2021) (BayWAVE, 2017).

- Paradise Drive connects Tiburon to the County and US-101, and it is part of the Bay Trail. Parts of the road are vulnerable to flood under 66" (5.5ft or 1.7m) SLR, though may experience inundation during storm events under less SLR (Corte Madera Climate Adaptation Assessment, 2021).
- SMART and GGBHTD corridors through Corte Madera Marsh sit on elevated berms which protect parts of Corte Madera from tidal flooding. The Corte Madera Climate Adaptation Assessment has identified the marshland area for potential integrated adaptation strategies (2021).
- Casa Buena Drive floods during extreme precipitation events, and as a key connector to Tamalpais Drive for residents and businesses, it's a key vulnerable asset in Corte Madera (Corte Madera Climate Adaptation Assessment, 2021).
- Mill Valley to Sausalito Path and the North-South Greenway Path contain the highest usage of Marin's Active Transportation facilities.

6.1.8 Town of Fairfax

The Town of Fairfax sits over 100ft above sea level in inland Marin. Residents rely on the road network to access other communities in Marin and the greater Bay Area. Though none of the infrastructure in the town is exposed to coastal hazards, key connector routes may be vulnerable to sea level rise. Also Fairfax Creek, San Anselmo Creek, and their tributaries run through the town, which may expose the town to riverine flooding.

Asset	
Airports	0
Golden Gate Transit Stops	0
Golden Gate Ferry Terminals	0
Marin Transit Stops	15
SMART Stations	0
Caltrans Maintenance Facilities	0
Park and Ride	0
OBAG Projects	0
Plan Bay Area Projects	0
TIP Projects	0
Transit Hubs	0
State Highway Bridges	0
Road Tunnels	0
Bikeways (Existing and Proposed)	18 miles
HOV Lanes	6 miles
Trails	12 miles
Roadways	71 miles

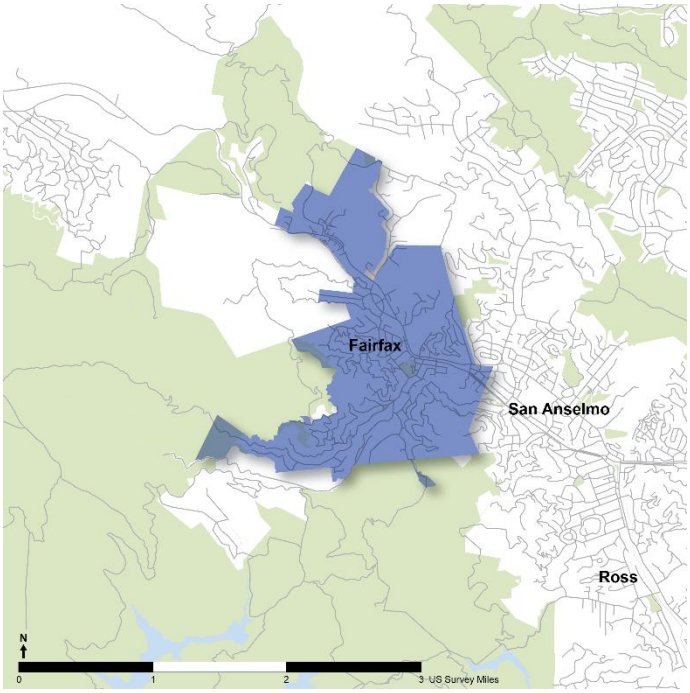

Figure 18 Fairfax City Boundary

Key focus areas, highlighting vulnerable communities or assets:

- No assets exposed to coastal hazards, but riverine flood has caused damage in the past, including to major roads (MCM LHMP).
- Key corridors that connect Fairfax to the region may be impacted by sea level rise. See San Rafael, Larkspur, and Corte Madera sections for more information on these routes. See the following plot for network link volumes, noting the significant volume from the coast inland to Fairfax.

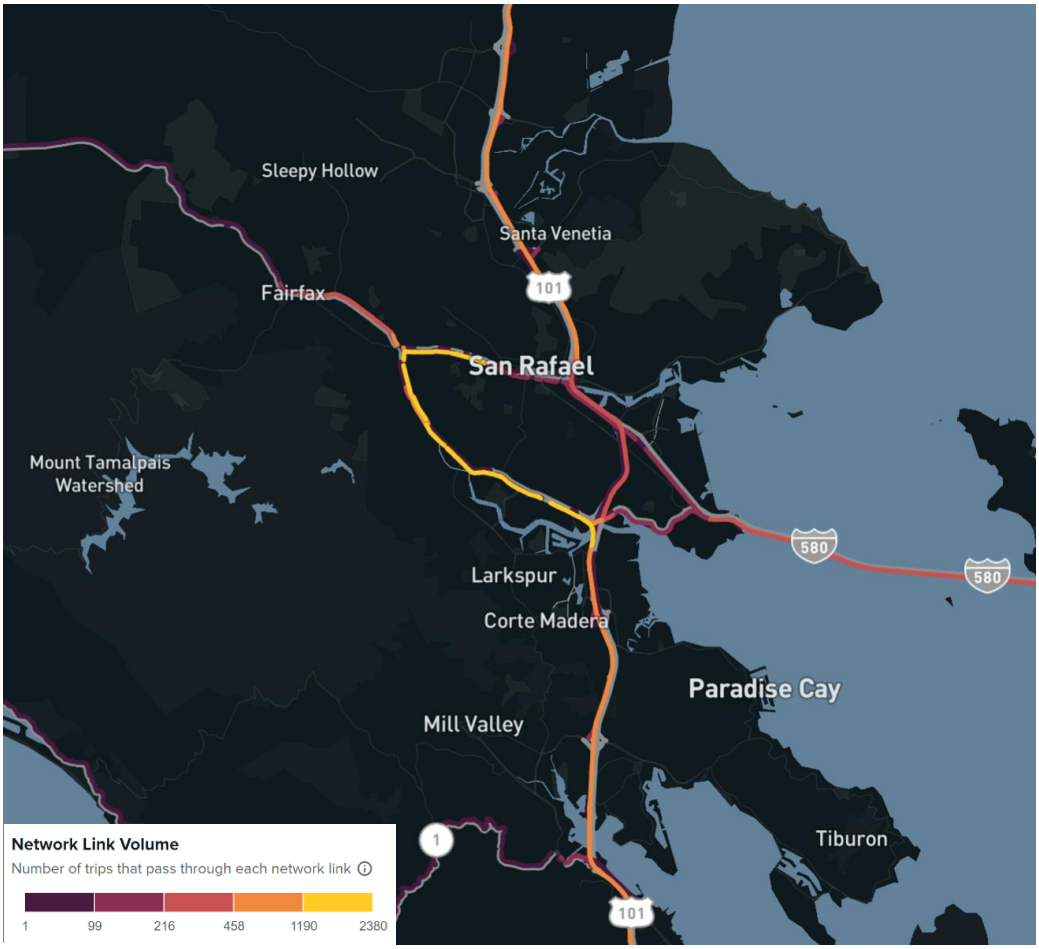

Figure 19: Network Link Volume data from Replica (replicahq.com).

6.1.9 Town of Ross

The town of Ross is a small, inland community of roughly 2,000 residents. It is located along the Corte Madera Creek, upstream of Larkspur. It is connected to nearby communities via Sir Francis Drake Boulevard, a major corridor that connects to US-101. None of the infrastructure in Ross is exposed to coastal hazards although the tidal influence from the San Francisco Bay is expected to extend upstream in Corte Madera Creek as a result of future sea level rise which could worsen the existing riverine flood issues along this creek during future extreme rainfall and high tide events.

Asset	
Airports	0
Golden Gate Transit Stops	0
Golden Gate Ferry Terminals	0
Marin Transit Stops	4
SMART Stations	0
Caltrans Maintenance Facilities	0
Park and Ride	0
OBAG Projects	0
Plan Bay Area Projects	0
TIP Projects	0
Transit Hubs	0
State Highway Bridges	0
Road Tunnels	0
Bikeways (Existing and Proposed)	5 miles
HOV Lanes	0 miles
Trails	2 miles
Roadways	44 miles

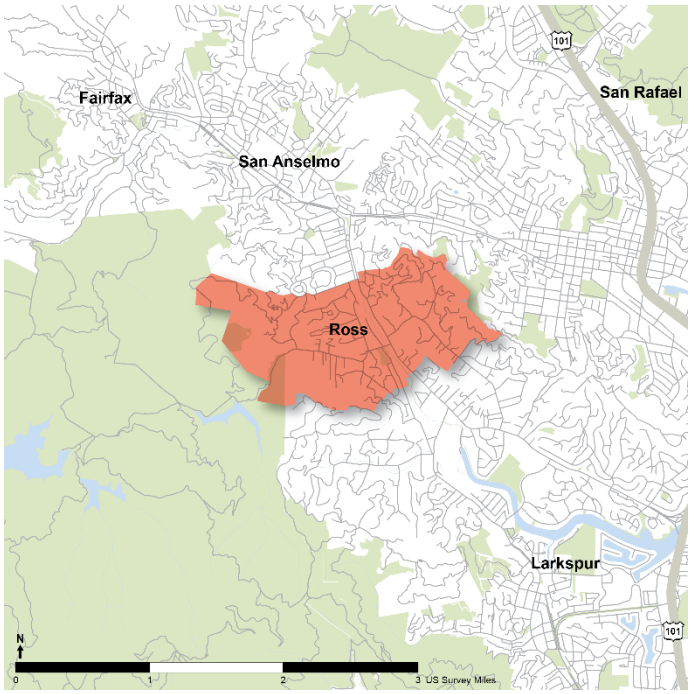

Figure 20 Ross City Boundary

Key focus areas, highlighting vulnerable communities or assets:

- No assets exposed to coastal hazards, but riverine flood has caused damage in the past, including to major roads (MCM LHMP).
- Key corridors that connect Ross to the region may be impacted by sea level rise. See San Rafael, Larkspur, and Corte Madera for more information. See the following plot for network link volumes, noting the significant volume from the coast inland to Ross (due south of where it says ‘San Anselmo’ in the image).

Figure 21: Network Link Volume data from Replica (replicahq.com).

6.1.10 Town of San Anselmo

The Town of San Anselmo sits about 50ft above sea level in inland Marin. Residents rely on the road network to access other communities in Marin and the greater Bay Area, though none of the infrastructure in the town is exposed to coastal hazards like sea level rise. San Anselmo Creek and its tributaries run through the town, which expose the town to riverine flooding. The tidal influence from the San Francisco Bay is expected to extend upstream in Corte Madera Creek as a result of future sea level rise which could worsen the existing riverine flood issues in San Anselmo during future extreme rainfall and high tide events.

Asset	
Airports	0
Golden Gate Transit Stops	3
Golden Gate Ferry Terminals	0
Marin Transit Stops	20
SMART Stations	0
Caltrans Maintenance Facilities	0
Park and Ride	0
OBAG Projects	0
Plan Bay Area Projects	-Golden Gate Transit Bus Upgrades
TIP Projects	0
Transit Hubs	1
State Highway Bridges	0
Road Tunnels	0
Bikeways (Existing and Proposed)	25 miles
HOV Lanes	0 miles
Trails	4 miles
Roadways	108 miles

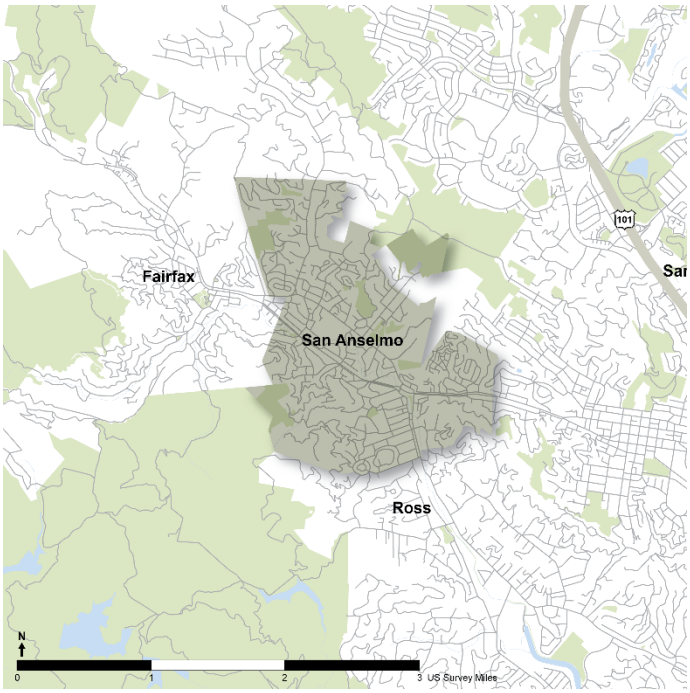

Figure 22 San Anselmo City Boundary

Key focus areas, highlighting vulnerable communities or assets:

- No assets exposed to coastal hazards, but riverine flood has caused damage in the past, including to major roads (MCM LHMP).
- Key corridors that connect San Anselmo to the region may be impacted by sea level rise. See San Rafael, Larkspur, and Corte Madera for more information. See the following plot for network link volumes, noting the significant volume from the coast inland to San Anselmo (located at the intersection west of San Rafael).

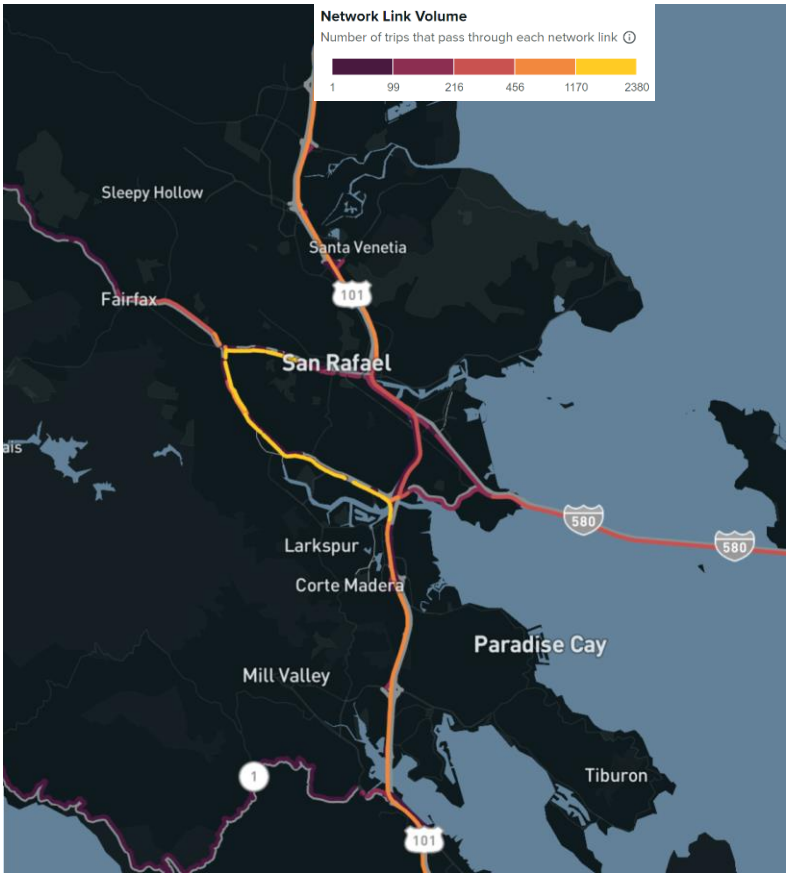

Figure 23: Network Link Volume data from Replica (replicahq.com).

6.1.11 Town of Tiburon

The Town of Tiburon comprises a peninsula that extends from main Marin into the San Francisco Bay. Tiburon Boulevard (CA-131), which connects the town (and adjacent Belvedere) to the mainland, is a key transportation asset exposed to coastal hazards like sea level rise.

Asset	
Airports	0
Golden Gate Transit Stops	0
Golden Gate Ferry Terminals	2
Marin Transit Stops	23
SMART Stations	0
Caltrans Maintenance Facilities	0
Park and Ride	1
OBAG Projects	-Paradise Drive
Plan Bay Area Projects	0
TIP Projects	-Paradise Drive Improvements
Transit Hubs	0
State Highway Bridges	0
Road Tunnels	0
Bikeways (Existing and Proposed)	13 miles
HOV Lanes	0 miles
Trails	45 miles
Roadways	112 miles

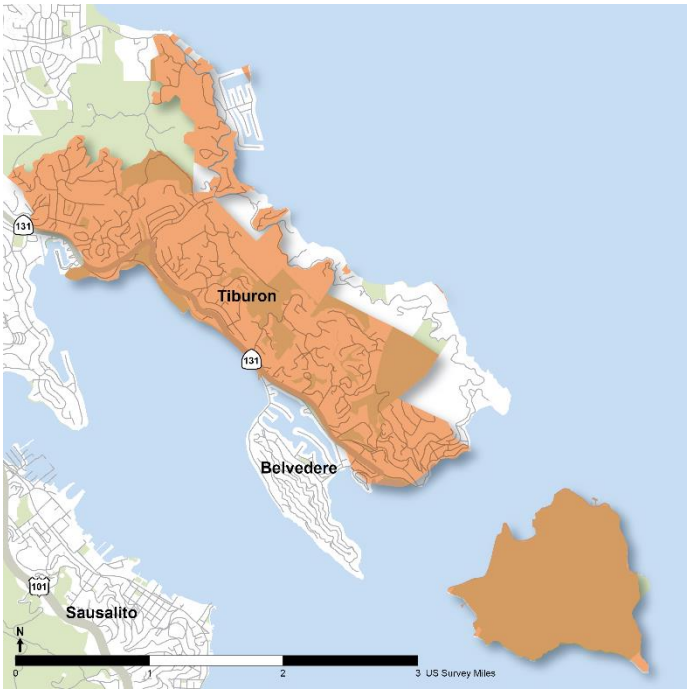

Figure 24 Tiburon City Boundary

Key focus areas, highlighting vulnerable communities or assets:

- Ferry landings in Tiburon have been identified as vulnerable to near-term SLR in the Marin Shoreline Sea Level Rise Vulnerability Assessment (BayWAVE, 2017).
- Paradise Drive connects Tiburon to the County and US-101, and it is part of the Bay Trail. Parts of the road are vulnerable to flood under 66" (5.5ft or 1.7m) SLR, though may experience inundation during storm events under less SLR (Corte Madera Climate Adaptation Assessment).

6.1.12 Unincorporated Communities

Unincorporated communities in the County of Marin include Greenbrae, Kentfield, Marin City, Bolinas, Dillon Beach, Forest Knolls, Inverness, Lagunitas, Marshall, Nicasio, Olema, Point Reyes, San Geronimo, Stinson Beach, and Tomales.[6]

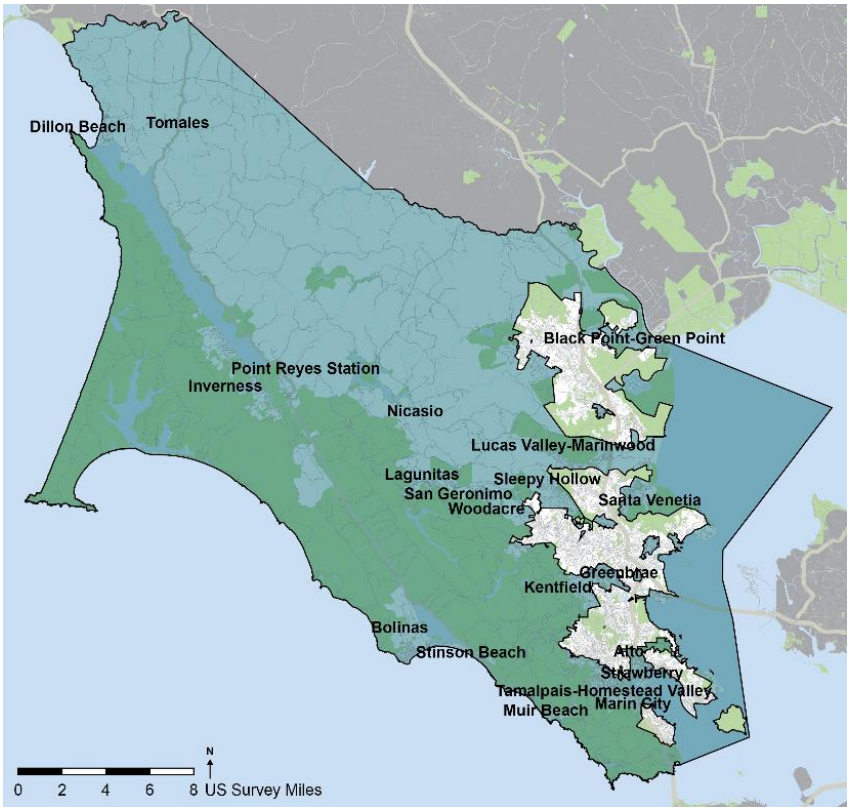

Figure 25 Unincorporated Marin County Boundary

Asset	
Airports	Gnoss Field
Golden Gate Transit Stops	18
Golden Gate Ferry Terminals	1
Marin Transit Stops	136
SMART Stations	0
Caltrans Maintenance Facilities	- Manzanita Maintenance Station - Point Reyes Maintenance Station -San Rafael Paint Shop
Park and Ride	5
OBAG Projects	0
Plan Bay Area Projects	-Richmond-San Rafael Forward - Per-Mile Tolling on Congested Freeways with Transit Alternatives - Golden Gate Transit Bus Upgrades - SR-37 Long-Term Project

[6] Marin Communities - County of Marin (marincounty.org)

	-Marin-Sonoma Narrows - Bus on Should on Highway 101
TIP Projects	-Toll Bridge Rehabilitation Program -Fort Baker Vista Point Trail -Hicks Valley/Marshall-Petaluma/Wilson Hill Road Rehab -Old Redwood Highway Multi-Use Path - Ferry Channel and Berth Dredging
Transit Hubs	6
State Highway Bridges	32
Road Tunnels	4
Bikeways (Existing and Proposed)	224 miles
HOV Lanes	7 miles
Trails	683 miles
Roadways	1,461 miles

Key focus areas, highlighting vulnerable communities or assets:

- The Manzanita Park & Ride, Shoreline Highway (Almonte) and US-101 (Strawberry) already experience flooding at high tides, which is expected to worsen under SLR (Marin Shoreline SLR Vulnerability Assessment, BayWAVE, 2017) (C-SMART, 2018) (ART Richardson Local Assessment, BCDC, 2020) (TAM Annual Report, 2022).
- SR-37 – See details in 'City of Novato' section.
- Shoreline Highway (SR-1) – This critical asset already experiences flooding during present-day storms, and portions of it are vulnerable to inundation under future 10" (0.8ft or 0.25m) SLR conditions. It connects most of the communities in western Marin to the rest of the county and the region. Particularly exposed sections can be found in Bolinas, Stinson Beach, and Point Reyes Station (C-SMART, 2018).
- Stinson Beach – Low-lying parts of Stinson Beach are located in FEMA VE zones, which is a 100-yr flood zone exposed to tsunamis and/or wave action (MCM LHMP). A key corridor, Shoreline Highway (SR-1) is the only access road to the community, and it is vulnerable to inundation during storm events with as little as 10" (0.8ft or 0.25m) SLR (C-SMART, 2018).
- Santa Venetia – flat, low-lying terrain in this community leads to drainage challenges, especially during high tides. The community relies on a system of pumps and levees to protect infrastructure and buildings (MCM LHMP). An ongoing project to replace wooden structure part of the levees will improve flood protection in the area (Santa Venetia Floodwall Project, 2023).
- Kentfield – Lucky Drive floods during present-day king tide events and is also susceptible to riverine flooding from Corte Madera Creek. This short corridor represents an essential connection between Corte Madera, Larkspur, Kentsfield, and other Central Marin communities to US-101 (Corte Madera Climate Adaptation Assessment, 2021) (BayWAVE, 2017) (Corte Madera Creek Flood Risk Management Project, 2020).
- Muir Beach – Shoreline Highway (SR-1) is vulnerable to inundation under 80" (6.7ft or 2.0m) SLR, according to C-SMART (2018). The community also relies on the vulnerable US-101 / SR-1 Manzanita Interchange to connect to the county and region, particularly to the south.
- Inverness – Sir Francis Drake Boulevard has present-day risk to flooding during storm events, which are expected to worsen with climate change. Living shoreline solutions are being explored for this community and others along Tomales Bay (Tomales Bay Living Shoreline Feasibility Study, 2022).

- Marin City – This Priority Development Area on Richardson Bay is exposed to sea level rise and flooding along the coast, particularly US-101 which connects the region and Donahue Street which is the only road in and out of the community (ART Richardson Local Assessment, BCDC, 2020). The Marin City population has been identified as socially vulnerable, discussed in Resilient by Design Bay Area Challenge report for Permaculture + Social Equity Team (P+SET) (2018). As identified by the community, local flooding locations, which have been inundated in previous storms or experienced drainage issue from sediment and debris, include Cole Drive west of US-101, at the foot of Olio St. and Waldo Ct., foothill of Burgess Ct., and the intersections of US-101, Donahue St., and Drake Avenue (Marin City Drainage Study, 2018).

APPENDIX E

VULNERABILITY ASSESSMENT MEMO

-

Transportation Authority of Marin

Sea Level Rise Adaptation Planning for Marin County's Transportation System

Focus Areas Memo

V2 | May 19, 2025
V1 | November 3, 2023

Click or tap here to enter text.

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Contents

1. Executive Summary

Sea level rise affects everyone in Marin County, from those living close to the shoreline to those living in the hills. Even those with property outside of the inundation zone will be affected by service disruptions due to the flooding of wastewater treatment plants and hospitals, and most relevant to TAM's interests, delays when flooding impacts key transportation routes, such as Highways 101 and 37. The impacts are likely to be felt most acutely by those with fewer resources, such as underserved and marginalized communities.

Marin County has been a leader in California and across the nation on understanding and preparing for its vulnerability to sea level rise (see Existing Plan Review Memo). To date, there have been several important efforts to identify exposure and hazards, as well as begin to map solutions, including countywide projects such as BayWAVE and C-SMART, in combination with existing and burgeoning city efforts in Sausalito, Corte Madera, San Rafael, and many others.

With the passage of Measure AA, the Transportation Authority of Marin (TAM) now has dedicated, on-going funds for sea level rise protection, estimated at approximately $250,000 annually based on the current revenue projection. These funds have a wide array of eligibility and potential uses and can be used to respond to the various needs identified in vulnerability assessments prepared by BayWAVE, C-SMART, and Caltrans. TAM has contracted Arup, Pathways Climate Institute, and WRT to support its inaugural efforts to identify vulnerable areas in the County, develop area-specific sea level rise adaptation strategies, and create an implementation plan for TAM.

Following a review of existing work in and around Marin County, this next phase of the project (Task 3) updates the understanding of coastal flood vulnerability in Marin County, with a focus on the transportation system. Since the last countywide assessments were conducted, information was released on how sea level rise will also impact shallow groundwater tables, commonly referred to as groundwater rise. Groundwater rise projections are assessed in combination with permanent overland inundation from rising sea levels, as well as an analysis of current and future temporary 100-year flood exposure from both coastal storm surge and waves, as well as coastal/fluvial/pluvial impacts identified by FEMA floodplain mapping.

One important goal of this flood hazard analysis is to use the latest science to both reaffirm known locations of current and future coastal flood vulnerability and identify any new potential flood hazard locations. The focus areas can then be used to spur discussion within TAM and across Marin County to identify ongoing or planned transportation improvements and adaptation plans and increase coordination among local partners to implement measures that reduce the County's transportation flood vulnerability. Through this analysis, the consultant team identified 15 focus areas and provided information on the flood related hazards for each, the timing of impact on roads, impacts to multimodal transit and bike routes, and identification of key community and lifeline assets within each focus area to connect the transportation system to the communities they serve.

1.1 Purpose

This memorandum summarizes methods developed to identify Marin County coastal flood focus areas and to identify and present focus area locations, along with exposure statistics, focusing on transportation and transit assets. This memo will:

1. Define the multi-hazard, multi-stakeholder driven methodology to identify focus area locations
2. Discuss identified focus area locations
3. Discuss online data viewer that will be used for TAM and Technical Advisory Committee (TAC) and Focus Group discussions
4. Describe how focus area analysis can inform subsequent tasks and future TAM projects

For this project, ***focus areas*** are defined as locations that are vulnerable to sea level rise coastal hazards and fluvial/pluvial flood exposure, with implications to both Marin's transportation assets, as well as to important community and lifeline assets.

1.2 Approach & Outcomes

In recognition of the wealth of work that Marin County has already undertaken to map and understand its vulnerability to coastal flood hazards, the goal of Task 3 is to update known vulnerabilities, refine with the latest scientific information, and propose a suite of focus areas that will support future discussions for adaptation planning across Marin County, with a focus on the County's transportation assets. The exposure analysis, including the delineated focus areas, is provided in GIS geodatabases and through an online Web Map to increase uptake across the entire county. The focus areas are intended to spur future discussions on shared coastal flood hazard exposure, guide conversations about ongoing and planned transportation and adaptation projects, and encourage multi-stakeholder coordination as the County works to prepare and implement flood hazard adaptation measures. The boundaries for the focus areas should be interpreted as general boundaries and not strict boundaries.

2. Focus Area Location Identification Methodology

2.1 Data Collection and Management

The consultant team worked with TAM and the TAC to collect and collate a suite of countywide assets for the flood exposure and vulnerability assessment. In turn, building on past efforts, the consultant team updated a countywide exposure analysis and included an additional sea level rise flood projection as well as new scientific flood on exposure to sea-level rise driven groundwater rise. The following section describes the methods to collect and vet the different data sources.

2.1.1 Marin County Asset Data

TAM, in collaboration with the TAC and county representatives, solicited, collected, and shared the best available information on Countywide assets, such as roadways, facilities, and community infrastructure. Prior to the passage of Measure AA, which explicitly funds and empowers TAM to assess transportation vulnerability to sea level rise, Marin County's Department of Public Works led a project that assessed sea level rise impacts to Marin County transportation assets, with the goal of providing project-level information on coastal flood vulnerability and to support adaptation planning. The first iteration of the County's exposure analysis was completed as TAM's study was beginning. The consultant team leveraged DPW's work collecting and cataloguing key County assets, which allowed the consultant to use the most recently vetted and reviewed asset information in this analysis.

Created as part of the Existing Plan Review, an ArcGIS online group repository was developed for coordination and sharing of data among the consultants (Figure 1). Accompanying excel files categorized each layer type as a point, line, or polygon and described relevant attribute characteristics, such as the number of assets within a specific category (e.g., 6 assets within the SMART layer or 549 assets within the Marin Transit Stops layer).

Once all the GIS data layers were compiled, the consultant team identified which assets would be appropriate for exposure analysis. The consultant team developed asset-based GIS geodatabases that could then be used for the exposure analysis (see section 3.1.1). Table 1 lists the full suite of assets included in the analysis.

Table 1 List of Assets

Layer Category	Layer Name	shape	data source
Active Transportation - Bike	Bikeways	polyline	TAM / TAC
Active Transportation - Trails	Trails	polyline	County SLR Transportation Tool
Airport	Airports	point	TAM / TAC
Community Assets	School Locations	point	County SLR Transportation Tool
County Assets	City and County Facilities	point	County SLR Transportation Tool
	County Facilities	point	TAM / TAC
	Publicly Owned Parcels	polygon	County SLR Transportation Tool
Emergency Response	Sand/Sandbag Provision Locations	point	County SLR Transportation Tool
	Tsunami Evacuation Zones	polygon	County SLR Transportation Tool
Equity	Equity Priority Communities	polygon	MTC Equity Priority Communities
Lifelines	Fire Stations	point	County SLR Transportation Tool
	Hospitals	point	County SLR Transportation Tool
	Law Enforcement	point	TAM / TAC
	Medical Facilities	point	TAM / TAC
Roads	HOV Lanes	polyline	TAM / TAC
	Marin County Roads	polyline	TAM / TAC
	Road Tunnels	polyline	TAM / TAC
Transit	Bus Routes OSM	polyline	TAM / TAC
	Bus Stops OSM	point	TAM / TAC
	GGT Ferry Stops	point	TAM / TAC
	GGT Routes	polyline	TAM / TAC
	GGT Stops	point	TAM / TAC
	Hubs and Park and Rides	point	TAM / TAC
	Marin Transit Routes	polyline	TAM / TAC
	Marin Transit Stops	point	TAM / TAC
	SMART Route	polyline	TAM / TAC
	SMART Stops	point	TAM / TAC
	Transit Hubs	point	TAM / TAC
Utilities	Channels	polyline	TAM / TAC
	Channels	line	TAM / TAC
	Manholes	point	County SLR Transportation Tool
	PGE Substations	point	TAM / TAC
	Pipes	polyline	TAM / TAC
	Pipes	line	TAM / TAC
	Pump Stations	point	County SLR Transportation Tool
	Pump Stations	point	TAM / TAC
	Stormwater Catchment Basins	point	County SLR Transportation Tool
	Stormwater Drainage Structures	point	County SLR Transportation Tool
	Wastewater Facilities	point	County SLR Transportation Tool
	Wastewater Treatment Facilities	point	TAM / TAC

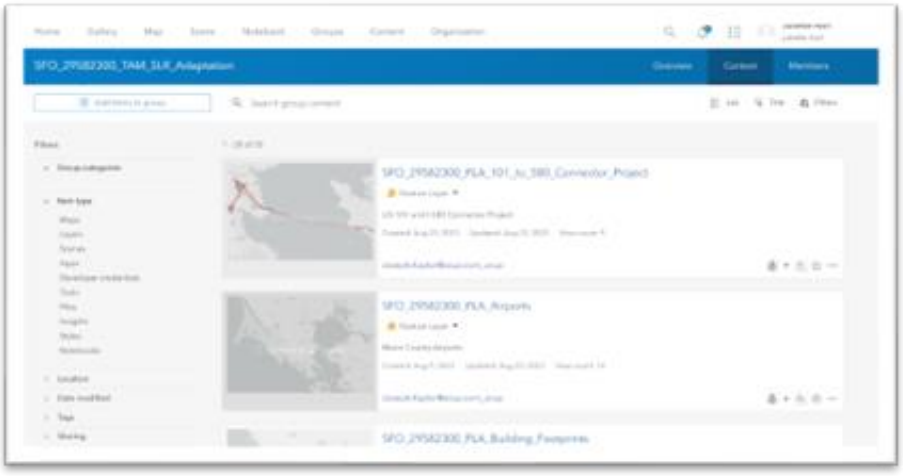


Figure 1 Screenshot of ArcGIS group repository that includes all vetted Marin County transportation and asset information.

2.1.2 Climate Hazard Data

Climate hazards assessed for this study include: permanent sea-level rise inundation, temporary coastal flooding from 1-percent annual chance (100-year) coastal storm event today and with sea level rise, 100-year and 0.2-percent annual chance (500-year) FEMA special flood hazard area (which combines coastal, fluvial and pluvial flood exposure based on historical conditions), and sea level rise-driven shallow and emergent groundwater. Table 2 provides an overview of the data sources, projections, and justification for the selected projections.

Table 2: List of Data Sources

Climate Hazard	Data Source	Projections	Justification & Constraints
SLR – Permanent Inundation	USGS Coastal Storm Modeling System (CoSMoS)	10 in (0.25 m) 20 in (0.5 m) 39 in (1 m) 59 in. (1.5 m)	For consistency with BayWAVE and C-SMART, this analysis repeated the use of the 10, 20 and 59 in projections of SLR. On current greenhouse gas (GHG) emissions trajectories (see Figure 2), recent federal sea level rise projections indicate we are likely to experience 39 in of SLR by 2070 – 2090. Thirty-nine inches of SLR also provides a mid-range projection between 20 in and 59 in and correlates with marked increases in flooding in most of the focus areas.
SLR – Temporary Flooding (100-year Coastal Storm)	USGS Coastal Storm Modeling System (CoSMoS)	0 in + 100 yr storm 10 in + 100 yr storm 20 in + 100 yr storm 39 in + 100 yr storm 59 in + 100 yr storm	The 0 in + 100-year storm scenario provides a projection of flood exposure from a 100-year coastal event at today's current spring astronomical tide. For consistency with the SLR flood exposure, analysis was also conducted for the 100-year coastal storm with 10, 20, 39, 59 in of SLR.

SLR-induced Shallow groundwater (GW) – SF Bay	Adapting to Rising Tides (ART) Shallow Groundwater	12 in (1 ft) 24 in (2 ft) 36 in (3 ft) 66 in (5.5 ft)	For the SF Bay region, the ART shallow GW projections were used. To best align to the SLR amounts used for the CoSMoS tidal and storm surge flooding, the closest available ART scenarios were used. While not exact matches, the projections are close enough to the CoSMoS SLR projections, given the associated uncertainty in both projections (CoSMoS and ART).
SLR-induced Shallow groundwater (GW) – Ocean	CoSMoS – Groundwater (GW)	10 in 20 in 39 in 59 in	For the open Pacific coast, CoSMoS-GW is available; the ART Shallow GW modeling is not. Here the team selected the SLR-induced GW projections that match the SLR projections used to project flood exposure from SLR and the 100-year storm events.
FEMA Special Flood Hazard Area	FEMA	100-year floodplain 500-year floodplain	To understand current flood exposure from the combination of coastal and fluvial impacts, the 100-year and 500-year floodplain extents were analyzed. The FEMA floodplain is based on historical conditions and does not consider climate change. While no future changes in the floodplain due to climate change are available, the 500-year floodplain can represent potential increases in the 100-year floodplain.

The modeling information used in this analysis all derive from authoritative and trusted data sources that are industry standard for assessing exposure to coastal flood hazards.

- Two data sources - the FEMA floodplain extents and the USGS Coastal Storm Modeling System – are developed by federal institutions and follow vetted, tested, and peer-reviewed methodologies. CoSMoS was funded in part by the CA Ocean Protection Council, along with internal funding from the USGS. It is recommended as one of the trusted resources for coastal hazard analysis for the entire coast of California – both oceanside and bayside.
- The Adapting to Rising Tides (ART) Shallow Groundwater Modeling was developed by Pathways Climate Institute and the San Francisco Estuary Institute (SFEI), two recognized and trusted science-based entities that serve the San Francisco Bay Area. The SF Bay Conservation and Development Commission (BCDC) promotes and recommends the use of the ART Shallow Groundwater modeling for assessing the impacts to shallow groundwater tables wherever it is available in the SF Bay area. Moreover, Marin County played an integral role in both providing information and reviewing the model results during the development of the model. ART does not provide shallow groundwater projections for the open Pacific coast of Marin County. For this, the consultant team turned to the USGS CoSMoS-Groundwater (GW) modeling. CoSMoS-GW was developed for the entire coast of California and was

developed using a model-based approach. While different than the data-driven approach used in the ART modeling, CoSMoS-GW (also funded by USGS and the CA OPC) provides reliable, authoritative, and trusted projections for shallow groundwater rise, important for assessing impacts to the Stinson Beach and Inverness focus areas.

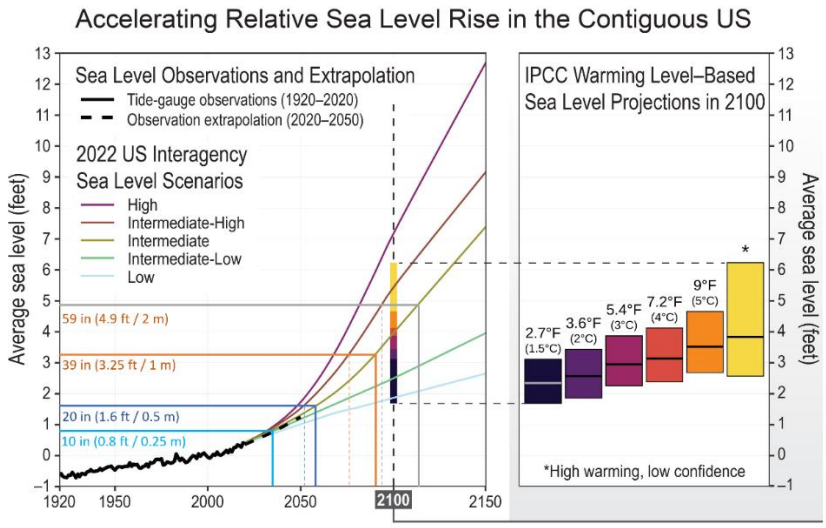


Figure 2: Federal sea level rise projections for the U.S. The colored lines in the left panel provide sea level rise projections from 1920 to 2150 under a range of greenhouse gas emissions scenarios. The black line indicates observations and a linear extrapolation of current observations from 2023 to 2050. We are currently tracking on the "Intermediate" projection curves. Assuming the world continues tracking on this Intermediate curve, the consultant team highlighted when the different SLR scenarios used in this project are expected to be reached: ~2040 for 10 inches; ~2060 for 20 inches; ~2090 for 39 inches; and ~2110 for 59 inches. This figure also allows the reader to extrapolate different timeframes of sea level rise based on different emissions trajectories. If globally, our emissions accelerate and we begin tracking on the intermediate-high curve, we are likely to experience higher rates of sea level rise sooner. The State of California, through the CA Ocean Protection Council is currently updating its recommended sea level rise projections. They are expected to follow the federal sea level rise projections.

Note that updated provisions from California Ocean Protection Council (OPC) and from the San Francisco Bay Conservation and Development Commission (BCDC) became available after the publication of this draft and were used in subsequent work for this TAM study of Sea Level Rise Adaptation Planning for Marin County's Transportation System.

2.1.3 Technical Advisory Council Engagement

TAM invited representatives from Marin County, cities in the County, Caltrans, MTC, and BCDC to serve on the Technical Advisory Committee (TAC). The role of the TAC is to provide thought leadership and feedback throughout the course of the project. TAM worked with the TAC to identify relevant asset data sets to include in the exposure analysis. The consultant team presented the proposed analysis methodology to the TAC at the first TAC meeting (Oct. 12, 2023). Feedback from the TAC was incorporated and included into the updated methodology development. The TAC reviewed early versions of this memo and provided feedback on the identified focus areas. Feedback from the TAC was incorporated to develop the final suite of focus areas.

2.1.4 Data Limitations and Assumptions

The coastal flood hazard exposure analysis builds off prior Marin County analysis and existing spatial data sets, adding new information on shallow groundwater rise and additional sea level rise scenarios to refine the understanding of both extent and timing of impacts. By building off prior analyses and data sets, several assumptions and limitations apply.

The topographic Digital Elevation Model (DEM) supporting the coastal flood hazard maps represent 2009-2011 conditions, therefore any new urban development or shoreline improvements may not be captured in the current maps. The DEM and all derived data layers have a horizontal resolution of 2 meters. The elevation data has a vertical accuracy of approximately 18 cm. The horizontal accuracy of the 2010 lidar (the bulk of the topography) has a root mean square error (RMSE) of 1m. Additional localized modifications to the DEM were implemented for the ART mapping products in 2018. Newer shoreline LiDAR information could be incorporated in subsequent discussions regarding future adaptation (Task 4), but it was not incorporated during the exposure analysis due to the heavy computational resources required for a county-wide implementation. Future efforts may elect to analyze this information, but it was not included in the current project scope.

Travel demand and capacity (e.g., detour length and annual average daily traffic) was not considered in the exposure analysis to identify individual road segment criticality or delineation of the focus areas. Efforts to integrate TAM's model into County SLR planning efforts and tools are encouraged.

Asset locations were primarily represented as GIS point data, meaning the full footprint of several assets including hospitals, schools, community centers and other county facilities and were not captured in the overlay of the coastal hazards. The exposure analysis assigned a Yes or No attribute to these assets, rather than an area or percentage of the asset exposed to each of the flood hazards.

For the exposure analysis, the linear road network was segmented into 1/10th mile sections to assign an average depth of permanent inundation from sea level rise or temporary flooding from coastal storm surge and sea level rise. Due to the road segmentation, if any portion of each 1/10th mile segment overlaps with the flood hazard extents, the segment is identified as exposed.

The connections between assets within and across communities (e.g., local and regional road network dependencies on hospitals) were considered qualitatively in the development of the focus areas. Additional information on regional reliance on assets, or interdependencies and cascading impacts of assets (e.g., PGE stations) could refine the delineation of the focus areas and further inform the adaptation planning.

Elevated portions of roadways (bridges and overpasses) were manually identified to the best extent possible and removed from the exposure analysis, however some elevated segments may still remain in the resultant GIS outputs with the hazard exposure information.

2.2 Coastal Flood Hazard Exposure Analysis Methodology

2.2.1 Exposure Analysis

The exposure assessment was completed in GIS by overlaying the individual asset layers in the sector-based geodatabases with the hazard layers described in Table 2. The exposure assessment was based on how each asset is represented:

- For ***point assets*** (e.g., bus stops, pump stations), the assessment evaluated whether each asset was within the inundation zone for each of the hazard scenarios.
- For ***linear assets*** (e.g., roadways, SMART routes, channels), the length and percentage of the asset within the hazard zones were calculated. Roadways were divided into 528-foot ($1/10^{th}$ mile) segments and tagged with inundation statistics for each of the hazard scenarios, such as the first instance of exposure for SLR inundation and groundwater emergence.
- For ***polygon assets*** (e.g., parks, large facilities, EPC zones), the area and the percentage of the asset within the SLR inundation zones were calculated.

2.2.2 ArcGIS Geodatabase and Online Data Viewer

The exposure information was added to the GIS geodatabases to allow asset managers to identify when (and by how much) each asset would be exposed to flood hazards for each scenario. These geodatabases were provided to TAM for their use and dissemination, as appropriate.

Because not all agencies have access to desktop ArcGIS applications, all the coastal hazard projections and asset data, as well as the identified focus areas, are available through an ArcGIS Web Map (Figure 3).

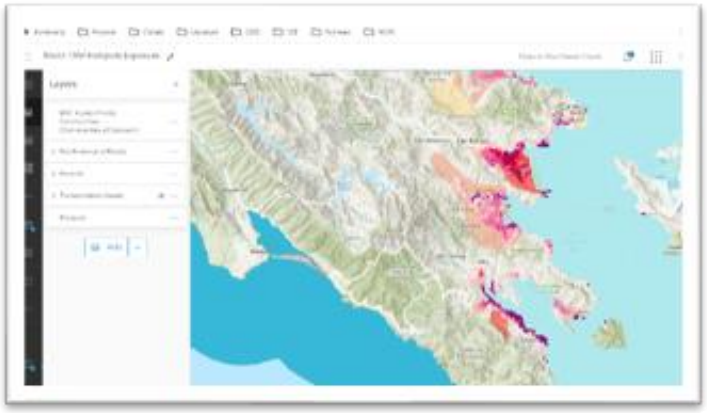


Figure 3 Screenshot of ArcGIS Web Map

2.3 Methodology to Delineate Vulnerability Focus Areas

Upon completion of the exposure analysis, the consultant team reviewed the exposure maps and statistics to propose an initial suite of focus areas. Initial outlining of the focus areas was based on extent of exposure for each of the different types of hazards. The team then used a series of questions to guide an iterative process to refine the proposed focus areas (Figure 4).

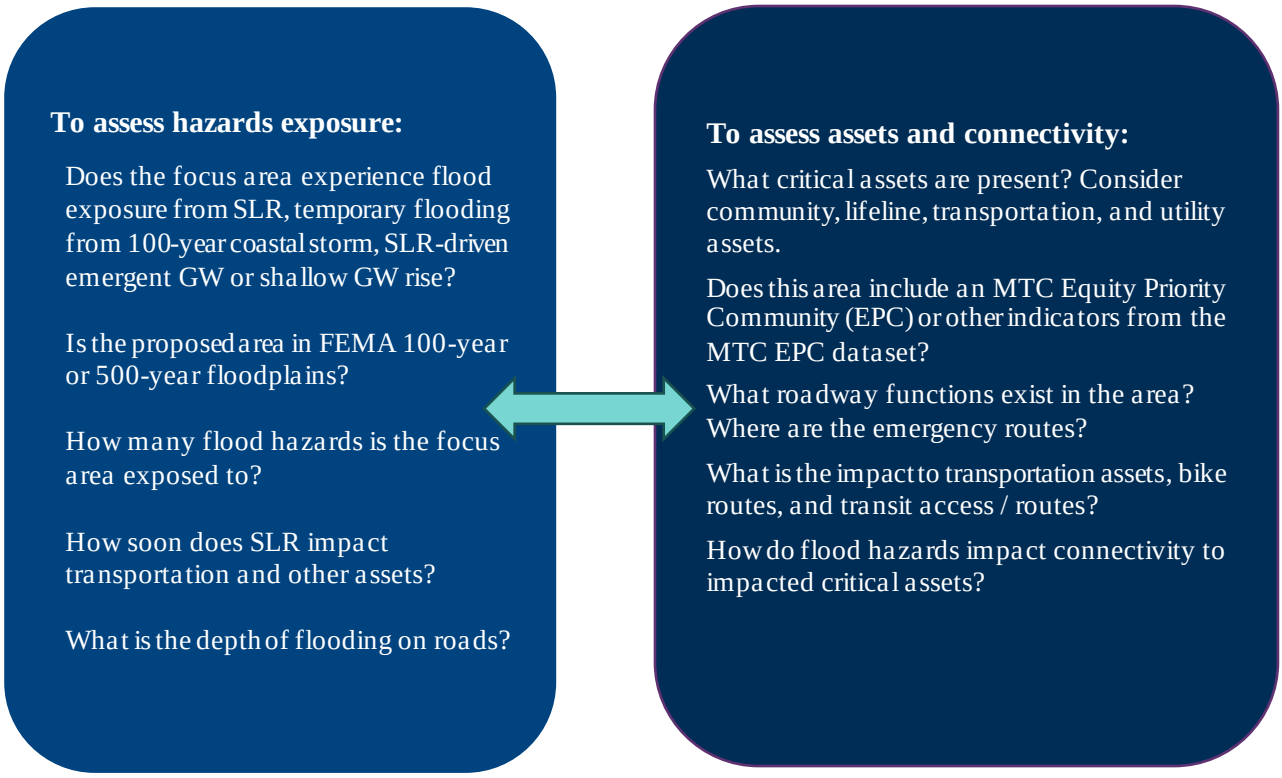


Figure 4 Vulnerability Focus Area identification guiding questions used to qualitatively delineate focus areas.

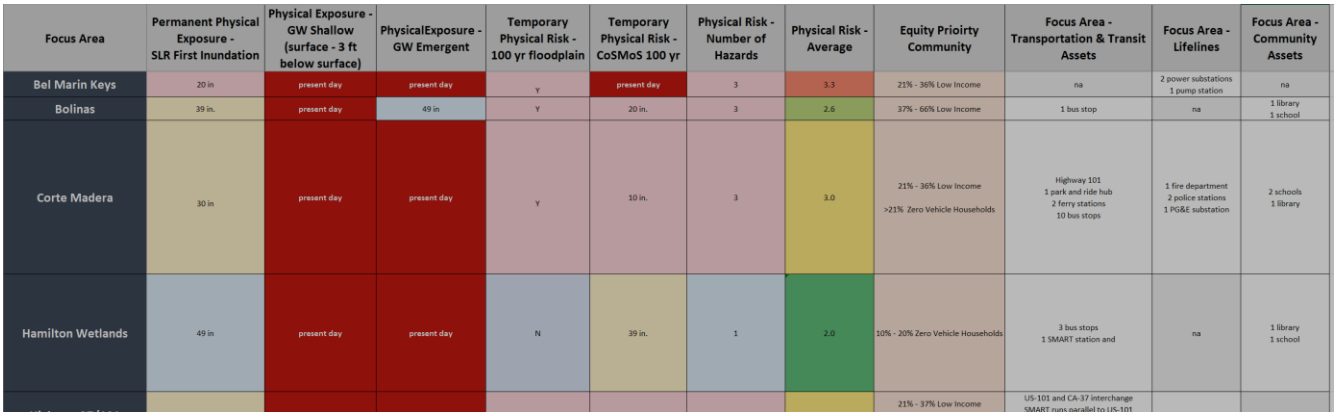
The initial focus areas were reviewed by TAM and presented to the TAC at the second TAC meeting (December 12, 2023). Feedback from these discussions helped refine the proposed suite of 15 focus areas.

3. Identified Focus Areas

3.1 Overview of Proposed Focus Areas

Following the methodology described above, 15 focus areas were identified (Figure 5). They ranged in their size, the number of hazards they experience (though most of them experience all three), the impact to transportation and transit assets, and the approximate number of lifelines and community assets included. The associated Appendix A: Hazard Matrix excel file (Figure 6) provides an overview of each of the focus areas and a subset of their exposure statistics.

Figure 5 Map of 15 vulnerability focus areas.

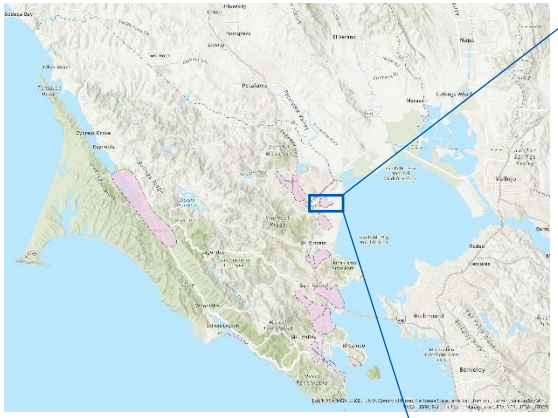


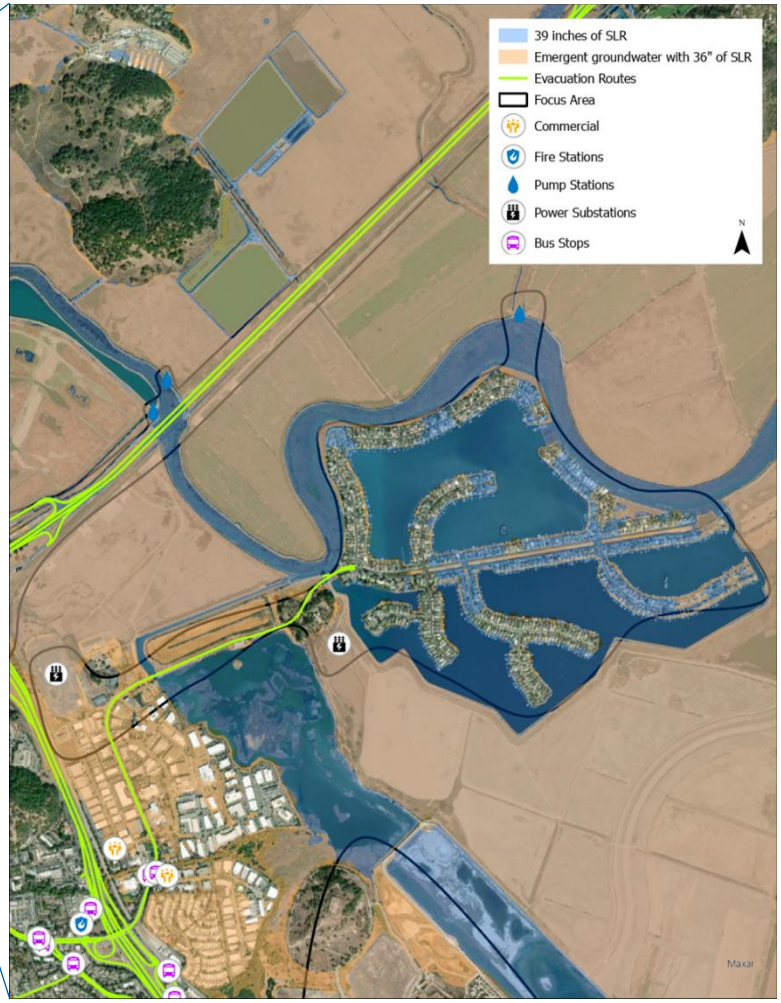
Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community	Focus Area - Transportation & Transit Assets	Focus Area - Lifelines	Focus Area - Community Assets
Bel Marin Keys	20 in	present day	present day	Y	present day	3	3.3	21% - 36% Low Income	na	2 power substations 1 pump station	na
Bolinas	39 in.	present day	49 in	Y	20 in.	3	2.6	37% - 66% Low Income	1 bus stop	na	1 library 1 school
Corte Madera	30 in	present day	present day	Y	10 in.	3	3.0	21% - 36% Low Income >21% Zero Vehicle Households	Highway 101 1 park and ride hub 2 ferry stations 10 bus stops	1 fire department 2 police stations 1 PG&E substation	2 schools 1 library
Hamilton Wetlands	49 in	present day	present day	N	39 in.	1	2.0	10% - 20% Zero Vehicle Households	3 bus stops 1 SMART station and	na	1 library 1 school
								21% - 37% Low Income	US-101 and CA-37 interchange SMART runs parallel to US-101		

Figure 6: Screenshot of Focus Area Hazard Matrix. This matrix provides summary information about each focus area.

In the following section, we provide high level overviews of each of the focus areas and list a suite of exposure statistics that help provide contextual information about the selected sites. There are any number of queries that can be asked of the exposure data; therefore these descriptions are intended to provide one possible set of answers to one possible set of questions. It is expected that as TAM and County partners begin the work of developing adaptation and implementation plans, the exposure analysis can be queried to help with identification of the different flood impacts to asset, properties, and people, and help advance discussions relevant to each site.

3.1.1 Bel Marin Keys Focus Area

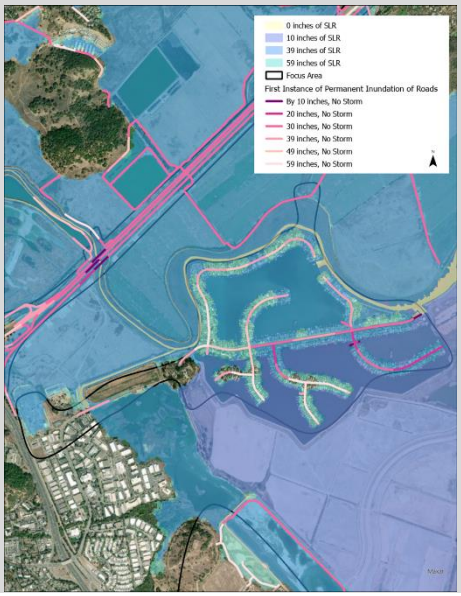




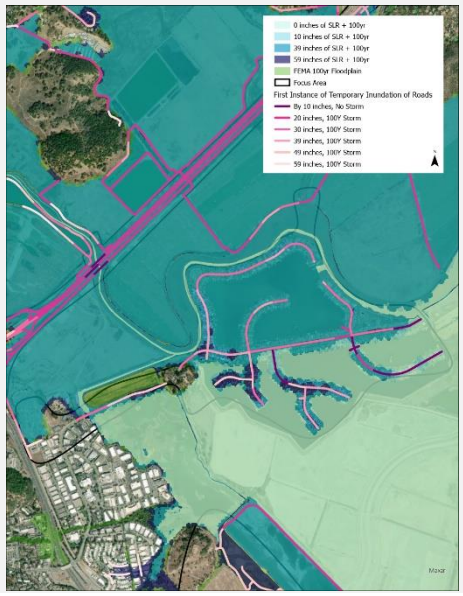
The site includes:

- 2 power substations
- 1 pump station
- 1 ingress/egress route

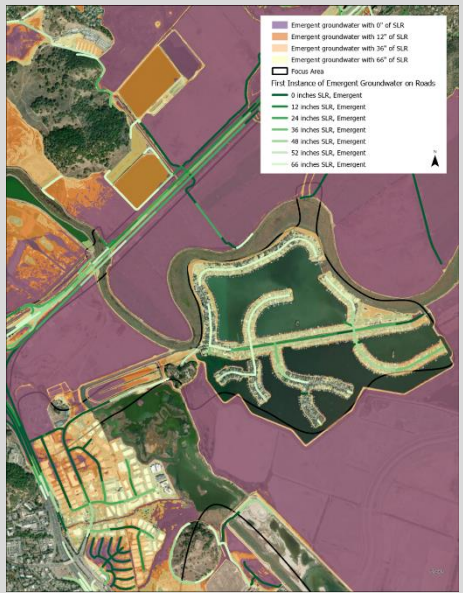
Permanent Inundation Exposure



Temporary Flood Exposure

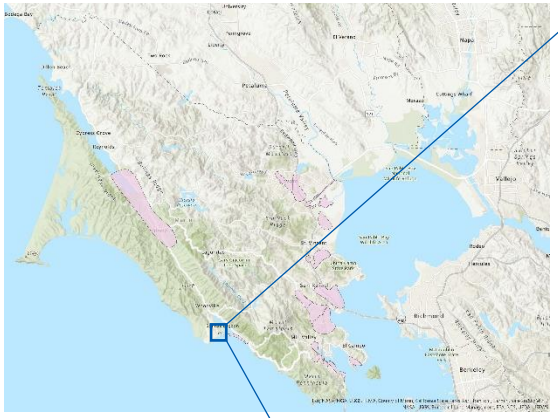


Groundwater Rise Exposure



Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community
Bel Marin Keys	20 in	**present day**	**present day**	In FEMA 100 yr Floodplain	**present day**	3	3.3	21% - 36% Low Income

3.1.2 Bolinas Focus Area

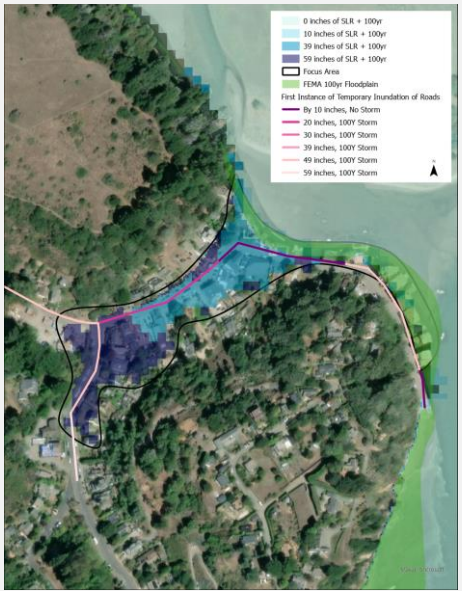


This site includes:

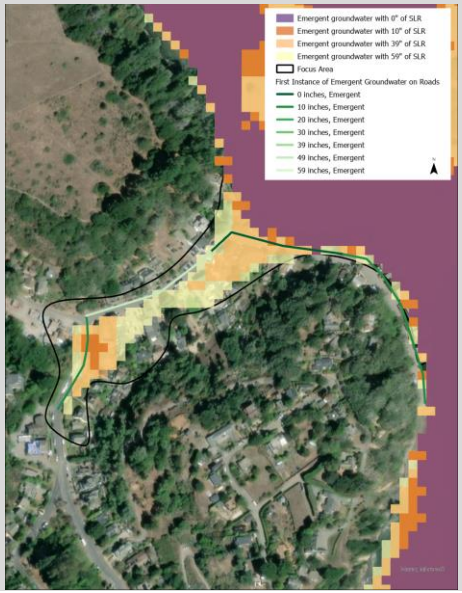
- 1 bus stop
- 1 library
- 1 school
- 1 ingress/egress route

Permanent Inundation Exposure

Temporary Flood Exposure

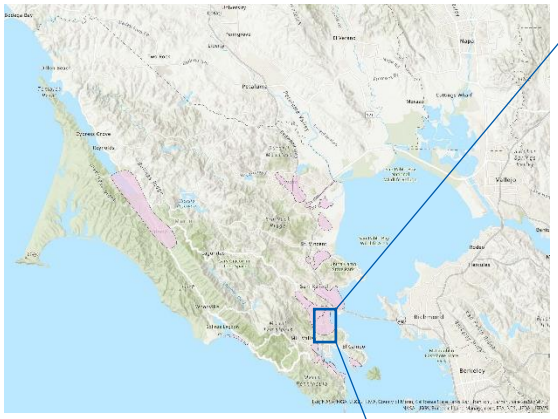


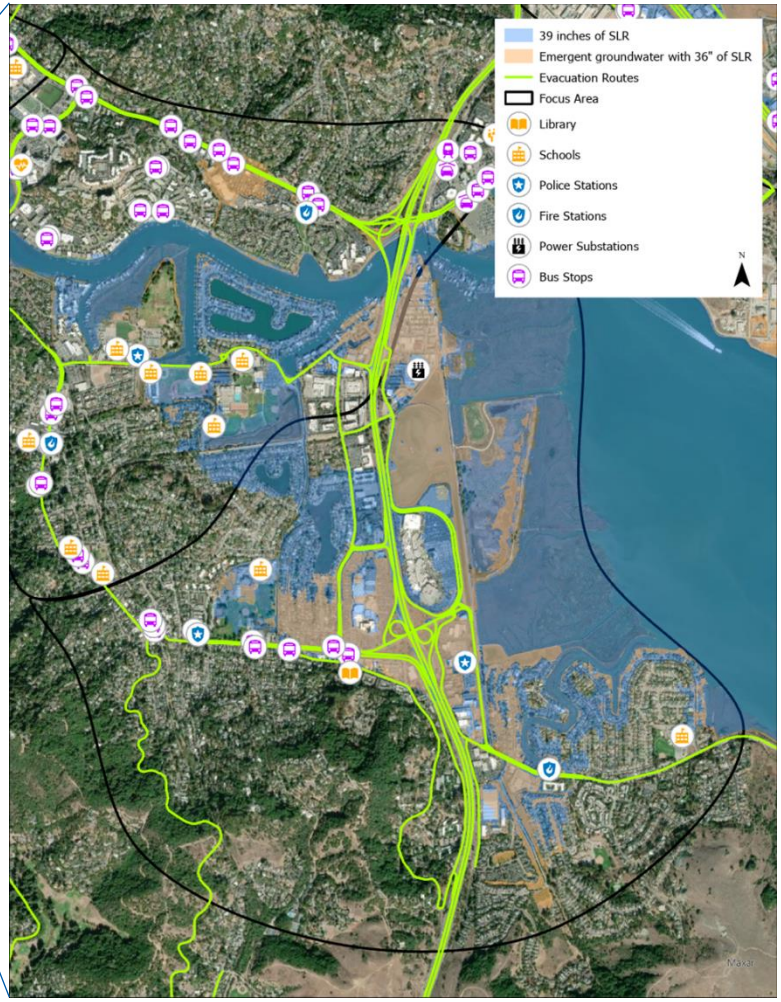
Groundwater Rise Exposure



Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average
Bolinas	39 in.	**present day**	49 in	In FEMA 100 yr Floodplain	20 in.	3	2.6

3.1.3 Corte Madera Focus Area

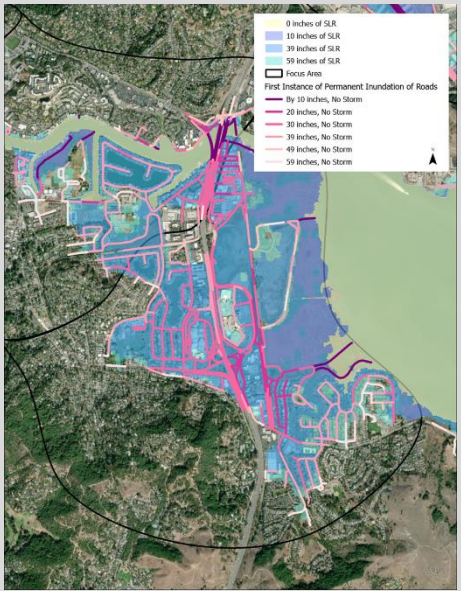




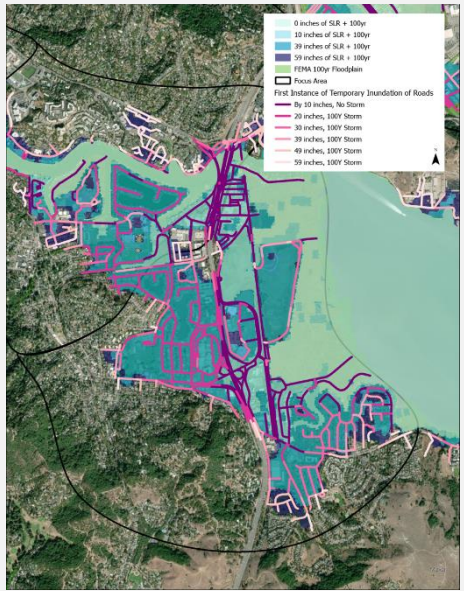
The site includes:

- 1 fire station
- 2 schools
- 1 library
- 2 police stations
- 1 hub, park, and ride area
- 2 ferry stops
- 1 power substation
- 10 bus stops, including local and Golden Gate Transit (GGT)
- Highway 101

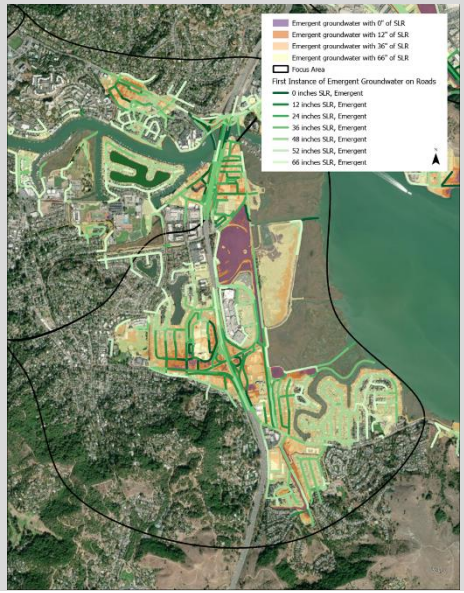
Permanent Inundation Exposure



Temporary Flood Exposure

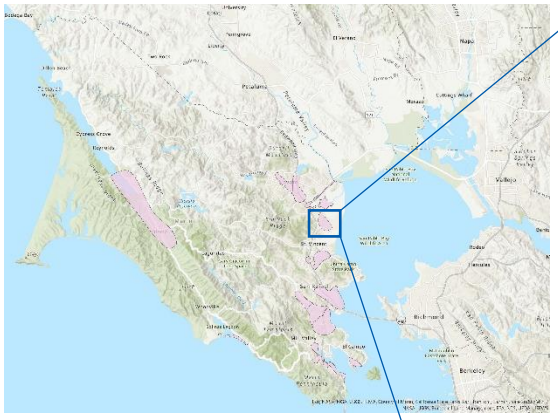


Groundwater Rise Exposure



Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community
Corte Madera	30 in	present day	present day	In FEMA 100 yr Floodplain	10 in.	3	3.0	21% - 36% Low Income >21% Zero Vehicle Households

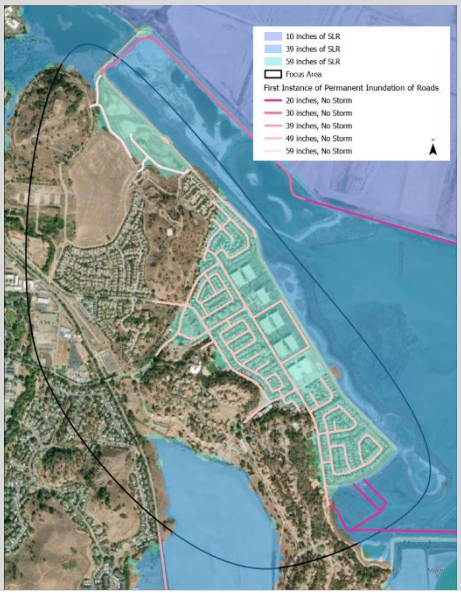
3.1.4 Hamilton Wetlands Focus Area



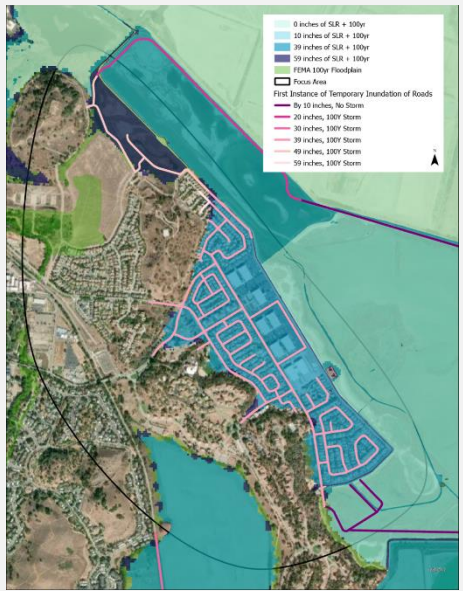
The site includes:

- Highway 101
- 1 library
- 3 bus stops
- 1 school
- 1 SMART station
- 1 ingress/egress route

Permanent Inundation Exposure



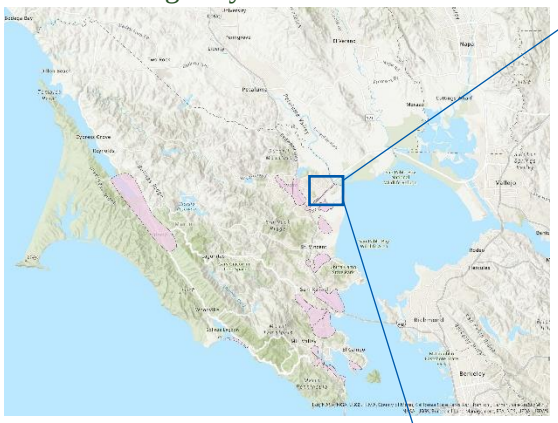
Temporary Flood Exposure

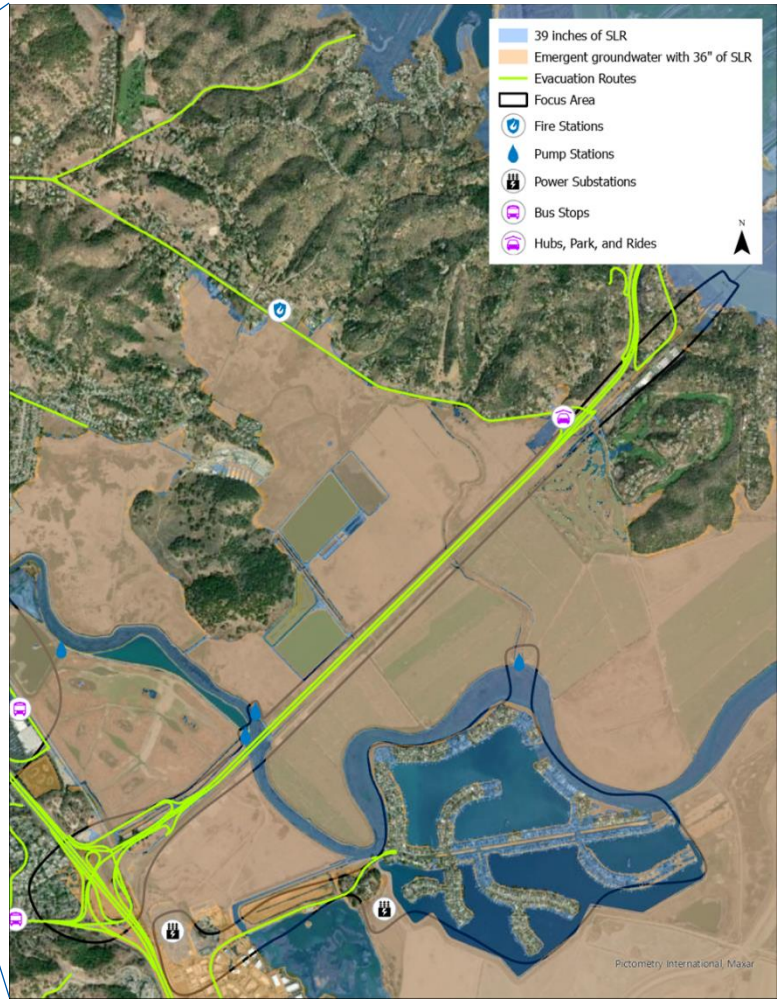


Groundwater Rise Exposure

Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community
Hamilton Wetlands	49 in	present day	present day	NOT in FEMA 100 yr Floodplain	39 in.	1	2.0	10% - 20% Zero Vehicle Households

3.1.5 Highway 37 / 101 Focus Area

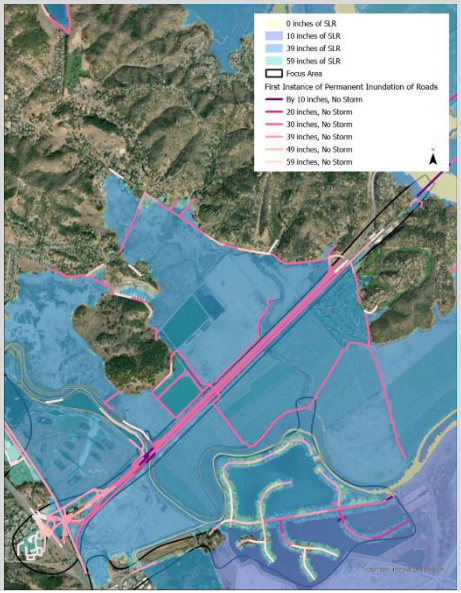




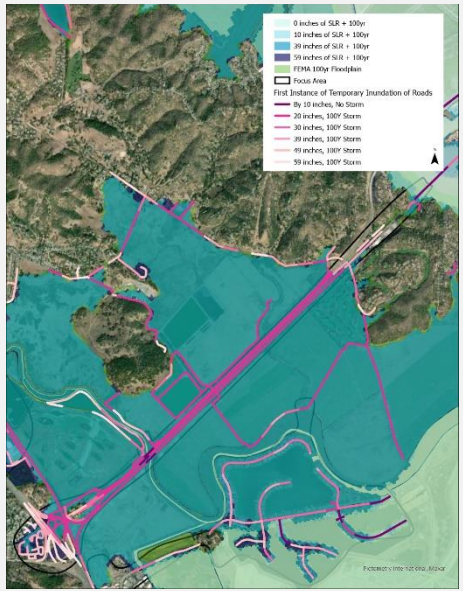
The site includes:

- Highway 37 and Highway 101
- 2 pump stations
- 1 park, hub, and ride area
- 1 ingress/egress route

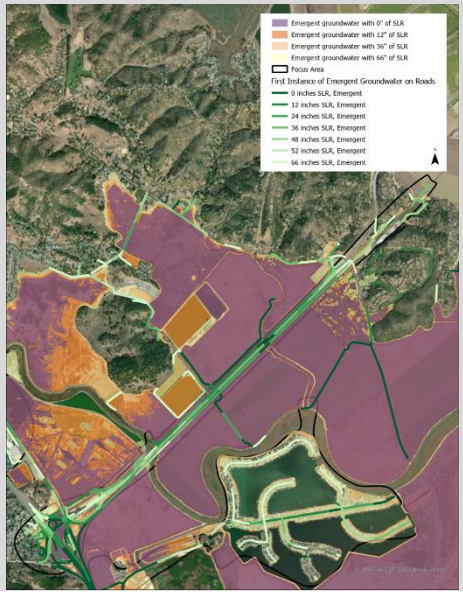
Permanent Inundation Exposure



Temporary Flood Exposure

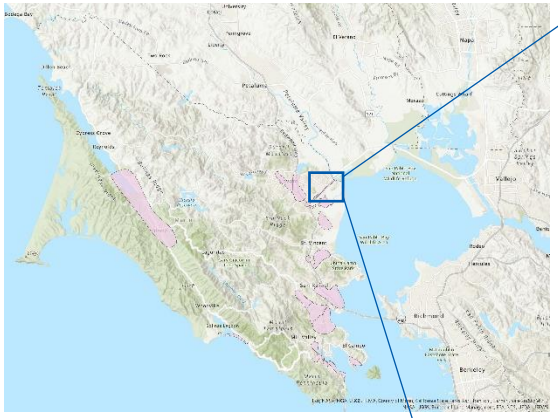


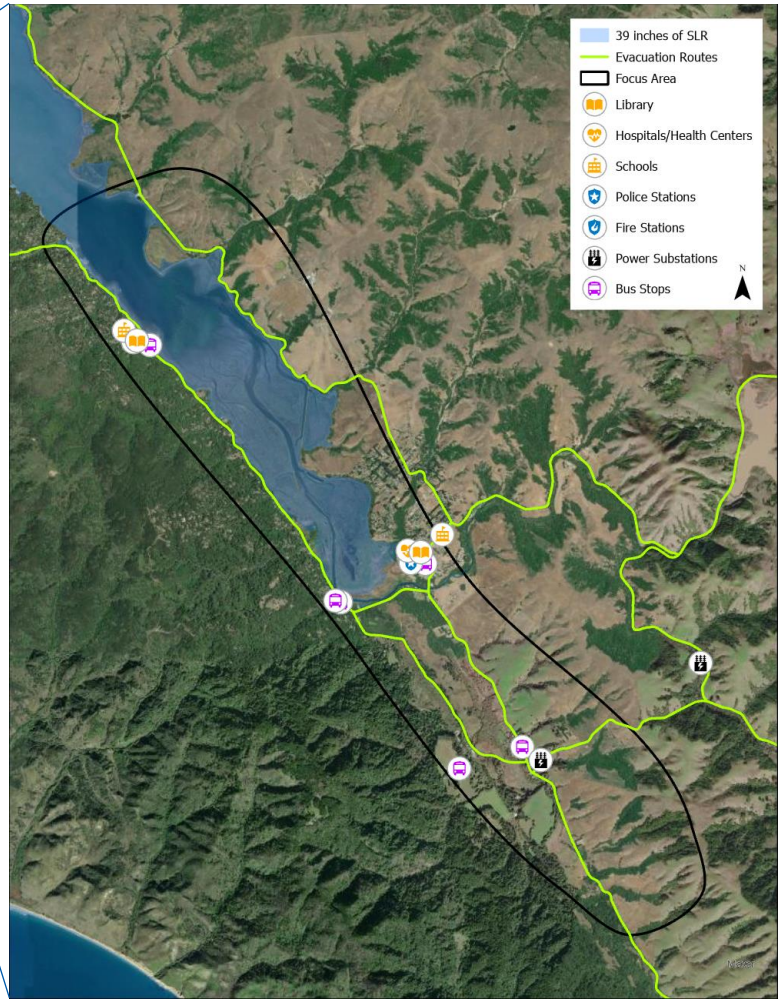
Groundwater Rise Exposure



Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community
Highway 37/101	30 in	**present day**	**present day**	In FEMA 100 yr Floodplain	20 in.	3	3.0	21% - 37% Low Income 10% - 20% Zero Vehicle Households

3.1.6 Inverness Focus Area

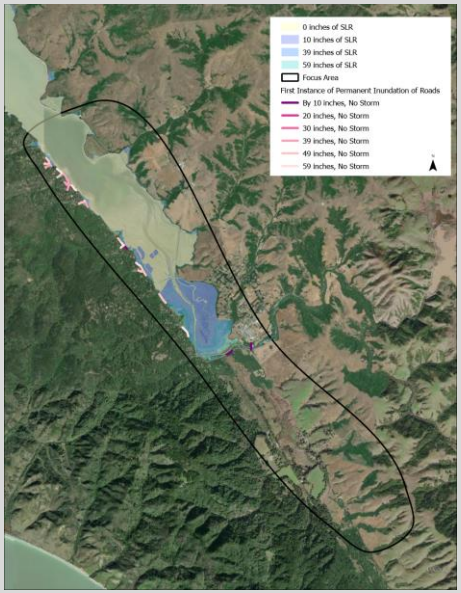




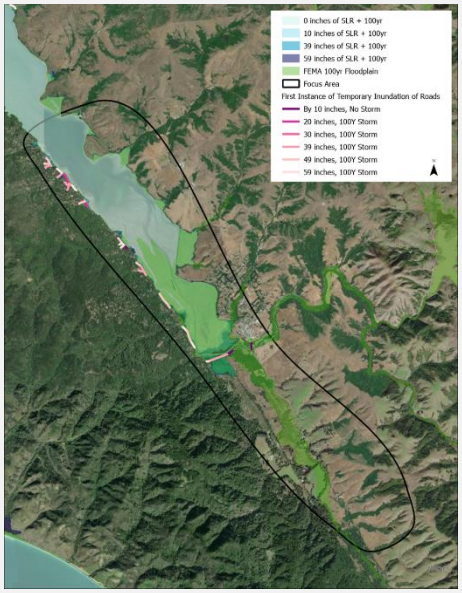
This site includes:

- 1 power substation
- 6 bus stops (no GGT bus stops)
- 1 school
- 1 police station
- 1 fire station
- 2 libraries
- 1 health center/hospital
- 1 ingress/egress route

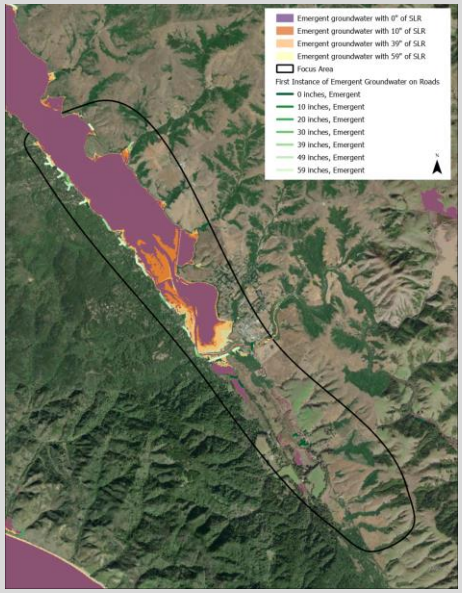
Permanent Inundation Exposure



Temporary Flood Exposure

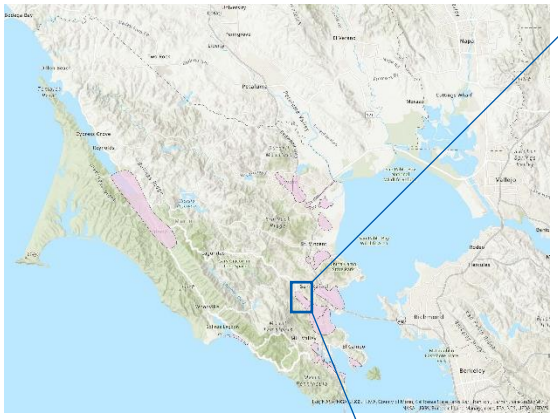


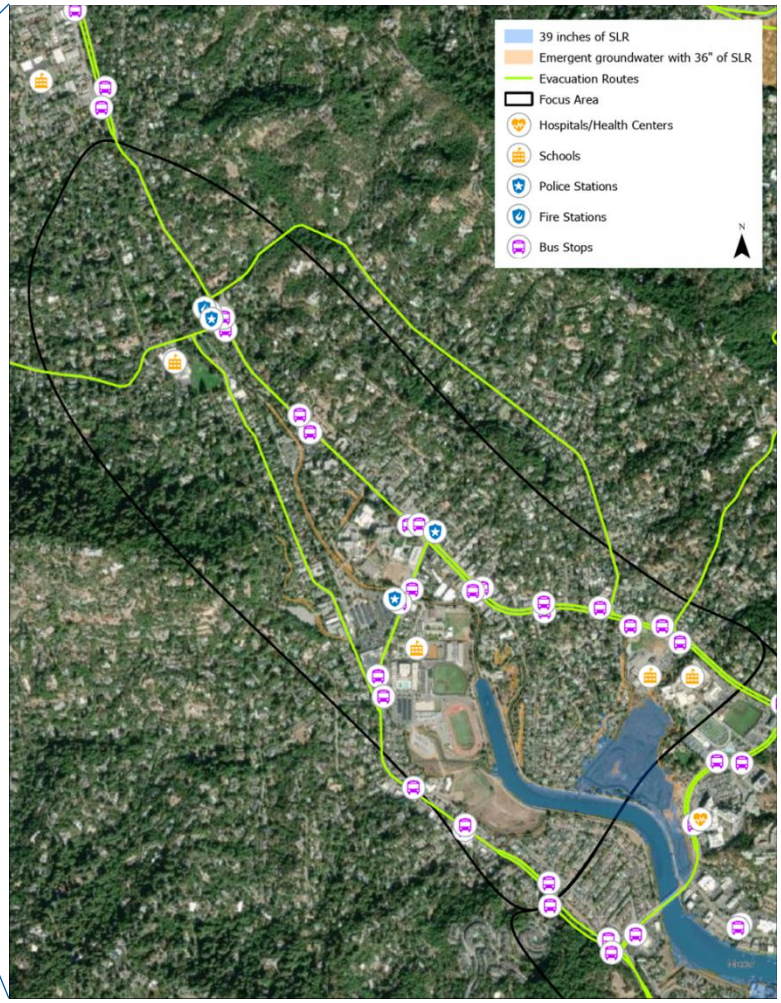
Groundwater Rise Exposure



Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	Physical Exposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Priority Community Factors
Inverness	30 in	not impacted	not impacted	Y	20 in.	2	1.7	18% - 23% Low Income

3.1.7 Kentfield Focus Area

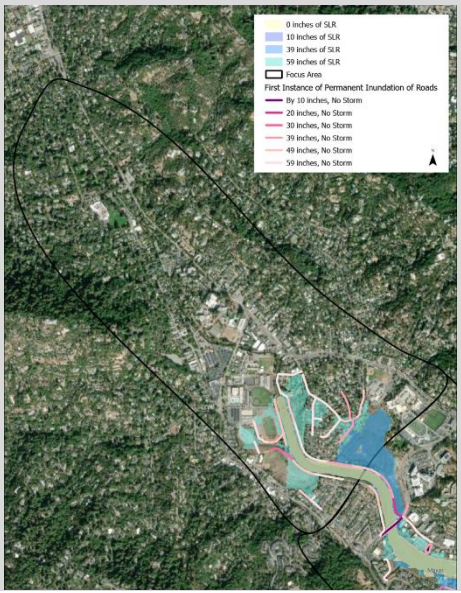




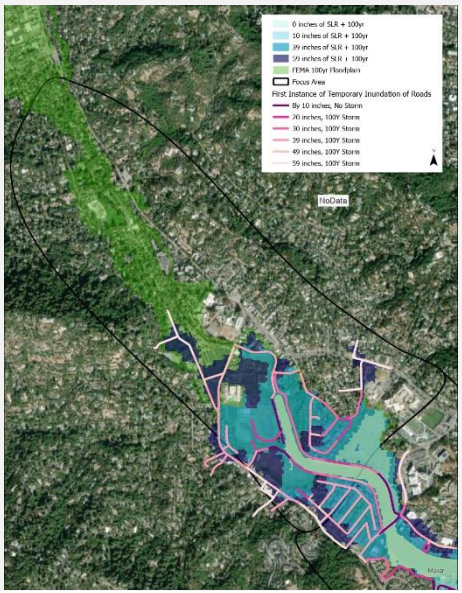
The site includes:

- 4 schools
- 2 fire stations
- 3 police stations
- 1 municipal
- 21 bus stops
- 1 ingress/egress route

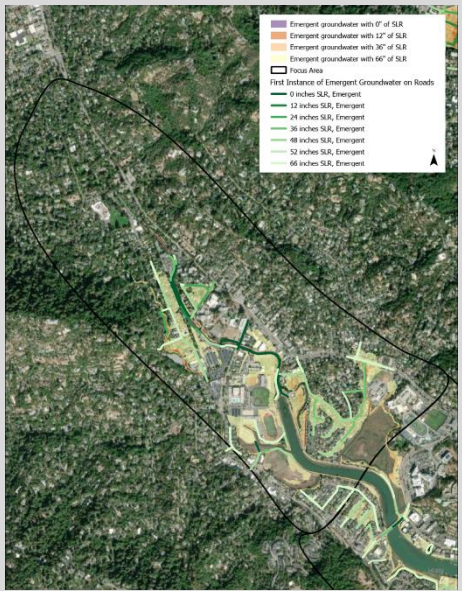
Permanent Inundation Exposure



Temporary Flood Exposure

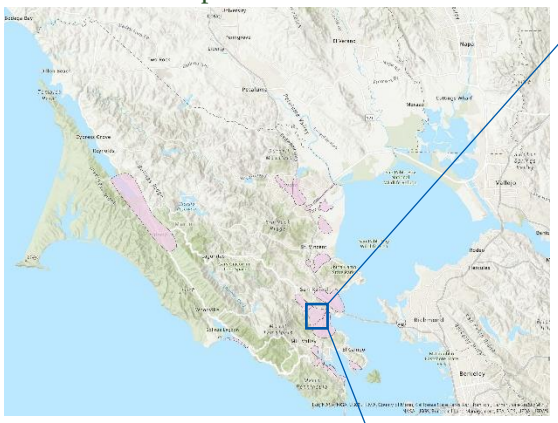


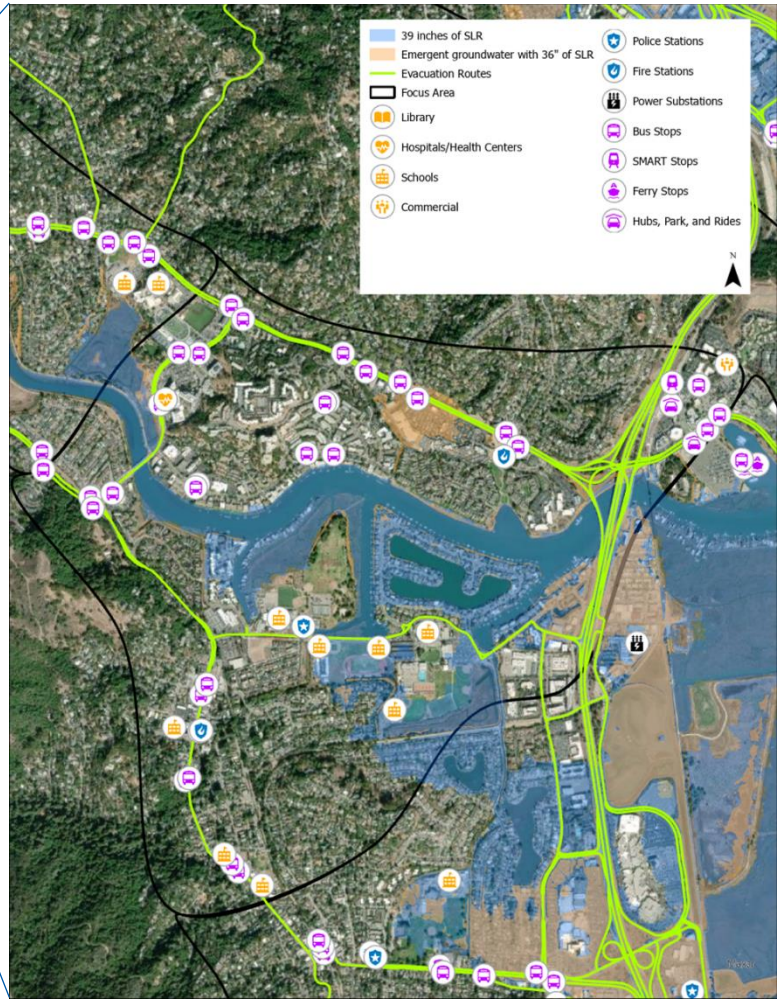
Groundwater Rise Exposure



Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community
Kentfield	49 in	present day	48 in.	In FEMA 100 yr Floodplain	30 in	3	2.3	No

3.1.8 Larkspur Focus Area

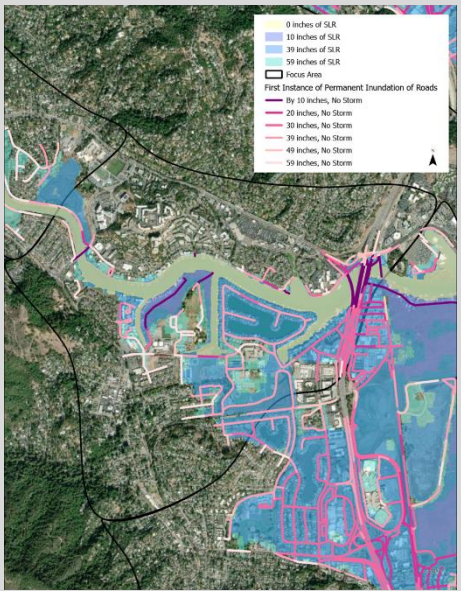




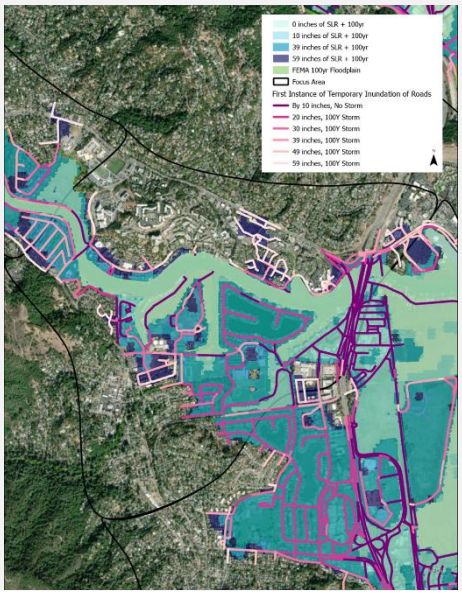
The site includes:

- 1 hospital
- 9 schools
- 1 commercial
- 1 police station
- 2 fire stations
- 1 municipal
- Highway 101
- 32 bus stops, including local and Golden Gate Transit (GGT)
- 1 SMART station
- 2 hub, park, and ride areas

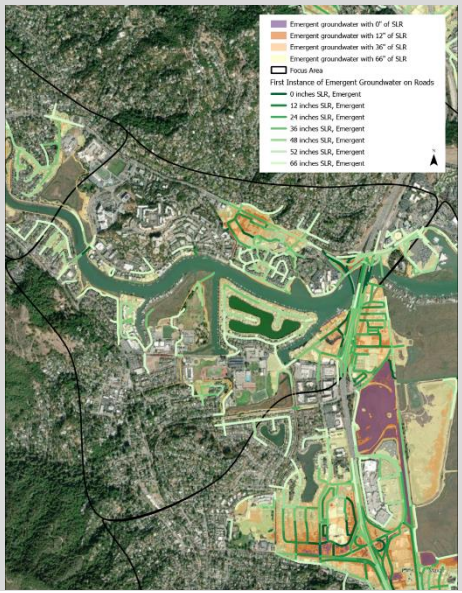
Permanent Inundation Exposure



Temporary Flood Exposure

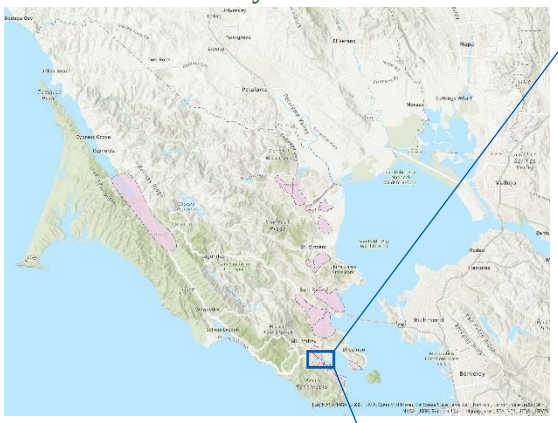


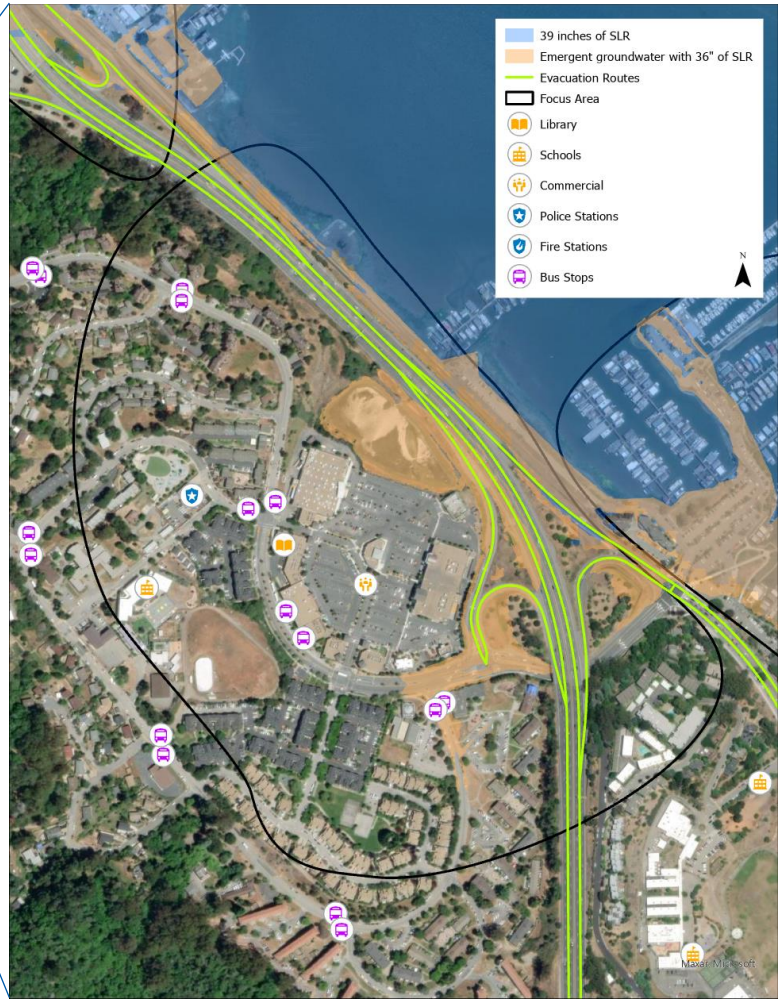
Groundwater Rise Exposure



Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community
Larkspur (Hospital)	39 in.	12 in	52 in	In FEMA 100 yr Floodplain	10 in.	3	2.5	21% - 36% low income

3.1.9 Marin City Focus Area

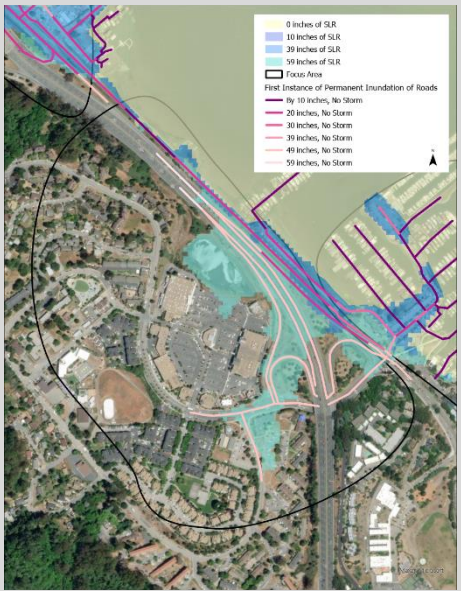




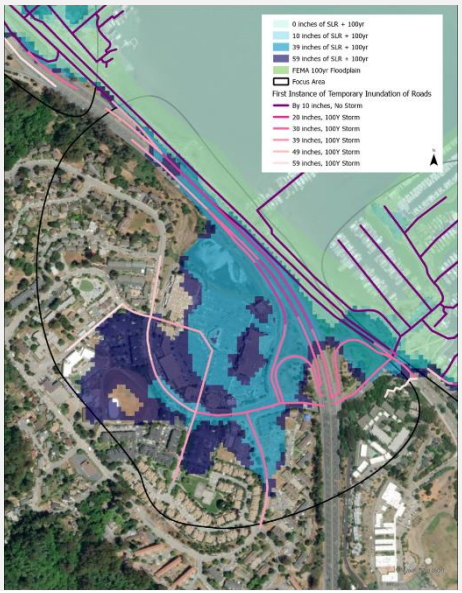
This site includes:

- Highway 101
- 10 bus stops including local and Golden Gate Transit (GGT)
- 1 library
- 1 school
- 1 police station
- 1 commercial shopping center
- 1 ingress/egress route

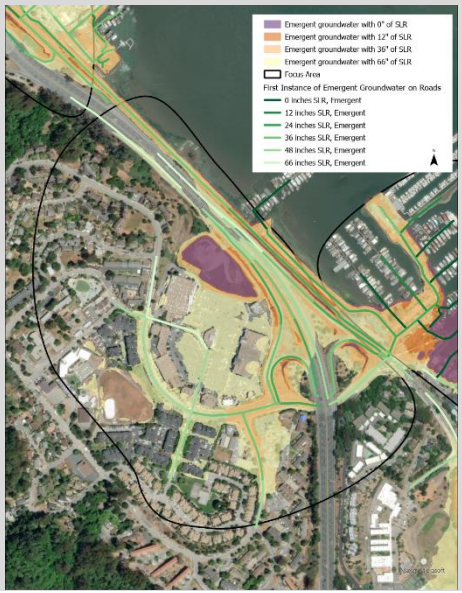
Permanent Inundation Exposure



Temporary Flood Exposure

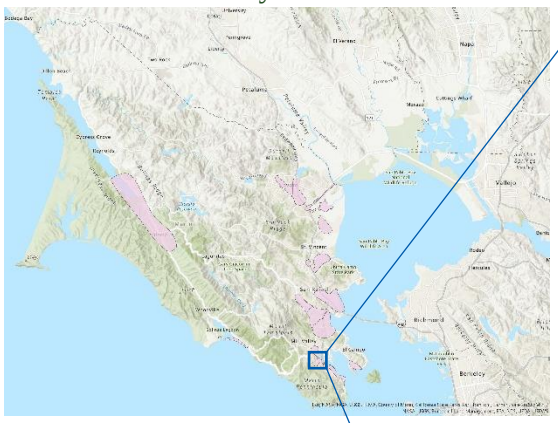


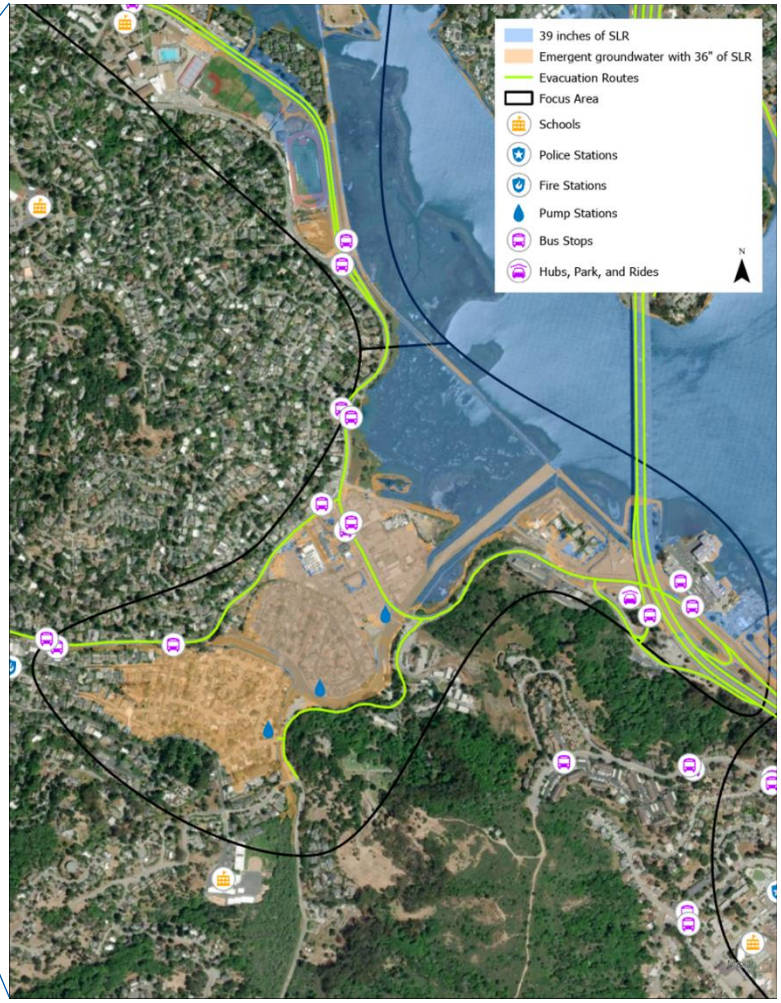
Groundwater Rise Exposure



Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community
Marin City	20 in	present day	12 in	In FEMA 100 yr Floodplain	present day	3	2.7	Highest MTC Equity Priority Area >66% Low Income 10% - 20% Zero Vehicle Households

3.1.10 Mill Valley – Manzanita / Tam Junction Focus Area

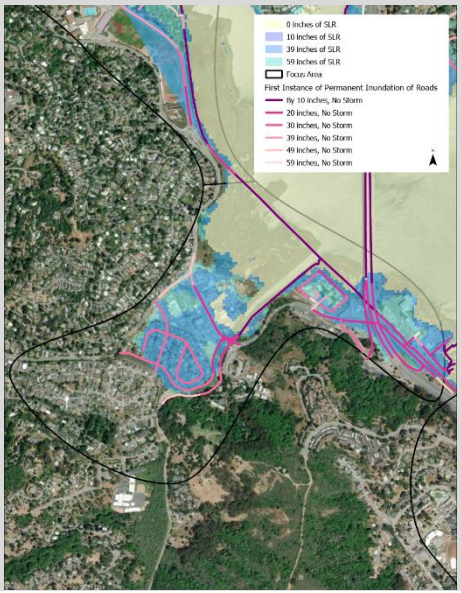




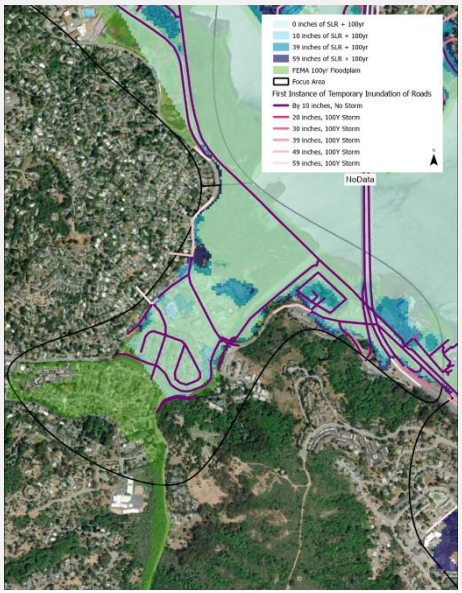
This site includes:

- 3 pump stations
- 14 bus stops, including local and Golden Gate Transit (GGT)
- 1 hub, park, and ride area
- 1 ingress/egress route

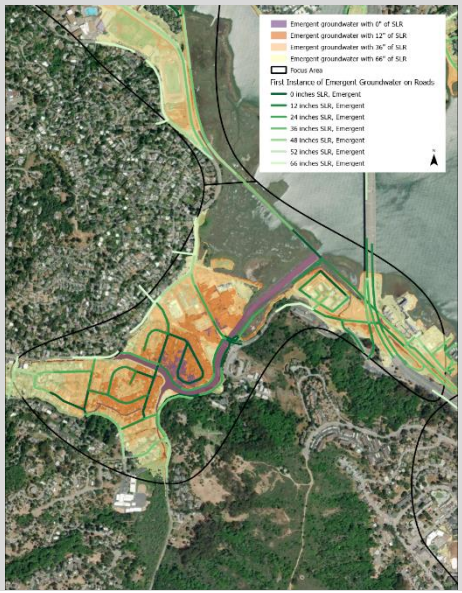
Permanent Inundation Exposure



Temporary Flood Exposure

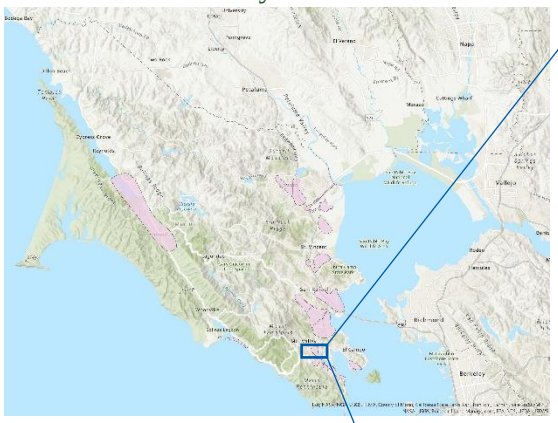


Groundwater Rise Exposure



Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community
Mill Valley - Manzanita / Tam Valley	By 10 in	present day	present day	In FEMA 100 yr Floodplain	present day	3	3.3	No

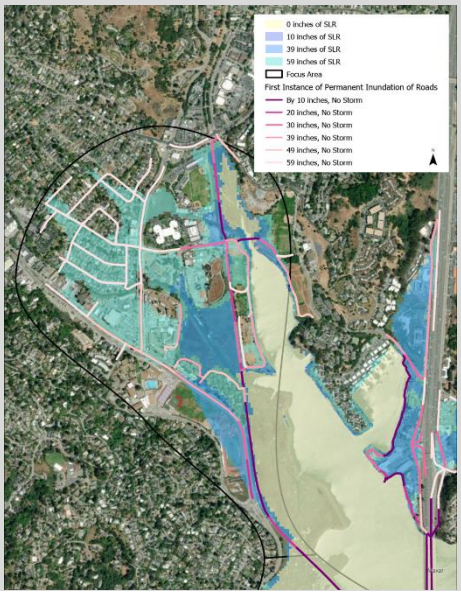
3.1.11 Mill Valley – Miller Ave Focus Area



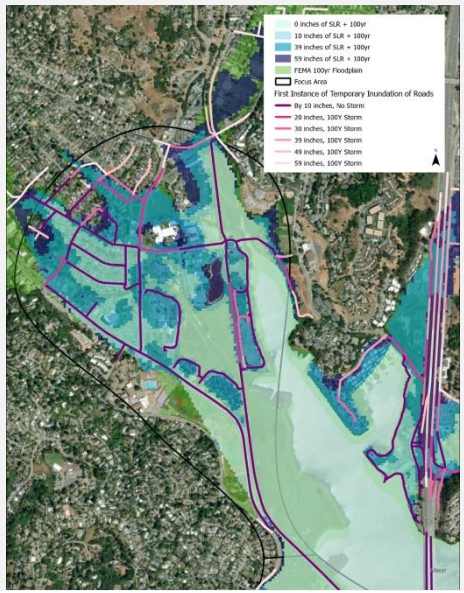
This site includes:

- 18 bus stops, including local and Golden Gate Transit (GGT)
- 2 pump stations
- 1 wastewater treatment plant
- 1 power substation
- 2 schools

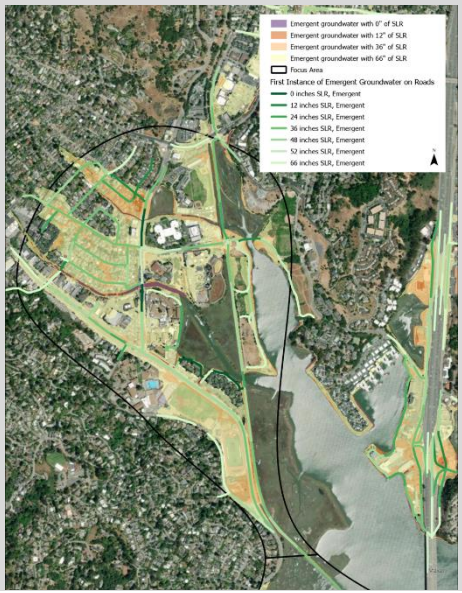
Permanent Inundation Exposure



Temporary Flood Exposure

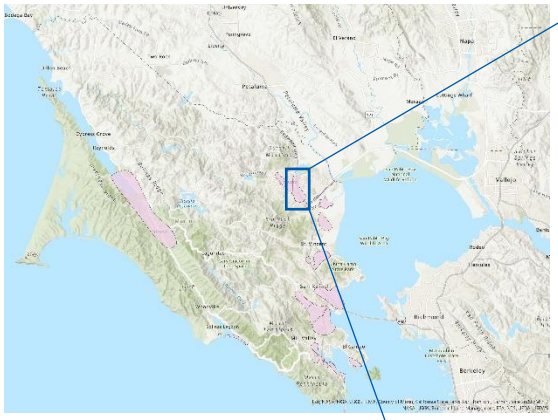


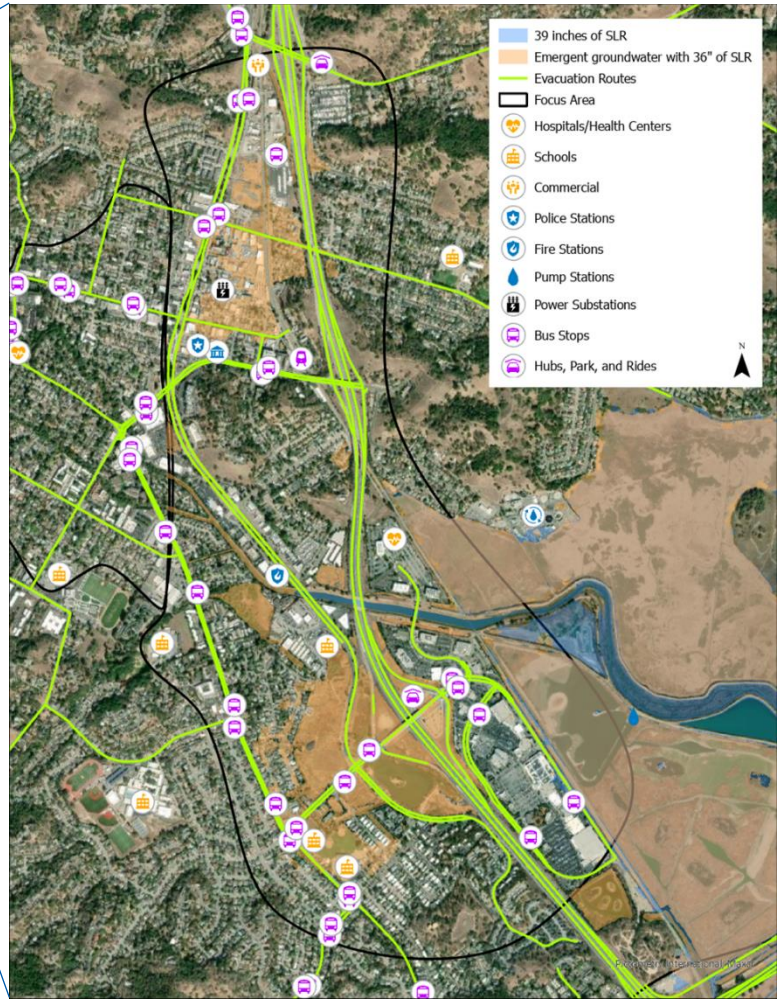
Groundwater Rise Exposure



Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community
Mill Valley - Miller Ave	By 10 in	present day	present day	In FEMA 100 yr Floodplain	present day	3	3.3	10% - 20% Zero Vehicle Households

3.1.12 Novato - Downtown Focus Area

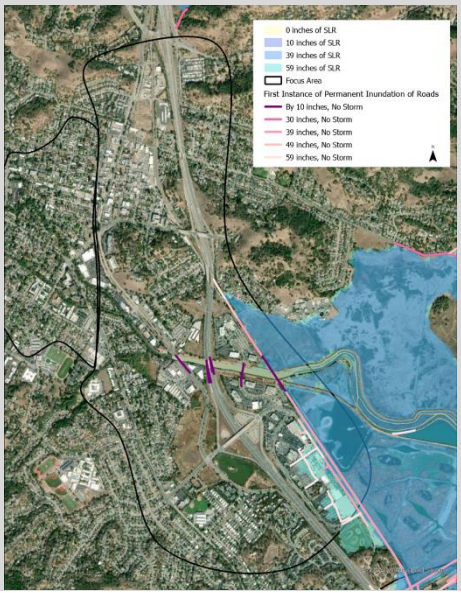




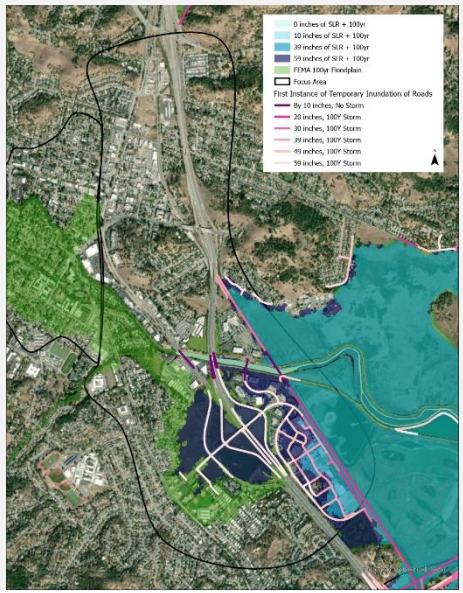
The site includes:

- 40 bus stops, including local and Golden Gate Transit (GGT)
- 1 hospital/health center
- 4 schools
- 1 power substation
- 1 fire station
- 1 police station
- 1 municipal
- 1 commercial
- 1 park, ride, and hub area
- 1 SMART station
- 1 ingress/egress route

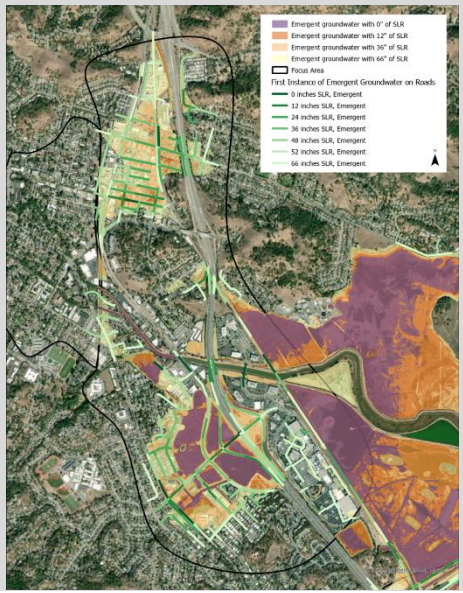
Permanent Inundation Exposure



Temporary Flood Exposure

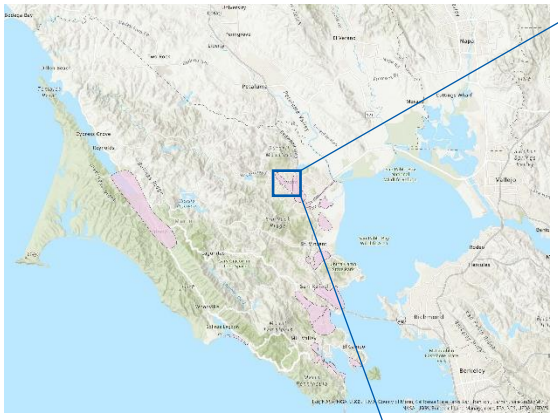


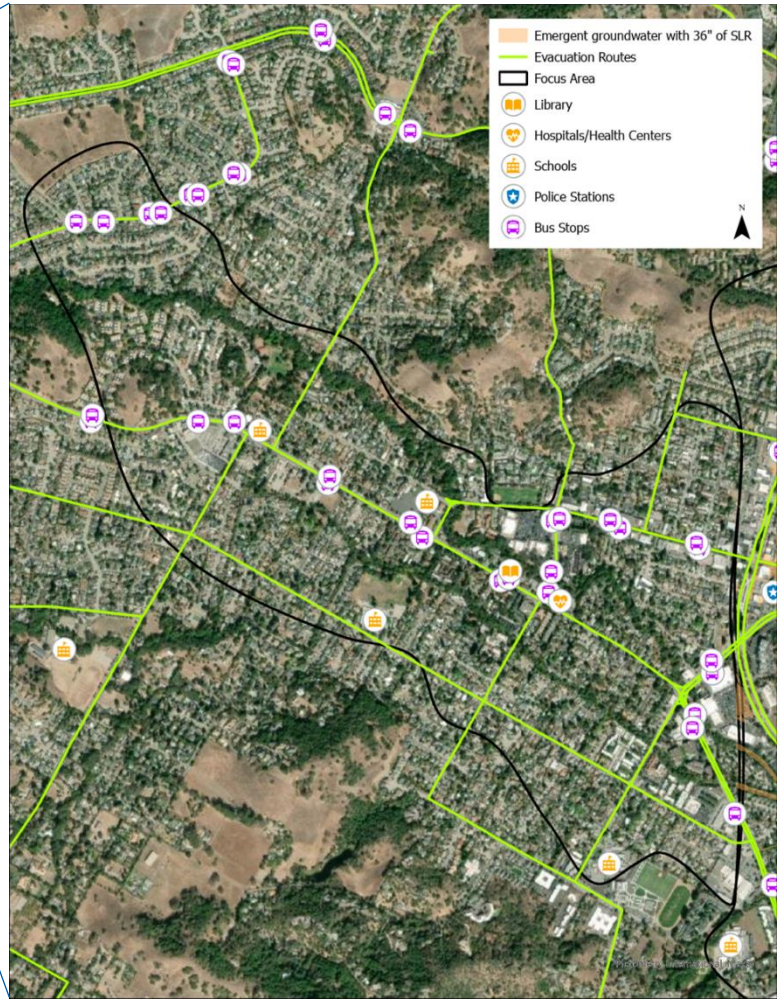
Groundwater Rise Exposure



Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community
Novato - West	**By 10 in**	**present day**	24 in.	In FEMA 100 yr Floodplain	20 in.	3	3.2	21% - 36% Low Income >21% Zero Vehicle Households

3.1.13 Novato – West Focus Area

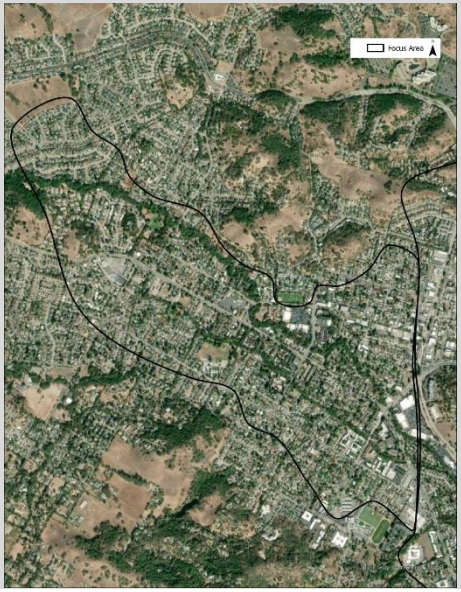




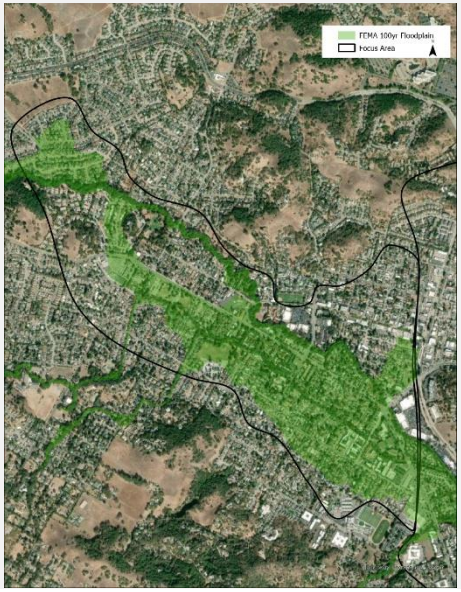
The site includes:

- 1 library
- 1 hospital/health center
- 6 schools
- 27 bus stops

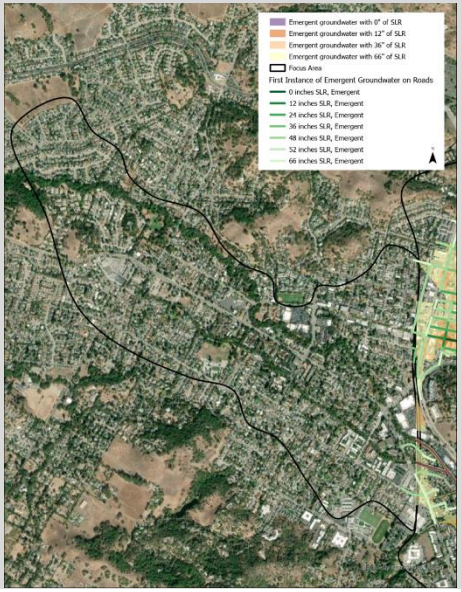
Permanent Inundation Exposure



Temporary Flood Exposure

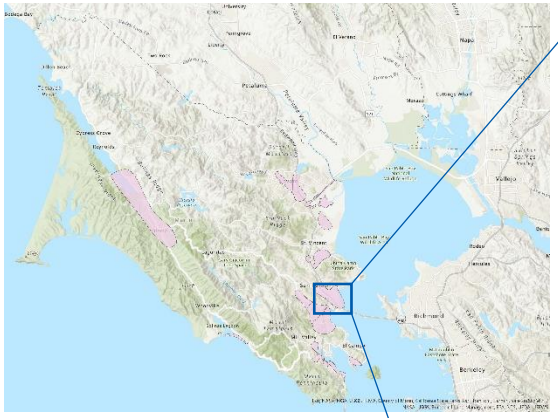


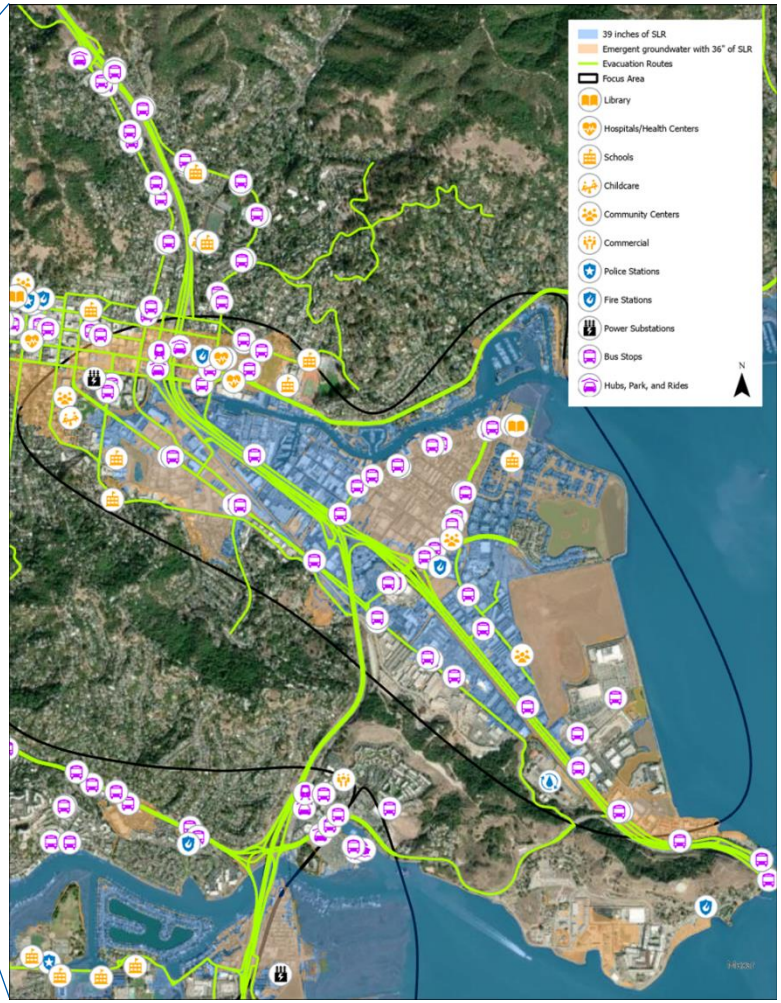
Groundwater Rise Exposure



Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community
Novato - Downtown	not impacted	not impacted	not impacted	In FEMA 100 yr Floodplain	not impacted	1	0.7	37% - 66% Low Income >21% Zero Vehicle Households

3.1.14 San Rafael – Canal Neighborhood Focus Area

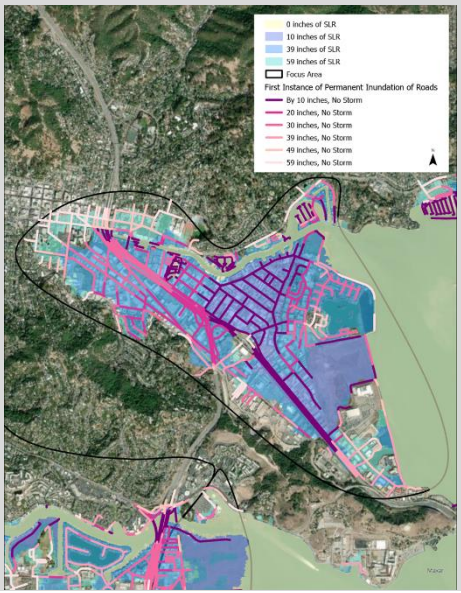




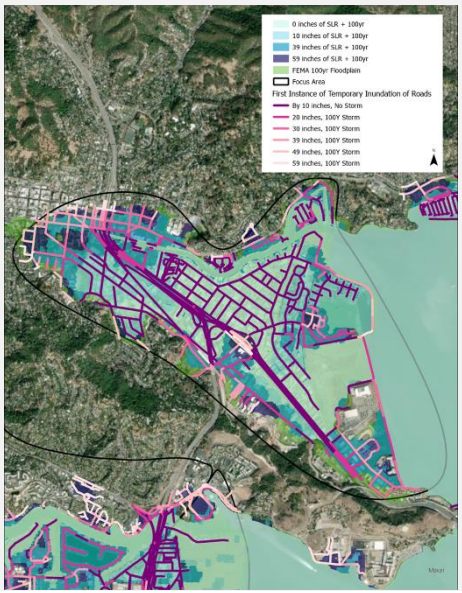
This site includes:

- Highway 101 and Highway 580
- Richmond-San Rafael Bridge is less than a mile away from the southern end of focus area.
- 71 bus stops, including local and Golden Gate Transit (GGT)
- 1 SMART station
- 4 hub and park locations
-

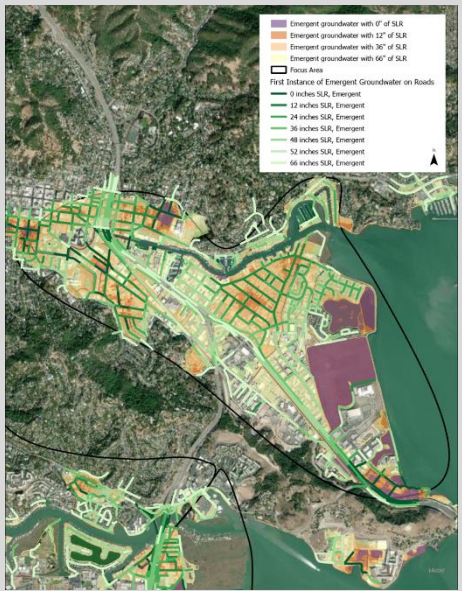
Permanent Inundation Exposure



Temporary Flood Exposure

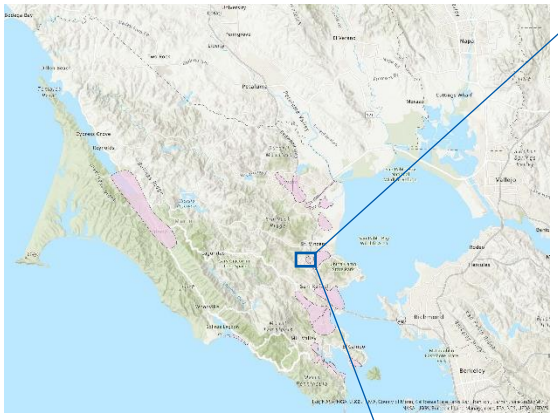


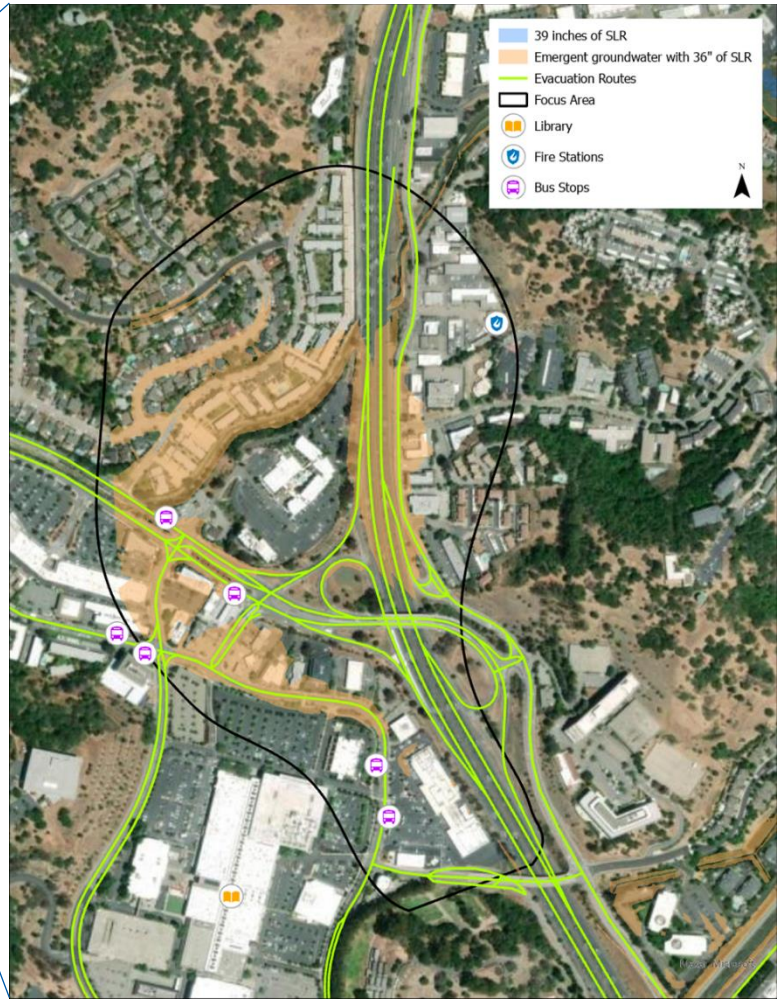
Groundwater Rise Exposure



Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community
San Rafael - Canal Neighborhood	**By 10 in**	**present day**	12 in	In FEMA 100 yr Floodplain	**present day**	3	3.3	**Highest MTC Equity Priority Area >66% Low Income >21% Zero Vehicle Households**

3.1.15 San Rafael North Focus Area

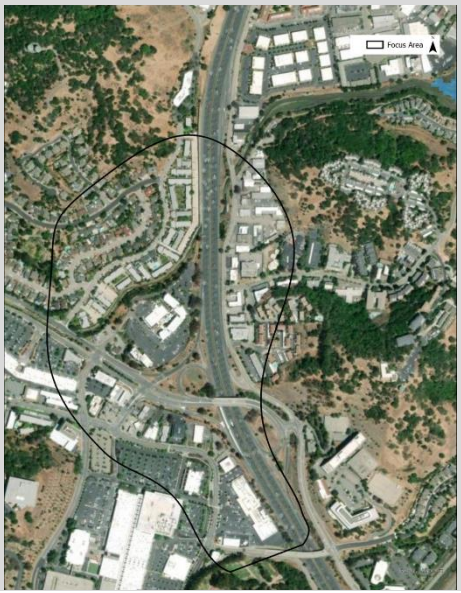




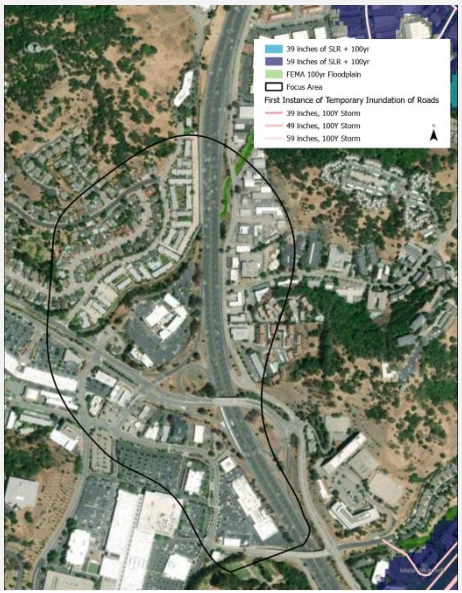
The site includes:

- Highway 101
- 1 fire station
- 6 bus stops, including local and Golden Gate Transit (GGT)

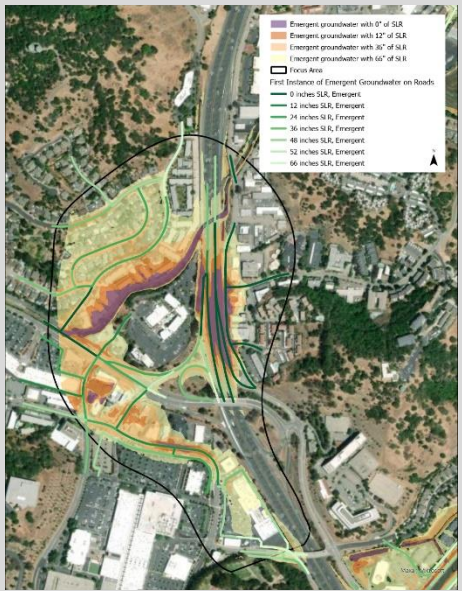
Permanent Inundation Exposure



Temporary Flood Exposure

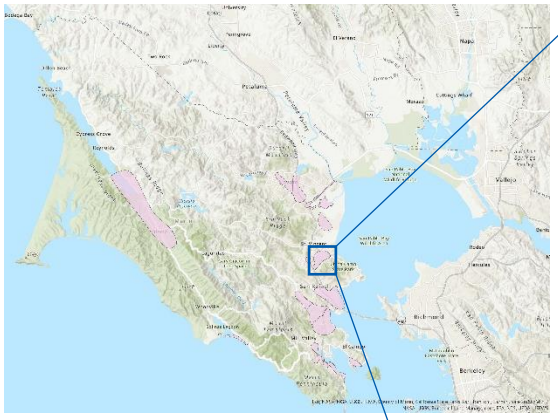


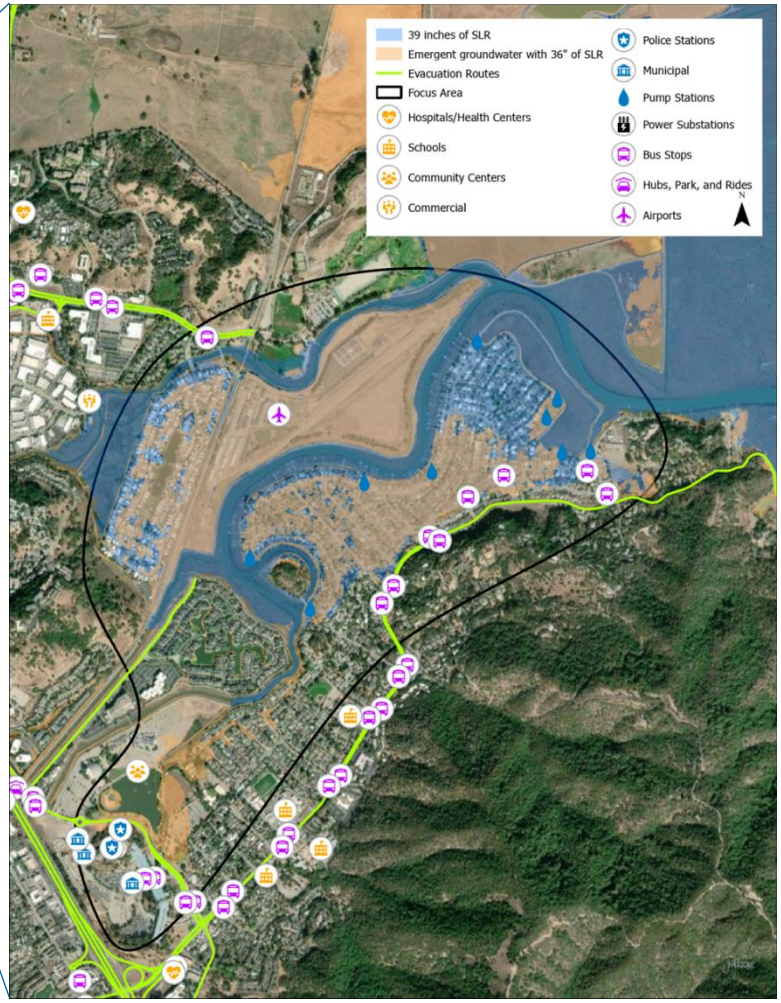
Groundwater Rise Exposure



Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community
San Rafael - North	not impacted	**present day**	**present day**	In FEMA 100 yr Floodplain	not impacted	2	2.0	**High MTC Equity Priority Area 37% - 65% Low Income >21% Zero Vehicle Households**

3.1.16 Santa Venetia Focus Area

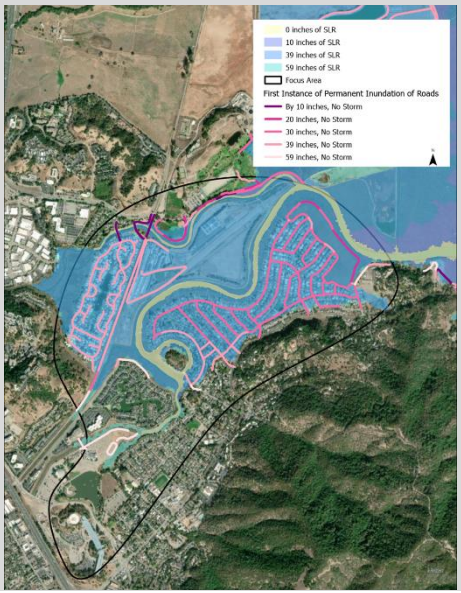




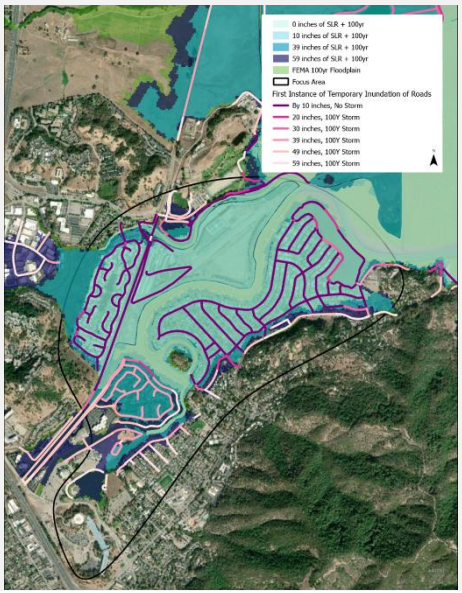
The site includes:

- 13 bus stops
- 1 airport
- 2 police stations
- 9 pump stations
- 1 ingress/egress route

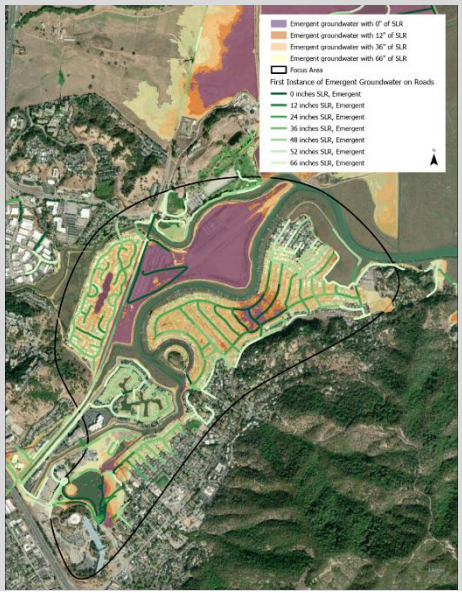
Permanent Inundation Exposure



Temporary Flood Exposure

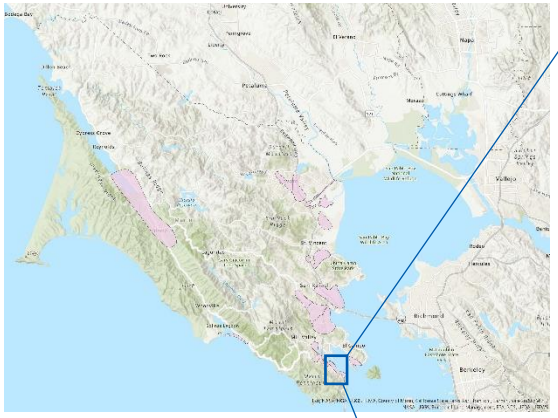


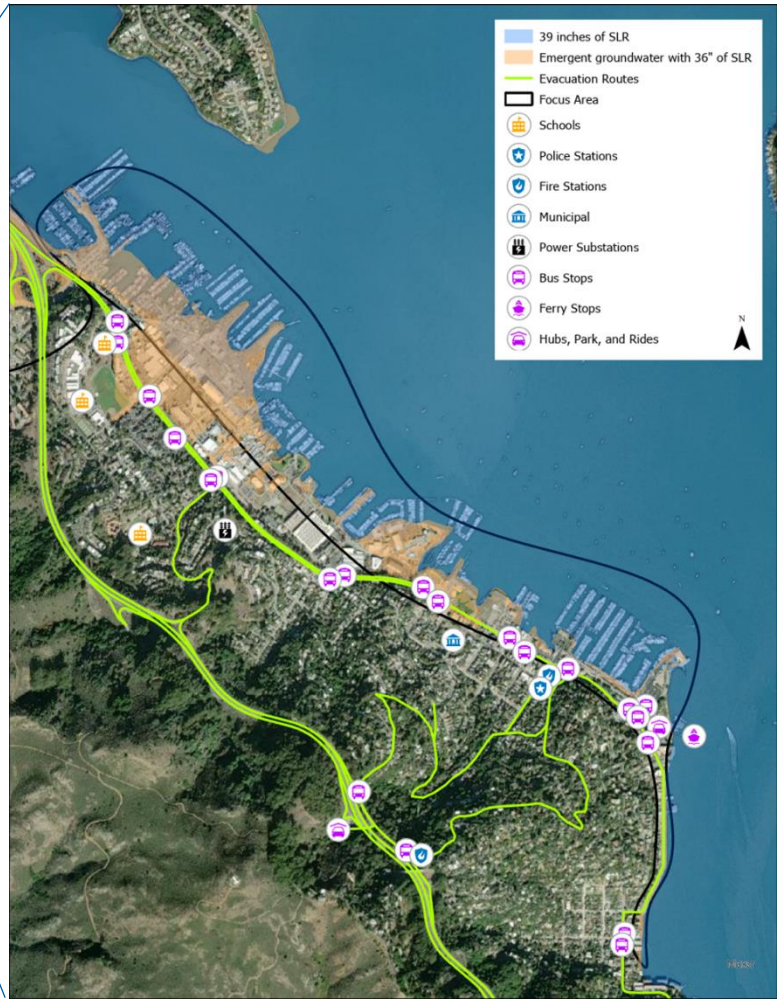
Groundwater Rise Exposure



Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community
Santa Venita	30 in.	present day	12 in.	In FEMA 100 yr Floodplain	10 in.	3	2.9	12% - 20% Low Income 10% - 20% Zero Vehicle Households

3.1.17 Sausalito Focus Area

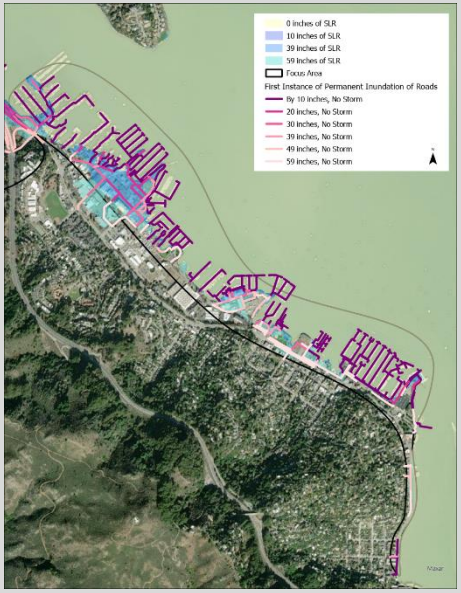




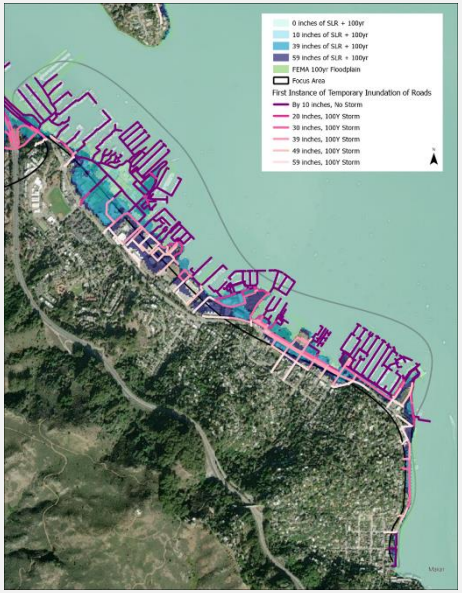
This site includes:

- 16 bus stops
- 1 park and ride hub area
- 3 arterials, Bridgeway, Richardson Street, and San Carlos Avenue; 7 collectors; and a network of local streets
- 1 ingress/egress route

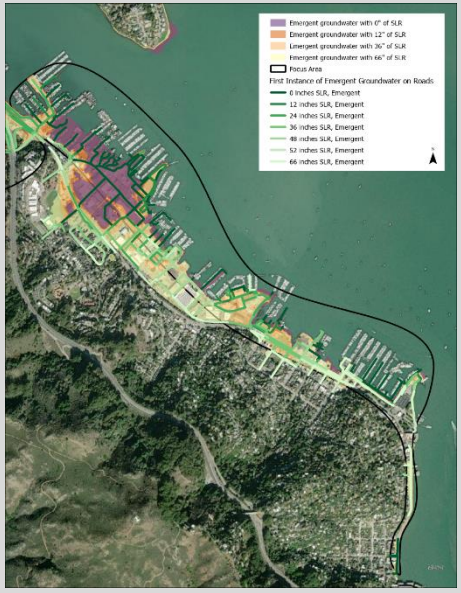
(A) Permanent Inundation Exposure



(B) Temporary Flood Exposure

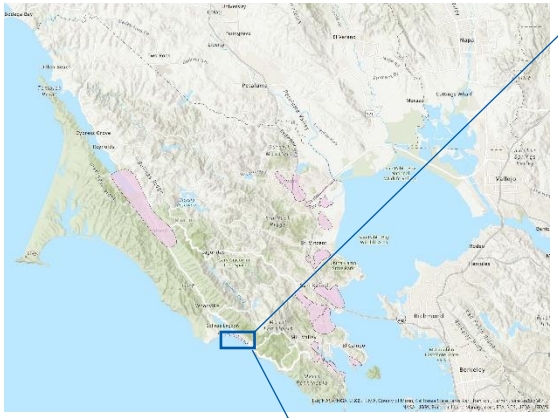


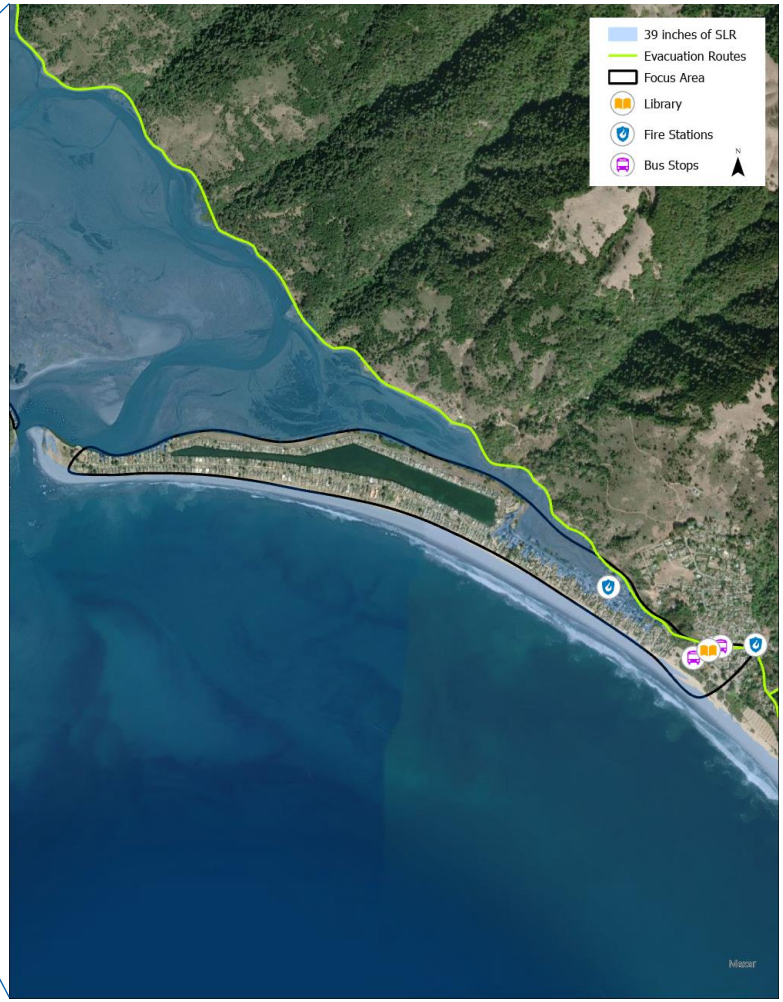
(C) Groundwater Rise Exposure



Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community
Sausalito	30 in.	present day	present day	In FEMA 100 yr Floodplain	present day	3	3.1	No

3.1.18 Stinson Beach Focus Area





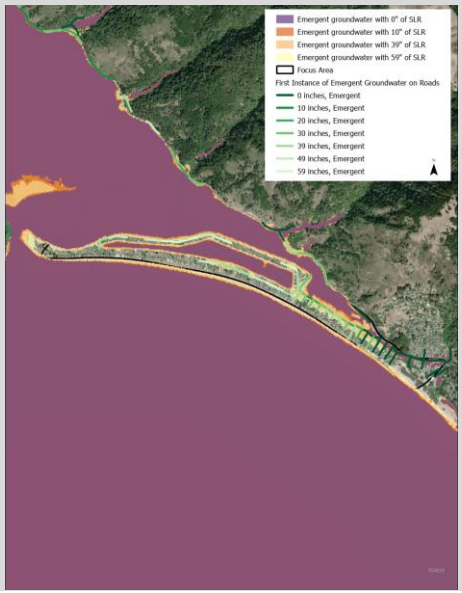
This site includes:

- 3 bus stops
- 2 fire stations (1 unmanned annex)
- 1 library
- 1 ingress/egress route

Permanent Inundation Exposure

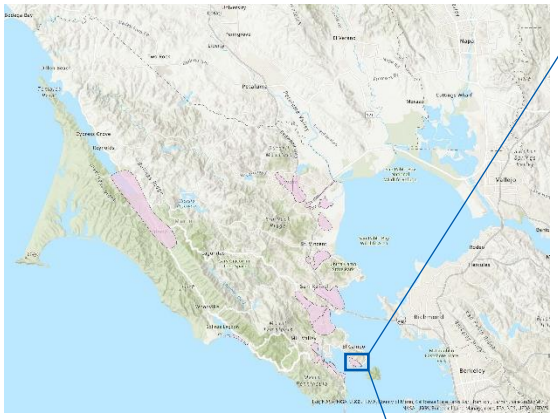
Temporary Flood Exposure

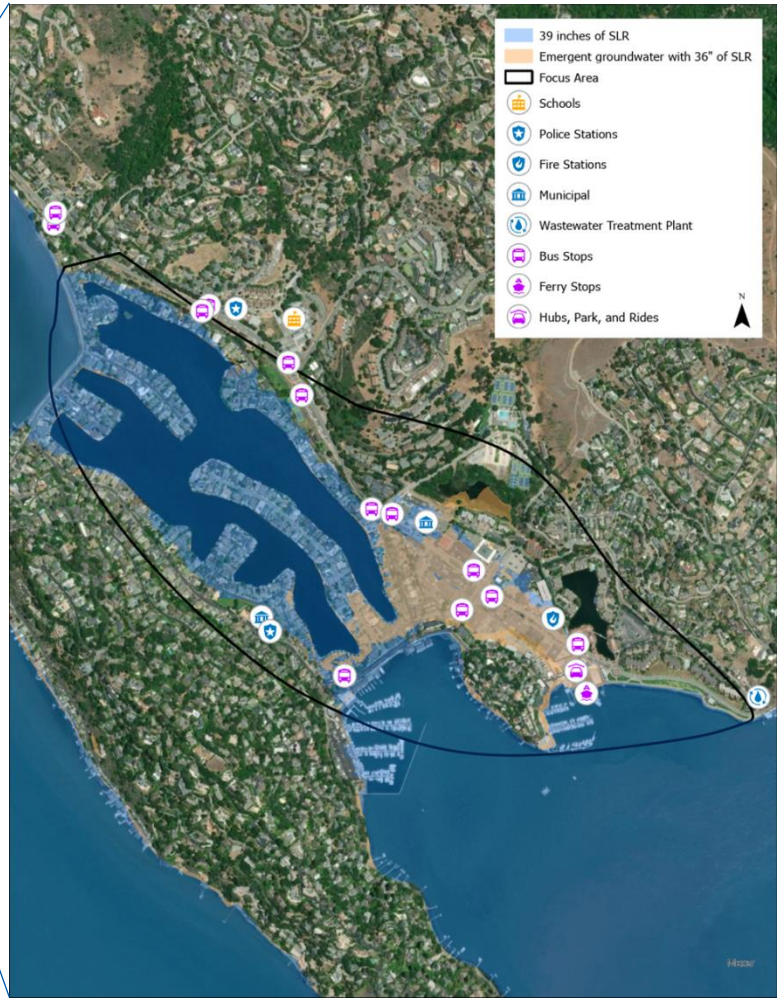
Groundwater Rise Exposure



Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community
Stinson Beach	By 10 in	present day	36 in	In FEMA 100 yr Floodplain	10 in.	3	3.2	37% - 66% Low Income

3.1.19 Tiburon Focus Area

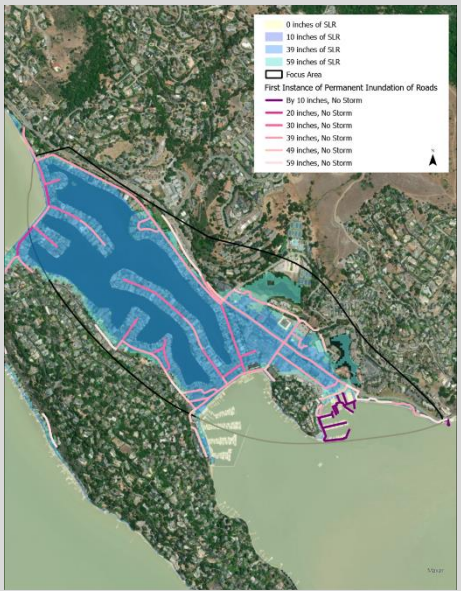




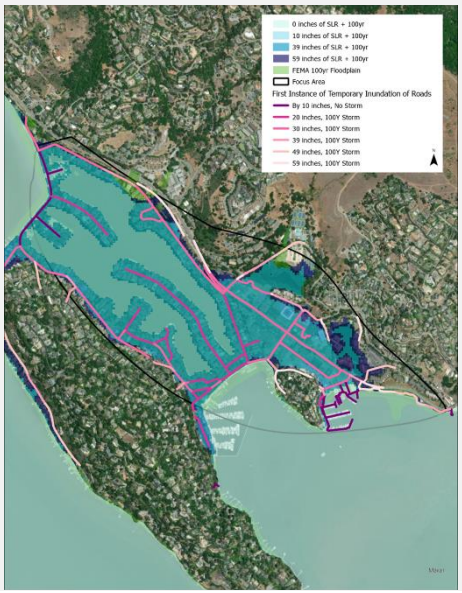
The site includes:

- 8 bus stops
- 2 municipal
- 1 fire station
- 1 police station
- 1 hub, park, and ride area
- 1 ferry stop
- 1 ingress/egress route

Permanent Inundation Exposure



Temporary Flood Exposure



Groundwater Rise Exposure

Focus Area	Permanent Physical Exposure - SLR First Inundation	Physical Exposure - GW Shallow (surface - 3 ft below surface)	PhysicalExposure - GW Emergent	Temporary Physical Risk - 100 yr floodplain	Temporary Physical Risk - CoSMoS 100 yr	Physical Risk - Number of Hazards	Physical Risk - Average	Equity Prioirty Community
Tiburon	30 in.	present day	present day	In FEMA 100 yr Floodplain	20 in.	3	2.8	No

4. Next Steps

The process to designate the focus areas is an important step in refining and reconfirming locations across the entirety of Marin County that are vulnerable to coastal flood exposure, including vulnerability of permanent inundation due to sea level rise, temporary flooding from current day high tides, pluvial and fluvial flood exposure, and sea level rise-driven groundwater rise.

Through the creation of the GIS geodatabases that provide asset-level information on flood exposure, as well as the Web Map, updated climate hazard exposure information is now available to TAM, the TAC and City/County of Marin for their own adaptation efforts. In the focus area profile sheets, the consultant team provides initial overview of each of the focus areas. The associated Focus Area Hazard Matrix excel file provides summary information for each focus are. There are any number of questions that can be asked of the exposure analysis. The focus area provide one way to organize this information and bound it within an identified geography.

These focus areas will now drive discussion for the next phase of the project, Task 4, and will support TAM and the TAC to begin to map out adaptation opportunities across the Marin County.

APPENDIX F

PLAN BAY AREA 2050+ RESILIENCE PROJECT LIST

Plan Bay Area 2050+ Final Blueprint: Final Resilience Project List[1]
Attachment G

Locally Developed Projects: Strategy EN1. Adapt to Sea Level Rise[2]

Project ID	Project Title/Program	Scope	Project Site Status	Opening Period	Location	Total Cost (YOE, millions$)
5294	South Bay Salt Ponds: Eden Landing - Southern Eden Landing (Phase 2)	Levees and dikes; Restoration/Rehabilitation/Enhancement	Planning/Scoping	2025-2035	Alameda	$80
5302	Restore Hayward Marsh (Former USD Treatment Marsh)	Other	Planning/Scoping	2025-2035	Alameda	$40
5330	Berkeley North Basin Strip - McLaughlin Eastshore State Park	Other; Restoration/Rehabilitation/Enhancement	Planning/Scoping	2036-2050	Alameda	$14
5386	Intertidal Habitat Improvement Project - McLaughlin Eastshore State Park	Restoration/Rehabilitation/Enhancement	Planning/Scoping	2036-2050	Alameda	$2
9403	San Leandro Treatment Wetland for Pollution Reduction, Habitat Enhancement, and Shoreline Resiliency	Restoration/Rehabilitation/Enhancement	In-progress/Implementation	2025-2035	Alameda	$1
9820	EBDA First Mile Horizontal Levee Project	Ecotone Levees	Proposed	2025-2035	Alameda	$118
10302	Marina Sea Level Rise (BMASP)	Flood walls and berms; Seawalls	Proposed	2036-2050	Alameda	Committed Funding
10501	Emeryville CAP - Emeryville Crescent Marsh Living Levee (Or Other Protective Measures)	Ecotone Levees	Identified Need	2036-2050	Alameda	$169
10552	Long Beach Restoration Project Design	Other	Planning/Scoping	2025-2035	Alameda	Committed Funding
11004	SLR Road Map - Bay Bridge Touchdown Living Levee	Ecotone Levees	Proposed	2036-2050	Alameda	$10
11042	Hayward Area Shoreline Adaptation Master Plan (SAMP) Planning Area	Ecotone Levees; Elevate or realign transportation; Levees and dikes; Other; Restoration/Rehabilitation/Enhancement; Sediment Management	In-progress/Implementation; Planning/Scoping; Proposed	2025-2035	Alameda	$1,301
11402	Estudillo Canal Reconstruction	Levees and dikes; Tide Gate	Proposed	2036-2050	Alameda	$51
11575	Monarch Bay Shoreline Development Project	Revetments and riprap	Planning/Scoping	2036-2050	Alameda	$52
11576	Neptune Drive Floodwall Project	Levees and dikes	In-progress/Implementation	2036-2050	Alameda	$5
786000	Berkeley Pier Project	Elevate land; Realign Transportation	Planning/Scoping	2036-2050	Alameda	$113
799000	Oakland-Alameda Estuary Adaptation Project	Other	Proposed	2036-2050	Alameda	$146
800000	Bay Farm Island Project	Other	Proposed	2025-2035	Alameda	$68
7851	Alameda Point	Elevate land; Levees and dikes; Restoration/Rehabilitation/Enhancement; Seawalls	Completed; Planning/Scoping; Proposed	2025-2035	Alameda, San Francisco	$381
80802	Alviso Wetland Railroad Adaptation Alternative	Elevate or realign transportation	Planning/Scoping	2036-2050	Alameda, Santa Clara	$3,022
5309	Pacheco Marsh Restoration	Acquisition/Preservation/Protection; Restoration/Rehabilitation/Enhancement	In-progress/Implementation	2036-2050	Contra Costa	$15
5328	East Antioch Creek Marsh Restoration	Restoration/Rehabilitation/Enhancement	Planning/Scoping	2025-2035	Contra Costa	$6
5339	Big Break Regional Shoreline - Wetland Restoration and Public Access	Other	Planning/Scoping	2025-2035	Contra Costa	$22
5757	Lower Wildcat Creek	Restoration/Rehabilitation/Enhancement	Planning/Scoping	2025-2035	Contra Costa	$1
5871	Marsh Creek Habitat Enhancement Project	Restoration/Rehabilitation/Enhancement	Construction in-progress	2025-2035	Contra Costa	Committed Funding

[1] The Resilience Project List is built off the Sea Level Rise Adaptation Funding and Investment Framework (Framework), a co-led effort by MTC/ABAG and the Bay Conservation and Development Commission (BCDC).
[2] Defining information was provided by local governments. First compiled in 2022-2023 and updated in spring 2024.

Project ID	Project Title/Program	Scope	Project Site Status	Opening Period	Location	Total Cost (YOE, millions$)
9913	North Richmond Shoreline Living Levee	Other	Planning/Scoping	2025-2035	Contra Costa	$20
21703	ouR Home - Resilient By Design	Ecotone Levees; Levees and dikes; Restoration/Rehabilitation/Enhancement	Proposed	2025-2035	Contra Costa	$237
782000	Waterfront Marina Trust Land Use Plan	Seawalls	In-progress/Implementation	2025-2035	Contra Costa	$15
5292	Bel Marin Keys V Wetlands Restoration	Restoration/Rehabilitation/Enhancement; Sediment Management	Completed; In-progress/Implementation	2025-2035	Marin	$156
5379	Bolinas Lagoon North End Wetland Enhancement/SLR Adaptation Project	Restoration/Rehabilitation/Enhancement	Planning/Scoping	2025-2035	Marin	$53
5422	McInnis Marsh Habitat Restoration	Restoration/Rehabilitation/Enhancement; Sediment Management	Planning/Scoping	2036-2050	Marin	$19
5423	Corte Madera Creek - College of Marin "Dog Park" Habitat Restoration	Restoration/Rehabilitation/Enhancement	Planning/Scoping	2036-2050	Marin	$1
5469	Tiscornia Marsh Restoration and Sea Level Rise Adaptation Project	Levees and dikes; Restoration/Rehabilitation/Enhancement	In-progress/Implementation	2025-2035	Marin	<$1
7865	Marina Village Flood Berm Upgrades	Flood walls and berms	Unknown	2025-2035	Marin	$87
7868	San Quentin Pump Station Reconstruction	Storm Drains and Stormwater Pumps	In-progress/Implementation	2025-2035	Marin	$10
9066	New Life for Eroding Shorelines	Restoration/Rehabilitation/Enhancement; Sediment Management	Planning/Scoping	2036-2050	Marin	Committed Funding
9420	Deer Island Basin Complex Tidal Wetlands Restoration	Restoration/Rehabilitation/Enhancement	In-progress/Implementation; Planning/Scoping	2036-2050	Marin	$87
9811	Evolving Shorelines Project at Bothin Marsh	Ecotone Levees; Restoration/Rehabilitation/Enhancement; Sediment Management	Planning/Scoping	2025-2035	Marin	$1
10788	Transforming Marin City's Urban Wetland	Other	Planning/Scoping	2036-2050	Marin	$4
11079	Santa Venetia Levee Upgrade Project (South Fork Gallinas Creek)	Flood walls and berms	Permitting	2036-2050	Marin	Committed Funding
11547	The Corte Madera Climate Adaptation Assessment	Elevate or realign transportation; Restoration/Rehabilitation/Enhancement	Planning/Scoping; Proposed	2025-2035	Marin	$16
11578	Mill Valley Flood Management and Storm Drain Master Plan	Storm Drains and Stormwater Pumps	Proposed	2025-2035	Marin	$53
30102	Protect Belvedere (Belvedere Critical Infrastructure Project)	Levees and dikes	Proposed	2036-2050	Marin	$51
790000	Cardinal Road Levee Upgrade Project	Flood walls and berms	Proposed	2036-2050	Marin	$6
798000	Marin City Stormwater Plan	Other	Planning/Scoping	2036-2050	Marin	$0
811000	Manzanita Sea Level Rise	Elevate or realign transportation	Planning/Scoping	2025-2035	Marin	$1,252
812000	Lagunitas Creek Bridge	Elevate or realign transportation	In-progress/Implementation	2036-2050	Marin	$84
813000	US 101 at Marin City	Storm Drains and Stormwater Pumps	In-progress/Implementation	2036-2050	Marin	$33
815000	Tomales Bay	Bulkheads	Proposed	2036-2050	Marin	$66
819000	SMART Track Raise at Hanna Ranch Rd.	Elevate or realign transportation	Proposed	2025-2035	Marin	$1
80605	SR 37 Corridor - Ultimate Project	Elevate or realign transportation; Levees and dikes	Planning/Scoping; Proposed	2036-2050	Marin, Napa, Solano, Sonoma	$11,354
5321	Novato Baylands	Restoration/Rehabilitation/Enhancement	Planning/Scoping	2025-2035	Marin, Sonoma	$7
10242	Adaptation and Resilience Plan for the Petaluma River Baylands	Restoration/Rehabilitation/Enhancement	Proposed	2025-2035	Marin, Sonoma	$0
5548	Napa River Flood Protection Project	Acquisition/Preservation/Protection; Restoration/Rehabilitation/Enhancement	In-progress/Implementation	2036-2050	Napa	Committed Funding
10406	American Canyon Wetlands Restoration Plan	Restoration/Rehabilitation/Enhancement	Planning/Scoping	2025-2035	Napa	$49
5319	Cullinan Ranch Restoration Project	Restoration/Rehabilitation/Enhancement	Completed; In-progress/Implementation	2025-2035	Napa, Solano	$7

Project ID	Project Title/Program	Scope	Project Site Status	Opening Period	Location	Total Cost (YOE, millions$)
80604	The Grand Bayway	Restoration/Rehabilitation/Enhancement	Proposed	2025-2035	Napa, Solano	$115
9414	Sonoma Creek Baylands Strategy	Restoration/Rehabilitation/Enhancement	Planning/Scoping	2025-2035	Napa, Solano, Sonoma	$482
5306	Candlestick Point - Yosemite Slough Wetland Restoration	Restoration/Rehabilitation/Enhancement	Completed; In-progress/Implementation	2025-2035	San Francisco	$8
5560	Heron's Head Park	Other; Restoration/Rehabilitation/Enhancement; Sediment Management	In-progress/Implementation	2025-2035	San Francisco	Committed Funding
7878	SFMTA Islais Creek Facility: Floodproofing	Elevate or realign transportation	Planning/Scoping	2025-2035	San Francisco	<$1
7879	San Francisco Waterfront Flood Study	Other	Proposed	2036-2050	San Francisco	$21,401
9665	India Basin Shoreline Park	Restoration/Rehabilitation/Enhancement	Completed; Construction in-progress; Planning/Scoping	2036-2050	San Francisco	$275
11045	China Basin Park (Mission Rock Development)	Elevate land; Green Stormwater Infrastructure	In-progress/Implementation	2036-2050	San Francisco	Committed Funding
11065	Treasure Island/Yerba Buena Island Development Project	Elevate land	Construction in-progress; Planning/Scoping	2036-2050	San Francisco	$274
11066	Treasure Island Adapative Shoreline Improvement Study	Revetments and riprap	Proposed	2036-2050	San Francisco	$17
11550	Downtown Coastal Resilience Project	Flood walls and berms	Planning/Scoping	2025-2035	San Francisco	$95
11552	Wharf J9 Replacement Project	Other	Planning/Scoping	2036-2050	San Francisco	$110
11583	Embarcadero Early Projects (Embarcadero Seawall Program)	Seawalls	Planning/Scoping	2036-2050	San Francisco	$275
11584	Islais Creek Southeast Mobility and Adaptation Strategy	Other	In-progress/Implementation	2036-2050	San Francisco	$1,341
50204	Ocean Beach Climate Change Adaptation Project	Seawalls; Sediment Management	Planning/Scoping	2036-2050	San Francisco	Committed Funding
50206	Hunters Point Shipyard Project and Candlestick Point Redevelopment Project	Elevate land; Flood walls and berms; Storm Drains and Stormwater Pumps	Proposed	2036-2050	San Francisco	$1,080
787000	Mission Bay Ferry Terminal Project	Elevate or realign transportation	Planning/Scoping	2036-2050	San Francisco	$453
792000	North Ocean Beach Dune Restoration	Restoration/Rehabilitation/Enhancement	Proposed	2036-2050	San Francisco	$97
794000	Lefty O'Doul Bridge Replacement	Elevate or realign transportation	Proposed	2036-2050	San Francisco	$328
795000	Peter Maloney Bridge Replacement	Elevate or realign transportation	Proposed	2036-2050	San Francisco	$409
7886	Pescadero Sea Level Rise Adaptation Project	Realign Transportation	Planning/Scoping	2036-2050	San Mateo	$1,658
9677	Strategy to Advance Flood Protection, Ecosystems and Recreation along San Francisco Bay	Restoration/Rehabilitation/Enhancement	Planning/Scoping	2025-2035	San Mateo	$36
9951	Bay Rise Park - 410 Airport Blvd	Other; Restoration/Rehabilitation/Enhancement	Planning/Scoping	2036-2050	San Mateo	$43
10236	East Palo Alto and Dumbarton Bridge Resilience Study	Elevate or realign transportation	Proposed	2025-2035	San Mateo	$1
11063	SFO Shoreline Protection Program	Flood walls and berms; Revetments and riprap	Planning/Scoping	2025-2035	San Mateo	$799
11523	WBSD Flow Equalization and Resource Recovery Facility (FERRF) Levee Improvements Project	Flood walls and berms	Construction planned	2025-2035	San Mateo	$51
11553	Bedwell Bayfront Park Entrance Improvements Project	Elevate land	Planning/Scoping	2025-2035	San Mateo	$41
11558	Lower Colma Creek Section 103 CAP	Elevate land; Flood walls and berms	Unknown	2036-2050	San Mateo	$28
11559	The Spit and Oyster Point SLR Protection	Other	Planning/Scoping	2025-2035	San Mateo	$41
60401	Millbrae and Burlingame Shoreline Area Protection and Enhancement Project	Ecotone Levees; Flood walls and berms; Restoration/Rehabilitation/Enhancement	Planning/Scoping	2036-2050	San Mateo	$3,730
61301	Pacifica Sea-Level Rise Adaptation Plan Adaptation Options	Seawalls; Sediment Management	Planning/Scoping	2036-2050	San Mateo	$1,263

Project ID	Project Title/Program	Scope	Project Site Status	Opening Period	Location	Total Cost (YOE, millions$)
61401	Redwood City Emergency Preparedness Project	Elevate land	Planning in-progress	2025-2035	San Mateo	$23
61602	Redwood Shores Protection and Enhancement Project	Levees and dikes; Restoration/Rehabilitation/Enhancement	Identified Need	2025-2035	San Mateo	$186
788000	Port of Redwood City Project	Elevate land	Planning/Scoping	2036-2050	San Mateo	$2
802000	North County Regional Sea Level Mitigation	Ecotone Levees; Tide Gate	Proposed	2036-2050	San Mateo	$324
807000	Dumbarton Bridge West Approach Sea Level Rise Project	Elevate or realign transportation	Planning/Scoping	2036-2050	San Mateo	$3,035
817000	Surfers Beach	Restoration/Rehabilitation/Enhancement	Proposed	2036-2050	San Mateo	$5
818000	Brisbane Area Shoreline Resilience Project	Ecotone Levees	Proposed	2036-2050	San Mateo	$810
9714	San Francisquito Creek Flood Protection Project	Restoration/Rehabilitation/Enhancement	Completed; In-progress/Implementation	2025-2035	San Mateo, Santa Clara	$240
5297	South Bay Salt Ponds: Alviso - Mountain View Ponds - A1, A2W (Phase 2)	Restoration/Rehabilitation/Enhancement	In-progress/Implementation	2025-2035	Santa Clara	$22
5665	South Bay Salt Pond Restoration: Phase 2	Ecotone Levees; Restoration/Rehabilitation/Enhancement	In-progress/Implementation	2036-2050	Santa Clara	Committed Funding
5744	South San Francisco Bay Shoreline Project	Restoration/Rehabilitation/Enhancement	In-progress/Implementation	2036-2050	Santa Clara	$214
7901	Palo Alto Baylands	Ecotone Levees	In-progress/Implementation	2036-2050	Santa Clara	$7
9107	South Bay Salt Ponds: Alviso - Ponds A9, A10, A11, A12, A13, A14, A15	Restoration/Rehabilitation/Enhancement	Proposed	2036-2050	Santa Clara	$166
11590	South San Francisco Bay Shoreline Project, Phase III	Levees and dikes; Sediment Management	Proposed	2025-2035	Santa Clara	$78
11594	Regional Water Quality Control Plant (RWQCP) New Outfall Pipeline Project	Other	Planning/Scoping	2025-2035	Santa Clara	$23
71102	Palo Alto Flood Basin	Tide Gate	In-progress/Implementation	2025-2035	Santa Clara	$53
814000	Santa Clara Living Shoreline	Ecotone Levees	Proposed	2025-2035	Santa Clara	$247
5923	Peytonia Slough Area	Acquisition/Preservation/Protection	Unknown	2036-2050	Solano	Committed Funding
5926	Peytonia Slough South	Acquisition/Preservation/Protection	Unknown	2036-2050	Solano	Committed Funding
5930	Grizzly Island Wildlife Area, Goodyear Slough	Acquisition/Preservation/Protection	Unknown	2025-2035	Solano	Committed Funding
80603	City of Benicia Urban Waterfront Enhancement and Master Plan	Flood walls and berms; Levees and dikes; Restoration/Rehabilitation/Enhancement	Identified Need; Planning/Scoping	2025-2035	Solano	$14
11595	Tubbs Island Levee Improvement Project	Levees and dikes	Planning/Scoping	2025-2035	Sonoma	$9

Placeholder Projects: Strategy EN1. Adapt to Sea Level Rise[3]

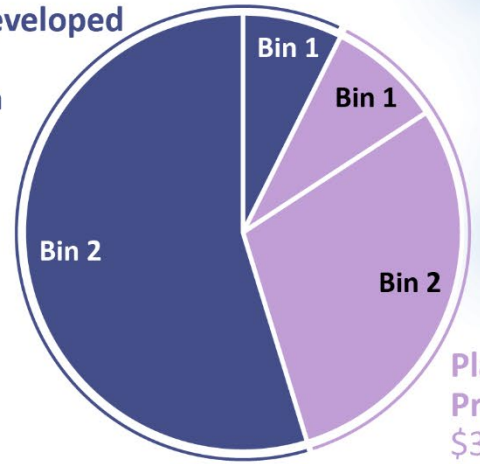
Site Status	Opening Period	Location	Total Cost (YOE, millions$)
Placeholder	2025-2035	Alameda	***$187***
Placeholder	2036-2050	Alameda	***$4,618***
Placeholder	2025-2035	Contra Costa	***$1,299***
Placeholder	2036-2050	Contra Costa	***$6,088***
Placeholder	2025-2035	Marin	***$1,156***
Placeholder	2036-2050	Marin	***$2,554***
Placeholder	2025-2035	Napa	***$0***
Placeholder	2036-2050	Napa	***$102***
Placeholder	2025-2035	San Francisco	***$0***
Placeholder	2036-2050	San Francisco	***$103***
Placeholder	2025-2035	San Mateo	***$1,248***
Placeholder	2036-2050	San Mateo	***$448***
Placeholder	2025-2035	Santa Clara	***$709***
Placeholder	2036-2050	Santa Clara	***$578***
Placeholder	2025-2035	Solano	***$507***
Placeholder	2036-2050	Solano	***$925***
Placeholder	2025-2035	Sonoma	***$76***
Placeholder	2036-2050	Sonoma	***$48***
Placeholder	2025-2035	Multi-County	***$135***
Placeholder	2025-2035	Multi-County	***$0***
Region-wide Sediment Beneficial Reuse	2025-2035	All	***$1,754***
Region-wide Sediment Beneficial Reuse	2036-2050	All	**$3,240**

[3] Defining information was developed by regional agency staff. These locations are areas that flood with 4.9-feet water rise and assume green project types when suitable. The placeholders are used to quantify the total regional financial need, even in areas where local planning has not yet identified an adaptation pathway.

Plan Bay Area 2050+ Final Blueprint: Final Resilience Project List Map

Share of Resilience Project List Projects by Bin and Source

Locally Developed Projects
$59 billion



Placeholder Projects
$37 billion

Bin 1 projects address flood impacts with 1-foot of rise. Assumed in 2025-2035
Bin 2 projects address flood impacts with 1-foot to 4.9-feet of rise. Assumed in 2036-2050.

Legend

Locally Developed Projects

Defining information was provided by local governments. First compiled in 2022-2023 and updated in spring 2024.

Placeholder Projects

Defining information was provided by regional agency staff. These locations are areas that flood with 4.9-feet of water rise and assume green project types when suitable. The placeholders are used to quantify the total regional financial need, even in areas where local planning has not yet identified an adaptation pathway.