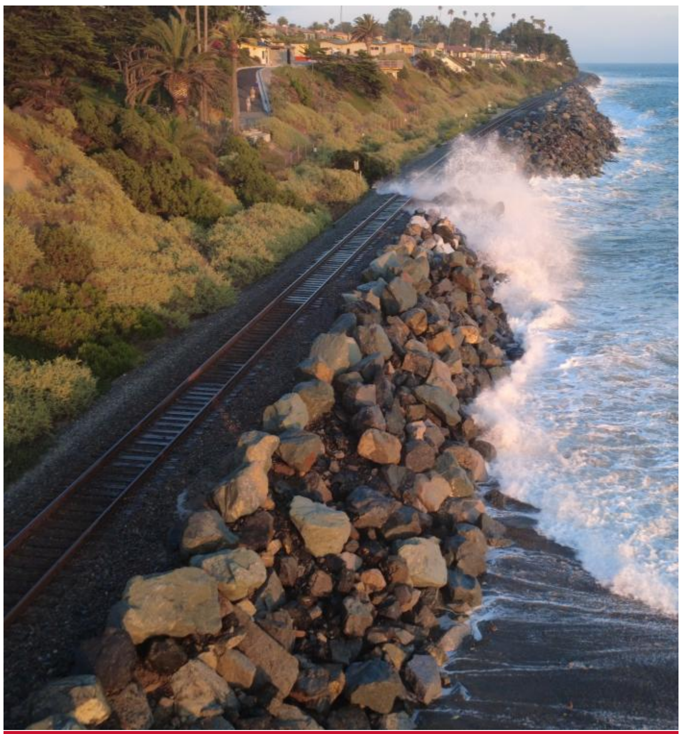
ATTACHMENT C



Coastal Rail Resiliency Study - Feasibility Report

DRAFT

Orange County Transportation Authority

Southern California

July 2026

OCTA

Prepared by:

HDR

This page is intentionally left blank.

Executive Summary

The Orange County Transportation Authority (OCTA) owns a critical 40-mile segment of the 351-mile Los Angeles-San Diego-San Luis Obispo Rail Corridor (LOSSAN Corridor) between San Clemente and Fullerton, California. This corridor is the second busiest intercity passenger rail corridor in the United States and serves as a vital freight and Strategic Rail Corridor Network (STRACNET) defense route connecting major ports and military bases. It also serves Amtrak Pacific Surfliner intercity trains, Southern California Regional Rail Authority (SCRRA) Metrolink regional rail service, and BNSF Railways (BNSF) freight trains. Any disruptions affect regional mobility, interstate commerce, and military readiness. Within this system, the 7-mile segment between Dana Point (north of Doheny State Beach) and San Clemente (north of Trestles Beach) is among the most vulnerable rail corridors in the State of California. The coastal alignment and exposure to the Pacific Ocean create vulnerabilities to catastrophic failure to the various rail operations due to coastal bluff erosion, dry beach loss, revetment deterioration, and geologic landslide bluff failure. In recent years, these conditions have led to repeated service disruptions, particularly in the San Clemente area, posing risk to reliable rail service for both passenger and freight rail operations.

OCTA is committed to providing a safe, reliable, and resilient railroad corridor that supports the movement of people, freight goods, and national defense operations. However, the corridor's stability is increasingly threatened by ongoing coastal erosion, more frequent and intense storm events, and accelerating sea level rise. There is a projected 1.3 to 1.7 feet of sea level rise by 2055, expected to result in 13 to 17 feet of beach width loss. These conditions have led to persistent bluff failures and landslides that jeopardize the integrity of the rail line and disrupt regional mobility. This Feasibility Study is therefore essential to identify long-term, sustainable solutions that protect this critical transportation corridor and support its continued function for passengers, freight operators, and national military readiness. Building on OCTA's 2024 Initial Assessment (see Appendix A), this Feasibility Study identifies, evaluates, and shortlists potential adaptation concepts and engineering solutions that can enhance operational reliability and protect the coastal rail corridor from Dana Point to Trestles Beach in the short (less than 10 years) to medium term (up to the next 30 years). The Study identifies and assesses the most vulnerable locations along the corridor where hazards pose risks of structural damage or operational disruptions, and it develops alternative concepts that reduce future service interruptions and closures. Ultimately, this Feasibility Study supports responsible stewardship of the railroad corridor by advancing multi-beneficial solutions that enhance service reliability, strengthen coastal resilience, and deliver positive outcomes for the surrounding community.

Study Approach

In response to these challenges, OCTA initiated the Coastal Rail Resiliency Study to identify practical, implementable solutions to maintain safe and reliable rail operations over the next 30 years. The Feasibility Study analyzes the corridor within three geographic zones—rail, bluffside, and beachside—each associated with distinct hazard types. To support a context-sensitive evaluation, the corridor is divided into seven Typical Sections that share similar physical characteristics, land uses, and historic erosion conditions. These typical sections help identify which adaptation strategies are appropriate for each part of the alignment.

A total of 23 alternative concepts were developed across three categories:

- **Rail Concepts** (3) – Improve structural stability of the track foundation and extend the useful life of rail infrastructure.
- **Bluffside Concepts** (9) – Address bluff erosion, sliding, and debris hazards originating leeward (east) of the corridor from blocking the tracks.
- **Beachside Concepts** (11) – Address coastal erosion, flooding, and wave overtopping hazards seaward (west) of the corridor impacting track stability.

Concepts were developed through technical analysis, community feedback, and input from an Expert Panel comprising coastal engineers, geomorphologists, geotechnical specialists, and environmental experts. The alternative concepts are developed as a coordinated program of improvements that combine rail stabilization, bluff protection, and coastal/shoreline protection measures. There were multiple rounds of community outreach conducted throughout the study. Community and stakeholder input played a significant role in shaping beachside concepts, particularly emphasizing sand placement, access to recreational areas, and sensitivity to environmental and permitting constraints.

Screening and Evaluation Process

Each concept was evaluated using a structured scoring framework aligned with the project's Purpose and Need. Five evaluation categories, weighted according to technical and community priorities, guided the scoring:

- Resilience and Rail Reliability (25 percent)
- Implementability and Constructability (25 percent)
- Public Assets and Environmental Impacts (20 percent)
- Cost (20 percent) Alignment with Related/Planned Projects (ten percent)

Within these categories, concepts were scored from 0 to 5 on criteria such as longevity, storm/sea-level rise resilience, maintenance requirements, constructability, environmental compatibility, permitting feasibility, and alignment with regional coastal programs. Community feedback directly influenced the weighting of public-facing criteria and led to modifications, including incorporation of one-time sand placement into most beachside concepts.

All 23 concepts were scored independently; the highest-performing concepts within each solution category were then shortlisted for more detailed technical analysis.

Shortlisted Concepts

The screening process resulted in eight concepts being advanced for further study:

Rail Concepts

- Alternative materials for critical railroad infrastructure (lower lifecycle costs, minimal construction impacts)
- Ground improvement (track bed stabilization; high value for long-term track stability)

Bluffside Concepts

- Catchment walls (effective, low-impact alternative concept for smaller-scale slope failures)
- Tieback/soil-nail/pin-pile walls (proven method to stabilize moderate-scale bluff hazards)

Beachside Concepts

- One-time sand placement with riprap shoreline protection
- One-time sand placement with engineered rock revetment shoreline protection
- One-time sand placement with seawall shoreline protection
- One-time sand placement with combination (seawall and rock) shoreline protection

These concepts represent the most feasible and effective options for improving resilience while balancing environmental, community, operational, and permitting considerations. They are intended to be applied programmatically and may be combined in different ways depending on the conditions within each Typical Section.

Next Steps

The Feasibility Study helps establish a program of projects for the coastal rail corridor to address risks along the bluffs, the beach, and within the railroad right-of-way. The shortlisted concepts will undergo more location-specific detailed technical and environmental analysis, including engineering feasibility assessments, refined coastal and geotechnical evaluations, advanced engineering, and coordination with partner agencies. OCTA will also seek funding for the program of projects to help advance the short-listed concepts to support the resilience and reliability of the coastal rail corridor. This Feasibility Study guides the selection and sequencing of short to medium-term improvements to maintain railroad operations within the existing railroad right-of-way for the next 30 years and support regional planning for a long-term coastal rail strategy. A separate long-term study will be led by the State to develop solutions beyond 30 years, including potential rail line relocation.

Contents

Figures

Tables

This page is intentionally left blank.

1. Project Background and Purpose

In Fall 2023, OCTA initiated the Coastal Rail Resiliency Study (CRRS) to evaluate and respond to the increasing coastal hazards affecting the seven-mile segment of the LOSSAN Corridor between Dana Point (north of Doheny State Beach) and San Clemente (north of Trestles Beach) near the border of San Diego County in the south. This corridor – one of the nation's busiest passenger rail routes and a critical freight and Department of War Strategic Rail Corridor Network (STRACNET) defense asset – is increasingly vulnerable to shoreline erosion, beach narrowing, storm-driven overtopping, bluff instability, and sea-level rise. These conditions have resulted in repeated service disruptions and emergency stabilization efforts, underscoring the need for a coordinated, short-term (less than ten years) to medium-term (up to 30 years) resilience strategy.

Building on OCTA's 2024 Initial Assessment, this Feasibility Study expands the analytical scope by integrating coastal engineering, geomorphology, shoreline change monitoring, geotechnical assessment, and multi-hazard risk evaluation. Twenty-three adaptation concepts were developed and refined through technical analysis, stakeholder and community engagement, and input from an expert multidisciplinary panel. The study utilizes a programmatic, typical-section–based framework to make sure that adaptation strategies are context-sensitive, scalable, and aligned with both short- and medium-term operational needs.

1.1. Purpose and Need

This Feasibility Study provides the technical foundation for identifying short- to medium-term improvements capable of sustaining rail operations for the next 30 years while protecting public access, recreational assets, and environmentally sensitive coastal resources. It also supports long-range regional planning for the future of coastal rail alignments in Southern California. The Project Development Team developed the Project Charter (Appendix B) to document the goals and objectives of the study and develop the framework of the purpose and need for the project.

Purpose:

- Identify, evaluate, and compare adaptation concepts that enhance resilience and operational reliability across a 30-year planning horizon.
- Develop a programmatic, typical-section–based framework for applying rail, bluff, and beachside adaptation concepts.
- Support safe, reliable, and uninterrupted passenger, freight, and STRACNET defense mobility.
- Inform the selection of feasible short- to medium-term projects and prepare for future design, permitting, and funding efforts.
- Establish data and technical basis to inform long-term coastal rail planning beyond the 30-year timeframe.

Need:

- A resilient and stable rail corridor capable of withstanding erosion, bluff failure, storm impacts, and sea-level rise.
- Reduced frequency and severity of hazard-related rail closures affecting passenger, freight, and defense operations.
- Improved safety and reliability through mitigation of projected geotechnical and coastal hazards.
- Coordinated regional solutions to sediment management, beach erosion, bluff stability, and shoreline evolution.
- Protection of public assets, coastal access, recreation, and adjacent environmental resources.

1.2. Goals and Objectives

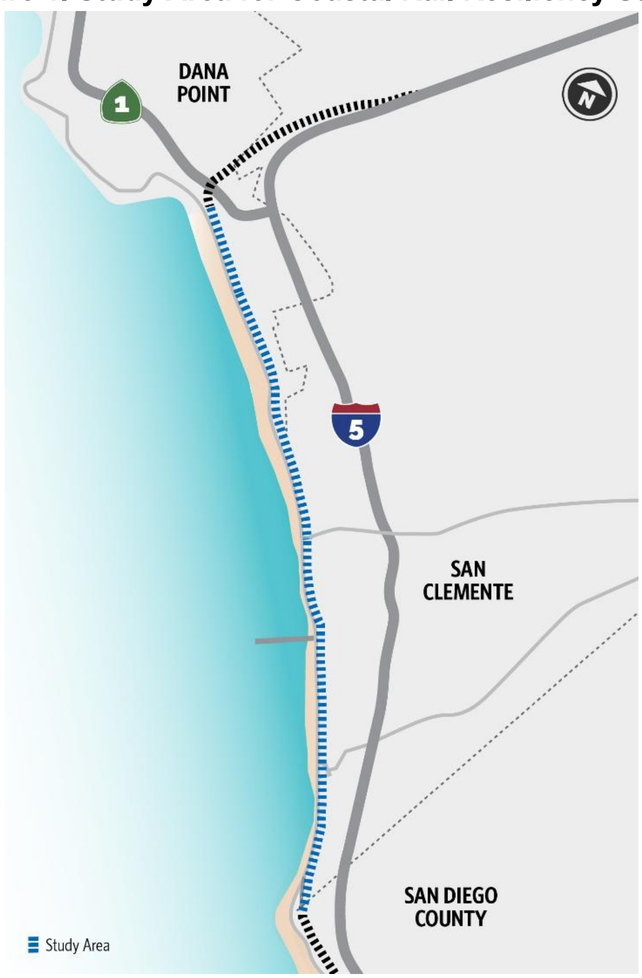
The goals and objectives of the CRRS are to guide the development and prioritization of adaptation concepts that enhance safety, reliability, environmental stewardship, and long-term operability of the coastal rail corridor. This Feasibility Study reflects multidisciplinary analysis, community engagement, and expert guidance to ensure practical, scalable resilience strategies entailing:

- Identify feasible rail, bluffside, and beachside concepts that address erosion, landslides, flooding, and climate-driven coastal evolution.
- Establish a robust, data-driven and physics-based, multi-hazard risk assessment process for evaluating vulnerability across typical sections.
- Develop a programmatic, corridor-wide framework for applying adaptation concepts based on localized conditions.
- Maintain uninterrupted passenger, freight, and defense mobility by mitigating hazard-related service disruptions.
- Protect environmental and cultural resources, including sensitive habitats and Section 4(f) properties.
- Preserve or enhance public coastal access, recreation, and multi-use trail connectivity.
- Strengthen coordination with local, regional, state, and federal agencies to support integrated coastal resilience planning.
- Incorporate community priorities into the evaluation and refinement of adaptation concepts.
- Establish monitoring and adaptive management practices to guide long-term performance and future planning.
- Identify funding, permitting, and implementation pathways for short- to medium-term project delivery.

2. Study Area and Existing Settings

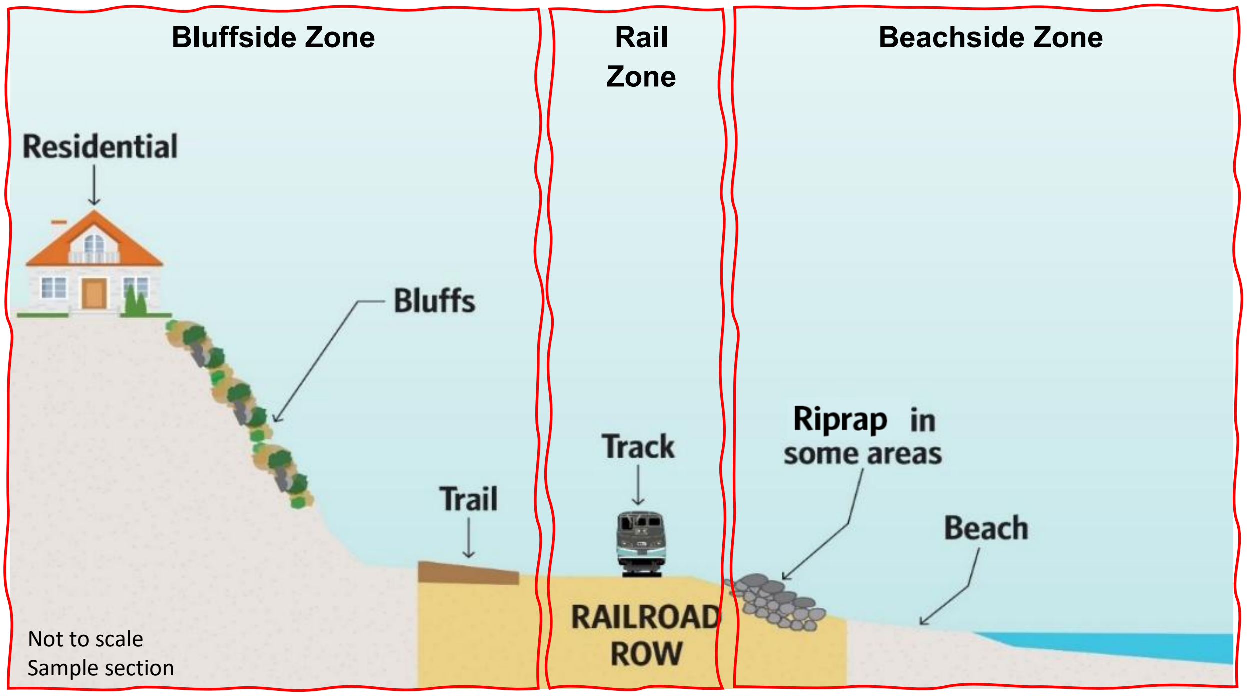
The Coastal Rail Corridor in southern Orange County is owned by OCTA and has passenger rail operations by Southern California Regional Rail Authority (Metrolink) and Amtrak (Pacific Surfliner), and freight rail operations by BNSF. The segment of railroad from Dana Point to Trestles Beach, which runs along the coastline, is part of the greater 351-mile LOSSAN Corridor. The study area, as shown in Figure 1, is a seven-mile segment of the Coastal Rail Corridor with a single track between Mile Post (MP) 200.0 and MP 207.4, running from Dana Point/San Clemente (Doheny State Beach) in the north to Trestles Beach near the border of San Diego County in the south. The study corridor runs west of the Coast Highway/El Camino Real and passes through the cities of Dana Point and San Clemente in Orange County.

Figure 1. Study Area for Coastal Rail Resiliency Study



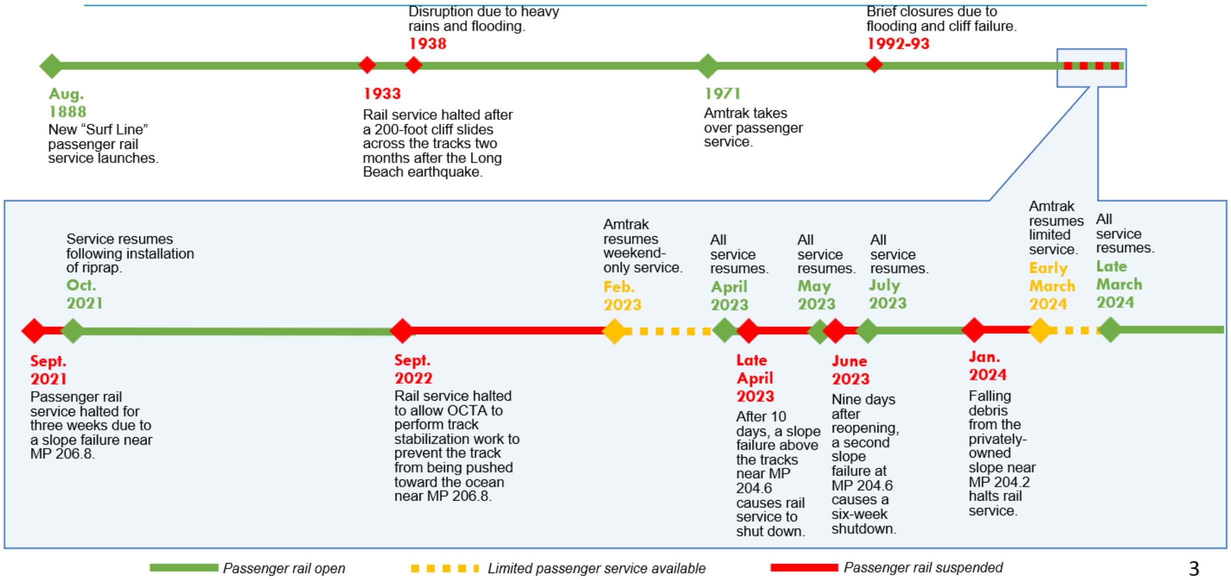
The railroad corridor has been analyzed in three zones in the cross-shore direction (illustrated in Figure 2), including the Bluffside Zone, Rail Zone, and Beachside Zone. These zones have unique challenges and alternative concepts to address the challenges. The Rail Zone is the area within the railroad Right-of-Way (ROW) where the track bed is located. It also has critical rail assets, such as stations, signals, and communications infrastructure. The Bluffside Zone is the area directly inland of the railroad tracks. It is defined by intermittent inland bluffs, some of which support blufftop residential properties and recreational trails. In several sections of the study area, paved roads and the Pacific Coast Highway (PCH) run parallel to the tracks on the east side, offering a buffer from bluff erosion. The Beachside zone is the area between the tracks and the ocean. This zone features a range of shoreline settings, including riprap armoring along the seaside of the railroad, as well as sandy beaches that accommodate recreational infrastructure, including lifeguard stations, restrooms, and athletic courts.

Figure 2. Zone Types



The coastal rail corridor has had a history of closures dating back several decades. However, rail operations have been impacted greatly over the last five years. Figure 3 provides a timeline of the history of passenger rail closures along the coastal rail corridor.

Figure 3. History of Passenger Rail Closures



Recent and ongoing areas of instability that have caused or threatened significant disruptions to passenger rail operations, listed from north to south, are provided in Table 1.

Table 1. Recent Rail Closures Impacting Passenger Rail Operations

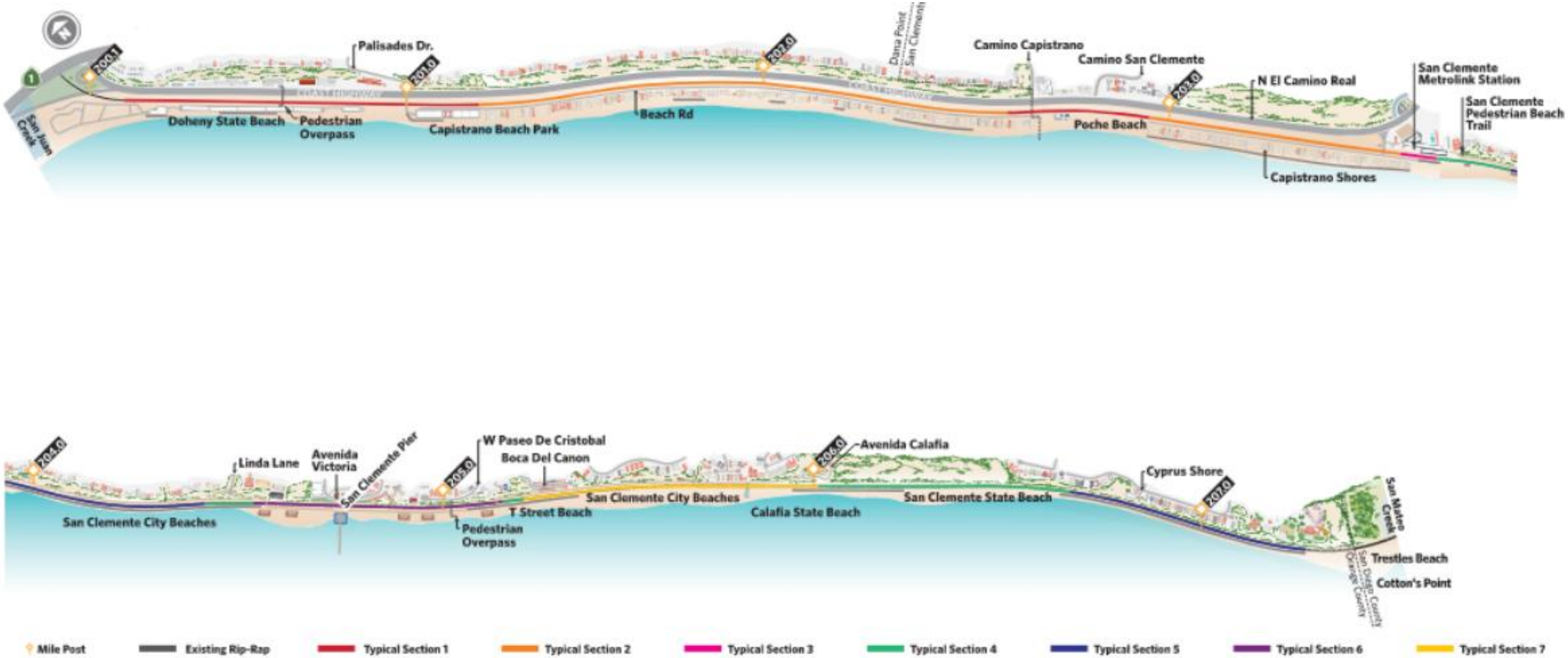
Closure	Location (MP)	Period	Type of Closure	Days
Mariposa	204.2	1/24/24 – 3/5/24	Full Closure	42
Mariposa	204.2	3/6/24 – 3/25/24	Limited Daily Service	20
Casa Romantica	204.6	4/27/23 – 5/26/23	Full Closure	30
Casa Romantica	204.6	6/5/23 – 7/16/23	Full Closure	42
Cyprus Shore	206.7	9/30/22 – 2/3/23	Full Closure	127
Cyprus Shore	206.7	2/4/23 – 4/16/23	Limited Weekend Service	72

2.1. Existing Settings

Existing settings in the study area were defined in typical cross-shore sections to support a context-sensitive approach for developing potential concepts. These sections present comparable surrounding land uses, spacing between different Zone Types (Figure 2), and geotechnical characteristics. Figure 4 provides an overview of the study area and the delineated footprints of typical sections that apply within it.

Figure 4. Overview of Typical Sections through Study Area

Figure 5. Coastal Rail Corridor Between Dana Point to Trestles Beach (north to south)



This page is intentionally left blank

2.1.1. Typical Section 1: Railroad between Roadway and Beach

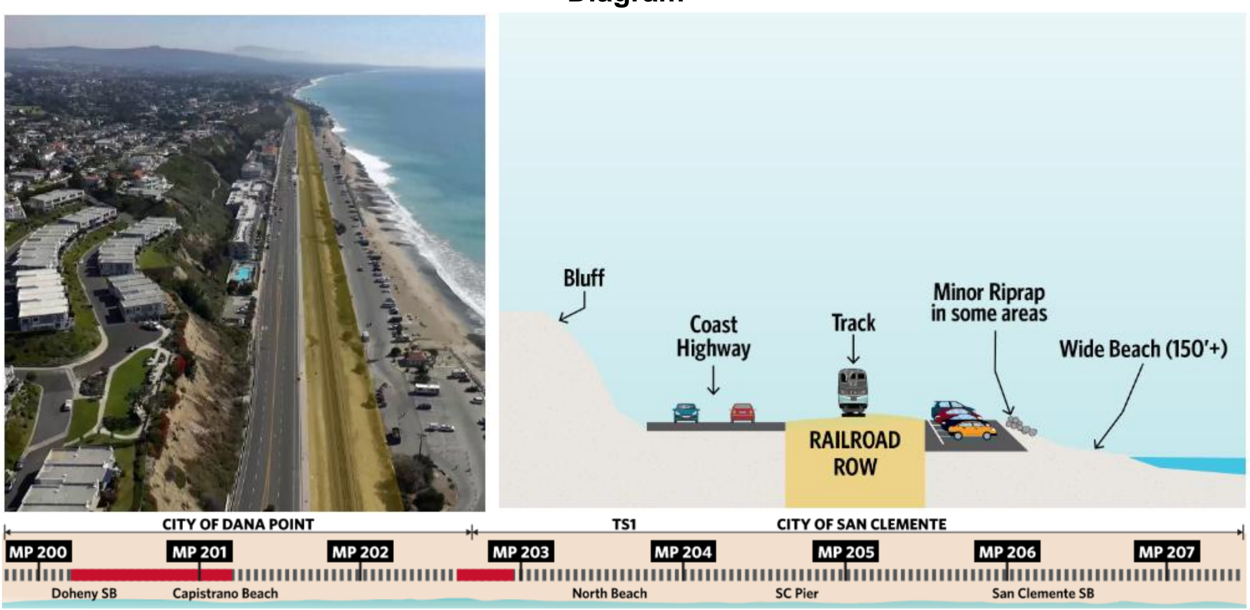
The Typical Section 1 typology features, from landward to seaward, inland bluffs (some with blufftop and street-level residential properties), Coast Hwy, a single-track rail corridor, parking, intermittent riprap, and beach (Figure 6). The sandy beach in this typical section is wide (approximately 150 feet from the riprap to the mean high water (MHW) shoreline[1]). Approximately 1.35 miles (see Table 2) of the corridor is comprised of this typology. These segments include the corridor near Doheny State Beach and Capistrano Beach.

Table 2. Limits of Typical Section 1

Begin Limit (MP)	End Limit (MP)
200.20	201.20
202.60	202.95

On the landside of the track, Coast Hwy provides a buffer for bluff erosion for this typical section. Private developments, existing riprap, and wide sandy beaches seaside of the track also provide some protection from coastal erosion. This typical section has been the site of previous sand placement efforts, most recently, Orange County Parks placed sand at Doheny State Beach and Capistrano Beach in 2023 and 2024. Concepts recommended for Typical Section 1 include rail and beach adaptation projects.

Figure 6. Typical Section 1 – Aerial Photograph, Cross-Sectional Sketch, and Alignment Diagram



[1] MHW is a tidal datum representing the average of observed high-water elevations at NOAA tide stations. The reference tide station for this study was NOAA's La Jolla station.

2.1.2. Typical Section 2: Railroad between Roadway/Trail and Homes

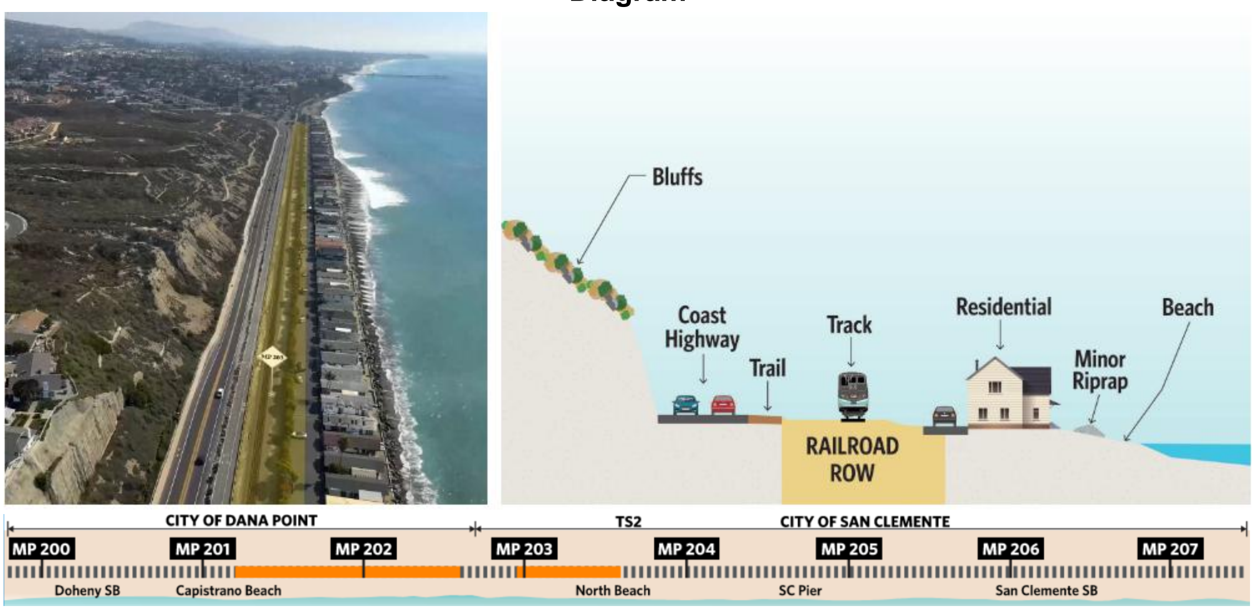
The Typical Section 2 typology features, from landward to seaward, inland bluffs, Coast Hwy, a recreational trail, a single track, residential streets, residences, intermittent riprap, and narrow beach (less than 100 feet from the riprap to the MHW shoreline) sections (see Figure 7). Approximately 2.07 miles (see Table 3) of the corridor is comprised of this typology. These segments include areas south of Capistrano Beach and areas in San Clemente near North Beach.

Table 3. Limits of Typical Section 2

Begin Limits (MP)	End Limits (MP)
201.20	202.60
202.95	203.62

On the landside of the track, Coast Hwy provides a buffer against bluff erosion for this typical section. On the seaside of the track, Beach Road, residential development, intermittent riprap armoring, and sandy beach separate the track from the ocean. Concepts recommended for Typical Section 2 include rail and beach adaptation projects.

Figure 7. Typical Section 2 – Aerial Photograph, Cross-Sectional View and Alignment Diagram



2.1.3. Typical Section 3: Railroad between Development and Beach

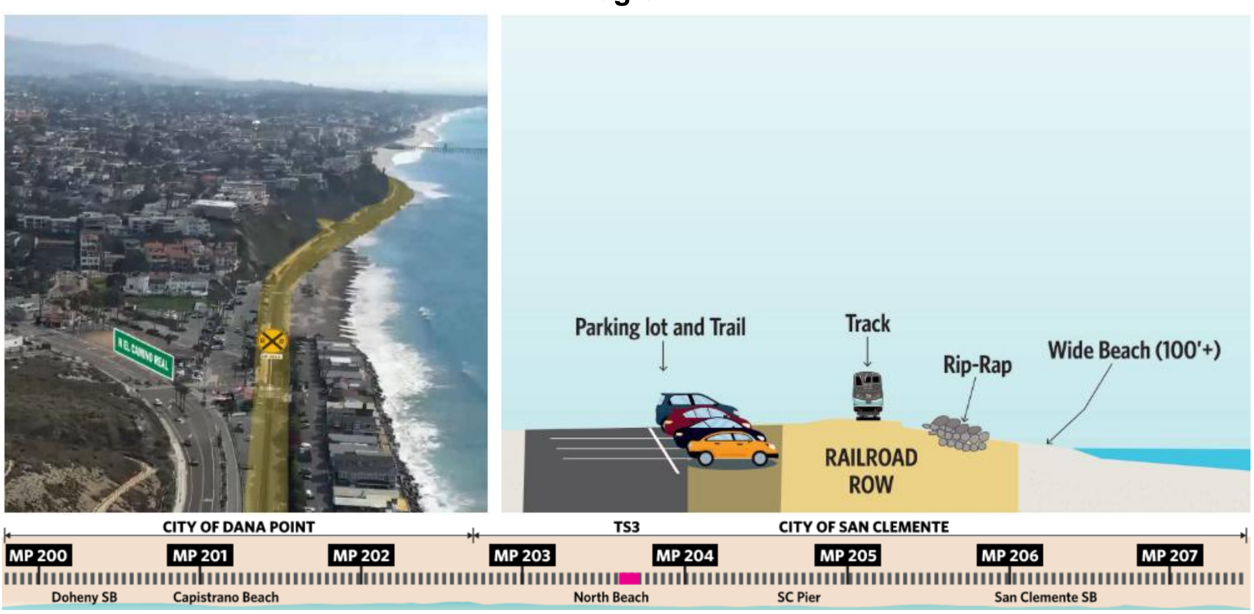
The Typical Section 3 typology features, from landward to seaward, paved parking lots, a single track, riprap, and narrow beach (less than 100 feet from the riprap to the MHW shoreline) (see Figure 8). Approximately 0.1 mile (see Table 4) of the corridor is comprised of this typology. This segment includes North Beach in the City of San Clemente.

Table 4. Limits of Typical Section 3

Begin (MP)	End (MP)
203.62	203.72

There are no adjacent bluffs landside of the track in this typical section. The only protection this section of track has against coastal erosion is riprap armoring and up to 100-foot-wide sandy beach, which has been the site of previous sand placement efforts by the City of San Clemente and OCTA as recently as 2024 and 2025. The beach width in this typical section has varied, with widths up to 100 feet wide. It is worth noting that the shoreline has been dynamic over recent years with fluctuating beach widths and elevations. Concepts recommended for Typical Section 3 include rail and beach adaptation projects.

Figure 8. Typical Section 3 – Aerial Photograph, Cross-Sectional View and Alignment Diagram



2.1.4. Typical Section 4: Railroad between Bluff/Trail and Beach

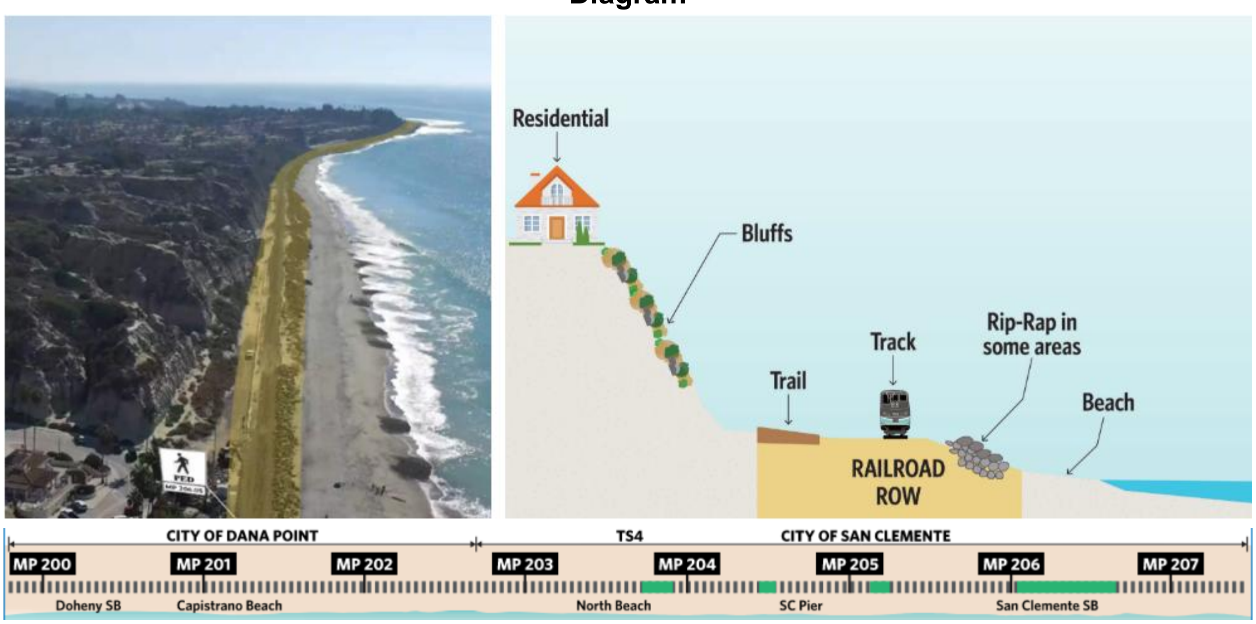
The Typical Section 4 typology features, from landward to seaward, inland bluffs topped with a mix of single-family and multifamily residential development, a pedestrian trail, a single track, intermittent riprap, and sandy beach with a variable width (50-150 feet from the riprap to the MHW shoreline) (see Figure 9). Approximately 1.02 miles (see Table 5) of the corridor is comprised of this typology. These segments include sections of North Beach, T-Street Beach, and San Clemente State Beach.

Table 5. Limits of Typical Section 4

Begin Limits (MP)	End Limits (MP)
203.72	203.92
204.42	204.54
205.16	205.22
206.02	206.66

The track here is in proximity to steep inland bluffs prone to erosion and landslides. The unpaved trail east of the track provides minimal buffer against large debris and slides. The only protection this section of track has against coastal erosion is riprap armoring and a wide sandy beach (up to 150 feet from the riprap to the MHW shoreline). Concepts recommended for Typical Section 4 include bluff, rail, and beach adaptation projects.

Figure 9. Typical Section 4 – Aerial Photograph, Cross-Sectional View and Alignment Diagram



2.1.5. Typical Section 5: Railroad between Bluff/Trail and Ocean

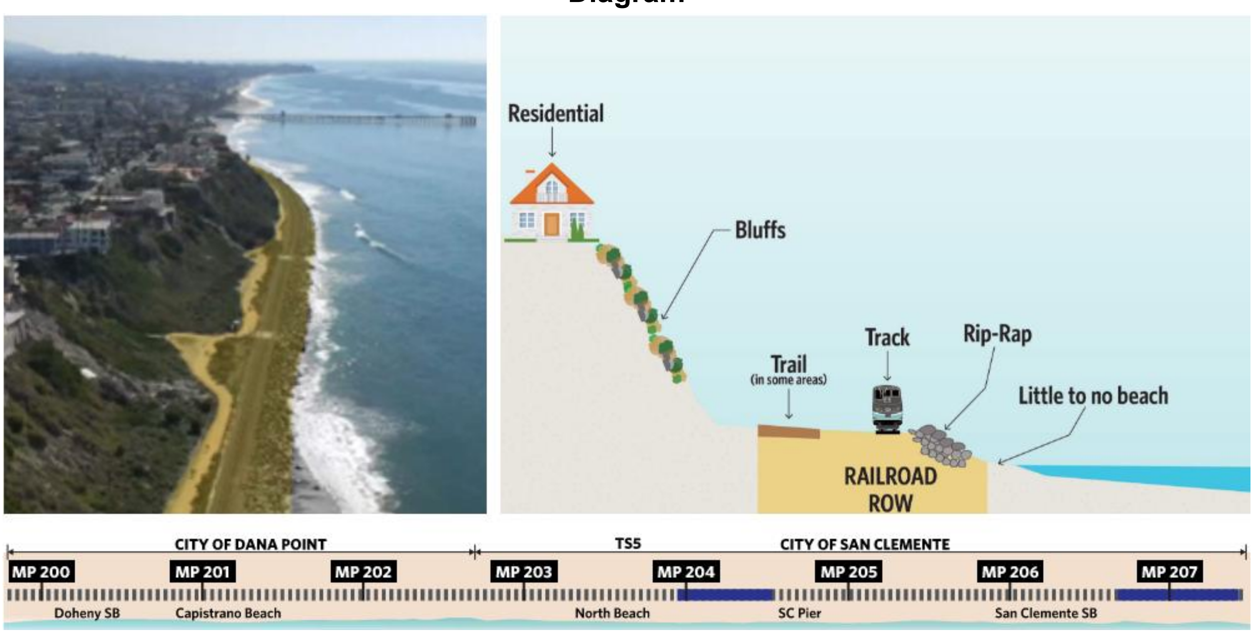
The Typical Section 5 typology features, from landward to seaward, inland bluffs topped with large multifamily and single-family residential developments, intermittent pedestrian trails, a single track, riprap, and little to no beach (less than 100 feet from the riprap to the MHW shoreline). This typology is similar to Typical Sections 4 and 7, but without the wide sandy beach between the track and the water (see Figure 10). Approximately 1.09 miles (see Table 6) of the corridor is comprised of this typology. These segments include the stretch between North Beach and the San Clemente Pier through the Mariposa area and south of San Clemente State Beach from Cyprus Shore to the county line.

Table 6. Limits of Typical Section 5

Begin Limits (MP)	End Limits (MP)
203.92	204.42
206.66	207.25

These sections are in proximity to steep inland bluffs prone to erosion and landslide adjacent to the track. The unpaved trail landside of the track provides little to no buffer against large debris and landslides. The only protection this section of track has against coastal erosion is riprap armoring because there is little to no sandy beach in this typical section. These sections of track are prone to wave overtopping, which causes track instability and creates maintenance issues for the railroad. Concepts recommended for Typical Section 5 include bluff, rail, and beach adaptation projects.

Figure 10. Typical Section 5 – Aerial Photograph, Cross-Sectional View and Alignment Diagram



2.1.6. Typical Section 6: Railroad between Bluff and Trail/Beach

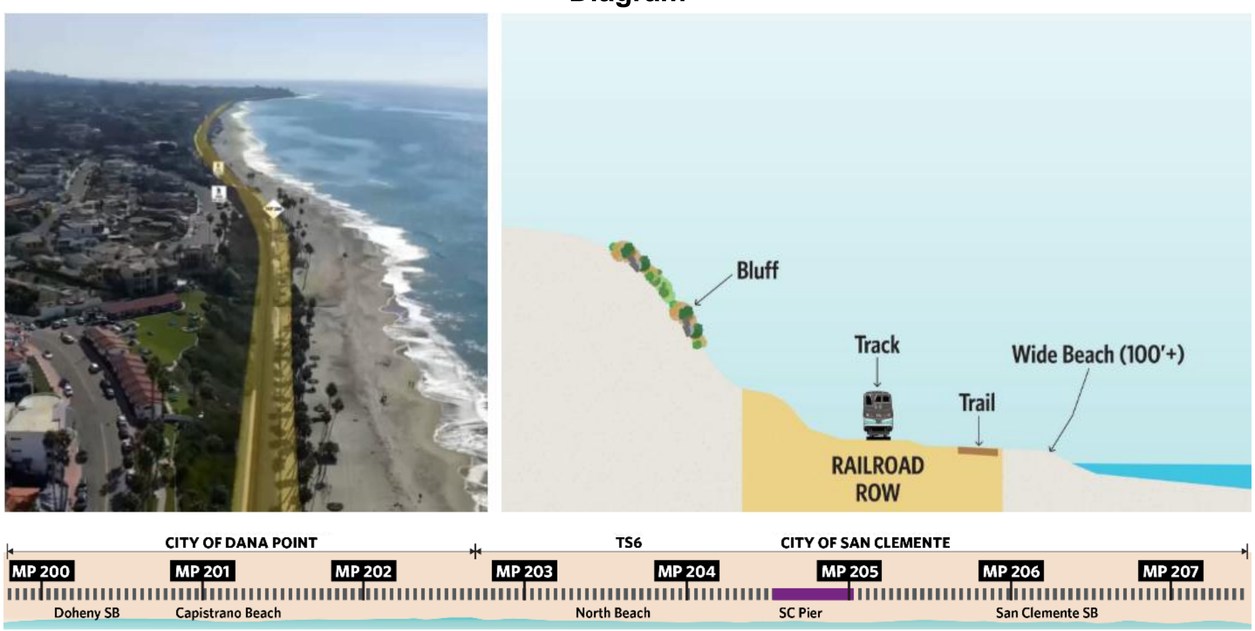
The Typical Section 6 typology features, from landward to seaward, inland bluffs, a single track, a recreational trail, and wide (between 100-200 feet from the trail to the MHW shoreline) beach sections (see Figure 11). Approximately 0.62 miles (see Table 7) of the corridor is comprised of this typology. This segment includes the beach around San Clemente Pier.

Table 7. Limits of Typical Section 6

Begin Limits (MP)	End Limits (MP)
204.54	205.16

Bluffs in this area are less steep and feature no residences atop the bluffs, unlike Typical Sections 4 and 5. In these sections, the track is set back from the water, separated by a pedestrian trail and wide sandy beaches to the seaward side. The track in this area has not historically been subject to coastal erosion or wave overtopping thanks to the wide beach, and riprap has not been required at this location. This typical section has been the site of previous sand placement efforts, most recently the United States Army Corps of Engineers federal sand placement program in 2024, with planned renourishments every six years[2]. Concepts recommended for Typical Section 6 include bluff, rail, and beach adaptation projects.

Figure 11. Typical Section 6 – Aerial Photograph, Cross-Sectional View and Alignment Diagram



[2] https://www.sanclemente.gov/300/San-Clemente-Sand-Replenishment

2.1.7. Typical Section 7: Railroad between Trail and Beach

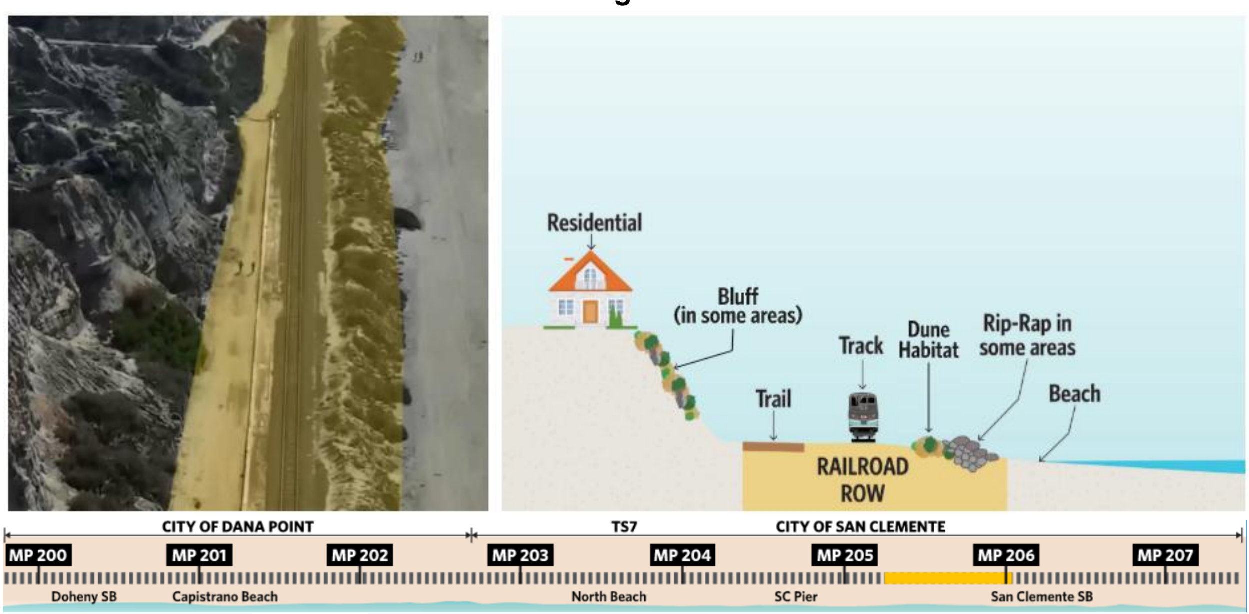
The Typical Section 7 typology features, from landward to seaward, inland bluffs, a pedestrian trail, a single track, intermittent riprap, and beach sections of variable width (50 - 100 feet from the riprap to the MHW shoreline) (see Figure 12). Approximately 0.80 miles (see Table 8) of the corridor is comprised of this typology. These segments include segments of the corridor south of the San Clemente Pier and near San Clemente State Beach.

Table 8. Limits of Typical Section 7

Begin Limits (MP)	End Limits (MP)
205.22	206.02

These sections are in proximity to steep inland bluffs prone to erosion and landslides adjacent to the track. The unpaved trail east of the track provides little to no buffer against potential large debris and landslides. For areas around MP 205.30, 205.75 and 206.00, bluffs are not present and have residential development located landward of the unpaved trail. These sections of track have riprap armoring, dune habitat, and narrow sandy beach seaward of the are acting as a buffer to protect the track from coastal erosion. Concepts recommended for Typical Section 7 include rail and beachside adaptation projects.

Figure 12. Typical Section 7 – Aerial Photograph, Cross-Sectional View and Alignment Diagram



2.2. Summary of Typical Sections

Table 9 summarizes the existing natural and built environment conditions between the railroad ROW and the coastline and if the Typical Section is at risk of service disruption from natural erosion or storm events from the bluffside, rail, and beachside in the short- to medium-term.

Table 9. Summary of Typical Sections with Service Disruption Risk

	Typical Section 1	Typical Section 2	Typical Section 3	Typical Section 4	Typical Section 5	Typical Section 6	Typical Section 7
Existing conditions between rail & coastline	Public parking & beach	Street, residences & beach	Beach	Beach	Little to no beach	Trail & beach	Dunes & beach
Bluffside Risk				✓	✓	✓	
Rail Risk	✓	✓	✓	✓	✓	✓	✓
Beachside Risk			✓	✓	✓	✓	✓

3. Short- to Medium-Term Alternative Concept Development

A total of 23 Alternative Concepts were developed following preliminary assessments and technical analyses, community and stakeholder engagement, and expert panel engagement. The alternative concepts fall into three zone types or categories focused on different aspects of alignment resiliency: Rail Zone, Bluffside Zone, and Beachside Zone alternative concepts. Each alternative concept represents an individual intervention that can be used as a single component or in combination with other concepts.

3.1. Community-Informed Alternative Concept Refinement

The list of alternative concepts was refined in response to various rounds of stakeholder and community input. This feedback was collected over the course of the study and helped identify additional priorities and concerns, leading to the inclusion of new alternatives and the addition of sand replenishment to all the beachside concepts to address local community and regulatory agency concerns about coastal access, beach erosion, and to enhance coastal protection. Community and scientific insight around addressing root causes and drivers of shrinking sandy beaches (coastal squeeze) also led to the addition of watershed modification (i.e., sediment transport in San Juan Creek) to the beachside concepts being considered. More details on community engagement efforts and local concerns can be found in the Community Engagement Report found in Appendix C.

3.2. Expert Panel Review

After the initial alternative concept list was developed, an expert panel was convened to assess the initial alternative concepts and provide feedback. The expert panel consisted of a two-day, in-person session between December 3 and 4, 2024, in San Clemente, which included presentations, discussions, and a site visit. The goal of this process was to engage with academic and professional experts from various disciplines, including coastal geomorphology, marine biology, geotechnical engineering, and coastal engineering, to document their input regarding the CRRS. A complete summary of the Expert Panel Review can be found in Appendix D. The expert panel consisted of the following members:

Table 10. Expert Panel Participants

Name	Affiliation	Role or Discipline
Jeff Ball	Orange County Business Council	Moderator
Adam Young, PhD	Scripps Institution of Oceanography	Coastal Geomorphology
Lawrence Honma	Merkel & Associates	Marine Biology
James Gingery, PhD, P.E., G.E.	Keller West	Contractor/Geotechnical Engineer
Wenkai Qin, PhD	NV5	Coastal Engineer

The panel experts were selected based on their previous work and knowledge of the various disciplines related to coastal challenges in the region. The section below summarizes the panel's specific recommendations and how they were incorporated.

3.2.1. Alternative Concept Feedback

The expert panel recommendations led to the addition of one new alternative concept and several modifications to the initial alternative concept list. The recommendations were based in part on similar cases and best practices seen elsewhere in the region.

- **New Rail Alternative Concept:** The panel recommended grouting of the rail track bed. The team incorporated the feedback, adding a new rail alternative concept, *Rail 3 – Ground improvement (track-bed stabilization).*
- **Alternative Concepts with Sand Retention Measures:** The panel also recommended including sand retention measures in tandem with sand placement (beach nourishment) programs. This included shore-connected structures, such as groins, or offshore alternative concepts, such as artificial reefs or breakwaters. These recommendations are reflected in beach concepts where the team added four additional alternative concepts (4.1 to 4.4) that included sand retention measures to four existing alternative concepts (2.1 to 2.4) that were originally various shoreline protection structures paired with sand placement.
- **Armoring Alternative Concepts:** The panel recommended engineered revetements and riprap over seawalls, as seawalls require deeper foundations, reflect wave energy, and are more challenging to construct due to obstructions from existing buried riprap. The team opted to keep all the original shoreline protection structures from the initial alternative concept list, including seawalls, to assess them using the criteria screening process.
- **Program of Alternative Concepts:** The panel recommended that concepts be applied as a program of alternative concepts per typical section aligned with the project team's existing plan.
- **Habitat Friendly Materials:** The panel recommended considering habitat friendly concrete (e.g., eco-concrete) armor units as an alternative to stone armoring, where practical.

3.2.2. Criteria Recommendations

The expert panel identified several considerations to incorporate into the criteria screening process. While most recommendations aligned with the draft criteria, they did result in minor modifications to the screening criteria.

- **Biological and Cultural Assessments:** The panel recommended including screening criteria weigh heavily on biological and cultural assessments for the project area. In response, the team assigned the screening category "Public Assets & Environmental Impacts" a weight of 20 percent of the total concept score.
- **Permitting Requirements:** The panel advised incorporating permitting complexity and timelines into the evaluation process to anticipate regulatory challenges and delays. The existing permitting criteria in the draft screening were retained without changes.
- **Elevation Challenges:** The panel advised that criteria account for height requirements of an elevated rail option and potential challenges in constructability, permitting, or community

opposition. However, the constructability and public assets categories address these factors; therefore, the existing criteria were retained without changes.

3.2.3. General Study Considerations

The expert panel also provided feedback that applied broadly to the project rather than to specific concepts. Those recommendations are captured below and noted for future consideration but are not pertinent at this feasibility study phase.

- **Monitoring Protocols:** The panel emphasized the need for monitoring to establish baseline and post-construction conditions.
- **Biological Resource Surveys:** The panel advised that baseline biological resource surveys be performed on both land and offshore areas.
- **Mitigation Contributions:** The final project level recommendation was to consider out-of-kind fee contributions or funding to other agencies' efforts to mitigate potential impacts.
- **Repurposing materials:** Other recommendations included the consideration of opportunities to repurpose materials from inland of the rail in any applicable concepts. This includes the opportunity to apply sustainable best practices in reusing component or earthen site materials with the potential added benefit of cost savings and reduction in materials transportation. The recommendation was noted for future consideration but not applied to this phase of the study.

3.3. Alternative Concepts

The following sections detail the finalized list of alternative concepts for evaluation.

3.3.1. Rail Concepts

These alternative concepts address the stability and resilience of the rail tracks themselves.

Table 11. List of Rail Concepts

Alternative Concept Name
1 – Elevated tracks
2 – Alternative materials for critical railroad infrastructure to reduce lifecycle costs
3 – Ground improvement (track-bed stabilization)

3.3.2. Bluffside Concepts

These alternative concepts focus on the reduction of impacts to passenger and freight rail safety and service due to bluff erosion, bluff failure events such as landslides, and shortlisted reinforcement methods suitable to minimize future rail track damage and/or blockage.

Table 12. List of Bluffside Concepts

Alternative Concept Name
1 – Catchment walls (bluff failure)
2 – Stabilization grading (buttressing)
3 – Tieback / Soil-Nail / Pin-Pile Walls (bluff failure)

4 – Ground improvement
5 – Surface matting and deep-rooted vegetation planting (surface erosion)
6 – Surface drainage improvement / detention basins / undertrack outlets
7 – Deflection walls in tributaries (sediment discharge)
8 – Up-gradient cut-off drains (groundwater control)
9 – Hydraugers (Horizontal drains for groundwater control)

3.3.3. Beachside Concepts

These alternative concepts aim to address coastal erosion and flooding hazards on the beach (west) side of the tracks, where wave overtopping or erosion-induced track destabilization may impact passenger and freight rail safety and service.

Table 13. List of Beachside Concepts

Alternative Concept Name
1 – Beach nourishment with planned replenishment (assumed to be every 5 years and implemented by other agencies outside of OCTA)
2.1 – One-time sand placement with riprap shoreline protection structure
2.2 – One-time sand placement with engineered rock revetment shoreline protection structure
2.3 – One-time sand placement with seawall shoreline protection structure
2.4 – One-time sand placement with combination shoreline protection structure
3 – One-time sand placement with sand retention measures and no shoreline protection structure
4.1 – One-time sand placement with sand retention measures and riprap shoreline protection structure
4.2 – One-time sand placement with sand retention measures and engineered rock revetment shoreline protection structure
4.3 – One-time sand placement with sand retention measures and seawall shoreline protection structure
4.4 – One-time sand placement with sand retention measures and combination shoreline protection structure
5 – Watershed modifications

4. Screening Methodology

A screening methodology was developed to evaluate each alternative concept and identify the most effective resilience solutions to support safe and reliable rail service in the short- to medium-term future along the entire 7-mile study area corridor. Individual location project-specific design and permitting will be handled during the next phase of this program. Screening for the corridor-wide solutions began with a comprehensive review of previous studies, regional planning efforts, and industry best practices to identify essential considerations and develop a range of potential screening criteria. The criteria were then organized into broader categories that could be weighed according to study priorities.

4.1. Identification of Screening Criteria

The Project Development Team established evaluation categories and criteria based on the Project Purpose and Need and Project Charter, which emphasize safety, reliability, and consistency with regional planning objectives. Additional evaluation criteria were identified using the Federal Transit Administration (FTA) 2024 Transit Resilience Guidebook, which reinforce the importance of local policy alignment and coastal plan integration. Public input, including feedback from local stakeholders, advocacy groups, community-based organizations, and the public at large, further informed the criteria to reflect community concerns and priorities.

4.2. Screening Categories

The sections below explain the evaluation categories, define the scorable criteria within each category, and detail the corresponding scoring (performance measures). The criteria scores define low to high favorability scores (respectively, 0 to 5) for each criterion as well as some key questions that were discussed during the scoring process.

Table 14. Screening Categories and Criteria

Categories	Criteria
Resilience and Rail Reliability	Ability to maintain service during maintenance
	Longevity of concept (optimal conditions)
	Sensitivity to storms, sea level rise, beach erosion
	Track resilience – bluff stability
Cost	Construction costs
	Maintenance costs
	Lifecycle costs
Implementability and Constructability	Ability to maintain service during construction
	Speed of implementation
	ROW requirements
	Constructability
	Ability to meet design criteria
Public Access, Assets and Environmental Impacts	Local resources
	Public facilities
	Utilities

	Grade crossings
	Surfing and swimming
	Multi-use paths and pedestrian access (parallel to beach)
	Beach/coastal access
	Permitting
	Sensitive habitats
	Section 4(f) resources
Alignment with Related/Planned Projects	Consistent with local municipality preferences, ongoing, and future projects
	Consistent with federal, State, and regional projects and planning efforts

4.2.1. Resilience and Rail Reliability

Evaluate each alternative concept's ability to meet the core objective of the project: supporting rail resilience and minimizing service disruptions across the study/project range of up to 30 years. This category assesses how effectively alternative concepts sustain rail operations under typical and extreme conditions, including general longevity, vulnerability to coastal hazards, and bluff stability. The criteria consider how each alternative concept performs to reliably protect rail infrastructure against risks to service continuity, safety, and long-term performance.

Table 15. Resilience and Rail Reliability Criteria (Sub Criteria) Definitions

Criteria	Scoring 0-5 with "5" or "high" being most desirable
Ability to maintain service during maintenance	**Fail (0):** The concept may lead to long-term service interruptions during maintenance due to critical impact on the rail infrastructure. **Low (1):** The concept results in frequent or prolonged service disruptions during maintenance, lasting weeks or months. **Medium (3):** The concept may lead to intermittent service disruptions during maintenance, lasting a few days. **High (5):** The concept allows maintenance to occur with minimal service impacts, limited to off-peak hours or weekends. **Key Questions:** • *Will the concept require rail service interruptions for maintenance? If so, how long and at what frequency?* • *Is there a way maintenance can be performed with minimal disruption (such as night and weekend phasing) or will it require extended service disruptions?*
Longevity of concept	**Fail (0):** The concept is incompatible or unsuitable for the area and would show signs of degradation within a few weeks or months of implementation. **Low (1):** The concept has a short operational lifespan and requires major intervention within five years. **Medium (3):** The concept has a moderate lifespan and would require replacement or upgrade within 15 years. **High (5):** The concept remains effective for close to 30 years with minimal need for replacement or major upgrades. **Key Questions:** • *What is the expected operational life of the concept under typical conditions, and will it remain functional throughout the 30-year project horizon?* • *What is the failure rate of the concept across 30 years?*

Sensitivity to storms, sea level rise, beach erosion	**Fail (0):** The concept amplifies the effects of present-day storm events, sea level rise, and erosion, jeopardizing rail infrastructure and the surrounding environment. **Low (1):** The concept is highly vulnerable to present day storm events, sea level rise, and coastal erosion, risking damage or failure. **Medium (3):** The concept is designed to withstand moderate storm events (10- to 50-year return events) with limited damage to the rail infrastructure. **High (5):** The concept is designed to withstand severe storm events (50- to100-year return events) with sea level rise and projected long-term coastal changes. **Key Questions:** • *What is the rating or ability of the concept to withstand storm events and rising sea levels at present-day intensity?* • *What is the rating or ability of the concept to withstand storm events and rising sea levels at projected future intensities or major storm events?*
Track resilience – bluff stability	**Fail (0):** The concept would accelerate rail corridor exposure to bluff erosion and landslide risks, jeopardizing track integrity and increasing risks of service interruptions. **Low (1):** The concept leaves the rail corridor exposed to bluff erosion and landslide risks, threatening track integrity and passenger and freight rail service. **Medium (3):** The concept reduces the rail corridor's exposure to bluff erosion and landslide risks, requiring mild to moderate emergency repairs following severe storm events. **High (5):** The concept fully stabilizes the bluff, preventing erosion and landslides that could impact passenger and freight rail operations. **Key Questions:** • *What is the rating or ability of the concept to effectively prevent bluff erosion and landslides that could compromise track stability or require emergency repairs?* • *Will the concept offer bluff erosion and landslide protection across the 30-year span?*

4.2.2. Cost

Assess the high-level cost magnitudes associated with each alternative concept from initial implementation through long-term maintenance and lifecycle phases, relative to a "no action" scenario across the same geographic areas and a study/project range of 30 years. This category evaluates high-level capital investment, ongoing operations and maintenance (O&M) needs, and total lifecycle costs to determine whether an alternative concept presents a cost-effective solution or prohibitive costs beyond available funding that could impact implementation feasibility or long-term sustainability of the concept.

Table 16. Cost Criteria (Sub Criteria) Definitions

Criteria	Scoring 0-5 with "5" or "high" being most desirable
Construction costs	**Fail (0):** The concept requires high capital investments that would escalate over time. **Low (1):** The concept requires the highest capital investment compared to (or relative to) other alternatives. **Medium (3):** The concept requires a mid-range capital investment relative to other alternatives. **High (5):** The concept requires the lowest capital investment relative to other alternatives. **Key Questions:** • *What is the estimated capital cost to implement the concept, and how does it compare to other alternatives?* • *What are the impacts of construction on the surrounding community?*
Maintenance costs	**Fail (0):** The concept requires significant, ongoing, and continuously increasing maintenance costs. **Low (1)**: The concept requires frequent maintenance and the highest maintenance costs relative to other alternatives. **Medium (3):** The concept requires sporadic maintenance, requiring moderate maintenance costs. **High (5)**: The concept requires no maintenance after construction, requiring limited long-term upkeep and incurring low to no maintenance costs. **Key Questions:** • *How frequent or regularly will maintenance be required for the concept after construction?* • *What are the projected annual O&M costs for the concept over the concept's usable life?*
Lifecycle costs	**Fail (0):** The concept incurs high and increasing lifecycle costs, requiring investments that outlast concept lifecycle. **Low (1):** The concept has the highest combined capital and -long-term maintenance, operations, and disposal costs over its full lifespan relative to other concepts. **Medium (3):** The concept has moderate combined capital and long-term maintenance, operations, and disposal costs over its full lifespan relative to other concepts. **High (5):** The concept has the lowest combined capital and -long-term maintenance, operations, and disposal costs over its full lifespan relative to other concepts. **Key Questions:** • *How frequently will lifecycle replacements or upgrades be required for the concept after construction?* • *What is the total estimated cost of the concept over its full lifecycle, including construction, maintenance, replacement, operations, and disposal needs?*

4.2.3. Implementability and Constructability

Evaluate each alternative concept's feasibility for construction and service delivery within the existing corridor and project footprint, relative to a "no action" scenario across the same geographic areas and a 30-year study horizon. This category assesses whether an alternative concept is suitable considering the unique characteristics of the project area, and whether it can be implemented without sustained service disruptions, taking into account factors such as construction complexity, ROW requirements, implementation timeline, and ability to meet design standards. The goal is to determine whether the alternative concept offers a practical and timely path to delivery or presents challenges that could delay or complicate implementation.

Table 17. Implementability and Constructability Criteria (Sub Criteria) Definitions

Criteria	Scoring 0-5 with “5” or "high" being most desirable
Ability to maintain service during construction	**Fail (0):** The concept requires long-term disruptions to rail operations that may significantly deter ridership over time. **Low (1):** The concept requires rail operations to be suspended for more than 30 days within a single year, significantly disrupting service. **Moderate (3):** The concept requires brief suspensions to rail service lasting no more than a week each year. **High (5):** The concept allows construction to proceed without any interruption to rail operations. **Key Questions:** • *If the concept requires suspension of rail service during construction, will the disruption be partial or full, and how long will it last?* • *Can construction-related disruptions to rail service be reduced, phased, or scheduled to minimize impacts?*
Speed of implementation	**Fail (0):** The concept requires extensive preliminary work (permitting, design, or construction complexity) that delays concept implementation beyond projected timelines. **Low (1):** The concept requires 5 or more years to implement due to permitting, design, or construction complexity. **Medium (3):** The concept can be implemented within four to five years. **High (5):** The concept can be implemented within four years or less. **Key Question:** • *What is the estimated timeline for full implementation of the concept, including permitting, design, and construction?*
ROW requirements	**Fail (0):** The concept requires substantial permanent acquisition of additional ROW, involving several private property owners, complex easements, and incurring legal challenges. **Low (1):** The concept requires some permanent acquisition of additional ROW outside the existing corridor, involving numerous private property owners or complex easements. **Medium (3):** The concept may require some medium to long-term easements, involving a limited number of property owners. **High (5):** The concept is fully contained within the existing corridor and does not require any new ROW, aside from possible short-term or temporary easements. **Key Questions:** • *Will the concept require the acquisition of additional permanent ROW outside the existing corridor, and is that land publicly or privately owned?* • *Will the concept require acquiring temporary easements for construction outside of the existing ROW?* • *How much additional land acquisition will the concept require?*

Constructability	**Fail (0):** The concept is extremely complex and there is no example in the region where it was built. **Low (1):** The concept presents high technical complexities and would require major adaptation to be locally feasible. **Medium (3):** The concept is moderately complex but similar projects have been built in the region in the past. **High (5):** The concept is very simple and fully adapted to the local context, with several examples of similar projects built in the region. **Key Questions:** • *How complex is the project from a technical standpoint?* • *Are there relevant case studies of similar projects in the region?*
Ability to meet design criteria	**Fail (0):** The concept does not address any of the key goals and objectives of the project and would even counteract the agency's efforts. **Low (1):** The concept does little to fulfill the goals and objectives of improving rail resiliency along the corridor. **Medium (3):** The concept would partially meet the design criteria and goals and objectives of the project. **High (5):** The concept complies with the long-term goals and objectives of the project. **Key Question:** • *How well does this concept address the imperative needs identified in this project?*

4.2.4. Public Access, Assets, and Environmental Impacts

Evaluate each alternative concept's potential impacts on public infrastructure, recreational assets, and environmental resources relative to a "no action" scenario across the same geographic areas and a study/project range of 30 years. The criteria assess whether the alternative concept preserves or enhances access, safety, and ecological integrity, or introduces disruptions that could reduce public benefit, increase vulnerability of local ecosystems, or negatively impact surrounding communities. It also looks at permitting requirements and whether permitting complexities would prohibitively hinder project implementation.

Table 18. Public Assets and Environmental Impacts Criteria (Sub Criteria) Definitions

Criteria	Scoring 0-5 with "5" or "high" being most desirable
Local resources	**Fail (0):** The concept causes permanent alterations or disruptions to the operations or accessibility of local resources. **Low (1):** The concept causes significant disruption to the operations or accessibility of local amenities, such as attractions, schools, cultural resources, emergency resources, local businesses, etc. **Medium (3):** The concept causes some temporary disruptions to the operations or accessibility of local resources. **High (5):** The concept protects or enhances the operations or accessibility of local resources. **Key Questions:** • *What local resources exist in the proximity of the alignment and might be impacted throughout the corridor?* • *Will the concept result in degradation or improvement of local resources?* • *Will the concept result in temporary impacts on local resources in the vicinity due to construction or implementation during the 30-year project span?*

Public facilities	**Fail (0):** The concept permanently deteriorates or removes public facilities. **Low (1):** The concept significantly affects availability of public facilities such as restrooms, or recreational areas through closures, relocations, or restricted access. **Medium (3):** The concept temporarily affects availability of public facilities. **High (5):** The concept protects or enhances continuous availability of existing public facilities. **Key Questions:** • *Will the concept require permanent relocation or removal of nearby public facilities such as restrooms, recreational areas, or community spaces?* • *Will the concept cause temporary closures or restricted access to public facilities in the vicinity due to construction or implementation within the 30-year project span?*
Utilities	**Fail (0):** The concept results in long-term service outages and interruptions and may affect the integrity and safety of the local utility network. **Low (1):** The concept results in extensive disruptions, relocations, or service outages for multiple utilities (water, electricity, gas, sewage, or communications, etc.). **Medium (3):** The concept results in temporary service disruptions or outages for more than one utility. **High (5):** The concept maintains uninterrupted service for all adjacent utilities (water, electricity, gas, sewage, or communications, etc.). **Key Questions:** • *Are utilities at risk of service disruptions?* • *Will the concept require permanent relocation of nearby utilities, such as water, electricity, gas, sewage, or communications infrastructure?* • *Will the concept cause temporary service disruptions to utilities, such as water, electricity, gas, sewage, or communications, in the vicinity due to construction or implementation within the 30-year project span?*
Grade crossings	**Fail (0):** The concept causes permanent disruptions or elimination of existing grade crossings and major re-routing of roads and tracks. **Low (1):** The concept causes multiple disruptions to grade crossings, including closures or re-routing of roads and tracks. **Medium (3):** The concept causes temporary disruptions to grade crossings, including closures or re-routing of roads and tracks. **High (5):** The concept avoids impacts on grade crossings and maintains or improves service levels and circulation patterns. **Key Questions:** • *Are grade crossings at risk of increased delays, closures, or safety concerns?* • *Will the concept require permanent relocation, closure, or reconfiguration of nearby rail grade crossings?* • *Will the concept cause temporary disruptions to rail grade crossings, such as closures or detours, due to construction or implementation within the 30-year project span?*

Surfing and swimming	**Fail (0):** The concept leads to permanent changes that make the area unsuitable for surfing or swimming. **Low (1)**: The concept significantly alters or obstructs surf breaks and swimming areas, reducing availability of recreational resources. **Medium (3):** The concept causes temporary disruptions or minor alterations of the swimming and surfing experience. **High (5)**: The concept preserves the availability and quality of surfing and swimming recreational resources. **Key Questions:** • *Are surf breaks or swimming areas at risk of degradation, loss of access, or elimination?* • *Will the concept permanently alter or eliminate the existing surf breaks or designated swimming areas?* • *Will the concept cause temporary disruptions or reductions in access to surf breaks or swimming access due to construction or implementation within the 30-year project span?*
Multi-use paths and pedestrian access	**Fail (0):** The concept permanently removes or severely restricts access to pedestrian and multi-use paths, with no replacements or alternatives. **Low (1):** The concept results in reduced access, removal, or relocation of multi-use paths and pedestrian routes. **Medium (3):** The concept causes temporary disruptions or partial relocations of pedestrian paths, with mitigations. **High (5):** The concept maintains or enhances pedestrian and multi-use path access, potentially adding new connections or re-opening closed paths. **Key Questions:** • *Will pedestrian access or multi-use paths face increased safety risks, reduced connectivity, or deterioration if no improvements are made?* • *Will the concept result in permanent removal, relocation, or significant alteration of existing pedestrian pathways or multi-use trails?* • *Will construction or implementation of the concept cause temporary closures, detours, or reduced access for pedestrians and non-motorized users over the 30-year project span?*
Beach/ coastal access	**Fail (0):** The concept permanently eliminates access to lateral beaches or coastal areas. **Low (1):** The concept results in multiple closures, long-term disruptions, or loss of lateral beaches and coastal areas, limiting public movement and recreation. **Medium (3):** The concept results in limited closures, short-term disruptions, or partial loss of access to lateral beaches and coastal areas, but public movement and recreational use are largely unaffected. **High (5):** The concept maintains full access to existing lateral beaches and coastal areas and may expand capacity for movement and recreation. **Key Questions:** • *Will lateral beach and coastal areas face increased erosion, reduced connectivity, or diminished recreational use if no improvements are made?* • *Will the concept result in permanent loss or significant alteration of lateral beaches or coastal areas used for recreation?* • *Will construction or implementation of the concept cause temporary closures, restricted movement, or reduced recreational areas along lateral beaches and coastal areas over the 30-year project horizon?*

Permitting	**Fail (0):** The concept involves prohibitive permitting barriers with multiple agencies and has low likelihood of approval. **Low (1)**: The concept involves complex permitting processes requiring multiple agencies and may include elements that are difficult to approve, such as hard infrastructure. **Medium (3):** The concept involves moderate permitting effort with multiple agencies but has reasonable likelihood for approval and manageable coordination. **High (5)**: The concept is eligible for exceptions or streamlined permitting processes, with minimal agency coordination. **Key Questions:** • *Will the concept face significant permitting challenges due to its design, agency involvement, or environmental requirements?* • *Does the concept entail complex permitting that is prohibitively long?* • *Are there components of the concept that could facilitate the permitting process, such as local priorities, the use of nature-based solutions or demonstrated environmental benefits?*
Sensitive habitats	**Fail (0):** The concept directly affects critical or sensitive habitats, with no realistic options for mitigation. **Low (1)**: The concept affects multiple sensitive habitats, with impacts that are difficult to mitigate. **Medium (3):** The concept affects some sensitive habitats, but impacts are limited and have feasible mitigation. **High (5):** The concept avoids sensitive habitats entirely. **Key Questions:** • *Does the concept have the potential to impact sensitive habitats?* • *Are any of these impacts possible to mitigate?*
Section 4(f) resources	**Fail (0):** The concept causes irreversible damage to Section 4(f) resources, such as parks, historic sites, or recreational areas, and may have legal consequences. **Low (1):** The concept causes permanent impacts on protected Section 4(f) resources with few feasible mitigation strategies. **Medium (3):** The concept causes temporary or minor impacts on Section 4(f) resources with mitigation strategies available. **High (5):** The concept avoids all impacts on Section 4(f) resources and maintains the integrity of these areas. **Key Questions:** • *Are there any Section 4(f) resources in the vicinity of the alignment along the corridor?* • *Will the concept result in temporary or permanent impacts on Section 4(f) resources, and can any such impact be mitigated or avoided?*

4.2.5. Related/Planned Projects

Evaluate each alternative concept's alignment with existing and planned coastal initiatives across local, regional, and state levels relative to "no action" across the same geographic areas and study/project range of 30 years. The criteria assess consistency with policies/plans, funding eligibility, permitting feasibility, and public support toward each alternative concept to identify whether the alternative concept supports a cohesive regional effort or presents conflicts that could increase the difficulty or feasibility of implementation.

Table 19. Related/ Planned Projects Criteria (Sub Criteria) Definitions

Criteria	Scoring 0-5 with "5" or "high" being most desirable
Consistent with city preferences, ongoing, and future projects	**Fail (0):** The concept counteracts city policies, planning initiatives, local studies, or goals and may face city opposition and legal challenges. **Low (1):** The concept is inconsistent with or in conflict with city policies or planning initiatives, such as coastal preservation, transportation, or climate action plans. The concept is not aligned with local goals or studies within the specified locations or time ranges. The concept faces public concern or opposition, or it fails to reflect community preferences, such as support for nature-based solutions, improved beach access, and other locally valued priorities. **Medium (3):** The concept is partially aligned with city policies or planning initiatives and some local goals. Similar concepts have received mixed public comments/support, which may require modification for broader acceptance. **High (5):** The concept is fully aligned with local policies or planning initiatives, including coastal preservation, transportation, and environmental sustainability plans. It is compatible with local goals or studies in the specified locations and time ranges. There is strong public support for the concept, and it aligns with community sentiments and preferences, such as favoring nature-based solutions, improving beach access, and reflecting local values. **Key questions:** • *Does the concept align with goals and plans outlined by local cities, transportation agencies, or regional plans focused on coastal resilience?*
Consistent with federal, state, projects, and planning efforts	**Fail (0):** The concept is incompatible with federal or State planning efforts and conflicts with key guidelines (e.g., California Coastal Commission). It risks disqualification from funding or regulatory rejection. **Low (1):** The concept is inconsistent with broader planning efforts and contradicts regional frameworks, such as Coastal Zone Management programs and State Adaptation Plans. It does not meet federal and State (California Coastal Commission) guidelines, jeopardizing funding and increasing permitting complexity. **Medium (3):** The concept aligns with some federal or State planning efforts and may meet basic permitting requirements but does not qualify for streamlined processes or funding incentives. **High (5):** The concept is fully aligned with regional planning efforts and complements frameworks like Coastal Zone Management programs and State Adaptation Plans. It meets all relevant federal and State (California Coastal Commission) guidelines, qualifies for funding, and benefits from streamlined permitting. **Key Questions:** • *Does the concept align with goals and plans outlined by the Coastal Commission and other regional, State, and federal agencies?* • *Is it consistent with State and federal mandates and eligible for funding and streamlined permitting?* • *Does it support collaboration across jurisdictions and contribute to long-term regional climate resilience?*

4.3. Screening Process – Scores and Weights

Each criterion was assigned a point score ranging from 0 to 5, with 0 indicating a failing performance and 5 indicating the most favorable outcome for that criterion. To provide robust and informed evaluations, scoring across alternative concept categories was guided by stakeholder insight and in-depth discussions with subject matter experts from multiple disciplines:

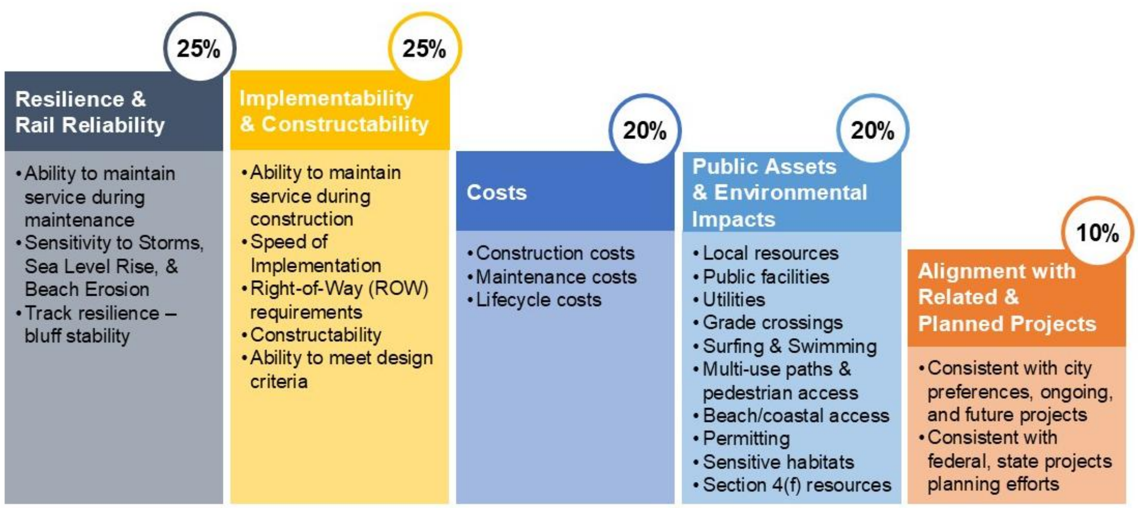
- Geotechnical engineering specialists contributed to assessments of Rail and Bluffside concepts.
- Coastal, rail and civil engineering specialists provided input on Rail and Beachside concepts.
- Rail and civil engineering professionals supported scoring across all alternative concept types to ensure that scoring reflected the proposed alternative concept overall.
- Environmental planning specialists informed evaluations of Sensitive Habitats and Section 4(f) Resources across all alternative concepts.

Total scores for each evaluation topic were weighed using a multiplier based on their assigned percentage. The weighting framework was informed by the project's Purpose and Need, as well as input from stakeholders and the community.

The following weights were assigned to each Evaluation Category (out of 100 percent):

- Coastal Resilience and Rail Reliability (25 percent)
- Implementability and Constructability (25 percent)
- Costs (20 percent)
- Public Assets & Environmental Impacts (20 percent)
- Related/Planned Projects (ten percent)

Figure 13. Evaluation Criteria and Weights



The alternative concepts were ranked from highest to lowest total point score within each solution type: rail, bluffside, and beachside. The top-scoring alternative concepts in each category will be carried forward for further analysis. A detailed scoring sheet for each alternative concept is included in Appendix E.

Table 20. Example Alternative Concept Scoresheet Methodology Categories, Criteria, and Point Scoring

	Category	Criteria	Points (0-5)	Total Points Per category
Example Concept: **Rail 1** **Elevated Tracks**	**Resilience and Rail Reliability**	Ability to maintain service during maintenance	3	**11**
		Longevity of concept (optimal conditions)	5	
		Sensitivity to storm, sea level rise, beach erosion	2	
		Track resilience – bluff stability	1	
	Cost	Construction costs	1	**9**
		Maintenance costs	5	
		Lifecycle costs	3	
	Implement-ability and Constructability	Ability to maintain service during construction	1	**8**
		Speed of implementation	1	
		ROW requirements	2	

4.4. Community Engagement

Community engagement and feedback played a critical role in shaping the evaluation framework and influencing how different factors were weighted. Public comments and advocacy groups expressed strong support for sand placement and emphasized the importance of maintaining safe, continuous access to coastal trails and lateral sandy beaches for recreation and resilience. Concerns about shoreline erosion and the impacts of hard shoreline protection structures were incorporated into the screening methodology.

In response to rounds of community input, the following actions were taken:

1. The categories “Public Assets and Environmental Impacts” and “Related/Planned Projects” were assigned weights of 20 percent and ten percent, respectively—together making up 30 percent of the total evaluation.
2. A one-time sand placement component was added to all shoreline protection structure concepts to help buffer the rail corridor and provide community benefits. Initially, three standalone alternative concepts without sand placement were considered for evaluation: Riprap, Engineered Rock Revetment, and Vertical Seawalls. These alternative concepts were ultimately removed from final scoring because they were inconsistent with community preferences or established plans and policies. One-time sand placement is now included in ten of the 11 beachside concepts, with the exception of the Watershed Modification alternative concept.
3. A sand placement-only alternative concept was added and evaluated in direct response to public preference. This also served as an exercise to evaluate the feasibility of reproducing ongoing local and regional sand placement projects on a corridor scale.

A comprehensive summary of the community engagement program and comments received are detailed in (See: Appendix C. Community Engagement Report).

5. Refined Alternative Concepts Shortlisted and Advanced for Further Study

The screening and evaluation process yielded a total of eight shortlisted alternative concepts to advance for further study. These alternative concepts are the top scoring in their respective categories (Rail, Bluffside, Beachside) and determined to be suitable to be used alone or in combination with other alternative concepts to address the hazards along the corridor. Based on expert panel recommendations, it would be ideal to have at least two concepts be carried forward for each category to provide a menu of options for implementation. In one category (beachside), the scores were very close together, so more than two alternative concepts were carried forward. Full scoring results and justifications can be found in Appendix E.

5.1. Results, Justifications, and Analysis

5.1.1. Rail Concepts

Two of the three Rail Concepts were shortlisted:

2. Alternative materials for critical railroad infrastructure to reduce lifecycle costs
3. Ground improvement (track-bed stabilization)

Table 21. Rail Concept Ranks and Summary Reasoning

Rail Concept	Rank	Shortlisted	Summary Reasoning
1. Elevate Tracks	3	No	High cost and construction impacts to rail service would make this alternative concept difficult to implement.
2. Alternative materials for critical railroad infrastructure to reduce lifecycle costs	1	Yes	Will limit impacts on surrounding communities and environmental assets. Easiest to implement and phase.
3. Ground improvement (track-bed stabilization)	2	Yes	Will have the greatest influence on railroad resiliency. May intermittently impact railroad operations during construction. May be combined with other bluffside alternatives.

5.1.2. Bluffside Concepts

Two of the nine Bluffside Concepts were shortlisted:

1. Catchment Walls
3. Tieback / Soil-Nail / Pin-Pile Walls

Table 22. Bluffside Concept Ranks and Summary Reasoning

Bluffside Concept	Rank	Shortlisted	Summary Reasoning
1. Catchment Walls	1	Yes	Proven cost-effective approach within the ROW to protect tracks.
2. Stabilization Grading	8	No	Difficult to construct, may impact adjacent private properties.
3. Tieback / Soil-Nail / Pin-Pile Walls	2	Yes	Proven cost-effective approach within the ROW to protect tracks.
4. Ground Improvement (stabilization)	5	No	May be combination with rail improvements related to ground improvements.
5. Surface Matting and Deep-Rooted Vegetation Planting	3	No	May be implemented in combination with other improvements, but not a corridor wide solution.
6. Drainage Improvement (grading / detention basins / undertrack outlets)	6	No	Limited to specific areas of reoccurring impacts, but not a corridor-wide solution.
7. Deflection Walls (in tributaries)	9	No	Requires periodic post-storm monitoring to maintain effectiveness. Only recommended in specific areas, but not a corridor wide solution.
8. Up-Gradient Cut-Off Drains	4	No	Only recommended in specific areas, but not a corridor wide solution.
9. Hydraugers	7	No	Difficult to construct and impacts on residential neighborhoods beyond ROW

5.1.3. Beachside Concepts:

Four of the eleven Beachside Concepts were shortlisted.

2.1. One-time sand placement with riprap shoreline protection structure

2.2. One-time sand placement with engineered rock revetment shoreline protection structure

2.3. One-time sand placement with seawall shoreline protection structure

2.4. One-time sand placement with a combination of shoreline protection structures

Table 23. Beachside Concept Ranks and Summary Reasoning

Beachside Concept	Rank	Carried Forward	Summary Reasoning
1. Beach nourishment with planned replenishment with No Shoreline protection structure	5	No	The scale of the effort, including lead time, funding, sand sourcing, permitting, and required sand volumes, would be a monumental undertaking, as demonstrated by similar large-scale regional initiatives. Maintaining a 30-year design life would require a regularly scheduled replenishment program managed by agencies with long-term coastal

			stewardship responsibilities. OCTA's governance structure as a transportation agency limits its ability to serve as the lead entity for an ongoing sand replenishment program, particularly given the unpredictability of sand movement during storm events.
2.1 One-time sand placement with Riprap shoreline protection structure	3	Yes	Proven solution that can be constructed within the railroad ROW while also improving beach access when combined with sand placement.
2.2 One-time sand placement with Eng. Rock Revetment shoreline protection structure	4	Yes	Will require extensive railroad operations impacts but still recommended in specific locations where ROW is wide enough to not have extensive operational impacts.
2.3 One-time sand placement with Seawall shoreline protection structure	2	Yes	Feasible solution that can be constructed within the railroad ROW while also improving beach access when combined with sand placement.
2.4 One-time sand placement with a Combination of shoreline protection structure	1	Yes	Feasible solution that can be constructed within the railroad ROW while also improving beach access when combined with sand placement.
3. One-time sand placement with sand retention measures and No shoreline protection	11	No	Negative impacts on recreational users (surfing/swimming) and may be very difficult to receive environmental approval and permitting.
4.1 One-time sand placement with sand retention measures and Riprap shoreline protection structure	8	No	Negative impacts on recreational users (surfing/swimming) and may be very difficult to receive environmental approval and permitting.
4.2 One-time sand placement with sand retention measures and Eng. Rock Revetment shoreline protection structure	9	No	Negative impacts on recreational users (surfing/swimming) and may be very difficult to receive environmental approval and permitting.
4.3 One-time sand placement with sand retention measures and Seawall shoreline protection structure	7	No	Negative impacts on recreational users (surfing/swimming) and may be very difficult to receive environmental approval and permitting.
4.4 One-time sand placement with sand retention measures and Eng. Rock Revetment shoreline protection structure	6	No	Negative impacts on recreational users (surfing/swimming) and may be very difficult to receive environmental approval and permitting.

5. Watershed modification	10	No	Must be implemented by other agencies and will take years to naturally replenish beach sand.

5.2. Summary of Shortlisted Alternative Concepts

The following shortlisted alternative concepts will be brought to the public again for additional stakeholder engagement and feedback.

Two rail concepts carried forward:

1. Alternative materials for critical railroad infrastructure to reduce lifecycle costs
2. Ground improvement (track-bed stabilization)

Two bluffside concepts carried forward:

1. Catchment Walls

3. Tieback / Soil-Nail / Pin-Pile Walls

Four beachside concepts carried forward:

2.1. One-time sand placement with riprap shoreline protection structure

2.2. One-time sand placement with engineered rock revetment shoreline protection structure

2.3. One-time sand placement with seawall shoreline protection structure

2.4. One-time sand placement with combination of seawall and revetment shoreline protection structure

6. Technical Assessment of Shortlisted Alternative Concepts

A preliminary technical assessment was performed on the eight shortlisted alternative concepts that emerged from the criteria screening process. These were completed to provide a more detailed understanding of the selected alternative concepts and their applicability to the specified Typical Sections of the corridor. Together, the Coastal Assessment (Section 6.1) and the Geotechnical Assessment (Section 6.2) describe the performance of the Beachside and Bluffside concepts in mitigating coastal erosion, flooding, sea level rise, and unstable bluff conditions that may affect the railway over the short to medium term over the next 30 years. By combining these perspectives, this section establishes the technical foundation for determining the location and type of targeted interventions necessary to maintain short and medium-term rail safety and resilience.

6.1. Coastal Assessment: Beachside Concepts

The focus of this coastal assessment of the shortlisted beachside concepts is to provide an initial assessment of the vulnerability of the rail corridor to coastal erosion and flooding, and related potential damage to the rail infrastructure over the next 10 to 30 years. The vulnerability assessment will help identify critical zones with high risk of damage to the rail corridor and will include an initial evaluation of beachside concepts' applicability in reducing coastal vulnerabilities.

6.1.1. Description of Shortlisted Beachside Concepts

The following sections provide descriptions of the shortlisted beachside concepts along with potential performance and potential implementation locations.

Concept 2.1 One-time Sand Placement with Riprap Shoreline Protection Structure

The project shoreline contains sections of rock riprap shore protection that are in varying conditions of repair. This alternative concept includes the placement of engineered new riprap or engineered repair of existing riprap, including retrieval of displaced riprap, combined with a one-time sand placement. The primary opportunities for implementation of this concept are in areas of existing riprap in need of repair. A typical section of One-time Sand Placement with Riprap Shore Protection Restoration is shown in Figure 14. An example of this action is the riprap repair project constructed in 2025, where an approximately 3,100-foot reach of contiguous riprap shore projection was repaired between North Beach and Linda Lane, with a before and after photo shown in Figure 15.

Figure 14. Typical Riprap Repair Restoration to The Existing Riprap

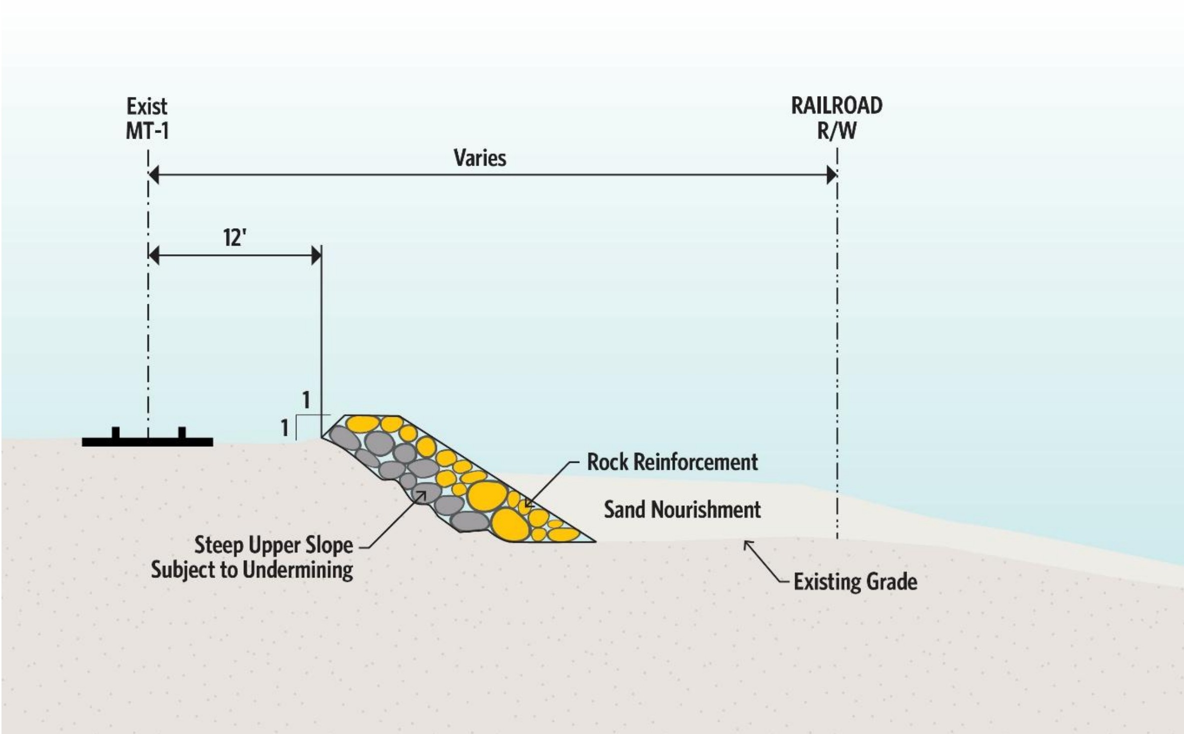


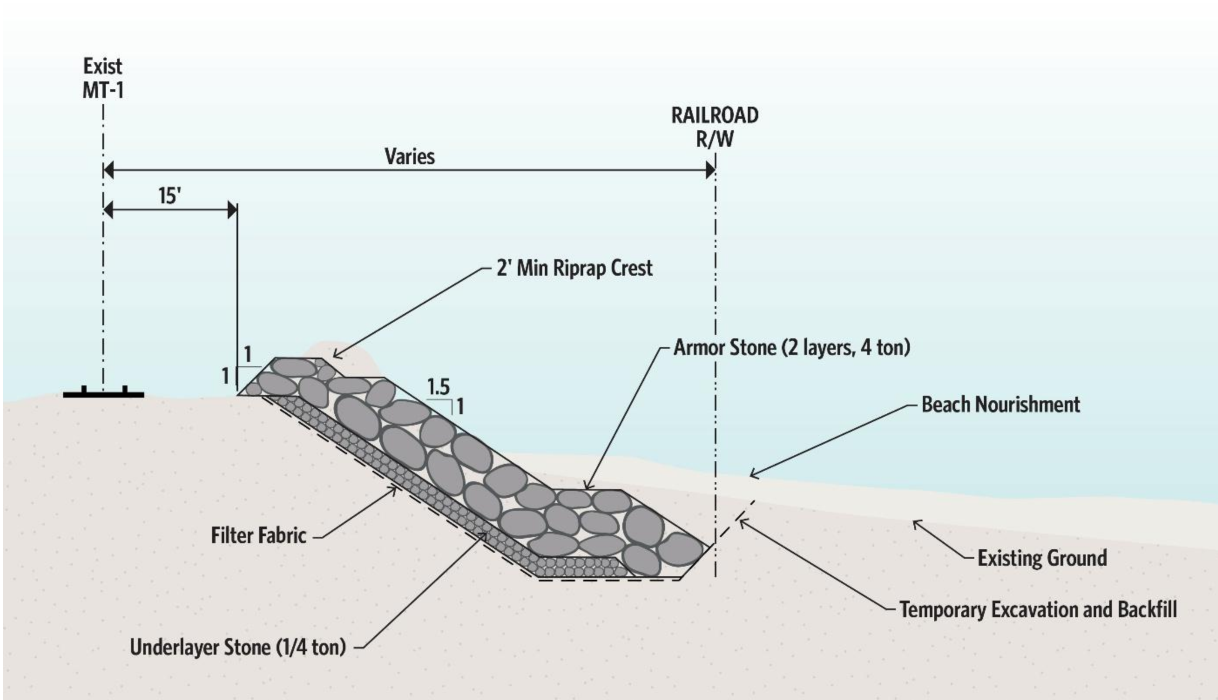
Figure 15. Riprap Repair at MP 204 Before and After

Concept 2.2 One-time Sand Placement with Engineered Rock Revetment Shoreline Protection Structure

Engineered revetments are typically constructed of quarried stone sized for stability based on extreme design wave and water level conditions. Figure 16 illustrates a typical engineered revetment structure. Key components include:

- Excavated slope of sufficient depth to protect against structure undermining from wave action,
- Placement of geotextile filter fabric underlayer to guard against sediment loss under wave attack,
- Smaller underlayer stone, and
- Outer double layer of armor stone.

Figure 16. Typical Engineered Revetment Shore Protection



Key constraints related to engineered revetment feasibility include the following: (1) the structure footprint must remain within the existing railroad ROW; and (2) construction excavation must remain outside the railroad's zone of influence for construction to occur without temporary shoring. Figure 16 illustrates the 15-foot offset from the track centerline and maximum slope of 1.5H:1V (SCRRA DCM 15.4.1) to avoid the zone of influence. The concept details and dimensions shown in the figure are typical design values to withstand extreme waves and water levels in Study Area.

Figure 17 shows the potential implementation locations for an engineered revetment. Green areas indicate locations where the revetment section would remain within the ROW, while red areas represent regions where the revetment section would likely encroach beyond the ROW. Opportunities for the construction of a fully engineered revetment are limited to two discrete segments in the southern portion of the project area. Figure 18 shows an aerial photo of areas along the coastal rail corridor where engineered revetment could potentially be implemented. A revetment toe elevation of +2 ft NAVD88 was assumed to protect against toe undermining. Areas where bedrock is above this elevation would result in a reduced revetment footprint due to a higher elevation of revetment toe, providing greater opportunity of implementation within the ROW.

Figure 17. Locations of Potential Application of Engineered Revetment Shore Protection

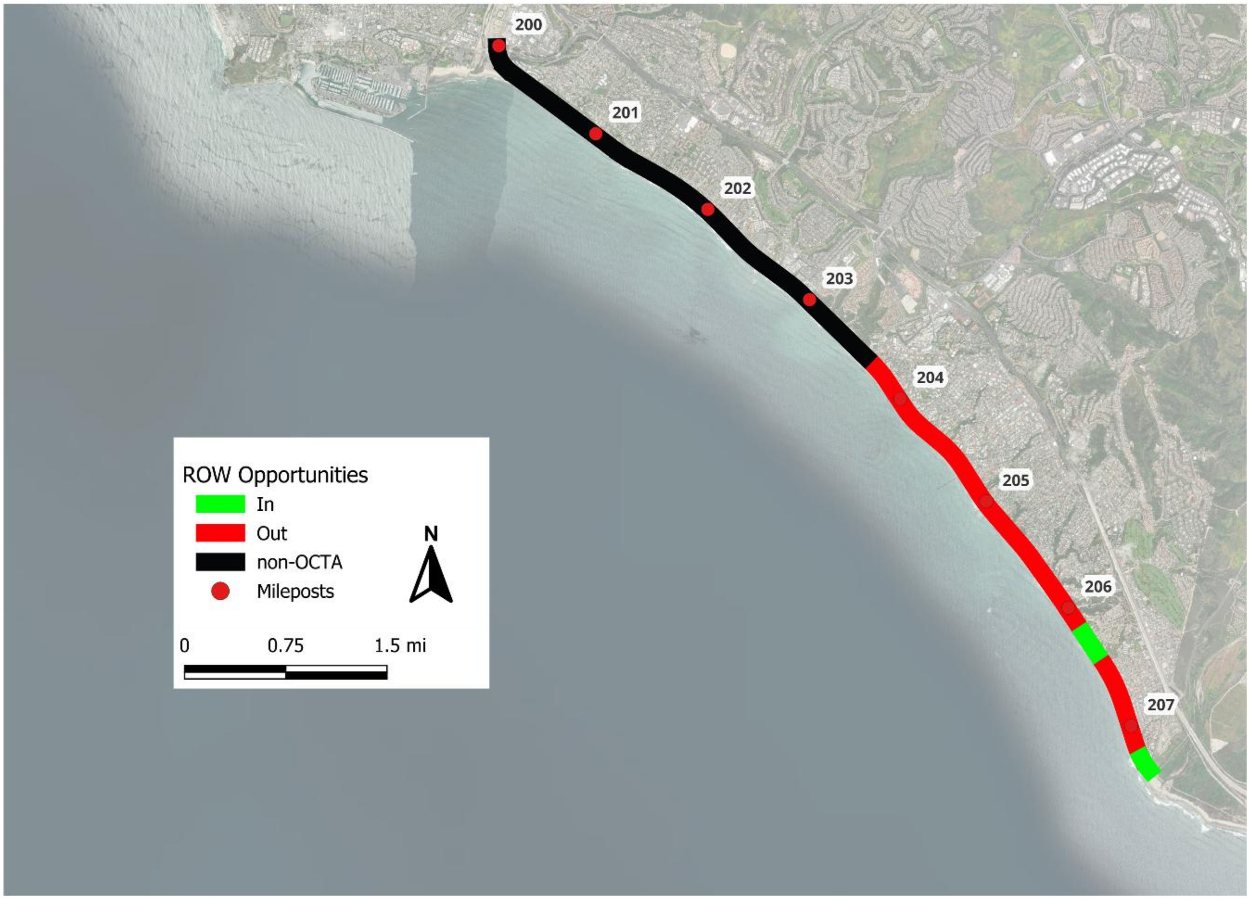
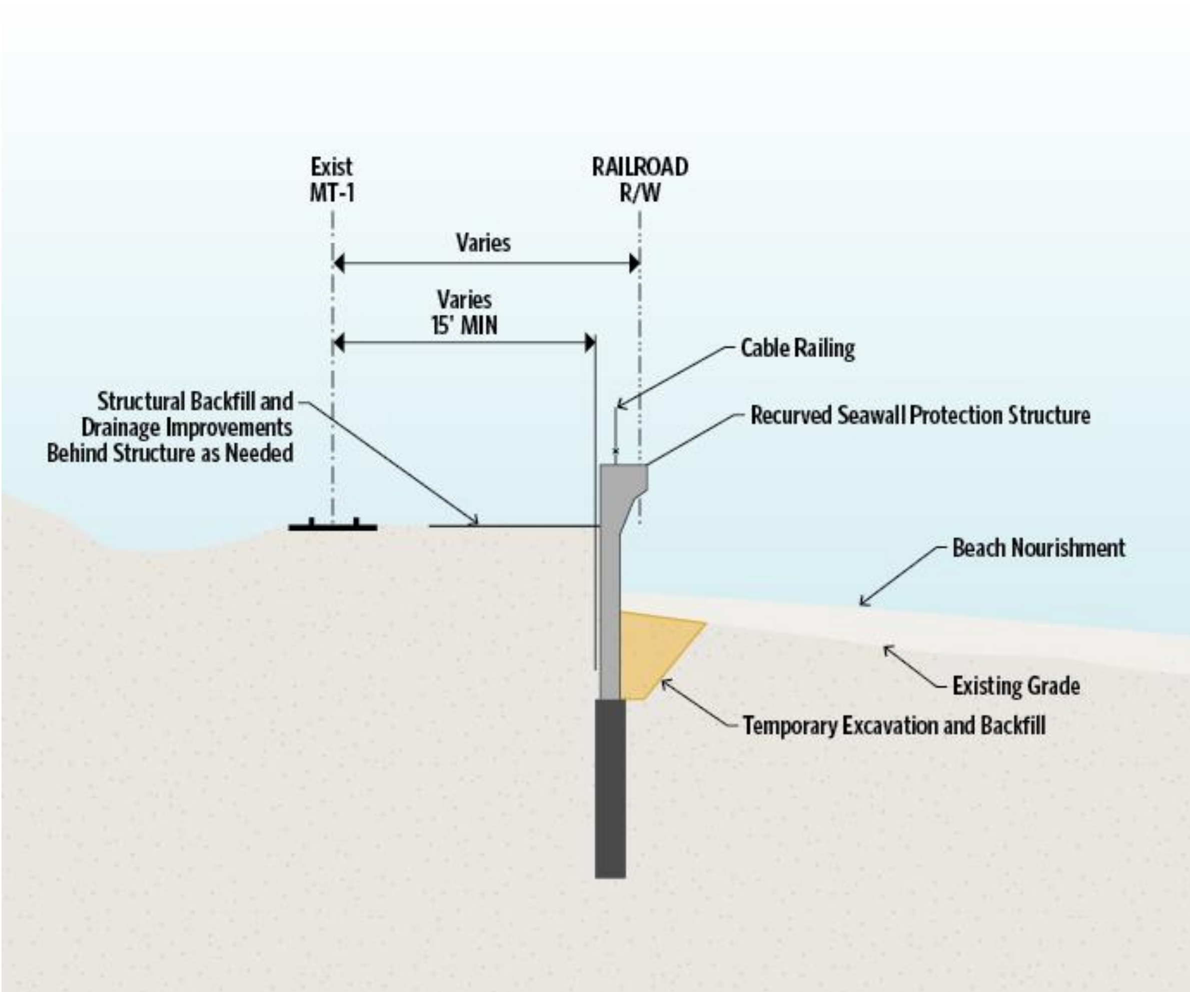


Figure 18 Area Requiring Shoreline Protection (MP 206.0 - MP 206.7)

Concept 2.3 One-time Sand Placement with Seawall Shoreline Protection Structure

A seawall could be constructed along the seaward alignment of the railway to protect the rail corridor from coastal erosion and flooding. This alternative would be paired with one-time sand placement in front of the seawall. Figure 19 depicts a typical seawall cross section. As shown, a vertical structure would require excavation into the seaward rail corridor slope to maintain the required offset from the rail tracks. While generally requiring less overall footprint area than a rock revetment, design challenges include proper foundation and lateral stability.

Figure 19. Typical Seawall Shore Protection



Seawalls are commonly used as shoreline protection measures in Southern California. They are considered more reflective of wave action (lower wave energy absorption) compared to other alternatives, such as rock revetment, and may cause potential surf zone impacts. A rendering of a seawall structure near San Clemente State Beach is shown in Figure 20. Examples of seawalls in Carlsbad, CA and Malibu, CA are shown in Figure 21 and Figure 22 respectively.

Detailed geotechnical investigations are required to establish seawall feasibility due to both physical constraints and ROW limitations. Existing buried riprap lies in many locations beneath and on the seaward side of the railway, complicating construction if the riprap is not removed. Relocating the seawall alignment seaward to avoid buried riprap may result in the seawall and its toe protection being placed outside the ROW limits and increase encroachment onto the public beach areas.

Figure 20. Rendering of Seawall at San Clemente State Beach

Figure 21. Seawall in Carlsbad, CA

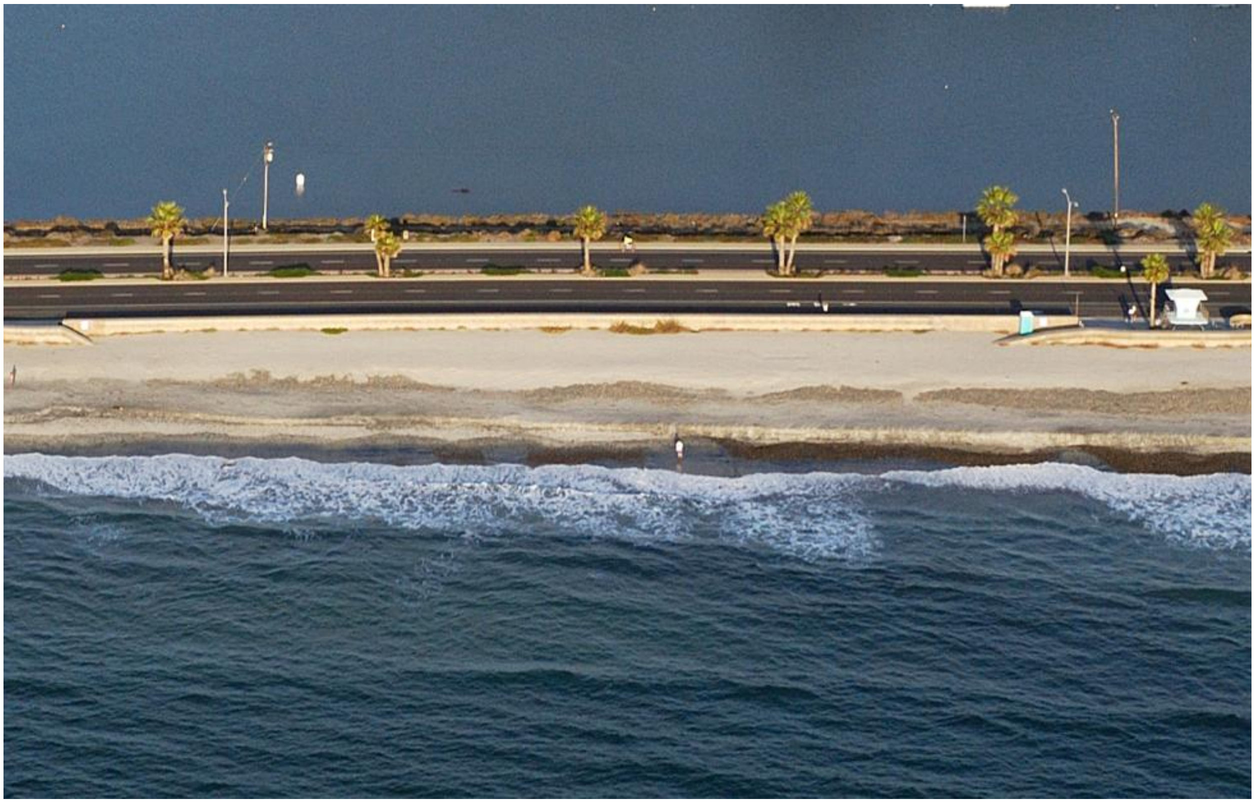
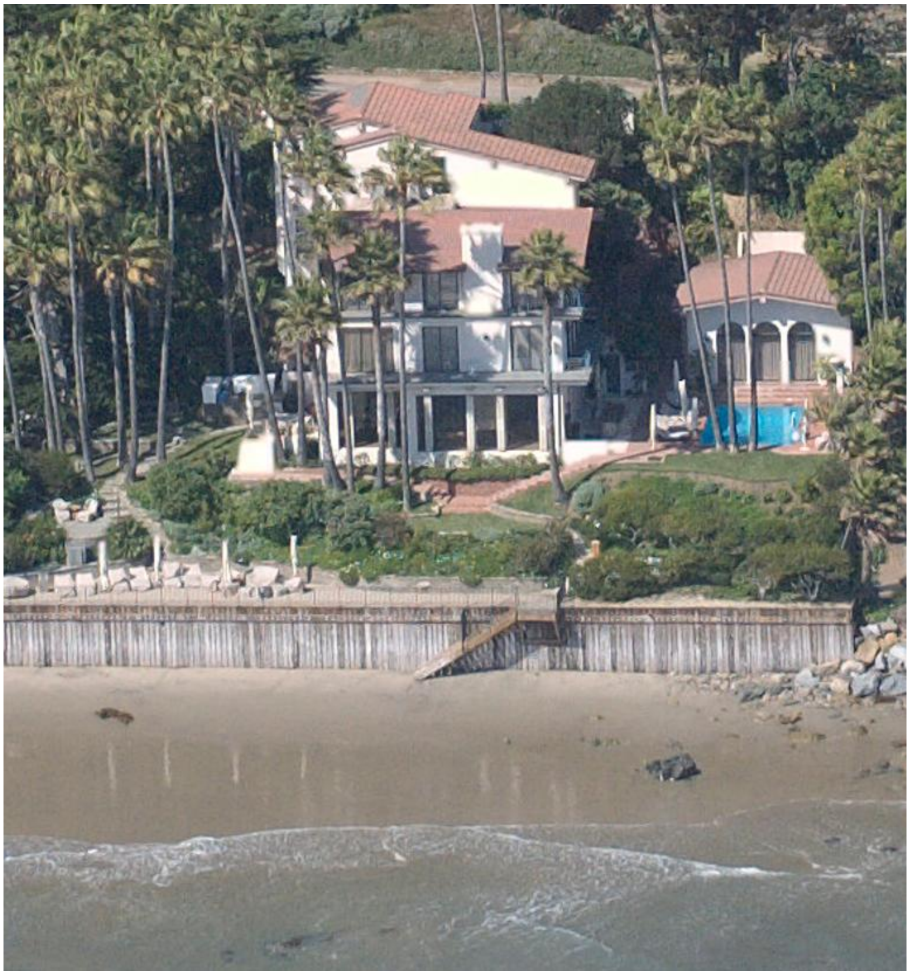


Figure 22. Seawall in Malibu, CA



Concept 2.4 One-time Sand Placement with Combination Seawall/Revetment Shoreline Protection Structure

In areas where a vertical seawall would be feasible from a constructability standpoint, a hybrid seawall-revetment structure concept could be considered that would incorporate the reduced footprint benefits of a seawall with the additional wave energy dissipation and reduced wave reflection by adding a relatively smaller revetment section seaside of the seawall. The revetment dimensions are typically larger than what would be required for seawall toe protection. The intent of the combination of the two alternative concepts is to provide a robust shore protection structure with enhanced shoreline erosion and flood reduction performance. The fronting revetment can further extend the life of the seawall structure due to the reduction of direct wave impact forces on the wall. An example of this hybrid structure is illustrated in Figure 23. A similar concept was included in OCTA's Rail Defense Against Climate Change Plan in January 2021, as shown in Figure 24. Examples of a combination wall in Laguna Beach, CA and Ventura County, CA are shown in Figure 25 and Figure 26 respectively.

Figure 23. Typical Combination Seawall/Revetment Shore Protection

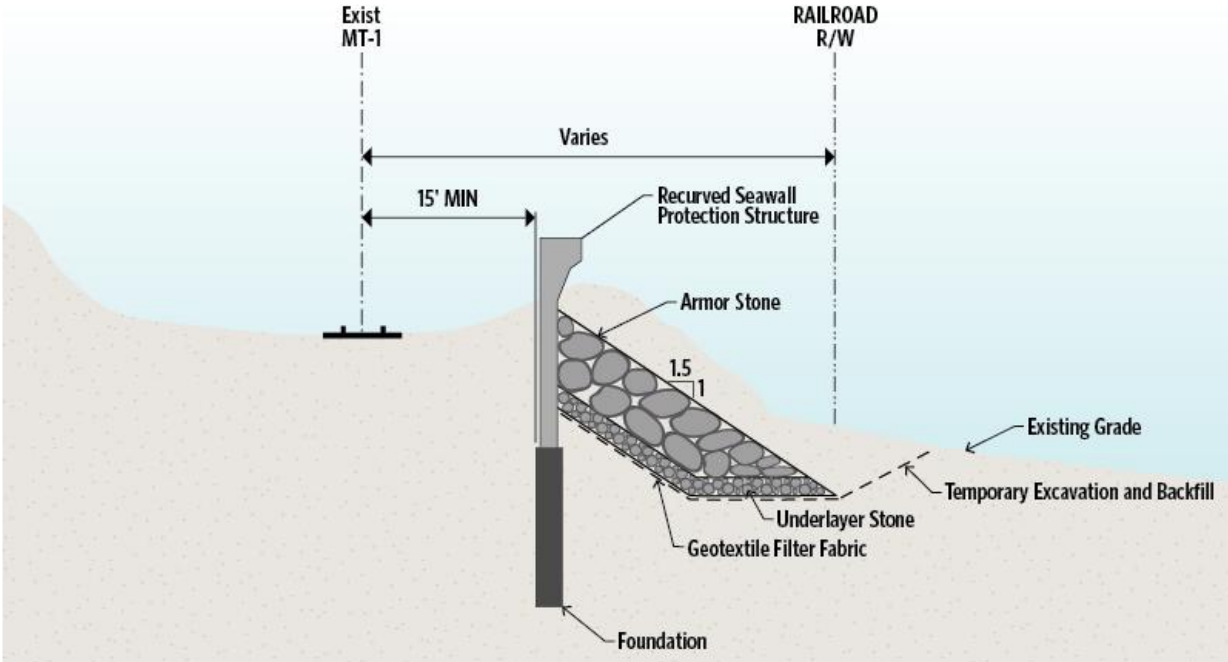


Figure 24. Revetment with Seawall Concept from OCTA's 2021 Study

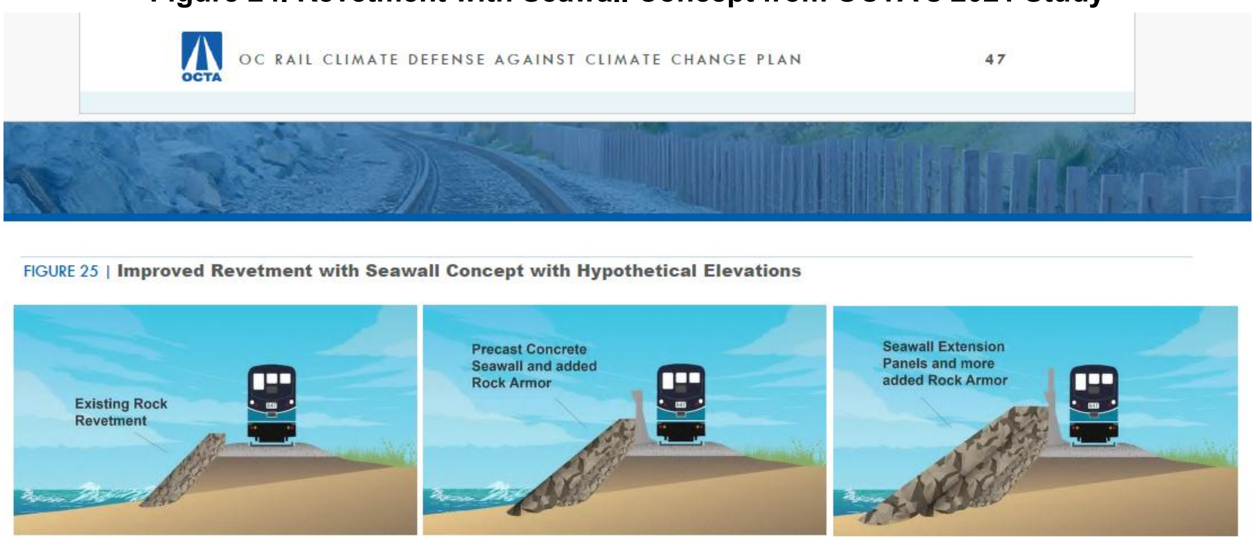


Figure 25. Combination Wall in Laguna Beach, CA

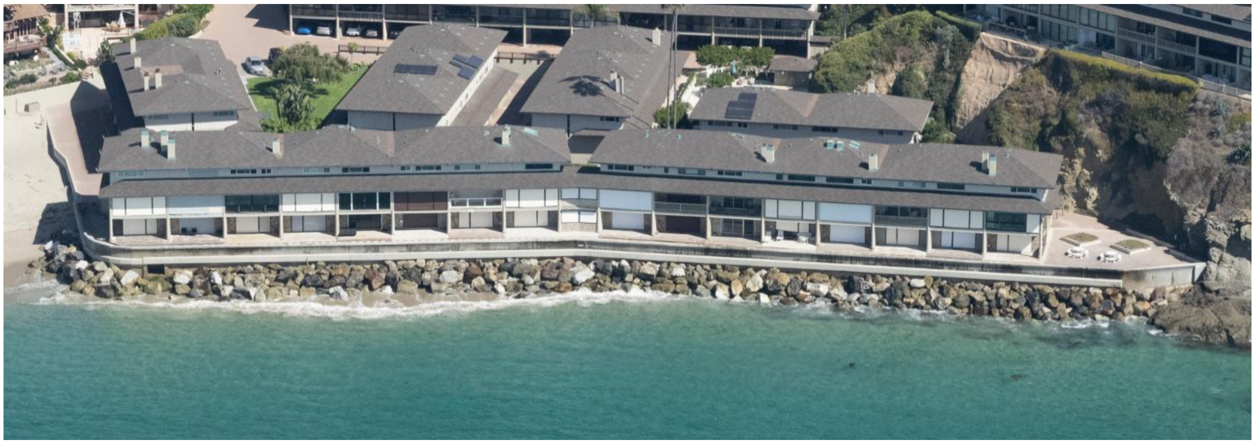
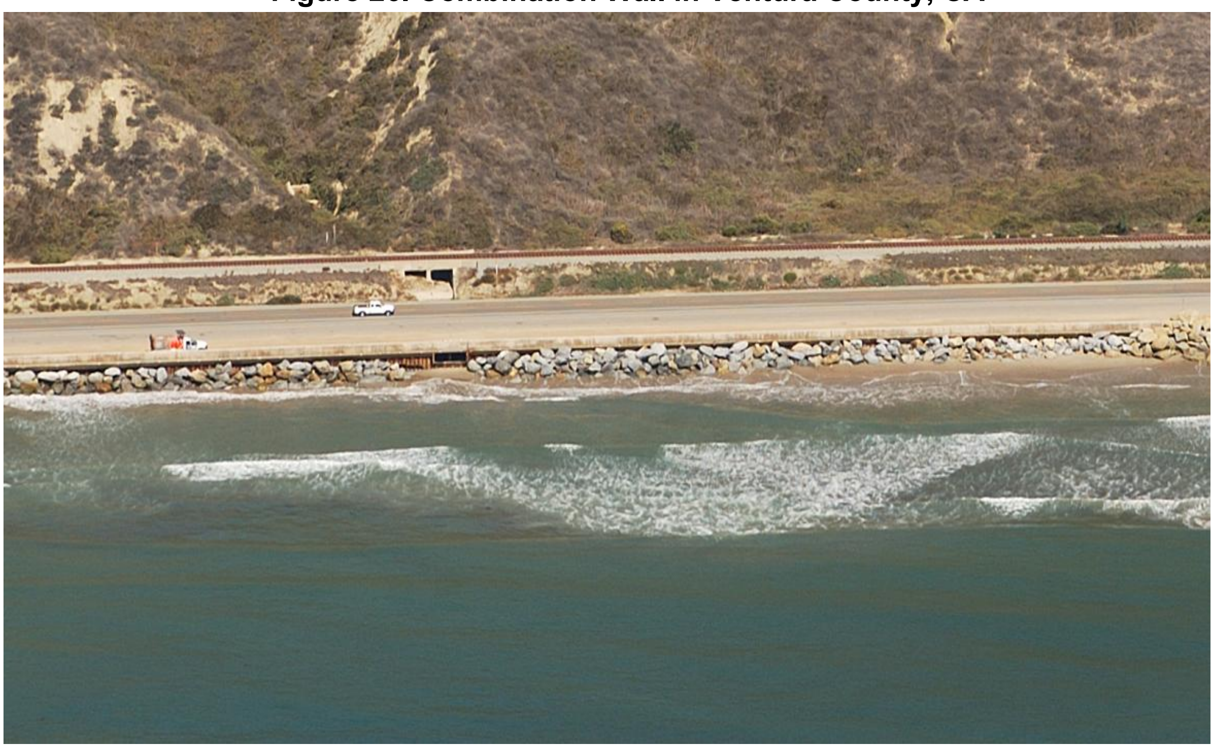


Figure 26. Combination Wall in Ventura County, CA



6.1.2. Shoreline Conditions

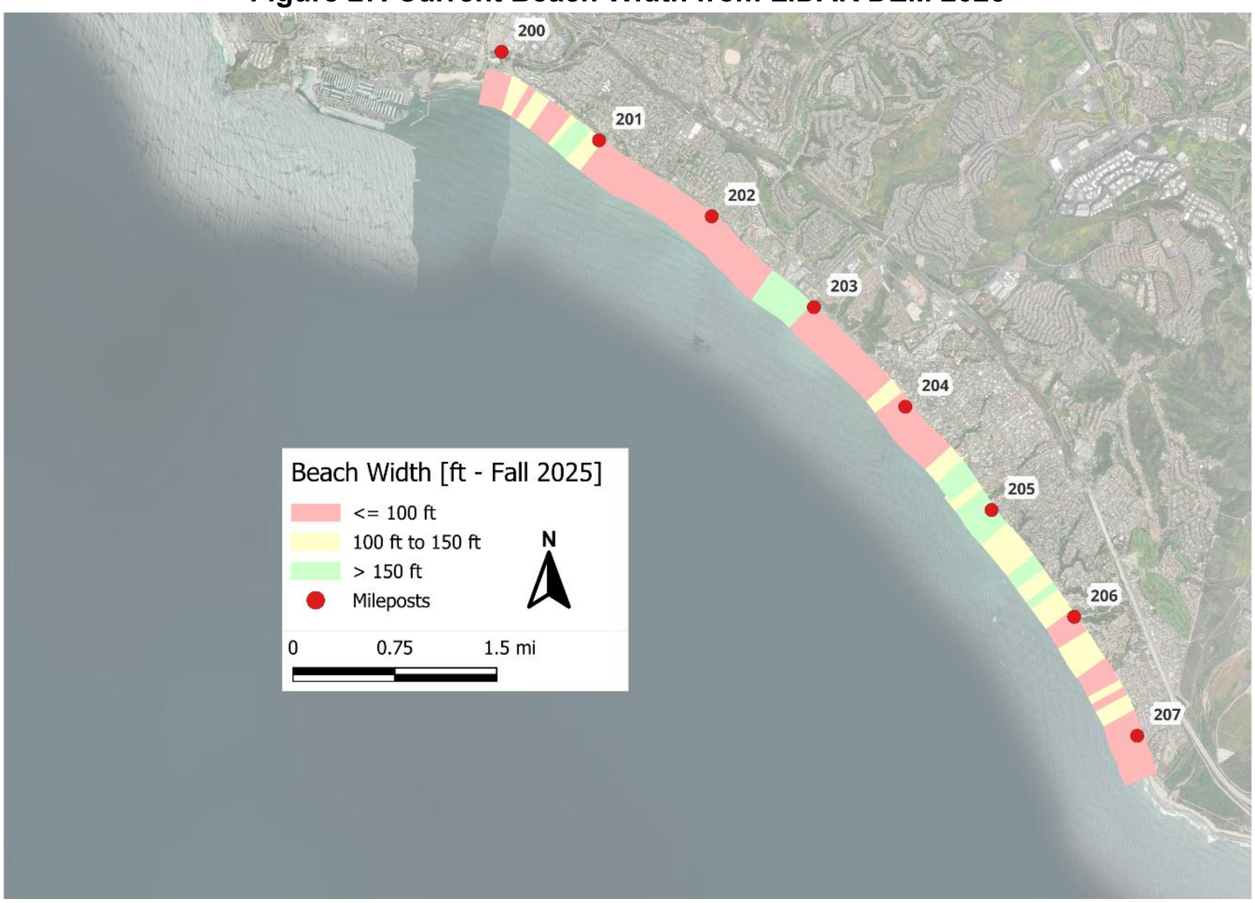
With the shortlisted beachside concepts described in the preceding section, the next step in their technical assessment is to describe the coastal setting and processes along the OCTA coastal rail corridor. The purpose of the analysis is to compile existing local beach width data and document how conditions have and are projected to change over time. This information is used to conduct a high-level vulnerability risk assessment of the rail corridor to coastal erosion and flood damage over the 30-year projected life of the alternative concepts.

Current (2025) Shoreline Position

The current (2025) beach widths were derived by mapping the MHW shoreline position based on LiDAR (Light Detection and Ranging) surveys conducted in March 2024 and March 2025. The 2025 LiDAR data coverage extends as far north as MP 203.6. LiDAR acquired in 2024 was used north of this location.

Beach width was calculated as the horizontal distance between the landward limit of the sandy beach and the point at which the beach intersected the plane of the MHW tidal datum. Figure 27 summarizes the beach widths in the study area relative to the back beach according to color bands representing defined ranges of beach width. The beach widths range from 162 feet to 2 feet. The greatest beach widths are located south of the San Clemente Pier, a site of recent sand placement project completed in late 2024. The narrowest beaches (2 feet) are adjacent to North Beach fronting the Capistrano Shores manufactured home community, as well as near Cyprus Shore.

Figure 27. Current Beach Width from LiDAR DEM 2025



Shoreline Change Trends

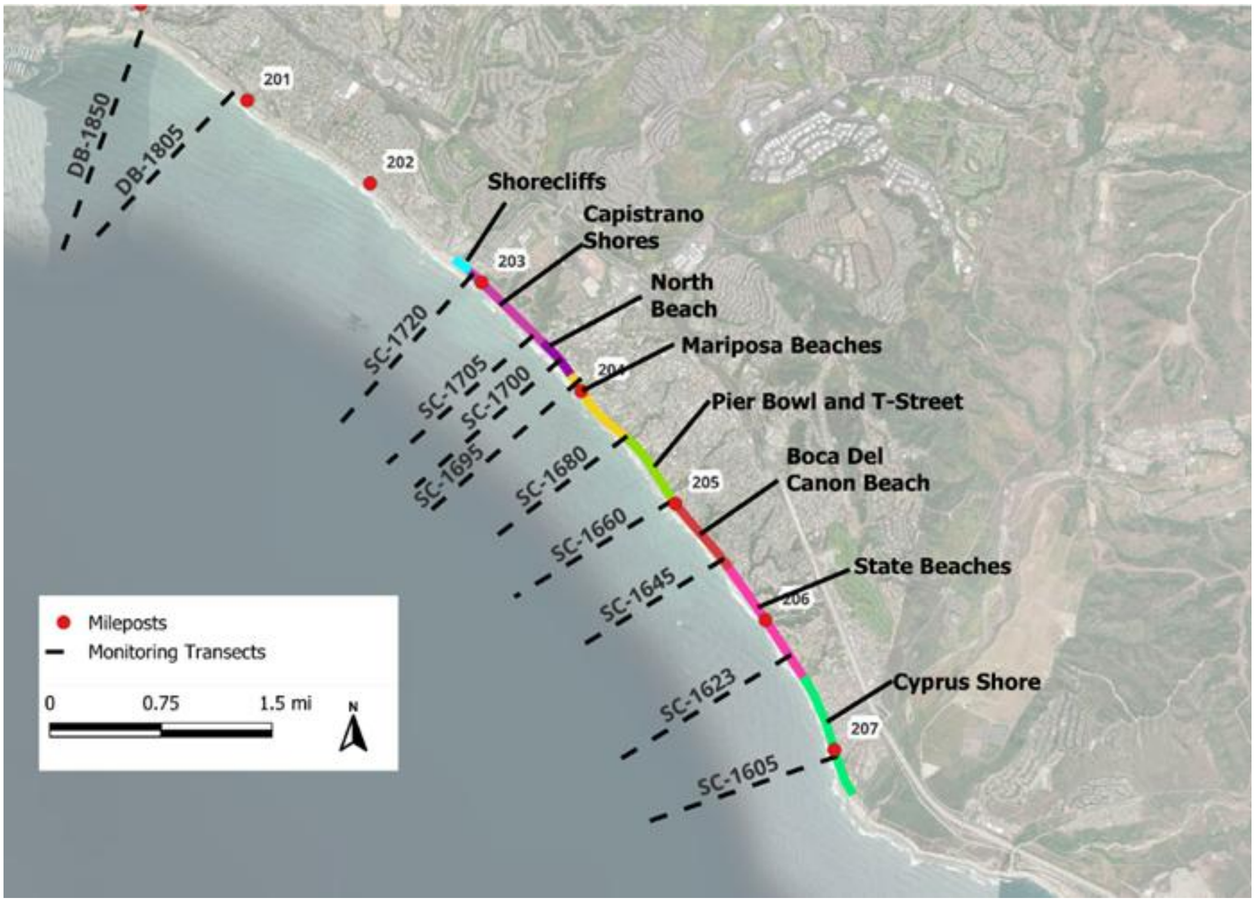
Beach transects

The City of San Clemente maintains a shoreline monitoring program that includes semi-annual beach profile surveys at 11 locations within the project area (Coastal Frontiers Corporation, 2025). The surveys extend offshore from the back beach to beyond the depth of closure, i.e., the seaward limit of active sand movement by wave action. Beach profile surveys have been conducted each fall and spring since 2001 with a hiatus between 2007 and 2022. The fall surveys document the condition of the beach prior to the winter wave season (typically among the widest beaches of the year), while the spring surveys document the condition of the beach at the end of the winter wave season (typically among the narrowest beaches of the year). The data provide relevant information on seasonal, annual, and long-term beach width changes in the region.

Figure 28 shows a map of the shoreline including Mile Post (MP) and shoreline monitoring transect locations. The shoreline sections are colored individually to provide a clear distinction between the different sections.

Surveys indicate seasonal shoreline change with a consistent pattern where winter conditions cause erosion in the northern and portions of the central transects, while summer conditions cause recovery primarily in the central and southern transects. Northern profiles at Doheny (DB-1850, DB-1805) indicated repeated erosion with limited recovery, reflecting a persistent narrowing trend, whereas North Beach (SC-1702, SC-1700) shows more stable seasonal response. Central transects (SC-1705, SC-1695) remain chronically narrow with minimal seasonal response. In contrast, the Pier Bowl and southern transects (SC-1680, SC-1660, SC-1645, SC-1623) typically experience reduced winter erosion and stronger summer accretion. This accretive response diminishes toward Cottons Point (SC-1605), which remains consistently erosive, resulting from a persistent north-to-south littoral transport.

Figure 28. Shoreline Monitoring Beach Transect Locations



Beach widths were derived from the profile data as the horizontal distance between the landward limit of the beach and the point at which the beach profile intersects the plane of the MHW tidal datum. Beach width trends then were derived for the period from 2001 to 2025. The shoreline change trend for each of the monitoring transects is shown in Figure 29 as colored bands representing eroding (exceeding one foot/year or more of shoreline erosion), stable (-1.0 to one foot/year), and accreting (exceeding one foot/year of accretion) conditions based on linear trends of observed beach widths. The beaches showing the greatest erosional trends are north of North Beach and along Cyprus Shore.

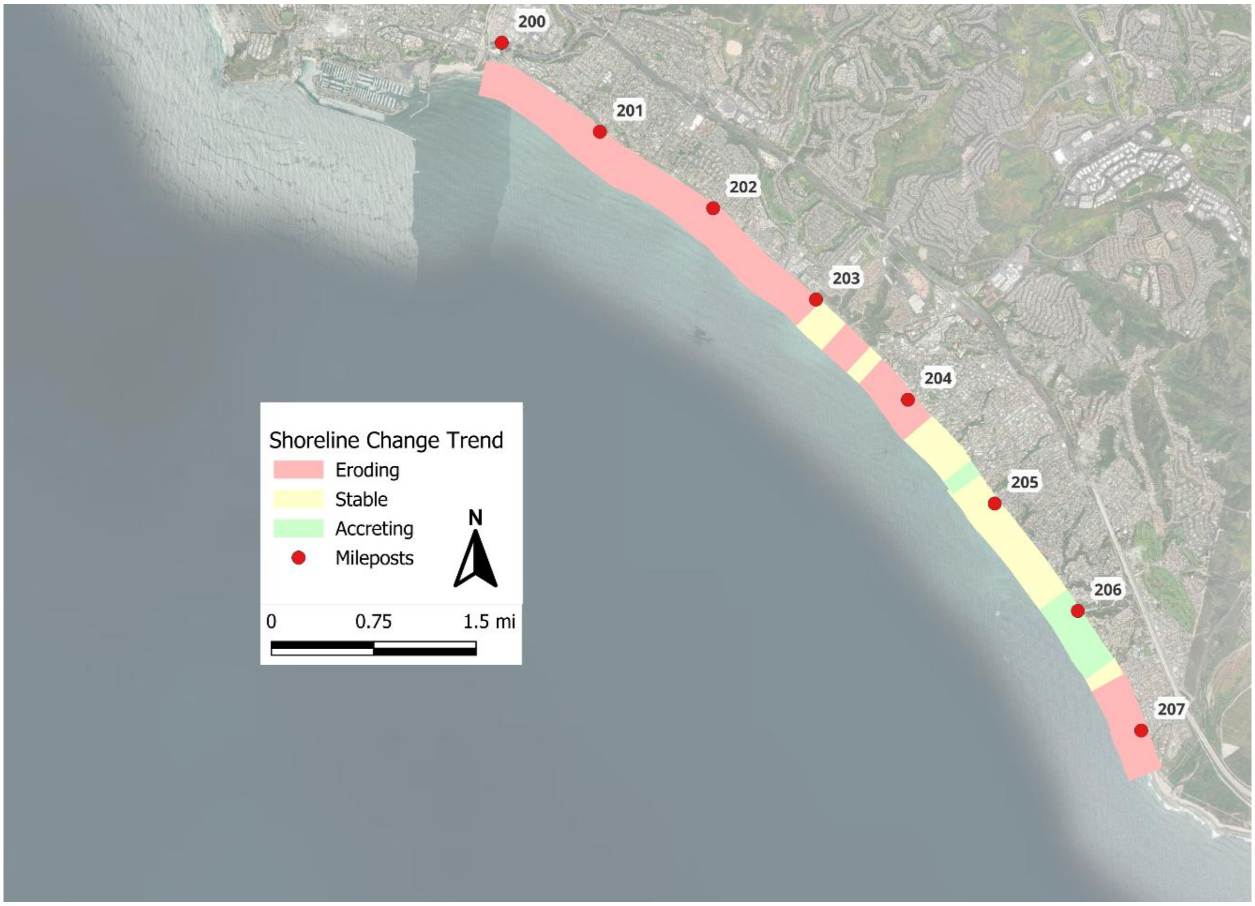
Figure 29. Shoreline Change Trends from Beach Transect Data

CoastSat Shoreline Change Trends

Advances in image processing techniques have enabled shoreline mapping using historical satellite imagery (Vos, K, et al. 2019). CoastSat provides satellite-based estimates of shoreline change at 330-foot (100-meter) intervals along the coast for the period from 1984 to 2022. Data frequency is roughly every 6 months from 1984 to 2000 and every 2 to 4 weeks from 2000 to 2022. The accuracy of mapped shorelines is stated as plus or minus 50 feet (plus or minus 15 meters). The satellite-derived shoreline data is not adjusted to a common vertical datum, which introduces additional inaccuracies (*e.g.*, the developers estimated plus or minus seven meter inaccuracy associated with tide elevations at Narrabeen, Australia, which has a comparable tidal regime to southern California). As such, individual data points are not comparable to localized survey data such as the beach transects, but given the high sampling frequency and assumption of random error, the CoastSat data can be used to evaluate decadal trends.

Figure 30 shows the shoreline change trend derived from CoastSat data for the period from 2001 to 2022. Based on the same metrics for eroding, stable, and accreting beaches, the CoastSat evaluation agrees reasonably well with the transect-based evaluation. Erosion predominates in the northern and southern portions of the region. The central portion of the region (between MP 204.2 and MP 206.5) is characterized by stability or accretion.

Figure 30. Shoreline Change Trends from CoastSat Data



Shoreline Retreat Attributable to Future Sea Level Rise

This Coastal Resiliency Study investigates beachside shoreline protection measures over a 30-year planning horizon. The current science to support planning for sea level rise (SLR) in California is summarized in the *Sea Level Rise Guidance 2024 – 2024 Science and Policy Update.*[3] Table 24, excerpted from the 2024 guidance, provides SLR projections at the nearest tide station in La Jolla, California.

[3] California Ocean Protection Council, 2024*, State of California – Sea Level Rise Guidance – 2024 Science & Policy Update*.

Table 24. Sea Level Scenarios for La Jolla, CA Tide Station

Median values of Sea Level Scenarios, in feet, for each decade from 2020 to 2150, with a baseline of 2000. All median scenario values incorporate the local estimate of vertical land motion.

YEAR	LOW	INT-LOW	INTERMEDIATE	INT-HIGH	HIGH
2020	0.2	0.2	0.3	0.3	0.3
2030	0.3	0.4	0.4	0.4	0.5
2040	0.4	0.5	0.6	0.7	0.8
2050	0.5	0.7	0.8	1.0	1.3
2060	0.6	0.8	1.1	1.6	2.0

For a maximum 30-year design life, the reference year is approximately 2055. The following SLR values are interpolated between Year 2050 and Year 2060 for Intermediate-High and High SLR scenarios:

- Year 2055 (interpolated) Intermediate-High SLR value: 1.3 ft
- Year 2055 (interpolated) High SLR value: 1.7 ft

Assuming a typical nearshore slope of (10:1), the loss of beach width associated with these SLR scenarios is:

- Year 2055 Intermediate-High SLR beach width reduction: 13 ft
- Year 2055 High SLR beach width reduction: 17 ft

Level of Rail Corridor Coastal Shore Protection

Existing rail corridor shore protection was categorized into four broad types based on evaluation of recent and historical aerial images and drone videos: (1) shoreline protected by non-OCTA infrastructure, (2) competent riprap (including recently repaired), (3) existing riprap in need of repair, and (4) little to no existing protection. Typical Sections 1 and 2 (Figures 6 and 7) provide an example of shoreline protected by non-OCTA infrastructure (i.e., public or private infrastructure is located seaward of the rail corridor). An example of a recently repaired riprap section is shown in Figure 31 and Figure 32 for a shoreline section between MP 203.9 and MP 204.5 (between North Beach and Linda Lane). In this area, the repair consisted of placing new rocks onto the damaged existing riprap section. Figure 33 shows a small reach at MP 206.6 with little to no existing shoreline protection.

Figure 31. Recent Revetment Repair between North Beach and Linda Lane

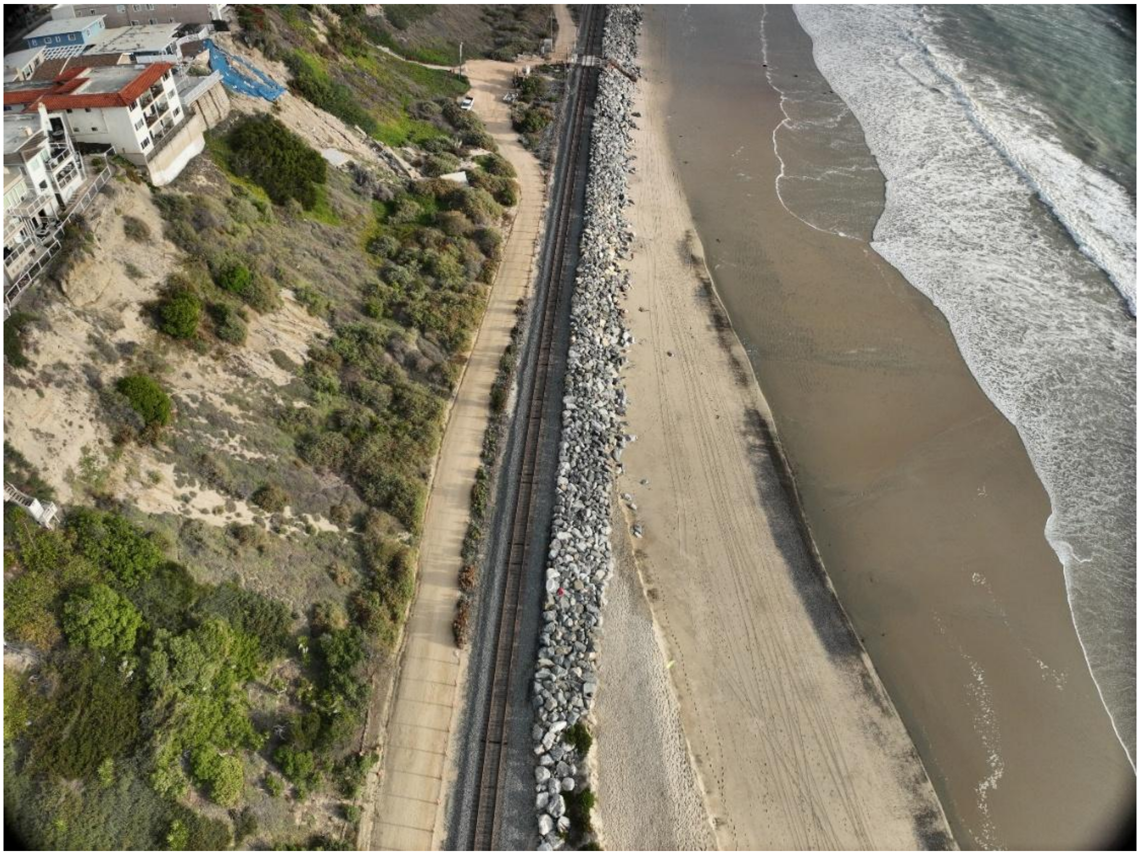


Figure 32. Photos from MP 204.5

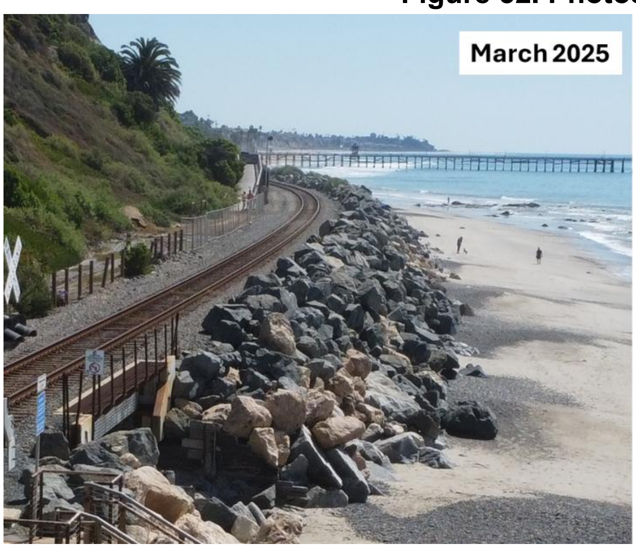


Figure 33. Aerial View of Little to No Shore Protection South of San Clemente State Beach Near MP 206.6

6.1.3. Vulnerability-Based Assessment for Beachside Protection of Rail Corridor

The entire length of shoreline from North Beach (MP203.6) to Cyprus Shores (MP207.3) was evaluated to assess vulnerability of existing coastal rail infrastructure and the need to implement one or more of the beachside concepts. The region from Doheny State Beach to North Beach (MP200.2 to MP203.6) was excluded because rail infrastructure in this region is effectively protected by existing public or private development (*e.g.*, Typical Section 1 where parking lots or roads are located seaward of the ROW (Figure 6), or Typical Section 2 where private development is located seaward of the ROW (Figure 7)). The evaluation considers shoreline conditions in combination with the existing level of shoreline protection in place. Sea level rise and related beach width loss were considered qualitatively when assigning categories.

The shoreline condition was assessed based on present-day beach width (Figure 27) and observed shoreline change trends (Figure 29 and Figure 30). Shoreline segments were categorized as *Critical*, *Compromised*, or *Adequate* based on a combination of parameters as illustrated in Figure 34. The range of categories is intended to define the likely protective capacity of the beach under current and future conditions (short-term: less than ten years; medium-term: up to 30 years). Shoreline segments with beach widths less than 100 feet were designated *Critical* regardless of the prevailing shoreline change trend, reflecting the limited protective capacity of the beach during a modest storm event under present conditions.

Shoreline segments with beach widths exceeding 150 feet and characterized by stable or accreting shorelines were designated *Adequate* under the assumption that these beaches offer adequate protective capacity at present and in the future. Shoreline segments designated *Compromised* reflect conditions that presently offer limited protective capacity during extreme storm events and may have diminished protective capacity in the future (over the medium-term period; up to 30 years).

Figure 34. Shoreline Conditions Assignment Matrix

Shoreline Change Rate \ Beach Width	<= 100 ft	100 to 150 ft	> 150 ft
Eroding <= -1 ft/yr	**Critical**	**Compromised**	**Compromised**
Stable -1 to 1 ft/yr	**Critical**	**Compromised**	**Adequate**
Accreting > 1 ft/yr	**Critical**	**Compromised**	**Adequate**

The vulnerability of the rail infrastructure was evaluated based on the assigned shoreline condition (Figure 35) and the existing level of protection in place. Three categories of shoreline protection were considered: 1) little to no protection, 2) riprap in need of repair, and 3) competent riprap (including recently repaired). As illustrated in Figure 35, shoreline segments were categorized as High, Moderate or Low Risk based on a combination of the shoreline condition and shoreline protection in place. All segments characterized as Adequate shoreline condition were designated Low Risk in recognition that the beach alone provides a sufficient buffer to the rail infrastructure. High Risk designations were assigned to areas with limited or degraded shoreline protection fronted by Critical or Compromised shoreline conditions. The Moderate Risk designation was used in areas with competent and/or recently repaired riprap fronted by Critical or Compromised shoreline conditions in recognition that these areas may be susceptible to damage during extreme storm events.

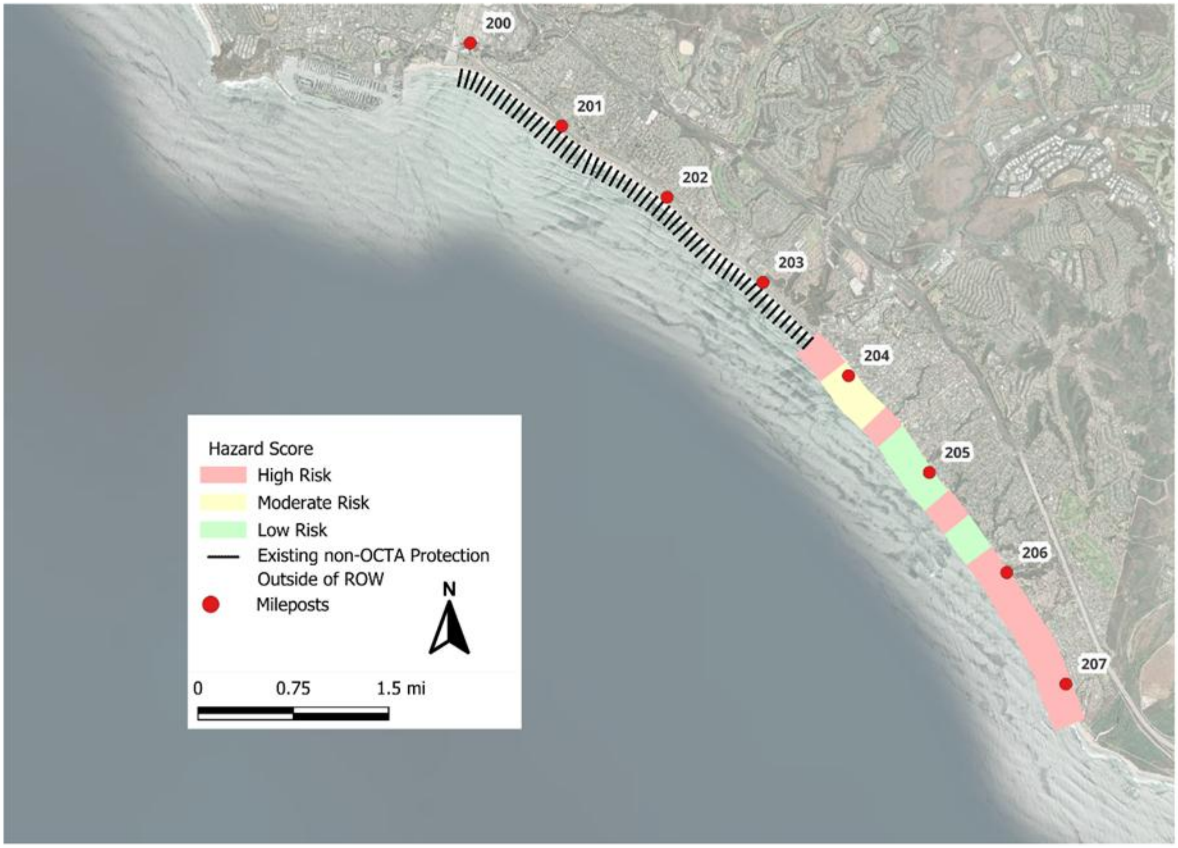
The results of the vulnerability assessment are shown in Figure 36. Only the regions near the San Clemente Pier and just north of San Clement State Beach are categorized as Low Risk. The remainder of the shoreline segments from North Beach to Cyprus Shore are considered High Risk or Moderate Risk.

Implementation of one or more of the beachside concepts should be considered in the High to Moderate Risk areas, with the High Risk areas addressed as soon as practical. The beachside concept selected will depend on several factors, including available ROW, geotechnical considerations, and constructability (*e.g.*, excavation constraints). As indicated in Section 6.1.1, the ROW is not sufficient to accommodate an engineered revetment in most areas. Similarly, buried riprap within the ROW may complicate construction of the seawall concepts.

Figure 35. Coastal Hazard Risk Assessment Assignment Matrix

Infrastructure Protection \ Shoreline Condition	Critical	Compromised	Adequate
Little to No Protection	High	High	Low
Riprap in need of Repair	High	High	Low
Presently Competent and/or Recently Repaired Riprap	Moderate	Moderate	Low

Figure 36. Coastal Hazard Risk Assessment Assignment Map



6.2. Geotechnical Assessment: Rail Concepts

Field reconnaissance indicates that the area of readily visible concern lies within the Mariposa ROW area where deposits appear susceptible to potential liquefaction and lateral spreading. Confirmation of this hazard and risk potential in this area will require future geotechnical study. Similar hazard conditions may exist in other areas of the alignment where deposits of saturated alluvium and/or older undocumented fill occur in areas coincident with the discharge of rivers into the ocean. The shortlisted concept alternative considered most efficient for track-bed stabilization against potential liquefaction and lateral spreading hazards is a process of in-situ ground improvement or ground stabilization, involving the use of Deep Soil Mixing (DSM) and/or a Stone Column placement befitting subsurface conditions. The process allows stabilization of a target soil mass without removing hazard-prone soils. The use of these alternative concepts is considered suitable where it is imperative to maintain track operations during the construction process.

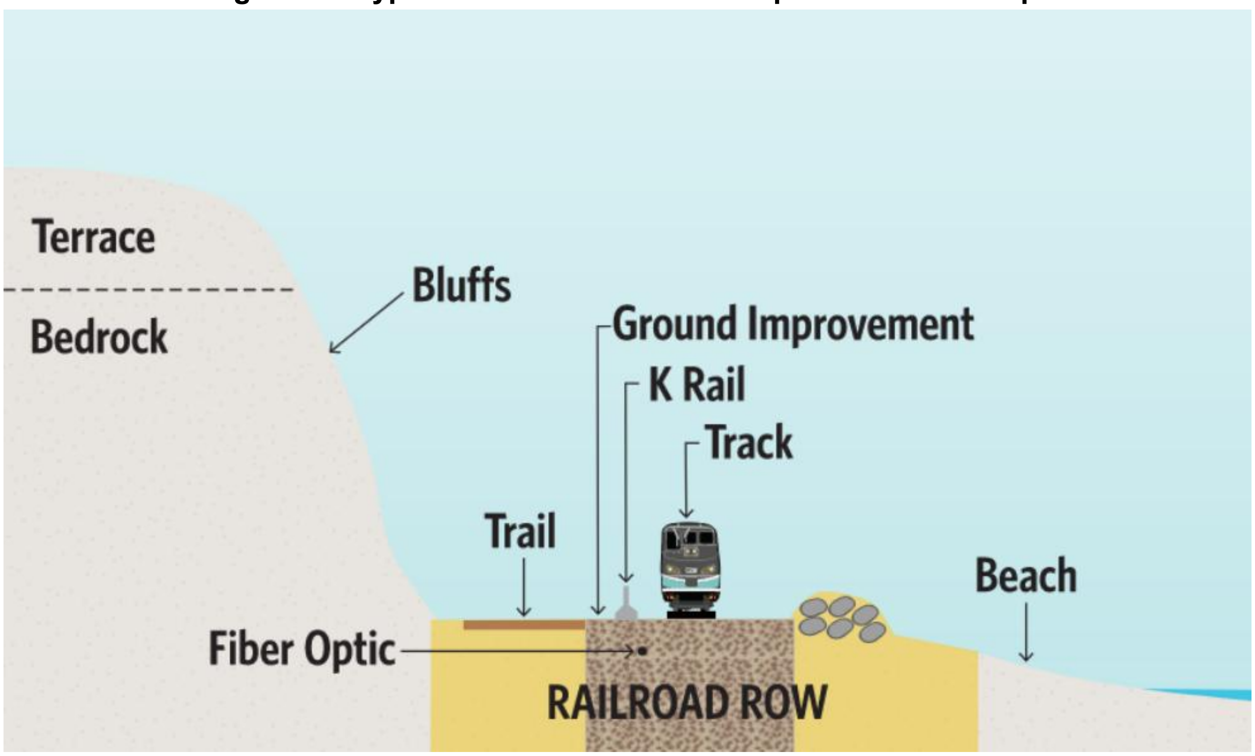
6.2.1. Shortlisted Rail Stabilization Concepts

Descriptions of shortlisted rail concept alternatives for ground improvement are provided below.

Deep Soil Mixing

Description – One of the most reliable ground stabilization methods for mitigating loosely consolidated saturated soil deposits, prone to liquefaction or significant settlement, is the process of DSM. The DSM process involves the in-place treatment of adverse soil with cement, strengthening of loose/saturated soils by mixing cement into the adverse soil mass, transforming the soil mass into the consistency of a cement-treated soil. The resulting properties provide conditions where the hazard is significantly mitigated and suitable for long-term support for existing ROW improvements. The DSM method can mitigate the full depth of an adverse soil deposit within the ROW. The resultant strength and stiffness of the product can be verified by post-construction strength tests. Typical Section A below depicts the conceptual layout of a ground improvement alternative (Figure 37).

Figure 37. Typical Section A - Ground Improvement Concept



Construction – The construction process is typically accomplished through use of large-diameter auger drilling equipment. Augers up to 8 feet in diameter are used to penetrate the full depth of soils, normally terminating in bedrock or competent soils. The cement is introduced through the center of the auger, and upon auger extraction, the soils are blended with the cement, leaving behind the design ratio mix of material.

Testing – Cylinder samples of the soil mix are prepared during construction. After the initial set-up period in the field, the cylinders are delivered to a physical laboratory for strength conformance testing.

Constraints – It requires pre-design sampling for mix design. It is a more costly process than other densification methods. Soil variability can influence column continuity and effectiveness.

Stone Columns

Description – Also referred to as vibro-replacement or vibro-displacement columns, the stone column method is another widely used and effective method of increasing resistance to liquefaction, settlement, lateral spreading, and cyclic strength losses during earthquakes, within loose and otherwise saturated sediments. The method is among the most economical alternative concepts to address liquefaction and lateral spreading hazards within the ROW. The process not only yields densified columns of rock, but also densified soils adjacent to the column. Adverse soils are ultimately entirely densified to form a broad stable deposit that provides long-term support to existing ROW infrastructures.

Design –To facilitate design, a subsurface geotechnical exploration is warranted within the area of potential concern. Drilling, sampling, laboratory testing, and cross section preparation are necessary to provide design parameters and construction bidding.

Construction – Auger holes for stone columns are typically on the order of 3 feet in diameter and embedded into competent soils or bedrock. It involves the introduction of imported crushed-stone rock into a tightly spaced pattern of drilled auger shafts, penetrating the full depth of an adverse soil deposit. The crushed rock is mechanically placed into the auger hole, then compacted down-hole using a vibratory probe/plate in intervals from the bottom up. The general area of Stone Columns is consistent with that presented in Figure 37 above, for ground improvement.

Limitations – The effectiveness of stone columns is limited to a specific range of gradation and percentage of fines. Soils suitable for this application require adequate lateral confinement. The method is generally ineffective in soils that are highly plastic, contain excessive fines, and are soft clays. A specialty contractor is required to facilitate design and construction.

6.3. Geotechnical Assessment: Bluffside Concepts

A preliminary geotechnical assessment of each shortlisted bluffside alternative concept was performed to identify areas of high rail corridor vulnerability due to sea cliff instability. The assessment was targeted for future periods of ten to 30 years. From the assessment, the alternative concepts considered most suitable to address existing and eminent conditions of slope instability were derived. The figures shown in the sections below depict the general layout of bluffside concepts.

6.3.1. Shortlisted Bluffside Concepts

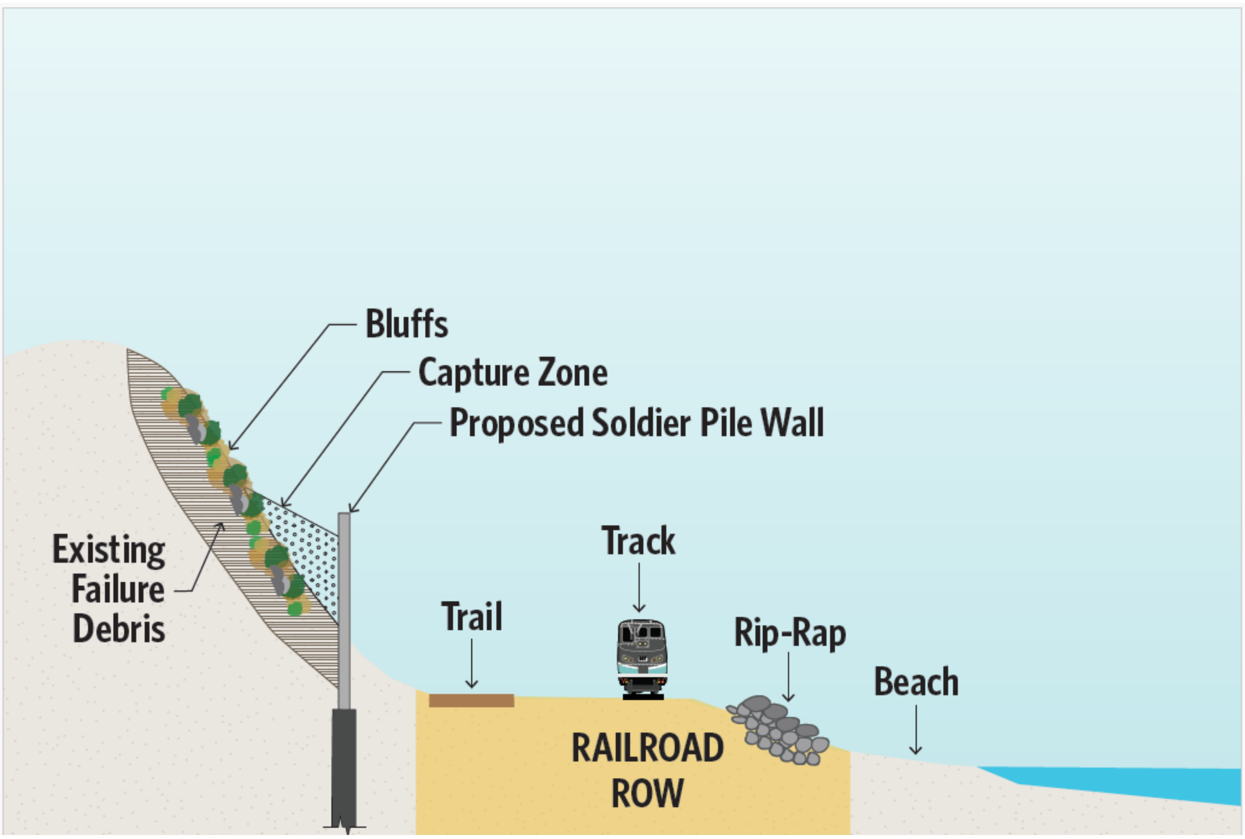
Descriptions of shortlisted bluffside concept alternatives and representative conceptual figures are provided below along with applications and anticipated locations along the rail corridor.

Catchment Wall

Description – Catchment walls are fixed, vertical, impact-resistant barriers that act as structural containment boundaries along the base of a slope. They are intended to catch, arrest, or block advancement of future rockfalls, shallow landslides, earthflows, heavy erosion, and/or mobilized nuisance soil material that would otherwise encroach into the rail corridor ROW. The walls are similar in function to rockfall barrier walls, retaining walls, and structural deflection walls. Use of such walls is convenient where conventional catchment ditches or fences are excluded or infeasible, or where ROW constraints require vertical structural solutions. Catchment walls are represented by a free-board area extending above the top of a soldier pile wall.

The walls consist of relatively short-spaced vertical soldier piles embedded into stable soils or bedrock at depth, with soil retention manifested by stacking of horizontal timber lagging between piles. An open free-board area established behind an upslope section of the wall serves as a zone to capture future slope debris. In similar conditions elsewhere along the ROW, these walls have served as simple but effective structures to stabilize slopes and maintain track operations. The walls can serve their purpose for lengthy periods until more permanent slope repairs can be implemented, and the walls can be abandoned. Typical Section B below depicts the general layout of a Catchment Wall concept (Figure 38).

Figure 38. Typical Section B - Catchment Wall Concept



Design – Where relatively narrow ROW areas exist, larger, more structurally demanding walls may be warranted. The closer a wall is to the source of an unstable bluff, the higher the demand for wall performance can be expected. Freeboard wall heights can be adjusted to accommodate variable volumes of expected debris.

Construction – The freeboard sections of a catchment wall consist of a timber/pile wall extending above the top of a soldier pile wall. The wall establishes an open area where future bluff failure debris can collect instead of advancing in the track ROW.

Maintenance – The downslope mobilization of slope debris into a catchment area will require periodic removal of captured debris in order to accommodate the capture of any future material.

Tieback / Soil-Nail Wall / Pin-Piles

Tieback / Soil-Nail / Pin-Pile systems are grouped as one style of concept alternative, given general similarities in purpose and slight differences in construction methodology. The systems transfer loads into competent material behind the wall to increase factors-of-safety within slopes subject to moderate-size failures. Once installed, it is possible to conceal all elements of construction from view by burial of the walls below the ground surface.

Tieback Walls

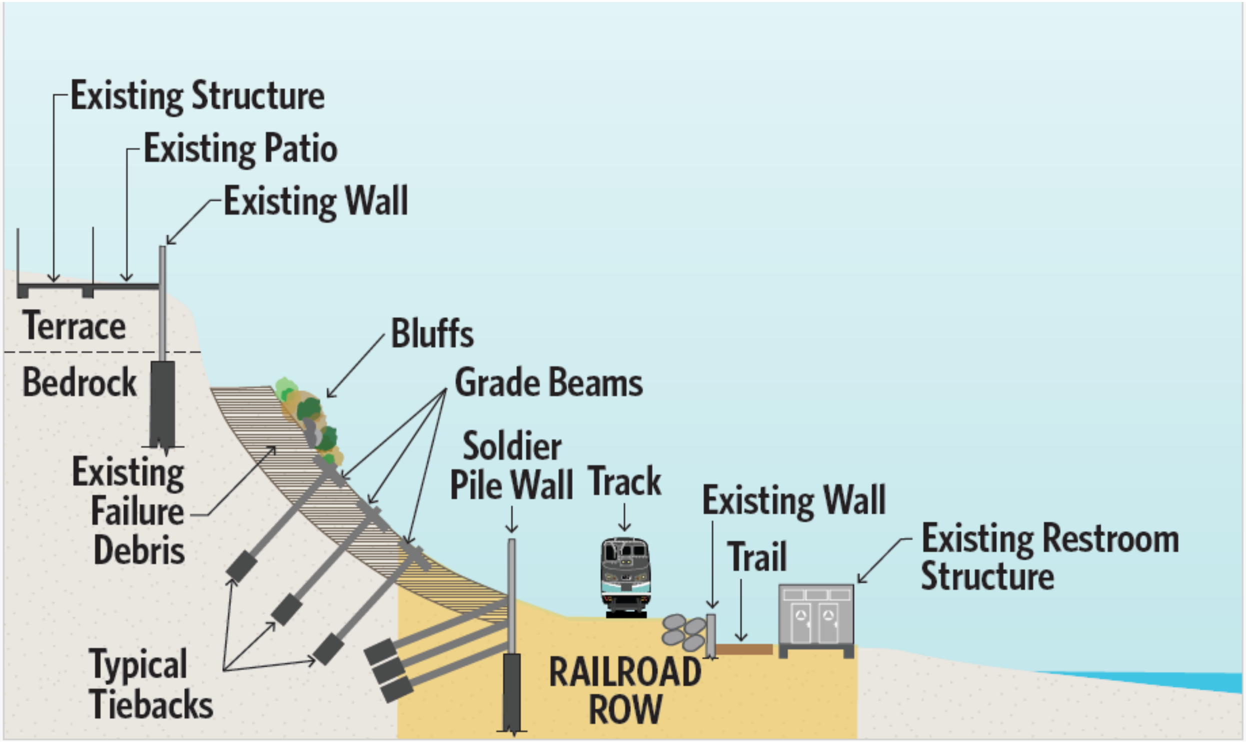
Description – Tieback systems provide a practical means of limiting lateral movements and construction impacts in areas of required deep cuts, constrained sites, or walls subjected to significant surcharge, as well as areas where it is necessary to increase the resisting forces associated with future slope failures. A tieback system is typically comprised of one or multiple vertical rows of prestressed anchors penetrating a vertical soldier pile wall or series of diaphragm/shotcrete-grade beams slightly angled toward/into a slope face. The use of tieback walls reduces structural demands and deflections compared to conventional cantilever retaining walls.

The systems are commonly employed where retained heights exceed 15 vertical feet, where near-vertical excavation or permanent grade separation is required, and/or there is insufficient space available for larger slope cuts or spread footing area availability.

Anchors typically consist of solid steel bars or lengths of flexible braided steel cables. The anchors are inserted into open shallow angle boreholes drilled into a slope, then grouted in place. Upon reaching design strength, the bonded tieback zones are placed in tension, tested, and permanently anchored to a grade beam at specific design loads.

Design – Anchor design is based on achieving adequate bond capacity in competent earth materials and providing an unbonded length that extends beyond the theoretical failure surface for global stability. Preliminary design commonly assumes a minimum unbonded length of approximately 15 to 25 feet. Final values are confirmed by pre-production and proof testing. The wall face and soldier piles are designed for recommended earth pressures (active or at-rest, depending on wall restraint), with lagging or shotcrete between piles, as required. Typical Section C below depicts the conceptual layout of soldier pile wall and grade beam type Tieback Wall alternatives (see Figure 39).

Figure 39. Typical Section C – Tieback Wall Concept



Constraints – Tieback anchors often extend beneath an area of adjoining public/private property with easements, jurisdictions, and/or public ROW. Legal agreements between affected owners/agencies are warranted before installation. Use of tieback anchors can also be limited due to the presence of existing utilities. Early coordination with owners and permitting agencies is recommended to confirm allowable anchor zones, setback requirements, and utility conflicts. Where permissions cannot be obtained, use of the soil-nail concept alternative may be more attractive.

Construction – Tieback anchor systems are installed by specialty subcontractors. Construction is performed in a top-down sequence where wall height increases along with consecutive anchor row installation. Tendons are installed at downward inclinations at lengths penetrating zones of retained soils/failure debris. The anchors include a bonded tieback length to provide pullout resistance, founded in competent soil or bedrock behind zones of expected failure wedge. Anchors include an unbonded length between slope face and bonded zone to accommodate anchor stressing/tensioning. The anchors are ultimately tested and locked off at a specified load to limit wall movement.

Testing – The stages of tieback wall construction include installation of grade-beam facing or soldier piles, excavation to the next level, drilling and grouting anchors, testing and lock off, then repeat to final grade. Anchor testing includes pre-production verification and proof testing with acceptance criteria on load/elongation and lock-off. Where granular or raveling soils are present, special drilling methods or casing may be needed for anchor and pile holes.

Drainage – Permanent walls should incorporate subdrainage behind the facing to reduce hydrostatic pressures, and anchor hardware should include corrosion protection appropriate for service life and exposure. For walls cast directly against shoring, prefabricated drains or equivalent measures are often used to manage groundwater and seepage.

Soil-Nail Wall

Description – Soil-nail walls are often used to stabilize existing ground and support vertical or near-vertical excavations for bluff stabilization where top-down construction is advantageous to maintain traffic and access. These walls are preferred where conventional temporary sloping is impractical due to ROW constraints, adjacent structures, utilities, or where excavation heights exceed what can be maintained safely unsupported. They are particularly effective in dense granular soils, stiff fine-grained soils, weathered rock, and residual soils that can maintain short-term vertical cuts (commonly 4 to 6 feet) during nail installation. The walls act in conjunction with a retained soil mass to form a reinforced soil block with improved shear strength. Soil-nail walls are used most efficiently under conditions where retained materials have adequate stand-up time and can form a competent reinforced mass once nailed. Figure 40 depicts the conceptual layout of a Soil-Nail Wall alternative.

Construction – Wall construction typically proceeds in stages, the general order of which includes excavation of an initial grade-beam facing, anchor drilling and grouting, reinforcement and drainage installation, shotcrete facing, anchor testing, and lock off. The process is then repeated for the next lower nail row. A typical row includes a closely spaced row of nails or passive steel bars penetrating a pre-excavated cut face. Minimum nail lengths commonly fall between 15 and 45 feet, depending on global stability demands and wall height. Bars are installed in near-horizontal, pre-drilled holes at short horizontal and vertical intervals. Unlike tieback walls, the steel bars are not pre-tensioned, and construction does not involve the use of grade beams or soldier piles. After the nails are placed, a drainage system is installed on the slope prior to applying or spraying a layer of reinforced shotcrete, providing structural continuity across the excavation face. The sprayed concrete that forms the visible wall surface can be added with color and texture for a natural look, and planter pockets to accommodate vegetation growth.

Design – Soil-nail wall design accounts for internal stability (nail tensile capacity, pullout resistance, bond stresses), external stability (global stability, sliding, overturning), and seismic performance using drained shear strength parameters.

Constraints – Soil-nails involve the use of generally shorter length steel bars than a tieback wall system, which may or may not extend into neighboring private or public property, warranting legal encroachment agreements between affected owners/agencies before installation. Soil-nail wall construction is often more difficult in loose clean sands, very soft clays, or where cobbles/boulders impede drilling. Construction requires sufficient temporary stand-up time for each lift, and it is not ideal where excessive groundwater inflow or seepage is present, unless specialized drilling/grouting methods are employed.

Testing – The nails require pre-production verification and proof testing with acceptance criteria on load/elongation and lock-off.

Drainage – Walls should incorporate subdrainage behind the facing to reduce hydrostatic pressures, and anchor hardware should include corrosion protection appropriate for service life and exposure.

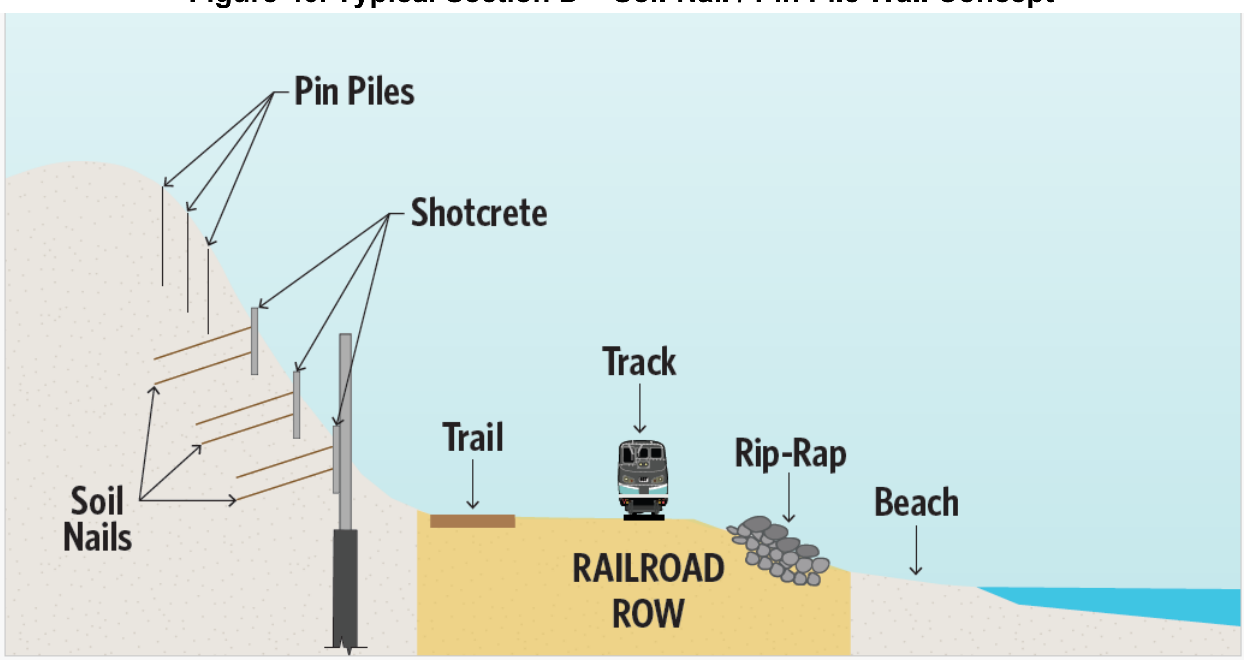
Pin-Piles

Description – Pin-piles are small-diameter, near-vertical shear-pins installed behind the face of a slope to provide shear resistance and stabilize slopes. The piles act as shear dowels, transferring forces into competent underlying soils and limiting lateral movement of the retained ground. Pin-piles are used commonly in areas where earthwork is constrained or local instabilities require deep reinforcement and where soft or compressible near-surface soils require reinforcement without full excavation, and shear transfers into competent underlying soils are required.

Although not considered a wall system in the same sense as a tieback or soil-nail wall, pin-piles function as a drilled element that resists lateral movement and shearing by developing skin friction and end bearing in denser or stiffer materials at depth.

Typical Section D below depicts the conceptual layout of Soil-Nail / Pin Pile Wall alternatives (see Figure 40).

Figure 40. Typical Section D – Soil-Nail / Pin Pile Wall Concept



Construction – Pins typically consist of high-strength steel pipes or threaded bars driven into a slope face at close horizontal and vertical spacing until a required load resistance is achieved. Installation is performed using small, highly portable equipment, such as pneumatic hammers or hydraulic rams, which offer a major advantage for sites with limited access. Field documentation is typically performed by a geologist, who maintains a log of stratigraphy and verifies compliance with design criteria.

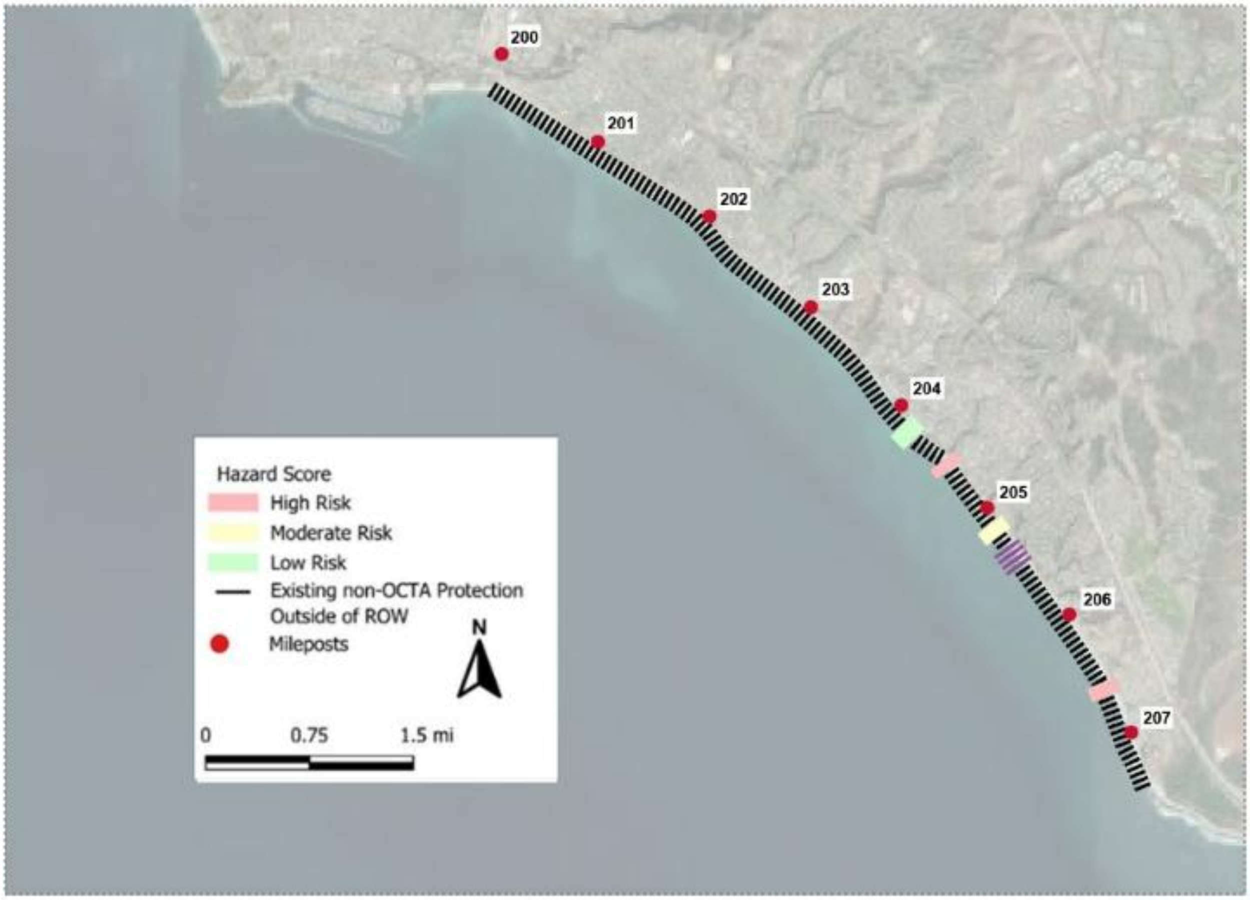
6.3.2. Summary and Locations

Table 25 summarizes the bluffside areas where catchment or tieback / soil-nail wall / pin-pile installation are considered favorable alternative concepts for bluffside stabilization. Included are approximate MP segments, reference name designations, and associated geotechnical cross sections constructed to depict general surface/subsurface conditions and conceptual configurations.

Table 25. Summary of Bluffside Concept Locations

MP Segment	Location Reference	Concept Type	Typical Section	Figure No.
204.15 to 204.24	Mariposa	Ground Improvement	A	Figure 37
204.52 to 204.56	Corto Lane	Catchment Wall	B	Figure 38
205.18 to 205.25	Mayor	Soil-Nail Wall / Pin Pile Wall	D	Figure 40
205.30 to 205.50	Christobal	Tieback Wall	C	Figure 39
206.60 to 206.65	Vista Blanca	Catchment Wall	B	Figure 38

Figure 41. Bluff Hazard Risk Assessment Assignment Map



7. Next Steps

The next steps of this process include conducting a more in-depth technical analysis of the shortlisted alternative concepts, such as engineering feasibility and environmental assessments. As the study progresses, these alternative concepts may be applied to typical track sections either individually or in combination to more effectively address the resilience challenges for each of the corridor's varied section typologies.

7.1. Funding

To support the next phases of the CRRS, funding will need to be identified across federal, State, and local levels. Relevant programs span areas such as rail safety, transportation infrastructure, climate and coastal resilience, sea-level rise adaptation, and nature-based solutions. Each funding source is evaluated based on its alignment with CRRS objectives, precedent from similar projects, geographic or agency fit (e.g., LOSSAN, OCTA), consistency with project goals, and overall funding availability. Sources rated as High Relevance have directly supported comparable efforts or are specifically designed for climate-resilient transportation. Low Relevance sources may focus on criteria such as zero-emission transit, local mobility, or equity, which are less central to this project's scope.

It is important to note that there is potential funding uncertainty due to changes in federal policy, particularly those that reduce emphasis on climate adaptation, equity, or environmental restoration. This risk applies primarily to federal programs. However, some California and local sources, while supported by State legislation and voter-approved funding, could also be affected by changes to federal matching requirements or reduced federal support for interagency coordination.

7.1.1. Federal Funding Sources

Funding Source	Description	Relevance	Justification
CRISI – Consolidated Rail Infrastructure and Safety Improvements Program (FRA)	Rail safety, infrastructure, and climate resilience	High	OCTA previously received 100 million for CRRS; directly supports rail corridor upgrades.
PROTECT – Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation Program (FHWA)	Surface transportation resilience, including coastal infrastructure	High	Targets climate-threatened infrastructure like LOSSAN; eligible for planning and construction.
RAISE – Rebuilding American Infrastructure with Sustainability and Equity and Reconnecting Communities Program (USDOT)	Multimodal access, equity, and infrastructure upgrades	High	LOSSAN corridor projects have received prior awards; supports community access and resilience.

Corridor Identification and Development Program (FRA)	Planning and development for intercity rail corridors	High	LOSSAN is a designated corridor; supports long-term planning and relocation feasibility.
National Railroad Partnership Program / Federal-State Partnership for Intercity Passenger Rail (FRA)	Capital projects that rehabilitate, repair or improve performance of intercity passenger rail service. Support planning, environmental review, and final design of projects	High	Most recent NOFO provided added emphasis on railroad safety, which is a key argument of stabilization efforts.
STGB - Surface Transportation Block Grant Program (USDOT)	Regional planning and preliminary engineering	High	Already contributed more than two million to CRRS; supports early-phase infrastructure planning.
RRIF – Railroad Rehabilitation and Improvement Financing (USDOT)	Credit assistance program supporting rehabilitation of rail equipment or facilities. Reimburses planning and design expenses.	High	Focused on development and rehabilitation of railroad infrastructure.
TIFIA - Transportation Infrastructure Finance and Innovation Act (USDOT)	Credit assistance program supporting large-scale passenger rail vehicle and facilities projects	High	Provides market-competitive alternatives to support large-scale projects.
National Coastal Resilience Fund (NFWF in partnership with NOAA)	Nature-based coastal resilience and habitat restoration	Medium	Relevant if CRRS includes dune restoration or bluff stabilization; competitive and habitat focused.
NOAA Regional Coastal Resilience Grants Program	Planning and implementation of coastal hazard mitigation	Low	Supports hazard mitigation and planning; less rail-specific and highly competitive.

7.1.2. State Funding Sources

Funding Source	Description	Relevance	Justification
TIRCP – Transit and Intercity Rail Capital Program (CalSTA)	Capital funding for rail modernization and resilience	High	LOSSAN corridor has received major awards; supports double tracking and climate adaptation.
LTCAP – Local Transportation Climate Adaptation Program (Caltrans)	Local agency support for climate-threatened infrastructure	High	OCTA has requested 25 million; designed for infrastructure like CRRS.
SB 1 Sea-Level Rise Adaptation Planning Grant – Track 1	Planning for sea-level rise impacts on infrastructure	High	Directly supports planning for vulnerable coastal infrastructure like rail corridors.

(Ocean Protection Council)			
California State Coastal Conservancy	Coastal access, bluff stabilization, and climate adaptation	High	Strong track record funding similar projects in Southern California coastal zones.
Caltrans Transit Grants Program	Transit operations, planning, and infrastructure	Low	Offers broad transit support; applicable but less targeted to coastal rail resilience.
Low Carbon Transit Operations Program (LCTOP)	Supports zero-emission transit and disadvantaged communities	Low	Relevant if CRRS includes zero-emission components or equity-focused access.
AB 109 Climate Adaptation and Resiliency Program (California Budget Act of 2017)	Budget Act funding for climate resilience	Low	Budget-based and less predictable; applicable for planning and adaptation.

7.1.3. Local and Regional Funding Sources

Funding Source	Description	Relevance	Justification
Orange County Fifth District Infrastructure Funding (Supervisor Katrina Foley)	Local discretionary funds for coastal and transportation projects	High	OC 5th District has previously allocated funds for CRRS; strong advocacy and alignment.
Measure M2 (Orange County)	Sales tax revenue for transportation improvements	High	OCTA-administered fund; eligible for planning, environmental review, and construction.
LOSSAN Corridor Capital Investment Program	Coordinated regional funding for corridor-wide upgrades	High	CRRS is a top priority for LOSSAN; facilitates joint funding and advocacy.
BNSF Public Infrastructure and Investments	Discretionary grant program that supports resilient and sustainable rail	High	As a key partner in the region, BNSF would also benefit from rail stabilization efforts
San Clemente Capital Improvement Program (CIP)	Local infrastructure and coastal protection	Medium	City has partnered on stabilization projects; limited scale but supportive.

7.2. Project Development

The CRRS develops a roadmap for potential future projects along the coastal rail corridor to protect the railroad in place for at least the next 30 years. The shortlisted alternative concepts from this study will be further developed and analyzed in future stages of the project. These next steps include location-specific feasibility analyses, preliminary engineering, environmental impact studies, and final design.

7.3. Long-Term Studies

This Feasibility Study focuses on identifying concepts that would support ongoing rail operations over the short- and medium-term. Beyond the 30-year timeline used to conduct this assessment, additional studies will be needed to identify long-term solutions to sustain rail resiliency and the system's ability to weather increasingly severe climate events. These long-term efforts will be led at the State level.

8. Conclusion

A total of 23 alternative concepts were evaluated through a detailed screening process, resulting in 8 shortlisted alternative concepts identified for further study and future implementation to enhance rail resilience along the approximate 7-mile segment of the LOSSAN corridor in south Orange County. These alternative concepts were organized into three categories: rail, bluffside, and beachside. Each concept category corresponds to specific resilience challenges the concepts aim to address. Shortlisted alternative concept selection was guided by a weighted scoring methodology that considered rail resilience, cost-effectiveness, constructability, public assets, environmental impact, and alignment with planned projects. Ongoing stakeholder and community engagement played a key role in shaping the evaluation, helping to develop and ultimately select alternative concepts that best balance the project's goal of improving rail resiliency with public concerns.

Appendix A. CRRS Initial Assessment – Technical Memo

Orange County Transportation Authority

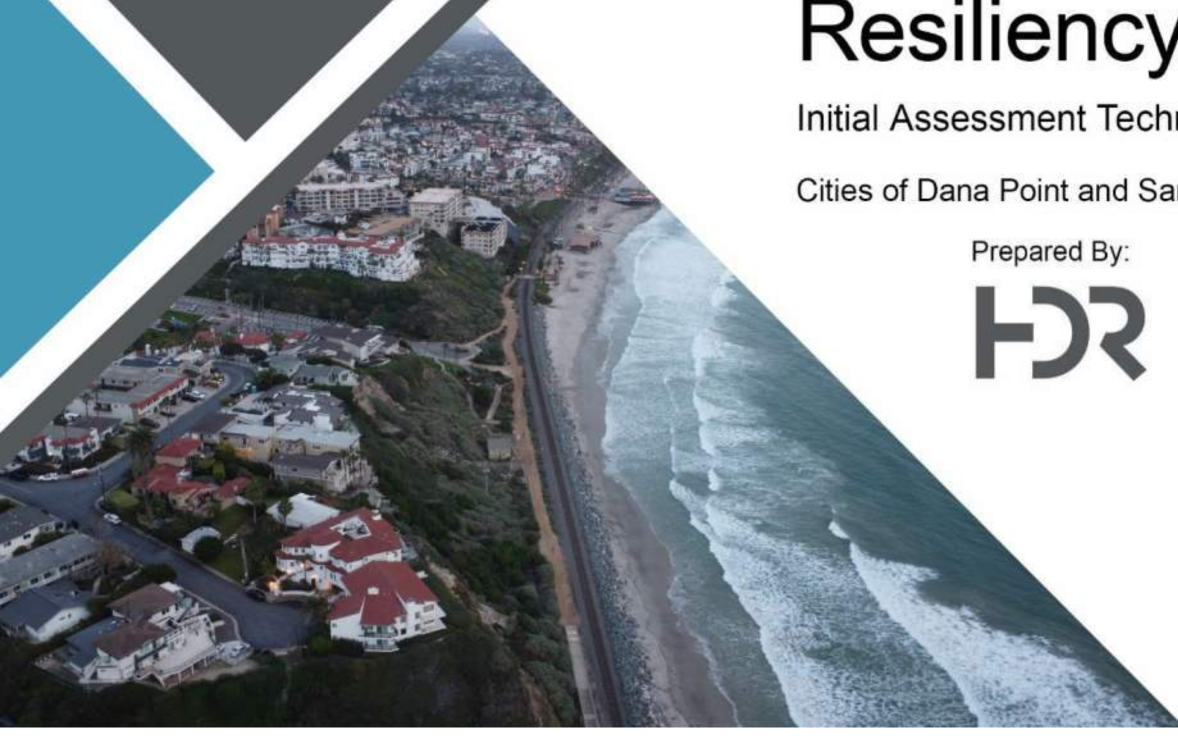
Coastal Rail Resiliency Study

Initial Assessment Technical Memorandum

Cities of Dana Point and San Clemente, CA

Prepared By: HDR

Prepared for: OCTA



January 2024

Last Updated: February 13, 2024

Table of Contents

List of Figures

Executive Summary

The Orange County Transportation Authority (OCTA) embarked on the Coastal Rail Resiliency Study (CRRS) in fall of 2023 with the goal of developing alternative concepts for maintaining railroad operations within the existing railroad corridor for the next 30 years. Concurrently, multiple inland bluff failures and coastal erosion events created state of emergencies in which operators such as Metrolink, Amtrak and BNSF had to cease operations. Acknowledging that these shutdowns in operations are causing financial burdens on taxpayers, OCTA is expediting an Initial Assessment of this coastal railroad corridor from Mile Post 200.00 to MP 207.40, which will be an appendix to the overall CRRS document.

The Goals and Objectives of the Initial Assessment are to conduct an existing conditions assessment of the railroad corridor by identifying areas that are susceptible to risk from bluff failures and coastal erosion within the next two years, resulting in a shutdown of railroad operations. The Initial Assessment was completed between October 2023 and January 2024 and is limited to improvements identified by the project team through site reconnaissance within the railroad right-of-way. This will build upon previous studies that OCTA, the County, and the Cities of San Clemente and Dana Point have conducted over the last several years. Finally, it will identify potential solutions and strategies along with next steps that OCTA and other stakeholders could take to keep the tracks operational. The potential solutions and strategies are documented under the Recommendations and are categorized in three areas by degree of concern: Potential Reinforcement Areas, Potential Monitoring Areas, and Potential Emergent Areas. All three of these categories will require further engineering and environmental studies to determine preferred remediation solution with a defined scope, schedule and budget that would be integrated into an Implementation Plan. The areas identified are based on site reconnaissance, however changing site conditions can lead to other imminent threats that are not highlighted in the Initial Assessment. It is also important to note that the Potential Reinforcement Areas and Potential Monitoring Areas do not indicate the implementing lead agency/entity.

Providing potential solutions is only a portion of the overall plan needed to address the needs along this coastal railroad corridor. The next steps address Governance challenges by revealing the need for better definition of roles and responsibilities of key stakeholders. The lead agency must develop an Implementation Plan that will be informed by a clear strategy on how to navigate the Regulatory Permitting process. Future emergencies are unavoidable but the response can be enhanced by the development of procedures which incorporate lessons learned from past emergencies. Given the nature of the bluff failures and coastal erosion, emergency response time can be expedited by stockpiling of Materials typically used in an emergency situation. Lastly, timely engagement of stakeholders must be considered so that each of their constituents are informed.

Introduction/Background

The coastal Rail Corridor in southern Orange County is owned by OCTA and operated by the Southern California Regional Rail Authority (SCRRA or Metrolink) and Amtrak Pacific Surfliner for passenger service and by the Burlington Northern-Santa Fe Railroad (BNSF) for freight service. This segment of railroad is part of the greater 351-mile Los-Angeles-San Diego-San Luis Obispo Rail Corridor (LOSSAN Corridor). The Department of Defense (DOD) has designated this key railroad line as a part of the Strategic Rail Corridor Network (STRACNET). Over the past three years, coastal Rail Corridor operations have been adversely affected by the processes of coastal bluff erosion, beach loss, revetment loss, and bluff failures. Recent bluff failures at MP 204.20 Mariposa Pedestrian Bridge, MP 204.60 Casa Romantica, and reactivation of an ancient landslide at MP 206.80 Cyprus Shore (Figure 1) have resulted in significant interruptions to railroad operations. The coastal Rail Corridor is subject to future similar threats, which can further impact railroad operations. OCTA, along with its rail operators, are seeking solutions to further reinforce this critical Rail Corridor.

Figure 1 MP 206.80 Track Stabilization Project (Cyprus Shore) May 2023

To reinforce the coastal Rail Corridor, OCTA is leading a CRRS to develop short to medium-term solutions for the seven-mile segment of coastal Rail Corridor between Mile Post (MP) 200.00 to MP 207.40 (see below). The CRRS will develop alternative concepts to protect the railroad in its current corridor for the next 30 years. The alternative concepts will be implementable in the short term (up to 10 years) and the medium term (11 to 30 years). The CRRS will coordinate with key stakeholders and interest groups in the region to take into consideration their needs and also participate in regional solutions. A separate long-term study will examine future coastal railroad corridor solutions beyond the 30-year horizon. Planning for the long-term study is under discussion and the lead agency has not yet been determined for that effort.

As an initial assessment to address immediate needs (next 2 years), the project team has conducted field reconnaissance to identify and assess areas along the OCTA coastal railroad corridor (MP 200.00–207.40). The assessment resulted in identification of areas warranting immediate monitoring and/or requiring corrective action and mitigation. The objective of this assessment is to identify and prioritize areas of immediate action to avoid and minimize potential emergencies that impact railroad operations. This segment of the railroad in South Orange County has experienced extended service disruptions over the last several years that have severely impacted the reliability of passenger rail service and thus, the riders who depend on the service. The measures identified within this Initial Assessment are intended to be actionable by OCTA and its railroad operator and maintainer, Metrolink.

The potential reinforcement areas identified will require additional design advancement, environmental approach, and permitting strategy to implement. The areas cover direct actions that can be implemented by OCTA or Metrolink to protect its infrastructure and avoid impacts to operations. Additionally, there are other solutions and efforts being led by other stakeholders to address regional erosion issues such as sand replenishment and OCTA will coordinate with the respective parties. While this Initial Assessment is limited to immediate actions to be performed by the railroad, the short- and medium-term solutions being explored will not be limited to that narrowed scope and will consider other regional solutions such as sand replenishment, seawalls, and groins and breakwaters as well.

Goals and Objectives

The goals and objectives of the Initial Assessment summarized in this memorandum is to (1) review the existing conditions of the coastal rail corridor, (2) research historical events and actions that have taken place to protect the railroad and coastline, (3) conduct field reconnaissance to note emergent areas, and (4) make recommendations for monitoring areas and potential reinforcement along the coastal Rail Corridor. This technical memorandum provides a roadmap of projects and implementation strategies that are immediately actionable by the railroad.

Methodology

The project team conducted a review of coastal processes, readily available literature, and a geologic/geotechnical reconnaissance of the site to develop recommendations for monitoring and identification of potential reinforcement areas.

The monitoring areas are identified as locations with observed signs of potential near-term concern. The areas should be monitored for additional movements and any signs of emerging distress using topographic surveys, site observations, and monitoring equipment. The tracked data should be utilized to develop a baseline condition and to compare against possible thresholds for future action.

Furthermore, the project team has identified potential reinforcement areas that are recommended to reinforce critical rail infrastructure and avoid an emergency that impacts rail operations. These potential reinforcement areas may need to be studied further through alternatives analysis to select a recommended path forward and develop environmental and permitting strategies to be ready for construction.

The areas were identified based on the project team's research and field reconnaissance; however, the risk of additional wave erosion impacts, bluff instability impacts and local erosion in other areas still exists with changing climate conditions and landscape. The potential reinforcement solutions presented in this memorandum, along with additional site-specific alternatives, can be implemented elsewhere throughout the corridor.

Previous Efforts by OCTA

This Initial Assessment builds on previous OCTA efforts in its pledge to study climate change impacts and implement sustainability measures. In January 2021, OCTA released its "OCTA Rail Defense Against Climate Change Plan," which focused on the approximately 25-mile section of railway from Jeffery Road in Irvine to the Orange/San Diego County border and evaluated Metrolink Stations in Orange County south of Irvine, CA. The purpose of the plan was to characterize and understand future climate-related risk to the rail system and passengers to identify strategies to help mitigate those risks and to preserve the continuity of the rail service into the future.

Areas of previous bluff and coastal erosion were also reviewed, as has occurred most recently at MP 204.20 Mariposa Pedestrian Bridge bluff failure, MP 204.60 at Casa Romantica, and the reactivated ancient landslide at MP 206.80 at Cyprus Shore. Metrolink maintenance crews continue to observe, inspect, and place riprap slope protection for shoreline erosion areas as they develop. This Initial Assessment considers previously impacted areas and suggests other complementary solutions and strategies to maintain railroad operations.

Overview of Baseline Conditions

The project team collected data to document the existing conditions through field reconnaissance with Metrolink maintenance staff, geotechnical desktop studies pertinent to the coastal corridor, and mining through Metrolink's storage office, which contained records for maintenance through the coastal corridor. The project team compiled the existing conditions informed by the data collection and organized per expertise:

- Coastal and geotechnical identifying possible causes for erosion and degradation; and
- Impacts on Metrolink assets: track, drainage, signals.

Data Collection

Site Visits

Two site visits were conducted to observe existing conditions and identify vulnerabilities to coastal erosion, potential bluff failures, and impacts to the coastal rail corridor. The first covered

MP 203.70 to Calafia State Beach at MP 206.00 on November 28, 2023; the second covered the remaining reach from MP 206.00 to MP 207.40 on January 12, 2024. Key observations related to coastal erosion, bluff stability and local erosion, and related flooding/overtopping vulnerability are summarized as follows:

- Metrolink personnel indicated there were no coastal erosion issues north of Metrolink Station (MP 203.70) except at Capistrano Beach Park where there is a rail crossing. The County of Orange has been managing shoreline protection along this reach. The Rail Corridor is not threatened at this location.
- Metrolink personnel identified an area of recent shoreline erosion and subsequent riprap installation near MP 203.85.
    - The riprap slope, historically stacked from railcars along this reach, has face profiles exceeding ratios of 1:1 (horiz:vert) (see Figure 8 and Figure 12, below).
- Metrolink personnel cited another erosional hotspot location at Mariposa Point near MP 204.20 and spanning the length of an elevated pile-supported pedestrian walk/bridge paralleling the shoreline. After the site visit, this area experienced a bluff failure with runout onto the track at MP 204.20 on January 24, 2024, which halted rail operations. This area is known to have lost significant beach deposits and riprap shore protection in recent years (see Figure 9, below). Recent riprap was placed between Mariposa Point and the marine safety building. Additionally, failures and groundwater seepage are a chronic occurrence within the adjacent bluff.
- No additional areas vulnerable to coastal erosion and flooding were identified from the San Clemente Pier southward to San Clemente State Beach (MP 206.50).
- From just south of the Califia State Beach parking lot, near MP 206.00 to approximately MP 206.60, the rail corridor has little or no riprap shore protection. The shoreline fronting the rail corridor indicates advancing erosion, with vertical scarps in the native beach material exceeding 10 feet near the rail line (see Figure 10).
- Metrolink personnel indicated continued chronic maintenance issues following storm events within the limits of the San Clemente State Beach Campground, MP 206.00 to MP 206.50, with sediments generated by bluff erosion and the mouths of canyons.
- In the vicinity of MP 207.00, Metrolink personnel indicated emergency riprap repairs have been required.
- Riprap was observed to also include much smaller stone and the upper portions of the slope are very steep (steeper than 1:1) (see Figure 11).

Desktop Studies

The project team performed a search of available literature including published geologic maps, state hazard maps, and historical aerial photographs. The documents were reviewed to identify areas of historical bluff instability and establish levels of potential risk to future impacts along the coastal Rail Corridor.

While no new beach profile data were collected for this effort, the City of San Clemente recently initiated a fall and spring beach profile survey program to cover years 2022 through 2025. The program measures changes in shoreline topography and bathymetry at 12 sites from Doheny Beach to San Mateo Point. shows the locations of the beach profile sites in relation to the OCTA Coastal Railroad ROW (MP 200.20–MP 207.40). The purpose of the shoreline monitoring program is to facilitate and plan shoreline projects and to document the impact of natural events such as El Niño and sea level rise (SLR). The program augments historic data sets acquired by the U.S. Army Corps of Engineers (USACE) in the 1980s and a prior City of San Clemente monitoring program covering 2001–2007.

Figure 3 shows the mean high water (MHW) level beach width, which represents the width of the beach from the backshore edge of sand seaward to the MHW elevation. The MHW beach width is generally considered to represent the *dry beach width*. The shaded gray area illustrates the envelope of historical measured beach widths based on available data from 1983–2009. The dark blue line shows the beach width measured in fall 2022, when beach survey monitoring was reinitiated. Between MP 202.00 to 203.00, the beach monitoring results show the fall 2022 beach width to be at or below historic minimums, and up to 50 feet narrower than the historical range; however, dry beach width remains in this area and the rail is set back from the shore. Between MP 203.00 to 204.00, most of the beach remains at or near historic minimum width, with no dry beach through much of this area. A more dramatic reduction in dry beach width is demonstrated in the vicinity of Cyprus Shore (MP 207.05) where, in fall 2022, there was no dry beach measured. Survey measurements prior to 2009 (range shown in gray) near Cyprus Shore indicate a beach not narrower than 100 feet. These measurements are consistent with the onset of coastal erosion and related flooding and damage within the Rail Corridor that warranted emergency remedial shore protection and stabilization construction at that location.

Figure 4 includes the fall 2023 beach width and illustrates relatively little change compared to the fall 2022 shoreline position.

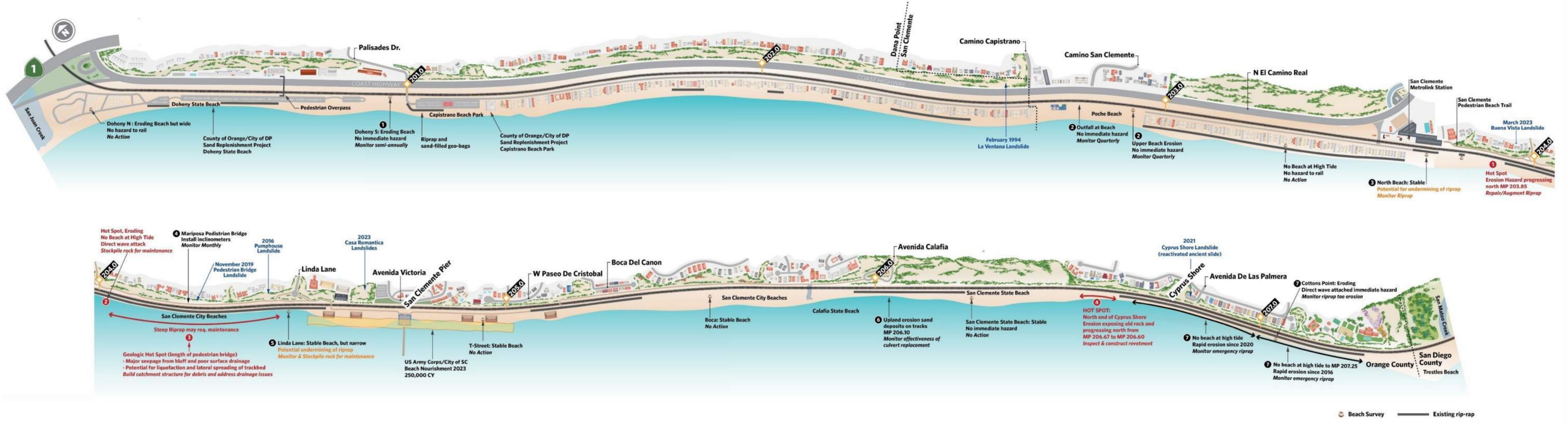


Figure 2 MP 200.00–MP 207.40, Dana Point and San Clemente Monitoring and Potential Reinforcement Area Locations

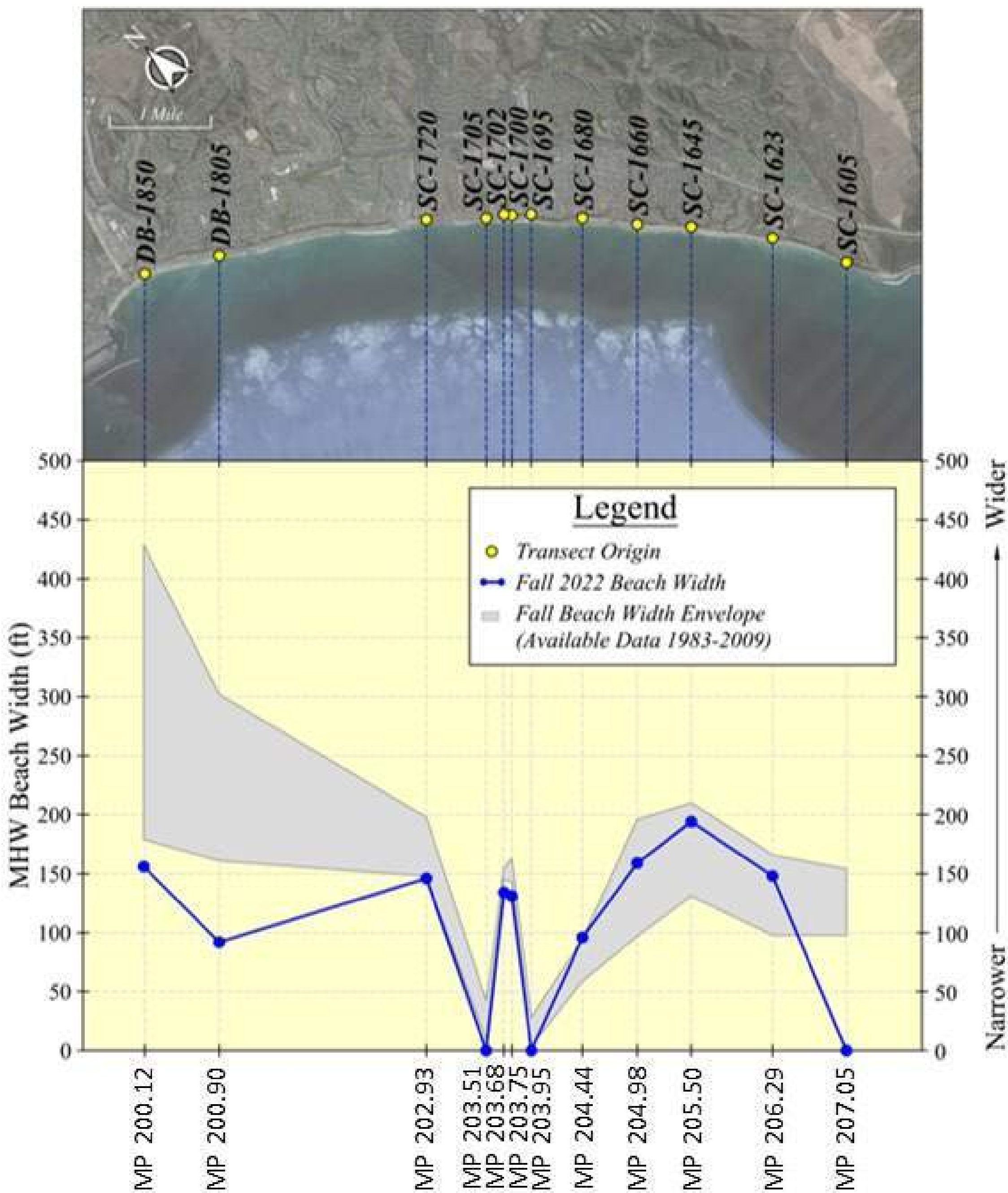


Figure 3 Fall 2022 Beach Widths Relative to Historic Shoreline Position per Survey Comparisons Conducted by Coastal Frontiers

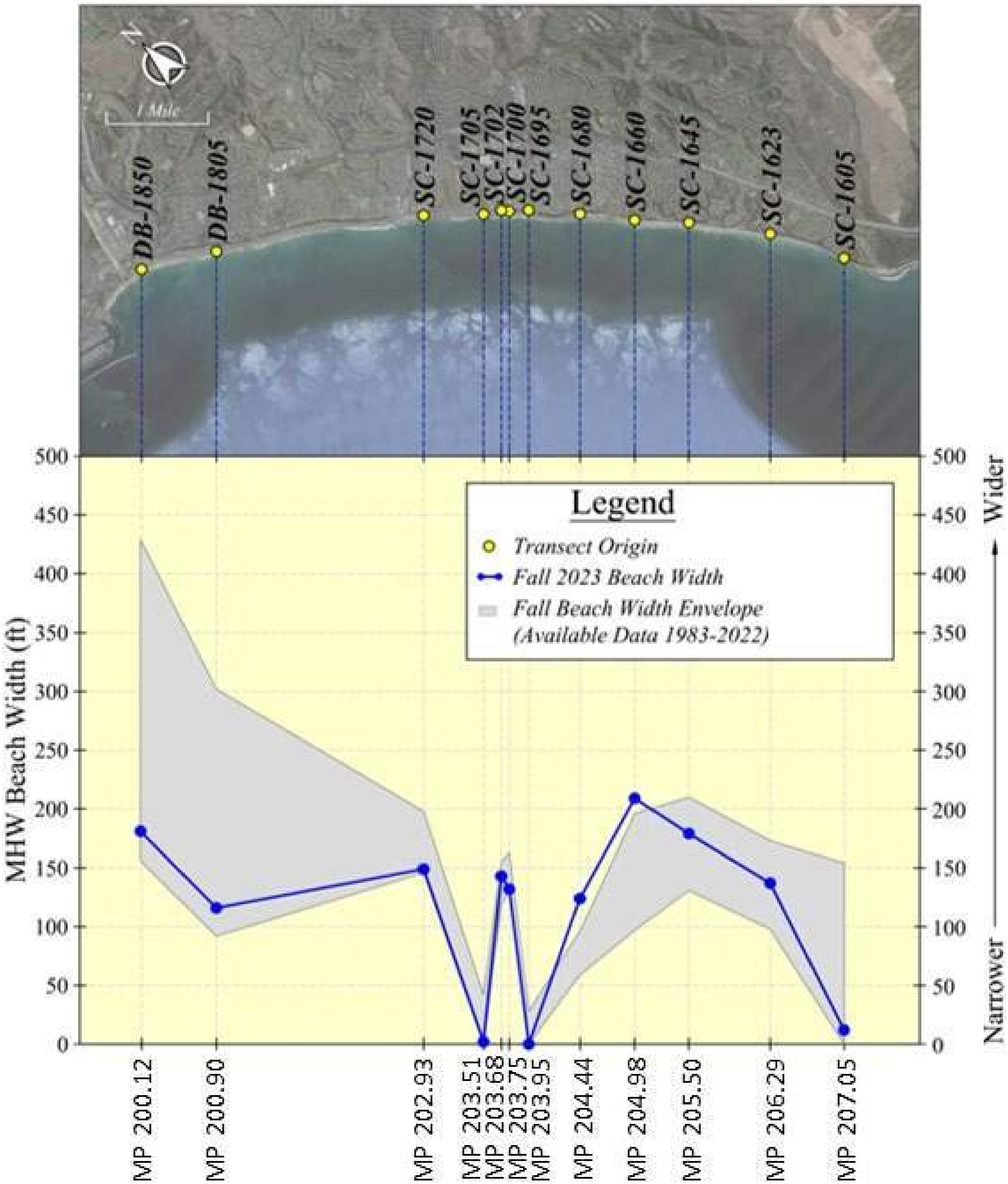


Figure 4 Fall 2023 Beach Widths Relative to Historic Shoreline Position per Survey Comparisons Conducted by Coastal Frontiers

Previous Metrolink Activities

As part of the project team's effort to document past maintenance activity along the ROW between MP 200.00 and 207.40 on the Orange Subdivision, representatives made a visit to SCRRA's Melbourne warehouse on December 12, 2023, to search for relevant track maintenance records, project as-builts, and various historical documents stored within the vault. As part of this research, six documents were found relevant to the project area:

- Preliminary Geotechnical Investigation for proposed site of Metrolink North Beach commuter rail station in San Clemente, dated March 4, 1994. The report details soil conditions within the project area and notes the site being an active floodplain at the time as well as an instance of flooding within the area. Page 3 of 25 states, “Prior for the general development of the area, the site was considered an active floodplain. The winter storms of 1993 caused the Segunda Deshecha Cañada drainage channel to flood.”
- Railroad Cross-Sections at Dana Point, dated January 16, 1998. This survey report generated in response to a request by the Capistrano Bay District regarding ROW encroachment from a non-reinforced concrete block garden wall. The report describes existing conditions of the wall relative to the OCTA ROW, as well as impacts (i.e., interference) to any future ROW maintenance and future construction.
- Plan set for Metrolink North Beach commuter rail station in San Clemente (at 1850 Avenida Estacion), dated May 27, 1994. Of note are the grading plans (sheet PC-0004) and cross-sections (PC-0007) showing changes within ROW and immediate vicinity.
- City of Dana Point Landslide Remediation and Slope Reconstruction Construction Documents, dated May 5, 1994. This plan set details a proposed tieback system to stabilize the slope along the Coast Highway. The project is not railroad-related, as the slope in question is located on the other side of the Coast Highway away from the tracks, but the grading plan (sheet C-2) does show proposed impacts within OCTA ROW (i.e., removal of retaining wall).
- Preliminary Plans for Multi-Use Beach Trail within City of San Clemente, dated unknown. Project-related impacts/modifications (pedestrian access, overpasses) within the railroad ROW are marked up throughout the set, with the last sheet in the set (C-14) detailing the proposed trail in relation to the existing tracks.
- FEMA/OES Disaster 1585 for 2/16/05–2/23/05 Winter Storms. A collection of project worksheets, images, and correspondences related to repairs made at various locations throughout the SCRRA network following storm damage within the as-specified time frame (incident period). Each site worksheet details the type(s) of damage done by the storms.

Additionally, SCRRA has noted the potential presence of historical track outages and emergency responses documented within its internal database system. HDR was not provided access and this information has not yet been provided to HDR.

Existing Conditions

Coastal

Shoreline monitoring since 2022 indicates that most shorelines in the study area are retreating (eroding), with historical minimum beach widths at the northern extent of the study area (MP

200.00 to 204.30) and the southern extent (MP 206.60 to 207.20 - Cyprus Shores). Ongoing actions by the City of San Clemente to monitor the beach profile and rate of change will continue. Recent action (December 2023) by the USACE to nourish the beach with 250,000 cubic yards of sand will supplement the lack of supply to the beach system but is unlikely to affect the overall trajectory of beach erosion in the near term. At the time of this initial assessment, the project is on hold due to poor sand quality from initial loads.

Vulnerabilities related to shoreline erosion and related wave overtopping have been identified to present near-term imminent risk (0 to 2 years) to rail operations and/or infrastructure. For vulnerabilities related to reduced shore protection resulting from damage to existing sloping riprap, the only viable short-term strategy is to repair the damaged structure. Repair options include addition of riprap in areas where it has been dislodged and displaced downslope and seaward. Minor improvements that would not represent new development may include use of larger armor stone, with repair operations supported by placement operations from the seaward side of the riprap slope when sufficient dry beach is available to support construction operations during low tide conditions. Rock placement from beach side of the slope generally results in higher-quality construction via improved nesting of adjacent stone and tighter placement density, resulting in greater stability and durability.

Recent coastal erosion has also been observed along the reach between MP 206.00 and MP 206.60 where little to no riprap exists. This may present an opportunity to construct sections of engineered revetment, which provide significantly greater shore protection performance in the longer term. Compared to the rocks placed in riprap slope protection, the rocks placed in a properly engineered revetment will remain in place, thereby providing more protection from wave-induced beach erosion and associated wave overtopping. The key advantages of an engineered revetment versus a riprap slope are listed below:

- Founding the toe of revetment in a keyway excavation, preferably established in shallow bedrock to minimize erosional undermining.
- Placement of geotextile filter fabric within the temporary back-cut behind the revetment to reduce loss of finer embankment material by piping.
- Employment of specialized revetment stone design to promote added hydraulic stability, including revetment-perpendicular long-axis placement and careful nesting and armor stone size placement.

Construction constraints include beach accessibility, sufficient beach width, availability of equipment, and time-sensitive construction hours during periods of low tides. Based on site observations, discussions with Metrolink personnel, and analysis of beach profile survey data, potential reinforcement areas for the coastal rail corridor shoreline protection include:

- Ongoing revetment damage and deterioration at MP 203.80.
- Ongoing revetment damage and deterioration along Mariposa Point between MP 204.00 and MP 204.50.
- Unprotected Rail Corridor from MP 206.00 to MP 206.60.

- Ongoing revetment damage and deterioration in localized areas between MP 206.60 and MP 207.40.

Geotechnical

A majority of the coastal bluff along the coastal rail corridor has experienced failures in some manner as part of natural and/or anthropogenic processes of landward retreat. Such typically involve a failure of bluff-top terrace deposits, weathered bedrock within the bluff face, and surface vegetation. Causes can often be attributed to construction of unpermitted bluff-top retaining structures by private property owners acting as dams to subsurface waters and increased hydrostatic pressures. Where bluffs are set back a greater distance from the coastal rail corridor, these failures commonly result in runout of deposits that do not reach the corridor. In locations where the bluff lies in closer proximity to the corridor, these failures can encroach into/over the tracks requiring removal of debris and sometimes installation of pile-lagging walls parallel to the tracks. While these failures are often spectacular from a general public and media perspective, they tend to pose only a low threat to the integrity of the corridor, requiring short-lived maintenance efforts to restore track service.

Rare along the bluff is the occurrence of larger deep-seated landslides involving bedrock with basal ruptures projecting beneath the tracks. Such tend to involve reactivation of older pre-existing ancient landslides in response to a loss of beach support, conditions of natural or anthropogenic groundwater, anthropogenic modification of driving forces in areas landward of the corridor, or combinations thereof.

Track

The existing track alignment consists of a single track line within the project limits. The operational speeds vary from 40 miles per hour (mph) to 90 mph for passenger trains and 40 mph to 50 mph for freight trains. There are two passenger stations within the project limits at San Clemente North Beach and San Clemente Pier.

The track corridor has various cross sections throughout the project limits. The typical cross sections are summarized below:

- MP 200.00–MP 201.20: Pacific Coast Highway to the east of the track alignment and Beach Road and Doheny State Beach and Capistrano State Park to the west of the track.
- MP 201.20–MP 202.65: Pacific Coast Highway to the east of the track alignment and residential homes to the west of the track.
- MP 202.65–MP 202.95: Pacific Coast Highway to the east of the track alignment and Poche Beach to the west of the track.
- MP 202.95–MP 203.60: Pacific Coast Highway to the east of the track alignment and residential homes to the west of the track.
- MP 203.60–MP 207.70: Bluffs to the east of the track and various widths of beach to the west of the track.

Drainage

Surface drainage issues persist within various segments of the coastal rail corridor. The primary issues tend to occur in close proximity to the toe of bluffs. Local graded track-side drainage ditches have been installed as part of maintenance efforts to control surface waters locally, but many have been eroded and/or become infilled with sediment over time, causing ponding. Locations of poor drainage are highlighted below.

Signals

Signal equipment in the area requires more maintenance than other areas outside of the coastal corridor due to the corrosive forces from the marine atmosphere. Additional coatings and selected materials are used for the signal equipment throughout the project limits; however, the frequent maintenance needs remain necessary.

Summary of Emergent Areas

The project team reviewed recent and historical aerial photography, beach profile surveys, and publicly available studies to characterize long-term and recent trends. As evidenced by extensive armoring along nearly the entire study area, shoreline erosion has been a historical concern and has recently reemerged as a major concern in several locations. An extensive historical investigation was not performed for this study as the project team's efforts focused on immediate (up to 2 years) issues throughout the study area. Aerial maps of the coastal rail corridor are provided in the appendix of this report for reference to areas summarized below. Below is a color-coded summary of potential evolving site conditions to the rail corridor associated with bluff stability and coastal erosion. Areas highlighted in green are considered representative of a low potential impact. Those of moderate impact are highlighted in yellow. Areas considered a higher potential emergent impact to the rail corridor are highlighted in red.

Table 1. Summary of Emergent Areas, MP 200.00–201.00

MP 200.00–201.00	Bluff setback relatively distant from the Rail Corridor; periodic bluff failures involving terrace and weathered bedrock deposits notable historically; potential impact to Rail Corridor considered low. Coastal erosion potential impact is low, due to wide beaches and park infrastructure between the Rail Corridor and shoreline.

Table 2. Summary of Emergent Areas, MP 201.00–202.00

MP 201.00–201.70	Bluff set-back relatively distant from the Rail Corridor; steep/high bluff profile; periodic bluff failures involving terrace and weathered bedrock deposits notable historically; potential impact to Rail Corridor considered low. Coastal erosion potential impact is low, due to park infrastructure and private properties between the Rail Corridor and shoreline.
MP 201.70–201.90	Bluff set-back relatively distant from Rail Corridor; periodic bluff failures involving terrace and weathered bedrock deposits notable historically; potential for bedrock landslide runout into Rail Corridor is low in near term and potentially moderate in long term. Coastal erosion potential impact is low, due to private properties between the Rail Corridor and shoreline.

MP 201.90–202.10	Bluff set back relatively distant from Rail Corridor ; steep/high bluff profile; periodic bluff failures involving terrace and weathered bedrock deposits notable historically; potential impact to Rail Corridor considered low. Coastal erosion potential impact is low, due to private properties between the Rail Corridor and shoreline.

Table 3. Summary of Emergent Areas, MP 202.00–203.00

MP 202.10–202.30	Bluff set-back relatively distant from Rail Corridor; periodic bluff failures involving terrace and weathered bedrock deposits notable historically; potential for bedrock landslide runout onto Rail Corridor considered low in the near term and elevated in in the long term. Coastal erosion potential impact is low, due to private properties between the Rail Corridor and shoreline.
MP 202.30–202.50	Bluff set back relatively distant from Rail Corridor; steep/high bluff profile; periodic bluff failures involving terrace and weathered bedrock deposits notable historically; potential impact to Rail Corridor considered low. Coastal erosion potential impact is low, due to private properties between the Rail Corridor and shoreline.
MP 202.50–202.65	Location of large past bedrock landslide with runout over/beyond Rail Corridor; bluff stabilized by wall repair; potential future impact considered low. Coastal erosion potential impact is low, due to private properties between the Rail Corridor and shoreline.
MP 202.65–202.80	Bluff condition absent due to mouth of canyon crossing; Rail Corridor subject to potential liquefaction, lateral spreading, and tsunami hazards; threat assessment to Rail Corridor requires geotechnical exploration. Coastal erosion potential impact is moderate. Drainage crossing armor should be monitored and some repair needed following major storms.
MP 202.80–202.98	Location of past bluff instability; bluff stabilized by wall repair; potential impact to Rail Corridor considered low. Coastal erosion potential impact is moderate, as dry beach remains.
MP 202.98–203.01	Location of 2:1 (horiz:vert) bluff layback and surface drain installation; potential impact to Rail Corridor considered low. Coastal erosion potential impact is low, due to private properties between the Rail Corridor and shoreline.

Table 4. Summary of Emergent Areas, MP 203.00–204.00

MP 203.01–203.11	Bluff set-back relatively distant from Rail Corridor; steep/high bluff profile; periodic bluff failures involving terrace and weathered bedrock deposits notable historically; potential impact to Rail Corridor considered low. Coastal erosion potential impact is low, due to private properties between the Rail Corridor and shoreline.
MP 203.11–203.50	Location of 2:1 (horiz:vert) bluff layback and surface drain installation; potential impact to Rail Corridor considered low. Coastal erosion potential impact is low, due to private properties between the Rail Corridor and shoreline.

MP 203.50–203.71	Bluff condition absent due to canyon crossing; area subject to potential liquefaction, lateral spreading, and tsunami hazards; threat assessment to Rail Corridor requires geotechnical exploration. Coastal erosion potential impact is low, due to private properties between the Rail Corridor and shoreline.
MP 203.71–204.00	Bluff set-back relatively distant from Rail Corridor; periodic bluff failures involving terrace and weathered bedrock deposits notable historically; potential for terrace/bedrock landslide runout into Rail Corridor considered low in near-term, more elevated in long term.
MP 203.71-203.80	Coastal erosion potential impact is moderate from 203.71 to 203.80.
MP 203.80–203.90	Coastal erosion potential impact is high near MP 203.80 to 203.90 due to beach narrowing and ongoing erosion progressing north from the existing riprap.

Table 5. Summary of Emergent Areas, MP 204.00–205.00

MP 204.00–204.30	Rail Corridor located on/or adjacent to bluff; periodic bluff failures involving terrace and weathered bedrock deposits notable historically; shoreline eroded; heavy riprap protection in place; heavy seepage in bluff face; track bed underlain by older slide debris that is saturated and subject to potential liquefaction and lateral spreading; high potential for terrace/bedrock landslide, liquefaction, and/or wave erosion impacts to Rail Corridor. Coastal erosion potential impact is high due to direct wave attack, displaced stones, ongoing maintenance requirements, and steep riprap slopes.
MP 204.20	January 24, 2024, bluff failure occurred on adjacent property with runout onto tracks, impacting Mariposa Pedestrian Bridge and halting rail service; slide movement sheared sections of pedestrian bridge deck from its bents due to lateral pressure on the structure; slide debris shifted Enviro-blocks at former slope toe onto the Rail Corridor; slide mass graded to 2:1 (h:v) and covered with Visqueen; threat of future bluff failures and Rail Corridor closures remains high. Coastal erosion potential impact is high due to direct wave attack, displaced stones, ongoing maintenance requirements, and steep riprap slopes.
MP 204.30–204.37	Bluff set-back relatively distant from Rail Corridor; steep/high bluff profile; periodic bluff failures involving terrace and weathered bedrock deposits notable historically; potential for terrace/bedrock landslides and runout onto Rail Corridor considered low in the near-term, more elevatedlong term.
MP 204.30–204.37	Coastal erosion potential impact is high due to direct wave attack, displaced stones, ongoing maintenance requirements, and steep riprap slopes.
MP 204.37–204.42	Location of past terrace/bedrock landslide (Pumphouse Landslide); unrepaired slide mass remains in relatively close proximity to Rail Corridor; potential reactivation of slide and runout onto Rail Corridor considered moderate; potential damage to sewer pumpstation due to continued landslide creep, and possible runout onto Rail Corridor requiring maintenance considered low to moderate in the near-term. Coastal erosion potential impact is moderate due to narrow beach and condition of existing riprap exposed to wave action and beach. Monitoring is warranted.
MP 204.42–204.46	Bluff condition absent; potential impact to Rail Corridor considered low.
MP 204.46–204.55	Existing building mitigates bluff stability concerns; potential impact to Rail Corridor considered low.
MP 204.55–204.58	Bluff set back relatively distant from Rail Corridor; low bluff height; periodic bluff failures involving terrace and weathered bedrock deposits notable historically; potential impact to tracks considered low; potential impacts to railroad signal house and railroad switching system at Corto Lane Ped Crossing near the toe bluff considered moderate. Coastal erosion potential impact is low to moderate in this vicinity due to beach width and existing infrastructure.

MP 204.58–204.65	Location of past terrace/bedrock landslide (Casa Romantica Landslide); slide mass stabilization in progress; timber/pile wall installed at toe; potential impact to Rail Corridor considered low.
MP 204.65–204.75	Low bluff profile; Rail Corridor subject to potential liquefaction, lateral spreading, and tsunami hazards; threat assessment to Rail Corridor requires geotechnical exploration.
MP 204.75–204.91	Bluff set back relatively distant from Rail Corridor; moderate bluff profile; periodic bluff failures involving terrace and weathered bedrock deposits notable historically; potential impact to Rail Corridor considered low.

Table 6. Summary of Emergent Areas, MP 205.00–206.00

MP 204.91–205.11	Bluff height relatively moderate; periodic bluff failures involving terrace and weathered bedrock deposits notable historically; potential impact to Rail Corridor considered low.
MP 205.11–205.25	Bluff height relatively high; location of past terrace/bedrock landslides (SCL Mayor Landslide); slide debris remains; potential impacts to Rail Corridor due to slide reactivation considered moderate.
MP 205.25–205.38	Bluff condition absent; potential impact to Rail Corridor considered low.
MP 205.38–205.50	Bluff set back relatively distant from Rail Corridor; steep bluff profile; potential impact to Rail Corridor considered low.
MP 205.50–205.58	Bluff set back relatively distant from Rail Corridor; steep/high bluff profile; periodic bluff failures involving terrace and weathered bedrock deposits notable historically; potential impacts to Rail Corridor considered low.
MP 205.58–205.7	Bluff set back relatively distant from Rail Corridor; steep/high bluff profile; periodic bluff failures involving terrace and weathered bedrock deposits notable historically; potential terrace/bedrock landslide runout onto Rail Corridor considered moderate.
MP 205.70–205.82	Bluff condition absent; potential impacts to Rail Corridor considered low.
MP 205.82–205.95	Bluff set back relatively distant from; steep/high bluff; bedrock relatively stable; potential impact to Rail Corridor considered low. Coastal erosion potential impact is moderate due to narrow beach and existing exposed riprap.
MP 205.95–206.03	Bluff set back sufficient distance from Rail Corridor; potential impact to Rail Corridor considered low. Coastal erosion potential impact is moderate due to narrow beach and existing exposed riprap.

Table 7. Summary of Emergent Areas, MP 206.00–207.00

MP 206.03–206.30	Bluff set back relatively distant from Rail Corridor; steep/high bluff profile; bedrock relatively stable, area subject to canyon outwash flooding and erosion; potential impact to Rail Corridor considered low to moderate.
MP 206.30–206.55	Bluff set back relatively distant from Rail Corridor; steep/high bluff profile; bluffs susceptible to potential bedrock landslides; potential for landslide runout into Rail Corridor considered moderate.
MP 206.55–206.64	Location of recent landslide with runout onto Rail Corridor; landslide remains unmitigated; potential slide reactivation and runout into Rail Corridor considered moderate to high. Coastal erosion potential impact is high due to narrow beach, recent erosion and exposure of the fill slope supporting the track between MP 206.60 and 206.65.
MP 206.64–206.72	Bluff set back relatively distant from Rail Corridor; bluff height moderate; bluff susceptible to bedrock landslides; potential bluff impacts to Rail Corridor considered moderate to high. Coastal erosion potential impact is high due to narrow beach, recent erosion and exposure of the fill slope supporting the track in the vicinity of MP 206.60 to 206.65.
MP 206.72–207.34	Bluff set back relatively distant from Rail Corridor; area of ancient Calle Ariana Landslide (repaired) extending beneath Rail Corridor; moderate bluff height; bluff susceptible to bedrock landslides; future potential impact to Rail Corridor considered low to moderate.

	Coastal erosion potential impact is moderate to high due to lack of a dry beach and riprap placed to stabilize the shoreline. Ongoing monitoring and reinforcement of the existing riprap is expected near Cypress Shore.

Recommendations

Potential Strategies and Solutions

Strategy 1. **Proactive Monitoring of the Shoreline.** The project team recommends OCTA and SCRRA implement a monitoring program that combines topographic survey and site observations at various locations and frequencies. These data will allow OCTA and SCRRA to establish baseline conditions that will support other strategies. This strategy can be implemented in a matter of months. We also suggest up to three low-cost water level sensors be installed at appropriate locations (bridge crossings, pier, and Dana Point) for a real-time alert of high-water conditions and potential wave damage. These real-time high-water conditions in concert with real-time offshore wave buoy data could help establish coastal metrics for threshold and support rationale for reinforcement actions.

Strategy 2. **Establish Thresholds for Reinforcement.** Long-term, short-term, and seasonal shoreline position (MHW contour) relative to the Rail Corridor centerline of track should be assessed, and thresholds set for acting against imminent emergent conditions. Thresholds may vary spatially based on the geometry and elevation of the Rail Corridor and comparison longer term trends. Establishing thresholds will allow OCTA and SCRRA to plan responses for the coming storm(s) or storm season and provide a rationale to regulatory agencies to support action and emergency after-the-fact permitting. This strategy can be implemented within six months of implementing Strategy 1.

Strategy 3. **Prepare for Maintenance.**

3A. OCTA and SCRRA should stockpile sufficient tonnage of rock to reinforce existing riprap when stones are displaced and to add rock to emerging erosion areas as identified by monitoring. At minimum, not less than 5,500 tons of 2–6-ton rock should be stockpiled at the ready for responding to erosion of existing riprap and emergent hot spots.

3B. OCTA to coordinate with SCRRA and its maintenance contractor to develop a 2 to 5-year scope, estimated cost, and schedule to respond to short-term recurring slope movements and coastal erosion. This plan could include but is not limited to stockpiling riprap in various sizes, acquiring or leasing areas accessible by rail equipment to stage and load the stockpiled riprap, and ensuring that adequate equipment such as rail side car loaders and large excavators are readily available.

Solution A. **Engineered Revetment.** The project team recommends OCTA pursue design and implementation of engineered revetment sections in potential reinforcement areas that currently have limited or no riprap shore protection. These structures will provide greater durability and survivability, plus are more effective at dissipating wave energy to minimize wave overtopping and associated track inundation. Constructing an engineered revetment will entail access on the dry beach, which requires advanced planning to work at low tide.

Solution B. **Riprap Reinforcement.** Continued placement (stacking) of riprap to repair and reinforce existing riprap from the trackway will continue to be needed as stones are displaced and undermined by storms. This method is a stopgap measure and is not expected to resist all storms or withstand significant erosion of the beach beyond the toe of the riprap slope.

Monitoring Areas

A coastal shoreline monitoring program (see Figure 5) is recommended to quantify changes in both the condition of the shore protection and the overall shoreline position relative to the rail ROW. The recommended monitoring program includes on-the-ground site observations and drone-based topographic and aerial photogrammetric surveys conducted at low tide. A summary of the Monitoring Areas along with frequency of monitoring are provided in Table 8 below.

Site Observations

Potential reinforcement areas should be visually observed by a qualified coastal engineer after storm events and on a monthly basis during winter. The purpose is to observe the existing condition of the existing shoreline and existing protection for signs of further deterioration or damage.

Drone-based Photogrammetry and Topographic Survey

Each potential reinforcement area should be monitored monthly and after significant coastal storm events to assess the vulnerability of the railway to damage from coastal erosion. The monitoring should include acquisition of topographic and photographic data (orthometric and oblique aerial imagery) documenting the condition of the region between the railroad and the Mean Higher High Water (MHHW) contour (i.e., the dry beach and rock shore protection). The recommended program could be conducted using a small Unmanned Aircraft System (sUAS) operated by personnel with Federal Aircraft Administration (FAA) Remote Pilot Certification (Small UAS, Part 107) and a Real-Time Kinematic Global Navigation Satellite System (RTK GNSS). Structure-from-Motion (SfM) techniques can then be used to develop an ortho-rectified composite image (orthomosaic) of the survey area and a detailed Digital Elevation Model (DEM) from the sUAS and RTK GNSS data with a resolution of approximately 0.1 foot or better. This technique has recently been used to monitor rock shore protection in Southern California and to rapidly identify localized areas of revetment deterioration, including rock displacement. Both the DEM and aerial imagery can be used to assess changes in the beach configuration and rock shore protection to identify potential areas of concern. Long-term changes also can be

Figure 5. Summary of Monitoring Locations and Reinforcement Areas

assessed using historical topographic data obtained in the vicinity, and physical reconnaissance by professional geologists and engineers where available.

Proactive monitoring would allow OCTA to set a baseline condition and evaluate the progression of erosion, movement of tracks in areas of underlying instability, establish thresholds for immediate maintenance, and justify actions to regulatory bodies when emergent issues arise. Drone-based monitoring allows efficient capture of large areas, including those areas that do not require intensive monitoring efforts at this time.

Site 1: Doheny South, MP 200.80 – 201.00

The adjacent shoreline infrastructure at Doheny State Beach (see Figure 6) to the west and Capistrano Beach Park to the east have experienced erosion, and erosion control measures have been implemented. The project team recommends shoreline monitoring in this area where beach has not yet eroded to the point of imminent threat to the rail but may do so in the future. Semi-annual monitoring concurrent with spring/fall beach monitoring is recommended.

Figure 6. Monitoring Site 1: South Doheny Beach Erosion near Parking Lot

Site 2: Poche Beach, MP 202.70

Outfalls and drainages allow waves to propagate inland, and in combination with ongoing beach erosion may erode the rail ROW in future. Quarterly monitoring is recommended. See Figure 7.

Figure 7. Monitoring Site 2: MP 202.70, Poche Beach Outfall and Pedestrian Underpass

Site 3: North Beach, MP 203.65 – 203.70

There is ongoing coastal erosion at the base of the riprap slope causing stone to be undermined and dislodged downslope. This reach should be monitored as part of the coastal shoreline monitoring program. See Figure 8.

Figure 8. Monitoring Site 3: MP 203.65, North Beach, November 2023

Site 4: Mariposa Pedestrian Bridge, MP 204.00–204.30

The project team recommends installation of a series of slope monitoring equipment such as inclinometers, tilt sensors, gauges, etc. along an approximately 1,000-linear foot rail corridor section, between the rail corridor and existing pedestrian bridge. Casings should be installed approximately 100 feet on-center and penetrate saturated surficial sediments (fill, colluvium, slide debris), and extend into competent bedrock at depth. Baseline readings (monitoring) should be performed during the week following installation. Future rounds of monitoring should be conducted twice within the next month and once a month thereafter for a year. Subsequent readings should be performed twice annually. Monitoring should also take place following significant events that could potentially manifest in track movement, including, but not limited, to future earthquakes, bluff failures, significant storms, or significant beach erosion.

There is ongoing coastal (beach) erosion along the base of riprap slopes causing stone to be undermined and dislodged seaward. This reach should be monitored as part of the coastal shoreline monitoring program. See Figure 9.

Figure 9. Monitoring Sites 4 and 5: MP 204.00–204.30, Mariposa Pedestrian Bridge – January 21, 2024.

Site 5: Linda Lane, MP 204.50

There is ongoing coastal erosion at the base of the riprap slope causing stone to be undermined and dislodged seaward. This reach should be monitored as part of the coastal shoreline monitoring program.

Site 6: Avenida Calafia, MP 206.10

The face of the sea cliff is entrenched by several small to large size re-entrant canyons generating periodic sediment discharge into low-lying terrain along the landward Rail Corridor margin. Impacts have included flooding, blocking of drainage structures, and deposition of sediment within the Rail Corridor during larger storm events. See Figure 10. Frequent post-storm maintenance efforts have been required to preserve train service, including removal of sediment and ponded water, restoration of surface flow, and installation of concrete blocks at the mouth of canyons in attempt to restrain sediment transport.

Figure 10. Monitoring Site #6: MP 206.10, Calafia State Beach, January 2024

Possible solutions to mitigate the above conditions may include the following:

- Construction of sediment catchment ditches or walls at toe of bluff;
- Construction of drainage channels at toe of bluff to improve surface drainage and act as sediment catchment ditches;
- Improve, enlarge, and/or install additional under-track drainage outlets connecting to the beach;
- Improve surface drainage by grading the northeastern track zone to accommodate the distribution of runoff to new and/or existing outlets;
- Stabilize erosion-prone areas of bluff and canyons with jute-matting or similar methods to minimize erosion of bare ground;
- Introduce native plants on slopes underlain by colluvium/slope wash and older alluvium); and
- Improve sediment barriers at canyon discharge points.
- Construction of drainage channels at toe of bluff to improve surface drainage and act as sediment catchment ditches.
- Improve, enlarge, and/or install additional under-track drainage outlets connecting to the beach.

- Improve surface drainage by grading the northeastern track zone to accommodate the distribution of runoff to new and/or existing outlets,
- Stabilize erosion prone areas of bluff and canyons with jute-matting or similar methods to minimize erosion of bare ground.

Site 7: Cyprus Shore to County Line, MP 206.70–207.25

This reach (see Figure 11) should be monitored as part of the coastal shoreline monitoring program to ensure that the riprap section is stable and withstanding wave and weather conditions.

Figure 11. Monitoring Site 7: MP 206.70–207.25, Cyprus Shore to County Line, December 2023

Table 8. Summary of Monitoring Areas

Site	Location (MP)	Description	Monitoring (Frequency)
1	200.80–201.00	Doheny South: Eroding Beach	Riprap condition and beach erosion (Semi-annually, Post-storm)
2	202.70	Poche Beach South Shore Pedestrian Underpass and outfall at beach	Beach erosion and scour protection around structures (Quarterly)
3	203.65–203.70	North Beach: Potential for undermining of riprap	Riprap condition and beach erosion (Semi-annually, Post-storm)
4	204.00–204.30	Mariposa Pedestrian Bridge	Install slope monitoring equipment to assess potential track-bed movement (Monthly, post-storm, post-landslide, and post-earthquake)
5	204.50	Linda Lane: Stable beach but narrow	Riprap condition and beach erosion (Semi-annually, Post-storm)
6	206.10	Calafia State Beach: upland erosion sand deposits on tracks	Effectiveness of culvert replacement (Post-storm, King Tides)
7	206.60–207.25	Cyprus Shore to County Line	Monitor effectiveness of emergency riprap (Semi-annually, Post-storm)

Potential Reinforcement Areas

Four areas were identified by the project team through its initial assessment for potential reinforcement to further solidify the stability of the railroad corridor. The potential reinforcement areas are initial concepts that will require additional analysis and investigation in terms of alternative analysis, site access, constructability, and permitting. Each site has potential limitations that need to be examined further. The Potential Reinforcement Areas are summarized in Table 9 below. **It is important to note the following descriptions for the potential reinforcement work do not indicate the implementing lead agency/entity.**

Site 1: MP 203.80 to MP 203.90

Place new rock and/or rework existing rock that has fallen out of section to restore the structure slope and crest elevation, thereby providing beach erosion protection and reduction in wave overtopping. Where possible, place new, larger rock and/or rework existing rock in a way that reduces the slope, thereby improving the stability of the rocks. See Figure 12 and Figure 13.

Figure 12. Potential Reinforcement Area 1: MP 203.85, November 2023

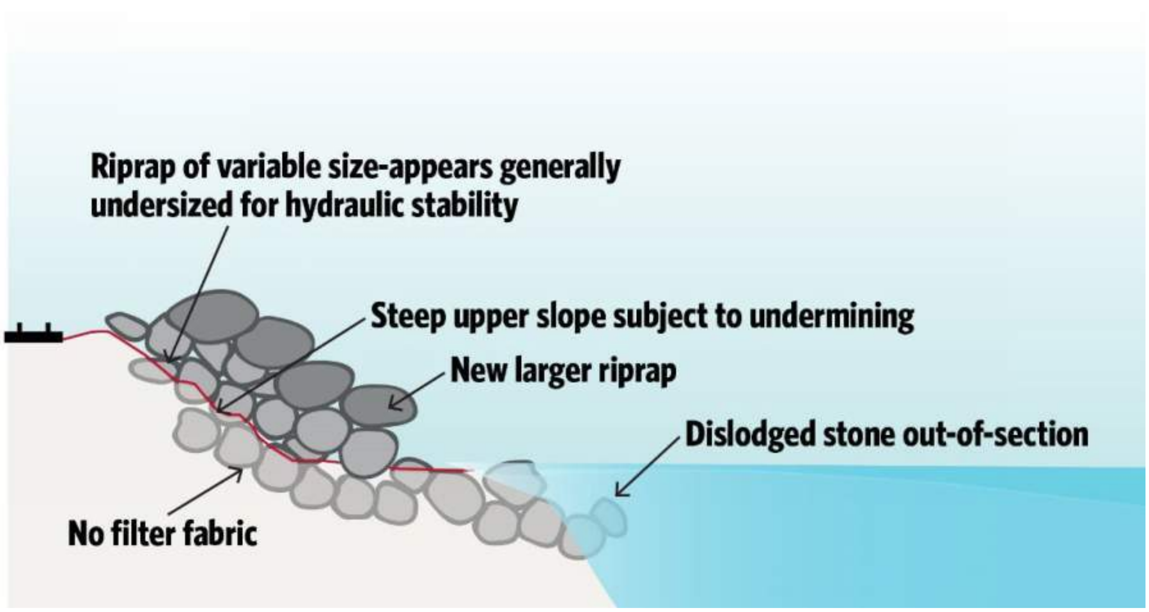


Figure 13. Potential Temporary Reinforcement Solution for Sites 1 and 2 where existing riprap exists

Site 2: MP 204.00 to MP 204.40

Place new rock and/or rework existing rock that has fallen out of section to restore the structure slope and crest elevation, thereby providing beach erosion protection and reduction in wave overtopping. Where possible, place new, larger rock and/or rework existing rock in a way that reduces the slope, thereby improving the stability of the rocks. See Figure 13.

Figure 14. Potential Reinforcement Site 2: MP 204.10, November 2023

Site 3: San Clemente City Beaches

Following identification of this site needing immediate attention, a landslide occurred that led to the suspension of passenger and freight rail service on January 24, 2024. OCTA and Metrolink took immediate action and performed the following remediation work:

- Removal of two damaged spans of the pedestrian bridge
- Grading of the slope, clearing of debris in drainage culvert, placement of riprap and geotechnical fabric to allow culvert drainage, placement of Visqueen plastic, slope monitoring
- other best management practices to prevent surface water infiltration

However, due to inclement weather and continual movement of the earth, passenger rail service has yet to resume as of early February 2024.

Additional work is anticipated which could include design and construction of a temporary solution within the railroad right-of-way to protect the tracks. Investigate the source(s) of chronic failures affecting the bluff face, which could involve water as the culprit for the underlining issues. Other parties are anticipated to be responsible for the remaining remedial work to restore the Beach Trail access.

See Figure 15 and Figure 16.

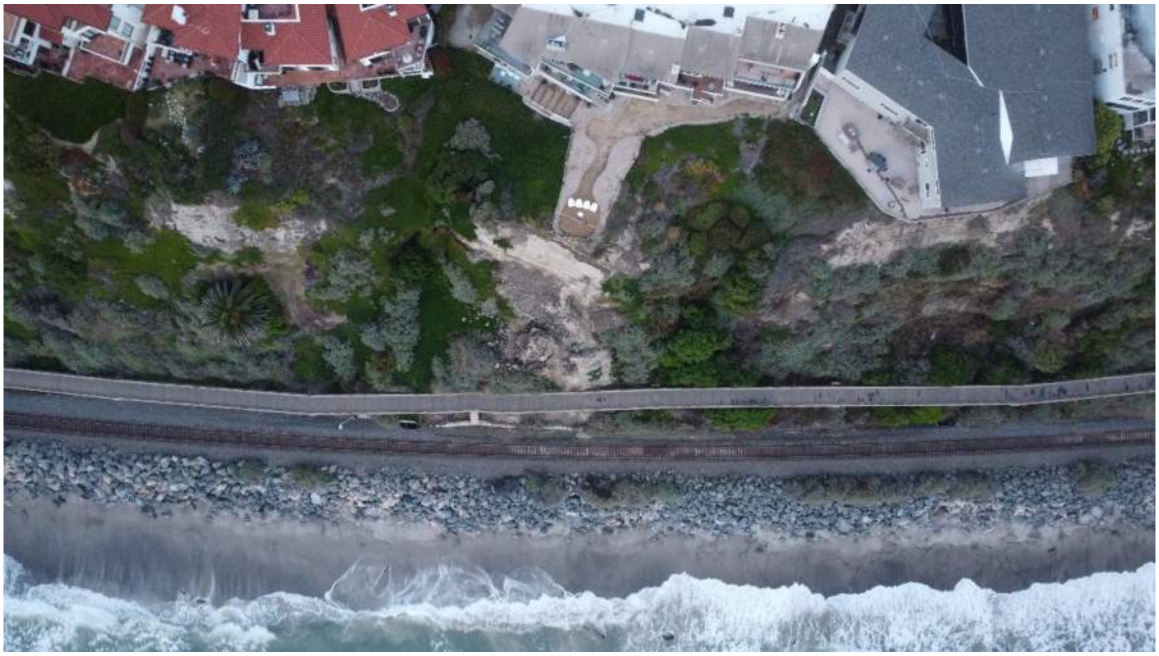


Figure 15. Potential Reinforcement Site 3: MP 204.00 to 204.50, steep bluffs, potential to impact tracks, poor track-side drainage with potential for liquefaction – January 21, 2024

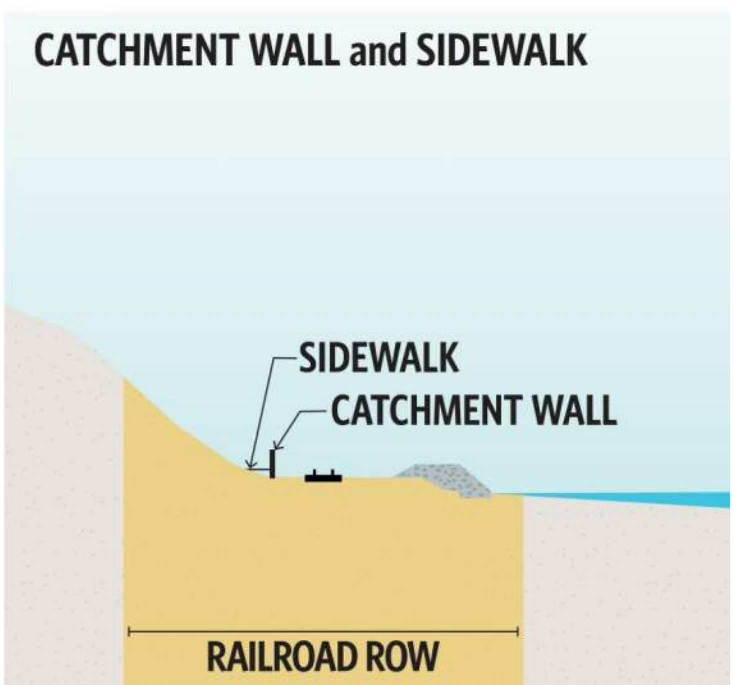


Figure 16. Potential Solution for Reinforcement Site 3

Site 4: North End Cyprus Shore
Installation of an engineered revetment with filter fabric to minimize piping (movement of fine-grained sediment through voids in the rocks) and a layered-stone placement design with keyway founded in bedrock or to a toe elevation of +2 ft or lower is recommended. Dual purpose of revetment is to arrest continued landward retreat of soils into Rail Corridor. See Figure 17 and Figure 18.

Figure 17. Potential Reinforcement Site 4: MP 206.00 to 206.67, North End of Cyprus Shore Project, July 2023

Loss of riprap exposes unstable deposits of beach sand, slide debris, and/or fill deposits beneath ROW, subject to rapid retreat as erosion and toppling during future storms.

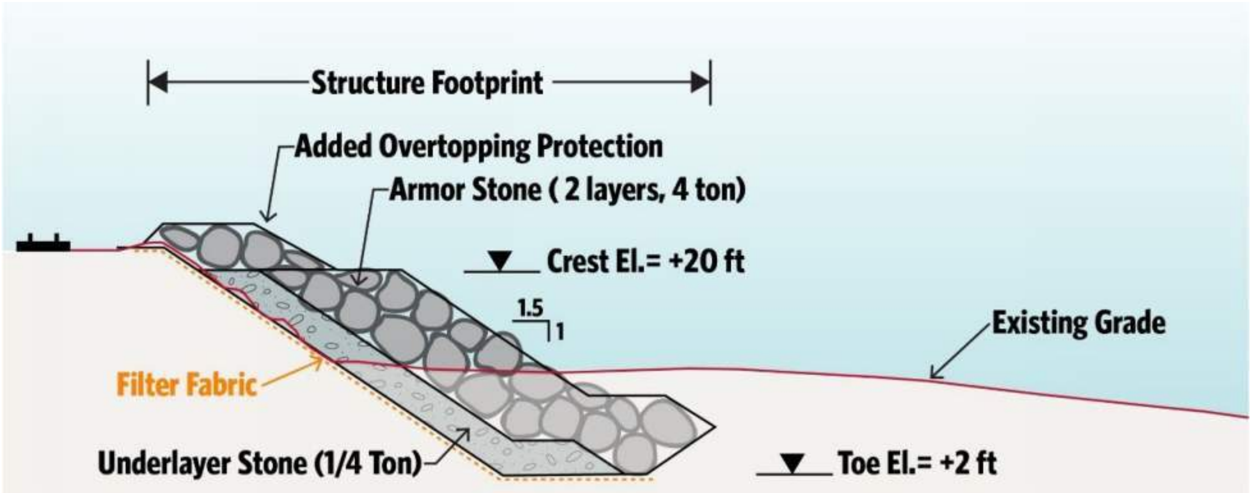


Figure 18. Potential Solution for Reinforcement Site 4 with Engineered Revetment Section

Table 9. Summary of Potential Reinforcement Areas

Site	Location (MP)	Description	Potential Solution(s)	Potential Limitation(s)
1	203.80–203.90	Erosion Hazard deteriorating	Repair/Augment Riprap	Access, constructability, permitting
2	204.00–204.40	Erosion: No beach at high tide and direct wave attack	Stockpile rock for maintenance	Access, constructability, permitting
3	204.00–204.50	Geologic: Major seepage from bluff face and poor surface drainage lead to track-bed saturation and potential for liquefaction and lateral spreading of track-bed	Build subdrain cutoff for groundwater, catchment structure for slope debris surface drainage control	Access, constructability, utility conflicts
4	206.00–206.67	North end of Cyprus Shore: Erosion exposing old riprap	Inspect and construct revetment as needed	Access, constructability, permitting

Other Key Considerations

Governance (Roles and Responsibilities)

As a part of the next steps for the Coastal Rail Resiliency Study, OCTA will develop a Governance Plan to provide a vision for roles, responsibilities, and an implementation plan for capital projects. OCTA is the owner of the ROW and Metrolink is the operator and maintainer of the ROW. However, both agencies have professional services and construction contracts that enable them to deliver capital projects. Roles and the implementation plan will consider the roles and responsibilities of OCTA and other key stakeholders in the region.

Environmental Clearance Strategy

As defined by State Legislature, California Environmental Quality Act (CEQA) Statutory Exemptions (SE) exist to cover specific types of projects with special qualifications. These exemptions are delineated in Public Resource Code (PRC) Section 21080 et seq.

California Code of Regulations, Title 14, Section 15269(b) allows for emergency repairs to publicly owned service facilities "necessary to maintain service essential to the public health, safety or welfare." This includes emergency repairs that "require a reasonable amount of planning to address an anticipated emergency." Further, Section 15269(c) allows for an SE for:

> Specific actions necessary to prevent or mitigate an emergency. This does not include long-term projects undertaken for the purpose of preventing or mitigating a situation that has a low probability of occurrence in the short-term, but this exclusion does not apply:
>
> (i) If the anticipated period of time to conduct an environmental review of such a long-term project would create a risk to public health, safety or welfare, or
>
> (ii) If activities (such as fire or catastrophic risk mitigation or modifications to improve facility integrity) are proposed for existing facilities in response to an emergency at a similar existing facility.

Given the amount of recent storm damage including shoreline erosion, land subsidence, gradual earth movements, and landslides, there is a high probability that further damage will occur within this corridor that jeopardizes the continued use of the existing railroad infrastructure.

To streamline the environmental process for the recommended maintenance activities proposed for potential reinforcement areas, it is recommended that a single, corridor-wide SE be utilized. This SE should identify the extent of the project corridor, Dana Point (MP 200.00) to San Clemente (MP 207.40), and list all potential improvements, including, but not limited to, placing riprap from the railroad ROW, constructing engineered revetment with riprap, and building catchment walls. The SE should specifically use language to include emergency actions that may be required within the corridor (see further discussion below). Alternately, an SE can be filed for individual potential reinforcement areas projects identified in this study.

If a federal nexus is established through a federal permit (such as a USACE permit) or federal funds are applied either entirely or in part by the federal government to any of the work in this corridor, the National Environmental Policy Act (NEPA) may apply. The NEPA Class of Action (Categorical Exclusion, Environmental Assessment, or Environmental Impact Statement) would be coordinated with and determined by the federal lead agency.

Regulatory Permitting Strategy

Potential reinforcement areas may also need to comply with other applicable federal, state, and local laws. All potential reinforcement areas identified above are located within the Coastal Zone Boundary. As such, all potential reinforcement areas require some level of coordination with the California Coastal Commission (CCC). Depending on the location and extent of potential improvements, USACE, Regional Water Quality Control Board (RWQCB), United States Fish and Wildlife Service (USFWS), and California Department of Fish and Wildlife (CDFW) regulatory requirements, among others, may need to be addressed, as discussed below.

Coastal Development Permitting

All work proposed on tidelands, submerged lands, and other public trust lands must be coordinated with and potentially receive a permit from the CCC. In addition, activities authorized, funded, or carried out by the federal government that affect coastal zone resources must be reviewed by the CCC for consistency with the federally approved California Coastal Management Program, including the California Coastal Act (CCA) (PRC 30330, and 30400).

Coastal Development Permits (CDPs) are the regulatory mechanism by which proposed projects in the coastal zone comply with the policies of Chapter 3 of the CCA. Specifically, California Code of Regulations, Title 14 – Natural Resources, Section 13252 details repair and maintenance activities pertinent to this transportation corridor that require a CDP and including repair and/or maintenance of surface or subsurface structures. CDPs are required for any repair or maintenance to facilities or structures or work located in an environmentally sensitive habitat area, any sand area, within 50 feet of the edge of a coastal bluff or environmentally sensitive habitat area, or within 20 feet of coastal waters or streams that include the placement or removal of materials (including riprap, sand, etc.) or when the presence of mechanized equipment or construction materials is needed.

The executive director of the CCC has the discretion to exempt ongoing routine repair and maintenance activities of local governments, state agencies, and public utilities (such as railroads) involving shoreline works protecting transportation roadways per Cal. Code Regs. tit. 14 §13252 3(c)(e). Therefore, it is recommended as a first step that OCTA request an exemption from the Executive Director of the Commission for any maintenance work and/or work in all potential reinforcement areas.

If an exemption is not granted, a secondary option is to apply for a singular Ongoing Maintenance Activities Permit for the corridor, as allowable under Cal. Code Regs. tit. 14 § 13252 3(d). The CCC may issue a permit for maintenance activities for a term in excess of the two-year term provided by these regulations. Issuance of this permit may also require preparation of an associated CDP to address potential effects maintenance activities may have on natural/coastal resources. Therefore, it is recommended that OCTA prepare, process, and obtain Ongoing Maintenance Activities Permit for maximum time allowable, since this step is crucial to streamlining proactive prevention of damage to railroad infrastructure moving forward.

To move forward with discussions for this type of a Maintenance Activities Permit, it is recommended that OCTA request a pre-application meeting with Coastal Staff to discuss the preparation of a Maintenance Improvement Plan for the Reinforcement Areas that includes:

- Type of maintenance/improvement required (materials, quantities, etc.).
- Environmental footprint, including construction access, temporary, and permanent impact areas.
- Post-maintenance/improvement requirements (materials, quantities), where warranted.

- Drone footage and/or LiDAR for the corridor as proof of existing conditions for permitting purposes.
- Discussion of preparation of a CDP in support of this work.

It is also recommended that field surveys (Biological Resources, Aquatic Resources Delineation, and Cultural Resources) be completed for the corridor with the subsequent reports used for the support of the permitting process and mitigation.

There is an alternate option for CDP available for federal activities, development projects, permits and licenses, and/or support to state and local governments. The CCC has a Federal Consistency Unit that implements the Coastal Zone Management Act (CZMA) of 1972. All federal activities affecting the coastal zone must undergo a review for consistency with the CZMA process called a Consistency Determination for federal agencies activities and development projects or a Consistency Certification for federal permits and licenses, and/or federal funding to state and local agencies. This process is intended to allow for coordination among federal agencies, plus allowing the public an opportunity to participate in the process.

Clean Water Act Permitting

Depending upon the location(s) and extent of each proposed improvement and/or maintenance activity and their impacts to aquatic resources, Clean Water Act permitting may be required with the USACE and RWQCB or State Water Resources Control Boards (Water Boards). Permits for Section 404 of the Clean Water Act are addressed through USACE and may be covered under nationwide permits, such as Nationwide Permit 13 (NWP 13), which covers bank stabilization less than 500 feet in length solely for erosion protection, Regional Permits, which cover projects considered to have insignificant environmental impacts, or Individual Permits for projects with severe impacts with no practical alternative. Individual Permits may require environmental assessment under NEPA. Implementation of Section 401 of the Clean Water Act Water Quality Certification and Waste Discharge is delegated to the State Water Boards.

Porter-Cologne Water Quality Control Act

Depending upon the location(s) and extent of each proposed improvement and/or maintenance activity and their impacts to aquatic resources, the Porter-Cologne Water Quality Control Act may need to be addressed. The Porter Cologne Water Quality Control Act is the clean water act of California that expanded the enforcement authority of the Water Boards in California.

Lake and Streambed Alteration Agreement

If any portion of proposed improvement and/or maintenance activity is determined to substantially divert or obstruct the natural flow of, or substantially change or use any material from the bed, channel, or bank of, any river, stream, or lake, or deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake, per the CDFW Fish and Game Code Section 1602 a Streambed Alteration Agreement (SAA) may be needed.

Endangered Species

Depending upon the location(s) and extent of each proposed improvement and/or maintenance activity and their proximity to biological resources, state and or federally listed species may be affected. Depending on the species and the presence of a federal nexus, consultation with USFWS and/or National Oceanic and Atmospheric Administration may be necessary in addition to CDFW to comply with the California Endangered Species Act (CESA).

Other Coordination

The California State Lands Commission (SLC) has jurisdiction of the landward boundary of "sovereign lands," defined as the area between the ordinary high-water mark for tidal waterways and the ordinary low-water mark for navigable non-tidal waterways. The area between the ordinary low-water mark and the ordinary high-water mark at navigable non-tidal waterways are subject to the Public Trust Easement. As such, the location of improvements should be overlain with the Mean High Tide Line (MHTL) and early coordination should occur with the SLC to decide whether a lease is required to complete the activity.

Procedures for Emergency Response

Emergency Response Protocol

It is recommended that a coordination protocol be put into place between OCTA and Metrolink to streamline emergency responses, as follows:

1) Metrolink Maintenance identifies immediate emergency maintenance need within the corridor.
2) OCTA, Metrolink, and Professional Services Support meet to discuss scope of maintenance required and suggests the following level staff are included:
    a. OCTA: Executive Leadership and staff.
    b. Metrolink: Executive Leadership and Maintenance.
    c. Professional Services Support: Engineering Lead(s), Geotechnical Lead(s), and support staff.
3) Metrolink notifies (i.e., via emails and/or telephone communications) OCTA and Professional Services Support the following information about the emergency response:
    a. Type of maintenance activity (e.g., riprap placement).
    b. Project limits.
    c. Quantity of material import.
    d. Type of construction equipment required.
    e. Construction access requirements (rail, beach, etc.).
    f. Proposed construction timeframe and whether the improvement is temporary or permanent.
    g. Provide as-builts and plans as soon as available.
4) The team determines if environmental clearance or permitting is required and notifies agencies (if needed). Critical factors to consider include but are not limited to whether

maintenance locations are outside the railroad ROW and/or locations in the railroad ROW that have the potential to impact sensitive natural/coastal resources.

Emergency Environmental Clearance

If any of the key maintenance locations turns into an emergency, the SE for the corridor (recommended above in Environmental Clearance Strategy Section) should be leveraged for environmental clearance without the need for a new SE for each emergency location. Until a corridor-wide SE is in place, each location would require a new SE be filed for individual potential reinforcement areas projects identified in this study.

Emergency Regulatory Permitting

The CCC defines emergency work as "… generally a period of 24 to 72 hours after the emergency occurrence …." If the Ongoing Maintenance Activities Permit, discussed above, is not yet in place at the time of the emergency, early coordination with the CCC and any other location-appropriate agencies should occur as soon as possible after the incident (and preferably prior to the repair) to assess the need for the following emergency permitting:

- CCC Emergency CDP, followed by a formal CDP application, potentially with mitigation included.
- USACE Regional General Permit (RGP) #63 and coordination with RWQCB:
  - RGP #63 provides for a rapid respond for protection activities in emergency situations, defined specifically by USACE when there is a "clear, sudden, unexpected, and imminent threat to life or property demanding immediate action to prevent or mitigate loss of, or damage to, life, health, property, or essential public services (i.e., a situation that could potentially result in an unacceptable hazard to life or a significant loss of property if corrective action requiring a permit is not undertaken immediately).
- Section 401/Section 404/Porter Cologne Act/CDFW 1602/FESA/CESA.
- Coordination with SLC for MHTL and potential lease needed for emergency location(s).

Stockpiles of Materials Needed in Emergency

Stockpiles of armor stone (2– to 6-ton tons in size) should be established so that materials can be readily delivered to reinforcement and repair areas as needed. For existing riprap with direct wave attack (not including Cyprus Shore), stockpiled materials should be approximately 2 tons per foot length. Therefore, about 5,500 tons of stone should be prepared at the ready. This stone could be used for engineered revetment or riprap placement.

For emergent areas at developing reinforcement areas at the north end of Cyprus Shore, additional new armor stone will be needed and the amount will depend upon the design and length selected by OCTA for reinforcement. These areas may require about 10 tons per foot length.

Engagement of Stakeholders

There are a number of stakeholders that will be engaged throughout the life of the study to obtain input and feedback. OCTA is actively collaborating and soliciting input from stakeholders and interest groups to help inform and shape the short- and medium-term design concepts. OCTA will host listening sessions with the following groups, but are not limited to:

- Project Development Team (PDT).
- Stakeholder Working Group (SWG).
- Freight and Goods Movement.
- Coastal and Marine Habitat Community-Based Organizations.
- Emergency Responders.
- Major Employers, Key Destinations, and Other Business Interests.
- Residential Groups.
- Elected Officials Roundtable.
- General Public.

A listening session was held to present the draft monitoring and potential reinforcement areas to solicit feedback from key stakeholders and interest groups to understand how the solutions can coincide with and contribute to ongoing efforts to develop a resilient coastline.

Next Steps

The monitoring sites and the potential reinforcement areas identified within this technical memorandum should be studied further and advanced through the design, environmental, and permitting processes. Each project needs to be evaluated further and have a more detailed design developed, as well as have an environmental and permitting strategy developed so projects can be advanced to construction in a timely manner. The areas were identified based on the project team's research and field reconnaissance; however, the risk of additional coastal wave impacts, bluff instability impacts, and local erosion in other areas still exists with changing climate conditions and landscape.

The potential reinforcement areas will also need to be coordinated with key stakeholders such as the City of San Clemente, City of Dana Point, CCC, State Parks, SLC, Metrolink, BNSF, Amtrak, and others. This coordination will take place through outreach efforts to gather input and inform key stakeholders of improvements to the railroad corridor.

It is recommended that OCTA develop a Project Delivery Plan that expands on each of these recommended areas by developing an Alternatives Analysis and select a Preferred Alternative to advance to Project Acceptance and Environmental Document (PA/ED). Key stakeholders and permitting agencies should be engaged during this process. With concurrence, the projects should be advanced to Final Design and Construction. The Project Delivery Plan should also consider the potential for bundling projects together for greater efficiency.

Appendix B. Project Charter

PROJECT CHARTER

South Coast Rail Infrastructure Feasibility Study/
Alternative Concepts Analysis
DATE PREPARED: February 20, 2024

OBJECTIVE
This Project Charter will document the goals and objectives of the Coastal Rail Resiliency Study (CRRS). This document is the framework in developing the Purpose and Need for the CRRS. The CRRS will study a seven-mile stretch of the railroad corridor in south coastal Orange County from approximately milepost (MP) 200 to MP 207.4 with the main goal of protecting the rail line under its existing alignment. The approximate seven-mile study area (see Figure 1) includes the cities of Dana Point, San Clemente, and unincorporated portions of the counties of Orange and San Diego. The Project Charter will provide critical guidance to the Project Development Team (PDT), Stakeholder Working Group (SWG), and others to expedite and complete this phase of the study.

This study will address two main challenges. The first entails addressing the continuous beach loss on the west side of the railroad track; and the second involves contending with erosion/landslide issues on the east side of the track. The loss of beach on the west side has led to service disruptions and emergency projects which involved adding riprap to stabilize the railroad. Erosion/landslides on the east side of the track have also led to service disruptions and emergency projects to protect the integrity of the track. The concepts for future work are subject to environmental and coastal regulatory approvals consistent with California Environmental Quality (CEQA), National Environmental Policy Act (NEPA). This process will entail stakeholders' coordination and evaluating the feasibility of improvements that would make the railroad more resilient to unforeseen climate-related events up to the next 30 years. OCTA has been coordinating with the cities in the project area as well as regulatory/permitting agencies including California Coastal Commission, State Lands Commission, and the United States Army Corps of Engineers.

The study context should develop the basis for protecting the railroad in its current alignment while continuing to allow passenger train and freight movement, as well as maintaining availability for strategic military operations. As defined by the United States Department of Defense, the rail line between Los Angeles and San Diego is designated as a Strategic Rail Corridor Network, which consists of key railroad lines most important to national defense. The study area will include approximately 500 feet to the east and west of the existing LOSSAN Corridor, though longer-term considerations will likely extend beyond these limits. This study will take into consideration federal, state, and local sustainability planning efforts and incorporate elements of these plans, as appropriate.

BACKGROUND/PROJECT DESCRIPTION
Over the past several years, storm surges, combined with several other environmental

factors including sea level rise and bluff erosion, have damaged the Los Angeles-San Diego-San Luis Obispo Rail Corridor (LOSSAN Corridor) and adjacent infrastructure. The LOSSAN Corridor is the second busiest rail corridor in the nation. This has resulted in increased required maintenance and emergency repair measures to stabilize the infrastructure. The emergency repairs have also involved substantial service disruptions and delays, and significant cost to OCTA and the state. To minimize further unexpected disruptions to rail service, OCTA prepared an Initial Assessment (site conditions between November 2023 and January 2024) of the seven-mile stretch of the railroad to identify and assess next steps for the most critical segments of the rail line. This effort resulted in identification of sites that required monitoring and in need of immediate reinforcement actions. Immediately following the assessment period, one of the identified sites experienced a substantial slope failure and led to the closure of the railroad in late January 2024. Therefore, this underscores the urgency that reinforcement actions are required. It is important to note the railroad has experienced an unprecedented number of service disruptions over the last several years, as compared to disruptions that generally occur once every several decades in the past.

In addition to the Initial Assessment timeframe to address immediate needs (0 to 5 years) to protect the rail line, the focus of the CRRS will be on the short- (5 to 10 years) and medium-terms (11 to 30 years). Evaluation criteria will be developed with stakeholder input to establish a framework to vet and develop a set of viable Alternative Concepts (AC) along with the associated design geometric concepts that will address coastal rail protection.

This feasibility study will support the development of partnerships and assist in directing priorities for future rail planning efforts, including potential project-level preliminary engineering and environmental analysis.

The following objectives are key to the success of this study:

- Develop the study’s purpose and need to help guide short-term and medium-term decision making.
- Identify and assess the most critical segments of the seven-mile stretch of the railroad to determine if immediate actions are warranted to mitigate risk of additional service disruptions (i.e. Initial Assessment - 0 to 5 years).
- Assess existing and future risks, issues, and challenges with the maintenance and operation of rail services along the existing LOSSAN Corridor alignment in the study area.
- Assess and identify short- (5 to 10 years) and medium-term (11 to 30 years) solutions to address the seven-mile segment of the LOSSAN rail corridor.
- Conduct listening sessions with a multitude of stakeholders to better understand their views.
- Identify and engage key stakeholders at the local, state, and federal levels.
- Seek the advice of a panel of experts on potential solutions as well as the root causes of the issues.

- Develop partnerships with stakeholders and work collaboratively to identify, advance, and implement immediate, and short- and medium-term solutions along the LOSSAN Corridor within the study area.
- Assess and compare potential project alternatives for compliance with the local jurisdiction's City policies and on-going Local Coastal Plan.
- Prepare a preliminary geotechnical report that will help to guide the assessment of the Alternative Concepts (ACs).
- Analyze and include as part of this analysis past and current beach sand profiles.
- Assess and report on potential impacts of the ACs to local resources, facilities, and utilities for the cities of Dana Point and San Clemente.
- Assess recreational impacts such as effects on surfing, multi-use path, California State Parks, and swimming resources.
- Identify up to six (6) ACs and develop strategies for the LOSSAN Corridor within the study area.
- Conduct a preliminary environmental analysis on the initial set of ACs and refine them.
- Identify the core elements for an emergency maintenance and operation deployment plan in the event of future incidents.
- Develop an action plan for implementation of the recommended short- and medium-term improvements as well as a framework and action plan for identifying potential long-term improvements. Identify follow-up activities and recommend coordination with existing projects along the LOSSAN corridor, as appropriate.

PUBLIC OUTREACH

This study will solicit the input of a multitude of stakeholders and forge partnerships with other entities and agencies. Listening sessions will be held to gather collaborative input from key stakeholders in various public and private sectors. Listening sessions are the initial public outreach milestone and seek to:

- Identify key stakeholders
- Share expectation to maintain in-place the existing coastal rail line and minimize passenger and freight service disruptions for up to 30-years
- Assess vulnerabilities and issues of concern
- Identify potential opportunities to further enhance collaboration
- Document feedback

Listening session attendees participated in a facilitated discussion regarding potential reinforcement areas, rail corridor resilience and service disruptions, ways to enhance communication and ideas to enhance railroad stability.

Listening sessions were conducted with the PDT, SWG, Major Employers/Business Interests, Freight and Goods Movement, Emergency Responders, Coastal and Marine Habitat Community Based Organizations, residential groups, the public and local, state, and federal elected officials.

Stakeholder engagement will continue intermittently throughout the CRRS study at key milestones including but not limited to initial concept development, refinement of concepts, and development of the draft feasibility study report.

The PDT members would include staff or representatives from, but are not limited to:
OCTA, Metrolink, LOSSAN/Amtrak, Caltrans, BNSF, and the cities of San Juan Capistrano, San Clemente, and Dana Point, County of Orange (including Orange County Board of Supervisor – District 5, Orange County Parks, and Orange County Flood Control District).

The SWG members would include the PDT with additional members from:
- Federal agencies: United States Army Corps of Engineers, United States Fish and Wildlife Service, Federal Railroad Administration (FRA), Federal Transit Administration, Surface Transportation Board, United States Marine Corps, etc.
- State agencies: California State Parks, California Coastal Commission (CCC), California Department of Fish and Wildlife, San Diego Regional Water Quality Control Board, State Lands Commission, etc.

The Community Stakeholder Roundtable would include representatives from:
- Non-governmental organizations: homeowners associations, environmental organizations, community-based organizations, etc.

The Elected Roundtable would include but not limited to local, state and federal elected officials and staff.
- OCTA Board of Directors, Orange County Board of Supervisors, U.S. Senate, U.S. House of Representatives, California State Assembly, California State Senate, LOSSAN Board of Directors, etc.

The Panel Expert members would include the following specialties:
- Geology
- Seismology
- Oceanography
- Coastal Resilience
- Climate Change

Figure 1

Coastal Rail Infrastructure Resiliency Project
Project Location
LOSSAN
OCTA
LOCATION MAP
San Luis Obispo
Santa Barbara
Ventura
Los Angeles
Orange
San Diego
MAP LOCATION
LOSSAN Corridor
LAGUNA NIGUEL
SAN JUAN CAPISTRANO STATION
SAN JUAN CAPISTRANO
DANA POINT
SAN CLEMENTE
SAN CLEMENTE STATION
SAN CLEMENTE PIER STATION
Milepost 204.6
Milepost 206.8
ORANGE COUNTY
SAN DIEGO COUNTY
MARINA HILLS
BEACON HILL
STREET OF THE GOLDEN LANTERN
DEL OBISPO
ALIPAZ
CAMINO DEL AVION
RANCHO VIEJO
SAN JUAN CREEK
LA PATA
ORTEGA
STONEHILL
PACIFIC COAST
DANA POINT HARBOR
CAMINO LAS RAMBLAS
DEL RIO
TALEGA
CAMINO DE LOS MARES
CAMINO VERA CRUZ
VISTA HERMOSA
CAMINO DE ESTRELLA
CAMINO CAPISTRANO
AVENIDA PICO
EL CAMINO REAL
Rail Line
Project Location
Source: OCTA
0
1
2
Miles
6/28/2023

Appendix C. Community Engagement Report

COASTAL RAIL RESILIENCY STUDY

Community Engagement Summary Report

June 2026

Prepared for: Orange County Transportation Authority (OCTA)
550 South Main Street
P.O. Box 14184
Orange, CA 92863-1584

Prepared by: Arellano Associates
5851 Pine Avenue, Suite A
Chino Hills, CA 91709

Page intentionally left blank.

Table of Contents

Tables

Appendices

Detailed engagement documentation, including full meeting summaries, presentation materials, and outreach records, is maintained separately from this report and available upon request.

Referenced Engagement Documents

- CRRS Listening Sessions Summary Report (2024)
- CRRS Public Meetings Summary Report – July 2025
- CRRS Public Meetings Summary Report – October 2025
- CRRS Public Meetings Summary Report – August 2026 (upon completion)

Executive Summary

The Orange County Transportation Authority (OCTA) conducted a multi-phased community engagement program to inform the Coastal Rail Resiliency Study (CRRS), which evaluates strategies to protect the coastal rail corridor for the next 30 years while maintaining reliable passenger and freight operations.

Engagement was designed to reach corridor communities, stakeholders, and partner agencies early and throughout the study process. Activities included stakeholder listening sessions and multiple rounds of public meetings, supported by bilingual outreach through digital, print, and direct notification methods. Across all phases, engagement emphasized accessibility, transparency, and opportunities for both verbal and written input.

What We Heard

Community and stakeholder input was consistent across engagement phases. Participants expressed strong support for beach nourishment and nature-based approaches, emphasizing the importance of maintaining sandy beaches as both a protective buffer and a valued community asset. Coastal access, recreational use, and preservation of the coastal environment were identified as key priorities.

At the same time, stakeholders raised concerns about the potential impacts of hard shoreline protection structures, including beach loss, reduced access, and long-term environmental effects. Many participants also emphasized the need for long-term, sustainable solutions that address underlying coastal processes, including sediment supply and shoreline change.

How Input Shaped the Study

Public input directly informed the development and evaluation of alternative concepts. In response to community priorities, beach nourishment was incorporated into all shoreline protection concepts, and a beach nourishment-only concept was added to evaluate a nature-based approach as a standalone strategy.

Community feedback also influenced the evaluation framework. Criteria related to public access, environmental impacts, and consistency with community and regional priorities were given increased weight, ensuring that community considerations were integrated alongside technical and cost factors.

In addition, shoreline protection concepts that did not include beach nourishment were not advanced, as they were inconsistent with community preferences and broader planning considerations.

Outcome

The engagement process helped shape a refined set of alternatives that balance engineering feasibility with community priorities. While technical analysis identified constraints related to constructability, permitting, and long-term performance, community input played a key role in ensuring that the alternatives reflect local values related to coastal access, recreation, and environmental stewardship.

The Final Community Engagement Report documents this process and demonstrates how input from stakeholders and the public informed the CRRS, supporting the development of feasible, community-informed solutions for the coastal rail corridor.

1. Engagement Overview

The Coastal Rail Resiliency Study (CRRS) engagement program was designed to inform corridor communities and stakeholders, gather meaningful input, and support development of community-informed resilience strategies for the coastal rail corridor. Engagement occurred throughout the study process and included stakeholder listening sessions, public meetings, and bilingual outreach using both traditional and digital communication methods. Input received through these efforts helped inform refinement of alternative concepts and elements of the study evaluation framework.

1.1 Community Engagement Approach

A coordinated, bilingual (English/Spanish) outreach program was implemented to inform corridor communities and stakeholders, encourage participation, and provide multiple opportunities for input throughout the study.

Engagement combined direct stakeholder outreach with broad public notification using both traditional and digital methods. Outreach activities included stakeholder email invitations and reminders, e-blasts, social media outreach, newspaper advertisements, postcard mailings, community flyer distribution, press releases, and project webpage updates. A bilingual outreach toolkit was also shared with Project Development Team members and partner organizations to help expand awareness through their respective networks.

Engagement opportunities were provided in both in-person and virtual formats, with Spanish interpretation available at public meetings. Participants were able to provide verbal and written input throughout the study process.

Table 1 - Engagement Methods Summary

Outreach Method	Description / Reach
E-blasts	Distributed to stakeholder database; contact list grew to 900+ subscribers

Outreach Method	Description / Reach
Social Media	Paid and organic outreach across Facebook, Instagram, and X in English and Spanish
Newspaper Advertising	Ads placed in San Clemente Times and Dana Point Times
Direct Mail	Bilingual postcards mailed to corridor-adjacent properties
Community Flyers	Distributed at community centers, libraries, schools, and city facilities
Door-to-Door Outreach	Conducted for bluff resident listening session
Press Releases	Issued prior to public meeting rounds
Outreach Toolkit	Shared with partner agencies and PDT members to expand reach

1.2 Listening Sessions Overview

OCTA conducted 11 listening sessions between January and May 2024 to gather input from agencies, stakeholder groups, businesses, advocacy organizations, residents, and elected officials. The sessions were intended to identify concerns, understand corridor vulnerabilities, and inform concept development early in the study process.

Several listening sessions included discussion of OCTA's Initial Assessment and related stabilization efforts, as stakeholders sought to understand the distinction between immediate actions being taken to address vulnerable corridor locations and the CRRS's longer-term focus on evaluating resilience strategies for the next 30 years.

Table 2 - Listening Sessions Stakeholder Participation Summary

Stakeholder Group	Format	Participants
Agencies and Rail Partners	Virtual / Hybrid	53
Businesses and Freight Interests	Virtual	16
Emergency Responders	Virtual	4
Coastal and Environmental Organizations	Hybrid	34
Residential and Bluff Communities	Virtual / In-Person	324
Elected Officials	In-Person	23
Total		**431**

1.3 Public Meetings Overview

OCTA conducted three rounds of public meetings in 2025 to present draft and refined alternatives, gather community feedback, and share evaluation results and next steps. Meetings were conducted in both in-person and virtual formats, with Spanish interpretation available at each session. A final round of public meetings is planned for August 2026 to gather feedback on the Draft Feasibility Study Report prior to finalization.

Table 3 - Public Meeting Participation Summary

Public Meeting Round	Focus	Participation
Round 1 – July 2025	Draft alternative concepts	150
Round 2 – October 2025	Refined alternatives and evaluation results	74
Round 3 – August 2026	Draft Feasibility Study Report	TBD

2. Key Community and Stakeholder Input

Community and stakeholder input throughout the Coastal Rail Resiliency Study (CRRS) was consistent across engagement phases and stakeholder groups, with several key themes emerging.

2.1 Nature-Based Solutions and Beach Nourishment

Participants expressed strong support for beach nourishment as a primary strategy to address coastal erosion and protect the rail corridor. Many stakeholders emphasized the importance of maintaining sandy beaches as a natural buffer while also preserving their environmental and recreational value.

2.2 Coastal Access and Recreation

Stakeholders consistently highlighted the need to maintain safe, continuous access to beaches, coastal trails, and recreational areas. Protecting the usability and connectivity of these resources was identified as a critical priority for the surrounding communities.

2.3 Shoreline Protection Concerns

Participants raised concerns about the potential impacts of shoreline protection structures such as riprap, revetments, and seawalls. These concerns focused on beach narrowing, reduced access, and potential long-term environmental effects.

2.4 Long-Term Resilience and Sustainability

Community members and stakeholders expressed interest in solutions that address the underlying drivers of coastal erosion, including sediment supply and shoreline dynamics. There was also interest in exploring regional and watershed-based strategies to improve long-term coastal resilience.

2.5 Transparency and Ongoing Engagement

Participants emphasized the importance of clear communication, transparency in decision-making, and continued opportunities for input as the study progresses.

3. How Community Input Influenced the Study

Community and stakeholder input played a meaningful role in shaping the development, evaluation, and refinement of alternative concepts in the CRRS. Feedback was incorporated throughout the study and influenced the alternatives considered and the framework used to evaluate them.

3.1 Refinement of Alternative Concepts

Public input directly informed the evolution of beachside concepts. In response to strong community preference for nature-based approaches, beach nourishment was incorporated into nearly all shoreline protection alternatives to provide both coastal resilience and community benefits.

A beach nourishment-only concept was also introduced to reflect stakeholder interest in evaluating a standalone nature-based strategy. In addition, input related to sediment supply and coastal processes contributed to the inclusion of watershed modification concepts to explore long-term opportunities for improving sand availability.

3.2 Integration into Evaluation Framework

Community priorities were incorporated into the screening and evaluation process. Criteria related to public access, environmental impacts, and consistency with community and regional priorities were elevated in importance.

As a result, the categories *Public Assets and Environmental Impacts* and *Related/Planned Projects* together account for 20 percent of the total evaluation weighting, ensuring that community considerations were meaningfully reflected alongside technical, cost, and constructability factors.

3.3 Modification and Elimination of Alternatives

Community input contributed to the decisions about which concepts advanced through the screening process. For example, shoreline protection approaches without beach nourishment were not carried forward.

At the same time, the evaluation process balanced public input with technical feasibility, permitting requirements, and long-term performance. For example, while a sand-only approach was strongly supported, technical analysis identified challenges in achieving the study's 30-year reliability objectives without recurring beach nourishment, including substantial long-term commitments for sand sourcing, placement, monitoring, permitting, and funding. The shortlisted beachside alternative concepts include a one-time beach nourishment component, reflecting its high priority within the community.

3.4 Alignment with Implementation Considerations

Stakeholder input reinforced the importance of aligning potential solutions with regulatory requirements, environmental considerations, and regional planning efforts. This helped ensure that the refined alternatives reflect both community priorities and the practical realities of implementation.

4. CONCLUSION

The Coastal Rail Resiliency Study community engagement program was designed to inform, engage, and gather feedback from a broad range of communities, stakeholders, and partner agencies throughout the study process. Through listening sessions, public meetings, and ongoing outreach, OCTA created opportunities for meaningful dialogue regarding the future of the corridor.

As the study progressed, community and stakeholder input helped shape the refinement and evaluation of alternative concepts, resulting in a set of alternatives that balance the need to protect the rail line as a vital passenger, freight, and defense transportation asset while also reflecting community priorities related to beach preservation, coastal access, recreation, and environmental stewardship. Input from community members, advocacy organizations, and state and federal resource agencies contributed to the incorporation of beach nourishment and other community-benefit considerations into the alternatives evaluated through the study.

The process demonstrates how technical analysis, regulatory considerations, and community values can be integrated to support informed decision-making. The resulting alternatives provide a foundation for advancing rail resiliency while preserving the coastal resources and public amenities that are important to the communities served by the corridor.

Appendix

COASTAL RAIL RESILIENCY STUDY

OCTA

Appendix A

A.1 Fact Sheet
A.2 FAQ
A.3 Public Meeting Flyer
A.4 Postcard Mailer
A.5 E-blast Example
A.6 Social Media Example
A.7 Press Release Example
A.8 Newspaper Advertisement Example

ORANGE COUNTY COASTAL RAIL RESILIENCY STUDY

OCGO
Local Tax Dollars at Work

OCTA is evaluating strategies to ensure uninterrupted rail operations in south Orange County.

AT A GLANCE

FUNDING: $2 million+ (Surface Transportation Block Grant Program & Measure M2)

CONTACT: Chris Boucly
Senior Department Manager
Public Outreach
(714) 560-5326
CRRS@octa.net

WEBSITE: OCTA.net/CRRS

Fact Sheet Updated 6/18/25

STUDY OVERVIEW

OCTA is studying rail challenges in south Orange County to assess existing and future environmental risks and issues with operations and maintenance along the Los Angeles – San Diego – San Luis Obispo (LOSSAN) Rail Corridor. The study will evaluate strategies to address these challenges.

OCTA owns 40+ miles of rail between the cities of San Clemente and Fullerton. This vital link in the 351-mile LOSSAN Rail Corridor is the second busiest passenger rail corridor in the nation and annually carries more than $1 billion in freight throughout Southern California. Between Los Angeles and San Diego, the line is designated as a Strategic Rail Corridor Network by the Department of Defense due to its connectivity with military bases and major ports.

Near heavily populated and built-out residential and commercial areas, this rail line is vulnerable to catastrophic failure due to changing environmental conditions and coastal erosion, rendering passenger rail service inoperable for extended periods. Service suspension has occurred multiple times over the last several years, underscoring the importance of addressing the vulnerability of the railroad.

STUDY OBJECTIVES

The Coastal Rail Resiliency Study (CRRS) will evaluate strategies to protect the railroad in place for up to 30 years and ensure uninterrupted rail operations while minimizing passenger and freight service disruptions. It will include a detailed analysis of seven miles of critical coastal rail corridor between Dana Point and San Clemente up to the San Diego County line (map of study area on reverse).

Key milestones include conducting an initial assessment to identify and evaluate locations at immediate risk; establishing evaluation criteria to vet potential alternative concepts; developing these concepts, and ultimately, presenting draft and final feasibility study reports.

A separate long-term study will look at potential rail line relocation to an inland alignment between San Juan Capistrano and San Onofre State Beach. Given the potential magnitude of this effort, it will require the involvement of state and federal agencies. Discussions are underway to determine which agency is best positioned to lead that effort.

PUBLIC INVOLVEMENT

Public involvement is a critical study component and fundamental to shaping its outcome. Initial listening sessions with stakeholders took place in 2024. Additional stakeholder and public meetings will continue through the end of the study.

STUDY MILESTONES

Orange County Transportation Authority
550 S. Main Street
P.O. Box 14184
Orange, CA 92863-1584
(714) 560-OCTA
www.octa.net


SAN JUAN CAPISTRANO
CAMINO LAS RAMBLAS
Milepost 200.0
DANA POINT
DOHENY STATE BEACH
COAST
CAMINO DE ESTRELLA
CAMINO MIRA COSTA
CAMINO DE LOS MARES
CAMINO VERA CRUZ
AVENIDA VAQUERO
CAMINO CAPISTRANO
5
CAPISTRANO BEACH PARK (COUNTY)
VISTA HERMOSA
POCHE COUNTY BEACH
SAN CLEMENTE
SAN CLEMENTE STATION
SAN CLEMENTE PIER STATION
SAN CLEMENTE CITY BEACH
EL CAMINO REAL
SAN CLEMENTE STATE BEACH
ORANGE COUNTY
SAN DIEGO COUNTY
Milepost 207.4
LOCATION MAP
Ventura
Los Angeles
Orange
MAP LOCATION
LOSSAN Corridor
Study Area
Source: OCTA
0
0.5
1
Miles

OCTA | OCGO
Local Tax Dollars at Work

ORANGE COUNTY COASTAL RAIL RESILIENCY STUDY

Frequently Asked Questions (FAQ)

STUDY BACKGROUND

What is the Coastal Rail Resiliency Study (CRRS)?

OCTA is studying challenges in south Orange County to assess existing and future environmental risks to passenger rail operations and maintenance along the Los Angeles – San Diego – San Luis Obispo (LOSSAN) Rail Corridor. The Study will develop and evaluate alternative concepts that can be applied to the bluffs, beaches, and rail infrastructure components along the coastal segment of the corridor.

What is the purpose of the Study?

Near heavily populated and built-out residential and commercial areas, rail service operates along a 7-mile stretch of beach in South Orange County. This portion of the LOSSAN Rail Corridor is affected by changing environmental conditions and coastal erosion, which has rendered passenger rail service inoperable for extended periods. Service has been suspended multiple times over the last several years, underscoring the importance of the Study.

What are the Study objectives?

The Study will evaluate alternative concepts to protect the railroad in place for up to 30 years to help minimize interruptions to passenger and freight rail operations. The Study will include a detailed analysis of seven miles of vulnerable coastal track stretching between Dana Point-San Clemente south to the San Diego County Line.

Key milestones include establishing evaluation criteria to vet potential alternative concepts to protect the rail line; developing these concepts; and ultimately presenting draft and final feasibility study reports. Feedback from the public and other stakeholders will be solicited at multiple milestones during the Study and integrated in the course of its development.

Who is leading this Study and what is the coordination with other agencies?

OCTA is leading the Study to protect the existing railroad in place. OCTA is assessing the feasibility of the alternative concepts at a high-level. The concepts will be further refined and developed upon the completion of this Study as a part of a comprehensive coastal capital program.

Who uses this corridor and why is this rail corridor important?

This segment of the 351-mile LOSSAN Rail Corridor is a vital transportation link that supports daily commuters and travelers, plays an essential role in national defense, and serves as a key BNSF freight line.

The South County portion of the LOSSAN Rail Corridor also has a diverse range of interests and stakeholders, including multiple federal, state, and local agency jurisdictions, residential and business property owners. The area has significant coastal habitat and serves millions of recreational users and tourists each year.

The LOSSAN Rail Corridor is the second busiest passenger rail corridor in the nation and annually carries more than $1 billion in freight throughout Southern California. Between Los Angeles and San Diego, the line is also designated as a Strategic Rail Corridor for national defense.

FUNDING AND SCHEDULE

How is the Study funded?

The Study is funded by the federal Surface Transportation Block Grant Program and through OCTA's local half-cent sales tax for transportation improvements – Measure M2.

What is the Study schedule?

The Study began in Fall 2023 and the Final Feasibility Study Report is scheduled for completion in Summer 2026.

ENVIRONMENTAL IMPACTS

What is causing coastal erosion in San Clemente?

Coastal erosion in San Clemente is caused by multiple factors including lack of sand supply and slope failure. The erosion has become an all-too-familiar story in recent years along Southern California's coast, with shrinking beaches and unstable slopes bringing nearby infrastructure – homes, roads, railways, utilities – much closer to the ocean tides.
For more information on sea-level rise, please see the City of San Clemente's Sea Level Rise Vulnerability Assessment.

What coastal infrastructure will be impacted by changing environmental conditions and sea-level rise along the coastal rail corridor?

Coastal erosion is threatening south Orange County's coastline, and the effects have become more severe in recent years. The railroad track, homes along the coast, and recreational facilities on the beaches are facing increased risk. Passenger rail service has been suspended on multiple occasions between Orange and San Diego counties for several months as crews conducted emergency repairs caused by beach erosion in San Clemente.

What has OCTA done to protect the tracks in San Clemente?

OCTA and Metrolink have completed four emergency projects to protect the railroad track in San Clemente as a result of coastal erosion and slides from private and city property above the track making it unsafe to operate passenger rail service.

The projects include:

- Installing ground anchors into a slope adjacent to the private Cyprus Shore community. The sliding slope created destabilizing track movement. The project cost approximately $21.7 million, and OCTA secured funding from state and federal sources to fund the project (Figure 1).

Figure 1: Cyprus Shore

- Constructing a $6 million temporary barrier wall below the City of San Clemente-owned Casa Romantica Cultural Center and Gardens where a landslide from the City's property forced debris onto the track making it unsafe to operate passenger rail service. The project was funded with state and local dollars (Figure 2).

Figure 2: Casa Romantica

- A catchment wall was constructed at Mariposa Point in San Clemente where a private property landslide caused a City of San Clemente-owned bridge to collapse and forced debris onto the track making it unsafe to operate passenger rail service. The approximately $9.2 million project was funded by the state (Figure 3).

Figure 3: Mariposa Point

- Restored existing degraded riprap protection between MP 203.80–203.90 and MP 204.00–204.40 to the tracks. The work addressed ongoing wave damage and beach erosion that has resulted in overall riprap loss from the standard design section, over-steepened slopes, unstable stones, exposure of the rail embankment to wave action, and overall degradation in protective capacity to the rail embankment in San Clemente, California. OCTA restacked and repositioned existing riprap that had fallen out of section and had become over-steepened. OCTA also installed approximately 5,895 tons of rock between the track and typical toe of slope within the railroad ROW to repair the track embankment (Figure 4).

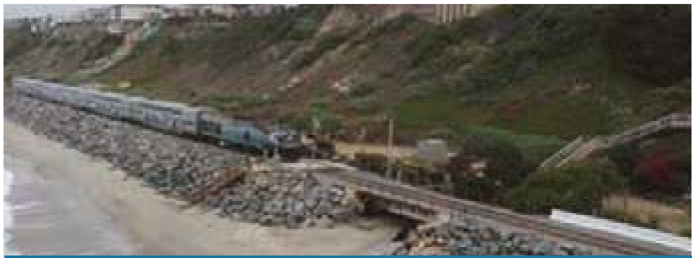


Figure 4: Area 1 and 2

Does operation of trains exacerbate the erosion or landslide potential of coastal bluffs?

The railroad has been in operation for over 130 years and there is no evidence to suggest that operating trains causes bluff erosion or landslide activity. Bluff erosion and landslide activity in the area is associated with steep slopes, unfavorable geologic conditions, surface runoff and groundwater saturation.

The protection of the rail line provides a buffer between beach erosion and inland private properties. The challenges on the inland side of the rail line will remain, unless the surface erosion and groundwater-associated issues are addressed.

None of the recent landslides at Cyprus Shores, Casa Romantica, or the Mariposa Pedestrian Trail were associated with vibrations from trains traveling through the area. In addition, rail service has been stopped and restarted at each of these locations without any correlation between movements on any of the landslides. This data has been verified with measurements taken in real-time using both below ground and surface motion sensors, which provide a continuous stream of data. These sensors indicated correlations between slope movement and rainfall as well as tidal cycles. The sensors did not indicate any landslide movements associated with rail operations. Therefore, the data does not support claims that train vibrations activate or exacerbate landslides.

Why isn't OCTA monitoring vibration and moisture content along the bluffs in San Clemente? Is that something you should understand to predict landslides?

Recognizing that the bluffs are generally outside of OCTA's right-of-way, we are limited in our ability to conduct activities on property outside of our control. It is clear the bluffs contain persistent groundwater flow demonstrated by naturally occurring springs visible along the entire alignment. Because of this, monitoring groundwater would not provide actionable data to predict exact landslide locations that would potentially impact rail service. There is no evidence or correlation of train movements causing vibrations significant enough to contribute to activating landslides in this corridor (see previous detailed answer).

NEIGHBORING AND PAST STUDIES

What are examples of studies and work that have been completed so far?

There are many local, regional and state projects that have come before this Study, each providing context and understanding to various aspects and challenges. A few projects and studies that will help inform the process ahead are:

- San Diego Association of Governments (SANDAG) Del Mar Rail Realignment (ongoing) – assessing the conditions and options to continue rail service in San Diego County.
- OCTA's San Clemente Track Protection Project (2023) – included installation of a temporary barrier wall in response to an adjacent landslide.
- San Clemente Coastal Resiliency Plan (2021) – to assess how sea-level rise and sand erosion will impact the coastal town.
- OCTA's Rail Infrastructure Study Defense Against Climate Change (2020) – an early study to assess the potential effects of climate change on OCTA's rail corridor.
- City of Dana Point Sea Level Rise Vulnerability Assessment (2019) – to assess City's vulnerability of infrastructure, land uses, and coastal resources in the Dana Point coastal zone.
- City of San Clemente Sea Level Rise Vulnerability Assessment (2019) – to assess City's vulnerability of infrastructure, land uses, and coastal resources in the San Clemente coastal zone.
- OC Sand Compatibility Use Program (2017) – recommended policy and action to promote the availability of upland sand sources for beach nourishment to guide the formulation of Orange County's opportunistic beach nourishment program.
- OC Coastal Regional Sediment Management Plan (2013) – information to develop policies and/or execute management sub-plans to restore and preserve the future vitality of Orange County beaches and coastal areas.

SAND SOURCE, VIABILITY, AND MANAGEMENT

Why isn't sand only sufficient to provide protection for the railroad?

Sand only is being considered as an alternative concept, however the protection offered by sand diminishes over time. Sand nourishment projects typically require replenishment cycles to replace the sand that erodes and is redistributed along the shore, which requires perpetual cost to monitor and maintain. While OCTA is supportive of a regional solution to bring more sand back to South County beaches, the LOSSAN Rail Corridor is a strategic and critical rail network that cannot afford to be disrupted. A sand-only solution may not provide the desired design life to protect the crucial asset under extreme erosion or storm conditions without significant planned maintenance and/or placement of large sand volumes that may not be permittable due to recreational and environmental impacts.

What are the differences between the United States Army Corps of Engineers (USACE) and California Coastal Commission (CCC) agency objectives regarding sand management approaches?

The USACE's objectives are to keep navigational channels clear, provide shoreline protection to avoid and minimize aquatic resource losses, and allow for commerce to travel. The CCC's primary objectives are to preserve public access to the coast, enhance coastal access where possible, conserve natural resources within the Coastal Zone, and plan for long-range coastal development.

Why is armoring structure preferred to protect the railroad? How does the armoring structure protect against wave action that can damage the railroad?

Armoring provides key protection and stability to the railroad as the last line of defense. We plan on pairing the armoring with sand nourishment, however the sand is subject to higher erosion and lateral transport, and therefore the armoring is required to protect and stabilize the track embankment. Seawalls are an alternative armoring structure that provide last line of defense to the railroad with a smaller beach footprint.

The railroad track embankment is built of porous ballast, which is naturally draining. The armoring is designed to be interlocking with voids, which allows for good drainage and energy absorption which reduces erosive forces on the railroad. Armoring is durable and cost effective with its ability to withstand harsh environmental conditions, making it suitable for the railroad as it requires minimal maintenance.

PUBLIC PARTICIPATION

How can the public provide input on the Study?

Stakeholders will have a number of opportunities to learn about the evolving alternative concepts and provide input throughout the Study. A series of Listening Sessions were held in 2024 with a variety of interest groups including a series of public meetings to learn from a broad and diverse range of key stakeholders and interested parties. Additional public meeting opportunities will occur throughout the Study in the development of a draft and final study report.

How can I get involved?

Public participation and engagement will be ongoing throughout the Study development. Please sign-up to receive Study updates at OCTA.net/CRRS.

Who do I contact with Study questions?

Please direct public comments and inquiries to OCTA's Senior Public Outreach Department Manager, Chris Boucly, either via email at cboucly@octa.net or by phone at (714) 560-5326.

OCTA | OCGO Local Tax Dollars at Work — REBUILDING CA

Orange County Transportation Authority
550 S. Main Street
P.O. Box 14184
Orange, CA 92863-1584
(714) 560-OCTA
www.octa.net

COASTAL RAIL RESILIENCY STUDY

Join our public meetings and share your input!

The Orange County Transportation Authority (OCTA) recently initiated the Coastal Rail Resiliency Study (CRRS). The train tracks between Dana Point and the county line are used for travel by commuters, tourists, goods movement and the Department of Defense.

The CRRS is exploring solutions to protect approximately seven miles of coastal railroad in place for up to 30 years.

We want to hear from you!

Join our virtual and/or in-person public meetings to learn more about the study and provide your input. The same information will be presented at each meeting.

Public Meeting #1 (Virtual)
Thursday, April 11, 2024
5:00 – 6:30 p.m.
Zoom Link: https://bit.ly/CRRS-PublicMtg1
Webinar ID: 871 3383 6211
Call-in: +1 (669) 900-6833

Public Meeting #2 (In Person)
Thursday, May 30, 2024
5:00 – 6:30 p.m.
San Clemente City Hall
910 Calle Negocio, San Clemente, CA 92673

Spanish interpretation will be available at both meetings. Special accommodations and additional interpretations are available by calling 714-636-7433. Requests must be made at least 72 hours in advance of a scheduled meeting.

octa.net/crrs

crrs@octa.net

Scan to sign up for updates!

COASTAL RAIL

RESILIENCY STUDY

Scan to sign up for updates!

!Escanee para inscribirse y recibir notificaciones!

OCTA

Join our public meetings and share your input!

The Orange County Transportation Authority (OCTA) recently initiated the Coastal Rail Resiliency Study (CRRS). The train tracks between Dana Point and the county line are used for travel by commuters, tourists, goods movement and the department of defense.

The CRRS is exploring solutions to protect approximately seven miles of coastal railroad in place for up to 30 years.

¡Participe en nuestras reuniones públicas y comparta su opinión!

La Autoridad de Transporte del Condado de Orange (OCTA) inició recientemente el Estudio de Resiliencia del Ferrocarril Costero (CRRS). Las vías del tren entre Dana Point y la línea del condado son utilizadas por viajeros, turistas, movimiento de mercancías y el departamento de defensa.

El CRRS está explorando soluciones para proteger aproximadamente siete millas de ferrocarril costero por hasta 30 años.

COASTAL RAIL RESILIENCY STUDY

We want to hear from you!

Join our virtual and/or in-person public meetings to learn more about the study and provide your input. The same information will be presented at each meeting.

Public Meeting #1 (Virtual)
Thursday, April 11, 2024
5:00 – 6:30 p.m.
Zoom Link: https://bit.ly/CRRS-PublicMtg1
Webinar ID: 871 3383 6211
Call-in: +1 (669) 900-6833

Public Meeting #2 (In Person)
Thursday, May 30, 2024
5:00 – 6:30 p.m.
San Clemente City Hall
910 Calle Negocio, San Clemente, CA 92673

Spanish interpretation will be available at both meetings. Special accommodations and additional interpretations are available by calling 714-636-7433. Requests must be made at least 72 hours in advance of a scheduled meeting.

¡Queremos escuchar su opinión!

Participe en nuestras reuniones públicas virtuales y/o en persona para obtener más información sobre el estudio y dar su opinión. La misma información se presentará en cada reunión.

Reunión pública #1 (Virtual)
Jueves, 11 de abril de 2024
5:00 a 6:30 p.m.
Enlace de Zoom: https://bit.ly/CRRS-PublicMtg1
ID del seminario web: 871 3383 6211
Por teléfono en español: +1 (571) 317-3112
Código de acceso: 625-161-933

Reunión pública #2 (En persona)
Jueves, 30 de mayo de 2024
5:00 a 6:30 p.m.
San Clemente City Hall
910 Calle Negocio, San Clemente, CA 92673

Habrá interpretación en español en las dos reuniones. Adaptaciones especiales e interpretaciones adicionales están disponibles llamando al 714-636-7433 por lo menos 72 horas antes de cada reunión.

Stay Connected
Manténgase conectado
octa.net/crrs
crrs@octa.net

OCTA

Orange County Transportation Authority
c/o Arellano Associates
5851 Pine Avenue, Suite A
Chino Hills, CA 91709

PRESORTED
FIRST CLASS
U.S. POSTAGE PAID
SANTA ANA, CA
PERMIT NO. 985

Jessica Rangel

From: Orange County Transportation Authority <crrs@projectinfo.ccsend.com>
Sent: Tuesday, April 9, 2024 10:05 AM
To: Jessica Rangel
Subject: Reminder: Join us for a Virtual Public Meeting on 04/11!

Español

Dear Community Member/Stakeholder:

The Orange County Transportation Authority (OCTA) recently initiated the Coastal Rail Resiliency Study (CRRS). The train tracks between Dana Point and the county line are used for travel by commuters, tourists, goods movement and the department of defense. The CRRS is exploring solutions to protect approximately seven miles of coastal railroad in place for up to 30 years. ***We want to hear from you! Join our public meetings to learn more about the study and provide your input.***

Upcoming Public Meetings

Public Meeting #1 (Virtual)
Thursday, April 11, 2024
5:00 – 6:30 p.m.
Webinar ID: 871 3383 6211
Call-in: +1 (669) 900-6833

Register Here

Public Meeting #2 (In-Person)
Thursday, May 30, 2024
5:00 – 6:30 p.m.
San Clemente City Hall
910 Calle Negocio, San Clemente, CA 92673

Spanish interpretation will be available. Special accommodations and additional interpretations are available by calling 714-636-7433. Requests must be made at least 72 hours in advance of a scheduled meeting.

Study Overview

OCTA is Orange County's lead transportation agency which owns and is tasked with maintaining an operable segment of the Los Angeles-San Diego-San Luis Obispo Rail Corridor (LOSSAN), one of the state's busiest passenger rail routes and an essential link in the region's freight and goods movement network. The purpose of this study is to identify and analyze short- and medium-term improvement concepts that could protect the existing railroad along its current alignment ensuring uninterrupted service and benefiting economic vitality.

Key Milestones

Key milestones expected from the CRRS include conducting a vulnerability assessment to identify and evaluate locations at immediate risk; establishing evaluation criteria to vet potential alternative concepts; developing these concepts, and ultimately presenting draft and final feasibility study reports. OCTA will build on previous efforts led by others, as appropriate. Additionally, maintaining active stakeholder involvement will be crucial throughout this study, beginning with a series of listening sessions and continuing with consistent engagement throughout the 24-month study duration.

Contact Us

For more information regarding the study, please visit the website at ***octa.net/crrs***.

OCTA

April 3 ·

You're invited! The **Coastal Rail Resiliency Study** (CRRS) is exploring solutions to protect approximately seven miles of coastal railroad in place for up to 30 years. Join our public meetings to learn more about the CRRS and share your thoughts.

📅 Thurs., April 11 | 5:00–6:30 p.m. 📍Zoom
📅 Thurs., May 30 | 5:00–6:30 p.m. 📍 San Clemente City Hall

Visit www.octa.net/CRRS for m... See more

13 5

Like Comment

FOR MORE INFORMATION:
Eric Carpenter (714) 560-5697
Megan Abba (714) 560-5671

FOR IMMEDIATE RELEASE:
March 11, 2024

OCTA Continues Rail Protection Work on Both Emergency and Longer-Term Basis

While emergency work in San Clemente has been top priority, OCTA continues to work with local, state and federal partners to study and secure funding for lasting solutions

ORANGE – While the Orange County Transportation Authority and Metrolink team continues emergency work to protect the rail line in San Clemente at Mariposa Point, OCTA is pushing ahead on a study to find lasting solutions to prevent additional emergencies by addressing other areas in need of reinforcement.

On Monday, the OCTA Board received an update on the Coastal Rail Resiliency Study and an initial assessment that identified sites along the coastal rail line recommended for monitoring and reinforcement to ensure that rail traffic can continue moving without additional interruptions.

“We understand this rail line is vital for the safe movement of people and goods in Orange County and the region,” said OCTA Chair Tam T. Nguyen. “So even as we complete the emergency work, OCTA is moving forward on many fronts, along with all our partners and stakeholders, to make sure we are protecting the coastal rail line for many years to come.”

The OCTA-led Coastal Rail Resiliency Study aims to evaluate and implement strategies to fortify the railway in the vulnerable 7-mile stretch between Dana Point and the San Diego County Line and to keep rail traffic moving through the area for the next 30 years, while longer-term solutions are explored.

The initial assessment presented to the Board on Monday identified seven areas along that stretch in need of reinforcement and monitoring, to prevent additional soil and debris from privately owned hillsides from falling into the rail right of way. The potential solutions are meant to protect the track from threats on the coastal and inland side caused by erosion and storm surges, among other risks.

Potential solutions for near-term reinforcement include installing monitors to analyze soil or track movement, building additional catchment walls, and engineering placement of large protective boulders (known as riprap) where appropriate.

Bringing in additional sand on the coastal side, as mentioned by numerous community groups and members of the public, is also being studied as part of the longer-term solution.

The immediate goal is to address the areas identified in need of reinforcement as soon as possible before the next storm season arrives. OCTA will continue to work with local, state and federal partners and explore all funding options.

At the same time, OCTA is working on the Coastal Rail Resiliency Study, meeting with groups of stakeholders in individual listening sessions to discuss the study and get input all along the way.

Two listening sessions with the public are being planned:

- **April 11, a virtual public meeting via Zoom will be held to get public input.**
- **May 21, an in-person public meeting will be held in San Clemente. (Details about the time and location of that meeting are still being finalized.)**
- **To register to attend either meeting and receive updates, please visit: www.octa.net/CRRS.**

While the areas in need of immediate reinforcement are being addressed, the Coastal Rail Resiliency Study continues. The initial concepts developed with community input are scheduled to be presented later this year, then refined, before a draft plan to address protecting the rail line in place for the next 10 to 30 years goes to the OCTA Board in 2025.

Because California continues to grapple with the increasing prevalence of storm-related damage to its transportation infrastructure, OCTA recognizes the importance of adaptive strategies to maintain safe and efficient rail services.

OCTA will also work with all partners and stakeholders to explore long-term solutions for protecting rail movement for generations to come – solutions that could eventually include moving the rail line inland. As part of those long-term efforts, OCTA is advocating for state-led capital project effort to address concerns along the 351-mile LOSSAN corridor to safeguard the future of rail transportation across the region.

Update on Emergency Work

The OCTA and Metrolink team are continuing work on a nearly 200-foot-long catchment wall at Mariposa Point (Milepost 204.2) in San Clemente to protect the track, following a Jan. 23 landslide on a privately owned slope above the rail line.

The 33 steel beams that form the foundation of the wall were finished last week, and the team on Monday finished installing the wooden panels that will make up the wall to prevent additional soil and debris from falling into the rail right of way.

On March 6, Amtrak Pacific Surfliner resumed limited passenger service through the area during morning and evening hours, so that the wall construction could continue throughout daytime hours.

With the catchment wall in place, grading, drainage and additional track work will continue throughout this week. Once the construction work is finished, OCTA, Metrolink and the LOSSAN Rail Corridor Agency will work together to safely restore full passenger service as soon as possible. That schedule is still being determined.

Passengers are asked to check for the latest service updates at www.metrolinktrains.com and www.pacificsurfliner.com/alerts.

For more information and updates on the current rail work visit www.octa.net/railupdates.

# # #

About OCTA: The Orange County Transportation Authority is the county transportation planning commission, responsible for funding and implementing transit and capital projects for a balanced and sustainable transportation system that reflects the diverse travel needs of the county's 34 cities and 3.2 million residents. With the mission of keeping Orange County moving, this includes freeways and express lanes, bus and rail transit, rideshare, commuter rail and active transportation. To sign up for more OCTA news, visit octa.net/GetConnected

Giant crochet transforms Casa Romantica

BY ANGÉLICA ESCOBAR

The art gallery at Casa Romantica has transformed. Once a bright, spare room with white walls and traditional Spanish Revival architecture, the space now pulses with texture and tension. Crimson threads creep across ceilings, wrap around doorways and burst from alcoves in dense, knotted clusters. These are not your grandmother's doilies.

They are the work of Ashley V. Blalock, a San Diego-based fiber artist whose site-specific installation "Keeping Up Appearances" is now on view through Sept. 7. Using the traditional crochet doily as her primary sculptural form, Blalock reclaims the domestic and decorative object to explore themes of memory, family, materiality and discomfort.

Blalock says the doily was a natural starting point for her medium: "Crochet holds its shape once you block it. It's not like knitting — it's sti er, stronger. Doilies were traditionally used to protect furniture, but now people don't use them anymore. We're not preserving heirloom furniture — we're assembling flat-pack IKEA."

The disappearance of the doily from everyday life, she says, speaks to a broader cultural shift: "I like old things. Things that last. These days, everything is made to fall apart. We throw it away. This work mourns that a little."

At Casa Romantica, her doilies have grown in scale

(Cont. on page 6)

Ashley V. Blalock's Keeping Up Appearances transforms Casa Romantica's gallery with sprawling red crochet doilies, blending domestic tradition with bold, site-specific installation. On view through Sept. 7. Photo: Angélica Escobar

Appendix D. Expert Panel Workshop Summary Report

Expert Panel Workshop Summary Report

Prepared for: Orange County Transportation Authority (OCTA)
550 South Main Street
P.O. Box 14184
Orange, CA 92863-1584

Prepared by: Arellano Associates
5851 Pine Avenue, Suite A
Chino Hills, CA 91709

Page intentionally left blank.

Table of Contents

Overview

Purpose of Expert Panel

The purpose of the Coastal Rail Resiliency Study (CRRS) expert panel session was to engage with academic and professional experts from various disciplines including coastal geomorphology, marine biology, geotechnical engineering, and coastal engineering and document their input regarding the CRRS. The panel experts were selected based on their previous work and knowledge of the various disciplines related to coastal challenges in the region. The CRRS is underway to assess a seven-mile stretch of the coastal rail line to minimize passenger rail service disruptions. The workshop occurred between December 3 and 4, 2024.

Desired Goals

The goal of the expert panel session was to elicit feedback from the group to identify any further measures needed to safeguard the south Orange County coastal rail line in place for the foreseeable future, which is estimated to be several decades out. Through informative presentations and collaborative discussions with academic and professional experts, the session sought to:

- Provide experts with a background and history of the rail line, previous emergencies that have led to passenger rail service disruptions, and the four reinforcement area projects to proactively protect the coastal rail line
- Provide an overview of the existing seven typical sections and concepts that are part of the short- to medium-term study
- Gather feedback on whether OCTA could have taken a different approach in addressing the previous emergencies; the initial assessment and short- to medium-term study
- Document expert feedback, questions, concerns, etc.

Panel Format

The expert panel was a two-day in-person session that consisted of presentations, discussions, and a site visit. Jeff Ball, the Chief Executive Officer of the Orange County Business Council (OCBC), served as the facilitator for the session to guide dialogue and create a collaborative discussion that led to meaningful and productive insights. During the two-day session, OCTA shared background information on OCTA's role in the LOSSAN corridor, past rail closures, and impacts and challenges of changing environmental conditions. OCTA also provided an overview of the CRRS multi-phased approach, reviewed the initial four reinforcement areas, and conducted a site visit to key locations – San Clemente State Beach, Casa Romantica, and Mariposa Point. In addition, OCTA discussed ongoing regional efforts, reviewed draft alternative concepts, and short- to medium-term solutions.

Materials

Panelists were provided with informational print materials including:

- Itinerary
- Factsheet
- Initial Assessment Technical Memo
- August 29, 2024 Staff report, presentation, and attachments to OCTA Board
- Copies of presentations
- Study area map handout
- Typical sections 1-7 handout

Panel Details

MEETING DETAILS	Holiday Inn Express, San Clemente, CA Tuesday, December 3, 2024 | 10:00 AM – 5:30 PM Wednesday, December 4, 2024 | 9:00 AM – 3:00 PM
Project Team	Six Presenters: Darrell E. Johnson, Rose Casey, Dan Phu, Rob Klovsky (HDR), Gheorghe Rosca (HDR), and Avi Shah (HDR) One Coastal Frontiers Representative: Russel Boudreau (Coastal Frontiers) Three Outreach Consultants: Maria Yañez-Forgash (AA), Nancy Verduzco (AA), and Keven Michel (AA) Three additional project staff in attendance
Moderator	Jeff Ball, OCBC
Panelists	• Adam Young, Scripps Institution of Oceanography • Wenkai Qin, NV5 • Lawrence Honma, Merkel & Associates • James Gingery, Keller West

Discussion

PREVIOUS EMERGENCY WORK

After learning about the previous emergency work, panelists were asked if OCTA should have done things differently with previous emergencies. See below for key takeaways.

A. Key Takeaways

- An observation from one of the panelists indicated the riprap at Cyprus Shore may function as a mini jetty and accumulate sand. There is no “one time fix” – maintenance and monitoring will likely be a part of any solution.
- Moving forward, OCTA should consider riprap greater than 6-ton in size, as this provides greater stability.
- The OCTA team indicated Cyprus Shore is the only known ancient landslide in the study area but will have an expert/certified geologist review stereoscopic photographs and old geologic maps. Consider a risk ranking system.

REINFORCEMENT AREAS

Panelists also had an opportunity to discuss the four reinforcement areas. Below is a summary of key takeaways.

A. Key Takeaways

- OCTA should assess the existing conditions to establish baseline biological resources conditions of the project area. These would include assessing the terrestrial and marine resources.

- OCTA should assess the baseline sand profile conditions and geotechnical risk factors with the bluffs.
- Consider modifying the armoring so that it would be covered with sand. This reaffirms OCTA's plan to place sand as a self-mitigating measure of the armoring actions.
- Panelist noted it is unusual to see such a wide variance in beach width in a small area.
- Panelists offered to conduct peer reviews of key studies.

SHORT- TO MEDIUM-TERM SOLUTIONS

OCTA conducted a robust discussion of the short- to medium-term concepts, which consist of a menu of bluffside, beachside, and rail concepts. These concepts were used to apply to each typical section throughout the seven-mile stretch of the study area. Below are key takeaways received during this discussion.

A. Key Takeaways

- OCTA consultant provided an overview of the short- and mid-term concepts, a panelist suggested that OCTA consider habitat friendly concrete blocks in the lower portions of the engineered revetment. The panelist noted the Port of San Diego had piloted this method and it was approved by Coastal Commission. OCTA should also consider sand dunes, where feasible.
- Consider out of kind fee contributions or contribute funding to other agencies' efforts to mitigate for potential impacts. OCTA should consider self-mitigating project features or components. This should be the theme for any of the proposed armoring actions that are part of this effort. Note, OCTA will be responsible for additional monitoring activities.
- A panelist suggested that OCTA consider opportunities to repurpose materials from the inland side of the rail line.
- The group engaged in a good discussion on the feasibility of grouting methods. It's important to keep in mind whatever solutions are being looked at, they would not impede groundwater movement/flow. The group agreed that horizontal drains are the most efficient dewatering method versus any vertical drainage system.
- A panelist suggested OCTA undertake a comprehensive biological and cultural assessment of the study area.
- Discussions ensued regarding the benefits of engineered revetment vs. seawall; the panelists recognized that seawalls have a smaller footprint but deeper foundation and reflect wave energy. Therefore, riprap may be easier to permit than seawalls. A panelist noted seawalls can be challenging with dewatering, concerned with existing materials (i.e., riprap) that would make constructing a seawall difficult.
- The group discussed the necessary height and challenges related to elevating the rail line.
- A panelist suggested that OCTA consider looking at a rail bridge concept, similar to what has been implemented in New South Wales, Australia (Sea Cliff Bridge - Stanwell Park | VisitNSW.com).
- A panelist inquired if there is a potential to include a trail on top of seawalls. Additional discussions ensued regarding integrating self-mitigating project components.
- OCTA should consider artificial reef, breakwater, and other sand retention measures. Reefs have co-benefits with wave dissipation.
- OCTA should put more emphasis on monitoring and having current data. This will help in understanding the baseline conditions and aid in comparing post-construction conditions, which

may be a requirement of the Coastal Commission. This data is needed for the bluffs which would include augmenting existing LiDAR data for certain areas of the bluff.
- There is no "one size fits all" solution and OCTA should consider sand retention features along with sand nourishment and sand dunes.
- Need to consider a program of solutions for each segment, clearly define who the lead is for those efforts as well as improvements that would be implemented/funded by others.
- OCTA should perform baseline biological resources survey on both land and offshore areas.

NEXT STEPS

Rose concluded the panel session by thanking panelists for their participation and insightful feedback. She summarized key points and shared next steps, including the following:

- OCTA will synthesize insights from the panelists.
- OCTA will look to augment how we evaluate the various concepts as they head into the evaluation process.
- OCTA will share the concepts with the Project Development Team, which is comprised of the cities of San Clemente, Dana Point, and San Juan Capistrano, County of Orange, State Parks, and others.
- OCTA will present these concepts to the OCTA Board early 2025 and then consider the general input in the process.
- OCTA will look into establishing a baseline for the biological resource conditions of the project area.
- OCTA will look into assessing the baseline sand profile conditions and geotechnical conditions of the bluffs.
- OCTA will have check-ins with the public as the study progresses.
- OCTA will follow up with panelists to see if they're interested in doing a peer review of certain technical studies.

Appendix E. Detailed Scoring Sheet

Short Name	Concept Name	Rail Resilience & Reliability	Implement-ability & Construct-ability	Public Assets & Environ-mental	Cost	Alignment with Related Planned Projects	Concept Total Score (Weighted)	Rank
Rail-1	1 - Raised Track Embankment	16.5	9.6	14.4	11.2	12.0	**64**	**3**
Rail-2	2 - Alternative materials for critical railroad infrastructure to reduce lifecycle costs	25.5	30.0	24.0	17.6	12.0	**109**	**1**
Rail-3	3 - Ground improvement (track-bed stabilization)	30.0	21.6	17.3	20.8	12.0	**102**	**2**
Bluff-1	1 - Catchment walls (block slide debris)	30.0	26.4	18.7	17.6	9.6	**102**	**1**
Bluff-2	2 - Stabilization grading (buttress slide toe)	30.0	18.0	14.9	16.0	7.2	**86**	**8**
Bluff-3	3 - Tieback / soil nail / pin-pile walls (mitigate larger slides)	30.0	18.0	20.6	20.8	12.0	**101**	**2**
Bluff-4	4 - Ground improvement (bluff stabilization)	22.5	19.2	19.2	20.8	12.0	**94**	**5**
Bluff-5	5 - Surface matting & deep-rooted vegetation planting (reduce sediment erosion)	21.0	22.8	21.6	17.6	12.0	**95**	**3**
Bluff-6	6 - Drainage improvement via grading / detention basins / undertrack outlets	19.5	24.0	16.8	22.4	7.2	**90**	**6**
Bluff-7	7 - Deflection walls in tributaries (reduce flood and sedimentation flow rates)	16.5	21.6	18.7	17.6	9.6	**84**	**9**
Bluff-8	8 - Up-gradient cut-off drains (reduce source of water)	21.0	21.6	18.2	24.0	9.6	**94**	**4**
Bluff-9	9 - Hydraugers (lower hydraulic pressure and slide potential)	27.0	14.4	16.8	20.8	7.2	**86**	**7**
Beach-1	1 - Beach nourishment with planned replenishment with No Shoreline protection structure	12.0	14.4	18.2	4.8	12.0	**61**	**5**
Beach-2.1	2.1 - One-time sand placement with shoreline protection structure (1 - Riprap)	21.0	15.6	14.9	9.6	7.2	**68**	**3**
Beach-2.2	2.2 - One-time sand placement with shoreline protection structure (2 - Engineered rock revetment)	22.5	9.6	14.9	11.2	7.2	**65**	**4**
Beach-2.3	2.3 - One-time sand placement with shoreline protection structure (3 - Vertical seawall)	22.5	14.4	14.9	11.2	7.2	**70**	**2**
Beach-2.4	2.4 - One-time sand placement with shoreline protection structure (4 - Combination of seawall and rock)	24.0	14.4	15.4	9.6	7.2	**71**	**1**
Beach-3	3 - One-time sand placement with sand retention measures (artificial reefs, breakwaters, jetties) & NO shoreline protection structure	15.0	8.4	13.0	4.8	7.2	**48**	**11**
Beach-4.1	4.1 - One-time sand placement with sand retention measures (artificial reefs, breakwaters, jetties) & shoreline protection structure (1 - Riprap)	21.0	7.2	15.4	3.2	7.2	**54**	**8**
Beach-4.2	4.2 - One-time sand placement with sand retention measures (artificial reefs, breakwaters, jetties) & shoreline protection structure (2 - Engineered rock revetment)	22.5	4.8	15.4	3.2	7.2	**53**	**9**
Beach-4.3	4.3 - One-time sand placement with sand retention measures (artificial reefs, breakwaters, jetties) & shoreline protection structure (3 - Vertical seawall)	22.5	8.4	14.9	3.2	7.2	**56**	**7**
Beach-4.4	4.4 - One-time sand placement with sand retention measures (artificial reefs, breakwaters, jetties) & shoreline protection structure (4 - Combination)	25.5	9.6	15.4	3.2	7.2	**61**	**6**
Beach-5	5 - Watershed modifications to increase beach sand supply (implemented by others)	7.5	9.6	8.6	14.4	12.0	**52**	**10**

Notes:

Beach-1: Assumed to be every five years and implemented by other agency outside of OCTA