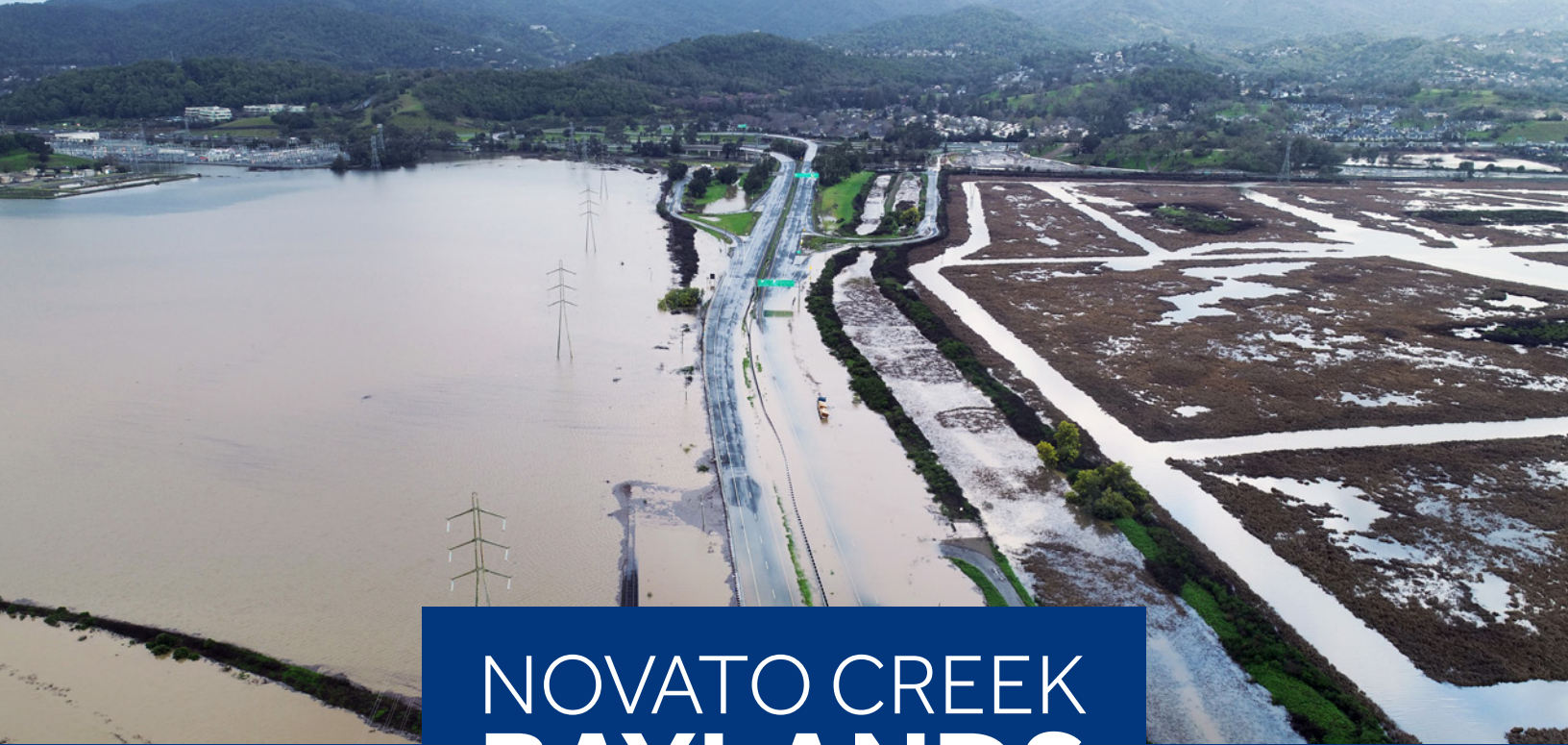
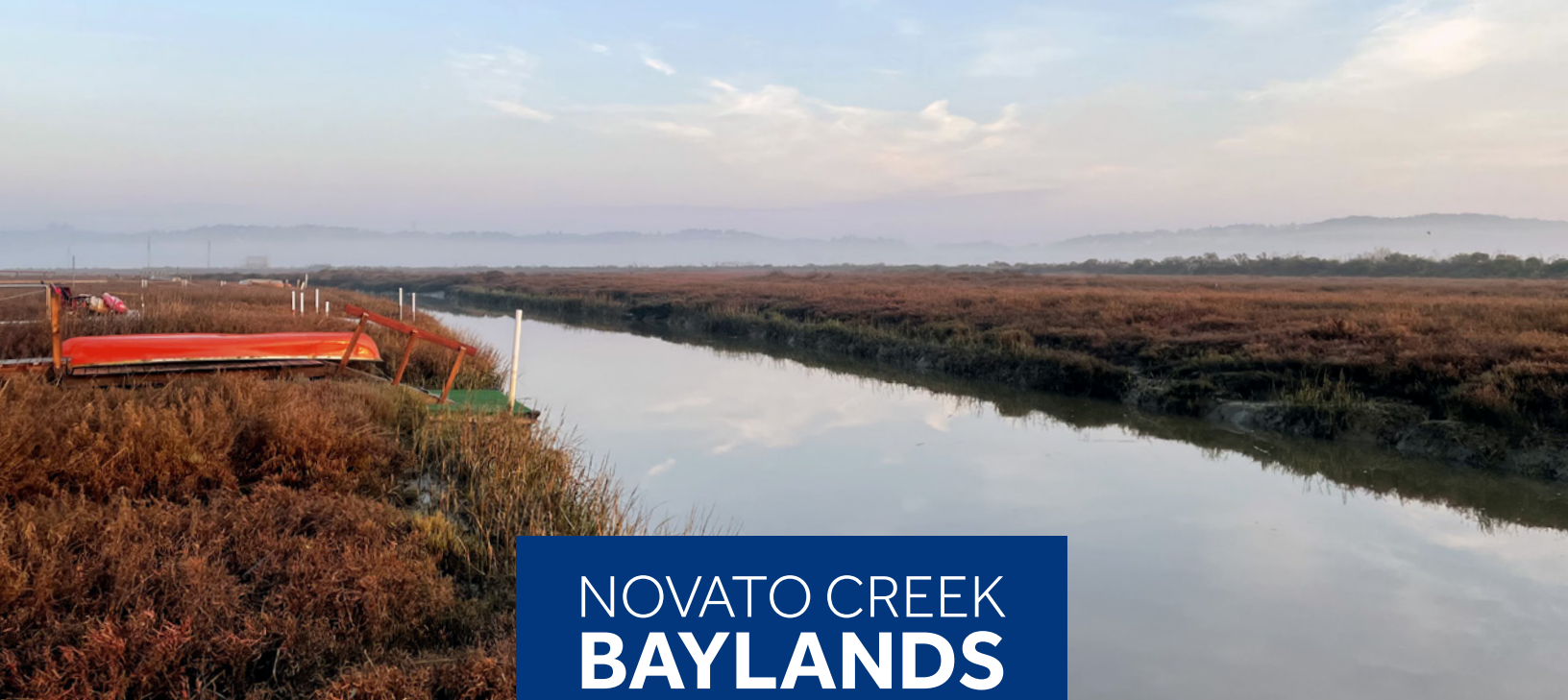




NOVATO CREEK **BAYLANDS STRATEGY**





NOVATO CREEK BAYLANDS STRATEGY

PREPARED BY

San Francisco Estuary Institute
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COVER IMAGES

Above: Flooding on State Route 37, February 27, 2019. Photo by Marin County Department of Public Works.

Below: Lower Novato Creek, December 2022. Photo by Ellen Plane.

EXECUTIVE SUMMARY IMAGES

Page i: Great Blue Heron at Novato Creek. Photo by Ellen Plane.

Page vi: Novato Creek, looking downstream from the Bel Marin Keys community. Photo by Ellen Plane.

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EXECUTIVE SUMMARY

The Novato Creek baylands represent one of the largest remaining tidal wetland restoration opportunities in the San Francisco Bay Area. Today, over 4,000 acres of undeveloped, diked baylands along Novato Creek are disconnected from San Pablo Bay. Rising sea levels and increasingly intense storms threaten the aging flood protection system here, causing repeated flooding of State Route 37 (SR 37). The Novato Creek Baylands Strategy (Strategy) provides a roadmap to reconnect these lands to the tides, reducing upstream flood risk while restoring natural habitat.

The Strategy was shaped by an iterative process involving focused meetings with over a dozen regional partners, infrastructure operators, and landowners to ensure proposed restorations align with current management and future goals. This engagement process identified multiple opportunities for “win-win” solutions that can reduce flood risk and infrastructure maintenance costs while expanding baylands habitats and increasing resilience to sea level rise.

Vision and Goals

The future Novato Creek baylands are envisioned as an expansive, connected ecosystem where mudflats and marshes transition gradually into protected uplands. The Strategy is guided by three primary goals:

- **Goal #1:** Restore tidal ecosystems to the maximum extent possible, including subtidal habitats, mudflats, marshes, and adjacent upland transition zones.
- **Goal #2:** Increase the resilience of the Novato Creek baylands and upstream areas to flooding under current and future climate conditions to benefit people and wildlife.
- **Goal #3:** Build community and Tribal needs and priorities into the Strategy and its restoration options.

The Problem

Landscape modification in the Novato Creek baylands has reduced tidal habitat and increased flood risk. Since the mid-1800s, diking and draining of wetlands has eliminated approximately 90% of the area's tidal marsh, greatly reducing available habitat for species such as the California Ridgway's rail, salt marsh harvest mouse, California black rail, and steelhead. In diked areas, the land has subsided below its original elevation. The majority of the diked baylands are at intertidal elevations, but the most subsided areas are so low that they would become subtidal open water if breached today.

Diking of historical tidal marshes disconnected Novato Creek from its floodplain, reducing tidal exchange and contributing to sediment accumulation in the channel. This buildup has reduced the creek's capacity to convey flood flows, leading to upstream flooding in the City of Novato. Sea level rise and more intense storm events are expected to further increase flood risk in the coming decades.

Restoration Constraints and Considerations

- » **Transportation:** The SR 37 corridor and the Sonoma Marin Area Rail Transit (SMART) rail line bisect the Novato Creek baylands and are the primary physical barriers to restoration. Planned replacement of the SR 37 bridge over Novato Creek and future elevation of SR 37 onto a causeway by the 2050s would remove one major barrier. However, the SMART rail line would also need to be elevated to maximize restoration opportunities.
- » **Utilities:** Electric transmission lines, water lines, and wastewater lines cross the Novato Creek baylands. The Novato Sanitary District has extensive infrastructure in the baylands, including storage ponds and an outfall line. The Strategy details how infrastructure can be protected or modified to facilitate restoration.
- » **Cultural Sensitivity:** A cultural resources assessment, conducted in coordination with the Federated Indians of Graton Rancheria, identified 81 previously documented cultural resources and areas of buried site sensitivity within the Novato Creek baylands. All future restoration activities must consider and address the identification and protection of Tribal cultural resources in consultation with Graton Rancheria.
- » **Public Access:** Access to the baylands is currently fragmented. The Strategy does not define how trails will be integrated into future restoration projects, as this will be determined at later stages of planning and design. However, principles to guide the integration of public access into future projects are identified.

Recommended Restoration Actions

Based on opportunities and constraints identified through discussions with landowners, land managers, and community representatives, the Strategy team developed **landscape-scale restoration alternatives**: broad visions for reconnecting and restoring the Novato Creek baylands. These alternatives were evaluated based on their performance in achieving project goals—including reducing flood risk, increasing tidal habitat, and minimizing long-term maintenance costs—to identify a preferred landscape-scale alternative.

Following selection of the preferred landscape-scale alternative, the Strategy team developed **project-scale restoration alternatives** that could help build toward it. These project-scale options were also evaluated against the same criteria to assess how well they advance project goals.

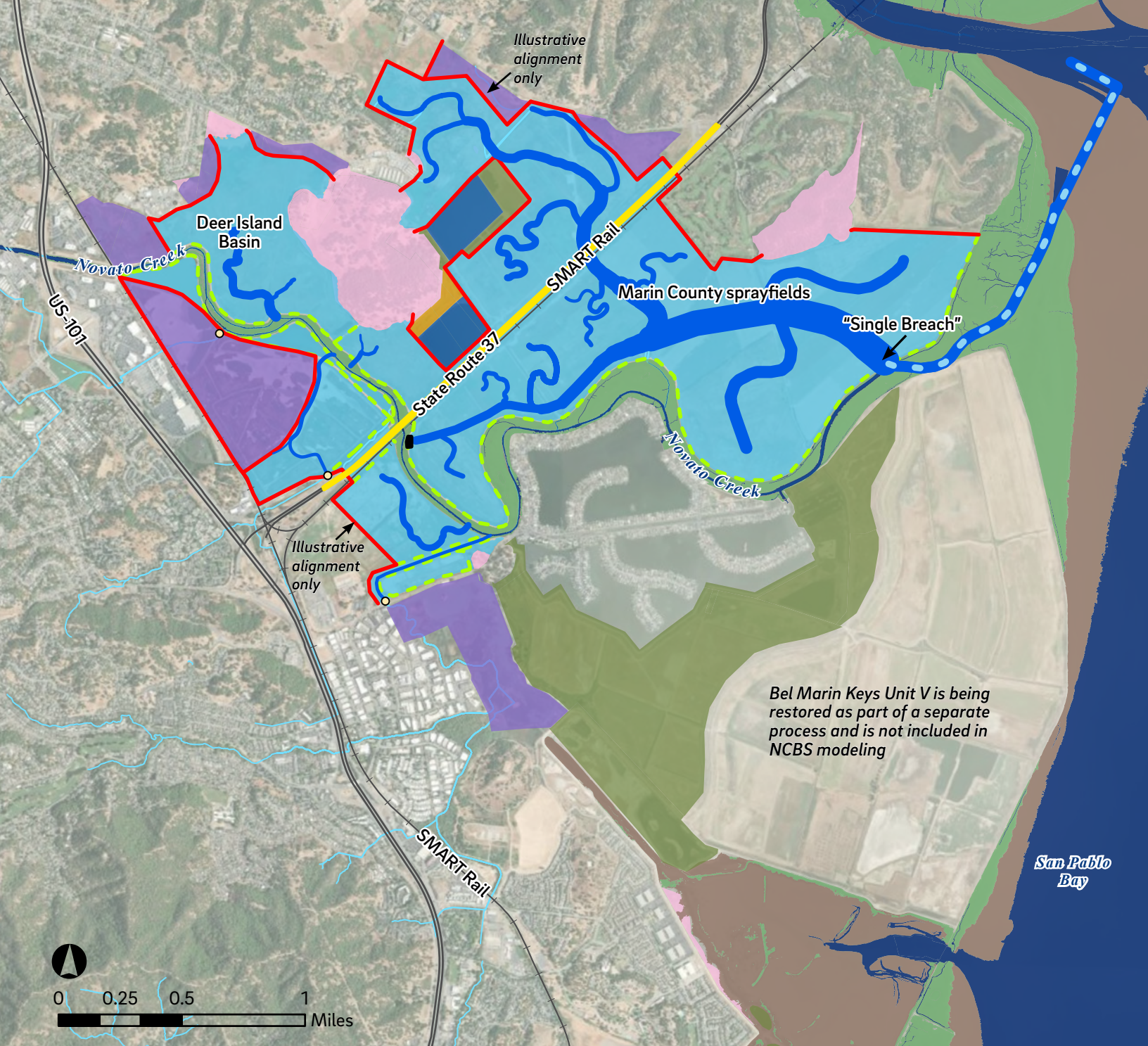
Landscape-Scale Restoration Alternatives

The landscape-scale alternatives aim to maximize the area of restored tidal habitat and connections to natural upland transition zones. These alternatives involve constructing setback levees in some locations, breaching bayward berms, excavating new tidal channels, and dredging existing channels to improve tidal conveyance. Specific design features like ecotone levees and high tide refuge islands are not included in the landscape-scale restoration alternatives, though they will likely be incorporated in future phases of design. A major question in designing the possible restoration scenarios for the Novato Creek baylands was determining how to configure the channel network to deliver adequate tidal flows to the heavily subsided basins. The Strategy team compared two primary landscape-scale alternatives: a **Multiple Breach** approach that reconnects the existing Novato Creek channel to diked baylands via multiple channel connections, and a **Single Breach** approach that routes most of the flow through the Marin County sprayfields.

Alternative 2: Single Breach (Figure ES-1) is the preferred long-term restoration alternative due to the following benefits:

- **Habitat Development:** Routing most tidal flow through restored basins rather than the constrained Novato Creek channel increases tidal range and sediment accretion in restored areas, allowing marshes to establish more quickly and keep pace with sea level rise.
- **Flood Protection:** Expanding the creek's floodplain reduces peak water levels during the 50-year flood event by **more than 3 feet at SR 37 and 1.5 feet at US-101**.
- **Lower Cost & Impact:** Requires less dredging within existing marshes than the Multiple Breach approach, reducing construction impacts, costs, and permitting challenges.

Implementation of this alternative would require raising SR 37 and SMART onto causeways across the full extent of the baylands. Given that this is unlikely to happen in the near term, a **subset alternative (Alternative 2a: Single Breach, Near Term) could be pursued in the interim**. This would involve constructing a temporary setback levee to protect SR 37 and SMART. Benefits of Alternative 2a are similar to Alternative 2, though reduced in extent.



Alternative 2: Single Breach

— Raise or construct levee*	— Tidal restoration	Existing tidal habitats
- - - Intermittently lower levee	— Natural upland transition zone	— Intertidal/subtidal (channel & Bay)
— Road and rail causeways**	Nontidal habitats	— Tidal marsh
— Channel	— Seasonal wetland	— Tidal flat
- - - Dredging	— Recycled water storage pond	
■ Overflow weir	— Stormwater basin	
○ Pump station/tide gate	— Wildlife pond	

*may include ecotone slope

**existing road and rail beds removed

Figure ES-1. Alternative 2: Single Breach emerged as the preferred long-term restoration alternative based on the evaluation criteria. By routing most of the tidal flow through a new channel in the Marin County sprayfields, this configuration maximizes habitat development and flood risk reduction for upstream areas while minimizing the extent of dredging required in existing marshes.

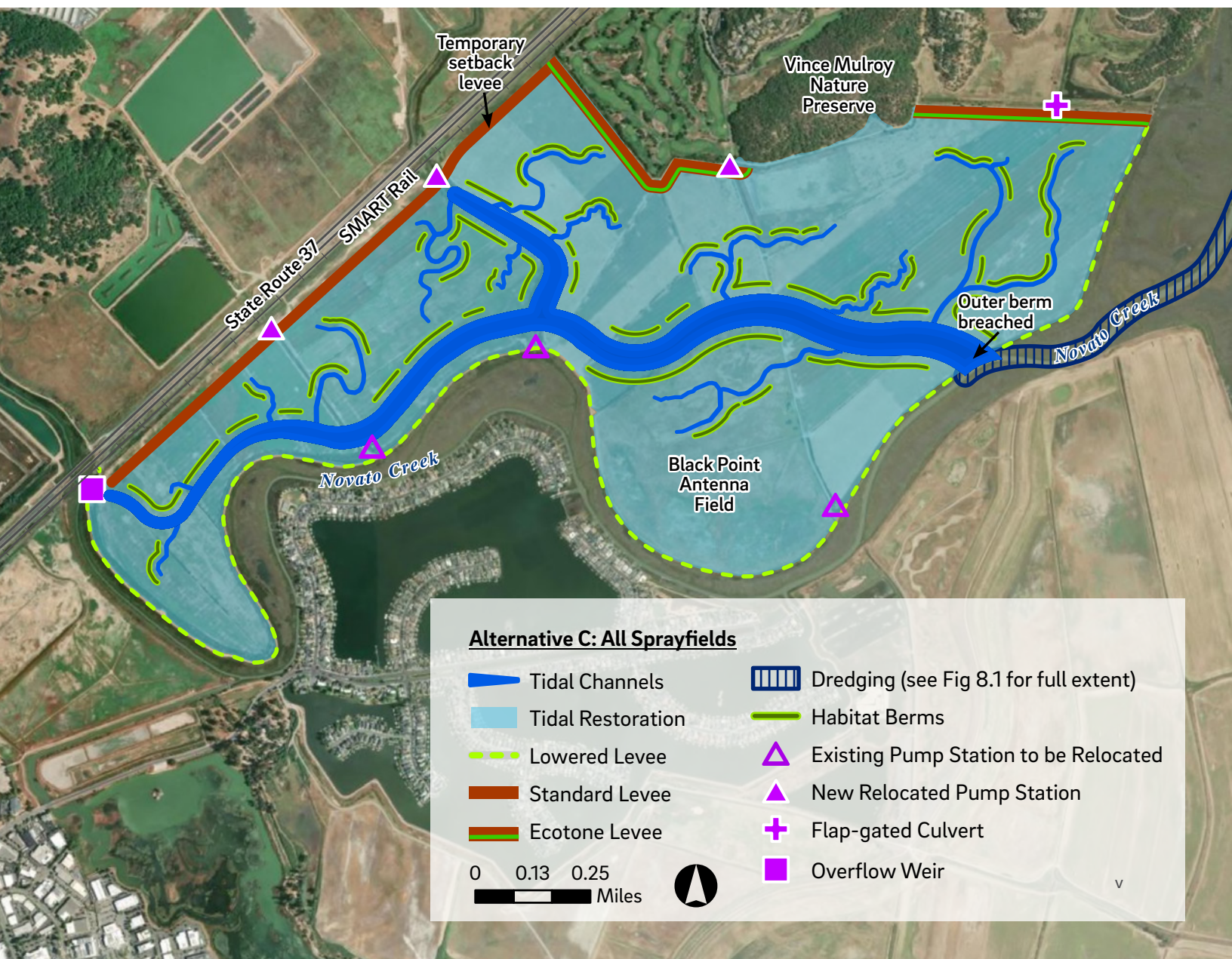
Project-Scale Restoration Alternatives

The Strategy team evaluated several near-term projects to advance the landscape-scale restoration vision, including restoration of Deer Island Basin and some or all of the Marin County sprayfields southeast of SR 37. While multiple project options performed well against the evaluation criteria, the Strategy identifies **Alternative C (All Sprayfields)** as the preferred first project to pursue (Figure ES-2). This alternative includes construction of a temporary setback levee to protect SR 37 and SMART, breaching the outer berm protecting the sprayfields, dredging Novato Creek downstream of the breach, and restoring the full area of the Marin County sprayfields and the Black Point Antenna Field to tidal habitat.

Alternative C (All Sprayfields) is the preferred first project to pursue due to the following benefits:

- **Ecological Benefit:** Restores 829 acres of tidal habitat and establishes a wetland-upland transition zone connection at the Vince Mulroy Nature Preserve.
- **Levee Maintenance:** Eliminates the need to maintain nearly 17,000 linear feet of aging, non-engineered berms.
- **Cost Efficiency:** Although the estimated total cost (\$40 million) is higher than smaller options, it is the most cost-effective at \$49,000 per acre, including flood protection and dredging in addition to restoration features.

Figure ES-2. Alternative C: All Sprayfields emerged as the preferred first project to pursue due to its cost efficiency, large restored area, and flood reduction benefits.



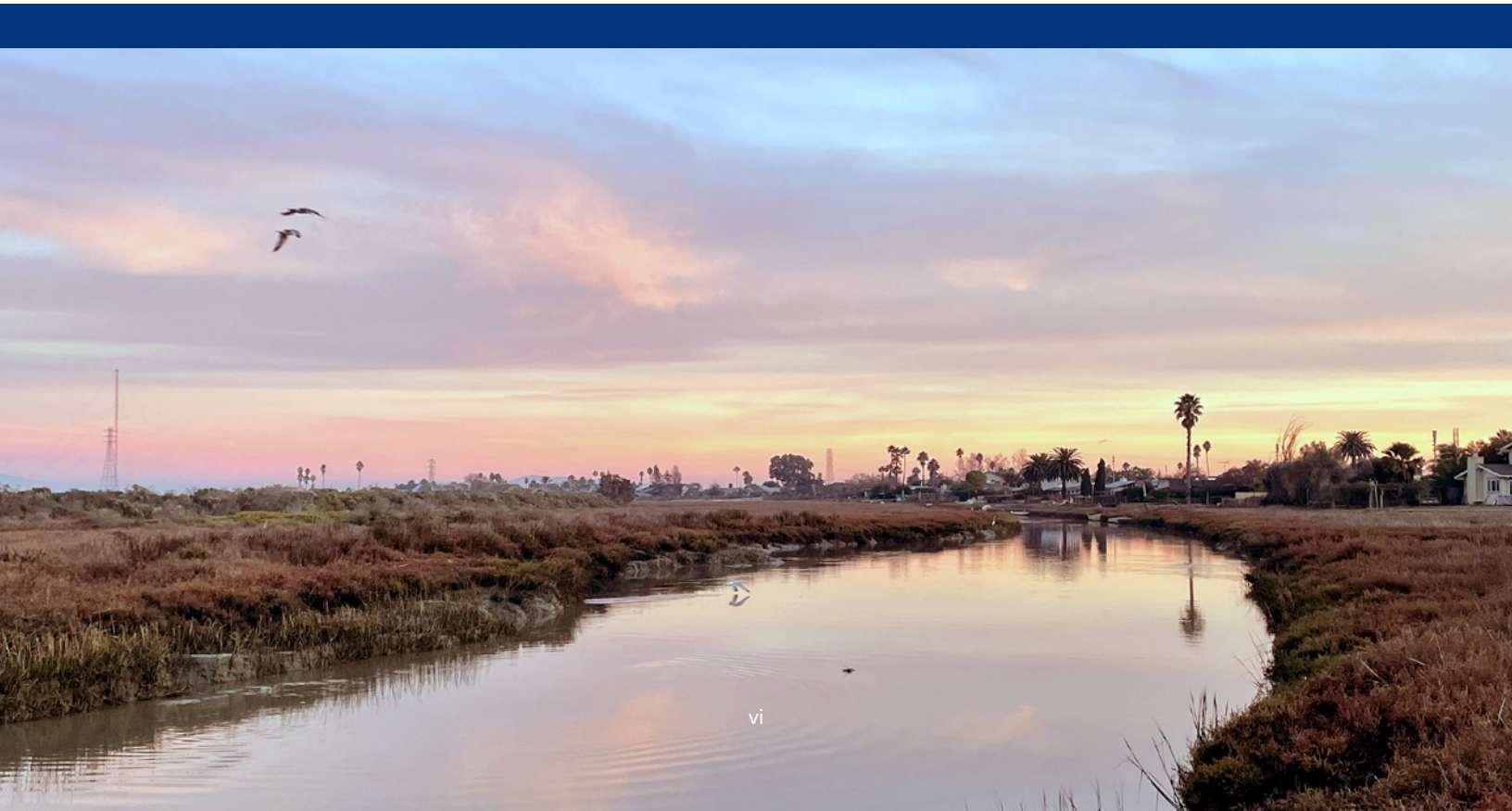
Implementation Strategy

Restoration of the Marin County sprayfields (including the Black Point Antenna Field) can proceed in the near term independently of major highway, railroad, or wastewater infrastructure modifications. Medium-term restoration projects that can proceed once infrastructure constraints are resolved and with landowner cooperation include Deer Island Basin, Lynwood Basin, the Pattern Energy basin, and the Bel Marin Keys Dredged Sediment Disposal Area. Longer-term restoration of the Simmons Slough area (Marin Audubon Society property and Novato Sanitary District Sprayfields) depends on the future elevation of SR 37 and the SMART rail line onto causeways.

The Strategy suggests possible funding sources for implementing the identified projects. Potential sources include Measure AA (SF Bay Restoration Authority) and Proposition 4 (2024 Climate Bond). Because the suggested projects align with the North Bay Baylands Regional Conservation Investment Strategy (RCIS), another possibility is Mitigation Credit Agreements (MCAs), which can fund restoration while offsetting infrastructure impacts. Given planned work on the SR37 corridor, there are likely opportunities to align restoration with infrastructure upgrades to reduce the need for purchase of mitigation credits elsewhere.

Looking Ahead

The Strategy outlines a long-term plan to restore one of the largest remaining diked bayland landscapes in San Pablo Bay. Through extensive collaboration with agencies, landowners, infrastructure operators, community representatives, and Tribal partners, the Strategy identifies restoration approaches that align baylands habitat expansion, flood risk reduction, and infrastructure resilience. By pairing a clear long-term restoration vision with achievable near-term projects, the Strategy establishes a practical pathway for implementation that can begin immediately, in tandem with adaptation of major infrastructure corridors. With sustained multi-agency coordination, these actions can support a more resilient and ecologically functional landscape that benefits both people and wildlife under changing future conditions.



GLOSSARY

Accretion: The process of sediment accumulation that increases the elevation of marshes and mudflats over time.

Baylands: The area between the maximum and minimum extent of the tides including tidal and diked habitats.

Diked baylands: Areas that were historically connected to the Bay and that would be subject to tidal influence if not for unnatural obstructions like levees and berms.

Ecotone: A transition zone between two different biological communities, such as the area where a marsh meets the upland.

Ecotone levee: An engineered flood protection structure that features a significantly wider, gentler slope on its bayward side compared to a standard levee. This gradual slope, or “ecotone slope,” creates a transitional habitat zone that mimics the natural interface between tidal marshes and upland areas.

Fluvial: Relating to a river or stream.

Geoarchaeological: The application of earth science techniques to analyze landform age and environmental factors, such as distance to water, to predict the likelihood of encountering buried or submerged archaeological resources.

Landscape-scale alternative: A broad restoration vision that considers how to connect and restore an entire baylands system across multiple properties and jurisdictions. For this strategy, landscape-scale alternatives span the Novato Creek baylands and would be implemented through a series of phased projects.

NAVD88 (North American Vertical Datum of 1988): A standard vertical reference used to establish consistent land elevations and tidal datums.

Operational Landscape Unit (OLU): Connected geographic areas sharing certain physical characteristics that would benefit from being managed as a unit in order to provide desired ecosystem functions and services. For more information, see SFEI and SPUR (2019).

Panne: Natural ponds in the marsh interior, usually less than a foot deep, that fill with water during very high tides.

Piled causeway: An elevated roadway or railway supported by piers that allows for full hydraulic connectivity and habitat movement underneath.

Progradation: Expansion of the marsh edge towards the bay.

Project-scale alternative: Option for a near-term independent restoration project that can start to build toward the landscape-scale restoration alternatives.

GLOSSARY (CONTINUED)

Setback levee: A new flood protection structure constructed further inland than the original to allow for tidal restoration of the land in between.

Subsidence: The sinking of land elevation caused by the oxidation and compaction of wetland soils after they have been diked and drained.

Thalweg: The line connecting the deepest points of a riverbed along its length.

Tidal datums: Standardized elevation reference points based on local tide phases, such as Mean Higher High Water (MHHW) or Mean Lower Low Water (MLLW).

Tidal prism: The total volume of water that flows into and out of a restored area or channel during a single tidal cycle.

Tidal scour: Natural erosion and expansion of a channel bed or banks caused by the flow of the flood and ebb tide.

Upland transition zone: The area landward of a marsh that provides high tide refugia for marsh wildlife, supports unique plant communities, and allows space for wetlands to migrate upland as sea levels rise.

ACKNOWLEDGEMENTS

We thank the members of the Technical Advisory Committee for their time, expertise, and collaboration throughout the development of the Novato Creek Baylands Strategy. Participating agencies and organizations included the Bay Conservation and Development Commission, Bel Marin Keys Community Services District, California Department of Fish and Wildlife, California State Coastal Conservancy, California State Lands Commission, Caltrans, City of Novato, County of Marin, Marin/Sonoma Mosquito and Vector Control District, Metropolitan Transportation Commission, National Marine Fisheries Service, Novato Sanitary District, Pacific Gas & Electric, Pattern Energy, San Francisco Bay Regional Water Quality Control Board, San Francisco State University, Sonoma-Marín Area Rail Transit, and the U.S. Army Corps of Engineers. Their feedback and review of draft materials substantially strengthened the final version of this report. We look forward to continuing the productive partnerships and conversations initiated through this process.

Thank you to the additional SFEI staff who contributed to the development of this report: Alex Braud, Laura Feinstein, and Ruth Askevold.

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Site visit at Deer Island. Photo by Luisa Valiela.

1. INTRODUCTION

The Novato Creek baylands represent one of the largest remaining tidal wetland restoration opportunities in the San Francisco Bay Area. Approximately 4,676 acres of undeveloped diked baylands—about 15 percent of the diked baylands in San Pablo Bay—remain disconnected from tidal influence along Novato Creek (SFEI 2025a). Most of these lands are publicly owned. This creates a rare opportunity to pursue coordinated, landscape-scale restoration that can deliver major benefits for estuarine ecosystems while also improving flood protection and lowering long-term flood infrastructure maintenance costs.

Diking and watershed modification along lower Novato Creek have resulted in extensive loss of tidal marsh habitat, reduced floodplain storage, and widespread ground subsidence. These changes have placed increasing pressure on an aging flood protection system that is vulnerable to erosion and failure, as demonstrated by repeated flooding of State Route 37 (SR 37) in 2017, 2019, and 2023. Reduced channel capacity in Novato Creek due to sediment build-up, combined with sea level rise and more intense storm events, is expected to further increase flood risk in the coming decades. Addressing these challenges will require integrated solutions that reconnect baylands to the tides, which will help move sediment through the system while also improving flood resilience for nearby communities and infrastructure.

In 2015, the San Francisco Estuary Institute (SFEI) and partners created the Novato Creek Baylands Vision, which describes a future in which restored tidal marshes along Novato Creek provide critical habitat and open up space to store floodwaters (SFEI 2015). Current and planned investments—most notably, planned upgrades to SR 37—present an opportunity to advance this vision by aligning transportation improvements with habitat restoration and flood protection goals. Careful coordination is essential to ensure that infrastructure upgrades support, rather than constrain, long-term restoration potential.

The Novato Creek Baylands Strategy (the Strategy) develops a long-term restoration vision and identifies near-term projects that work towards the 2015 Novato Creek Baylands Vision; it also builds on the approach applied to similar strategies for the Sonoma Creek and Petaluma River watersheds. The Strategy was developed in coordination with infrastructure operators, landowners, and other interested parties. It creates a sequence of restoration projects as part of a larger, coordinated effort. The sooner the projects identified in the Strategy are implemented, the more effective they will be in increasing the resilience of the Novato Creek baylands to sea level rise.

The Strategy opens with a discussion of the vision, goals, and approach (Chapter 2), followed by a description of the engagement process with project advisers and other interested parties (Chapter 3). It then provides a description of landscape evolution and existing conditions in Chapter 4, while Chapter 5 summarizes the findings of the cultural resources assessment and their relevance for future phases of design and implementation. After detailing public access considerations in Chapter 6, the document transitions to restoration alternatives: Chapter 7 lays out both near-term and long-term landscape-scale restoration alternatives, while Chapter 8 describes near-term project-scale restoration alternatives that could kick-start progress toward those broader landscape-scale goals. In Chapter 9, all alternatives are assessed according to evaluation criteria related to the project goals. Finally, Chapter 10 describes the implementation constraints associated with each project and lays out a potential timeline, followed by a discussion of next steps in Chapter 11.

2. VISION, GOALS, AND APPROACH

Strategy Vision

We envision that the future Novato Creek baylands will have expansive, connected tidal wetland habitats including marshes and mudflats. Wherever feasible, these tidal habitats will be linked to protected wetland-upland transition zone, uplands, and watersheds, which provide high tide refuge habitat and space for wetlands to migrate upslope as sea levels rise. These upland connections will also deliver freshwater and sediment to downstream habitats and allow wildlife to move between the baylands and surrounding lands. These diverse habitats will benefit native species and improve climate change resilience for wildlife and the ecological processes they depend on.

We envision that these restored and protected habitats will also provide benefits for neighboring landowners and communities, such as water quality improvement, flood protection, and recreational opportunities. Infrastructure, including transportation corridors and wastewater treatment systems, will be designed to accommodate rising seas and the movement of water, habitats, and species. Sites of cultural importance will be honored, and Tribal priorities will be centered in the restoration process. Through this strategy, the Novato Creek baylands will become a more resilient and interconnected landscape where restored ecosystems support and protect the communities and wildlife that depend on them.

Aerial view of the Novato Creek baylands. Photo by Ben Botkin, SFEP.



Strategy Goals

Goal #1: Restore tidal ecosystems to the maximum extent possible, including subtidal habitats, mudflats, marshes, and adjacent upland transition zones.

Collaborate with infrastructure agencies to remove barriers to tidal habitat connectivity and integrate tidal restoration into infrastructure upgrade projects.

Goal #2: Increase the resilience of the Novato Creek baylands and upstream areas to flooding under current and future climate conditions to benefit people and wildlife.

- Maintain, if not improve, flood protection of existing and future assets from sea level rise.
- Work with agencies to increase the resilience of critical infrastructure to sea level rise, or relocate infrastructure when possible.
- Use nature-based approaches to reduce flood risk where possible.
- Reduce levee maintenance costs by setting back levees and reducing their total length.

Goal #3: Build community and Tribal needs and priorities into the Strategy and its restoration options.

- Incorporate feedback from community members and Tribes into the Strategy, and raise local support for the Strategy among landowners, public agencies, and elected officials.
- Promote local stewardship of the wetlands as a way to strengthen community engagement with the Strategy and its implementation today and in the future.

Approach

The overarching approach to creating the Strategy was to:

- Develop a phased plan based on data, models, and prioritization to restore the Novato Creek baylands. This plan can be used to pursue funding to advance the pace and scale of habitat restoration and climate change adaptation. The cost-effective plan will have both near-term and long-term project alternatives that can be achieved with the level of funding available from existing grant programs.
- Integrate permitting considerations into Strategy development to help streamline future permitting efforts.
- Integrate the Risk Assessment and Mitigation Program (RAMP) and Regional Conservation Investment Strategies (RCIS) findings and information into the Strategy to open up options for various future restoration funding mechanisms.

3. ENGAGEMENT

Development of the Strategy relied on a purposeful and collaborative engagement process designed to ground the Strategy in the lived knowledge, operational context, and ecological priorities of the lower Novato Creek watershed. Engagement shaped how restoration opportunities were identified, how constraints were characterized, and how feasibility and implementation considerations were incorporated. Throughout the process, the Strategy team emphasized open communication, iteration, and practical alignment with on-the-ground conditions.

Engagement activities included interview-style meetings with individual entities, discussions with a Technical Advisory Committee (TAC), and annual Interested Parties meetings. Between September 2024 and June 2025, the Strategy team held 17 focused meetings with organizations responsible for infrastructure, utilities, flood and drainage systems, land and resource management, and transportation as well as private businesses and landowners. These conversations provided essential detail on access and maintenance needs, jurisdictional responsibilities, hydrologic conditions, potential restoration opportunities, and the growing risks associated with sea level rise and coastal and inland flooding.

Meeting participants represented a broad and diverse set of partners, including the San Francisco Bay Trail, California State Coastal Conservancy, U.S. Army Corps of Engineers, Novato Sanitary District (NSD), Pattern Energy, Marin County, California Department of Fish and Wildlife (CDFW), State Lands Commission, SMART, Bel Marin Keys Community Services District, City of Novato, Pacific Gas & Electric, Greenpoint Nursery, and Marin/Sonoma Mosquito Abatement District. These partners provided valuable insight into infrastructure constraints, habitat considerations, operational practices, regulatory expectations, public access goals, and community priorities.

Two TAC meetings, held in December 2024 and April 2026, added technical and regulatory guidance on sediment processes, permitting, hydrology, habitat function, and restoration feasibility. In parallel, four annual Interested Parties meetings between 2023 and 2026 created an open forum for community members, Tribal representatives, public agencies, and other interested groups to follow project progress and contribute perspectives.

The Federated Indians of Graton Rancheria were informed of and provided input to the strategy as it was being developed. A confidential Cultural Resource Assessment was completed by Far Western, a cultural resources management firm, who worked directly with the Federated Indians of Graton Rancheria to ensure cultural resources were identified in the project area and that designs were sensitive to those findings.

The cumulative input from these engagements directly shaped the Strategy. Partners helped broaden the constraints and opportunities considered in restoration planning by highlighting utility alignments, jurisdictional boundaries, private land ownership, access limitations, land use changes, and specific community and Tribal priorities. Feedback gathered from the interview meetings informed adjustments to site-specific recommendations at both parcel and project scales, ensuring that local context and operational needs were appropriately reflected. Partner input influenced the design and comparison of restoration alternatives, helping balance ecological objectives with flood risk management, infrastructure protection, community needs, and practical implementation pathways.

As project concepts evolve toward implementation, continued engagement with local landowners, regulators, Bel Marin Keys community members, the Federated Indians of Graton Rancheria, and public land managers will be essential to support coordinated and effective restoration outcomes.

The resulting Strategy reflects the shared insight and commitment of regional and local partners to support resilient baylands capable of adapting to climate change while accommodating essential infrastructure and community needs.

Deer Island. Photo by Ellen Plane, SFEI.



4. EXISTING CONDITIONS

Study Area

The study area for this Strategy was adapted from the Novato Operational Landscape Unit (Figure 4.1). Operational Landscape Units, or “OLUs,” are planning units that were created for the Bay Area in the San Francisco Bay Shoreline Adaptation Atlas (SFEI and SPUR 2019). OLUs are geographically connected areas with similar physical landscape characteristics that allow land managers to plan for climate impacts using natural landscape boundaries rather than jurisdictional ones. Because management actions in one part of an OLU are likely to affect

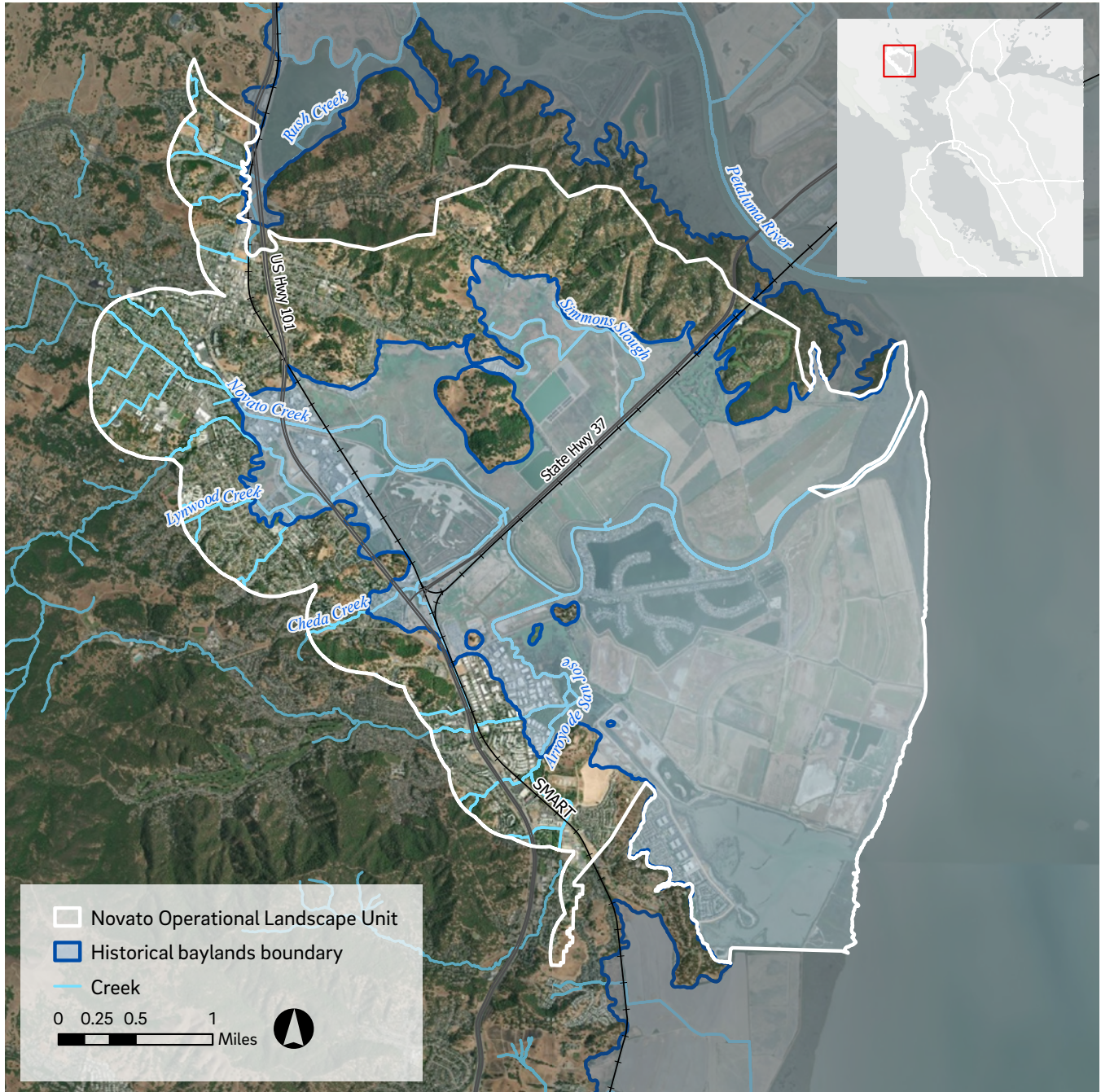


Figure 4.1 Study area map for the Strategy; the Strategy focuses primarily on the area within the historical baylands boundary (dark blue outline) east of the North-South SMART rail line.

other areas, managing the entire OLU as a single unit supports more effective, ecologically resilient climate adaptation planning at an appropriate scale.

This report is a restoration and resilience strategy for the Novato Creek baylands, not a sea level rise adaptation plan for the OLU or the communities within it. Thus, the Strategy specifically focuses on the undeveloped historical baylands and adjacent undeveloped uplands of the Novato OLU. To help analyze and describe variation in conditions and ownership across this landscape, the study area is divided into 22 parcel-based units, as shown in Figure 4.2 and Table 4.1. This strategy does not cover the City of Novato, Bel Marin Keys, or any other urbanized portions of the OLU, including the area west of the North-South SMART rail line. Key locations referenced in the Strategy are shown in Figure 4.3.

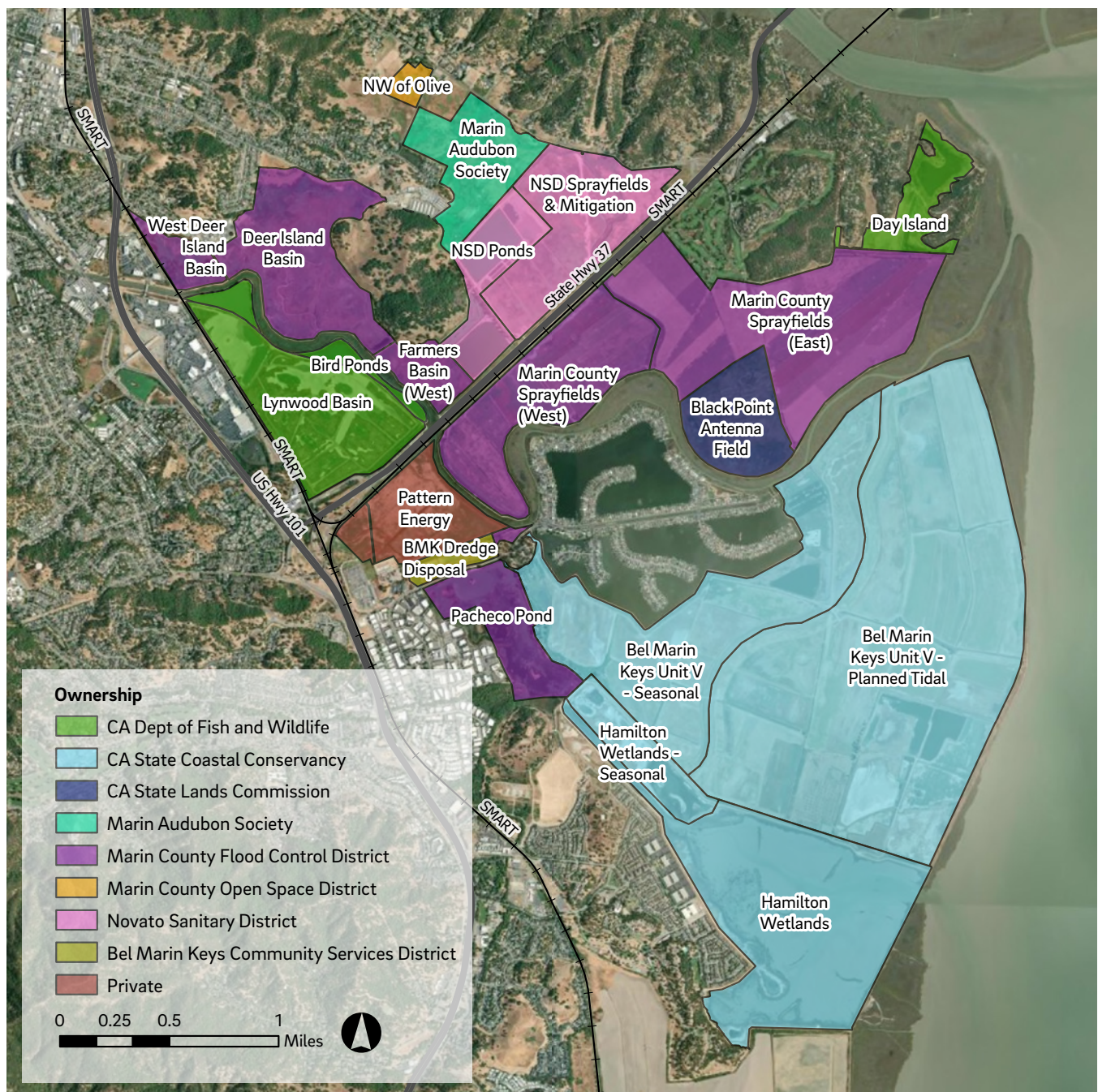


Figure 4.2. The named units described in the Strategy. The boundaries and ownership are based on parcel data provided by Marin County.

Table 4.1. Ownership, acreage, and average elevation of each unit shown in Figure 4.2. Elevations based on the digital elevation model compiled for the Baylands Habitat Map 2020 (WRMP 2025). CDFW is California Department of Fish and Wildlife.

Unit	Owner	Acres	Elevation (Ft NAVD)
BMK Dredge Disposal	Bel Marin Keys Community Services District	28	7.6
Bird Ponds	CDFW	40	Unknown
Day Island	CDFW	82	1.3
Lynwood Basin	CDFW/State Lands Commission	255	3.2
Bel Marin Keys Unit V - Seasonal	CA State Coastal Conservancy	523	-2.5
Bel Marin Keys Unit V - Planned Tidal	CA State Coastal Conservancy	1,261	-2.6
Hamilton Wetlands - Seasonal	CA State Coastal Conservancy	92	5.7
Hamilton Wetlands - Tidal	CA State Coastal Conservancy	529	3.5
Black Point Antenna Field	CA State Lands Commission	128	-0.6
Marin Audubon	Marin Audubon Society	140	1.1
Deer Island Basin	Marin County Flood Control District	244	2.4
Farmers Basin (West)	Marin County Flood Control District	50	1.5
Marin County Sprayfields (East)	Marin County Flood Control District	458	0.4
Marin County Sprayfields (West)	Marin County Flood Control District	259	0.8
Pacheco Pond	Marin County Flood Control District	117	Unknown
West Deer Island Basin	Marin County Flood Control District	41	3.8
NW of Olive	Marin County Open Space District	18	2.9
NSD Ponds	Novato Sanitary District	113	Unknown
NSD Sprayfields & Mitigation	Novato Sanitary District	230	0.6
Pattern Energy	Private	134	1.0

Pacheco Pond, October 2024. Photo by Jeremy Lowe, SFEI.



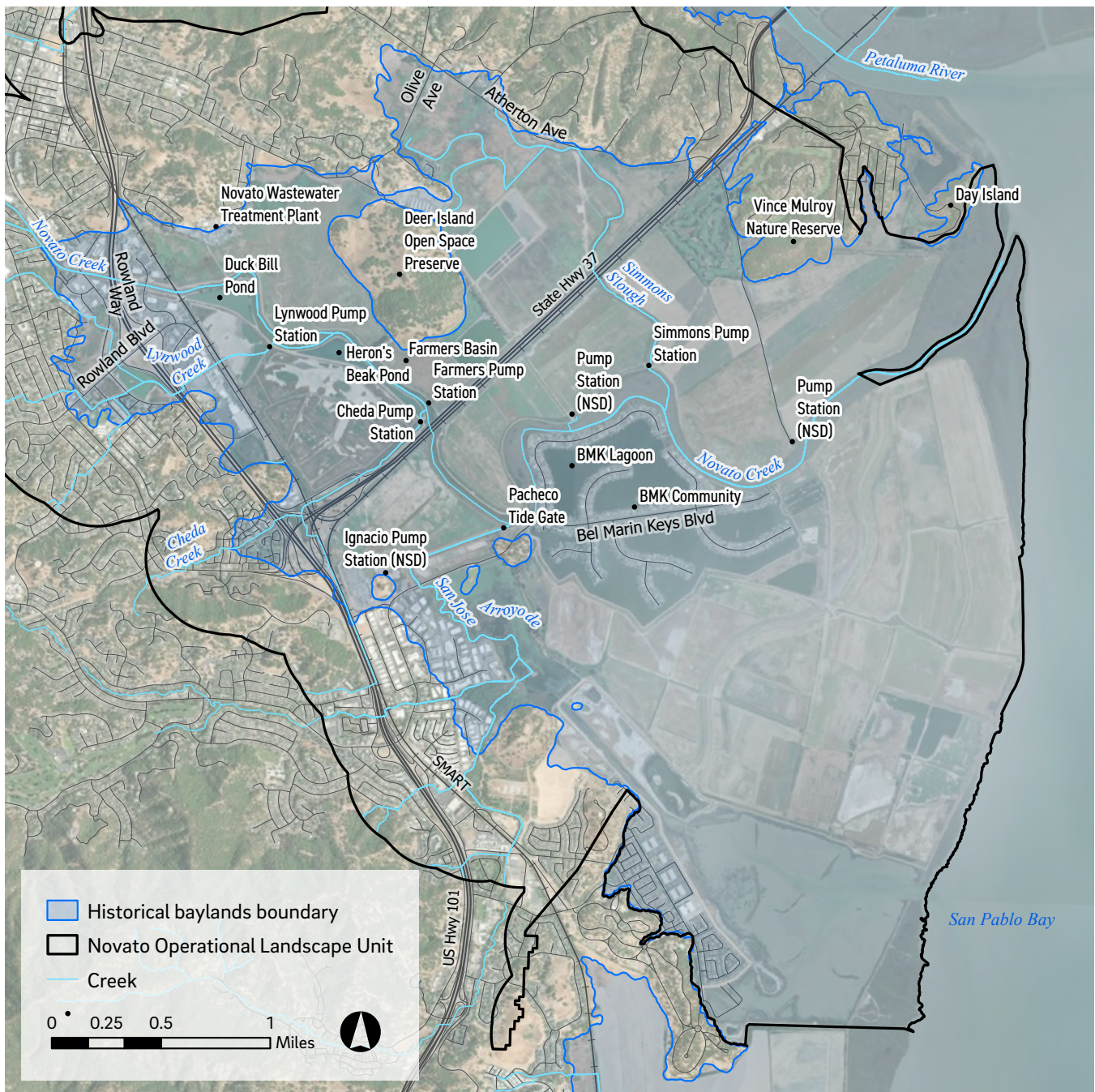


Figure 4.3. Key locations referenced in the Strategy.

The historical and contemporary conditions of the Novato Creek baylands were documented by SFEI in the Novato Creek Baylands Vision (SFEI 2015) and the Novato Creek Baylands Historical Ecology Study (Salomon et al. 2015). Information from the historical ecology study is repeated in this document for ease of use; both the "Historical Landscape" and "Contemporary Landscape" sections below are taken directly from that study, with some updates to reflect changes in contemporary conditions in the last decade. The study area for the historical ecology study differs slightly from the Novato OLU, extending around Black Point west of Day Island. These additional areas are included in the tidal marsh metrics (e.g., area, channel length) presented in this section but are a small part of the total. For more information on the historical ecology study and its methods, please visit: <https://www.sfei.org/documents/novato-creek-baylands-historical-ecology-study>.

Historical Landscape

In the mid-1800s, lower Novato Creek was surrounded by an extensive tidal marsh extending from Black Point to Long Point (near Hamilton Wetlands), and from San Pablo Bay to west of present-day US-101 (Figure 4.4). A broad, fringing tidal flat over one mile wide separated the tidal marsh from San Pablo Bay at low tide. The tidal marsh was bisected from west to east by Novato Creek's mainstem channel, which followed a route similar to that occupied by the channel today.

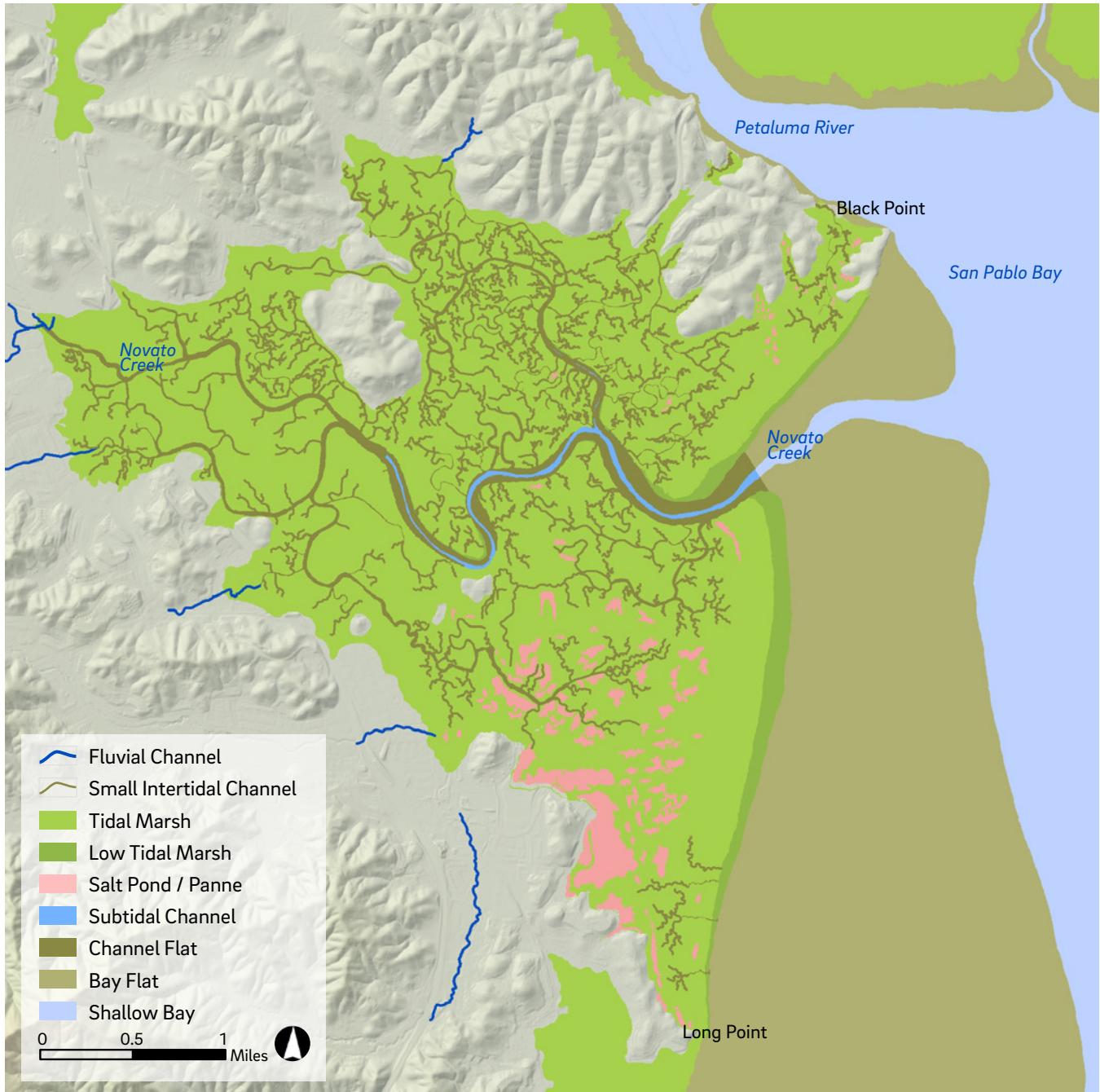


Figure 4.4. Historical habitats of the Novato Creek baylands, mid-1800s. Source: Novato Creek Baylands Historical Ecology Study, Salomon et al. 2015.

Bayland Habitat Types

Prior to significant Euro-American modification, the Novato Creek baylands covered approximately 8,070 acres at the downstream end of Novato Creek. Tidal marsh plain covered nearly 4,490 acres and was laced by a network of over 100 miles of channels in a dendritic tidal channel network. Novato Creek's mainstem made up only about five miles of the historical tidal channel length. More than one hundred pannes dotted the marsh interior, and over 2,000 acres of wide mudflats occurred along the margins of San Pablo Bay.

Four distinct zones of the tidal marsh were inferred from historical sources (Figure 4.5). The largest zone consisted of well-drained tidal marsh (Figure 4.5, area B), evidenced by a high density of tidal channels and few marsh pannes. To the east of this primary zone, a wave-built berm (Figure 4.5, area A) along much of the shoreline north and south of Novato Creek's mouth restricted tidal channel connection to the Bay. From this berm, small tidal channels drained westward, ultimately emptying into the mainstem of lower Novato Creek rather than draining eastward toward San Pablo Bay. In the third zone (Figure 4.5, area C), the presence of pannes and a lower density of tidal channels indicates that tidal flow was more obstructed, resulting in ponding. This area was likely slightly higher in elevation than most of the marsh plain (though not as high as the wave-built berms), in part due to sediment deposition from smaller creeks (Arroyo San Jose and Arroyo Pacheco) draining into the marsh. The fourth zone of freshwater influence (Figure 4.5, area D) was associated with areas where Novato Creek and smaller creeks entered the tidal marsh, supplying freshwater and sediment from their respective watersheds. The extent of freshwater influence would have varied annually and seasonally based on streamflow, but there is not sufficient data to quantify the size range of this zone. Ecologically, the zone of freshwater influence was a transition zone between tidal and fluvial habitats.

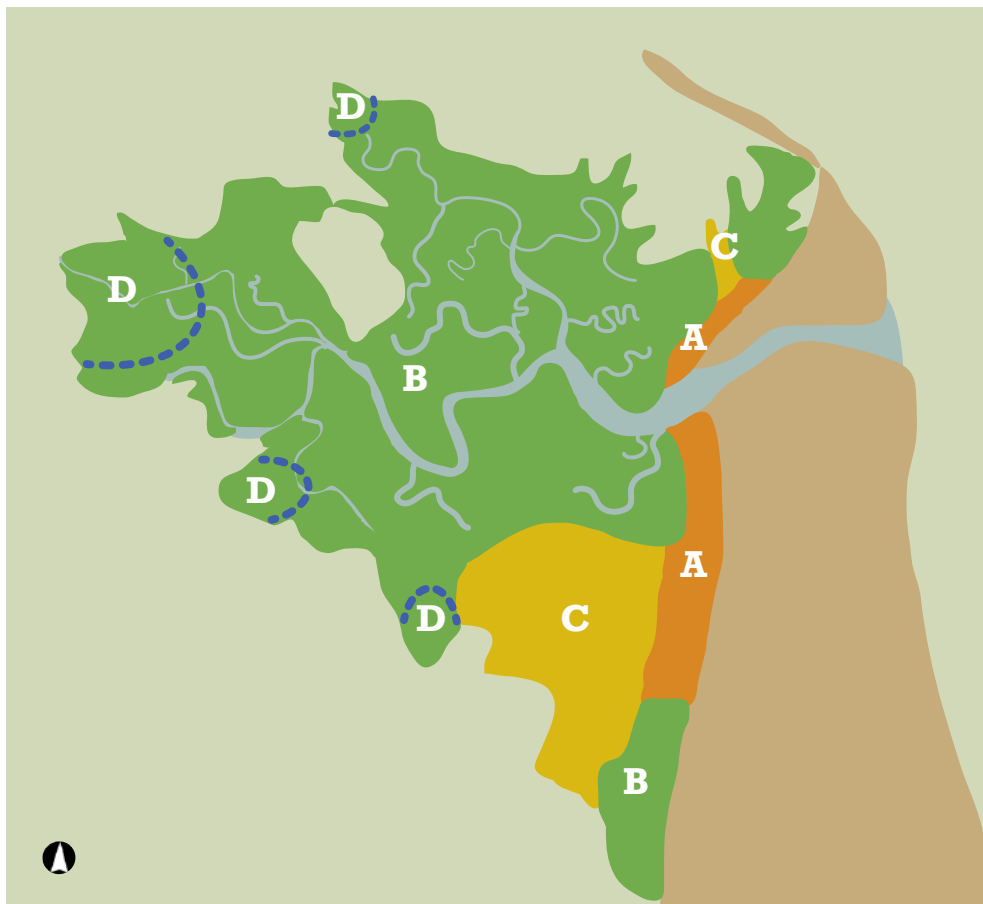


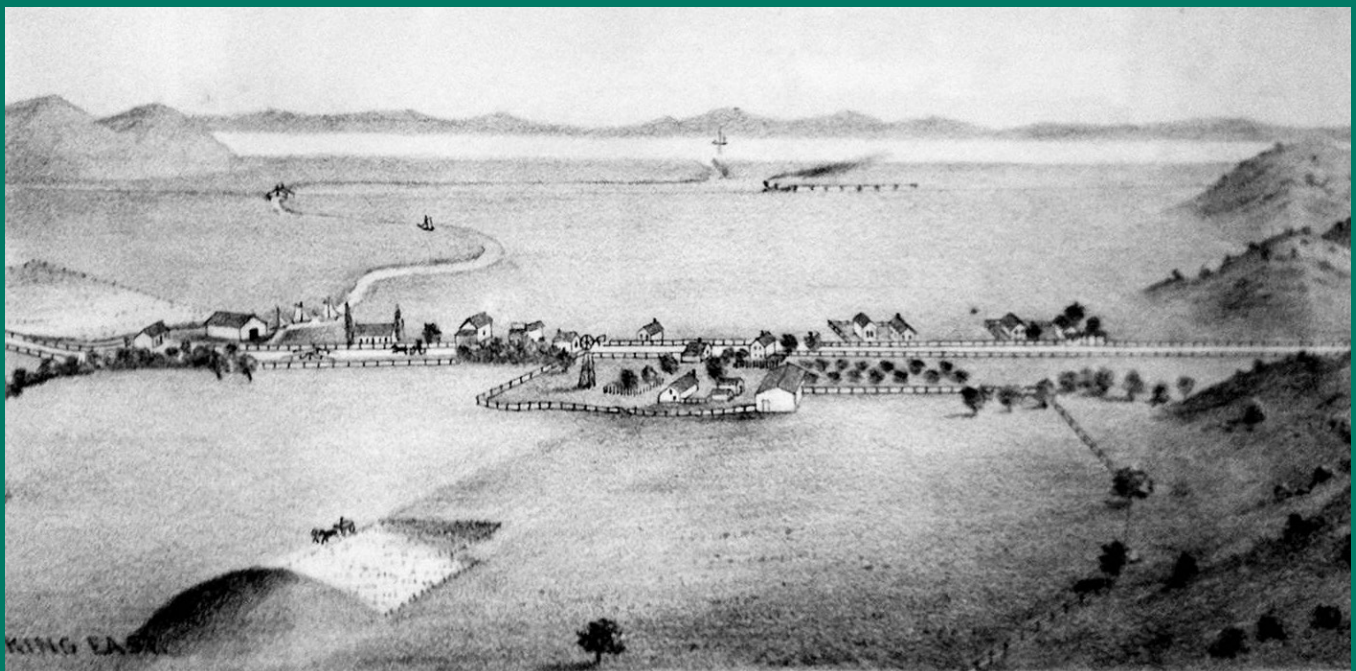
Figure 4.5. Four distinct zones of the historical tidal marsh in the Novato Creek baylands. (A) A wave-built berm, (B) well-drained tidal marsh, (C) less well-drained tidal marsh with an abundance of pannes, and (D) areas of freshwater influence where creeks entered the baylands. Source: Novato Creek Baylands Historical Ecology Study, Salomon et al. 2015.

Transition Zone

The Novato Creek baylands historically supported both a flatter (low-gradient, alluvial plain) and a steeper (high-gradient, hillslope) tidal-terrestrial interface. The low-gradient interface type made up 8 miles (36%) of the interface, in the lowland areas where Novato Creek and smaller creeks entered the marsh. In contrast, the high-gradient interface (15 miles, 64%) was found at the base of hillslopes adjacent to the tidal marsh, including Deer Island and several other hills surrounded entirely by marsh. While they composed the majority of the Novato Creek baylands tidal-terrestrial interface, steep transition zones were not as common elsewhere around the Bay. Comparable historical examples of this interface include the Coyote Hills near Hayward and the hills of the Richmond Potrero.

KEY TAKEAWAYS FOR THE STRATEGY

- » Until the mid-1800s, tidal marsh made up most of the Novato Creek baylands (~5,000 acres of tidal marsh).
- » This large expanse of tidal marsh had an extensive tidal channel network; the creek's mainstem accounted for only about five miles of the 100+ total miles of channels.
- » The historical Novato Creek baylands had four tidal marsh zones: a wave-built berm; extensive well-drained marsh with dense channels and few pannes; smaller poorly drained marsh with many pannes, indicating restricted tidal flow; and freshwater-influenced areas near creeks delivering water and sediment.
- » These baylands had areas of both flatter and steeper transition zones, with the steeper transition zone making up most of this habitat type.



A lithograph (ca. 1870) shows extensive tidal marshes connected to natural transition zones, and a wider and deeper Novato Creek navigable by schooners. Courtesy of The Bancroft Library, UC Berkeley.

Contemporary Landscape

The Novato Creek baylands have experienced a dramatic reduction in tidal extent and habitat area since the mid-1800s, beginning with intensive diking and filling in the second half of the 19th century. The current extent of tidal marsh is now greatly diminished compared to its historical extent. Areas of new marsh have formed, though they are relatively small compared to the historical extent. They include ~650 acres of recently restored marsh at Hamilton Wetlands, narrow fringing marsh along lower Novato Creek, and a wider fringe of marsh along the San Pablo Bay shoreline, which expanded out into the Bay during a period of high sediment flows to the Bay resulting from hydraulic mining in the Sierra Nevada (Figure 4.6). The once-extensive tidal channel network has been simplified and greatly diminished in drainage area. These losses are associated with corresponding decreases in ecological function provided by the baylands.

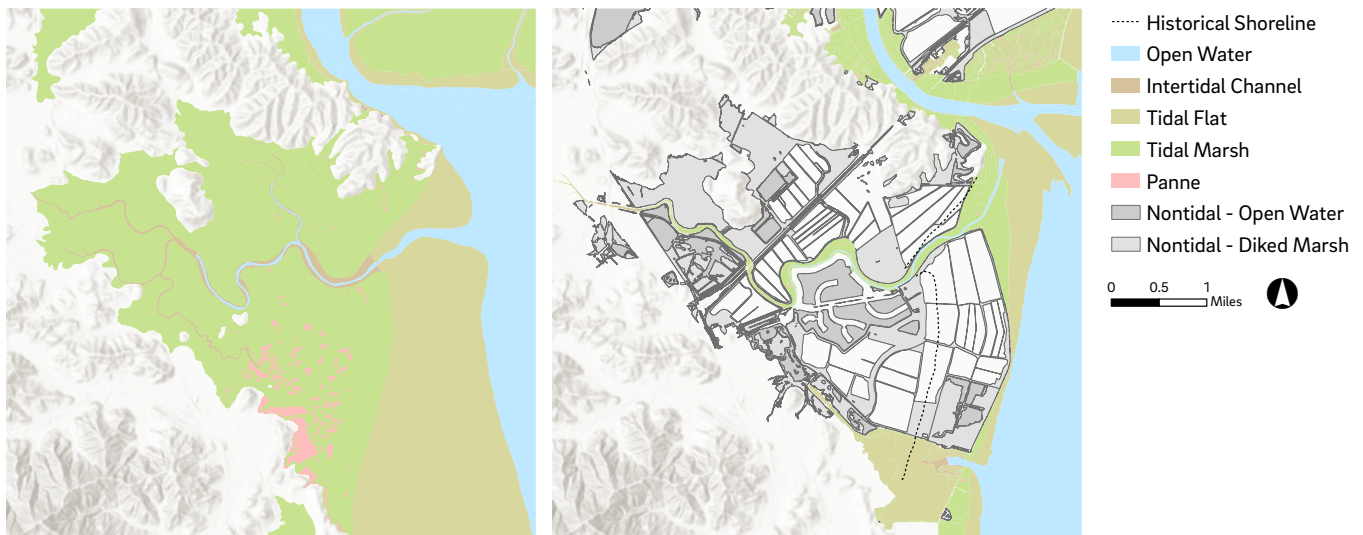


Figure 4.6. The extent of tidal wetlands has been greatly reduced within the Novato Creek baylands.

Novato Creek and Tidal Channel Network

In the contemporary Novato Creek baylands, the total channel length is 18 miles, representing a net decrease of 85% compared with historical channel length (Figure 4.7). The total includes channels in newly formed tidal marsh at the mouth of Novato Creek. It does not include the even-newer channels forming in the Hamilton Wetlands restoration site. Today, lower Novato Creek's mainstem is 6.4 miles long, one mile longer than it was historically because of the bayward expansion of diked baylands. However, the length of Novato Creek's tributaries and side channels has been reduced by 94%, from 98 miles to 6 miles.

Bayland Habitat Types

Prior to the Hamilton Wetlands restoration, the Novato Creek baylands had experienced an 83% loss in estuarine habitats (tidal marsh and channels, mudflat, salt pannes, and channel open water) within the Novato Historical Ecology Study's analysis area, dropping from 8,070 acres historically to 1,390 acres in the 21st century (Figure 4.8). Since the publication of the historical ecology study, the Hamilton Wetlands restoration has added back 650 acres of evolving estuarine habitat. Only 540 acres of tidal marsh were present in the Novato OLU in 2020, compared to 4,490 acres in the mid-1800s, representing a reduction of nearly 90% of the OLU's historical tidal marsh (WRMP 2025). In addition, the historical estuary consisted of large, contiguous areas of marsh, while today, the marshes near Novato Creek are smaller and more fragmented.

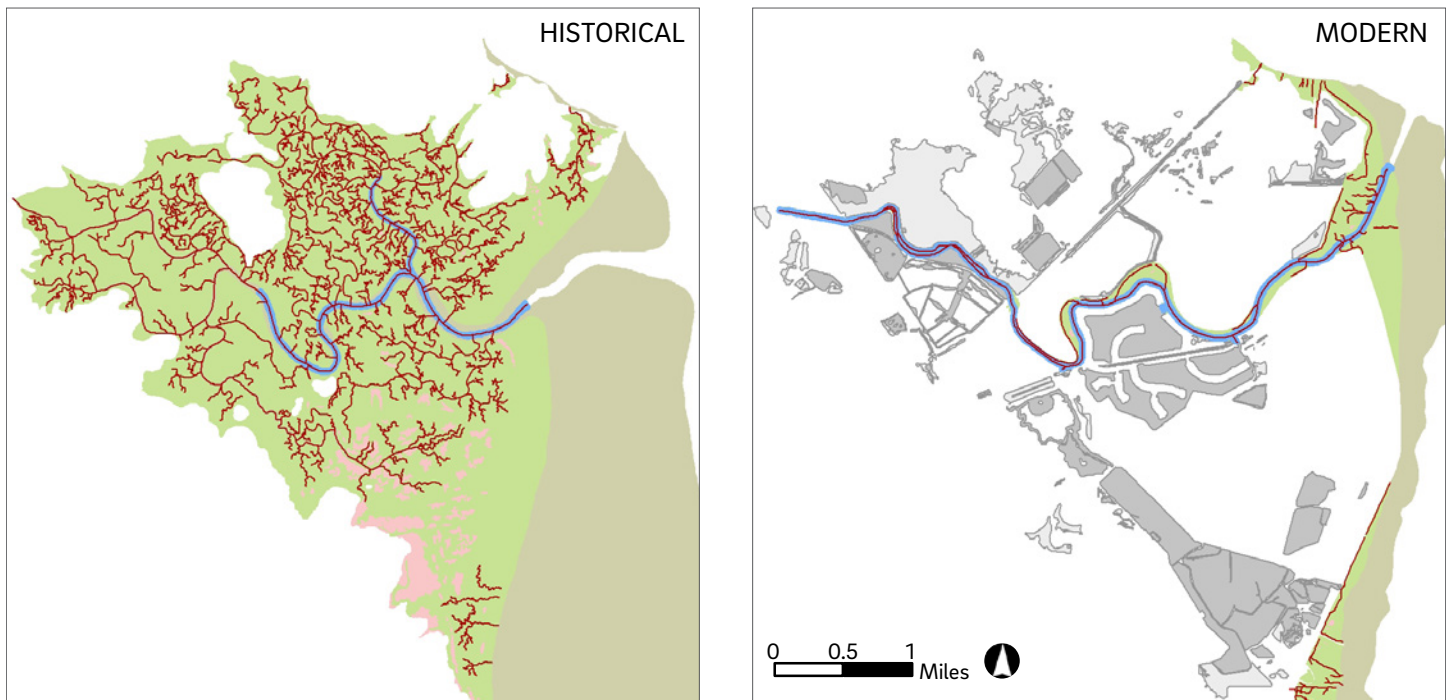


Figure 4.7. Historical and contemporary channel length for Novato Creek mainstem and tributaries. Modern map (right) is pre-breach of the Hamilton Wetlands and does not account for tidal channels forming at the site. Source: Novato Creek Baylands Historical Ecology Study, SFEI 2015.

■ Mainstem
■ Tributaries

Other historically prevalent habitat types have also been reduced in extent over the past century and a half. Of all the habitat types mapped, salt ponds/pannes have experienced the most dramatic reduction in extent, with a loss of 99% of their former area. Today, the Novato OLU has only 5 acres of tidal ponds/pannes (WRMP 2025). The mudflat along the eastern edge of the study area has experienced a 75% reduction in area due to the expansion of the fringing tidal marshes at the mouth of Novato Creek.

Habitat types have changed not just in extent, but in location. Most of the contemporary marsh (excluding the Hamilton Wetlands restoration site) is found in places where tidal marsh was not historically present, in areas that were historically tidal flats, channels, or shallow bay.

The contemporary diked baylands are dominated by low-lying undeveloped tracts, residential neighborhoods, flood and sanitation infrastructure, and wetland restoration projects (ongoing and planned). Flood and sanitation ponds, along with the managed lagoons of Bel Marin Keys, create non-tidal open water areas within the historical baylands footprint. In total, there are 690 acres of non-tidal open water and 2,030 acres of non-tidal vegetated wetland in the Novato OLU (WRMP 2025).

Transition Zone

The length of the natural transition zone between tidal marsh and terrestrial or upland habitats has decreased by nearly 100%, including the complete disappearance of the low-gradient interface. Remnants of the high-gradient interface are located at Day Island. Today, the tidal marsh is mostly lined by steep-sloped berms and levees constructed to confine Novato Creek and protect surrounding lands from flooding. Some transition zone was created as part of the Hamilton Wetlands restoration project.

KEY TAKEAWAYS FOR THE STRATEGY

- » Nearly all of the historical habitat (primarily tidal marsh) in the Novato Creek baylands has been lost due to diking and filling. Today, tidal marsh is restricted to narrow bands along the leveed Novato Creek channel, at the creek mouth, and at the restored Hamilton Wetlands, which added back 650 acres of estuarine habitat.
- » The once-extensive tidal channel network has also been severely diminished, with only 18 miles of channel remaining (85% decrease). The mainstem of Novato Creek makes up much of this length, rather than the smaller channels that historically made up most of the tidal channel network.
- » The Novato Creek baylands habitats have not only changed in their extent, but also their location; remaining habitat mostly exists in areas where it was not present historically.
- » Transition zone habitat has been almost entirely eliminated in the Novato Creek baylands, and flatter areas of transition zone are now completely gone.

View of Black Point from SR 37. Date unknown.



Elevation

Tidal elevations vary along the complex San Francisco Bay shoreline, and tidal elevations and ranges are important determinants of ecological conditions. Therefore, local tidal datums are essential to understanding current environmental conditions and provide important baseline information for analyzing impacts of sea level rise. Tidal datums measured using local tide gauges on Novato Creek are shown in Table 4.2. Ground elevations relative to generalized tidal datums for the Novato OLU are shown in Figure 4.8.

Table 4.2. Tidal datums for the Novato OLU. Source: SFEI 2025b. The average elevation of the higher of the two daily tides is Mean Higher High Water (MHHW); the average elevation of the lower of the two daily tides is Mean Lower Low Water (MLLW). Mean High Water (MHW) is the average of all the high-water elevations and Mean Low Water (MLW) the average of low-water elevations. Mean Sea Level (MSL) is the mean of observed water levels. These tidal datums are based on water levels in the Bay and do not account for tidal differences extending up the Novato Creek channel.

Tidal Datums (Feet NAVD)	Novato OLU
MHHW	6.2
MHW	5.6
MSL	3.4
MLW	1.1
MLLW	0.1

Low-lying diked baylands filled with stormwater, January 2023. Photo by Justin Lewis, courtesy Sonoma Land Trust.



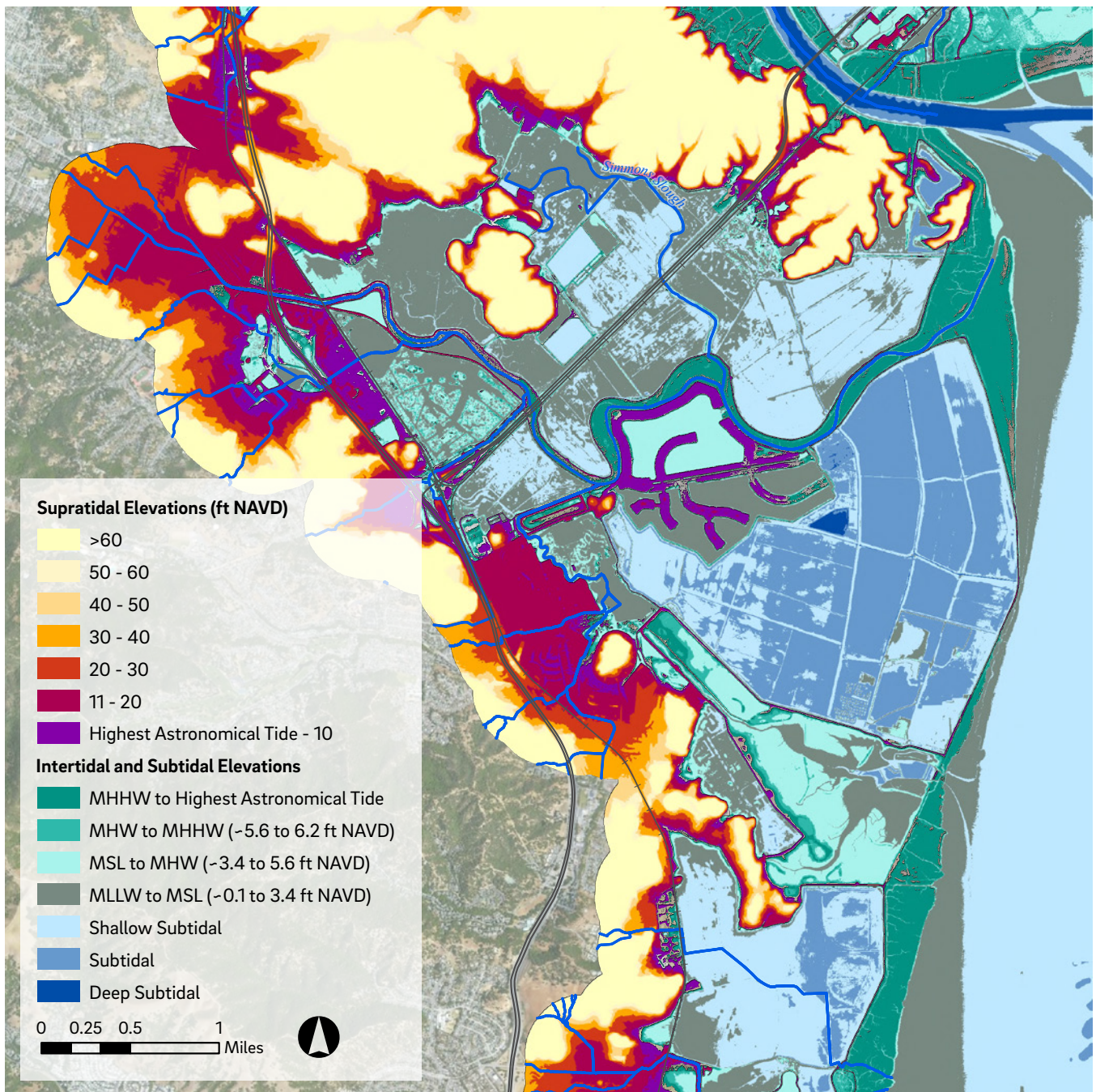


Figure 4.8. Elevations of the Novato Creek baylands (digital elevation model from WRMP 2025).

The diked baylands of the Novato OLU have subsided from their former tidal marsh elevations as wetland soils have oxidized and compacted over time (Figure 4.9). The most subsided areas are those nearest to the Bay, at Bel Marin Keys Unit V and the Marin County sprayfields. If restored without placement of additional fill, these areas will initially be subtidal open water habitat. Upstream and closer to the City of Novato, baylands are higher in elevation and will be mostly at mudflat elevations when initially restored. Average elevations for the baylands in each unit were calculated and are shown in Figure 4.10. The upper boundary for the elevation analysis was drawn using the upper boundary of the historical baylands.

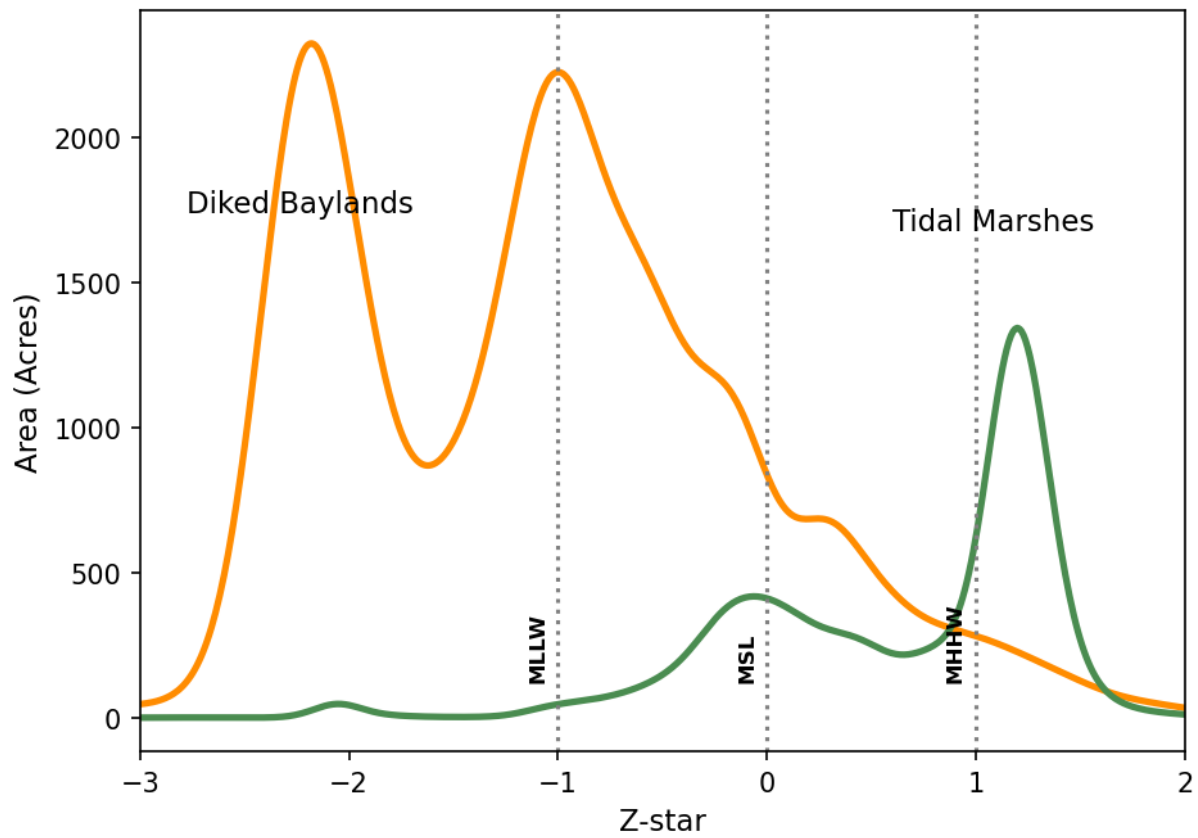


Figure 4.9. The Novato OLU's diked baylands are heavily subsided compared to its tidal marshes. Elevations are based on the digital elevation model from the Baylands Habitat Map 2020 (WRMP 2025). Z-star is a dimensionless measure of elevation relative to the tides.

Diked baylands (left), berm (center), and tidal marsh in the Novato Creek channel (right). Photo by Ellen Plane, SFEI.



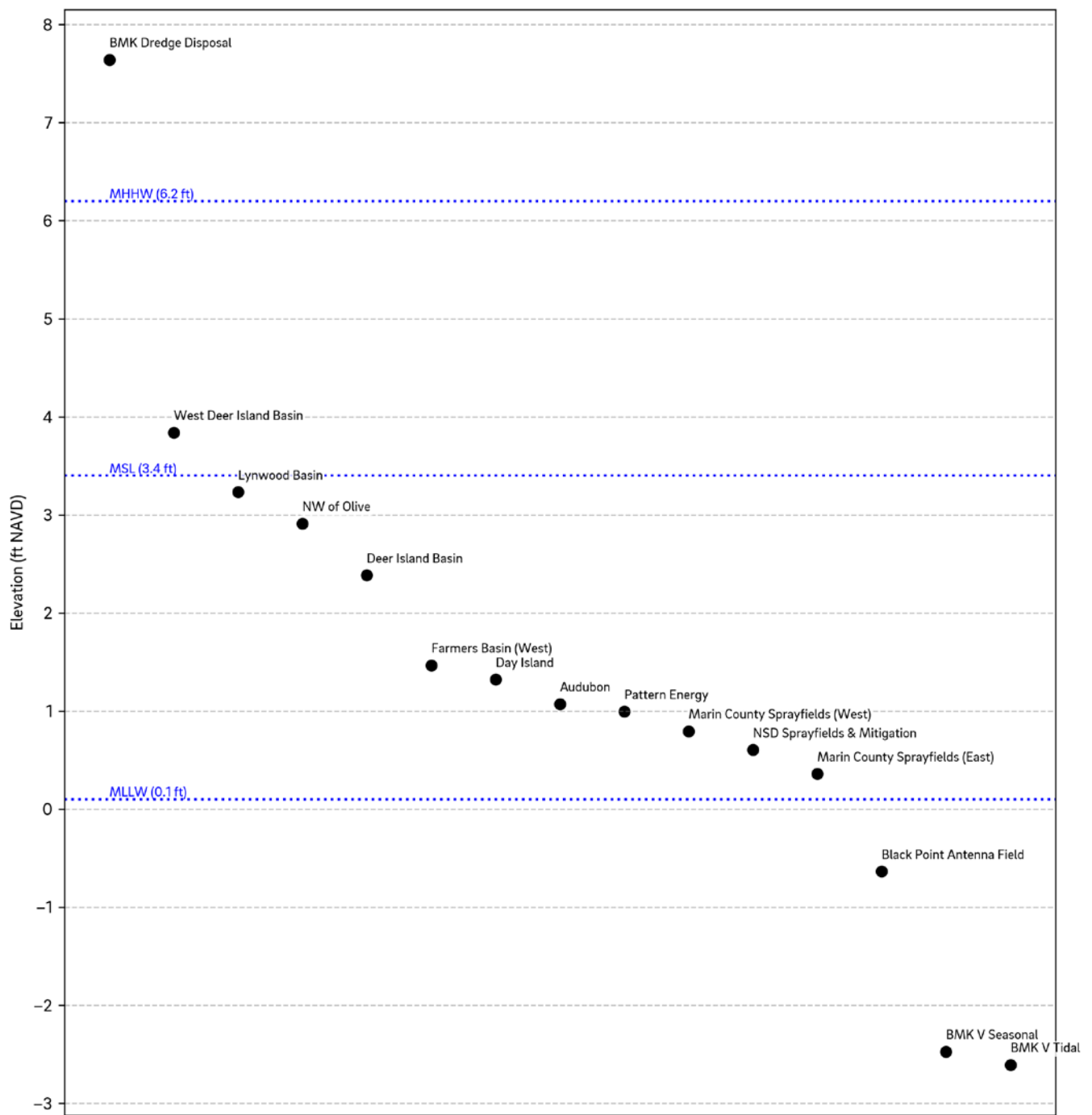


Figure 4.10. Average elevation of diked baylands. Tidal datums are averaged for the Novato OLU (Table 4.1). Elevations for Hamilton Wetlands, Bird Ponds, and Lynwood Basin are not included as the digital elevation model captures water surface elevations rather than ground elevations in these areas. The locations of each unit are shown in Figure 4.2. Digital elevation model from Baylands Habitat Map 2020 (WRMP 2025).

Habitats

Though significant areas of tidal habitat have been lost the study area still supports a range of habitat types today. Much of what used to be tidal marsh has been transformed into other habitat types. The main habitat types within the planning area include tidal marsh, diked wetland, agriculture, and grassland (Figure 4.11).

Tidal Waters

Brackish to saline subtidal open water and intertidal mudflat habitat exists in the Novato Creek channel, at the restored Hamilton Wetlands, and along the San Pablo Bay shoreline. Most of this area is within intertidal elevations and is mudflat at low tides, but parts of the Novato Creek channel bed and the main channel within the Hamilton wetlands are at subtidal elevations.

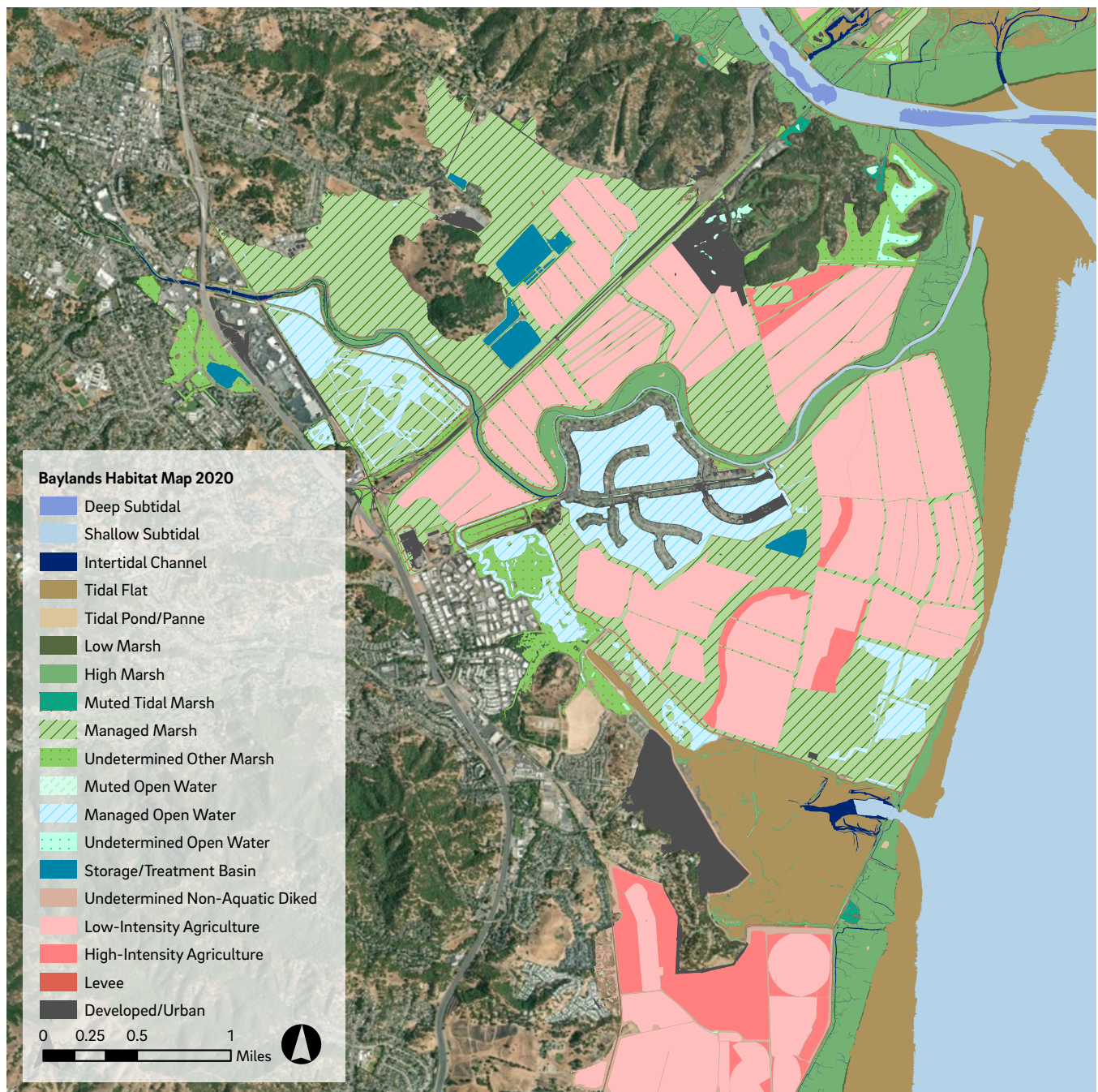


Figure 4.11. Modern baylands habitats (Baylands Habitat Map 2020, WRMP 2025).

Tidal Marsh

Vegetation in fringing tidal marshes is dominated by California cordgrass (*Spartina foliosa*) in the low marsh and pickleweed (*Sarcocornia pacifica*) in the mid- and high marsh. As tidal marshes become more brackish further up Novato Creek and north of SR 37, the mid- and high marsh are more dominated by alkali bulrush (*Bolboschoenus maritimus*). Other common plants found within tidal marshes in the study area include gumplant (*Grindelia stricta*), saltgrass (*Distichlis spicata*), jaumea (*Jaumea carnosa*), and alkali heath (*Frankenia salina*). Tidal marsh is included as a focal other conservation element in the North Bay Baylands Regional Conservation Investment Strategy (NBB RCIS) (ESA 2024).

Tidal marshes in San Francisco Bay can generally be classified into different evolutionary stages or age classes based on a variety of important physical and biological attributes. Large millennial tidal marshes, which are high value wetlands that were formed 2,000 to 5,000 years ago (e.g. Petaluma Marsh), are no longer found within the Novato Creek baylands. The other two evolutionary stages that are found within the Novato Creek baylands are new tidal marshes and centennial tidal marshes.

New tidal marshes are generally immature, low-elevation marshes at the early stages of evolution, and are most often found at recent restoration and mitigation projects aimed at recovering tidal wetland acreage. However, they can also be observed at areas along prograding shorelines (where sediments have naturally accumulated at high enough elevations to support colonization by wetland vegetation) and in areas along the upland-estuarine transition zone (where tidal wetland habitats migrate over adjacent terrestrial habitats due to sea level rise). Characteristics of new tidal wetlands often include extensive subtidal and/or intertidal mudflats, an immature tidal channel network, a general lack of high tide refugia, and vegetation dominated by low marsh species such as California cordgrass. New tidal wetlands within the planning area include Hamilton Wetlands.

Centennial tidal marshes are a large category of tidal wetlands that are mostly between 50 and 150 years old. Fringing infill wetlands and fringing overwash wetlands are the types of centennial tidal marshes present in the Novato Creek baylands. The marshes at the mouth of Novato Creek are fringing overwash wetlands, which are formed by wave- and current-driven deposition of sediment and debris; they typically occur high in the intertidal or supratidal zone and are characterized by limited tidal channels and retention of floodwaters on the marsh plain. The tidal marshes found along Novato Creek are fringing infill wetlands: narrow, linear wetlands that form along tidal channels. These wetlands form in response to leveeing along the creek, which reduces daily tidal flows and causes sediment deposition. A special characteristic of these marshes is the parallel arrangement of the channels, owing to the uniform slope of the marsh plains toward the larger channels they fringe.

Non-Tidal and Muted Wetland

Muted and non-tidal freshwater and brackish wetlands and ponds occur in diked areas at Pacheco Pond, Lynwood Basin, West Deer Island Basin, Deer Island Basin, Farmer's Basin, Heron's Beak Pond, Duck Bill Pond, Simmons Slough, Bel Marin Keys V and Bel Marin Keys Lagoon (Figures 4.2 and 4.3). Water in these areas is typically managed through the use of culverts, weirs, and/or pumps. There is also non-tidal pond and wetland habitat within the mitigation wildlife pond located in the NSD managed area north of SR 37. These ponds and wetlands are dominated by different vegetation depending on the hydrology, salinity, and soils, but some common vegetation includes cattails (*Typha angustifolia*), pickleweed, alkali bulrush, and other native and non-native plant species. The non-tidal and muted ponds and wetlands provide habitat for local wildlife, as well as foraging and roosting habitat for overwintering and migrating waterbirds.

A riparian and seasonal wet meadow area also occurs where Arroyo San Jose and Pacheco Creek flow into the southern end of Pacheco Pond. This unmanaged area is dominated by native vegetation and likely provides important wildlife habitat. Plant species in the seasonal wet meadows include Santa Barbara sedge (*Carex barbara*), Baltic rush (*Juncus balticus*), and creeping wild rye (*Elymus triticoides*), while those in the riparian areas include arroyo willow (*Salix lasiolepis*), red alder (*Alnus rubra*), and big leaf maple (*Acer macrophyllum*) (Peter Baye pers. comm., One Tam 2018a).

Diked Agricultural Baylands

Diked agricultural baylands currently occur over a large amount of the study area and are dominated by hay production. The fields owned by NSD north of SR 37 and by Marin County south of SR 37 are both used by NSD as treated effluent sprayfields. The sprayfields have drainage ditches that likely provide limited wetland habitat for wildlife. However, all these areas can provide foraging and breeding habitat for resident and migratory birds and other wildlife.

Other

Other low-lying properties in the study area include three privately owned parcels just south of SR 37. A former agricultural field in a basin owned by Pattern Energy is adjacent to Novato Creek and seasonally wet, creating a saline non-tidal environment. Just south of the Pattern Energy basin is another saline non-tidal wetland area managed for dredged sediment disposal for the Bel Marin Keys community. Closer to the Petaluma River at the edge of the Novato Creek baylands is the Stonetree Golf Course, which provides a variety of developed and managed wetland and upland habitats.

Upland Transition Zone

Transition zones are critical to consider in wetland restoration because they provide space for wetlands to migrate landward with sea level rise, support diverse habitats across elevation gradients, and offer critical habitat features, such as high tide refugia, for a wide range of tidal species (Goals Project 2015). The transition zone is defined in this report as areas within 500-meters of the back of marshes and diked baylands (Plane et al. 2024). This area encompasses most transition zone functions and services, including sea level rise accommodation for tidal marshes, flood protection, access for upland wildlife to food and resources from the marsh, and refuge for marsh wildlife (Robinson et al. 2017, Robinson 2018). Today, some connected transition zone habitat exists along levee slopes along the Novato Creek corridor, at the Hamilton Wetlands restoration site, and at Day Island.

Much of the area within the historical transition zone is developed, but several areas of annual grassland and oak woodland habitats remain undeveloped (though they are disconnected from the Bay) (Figure 4.12). If transition zone is reconnected by restoring tidal action to surrounding diked baylands, it could provide valuable transitional habitat for wildlife, most of it steeply sloped. Publicly owned and protected transition zones that could be reconnected if diked basins are restored exist at Deer Island/Deer Island Basin and the Vince Mulroy Preserve. Transition zone areas inland of Olive Ave and Atherton Ave are currently privately owned.

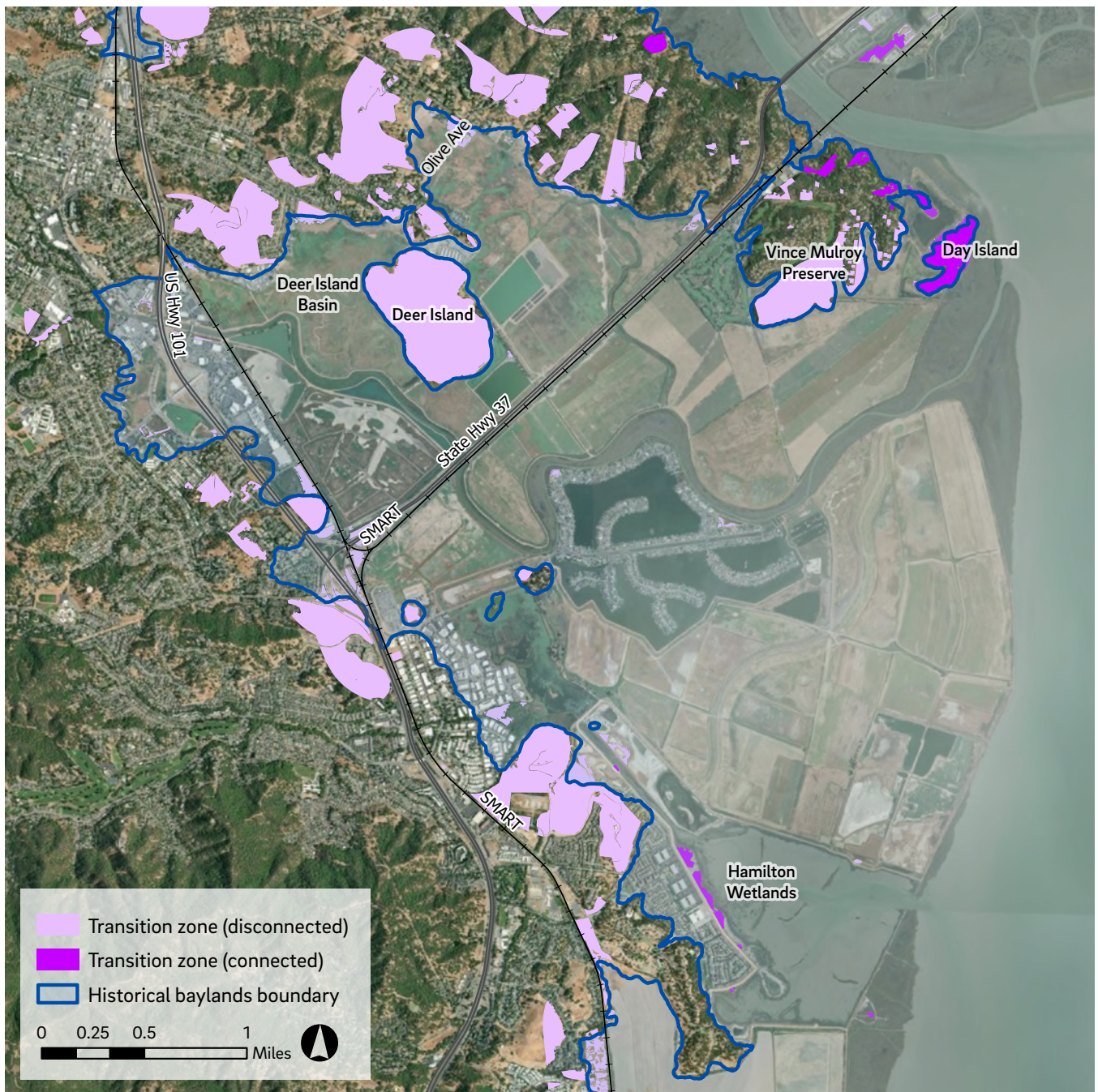


Figure 4.12. Upland transition zones within the study area mapped using the upper boundary transition zone approach (Robinson et al. 2017, 2018; Plane et al. 2024). "Disconnected" transition zone is currently separated from tidal influence by berms or levees, while "connected" transition zone is hydraulically connected to the Bay.

Species

Special-Status Plants and Important Plant Species

Few rare plants are documented within the study area, but rare plants may occur within the tidal marsh. Rare plant species that may be found in the study area include:

- Point Reyes bird's-beak (*Chloropyron maritimum* ssp. *palustre*)
- Marin knotweed (*Polygonum marinense*)
- Congested-headed hayfield tarplant (*Hemizonia congesta* subsp. *congesta*)
- Fragrant fritillary (*Fritillaria liliacea*)

An additional species, soft salty bird's-beak (*Chloropyron molle* ssp. *molle*; federally endangered, state rare) may potentially occur in study area due to the presence of nearby occurrences in similar habitats. It is also a non-focal species in the NBB RCIS (ESA 2024).

These plants are rare throughout the San Francisco Estuary due to the conversion of tidal marsh habitats to agriculture and other land uses. All are listed as rare or endangered in California by the California Rare Plant Ranking System (CNPS Rare Plant Program 2025).

Invasive Plant Species

Invasive plants occur throughout the study area, as they do throughout the San Francisco Estuary baylands. A few key invasive plants that occur within wetland and transition zones in the Novato Creek baylands include invasive cordgrass (*Spartina alterniflora* and invasive hybrids), perennial pepperweed (*Lepidium latifolium*), harding grass (*Phalaris aquatica*), Pacific bentgrass (*Agrostis avenacea*), and stinkwort (*Dittrichia graveolens*) (Goals Project 2015). Invasive cordgrass is actively monitored and controlled within the study area. No invasive cordgrass is known to be present in the Novato Creek baylands due in part to continued eradication efforts of this species and its hybrids throughout tidal marshes in San Francisco Bay (Olofson Environmental 2023). Perennial pepperweed occurs at high marsh and transition zone elevations in the Novato Creek baylands.

Many other invasive species occur throughout the agricultural baylands, diked wetlands, and non-native grasslands in the study area, including wild oats (*Avena* spp.), ripgut brome (*Bromus diandrus*), Italian ryegrass (*Festuca perennis*), poison hemlock (*Conium maculatum*), yellow starthistle (*Centaurea solstitialis*), fennel (*Foeniculum vulgare*), wild radish (*Raphanus* spp.), and Himalayan blackberry (*Rubus armeniacus*).

Invasive plant species can be detrimental to restoration projects as they often thrive in disturbed areas and become established before native vegetation does. Restoration projects should be prepared for invasive species observed in similar habitats nearby to colonize the restored areas. Prior to restoring an area, it is important to understand how invasive species may impact the habitats, and to what extent they should be managed once detected within the restoration area. Coordination with the Invasive Spartina Project is recommended for all tidal marsh restoration efforts. Early detection and rapid response for invasive plant species is the preferred management approach to reduce costs and improve habitat outcomes. However, within Marin County Flood Control District properties, herbicide cannot be used for invasive plant management, which limits available methods.

Special-Status Wildlife

California Ridgway's rail (*Rallus obsoletus obsoletus*), California black rail (*Laterallus jamaicensis coturniculus*), and salt marsh harvest mouse (*Reithrodontomys raviventris*) are endangered and threatened species that occur within the Novato Creek baylands are also included as focal and non-focal species in the NBB RCIS (ESA 2024).

California Ridgway's Rail

The California Ridgway's rail (formerly known as the California clapper rail and hereafter Ridgway's rail) is a secretive, hen-like waterbird that lives in salt and brackish tidal marshes in the San Francisco Bay. This species is listed as endangered at both the federal and state levels and is also a fully protected species under the California Fish and Game Code. They once occupied coastal California tidal marshes from Humboldt Bay southward to Morro Bay, as well as the estuarine marshes of San Francisco Bay and San Pablo Bay to the Carquinez Strait (Raabe et al. 2010). Resident populations are currently limited to San Francisco Bay, San Pablo Bay, Suisun Bay, and associated tidal marshes. Ridgway's rail is included as a focal species in the NBB RCIS (ESA 2024).

Ridgway's rail occurs almost exclusively in tidal salt and brackish marshes with unrestricted daily tidal flows, adequate invertebrate prey food supply, well developed tidal channel networks, and suitable nesting and escape cover during extreme high tides (Raabe et al. 2010). Ridgway's rail depends on mudflats or shallow water within an intricate network of tidal sloughs where there are both abundant invertebrate populations and taller plant material to provide cover at high tide and protection from predators. They rely on marsh plants such as Pacific cordgrass (*Spartina foliosa*), bulrush (*Bolboschoenus maritimus*), and pickleweed for breeding and feeding. Ridgway's rail depends on vegetation structure that allows nests to be built above high tides and wave action.

The most recent documentation of Ridgway's rail in the study area occurred in the tidal marshes at the mouth of Novato Creek and the Petaluma River (Liu et al. 2012).

California Black Rail

California black rail (black rail) is a small, secretive waterbird that is difficult to detect, complicating the study of the subspecies' natural history. Black rail resides in a variety of wetland habitats across its range in California and Arizona (Evens et al. 1991). The most geographically extensive occupied habitats exist in San Francisco Bay, specifically in tidal marshes along the Petaluma and Napa rivers, San Pablo Bay, Suisun Bay, and Suisun Marsh, with the latter supporting a large proportion of the subspecies (Evens et al. 1991, Spautz et al. 2005). Black rail is listed as threatened in California because of population declines attributed in large part to loss of more than 90 percent of historic wetland habitat in the state (Tsao et al. 2015). It is also a fully protected species under the California Fish and Game Code. This species is included as a focal species in the NBB RCIS (ESA 2024).

Black rail occur almost exclusively in tidal marsh habitat in San Francisco Bay. The highest concentrations are in marshes associated with large rivers and sloughs (Evens et al. 1991, Spautz and Nur 2002). A factor that may explain why the largest populations of black rail are found in the North Bay of the San Francisco Estuary is a great abundance of emergent marsh vegetation. Emergent marsh vegetation offers high quality habitat for black rails, providing them with high food abundance, nest site availability, and access to high tide refugia habitat (Raabe et al. 2010).

Narrow strips of tidal marsh along most of Novato Creek within the study area may be too limited in size to provide habitat to black rails; the wider areas of tidal marsh at the mouth of Novato Creek are more likely to provide habitat for them.

Salt Marsh Harvest Mouse

The salt marsh harvest mouse is a small mouse endemic to the greater San Francisco Bay. It is listed as an endangered species at both the federal and state levels and is also a fully protected species under the California Fish and Game Code. This species is also a focal species in the NBB RCIS (ESA 2024). Salt marsh harvest mouse have become endangered because much of their habitat has been destroyed, and what remains has been highly fragmented, modified, and degraded.

The salt marsh harvest mouse is dependent on dense vegetation cover, usually in the form of pickleweed (*Sarcocornia pacifica*) and other salt dependent or salt tolerant vegetation in both tidal and diked salt and brackish marshes. Salt marsh harvest mouse likely remain in their home ranges when high tides inundate marsh vegetation, swimming or clinging to taller vegetation, such as marsh gumplant or floating debris (USFWS 2013).

In the study area, salt marsh harvest mouse may occur in tidal marshes and diked baylands where salt marsh vegetation is present.

Steelhead – Central California Coast Distinct Population Segment (DPS)

Novato Creek historically supported large numbers of steelhead (*Oncorhynchus mykiss irideus*), but their populations have declined sharply in the past several decades (NMFS 2016). Steelhead are listed as threatened under the federal Endangered Species Act and are a state species of special concern. Steelhead migrate through San Pablo Bay waters in transit between freshwater spawning areas and the Pacific Ocean and may therefore occur seasonally in the lower portions of Novato Creek. Steelhead are known to occur in the upper reaches of the Novato Creek watershed and may pass through the study area to forage in transit between San Pablo Bay and upstream freshwater habitat (NMFS 2016). Diked baylands restoration along Novato Creek would benefit steelhead by creating tidal marshes that provide refuge and foraging habitat for juvenile steelhead.

Other Important Wildlife Species

Other important bird species that currently could occur within the study area include waterfowl, shorebirds, passerines, raptors, herons, and egrets. The extensive intertidal mudflats surrounding San Pablo Bay are considered a key migratory staging and refueling area for over-wintering and migratory shorebirds on the Pacific Flyway (Goals Project 2000). Dabbling and diving ducks use tidal creeks and sloughs and tidal marsh habitat for foraging. Dabbling ducks also may breed in upland areas next to tidal marshes. San Pablo song sparrow (*Melospiza melodia samuelis*) and salt marsh common yellowthroat (*Geothlypis trichas sinuosa*) are CDFW species of special concern and US Fish and Wildlife Service (USFWS) birds of conservation concern that may occur in tidal marshes within the study area. They are also included as non-focal species in the NBB RCIS (ESA 2024). Waterfowl and shorebird habitat is included in the NBB RCIS as a focal other conservation element (ESA 2024).

Many raptor species may utilize habitats within and around Novato Creek for foraging, nesting, and roosting. Species such as the golden eagle (*Aquila chrysaetos*) and Swainson's hawk (*Buteo swainsoni*) hunt in grasslands and nest in trees near wetlands, in grasslands, and along the edges of ephemeral creeks. Swainson's hawk is a non-focal species in the NBB RCIS (ESA 2024). Bald eagles (*Haliaeetus leucocephalus*) may nest in tall trees along or near water bodies. Burrowing owls (*Athene cunicularia*) occupy open, well-drained habitat with short, sparse vegetation and underground burrows excavated by ground squirrels. Burrowing owl is a focal species in the NBB RCIS (ESA 2024). Other species in the study area, such as northern harrier (*Circus hudsonius*) and white-tailed kite (*Elanus leucurus*), forage over wetland and grassland areas. Osprey (*Pandion haliaetus*) use San Pablo Bay and tidal creeks in the study area for foraging and nest in perches near their foraging grounds.



Ducks at the Pattern Energy basin, February 2024. Photo by James Muller, SFEP.

Heron and egrets use tidal marshes and other wetlands within the study area for foraging. Known nesting colonies exist on an island in Pacheco Pond and at the Meditation and Retreat Center between Pacheco Pond and the Bel Marin Keys community.

Important aquatic species that may occur within the study area include northwestern pond turtle (*Actinemys marmorata*), green sturgeon – southern DPS (*Acipenser medirostris*), and longfin smelt – San Francisco Bay-Delta DPS (*Spirinchus thaleichthys*). There are three evolutionarily significant chinook salmon (*Oncorhynchus tshawytscha*) units that may potentially use the study area: Sacramento River winter-run (federally endangered, state endangered), Central Valley spring-run (federally threatened, state threatened), and Central Valley fall/late fall-run (state species of special concern). All of these aquatic species are included as focal species in the NBB RCIS except for longfin smelt, which is a non-focal species (ESA 2024).

Northwestern pond turtles (*Actinemys marmorata*) are typically found in ponds, lakes, rivers, streams, creeks, marshes, and irrigation ditches where suitable basking sites are available (Nafis, 2025). Northwestern pond turtles occur within Duck Bill Pond (Figure 4.3) but individuals will be relocated outside of the study area prior to tidal restoration of the pond (anticipated to begin in 2026). Northwestern pond turtles may occur in other slow-moving currents within freshwater creeks or ponds in the study area where there are sufficient basking sites and refugia.

Subadult and adult green sturgeon occupy a diversity of depths within bays and estuaries for feeding and migration. Green sturgeon may be present in San Pablo Bay, Novato Creek, and other tidal channels throughout the study area at any time of the year. Novato Creek is within National Marine Fisheries Service-designated critical habitat for green sturgeon. Juvenile and subadult longfin smelt inhabit brackish water areas of the San Pablo Bay estuary during the fall and winter, primarily living in tidal sloughs and rivers such as Novato Creek. Migrating and juvenile chinook salmon use the San Pablo Bay estuary seasonally and have been documented during post-construction monitoring in the Hamilton Wetlands restoration project.

Other important wildlife species in the study area include bats and bumble bees. Roosting habitat for bats includes trees and structures such as bridges, buildings, and barns. Open areas, especially along riparian corridors, waterways, and ecotones provide foraging habitat. Western red bat (*Lasiurus frantzii*), silver-haired bat (*Lasionycteris noctivagans*), hoary bat (*Lasiurus cinereus*), and Yuma myotis (*Myotis yumanensis*) were all detected at the Deer Island Open Space Preserve in 2018 (One Tam 2018b). Bat habitat is included as a focal other conservation element in the NBB RCIS (ESA 2024). Western bumble bee (*Bombus occidentalis*) and Crotch's bumble bee (*Bombus crotchii*) depend on grassland habitats with floral resources and underground cavities. Crotch's bumble bee is included as a focal species in the NBB RCIS, and the western bumble bee is a non-focal species (ESA 2024).

Invasive Wildlife Species

It will be important to monitor for invasive nutria (*Myocastor coypus*) as they continue expanding into San Pablo Bay. Nutria can cause extensive damage to native plant communities, soil structure, and levee stability through their aggressive feeding and burrowing behavior. Nutria were first reported in San Pablo Bay in 2026 (CDFW 2026).

Mosquitoes & Vector Control

The Marin/Sonoma Mosquito and Vector Control District conducts mosquito surveillance and treatments within the diked Novato Creek baylands to control breeding mosquito populations. Areas of particularly high mosquito production include Deer Island Basin, the Simmons Slough wetlands (Marin Audubon Society), Pacheco Pond, and the Marin County and NSD sprayfields, all of which are treated up to several times annually with larvicides to control mosquitoes that can transmit West Nile virus to people and wildlife. A carefully designed conversion to tidal habitat could provide a more sustainable solution through mosquito source reduction. Mosquitoes currently known to transmit West Nile virus typically do not live in tidal marshes, and improved tidal flushing would reduce habitat suitable for mosquito breeding. Restoring these areas would decrease mosquito production over hundreds of acres and reduce the need for ongoing larvicide treatments. This could ultimately improve public health, lower transmission of West Nile Virus to avian species, and cut costs for public agencies.

Infrastructure

Transportation infrastructure represents a significant constraint to restoration and a challenge to improving the resilience of the Novato Creek baylands as sea level rises. SR 37 and the SMART rail line run northeast-southwest through the middle of the baylands, reducing hydraulic connectivity between the Deer Island Basin and Simmons Slough areas to the northwest and the Marin County sprayfields to the southeast (Figure 4.13). However, there are plans to raise the entire length of SR 37 on a piled causeway by the 2050s. If the SMART rail line were raised as well, this would open up a major opportunity to hydraulically reconnect and restore tidal action to much of the historical Novato Creek baylands. Other vital pieces of infrastructure exist in these baylands, and restoration

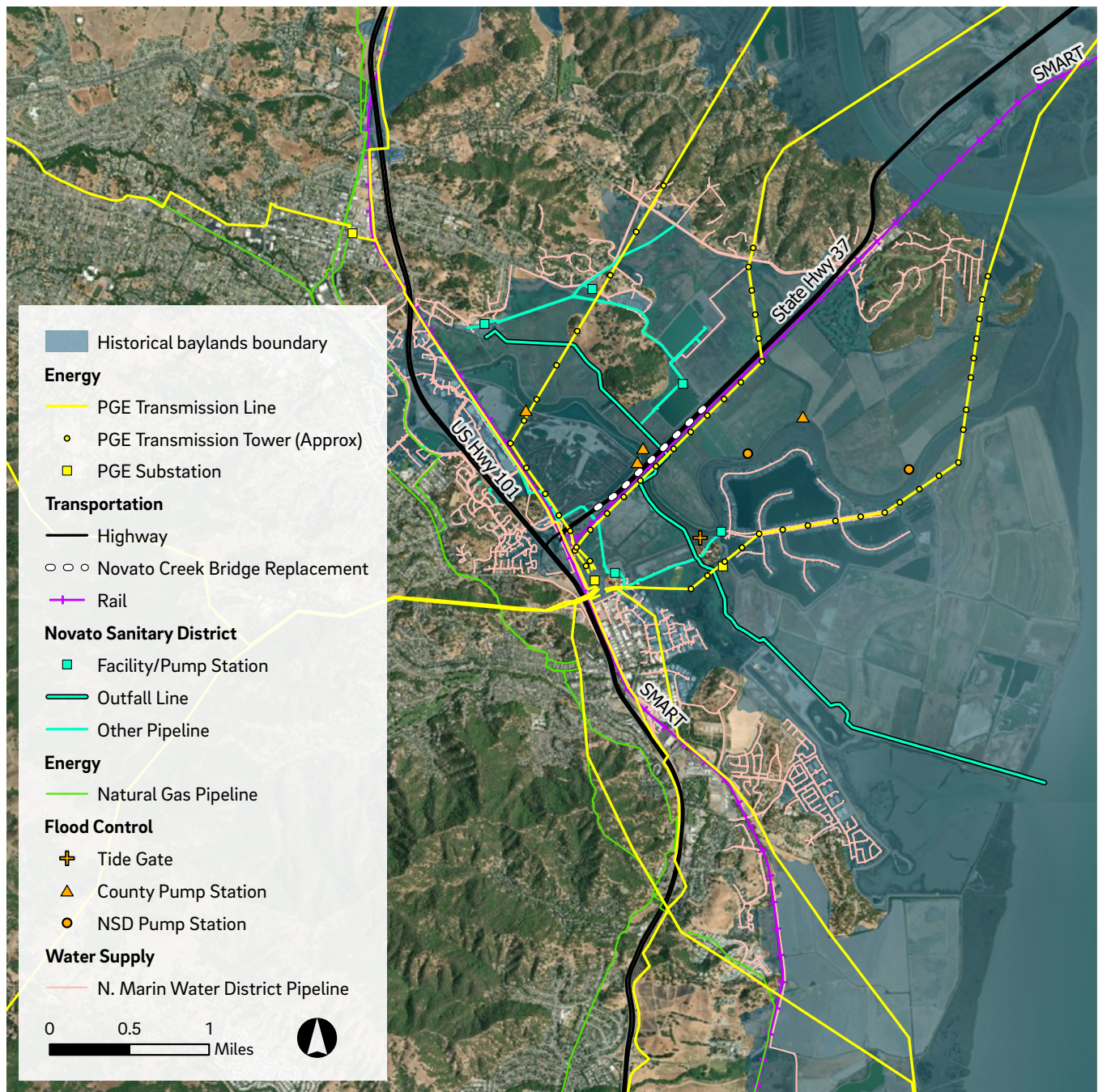


Figure 4.13. Key infrastructure present in the Novato Creek baylands. Transportation infrastructure represents the biggest constraint for baylands restoration. Data sources: California Energy Commission, Caltrans, Marin County Flood Control District, NSD, North Marin Water District.

proponents will need to collaborate with local infrastructure managers in this area (PG&E, NSD, North Marin Water District, etc.) to either adapt or work around existing infrastructure.

State Route 37

SR 37 is a key transportation corridor connecting Solano County in the east to Marin County in the west. It runs through the middle of the study area, bisecting the historical Novato Creek baylands (Figure 4.13). The roadway is low-lying and highly vulnerable to flooding and sea level rise, protected only by non-engineered berms that have failed in the past. Nine of the top fifteen highway segments ranked as climate change adaptation priorities for Caltrans District 4 (Bay Area) are on SR 37; four of these segments are in the Novato Creek baylands (Caltrans District 4 2020).



SR 37 flooding and congestion relief planning efforts provide a historic opportunity to reconnect the Novato Creek baylands to the Bay. Findings of Caltrans' Planning and Environmental Linkages Report (PEL) point to the preferred alternative of an elevated, piled causeway along the current alignment (Caltrans 2022). If the road is raised on an elevated, piled causeway and the adjacent SMART rail line is also raised, the range of restoration alternatives that are possible is greatly expanded. The piled causeway would allow more tidal flow through the Novato Creek and Simmons Slough crossings and enable hydrologic connectivity between existing and future tidal and transitional habitats.

The section of piled causeway through the Novato Creek baylands will be constructed in two phases:

Phase 1: Replace the Novato Creek Bridge with a 1,000-foot piled causeway by 2030, with earthen approaches on both ends of the raised bridge (Figure 4.14).

Phase 2: Build remaining portions of the piled causeway from US 101 to Novato Creek Bridge and from Novato Creek Bridge to Atherton Avenue by 2045 (not yet funded).



Figure 4.14. Rendering of the lengthened and raised Novato Creek Bridge after completion of Phase I of the project. Source: Caltrans District 4 video, 4Q321 Construction Staging DRAFT v2.

The completed piled causeway will have a deck elevation of 26 feet NAVD88 and consist of four 12-foot-wide lanes, a 2-foot-wide median barrier, two 10-foot-wide inside shoulders, two 12-foot-wide outside shoulders, two 2-foot-wide outside barriers, and a 14-foot-wide Class I bicycle and pedestrian path with a 2-foot-wide barrier, resulting in a total roadway width of 114 feet.

Atherton Avenue & Olive Avenue

Atherton Avenue is a local road within the Novato Creek baylands (Figure 4.3). It skirts the northern side of the Novato Creek baylands, sitting at or just above tidal elevation as it runs north from SR 37. It intersects with Olive Avenue, another local road, in the northern section of the Novato Creek baylands. Olive Avenue cuts across the northern section of the baylands. Northwest of Deer Island, Olive Avenue sits at a higher elevation (mostly at supratidal elevations, 8-10 ft NAVD) but farther east, it runs through subsided diked baylands, elevated only slightly higher than surrounding diked wetlands (4-5 ft NAVD). Sections of both Atherton Avenue and Olive Avenue would likely need to be raised or protected if tidal action is restored to the Novato Creek baylands north of SR 37. There are no current plans to reconfigure or raise either road.

SMART Rail Line (East-West)

The East-West SMART rail line (aka the Brazos Junction Branch) connects the SMART North-South rail line in Novato to the Union Pacific Railroad (Capitol Corridor) in Fairfield. In the Novato Creek baylands, SMART runs alongside SR 37 between US-101 and Atherton Avenue. It goes over bridges at Novato Creek and Simmons Slough (Figure 4.14). The rail line is active today as a freight line, though with minimal usage. SMART is exploring potential future opportunities to develop passenger rail to connect Marin County with the Capitol Corridor and/or the Vallejo Ferry Terminal (SMART 2022).

The east-west SMART rail line is one of the primary barriers to habitat and hydrologic connectivity in the study

area. Along with SR 37, it bisects the historical Novato Creek baylands. In addition, both SR 37 and the rail line are at substantial risk of flooding if the non-engineered earthen levees and stormwater pumps operated by Marin County and private landowners fail; both road and rail have already been damaged by flooding (SMART 2022). Without any changes, the SMART rail line will be increasingly vulnerable to flooding and also hinder restoration of approximately 370 acres of baylands at Simmons Slough. If the rail line is not raised, levees will need to be constructed to protect the SMART rail line in order to allow restoration of the Marin County sprayfields to the south.



Flooding on February 14, 2019 damaged the SMART tracks just east of Novato Creek (creek channel visible in background).
Photo by Marin County Department of Public Works.

Transportation planners previously considered changing the existing rail alignment to put both the SMART rail line and SR 37 on a combined causeway through the Novato Creek baylands (Caltrans 2022). However, due to the different design criteria, a combined causeway will not be pursued. Instead, a parallel rail causeway would need to be constructed separately from the planned SR 37 causeway. Should a final determination be made to develop passenger rail along this corridor, the tracks would need to be elevated on a causeway to protect the infrastructure from flooding. Depending on landowner participation, this solution would allow reconnection of San Pablo Bay to newly restored marshes and adjacent uplands north of the SMART rail line.

PG&E Transmission Lines & Towers

Multiple PG&E transmission lines, towers, and substations are present in the study area (Figure 4.15). In preparation for future sea level rise and anticipated flooding, PG&E has already raised and replaced several transmission towers, both along SR 37 (Ignacio-Sobrante line) and where the transmission lines cross Novato

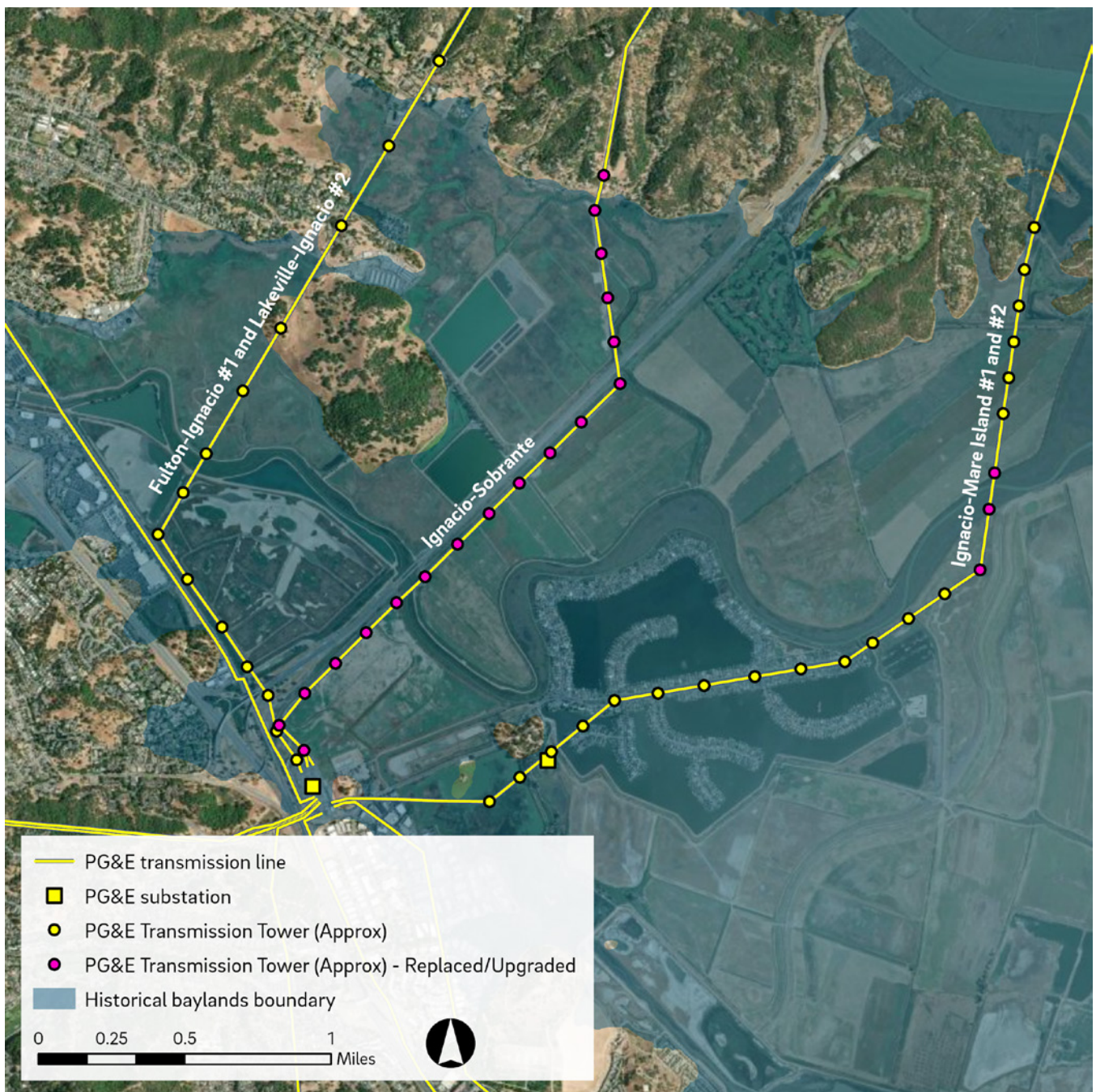


Figure 4.15. PG&E transmission lines and towers in the Novato Creek baylands. Towers shown in pink have been replaced or their foundations upgraded so they are resilient to future sea level rise.

Creek near the creek mouth (Ignacio-Mare Island Line). According to PG&E, these towers are designed to be at least 8 feet above sea level and will accommodate new tidal conditions when the berms are breached.

Not all the transmission towers vulnerable to flooding in the baylands have been replaced. Some of the older towers may need to be replaced before restoration can occur. In addition, PG&E needs access to all of its towers for maintenance, either via road, boardwalk, or boat. Restoration projects aligned with this Strategy will need to coordinate with PG&E in the design phase to ensure the transmission towers are stable and access to them is maintained within restored areas.

Novato Sanitary District Facilities

NSD's treatment facility is next to Deer Island Basin. Critical sewer lines, pump stations, storage pods, and other infrastructure are also located within the diked baylands, including the basins and sprayfields between Deer Island and Simmons Slough (Figure 4.16). The present NSD outfall line runs approximately north-south through the baylands from the main treatment facility out to the Bay (Figure 4.13). Improved effluent quality following recent upgrades to the treatment process presumably means that a truncated outfall line and year-round discharge to Deer Island Basin is possible following restoration of tidal flows. This would remove a major constraint to restoration at Deer Island Basin and depends on NSD receiving a shallow water discharge permit from the SF Bay Regional Water Quality Control Board and funding for the modifications.



Figure 4.16. Novato Sanitary District infrastructure in the Simmons Slough area.

Due to a dry season discharge prohibition, NSD has used treated wastewater effluent to irrigate sprayfields (both NSD-owned and leased from Marin County). The sprayfields have historically been leased for cattle ranching. A new year-round discharge permit for NSD would allow for restoration of over 800 acres of land previously used as sprayfields.

Effluent storage ponds at Simmons Slough need to be maintained, but biosolids infrastructure (dedicated land disposal site and facultative sludge lagoons) will be decommissioned in approximately 2034-2036 and could potentially be reconfigured as part of the restoration strategy. The Bahia Force Main, which runs through both the Marin Audubon property and the northern section of Deer Island Basin, would need to be relocated to allow



View from Deer Island across effluent storage pond and sprayfields toward San Pablo Bay. Photo by Ellen Plane, SFEI.

restoration of diked baylands in this area. The basins the pipelines currently run through would be permanently (tidally) inundated, and setback levees would need to be constructed along alignments crossing the pipelines.

The property between Simmons Slough and the east end of Atherton Avenue was designated as mitigation for a project completed in 1984 and is not actively managed. There may be opportunities to include this area in future tidal restoration efforts, pending further coordination with the NSD and regulatory partners.

A more thorough description of restoration opportunities and constraints associated with NSD infrastructure is provided in Appendix A.

Flood Control (Pumps & Gates)

Several Marin County Flood Control District-owned pump stations and a tide gate are present in the Novato Creek baylands (Figure 4.13). NSD operates and maintains two drainage pump stations on the inboard side of the Novato Creek levee within the sprayfields. The management of these pump stations would revert to the County of Marin when the lease is terminated. Depending on how and where the baylands are restored, some of the pumps could be removed because they will become redundant as the acreage of diked baylands and associated drainage area is reduced. However, restoration designs will still need to account for stormwater from upland watersheds currently collected in diked baylands and routed to pump stations. Pump stations will need to be relocated along with setback levees or replaced with detention basins inland of setback levees. Marin County Flood Control District is exploring various future management options for Pacheco Pond. Expansion of the existing overflow weir to bring floodwater into the seasonal wetlands of Bel Marin Keys Unit V is a likely recommended alternative. Another alternative being explored is moving the Pacheco Pond tide gate from its current location on Novato Creek to Bel Marin Keys Drive.



Simmons Pump Station, October 2024. Photo by Jeremy Lowe, SFEI.

Water Mains & Gas Pipelines

Generally, water supply infrastructure in the Novato Creek baylands is located along established roadways, but there are several exceptions to this. There are potable and recycled water lines near the southeast corner of Deer Island Basin and crossing Simmons Slough toward Atherton Avenue. North Marin Water District's potable facilities also cross under SR 37 on the western side of the Novato Creek baylands (Figure 4.13).

No gas pipelines are present in the Novato Creek baylands, according to PG&E (PG&E 2025).

Restoration Opportunities & Considerations

Table 4.3 summarizes restoration opportunities and feasibility considerations for each unit within the study area, based on conversations with landowners. Most of the lands in the Novato Creek baylands are publicly owned. While public properties are more likely to be restored in the near-term, private properties have been included for full consideration of potential opportunities. Any restoration would occur only by mutual agreement with a willing landowner. A more detailed description of restoration opportunities and constraints for each parcel is provided in Appendix A.

Table 4.3. Restoration opportunities and feasibility considerations by unit.

Unit Name (Owner)	Location	Restoration Opportunities	Feasibility Considerations
Simmons Slough Wetlands (Marin Audubon Society)		- Full tidal marsh restoration potential.	- Tidal range may be muted due to distance from the Bay. - SR 37 and SMART rail crossings over Simmons Slough may constrain tidal prism. - Need to maintain stormwater drainage and prevent flooding on nearby roads and private properties. - PG&E transmission line runs through parcel (though no towers). - NSD's Bahia Force Main crosses through the parcel; force main infrastructure would need to be protected or relocated.
Pattern Energy		- At least partial restoration (eastern portion of the site) possible if future development is limited.	- Current levee system in poor condition; setback levee could provide needed flood protection for future development. - NSD force main infrastructure would need to be protected or relocated. - Upgrading of levee adjacent to Pacheco Pond outlet channel would be required.
Northwest of Olive Avenue		- Potential muted or full tidal restoration. - Restoration would allow a connection to natural upland transition zone.	- Likely requires roadway modification to expand flow capacity under Olive Avenue - Need to maintain stormwater drainage and prevent flooding on nearby roads and private properties

Table 4.3 (continued).

Unit Name (Owner)	Location	Restoration Opportunities	Feasibility Considerations
NSD Ponds, Sprayfield, and Mitigation Site		- Possible tidal restoration of mitigation site (dependent on State permission). - Sprayfield restoration may be possible in 10–20 years. - NSD may allow new channels to be dug through their property to facilitate restoration at the Marin Audubon property to the north. - Possible future reconfiguration and restoration of sludge lagoons and dedicated land disposal (DLD) site when no longer used.	- DLD site must be managed and protected after closure to prevent leaching and possible contamination of adjacent wetlands. - Infrastructure (e.g., PG&E lines and towers) present in parcel. - Soil testing prior to restoration is advised due to the years of application of treated wastewater to the NSD sprayfield.
Marin County Sprayfields (Marin County Flood Control District)		- Extensive tidal wetland restoration potential. - Possible connection to upland transition zone at Vince Mulroy Preserve. - End of current NSD lease term may allow near-term implementation.	- Setback levees likely needed to protect SR 37 and SMART rail if restoration proceeds in near-term. - Must consider adjacent contaminated Black Point Antenna Field and PG&E infrastructure. - Must avoid detrimental impacts to neighboring Bel Marin Keys (BMK) community across Novato Creek. - Soil testing prior to restoration is advised due to the years of application of treated wastewater to the Marin County sprayfields.
Black Point Antenna Field (State Lands Commission)		- If fully remediated, could connect habitat with restored Marin County Sprayfields to create a more cohesive habitat patch and reduce levee construction and maintenance costs.	- The most acute contamination at the site (transformers and fuel tanks) has been removed, but there may be additional contamination on site that needs to be cleaned up prior to restoration. The potential remediation cost required for restoration is unknown. - State Lands Commission is open to restoration if the restoring agency applies for a lease.
Day Island Unit (California Department of Fish and Wildlife - CDFW)		- Potential long-term opportunity to restore tidal wetlands next to upland transition zone and/or to restore and reconnect Novato Creek baylands to Petaluma baylands.	- CDFW intends to maintain this area as it currently exists and states that the Day Island Unit will not be included in any foreseeable restoration projects or strategies.

Table 4.3 (continued).

Unit Name (Owner)	Location	Restoration Opportunities	Feasibility Considerations
Bel Marin Keys Community & Dredged Sediment Disposal Area (Bel Marin Keys Community Services District)		- Restoring tidal prism could improve creek navigation and reduce dredging requirements. - Current dredged sediment disposal area may be restorable if an alternate storage location is identified. - Dredged sediment stored in disposal area and any future dredged material from lagoon could aid in marsh restoration.	- Alternative placement location needed for dredged material. Dredged material could be used in restoration if of suitable quality for wetland placement.
Deer Island Basin Complex (Marin County Flood Control District)		- Full tidal restoration potential. - Could improve creek hydraulics and flood protection, and reduce the need to dredge Novato Creek.	- Full restoration is not feasible unless NSD outfall line is relocated or terminated; discharge location could be moved to Deer Island Basin (this would require coordination with and approval from the San Francisco Bay Regional Water Quality Control Board). - The Bahia Force Main, Final Digested Sludge, and Decant Return lines cross through the north of Deer Island Basin and would need to be relocated to allow restoration to occur. - Must retain flood storage function and manage stormwater from surrounding neighborhoods.
Bird Ponds (Marin County Flood Control District)		- Tidal restoration approved and planned (construction in 2026). - Will restore habitat and improve flood protection. - Additional tidal prism will help scour the Novato Creek channel.	

Table 4.3 (continued).

Unit Name (Owner)	Location	Restoration Opportunities	Feasibility Considerations
Hamilton Wetlands (California State Coastal Conservancy -SCC)		- Restoration completed (2014). - Ongoing adaptive management only.	
Bel Marin Keys Unit V (SCC)		- Large-scale tidal and seasonal wetland restoration planned.	-Project proponents US Army Corps of Engineers and State Coastal Conservancy are working through numerous considerations including hydraulic impacts, maximizing benefits from sediment placement, and reducing impacts on sensitive species. -Continued coordination with restoration projects associated with the Strategy is recommended.
Pacheco Pond (Marin County Flood Control District)		- Changes to the management of the pond (being explored through a separate project) could improve connectivity and ecosystem function while reducing management needs.	- Any change must not increase flood risks to adjacent properties. - Sensitive species present (e.g., San Pablo song sparrow).
Lynwood Basin (State Lands Commission in coordination with CDFW; levee corridor leased by Marin County Flood Control District)		- 40% of basin (i.e., southern section) could be restored to tidal wetland habitat (Wood-Rodgers 2024), but additional confirmation is needed in future design phases, along with approval from CDFW, State Lands Commission, and Marin County Flood Control District.	- Must retain flood control function in remaining 60% of basin (i.e., northern section) and avoid impacts to Rowland Way drainage. - Lynwood and Cheda pump stations must be accessible from SR37. - PG&E infrastructure present. - SMART rail on western edge of basin would need to be protected from any increase in water surface elevation.

5. CULTURAL RESOURCES

Far Western Anthropological Research Group, Inc., (Far Western) conducted a records search, literature review, and geoarchaeological sensitivity assessment for the Strategy. The Strategy team requested support to ensure that archaeological and Tribal resources are addressed and considered in planning for future projects under the Strategy. A key component of the overall Strategy is to analyze existing site conditions, develop restoration alternatives, evaluate geomorphic and habitat evolution, and assess the feasibility and cost of alternatives. This work was prepared before any defined project and is intended to inform the Strategy's overall development as it relates to cultural and Tribal resources sensitivity within the study area.

This chapter presents the methods and results—including a records search at the Northwest Information Center (NWIC), a search of the Native American Heritage Commission (NAHC) Sacred Lands File, desktop archival review, geoarchaeological study, and archaeological site sensitivity analysis—to inform the needs for additional studies that may require compliance with the California Environmental Quality Act (CEQA) and/or Section 106 of the National Historic Preservation Act (NHPA), if applicable.

The full technical report (Osterlye 2025) is a confidential document and has not been made available to the public, stakeholders, or partnering agencies; however, it has been reviewed by the Federated Indians of Graton Rancheria (Graton Rancheria) and the cultural resources recommendations and considerations have been developed in coordination with the Tribe. Graton Rancheria is the only federally recognized tribe with ancestral lands in Marin County. Graton Rancheria is comprised of Coast Miwok and Southern Pomo people, and the Tribe is traditionally and culturally affiliated with Marin County and the study area.

Background Research Methods and Results

The following section summarizes the results of the records searches from the NWIC of the California Historical Resources Information System in Rohnert Park, California. Previous records searches conducted for Marin County were utilized and a supplemental records search was conducted on August 1, 2024, and included the study area and a one-quarter mile records search buffer.

The records search identified 318 previously conducted cultural resources studies within the study area. The records search identified 113 previously recorded cultural resources within the records search area, 81 of which intersect the study area. The intersecting resources include 24 historic-era built environment, one modern built environment, one historic-era district, five historic-era archaeological, one multi-component (including both precontact and historic-era), and 49 precontact archaeological sites.

Precontact resources recorded within the Study Area include shell midden and shellmound sites, most commonly located along the bay margin and at confluences of freshwater sources and marsh, and bedrock mortars, most commonly along ridges and hillsides containing bedrock outcrops. Many of these precontact resources also contain important associated cultural items, such as shell beads, flaked stone tools and lithic debitage, charmstones, marine shell, and faunal remains. It is not uncommon for precontact midden and shellmound sites to also contain ancestral remains and associated funerary items. Tribal cultural resources, discussed below, are also anticipated resource types and include sites, features, places, landscapes, natural resources, and objects with cultural value to descendant communities.

Historic-era resources recorded within the study area include structural remains associated with Hamilton Army Airfield, farming, water conveyance, and residential structures. Some of these historic-era resources also contain associated artifact assemblages, including domestic refuse scatters or privies containing materials such as bottles, cans, and ceramics, and structural debris including brick, milled lumber, and structural hardware.

A search of the National Register of Historic Places (National Register), the California Register of Historical Resources (California Register), California Historic Landmarks (California Office of Historical Preservation [OHP] 2024a), and the California Points of Historical Interest (OHP 2024b) identified two resources listed on the National Register: the Stephen Porcella House and Fashion Shop at 800 Grant Avenue, and the Hamilton Army Air Field Discontiguous Historic District at the southern reach of the study area. Historic properties are cultural resources that are listed or are eligible for listing on the National Register, and historical resources are cultural resources that are listed or eligible for listing on the California Register. Properties listed on these registers include Tribal resources, buildings, structures, sites, objects, and districts that are considered historically significant and meet certain criteria that deem them eligible for preservation.

Far Western reviewed online historical maps and aerial photographs depicting features such as roads, buildings, other structures and infrastructure, and waterways. The objectives of this archival review were to generally reconstruct the history of land use within the Study Area and to provide additional information regarding the potential for the presence of historic-era resources. Historical maps and photographs were reviewed at several online repositories, in particular the US Geological Survey National Oceanic and Atmospheric Administration Historical Shoreline Surveys, the David Rumsey Map Collection, and Digital Collections of the Bancroft Library, among others.

Native American Coordination and Outreach

While there is no currently defined project or regulatory nexus at this phase of the study, outreach was initiated with the NAHC on July 11, 2024, requesting a review of their Sacred Lands File and list of individuals/groups who might have knowledge concerning cultural and Tribal resources within the Study Area. In a letter dated August 1, 2024, the NAHC responded that the results of the Sacred Lands File search were positive and to contact Graton Rancheria for more information. They also included a list of individuals/groups who might have knowledge concerning cultural and Tribal resources within the study area. Letters were sent by the County of Marin to the contacts provided by the NAHC on September 30, 2024. On November 4, 2024, Graton Rancheria requested additional Strategy details and inquired about the anticipated regulatory process. The County sent a Strategy summary to Graton Rancheria on April 15, 2025, including the extent of the Strategy and roles of the agencies and groups involved. A follow up email from the County was sent on May 16, 2025. The County provided a draft version of this report to Graton Rancheria for review on May 26, 2026.

Geoarchaeological Assessment

The following discussion summarizes the methods for assessing potential for buried and submerged archaeological sites. Sensitivity assessments in the San Francisco Bay area indicate that three environmental factors—distance-to-water, slope, distance to confluence—are most strongly correlated with the location of known sites, as well as landform age.

The geoarchaeological analysis indicates that over half (55.1%) of the study area has a low or lowest sensitivity for buried cultural deposits, which is primarily due to the presence of ancient bedrock landforms at the surface

(pre-Quaternary in age) with no potential to contain archaeological materials. Conversely, the Holocene alluvial landforms adjacent to Novato Creek, Pacheco Creek, and Arroyo San Jose have a high or highest sensitivity for buried sites in historically terrestrial settings. Buried sites in this area could be situated at a shallow depth yet not currently visible. Additionally, a portion of the study area within the historic-era extent of the San Francisco Bay estuary has a high sensitivity for submerged sites.

Recommendations and Future Considerations

Recommendations and future considerations were prepared at the request of the project, to present cultural resources recommendations and potential decision-making considerations for future projects within the Strategy study area. The following draws on the background information as presented in this memo to provide considerations related to cultural and Tribal resources sensitivity within the study area.

Native American Consultation

The search of the NAHC's Sacred Lands File resulted in positive findings for sacred sites within the study area, and three Native American groups/interested parties were identified by the NAHC: the Federated Indians of Graton Rancheria, the Guidiville Rancheria of California, and the Muwekma Ohlone Tribe of the San Francisco Bay Area. All listed parties should be contacted and informed of proposed projects via letters and project maps and provided an opportunity to comment and/or consult on a project(s) and assist in the identification, recording, and any treatment measures for Tribal Cultural Resources. The project proponents will continue outreach efforts with Graton Rancheria as projects associated with the Strategy are initiated and implemented.

Local Historical Society Consultation

For anticipated efforts pertaining to CEQA or Section 106, outreach letters should be sent to local historical societies and organizations requesting any historical information relevant to the project(s).

Archival Research

Specific future study areas should be subject to desktop archival research, including a review of historical maps and photographs, to assess the potential for historic-era archaeological resources and further describe the historical land development. More detailed supplemental archival research may be necessary based on the results of initial research and fieldwork. If historic era-built environment resources are present, assessment by a qualified architectural historian may be necessary.

Pedestrian Survey

For future projects, pedestrian survey by qualified archaeologists and Graton Rancheria is recommended within portions of the project that have not been subject to previous adequate archaeological and Tribal survey (i.e., surveys conducted greater than five years ago), known or suspected site locations, and culturally sensitive areas identified by Tribal consultation. The purpose of the pedestrian survey is to identify cultural resources visible at the surface and to formally record or update them on California Department of Parks and Recreation (DPR) 523 site forms.

Presence/Absence Identification

Such an investigation would be applicable if the buried site sensitivity assessment reveals a high potential for undocumented buried sites. The investigation would be conducted relative to the locations and depths of construction disturbance in previously undisturbed areas, as indicated by project design plans. Testing strategy would be dependent on the anticipated maximum depth of disturbance during proposed activities and may involve a combination of controlled hand excavation, mechanical trenching, and/or geoarchaeological coring. As numerous cultural resources have been previously identified within the study area, identification testing would be recommended to establish whether additional resources are present and delineate the boundaries of these resources. Testing within the study area would involve early coordination with Graton Rancheria, preparation of testing plan, and permit/access permissions.

Significance Evaluation

Additional test excavations to determine content, boundaries, and eligibility to the National and California Registers would be applicable if archaeological sites and Tribal cultural resources of unknown eligibility are present within a proposed project(s), with the possibility for avoidance by project activities.

Data Recovery Mitigation

This would be applicable only if cultural resources evaluated as historically and legally significant are present within an anticipated project and cannot be avoided by project activities. Any such mitigation would be determined in close coordination with Graton Rancheria and involve the preparation of a treatment plan.

Environmentally Sensitive Area and/or Archaeological/Tribal Monitoring

These measures would be put in place if an archaeological site and/or Tribal cultural resource is situated within a project and can be avoided by establishing an Environmentally Sensitive Area, a plan to protect the resource from project impacts.

Supplemental Studies and Mitigation

Additional studies and mitigation because of consultation with Graton Rancheria may need to be developed to further consider potential impacts (direct and indirect) to archaeological, Tribal, and natural resources as a result of the undertaking(s). Such examples may include but are not limited to cultural landscape studies, ethnobotanical research and documentation, oral history accounts, traditional and cultural mapping of resources, interpretive and educational forums, monitoring programs, cultural sensitivity and awareness training, and regular planning meetings with related agencies and interested parties.

6. PUBLIC ACCESS

The Strategy team met with staff from the San Francisco Bay and Water Trail, Marin County, the City of Novato, the State Coastal Conservancy, and other interested parties to share information about the planning process, review existing and proposed public access facilities and plans, and solicit input on the Strategy.

Plans for public access in the study area can be found in several existing documents, including the Marin County Unincorporated Area Bicycle and Pedestrian Master Plan, the City of Novato Bicycle/Pedestrian Plan, the SR 37 Public Access Scoping Report, and the San Francisco Bay Trail and Water Trail websites (City of Novato 2023, Marin County Department of Public Works 2018, Team Common Ground 2020, MTC 2023). Some of these plans have already been partially implemented.

Existing Land Access

The primary regional trail corridors are the Bay Trail and the Great Redwood Trail (Figure 6.1), supplemented by several isolated pedestrian and bicycle paths that do not connect to these larger networks. North–south access is provided primarily by segments of the Great Redwood Trail that follow the SMART rail corridor through Marin and Sonoma counties, including segments of multi-use paved pathway between the Novato Hamilton and Novato Downtown stations. Additional access is available along portions of the Bay Trail near Hamilton Wetlands.

Northwest of SR 37 is the 154-acre Deer Island Open Space Preserve, which is owned and operated by Marin County Parks and Open Space District. The preserve includes a loop trail where visitors can run, walk, horseback ride, and see wildlife such as deer and many species of birds.

Bay Trail at Hamilton Wetlands. Photo by Ellen Plane, SFEI.





Figure 6.1. Existing and proposed alignments of the Bay Trail and Great Redwood Trail (SMART Pathway) through the Novato Creek baylands.

Existing Water Access

Existing water access in the Novato Creek baylands is limited. There is one existing boat launch, Black Point Boat Launch, which is located along the Petaluma River, just south of the SR 37 crossing. Black Point Boat Launch is maintained by Marin County Parks and is part of the San Francisco Bay Water Trail, which is a growing network of non-motorized small boat launching and landing sites across the San Francisco Bay Estuary. Motorboats and non-motorized watercraft can be launched from this site.

Future Access: Opportunities and Challenges

Public access helps build support for restoration initiatives, fosters a sense of place, improves public health through open space recreation, and contributes to the welfare of surrounding communities. **However, it cannot be overstated that public access must consider the sensitivity of ecological resources when considering new access points. Public access planning, design, and implementation should avoid impacts to wildlife and habitats while also seeking to accomplish community benefits in newly restored areas.** For example, trails should be designed to provide adequate space for high tide refugia and marsh migration at the inland edge of marshes.

Proposed Bay Trail segments in the Novato OLU include a segment west of the Bel Marin Keys community between Pacheco Pond and Hamilton Drive, as well as a segment along SR 37 between US-101 and the Petaluma River as part of the broader SR 37 improvement plan. These trail and access improvements are also highlighted in the City of Novato and County of Marin Bike and Pedestrian Plans and the Bay Area Regional Collaborative Grand Bayway SR 37 Public Access Scoping Report (Team Common Ground 2020). Coordination with the SR 37 improvement plan will be critical to align future bike and pedestrian infrastructure with existing and planned trail networks.

Phase I of the Bel Marin Keys Unit V Restoration project included construction of setback levees for flood control and creation of seasonal wetlands, but it did not add new public access. However, the overall project is required by BCDC to provide maximum feasible public access consistent with resource protection and regional policies. The long-term plan for Bel Marin Keys Unit V envisions a Bay Trail segment along the east side of Pacheco Pond, linking the existing Bay Trail around the Hamilton Wetlands Restoration area to Bel Marin Keys Boulevard.

Opportunities for future water access, including potential additions to the San Francisco Bay Area Water Trail, could be considered where they are determined to be safe, feasible, and compatible with ecological objectives, including minimizing disturbance to wildlife. The San Francisco Bay Area Water Trail Plan ultimately seeks to facilitate a network of launch sites every three to four miles and boat-in overnight opportunities every eight miles. The Bay Area Water Trail network seeks enhancements to existing boat launch locations and encourages appropriate development of new facilities designed to meet regional access needs. While there are currently no plans to add sites within the study area at this time, the restoration alternatives this Strategy explores will increase aquatic habitat within the Novato Creek baylands, which may create opportunities to add sites in the future.

There are constraints to implementing public access objectives. Obstacles on public land include limited funding for new facilities and ongoing maintenance and law enforcement required to maintain and manage facilities. Additional constraints include the risk of future flooding and/or the cost of protecting potential public access sites from sea level rise, fluvial flooding events, and tidal inundation of restored areas, as well as the need to protect wildlife nesting and foraging areas from human disturbance.

Public Access Guiding Principles

In consideration of these and other factors, the Strategy offers several guiding principles to assist future projects with increasing public access opportunities in the Novato Creek baylands.

1. Public access should be thoughtfully designed to avoid disturbance to habitats and wildlife during and after construction, with site design and interpretive elements used to guide appropriate use and promote stewardship of natural resources.
2. Options for public access should be considered early in project design and include engagement with local and regional public access groups to encourage project alignment, accessibility, and educational opportunities.
3. As public access is considered for inclusion in site design, attempt to ensure that resources—including funding and the entity responsible for the design, construction, maintenance, law enforcement, and ownership of the access facility—have been identified to the extent feasible and that potential responsible parties have been consulted.
4. Build trails that are adaptable to sea-level rise, flooding, and inundation without harm to the surrounding habitat by using modular, movable elements or natural materials that will deteriorate.
5. All public access should be adaptable to ensure ongoing facility safety and maintenance. Facility safety and maintenance needs may change with anticipated changing landscape conditions.
6. Public access site designs should be developed with visitor experience in mind, including comfort, ease of access, and visual quality. Designs should highlight the natural beauty of the setting and leverage existing assets and characteristics.

7. LANDSCAPE-SCALE RESTORATION ALTERNATIVES

This chapter describes landscape-scale restoration alternatives that span the Novato Creek baylands and would be implemented through a series of phased projects. The following chapter (Chapter 8) presents project-scale restoration alternatives that could initiate this phased approach and begin advancing toward the broader landscape-scale restoration alternatives.

Before developing alternatives constrained by current infrastructure and ownership, it is important to first define the full range of potential restoration within the Novato Creek baylands (Figure 7.1). This figure illustrates the maximum extent of restoration that would be possible if all undeveloped historical baylands were restored to full tidal conditions. While some areas are currently unavailable or impractical to restore, visualizing this 'maximum potential' highlights the long-term potential habitat benefits and identifies vulnerable areas that will require levee protection if they are not restored.

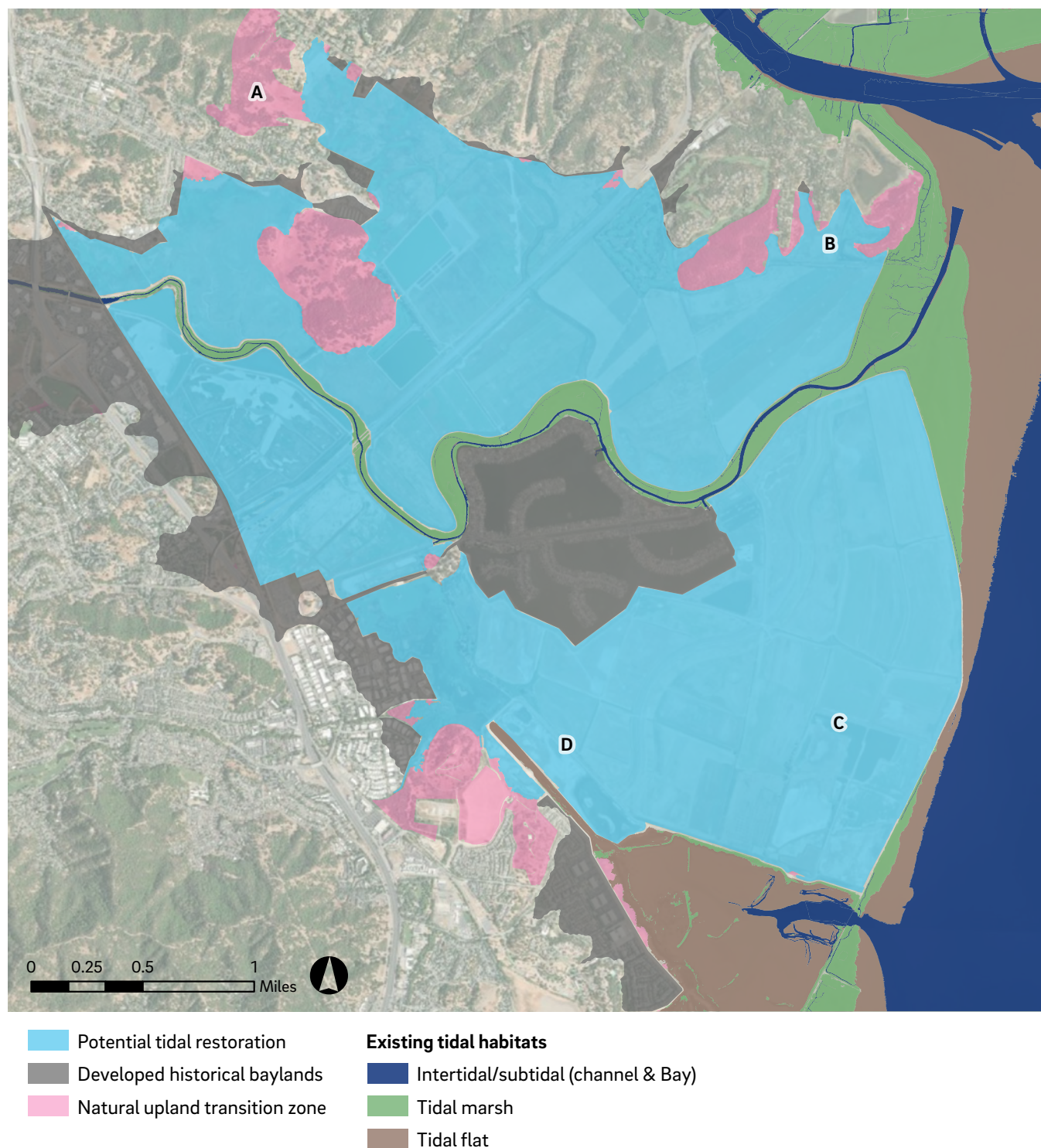
Because Figure 7.1 is meant to illustrate maximum restoration potential rather than serve as a true restoration alternative, the team did not assess flooding implications, specific levee alignments, or infrastructure relocation strategies. While privately owned parcels are shown as potentially restored, any future action would require the participation of willing landowners. Additionally, this scenario does not explore an alternative stormwater management system for the upland flows currently handled by the baylands' basins.

In Figure 7.1, the line of protection is set back to existing development. All existing outboard berms protecting diked baylands are breached, lowered or removed, and the historical baylands are restored to full tidal action. Transportation infrastructure (SR 37, local roads, and SMART) is raised or relocated. Wastewater and water pipelines, storage ponds, and other infrastructure are relocated outside the historical baylands, and the NSD wastewater outfall line is truncated to allow discharge directly into Deer Island Basin. PG&E towers are accessed either by boat or elevated boardwalks. Levees no longer constrain the Novato Creek channel.

Notably, Figure 7.1 shows expanded connections to natural upland transition zones, including areas not reconnected in the landscape-scale restoration alternatives described below, such as the undeveloped upland area northwest of Olive Ave (marked with letter **A** in Figure 7.1) and at Day Island. Figure 7.1 also shows the basin next to Day Island as restored (**B**), but this is not included in the restoration alternatives as it is not being considered for restoration by CDFW. However, if it were to be restored in the future, it would provide valuable connections to upland transition zone.

Restoration of Bel Marin Keys Unit V (**C**) is shown in Figure 7.1 but not considered in the restoration alternatives as it is being pursued by the USACE and the State Coastal Conservancy as part of a separate project. Because all the undeveloped diked baylands in the study area are reconnected to the tides in Figure 7.1, the managed seasonal wetlands at Hamilton Wetlands and Bel Marin Keys V (**D**) are shown as tidal. The intent of this map is not to recommend a new management strategy for these areas, but rather to illustrate the maximum potential for tidal restoration across the Novato Creek baylands.

Figure 7.1. Maximum potential area of restoration in the Novato Creek baylands (does not account for constraints). Letter labels correspond to descriptions in the text.



Alternative 0: Baseline (ca. 2030)

The baseline alternative (Figure 7.2) provides a reference point for the restoration alternatives. It assumes no future action is taken beyond the two projects already in the implementation phase, the Bird Ponds restoration and SR 37 Novato Creek Bridge Replacement. This differs from the remaining restoration alternatives, which all include active intervention to restore additional tidal habitat.

Figure 7.2. Alternative 0: Baseline (ca. 2030). Letter labels correspond to descriptions in the text.



Baseline (ca. 2030)

- ○ Novato Creek Bridge Replacement
- Existing berm/levee
- Pump station/tide gate
- Upland transition zone
- Restored tidal wetland

Existing tidal habitats

- Intertidal/subtidal (channel & Bay)
- Tidal marsh
- Tidal flat

The baseline alternative assumes existing berms and levees are maintained at their existing heights (i.e., not raised) and repaired if breached. In this scenario, diked baylands remain the majority land use type in the Novato Creek baylands, tidal habitat is limited, and there is limited connectivity between the tidal marsh and upland transition zones.

Marin County's Bird Ponds restoration project **(A)** is anticipated to be completed in 2027. In the baseline alternative, berms surrounding Heron's Beak and Duck Bill Pond are lowered and tidal action is restored to both ponds by breaches to Novato Creek. The creek is dredged to expand channel capacity from the upstream end of Duck Bill Pond (northern pond) to the downstream end of Heron's Beak Pond (southern pond).

The SR 37 Novato Creek Bridge Replacement project **(B)**, also known as Phase I of the SR 37 Flood Reduction Project, is anticipated to be completed in 2030. The bridge is replaced with a 1000-foot causeway in the baseline alternative.

Aerial view of the Novato baylands, looking downstream over the Bird Ponds toward San Pablo Bay. Photo by Sue Lattanzio.



The restoration alternatives include two full restoration alternatives and a near-term subset of each one that represents restoration opportunities prior to the planned elevation of SR 37 and the possible elevation of SMART onto separate causeways. This chapter describes each alternative and the rationale for its development. A comparative evaluation of alternatives, including modeling results, is presented in Chapter 9. Specific project-scale alternatives that could be implemented in the near-term and build toward these landscape-scale alternatives are presented in Chapter 8.

Alternative 1: Multiple Breaches

Rationale

The “multiple breaches” approach uses multiple breaches along the whole length of the existing Novato Creek channel to reconnect the diked baylands. This approach closely mimics the historical alignments of the tidal channel network (Figure 7.3).

Description

Alternative 1 reintroduces tides to 1,751 acres of diked, subsided baylands, creating a range of tidal habitats. Deer Island Basin (letter **A** in Figure 7.3) is restored to tidal action via a channel connection to Novato Creek and the berms separating Deer Island Basin from Novato Creek are lowered. Restored tidal areas are reconnected to natural upland transition zone at Deer Island and in the northern corner of the existing basin. Existing wastewater pipelines are relocated, the NSD outfall line is truncated, and treated wastewater is discharged directly into Deer Island Basin. Setback levees are constructed to protect inland areas. These may include ecotone slopes and/or horizontal levee seepage slopes to polish treated wastewater. Two portions of the existing basin are preserved as stormwater basins to prevent backwater flooding of inland neighborhoods. The berm separating Deer Island Basin from West Deer Island Basin (**B**) is raised to preserve stormwater detention capacity in West Deer Island Basin.

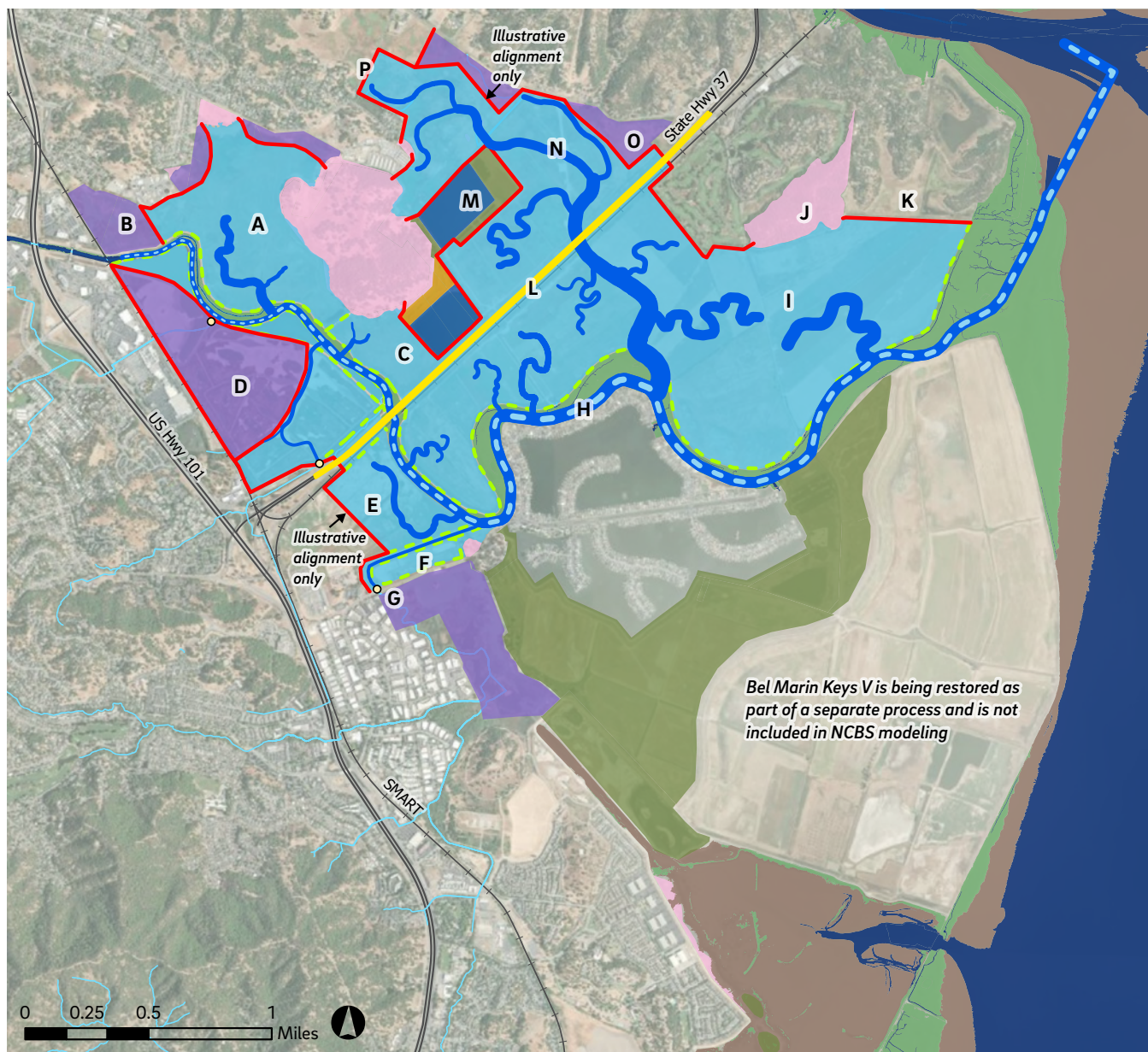
Farmer’s Basin (**C**) is restored to tidal action via a connection to Novato Creek, and the berms separating the basin from Novato Creek are lowered. The berm separating Farmer’s Basin from the adjacent NSD storage and wildlife ponds is raised to prevent flooding of the ponds.

Lynwood Basin (**D**) is partially restored. Existing berms along the west and east sides of the basin are raised to protect inland areas from flooding, and the existing Lynwood Pump Station is maintained. A setback levee is constructed through the basin to allow restoration of the southeastern third of the basin, which is breached and connected to Novato Creek. Existing berms surrounding the southeast corner of the basin are lowered. The Cheda Pump Station is relocated inland to the new levee alignment.

The Pattern Energy basin (**E**) is partially restored via a new channel connection to Novato Creek. A setback levee is constructed to protect inland areas from flooding. The location of the setback levee shown on the map is illustrative only and will depend on the footprint of future development. The existing berms along the north, east, and south sides of the basin are lowered to allow reconnection to the restored Lynwood Basin to the north, Novato Creek to the east, and the restored Bel Marin Keys (BMK) Dredged Disposal area to the south.

The BMK Dredged Sediment Disposal Area (**F**) is restored to tidal marsh, with surrounding berms lowered. Supratidal areas are graded to marsh elevation, and excess material is beneficially reused to create ecotone slopes or other features within the restored landscape. An alternative dredged material disposal plan is established to support continued operation of the Bel Marin Keys Community Services District’s routine lagoon maintenance program. This may include beneficial reuse to promote accretion in restored areas (e.g., thin-lift placement of dredged material).

Figure 7.3. Alternative 1: Multiple Breaches. Letter labels correspond to descriptions in the text.



Alternative 1: Multiple Breaches

— Raise or construct levee* - - - Intermittently lower levee — Road and rail causeways** — Channel - - - Dredging ○ Pump station/tide gate	— Tidal restoration — Natural upland transition zone Nontidal habitats — Seasonal wetland — Recycled water storage pond — Stormwater basin — Wildlife pond	Existing tidal habitats — Intertidal/subtidal (channel & Bay) — Tidal marsh — Tidal flat *may include ecotone slope **existing road and rail beds removed
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An ongoing study is analyzing potential future management options for Pacheco Pond. One possible alternative explored in the study is relocating the Pacheco Pond tide gate to Bel Marin Keys Boulevard, as shown in Alternative 1 (G). Pacheco Pond is maintained as a stormwater detention basin.

To increase tidal range in restored areas and provide adequate channel capacity to convey upstream flood flows, the Novato Creek channel is dredged from Duck Bill Pond/West Deer Island Basin in the west to Petaluma River in the east **(H)**. The dimensions of the dredged channel were estimated using tidal prisms associated with the restored areas and regional relationships between channel geometry and tidal prism, except where channel width was constrained by the existing Novato Creek levees.

The Marin County sprayfields are restored to tidal action via multiple breaches to Novato Creek **(I)**, and the existing outboard levee along Novato Creek is lowered in places. Existing pump stations along Novato Creek are removed. Berms along the golf course and the CDFW Day Island Unit are raised, possibly with ecotone slopes included to provide transition zone habitat. This alternative presumes that any remaining contamination at the Black Point Antenna Field is remediated or capped, and existing structures are removed prior to restoration.

Restored tidal baylands are connected to natural upland transition zone at the Vince Mulroy Preserve **(J)**. During the design phase, solutions will need to be considered to allow bayland-upland connectivity while preserving emergency access, as there is currently a fire road between the Preserve and the Marin County sprayfields.

While the Day Island Unit area **(K)** is not being considered for restoration by CDFW at this time, it could provide benefits if restored to tidal marsh in the future, though some areas would still need to be protected from flooding.

SR 37 and SMART **(L)** are raised on separate elevated causeways, and the existing road and rail beds are removed to allow tidal connection from the restored Marin County sprayfields to the restored NSD sprayfields/Simmons Slough wetlands.

The NSD basins **(M)**, including the wildlife pond and two recycled water storage ponds, are protected by setback levees and maintained for their current functions unless alternate storage locations outside the baylands can be found. The existing Dedicated Land Disposal site and Facultative Sludge Lagoons are capped and converted to seasonal wetland habitat.

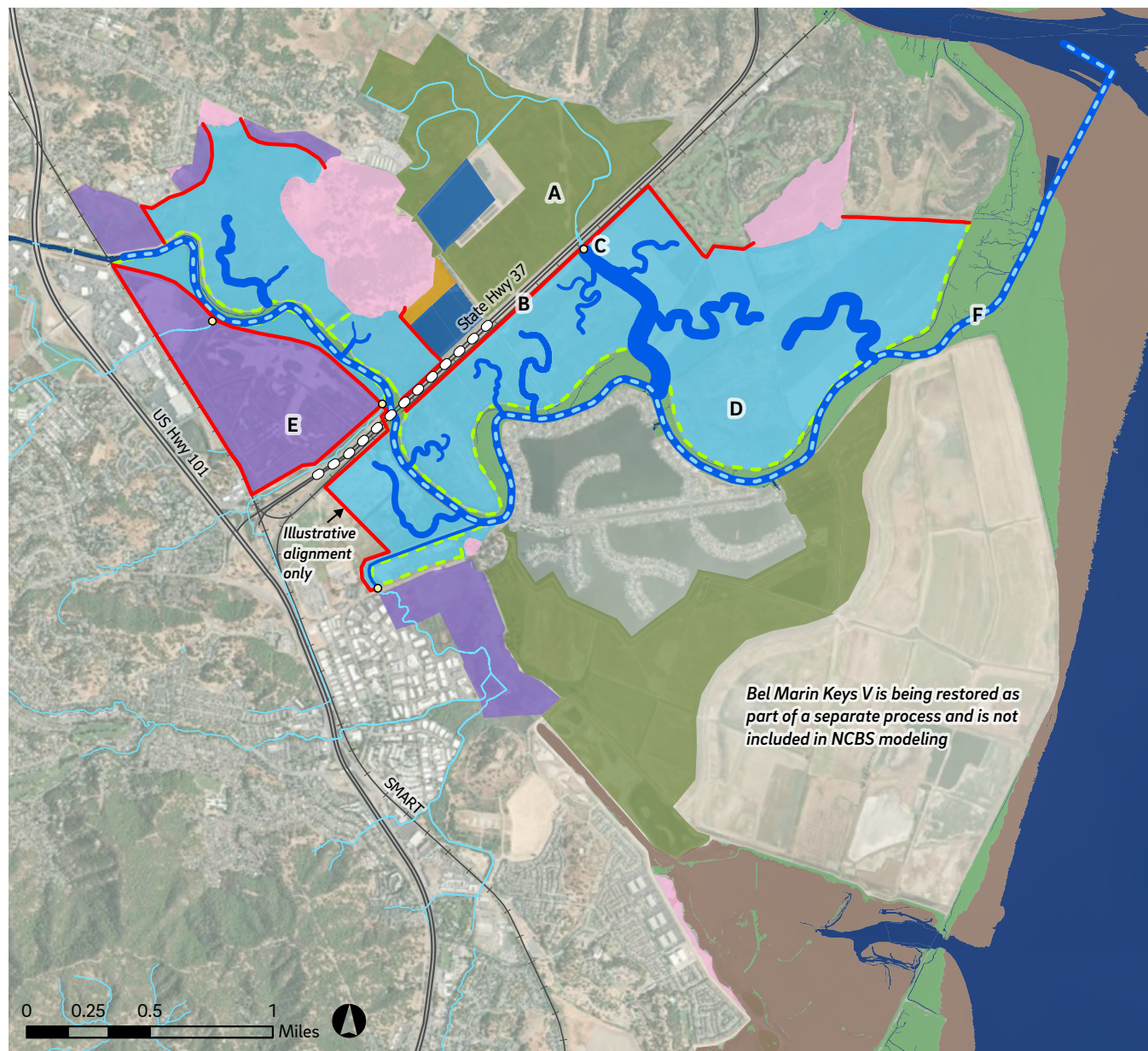
The Simmons Slough area **(N)** is restored to tidal action, including the existing NSD-owned sprayfield and mitigation site and the Marin Audubon property. Tidal connectivity is provided through an expanded Simmons Slough, and existing berms on either side of the slough are lowered. Underground pipelines are relocated and setback levees are constructed and/or raised to protect Olive Avenue, Atherton Avenue, and other inland development. The setback levees are not placed directly along Atherton Avenue; instead, space is maintained between the levees and the roadway to provide stormwater detention capacity for drainage from neighborhoods inland of Atherton Avenue **(O)**. Alternative strategies for managing stormwater in this area could be explored, and the levee alignments shown are illustrative only. For example, raising Olive Avenue **(P)** rather than protecting it would allow restoration of additional baylands to the north, as well as a connection to undeveloped transition zone.

Alternative 1a: Multiple Breaches - Near-Term

Rationale

As a subset of Alternative 1, this option represents restoration possible after the SR 37 Novato Creek Bridge is built, but before SR 37 and SMART are fully raised across the entirety of the baylands. (Note: Elevating the SMART rail line is not currently planned). Alternative 1a includes a setback levee to protect SR 37 and SMART, which would ultimately be removed to achieve the full restoration shown in Alternative 1. As in Alternative 1, the “multiple breaches” option routes tidal flows through multiple breaches from the existing Novato Creek channel to the diked baylands and closely mimics the historical alignments of the tidal channel network (Figure 7.4).

Figure 7.4. Alternative 1a: Multiple Breaches - Near-Term. Two elements shown in this graphic differ from the modeling for this alternative: Black Point Antenna Field (D) is depicted here as restored; however, the model treated this area as protected by levees. Dredging (F) was intentionally excluded from the model to test necessity. Results indicate that dredging is required for this alternative to be functional. Letter labels correspond to descriptions in the text.



Alternative 1a: Multiple Breaches - Near Term

— Raise or construct levee*	— Tidal restoration	Existing tidal habitats
- - - Intermittently lower levee	— Natural upland transition zone	— Intertidal/subtidal (channel & Bay)
○ ○ Novato Creek Bridge Replacement	Nontidal habitats	— Tidal marsh
— Channel	— Seasonal wetland	— Tidal flat
— Dredging	— Recycled water storage pond	
○ Pump station/tide gate	— Stormwater basin	
	— Wildlife pond	

*may include ecotone slope

Description

Because it is an intermediate step on the way to implementing Alternative 1, most of this alternative is a subset of Alternative 1. The differences between this alternative and Alternative 1 are highlighted below.

Alternative 1a reintroduces tides to 1,257 acres of diked, subsided baylands, creating a range of tidal habitats. In Alternative 1a, the land north of SR 37 along Simmons Slough (which includes NSD sprayfields and Marin Audubon-owned land) is not restored to tidal action **(A)**. This is because the SMART Rail line and SR 37 from the Novato Creek Bridge to Atherton Avenue have not yet been raised on an elevated causeway and must be protected in place. NSD can continue using the facilities in the Simmons Slough area, including the sprayfield north of SR 37, storage ponds, Dedicated Land Disposal site and Facultative Sludge Lagoons, as it does currently. The Marin Audubon Society parcels and the NSD mitigation site continue to function as seasonal wetlands.

A setback flood protection levee **(B)** is constructed to protect the SMART rail, PG&E transmission towers, and SR 37 from flooding when the Marin County sprayfields are restored. The eastern embankment of the raised Novato Creek Bridge ties into a raised levee along the inland edge of Farmer's Basin. Final levee design, including the final elevation and specific alignment, would be determined during a later design phase. Because the levee is intended to be temporary and eventually removed to allow restoration of the Simmons Slough area, it would likely not include an ecotone slope. It would also not be designed for more than a small to moderate level of sea level rise. If SR 37 and SMART are not raised, the levee will have to remain in place and be raised to accommodate further sea level rise. The levee footprint should be designed so that additional fill can be placed to raise the levee crest elevation, if necessary.

To manage upstream water levels, the Simmons Pump Station is relocated from its present location on Novato Creek to the setback levee **(C)**.

In the hydraulic modeling for this alternative, Black Point Antenna Field **(D)** is protected by levees and not restored to tidal action. However, a better and more cost-effective option, if feasible, would be to remediate any remaining contamination and restore this site along with the sprayfields (as shown in Figure 7.4).

Restoration of Lynwood Basin **(E)** is not included in this near-term alternative as there are multiple planning issues that need to be resolved before restoration (see Chapter 10 for more details).

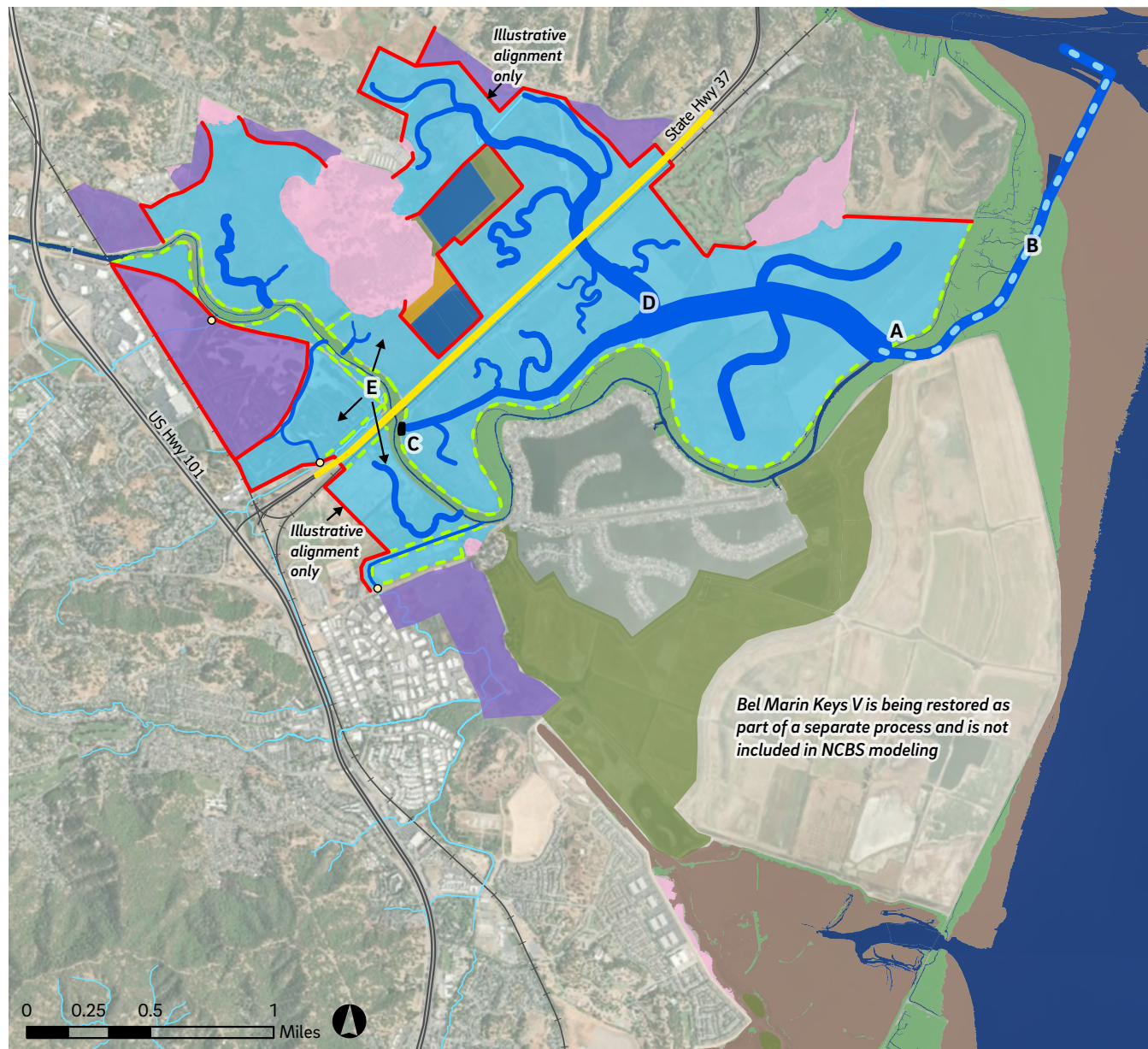
Dredging of Novato Creek is shown **(F)** but was not modeled for this alternative to test the effect of not dredging on flood water levels and tidal ranges. Results indicated that dredging is needed to avoid flood impacts and severely muted conditions in restored areas.

Alternative 2: Single Breach

Rationale

The "Single Breach" configuration routes most of the tidal flow through the Marin County sprayfields via a single breach near the mouth rather than routing flows along the length of the constrained Novato Creek channel (Figure 7.5). This improves tidal connectivity to the restored baylands, increasing tidal range, tidal prism, and marsh accretion rates, while also expanding capacity to convey floodwaters during storm events.

Figure 7.5. Alternative 2: Single Breach. Letter labels correspond to descriptions in the text.



Alternative 2: Single Breach

— Raise or construct levee* - - - Intermittently lower levee — Road and rail causeways** — Channel - - - Dredging ▬ Overflow weir ○ Pump station/tide gate	▬ Tidal restoration ▬ Natural upland transition zone Nontidal habitats ▬ Seasonal wetland ▬ Recycled water storage pond ▬ Stormwater basin ▬ Wildlife pond	Existing tidal habitats ▬ Intertidal/subtidal (channel & Bay) ▬ Tidal marsh ▬ Tidal flat *may include ecotone slope **existing road and rail beds removed
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Description

Most of the elements for this alternative are identical to Alternative 1: Multiple Breaches; like Alternative 1, Alternative 2 reintroduces tides to 1,751 acres of diked, subsided baylands, creating a range of tidal habitats. The following elements differ from Alternative 1:

Rather than breaching in multiple locations along Novato Creek, the Marin County sprayfields are restored via a single breach to Novato Creek at the eastern end of the basin **(A)**. Flows from the County sprayfields and the Simmons Slough area north of SR 37 and SMART are routed through this breach. The main channel as shown is sized based on existing tidal prism of the subsided diked baylands and will reduce in width as the baylands accrete and marsh elevations increase.

Rather than dredging through the entire length of Novato Creek from West Deer Island Basin to Petaluma River (as in Alternative 1), dredging is limited to the reach between the breach and Petaluma River **(B)**. The dredged channel dimensions used to model this alternative were determined based on avoiding increases in flood water levels along Novato Creek rather than by maximizing tidal range in the restored areas. The dredged channel size was iteratively increased until no increase in flood water levels was predicted with the hydraulic modeling.

An overflow weir **(C)** connects Novato Creek to the new channel through the sprayfields only during high flows. Under normal tidal conditions, the creek and new channels are not connected except for the single breach at the downstream end. During storms, the weir allows floodwaters from Novato Creek to overflow into the new channel and flow out to the Bay, reducing upstream water levels and flooding in the City of Novato. Levee lowering along the Novato Creek channel also allows floodwaters to escape from the creek into the restored baylands.

Rather than connecting directly to Novato Creek at the present location of the Simmons Pump Station, Simmons Slough is connected to the new primary channel through the Marin County sprayfields **(D)**.

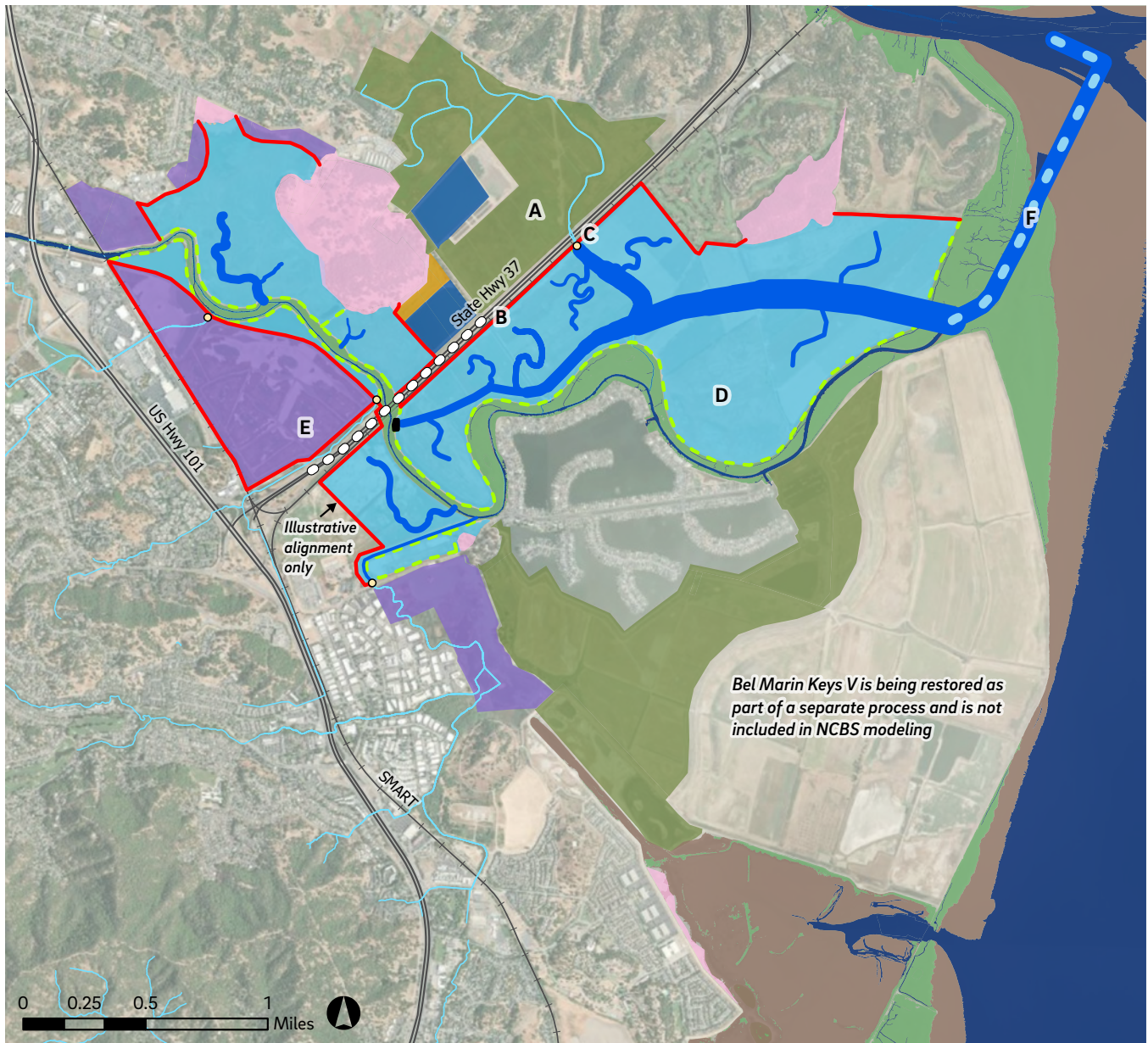
As in Alternative 1, restored areas north of SR 37 and west of Novato Creek **(E)** are connected to Novato Creek, so that sufficient tidal prism is added to Novato Creek to increase natural scour and reduce in-channel sedimentation.

Alternative 2a: Single Breach – Near-Term

Rationale

As a subset of Alternative 2, this option represents restoration possible after the SR 37 Novato Creek Bridge is built, but before SR 37 and SMART are fully raised across the entirety of the baylands. (Note: Elevating the SMART rail line is not currently planned.) Alternative 2a includes a setback levee to protect SR 37 and SMART, which would ultimately be removed to achieve the vision shown in Alternative 2. As in Alternative 2, the “Single Breach” configuration routes a greater portion of tidal flow through existing diked baylands rather than the constrained Novato Creek channel (Figure 7.6). This improves tidal connectivity to the restored baylands, increasing tidal range, tidal prism, and marsh accretion rates while also expanding capacity to convey floodwaters during storm events.

Figure 7.6. Alternative 2a: Single Breach – Near-Term. One element shown in this graphic differs from the modeling for this alternative: Black Point Antenna Field (D) is depicted here as restored; however, the model treated this area as protected by levees. Letter labels correspond to descriptions in the text.



Alternative 2a: Single Breach - Near Term

— Raise or construct levee*	— Tidal restoration	Existing tidal habitats
- - - Intermittently lower levee	— Natural upland transition zone	— Intertidal/subtidal (channel & Bay)
○ ○ Novato Creek Bridge Replacement	Nontidal habitats	— Tidal marsh
— Channel	— Seasonal wetland	— Tidal flat
— Dredging	— Recycled water storage pond	
— Overflow weir	— Stormwater basin	
○ Pump station/tide gate	— Wildlife pond	

*may include ecotone slope

Description

Because it is an intermediate step on the way to implementing Alternative 2, most of this alternative is a subset of Alternative 2. The differences between this alternative and Alternative 2 are highlighted below.

Alternative 2a reintroduces tides to 1,257 acres of diked, subsided baylands, creating a range of tidal habitats. In Alternative 2a, the land north of SR 37 along Simmons Slough (which includes NSD sprayfields and Marin Audubon-owned land) is not restored to tidal action **(A)**. As in Alternative 1a, land uses in this area remain as they are currently: NSD facilities and seasonal wetlands.

A setback flood protection levee **(B)** is constructed to protect the SMART rail, PG&E transmission towers, and SR 37 from flooding when the Marin County sprayfields are restored. As described in Alternative 1a, design details for the levee design will be determined during the project implementation phase.

To maintain flood control for upstream areas, the Simmons Pump Station is relocated from its present location on Novato Creek to the setback levee **(C)**. Rather than flowing directly into Novato Creek as in Alternative 1a, Simmons Slough is connected to the new primary channel running through the Marin County sprayfields.

In the hydraulic modeling for this alternative, Black Point Antenna Field **(D)** is protected by levees and not restored to tidal action. However, a better and more cost-effective option, if feasible, would be to remediate any remaining contamination and restore this site along with the sprayfields (as shown in Figure 7.6).

The southern portion of Lynwood Basin **(E)** is not restored in this alternative as it is anticipated to be a longer-term project.

The dimensions of the dredged Novato Creek channel **(F)** are larger than those in Alternative 2 to avoid increases in floodwater levels as well as more closely follow regional relationships between channel geometry and tidal prism to increase the tidal range within the restored areas.

8. PROJECT-SCALE RESTORATION ALTERNATIVES

This chapter presents distinct alternatives for near-term independent restoration projects that can start building toward the landscape-scale restoration alternatives presented in Chapter 7. Multiple potential configurations of a near-term restoration project for the Marin County sprayfields are presented, as well as a description of the Deer Island Basin restoration project (Figure 8.1). All alternatives reduce the total length of levees that need to be maintained in the Novato Creek baylands and pull the line of protection inland.

The three sprayfields alternatives, which represent different approaches for an initial project, contain similar elements: a primary tidal channel that is oversized to accommodate future restoration projects, dredging to Petaluma River, and ecotone levees. These alternatives each propose a single oversized breach, so they would be most suitable for building towards the Single Breach alternatives (Alternative 2 and Alternative 2a) in the landscape-scale restoration alternatives (see Chapter 7).

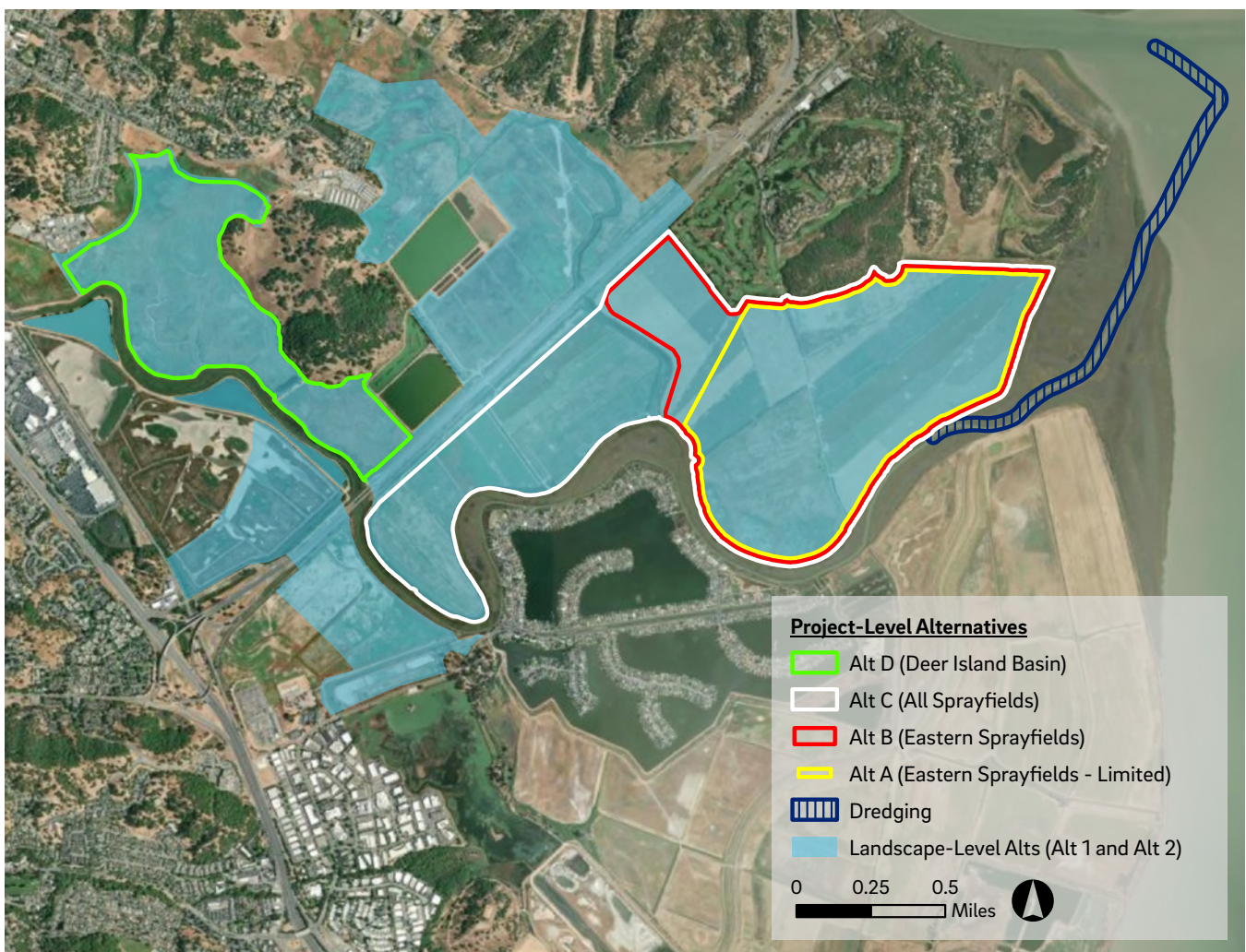


Figure 8.1. Project-scale restoration alternative boundaries and dredging extents.

Alternative A: Eastern Sprayfields – Limited

Rationale

Restoring a smaller area could reduce overall project costs (although not necessarily the cost per acre restored) and may provide a more feasible first project. Because the same amount of Novato Creek dredging downstream of the breach is proposed for Alternatives A, B, and C, the smaller tidal prism associated with Alternative A would result in a larger tidal range within the restored area. For Alternatives A, B, and C, the dredged Novato Creek channel is sized to provide sufficient conveyance to avoid flood impacts, while the channel excavated within the sprayfields is sized to convey tidal flows (prism) from future restored areas.

This alternative minimizes the length of new setback levee by connecting directly from the golf course to the existing levee west of Simmons Slough (Figure 8.2).

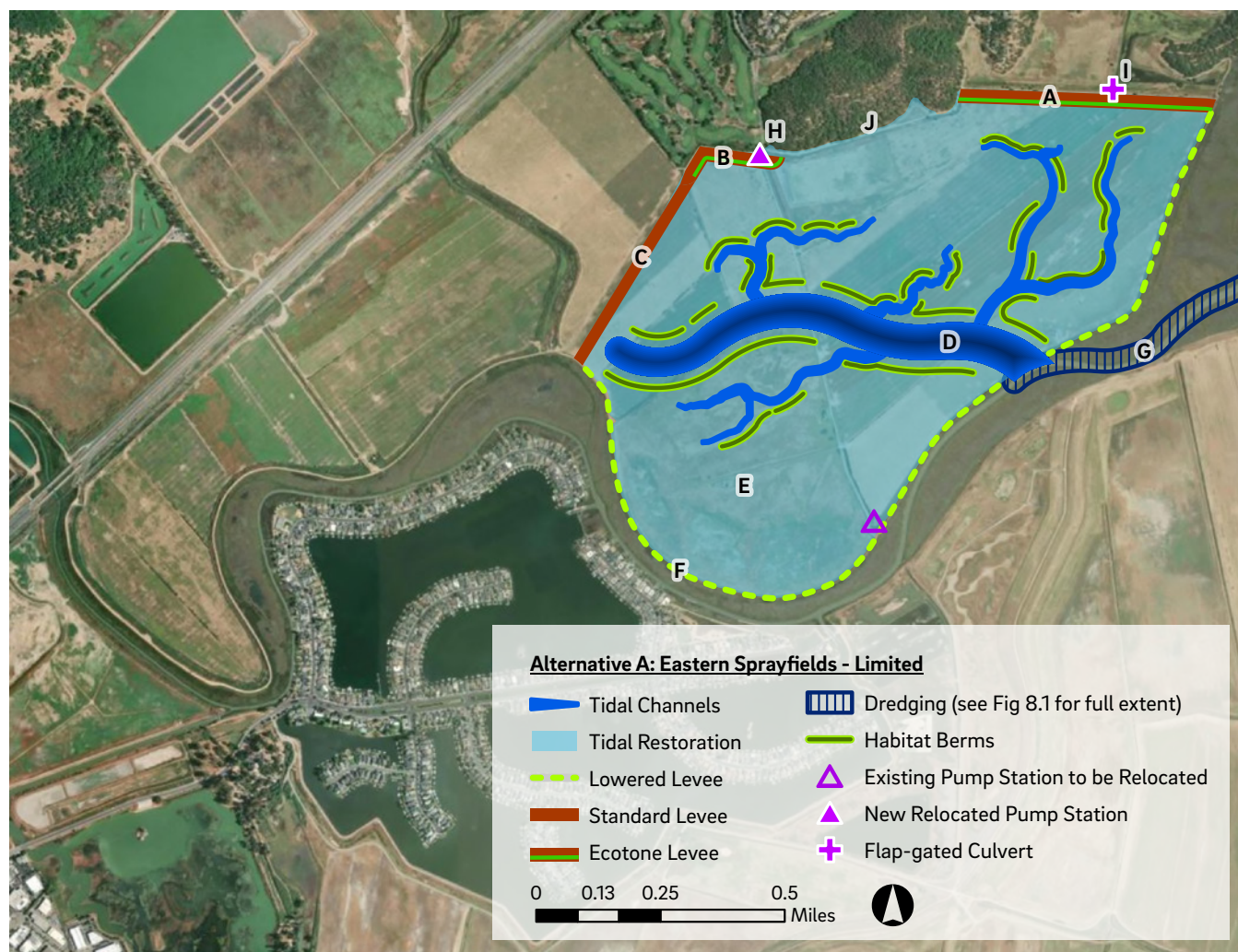


Figure 8.2. Alternative A: Eastern Sprayfields – Limited. Letter labels correspond to descriptions in the text.

Description

Ecotone levees are constructed at Day Island Road (A) and south of the golf course (B). These levees include a wider ecotone slope next to the restored baylands. The ecotone levees are in locations consistent with the landscape-scale alternatives 1 and 2. A new standard levee runs along an existing berm between the golf course

and Novato Creek **(C)**. This levee has a narrower cross section with steeper slopes and would be removed in an eventual larger-scale restoration project (i.e., designed to be temporary).

A channel is excavated to connect the eastern sprayfield to Novato Creek **(D)**, with side-cast habitat berms. The main channel is sized to accommodate a tidal prism of the eventual aspirational maximum extent of restored tidal marsh. Minor tidal channels are excavated in the footprint of historic tidal channels to drain the restored basin. The main channel breaches the existing levee and connects to Novato Creek west of the existing PG&E utility line. For all sprayfields alternatives (A-C), three PG&E towers may need replacement or retrofitting before site breaching. A boardwalk may need to be constructed to maintain access to the utility towers within the restored tidal marsh; alternatively, PG&E may be able to access towers via boats, as is done at other sites. A tidal channel crosses the existing PG&E line to drain the eastern end of the sprayfields, but avoids existing tower footings. Additionally, the Black Point Antenna Field **(E)** may require further cleanup, including structure removal. In addition to the tidal channel breach, the existing levee adjacent to Novato Creek is lowered to allow for tidal inundation **(F)**. Novato Creek is dredged from the breach to the creek mouth to expand tidal prism in the restored site and reduce backwater flood impacts upstream **(G)**.

An existing pump station next to Novato Creek, at the southeastern corner of the Black Point Antenna Field, is relocated to the northern (inboard) side of the new levee at the golf course **(H)**. A new culvert with a slide and flap gate is installed on the inboard side of the new ecotone levee at Day Island Road to drain the area to the north via gravity to the restoration area **(I)**. CDFW is not currently considering restoration of the Day Island Unit, but if this becomes a possibility in the future, this infrastructure could be relocated farther inland. Note that existing and proposed drainage circulation will require further investigation in future design phases.

Restored tidal baylands are connected to natural upland transition zone at the Vince Mulroy Preserve **(J)**. During the design phase, solutions will need to be considered to allow bayland-upland connectivity while preserving emergency access, as there is currently a fire road between the Vince Mulroy Preserve and the Marin County sprayfields.

Alternative B: Eastern Sprayfields

Rationale

This alternative maximizes restoration of tidal habitat east of Simmons Slough while limiting the length of levee along the SMART rail and SR 37 (Figure 8.3).

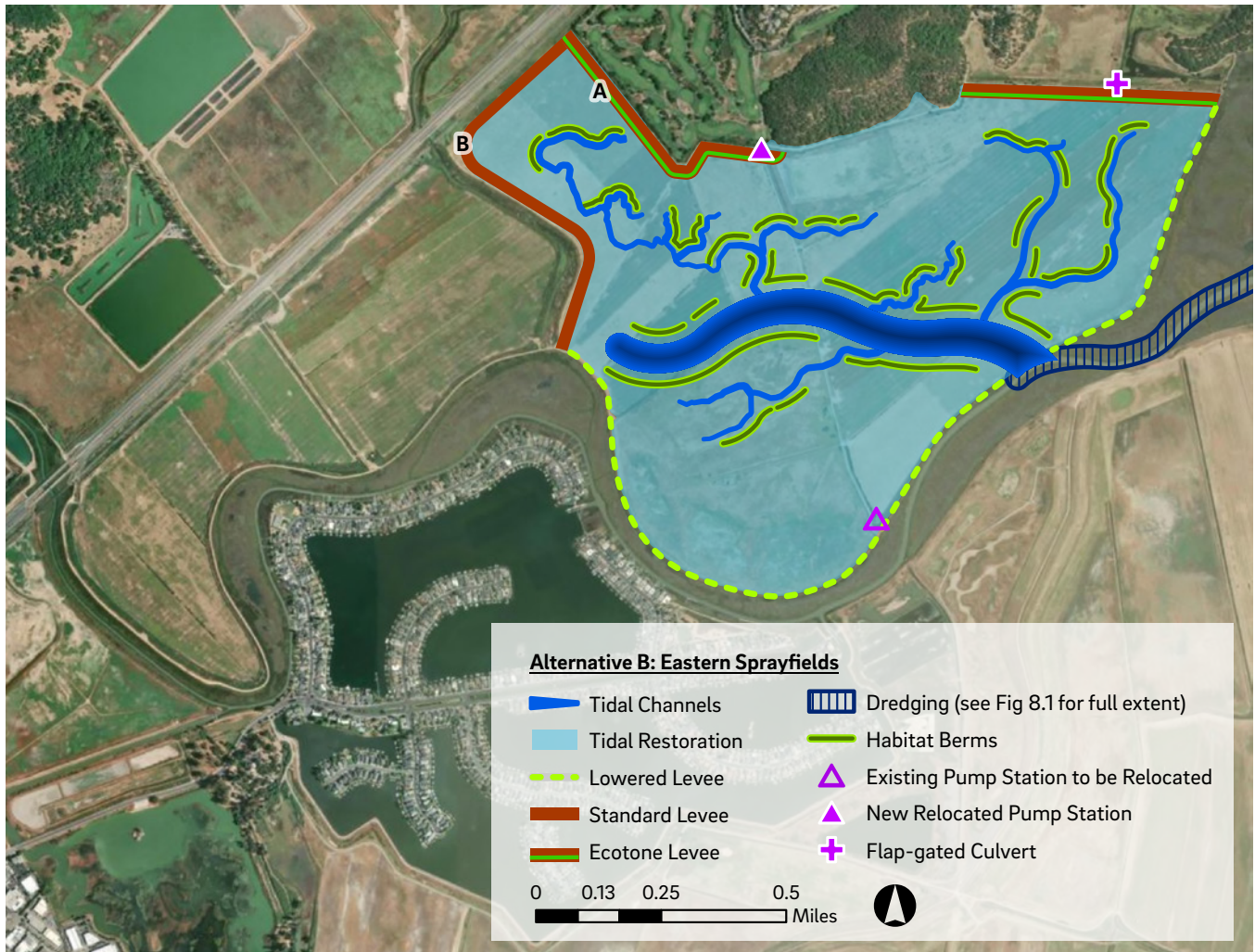


Figure 8.3. Alternative B: Eastern Sprayfields. Letter labels correspond to descriptions in the text.

Description

Several elements from Alternative B are consistent with the previous alternative (Alternative A), including constructing ecotone levees at Day Island Road and south of the golf course, excavating a tidal channel with side-cast habitat berms to connect the eastern sprayfield to Novato Creek, lowering the existing levee along the northern bank of Novato Creek, and dredging Novato Creek from the breach to the creek mouth. As in Alternative A, restored baylands are connected to protected uplands at the Vince Mulroy Preserve, but solutions will need to be considered to maintain fire road access while promoting bayland-upland connectivity.

Alternative B expands on Alternative A by extending the ecotone levee along the southwest side of the golf course (A), constructing standard (i.e., temporary) levees along the eastern bank of Simmons Slough and SMART/SR 37 (B), and constructing additional tidal channels and habitat berms. The standard levee along SMART/SR 37 could be lengthened in the future if the sprayfields west of Simmons Slough are also restored before the road and rail are raised onto causeways. Like Alternative A, this alternative also proposes a new culvert and relocated pump station inboard of the proposed ecotone levees.

Alternative C: All Sprayfields

Rationale

This alternative maximizes restoration of the County-owned land southeast of SR 37 (Figure 8.4). Enlargement of Simmons Slough in this alternative would prepare the area north of SR 37 for potential future restoration.

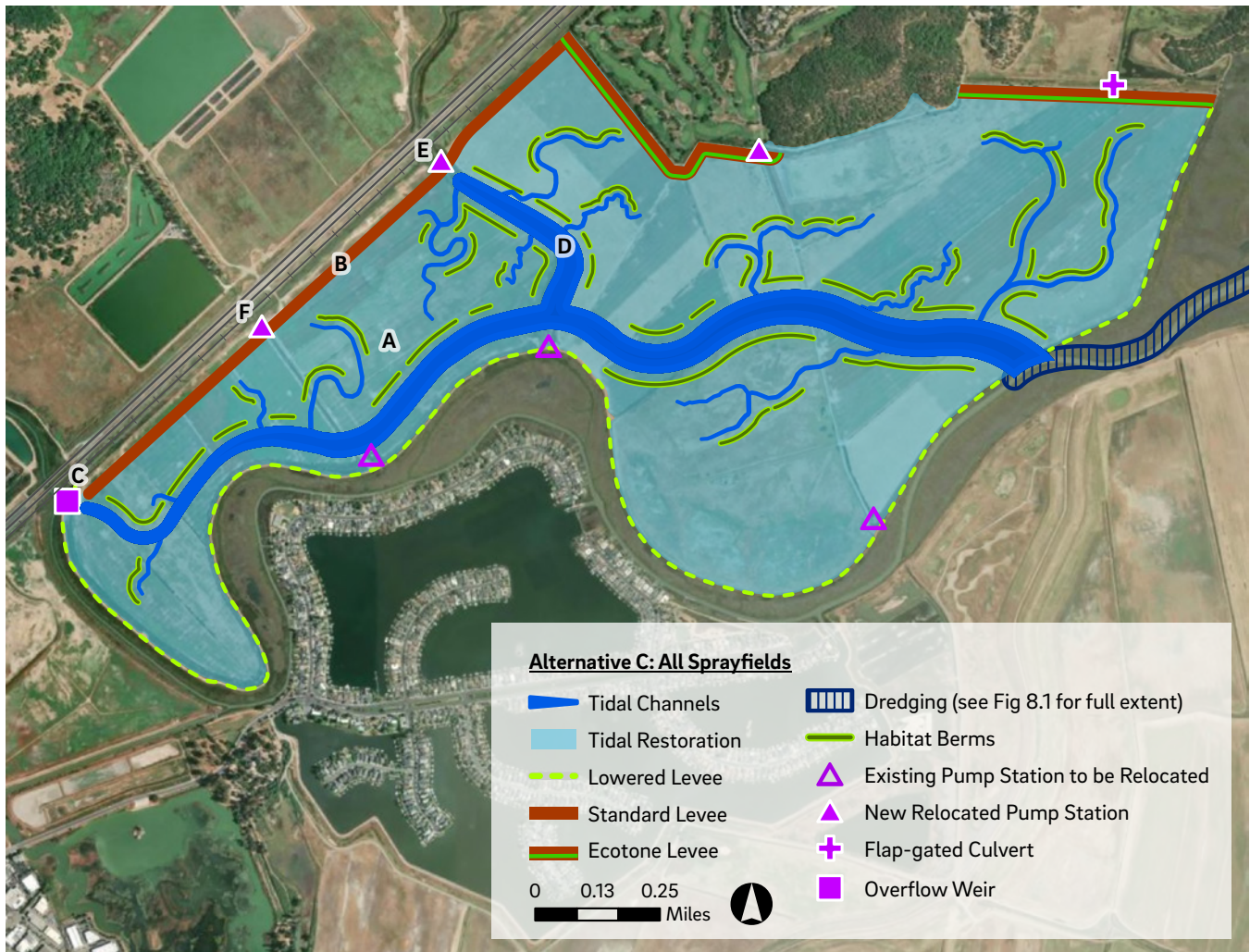


Figure 8.4. Alternative C: All Sprayfields. Letter labels correspond to descriptions in the text.

Description

Consistent with the previous alternatives, Alternative C includes constructing ecotone levees along Day Island Road and the golf course, excavating of a tidal channel with side-cast habitat berms to connect the eastern sprayfield to Novato Creek, lowering the existing levee along the northern bank of Novato Creek, and dredging Novato Creek from the breach to the creek mouth to improve tidal exchange in the restored site and avoid backwater flooding upstream. As in Alternatives A and B, restored baylands are connected to protected uplands at the Vince Mulroy Preserve, but solutions will need to be considered to maintain fire road access while promoting bayland-upland connectivity.

In addition to these elements, Alternative C expands tidal restoration further southwest to encompass all the sprayfields **(A)**. A standard levee is constructed along the entire length of SMART/SR 37, aligned south of the existing PG&E electric transmission line **(B)**. This levee would be removed if an expanded landscape-scale restoration project were pursued. An overflow weir connects the sprayfields to Novato Creek near the railroad

bridge, allowing water to flow from Novato Creek into the sprayfields during high flow events **(C)**. Tidal flows (non-flood conditions) would continue to be routed through the restoration site, reducing the extent of dredging required within Novato Creek.

Simmons Slough is enlarged in this alternative to accommodate potential future tidal flows of a restored tidal marsh area north of SR 37 **(D)**. To manage upstream water levels, the Simmons Pump Station is relocated from its present location on Novato Creek to where Simmons Slough meets the new levee **(E)**. Another pump station further west is relocated to the western side of the proposed levee in front of SR 37 **(F)**. These two pump relocations are in addition to the pump relocation and new culvert proposed in Alternatives A and B.

Alternative D: Deer Island Basin

Rationale

Restoring Deer Island Basin, which is farther upstream and closer to head of tide than the other project-scale alternatives, provides greater upstream flood reduction benefits in the City of Novato. Restoring Deer Island Basin creates a habitat connection to natural upland transition zone at Deer Island. It also allows NSD to shorten their outfall and discharge directly to the restored Deer Island Basin, if permitted. Restoring Deer Island Basin would increase the size of Novato Creek over time. Its restoration also reduces the length of levee that needs to be maintained along Novato Creek (Figure 8.5).

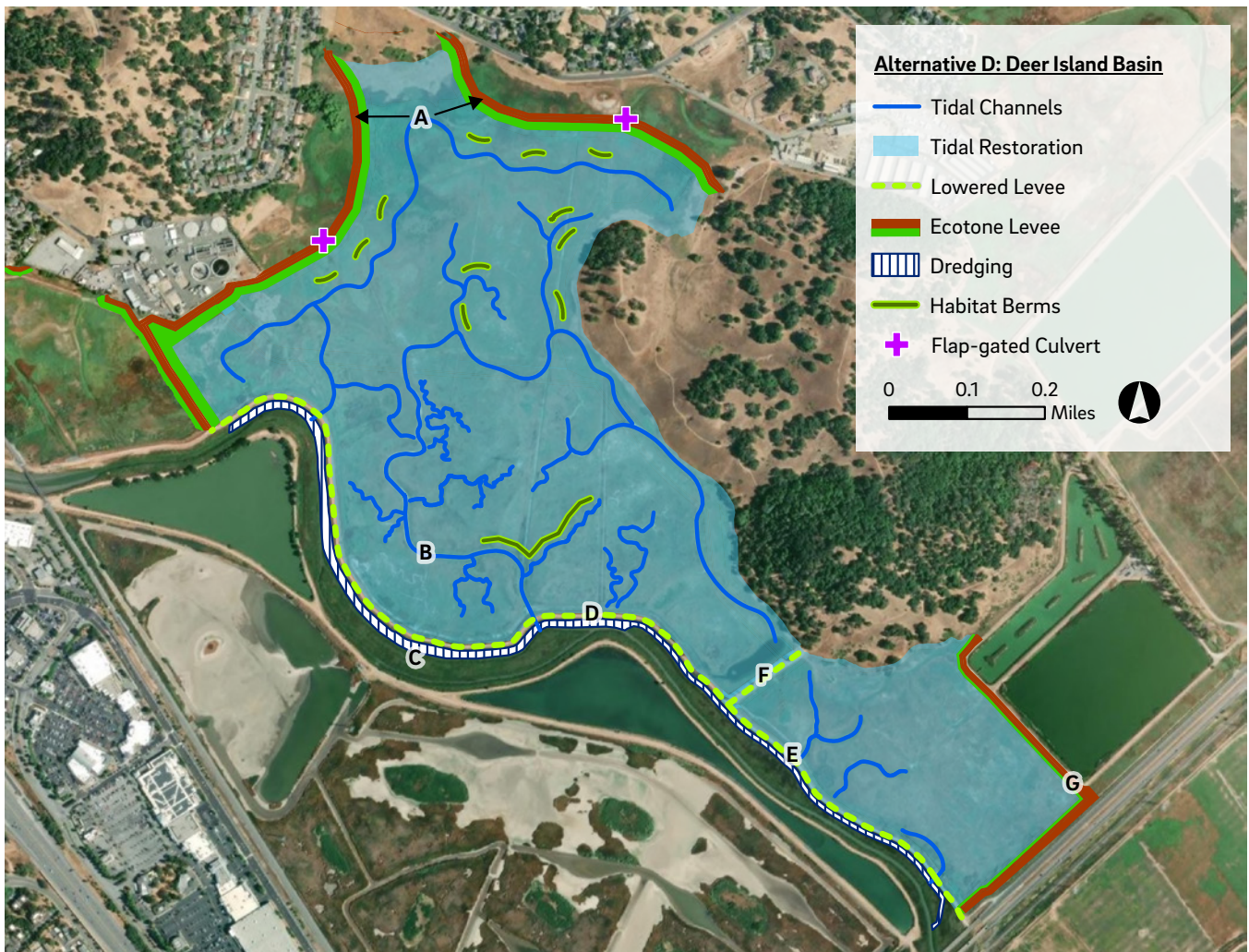


Figure 8.5. Alternative D: Deer Island. Letter labels correspond to descriptions in the text.

Description

Levees are constructed along the inland edge of Deer Island Basin, leaving space for stormwater detention inland of the restored area **(A)**. Channels are excavated in Deer Island Basin **(B)**, Novato Creek is widened by dredging to increase channel capacity **(C)**, and levees are lowered and selectively breached to connect Deer Island Basin with Novato Creek **(D)**. This alternative would also include a secondary breach to connect Farmers Basin with Novato Creek **(E)**, lowering a berm to connect Farmers Basin to Deer Island Basin **(F)**, and constructing ecotone levees on the south and eastern edge of the site **(G)**. Additional design elements include habitat berms. This alternative requires reconfiguration of existing NSD infrastructure prior to restoration, including the outfall line and the Bahia Force Main. Two PG&E towers may require replacement or retrofit prior to breaching the site.

DESIGN CONSIDERATIONS FOR VECTOR CONTROL

Projects that restore diked areas to tidal habitat will reduce ponding, increase tidal flushing, increase the vigor and habitat value of tidal marsh vegetation, and reduce available habitat for mosquitoes that transmit West Nile Virus, which would benefit public health. As projects move forward to the design and implementation phase, it is important to consider ways to maximize this benefit. In tidally restored areas, tidal channels should maximize efficient tidal exchange and be appropriately sized to accommodate sedimentation. Stormwater detention areas inland of setback levees should be designed to facilitate mosquito surveillance and invasive vegetation management and minimize mosquito breeding. These areas should be dewatered in 72 hours or less after a storm, and their layout, side slopes, and other drainage considerations should be discussed with the Marin/Sonoma Mosquito and Vector Control District.

All areas, both tidal and nontidal, should be designed to ensure adequate access for surveillance and treatment as needed. Adaptive management should be accounted for in permitting and may be necessary after completion of the designed project to improve or address drainage issues, increase habitat value, and remove channel blockages from side slumping.

9. ALTERNATIVES ASSESSMENT

Evaluation criteria were developed by the Strategy team to measure the performance of each restoration alternative relative to the objectives listed in Chapter 2. This chapter assesses the landscape-scale and project-scale alternatives according to these evaluation criteria. The assessment compares environmental benefits, flood protection benefits, sea level rise resilience, feasibility, and costs. Qualitative rankings (low, medium, high) for each criterion are assessed for each of the landscape-scale alternatives and project-scale alternatives. Select quantitative metrics supporting the rankings, such as levee lengths and cost estimates, are also provided in this chapter. Additional detail on the calculation of flood protection benefits from the hydraulic model is available in Appendix B, and additional detail on the cost estimates is available in Appendix C.

Methods: Habitat Area Estimates

Habitat areas were estimated post-breach and for year 2070, assuming 1.4 feet of sea level rise relative to a 2000 baseline and assuming restoration in 2040 (Tables 9.1-9.3). A modified version of the Marsh Equilibrium Model (MEM) (Morris et al. 2002) was used to estimate accretion rates over time based on methods previously developed by SFEI for the Baylands Resilience Framework (Plane et al. 2024). This model uses generalized parameters for the area rather than locally measured values for suspended sediment concentrations and vegetation parameters (Stralberg et al. 2011; Schile et al. 2014; Woltz et al. 2023). It is a one-dimensional model that does not account for sediment inputs from the watershed. It uses an average tide range for the OLU (i.e. the tide range along the shoreline at the mouth of Novato Creek) and not the localized tidal range in restored areas. It provides a rough estimate of expected accretion only.

Habitat types were designated according to Takekawa et al. (2013), which compiled plant communities across twelve sites in the San Francisco Estuary. Each alternative categorizes habitat types within the tidal restoration footprint as well as quantifying the transition zone adjacent to the restored area. This natural transition zone includes areas within 500 meters of the back of marshes and diked baylands. This distance is identified as the best estimate for capturing most transition zone functions, including evolutionary adaptation (Robinson et al. 2017). For each alternative, the 2070 tidal marsh acreages include adjacent natural transition zone areas that will naturally convert to marsh due to sea-level rise.

Restoration features, such as habitat berms and levees, were assumed to be at constructed grades immediately post-restoration and to experience settlement and subsidence of up to 3 feet by 2070. Higher fill depths (including levee tops) were assigned settlement and subsidence of 3 feet, berm crests were assigned 2 feet, and lower elevations (such as side slopes of habitat berms) were assigned 1 foot.

Methods: Cost Estimates

As stated in Appendix C, cost estimates include a 30% contingency on the subtotal of construction costs. In addition to overall cost estimates, construction costs are also shown by category - restoration, flood protection, and dredging - to indicate the relative contribution of these categories towards the overall cost. Restoration costs include channels and habitat berms inside the restored areas, lowering the levee along Novato Creek, containment berms for beneficial use of dredged material, and pro-rated costs for general and site preparation. Flood protection costs include standard and ecotone levees, water control structures, revegetation, and pro-rated costs for general and site preparation. Dredging costs include excavation and placement of dredged material.

These categorized costs are also scaled per unit (per cubic yard (CY) for dredging, per acre for restoration and flood protection.

In addition to the cost of constructed elements shown in the tables, the project will incur 'soft costs' for pre-construction and construction period services. Pre-construction services include design, environmental compliance, and permitting, and are estimated at 4-5% of the construction cost. Construction period services include engineering support, construction management, and biological monitoring, each estimated at 5% of pre-contingency construction costs (total 15%). Construction period services also include vegetation establishment maintenance for planted areas, estimated at 1% of pre-contingency construction costs.

Each estimate also includes a 'potential cost reduction' figure, representing options to streamline restoration features. Specifically, this figure assumes that all levees are constructed as standard levees rather than ecotone levees and that the extent of habitat berms inside the restored area is reduced by 50%. These reductions would result in less vegetated marsh habitat and have implications for wind-wave sheltering and sedimentation.

Assessing the Landscape-Scale Restoration Alternatives

Baseline Alternative

The Baseline Alternative fails to meet the project objectives (Table 9.1). It fails to restore significant tidal ecosystems and does not result in an appropriate mix of habitat types, full tidal exchange, or significant benefits to threatened and endangered species. It also does not increase the resilience of the Novato Creek baylands to flooding. Under this alternative, levees will continue to fail periodically, and unplanned breaches will require ongoing and expensive maintenance. Though it may be the least expensive option in the near-term (no design, permitting, or construction costs), it may be the most expensive option in the long-term. It will require ongoing maintenance costs associated with maintaining the existing berms, which were not designed for flood risk management, as well as keeping the extensive area of diked baylands dry with seven pump stations.

Long-Term Alternatives

The performance of the long-term alternatives (Alternatives 1 and 2) relative to the baseline alternative is shown in Table 9.1. The long-term alternatives represent the maximum extent of restoration given existing constraints and potential future projects along SR 37 and the SMART rail corridor, and therefore meet the goal of restoring tidal ecosystems to the maximum extent possible.

Alternative 1 - Multiple Breaches and Alternative 2 - Single Breach perform well in improving flood protection by reducing water levels in Novato Creek (by about 3 feet at SR 37 and about 1.5 feet at US-101). These alternatives also reduce erosion potential at the Bel Marin Keys community during large flow events by lowering flow velocities. Though Alternative 1 performs slightly better in reducing flood water levels than Alternative 2, this improvement comes at the cost of increased dredging of existing marshes, leading to greater short-term habitat impacts, more complex permitting, and higher construction costs. In addition, the limited width between the existing berms along Novato Creek may inhibit channel expansion and the development of a full tidal range within the restored areas under Alternative 1.

In summary, Alternatives 1 and 2 both perform well in the alternatives assessment. However, the new channel through the sprayfields in Alternative 2 conveys more tidal prism and increases the tidal range more in restored areas relative to Alternative 1. It is also more feasible to implement due to the decreased extent of dredging required in existing marshes. Therefore, Alternative 2 ranks highest according to the evaluation criteria.

Table 9.1. Performance ratings for long-term (maximum) restoration alternatives relative to the baseline alternative. Qualitative rankings (low, medium high) in the criteria tables are assessed relative to the other landscape-scale alternatives.

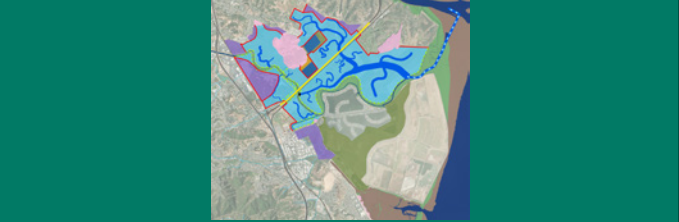
Evaluation Criteria	0. Baseline	1. Multiple Breach	2. Single Breach
			
Environmental/ecological benefits			
Appropriate mix of habitat types¹	No	High	High
	No restored tidal habitat.	Small extent of initial marsh habitat. Additional marsh will develop over time. 1,751 acres of restored area in baylands. <u>Year 2040 Habitats (immediately post breach) (acres)</u> • Upland: 135 • Tidal Marsh: 136 • Mudflat: 723 • Subtidal: 756 • Adjacent natural transition zone: 240 • Additional marsh with beneficial use of dredged material: 148 <u>Year 2070 Habitats (acres)</u> • Upland: 76 • Tidal Marsh: 177 • Mudflat: 1,330 • Subtidal: 171 • Adjacent natural transition zone: 237 • Additional marsh with beneficial use of dredged material: 148	Small extent of initial marsh habitat. Additional marsh will develop over time. 1,751 acres of restored area in baylands. <u>Year 2040 Habitats (immediately post breach) (acres)</u> • Upland: 133 • Tidal Marsh: 132 • Mudflat: 686 • Subtidal: 801 • Adjacent natural transition zone: 240 • Additional marsh with beneficial use of dredged material: 55 <u>Year 2070 Habitats (acres)</u> • Upland: 74 • Tidal Marsh: 172 • Mudflat: 1,261 • Subtidal: 246 • Adjacent natural transition zone: 237 • Additional marsh with beneficial use of dredged material: 55
Full tidal exchange	No	Medium-High	High
	No tides restored.	Tidal range: 2.9 ft at Deer Island, 3.0 ft in other restored areas (40 and 42% of full tidal range in Bay; 110 and 60% of Baseline tidal range at these locations in the Novato Creek channel). This is reasonable but less than ideal tidal exchange with Novato Creek and could be increased with additional dredging or time for tidal scour. However, width constraints imposed by existing levees may inhibit channel expansion and development of a full tidal range within the restored areas.	Tidal range: 3.0 ft at Deer Island, 3.6 ft in other restored areas (42 and 50% of full tidal range in Bay; 120 and 70% of Baseline tidal range at these locations in the Novato Creek channel). This is reasonable but less than ideal tidal exchange with Novato Creek and could be increased with additional dredging or time for tidal scour. The new sprayfields channel conveys significant tidal prism, thereby bypassing width constraints within the existing Novato Creek corridor.
Benefits to threatened & endangered species	No	High	High
	No restored tidal habitat.	• Large restored area (1,751 ac), not including Bel Marin Keys Unit V. • Long-term benefits for salt marsh harvest mouse and Ridgway's Rail once marsh develops. • Will require mitigation for short-term impacts to these species. • High initial and long-term benefits for fish.	• Large restored area (1,751 ac), not including Bel Marin Keys Unit V. • Long-term benefits for salt marsh harvest mouse and Ridgway's Rail once marsh develops. • Will require mitigation for short-term impacts to these species. • High initial and long-term benefits for fish.

Table 9.1 (continued). Performance ratings for long-term (maximum) restoration alternatives relative to the baseline alternative. Qualitative rankings (low, medium high) in the criteria tables are assessed relative to the other landscape-scale alternatives.

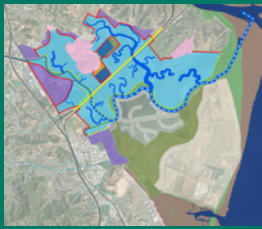
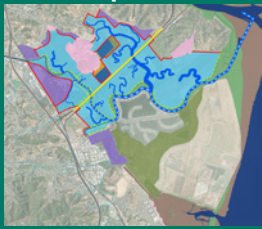
Evaluation Criteria	0. Baseline	1. Multiple Breach	2. Single Breach
			
Reduced breeding habitat for mosquitoes that can transmit West Nile Virus	No No restored tidal habitat.	High Restoration includes areas currently requiring high levels of larvicide treatment for mosquito control (Deer Island Basin, Simmons Slough wetlands, Sprayfields).	High Restoration includes areas currently requiring high levels of larvicide treatment for mosquito control (Deer Island Basin, Simmons Slough wetlands, Sprayfields).
Flood protection benefits			
Reduced flooding (50-year event)	No No reduction in flooding.	Very High Peak flood reduction of 3.5 ft at SR 37, 1.7 ft at US-101.	Very High Peak flood reduction of 3.1 ft at SR 37, 1.5 ft at US-101.
Avoids erosion impacts to Bel Marin Keys community during 50-year flood event	Medium Avoids erosion, except when levees breach (unplanned) and are not repaired quickly.	High Modeled velocities decrease in Novato Creek at the BMK community, with associated reduced erosion for the 50-year event.	High Modeled velocities decrease in Novato Creek at the BMK community, with associated reduced erosion for the 50-year event.
Resilience			
Sea level rise resilience	Low Levees will fail increasingly frequently and require greater maintenance with sea level rise.	High • High habitat migration space. • No protection of flood-prone diked baylands. • Long-term flood reduction. • Diked baylands and levees protecting developed properties continue to require maintenance.	High Similar to Alternative 1 .
Implementability			
Readiness to proceed	Very High Status quo.	Medium-Low Requires multiple infrastructure modifications, including both SMART and SR 37 causeways, and cooperation by multiple landowners.	Medium-Low Requires multiple infrastructure modifications, including both SMART and SR 37 causeways, and cooperation by multiple landowners.

Table 9.1 (continued). Performance ratings for long-term (maximum) restoration alternatives relative to the baseline alternative. Qualitative rankings (low, medium high) in the criteria tables are assessed relative to the other landscape-scale alternatives.

Evaluation Criteria	0. Baseline	1. Multiple Breach	2. Single Breach
			
Ability to obtain permits	Very High	Medium-Low	Medium
	No permits needed & levee repairs performed under emergency permits.	- Dredging Novato Creek directly impacts 56 ac of tidal marsh. Approx 1.67 MCY of dredging. - Dredging impacts are similar to the long-term impacts after tidal scour.	- Dredging of Novato Creek directly impacts 16 ac of tidal marsh. Approx 0.6 MCY of dredging. - Dredging impacts are similar to the long-term impacts after tidal scour.
Cost Feasibility			
Construction cost feasibility (near-term)	High	Low	Low
	No construction.	Approx \$120M - Restoration features: \$16M - Flood protection: \$67M - Dredging: \$37M - Potential cost reduction²: \$4M	Approx \$97M - Restoration features: \$15M - Flood protection: \$65M - Dredging: \$17M - Potential cost reduction²: \$4M
Construction cost efficiency per acre	High	Medium-High	Medium-High
	No construction.	\$69,000 / ac - Restoration features: \$9k / ac - Flood protection: \$38k / ac - Dredging: \$21 / CY	\$55,000 / ac - Restoration features: \$9k / ac - Flood protection: \$37k / ac - Dredging: \$24 / CY
Operation and maintenance cost effectiveness	Low	Medium-High	Medium-High
	High maintenance associated with maintaining large extent of low, poorly constructed existing levees (8.7 miles including internal berms at Simmons Slough and Deer Island Basin) and 7 pump stations.	Maintenance of 10 miles of new or improved levees (see Levee Maintenance section below for more detail) and 1 pump station.	Maintenance of 10 miles of new or improved levees (see Levee Maintenance section below for more detail), 1 pump station, and one new water control structure.

1. Habitat calculations are approximate and may not accurately represent the effects of sediment dynamics, including settlement and sedimentation. The habitat evolution modeling used here assumes full tidal range and does not account for restrictions to tidal flow.

2. Potential cost reduction incorporates targeted reductions to ecotone levee and habitat berm features. See note in "Methods: Cost Estimates" section above.

Near-Term Alternatives

Ratings for the near-term alternatives—Alternative 1a: Multiple Breach and Alternative 2a: Single Breach—are shown in Table 9.2. The choice of which near-term alternative to pursue will determine which long-term restoration alternative is possible. Dredging was not included in the modeling of Alternative 1a to assess the tradeoffs associated with dredging versus relying on natural tidal scour to enlarge Novato Creek over time. The absence of dredging is not inherent to Alternative 1a, which could readily be redefined to include dredging. The performance assessment matrix (Table 9.2) is based on Alternative 1a as modeled (without dredging). However, a discussion of how Alternative 1a might perform if dredging were incorporated is included below.

Alternative 1a (without dredging) performs better than Alternative 2a in some areas and worse in others, with worse performance overall.

- On the plus side for Alternative 1a, short-term disturbance of existing marsh habitat is lower and the ability to obtain permits is potentially higher due to the absence of dredging. Construction costs are also lower, as no dredging is included.
- However, modeling results show a severely reduced tidal range in Novato Creek and in restored areas in the absence of dredging. This would be undesirable as it would affect existing marsh and delay restored habitat development, limiting the benefit to marsh species.
- As Novato Creek scours over time in Alternative 1a, this could cause erosion along the banks of Novato Creek at the Bel Marin Keys community. While the Bel Marin Keys Community Services District has expressed an interest in some widening and deepening of Novato Creek, uncontrolled scour in terms of location and extent could be problematic.
- Both alternatives perform similarly in terms of flood risk reduction at US-101 and restored habitat acreage. However, habitat types and evolution will differ due to restricted tidal range under Alternative 1a.

If Alternative 1a were pursued, some dredging in the Novato Creek channel would be needed to improve tidal exchange. Dredging for a revised Alternative 1a would likely need to extend from the mouth of Novato Creek to the most upstream breach location, a more extensive footprint and higher volume than for Alternative 2a. If Alternative 1a were revised to include dredging (not shown in Table 9.2), Alternatives 1a and 2a would perform more similarly across a broader range of criteria, but Alternative 2a would likely perform better.

- With Alternative 1a revised to include dredging, Alternatives 1a and 2a would likely perform similarly for full tidal exchange, flood risk reduction, and construction costs.
- Permitting feasibility may be lower for a revised Alternative 1a compared to 2a, since dredging would need to extend further upstream versus being limited to the downstream segment of Novato Creek.
- With a revised Alternative 1a, the Bel Marin Keys community could benefit from a larger dredged channel for navigation. However, this channel would be dynamic, subjecting the community to additional and perhaps undesirable scour. The extent and patterns of scour would be difficult to predict precisely. A similar navigation benefit could be achieved by adding a water control structure to Alternative 2a upstream of the Bel Marin Keys community, opening the structure to allow tidal scour when desired and closing it as needed to avoid scour impacts – an adaptable solution. Such a structure could be added to Alternative 2a if requested by the Bel Marin Keys community and funding is obtained.

In summary, Alternative 2a (single breach) performs better than Alternative 1a (multiple breaches) across the evaluation criteria, regardless of whether Alternative 1a is modified to include dredging.

Table 9.2. Performance ratings for the near-term alternatives. Qualitative rankings (low, medium high) in the criteria tables are assessed relative to the other landscape-scale alternatives.

Evaluation Criteria	1a. Multiple Breach Near-Term ¹	2a. Single Breach Near-Term
		
Environmental/ecological benefits		
Appropriate mix of habitat types²	Medium-High Small extent of initial marsh habitat. Additional marsh will develop over time. 1,257 acres of restored area in baylands. <u>Year 2040 Habitats (immediately post breach) (acres)</u> • Upland: 82 • Tidal Marsh: 78 • Mudflat: 510 • Subtidal: 586 • Adjacent natural transition zone: 237 • Additional marsh with beneficial use of dredged material: 0 <u>Year 2070 Habitats (acres)</u> • Upland: 38 • Tidal Marsh: 112 • Mudflat: 1,001 • Subtidal: 109 • Adjacent natural transition zone: 234 • Additional marsh with beneficial use of dredged material: 0	Medium-High Small extent of initial marsh habitat. Additional marsh will develop over time. 1,257 acres of restored area in baylands. <u>Year 2040 Habitats (immediately post breach) (acres)</u> • Upland: 79 • Tidal Marsh: 75 • Mudflat: 484 • Subtidal: 618 • Adjacent natural transition zone: 237 • Additional marsh with beneficial use of dredged material: 159 <u>Year 2070 Habitats (acres)</u> • Upland: 37 • Tidal Marsh: 108 • Mudflat: 950 • Subtidal: 165 • Adjacent natural transition zone: 234 • Additional marsh with beneficial use of dredged material: 159
Full tidal exchange	Low Tidal range: 0.8 ft in all restored areas (20% of Baseline tidal range at these locations in the Novato Creek channel). Initially muted tides because no dredging of Novato Creek. Performance would be improved with dredging.	High Tidal range: 1.2 ft at Deer Island, 6.8 ft in other restored areas (50 and 140% of Baseline tidal range at these locations in the Novato Creek channel). Good tidal exchange downstream of SR 37 and Simmons Slough with dredging of Novato Creek
Benefits to threatened & endangered species	Medium-High • Intermediate restored area. • Long-term benefits for salt marsh harvest mouse and Ridgway's Rail once marsh develops. • High initial and long-term benefits for fish.	Medium-High • Intermediate restored area. • Long-term benefits for salt marsh harvest mouse and Ridgway's Rail once marsh develops. • High initial and long-term benefits for fish.

Table 9.2 (continued). Performance ratings for the near-term alternatives. Qualitative rankings (low, medium high) in the criteria tables are assessed relative to the other landscape-scale alternatives.

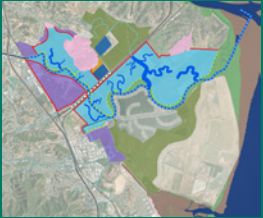
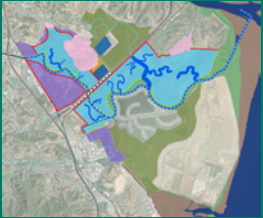
Evaluation Criteria	1a. Multiple Breach Near-Term¹ 	2a. Single Breach Near-Term 
Reduced breeding habitat for mosquitoes that can transmit West Nile Virus	Medium-High • Restoration includes areas currently requiring high levels of larvicide treatment for mosquito control (Deer Island Basin, Sprayfields). • Does not include restoration of Simmons Slough wetlands, another high mosquito-breeding area.	Medium-High • Restoration includes areas currently requiring high levels of larvicide treatment for mosquito control (Deer Island Basin, Sprayfields). • Does not include restoration of Simmons Slough wetlands, another high mosquito-breeding area.
Flood protection benefits		
Reduced flooding (50-year event)	Medium Peak flood reduction of 1.1 ft at SR 37 and at US-101.	Medium Peak flood reduction of 1.0 ft at SR 37 and at US-101.
Avoids erosion impacts to Bel Marin Keys community during 50-year flood event	Low Long-term tidal scour and erosion in response to upstream breaches and lack of dredging. The exact locations and extents of natural tidal scour / erosion are difficult to predict and manage. Lower flood velocities in Novato Creek at the BMK community, with associated reduced erosion during large flood events.	High Little change in flood velocities compared to Baseline. Avoids tidal scour and erosion in Novato Creek at the BMK community.
Resilience		
Sea level rise resilience	Medium-High • Same as Alternative 1 for restored areas. • Retained diked baylands (not restored near-term) continue to require maintenance.	Medium-High • Same as Alternative 2 for restored areas. • Retained diked baylands (not restored near-term) continue to require maintenance.
Implementability		
Readiness to proceed	Medium-High Requires some infrastructure modifications (e.g. truncation of NSD outfall line) and cooperation of multiple landowners.	Medium-High Requires some infrastructure modifications (e.g. truncation of NSD outfall line) and cooperation of multiple landowners.
Ability to obtain permits	High No direct impacts from dredging (long-term conversion of marsh to open water along Novato Creek via natural tidal scour would be greater than for Alternative 2a).	Medium-Low Dredging of Novato Creek directly impacts 36.9 ac of tidal marsh. Approx 1,800,000 CY of dredging (long-term habitat conversion is less than Alternative 1a after tidal scour).

Table 9.2 (continued). Performance ratings for the near-term alternatives. Qualitative rankings (low, medium high) in the criteria tables are assessed relative to the other landscape-scale alternatives.

Evaluation Criteria	1a. Multiple Breach Near-Term ¹	2a. Single Breach Near-Term
		
Cost Feasibility		
Construction cost feasibility (near-term)	Medium	Medium-Low
	Approx \$58M • Restoration features: \$12M • Flood protection: \$45M • Dredging: \$0M • Potential cost reduction³: \$3M	Approx \$103M • Restoration features: \$13M • Flood protection: \$51M • Dredging: \$39M • Potential cost reduction³: \$3M
Construction cost efficiency per acre	Medium-High	Medium
	\$46,000 / ac • Restoration features: \$10k / ac • Flood protection: \$36k / ac • Dredging: N/A	\$82,000 / ac • Restoration features: \$10k / ac • Flood protection: \$40k / ac • Dredging: \$21 / CY
Operation and maintenance cost effectiveness	Medium-High	Medium-High
	Maintenance of 7 miles of levees and 2 pump stations.	Maintenance of 7 miles of levees, 2 pump stations, and one new water control structure.

1. As described in Chapter 7, there are two key differences between the alternative as described in the figure and the alternative as modeled: (1) Dredging of Novato Creek is shown but was not modeled for this alternative to test the effect of not dredging on flood water levels and tidal ranges. Results indicated that dredging is needed to avoid flood impacts and severely muted conditions in restored areas. (2) In the hydraulic modeling for this alternative, Black Point Antenna Field is protected by levees and not restored to tidal action.

2. Habitat calculations are approximate and may not accurately represent the effects of sediment dynamics, including settlement and sedimentation. The habitat evolution modeling used here assumes full tidal range and does not account for restrictions to tidal flow.

3. Potential cost reduction incorporates targeted reductions to ecotone levee and habitat berm features. See note in "Methods: Cost Estimates" section above.

Assessing the Project-Scale Alternatives

Performance of the project-scale alternatives is shown in Table 9.3. In terms of habitat benefits, Alternative C (All Sprayfields) and Alternative D (Deer Island) perform best, with Alternative C having the largest restored area and habitat acreage and Alternative D creating excellent connectivity to upland transition zone and marsh migration space. Additionally, the proximity of Deer Island to NSD could allow irrigation of an ecotone levee with treated wastewater, resulting in transitional habitat benefits. The sprayfield alternatives (A, B, and C) have greater tidal range than Alternative D in restored areas, allowing faster habitat development, though their starting elevations and sediment supply are lower than at Deer Island. Hydraulic modeling suggests that the sprayfield alternatives will have a near full tidal range around 2070, following scour and expansion of Novato Creek from the larger tidal prism.

Model results indicate that all alternatives provide flood risk reduction benefits upstream along Novato Creek at SR 37 and US-101 due to the additional flow conveyance through the restored areas.

For sea level rise resilience, Alternative D connects to more marsh migration space, conferring more habitat resilience benefits. However, Alternative D does not reduce the area of diked baylands requiring protection and maintenance as much as the other alternatives.

The sprayfield alternatives (A, B, and C) have no major external project dependencies. Alternative D (Deer Island) may proceed upon obtaining permission and coordination to truncate the NSD outfall line and relocate other pipelines crossing the basin.

Alternative A and Alternative D have the lowest total project costs, but Alternative C has the lowest cost per acre, making it an efficient use of restoration funds. All project alternatives offer operation and maintenance (O&M) benefits by replacing existing low, non-engineered berms—which are susceptible to overtopping and expensive to maintain—with new flood protection levees and by eliminating one or more existing pump stations. Alternatives A and C provide the greatest O&M benefits.

Overall, Alternative C (All Sprayfields) performs as well as or better than the other alternatives with respect to the evaluation criteria, with a few exceptions. One exception is the reduction in mosquito breeding habitat (Deer Island Basin restoration would provide more benefit from this perspective). Another exception is the construction cost feasibility criterion. Alternative C has the largest construction cost—a product of its large scale—and thus rates lower. This alternative, however, is the most cost effective, with the lowest cost per acre.

Table 9.3. Performance ratings for the project-scale alternatives. Qualitative rankings (low, medium high) in the criteria tables are assessed relative to the other project-scale alternatives.

Evaluation Criteria	A. Sprayfields East Limited 	B. Sprayfields East 	C. All Sprayfields 	D. Deer Island 
Environmental/ecological benefits				
Appropriate mix of habitat types ¹	Medium-High Small extent of initial marsh habitat. Additional marsh will develop over time. 495 acres of restored area in baylands. <u>Year 2040 Habitats (immediately post breach) (acres)</u> • Upland: 26 • Tidal Marsh: 25 • Mudflat: 85 • Subtidal: 359 • Adjacent natural transition zone: 59 • Additional marsh with BU²: 55 <u>Year 2070 Habitats (acres)</u> • Upland: 12 • Tidal Marsh: 34 • Mudflat: 410 • Subtidal: 40 • Adjacent natural transition zone: 59 • Additional marsh with BU²: 55	Medium-High Small extent of initial marsh habitat. Additional marsh will develop over time. 575 acres of restored area in baylands. <u>Year 2040 Habitats (immediately post breach) (acres)</u> • Upland: 37 • Tidal Marsh: 27 • Mudflat: 141 • Subtidal: 370 • Adjacent natural transition zone: 59 • Additional marsh with BU²: 55 <u>Year 2070 Habitats (acres)</u> • Upland: 20 • Tidal Marsh: 38 • Mudflat: 478 • Subtidal: 40 • Adjacent natural transition zone: 59 • Additional marsh with BU²: 55	High Small extent of initial marsh habitat. Additional marsh will develop over time. 829 acres of restored area in baylands. <u>Year 2040 Habitats (immediately post breach) (acres)</u> • Upland: 50 • Tidal Marsh: 47 • Mudflat: 255 • Subtidal: 477 • Adjacent natural transition zone: 59 • Additional marsh with BU²: 55 <u>Year 2070 Habitats (acres)</u> • Upland: 25 • Tidal Marsh: 62 • Mudflat: 658 • Subtidal: 84 • Adjacent natural transition zone: 59 • Additional marsh with BU²: 55	High Small extent of initial marsh habitat. Additional marsh will develop over time. 268 acres of restored area in baylands. <u>Year 2040 Habitats (immediately post breach) (acres)</u> • Upland: 23 • Tidal Marsh: 15 • Mudflat: 183 • Subtidal: 47 • Adjacent natural transition zone: 175 • Additional marsh with BU²: 7 <u>Year 2070 Habitats (acres)</u> • Upland: 17 • Tidal Marsh: 23 • Mudflat: 192 • Subtidal: 39 • Adjacent natural transition zone: 172 • Additional marsh with BU²: 7
Full tidal exchange	High • Tidal range similar to Alternative C (not modeled) • Good tidal exchange with dredging of Novato Creek.	High • Tidal range similar to Alternative C (not modeled) • Good tidal exchange with dredging of Novato Creek .	High • Tidal range: 5.4 ft (110% of Baseline at this location in Novato Creek channel). • Good tidal exchange with dredging of Novato Creek.	Low Initially muted tides. Performance would be improved with additional dredging of Novato Creek. Channel anticipated to scour and expand over time (10-20 yrs) to provide full tidal range.
Benefits to threatened & endangered species	Medium-High • Moderate restored area. • Long-term benefits for salt marsh harvest mouse and Ridgway's Rail once marsh develops. • High initial and long-term benefits for fish.	Medium-High • Moderate restored area. • Long-term benefits for salt marsh harvest mouse and Ridgway's Rail once marsh develops. • High initial and long-term benefits for fish.	High • Larger restored area. • Long-term benefits for salt marsh harvest mouse and Ridgway's Rail once marsh develops. • High initial and long-term benefits for fish.	Medium-High • Smaller restored area • Initial muted tides inhibit development. • Good transition zone habitat. • Long-term benefits for salt marsh harvest mouse and Ridgway's Rail once marsh develops. • High initial and long-term benefits for fish.

Table 9.3 (continued). Performance ratings for the project-scale alternatives. Qualitative rankings (low, medium high) in the criteria tables are assessed relative to the other project-scale alternatives.

Evaluation Criteria	A. Sprayfields East Limited 	B. Sprayfields East 	C. All Sprayfields 	D. Deer Island 
Reduced breeding habitat for mosquitoes that can transmit West Nile Virus	Medium Moderate restored area; reduces some mosquito breeding habitat.	Medium Moderate restored area; reduces some mosquito breeding habitat.	Medium-High Larger restored area; reduces more mosquito breeding habitat.	High Deer Island Basin is currently the most challenging site in the Novato Creek baylands for mosquito control. Restoring would reduce mosquito breeding habitat.
Flood protection benefits				
Reduced flooding (50-year event)	Medium Not modeled. Assumed similar to Alternative C.	Medium Not modeled. Assumed similar to Alternative C.	Medium Peak flood reduction of 0.6 ft at SR 37, 0.2 ft at US-101.	High Peak flood reduction of 0.3 ft at SR 37, 0.9 ft at US-101. ³
Avoids erosion impacts to Bel Marin Keys community during 50-year flood event	High Little change in velocities compared to Baseline. Avoids tidal scour erosion in Novato Creek at the BMK community.	High Little change in velocities compared to Baseline. Avoids tidal scour erosion in Novato Creek at the BMK community.	High Little change in velocities compared to Baseline. Avoids tidal scour erosion in Novato Creek at the BMK community.	Medium May result in some erosion in Novato Creek at the BMK community.
Resilience				
Sea level rise resilience	Medium Moderate restored area among project-scale alternatives; moderate diked baylands remaining to maintain.	Medium Moderate restored area among project-scale alternatives; moderate diked baylands remaining to maintain.	High Most restored area among project-scale alternatives; least diked baylands remaining to maintain.	High Large area of transition zone and marsh migration space.
Implementability				
Readiness to proceed	High May be implemented with no major external project dependencies. Inclusion of the Black Point Antenna Field subject to approval of State Lands Commission.	High May be implemented with no major external project dependencies. Inclusion of the Black Point Antenna Field subject to approval of State Lands Commission.	High May be implemented with no major external project dependencies. Inclusion of the Black Point Antenna Field subject to approval of State Lands Commission.	Medium May proceed upon obtaining permission and coordination to truncate the NSD outfall line and to relocate other pipelines crossing the basin, assuming any temporary rise in water levels on downstream properties are mitigated, especially to the SMART railroad. Preliminary design complete.

Table 9.3 (continued). Performance ratings for the project-scale alternatives. Qualitative rankings (low, medium high) in the criteria tables are assessed relative to the other project-scale alternatives.

Evaluation Criteria	A. Sprayfields East Limited 	B. Sprayfields East 	C. All Sprayfields 	D. Deer Island 
Ability to obtain permits	Medium Dredging Novato Creek directly impacts 15.7 ac of tidal marsh. Approx 620,000 CY of dredging. Long-term, this marsh would be impacted by tidal scour regardless of initial dredging.	Medium Same as Alternative A.	Medium Same as Alternative A.	High Dredging Novato Creek directly impacts 9.8 ac of tidal marsh. Long-term, this marsh would be impacted by tidal scour regardless of initial dredging.
Cost Feasibility				
Construction cost feasibility (near-term)	High Approx \$27M - Restoration features: \$6M - Flood protection: \$9M - Dredging: \$13M - Potential cost reduction⁴: \$2M	Medium-High Approx \$31M - Restoration features: \$6M - Flood protection: \$13M - Dredging: \$13M - Potential cost reduction⁴: \$2M	Medium Approx \$40M - Restoration features: \$9M - Flood protection: \$18M - Dredging: \$13M - Potential cost reduction⁴: \$3M	Medium-High Approx \$29M - Restoration features: \$1M - Flood protection: \$26M - Dredging: \$2M - Potential cost reduction⁴: \$1M
Construction cost efficiency per acre	Medium \$55,000 / ac - Restoration features: \$12k / ac - Flood protection: \$17k / ac - Dredging: \$21 / CY	Medium \$55,000 / ac - Restoration features: \$10k / ac - Flood protection: \$22k / ac - Dredging: \$21 / CY	Medium-High \$49,000 / ac - Restoration features: \$11k / ac - Flood protection: \$22k / ac - Dredging: \$21 / CY	Medium-Low \$109,000 / ac - Restoration features: \$5k / ac - Flood protection: \$97k / ac - Dredging: \$20 / CY
Operation and maintenance cost effectiveness	Medium-High Levee maintenance 6,100 lf of new levees - Eliminates need to maintain 8,000 lf of existing berm 57% reduction from existing 14,100 lf of levees in alternative footprint Relocates 1 (NSD) pump station	Medium Levee maintenance 10,400 lf of new levees - Eliminates need to maintain 6,650 lf of existing berm 39% reduction from existing 17,100 lf of levees in alternative footprint Relocates 1 (NSD) pump station	Medium-High Levee maintenance 12,900 lf of new levees - Eliminates need to maintain 16,900 lf of existing berm 57% reduction from existing 29,800 lf of levees in alternative footprint Relocates 3 (NSD) pump stations	Medium-Low Levee maintenance 7,300 lf of new levees - Eliminates need to maintain 1610 lf of existing berm 18% reduction from existing 8,900 lf of levees in alternative footprint Eliminates 1 (County) pump station

1. Habitat calculations are approximate and may not accurately represent the effects of sediment dynamics, including settlement and sedimentation. The habitat evolution modeling used here assumes full tidal range and does not account for restrictions to tidal flow.

2. BU is beneficial use of dredged material.

3. Flood model results for Deer Island are from ESA (2023).

4. Potential cost reduction incorporates targeted reductions to ecotone levee and habitat berm features. See note in "Methods: Cost Estimates" section above.

Levee Maintenance

One objective of the Strategy is to reduce levee maintenance costs by setting back levees and reducing their overall length. The levees associated with each landscape-scale alternative are shown in Figure 9.1, and the lengths of these levees are described below. All lengths are approximate.

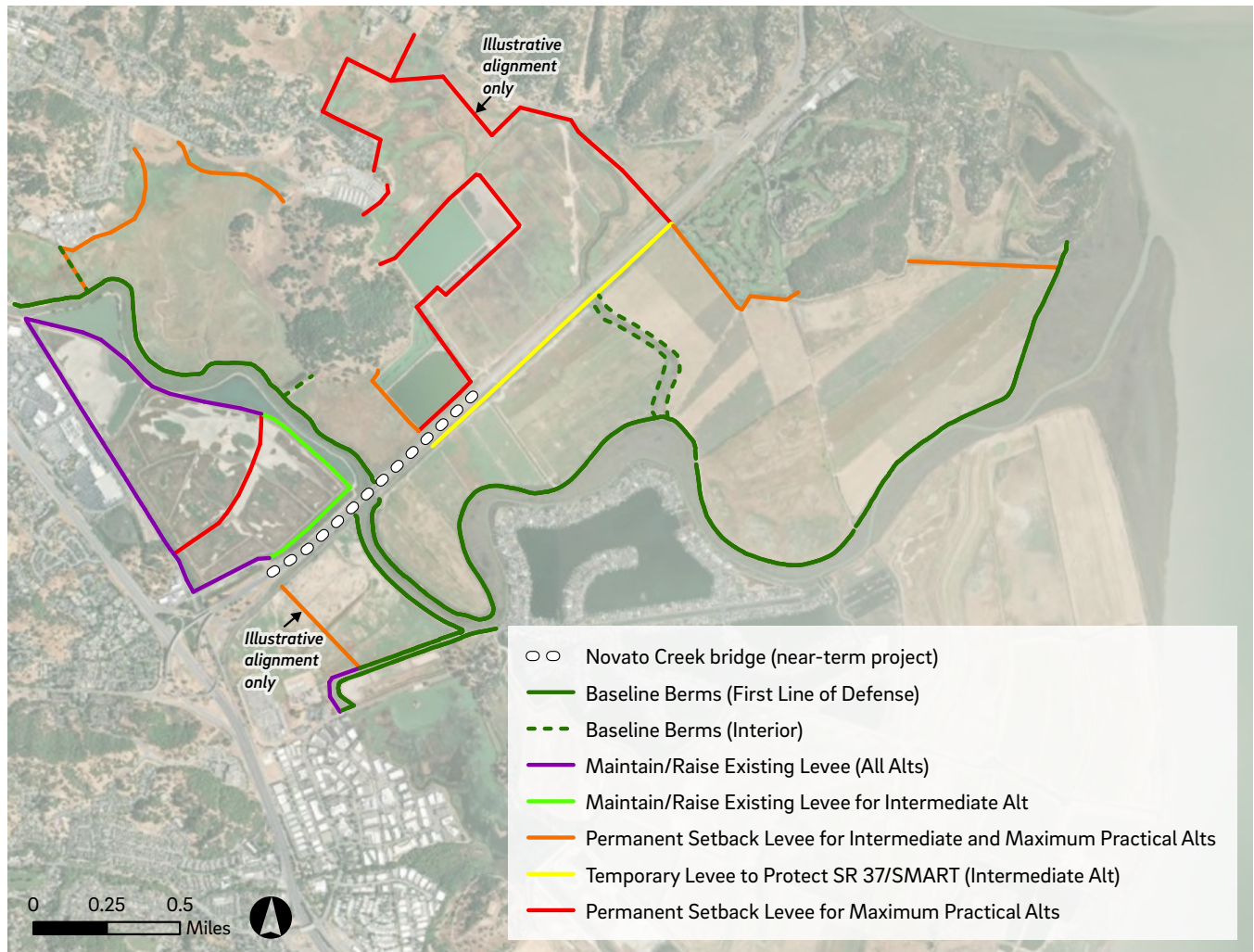


Figure 9.1. Levees associated with each alternative.

Currently, 7.3 miles of non-engineered berms provide the first line of flood protection for the Novato Creek baylands. This increases to 8.7 miles when including berms along Simmons Slough through the Marin County sprayfields, as well as the berms separating West Deer Island Basin and Farmers Basin from Deer Island Basin. About 2.5 miles of these berms—primarily around Lynwood Basin—are retained in the landscape-level alternatives. Currently, the western berm of Lynwood Basin is the existing SMART rail embankment, but a higher levee is required here to prevent inland flooding during the modeled 50-year event. Approximately 0.8 miles of berm along the southeastern corner of Lynwood Basin are retained in the near-term alternatives but would be removed or breached in the long-term landscape-level alternatives to restore the southern portion of the basin.

The near-term alternatives require construction of an approximately 1.1-mile-long temporary levee to protect SR 37 and SMART; this levee would be removed once both are raised on causeways. Setback levees are required in both the near-term and long-term landscape-level restoration alternatives to protect inland areas. In the

long-term restoration alternatives, 2 miles of the total 9.9 miles of levee are needed to protect NSD ponds; if these ponds are relocated in the future, these levees may no longer be necessary. Additional setback levees are also required to protect Olive Avenue and Atherton Avenue. Raising these roads to reconnect upland areas could reduce costs for levee construction and improve habitat connectivity but would require reassessing flood management for these areas.

As drawn, the near-term landscape-scale alternatives are the only landscape-scale options that achieve the goal of reducing overall levee length, even with the temporary setback levee to protect SR 37 and SMART. In the long-term restoration alternatives, the extensive setback levees needed to protect roadways, detention basins, and NSD ponds in the Simmons Slough area push the total levee length above the baseline alternative. However, these alternatives may still provide cost savings for the Marin County Flood Control District due to a reduced number of pump stations. Additionally, modern, engineered levees constructed to current standards are likely to require notably less maintenance over the next 50–100 years than the existing low non-engineered berms that will be overtopped more frequently, especially with sea level rise.

Project-scale alternatives A and C reduce the total length of levees requiring maintenance most compared to existing conditions. While all alternatives eliminate the need to maintain some reach of the levee along Novato Creek, these alternatives have proportionally greater reductions in the length of levee to maintain. However, as noted for the landscape-scale alternatives, Alternatives B and D may still provide O&M cost savings due to a reduced number of pump stations and the replacement of existing low non-engineered berms with modern, engineered levees constructed to current standards.

Cost Estimates

The cost estimates in Tables 9.4 and 9.5 highlight the tradeoffs between restoration scale, flood protection, and implementation feasibility. As described above, Alternative 2 (Single Breach) is the preferred long-term approach based on the evaluation criteria. In the near term, Alternative 2a is preferred as it establishes the oversized channel and hydraulic connections needed to support the preferred long-term strategy while delivering habitat and flood protection benefits. For project-scale implementation, Alternative C (All Sprayfields) provides the best balance of near-term habitat gains, cost efficiency, and long-term alignment with the preferred landscape-scale vision, making it the most effective near-term project for advancing the broader Strategy goals.

Table 9.4 displays the rough order of magnitude (ROM) costs for all the landscape- and project-scale alternatives. The total cost is represented both in 2026 dollars and escalated annually by 3% to 2040 to provide an approximation of when construction may begin on a preferred alternative. See Appendix C for more detailed cost estimate information.

Table 9.4 Rough Order of Magnitude (ROM) Construction Costs by Alternative.

	Construction Category			Total Cost, 2026 (construction plus contingency and soft costs)	Total Cost, 2040
	Restoration Features	Flood Protection Features	Dredging		
Landscape-Scale Alternatives					
1: Multiple Breaches	\$16M	\$67M	\$37M	\$120M	\$182M
2: Single Breach	\$15M	\$65M	\$17M	\$97M	\$146M
1a: Multiple Breaches - Near-Term	\$12M	\$45M	\$0M	\$58M	\$87M
2a: Single Breach - Near-Term	\$13M	\$51M	\$39M	\$103M	\$155M
Project-Scale Alternatives					
A: Eastern Sprayfields - Limited	\$6M	\$9M	\$13M	\$27M	\$41M
B: Eastern Sprayfields	\$6M	\$13M	\$13M	\$31M	\$48M
C: All Sprayfields	\$9M	\$18M	\$13M	\$40M	\$61M
D: Deer Island	\$1M	\$26M	\$2M	\$29M	\$44M

Notes:

1. Cost estimates use a 50% contingency to account for project uncertainties.
2. Costs for 2040 assume 3% annual escalation from 2026.
3. These estimates are subject to refinement and revisions as the design is developed in future stages of the project.
4. Note that in providing cost estimates, ESA has no control over the actual costs at the time of construction.
5. This cost estimate is based on: ESA's previous experience, bid prices from similar projects, R.S. Means (2026) edition. ESA makes no warranty, expressed or implied, as to the accuracy of such estimates as compared to bids or actual costs.

Table 9.5 displays the approximate construction cost per acre of restored area. In general, the cost per acre of each alternative decreases as the site size increases. However, this can vary, primarily due to the inclusion of Novato Creek dredging components in the landscape-scale alternatives.

See Appendix C for itemized cost estimates, including assumptions about elements that are not included in these estimates.

Table 9.5 Rough Order of Magnitude (ROM) Construction Cost per Acre by Alternative.

		Construction Category			Total Cost per Acre, 2026 (\$/acre)
	Area (acres)	Restoration Features (\$/acre)	Flood Protection Features (\$/linear foot)	Dredging (\$/cubic yard)	
Landscape-Scale Alternatives					
1: Multiple Breaches	1,751	\$9,000	\$38,000	\$21	\$69,000
2: Single Breach	1,751	\$9,000	\$37,000	\$24	\$55,000
1a: Multiple Breaches - Near-Term	1,257	\$10,000	\$36,000	-	\$46,000
2a: Single Breach - Near-Term	1,257	\$10,000	\$40,000	\$21	\$82,000
Project-Scale Alternatives					
A: Eastern Sprayfields - Limited	495	\$11,604	\$17,284	\$21	\$55,199
B: Eastern Sprayfields	575	\$10,163	\$21,894	\$21	\$54,707
C: All Sprayfields	829	\$11,079	\$21,745	\$21	\$48,534
D: Deer Island	268	\$5,439	\$97,381	\$20	\$108,719

Notes:

1. Cost estimates use a 50% contingency to account for project uncertainties.
2. Costs for 2040 assume 3% annual escalation from 2026.
3. These estimates are subject to refinement and revisions as the design is developed in future stages of the project.
4. Note that in providing cost estimates, ESA has no control over the actual costs at the time of construction.
5. This cost estimate is based on: ESA's previous experience, bid prices from similar projects, R.S Means (2026) edition. ESA makes no warranty, expressed or implied, as to the accuracy of such estimates as compared to bids or actual costs.

10. IMPLEMENTATION STRATEGY

Sequencing

Table 10.1 summarizes the preconditions required for each project to proceed. This table focuses only on external dependencies that are outside the control of the projects but are necessary to enable each project to move forward. These projects have many other feasibility considerations that could affect implementation timing. These feasibility considerations are described in Table 4.3, "Restoration opportunities and feasibility considerations by unit."

Table 10.1. External dependencies that must be met for each project to move forward. Near-term projects identified in Chapter 8 are highlighted in yellow. The dependencies in the top row are listed in roughly the order of likelihood of implementation, though this could shift.

Unit Name	Possible remediation	Possible PG&E tower improvements	Requires moving tide gate	Requires NSD outfall line to be truncated	Requires other pipeline relocation/modification	Requires SR 37/SMART to be raised	Requires Olive Ave to be raised
Marin County Flood Control District Sprayfields		X					
Black Point Antenna Field	X						
Bel Marin Keys Dredged Sediment Disposal Area			X				
Lynwood Basin		X					
Deer Island Basin Complex		X		X	X		
Pattern Energy				X			
Simmons Slough wetlands (Marin Audubon Society)					X	X	
NSD Ponds, Sprayfields, and Mitigation Site					X	X	
Northwest of Olive Avenue					X	X	X

The Marin County sprayfields have relatively few dependencies compared to other near-term project options and are a logical first project to implement. Other than possible foundation reinforcement or tower replacement needed for three PG&E electric transmission towers, there are no major external project dependencies. If feasible, the Black Point Antenna Field could be included as part of this early effort.

The Lynwood Basin project could also proceed in the absence of major infrastructure changes, assuming any rise in water levels on downstream properties are mitigated, especially to the SMART railroad. Restoration would be subject to review and approval of the Marin County Flood Control District, CDFW, and the State Lands Commission. The Lynwood Basin project would require careful design of a new setback levee crossing the basin and relocation of the Cheda pump station to maintain flood protection for upstream areas. There are multiple

planning issues still to resolve for the Lynwood Basin project; for example, with the basin in its current condition, water levels cannot be raised because this would lead to flooding of Rowland Drive.

Restoration of the Bel Marin Keys Dredged Sediment Disposal Area could proceed once the Pacheco Tide Gate is relocated from its current position to Bel Marin Keys Boulevard. This is currently being evaluated through a separate project but is unlikely to be selected as the preferred alternative for management improvements of Pacheco Pond. While not an external project dependency, an additional key feasibility consideration is identifying an alternative disposal location for dredged sediment (e.g., beneficial reuse for ecotones or other habitat features, thin-layer placement on existing marshes, or stockpiling at another site).

The Deer Island Basin Complex project could proceed once a permit to truncate the NSD outfall line is secured and other pipelines crossing the basin are relocated. The truncation of the outfall line would need to proceed in coordination with the restoration of the basin, as the new discharge location would be in the restored basin. Restoration of a portion of the Pattern Energy basin could also move forward once the outfall line is truncated, if Pattern Energy decides to participate. The NSD outfall line currently runs along the eastern edge of the Pattern Energy basin.

The remaining projects depend on raising SR 37 and SMART onto elevated causeways. These projects include the Simmons Slough wetlands (Marin Audubon Society), the NSD sprayfield and mitigation site, and areas northwest of Olive Avenue. Restoration of areas northwest of Olive Avenue would also require raising Olive Avenue.



Electric transmission tower foundation replacement underway in NSD sprayfields near Simmons Slough, August 2025.
Photo by Ellen Plane, SFEI.

SR 37, SMART, AND RESTORING THE NOVATO CREEK BAYLANDS

There are currently four barriers posed by transportation infrastructure to achieving the restoration vision outlined in the Strategy: the SR 37 and SMART rail crossings over both Novato Creek and Simmons Slough. These barriers reduce the maximum width of the channel at each location, which hinders the ability to convey flow from upstream restorations and blocks in-channel flows. The pilings of the existing SR 37 bridge obstruct 3-8% of the total flow area at MHHW, while the pilings of the SMART bridge obstruct 17-19%.

The planned Novato Creek Bridge replacement will remove one of these barriers. The estimated channel width at SR 37 with future upstream restorations (Bird Ponds, Deer Island Basin, Farmers Basin, partial restoration of Lynwood Basin) is 380 feet, with the thalweg at -10 feet NAVD. A channel of this size would be a tight fit through the existing bridge, and the existing thalweg is just -1 ft NAVD. The new bridge will be large enough to convey flows from all the upstream restorations identified in the Strategy. The Strategy assumed this bridge would be replaced in the baseline modeling.

The other three barriers will still need to be addressed. SR 37 will be raised between Novato Creek and Atherton Avenue as part of Caltrans' Phase 2 project, which is planned but not yet funded. This would remove the SR 37 barrier at Simmons Slough. There are currently no plans to elevate the SMART track, but this will likely be evaluated as part of conceptualizing an east-west passenger rail system.



Near-Term Enhancement Actions

The restoration projects identified in this Strategy are large in scale, with costs on the order of tens of millions of dollars. Smaller, habitat-focused projects could be pursued in parallel as plans for larger efforts advance.

For example, high-tide refuge islands and other forms of high-tide refugia could be added to marshes within the existing Novato Creek channel to benefit rails and other wildlife species. Additional projects could target diked areas to enhance habitat value, such as regrading them to create ponds and mounds that support varied topography and microhabitats, invasive species removal, and native plantings. Similar efforts have already been implemented at the Marin Audubon Society property on Simmons Slough and could be replicated elsewhere.

Drainage and pumping regimes could also be adjusted to encourage the formation of seasonal wetlands in areas currently kept dry. This approach would expand habitat for species like dabbling ducks and help reduce subsidence rates in diked baylands. Coordination with the Marin Sonoma Mosquito Abatement District would be required for these actions.

Integration with Bel Marin Keys Unit V Restoration

As implementation moves forward, close coordination between the Strategy's projects and the Bel Marin Keys Unit V restoration will be essential to ensure alignment and avoid conflicting design assumptions. With alternatives for this Strategy now defined, the Bel Marin Keys Unit V project should evaluate how the modified landscape described in the Strategy—particularly, the proposed main breach to the sprayfields—may influence its design, hydrodynamics, and habitat outcomes. Future design phases for the Strategy's projects should also incorporate the most up-to-date alternatives and modeling from the Bel Marin Keys Unit V effort to support consistent analysis. Given that timelines for both efforts remain uncertain, continuing close coordination will be essential to keep designs aligned as they evolve.

The dredging from the Marin County sprayfields to the Petaluma River channel proposed in this Strategy would benefit the Bel Marin Keys Unit V project if a future breach to Novato Creek is pursued. However, additional dredging would likely be required given the large tidal prism of the proposed Bel Marin Keys Unit V restoration area. This creates a potential opportunity for cost-sharing and joint planning around dredging, which should be explored further as both projects advance. Additional details on the Bel Marin Keys Unit V project are provided in Chapter 4 (Existing Conditions).

Implementation Funding

Grants

Measure AA, administered by the San Francisco Bay Restoration Authority, provides a reliable regional funding source for tidal wetland restoration, shoreline flood protection, water quality improvements, and associated public access. Measure AA funds are well suited for design and construction of Strategy projects. Projects can be phased to align with competitive grant cycles and combined with other funding sources to support larger implementation efforts.

At the state level, Proposition 4 (2024 Climate Bond) offers significant new funding for coastal resilience, habitat restoration, and nature-based solutions. Possible agencies whose Proposition 4-funded programs might be a good fit for the implementation of Strategy projects include the State Coastal Conservancy, Wildlife Conservation

ADVANCING THE PRIORITIES OF THE BMK COMMUNITY

The Strategy team worked with Bel Marin Keys Community Services District (BMK CSD) staff to identify ways that the future restoration projects can advance management goals that benefit the community.

► BMK CSD priorities

- Improve navigability and reduce in-channel sedimentation in Novato Creek.
- Reduce flood risk, especially in the context of sea level rise.
- Improve water quality in Novato Creek.

► How BMK CSD priorities informed the NCBS

Opening Novato Creek to greater tidal flows is aligned with BMK CSD priorities because it would naturally widen and deepen the creek, improving navigability, enhancing water exchange and water quality, and increasing floodplain storage to help reduce flood risk during storms. Restoring areas upstream of the BMK community is the most effective way to increase flow and improve navigability. Particularly beneficial restoration sites from this perspective include Deer Island Basin, Bird Ponds, Lynwood Basin (partial), and Pattern Energy.

In developing alternatives via an iterative modeling process, we used the following objectives for the Novato Creek reach along Bel Marin Keys:

- Increase daily tidal flows to scour and maintain a larger channel, clear in-channel sedimentation, improve tidal flushing and water quality, and improve navigation.
- Avoid excessive tidal flows and increased velocities during storms to avoid detrimental erosion of BMK CSD levees.
- If possible, reduce water levels at the BMK community during storm conditions.

► Preferred restoration alternatives are aligned with BMK CSD priorities

The preferred alternatives generally meet these objectives. For example,

- Daily tidal flows are expected to increase tidal flushing and support a wider and deeper Novato Creek along the length of the BMK community and downstream to the Bay. Alternative C (All Sprayfields) would result in a wider and deeper creek downstream of the BMK community to the Bay.
- Modeling for the 50-year storm indicates that long-term restoration under Alternative 2 would reduce velocities in Novato Creek near the BMK community, resulting in lower erosion potential. Modeling shows little change in velocities for Alternative C.
- Peak water levels for the 50-year storm event are modeled to decrease by up to 1.8 ft at the BMK Community for long-term Alternative 2 and by up to 1.1 ft for Alternative C.

If the sprayfields are restored first, sedimentation may occur in the Novato Creek channel upstream of the breach, along the BMK community. Although we did not model sedimentation directly and model results for Alternative C do not show a clear pattern of reduced velocities within Novato Creek upstream of the breach, sedimentation upstream of the breach has been observed in other restoration projects. Pairing the sprayfields restoration with an upstream restoration could negate this effect by increasing the tidal prism within the Novato Creek channel. However, if this pairing is not possible, engineered options to optimize Novato Creek flow and reduce sedimentation can be explored during the design phase. For example, the overflow weir structure shown in Alternatives 2, 2a, and C could be converted to a flashboard weir or culvert to return flows to Novato Creek upstream of the Bel Marin Keys Community.

► **Possible BMK CSD contributions to future restoration:**

BMK CSD has historically used dredged material from lagoon maintenance to support local restoration projects including at Hamilton Wetlands. Future material removed from the lagoons can similarly support Strategy projects by raising elevations in subsided sites, supporting developing marshes via strategic placement, or creating habitat features like ecotone levees and marsh mounds. If long-term beneficial reuse applications such as these are permitted, the existing Dredged Sediment Disposal Area would no longer be needed and could be restored. Until these applications are permitted, the existing disposal area must be maintained.

Another possible contribution from BMK CSD is to coordinate lagoon releases to take advantage of natural scour potential. When the lower creek reaches are dredged and channel sediment is loosened, coordinated releases from the Bel Marin Keys lagoons and/or Pacheco Pond (assuming Pacheco tide gates are repaired) could increase flow and help scour the channel. Future projects should coordinate schedules with BMK CSD to maximize benefit from lagoon releases.



Bel Marin Keys Community, April 2024. Photo from Google Earth.

Board, and the State Water Resources Control Board. State Coastal Conservancy and Wildlife Conservation Board programs are particularly aligned with tidal marsh restoration, land acquisition, habitat enhancement, and public access components of Strategy projects, while State Water Resources Control Board funding is aligned with the water quality and multi-benefit flood management objectives.

Additional grant programs are available through the State Coastal Conservancy and Ocean Protection Council as well as from federal programs, including the Environmental Protection Agency San Francisco Bay Water Quality Improvement Fund and the National Fish and Wildlife Foundation. Strategy projects are likely to be well positioned for these programs because they achieve multiple benefits for habitat creation, flood reduction, water quality improvement, and public access.

Integrated Transportation Projects

Integrating the restoration actions identified in this Strategy with planned transportation infrastructure presents an opportunity to secure funding and streamline the permitting process. By funding these restorations as integrated components of the SR 37 corridor improvement projects, projects can be “self-mitigating,” avoiding the need to seek mitigation credits elsewhere. For instance, the Phase 2 Caltrans project—which involves elevating the roadway on a piled causeway from Novato Creek to Atherton Avenue—could be designed as an integrated transportation and restoration effort that incorporates opportunities identified in the Strategy (e.g. Marin County Sprayfields or Simmons Slough restorations, depending on timing and other constraints). This approach mirrors the successful model currently employed for the Tolay Creek Bridge and Strip Marsh East projects, where infrastructure and restoration projects are treated as a single investment. This integrated funding mechanism would leverage transportation budgets to achieve regional conservation goals, ensuring that climate-adaptive infrastructure and habitat restoration are advanced in tandem.

Mitigation Credit Agreements

CDFW’s Regional Conservation Investment Strategy (RCIS) Program was developed to address the growing need for regional, ecosystem-based approaches to species protection and recovery. A RCIS is a voluntary, non-binding, non-regulatory regional plan for species and habitat conservation that identifies goals, objectives, priorities, and actions that can be implemented to guide conservation. A key function of the RCIS Program is to enable the development of Mitigation Credit Agreements (MCAs) with CDFW and, as appropriate, other regulatory agencies. MCAs allow project proponents to fulfill mitigation requirements in advance of project impacts.

Appendix D explores the potential application of MCAs in the Novato Creek baylands and provides relevant considerations for the development of future MCA opportunities. While MCAs may offer a valuable mechanism to help fund the large-scale restoration envisioned in this strategy, it is important to emphasize that all infrastructure and development projects next to sensitive habitats should first and foremost prioritize impact avoidance and minimization. Projects should integrate nature-based approaches wherever feasible to reduce the need for compensatory mitigation. In instances where impacts are truly unavoidable and mitigation is required, MCAs can serve as a proactive means of generating credits in advance. Although MCA frameworks do not allow for restrictions on what types of entities and projects can use these credits, this strategy recognizes the importance of encouraging, where possible, the alignment of available credits with regionally significant public infrastructure efforts (such as the SR 37 corridor improvements) to help maximize broader ecological and community benefits.

Permitting

As multi-benefit habitat restoration projects, the projects identified in the Strategy would likely be eligible for streamlined permit review under the Bay Restoration Regulatory Integration Team (BRRIT) process. Regulatory agencies expected to exert jurisdiction over the natural resources likely to be affected by the Strategy include the following:

- Clean Water Act (CWA) Section 404 – United States Army Corps of Engineers (USACE) – waters of the U.S. (WOTUS)
- Federal Endangered Species Act (FESA) – U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS) – federally listed species and their critical habitat
- National Historic Preservation Act (NHPA) Section 106 – State Historic Preservation Office (SHPO) – historic properties
- Fish and Game Code 1600 – California Department of Fish and Wildlife (CDFW) – rivers, streams, and lakes
- Fish and Game Code 2080/2080.1 – CDFW – state listed species
- CWA Section 401/Porter Cologne Water Quality Control Act – Regional Water Quality Control Board (Regional Board) – waters of the state (WOTS)
- McAteer Petric Act and Coastal Zone Management Act – San Francisco Bay Conservation and Development (BCDC)

There are several streamlined permitting/CEQA approaches available for restoration projects. Under CDFW jurisdiction, this includes the CEQA Statutory Exemption for Restoration Projects (SERP) and the Restoration Management Permit (RMP), which provides authorizations for:

1. Take of California Endangered Species Act threatened, endangered, or candidate species;
2. Take of Fully Protected Species;
3. Take of plant species designated as “rare” pursuant to the Native Plant Protection Act;
4. Take of other species including mammals, birds, fish, amphibians, or reptiles; and
5. Authorization of impacts to rivers, lakes, and streams that would otherwise be subject to a Lake or Streambed Alteration Agreement.

The USFWS Statewide Restoration Programmatic Biological Opinion (PBO) and Central Coast NMFS PBO provide streamlined permitting options for restoration projects needing coverage for impacts to federally listed species. The aquatic resource agencies also have several streamlined permitting pathways. USACE has several Nationwide Permits that may be applicable to the restoration alternatives presented in this strategy, and the RWQCB has a Statewide Restoration General Order.

11. NEXT STEPS

As outlined in Chapter 10, advancing restoration across the project area will require sustained, multi-agency coordination to manage the many dependencies among projects. Some actions can move forward in the near-term, while others will require longer-term efforts to remove constraints and position additional sites for restoration.

Actions identified in the Strategy that can be pursued immediately include:

1. Advancing design development for the Marin County sprayfields project, including pursuing funding from Measure AA, Proposition 4, or both.
2. Completing soil testing and determining whether additional remediation is needed to enable restoration of the Black Point Antenna Field, in collaboration with the landowner, the State Lands Commission.

Continued coordination is needed to enable additional near-term restoration projects at other locations identified in the Strategy:

3. Coordination with NSD to ensure that restoration of Deer Island Basin can proceed in conjunction with truncation of the outfall line.
4. Continued collaboration with Pattern Energy on potential restoration options as they determine future uses of their parcel.
5. Engagement with the Bel Marin Keys Community Services District to help involve the local community in the restoration effort and advance planning for restoration of the dredged sediment disposal area.

Larger and longer-term coordination is needed so that these individual projects can eventually advance toward the long-term landscape-scale restoration alternatives described in Chapter 7.

6. Ongoing engagement with Caltrans will remain critical as SR 37 corridor improvements advance. This may include exploration of mitigation credit agreements as a mechanism for funding restoration projects, as well as opportunities to integrate transportation improvements with baylands restoration, such as identifying beneficial use opportunities for fill removed as part of the roadway project.
7. Continued collaboration with SMART to integrate their planning with the restoration effort as they explore the feasibility of passenger rail along this corridor and address sea level rise vulnerability. Full implementation of the long-term restoration alternatives is not possible if SMART remains in place.
8. Coordination with USACE and the State Coastal Conservancy will help ensure compatibility with planned restoration at Bel Marin Keys Unit V and identify potential synergies between the projects and construction timelines.
9. Coordination with CDFW and the State Lands Commission regarding potential future restoration of part of Lynwood Basin, including additional feasibility analysis and design development.
10. Coordination with the Marin/Sonoma Mosquito and Vector Control District to ensure that planned restoration designs minimize mosquito breeding habitat to benefit public health.

Phased implementation of individual projects identified in this Strategy can start to build toward a cohesive, connected landscape. The sooner tidal restoration projects are implemented, the better chance they will have of keeping pace with sea level rise.

Simmons Slough Wetlands. Photo by Ellen Plane, SFEI.



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