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Planning for Sea Level Rise at AWWTP

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Problem Overview

The City of Arcata has reached out to the ERE department to design solutions for protecting Arcata Wastewater Treatment Plant (AWWTP) from the predicted sea level rise (SLR) of 1.67 meters by 2100 (OPC, 2020) Using the engineering design process, three alternatives were generated. The Delphi method found that a living shoreline design would meet design criteria.

Alternative Analysis

Alternative 1: Fortifying with increased height of levee, the entire length around the treatment plant.

Alternative 2: Relocation to land parcel above highway 255. Design utilizes caltrans fortification of Highway 255 as sea wall protection. Plant is relocated inland of Bay with newly constructed saltwater wetlands.

Alternative 3: Living Shorelines (preferred)

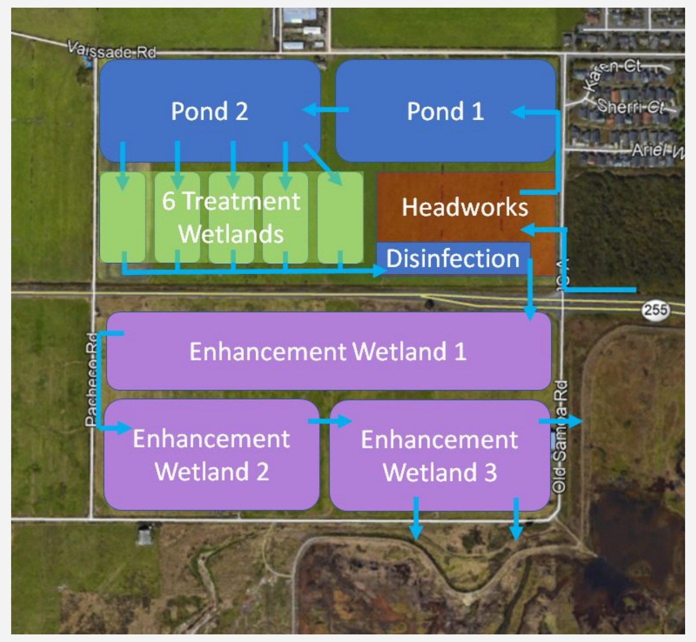

Figure 1: Treatment plant layout for relocation option (Alternative 2).

Table 1: Weighting results for determining optimum alternative

Delphi Martix			Score					
			Living Shoreline		Levy Fortification		Relocation	
Criteria		Client Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Economic	Implementation (Capital Cost)	8	8	64	3	24	3	24
	Net Operation/ Maintenance	8	9	72	3	24	6	48
Environmental	Habitat Protection & Mitigation	4	8	32	7	28	3	12
	Energy Demand	5	5	25	5	25	1	5
	Prevention of Sea Level Rise/Adaptability	10	8	80	4	40	9	90
Social	Human Community Protection	6	5	30	5	30	8	48
	Community Enhancement & Approval	5	8	40	4	20	6	30
		Total	343		191		257	

Preferred Alternative: Living Shorelines

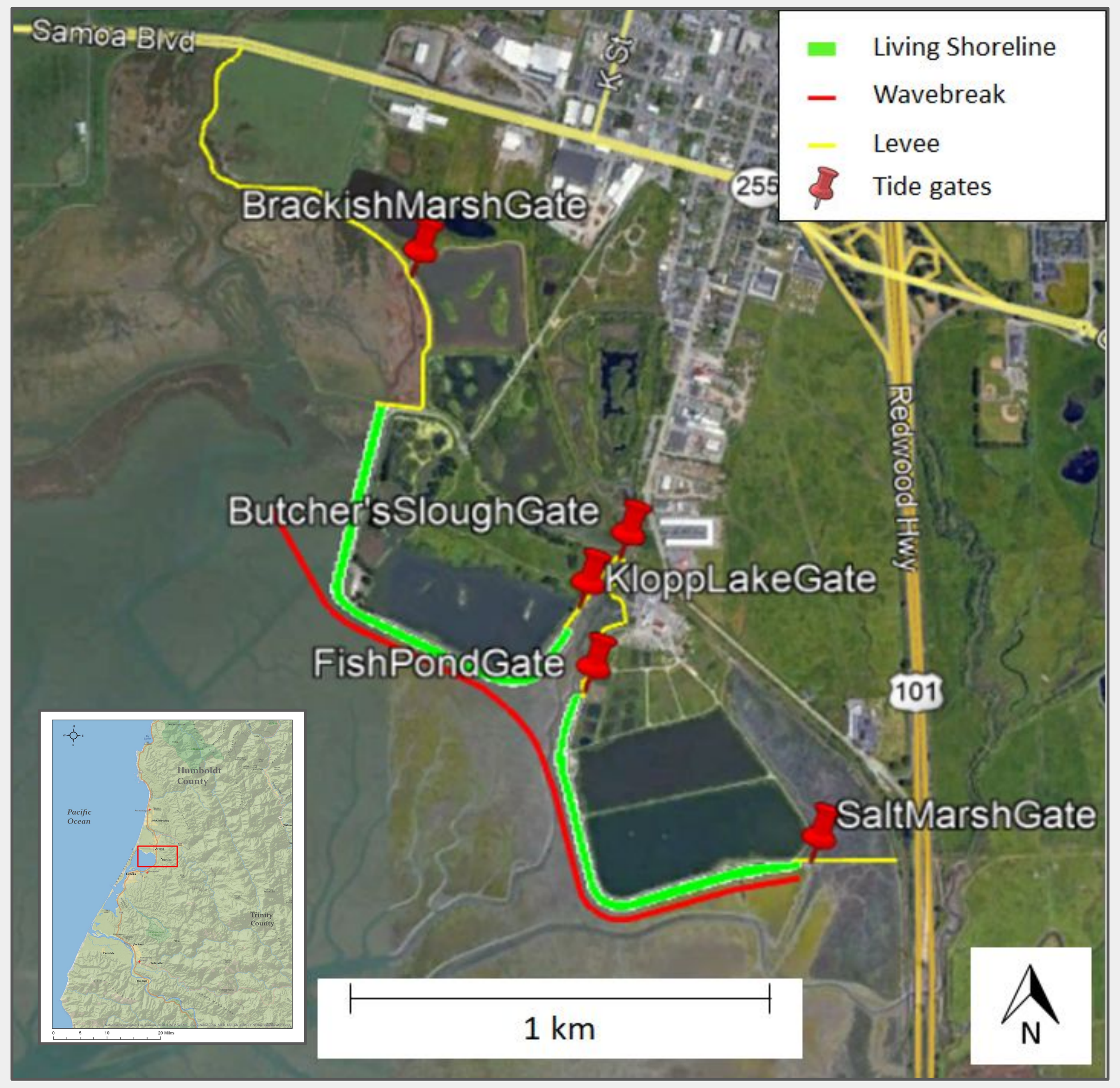

Figure 2 : Layout of design location in the Arcata Bay, with tide gate locations, revetment and living shoreline.

Shoreline (Figures 4 & 6)

- 10:1 slope, recommended for salt marshes/ sediment accumulation (Smith, 2006)
- Top elevation: 10 feet
- Width: 87 feet
- Planted with native saltmarsh vegetation
- oyster reef material toe
- Wavebreak 20 meters offshore
  - 2.5'x 3' concrete reef balls
  - 2 staggered rows, 3' between each ball

The overall design is meant to encourage natural sediment accumulation on the living shoreline, allowing it to build up in height over time in response to rising sea levels. The shoreline is planted with a variety of vegetation for better resiliency and bank stabilization. Wave breaks are placed offshore to dissipate incoming wave energy, allowing for marsh stability. A revetment system and tide gates encompass areas where a living shoreline is infeasible.Total cost for this design was estimated at $14.8 million .

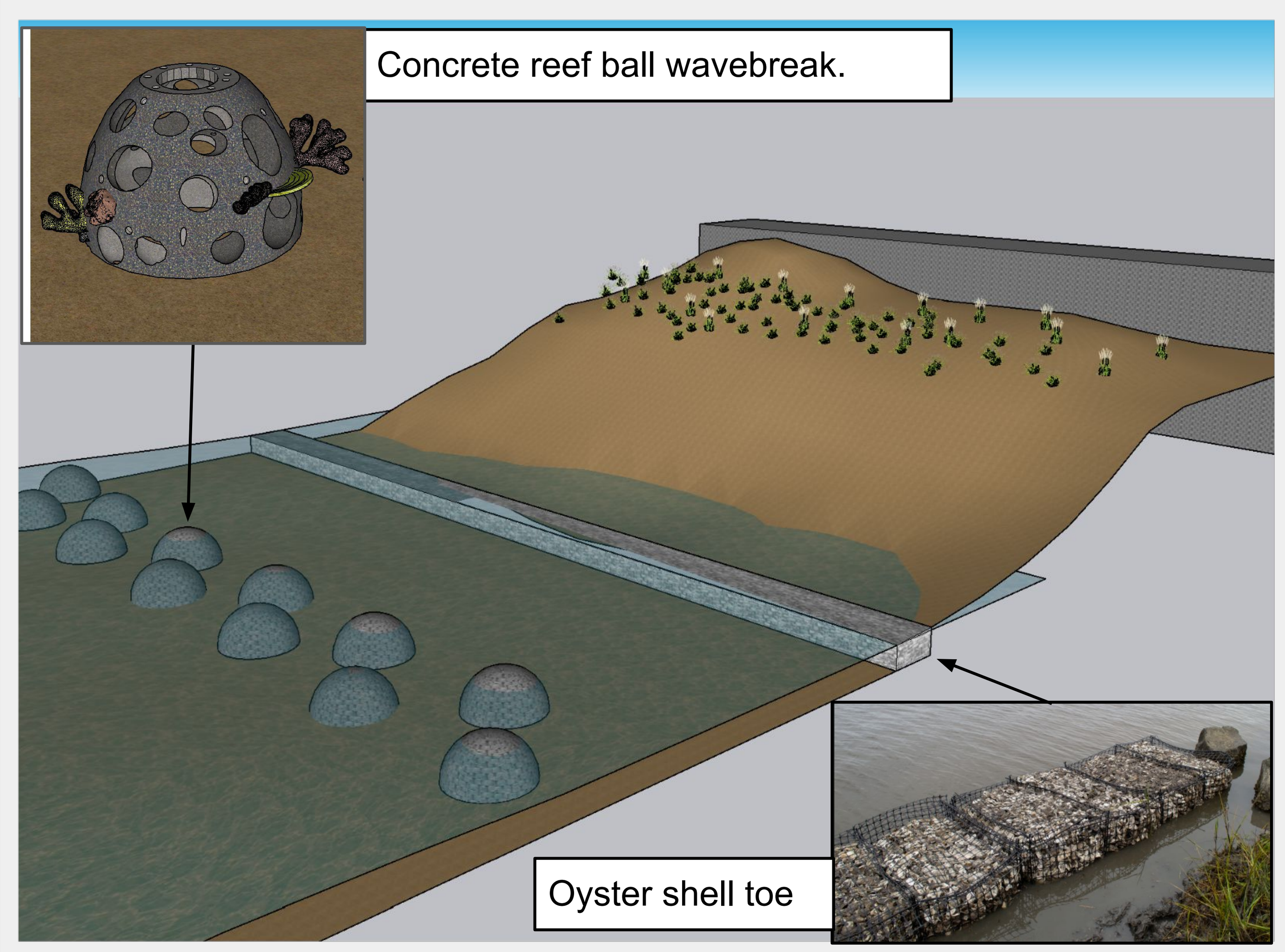

Figure 4: 3D rendering of living shoreline, incorporating concrete wavebreak reef balls, an oyster shell toe, and native vegetation.

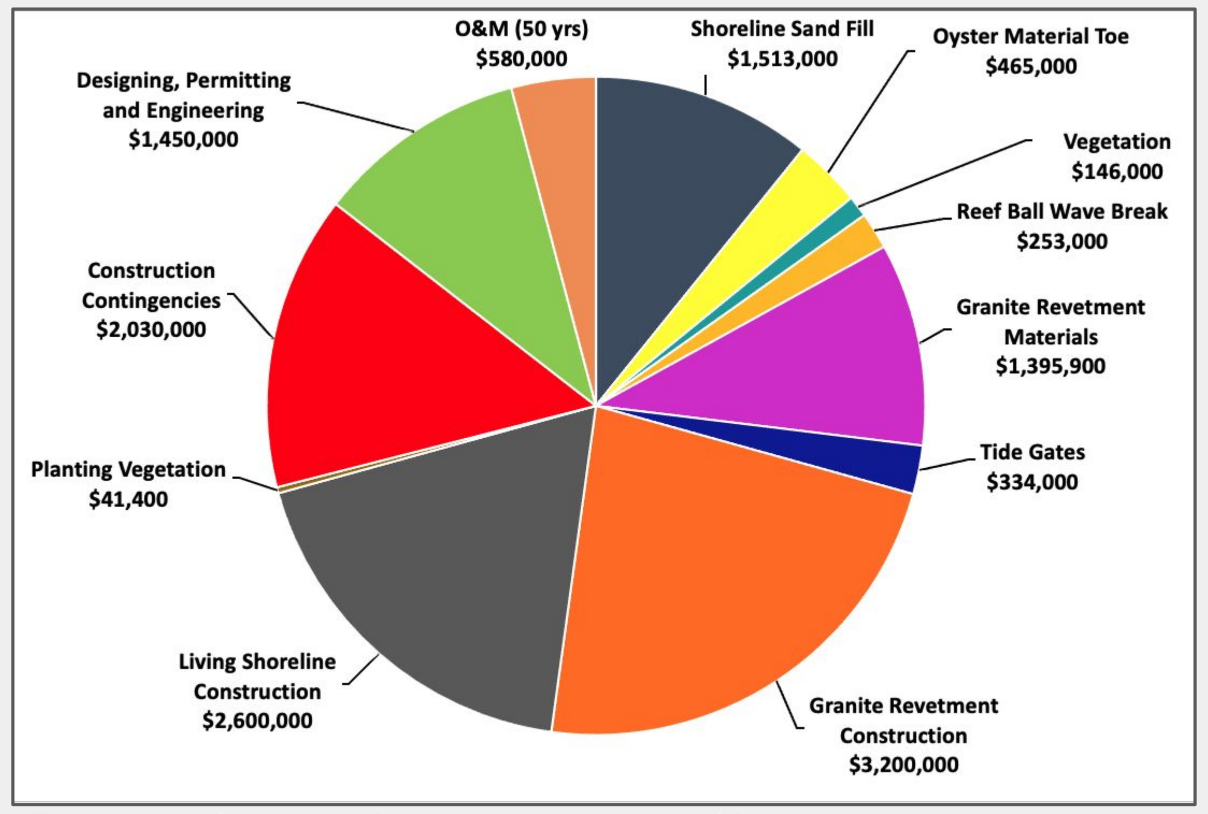

Figure 3: Cost analysis breakdown of living shoreline expenses. Total estimated cost is $14.8-million.

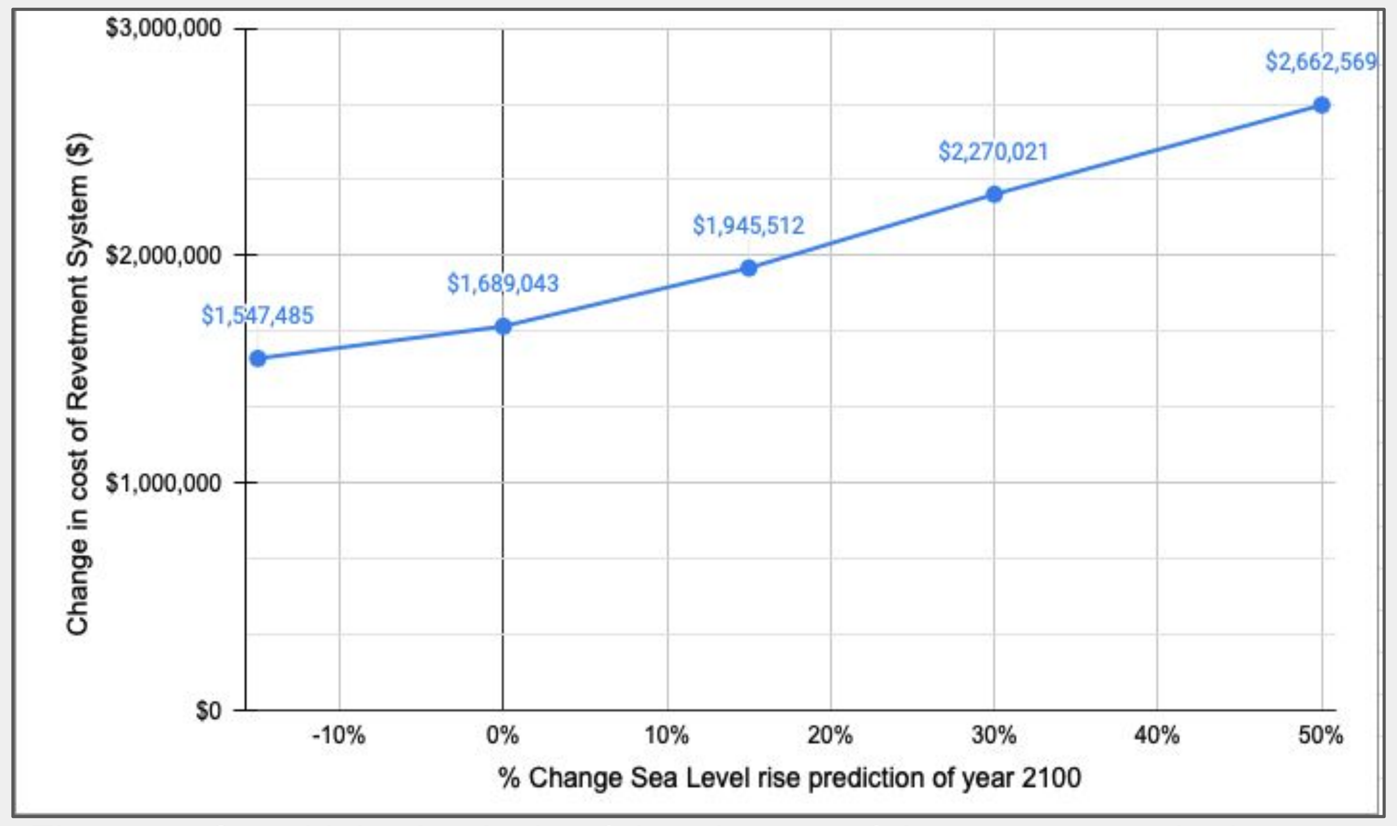

Figure 5: Sensitivity Analysis of the change of the revetment design material cost vs the % change of SLR prediction of 2100

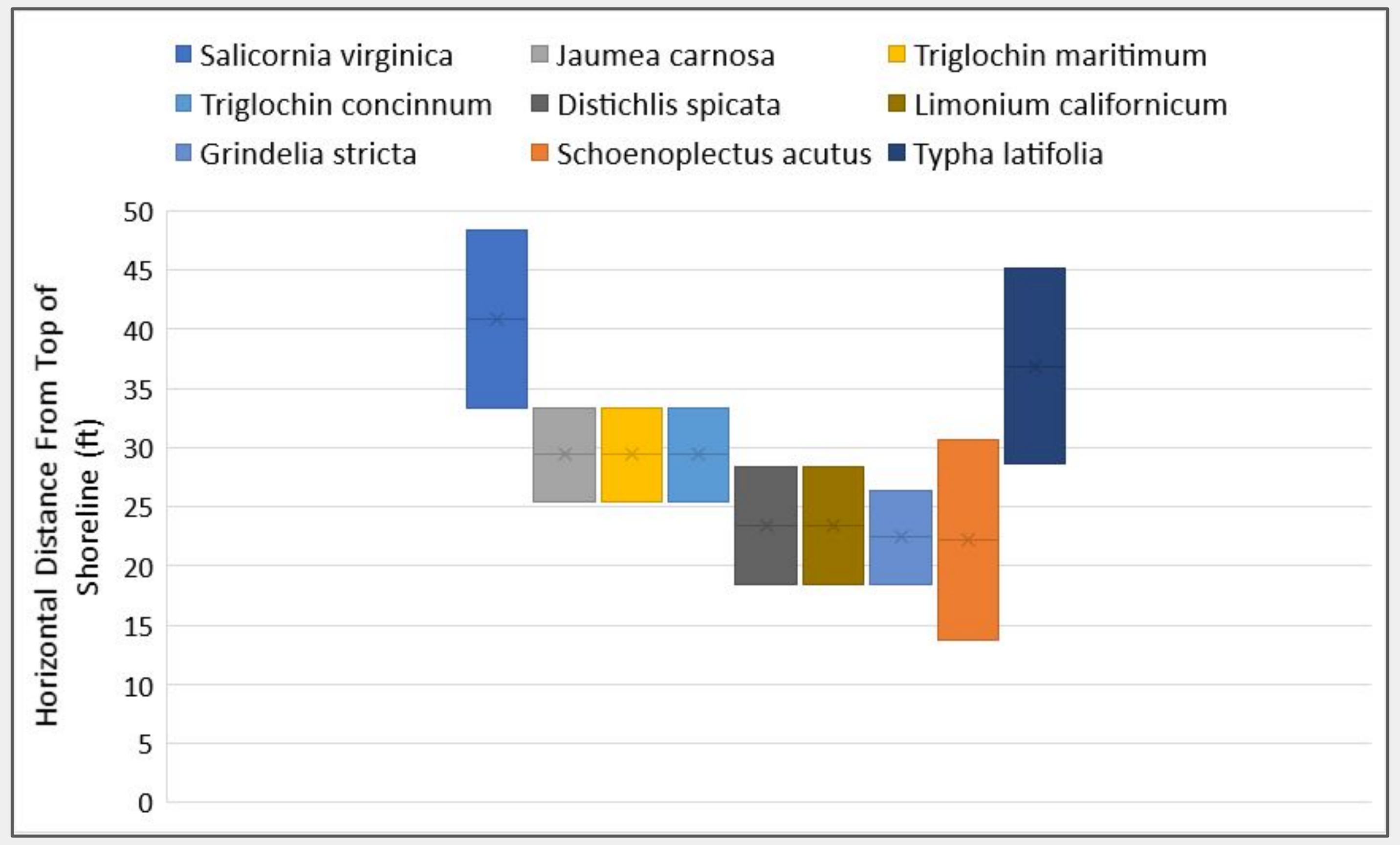

Figure 6: (above) Vegetation distribution plan for planting the living shoreline design. Plants species are evenly distributed with 2-ft centers per plant.

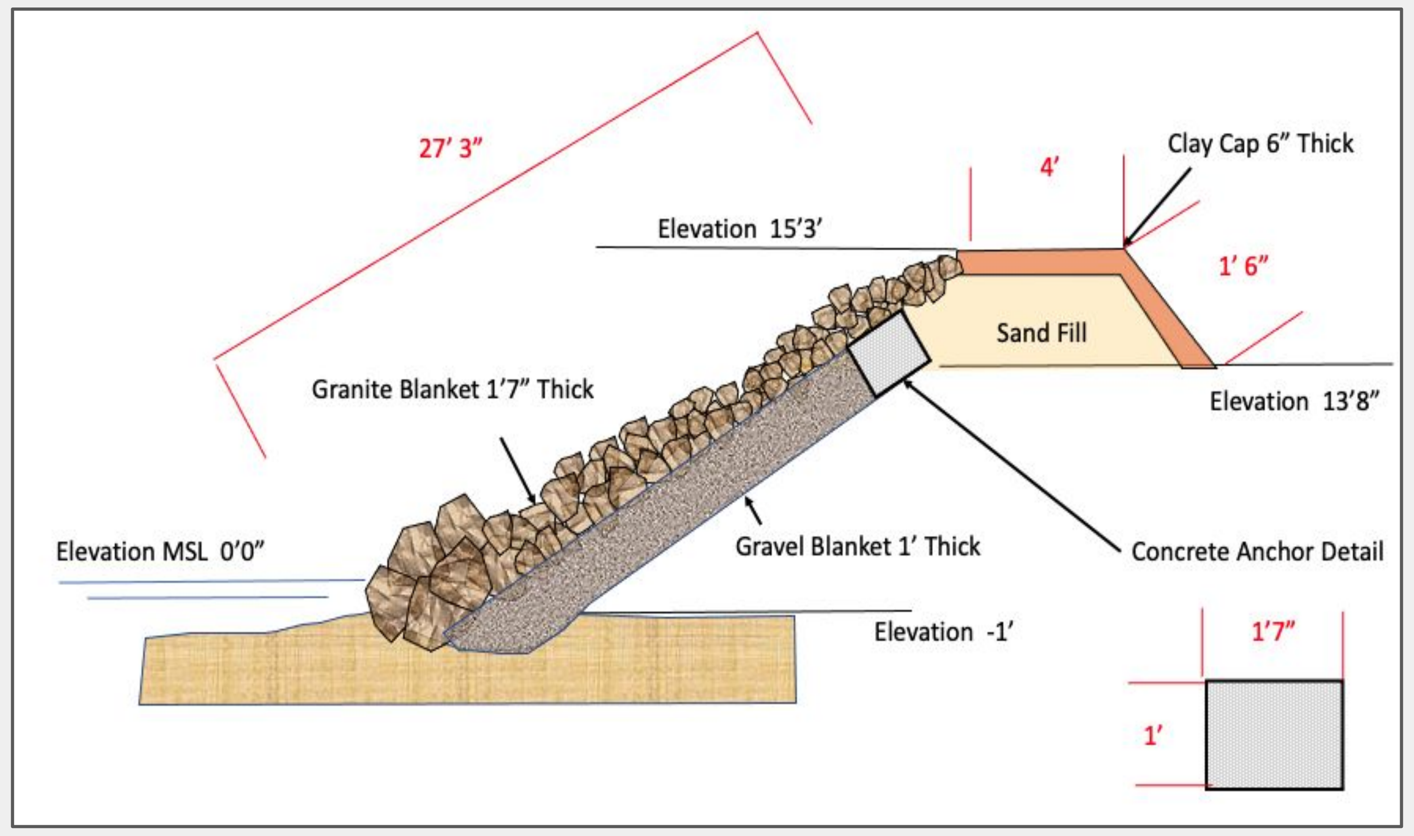

Figure 7: Revetment design with schematic details (USACE 1984).

Revetment Design (Above)

The Revetment system will extend and connect the living shoreline section to Highway 255 and 101. The seaside slope will have a 2:1 slope for better structural stability. The slope will consist of crushed granite rock. Existing elevation will increase with a sand fill clay cap berm.

Sensitivity Analysis (Left)

The revetment design was planned to be adaptable for if the SLR prediction was greater than thought, the berm height could increase as well. This analysis shows the change in cost vs the % change in SLR prediction.

References

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