Encinitas-Solana Beach Coastal Storm Damage Reduction Project

San Diego County, California

Volume III (Appendices E through H)

Appendix E	**Economic Appendix**
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U.S. Army Corps of Engineers
Los Angeles District

April 2015

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Encinitas-Solana Beach Coastal Storm Damage Reduction Feasibility Study

San Diego County, California

Appendix E

Economics

U.S. Army Corps of Engineers
Los Angeles District

April 2015

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EXECUTIVE SUMMARY

The study area is located along the Pacific Ocean coastline in San Diego County, California. The City of Encinitas is the northern boundary of the study area, approximately 10 miles south of Oceanside Harbor, and 17 miles north of Point La Jolla. The southern boundary of the study area is the southern end of the City of Solana Beach. The study area coastline consists primarily of denuded beaches and coastal bluffs from 30 to 100 feet high with the exception of San Elijo Lagoon, a low-lying area about one mile in length near the center of the study area.

Beach erosion and bluff failures have been ongoing problems in both Encinitas and Solana Beach. As the beaches narrow, sensitive sandstone bluffs are exposed to crashing waves, which carve notches into the bluffs. Bluffs affected by these notches are then prone to episodic collapse. Consequently, residential properties on the upper bluff experience land loss and property owners are required to spend significant resources to try to protect their property otherwise the structures will eventually be lost. In addition to this problem, the study area also has high demand for recreation while the narrow beach area combined with bluff failures represent a significant safety issue for those recreating. Opportunities exist to reduce bluff failures and/or mitigate the danger from those failures. Both cities employ lifeguards year-round that encourage recreating away from the base of the bluffs. Unfortunately, deaths and injuries have continued to occur from bluff instability and failures. Other opportunities exist to reduce coastal processes that cause bluff failures, and thereby reduce National Economic Development (NED) costs and damages, as well as threats to life and safety. Certain alternatives which increase the size of the beach area can provide significant recreational benefits as well.

The without project conditions are forecasted to include two distinct responses to ongoing land loss: either armor the parcel with a seawall to prevent structure collapse or fail to armor the parcel and allow structure collapse. The damages under these two scenarios were weighted and combined to determine the expected without project damages. Residual sloughing at the bluff top edge was accounted in those expected damages. Based on the findings from the without project conditions analysis, approximately 2.9 miles of the study area was determined to have sufficient economic damages and suitable coastal characteristics to justify construction of project alternatives. That includes 1.5 miles of coastline within Encinitas—labeled Segment 1—and 1.4 miles of coastline within Solana Beach—labeled Segment 2—and both sites were evaluated independently for project alternatives. Among the array of alternatives proposed, economic analysis was performed on four hard and soft-structural alternatives. These include constructing a series of seawalls at the base of the coastal bluffs, placing notch fill in all sea caves, placing notch fill in combination with sand on the beaches to enhance coastal storm damage protection, and placing sand only. When evaluating sand placement only or when paired with notch fill, we analyzed sand placement that would initially extend the beach in 50-foot increments on average from 50 feet to 200 feet mean sea-level (MSL) within Encinitas and 50 feet to 400 feet mean sea-level within Solana Beach. In tandem with incremental increases to the beach footprint from sand placement, we also evaluated delaying nourishment cycles from 2 to 16 years leading to a large number of possible combinations to aid in selecting the Recommended Plans among hard and soft-structural alternatives.

Among this array of alternatives the NED Plan for Segment 1 (Encinitas) is sand placement extending the mean sea-level beach 100 feet on average immediately after fill placement and nourishing every five years. The NED Plan for Segment 2 (Solana Beach) is sand placement extending the beach 200 feet MSL and nourishing every 13 years. These are the results under the low/historic sea-level rise scenario. We also evaluated the high sea-level rise scenario and found the NED Plan was unchanged at Segment 1 but altered to nourish every 14 years at

Segment 2 while extending the beach 300 feet MSL. Based on detailed costs estimates produced by Cost Engineering, the net annual benefits for Segment 1 would be approximately $1.3 million and $1.8 million for Segment 2. Benefit-cost ratios are 1.48 and 1.99 at the current discount rate, respectively. Overall, the NED plan is expected to produce approximately $3.1 million net annual NED benefits and a benefit-cost ratio of 1.68 (1.51 at the seven percent discount rate).

The project alternatives were analyzed under three distinct scenarios in addition to sea-level rise to determine whether identification of the NED Plan at each segment was sensitive to the weighting used to establish without project damages, dredging cost increases at the secondary borrow site, and cost savings from joint nourishments at each segment.[1] Our analysis revealed that identification of the NED Plans was insensitive to the weighting used to establish without project damages, was insensitive to dredging cost increases at the secondary borrow site, but Segment 2 only was sensitive to cost savings from joint nourishments. Specifically, if nourishments can predictably occur concurrently at each segment, the resulting cost savings would alter the NED Plan at Segment 2 to nourish every 10 years rather than every 13 years (the “footprint” or average width to extend the beach would remain unchanged at 200 feet MSL). The NED Plan at Segment 1 would be unaltered by synchronized nourishments.

The Locally Preferred Plan (LPP) for Segment 1 (Encinitas) is sand placement extending the mean sea-level beach 50 feet on average immediately after fill placement and nourishing every five years. The LPP for Segment 2 (Solana Beach) is sand placement extending the beach 150 feet MSL and nourishing every ten years. The Recommended Plan for Segment 1 and Segment 2 is the Locally Preferred Plan. Based on detailed costs estimates produced by Cost Engineering, the net annual benefits from the Recommended Plan for Segment 1 would be approximately $250,000 and $1.4 million for Segment 2. Benefit-cost ratios are 1.11 and 1.84 at the current discount rate, respectively. Overall, the Recommended Plan is expected to produce approximately $1.6 million net annual NED benefits and a benefit-cost ratio of 1.42 (1.28 at the seven percent discount rate).

Under the LPP construction overlaps every ten years at both segments. While shared or synchronized sand nourishment may not be possible every ten years during the study period, financial, logistical and other considerations make two of four potential overlapping nourishments a reasonable assumption. Results for the LPP have been presented with these two nourishments occurring in 2025 and 2035, the first such opportunities to synchronize construction. However, should synchronization occur at the last two possible occurrences, 2045 and 2055, the LPP would continue to be justified at the current and seven-percent discount rates (BCRs of 1.09 and 1.03 for Segment 1 and 1.79 and 1.48 for Segment 2, respectively).

Coastal Storm risks include life-safety risk from collapsing bluff tops given the uncertainty around processes that cause and can halt episodic bluff collapse—the Recommended Plan has been formulated to reduce life-safety risk but does not purport to eliminate this completely. Risk also stems from the variability in the authorization, appropriation, and ultimate construction schedule for the project. The consequences of delaying construction include unanticipated damages from structure loss/collapse as well as injury or death from falling debris. Finally, risk

[1]At this feasibility stage we are unable to determine if synchronizing nourishments at Segment 1 & 2 would occur in practice due to differences in erosion rates at each segment and unknown financial and political constraints during the 50-year study period; therefore, the NED Plan was identified assuming only the initial fill could occur jointly. However, if joint nourishments could occur the savings would be substantial.

also includes coastal storm damages, which is a combination of the likelihood and consequence of continued land loss, potential structure loss, and seawall construction that the NED plan and LPP reduce but do not completely halt.

An alternative that results in zero residual damages is unlikely to exist in practice; therefore, an acceptable level of residual preventable damages must exist but is subjective. However, the relative effectiveness of alternatives is clearer. The NED plan is expected to reduce coastal storm damage risk further than the LPP. This could mean less potential structure loss, land loss, and seawall construction in the study area if the NED Plan is constructed. The LPP would still reduce coastal storm damage risk considerably compared to taking no action but not to the extent of the NED Plan or other more substantial alternatives, which could reduce residual risk further than even the NED Plan.

The Recommended Plan and NED Plan were evaluated in the Regional Economic Development (RED) and Other Social Effects (OSE) accounts. The No Action Plan was also evaluated in the OSE account. In general the LPP and NED Plans produce similar Regional Economic Development results. Results from the RED analysis show that the LPP and NED Plan would produce moderate income growth and job development to the greater San Diego area. The benefits from increased economic activity related to recreation would be more substantial but still relatively moderate compared to the gross regional product within the greater San Diego, the smallest economic unit of measure for the RED analysis. The regional economic impact to the communities of Encinitas and Solana Beach from implementing the LPP or NED Plans would likely be more profound and substantial due to increased hotel occupancy and related spending on local goods & services; however, we are not able to quantify those positive impacts at the community-level.

Evaluation under the OSE account revealed four dimensions that would be positively impacted by implementing the LPP and NED Plan—life-safety, social vulnerability & resiliency, displacement to population, and community cohesion & social connectedness. We found strong evidence that life-safety risks would be significantly reduced by implementing the NED Plan and significantly to moderately reduced by implementing the LPP compared to the No Action Plan. Existing beach widths are typically narrow with limited “dry sand” areas closer to the bluffs or only “wet sand” in some areas. While not utilizing as much sand volume as the NED Plan, the Recommended Plan still reduces life-safety risks primarily because the affected areas would be subject to less frequent episodic bluff collapse while at the same time beach visitors would be able to utilize wider beaches to keep a safe distance from the bluffs (currently 2.8 to 3 million visits occur in the study area annually). At the same time social vulnerability & resiliency, displacement to population, and community cohesion & social connectedness would all benefit moderately compared to the No Action Plan.

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1 INTRODUCTION

This report documents the National Economic Development (NED), Regional Economic Development (RED), and Other Social Effects (OSE) analyses of storm related damages to shoreline property in the cities of Encinitas and Solana Beach, San Diego County, California, and the benefits derived from various protection alternatives, and the findings from these analyses.

1.1 Study Authority

This study was authorized by a May 13, 1993 Resolution of the House Public Works and Transportation Committee that reads as follows:

"*Resolved by the Committee on Public Works and Transportation of the United States House of Representatives, that, in accordance with Section 110 of the River and Harbor Act of 1962, the Secretary of the Army, acting through the Chief of Engineers, is directed to make a survey to investigate the feasibility of providing shore protection improvements in and adjacent to the City of Encinitas, California, in the interest of storm damage reduction, beach erosion control, and related purposes*."

Additional authorization was given in an April 22, 1999 Resolution of the House Committee on Transportation and Infrastructure that reads as follows:

> *"Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army, in accordance with Section 110 of the River and Harbor Act of 1962, is hereby requested to conduct a study of the shoreline along the City of Solana Beach, San Diego County, California, with a view to determining whether shore protection improvements for storm damages reduction, environmental restoration and protection, and other related purposes are advisable at the present time."*

1.2 Study Purpose and Scope

The purpose of this economic appendix is to present a feasibility-level investigation to determine the average annual coastal storm-related damage to shoreline properties from the City of Encinitas southward through the City of Solana Beach under without and with-project conditions, determine with-project costs and benefits, analyze this information to determine the NED plan, and perform RED and OSE analyses. Storm-related damage is estimated in this analysis following the guidelines and procedures established for the assessment of National Economic Development (NED benefits in the *Economic and Environmental Principles for Water and Related Land Resources Implementation Studies*, February 3, 1983; the *Planning Guidance Notebook (Appendix E: Section IV, Hurricane and Storm Damage Protection*, ER 1105-2-100, 22 April 2000); and the *National Economic Development Procedures Manual – Coastal Strom Damage and Erosion*, IWR–91–R-6, dated November 1991. RED and OSE analyses follow the procedures and guidelines set forth in *Regional Economic Development Procedures Handbook*, 2011-RPT-01 and *The Planning Guidance Notebook*, ER 1105-2-100.

1.3 Study Area

The study area is located along the Pacific Ocean coastline in San Diego County, California as shown in see **Figure 1.3-1**. The City of Encinitas is the northern boundary of the study area, approximately 10 miles south of Oceanside Harbor, and 17 miles north of Point La Jolla. The southern boundary of the study area is the southern end of the City of Solana Beach. The Encinitas shoreline, about 6 miles long, is bounded by Batiquitos Lagoon to the north and to the south by San Elijo Lagoon. Major portions of the shoreline consist of narrow sand and cobble beaches fronting near-shore bluffs. The southern segment at Cardiff (4,920 feet) is a low-lying barrier spit fronting the San Elijo tidal lagoon. The study area continues through 1.7 miles of coastline in the City of Solana Beach for a total study area length of approximately 7.7 miles. The distinguishing characteristic of the study area is cliffs that rise to typical heights 100 feet above the Pacific Ocean. Storm-induced waves erode the bluff base leading to episodic bluff failures and bluff-top land loss that poses a threat to residential and commercial structures.

Figure 1.3-1 Encinitas- Solana Beach Study Area Map

1.4 Problems & Opportunities

Beach erosion and bluff failures have been ongoing problems in both Encinitas and Solana Beach. As the beaches narrow, sensitive sandstone bluffs are exposed to crashing waves, which carve notches into the bluffs (**Figure 1.4-1**). The bluffs affected by these notches are then prone to episodic collapse. Consequently, residential properties on the upper bluff experience land loss and property owners are required to spend significant resources to try to protect their property otherwise the structures will eventually be lost (**Figure 1.4-2**). In addition to this problem, the study area also has high demand for recreation while the narrow beach area combined with bluff failures represent a significant safety issue for those recreating. This risk, which is represented by repeated bluff failures in the study area, has been documented by the cities of Encinitas and Solana Beach. This documentation was used to create **Table 1.4-1** which lists major bluff failures since 2000 and consequences for those involved.

Opportunities exist to reduce bluff failures and/or mitigate the danger from those failures. Both cities employ lifeguards year-round that encourage recreating away from the base of the bluffs. Unfortunately, deaths and injuries have continued to occur from bluff instability and failures as shown in **Table 1.4-1**. Other opportunities exist to reduce coastal processes that cause bluff failures, and therefore reduce NED costs and damages, as well as threats to life and safety. Certain alternatives which increase the size of the beach area can provide significant recreational benefits as well. There are two major engineering methods, soft-structural and hard-structural, to reduce storm damage. The soft-structural method includes beach fills, sand scraping, or sand bypassing/recycling. Hard structures consist of the sand retention features that impede alongshore sand movement (e.g., groins, jetties, artificial reefs, or detached breakwaters), and the storm-protective features, which directly prevent shoreline or upland erosion (e.g., coastal armoring, seawalls or revetments).

Figure 1.4-1 Wave attacks to study area bluffs

Figure 1.4-2 Example of damage to structure and land loss at bluff top edge

Table 1.4-1 Major Bluff Failures since 2000

January 2000	A woman was killed in a bluff collapse while sitting on the beach in Leucadia.
January 2001	Four bluff-top homes in Leucadia (south of Beacon's Beach) were deemed unsafe by the City of Encinitas due to unstable and cracked bluffs. Large rocks were piled at the base of the bluffs to protect the cliffs from large surf and tides.
February 2001	A bluff collapse destroyed a portion of the trail at Beacon's beach off Neptune Avenue in Leucadia.
May 2001	In Solana Beach an adjoining bluff gave way as a neighbor was trying to reinforce it by driving steel pilings in to the bluff. A concrete slab from patio slid down toward the shore, taking with it a workman who had been standing on it. The bluff collapse also claimed part of an additional adjacent yard and rendered a portion of the house unsafe for occupancy. Owners of the three parcels obtained an emergency permit to build a 100-foot long, 35-foot high seawall.
July 2002	A man camping overnight in a small cave at South Carlsbad State Beach was killed when a portion of a bluff collapsed.
July 2002	About 80 tons of sandstone, rocks, and boulders fell onto the beach as a 75-foot wide by 12-foot high section of bluff collapsed just south of Fletcher Cove Park, a major recreation area.
September 2002	Major bluff failure; Potential threat; Approx. 4 cu. yd. boulders, aluvium, and iceplant debris cascaded onto the beach
December 2002	Major bluff failure; Potential threat; 10 cu. yds of earthen debris and concrete; Posts, concrete footings, and other wooden retaining devices precarious; Continuation of already badly eroded area

February 2003	Major bluff failure; Potential threat; Approx. 3 cubic yards, in and around existing sea cave plugs, large portion of bluff un-supported and in danger of collapse.
February 2003	Major bluff failure; 3rd Major failure 100 yards south of previously reported area; 3 cu. yd. of solid sandstone composition, debris and boulders.
November 2003	Major bluff failure; N. of cove, water flowing mid-bluff, report from Geosoils on file
March 2004	Major bluff failure; Upper and lower bluff failure over 2 cu. yds, dangling posts/rope
June 2004	Major, potential threat from overhang patio. Signs posted. Geosoils evaluating all.
July 2004	Major bluff failure; Directly S. of other failures, approx. 15' X 6' X 4'. Potential threat from overhang patio. Signs posted. Geosoils report on file. On or about 6/30, contractor removed wall and concrete deck that had become undermined. 7/6, u-channel posts and "Bluff Warning" signs installed
November 2004	Major bluff failure; Approx. 6' X 5' X 3', Initial failure was contained by protective shoring and fence system; subsequent bluff failure resulted in damage to shoring system.
November 2004	Major bluff failure; Potential threat; 2' X 8-10' portion of block wall separated from patio, large upper bluff failure, undermined a portion of concrete patio adjacent to rear of home. Overhanging portion to be removed and report to be updated.
November – December 2004	Major bluff failure; Approx. 22' X 5' X 3', bluff debris along with length of black pip, portion of fence dangling. Letter sent to owners 11/3.
November 2004	Major bluff failure; Upper bluff failure N. of Cove, area at top closed due to undermined fence along edge. Fence to be relocated and bench will be removed from outlook point, SW of Community center building.
April 2005	Major bluff failure; Although a large amount of material was deposited on the beach, it occurred from a localized area. Surrounding bluff does not appear in imminent danger of further failure.
June 2005	Major Upper bluff failure 2 cubic yards or more witnessed by lifeguard personnel.
August 2006	Major bluff failure; Potential threat; North of Seascape Sur access at reoccurring failure site; Geotechnical attached
July 2007	Significant failure, geotechnical evaluation on-going
August 2007	Major bluff failure; pre-existing failure site.
February 2008	A landscaper was trapped and injured when a retaining wall atop beach bluffs in Encinitas collapsed.
May 2009	Major bluff failure; pre-existing failure site.
January 2010	Debris from private access staircase scattered across 1/2 mile of Beach - referred to Code Enforcement
March 2010	Major bluff failure, photos taken, caution tape placed. On 3/12/2010 confirmed that the issue was resolved to satisfaction of Engineering Department
March 2010	Major bluff failure, photos taken, caution tape placed. On 3/17/2010 confirmed that the issue was resolved to satisfaction of Engineering Department
April 2010	300-350 cubic yards detached from lower bluff, fell to beach.

July 2010	Minor bluff failure, photos taken. Existing signage to be maintained by Marine Safety.
August 2010	Lifeguards and firefighters rescued an injured man who was found on the beach at the bottom of a 30-foot cliff at the end of E Street. He suffered fractures to his legs. The victim probably rolled the first sloped 60 or 70 feet before the 30-foot vertical drop-off. Signs warn visitors of the unstable cliffs.
December 2010	A bluff collapsed across two parcels damaging the existing seawall at the bluff base. An Encinitas lifeguard official subsequently warned, "Anybody that's walking anywhere on the North [San Diego] County beaches should be extremely aware of the danger and stay away from the cliffs."
January 2011	The southbound portion of San Elijo Avenue at Dublin Drive and Cornish Drive closed because of bluff collapses in mid-December leading to approximately 30 days of partial road closure.
January 2011	Major bluff failure (2 cubic yards or more). Lifeguards taped off area, photos taken. On 2/9/11 City staff member, Dan Goldberg confirmed the reported issue had been resolved to the satisfaction of the Engineering Department. The area at that time was reported as "currently appears stable. Marine Safety should continue to monitor the area and report any changes to the Engineering Department".

1.5 Study Area Delineation

To better characterize the coastal bluff and shoreline morphology as well as oceanographic conditions the study area was separated into nine reaches. Each reach was surveyed for the same characteristics including, but not limited to, parcel area, structure value, structure setback distance from bluff edge, presence of staircases, presence of seawalls, and toe notch depths at the base of the bluff. Without project analysis and plan formulation was performed on all reaches; however, through that process only reaches 3-5 and 8-9 were identified for viable alternatives primarily because of susceptibility to future bluff failures, the existence of viable alternatives to address this problem, and sufficient economic value to justify those alternatives.[2] Alternatives were formulated for Segment 1, which is approximately 7,800 feet in length and resides within reaches 3-5, and Segment 2, which is approximately 7,200 feet in length and consists of reaches 8 and 9. **Figure 1.5-1** shows the delineation of the study area reaches as well as Segments 1 and 2. As noted above, these segments were determined to be those with the greatest problems, opportunities, and potential for federal interest. The detailed description of each reach can be found in the Integrated Report (**Section 1.8.1**) and the reasons why the specific reaches were selected for detailed evaluation and plan formulation can be found below.

[2] The 1,510 foot stretch of bluff top immediately south of Reach 9, termed the Del Mar reach, is also included in the analysis because of incidental benefits from sand placement alternatives only. See section 1.5.10 below.

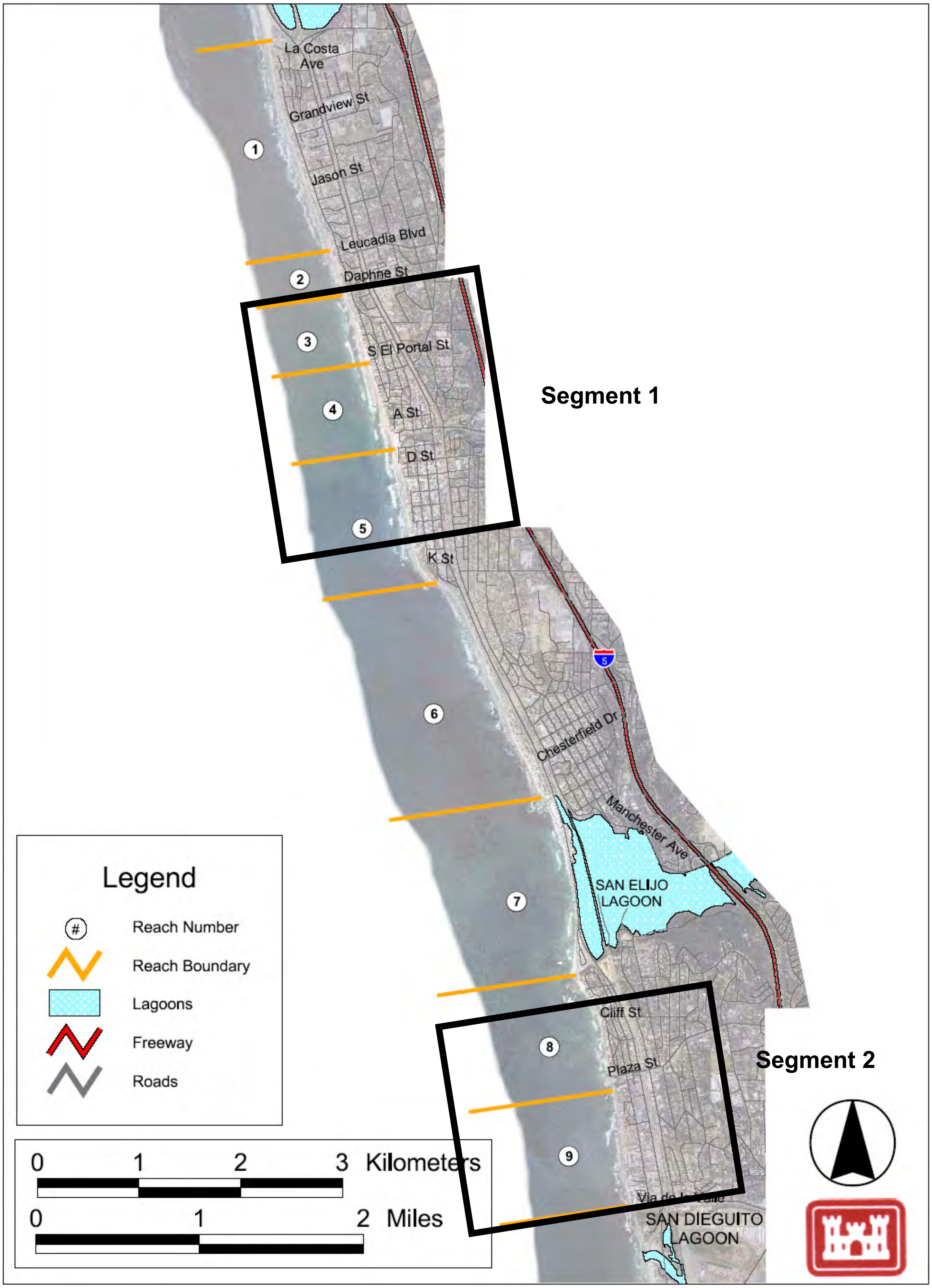

Figure 1.5-1 Reach Delineation

1.5.1 Reach 1

This reach is protected by many small seawalls, crib walls, masonry block structures, and concrete structures placed at the bottom and on the face of the bluff. Project alternatives were not proposed for this reach since the seacliffs along Reach 1 are comparatively stable because the bluff base is resistant to erosion, it has a relatively flatter upper bluff slope, vegetation cover, and presence of a continuous protective cobble berm.

1.5.2 Reach 2

This reach is protected by a substantial crushed rock slope and private seawalls constructed in the middle of the reach. Project alternatives were not proposed for this reach because of instability at the upper bluff as evidenced by severe landslides throughout the reach as opposed to instability at the base of the bluff due to toe notch erosion typical of the remaining reaches.

1.5.3 Reach 3

Reach 3 was evaluated for project alternatives because of the substantial number of unprotected parcels and the propensity for continued episodic bluff collapse.

1.5.4 Reach 4

Along the entire reach, except for the southern portion of the reach immediately adjacent to Moonlight Beach, an approximate 2 to 4- foot notch exists at the base of the bluff where notch protection measures have not been instituted. The prevalent notch development coupled with the already over-steepened upper bluff zone is prone to future bluff failures, some of which could be catastrophic. Consequently, Reach 4 was evaluated for project alternatives.

1.5.5 Reach 5

Large notches form sea caves that are often large enough to crawl and sometimes walk into. Due to the deteriorated nature of the bluff face along this reach, numerous bluff top failures have occurred in the last few years. As a result Reach 5 was evaluated for project alternatives.

1.5.6 Reach 6

Although a small number of private homes occupy the northern end, most of the reach segment contains the Highway 101 right-of-way and the San Elijo State Beach. A robust rock revetment was installed to protect the highway from future storm and tidal impacts in 1961. The southern portion of the reach is backed by the San Elijo State Beach Campground and contains non-engineered riprap that protects five beach access points. Given the protective features already in place and the small number of structures, Reach 6 was not evaluated for project alternatives.

1.5.7 Reach 7

This reach possesses a narrow sandy and cobble spit beach backed by Highway 101, which is protected by a non-engineered rock and concrete rubble revetment. The close proximity of the restaurants located in the northern section of the reach to the water’s edge has rendered and will continue to render them susceptible to periodic episodes of incidental inundation and structural damage. Moreover, severe storms also cause flooding along Highway 101. Reach 7 was evaluated for coastal storm surge (flooding) damages rather than bluff retreat/erosion.

1.5.8 Reach 8

The bluff top is fully developed throughout the reach with large multi-story private residences. The cliffs are approximately 80 feet high and presently the shoreline may be characterized as consisting of a narrow to non-existent sandy beach backed by high, wave cut cliffs. During the 1997-1998 winter months, sand was stripped away and the bluff face became directly exposed to wave abrasion. Severe toe erosion subsequently developed and bluff failures have been continuously reported since that event. Presently, notches, on the order of 4 to 8 feet, and large seacaves exist throughout the lower bluff region. Consequently, Reach 8 was evaluated for project alternatives.

1.5.9 Reach 9

Repeated wave exposure has resulted in the continued erosion of the bluff face and the associated recession of the upper bluff. It is expected that without corrective action, the magnitude of the upper bluff recession will most likely accelerate in this reach until the upper bluffs have fully equilibrated with the ongoing erosion occurring at the base of the bluff. Reach 9 was evaluated for project alternatives.

1.5.10 Del Mar Reach

This 1,510 ft stretch of shoreline lies immediately south of Solana Beach within the city of Del Mar and could benefit from soft-placement project alternatives, such as beach nourishment, evaluated for Reach 9 because of longshore drift. The beach width varies throughout the reach from 65 to 130 feet. There are functional and decorative fences and paved walkways at the edge of the bluff, three residential structures at varying distances from the bluff edge, and public access at the southern end. There are no coastal protection structures in this reach and it borders a lagoon to the south, which provides a clear termination point for this reach. This reach is included in the benefits calculations for soft-placement alternatives only.

2 DEMOGRAPHICS

2.1 Introduction

The cities of Encinitas and Solana Beach, California are located 25 and 23 miles north of San Diego, respectively. Both municipalities are located in San Diego County and were incorporated in 1986. Both cities are located along South Coast Highway 101 and are bordered on their western sides by the beaches of the Pacific Ocean. The communities are convenient to the metropolitan areas of both San Diego and Los Angeles, and are just 35 miles north of the United States border with Mexico.

2.2 Population

Approximately 60% of Californians live in Southern California, a distribution that has not changed significantly in the past four decades. Almost 75% of Californians live in the coastal regions, with the inland-dwelling proportion increasing steadily over the past three decades. The 2000 Census reported that the San Diego region (San Diego and Imperial Counties) of southern California maintains a population roughly equivalent to the State of Iowa within a land area (8,375 square miles) that is approximately the size of Massachusetts.

The population of San Diego County in 2010 comprised 8% of the population of California; the county population was 3,095,313 and the State population was 37,253,956. As shown in **Table 2.2-1**, the county experienced a net population increase of 10% between 2000 and 2010. This rate of growth is the same rate as California (10.0%) and the United States (9.7%) during the past decade. Through 2050 the State of California is projected to increase population by 59%, which is a faster rate of population growth than the United States (29%) or Encinitas and Solana Beach (29% and 24%) during that same period.[3]

Table 2.2-1 Historical and Projected Population

	1980	1990	2000	2010	2050	% Change (2000-2010)
Encinitas	n/a[4]	55,386	58,014	59,518	76,659	2.6%
Solana Beach	n/a[5]	12,962	12,979	12,867	15,942	-0.9%
San Diego County	1,861,846	2,498,016	2,813,833	3,095,313	4,384,867	10.0%
California	23,667,764	29,760,021	33,871,648	37,253,956	59,507,876	10.0%
United States	226,549,000	248,709,873	281,421,906	308,745,538	398,528,000	9.7%

The City of Encinitas has increased in population by 1,504 between 2000 and 2010. Total migration over that period is unknown but likely modest. The City of Solana Beach has maintained a fairly stable population since at least 1990 when there were just under 13,000 residents; however, the recent trend can be misleading because redevelopment over time in the

[3] Refer to Table 2-9 below.
[4] Encinitas and Solana Beach were not incorporated municipalities in 1980. They became incorporated in 1986.
[5] Ibid.

form of more dense "smart growth" is planned, which will add more residents to the City and surrounding areas but at a slower rate of growth than San Diego County as shown in **Table 2.2-1**. The median age of the population of Solana Beach is 45.1 years and the median age in Encinitas is 41.7 years. This compares to San Diego County's median age of 35.0 years, and the median age for California of 34.7 years. Solana Beach has a higher percentage of the population above age 65 (19%), compared to Encinitas (12%), and the State of California and San Diego County (both 11%). Solana Beach also has a lower percentage below age 18 (16%), compared to Encinitas (19%), and San Diego County (24%).

The population of the City of Encinitas is 75% White/Caucasian. Minority populations include: Asian (4%); American Indian & Alaskan Native (<1%); African American (<1%); Native Hawaiian (<1%); and other (<1%). Approximately 18% of the population is of Hispanic or Latino heritage.

The population of the City of Solana Beach is 74% White/Caucasian. Minority populations include: Asian (4%); American Indian & Alaskan Native (<1%); African American (<1%); Native Hawaiian (<1%); and other (<1%). Approximately 19% of the population is of Hispanic or Latino heritage.[6]

2.3 Housing

Encinitas has 23,664 households and the average household size is 2.69 persons. Solana Beach has 5,773 households and the average household size is 2.34 persons. According to the 2010 US Census data on housing tenure, 46% of San Diego County households are renters compared to 37% in Encinitas and 40% in Solana Beach (see **Table 2.3-1**). Among occupied units, 11% are owned free and clear of any mortgage or loan in San Diego County, while that figure is 11% in Encinitas and 13% in Solana Beach. Among the two largest populations in Encinitas and Solana Beach, White and Latino/Hispanic, housing tenure within the white population is predominantly owner-occupied (65-69%), while tenure within the Latino/Hispanic population is predominantly renter-occupied (56-75%). Neither population has a significant share of owner-occupied units held free-and-clear of any mortgage (7-13%)[7], as shown in **Table 2.3-2**. A smaller share of households have children in the study area when compared with county and state averages, which appears consistent with age demographics presented earlier in this section. The share of households with children is lowest in Solana Beach (22%), and higher in Encinitas (27%) but still below county and state levels, which are 31% in San Diego County and 33% in the State of California.

[6] The data for Ethnicity and Age for Encinitas, Solana Beach, and San Diego County was taken from San Diego Association of Governments (SANDAG) 2010 Population Characteristics. The data for the State of California was taken from the 2010 U.S. Census.
[7] 2010 US Census

Table 2.3-1 Housing Tenure by Family Type

	Encinitas		Solana Beach	
Housing Tenure	Household w/ Children	Household Adult only	Household w/ Children	Household Adult only
Owner-occupied	19%	44%	14%	47%
Renter-occupied	9%	28%	9%	31%
TOTAL[8]	27%	73%	22%	78%

Table 2.3-2 Housing Tenure by Ethnic Group

	Encinitas		Solana Beach	
Housing Tenure (within each ethnic group)	White	Latino/ Hispanic	White	Latino/ Hispanic
Owner-occupied with lien	58%	37%	52%	20%
Owner-occupied free & clear (no lien)	11%	7%	13%	6%
Renter-occupied	31%	56%	35%	75%
TOTAL	100%	100%	100%	100%

2.4 Employment

In San Diego County, the unemployment rate for December 2011 is 8.9%, while the cities of Solana Beach and Encinitas have lower unemployment rates of 6.0% and 6.3%, respectively. These rates of unemployment are all more favorable than the statewide rate of 11.1%.[9] For those employed, **Table 2.4-1** indicates the predominant sectors of employment for residents of the study area, according to the Profile of Selected Economic Characteristics: 2009 published by the U.S. Census Bureau. As shown in the table, the service industry is important in all regions associated with the study area. The service industry includes: information; professional, scientific, management, administrative and waste management services; educational, health and social services; arts, entertainment, recreation, accommodation and food services; public administration; and other services. **Table 2.4-1** also shows the share (%) of employment by sector. The share of employment across all industry sectors is fairly consistent between the State of California, San Diego County, and the city of Encinitas. Solana Beach is the exception—over 75% of employment is concentrated in services. These services are primarily professional, scientific, educational, and health care. Nearly all the service sector employment in Encinitas is concentrated in these same four segments.

[8] Percentages may not add to total due to rounding.
[9] Employment Development Department of California, Labor Market Information Division

Table 2.4-1 Employment Count & Share by Industry

Industry	Encinitas	Solana Beach	San Diego County	California
All-Industry Total	31,886	6,537	1,372,121	16,550,706
Farming & Mining	176	36	9,782	338,102
Construction	2,185	274	103,380	1,224,186
Manufacturing	2,823	427	126,675	1,745,489
Wholesale & Retail Trade	4,364	714	189,218	2,412,171
Transportation & warehousing, and utilities	689	125	50,056	776,881
Finance, insurance & real estate	2,835	593	106,631	1,194,673
Services (incl public)	17,800	4,961	750,473	8,355,058
Industry	**Encinitas**	**Solana Beach**	**San Diego County**	**California**
All-Industry Total	100%	100%	100%	100%
Farming & Mining	1%	1%	1%	2%
Construction	7%	4%	8%	7%
Manufacturing	9%	7%	9%	11%
Wholesale & Retail Trade	14%	11%	14%	15%
Transportation & warehousing, and utilities	2%	2%	4%	5%
Finance, insurance & real estate	9%	9%	8%	7%
Services (incl public)	56%	76%	55%	50%

2.5 Income

In **Table 2.5-1**, summarizing income distribution by number and share of households, there is pertinent information regarding income and effective buying power by household in the study area. Approximately 76% of county workers are listed as private wage and salary workers. Government workers comprise another 15% while another 8.6% are self-employed in non-incorporated businesses. Less than 1% (0.2%) are classified as unpaid family workers. 11.7% of the county population was living below the poverty level in 2009. As shown in **Table 2.5-1** the per capita income and median household income in both study area municipalities are higher than figures for the county and state.

Table 2.5-1 Income Distribution by Number & Share of Households (2009)

Income Distribution	Encinitas	Solana Beach	San Diego County	California
Total Households	23,250	5,773	1,040,945	12,177,852
Less than $15,000	1,530 (7%)	398 (7%)	95,136 (9%)	1,248,099 (10%)
$15,000 – $24,999	1,245 (5%)	528 (9%)	90,109 (9%)	1,141,560 (9%)
$25,000 - $34,999	1,457 (6%)	585 (10%)	92,016 (9%)	1,118,718 (9%)
$35,000 – $49,999	2,420 (10%)	594 (10%)	133,991 (13%)	1,541,545 (13%)
$50,000 - $74,999	3,292 (14%)	488 (8%)	185,522 (18%)	2,164,891 (18%)
$75,000 or more	13,306 (57%)	3,180 (55%)	444,171 (43%)	4,963,039 (41%)
Median Household Income	$87,287	$85,234	$63,727	$61,154
Per Capita Income	$49,341	-------------	$30,898	$29,405

3 EXISTING CONDITIONS

3.1 Beach Profile/Shoreline Retreat

The beach that had provided a natural, protective buffer zone and once protected the base of the coastal bluffs has been significantly depleted. As a result, erosion along the base of the coastal bluffs has occurred under continuous wave and tidal exposure such that notches and sea caves have formed at the toe of the bluff. Some of these notches extend for hundreds and, in some cases, thousands of feet along the bluff base. As a result of this toe erosion, the overall stability of the bluff is threatened and subsequently the upper bluff fails and shears off due to the reduced support at the base. A bluff failure is considered to have occurred when bluff material separates from the bluff and falls landing on the beach face at the bluff toe below.

Figure 3.1-1 shows a typical bluff profile in the study area. Bluffs in the study have been undergoing shoreline retreat. Shoreline retreat is defined as the gradual landward movement of the sea/land boundary as defined by the location of some tidal datum such as mean sea level. In the study area, this retreat is generally caused by shoreline erosion caused by wave attack of the beach and bluffs. Retreat of the coast may occur gradually, at a relatively uniform rate, or episodically, in large increments, followed by long periods of little or no retreat. Gradual retreat is well represented by annualized retreat rates; however, annualized rates do not adequately describe the nearly instantaneous retreat of several feet or tens of feet that may occur episodically. Episodic retreat affects both the sea cliff face and bluff top. The sea cliff is affected by large wave events eroding sea caves at the bluff toe and triggering block topping and block fall, collapsing these "notch caves". The sub aerial processes (rain, rilling, surficial overslope flow) acting on the bluff surface and crest generally produce a slower, more uniform erosion rate, but may also contribute to episodic failure over the longer term. In addition, deep-seated landslides can cut back into the coastal terrace upwards of 60 to 80 feet in a few hours or days.

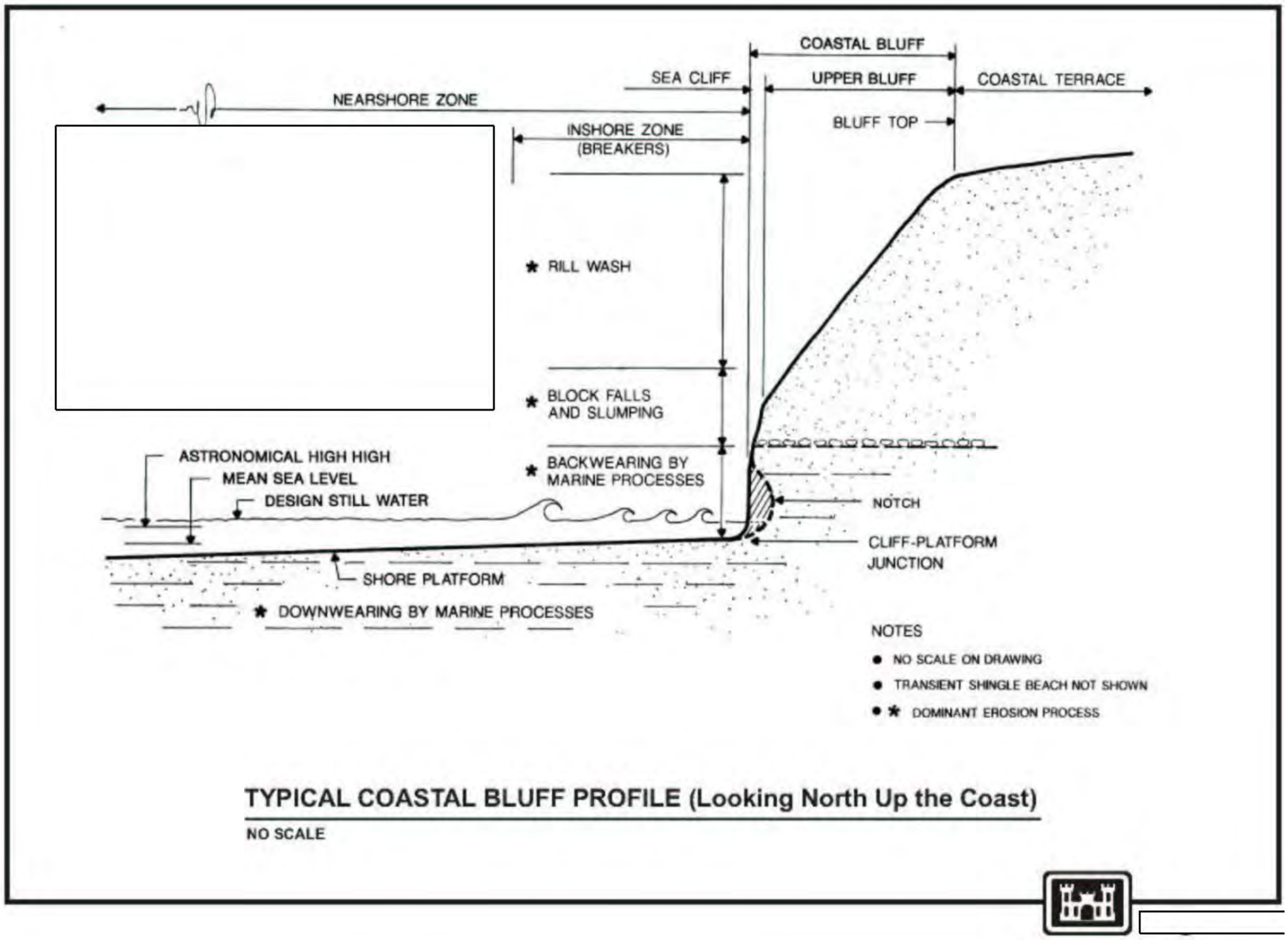

Figure 3.1-1 Typical Coastal Bluff Profile

3.2 Parcel & Structure Characteristics

Characteristics important to modeling the with and without project conditions have been carefully analyzed and catalogued, including those in **Table** 3.2-1. The study area has been broken down by nine reaches. All reaches have been analyzed but for brevity only characteristics for those areas that would be impacted by project alternatives, termed segments 1 & 2, have been broken down in the tables below. Segment 1 is 7,800 linear feet, lies entirely within Encinitas, and encompasses reaches three to five. Segment 2 is 7,200 linear feet, extends from the northern to southern border of Solana Beach, and encompasses reaches eight and nine. The Del Mar reach, immediately south of reach 9, would also receive sand, under all the beach nourishment alternatives, when placed at neighboring Reach 9 and therefore would contribute to the NED benefits calculation.

Table 3.2-1 Parcel Characteristics I

	Encinitas (Segment 1)	Solana Beach (Segment 2)	Study Area (Reaches 1-9)
Parcel Count	138	88	328
Structure Count[10]	112	81	291
Structure Value (Average)[11]	$327,474	$699,339	$407,551
Structure Value (Total in millions $)	$36.7	$56.6	$118.6
Toe Notch (Range)	0-6	0-6	0-6

3.2.1 Structure Count/Valuation

Surveys of the study area show 328 separate parcels and 291 structures. Of these 291 structures two-thirds, or 193 structures, currently do not have private seawalls and would be impacted by the project alternatives. Structure valuation is based on a complete visual survey of all structures in the study area to estimate structure quality and condition. This methodology follows guidelines from the Marshall & Swift Valuation Service and allows the replacement structure value to be estimated at current price levels and then depreciated.[12] Structure values were higher on average in Solana Beach (Segment 2) primarily because structure size tended to be larger. This increased size is primarily a result of the how the analysis was performed since all condominium and apartment complexes were evaluated at the structure level rather than at the individual unit level. Solana Beach has a relatively high share of medium to large condominium and apartment structures while Encinitas has a smaller share. In contrast single family residential structures are of similar size among both communities. Structure values are roughly $400,000 on average in the study area, which can be attributed to good to excellent construction quality, minimal deferred maintenance and repair, and an average structure size of 2,500 square feet for single family residences and 13,700 square feet for condominium structures.

3.2.2 Toe Notch

Toe notches are concave features at the base of the bluff caused by erosion from continuous exposure to wave attack (see **Figure 3.1-1**). As toe notches grow the probability of bluff collapse increases. Typically toe notches have been observed up to six feet in depth; toe notches deeper than six feet are not observed because bluff collapse has been observed occurring before the notch can deepen further.[13] The Bluff Retreat Model generated bluff top erosion rates by modeling toe notch erosion rates among other characteristics. The bluff-erosion events outputted from that model have been transferred to the economic model. Since the frequency and intensity of those bluff-top erosion events are dependent on initial toe notch depth, the economic model retains initial toe notch depth.

[10] Note counts are for structures only and not housing units, which are greater than the number of structures due to multi-family residential structures such as condominiums and duplexes.

[11] Average structure value in Solana Beach is higher primarily because a larger share of structures are multi-family residential.

[12] USACE Blue Book IWR 95-R-9. Significant price appreciation in the study area over the past several decades has created irreconcilable differences between market and assessed value because Proposition 13 limits parcel valuations for assessing property taxes to no more than 2% growth annually; therefore, the Marshall & Swift Valuation method was used to estimate market value of structures.

[13] A recent survey of toe notches in Encinitas showed 2 out of 190 parcels had toe notches of 8-11 feet deep. The other 188 parcels had toe notches of 6 feet or less.

3.2.3 Setback Distance

Setback distance is the shortest distance between the structure and bluff-top edge. For undeveloped parcels it is the span of the parcel from bluff-top edge to the opposite end of the parcel. As episodic events occur, the setback distance shortens and the lost parcel area is noted when modeling. Setback distance varies considerably from as little as one foot between structure and bluff edge to as much as 756 feet, as shown in **Table 3.2-2**. Parcels near the minimum setback distance generally have seawalls, with some exceptions. Parcels near the maximum setback distance are atypical and do not have seawalls. The typical setback distance is around 30 feet and a large share of structures are within 15-40 feet from the bluff-top edge.

Table 3.2-2 Parcel Characteristics II

	Encinitas	Solana Beach	Study Area
Setback Distance[14]			
Average	32 ft	34 ft	33 ft
Minimum	3 ft	1 ft	1 ft
Maximum	192 ft	756 ft	756 ft
Parcel Width[15]			
Average	74 ft	103 ft	78 ft
Minimum	28 ft	19 ft	19 ft
Maximum	784 ft	580 ft	784 ft

3.2.4 Parcel Width

Parcel width, which is the parcel dimension parallel to the bluff edge, is generally 50-100 feet wide for single-family residences and up to several hundred feet for multi-family residences. Solana Beach has larger average structure widths because larger, multi-family residences are concentrated there. However, single family residential parcel in Solana Beach and Encinitas are of similar width.

3.2.5 Seawall Trigger

All seawall permits must be evaluated and approved by the California Coastal Commission (CCC). The CCC is a designated coastal management agency for the purpose of administering the federal Coastal Zone Management Act in California. The CCC provided permitting information for all 48 seawall permits within the study area from 2000 to 2010. Of those 48 permits, 4 were denied, 2 were pending, 2 were withdrawn, and 6 were listed as “no objection” but without setback distances. The remaining 34 permits that were approved, had seawalls constructed, and had setback distances listed on the permit, were analyzed (see **Table 3.2-3**). This analysis showed seawalls have been approved and built when setback distance was as great as 35 feet and as little as -1 feet indicating at least a portion of the structure has been undermined. Three quarters were constructed when the setback distance was between 6 and 25 feet. The average setback distance was 16.2 feet but with considerable variation as shown by the standard deviation and range. No distinction was made between Encinitas and Solana Beach (Segments 1 & 2) because the sample of 34 permits could not be divided into smaller

[14] Initial setback distance from structure to bluff top edge; measurements are the shortest distance between structure and bluff top edge on each parcel.
[15] Distance from the bluff top edge to the end of the parcel; in other words the parcel dimension running perpendicular to the bluff edge

subsamples while retaining statistical significance. As a result the information was used to develop one "seawall trigger" that models the setback distance that triggers parcel owners to seek permits to construct seawalls across the study area. The "seawall trigger" approximates the historic setback distance distribution shown in **Table 3.2-3**.

Table 3.2-3 Historic Setback Distance Triggering Seawall

Sample Size	34
Years	2000-2010
Average	16.2 ft
Median	15.5 ft
Standard Deviation	9.1 ft
Minimum	-1 ft
Maximum	35 ft

The triggering event ('seawall trigger') establishes the setback distances from structure to bluff-top edge that causes the parcel owner to seek a seawall construction permit. Under the *Armoring Scenario* we have assumed that all parcel owners respond to the 'seawall trigger' by applying for a permit and all seawall permit applications are approved, although not in that same year. The model follows historical precedent: episodic events eventually threaten the structure; the affected parcel owner seeks a seawall permit; successful permit applications are typically approved in 1-3 years; and a seawall is constructed shortly thereafter. To model the delay between permit application and seawall construction we have added a seawall construction delay of one, two, or three years (i.e. the 'seawall trigger delay'). In this way the major steps to construct a seawall have been modeled—permit application, application review and approval, and finally seawall construction.

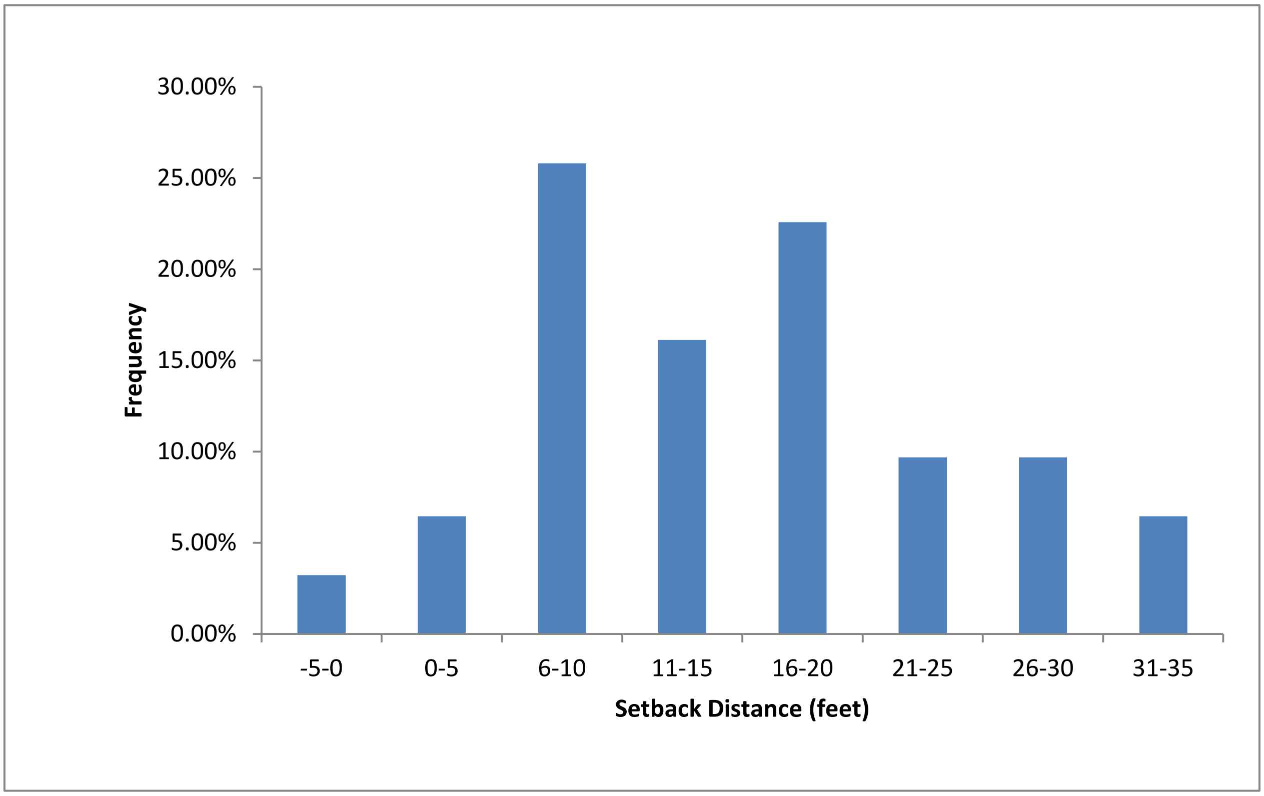

Figure 3.2-1 Historic Setback Distance Distribution

3.2.6 Seawall Costs

Constructing a seawall involves high fixed and variable costs that are paid exclusively by the affected parcel owner. Each seawall permit application involves engineering analysis, legal and consulting services, permit fees, and design plans. USACE does not have standard costs for constructing seawalls that would be suitable for accounting for all the application expenses as well as actual construction. TerraCosta Consulting Group is a company that has over 35 years of experience designing and constructing seawalls in California and their expertise was used to determine design, permitting and construction costs of seawalls within the project area. The permit application expense ranges from $96,000 to $150,000 and averages $123,000. Once permitting is approved two types of variables costs must be paid: construction and mitigation. Variable construction costs, which include materials, labor, and equipment, are generally proportional to the length of the seawall being constructed—the larger the seawall the higher these costs. Variable construction costs are around $7,400 per linear foot for the type of seawall permitted to be constructed in the study area by the California Coastal Commission (CCC) and local authorities.[16] The other variable cost is assessed by the CCC when seawalls are constructed to compensate the public for lost recreation opportunities and lost sand sedimentation benefits directly related to constructing seawalls at the base of the bluff. This fee is $3,500 feet per linear foot. When all fixed and variable costs are combined, a 50-foot long "lower" seawall on a single-family residential parcel costs $668,000, on average, as shown in

[16] Previously seawalls were constructed from rip-rap, wooden planks, and other materials but this is no longer permissible.

Table 3.2-4[17] A lower seawall two hundred feet in length to protect a large condominium structure costs over $2.2 million.

Table 3.2-4 "Typical" Seawall Construction Costs for lower seawall only

Seawall Construction Costs (lower seawall only)	Unit	Cost (Average)	"Typical" Seawall Cost (SFR Parcel -- 50 linear ft)
Construction:			
Fixed Costs[18]	per Parcel	$123,000	$123,000
Variable Costs[19]	per Linear ft	$7,400	$370,000
Variable Costs – Mitigation[20]	per Linear ft	$3,500	$175,000
Total	--	--	**$668,000**
Maintenance & Repair: (every 7 to 8 yrs)			
Fixed Costs[21]	per Parcel	$22,500	$22,500
Variable Costs[22]	per Linear ft	$275	$13,750
Total	--	--	**$36,250**

3.2.7 Maintenance & Repair

The study area bluff toe has minimal protection from wave attack, particularly during the winter when the beach profile is smallest. Under these conditions seawalls constructed with the same strength as the sandstone bluff require maintenance and repair every seven to eight years. Repair and maintenance like seawall construction requires a permit from the CCC. The associated permit and legal/consulting fees have been grouped as fixed costs along with design. Fixed costs are $22,500 and occur every 7 to 8 years typically. In addition variable costs for labor, materials, and equipment needed for repair are $275 per linear foot and are also incurred every 7 to 8 years. Since coastal engineering has determined that the winter beach profile within the study area exposes the bluff toe to continuous wave attack, all seawalls in the study area should be exposed and undergo the same repair and maintenance cycle every 7 to 8 years. When all fixed and variable costs are combined, maintaining a 50-foot long lower seawall on a single-family residential parcel would cost $36,250 every 7 to 8 years. Maintaining a lower seawall two hundred feet in length to protect a large condominium structure would cost $77,500 every 7 to 8 years.

3.2.8 Structure Sales

We analyzed sales data for 478 bluff-top and non bluff-top parcels sold within the study area between 2002 and 2010. Sixty of these sales were bluff-top parcels and the remaining 418 were

[17] Lower seawalls address erosion at the bluff toe. Often additional protection is added at the top of the bluff to aid in stability and protection from bluff failure. This feasibility study only addresses impacts to the bluff toe.
[18] Design, Permitting, Legal/Consulting
[19] Materials, Equipment, and Labor
[20] Sand sedimentation and recreation loss mitigation assessed by the California Coastal Commission
[21] Design, Permitting, Legal/Consulting
[22] Materials, Equipment, and Labor

neighboring, non bluff-top parcels. Bluff-top sales were brought to current price levels then every structure was valued using the methodology from *Marshall Valuation Service*.[23] This method was repeated for non bluff-top parcels and structures. Finally, estimated structure value was subtracted from sales price to determine land value. On average land value is $327 per square foot for bluff-top parcels and $107 per square foot for non bluff-top parcels within the study area, as shown in **Table 3.2-5**. These values were used later to estimate the value of land loss under future without project conditions as bluff failures occur. How land loss was generated and valued is explained in the *Model Methodology* section below.

Table 3.2-5 Structure Sales

	Sales Count (2002-2010)[24]	Land Value per SQFT (Average)	Land Value per SQFT (Range)
Bluff-top	60	$327	$25-$526
Non bluff-top	418	$107	$70-$952
Total	478	--	--

3.3 <u>Regional Beach Sand Project II</u>

3.3.1 Description of Project

Regional Beach Sand Project (RBSP) II was a local, one-time sand nourishment project organized and funded by the San Diego Association of Governments (SANDAG). RBSP II occurred in both study area communities during the fall & winter of 2012, three years before the USACE project, and is assumed to be a one-time occurrence.

Analysis of RSBP II showed minor impacts to without project conditions, which is consistent with the purpose of RBSP II—recreation improvement rather than coastal storm damage reduction (CSDR). There would also be a minor reduction in the amount of sand the USACE would place during the initial fill (refer to **Table 3.3-1**) as a result of RBSP II.

3.3.2 Impact to Without Project Damages and With Project Benefit Analysis

RBSP II impacts Segment 1 and 2 differently. Segment 1 received 220,000 cubic yards of beach fill and Segment 2 received 146,000 cubic yards in 2012. The initial evaluation of benefits and costs did not account for the impact of the RSBP II Project. This one-time fill provides limited benefits during the initial years of the period of analysis, while the sand remains in the system and has not been lost due to erosion. Hence, the initial results overstated potential benefits for alternatives since they do not account for the residual but temporary sand remaining in the system from the RSBP II project. Therefore, these limited storm damage reduction and recreation benefits associated with the one-time RSBP II fill were quantified and deducted from the initial results. Benefits for alternatives presented later in this report reflect this adjustment.

[23] Structure value (also termed "improvement value") could not be based on assessor data because Proposition 13 limits parcel valuations to no more than 2% growth annually for assessing property taxes. Therefore significant price appreciation over the past several decades has created irreconcilable differences between market and assessed value in the study area. As a result depreciated structure values were estimated using *Marshall Valuation Service*, the nationally recognized appraisal guide.

[24] Sales occurring within Solana Beach and Encinitas between 2002 and 2010 and indexed to current price levels.

3.3.3 Impact to Volume of Alternatives

Sand placed and remaining in the base year from RBSP II lowers the initial sand fill volume for the USACE project alternative modestly (refer to **Table 3.3-1**). This is because sand volume from RBSP II will remain in the system several years beyond the USACE base year. The exact amount of residual sand volume remaining in the base year differs by segment and alternative. This extra sand volume in the base year means the USACE project alternative will need less sand volume for the initial fill in the base year than the volumes established without the impact from RSPB II. To adjust for this, coastal engineering has determined the amount of fill volume remaining from RBSP II at the start of the study period.

The remaining fill volume in 2018, the start of the period of analysis, is subtracted from the amount of initial fill volume needed for the USACE project alternatives. This adjustment is made because the fill volumes provided by coastal engineering do not consider the impacts from RBSP II.

Table 3.3-1 Regional Beach Sand Project Fill Volume

	Encinitas	Solana Beach
Remainder by Base Yr	8,700 cy	102,200 cy

3.3.4 Impact to USACE Project Alternatives

One impact from RBSP II is an additional $67,000-76,700 in annualized coastal storm damage reduction in Segment 1 and $6,300-7,900 in Segment 2 for low and high sea-level rise, respectively, that is not included in the USACE project net benefits. Another impact is less beach fill volume required at the start of the study period. Segment 1 needs 8,700 cubic yards less fill and this partially offsets the effect to coastal storm damage reduction. Segment 2 needs 102,200 cubic yards less fill and this more than offsets the effect to coastal storm damage reduction. Therefore, including the impacts from RBSP II moderately reduces the net annual benefits of the USACE project alternatives for Segment 1 compared to excluding those impacts. In contrast it slightly increases the net benefits for Segment 2. Overall, this analysis determined that the impact from RBSP II is slight and essentially immaterial.

4 WITHOUT PROJECT ANALYSIS[25]

4.1 Layout & Process

Under future without project conditions, coastal engineering analysis has determined that the study area will be represented by the lowest stable nearshore/beach condition, which is defined as the denuded beach condition observed prior to the SANDAG replenishment (a beach replenishment that occurred in 2001). Essentially, only a thin lens of sand topping the natural bedrock platform exists during the summer and fall months. In the winter and spring seasons, a depleted beach condition, exposing the natural bedrock, occurs and is the basis for the Monte Carlo simulation in the Coastal Engineering bluff-erosion model to statistically characterize the episodic bluff failures. In addition, considerations of two sea level rise (SLR) scenarios under the depleted beach conditions were also included in the bluff failure analyses. The two SLR scenarios considered are the historic upward trend of sea level and the projected sea level rise of the NRC-III curve. See the Coastal Engineering Appendix for further details and explanation about sea-level rise and bluff failure modeling.[26]

Future without project conditions in the Economic Model use the erosion data from the Coastal Engineering Model to simulate two distinct behaviors to episodic bluff failure: *Retreat Scenario* and *Armoring (Seawall) Scenario*. For financial, personal, regulatory, or other reasons some owners will not build seawalls before their structures are rendered uninhabitable from bluff-top collapses. This behavior is captured under the *Retreat Scenario*, where all owners do not build seawalls in time to protect their structures. On the other hand many owners will be able to build seawalls before their structures are rendered uninhabitable. This behavior is captured in the *Armoring Scenario*, where all owners do build seawalls in time. In a later step the two scenarios are weighted to determine the expected Without Project Damages. See the *Without Project Damages* section for further explanation.

4.2 Methodology

The following summarizes the economic model used to assess without project conditions. A detailed description is included in the Economic Model Attachment E1. Shoreline retreat has been impacting the study area for at least three decades.[27] This has provided ample opportunity to observe the historical behavior of bluff-top parcel owners, which in turn has informed the modeling for without project conditions. When episodic retreat and failure of the bluff tops occurs, termed an “episodic event”, land is lost and coastal structures are threatened. In response many, but not all, bluff-top property owners seek permission to construct seawalls to protect their property from further erosion and collapse. Others will not or cannot construct a seawall before an episodic event renders their structure unsafe for occupancy. These two distinct responses to the process of wave attack, toe notch erosion, and bluff-top collapse form the basis of the economic modeling done in this study.

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[25] Presented at FY2012 price levels and discount rate used to identify NED Plan

[26] See also EC 1165-2-211 and the white paper *Approach to Incorporate Projected Future Sea Level Change into the Encinitas & Solana Beach Shoreline Protection Feasibility Study* and CEQA and NEPA Compliance Efforts.

[27] The 1982-83 El Nino season stripped away sand from the nearshore and deposited it too far offshore to remain in the system, allowing shoreline retreat to accelerate. See the Coastal Engineering Appendix for further details.

The without-project damages to the bluff top are generated because of low nearshore sand deposits (denuded beaches) that lead to toe notch erosion and ultimately bluff-top collapse from continuous exposure to wave attack. The model estimates the associated damages under the two different scenarios described in the previous section: *Retreat Scenario* and *Armoring (Seawall) Scenario*. Approximately 39% of the study area parcels are already protected to some extent by seawalls. This behavior is captured in the *Armoring Scenario*, where all owners do build seawalls in time. The exact weighting between these two scenarios and how that was derived is explained in the section 4.6.

Retreat Scenario assesses land loss from bluff-top collapse and any associated structure damages, stairway loss, seawall construction to preserve all infrastructure and land interior to the first row of bluff-top parcels but the first row of structures are not protected in time and are rendered uninhabitable. Under the *Retreat Scenario* seawall construction occurs after a structure has been lost to bluff collapse and before nearby roads, sewer lines, and other interior infrastructure has been lost. In this manner seawall construction has been modified from the *Armoring Scenario,* which initiates seawall construction prior to structure damage to the first row of bluff-top parcels rather than after structure damage.

Without project estimates shown in this section use FY2012 price levels and discount rate used to identify the NED plan.

4.3 Comparison: Retreat & Armoring Scenarios

Under the Retreat Scenario when episodic bluff failure occurs, first staircases are lost if present then land near the bluff-top edge is lost; repeated bluff failures could undermine the structure. If that happens the structure value and a portion of the contents inside are lost, the structure is demolished, and land loss continues. Eventually additional episodic bluff failures could threaten major public infrastructure and this would lead to publically financed seawall construction and maintenance since both cities would seek out emergency seawall permits and seek funding to construct public seawalls rather than incur the costs and disruptions of a “true” retreat scenario (financial costs and disruptions necessary to relocate buried and above-ground utility lines, loss of public roadways, and additional demands to acquire and relocate residences interior to the existing bluff-top parcels). The Retreat Scenario has the following damage categories (*asterisks indicates categories not present in Armoring Scenario):

- Staircase Loss
- Land Loss – Bluff-top
- Structure Loss*
- Structure Demolition & Removal*
- Land Loss – Non Bluff-top (interior to the structure)*
- Seawall Construction
- Seawall Maintenance

Under the Armoring Scenario when episodic bluff failure occurs first staircases are lost if present then land near the bluff-top edge is lost. Before the structure can be undermined by repeated bluff failures, a seawall is constructed and maintained by the parcel owner. The Armoring Scenario has the following damage categories:

- Staircase Loss
- Land Loss – Bluff-top

- Seawall Construction
- Seawall Maintenance

Structure loss, structure demolition & removal, and land loss valued at non bluff-top price levels are additional damage categories present in the *Retreat Scenario* but not present in the *Armoring Scenario* because the *Retreat Scenario* models parcel owners that do not or cannot react in time to secure the necessary seawall construction permits, financing, and construction experts prior to structure failure brought about by episodic erosion events. The *Retreat Scenario* also distinguishes between bluff-top and non bluff-top land value to account for land loss that occurs between the bluff edge and structure as well as land loss that occurs after the structure has failed.

4.4 Without Project Damages: Armoring (Seawall) Scenario

4.4.1 Layout & Process

The *Armoring* (Seawall) *Scenario* assesses land loss from bluff-top collapse and any associated stairway loss and seawall construction to preserve the first row of structures on the bluff-top parcels. This component of the model applies a random erosion event to the initial bluff-top setback distance that is dependent on each parcel's initial toe notch depth and location within the study area. After the episodic event is applied a new setback distance is determined--land and staircase losses are calculated, if applicable. The seawall trigger is applied to this new setback. If the seawall trigger is equal to or less than the setback distance, a permit is sought to construct a seawall and a delay of one to three years is applied before it can be constructed. Seawall permits are typically approved only to take emergency measures to protect the threatened structure. A delay between emergency seawall application, approval from the California Coastal Commission (CCC), and then construction is generally one to three years based on seawall permitting data submitted by the cities. Our modeling follows this precedence by allowing the seawall application to occur only when the structure is imminently threatened and construction to follow one to three years later. When a seawall is constructed, the cost of that seawall construction is applied and each subsequent year maintenance costs are assessed. No further damages from episodic events occur. If no seawall is constructed then another random erosion event occurs and the seawall trigger is applied to this new setback distance. This process is laid out in **Figure 4.4-1**.

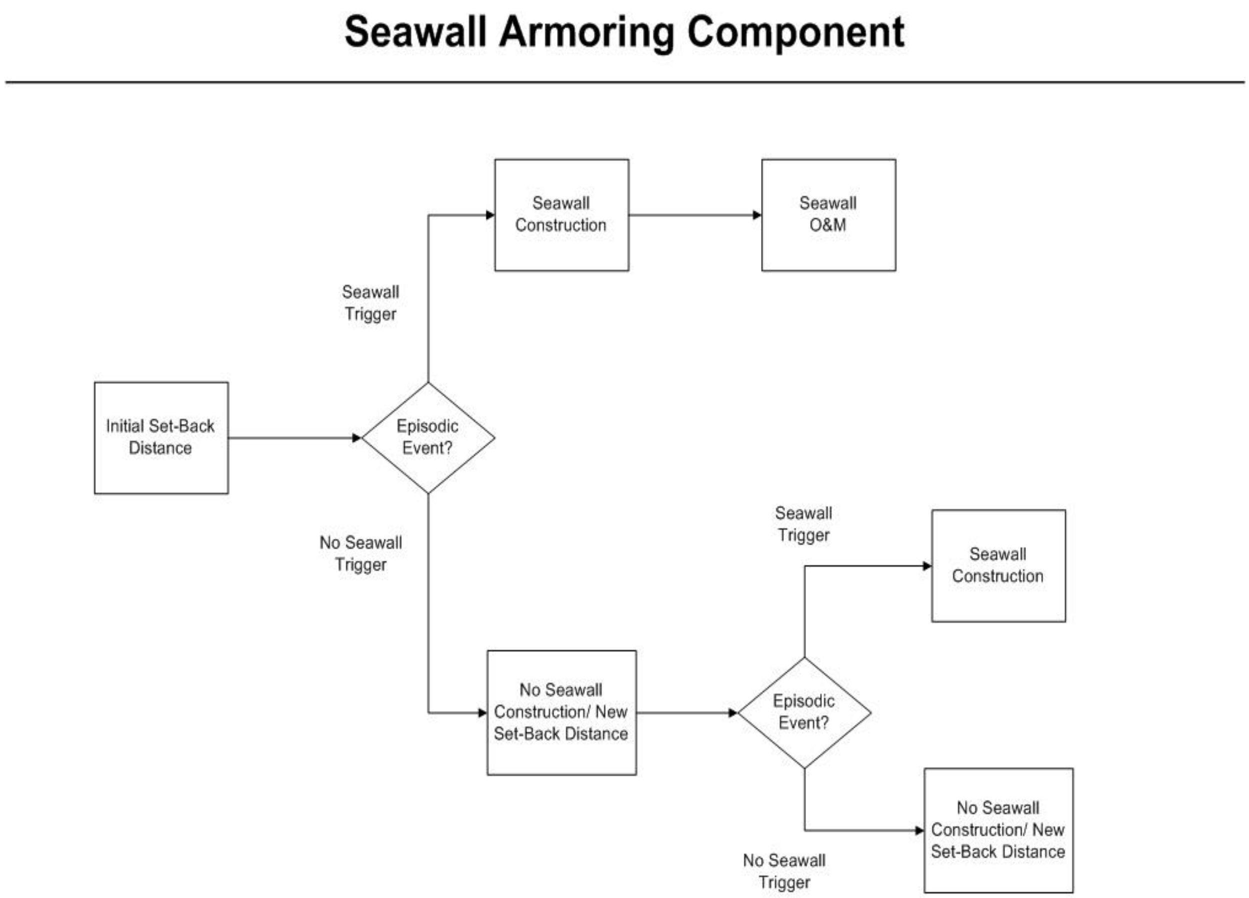

Figure 4.4-1 Seawall/Armoring Scenario Process

4.4.2 Episodic events

Armoring Scenario draws erosion data from a simulation of episodic events that are generated by the Bluff-Erosion Model.[28] This Bluff-Erosion model uses Monte-Carlo methods to combine waves, tides, initial toe notch depths, and empirical relationships of bluff failure geometry, notch depth growth with wave exposure, and bluff instability. Bluff retreat does not tie directly to a single coastal storm event but is caused by consistent wave attack to the base of the bluff during the winter season. The wave conditions used in the model are based on validated wave hindcasts over the period of 1979-2001, hence includes periods of both El Nino and La Nina (severe and mild) winter wave conditions. The simulation is conducted with a 3-hour time step, and through the creation of the frequency distributions, includes storm waves combined with tide and surge levels. The "shoreline", as adopted in this report, is the MSL contour, approximately +2.7 feet above mean lower low water (MLLW). The hardpan elevation at the bluff base ranges from +1.7 to +3.7 ft. The without project beaches within the study area are generally denuded.

The bluff-top erosion rates used for the economic modeling are direct outputs from the Bluff-Erosion Model. These outputs consist of 50 years of episodic events separated by location

[28] For additional explanation of how the erosion data was generated reference the Coastal Engineering Appendix, table 5-5 and the Bluff Erosion Model White Paper.

(study area reach) and initial toe notch depth (0, 2, 4 & 6 feet). Each combination of location and toe notch depth has 1,000 50-year bluff-top erosion events that are randomly drawn to run in the economic model. These episodic events form the basis for all *Armoring Scenario* damages—loss of staircases, land loss, seawall construction, and seawall maintenance. For additional explanation about how these erosion rates are derived refer to the Coastal Engineering Appendix.

4.4.3 Land Loss

Since all land loss under the *Armoring Scenario* occurs between the bluff-top edge and bluff-top structure (or bluff-top parcel demarcation line for undeveloped parcels), land loss is valued at the bluff-top price per square foot since there is no transfer of bluff top value to the interior row of properties when the bluff top structure is protected. The price per square foot was estimated using the methodology outlined in section 3.2.8.

4.4.4 Staircases Loss

Some parcels in the study area have staircases leading from the bluff top to the beach. Over time episodic events have caused several of these staircases to become unsafe or even collapse. Under without project conditions we expect more staircases to be lost. The replacement cost for a private staircase has been estimated at $42,000. Typically, after three feet of bluff-top erosion a staircase can fail. Therefore the "staircase trigger" occurs in the year there is three or more feet of cumulative erosion to the bluff top—in that year the staircase is lost. Since the number of staircases is limited, the impact to without project damages is minimal.

4.4.5 Seawall Construction & Maintenance

Historical seawall permit data in the study area was used to establish a probability distribution of bluff-top to structure setback distances immediately preceding application for a seawall permit, which must be done before a seawall can be legally constructed as explained in sections 3.2.5 and 4.2. Briefly, the triggering event ('seawall trigger') establishes the setback distances from structure to bluff-top edge that causes the parcel owner to seek a seawall construction permit. Under the *Armoring Scenario* we have assumed that all parcel owners respond to the 'seawall trigger' by applying for a permit and all seawall permit applications are approved, although not in that same year. The model follows historical precedent: episodic events eventually threaten the structure; the affected parcel owner seeks a seawall permit; successful permit applications are typically approved in 1-3 years; and a seawall is constructed shortly thereafter. In this way the major steps to construct a seawall have been modeled—permit application, application review and approval, and finally seawall construction. According to local experts who construct and maintain seawalls in the study area, seawall maintenance occurs at regular intervals since seawalls are exposed to recurring wave attacks. This has been modeled also.

4.4.6 Results

As noted previously, separate scenarios were modeled for low and high sea-level rise, as shown in **Table 4.4-1**. Results under the low sea-level rise scenario show that reaches 1 and 2 have moderate damage that is primarily the result of maintenance and repair to existing seawalls. These results were expected given the gentler sloping typical of the bluffs in this area and the propensity for Reach 2 to have landslides limiting the effectiveness of project alternatives that would address coastal erosion at the bluff toe. Reaches 3-5 have significantly more average annual damages due to the large number of unprotected parcels and bluff characteristics more conducive to seawall construction.[29]

Table 4.4-1 Armoring Average Annual Damages by Reach & Segment

Low SLR		
Reach	**Expected Values**	***Std Deviation***
1	$156,000	*4,000*
2	$291,000	*40,000*
3	$558,000	*108,000*
4	$1,124,000	*92,000*
5	$1,510,000	*195,000*
6	$28,000	*18,000*
7	n/a	n/a
8	$1,028,000	*251,000*
9	$1,680,000[30]	*377,000*
Total	**$6,375,000**	
Segment 1	$3,192,000	
Segment 2	$2,708,000	*324,000*
High SLR		
Reach	**Expected Values**	***Std Deviation***
1	$159,000	*5,000*
2	$357,000	*30,000*
3	$534,000	*121,000*
4	$1,200,000	*149,000*
5	$1,682,000	*267,000*
6	$108,000	*15,000*
7	n/a	n/a
8	$987,000	*287,000*
9	$2,177,000	*389,000*
Total	**$7,204,000**	
Segment 1	$3,415,000	*487,000*
Segment 2	$3,164,000	*697,000*

Reach 6 consists predominantly of San Elijo State Park and has few structures. As a result damages are minimal. Reach 7 does not have coastal bluffs and is a low-lying lagoon with several restaurants. It is evaluated for damages from storm surge inundation in a separate section *Without Project Analysis: Overtopping*. Reach 8 and 9 extend the entire coastline of Solana Beach. Reach 8 has a mix of single family residences and multi-family residential structures (condominiums) while Reach 9 is predominantly multi-family residential structures. Damages were substantial in both reaches—about $1 million in average annualized damages—and somewhat lower but still substantial in coastline immediately south of and contiguous to Solana Beach, the Del Mar Reach.

[29] For further details about Reach 1 and 2 refer to the coastal engineering appendix.

[30] Included are damages of $689,000 to parcels with structures contiguous to and immediately south of Reach 9 in the neighboring city of Del Mar. A portion of these damages would be prevented by sand placement alternatives.

Results under the high sea-level rise scenario show a similar pattern—damages are concentrated in reaches 3-5 and 8-9 and the Del Mar Reach. Damages for all reaches are modestly higher under this sea-level rise scenario except for reaches 8 and 9. This occurs at those reaches because more seawalls are constructed before the base year meaning that those damages would occur prior to the study period in the high sea-level rise scenario. In addition, across all reaches the total number of seawalls constructed increases only slightly under the high-sea level rise scenario. This is clear from the seawall counts shown in the table below for Segment 1 and 2. Segment 2, which includes reaches 8-9 and the several parcels contiguous to and immediately south of reach 9 (“Del Mar Reach”), is expected to have only two more seawalls constructed in the high versus low sea-level rise scenario.

The underlying reason for the modest increase to damages under the low sea-level rise scenario is revealed by the number of seawalls and the nominal damages for the study period shown in **Table 4.4-2** and **Table 4.4-3**, respectively. Under the low and high sea-level rise scenarios the number of seawalls constructed and the nominal damages are similar. This is because in general the existing, unprotected parcels that become threatened under either sea level rise scenario are the same; in other words, our modeling shows that for most unprotected parcels the uncertainty is not if a given parcel will need to construct a seawall in the future, but when will it need to do that—sooner under high SLR and later under low SLR. Therefore the difference in average annual damages between the two sea-level scenarios is exclusively the result of the timing of seawall construction (earlier in the study period under high SLR and later in the study period under low SLR) rather than more seawall construction under the high SLR.

Table 4.4-2 Armoring Scenario: Existing vs Future Seawall Construction

Low SLR	Existing Seawall Count (2011)	Existing Seawall Length (2011)	Without Project Seawall Count (2068)[31]	Without Project Seawall Length (2068)
Segment 1	30 seawalls	1,741 linear ft	110 seawalls	6,703 linear ft
Segment 2	46 seawalls	3,476 linear ft	80 seawalls	7,735 linear ft
Total	**76 seawalls**	**5,217 linear ft**	**190 seawalls**	**14,438 linear ft**
High SLR				
Segment 1	30 seawalls	1,741 linear ft	116 seawalls	7,136 linear ft
Segment 2	46 seawalls	3,476 linear ft	82 seawalls	7,735 linear ft
Total	**76 seawalls**	**5,217 linear ft**	**198 seawalls**	**14,871 linear ft**

The majority of damages analyzed occur in reaches 3-5 and 8-9 and the Del Mar Reach, which corresponds with Segment 1 and Segment 2, respectively. Closer examination of these two segments reveals that we expect a large number of seawalls to be constructed in the study area if no project is implemented. Segment 1 and 2 are approximately 15,000 linear feet combined. Under without project conditions we expect 90-95% of the lower bluff to be armored by the end of the study period under low and high sea-level rise scenarios, respectively. The cost of constructing and maintaining these seawalls in Segment 1, shown in **Table 4.4-3**, is on average $1.9-2.0 million each year of the period of analysis (average annualized value). In Segment 2 this cost is $1.2 million. Across both Segments the cost would be $3.1-3.2 million annualized. Land Loss, the other major damage category, amounts to $2.9-$3.4 million annual damages.

[31] Average number of seawalls constructed by year 50 of study period when running 1000 bluff erosion iterations in the Armoring Scenario component of the model

Total annualized damages across all categories are $5.9 million under low sea-level rise scenario and $6.6 million under high sea-level rise scenario.

Table 4.4-3 Armoring Scenario Annualized Damages

Low SLR	Armoring Construction/O&M	Land	Staircases[32]	Total
Segment 1	$1,883,000	$1,314,000	$2,000	$3,199,000
Segment 2	$1,165,000	$1,536,000	$0	$2,701,000
Total	$3,048,000	$2,850,000	$2,000	$5,900,000
High SLR				
Segment 1	$2,000,000	$1,415,000	$500	$3,415,500
Segment 2	$1,177,000	$1,987,000	$0	$3,164,000
Total	$3,177,000	$3,402,000	$500	$6,579,500

4.5 Without Project Damages: Retreat Scenario

4.5.1 Layout & Process

Retreat Scenario assesses land loss from bluff-top collapse and any associated stairway loss, structure loss, structure demolition costs. In addition we have assumed that seawalls are constructed to protect structures and infrastructure beyond the first row of bluff-top parcels to protect a significant amount of municipal infrastructure (roads, power & sewer lines, telecommunications equipment, etc.). Unchecked erosion capable of damaging this municipal infrastructure does occur for some parcels based upon the coastal modeling results, particularly under high sea-level rise. Representatives from the Cities of Solana Beach and Encinitas have specified that they would take proactive action to construct seawalls once such infrastructure is threatened, which is the reason for modifying the *Retreat Scenario* to include seawall construction to protect interior infrastructure.

The *Retreat Scenario*, like the *Armoring Scenario*, draws 50 years of random episodic events (bluff-top erosion) for each simulation. Year-by-year a new bluff-top setback distance is generated and all damages are retained. Damages may include staircase loss, land loss, structure loss, structure demolition, and seawall construction under specific circumstances. Seawall construction occurs only if erosion events cause less than 15% of the original parcel to remain. This ensures interior infrastructure is protected as both cities have indicated. No damages from episodic events occur to land, structures, and infrastructure interior to the first row of bluff-top parcels. Each subsequent year after a seawall is constructed seawall maintenance costs are applied. This process is laid out in **Figure 4.5-1**.

[32] Staircase losses are limited because few existing staircases are unprotected and of those that are unprotected damages tend to occur before the base year.

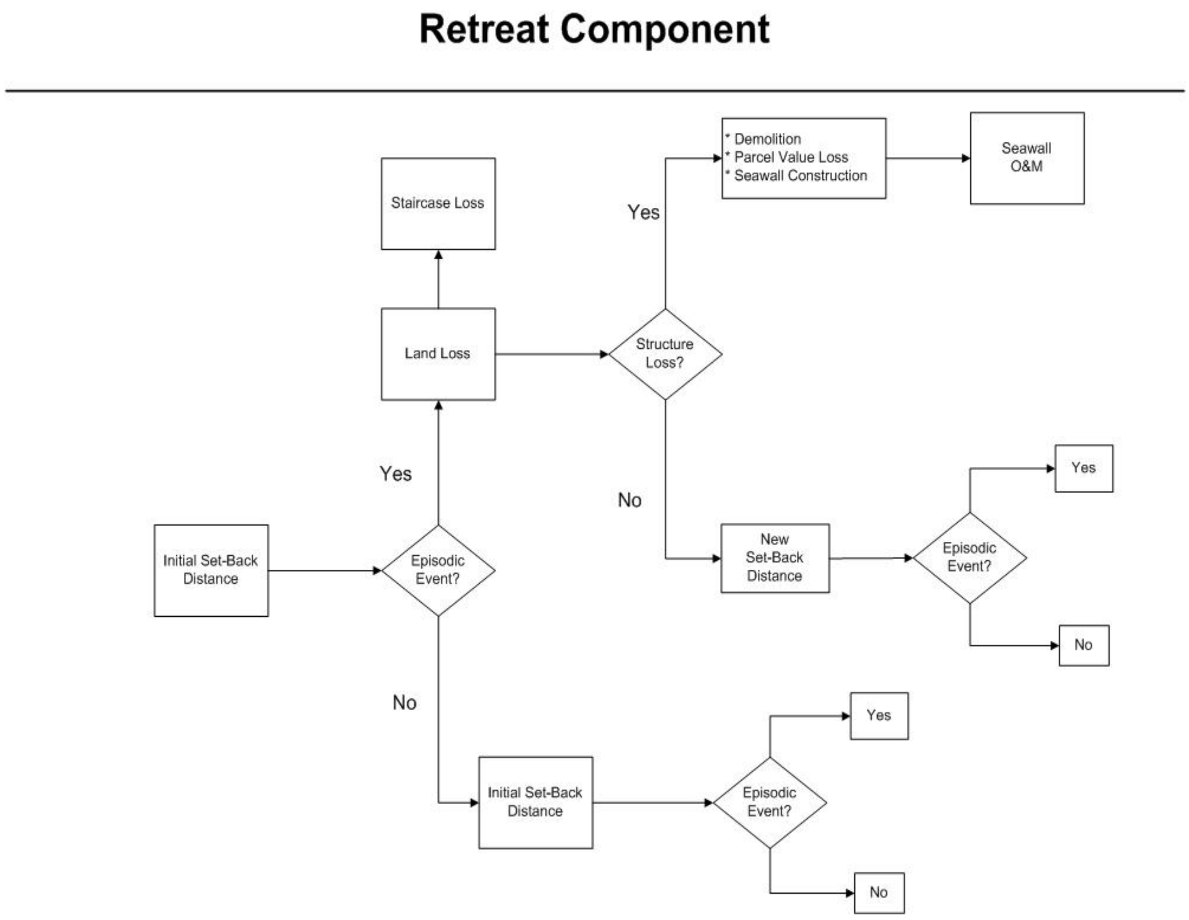

Figure 4.5-1 Retreat Scenario Process

4.5.2 Episodic events

The *Retreat Scenario*, like the *Armoring Scenario*, draws erosion data from a simulation of episodic events that are generated by the Bluff-Erosion Model.[33] See the *Armoring Scenario* section for a full explanation.

4.5.3 Seawall Trigger

Under the *Retreat Scenario* a seawall is constructed after the first row of parcels are lost because further erosion would undermine major public infrastructure such as roads, sewer lines, and power lines without this intervention. Representatives from both cities have informed us that resources would be made available to construct seawalls and prevent this catastrophic scenario. Unlike the *Armoring Scenario,* the seawall trigger for the *Retreat Scenario* has been modified to occur after the structure has been rendered uninhabitable by episodic events and once only 15% of the original parcel area remains. If the parcel does not have a structure, a seawall is constructed once 15% of the original parcel area remains.

[33] For additional explanation of how the erosion data was generated reference the Coastal Engineering Appendix, table 5-5 and the Bluff Erosion Model White Paper.

4.5.4 Structure & Content Damages

The *Retreat Scenario* and *Armoring Scenario* are laid out similarly; however, since the first row of structures can be lost under the *Retreat Scenario*, their value along with content damages and demolition costs have been included in the *Retreat Scenario*. Structure valuation is based on a complete visual survey of all structures in the study area to estimate structure quality and condition. This methodology follows guidelines from the Marshall & Swift Valuation Service and allows the depreciated structure value to be estimated at current price levels.[34] Demolition costs were estimated by a local demolition firm with experience demolishing residential structures. Estimates were given as a range of values per square foot that included both demolition and removal, which were then calculated for each structure in the study area. Content value is a percentage of the depreciated structure value that varies by usage type.

4.5.5 Land Loss Value: Bluff-top & Non Bluff-top

Since land loss under the *Retreat Scenario* occurs across the entire parcel, land value is distinguished by bluff-top and non bluff-top for parcels with structures (undeveloped parcels are only valued as non-bluff top). Land loss occurring between the bluff-top edge and structure is valued as bluff-top to be consistent with land valuation under the *Armoring Scenario*. Land loss occurring after the structure is lost is valued as non bluff-top, consistent with guidelines.[35] Bluff-top and non bluff-top land value was estimated using sales data between 2002 and 2010 for 60 bluff-top parcels and 418 non bluff-top parcels sold within the study area. First all structures were surveyed for structure quality and condition. On average the value of bluff-top land in the study area is $327 per square foot and non bluff-top value is $107 per square foot, as shown in **Table 4.5-1**. These values were applied to the area of bluff-top erosion on each parcel to value land loss.

Table 4.5-1 Sales Count and Land Value

	Sales Count[36]	Land Value per SQFT (Average)
Bluff-top	60	$327
Non bluff-top	418	$107
Total	478	--

4.5.6 Results

Results in **Table 4.5-2** under the low sea-level rise scenario show that reaches 1 and 2 have moderate damage that is primarily the result of maintenance and repair to existing seawalls. These results, which are similar to results in the Armoring Scenario described earlier, were

[34] Structure value (also termed "improvement value") could not be based on assessor data because Proposition 13 limits parcel valuations to no more than 2% growth annually for assessing property taxes. Therefore significant price appreciation over the past several decades has created irreconcilable differences between market and assessed value in the study area.

[35] ER 1105-2-100 Appendix E

[36] Sales occurring within Solana Beach and Encinitas between 2002 and 2010 and indexed to current price levels

Table 4.5-2 Retreat Average Annual Damages by Reach & Segment

Low SLR		
Reach	**Expected Values**	***Std Deviation***
1	$156,000	*4,000*
2	$162,000	*12,000*
3	$660,000	*36,000*
4	$946,000	*55,000*
5	$1,353,000	*132,000*
6	$13,000	*6,000*
7	n/a	n/a
8	$1,006,000	*72,000*
9	$2,824,000[37]	*226,000*
Total	**$7,120,000**	
Segment 1	$2,959,000	*159,000*
Segment 2	$3,830,000	*292,000*
High SLR		
Reach	**Expected Values**	***Std Deviation***
1	$158,000	*4,000*
2	$289,000	*11,000*
3	$788,000	*42,000*
4	$1,468,000	*78,000*
5	$1,892,000	*154,000*
6	$90,000	*5,000*
7	n/a	n/a
8	$1,257,000	*80,000*
9	$3,599,000[38]	*242,000*
Total	**$9,541,000**	
Segment 1	$4,148,000	*190,000*
Segment 2	$4,856,000	*295,000*

expected given the gentler sloping typical of the bluffs in this area and the propensity for Reach 2 to have landslides limiting the effectiveness of seawalls built at base of the bluff. As under the

[37] Included are damages of $712,000 to parcels and structures contiguous to and immediately south of Reach 9 in the neighboring city of Del Mar. A portion of these damages would be prevented by sand placement alternatives.

[38] Included are damages of $1,224,000 to parcels and structures contiguous to and immediately south of Reach 9 in the neighboring city of Del Mar. A portion of these damages would be prevented by sand placement alternatives.

Armoring Scenario reaches 3-5 have significantly more damage due to the large number of unprotected parcels and bluff characteristics more conducive to seawall construction.[39] Reach 6 consists predominantly of San Elijo State Park.

Damages under the high sea-level rise scenario are significantly higher than the low scenario. The reason is apparent when the structure loss is counted under both scenarios shown in **Table 4.5-3**. The expected number of structure losses under the Retreat Scenario is 72 in Segment 1 (reaches 3-5) and 32 in Segment 2 (reaches 8-9 and the several parcels contiguous to and immediately south of reach 9 referred to as the "Del Mar Reach") under both low and high sea-level rise scenarios—in other words the number of expected structure losses is identical. The undiscounted, nominal value of those structure losses is also similar. This means structure losses tend to occur on the same parcels under low and high sea-level rise scenarios but the timing of structure loss is different. High sea-level rise conditions tend to cause structure losses earlier in the study period compared to low sea-level rise conditions leading to higher annualized damages in the high sea-level rise scenario.

Overall, damages occurring under the Retreat Scenario are modestly greater than those under the Armoring Scenario. As explained earlier in this section the Retreat Scenario is not a "true" managed retreat scenario because officials at both cities (Solana Beach & Encinitas) have explained to USACE that their policy would be to protect public utility lines and roads immediately interior to the bluff top parcels with publically-financed seawalls obtained under emergency permits from the CCC. Therefore Retreat Scenario damages, are limited to structure loss, land loss, and seawall construction affecting the row of bluff top parcels only. This also means the timing of the major damages categories (structure loss and seawall construction) are pushed out further in to the future than the major damage occurring under the armoring scenario, which is seawall construction before the bluff top structure is undermined. This difference in timing, which is impacted by discounting, further diminishes the difference in damages between retreat and armoring scenarios.

Table 4.5-3 Retreat Scenario Structure & Content Loss (nominal values)

Low SLR	Existing Structure Count	Structures Loss Count	Structures Loss Value	Content Loss Value
Segment 1	119	72	$24,708,000	$2,518,000
Segment 2	77	32	$22,794,000	$1,747,000
Total	196	104	$47,502,000	$4,265.00
High SLR				
Segment 1	119	72	$24,708,000	$2,518,000
Segment 2	77	32	$23,361,000	$1,855,000
Total	196	104	$48,069,000	$4,373,000

Table 4.5-4 shows the annualized, discounted damages by category for the portions of the study area where most damages occur—Segment 1 and 2. As expected, more damages occur earlier in the study period so the high sea-level rise scenario has greater average annualized damages compared to low.

[39] For further details about Reach 1 and 2 refer to the coastal engineering appendix.

Table 4.5-4 Retreat Scenario Annualized Losses

Low SLR	Armoring Construction/O&M	Land, Staircase	Structure/Content, Demolition	Total
Segment 1	588,000	1,657,000	713,000	2,959,000
Segment 2	910,000	2,146,000	775,000	3,830,000
Total	1,498,000	3,803,000	1,488,000	6,789,000
High SLR				
Segment 1	1,381,000	1,882,000	856,000	4,148,000
Segment 2	1,442,000	2,517,000	897,000	4,856,000
Total	2,823,000	4,399,000	1,753,000	9,004,000

4.6 Weighting Armoring & Retreat Scenarios

The *Armoring* and *Retreat Scenarios* model two mutually exclusive behavior patterns to impending bluff collapse. We expect each parcel owner to follow one of these two patters: either armor the parcel with a seawall to prevent structure collapse or fail to armor the parcel and allow structure collapse. However we do not know which behavior pattern each individual parcel owner would follow under without project conditions. To assign individual weights to each parcel would require generating @Risk output distribution functions for each parcel and each scenario, and then combining them on an individual basis first before aggregating those results. This would imply a level of detail and certainty for the weighting that does not exist. Instead based on the limited information available on individual property owners, the PDT developed a weighting scheme for armoring and retreat for all of the property owners instead of developing individual probabilities for each homeowner.

The *Armoring Scenario* assumes all owners threatened by structure failure/collapse are able to construct seawalls in time. The *Retreat Scenario* assumes these same owners are unable to construct seawalls in time and the first row of structures collapse given enough bluff erosion. With Project Benefits are determined by the reduction in without project damages. To determine the amount of preventable without project damages (i.e. the with-project maximum benefits) the *Armoring* and *Retreat Scenario* damages have to be combined. Therefore, these scenarios are weighted by the probability of occurrence to determine the expected value.

Determining the probability of occurrence for the *Retreat Scenario* involves establishing the percentage of "unexpected" and "threatening" bluff-top collapses that could lead to structure failures. "Threatening events" are bluff top collapses that occur when the structure setback distance is between 25 and -5 feet, which is a range of distances that leave the structure vulnerable to collapse during the next episodic event. Parcels that experience threatening events may experience erosion events the following year that cause structure failure and these are called "unexpected events," which by definition cannot be acted upon in time to prevent the structure from failing regardless of parcel owners' responses. Unexpected events happen when setback distances greater than 0 feet are followed immediately the next year by episodic events that cause the setback distance to be less than -5 feet, which is the minimum setback distance that causes structure failure. The share of "unexpected events" to "threatening" and "unexpected" events is the basis for the minimum possible weighting for *Retreat Scenario*. This is the minimum weighting because all parcels subject to episodic bluff failures in the sequence just described would likely sustain structure failures despite proactive responses from the affected parcel owners. However this minimum weighting does not account for other factors impacting how parcel owners respond to episodic bluff failures. Consequentially, these values are adjusted upward by 15% based on subjective considerations for owners that do not have the financial means or timely construction permits to build seawalls in time as well as those that do not construct seawalls in time for other personal reasons. Therefore the minimum “objective” weighting, which differs by segment and sea-level rise scenario, was increased by 15% based on subjective criteria to finally arrive at the adjusted weighting that is applied to *Retreat & Armoring Scenarios* to calculate the expected without project damages. [40] We recognize the uncertainty associated with these weights and have conducted a sensitivity analysis to show the impact on plan selection and justification when applying a range of weights to the scenarios.[41]

When the “Adjusted Weighting” from **Table 4.6-1** is multiplied by the Armoring and Retreat Scenario Damages, the results are as shown in **Table 4.6-2** below.

Table 4.6-1 Retreat Scenario Weighting

	Minimum/Objective Weighting		Adjusted Weighting	
	Low SLR	**High SLR**	**Low SLR**	**High SLR**
Segment 1 (Encinitas)	2.9%	5.1%	18%	20%
Segment 2 (Solana Beach)	6.9%	14.1%	22%	29%

Table 4.6-2 Weighted Damages Results

Low SLR	Armoring Damages	Retreat Damages	Armoring Weighting %	Retreat Weighting %	Weighted Damages
Segment 1					
Expected Value	$3,199,000	$2,960,000	82%	18%	$3,156,000
Std Deviation	*304,000*	*151,000*			*252,000*
Segment 2					
Expected Value	$2,701,000	$3,831,000	78%	22%	$2,950,000
Std Deviation	*610,000*	*233,000*			*478,000*
High SLR					
Segment 1					
Expected Value	$3,416,000	$4,149,000	80%	20%	$3,548,000
Std Deviation	*466,000*	*180,000*			*383,000*
Segment 2					
Expected Value	$3,164,000	$4,860,000	71%	29%	$3,656,000
Std Deviation	*683,000*	*237,000*			*535,000*

Overall, damages occurring under the *Retreat Scenario* tend to be greater than those under the *Armoring Scenario*. The *Retreat Scenario* is not a “true” managed retreat scenario because officials at both cities (Solana Beach & Encinitas) have explained to USACE that their policy would be to protect public utility lines and roads immediately interior to the bluff top parcels with publically-financed seawalls obtained under emergency permits from the CCC. Therefore *Retreat Scenario* damages are limited to structure loss, land loss, and seawall construction affecting the row of bluff top parcels only. This also means the timing of major damages categories structure loss and seawall construction are pushed out further in to the future than

[40]*Sloughing (Residual) Damages* are subtracted after the expected without project damages have been calculated to arrive at the Remaining Preventable Damages. See the *Sloughing Damage Analysis* section for further details.
[41] See the section on *Risk and Uncertainty* later in this document.

the major damage occurring under the armoring scenario, which is seawall construction before the bluff top structure is undermined. This difference in timing, which is impacted by discounting, further diminishes the difference in damages between *Retreat* and *Armoring Scenarios*.

4.6.1 Sloughing Damages

Although each alternative prevents the storm damage cycle, none are designed to prevent the natural sloughing of the bluff in unstable, unprotected areas. Under the without project analysis the natural sloughing rate for unstable unprotected areas was hidden from direct observation by the bluff failure process but was incorporated into the process. This ensures that land subject to natural sloughing under with-project conditions that was not assessed in the without project conditions due to the process described above is not counted as a benefit.

With any of the alternatives in-place residual sloughing would occur in unstable areas until a stable angle of repose is achieved. Geotechnical analysis estimates the annual natural sloughing rates in unstable, unprotected areas of the study at 0.4 feet in Segment 2 and 0.5 feet to 0.68 feet in Segment 1. To simplify the modeling effort for natural sloughing geotechnical experts assumed that the annual sloughing rate would be prorated by the share of unstable area to total area by reach and applied to all properties in that reach, rather than incorporating a parcel by parcel approach to the model. This simplification returns approximately the same total land loss as a parcel by parcel analysis. The estimated percentages of land area considered unstable by reach are: 20% in Reach 3, 44.5% in Reach 4, 16% in Reach 5 (Segment 1), 28% in Reach 8, and 9.4% in Reach 9 (Segment 2).

Residual sloughing loss is estimated through the risk-based without project model by incorporating sloughing rates specific to each reach from the base operational year until the study ends. Sea-level rise does not affect sloughing because the sloughing process occurs outside of the influences from wave attack and toe notch erosion. These figures apply to all alternatives and all sea-level rise scenarios as all produce the same effect on sloughing. **Table 4.6-3** identifies sloughing damages by reach and segment. The largest share of sloughing damages occur in Reach 4, $200k, while the least occurred in the “Del Mar Reach”, $13k. Episodic events obscure the natural sloughing at the bluff edge. As a result these sloughing damages at the bluff edge have to be subtracted from without project damages to prevent “double counting.” For additional explanation refer to the Economic Model Attachment E1 and the Appendix B.

Table 4.6-3 Sloughing Average Annual Damages

Reach 1	n/a
Reach 2	n/a
Reach 3	$99,000
Reach 4	$202,000
Reach 5	$96,000
Reach 6	n/a
Reach 8	$88,000
Reach 9	$55,000[42]
Total	**$540,000**
Segment 1	$397,000
Segment 2	$143,000

4.6.2 Results

The maximum coastal storm damage reduction benefits, which were determined by taking the weighted damages from the *Armoring* and *Retreat Scenarios* and removing the sloughing damages, are shown below in **Table 4.6-4**. These are the maximum potential benefits that could be realized by alternatives that address coastal storm processes, as sloughing damages would occur under both with and without project conditions. These results from analyzing without project conditions are retained and evaluated under with project conditions to determine the CSDR Benefits (CSDRB) of each project alternative. See Section 5.2.1 for further explanation.

Table 4.6-4 Maximum Coastal Storm Damage Reduction Benefits (Average Annualized)

Low SLR	Armoring Damages	Retreat Damages	Weighted Damages	Residual/Sloughing Damages	Maximum CSDRB
Segment 1	$3,199,000	$2,960,000	$3,156,000	$397,000	**$2,759,000**
std dev	*304,000*	*151,000*	*252,000*	--	*247,000*
Segment 2	$2,701,000	$3,831,000	$2,950,000	$143,000	**$2,807,000**
std dev	*610,000*	*233,000*	*478,000*	--	*437,000*
HIGH SLR					
Segment 1	$3,416,000	$4,149,000	$3,548,000	$397,000	$3,166,000
std dev	*466,000*	*180,000*	*383,000*	--	*251,000*
Segment 2	$3,164,000	$4,860,000	$3,656,000	$143,000	$3,513,000
std dev	*683,000*	*237,000*	*535,000*	--	*478,000*

[42] Included are damages of $13,000 to parcels contiguous to and immediately south of Reach 9 in the neighboring city of Del Mar.

4.7 Without Project Damages: Overtopping

4.7.1 Layout & Process

Damages caused by wave run-up occur along the low-lying section of the study area at Cardiff State Beach within Reach 7, as shown in **Figure 4.7-1**. This reach does not have coastal bluffs; instead coastal storms generate damages in this reach when storm waves overtop Old Highway 101 and the revetments that protect three restaurants located west of Old Highway 101. Damages in this reach are categorized as clean-up costs (debris removal from Old Highway 101 and clean-up costs to the three restaurant interiors), damage costs to the three restaurant interiors, and traffic delay costs that are incurred when Old Highway 101 is closed due to debris in the roadway and clean up operations.

This analysis assesses the expected annual damages from return events (2-year to 100-year) given the probability of each return event occurring when tides are high enough to cause wave-overtopping. The two-year event (50% Annual Chance of Exceedance [ACE]) is considered minor and causes partial road closures and minimal structure content damages. Five and ten-year events (20% and 10% ACE) cause full road closures but minimal structure content damages. All other events are considered major and can cause full road closures and substantial structure and content damage (see **Table 4.7-1**).

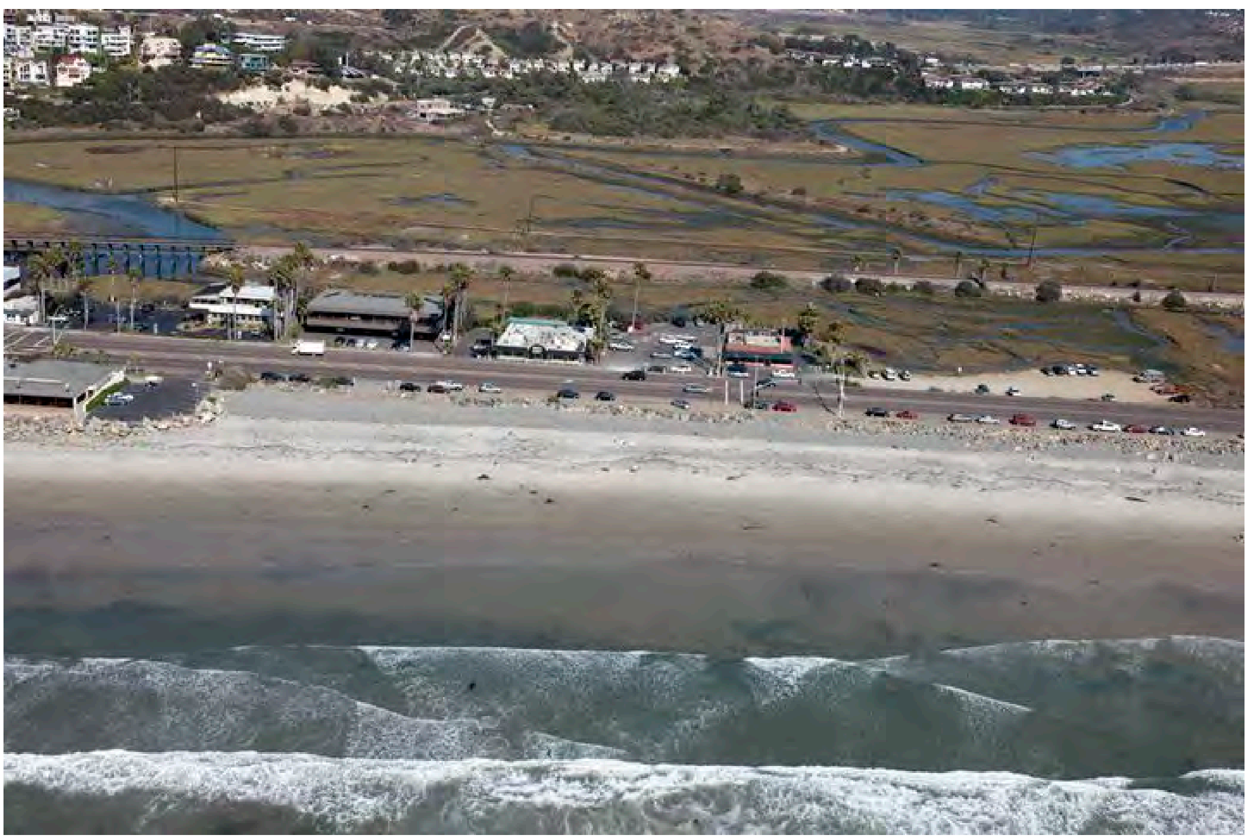

Figure 4.7-1 Reach 7

Table 4.7-1 Damage from Major Overtopping Event

Type	Unit Cost of Restoration	Total Cost
Plate-Glass	$32.99/sqft	$56,218
Carpeting & Fixtures	$14.57/sqft	$315,905
Kitchen	$906/linear ft	$453,095
Clean-up Costs	$896/event	$2,688
Total Cost		**$827,906**

4.7.2 Restaurant Clean-up

Water levels approximately two feet above the parking lot elevation caused by minor storms result in limited water damage to carpets in the restaurant. Moderate storms result in the occasional loss of plate glass walls which shield patio areas, and the restaurants have abandoned using outdoor patio areas, but have left the glass as additional protection for the restaurant windows. Major storms in 1988 and again in 1997 resulted in extensive destruction to the interior of one restaurant, though damage to the kitchen was minimal due to its placement in the building. Given this information a major storm event (4% ACE event or larger) is assumed to cause extensive destruction to the restaurants, but moderate storm events cause damages limited to clean-up costs. A major overtopping event, which can occur during 25-year return (4% ACE) events or greater, cause about $800,000 in damages to three structures in Reach 7. A minor overtopping event, defined as 2 to 10-year return events, causes about $2,700 in damages.

4.7.3 Highway 101 Cleanup

Storm waves deposit cobbles and other debris on the roadway and right-of-way that is routinely removed by the City of Encinitas. Partial or full closure of Old Highway 101 to vehicular traffic is often required during clean up operations (traffic delay damages are discussed in the next section). Roadway cleanup cost is calculated from costs incurred by the City of Encinitas to remove debris from the roadway after storm wave overtopping of Old Highway 101. Data provided by the City of Encinitas indicate that debris removal operations for events that close Old Highway 101 cost approximately $1,299 in labor, staff, and equipment costs.

4.7.4 Travel Delay

Travel delays, shown in **Table 4.7-2**, are caused when storm induced wave run-up deposits cobble and debris on the roadway requiring partial or full roadway closure during clean up operations. Roadway closure data provided by the City of Encinitas was compared to historic storm data to correlate roadway closures with the annual probability of storm events. Travel delay costs are based on the median household income for Encinitas obtained from the US Census Bureau. The amount is $86,131 or $41.41 per hour. Vehicle counts were broken down by trip purpose using the *Survey of California Drivers*. The value of travel time follows guidance from *Value of Time Saved for Use in Corps Planning Studies* IWR 91-R-12.

Table 4.7-2 Travel Delay Severity

	Add'l Travel Distance	Travel Delay	Total Cost
Partial Road Closure (minor event)	0 miles	1 minute	$73
Full Road Closure (major event)	3.5 miles	8 minutes	$9,474

Partial roadway closure will result from a two-year storm (50% ACE) event and that full roadway closure will result from storms ranging from the 25% ACE to the 1% ACE event. Using the man-hour estimates presented in **Table 4.7-2,** and assuming a two-person crew, a partial road closure would be two hours (rounded to the nearest full hour) in duration and a full road closure would be four hours in duration. Each day 21,251 cars travel north and southbound on Highway 101 through Reach 7 daily, which means on average 885 vehicles travel that route each hour. According to city officials vehicle traffic is not expected to increase noticeably during the study period so daily travel was held at 21,251.

Partial closure of the roadway at Old Highway 101 is expected to cause southbound (west side of the roadway) motorists to slow down due to merging traffic. Speed reduction during a partial roadway closure is expected to add negligible travel time (about one minute). Full closure of the roadway will cause northbound and southbound travel interruption.

4.7.5 Total Damages by Return Event

Based on the analyses performed on restaurant cleanup, highway cleanup, and travel delay, damages by return event are as shown in **Table 4.7-3**. Fifty-percent ACE events cause about $4,000 in total damages on average while 4% ACE events and larger cause $840,000 in damages primarily from restaurant cleanup.

Table 4.7-3 Damages by Annual Chance of Exceedance

Return Event	Travel Delay	Highway 101 Cleanup	Restaurant Cleanup	Total Damages
2 year (50% ACE)	$70	$1,300	$2,700	$4,000
5 year (20% ACE)	$9,500	$1,300	$2,700	$13,500
10 year (10% ACE)	$9,500	$1,300	$2,700	$13,500
25 year (4% ACE)	$9,500	$1,300	$827,900	$838,700
50 year (2% ACE)	$9,500	$1,300	$827,900	$838,700
100 year (1% ACE)	$9,500	$1,300	$827,900	$838,700

4.7.6 Expected Annual Damages

In order for an event to cause overtopping it must coincide with tidal conditions in the low-lying areas of Reach 7 only. All other reaches within the study area have bluff tops and are unaffected by overtopping in the manner Reach 7 is impacted. The probability tidal conditions are suitable for a given return event to cause overtopping factor in the share of tidal conditions that meet or exceed the threshold for overtopping given each return event. As would be expected tidal conditions exceed this threshold more frequently under a 1% ACE event

Table 4.7-4 Expected Annual Damages

Study Year	Low SLR	High SLR
1	$17,000	$21,000
10	$18,000	$25,000
20	$19,000	$30,000
30	$20,000	$36,000
40	$21,000	$42,000
50	$22,000	$48,000

compared to a 50% event and more frequently under the high sea-level rise scenario compared to the low. To determine expected annual damages (EAD), we combined the probability of wave exceedance, damages by return event, and probability of return event to determine EAD. The stream of projected EAD values was discounted to one present value and annualized to derive average annual damages. For instance note the total damages for the 10% ACE event are $13,500 and $838,700 for the 4% ACE event (see **Table 4.7-3**). The probability of tidal conditions exceeding the height that would allow the 10% ACE event to cause flooding is 22.05% in the base year under the low sea level scenario. This is multiplied by the total damages for the 10% ACE event, $13,500, to derive result, $2,970. This process is repeated for the remaining return events (50%, 20%, 4%, 2%, 1% events). Next the average damages across return events are calculated by finding the difference between the probability of each pair of return event (e.g., the 10% ACE event to 4% ACE event pair is 10% - 4% = 6%) and multiplying this by the average damages between those same pairs of return events (e.g., $217,800/2 + $2,970/2 = $110,400). The sum of this set of calculations is the expected annual damages ($17,200 in the base year). These calculations, shown in **Table 4.7-4**, are done for each return event for all 50 years of the study period, then summed and discounted to determine the net present value and annualized to estimate the equivalent annual damages for low and high sea-level rise scenarios.

4.7.7 Results

As shown in **Figure 4.7-2**, the expected annual damages (EAD) start near $18,000 in the base year and grow gradually under low sea-level rise conditions but accelerate under high sea-level rise conditions. However, even with accelerated growth expected annual damages remain below $50,000 in the final year of the study period. The average annual damages are $18,692 under the low sea-level rise scenario and $28,985 under the high sea-level rise scenario. This is primarily a result of the limited value of the structures in Reach 7, which is the only low-lying reach in the study area. Since there are only three structures in this reach and lack of space for new development and environmental concerns would likely restrain any future structure growth, the Project Delivery Team determined that the expected annual damages are not large enough to support any project alternatives. Therefore no project alternatives were formulated for detailed analysis to address wave-overtopping in Reach 7.

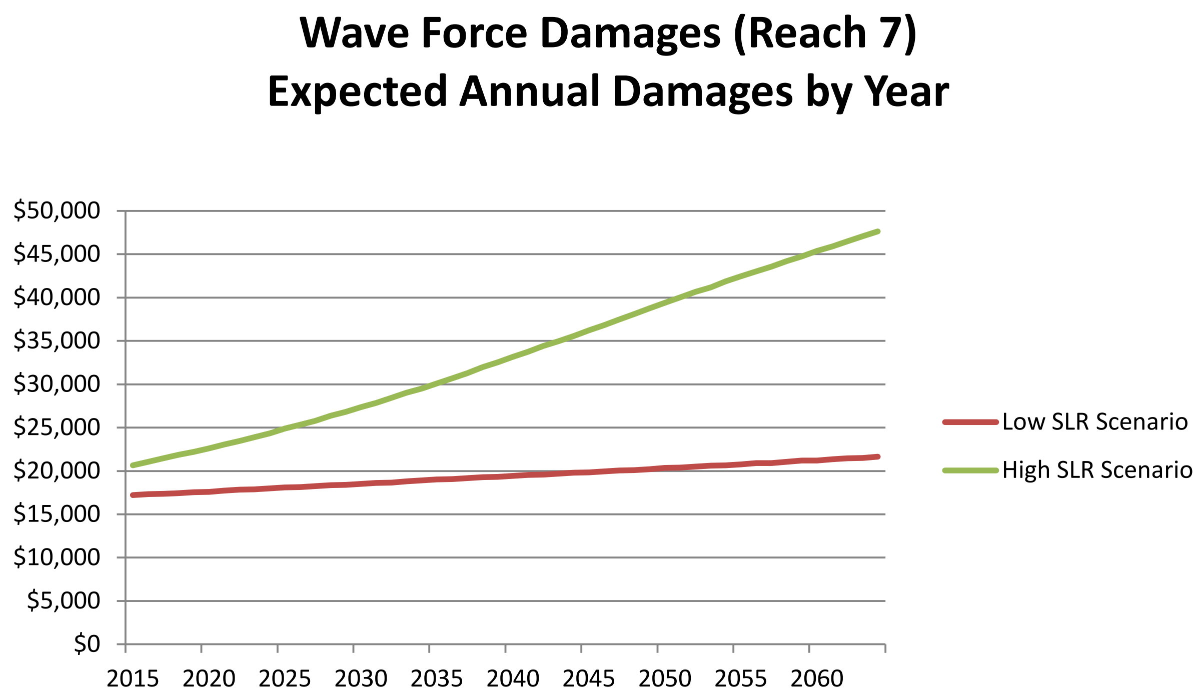

Figure 4.7-2 Expected Annual Damages Reach 7

4.8 Without Project Analysis: Recreation

4.8.1 Public Parking & Access

The city of Encinitas has approximately 2,566 public parking spots including street-side parking within a reasonable walking distance of nine different public access locations.[43] The distance between public access points varies from one-tenth to three-quarters mile. The city of Solana Beach has approximately 2,061 public parking spaces including street-side parking within a reasonable walking distance of four public access points. If only half of these parking spaces are available to beach visitors, over 10,000 daily visitors could arrive by vehicle at each city, which exceeds the current and anticipated future demand.

The study area is also serviced by regular public transit. Buses travel up and down the coastline (north-south) making stops near public access points 28-31 times every day. Buses traveling between the study area and inland communities make between one and two dozen stops daily with limited service on weekends. The study area is also serviced by commuter rail service that connects downtown San Diego and the coastal communities in the northern half of the county. The commuter rail makes stops within two to three blocks of the two most popular public access points within the study area. In addition many individuals have been observed bicycling to the study area beaches and several thousand residents and visitors in the study area reside or stay within walking distance of public access points.

[43] ER 1165-2-130 states parking must be “located reasonably nearby” the project. No specific distance is given; however, we have determined a reasonable walking distance is less than 1/3 of a mile. With the exception of Solana Beach transit parking (about 300 lots), street and public parking lots cited are typically 1/10 to ¼ mile from access points.

In sum the amount of parking is adequate to meet current and future peak demands, parking is located within reasonable walking distances from the access points, and if also taking into consideration visitation that is supported by modes other than car (buses, walking, bicycling, train), there is ample parking and other infrastructure to support projected recreation demand.

Solana Beach has implemented Land Use Plan provisions consistent with the California Coastal Management Program to ensure that "the protection, provision, and enhancement of coastal public access and recreation of opportunities in the City of Solana Beach [is] consistent with goals, objectives, and policies of the California Coastal Act. The policies can be broadly summarized as: improving existing public access opportunities by supporting proposals to enhance access-ways; providing objectives, standards, and designated sites for locating visitor serving recreational facilities and commercial uses such as hotels and motels; development of enhanced signage program to better identify public access and use opportunities; identifying and seeking removal of any unauthorized physical development, including signs and fences on the beach, which inhibit public use of public beach areas and state tidelands; and protecting existing and future parking availability near the shoreline and trail-access ways throughout the city."

Similarly, Encinitas has proposed a draft Comprehensive General Use Plan that includes a Local Coastal Program (LCP) consistent with the California Coastal Management Program. "The goals of the LCP are to protect, maintain and enhance the Coastal Zone environment; ensure balanced utilization and conservation; maximize public access to and along the coast; prioritize coastal dependent and related development; and encourage coordinated state and local initiatives to implement beneficial programs and other educational uses."

The cities are required by these Land Use Provisions and have intended for their beaches to be accessible to the public despite the unique challenges from bluff-top coastlines. Since public access to the beach along these coastal bluffs generally requires construction of stairways, often armored, on stable portions of the bluff, the paramount consideration and constraint is locating and obtaining easements to construct these stairways in a manner that allows visitors a safe descent to the beach. For this purpose the cities maintain eight public access points along the bluff-top to allow for safe descent to the beach. Two of these are within Segment 1 (Stonesteps and D-street) and three are within Segment 2 (Tide Beach, Seascape Surf, and Del Mar Shores). In addition Segment 1 includes one public access point at beach level (Moonlight) and Segment 2 includes two access points at beach level (San Elijo State Park and Fletcher Cove). Segment 1 includes good public access and sufficient parking but the northern portion of the Recommended Plan extends approximately 0.4 miles from the nearest public access point. The southern end of Segment 1 extends 0.5 miles from the nearest public access point. The distance between all public access points within Segment 1 is approximately 0.4 miles or less.

In the study area beach visitors have been routinely observed recreating throughout the study area and specifically more than ¼ mile from an access point. This can be partly attributed to the extensive urbanization along the coastline and large number of tourists. Beaches can become crowded throughout the summer and fall causing some beach visitors to walk the extra distance to enjoy open spaces for recreation. Others observed long distances from access points are taking beach walks or seeking out favored surfing and snorkeling spots among other reasons.

Although there are some locations along the project area where the distance between access points is somewhat greater than what the regulation construes to be the effective limit for public use: 1) the Cities have made every effort possible to provide as much beach access as possible given the geographical/physical constraints of the study area and; 2) the effective public use radius as cited in the regulation does not reflect the actual effective radius of public use in the Study Area, as significant recreation occurs throughout both of the Study Area segments, including those portions that exceed the referenced limits. The District believes that consideration should be given to the above factors regarding whether there should be any cost sharing implications relating to parking and access in the study area.

4.8.2 Valuation Process

Recreation values were estimated using the Unit Day Value (UDV) methodology. UDV was selected for the following reasons:

- The primary purpose of this project is coastal storm risk management (CRSM) and not recreation. While recreation benefits for this project are significant, they are considered incidental according to the Planning Guidance Notebook(PGN), (p. E-185) which notes that benefits are incidental when a project is formulated for other primary purposes and average annual recreation benefits are less than 50% of the average annual benefits required for justification (which applies to this study). In accordance with guidance we need to show the recommended project is economically justified with limited recreation benefits up to a maximum of 50 percent of total benefits and with the approach utilized, the project is economically justified at this threshold.
- The PGN specifies that if the size of the recreation being created is more than 750,000 visits, then generally a site specific model should be developed. However, for the plans evaluated in this study, the increase in visitation being generated is less than this threshold.
- The PGN does specify that factors to be considered when applying the UDV methodology include the technical challenges and costs of developing site specific models, and whether plan formulation and selection may be impacted. For this study, developing a site specific model would have been both costly and time consuming and would have negatively impacted study schedule, for a study that has already experienced significant delays. Using a site specific model would not have had an impact on the formulation of the alternatives, since none of the alternatives were formulated for a recreation purpose, since as noted, recreation is incidental and is a byproduct of the CSRM alternatives that include beachfills. Further, the UDV methodology employed was rigorous and detailed compared to most UDV analyses conducted for Corps studies. Significant time was spent developing defendable UDV point values and visitation estimates. It should also be noted that the UDV values employed are lower than those that were developed in some travel cost models such as the one developed by Dr. Phil King, and the UDVs employed reflect general recreation uses. Hence, the PDT is confident that the UDVs are not overstated. Despite this, (as will be shown later in the report) the project is economically justified based upon the values derived, and therefore plan justification is not in question.
- The existing site-specific Travel Cost Method estimation done by Dr. Phil King should not be applied to this study. It was done in 2001 and may no longer be an accurate estimate of recreation value. Since 2001 the share of visitors traveling various distances, the share of visitors traveling by various modes of transportation, and the cost per vehicle and airplane mile have changed sufficiently to lead to different estimates of consumer surplus today using the TCM developed in the King report. The surveys used to develop the travel cost in the King report were conducted during the summer season when a larger share of long-distance travelers typically visit these and other coastal shorelines in Southern California. Applying recreation values estimated in the King report

during the non summer season when approximately 40% of visitations occur would overestimate recreation value and consequently overestimate recreation benefits for each additional visitation generated by project alternatives. Finally, the resulting values from Dr. King's TCM analysis are significantly higher than any of the values in the UDV range for general recreation and even the lower end of the range for specialized recreation despite most activities in study area being general recreation, which raises concerns about the acceptability of using those results by both agency technical reviewers and the Corps' Office of Water Project Review.

- Experience at the District has demonstrated that the UDV approach is the one most commonly applied throughout the Corps for evaluating recreation benefits for projects with primary purposes other than recreation, such as flood risk management (FRM), CSRM and ecosystem restoration, even when visitation estimates and recreation benefits are significant.
- The District has determined that there is not an adequate, defendable site-specific model available for application in this study.

To perform the UDV methodology, recent detailed recreation visitor counts were produced by both cities and demonstrate that one-third of study area beach visits have occurred in Reaches 3-5 (Segment 1) and about 5% have occurred in reaches 8-9 (Segment 2) out of 3 to 3.3 million visits annually, as shown in **Table 4.8-1**.

Table 4.8-1 Historic Visitor Share by Reach (2005-2009)

Reach	Share of Visitors
1	14%
2	7%
3	5%
4	19%
5	8%
6	23%
7	21%
8	1%
9	4%

Recreation was valued using the Unit Day Value method as outlined by ER 1105-2-100 and IWR Report 86-R-4. Unit Day Values were assigned using the *Guidelines for Assigning Points for General Recreation*[44] and in consideration of expert opinions by Lifeguard Sergeants from both cities and a State Park Peace Officer & Senior Lifeguard at San Elijo State Park. Moonlight Beach within Encinitas hosts a significant share of the total recreation visits to the study area and has a large number of recreation facilities. Consequently, experts were asked to rate it separately from the rest of the study area beaches.

To keep the task clear and avoid inconsistencies between experts, they were instructed to use a relative scale from 1 to 5 to evaluate all five judgment factors used to develop UDV point values—recreation, experience, availability of opportunity, carrying capacity, accessibility, and environmental—and provide an explanation supporting how each judgment factor was rated. Since *Guidelines for Assigning Points for General Recreation* breaks each of the judgment

[44] EGM 12-03

factors in to five distinct point ranges (e.g., recreation experience with be two general activities earns 0-4 points, several general activities earns 5-10 points, several general & one high quality activity earns 11-16 points and so on), using this relative scale from 1 to 5 made translating results from the expert elicitation to UDV points simple and objective (e.g. scoring 1 on the relative recreation experience equates to 0-4 UDV points). Next the relative rankings produced by the experts were compared to the explanations given and the District's knowledge of the shoreline to ensure consistency and accuracy. Finally, the experts' relative rankings were converted to UDV point ranges as shown in **Table 4.8-2**.

Table 4.8-2 Expert Elicitation for UDV Point Values

Study Area Beaches UDV Expert Judgment	min points	max points	Moonlight Beach UDV Expert Judgment	min points	max points
4 kayaking, fishing, surfing, no volleyball, diving in kelp beds	17	23	4 kayaking, fishing, scuba, snorkeling, volleyball courts….high quality volleyball, snorkeling, kelp fishing	17	23
1 lots of places with similar alternatives such as Solana Beach	-	3	1 lots of places with similar alternatives	-	3
1 minimum facilities, just showers at each access point	-	2	3 adequate but not abundant restrooms on site, lots of space for volleyball courts, life guard towers on site	6	8
3 limited parking except for Moonlight, free parking on the streets	7	10	4 modest parking lots on-site and near PCH, with free parking on the streets	11	14
5 outstanding, no outdated structure, just raw environment	16	20	4 beautiful natural scenery, but older building around beach like lifeguard tower, restrooms which detract	11	15
Point Range Total	**40**	**58**		**45**	**63**

The expert elicitation provided an upper and lower range to establish UDV points. Based on that range and the District's experience applying the UDV method to other Southern California beaches, the typical recreation experience in the study area under non crowded conditions was estimated at 45 out of 100 points (see Table 4.8-3). Moonlight Beach, which warranted special consideration due to its facilities, large number of visits, beach-level access, and multiple recreation opportunities, was assigned 57 out of 100 points. We also adjusted point values downward when crowding occurred. **Figure 4.8-1** shows how crowding levels affect the unit day value. When the square footage per visitor is high, crowding levels are minimal. In that case beach visitors receive all forty-five points. However, crowding lowers the recreation experience and carrying capacity of the beach in particular thereby lowering the point value and unit day value. Crowding becomes an increasing issue during the study period because of beach erosion, which is why it was modeled.

Table 4.8-3 Basis for Unit Day Values

Basis for Maximum Unit Day Value (minimal crowding)		
Criteria	Point Value	Description
Recreation Experience	13	hiking/walking, sunbathing--no specialized activities typically
Availability of Opportunity	0	many other beach communities within 30 min drive
Carrying Capacity	9	adequate recreating area, limited restrooms, firepits, and lifeguard off-season (2 of 6 beaches in Encinitas w/ restroom, 1 of 4 Solana Beach, 2 of 2 in Cardiff/San Elijo)
Accessibility	14	good access throughout study area, adequate parking in most access points
Environmental	9	bluff-topped beaches with development apparent
Total Point Value	**45**	**out of 100 possible points (about $7.00 per visitor)**

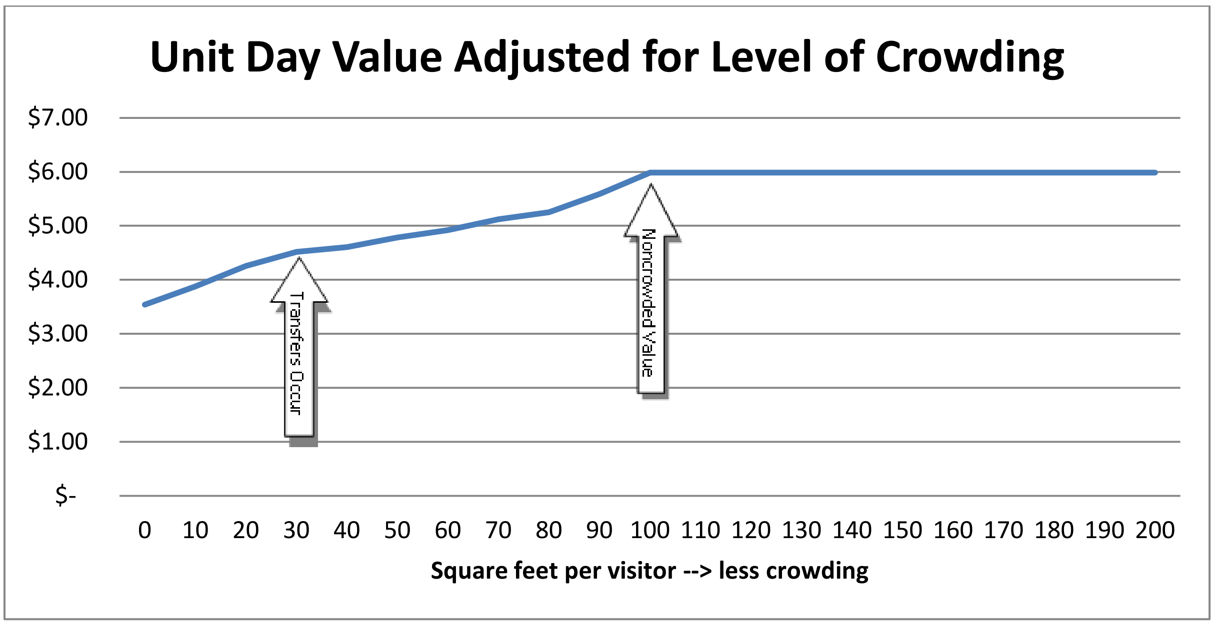

Figure 4.8-1 Unit Day Value Adjusted for Level of Crowding

Recreation demand is met in the following manner (and shown in **Figure 4.8-2**). First demand is met by visitations to the dry beach. These visitations are distributed among off peak days, peak weekdays, and peak weekends and assigned unit day values based on the average level of crowding (square feet per visitor). To derive the crowding level during the off-peak season, for instance, the total visitation demand during the off-peak season is divided by the number of off-peak days to determine the average visitors per day. Then the average visitors per day is divided by the turnover rate to determine the average number of visitors on the beach at any moment. Finally the beach area is divided by the average visitors on the beach at any moment to determine the level of crowding (square feet per visitor). The crowding level is not allowed to fall below 30 square feet per person on the dry beach because previous USACE studies have indicated beach visitors prefer to transfer to another location around this level of crowding. When there is excess demand that would lead to crowding beyond this cut-off, it is transferred to the wet beach.

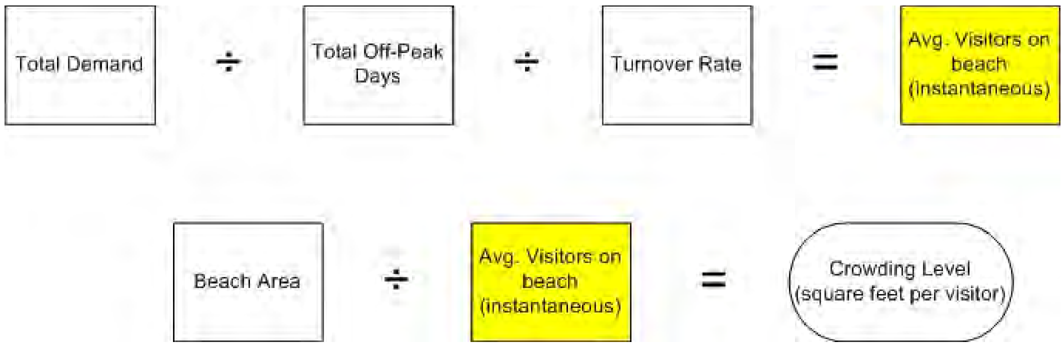

Figure 4.8-2 Example of how to calculate recreation values

4.8.3 Wet Beach Recreation

Visitors transfer to the wet beach rather than go to an off-site dry beach because historical attendance patterns show visitations have occurred on wet beaches, particularly during the winter when the beach area is smaller due to seasonal variations. Once visitors transfer to the wet beach, the same process used on the dry beach is used to determine the level of crowding on the wet beach. However, since wet beach recreation is generally inferior to the opportunity for both dry and wet beach recreation, visits to wet beaches are given one fixed UDV that is below the minimum dry beach UDV. Finally, when overcrowding occurs on the wet beach, potential visitors transfer to an off-site beach. The net benefits from this transfer are assumed to be the lowest unit day value, $3.58, and are applied to all off-site transfers.

4.8.4 Demand & Growth in Demand

Historical beach recreation levels were determined by a system of automatic counters at Encinitas and 13 months of surveying beach visitors in 2009-2010 at Solana Beach.[45] This initial level of recreation demand is grown at the same rate as the population of San Diego County is projected to grow by demographers at the California Department of Finance.[46] Since the California Department of Finance releases growth projection by decade only, the geometric mean for each ten-year period was calculated and applied annually to arrive at the year-over-year increase in recreation demand under without project conditions (see **Table 4.8-4**). Since this growth is based on county-wide projections, both Encinitas and Solana Beach shoreline visitations have been modeled with the same growth rates. Since a significant share of visitations has come historically from visitors outside of both cities, applying county-wide growth rates provides a reasonable projection for future recreation demand.[47] The results are shown below.

[45] City of Solana Beach Draft Land Lease/Recreation Fee Study, March 2010

[46] See http://www.dof.ca.gov/research/demographic/

[47] The California Department of Finance 2050 growth projections were based on demographic modeling subject to extensive peer review. In addition these growth projections are being used by Caltrans to plan long-term transportation for the region.

Table 4.8-4 Recreation Growth by Decade

Decade	Decade-over-Decade Growth Rate	Annual Growth Rate (Geometric Mean)
2010-2019	10.3%	0.99%
2020-2029	9.5%	0.91%
2030-2039	7.6%	0.73%
2040-2049	5.3%	0.52%
2050-2059	0%	0.00%
2060-2068	0%	0.00%

Growth rates are highest initially but gradually slow each decade, meaning the population of San Diego County, and therefore demand for recreation, is expected to grow more slowly in coming decades compared to recent increases. The California Department of Finance does not provide growth projections beyond 2050 so a conservative estimate of no additional growth from 2050-2068 was used instead.[48] These growth rates were applied to the most recent visitor data to project recreation demand as shown in **Table 4.8-5**.

Table 4.8-5 Recreation Demand in Study Area Beaches

Year	Segment 1 (Encinitas)	Segment 2 (Solana Beach)
2010	972,000	99,000
2020	1,072,000	109,000
2030	1,174,000	120,000
2040	1,263,000	129,000
2050	1,330,000	136,000
2068	1,330,000	136,000

4.8.5 Sea-Level Rise and Beach Erosion

Sea-level rise reduces the available beach area to recreate throughout time. This impact is addressed through scenario analysis of low and high sea-level rise as explained previously. Beach area has been estimated for all reaches. A distinct 50-year sequence of erosion rates is applied to the beach area for each sea-level rise scenario. Recreation values are captured for each sea-level rise scenario. As expected the high sea-level rise scenario causes more rapid beach loss than the low sea-level rise (see **Table 4.8-6**). With all else held constant, beach erosion causes recreation to transfer from the high-value dry beach to low-value wet beach and then from the low-value beach to an off-site beach, which is termed "transfer."

In the summer, when beach area is largest, the dry beach area is shown in **Table 4.8-6** under low and high sea-level rise scenarios. High sea-level rise has a profound impact on beach erosion compared to low, historic sea-level rise although beach area still is cut by more than 50% under low sea-level rise conditions during the period of analysis.

[48]Had the growth levels from 2040-2049 been applied to the remainder of the study period instead, demand would have increased 8.1% between 2050 and 2068, which is a modest difference from the projections in the model.

Table 4.8-6 Summer Dry Beach Area for Recreation

Low SLR Year	Segment 1 (Encinitas)	Segment 2 (Solana Beach)
2010	239,000 sqft	99,000 sqft
2020	473,000 sqft	251,000 sqft
2030	430,000 sqft	220,000 sqft
2040	387,000 sqft	189,000 sqft
2050	344,000 sqft	158,000 sqft
High SLR		
2010	229,000 sqft	92,000 sqft
2020	342,000 sqft	156,000 sqft
2030	135,000 sqft	8,000 sqft
2040	13,000 sqft	--
2050	--	--

4.8.6 Results

The recreation analysis under without project conditions reveals that recreation values peak at around 2050 under low sea-level rise scenario for Reaches 3-5 (Segment 1). This peak is due to the confluence of increasing recreation demand and minimum to moderate crowding levels. Throughout the remainder of the period of analysis, recreation values gradually fall because eroding beaches lead to higher crowding levels, which in turn cause UDV to decrease moderately and some visitors to transfer to offsite beaches. This same process occurs under the high sea-level rise scenario except earlier in the period of analysis, around 2020 when recreation values peak. As expected the beach erosion under the high SLR scenario reduces recreation values sooner and more significantly.

Recreation values in Reaches 8-9 (Segment 2) under the low SLR scenario continue to increase gradually during the period of analysis with the increase in demand. Historically, much of the recreation has occurred on wet beaches in this area and consequently we do not see the drop in recreation values associated with a shift from recreation on a dry beach to recreation on a wet beach.

Historical attendance records show around 1 million visits recently occurred between Reaches 3-5 in Encinitas while approximately 100,000 visits occurred between Reaches 8-9 in Solana Beach. Therefore, recreation values are significantly higher in Reaches 3-5. When broken down in to the segments that were analyzed for project alternatives, Segment 1 (Reach 3-5) peaks around $8.7 million in annual recreation value while Segment 2 (Reaches 8-9) peaks around $800,000 as shown in **Table 4.8-7**. We have recreation data for Reaches 1-2 and Reaches 6-7; however, we were not provided erosion rates owing to the lack of feasible alternatives in those reaches. Recreation values were developed for all reaches that could reasonably be expected to generate sufficient damages to justify project alternatives.

Table 4.8-7 Nominal Recreation Values by Reach by Decade

Low SLR							
	2010	*Base Yr*	*2020*	*2030*	*2040*	*2050*	*2060*
REACH 3	$727,000	$991,000	$1,012,000	$928,000	$995,000	$1,044,000	$994,000
REACH 4	$4,389,000	$4,831,000	$4,993,000	$5,383,000	$5,702,000	$5,900,000	$5,900,000
REACH 5	$1,277,000	$1,709,000	$1,783,000	$1,627,000	$1,665,000	$1,748,000	$1,748,000
…	…	…	…	...	…	…	…
REACH 8	$90,000	$115,000	$121,000	$108,000	$117,000	$123,000	$123,000
REACH 9	$481,000	$616,000	$536,000	$587,000	$628,000	$658,000	$658,000
TOTAL	$6,964,000	$8,262,000	$8,446,000	$8,634,000	$9,107,000	$9,473,000	$9,423,000
Segment 1	$6,393,000	$7,532,000	$7,789,000	$7,938,000	$8,362,000	$8,692,000	$8,642,000
Segment 2	$571,000	$731,000	$658,000	$696,000	$745,000	$781,000	$781,000
High SLR							
	2010	*Base Yr*	*2020*	*2030*	*2040*	*2050*	*2060*
REACH 3	$715,000	$807,000	$845,000	$779,000	$719,000	$757,000	$706,000
REACH 4	$4,312,000	$4,736,000	$4,841,000	$3,965,000	$3,197,000	$3,145,000	$2,921,000
REACH 5	$1,273,000	$1,417,000	$1,413,000	$1,381,000	$1,234,000	$1,299,000	$1,214,000
…	…	…	…	…	…	…	…
REACH 8	$90,000	$94,000	$99,000	$105,000	$81,000	$85,000	$81,000
REACH 9	$481,000	$511,000	$534,000	$414,000	$442,000	$466,000	$441,000
TOTAL	$6,871,000	$7,565,000	$7,732,000	$6,643,000	$5,672,000	$5,752,000	$5,363,000
Segment 1	$6,300,000	$6,960,000	$7,100,000	$6,124,000	$5,150,000	$5,202,000	$4,841,000
Segment 2	$571,000	$605,000	$633,000	$519,000	$523,000	$550,000	$522,000

The average annualized recreation values, which are shown in **Table 4.8-8** below, are $8.1 million for Segment 1 and $700,000 for Segment 2 under the low SLR scenario ($6.2 million and $600,000 under the high SLR scenario, respectively). Reach 4, which includes Moonlight Beach, has the highest value for Encinitas. Reach 9, which includes Fletcher Cove, has the highest value for Solana Beach. The lower recreation values under the high sea-level rise scenario result from higher erosion rates and less beach for recreation rather than changes to demand. We have assumed recreation demand would be unchanged by sea-level rise although the number of visits to the study are would be affected. Due to limited coastal storm damages to Reaches 1-2 and 6-7 no recreation analysis was performed for those reaches only; however, detailed counting by the city of Encinitas shows that 40-50% of total recreation visits occur in those reaches. Further analysis of existing conditions revealed that crowding levels at Reaches 1-2 are similar to Reaches 3-5 while crowding levels at Reach 6, which is situated in a low-lying lagoon, are less.

Table 4.8-8 Annualized Recreation Values by Reach

Low SLR		High SLR	
REACH 3	$980,000	REACH 3	$779,000
REACH 4	$5,357,000	REACH 4	$4,090,000
REACH 5	$1,714,000	REACH 5	$1,339,000
…	…	…	…
REACH 8	$117,000	REACH 8	$91,000
REACH 9	$601,000	REACH 9	$486,000
TOTAL	**$8,769,000**	**TOTAL**	**$6,785,000**
Segment 1	$8,051,000	Segment 1	$6,208,000
Segment 2	$718,000	Segment 2	$577,000

4.9 Without Project Summary of Results

A summary of without project results is presented in **Table 4.9-1**. First damages for the *Armoring* and *Retreat Scenarios* were calculated then weights were applied to each as shown below. The resulting Weighted Damages minus Sloughing Damages to the bluff top edge constitute Preventable Without Project Damages. Only Reach 7 was evaluated for overtopping because it is composed of low-lying areas. Recreation values were developed for all reaches that could reasonably be expected to generate sufficient damages to justify project alternatives. Without project damages are highest under the high sea-level rise scenario due to increased episodic erosion events and recreation values are lowest due to increased beach erosion. However, under the low and high sea-level rise scenarios the number of seawalls constructed and the nominal (undiscounted) damages are similar. This is because in general the existing, unprotected parcels that become threatened under either sea level rise scenario are the same; in other words, our modeling shows that for most unprotected parcels the uncertainty is not if a given parcel will need to construct a seawall in the future but when will it need to do that--sooner under high SLR and later under low SLR. Therefore the difference in average annual damages between the two sea-level scenarios is primarily the result of the timing of seawall construction (earlier in the study period under high SLR and later in the study period under low SLR) rather than more seawall construction under the high SLR. Refer to **Section 4.4.6** for further explanation.

Table 4.9-1 Without Project Summary of Results (Average Annual Values)

Low SLR	Armoring Scenario	Retreat Scenario	Weighted Armoring & Retreat Scenarios			Sloughing	Overtopping (Reach 7 only)	Preventable Without Project Damages	Rec Values
			Armor %	*Retreat %*	*Weighted Damages*				
Reach 1	156,000	156,000	82%	18%	156,000	n/a	n/a	156,000	n/a
Reach 2	291,000	162,000	82%	18%	268,000	n/a	n/a	268,000	n/a
Reach 3	558,000	660,000	82%	18%	576,000	99,000	n/a	477,000	980,000
Reach 4	1,124,000	946,000	82%	18%	1,092,000	202,000	n/a	890,000	5,357,000
Reach 5	1,510,000	1,353,000	82%	18%	1,482,000	96,000	n/a	1,386,000	1,714,000
Reach 6	28,000	13,000	82%	18%	25,000	n/a	n/a	25,000	n/a
Reach 7	n/a	n/a	n/a	n/a	n/a	n/a	19,000	19,000	n/a
Reach 8	1,028,000	1,006,000	78%	22%	1,023,000	42,000	n/a	981,000	117,000
Reach 9[49]	1,680,000	2,824,000	78%	22%	1,930,000	55,000	n/a	1,875,000	601,000
Total	**6,375,000**	**7,120,000**	**n/a**	**n/a**	**6,552,000**	**494,000**	**19,000**	**6,077,000**	**8,769,000**
Segment 1	3,192,000	2,959,000			3,150,000	397,000		2,753,000	8,051,000
Segment 2	2,708,000	3,830,000			2,953,000	97,000		2,856,000	718,000
High SLR	**Armoring Scenario**	**Retreat Scenario**	**Weighted Armoring & Retreat Scenarios**			**Sloughing**	**Overtopping (Reach 7 only)**	**Preventable Without Project Damages**	**Recreation Values**
			Armor %	*Retreat %*	*Weighted Damages*				
Reach 1	159,000	158,000	80%	20%	159,000	n/a	n/a	159,000	n/a
Reach 2	357,000	289,000	80%	20%	343,000	n/a	n/a	343,000	n/a
Reach 3	534,000	788,000	80%	20%	585,000	99,000	n/a	486,000	779,000
Reach 4	1,200,000	1,468,000	80%	20%	1,254,000	202,000	n/a	1,052,000	4,090,000
Reach 5	1,682,000	1,892,000	80%	20%	1,724,000	96,000	n/a	1,628,000	1,339,000
Reach 6	108,000	90,000	80%	20%	104,000	n/a	n/a	104,000	n/a
Reach 7	n/a	n/a	n/a	n/a	n/a	n/a	29,000	29,000	n/a
Reach 8	987,000	1,257,000	71%	29%	1,066,000	42,000	n/a	1,024,000	91,000
Reach 9[50]	2,177,000	3,599,000	71%	29%	2,590,000	55,000	n/a	2,577,000	486,000
Total	**7,204,000**	**9,541,000**	**n/a**	**n/a**	**7,825,000**	**992,000**	**29,000**	**7,402,000**	**6,785,000**
Segment 1	3,416,000	4,148,000	n/a	n/a	3,563,000	397,000	n/a	3,166,000	6,208,000
Segment 2	3,164,000	4,856,000	n/a	n/a	3,656,000	97,000	n/a	3,559,000	577,000

[49] Includes the several parcels and structures contiguous to and immediately south of Reach 9 that would receive some storm damage reduction benefits from any sand placement alternatives. See Armoring Scenario and Retreat Scenario for further details.
[50] Ibid.

5 WITH PROJECT ANALYSIS[51]

5.1 Layout & Process

The with-project alternatives capture the benefits from the reduction in coastal damages modeled under without-project conditions—*Armoring & Retreat Scenarios*—as well as increased recreation benefits, if applicable.[52] Without project damages from the *Armoring* and *Retreat Scenario* are weighted according to the probability of each scenario occurring. This determines the expected without project damages and also the maximum possible coastal storm damage reduction benefits that can be achieved from the array of project alternatives. The maximum benefits may or may not be achieved depending on the amount of coastal storm damage reduction each alternative offers. All project alternatives have been formulated to reduce coastal storm damage caused by wave attack to the base/toe of the exposed bluffs, as shown in **Table 5.1-1**.

Final Array of Project Alternatives Analyzed:

- Seawall/Hard Structure
- Toe Notch/Sea Cave Fill (*Notch Fill Plan)*
- Toe Notch/Sea Cave Fill & Sand Placement (*Hybrid Plan)*
- Sand Placement (*Beach Fill Plan*)

Table 5.1-1 Quantified Benefits by Project Alternative

Alternative	Coastal Storm Damage Reduction	Recreation
Seawall	YES	--
Notch Fill	YES	--
Hybrid	YES	YES
Beach Fill	YES	YES

The Seawall alternative requires constructing a series of seawalls at the base of the bluff from 25-35 feet tall and extending across all unprotected/unarmored parcels in Segment 1 and 2. Only parcels without existing seawalls would be impacted. The other hard structure alternative analyzed is the Notch Fill plan. This alternative requires applying notch fill inside sea caves/toe notches equivalent in strength and durability to the surrounding sandstone bluff. This material erodes when exposed to regular wave attack in the same manner as the surrounding sandstone; therefore, maintenance occurs at regular intervals to lower residual risk. The Notch Fill & Sand Placement alternative, also referred to as the *Hybrid Plan*, requires applying notch fill inside sea caves/toe notches in the same manner as the Notch Fill alternative. In addition sand is placed on the existing beach to enhance the protection offered by filling the toe notches. The Sand Placement alternative, also referred to as the *Beach Fill Only Plan*, requires sand to be placed on the existing beaches without augmentation from any hard structure. The *Hybrid*

[51] Presented with FY2012 price levels and discount rate used to identify NED plan in section 6

[52] Wave overtopping impacts several structures in Reach 7 only. The damages from this overtopping were too low to justify any project alternatives; therefore, no project alternative was evaluated for Reach 7.Project alternatives that provide recreation benefits are Beach Fill Only and Hybrid (Beach fill & Toe notch fill) Plans. Projects alternatives that provide no recreation benefits are the Seawall and Toe Notch/Sea Cave Fill plans.

Plans and *Beach Fill Only Plans* involved analyzing a range of added beach widths and nourishment cycles. Added beach width was analyzed in 50-foot increments from 50 feet to 200 feet (400 feet for Segment 2) and nourishments cycles from 2 years to 16 years for both segments. One hundred-twenty combinations of added beach width and nourishment cycle were evaluated for Segment 2 and sixty were evaluated for Segment 1.

The benefits that have been quantified for the alternatives are shown in **Table 5.1-1**. The seawall alternative offers coastal storm damage reduction but does not include any added recreation benefits. Placing notch fill inside the sea caves at the base of the bluff also offers coastal storm damage reduction without added recreation benefits. However the Hybrid and Beach Fill alternatives both provide coastal storm damage reduction and added recreation benefits. The costs have been quantified for the alternatives as shown in **Table 5.1-2**. The seawall alternative incurs construction, operation & maintenance, and sedimentation & recreation loss fees. These fees are imposed on the local sponsor by the CCC to mitigate for lost sand sediment and recreation value when hard structures are constructed on the coastal bluffs. The notch fill alternative also incurs construction, operation & maintenance, and sand sedimentation & recreation loss fees. The hybrid and beach fill alternatives do not incur these fees but do incur environmental mitigation costs for impacts to near-shore reefs.

Table 5.1-2 Quantified Costs by Project Alternative

Alternative	Construction	O&M	Environmental Mitigation	Sedimentation & Recreation Loss Fee
Seawall	YES	YES	--	YES
Notch Fill	YES	YES	--	YES
Hybrid	YES	YES	YES	--
Beach Fill	YES	YES	YES	--

5.2 <u>Methodology</u>

5.2.1 Project Benefits

<u>Sand Placement/Beach Fill Alternatives</u>

Weighting the *Armoring and Retreat Scenarios* and adjusting for residual sloughing at the bluff edge gives the maximum preventable in coastal damages, while the actual reduction depends on the amount of coastal storm damage reduction each alternative provides. To determine a relationship between beach width and damages prevented, a “Partial Benefit Capture Curve" was developed which defines the relationship between the mean sea level beach width and the percentage of potential benefits realized from protecting the toe of the bluff from coastal storm erosion. Specifically, the Partial Benefit Capture Curve computes the relative reduction in notch erosion during the vulnerable winter season when sand thickness at the base of the bluff is typically exposed. This relative reduction in notch erosion is assumed to be inversely proportional to episodic bluff collapse and the economic damages associated with that bluff collapse (e.g., land loss, private seawall construction, and public and private structure loss). This means that the following relationship has been modeled: given a relative reduction in bluff notch erosion, episodic bluff collapse would be reduced by this same relative amount as would

coastal storm damages. Refer to the **Coastal Engineering Appendix Section 6.6** for further explanation and key assumptions used to develop the Benefit Capture Curve.
Applying the "Partial Benefits Capture Curve" requires beach width measurements the entire length of Segments 1 & 2 for the duration of the period of analysis. To accomplish this, beach widths are broken down by increments then the length of beach at each increment of width is measured, which is weighted against the total length of each segment. To determine the benefits from each project alternative we applied the corresponding partial benefits percentage each year of the study period. Then this percentage for each year of the study period is multiplied by the maximum storm damage reduction benefits. Recall the maximum storm damage reduction benefits are the weighted *Retreat and Armoring Scenario* without project damages after accounting for residual sloughing damages at the top of the bluff that would not be impacted by any of the project alternatives.

For clarity a brief example is presented here, but for further explanation refer to the Economic Model Attachment E1. When analyzing the 2-year nourishment interval and the percentage of partial storm damage reduction benefits, the model generates these percentages for year 1 to 6 as shown in **Table 5.2-1**. Since the nourishment occurs every 2 years, the partial benefits percentage repeats every other year throughout the study period.

Table 5.2-1 Sample Calculation of Coastal Storm Damage Reduction Benefits

Added Beach Width	Base Yr 1-yr	Yr2 2-yr	Yr3 1-yr	Yr4 2-yr	Yr5 1-yr	Yr6 2-yr	…	Yr50 2-yr
50-foot	51.63%	44.22%	51.63%	44.22%	51.63%	44.22%	…	44.22%
100-foot	81.30%	77.39%	81.30%	77.39%	81.30%	77.39%	…	77.39%
150-foot	94.10%	91.98%	94.10%	91.98%	94.10%	91.98%	…	91.98%
200-foot	97.71%	96.92%	97.71%	96.92%	97.71%	96.92%	…	96.92%

To turn the partial benefits percentages shown in the table above in to project benefits, the Maximum CSDR benefits are multiplied by the percentages shown for each year of the study period and then discounted.

This means in the base year adding 100-feet to the MSL beach would provide $2,589,188 in CSDR benefits (81.30% x $2,786,220) and $2,464,829 on year after the base year (77.39% x $2,786,220). When nourishment occurs at the beginning of the following year this sequence repeats and so forth for the duration of the period of analysis. This same sequence of calculations was done for nourishment cycles two to sixteen years and added beach widths from 50 to 200 feet in Encinitas and 50 to 400 feet in Solana Beach.

<u>Hybrid Alternatives</u>

The *Hybrid Plan* is analyzed in the same manner as the *Beach-fill/Sand Placement* alternatives described in the previous section. Sand is placed before the base year and at fixed intervals during the period of analysis and benefits are calculated using the same "Partial Benefits Curve." The only difference is the Hybrid Plan includes construction of a toe notch fill applied in the base year along with the initial beach fill. The notch fill would not be maintained, however the beach would be regularly nourished providing protection to the notch fill. Steps to determine the project alternative Net annual benefits, which are identical to the *Beach-Fill* alternatives, are:

1) Apply Benefit Capture Curve (BCC) to determine percent of Maximum CSDRB each alternative captures
2) Add Recreation Benefits
3) Subtract Project Costs
4) Record Project Net Benefits

The only difference between the analysis of the Hybrid and Beach-Fill Only alternatives is the Benefit Capture Curve used in Step 1. We determined that filling sea caves/toe notches in the base year adds 6-9% more CSDRB than adding beach fill alone.[53] The exact reduction in damages is shown in **Table 5.2-2**. The project benefits attributable to the toe notch/sea cave fill occur by applying the notch fill in the base year. The beach is nourished at regular intervals from two to sixteen years with initial added beach width from 50 to 400 feet, mirroring the analysis performed on the *Beach Fill* plan.

Table 5.2-2 Additional Benefits Attributable to Toe Notch Fill

	Low SLR	High SLR
Segment 1	9.4%	6.9%
Segment 2	8.2%	5.9%

When the notch fill is placed, the majority of this benefit occurs when relatively small volumes of beach fill are placed. In contrast large volumes of beach fill provide significant protection to the bluff toe leaving little opportunity for added protection from the notch fill. Coastal engineering determined that the added benefits from the notch fill tend to taper off once the beach width extends approximately 125 feet MSL. In practice this means most of the added benefits from filling the sea caves/toe notches occur when combined with the smallest beach fills, 50-foot and 100-foot added initial width. For comparison the percent of maximum CSDRB for the Hybrid Plan including notch fill and beach fill are shown in **Table 5.2-3**.

[53] Refer to the Economic Model Addendum for an explanation on how benefits from toe notch fills were evaluated.

Table 5.2-3 Percentage of Partial Coastal Storm Damage Reduction Benefits for Hybrid Alternatives

Segment 1								
Added Beach Width	1-yr	2-yr	3-yr	4-yr	5-yr	6-yr	**…**	16-yr
50-foot	53.17%	45.91%	41.51%	32.53%	26.65%	19.40%	…	11.90%
100-foot	81.60%	77.78%	74.04%	69.66%	64.70%	54.33%	…	17.23%
150-foot	94.10%	91.98%	87.73%	88.87%	85.72%	76.95%	…	19.56%
200-foot	97.71%	96.92%	94.31%	94.61%	93.55%	87.75%	…	30.98%
Segment 2								
Added Beach Width	**1-yr**	**2-yr**	**3-yr**	**4-yr**	**5-yr**	**6-yr**	**…**	**16-yr**
50-foot	15.19%	14.28%	14.33%	13.02%	13.94%	13.44%	…	8.57%
100-foot	34.15%	33.39%	33.42%	33.54%	31.46%	30.05%	…	18.79%
150-foot	51.86%	50.10%	50.21%	50.90%	50.78%	48.02%	…	34.18%
200-foot	65.53%	64.36%	64.42%	63.47%	62.04%	62.08%	…	48.63%
250-foot	76.55%	73.96%	73.57%	72.64%	72.14%	72.04%	…	60.61%
300-foot	83.40%	81.95%	81.06%	78.33%	77.62%	79.93%	…	69.39%
350-foot	88.20%	86.77%	85.67%	82.48%	81.90%	85.36%	…	75.76%
400-foot	91.73%	89.99%	89.96%	85.28%	85.86%	89.69%	…	80.00%

Notch Fill Alternative

The *Notch Fill* alternative was analyzed using the bluff top erosion rates and damage categories also analyzed in the without project conditions. The *Notch Fill* alternative analysis involves placing notch fill in the existing sea caves/toe notches in the base year and evaluating these with-project damages. The difference between these with-project damages and without-project damages is the *Notch Fill* benefit. To arrive at the *Notch Fill* benefits this procedure was followed:

- The difference between damages occurring with the notch fills in place and without project damages are the benefits of the *Notch Fill* alternative.
- Bluff top erosion occurs as if all the study area toe notches are set to zero (flush with the existing sandstone bluffs), which simulates notch fill since it would be similar in strength and durability to the surrounding sandstone. This means all notches have been filled but are allowed to erode during the five years between maintenance cycles.
- Bluff top erosion that occurs during the first five years of the study period after the notch fill has been placed would reoccur in a similar pattern the following five years and all subsequent five year periods between notch fill maintenance.
- If, after filling the sea caves with the notch fill, bluff erosion triggers seawall construction, no more notch fill is placed at those parcels and no more erosion occurs for the remainder of the study period. The damages from seawall construction and associated costs are recorded.
- There are no recreation benefits.

Seawall Alternative

The Seawall Alternative is a series of seawalls constructed at the base of the bluff (lower seawall only) for all unprotected parcels. The existing unprotected parcels proxy for the actual unprotected parcel at the base year, which is a three-year difference but is a reasonable simplification since we expect few private seawalls to be constructed during the interim should the seawall alternative become the Recommended Plan. The unprotected parcels the seawall would be constructed on are approximately 6,300 linear feet in Segment 1 and 4,300 linear feet in Segment 2. Coastal storm damage reduction benefits are 100% of without project damages net of residual/sloughing damages at the bluff top edge. There are no recreation benefits.

Recreation Values & Benefits

Recreation values for each project alternative are calculated in the same manner as recreation values under without project conditions. First demand and beach area are established to determine the maximum visitation capacity of each dry beach by peak and off-peak seasons. Demand that exceeds this dry beach capacity is transferred to the wet beaches at a lower, fixed unit day value. Finally any excess demand on the wet beaches transfers to an off-site beach and is given the lowest recreation value. Point values and therefore unit day values are the same as without project conditions for a given level of crowding. For a more detailed explanation of how unit day values were developed see **Section 4.8**. This section focuses on how recreation demand grows with each project alternative.

The with-project recreation analysis incorporates increased recreation opportunities and the corresponding increase in recreation demand due to larger, maintained beach areas. Recreation point values are identical to the without project recreation analysis; the project alternatives were only evaluated for reducing crowding level at the beach, which increases recreation values using the same point scale as without project analysis, and increased demand. To model crowding levels and increased demand, two factors were analyzed: *Demand Growth* and *Beach Area Growth*. Demand growth is the projected increase in recreation demand. Based on guidance from IWR Report 86-R-4[54], the *Similar Project Method* was used to estimate additional recreation demand created by the project alternatives. According to this guidance:

> *The similar project method involves comparing certain characteristics of the proposed project with those of a bank of existing water resources projects for which use statistics and other information have been compiled. The most efficient and technically sound similar project techniques are those which provide for the development of per capita use curves from which use estimates are then indirectly derived.*

To this end use statistics for two nearby and similar beaches in Carlsbad and Oceanside were obtained, per capita use curves were created and then adjusted for dissimilarities between these two beaches and the beaches within the study area following guidance from IWR Report 860R-4.[55] The adjustment is necessary due to (1) inherent dissimilarities between these similar-

[54] IWR Report 86-R-4 *National Economic Development Procedures Manual - Recreation Volume I: Recreation Use and Benefit Estimation Techniques*.

[55] "Use Statistics" relevant to this analysis are beach attendance and the share of attendees traveling various distance to get to Carlsbad and Oceanside beaches. Use statistics were obtained for Carlsbad beaches from *The Economics and Fiscal Impact of Carlsbad Beaches* by Dr. Philip King (2005) and for Oceanside beaches from *US Army Corps of Engineers Beach Attendance Survey* (2005)

project beaches and the study area beaches despite close proximity, similar surrounding populations, and similar beach widths with a USACE project alternative in place and (2) insufficient data to develop a gravity model or use other methods of statistical control for dissimilar characteristics. A complete description of the analysis is available in the Economic Model Addendum.

Recreation growth is a result of added recreation capacity at both segments. Existing conditions are characterized by narrow beaches and limited opportunities to recreate on dry beach areas. Project alternatives would extend, and in some study area reaches create, dry beaches for additional recreation activities to occur. We estimate this would result in an additional 300-400 daily visits to each community's beaches depending on the size of the alternative, which is reflected in the recreation demand projections shown in **Table 5.2-4** and **Table 5.2-5**. In addition, recreation projections were informed by interviews with local lifeguards that indicated through anecdotal accounts that noticeably more visitations occurred in the study area beaches during the 1990s when beach widths were larger. Also of importance was an extensive survey done for Oceanside, a beach community immediately to the north of Encinitas, indicating that extensive erosion to those beaches would result in several hundred thousand less visits annually.[56] Although the impact to recreation from reduced beach widths may not be directly comparable to the impact from increasing beach widths, this report provided a better understanding of how and to what extent smaller beach widths such as those in Encinitas and Solana Beach negatively impact the recreational appeal of beaches and thereby suppress demand considerably.

The most obvious factors that could constrain recreation are parking and public access. We did not find either of these factors a constraint on the increased recreation demand we have forecasted during the study period. The city of Encinitas has approximately 2,566 public parking spots including street-side parking within a reasonable walking distance of nine different public access locations.[57] The distance between public access points varies from one-tenth to three-quarters mile. The city of Solana Beach has approximately 2,061 public parking spaces including street-side parking within a reasonable walking distance of four public access points. The distance between access points is approximately ¼ to ½ mile. Even if only half of these parking spaces are available to beach visitors, over 10,000 daily visitors could arrive by vehicle at each city. Therefore each beach has more than sufficient parking capacity near public access points to accommodate the 300-400 increase in daily visitations that have been projected for different beach fill and hybrid (beach fill plus notch fill) alternatives.

Recall only the sand placement and hybrid alternatives provide recreation benefits. The recreation demand under the sand placement and hybrid alternatives is shown in **Table 5.2-4** (note recreation demand is not affected by sea-level rise; only recreation capacity is affected):

[56] *The Economic and Fiscal Impact of Carlsbad's Beaches: A Survey and Estimate of Attendance* by Philip G. King, Ph.D., 2005. Estimates for decreased recreation visits were based on a 50% reduction in existing beach width.

[57] A reasonable walking distance is defined as no more than 1/3 of a mile. Parking and public access at San Elijo lagoon is included in this total. San Elijo lagoon has 835 parking spaces.

Table 5.2-4 Recreation Demand

SEGMENT 1[51] Initial Added Width	50-foot	100-foot	150-foot	200-foot
Base Yr -5	951,886	951,886	951,886	951,886
Base Yr	1,017,615	1,023,568	1,029,520	1,035,473
Yr 5	1,155,792	1,191,509	1,227,226	1,262,943
Yr 15	1,265,322	1,304,424	1,343,526	1,382,628
Yr 25	1,361,346	1,403,415	1,445,484	1,487,553
Yr 35	1,433,662	1,477,966	1,522,270	1,566,574
Yr 50	1,433,662	1,477,966	1,522,270	1,566,574

SEGMENT 2 Initial Added Width	50-foot	100-foot	150-foot	200-foot	250-foot	300-foot	350-foot	400-foot
Base Yr -5	99,190	99,190	99,190	99,190	99,190	99,190	99,190	99,190
Base Yr	126,503	130,131	133,845	138,972	144,099	149,225	150,847	152,468
Yr 5	243,217	264,988	287,270	318,032	348,793	379,554	389,281	399,008
Yr 15	266,266	290,100	314,494	348,170	381,847	415,523	426,172	436,821
Yr 25	286,473	312,116	338,360	374,592	410,824	447,057	458,513	469,970
Yr 35	301,690	328,696	356,334	394,491	432,648	470,805	482,870	494,936
Yr 50	301,690	328,696	356,334	394,491	432,648	470,805	482,870	494,936

The geometric mean growth rates in with project recreation demand are shown in **Table 5.2-5**. The geometric mean is the compound annual growth rate during the periods shown. For example, in Segment 1 between 2010 and the base year the geometric growth rate is 1.3%. This means that recreation demand grows on average 1.3% every year from 2010 to the base year. Between year 35 and year 50 recreation demand does not increase so the geometric mean is zero.

Table 5.2-5 Recreation Demand Compound Annual Growth Rate

SEGMENT 1 Initial Added Width	50-foot	100-foot	150-foot	200-foot
2010-Base Yr	1.0%	1.0%	1.0%	1.0%
Base Yr-Yr 5	2.6%	3.1%	3.6%	4.1%
Yr 5–15	0.9%	0.9%	0.9%	0.9%
Yr 15–25	0.7%	0.7%	0.7%	0.7%
Yr 25–35	0.5%	0.5%	0.5%	0.5%
Yr 35-50	0.0%	0.0%	0.0%	0.0%

SEGMENT 2 Initial Added Width	50-foot	100-foot	150-foot	200-foot	250-foot	300-foot	350-foot	400-foot
2010-Base Yr	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Base Yr-Yr 5	14.0%	15.3%	16.5%	18.0%	19.3%	20.5%	20.9%	21.2%
Yr 5–15	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
Yr 15–25	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
Yr 25–35	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Yr 35-50	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

All efforts were made to substantially estimate recreation values that would be realized throughout the study period. This includes utilizing accurate visitor counts, applying appropriate growth projections, and applying an objective and vetted system to estimate recreation value for visitors to the shoreline. Current estimates are that over ninety percent of visits involve beach-based recreation (sunbathing, beach walks, sporting activities, and other beach-based activates).[58] The remainder are engaged primarily in water-based activities including snorkeling, swimming, and surfing. Potential impacts to surf spots were analyzed extensively in the Coastal Engineering Appendix and the analysis concluded that most surf spots are not expected to be impacted but several would potentially experience changed conditions resulting in a different surf experience, although the change is expected to be temporary. However, surfers have different surfing preferences that made determining the overall direction of impact unclear. As a result of the unclear overall impact to surfing and the relatively small share of total visits that are due to surfers, the recreation analysis does not include explicit values for water-based recreation. In addition, if surfing were valued, the result should not be expected to materially impact the overall recreation values and benefits derived for this analysis or alter plan selection including the NED Plans.

5.2.2 Project Costs

Sand Placement Alternatives

The with-project costs for beach fill alternatives are mobilization and demobilization of equipment, pre-construction engineering & design, supervision & administration, operation & maintenance, monitoring, environmental mitigation, contingency, and cost per cubic yard of sand fill. The initial fill and subsequent nourishment cycles are calculated somewhat differently as shown in **Figure 5.2-1** and **Figure 5.2-2**. These calculations are used for the Sand Placement (Beach Fill Plan) and Hybrid alternatives only.

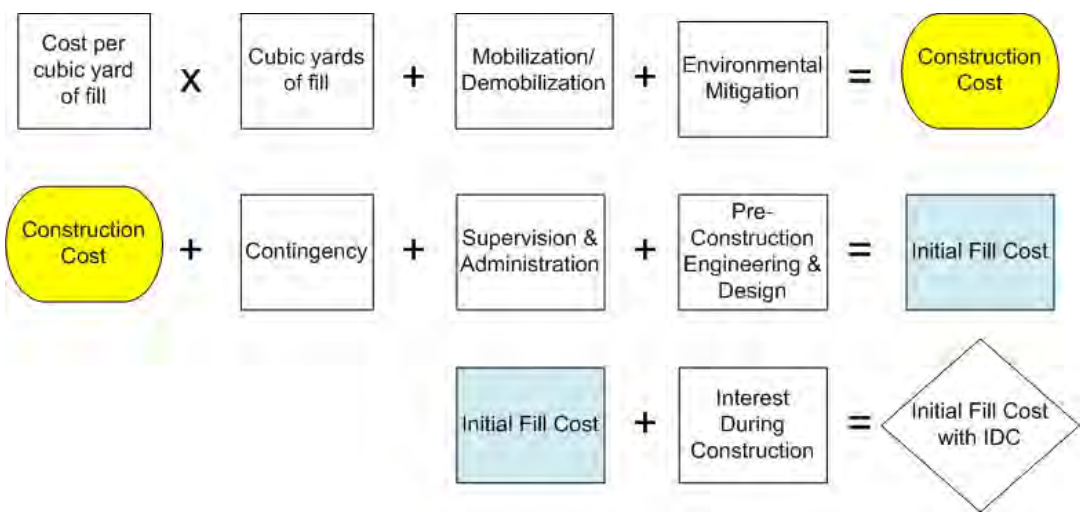

Figure 5.2-1 How to calculate initial fill cost for Preliminary Cost Estimates

[58] City of Solana Beach Draft Land Lease/Recreation Fee Study, March 2010 and City of Encinitas annual recreation reports and lifeguard estimates.

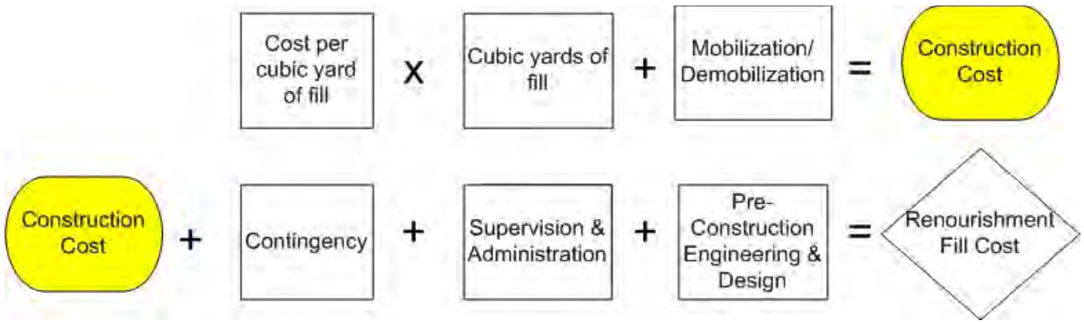

Figure 5.2-2 How to calculate nourishment fill cost for Preliminary Cost Estimates

Once the initial fill cost and subsequent nourishment costs have been calculated by year the final step involves discounting all these costs, calculating the present value cost for monitoring and operation & maintenance, and adding each together to determine the net present value for each alternative fill and nourishment cycle combination.[59] This gives the total costs during the study period for each project alternative and nourishment cycle. Note that mobilization/demobilization costs are only shared between the two segments during the initial fill because dredging equipment only has to be mobilized once for both segments. All subsequent nourishments are assumed to occur separately, which requires dredging equipment to be mobilized one time for each segment with the cost bore completely by each city, due to difficulty predicting funding and patterns of beach erosion during the 50 year study period. A cost summary for the beach fill and hybrid alternatives can be found in **Table 5.2-6**.

Table 5.2-6 Cost Summary for Beach Fill & Hybrid Alternatives

	Segment 1	Segment 2
Dredging (per cubic yard)	$7.62 (nearest borrow site) $11.43 (add'l borrow sites)	$7.15 (nearest borrow site) $10.75 (add'l borrow sites)
Mobilization/Demobilization	$1,535,050 (initial fill-shared) $2,482,092 (nourishment)	$1,535,050 (initial fill-shared) $2,657,864 (nourishment)
Environmental Mitigation	Varies by beach volume $70,729-$33,813,606 (NPV)	Varies by beach volume $70,729-$12,953,596 (NPV)
Contingency	35% of construction costs	35% of construction costs
Supervision & Administration	6.5% of construction & contingency costs	6.5% of construction & contingency costs
Pre-Construction Engineering & Design	10% of construction & contingency costs ($1 million minimum)	10% of construction & contingency costs ($1 million minimum)

[59] Environmental mitigation costs were provided by the project delivery team biologist.

	Segment 1	Segment 2
Interest During Construction	Varies by initial construction costs (6-month duration, 3.75% annually)	Varies by initial construction costs (6-month duration, 3.75% annually)
Lagoon Sedimentation Fee	Varies by beach volume $24,000-$122,500 annually	Varies by beach volume $19,000-$134,500 annually
Operation & Maintenance	$12,500 annually	$12,500 annually
Construction Monitoring	$100,000 annually (initial) $50,000 annually (nourishment)	$100,000 annually (initial) $50,000 annually (nourishment)

Hybrid Alternatives

The project costs consist of sand placement, which is calculated in the same manner described in the *Sand Placement Alternatives* in section 5.2.2 plus the construction of a toe notch fill to cover exposed toe notches at the base of the bluff with material of equivalent strength and durability to the surrounding sandstone. Affected notches must be prepped and then filled. Sand sedimentation & recreation loss fees have been included at a rate of $3,500 per linear foot, which is the amount applied consistently throughout this appendix when applicable. Construction costs assume filling the notches occurs immediately after sand placement allowing construction to occur regardless of tide cycle. Costs are estimated at $209-$211 per linear foot.

Notch Fill Alternative

The *Notch Fill* alternative analysis involves placing notch fill in the existing sea caves/toe notches in the base year and maintaining the fill at regular intervals. To arrive at the *Notch Fill* costs this procedure was followed:

- Notch fill maintenance occurs every five years.
- The notch fill costs $209-211 per linear foot, the fee to mitigate sand sedimentation and recreation loss (paid by local sponsor) is $3,500 per linear foot, and unprotected parcels receive notch fill.[60]
- Notch fill costs per linear foot are higher under the *Notch Fill* alternative compared to the *Hybrid Plan* because of the narrower beach with limited periods when construction can occur.
- Maintenance and initial fill cost are similar because the notch fill would erode on average 3-4 feet over 5 years (3.23 to 3.90 feet depending on the reach to be exact) and the existing sea caves erode on average 3-4 feet, therefore the notch fill is completely refilled every five years. This means the maintenance cost is the same as the initial notch fill cost.
- Contingency, pre-construction engineering design, and supervision & administration are 35%, 10%, and 6.5% of construction costs respectively.

[60] Recreation and sand sedimentation loss fee taken from *City of Solana Beach Draft Land Lease/Recreation Study*, July 2010.

Seawall Alternative

The unprotected parcels the seawall would be constructed on are approximately 6,300 linear feet in Segment 1 and 4,300 linear feet in Segment 2. Construction costs were developed by cost engineering and are expected to be similar to private seawall construction costs. Construction is $7,400 per linear feet for both segments. Sand sedimentation and recreation mitigation fees assessed by the CCC are $3,500 per linear foot. Contingency, pre-construction engineering design, and supervision & administration are 35%, 10%, and 6.5% of construction costs respectively.

5.3 With Project Results

5.3.1 Coastal Storm Damage Reduction Benefits

Coastal storm damage reduction benefits were evaluated for Beach Fill, Hybrid, Notch Fill, and Seawall alternatives using the steps outlined in the *Methodology* section above.

Sand Placement/Beach Fill Alternative: CSDR Benefits

Beach Fill alternatives generate average annual CSDR benefits as shown in **Table 5.3-1** and **Table 5.3-2**. These benefits range from approximately $600k to $2.4 million at Segment 1 and $200k to $2.3 million at Segment 2 under low SLR. Coastal storm damage reduction benefits are consistently higher when evaluating the high sea-level scenario.

Table 5.3-1 Beach Fill Average Annual Coastal Storm Damage Reduction Benefits for Segment 1

Low SLR ($1,00s)	50 ft	100 ft	150 ft	200 ft
2 yr nourishment	$1,280	$1,990	$2,317	$2,418
3 yr nourishment	$1,223	$1,947	$2,274	$2,397
4 yr nourishment	$1,135	$1,905	$2,260	$2,387
5 yr nourishment	$1,047	$1,855	$2,237	$2,376
6 yr nourishment	$962	$1,791	$2,190	$2,348
7 yr nourishment	$890	$1,701	$2,129	$2,309
8 yr nourishment	$841	$1,600	$2,079	$2,277
9 yr nourishment	$797	$1,513	$2,025	$2,244
10 yr nourishment	$751	$1,421	$1,949	$2,203
11 yr nourishment	$727	$1,368	$1,901	$2,171
12 yr nourishment	$701	$1,292	$1,838	$2,130
13 yr nourishment	$667	$1,240	$1,781	$2,094
14 yr nourishment	$639	$1,209	$1,732	$2,058
15 yr nourishment	$612	$1,164	$1,667	$2,008
16 yr nourishment	$582	$1,113	$1,600	$1,945
High SLR ($1,000s)	**50 ft**	**100 ft**	**150 ft**	**200 ft**
2 yr nourishment	$1,474	$2,292	$2,669	$2,786
3 yr nourishment	$1,408	$2,243	$2,620	$2,762
4 yr nourishment	$1,306	$2,195	$2,604	$2,751
5 yr nourishment	$1,205	$2,137	$2,577	$2,738
6 yr nourishment	$1,108	$2,064	$2,523	$2,706
7 yr nourishment	$1,024	$1,959	$2,453	$2,660
8 yr nourishment	$967	$1,842	$2,396	$2,623
9 yr nourishment	$918	$1,742	$2,333	$2,586
10 yr nourishment	$864	$1,636	$2,246	$2,538
11 yr nourishment	$837	$1,575	$2,190	$2,501
12 yr nourishment	$807	$1,488	$2,118	$2,454
13 yr nourishment	$767	$1,428	$2,051	$2,412
14 yr nourishment	$736	$1,393	$1,995	$2,371
15 yr nourishment	$704	$1,341	$1,920	$2,314
16 yr nourishment	$670	$1,282	$1,843	$2,241

Table 5.3-2 Beach Fill Average Annual Coastal Storm Reduction Benefits for Segment 2

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	$287	$849	$1,307	$1,644	$1,896	$2,085	$2,224	$2,320
3 yr nourishment	$283	$851	$1,303	$1,639	$1,881	$2,069	$2,205	$2,311
4 yr nourishment	$271	$855	$1,302	$1,629	$1,864	$2,041	$2,172	$2,275
5 yr nourishment	$268	$843	$1,302	$1,617	$1,852	$2,020	$2,149	$2,256
6 yr nourishment	$262	$827	$1,291	$1,611	$1,847	$2,019	$2,151	$2,260
7 yr nourishment	$257	$815	$1,273	$1,598	$1,835	$2,007	$2,140	$2,250
8 yr nourishment	$248	$802	$1,262	$1,593	$1,829	$1,998	$2,130	$2,242
9 yr nourishment	$242	$790	$1,245	$1,581	$1,817	$1,988	$2,118	$2,229
10 yr nourishment	$230	$773	$1,227	$1,568	$1,803	$1,974	$2,106	$2,218
11 yr nourishment	$220	$764	$1,215	$1,556	$1,794	$1,965	$2,098	$2,210
12 yr nourishment	$207	$748	$1,201	$1,544	$1,782	$1,953	$2,085	$2,197
13 yr nourishment	$198	$735	$1,187	$1,533	$1,772	$1,942	$2,075	$2,188
14 yr nourishment	$192	$725	$1,174	$1,522	$1,763	$1,935	$2,070	$2,184
15 yr nourishment	$184	$712	$1,159	$1,506	$1,750	$1,924	$2,059	$2,175
16 yr nourishment	$175	$694	$1,141	$1,491	$1,738	$1,913	$2,050	$2,165
High SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	$359	$1,061	$1,634	$2,056	$2,372	$2,609	$2,783	$2,904
3 yr nourishment	$354	$1,063	$1,629	$2,050	$2,353	$2,589	$2,759	$2,893
4 yr nourishment	$338	$1,068	$1,628	$2,037	$2,332	$2,553	$2,718	$2,848
5 yr nourishment	$334	$1,054	$1,627	$2,021	$2,316	$2,527	$2,690	$2,824
6 yr nourishment	$328	$1,033	$1,614	$2,014	$2,310	$2,527	$2,692	$2,829
7 yr nourishment	$321	$1,019	$1,592	$1,998	$2,295	$2,511	$2,678	$2,817
8 yr nourishment	$310	$1,002	$1,577	$1,992	$2,287	$2,500	$2,666	$2,806
9 yr nourishment	$302	$988	$1,557	$1,977	$2,272	$2,487	$2,650	$2,790
10 yr nourishment	$288	$967	$1,534	$1,960	$2,255	$2,470	$2,636	$2,777
11 yr nourishment	$275	$955	$1,519	$1,946	$2,244	$2,459	$2,625	$2,767
12 yr nourishment	$259	$935	$1,501	$1,931	$2,229	$2,443	$2,610	$2,750
13 yr nourishment	$248	$919	$1,484	$1,917	$2,217	$2,429	$2,597	$2,738
14 yr nourishment	$240	$906	$1,468	$1,903	$2,205	$2,421	$2,590	$2,734
15 yr nourishment	$230	$890	$1,449	$1,883	$2,189	$2,406	$2,577	$2,722
16 yr nourishment	$218	$868	$1,426	$1,864	$2,173	$2,394	$2,565	$2,710

These Coastal Storm Damage Reduction Benefits can be compared to the hypothetical preventable coastal storm damage, which are the weighted Armoring and Retreat Scenario damages minus the residual sloughing damages at the top of the bluff. For example the maximum/hypothetical coastal storm damage reduction benefits for Segment 1 are $2.76 million in average annual benefits under low sea-level rise and the table above shows that the 150-foot & 10-year nourishment interval alternative provides $1.96 million in average annual benefits. Dividing these two values shows that 71% of the preventable coastal storm damages are averted. This has been done for all beach fill alternatives and graphed in **Figure 5.3-1** and **Figure 5.3-2**.[61]

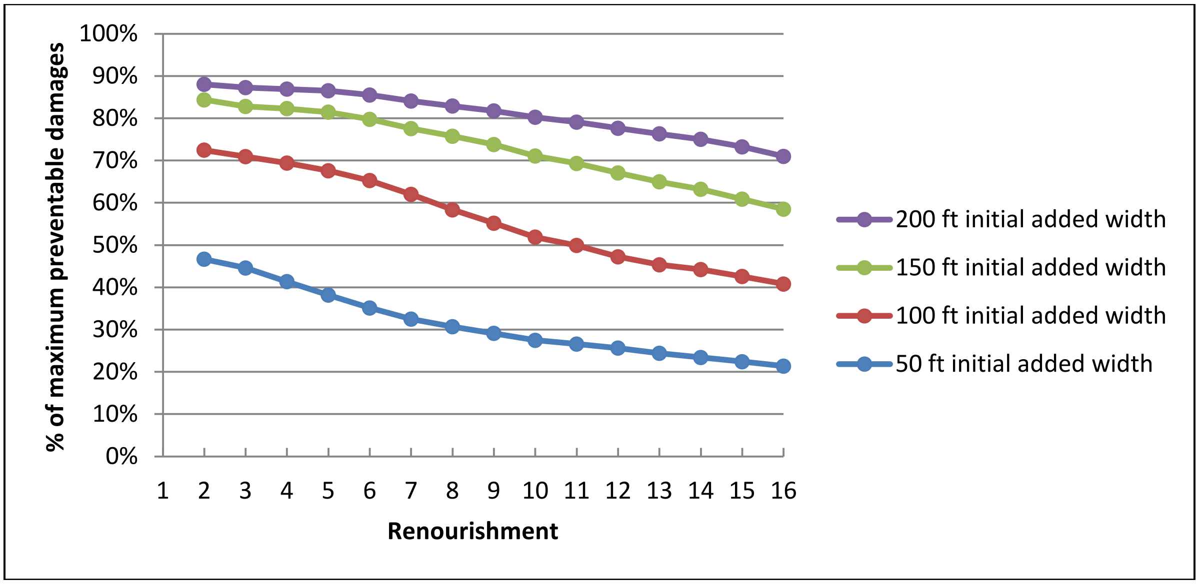

Figure 5.3-1 Share of Benefits Captured at Segment 1

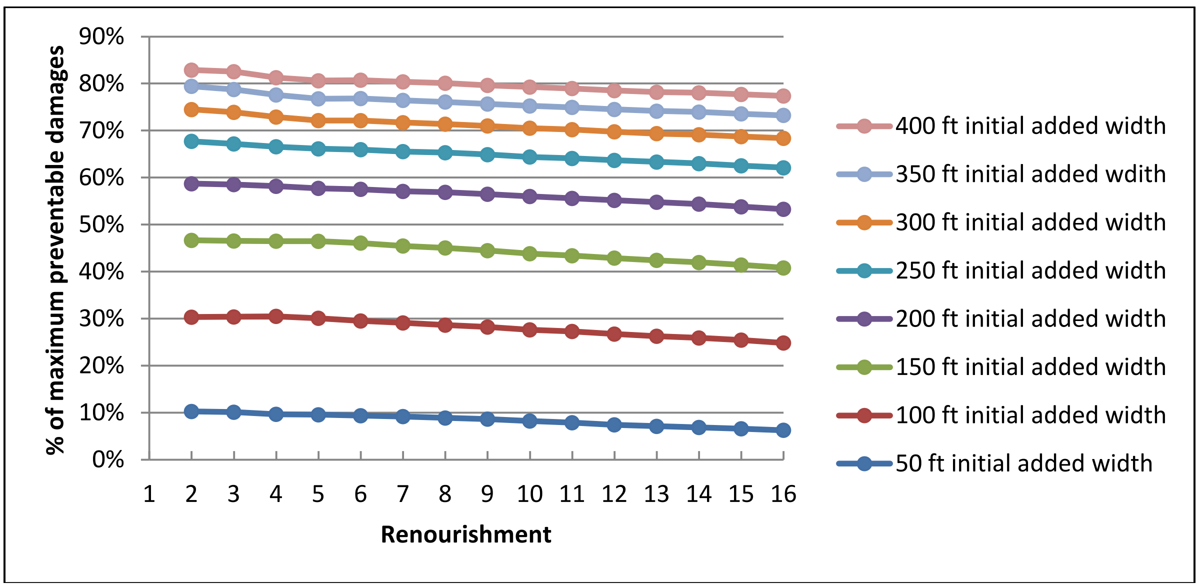

Figure 5.3-2 Share of Benefits Captured at Segment 2

<u>Hybrid Alternatives: CSDR Benefits</u>

Hybrid alternatives generate average annual CSDR benefits from approximately $700k to $2.4 million at Segment 1 and $400k to $2.3 million at Segment 2 under low SLR (**Table 5.3-3** and

[61] Additional sand placement occurs according to the sea-level rise to compensate for erosion due to sea-level rise. In this way the *Level of Protection* is nearly identical under both low and high sea-level rise so for brevity only the low sea-level scenario has been graphed below.

Table 5.3-4). Coastal storm damage reduction benefits are consistently higher when evaluating the high sea-level scenario. In addition constructing notch fill increases CSDR benefits more noticeably for smaller added beach widths and extended periods between nourishments compared to alternatives that only include sand placement. However, this difference diminishes when larger sand placements occur, since notch fill becomes redundant to some extent as the sand footprint increases.

Table 5.3-3 Hybrid Average Annual Coastal Storm Damage Reduction Benefits for Segment 1

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft
2 yr nourishment	$1,324	$1,999	$2,317	$2,419
3 yr nourishment	$1,269	$1,958	$2,276	$2,397
4 yr nourishment	$1,189	$1,916	$2,262	$2,388
5 yr nourishment	$1,110	$1,868	$2,239	$2,377
6 yr nourishment	$1,036	$1,807	$2,194	$2,350
7 yr nourishment	$973	$1,721	$2,135	$2,312
8 yr nourishment	$930	$1,628	$2,087	$2,281
9 yr nourishment	$893	$1,548	$2,034	$2,250
10 yr nourishment	$853	$1,464	$1,962	$2,209
11 yr nourishment	$834	$1,416	$1,916	$2,178
12 yr nourishment	$811	$1,348	$1,856	$2,138
13 yr nourishment	$783	$1,301	$1,802	$2,103
14 yr nourishment	$762	$1,274	$1,757	$2,069
15 yr nourishment	$741	$1,235	$1,698	$2,021
16 yr nourishment	$717	$1,189	$1,636	$1,961
High SLR ($1,000s)	**50 ft**	**100 ft**	**150 ft**	**200 ft**
2 yr nourishment	$1,512	$2,300	$2,669	$2,786
3 yr nourishment	$1,447	$2,253	$2,622	$2,762
4 yr nourishment	$1,352	$2,205	$2,606	$2,751
5 yr nourishment	$1,259	$2,149	$2,579	$2,738
6 yr nourishment	$1,170	$2,077	$2,526	$2,707
7 yr nourishment	$1,095	$1,977	$2,458	$2,663
8 yr nourishment	$1,043	$1,867	$2,402	$2,626
9 yr nourishment	$999	$1,773	$2,341	$2,590
10 yr nourishment	$951	$1,673	$2,256	$2,543
11 yr nourishment	$927	$1,616	$2,203	$2,507
12 yr nourishment	$900	$1,536	$2,133	$2,461
13 yr nourishment	$866	$1,480	$2,069	$2,420
14 yr nourishment	$840	$1,448	$2,017	$2,380
15 yr nourishment	$813	$1,401	$1,946	$2,324
16 yr nourishment	$784	$1,346	$1,873	$2,254

Table 5.3-4 Hybrid Average Annual Coastal Storm Damage Reduction Benefits for Segment 2

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	$420	$917	$1,340	$1,664	$1,907	$2,089	$2,224	$2,321
3 yr nourishment	$417	$916	$1,335	$1,661	$1,894	$2,075	$2,206	$2,312
4 yr nourishment	$406	$918	$1,336	$1,653	$1,880	$2,051	$2,178	$2,279
5 yr nourishment	$404	$908	$1,336	$1,642	$1,869	$2,033	$2,157	$2,261
6 yr nourishment	$401	$895	$1,326	$1,636	$1,864	$2,031	$2,158	$2,264
7 yr nourishment	$398	$887	$1,312	$1,625	$1,854	$2,020	$2,148	$2,254
8 yr nourishment	$392	$876	$1,301	$1,620	$1,848	$2,012	$2,139	$2,246
9 yr nourishment	$387	$867	$1,287	$1,610	$1,838	$2,003	$2,128	$2,234
10 yr nourishment	$379	$853	$1,271	$1,597	$1,825	$1,991	$2,117	$2,225
11 yr nourishment	$372	$845	$1,260	$1,587	$1,817	$1,983	$2,110	$2,217
12 yr nourishment	$363	$831	$1,248	$1,576	$1,806	$1,971	$2,099	$2,206
13 yr nourishment	$357	$820	$1,236	$1,566	$1,797	$1,962	$2,090	$2,197
14 yr nourishment	$352	$812	$1,224	$1,555	$1,788	$1,955	$2,084	$2,193
15 yr nourishment	$346	$801	$1,212	$1,541	$1,776	$1,945	$2,075	$2,184
16 yr nourishment	$340	$786	$1,196	$1,527	$1,765	$1,935	$2,066	$2,176
High SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	$480	$1,124	$1,665	$2,075	$2,382	$2,613	$2,783	$2,904
3 yr nourishment	$475	$1,123	$1,659	$2,071	$2,365	$2,594	$2,760	$2,893
4 yr nourishment	$461	$1,126	$1,660	$2,060	$2,347	$2,563	$2,723	$2,850
5 yr nourishment	$458	$1,113	$1,659	$2,045	$2,333	$2,539	$2,696	$2,828
6 yr nourishment	$453	$1,096	$1,646	$2,038	$2,326	$2,538	$2,698	$2,832
7 yr nourishment	$449	$1,085	$1,628	$2,023	$2,313	$2,523	$2,685	$2,819
8 yr nourishment	$440	$1,070	$1,614	$2,017	$2,305	$2,513	$2,674	$2,809
9 yr nourishment	$434	$1,058	$1,595	$2,004	$2,292	$2,501	$2,659	$2,794
10 yr nourishment	$422	$1,039	$1,574	$1,988	$2,276	$2,485	$2,645	$2,781
11 yr nourishment	$412	$1,029	$1,561	$1,974	$2,265	$2,475	$2,636	$2,772
12 yr nourishment	$399	$1,011	$1,544	$1,960	$2,251	$2,460	$2,621	$2,757
13 yr nourishment	$390	$996	$1,528	$1,947	$2,239	$2,447	$2,609	$2,745
14 yr nourishment	$384	$985	$1,514	$1,934	$2,228	$2,439	$2,603	$2,741
15 yr nourishment	$376	$970	$1,497	$1,915	$2,213	$2,425	$2,590	$2,730
16 yr nourishment	$367	$951	$1,476	$1,897	$2,198	$2,413	$2,579	$2,719

Notch Fill Alternative: CSDR Benefits

The Notch Fill Alternative provides coastal storm damage reduction benefits, as shown in **Table 5.3-5**, by reducing the frequency of bluff top erosion compared to without project conditions. This is achieved by constructing toe notch fills at the base of the bluff and maintaining these at regular intervals. The reduction in damages provided by the *Notch Fill* alternative (i.e. the notch fill benefits) is adjusted to remove residual/sloughing damages at the top of the bluff. There are no recreation benefits.

Table 5.3-5 Notch Fill Alternative Average Annual Benefits

Segment 1 *Notch Fill Alternative*			Segment 2 *Notch Fill Alternative*		
	Low SLR	High SLR[62]		Low SLR	High SLR
Benefits	$2,119,000	$1,840,000	Benefits	$797,000	$1,336,000
Std Deviation[63]	*474,000*	*896,000*	*Std Deviation*	*763,000*	*819,000*

Seawall Alternative: CSDR Benefits

The Seawall Alternative benefits, as shown in **Table 5.3-6**, are 100% of without project damages net of residual/sloughing damages. In other words, the seawall alternative is expected to protect against all without project damages excluding residual sloughing damages. There are no recreation benefits.

Table 5.3-6 Seawall Alternative Average Annual Benefits

Segment 1 *Seawall Alternative*			**Segment 2 *Seawall Alternative***		
	Low SLR	High SLR		Low SLR	High SLR
Benefits	2,786,000	3,185,000	Benefits	2,826,000	3,527,000
Std Deviation	*396,000*	*811,000*	*Std Deviation*	*590,000*	*638,000*

5.3.2 Recreation Values & Benefits

Sand placement and hybrid alternatives require beach fill that increases the quality and intensity of recreation. The hard structural alternatives by themselves produce no additional recreation benefits (e.g., seawall and notch fill alternatives). With project unit day values are identical to without project unit day values for the same level of crowding on the beach. For a description of how without project recreation values were derived review section 4.8. Sand placement and

[62] Reduction in damages occurring before the base year were not counted, resulting in lower “counted” benefits under the high sea-level rise scenario even though the total reduction in damages is greater than under the low sea-level rise.
[63] In the absence of correlation coefficients between with and without project damages these standard deviations assume perfect correlation, which leads to the largest estimate of the project standard deviations.

hybrid alternatives were evaluated to extend the mean-sea level (MSL) beach width 50 to 200 feet in Segment 1 and 50 to 400 feet in Segment 2 with nourishments occurring every 2 to 16 years.

Table 5.3-7 has been presented for illustrative purposes. It shows nominal recreation values by reach and segment decade with the base year and final year of the period of analysis added for comparison assuming the sand placement/hybrid alternative that extends the beach 200 feet MSL with nourishments occurring every 16 years. Values increase moderately by decade due to the initial increase in recreation demand following project construction but in tandem with county-wide population growth rates after initial construction. This means a sizeable increase occurs around the base year then modest increases at the same rate as without project conditions for the remainder of the period of analysis. The values are presented in nominal amounts (i.e., not discounted).

Table 5.3-7 Calculation Example for 200-foot/16 yr Alternative

Nominal Recreation Values by Decade for Sand Placement and Hybrid Alternatives ($1000s)								
Low SLR	2010	Base Yr	Yr 5	Yr 15	Yr 25	Yr 35	Yr 45	Yr 50
REACH 3	$715	$1,064	$1,298	$1,366	$1,517	$1,611	$1,575	$1,611
REACH 4	$4,389	$5,088	$6,207	$6,373	$7,189	$7,699	$7,221	$7,699
REACH 5	$1,273	$1,825	$2,224	$2,337	$2,610	$2,759	$2,728	$2,759
…								
REACH 8	$90	$154	$352	$385	$415	$437	$437	$437
REACH 9	$481	$843	$1,928	$2,102	$2,271	$2,392	$2,381	$2,392
TOTAL	$6,948	$8,974	$12,010	$12,563	$14,002	$14,898	$14,342	$14,898
Segment 1	$6,377	$7,978	$9,730	$10,076	$11,317	$12,069	$11,524	$12,069
Segment 2	$571	$996	$2,280	$2,487	$2,686	$2,829	$2,818	$2,829

With-project average annual recreation values, which have been discounted and rounded to thousands, are given in **Table 5.3-8** and **Table 5.3-9**. To generate these tables, we calculated recreation values for the entire period of analysis for all combinations of nourishment interval (2-16 years) and added beach width (50-200/400 ft MSL) then discounted. The results for the Beach Fill & Hybrid Alternatives are shown below in **Table 5.3-10** and **Table 5.3-11**. Note the seawall and notch fill alternatives do not generate any recreation benefits so no recreation values were calculated for those two alternatives.

Table 5.3-8 Recreation Average Annual Values for Beach Fill & Hybrid Alternatives Segment 1

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft
2 yr nourishment	$9,430	$9,900	$10,180	$10,460
3 yr nourishment	$9,380	$9,890	$10,180	$10,460
4 yr nourishment	$9,330	$9,880	$10,180	$10,460
5 yr nourishment	$9,180	$9,870	$10,180	$10,460
6 yr nourishment	$9,060	$9,840	$10,180	$10,460
7 yr nourishment	$8,950	$9,790	$10,170	$10,460
8 yr nourishment	$8,860	$9,750	$10,150	$10,450
9 yr nourishment	$8,780	$9,640	$10,130	$10,450
10 yr nourishment	$8,680	$9,550	$10,110	$10,440
11 yr nourishment	$8,640	$9,480	$10,090	$10,440
12 yr nourishment	$8,570	$9,400	$10,060	$10,420
13 yr nourishment	$8,460	$9,300	$10,020	$10,400
14 yr nourishment	$8,480	$9,290	$9,980	$10,390
15 yr nourishment	$8,450	$9,220	$9,920	$10,360
16 yr nourishment	$8,390	$9,140	$9,850	$10,340
High SLR ($1,000s)	**50 ft**	**100 ft**	**150 ft**	**200 ft**
2 yr nourishment	$9,350	$9,890	$10,180	$10,460
3 yr nourishment	$9,290	$9,880	$10,180	$10,460
4 yr nourishment	$9,090	$9,860	$10,180	$10,460
5 yr nourishment	$8,950	$9,840	$10,180	$10,460
6 yr nourishment	$8,850	$9,810	$10,170	$10,460
7 yr nourishment	$8,680	$9,760	$10,160	$10,450
8 yr nourishment	$8,540	$9,630	$10,130	$10,450
9 yr nourishment	$8,400	$9,540	$10,110	$10,450
10 yr nourishment	$8,270	$9,440	$10,080	$10,430
11 yr nourishment	$8,210	$9,370	$10,060	$10,420
12 yr nourishment	$8,120	$9,230	$10,020	$10,400
13 yr nourishment	$7,960	$9,080	$9,930	$10,380
14 yr nourishment	$7,980	$9,060	$9,890	$10,370
15 yr nourishment	$7,930	$8,960	$9,820	$10,340
16 yr nourishment	$7,870	$8,860	$9,740	$10,270

Table 5.3-9 Recreation Average Annual Values for Beach Fill & Hybrid Alternatives Segment 2

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	$1,790	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
3 yr nourishment	$1,790	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
4 yr nourishment	$1,790	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
5 yr nourishment	$1,780	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
6 yr nourishment	$1,780	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
7 yr nourishment	$1,740	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
8 yr nourishment	$1,710	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
9 yr nourishment	$1,690	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
10 yr nourishment	$1,660	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
11 yr nourishment	$1,640	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
12 yr nourishment	$1,620	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
13 yr nourishment	$1,580	$1,950	$2,110	$2,340	$2,560	$2,770	$2,770	$2,770
14 yr nourishment	$1,590	$1,950	$2,110	$2,340	$2,560	$2,770	$2,770	$2,770
15 yr nourishment	$1,570	$1,950	$2,110	$2,340	$2,560	$2,770	$2,770	$2,770
16 yr nourishment	$1,550	$1,940	$2,110	$2,340	$2,560	$2,770	$2,770	$2,770
High SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	$1,780	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
3 yr nourishment	$1,780	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
4 yr nourishment	$1,770	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
5 yr nourishment	$1,770	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
6 yr nourishment	$1,720	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
7 yr nourishment	$1,680	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
8 yr nourishment	$1,660	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
9 yr nourishment	$1,630	$1,950	$2,120	$2,340	$2,560	$2,770	$2,770	$2,770
10 yr nourishment	$1,600	$1,950	$2,110	$2,340	$2,560	$2,770	$2,770	$2,770
11 yr nourishment	$1,590	$1,950	$2,110	$2,340	$2,560	$2,770	$2,770	$2,770
12 yr nourishment	$1,560	$1,950	$2,110	$2,340	$2,560	$2,770	$2,770	$2,770
13 yr nourishment	$1,520	$1,950	$2,110	$2,340	$2,560	$2,770	$2,770	$2,770
14 yr nourishment	$1,520	$1,940	$2,110	$2,340	$2,560	$2,770	$2,770	$2,770
15 yr nourishment	$1,510	$1,940	$2,110	$2,340	$2,560	$2,770	$2,770	$2,770
16 yr nourishment	$1,480	$1,930	$2,110	$2,340	$2,560	$2,770	$2,770	$2,770

Similarly, with project benefits were generated for beach fill & hybrid alternatives to extend the mean-sea level (MSL) beach width 50 to 200 feet in Segment 1 and 50 to 400 feet in Segment 2 with nourishments occurring every 2 to 16 years. With-project recreation benefits, which equal with- minus without-project values, are given in **Table 5.3-12** . As expected recreation benefits increase with larger beach fills and shorter intervals between nourishments. Average annual recreation benefits range from approximately $400k to $2.4 million at Segment 1 and $800k to $2.1 million at Segment 2 under low SLR. Recreation benefits nearly double under high SLR at Segment 1. At a later stage the recreation benefits from these tables are paired with the coastal storm damage reduction benefits presented in Section 5.3.1 up to 50% of total benefits to calculate each alternative's net benefit.[64] Again note the seawall and notch fill alternatives do not generate recreation benefits.

Table 5.3-10 Full Recreation Average Annual Benefits for Beach Fill & Hybrid Alternatives Segment 1[65]

Low SLR ($1000s)	50 ft	100 ft	150 ft	200 ft
2 yr nourishment	$1,407	$1,847	$2,133	$2,406
3 yr nourishment	$1,380	$1,845	$2,132	$2,406
4 yr nourishment	$1,328	$1,840	$2,131	$2,406
5 yr nourishment	$1,274	$1,831	$2,129	$2,406
6 yr nourishment	$1,132	$1,815	$2,127	$2,406
7 yr nourishment	$1,012	$1,790	$2,125	$2,405
8 yr nourishment	$903	$1,743	$2,116	$2,403
9 yr nourishment	$807	$1,697	$2,101	$2,401
10 yr nourishment	$724	$1,592	$2,083	$2,399
11 yr nourishment	$626	$1,496	$2,059	$2,393
12 yr nourishment	$584	$1,433	$2,038	$2,384
13 yr nourishment	$519	$1,346	$2,005	$2,371
14 yr nourishment	$407	$1,244	$1,965	$2,351
15 yr nourishment	$432	$1,235	$1,928	$2,340
16 yr nourishment	$394	$1,164	$1,864	$2,310
High SLR ($1000s)	**50 ft**	**100 ft**	**150 ft**	**200 ft**
2 yr nourishment	$3,190	$3,688	$3,975	$4,249
3 yr nourishment	$3,142	$3,685	$3,974	$4,249
4 yr nourishment	$3,085	$3,672	$3,972	$4,249
5 yr nourishment	$2,882	$3,651	$3,970	$4,249
6 yr nourishment	$2,744	$3,631	$3,968	$4,249
7 yr nourishment	$2,644	$3,601	$3,965	$4,247
8 yr nourishment	$2,474	$3,549	$3,947	$4,245
9 yr nourishment	$2,330	$3,425	$3,926	$4,243
10 yr nourishment	$2,196	$3,329	$3,905	$4,237
11 yr nourishment	$2,061	$3,231	$3,874	$4,226
12 yr nourishment	$1,997	$3,158	$3,847	$4,212
13 yr nourishment	$1,908	$3,022	$3,808	$4,194
14 yr nourishment	$1,753	$2,872	$3,719	$4,171
15 yr nourishment	$1,774	$2,854	$3,683	$4,163
16 yr nourishment	$1,726	$2,754	$3,615	$4,129

[64] ER 1105-2-100 section 3-4

[65] Full recreation benefits shown. Actual recreation benefits used for plan selection are the lesser of recreation benefits shown or 50% of total benefits.

Table 5.3-11 Full Recreation Average Annual Benefits for Beach Fill & Hybrid Alternatives Segment 2[66]

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	$1,069	$1,234	$1,401	$1,619	$1,837	$2,056	$2,125	$2,194
3 yr nourishment	$1,069	$1,234	$1,400	$1,619	$1,837	$2,056	$2,125	$2,194
4 yr nourishment	$1,069	$1,233	$1,400	$1,619	$1,837	$2,056	$2,125	$2,194
5 yr nourishment	$1,068	$1,233	$1,400	$1,619	$1,837	$2,056	$2,125	$2,194
6 yr nourishment	$1,065	$1,233	$1,399	$1,619	$1,837	$2,056	$2,125	$2,194
7 yr nourishment	$1,059	$1,232	$1,399	$1,619	$1,837	$2,056	$2,125	$2,194
8 yr nourishment	$1,023	$1,232	$1,399	$1,619	$1,837	$2,056	$2,125	$2,194
9 yr nourishment	$991	$1,232	$1,398	$1,619	$1,837	$2,056	$2,125	$2,194
10 yr nourishment	$968	$1,231	$1,398	$1,619	$1,837	$2,056	$2,125	$2,194
11 yr nourishment	$941	$1,230	$1,398	$1,619	$1,837	$2,056	$2,125	$2,194
12 yr nourishment	$924	$1,230	$1,397	$1,619	$1,837	$2,056	$2,125	$2,194
13 yr nourishment	$898	$1,229	$1,397	$1,619	$1,837	$2,056	$2,125	$2,194
14 yr nourishment	$865	$1,228	$1,396	$1,618	$1,837	$2,056	$2,125	$2,194
15 yr nourishment	$867	$1,228	$1,396	$1,618	$1,837	$2,056	$2,125	$2,194
16 yr nourishment	$1,069	$1,234	$1,401	$1,619	$1,837	$2,056	$2,125	$2,194
High SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	$1,204	$1,373	$1,540	$1,760	$1,978	$2,196	$2,265	$2,334
3 yr nourishment	$1,200	$1,372	$1,539	$1,760	$1,978	$2,196	$2,265	$2,334
4 yr nourishment	$1,198	$1,372	$1,539	$1,760	$1,978	$2,196	$2,265	$2,334
5 yr nourishment	$1,195	$1,372	$1,539	$1,760	$1,978	$2,196	$2,265	$2,334
6 yr nourishment	$1,189	$1,372	$1,539	$1,760	$1,978	$2,196	$2,265	$2,334
7 yr nourishment	$1,141	$1,371	$1,538	$1,760	$1,978	$2,196	$2,265	$2,334
8 yr nourishment	$1,106	$1,371	$1,538	$1,760	$1,978	$2,196	$2,265	$2,334
9 yr nourishment	$1,079	$1,370	$1,538	$1,760	$1,978	$2,196	$2,265	$2,334
10 yr nourishment	$1,056	$1,370	$1,537	$1,760	$1,978	$2,196	$2,265	$2,334
11 yr nourishment	$1,025	$1,369	$1,537	$1,759	$1,978	$2,196	$2,265	$2,334
12 yr nourishment	$1,008	$1,369	$1,536	$1,759	$1,978	$2,196	$2,265	$2,334
13 yr nourishment	$983	$1,368	$1,536	$1,759	$1,978	$2,196	$2,265	$2,334
14 yr nourishment	$943	$1,367	$1,535	$1,758	$1,978	$2,196	$2,265	$2,334
15 yr nourishment	$945	$1,366	$1,535	$1,758	$1,978	$2,196	$2,265	$2,334
16 yr nourishment	$1,204	$1,373	$1,540	$1,760	$1,978	$2,196	$2,265	$2,334

5.3.3 Total Project Benefits

The Beach Fill, Hybrid, Notch Fill, and Seawall alternatives include coastal storm damage reduction benefits described in section 5.3.1. The Beach Fill and Hybrid alternatives include the recreation benefits as described in section 5.3.2, while Seawall and Notch Fill alternatives do not include any recreation benefits because none are generated by either alternative. Whenever applicable recreation benefits have been capped at 50% percent of total benefits per guidance.[67]

[66] Larger alternatives
[67] ER 1105-2-100 section 3-4

Sand Placement/Beach Fill Alternatives: Total Benefits

Beach Fill alternatives generate total average annual benefits, inclusive of the 50% cap on recreation benefits, as shown in **Table 5.3-12** and **Table 5.3-13**. Total benefits range from approximately $1.0 to $4.8 million at Segment 1 and $1.0 to $4.5 million at Segment 2 under low SLR. Total benefits are consistently higher when evaluating the high sea-level scenario.

Table 5.3-12 Total Average Annual Benefits for Beach Fill Alternatives at Segment 1

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft
2 yr nourishment	$2,688	$3,836	$4,449	$4,822
3 yr nourishment	$2,603	$3,792	$4,405	$4,801
4 yr nourishment	$2,463	$3,745	$4,390	$4,791
5 yr nourishment	$2,321	$3,686	$4,365	$4,781
6 yr nourishment	$2,095	$3,606	$4,316	$4,753
7 yr nourishment	$1,902	$3,491	$4,253	$4,712
8 yr nourishment	$1,744	$3,342	$4,195	$4,678
9 yr nourishment	$1,605	$3,210	$4,125	$4,645
10 yr nourishment	$1,476	$3,012	$4,032	$4,600
11 yr nourishment	$1,354	$2,864	$3,960	$4,562
12 yr nourishment	$1,285	$2,725	$3,875	$4,513
13 yr nourishment	$1,187	$2,586	$3,785	$4,464
14 yr nourishment	$1,047	$2,453	$3,696	$4,409
15 yr nourishment	$1,044	$2,400	$3,595	$4,348
16 yr nourishment	$977	$2,279	$3,464	$4,254
High SLR ($1,000s)	**50 ft**	**100 ft**	**150 ft**	**200 ft**
2 yr nourishment	$4,665	$5,980	$6,644	$7,036
3 yr nourishment	$4,550	$5,929	$6,594	$7,011
4 yr nourishment	$4,391	$5,867	$6,576	$7,000
5 yr nourishment	$4,087	$5,788	$6,547	$6,987
6 yr nourishment	$3,852	$5,694	$6,491	$6,955
7 yr nourishment	$3,668	$5,561	$6,419	$6,908
8 yr nourishment	$3,441	$5,391	$6,343	$6,868
9 yr nourishment	$3,248	$5,167	$6,260	$6,829
10 yr nourishment	$3,061	$4,965	$6,150	$6,775
11 yr nourishment	$2,898	$4,806	$6,065	$6,728
12 yr nourishment	$2,804	$4,646	$5,965	$6,666
13 yr nourishment	$2,675	$4,449	$5,859	$6,606
14 yr nourishment	$2,489	$4,264	$5,714	$6,542
15 yr nourishment	$2,478	$4,195	$5,604	$6,476
16 yr nourishment	$2,396	$4,036	$5,458	$6,370

Table 5.3-13 Total Average Annual Benefits for Beach Fill Alternatives at Segment 2

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	$1,356	$2,083	$2,708	$3,263	$3,733	$4,141	$4,349	$4,514
3 yr nourishment	$1,352	$2,085	$2,703	$3,258	$3,718	$4,125	$4,330	$4,505
4 yr nourishment	$1,340	$2,088	$2,702	$3,248	$3,701	$4,097	$4,297	$4,469
5 yr nourishment	$1,336	$2,076	$2,702	$3,236	$3,689	$4,076	$4,274	$4,450
6 yr nourishment	$1,327	$2,060	$2,690	$3,230	$3,684	$4,075	$4,276	$4,454
7 yr nourishment	$1,316	$2,047	$2,672	$3,217	$3,672	$4,063	$4,265	$4,444
8 yr nourishment	$1,271	$2,034	$2,661	$3,212	$3,666	$4,054	$4,255	$4,436
9 yr nourishment	$1,233	$2,022	$2,643	$3,200	$3,654	$4,044	$4,243	$4,423
10 yr nourishment	$1,198	$2,004	$2,625	$3,187	$3,640	$4,030	$4,231	$4,412
11 yr nourishment	$1,161	$1,994	$2,613	$3,175	$3,631	$4,021	$4,223	$4,404
12 yr nourishment	$1,131	$1,978	$2,598	$3,163	$3,619	$4,009	$4,210	$4,391
13 yr nourishment	$1,096	$1,964	$2,584	$3,152	$3,609	$3,998	$4,200	$4,382
14 yr nourishment	$1,057	$1,953	$2,570	$3,140	$3,600	$3,991	$4,195	$4,378
15 yr nourishment	$1,051	$1,940	$2,555	$3,124	$3,587	$3,980	$4,184	$4,369
16 yr nourishment	$1,244	$1,928	$2,542	$3,110	$3,575	$3,969	$4,175	$4,359
High SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	$1,563	$2,434	$3,173	$3,815	$4,350	$4,806	$5,049	$5,239
3 yr nourishment	$1,554	$2,436	$3,168	$3,809	$4,331	$4,785	$5,025	$5,227
4 yr nourishment	$1,536	$2,440	$3,167	$3,796	$4,310	$4,750	$4,984	$5,182
5 yr nourishment	$1,529	$2,426	$3,166	$3,781	$4,294	$4,723	$4,955	$5,159
6 yr nourishment	$1,516	$2,405	$3,152	$3,774	$4,288	$4,723	$4,957	$5,164
7 yr nourishment	$1,462	$2,390	$3,130	$3,758	$4,273	$4,707	$4,943	$5,151
8 yr nourishment	$1,416	$2,373	$3,115	$3,751	$4,265	$4,696	$4,931	$5,141
9 yr nourishment	$1,381	$2,358	$3,094	$3,737	$4,250	$4,683	$4,916	$5,124
10 yr nourishment	$1,344	$2,336	$3,071	$3,720	$4,233	$4,666	$4,901	$5,111
11 yr nourishment	$1,300	$2,324	$3,055	$3,705	$4,222	$4,655	$4,891	$5,101
12 yr nourishment	$1,267	$2,303	$3,037	$3,690	$4,207	$4,639	$4,875	$5,085
13 yr nourishment	$1,231	$2,287	$3,020	$3,676	$4,195	$4,625	$4,862	$5,073
14 yr nourishment	$1,183	$2,273	$3,002	$3,662	$4,183	$4,617	$4,855	$5,068
15 yr nourishment	$1,174	$2,256	$2,984	$3,641	$4,167	$4,603	$4,842	$5,056
16 yr nourishment	$1,146	$2,231	$2,961	$3,621	$4,151	$4,590	$4,830	$5,044

Hybrid Alternatives: Total Benefits

Hybrid alternatives generate total average annual benefits, inclusive of the 50% cap on recreation benefits, as shown in **Table 5.3-14** and **Table 5.3-15**. Total benefits range from approximately $1.1 to $4.8 million at Segment 1 and $1.2 to $4.5 million at Segment 2 under low SLR. Total benefits are consistently higher when evaluating the high sea-level scenario.

Table 5.3-14 Total Average Annual Benefits for Hybrid Alternatives at Segment 1

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft
2 yr nourishment	$2,733	$3,845	$4,449	$4,822
3 yr nourishment	$2,650	$3,803	$4,407	$4,801
4 yr nourishment	$2,518	$3,756	$4,391	$4,791
5 yr nourishment	$2,386	$3,699	$4,366	$4,781
6 yr nourishment	$2,169	$3,622	$4,320	$4,754
7 yr nourishment	$1,986	$3,511	$4,260	$4,715
8 yr nourishment	$1,834	$3,371	$4,202	$4,682
9 yr nourishment	$1,702	$3,246	$4,135	$4,650
10 yr nourishment	$1,578	$3,056	$4,044	$4,606
11 yr nourishment	$1,461	$2,913	$3,974	$4,569
12 yr nourishment	$1,396	$2,782	$3,893	$4,522
13 yr nourishment	$1,303	$2,648	$3,807	$4,473
14 yr nourishment	$1,170	$2,518	$3,722	$4,419
15 yr nourishment	$1,174	$2,471	$3,626	$4,361
16 yr nourishment	$1,112	$2,355	$3,501	$4,270
High SLR ($1,000s)	**50 ft**	**100 ft**	**150 ft**	**200 ft**
2 yr nourishment	$4,702	$5,988	$6,644	$7,036
3 yr nourishment	$4,589	$5,938	$6,596	$7,011
4 yr nourishment	$4,437	$5,877	$6,577	$7,000
5 yr nourishment	$4,141	$5,800	$6,549	$6,987
6 yr nourishment	$3,914	$5,707	$6,495	$6,956
7 yr nourishment	$3,739	$5,578	$6,424	$6,910
8 yr nourishment	$3,517	$5,415	$6,349	$6,872
9 yr nourishment	$3,329	$5,198	$6,267	$6,833
10 yr nourishment	$3,147	$5,002	$6,161	$6,780
11 yr nourishment	$2,989	$4,847	$6,077	$6,734
12 yr nourishment	$2,898	$4,694	$5,979	$6,673
13 yr nourishment	$2,774	$4,502	$5,877	$6,614
14 yr nourishment	$2,592	$4,319	$5,736	$6,551
15 yr nourishment	$2,587	$4,255	$5,630	$6,487
16 yr nourishment	$2,510	$4,101	$5,489	$6,383

Table 5.3-15 Total Average Annual Benefits for Hybrid Alternatives at Segment 2

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	$1,489	$2,151	$2,741	$3,283	$3,744	$4,144	$4,347	$4,512
3 yr nourishment	$1,486	$2,149	$2,735	$3,280	$3,730	$4,129	$4,329	$4,503
4 yr nourishment	$1,475	$2,151	$2,736	$3,272	$3,717	$4,105	$4,301	$4,470
5 yr nourishment	$1,472	$2,141	$2,736	$3,261	$3,706	$4,087	$4,280	$4,452
6 yr nourishment	$1,466	$2,128	$2,725	$3,255	$3,701	$4,086	$4,281	$4,455
7 yr nourishment	$1,457	$2,119	$2,710	$3,243	$3,691	$4,075	$4,271	$4,446
8 yr nourishment	$1,414	$2,107	$2,699	$3,238	$3,685	$4,067	$4,262	$4,438
9 yr nourishment	$1,378	$2,098	$2,685	$3,228	$3,674	$4,058	$4,251	$4,426
10 yr nourishment	$1,347	$2,084	$2,668	$3,216	$3,662	$4,045	$4,240	$4,416
11 yr nourishment	$1,312	$2,075	$2,658	$3,205	$3,653	$4,037	$4,233	$4,408
12 yr nourishment	$1,287	$2,060	$2,644	$3,194	$3,643	$4,026	$4,222	$4,397
13 yr nourishment	$1,253	$2,049	$2,632	$3,183	$3,633	$4,016	$4,212	$4,388
14 yr nourishment	$1,216	$2,039	$2,619	$3,173	$3,624	$4,009	$4,207	$4,385
15 yr nourishment	$1,213	$2,028	$2,606	$3,158	$3,612	$3,999	$4,197	$4,376
16 yr nourishment	$1,192	$2,012	$2,590	$3,143	$3,601	$3,989	$4,189	$4,367
High SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	$1,684	$2,496	$3,204	$3,835	$4,361	$4,809	$5,049	$5,239
3 yr nourishment	$1,675	$2,495	$3,198	$3,831	$4,343	$4,791	$5,026	$5,227
4 yr nourishment	$1,659	$2,498	$3,199	$3,819	$4,325	$4,759	$4,989	$5,185
5 yr nourishment	$1,653	$2,485	$3,198	$3,805	$4,311	$4,735	$4,962	$5,162
6 yr nourishment	$1,642	$2,468	$3,185	$3,798	$4,305	$4,734	$4,963	$5,166
7 yr nourishment	$1,589	$2,456	$3,166	$3,783	$4,291	$4,720	$4,950	$5,154
8 yr nourishment	$1,546	$2,441	$3,152	$3,777	$4,284	$4,710	$4,939	$5,144
9 yr nourishment	$1,513	$2,428	$3,133	$3,764	$4,270	$4,697	$4,925	$5,129
10 yr nourishment	$1,478	$2,409	$3,111	$3,748	$4,254	$4,682	$4,911	$5,116
11 yr nourishment	$1,437	$2,398	$3,097	$3,734	$4,243	$4,671	$4,901	$5,106
12 yr nourishment	$1,407	$2,379	$3,080	$3,719	$4,229	$4,656	$4,887	$5,091
13 yr nourishment	$1,373	$2,364	$3,064	$3,706	$4,217	$4,643	$4,875	$5,080
14 yr nourishment	$1,327	$2,352	$3,048	$3,692	$4,206	$4,635	$4,868	$5,076
15 yr nourishment	$1,321	$2,336	$3,032	$3,673	$4,191	$4,622	$4,856	$5,064
16 yr nourishment	$1,296	$2,314	$3,010	$3,654	$4,176	$4,609	$4,845	$5,053

Notch Fill & Seawall Alternatives: Total Benefits

The total benefits for the Notch Fill and Seawall alternatives are the same as the Coastal Storm Damage Reduction Benefits shown in section 5.3.1 since neither alternative offers recreation benefits.

5.3.4 Project Costs

Sand Placement Alternatives: Costs

Table 5.3-16 and **Table 5.3-17** list average annualized costs in thousands for all combinations of nourishment interval (2-16 years) and added beach widths (50-200/400 feet MSL) for the sand placement alternatives.

Table 5.3-16 Sand Placement Alternatives Average Annual Costs for Segment 1

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft
2 yr nourishment	$3,221	$3,664	$5,504	$7,562
3 yr nourishment	$2,517	$3,001	$4,780	$6,721
4 yr nourishment	$2,166	$2,608	$4,284	$6,106
5 yr nourishment	$1,842	$2,283	$3,941	$5,761
6 yr nourishment	$1,713	$2,251	$3,915	$5,681
7 yr nourishment	$1,625	$2,276	$3,986	$5,797
8 yr nourishment	$1,473	$2,132	$3,815	$5,595
9 yr nourishment	$1,347	$1,960	$3,661	$5,427
10 yr nourishment	$1,217	$1,822	$3,581	$5,218
11 yr nourishment	$1,173	$1,781	$3,546	$5,201
12 yr nourishment	$1,128	$1,750	$3,493	$5,135
13 yr nourishment	$1,032	$1,557	$3,287	$4,903
14 yr nourishment	$1,004	$1,518	$3,249	$5,103
15 yr nourishment	$978	$1,486	$3,220	$5,107
16 yr nourishment	$953	$1,443	$3,174	$5,058
High SLR ($1,000s)	**50 ft**	**100 ft**	**150 ft**	**200 ft**
2 yr nourishment	$3,393	$3,879	$5,890	$8,280
3 yr nourishment	$2,727	$3,235	$5,174	$7,455
4 yr nourishment	$2,396	$2,839	$4,693	$6,941
5 yr nourishment	$2,068	$2,572	$4,383	$6,534
6 yr nourishment	$1,973	$2,537	$4,387	$6,577
7 yr nourishment	$1,888	$2,600	$4,388	$6,579
8 yr nourishment	$1,728	$2,463	$4,352	$6,381
9 yr nourishment	$1,583	$2,291	$4,206	$6,218
10 yr nourishment	$1,478	$2,091	$4,018	$6,248
11 yr nourishment	$1,424	$2,044	$3,977	$6,236
12 yr nourishment	$1,375	$2,128	$3,922	$6,172
13 yr nourishment	$1,271	$1,939	$3,728	$5,957
14 yr nourishment	$1,247	$1,893	$3,687	$5,943
15 yr nourishment	$1,226	$1,857	$3,657	$5,946
16 yr nourishment	$1,208	$1,812	$3,612	$5,901

Table 5.3-17 Sand Placement Alternatives Average Annual Costs for Segment 2

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	$2,901	$3,401	$4,294	$5,011	$5,853	$6,657	$7,243	$7,847
3 yr nourishment	$2,055	$2,443	$3,202	$3,825	$4,569	$5,227	$5,723	$6,256
4 yr nourishment	$1,646	$1,980	$2,658	$3,237	$3,927	$4,629	$5,143	$5,580
5 yr nourishment	$1,405	$1,718	$2,335	$2,827	$3,502	$4,110	$4,583	$5,104
6 yr nourishment	$1,288	$1,605	$2,188	$2,613	$3,172	$3,762	$4,178	$4,652
7 yr nourishment	$1,192	$1,499	$2,072	$2,482	$3,045	$3,575	$3,966	$4,421
8 yr nourishment	$1,096	$1,395	$1,961	$2,329	$2,858	$3,371	$3,753	$4,208
9 yr nourishment	$1,018	$1,316	$1,875	$2,249	$2,742	$3,228	$3,585	$4,015
10 yr nourishment	$941	$1,234	$1,788	$2,132	$2,610	$3,075	$3,401	$3,815
11 yr nourishment	$922	$1,218	$1,769	$2,105	$2,606	$3,096	$3,351	$3,764
12 yr nourishment	$899	$1,189	$1,739	$2,096	$2,579	$3,077	$3,334	$3,758
13 yr nourishment	$828	$1,121	$1,667	$2,000	$2,462	$2,939	$3,178	$3,580
14 yr nourishment	$804	$1,115	$1,663	$1,994	$2,448	$2,903	$3,126	$3,511
15 yr nourishment	$782	$1,108	$1,653	$1,984	$2,432	$2,891	$3,114	$3,492
16 yr nourishment	$762	$1,093	$1,636	$1,964	$2,406	$2,851	$3,198	$3,451
High SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	$3,075	$3,648	$4,568	$5,337	$6,151	$6,920	$7,510	$8,121
3 yr nourishment	$2,233	$2,671	$3,459	$4,143	$4,816	$5,555	$6,086	$6,549
4 yr nourishment	$1,827	$2,193	$2,915	$3,552	$4,222	$4,903	$5,435	$6,010
5 yr nourishment	$1,589	$1,928	$2,581	$3,169	$3,750	$4,388	$4,875	$5,411
6 yr nourishment	$1,476	$1,828	$2,435	$2,942	$3,455	$4,036	$4,469	$4,961
7 yr nourishment	$1,383	$1,726	$2,324	$2,829	$3,352	$3,939	$4,257	$4,733
8 yr nourishment	$1,291	$1,617	$2,225	$2,667	$3,159	$3,732	$4,044	$4,523
9 yr nourishment	$1,216	$1,542	$2,122	$2,566	$3,043	$3,589	$3,877	$4,332
10 yr nourishment	$1,144	$1,465	$2,055	$2,500	$2,909	$3,437	$3,843	$4,136
11 yr nourishment	$1,128	$1,453	$2,030	$2,465	$2,945	$3,387	$3,795	$4,086
12 yr nourishment	$1,108	$1,429	$1,997	$2,435	$2,921	$3,371	$3,788	$4,083
13 yr nourishment	$1,041	$1,365	$1,956	$2,338	$2,804	$3,234	$3,634	$3,908
14 yr nourishment	$1,020	$1,363	$1,950	$2,331	$2,791	$3,197	$3,580	$3,840
15 yr nourishment	$1,003	$1,364	$1,940	$2,399	$2,776	$3,336	$3,574	$3,824
16 yr nourishment	$989	$1,356	$1,924	$2,377	$2,750	$3,297	$3,535	$3,788

<u>Hybrid Alternatives: Costs</u>

Table 5.3-18 and **Table 5.3-19** list average annualized costs rounded to thousands for all combinations of nourishment interval (2-16 years) and added beach widths (5-200/400 feet MSL) for the hybrid alternatives.

Table 5.3-18 Hybrid Alternatives Average Annual Costs for Segment 1

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft
2 yr nourishment	$3,316	$3,759	$5,599	$7,657
3 yr nourishment	$2,612	$3,096	$4,875	$6,816
4 yr nourishment	$2,261	$2,703	$4,379	$6,201
5 yr nourishment	$1,937	$2,378	$4,036	$5,856
6 yr nourishment	$1,808	$2,346	$4,010	$5,776
7 yr nourishment	$1,720	$2,371	$4,081	$5,892
8 yr nourishment	$1,568	$2,227	$3,910	$5,690
9 yr nourishment	$1,442	$2,055	$3,756	$5,522
10 yr nourishment	$1,312	$1,917	$3,676	$5,313
11 yr nourishment	$1,268	$1,876	$3,641	$5,296
12 yr nourishment	$1,223	$1,845	$3,588	$5,230
13 yr nourishment	$1,127	$1,652	$3,382	$4,998
14 yr nourishment	$1,099	$1,613	$3,344	$5,198
15 yr nourishment	$1,073	$1,581	$3,315	$5,202
16 yr nourishment	$1,048	$1,538	$3,268	$5,153
High SLR ($1000s)	**50 ft**	**100 ft**	**150 ft**	**200 ft**
2 yr nourishment	$3,536	$4,025	$5,992	$8,330
3 yr nourishment	$2,863	$3,374	$5,266	$7,494
4 yr nourishment	$2,528	$2,973	$4,779	$6,972
5 yr nourishment	$2,192	$2,700	$4,461	$6,556
6 yr nourishment	$2,099	$2,669	$4,471	$6,605
7 yr nourishment	$2,015	$2,736	$4,476	$6,611
8 yr nourishment	$1,850	$2,596	$4,437	$6,410
9 yr nourishment	$1,699	$2,419	$4,287	$6,241
10 yr nourishment	$1,590	$2,211	$4,090	$6,262
11 yr nourishment	$1,537	$2,166	$4,054	$6,257
12 yr nourishment	$1,488	$2,256	$4,002	$6,197
13 yr nourishment	$1,377	$2,055	$3,796	$5,968
14 yr nourishment	$1,354	$2,011	$3,757	$5,958
15 yr nourishment	$1,333	$1,976	$3,729	$5,966
16 yr nourishment	$1,316	$1,931	$3,685	$5,923

Table 5.3-19 Hybrid Alternatives Costs for Segment 2

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	$2,965	$3,466	$4,358	$5,076	$5,917	$6,722	$7,308	$7,912
3 yr nourishment	$2,120	$2,508	$3,266	$3,890	$4,633	$5,291	$5,787	$6,321
4 yr nourishment	$1,710	$2,045	$2,722	$3,301	$3,991	$4,694	$5,207	$5,644
5 yr nourishment	$1,469	$1,783	$2,400	$2,892	$3,566	$4,175	$4,647	$5,168
6 yr nourishment	$1,352	$1,669	$2,253	$2,677	$3,236	$3,826	$4,242	$4,716
7 yr nourishment	$1,256	$1,563	$2,136	$2,547	$3,109	$3,640	$4,030	$4,485
8 yr nourishment	$1,160	$1,459	$2,026	$2,393	$2,922	$3,436	$3,818	$4,273
9 yr nourishment	$1,082	$1,380	$1,939	$2,313	$2,807	$3,292	$3,649	$4,080
10 yr nourishment	$1,006	$1,298	$1,852	$2,197	$2,674	$3,139	$3,465	$3,879
11 yr nourishment	$987	$1,282	$1,833	$2,170	$2,671	$3,160	$3,415	$3,828
12 yr nourishment	$963	$1,254	$1,804	$2,160	$2,644	$3,142	$3,399	$3,822
13 yr nourishment	$892	$1,185	$1,732	$2,064	$2,526	$3,003	$3,242	$3,644
14 yr nourishment	$868	$1,179	$1,728	$2,058	$2,513	$2,968	$3,191	$3,575
15 yr nourishment	$847	$1,173	$1,718	$2,048	$2,497	$2,955	$3,178	$3,556
16 yr nourishment	$827	$1,157	$1,701	$2,028	$2,471	$2,915	$3,263	$3,516
High SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	$3,140	$3,712	$4,633	$5,401	$6,216	$6,984	$7,574	$8,186
3 yr nourishment	$2,297	$2,735	$3,524	$4,207	$4,880	$5,619	$6,150	$6,613
4 yr nourishment	$1,891	$2,257	$2,979	$3,617	$4,287	$4,967	$5,500	$6,074
5 yr nourishment	$1,654	$1,992	$2,645	$3,233	$3,815	$4,453	$4,939	$5,476
6 yr nourishment	$1,540	$1,892	$2,499	$3,007	$3,519	$4,100	$4,534	$5,026
7 yr nourishment	$1,448	$1,791	$2,389	$2,893	$3,416	$4,004	$4,321	$4,798
8 yr nourishment	$1,355	$1,682	$2,289	$2,731	$3,223	$3,796	$4,109	$4,588
9 yr nourishment	$1,280	$1,606	$2,187	$2,630	$3,108	$3,653	$3,941	$4,397
10 yr nourishment	$1,209	$1,530	$2,119	$2,564	$2,973	$3,502	$3,907	$4,200
11 yr nourishment	$1,192	$1,517	$2,094	$2,530	$3,010	$3,451	$3,860	$4,150
12 yr nourishment	$1,173	$1,494	$2,062	$2,499	$2,985	$3,435	$3,852	$4,148
13 yr nourishment	$1,106	$1,430	$2,020	$2,402	$2,868	$3,298	$3,699	$3,973
14 yr nourishment	$1,085	$1,428	$2,014	$2,395	$2,855	$3,261	$3,644	$3,904
15 yr nourishment	$1,067	$1,428	$2,004	$2,463	$2,840	$3,400	$3,638	$3,889
16 yr nourishment	$1,053	$1,420	$1,988	$2,442	$2,815	$3,361	$3,600	$3,853

Notch Fill Alternative: Costs

The Notch Fill Alternative provides coastal storm damage reduction benefits by reducing the frequency of bluff top erosion compared to without project conditions. The costs, shown in **Table 5.3-20**, include placement of notch fill to unprotected parcels at $209-$211 per linear foot plus sand mitigation & recreation loss fess of $3,500 per linear foot.[68]

[68] A sensitivity analysis was done to determine impact to plan selection if only half of the linear length of unprotected parcels needed notch fill across the entire period of analysis. The results show Segment 1 with $1,042,948 & $764,560 and Segment 2 at $63,281 & $603,312 net benefits for low and high sea-level rise, respectively. Under this less rigorous assumption the Notch Fill alternative continues to not maximize net benefits among the range of alternatives analyzed.

Table 5.3-20 Notch Fill Alternative Average Annual Costs

Segment 1 *Notch Fill Alternative*			Segment 2 *Notch Fill Alternative*		
	Low SLR	High SLR		Low SLR	High SLR
Cost	$2,252,000	$2,252,000	**Cost**	$1,535,000	$1,535,000

Seawall Alternative: Costs

The Seawall Alternative benefits are 100% of without project damages net of residual/sloughing damages. In other words, the seawall alternative is expected to protect against all without project damages excluding residual sloughing damages. There are no recreation benefits. Construction is $7,400 per linear feet for both segments. Sand sedimentation and recreation mitigation fees assessed by the CCC are $3,500 per linear foot. Contingency, pre-construction engineering design, and supervision & administration are 35%, 10%, and 6.5% of construction costs respectively.

Table 5.3-21 Seawall Alternative Average Annual Costs

Segment 1 *Seawall Alternative*			Segment 2 *Seawall Alternative*		
	Low SLR	High SLR		Low SLR	High SLR
Cost	$4,845,000	$4,845,000	**Cost**	$3,837,000	$3,837,000

5.3.5 Net Benefits

Sand Placement/Beach Fill Alternatives: Net Benefits with Limited Recreation Benefits[69]

Based on the coastal storm damage reduction benefits shown in **Section 5.3.1** and associated costs in **Section 5.3.4** no alternative was economically justified on coastal storm damage reduction benefits only. Recreation benefits are limited to 50% of the total benefits required for justification to ensure recreation is incidental to plan formulation.[70] Consequently, recreation benefits, not to exceed coastal storm damage reduction benefits, were included to determine the alternatives that are economically justified (net benefits greater than zero). All alternatives economically justified with limited recreation benefits are analyzed in a later step with full recreation benefits to determine the National Economic Development (NED) Plan.

Based on this threshold 50-foot, 100-foot, and 150-foot added beach width MSL alternatives were economically justified at Segment 1. No 200-foot added beach width alternatives were justified at Segment 1 using limited recreation benefits. See **Figure 5.3-3** and **Figure 5.3-4**.

Based on this threshold 100-foot through 400-foot added beach width MSL alternatives were economically justified at Segment 2. No 50-foot added beach width alternatives were justified at Segment 2 using limited recreation benefits. See **Figure 5.3-5** and **Figure 5.3-6**. All alternatives that were economically justified (BCR greater than or equal to 1.0) were evaluated with full recreation benefits to select the NED Plans in the next section.

[69] Recreation benefits up to 50% of total benefits.
[70] ER 1105-2-100 section 3-4b.(4)(a)

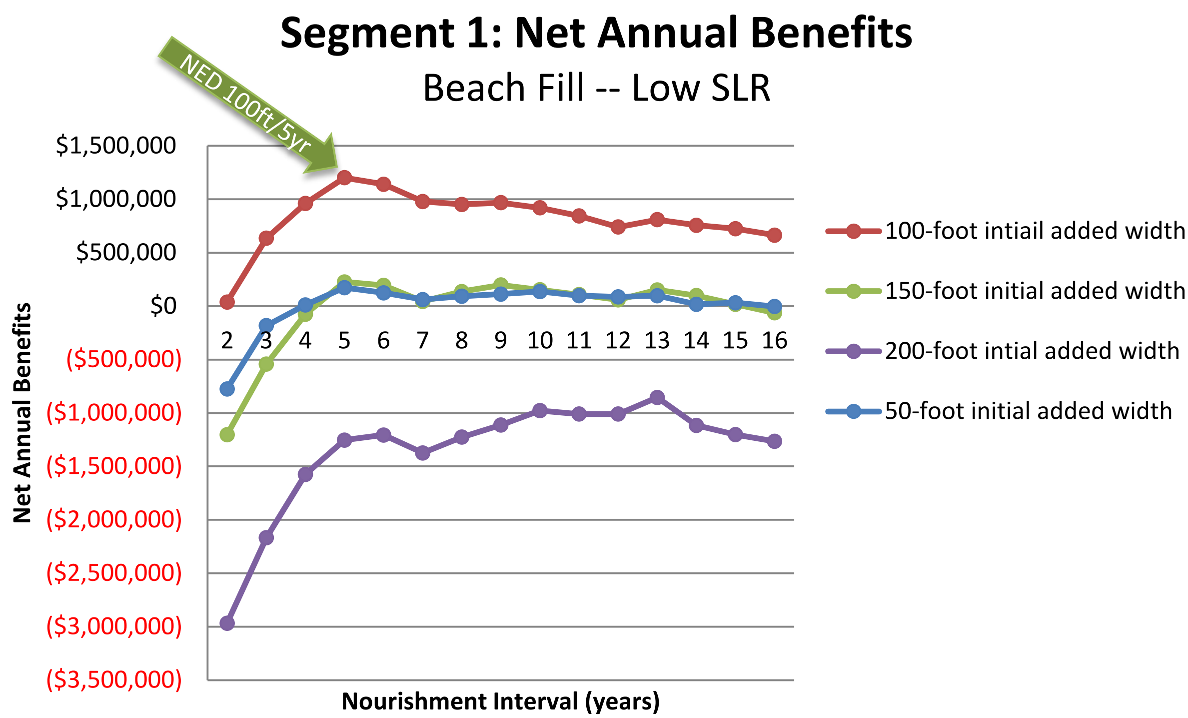

Figure 5.3-3 Net Annual Benefits for Segment 1 Beach Fill Alternatives with Limited Recreation Benefits (Low Sea-level Rise)

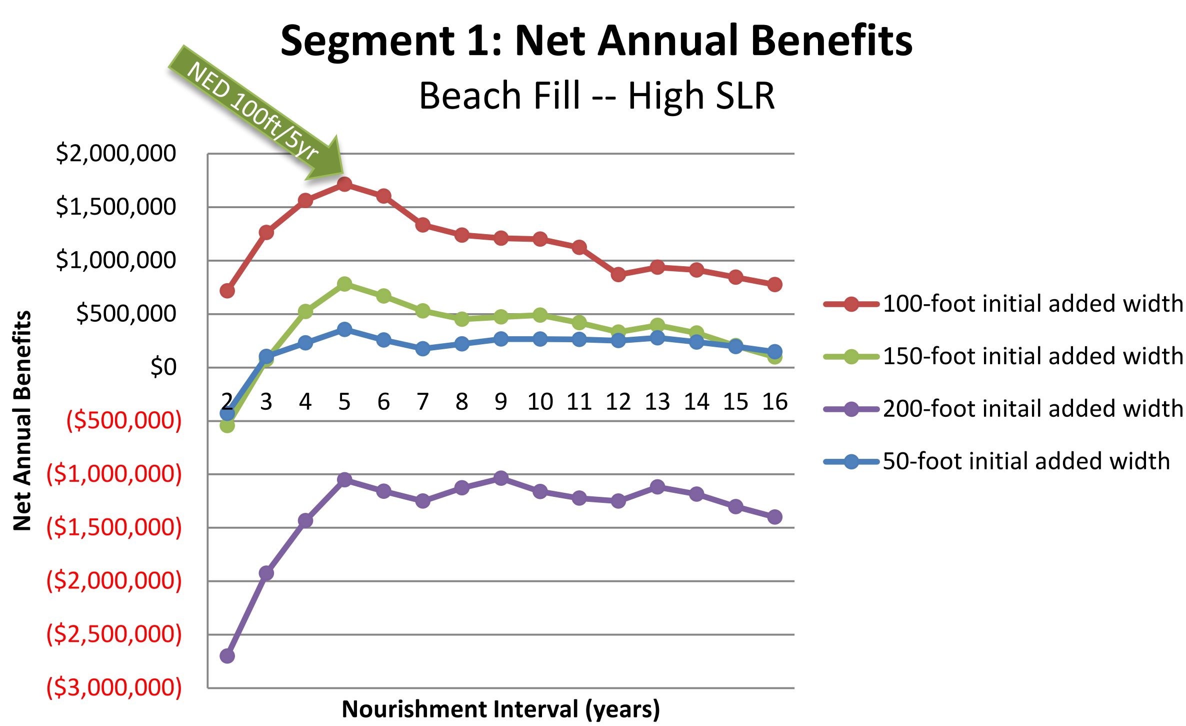

Figure 5.3-4 Net Annual Benefits for Segment 1 Beach Fill Alternatives with Limited Recreation Benefits (High Sea-level Rise)

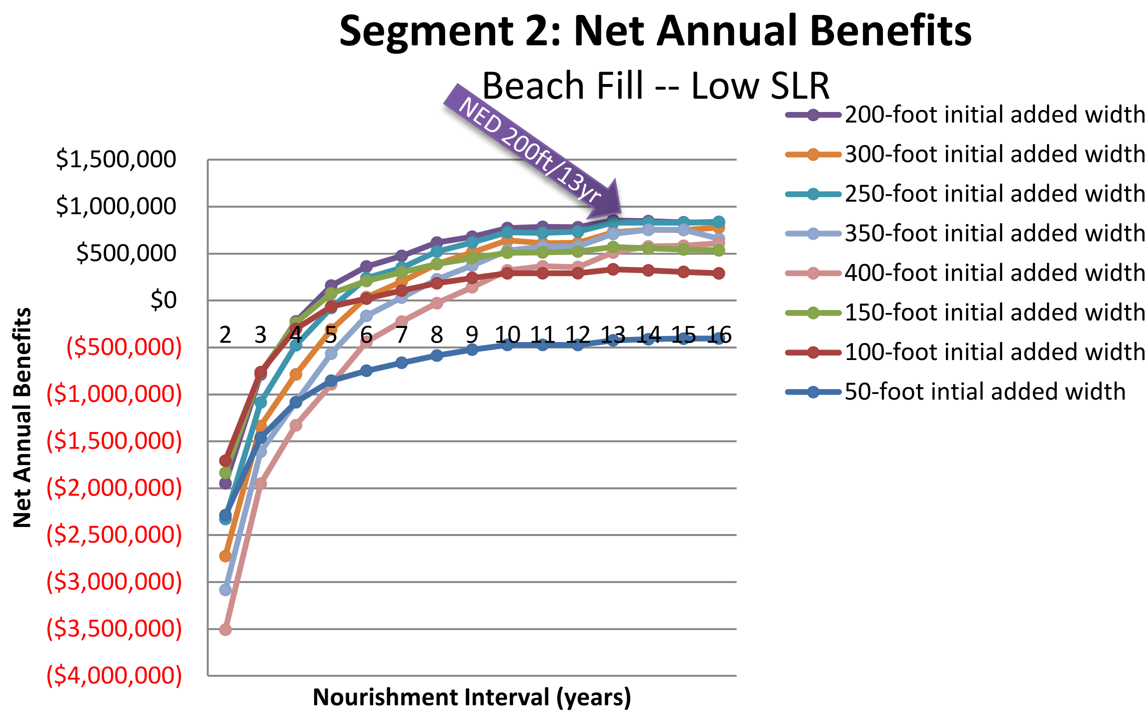

Figure 5.3-5 Net Annual Benefits for Segment 2 Beach Fill Alternatives with Limited Recreation Benefits (Low Sea-level Rise)

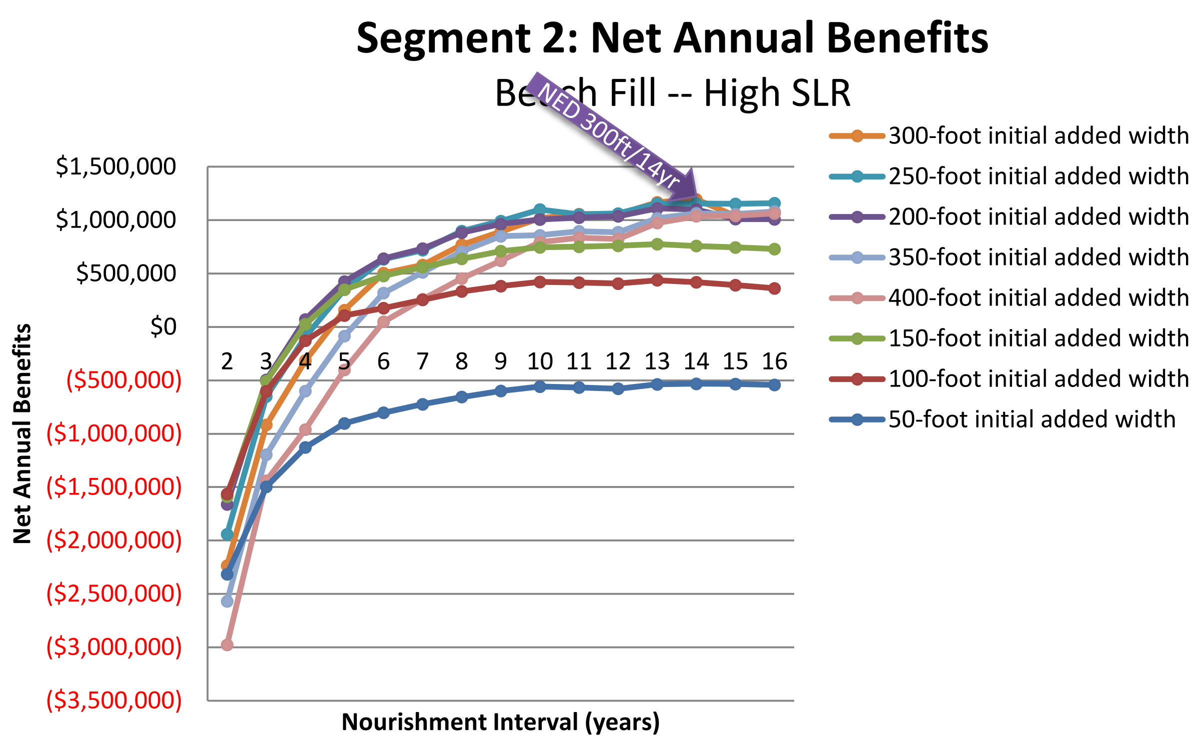

Figure 5.3-6 Net Annual Benefits for Segment 2 Beach Fill Alternatives With Limited Recreation Benefits (High Sea-level Rise)

Hybrid Alternatives: Net Benefits with Limited Recreation Benefits[71]

The net annual benefits for the Hybrid Alternatives, which include toe notch fill & sand placement, were analyzed for 50 to 400 feet of added beach width (200 feet for Encinitas) and two to sixteen year nourishment intervals. The results for all *Hybrid* alternatives broken down by Segment 1 & 2 as well as high and low sea-level rise scenarios are shown below. Note the hybrid alternatives with the highest net benefits are moderately lower than comparable beach fill alternatives.

When evaluated with limited recreation benefits the 100-foot, 150-foot, and 200-foot added beach width MSL alternatives were economically justified at Segment 1. No 200-foot added beach width alternatives were justified. See **Figure 5.3-7** and **Figure 5.3-8**.

When evaluated with limited recreation benefits the 100-foot through 400-foot added beach width MSL alternatives were economically justified at Segment 2. No 50-foot added beach width alternatives were justified. See **Figure 5.3-9** and **Figure 5.3-10**.

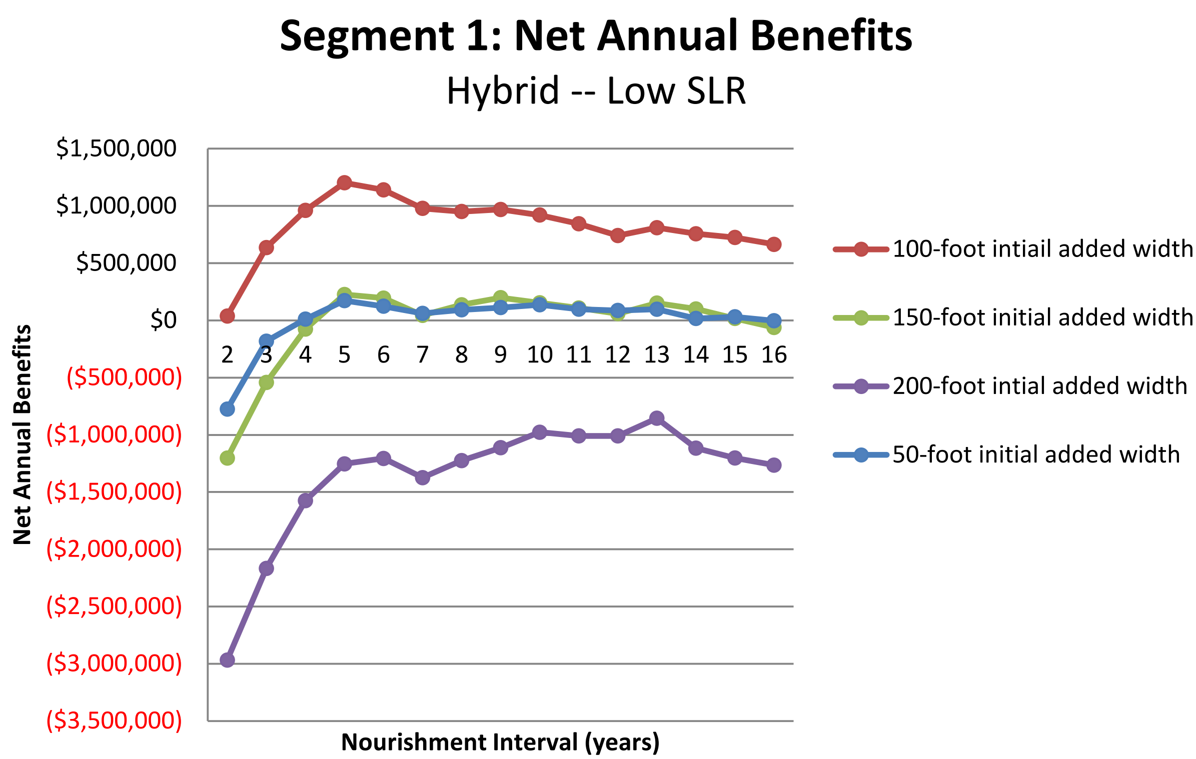

Figure 5.3-7 Net Annual Benefits for Hybrid Alternatives with Limited Recreation Benefits (Low Sea-Level Rise)

[71] Recreation benefits up to 50% of total benefits

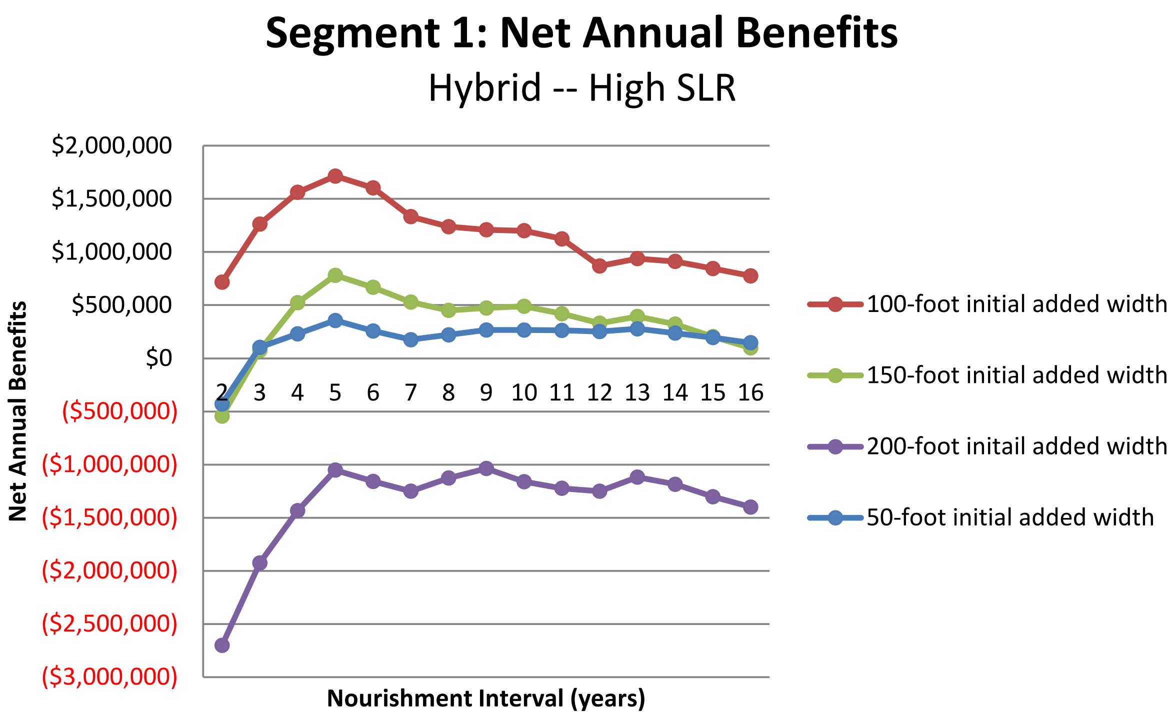

Figure 5.3-8 Net Annual Benefits for Hybrid Alternatives with Limited Recreation Benefits (High Sea-level Rise)

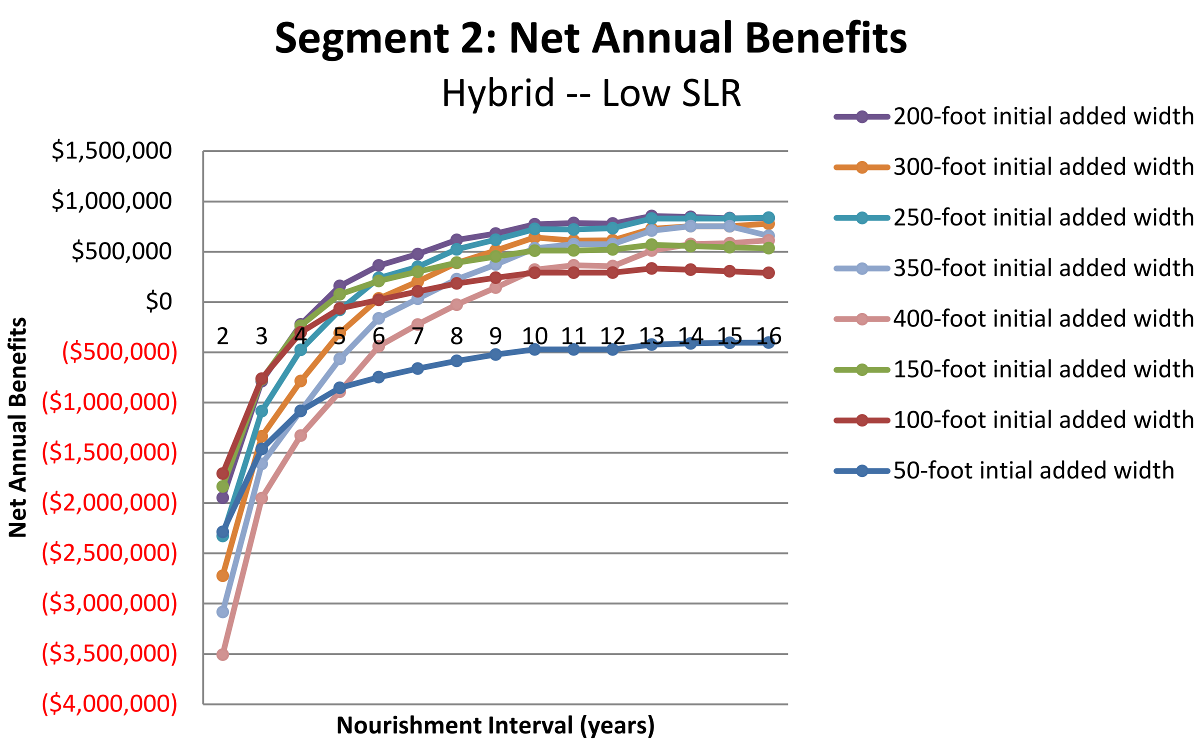

Figure 5.3-9 Net Annual Benefits for Hybrid Alternatives with Limited Recreation Benefits (Low Sea-Level Rise)

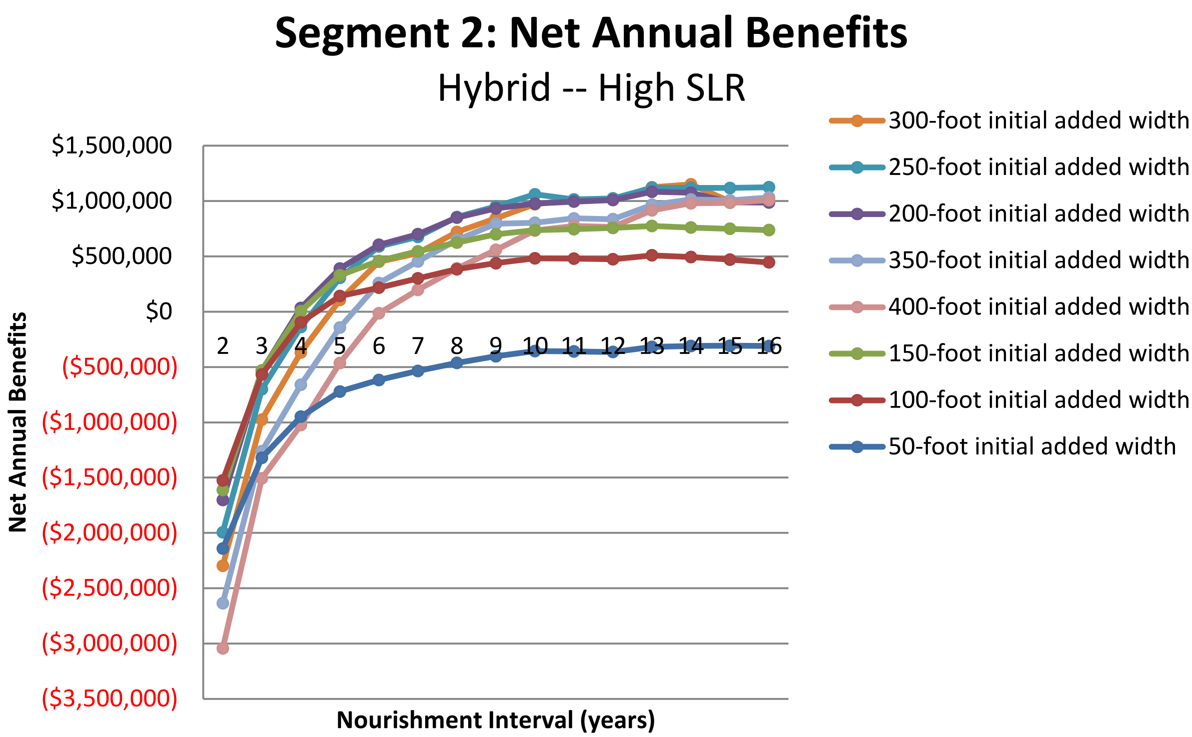

Figure 5.3-10 Net Annual Benefits for Hybrid Alternatives with Limited Recreation Benefits (High Sea-level Rise)

<u>Beach Fill Alternatives: Net Annual Benefits with Full Recreation Benefits</u>

The Beach Fill alternatives that are economically justified with limited recreation benefits (up to 50% of total benefits) were evaluated with full recreation benefits in **Table 5.3-22** and **Table** 5.3-23 to select the NED Plans. Among the beach fill alternatives evaluated at Segment 1, extending the beach 100 feet MSL and nourishing every 5 years maximizes NED net annual benefits. This result is consistent under low and high sea-level rise scenarios.

Table 5.3-22 Segment 1: Beach Fill Alternatives Net Annual Benefits with Full Recreation Benefits

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft
2 yr nourishment	--	$172	--	--
3 yr nourishment	--	$791	--	--
4 yr nourishment	$297	$1,137	--	--
5 yr nourishment	$479	$1,403	$424	--
6 yr nourishment	$382	$1,355	$401	--
7 yr nourishment	$277	$1,215	$267	--
8 yr nourishment	$271	$1,210	$380	--
9 yr nourishment	$258	$1,250	$464	--
10 yr nourishment	$259	$1,190	$451	--
11 yr nourishment	$181	$1,083	$414	--
12 yr nourishment	$157	$975	$382	--
13 yr nourishment	$155	$1,029	$498	--
14 yr nourishment	$43	$935	$447	--
15 yr nourishment	$66	$914	$375	--
16 yr nourishment	--	$836	--	--
High SLR ($1000s)	**50 ft**	**100 ft**	**150 ft**	**200 ft**
2 yr nourishment	--	$2,101	--	--
3 yr nourishment	--	$2,694	--	--
4 yr nourishment	$1,995	$3,028	--	--
5 yr nourishment	$2,019	$3,216	$2,164	--
6 yr nourishment	$1,879	$3,157	$2,104	--
7 yr nourishment	$1,780	$2,961	$2,031	--
8 yr nourishment	$1,713	$2,928	$1,991	--
9 yr nourishment	$1,665	$2,876	$2,054	--
10 yr nourishment	$1,583	$2,874	$2,132	--
11 yr nourishment	$1,474	$2,762	$2,088	--
12 yr nourishment	$1,429	$2,518	$2,043	--
13 yr nourishment	$1,404	$2,510	$2,131	--
14 yr nourishment	$1,242	$2,371	$2,027	--
15 yr nourishment	$1,252	$2,338	$1,947	--
16 yr nourishment	--	$2,224	--	--

Among the beach fill alternatives evaluated with full recreation benefits at Segment 2, extending the beach 200 feet MSL and nourishing every 13 years maximizes NED net annual benefits. Under the high sea-level rise scenario the alternative that maximizes NED net annual benefits is 300-feet added beach width nourished every 14 years.

Table 5.3-23 Segment 2: Beach Fill Alternatives Net Annual Benefits with Full Recreation Benefits

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	--	--	--	--	--	--	--	--
3 yr nourishment	--	--	--	--	--	--	--	--
4 yr nourishment	--	--	--	--	--	--	--	--
5 yr nourishment	--	--	$366	$409	--	--	--	--
6 yr nourishment	--	$455	$502	$618	$513	$315	--	--
7 yr nourishment	--	$549	$601	$736	$629	$489	$300	--
8 yr nourishment	--	$639	$699	$883	$809	$684	$503	--
9 yr nourishment	--	$706	$769	$952	$913	$817	$659	$409
10 yr nourishment	--	$771	$838	$1,055	$1,031	$956	$832	$599
11 yr nourishment	--	$777	$844	$1,070	$1,026	$927	$873	$642
12 yr nourishment	--	$788	$859	$1,068	$1,041	$932	$877	$635
13 yr nourishment	--	$843	$917	**$1,153**	$1,149	$1,060	$1,024	$803
14 yr nourishment	--	$838	$907	$1,147	$1,153	$1,089	$1,070	$869
15 yr nourishment	--	$832	$902	$1,140	$1,156	$1,090	$1,071	$878
16 yr nourishment	--	$828	$900	$1,145	$1,169	$1,119	$978	$909
High SLR ($1000s)	**50 ft**	**100 ft**	**150 ft**	**200 ft**	**250 ft**	**300 ft**	**350 ft**	**400 ft**
2 yr nourishment	--	--	--	--	--	--	--	--
3 yr nourishment	--	--	--	--	--	--	--	--
4 yr nourishment	--	--	--	--	--	--	--	--
5 yr nourishment	--	--	$586	$613	--	--	--	--
6 yr nourishment	--	$577	$718	$832	$834	$689	--	--
7 yr nourishment	--	$664	$806	$930	$922	$769	$688	--
8 yr nourishment	--	$756	$891	$1,085	$1,107	$966	$888	--
9 yr nourishment	--	$816	$973	$1,172	$1,208	$1,096	$1,040	$793
10 yr nourishment	--	$871	$1,017	$1,221	$1,325	$1,230	$1,059	$977
11 yr nourishment	--	$872	$1,026	$1,241	$1,277	$1,270	$1,097	$1,016
12 yr nourishment	--	$874	$1,040	$1,256	$1,287	$1,269	$1,088	$1,003
13 yr nourishment	--	$922	$1,064	$1,339	$1,392	$1,393	$1,229	$1,165
14 yr nourishment	--	$910	$1,053	$1,332	$1,394	**$1,421**	$1,277	$1,230
15 yr nourishment	--	$892	$1,044	$1,243	$1,392	$1,268	$1,269	$1,233
16 yr nourishment	--	$875	$1,037	$1,245	$1,401	$1,294	$1,296	$1,257

Hybrid Alternatives: Net Annual Benefits with Full Recreation Benefits

The Hybrid alternatives that are economically justified with limited recreation benefits (up to 50% of total benefits) were evaluated with full recreation benefits in **Table 5.3-24** and **Table 5.3-25**. Among the Hybrid alternatives evaluated at Segment 1, extending the beach 100 feet MSL and nourishing every 5 years maximizes NED net annual benefits. This result is consistent under low and high sea-level rise scenarios.

Table 5.3-24 Segment 1: Hybrid Alternatives Net Annual Benefits with Full Recreation Benefits

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft
2 yr nourishment	--	--	--	--
3 yr nourishment	--	$713	--	--
4 yr nourishment	$261	$1,059	--	--
5 yr nourishment	$453	**$1,321**	$337	--
6 yr nourishment	$364	$1,281	$317	--
7 yr nourishment	$270	$1,146	--	--
8 yr nourishment	$270	$1,149	$299	--
9 yr nourishment	$263	$1,196	$385	--
10 yr nourishment	$271	$1,144	$374	--
11 yr nourishment	$197	$1,042	$339	--
12 yr nourishment	$177	$942	--	--
13 yr nourishment	$181	$1,001	$431	--
14 yr nourishment	$75	$910	$383	--
15 yr nourishment	$105	$895	--	--
16 yr nourishment	$68	$822	--	--
High SLR ($1000s)	**50 ft**	**100 ft**	**150 ft**	**200 ft**
2 yr nourishment	--	--	--	--
3 yr nourishment	--	$2,567	--	--
4 yr nourishment	$1,913	$2,906	--	--
5 yr nourishment	$1,953	**$3,100**	$2,090	--
6 yr nourishment	$1,820	$3,042	$2,026	--
7 yr nourishment	$1,728	$2,845	--	--
8 yr nourishment	$1,671	$2,822	$1,915	--
9 yr nourishment	$1,635	$2,782	$1,983	--
10 yr nourishment	$1,562	$2,795	$2,073	--
11 yr nourishment	$1,456	$2,686	$2,026	--
12 yr nourishment	$1,414	$2,443	--	--
13 yr nourishment	$1,401	$2,450	$2,085	--
14 yr nourishment	$1,243	$2,312	$1,982	--
15 yr nourishment	$1,259	$2,283	--	--
16 yr nourishment	$1,199	$2,174	--	--

Among the Hybrid alternatives evaluated with full recreation benefits at Segment 2, extending the beach 200 feet MSL and nourishing every 13 years maximizes NED net annual benefits. Under the high sea-level rise scenario the alternative that maximizes NED net annual benefits is 300-feet added beach width nourished every 14 years.

Table 5.3-25 Segment 2: Hybrid Alternatives Net Annual Benefits with Full Recreation Benefits

Low SLR ($1,000s)	50 ft	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
2 yr nourishment	--	--	--	--	--	--	--	--
3 yr nourishment	--	--	--	--	--	--	--	--
4 yr nourishment	--	--	--	--	--	--	--	--
5 yr nourishment	--	--	$367	$409	--	--	--	--
6 yr nourishment	--	$455	$502	$617	$512	--	--	--
7 yr nourishment	--	$548	$600	$735	$627	$488	--	--
8 yr nourishment	--	$639	$700	$883	$808	$683	$502	--
9 yr nourishment	--	$706	$768	$951	$912	$816	$658	$408
10 yr nourishment	--	$770	$837	$1,055	$1,030	$955	$830	$597
11 yr nourishment	--	$776	$844	$1,070	$1,025	$925	$872	$640
12 yr nourishment	--	$789	$859	$1,067	$1,040	$932	$876	$633
13 yr nourishment	--	$843	$917	**$1,152**	$1,147	$1,059	$1,022	$802
14 yr nourishment	--	$838	$907	$1,146	$1,152	$1,088	$1,069	$867
15 yr nourishment	--	$832	$902	$1,140	$1,155	$1,089	$1,070	$877
16 yr nourishment	--	$835	$906	$1,146	$1,169	$1,118	$977	$908
High SLR ($1000s)	**50 ft**	**100 ft**	**150 ft**	**200 ft**	**250 ft**	**300 ft**	**350 ft**	**400 ft**
2 yr nourishment	--	--	--	--	--	--	--	--
3 yr nourishment	--	--	--	--	--	--	--	--
4 yr nourishment	--	--	--	--	--	--	--	--
5 yr nourishment	--	--	$554	$573	--	--	--	--
6 yr nourishment	--	$576	$687	$792	$787	--	--	--
7 yr nourishment	--	$666	$778	$891	$876	$717	--	--
8 yr nourishment	--	$759	$863	$1,046	$1,061	$915	$831	--
9 yr nourishment	--	$822	$947	$1,135	$1,163	$1,045	$985	$733
10 yr nourishment	--	$880	$993	$1,184	$1,281	$1,181	$1,005	$917
11 yr nourishment	--	$881	$1,003	$1,205	$1,234	$1,221	$1,043	$957
12 yr nourishment	--	$886	$1,019	$1,221	$1,245	$1,222	$1,035	$945
13 yr nourishment	--	$934	$1,044	$1,305	$1,350	$1,347	$1,177	$1,108
14 yr nourishment	--	$924	$1,035	$1,298	$1,352	**$1,375**	$1,225	$1,172
15 yr nourishment	--	$908	$1,028	$1,211	$1,352	$1,223	$1,219	$1,177
16 yr nourishment	--	$894	$1,022	$1,213	$1,362	$1,249	$1,246	$1,201

Notch Fill Alternative: Net Annual Benefits

The Notch Fill Alternative provides coastal storm damage reduction benefits by reducing the frequency of bluff top erosion compared to without project conditions. This is achieved by constructing toe notch fills at the base of the bluff and maintaining these at regular intervals. There are no recreation benefits. The costs include placement of notch fill to unprotected parcels.[72]

Table 5.3-26 Notch Fill Alternative Net Annual Benefits

Segment 1 *Notch Fill Alternative*			**Segment 2** *Notch Fill Alternative*		
	Low SLR	High SLR		Low SLR	High SLR
Benefits	$2,119,000	$1,840,000	Benefits	$797,000	$1,336,000
Costs	$2,252,000	$2,252,000	Costs	$1,535,000	$1,535,000
Net Benefits	**$(133,000)**	**$(411,000)**	**Net Benefits**	**$(738,000)**	**$(198,000)**
Std Deviation[73]	*474,000*	*896,000*	*Std Deviation*	*763,000*	*819,000*

Seawall Alternative: Net Annual Benefits

Alternative benefits are 100% of with-out project damages net of residual/sloughing damages. In other words, the seawall alternative is expected to protect against all without project damages excluding residual sloughing damages. There are no recreation benefits. The costs include construction with all associated costs and sand sedimentation & recreation loss fees for all unprotected parcels at a rate of $3,500 per linear foot, which is the amount applied consistently throughout this report when applicable.

Table 5.3-27 Seawall Alternative Net Annual Benefits

Segment 1 *Seawall Alternative*			**Segment 2** *Seawall Alternative*		
	Low SLR	High SLR		Low SLR	High SLR
Benefits	2,786,000	3,185,000	Benefits	2,826,000	3,527,000
Costs	4,845,000	4,845,000	Costs	3,837,000	3,837,000
Net Benefits[74]	**$(2,059,000)**	**$(1,660,000)**	**Net Benefits**	**$(1,011,000)**	**$(310,000)**
Std Deviation	*396,000*	*811,000*	*Std Deviation*	*590,000*	*638,000*

[72] A sensitivity analysis was done to determine impact to plan selection if only half of the linear length of unprotected parcels needed notch fill across the entire study period. The results show Segment 1 with $1,042,948 & $764,560 and Segment 2 at $63,281 & $603,312 net benefits for low and high sea-level rise, respectively. Under this less rigorous assumption the Notch Fill alternative continues to not maximize net benefits among the range of alternatives analyzed.

[73] In the absence of correlation coefficients between with and without project damages these standard deviations assume perfect correlation, which leads to the largest estimate of the project standard deviations.

[74] Standard deviation for Segment 1 net benefits is $395,732 low SLR and $811,413 high SLR. Segment 2 is $590,455 low SLR and $637,897 high SLR.

6 SELECTION OF THE NED AND LOCALLY-PREFERRED PLANS

6.1 Alternatives Analyzed

The NED Plans for Segment 1 and 2 were selected among all the alternatives considered to "reasonably maximize net national economic development benefits, consistent with the Federal objective…"[75] All alternatives economically justified (BCR greater than one) with limited recreation benefits up to 50% of total benefits, were also analyzed with full recreation benefits to determine the NED Plan. Consequently, the benefits quantified to determine the NED Plan were Coastal Storm Damage Reduction (CSDR) and full recreation if applicable. The costs included construction and related activities, monitoring, environmental mitigation if applicable, sand sedimentation & recreation loss fee, and lagoon sedimentation fees. All alternatives assume joint construction of Segments 1 and 2 with commensurate savings for the initial fill/construction if applicable but no joint construction during any subsequent beach nourishments. In other words, we have assumed dredging equipment only needs to be mobilized one time to construct the initial project at both segments (Hybrid and Beach Fill alternatives only). All later nourishments would be constructed separately meaning dredging equipment would need to be mobilized once for each segment. For a complete and detailed listing of benefits and costs see the *Project Benefits* and *Project Costs* sections earlier in this appendix.

Alternatives analyzed:

- Seawall/Hard Structure
- Toe Notch/Sea Cave Fill
- Toe Notch/Sea Cave Fill & Sand Placement (*Hybrid Plan)*
- Sand Placement (*Beach Fill Plan*)

Once the net annual benefits for the *Seawall*, *Notch Fill*, *Hybrid*, and *Beach Fill* alternatives were compared, the Beach Fill alternatives, which have the highest net benefits, were selected as the NED Plan for Segment 1 and Segment 2 because among the alternatives analyzed, the *Beach Fill* alternatives maximize net benefits for both segments (FY 2012 price levels and preliminary cost estimates unless otherwise noted).

[75] *Economic and Environmental Principles for Water and Related Land Resources Implementation Studies*

Table 6.1-1 Selection of the NED Plan: Average Annual Benefits[76]

Low SLR	SEGMENT 1		SEGMENT 2		
Alternative	**CSDR Benefits**	**Recreation Benefits (Full/Limited)**[77]		**CSDR Benefits**	**Recreation Benefits**
Seawall			**Seawall**		
Exp Value	$2,786,000	n/a	Exp Value	$2,826,000	n/a
Std Dev	*396,000*		*Std Dev*	*590,000*	
Notch Fill			**Notch Fill**		
Exp Value	$2,119,000	n/a	Exp Value	$797,000	n/a
Std Dev	*474,000*		*Std Dev*	*762,000*	
Hybrid (5yr/100 ft)			**Hybrid (13yr/200 ft)**		
Exp Value	$1,878,000	$1,831,000 /$1,604,000	Exp Value	$1,566,000	$1,619,000 /$1,353,000
Std Dev	*618,000*		*Std Dev*	*644,000*	--
Beach Fill (5yr/100 ft)			**Beach Fill (13yr/200 ft)**		
Exp Value	$1,855,000	$1,831,000 /$1,598,000	Exp Value	$1,533,000	$1,619,000 /$1,337,000
Std Dev	*618,000*		*Std Dev*	*642,000*	--
High SLR					
Seawall			**Seawall**		
Exp Value	$3,185,000	n/a	Exp Value	$3,527,000	n/a
Std Dev	*811,000*		*Std Dev*	*638,000*	
Notch Fill			**Notch Fill**		
Exp Value	$1,840,000	n/a	Exp Value	$1,337,000	n/a
Std Dev	*896,000*		*Std Dev*	*819,000*	
Hybrid (5yr/100 ft)			**Hybrid (14yr/300 ft)**		
Exp Value	$2,151,000	$3,651,000 /$2,150,000	Exp Value	$2,439,000	$2,196,000 /$1,995,000
Std Dev	*722,000*	--	*Std Dev*	*755,000*	--
Beach Fill (5yr/100 ft)			**Beach Fill (14yr/300 ft)**		
Exp Value	$2,137,000	$3,651,000 /$2,141,000	Exp Value	$2,421,000	$2,196,000 /$1,992,000
Std Dev	*722,000*	--	*Std Dev*	*754,000*	--

[76] FY 2012 price levels

[77] Expected values shown for Limited Recreation Benefits because CSDR Benefits are non-deterministic. This is the reason why limited recreation benefits can be lower than full recreation benefits when full recreation benefits are in turn lower than expected CSDR benefits. Consequently, the expected values for CSDB are slightly higher than the limited recreation benefits.

Table 6.1-2 Selection of the NED Plan: Average Annual Costs[78]

Segment 1 Low SLR	Initial Construct	Nourishment Construct	Environ Mitigation	Monitoring/ O&M	Lagoon Sedimentation Fee	Sediment/ Recreation Loss Fees
Seawall	3,818,000	n/a	n/a	n/a	n/a	1,027,000
Notch Fill	720,000	n/a	n/a	505,000	n/a	1,027,000
Hybrid (5yr/100ft)	674,000	1,551,000	3,000	73,000	56,000	n/a
Beach Fill (5yr/100ft)	576,000	1,551,000	3,000	73,000	56,000	n/a
High SLR						
Seawall	3,818,000	n/a	n/a	n/a	n/a	1,027,000
Notch Fill	720,000	n/a	n/a	505,000	n/a	1,027,000
Hybrid (5yr/100ft)	706,000	1,832,000	3,000	73,000	56,000	n/a
Beach Fill (5yr/100ft)	608,000	1,832,000	3,000	73,000	56,000	n/a
Segment 2 Low SLR						
Seawall	3,134,000	n/a	n/a	n/a	n/a	703,000
Notch Fill	492,000	n/a	n/a	340,000	n/a	703,000
Hybrid (13yr/200ft)	1,009,000	523,000	357,000	86,000	105,000	n/a
Beach Fill (13yr/200ft)	943,000	523,000	357,000	86,000	105,000	n/a
High SLR						
Seawall	3,134,000	n/a	n/a	n/a	n/a	703,000
Notch Fill	492,000	n/a	n/a	340,000	n/a	703,000
Hybrid (14yr/300ft)	1,706,000	885,000	615,000	87,000	119,000	n/a
Beach Fill (14yr/300ft)	1,640,000	885,000	615,000	87,000	119,000	n/a

[78] Preliminary cost estimates at FY 2012 price levels

Table 6.1-3 NED Plan Selection: Net Annual Benefits[79]

Low SLR		SEGMENT 1				SEGMENT 2	
Alternative	**Benefits**	**Costs**	**Net Benefits**	**Alternative**	**Benefits**	**Costs**	**Net Benefits**
Seawall	2,786,000	4,845,000	$(2,059,000)	**Seawall**	2,826,000	3,837,000	$(1,011,000)
Notch Fill	2,119,000	2,252,000	$(133,000)	**Notch Fill**	797,000	1,535,000	$(738,000)
Hybrid (5yr/100ft)				**Hybrid (13yr/200ft)**			
Exp Value	3,699,000	2,378,000	$1,321,000	Exp Value	3,183,000	2,061,000	$1,122,000
Std Dev			983,000	*Std Dev*			*1,004,000*
Prob NB>0[80]			*85%*	*Prob NB>0*			*80%*
Beach Fill (5yr/100ft)				**Beach Fill (13yr/200ft)**			
Exp Value	3,686,000	2,283,000	$1,403,000	Exp Value	3,152,000	2,000,000	$1,153,000
Std Dev			*987,000*	*Std Dev*			*1,103,000*
Prob NB>0			*86%*	*Prob NB>0*			80%
High SLR							
Seawall	3,185,000	4,845,000	$(1,660,000)	**Seawall**	3,527,000	3,837,000	$(310,000)
Notch Fill	1,840,000	2,252,000	$(411,000)	**Notch Fill**	1,336,000	1,535,000	$(310,000)
Hybrid (5yr/100ft)				**Hybrid (14yr/300ft)**			
Exp Value	5,800,000	2,700,000	$3,100,000	Exp Value	4,635,000	3,261,000	$1,375,000
Std Dev			*1,469,000*	*Std Dev*			*1,119,000*
Prob NB>0			*85%*	*Prob NB>0*			*86%*
Beach Fill (5yr/100ft)				**Beach Fill (14yr/300ft)**			
Exp Value	5,788,000	2,572,000	$3,186,000	Exp Value	4,617,000	3,197,000	$1,421,000
Std Dev			*1,468,000*	*Std Dev*			*1,165,000*
Prob NB>0			*85%*	*Prob NB>0*			85%

6.2 Selection of the NED Plan[81]

Table 6.2-1 below highlights key characteristics of the NED Plans for Segment 1 and 2 at current (FY2015) price levels under the low sea level rise scenario. Note the NED Plan was selected using preliminary cost estimates shown in the previous section. Detailed cost estimates were produced for this scenario only, thus the high sea-level scenario includes benefits only.

- The NED Plan for Segment 1 is the Beach Fill alternative with an initial dredged volume of 820,000 cubic yards (880,000 cubic yards under high SLR) that extends the base year beach width at mean-sea level approximately 100 feet. Nourishments would occur every 5 years and require dredging 340,000 cubic yards of material (400-480,000 cubic yards under high SLR). Net annual benefits are expected to be approximately $1.3 million annually under the low sea-level rise scenario.
- The NED Plan for Segment 2 is the Beach Fill Alternative with an initial dredged volume of 1,180,000 cubic yards (1,970,000 cubic yards under high SLR) that extends the base year beach width at mean-sea level approximately 200 feet (300 feet under high SLR). Nourishments would occur every 13 years (14 years under high SLR) and require

[79] Totals may not add up due to rounding. Full recreation benefits included where applicable. FY 2012 price levels and preliminary cost estimates.
[80] Long-run probability net benefits would be greater than zero.
[81] Current (FY 2015) price levels with detailed costs estimates and current discount rate. Will NOT match preceding tables in FY 2012 price levels.

dredging 500,000 cubic yards of material (1-1.1 million cubic yards under high SLR). Net annual benefits are expected to be approximately $1.8 million under the low sea-level rise scenario.

Table 6.2-1 NED Plan Specifications[82]

Low SLR	SEGMENT 1	SEGMENT 2
Type	Beach Fill	Beach Fill
Initial Added Width	100 ft	200 ft
Initial Volume Dredged	820,000 cy	1,180,000 cy
Nourishment Interval	5 yr	13 yr
Nourishment Volume Dredged	340,000 cy	500,000 cy
Coastal Storm Damage Reduction Benefits		
CSDR and Full Recreation – expected value	$4,021,000	$3,562,000
CSDR and 50% Recreation – expected value	$3,961,000	$3,524,000
CSDR only – expected value	$1,981,000	$1,762,000
Net Annual Benefits[83]		
CSDR and Full Recreation – expected value/ prob>0	$1,295,000 95%	$1,775,000 99%
CSDR and Limited Recreation – expected value/ prob>0	$1,235,000 81%	$1,737,000 88%
CSDR only – expected value/ prob>0	-$746,000 10%	-$25,000 52%
Standard Deviation	*664,000*	*683,000*
BCR		
CSDR and Full Recreation – expected value	1.48	1.99
CSDR and Limited Recreation – expected value	1.45	1.97
CSDR only – expected value	0.73	0.99
High SLR	SEGMENT 1	SEGMENT 2
Type	Beach Fill	Beach Fill
Initial Added Width	100 ft	300 ft
Initial Volume Dredged	880,000 cy	1,970,000 cy
Nourishment Interval	5 yr	14 yr
Nourishment Volume Dredged	403-476,000 cy	900-1,020,000 cy
Benefits		
CSDR and Full Recreation – expected value	$6,882,000	$5,304,000
CSDR and Limited Recreation – expected value	$5,670,000	$5,304,000
CSDR only – expected value	$2,835,000	$3,108,000
Net Annual Benefits – NOT AVAILABLE, NO DETAILED COST ESTIMATE		
BCR - NOT AVAILABLE, NO DETAILED COST ESTIMATE		

[82] Current (FY 2015) price levels, detailed cost estimate, and current discount rate

[83] While benefits are calculated stochastically, costs are deterministic. This limits the accuracy when estimating the probability net benefits are greater than zero (prob>0). Probabilities should be used for comparison purposes only.

6.3 Selection of the Locally-Preferred (Recommended) Plan

In order to address the California Coastal Commission's findings that the NED plan is not consistent with the Coastal Zone Management Act (CZMA) to the maximum extent feasible, the sponsors have requested a Locally Preferred Plan (LPP). The Commission found that the NED plan was not consistent to the maximum extent practicable with the marine resources, beach nourishment, and dredging and filling policies; the public access and recreation policies; and the archaeological policy of the California Coastal Act, all of which are enforceable policies of the California Coastal Management Program. To be consistent a project alternative had to be selected "...that includes a reduced volume of sand, narrower constructed beaches at Encinitas and Solana Beach, and reduced nourishment footprints to avoid sensitive nearshore habitat and the Swami's SMCA in order to further minimize potential adverse effects on marine resources, which in turn would reduce project mitigation requirements" compared to the NED Plan.[84] To achieve consistency reduced volume alternatives were proposed and duly accepted as consistent with the act. The reduced volume alternatives, formally known as the LPP, minimizes environmental impacts while balancing the competing needs for reduced coastal storm damage and life-safety risks. The LPP would extend the mean sea-level shoreline width in Segment 1 (Encinitas) by 50 feet on average during the year of placement as compared to 100 feet for the NED Plan. The LPP for Segment 2 (Solana Beach) extends the shoreline width 150 feet on average compared to 200 feet for the NED Plan. The timing for future nourishments remains every 5 years in Segment 1 but would occur somewhat sooner, every 10 years, in Segment 2. As a result future nourishments could overlap every 10 years. Due to the potential cost savings associated with synchronizing future nourishment events, there is strong local support for doing so whenever possible. However, because of uncertainties related to the timing of required nourishments in the two segments given substantial differences in erosion rates, as well as those relating to timing and availability funding for future nourishment cycles, the projected cost estimates for the LPP were developed assuming that two of the four possible events would overlap. Specifically, the cost estimates reflect that future nourishments would be concurrent and therefore realize associated cost savings in the years 2025 and 2035. These are the first two opportunities for nourishments to synchronize after the initial construction in the base year. Results for the LPP include this planning expectation. However, a scenario analysis was also performed with synchronized nourishment during the *last two* potential overlapping cycles in 2048 and 2058 and demonstrates economic justification as well. That scenario analysis is presented in Section 8.

Under the low sea level rise scenario Segment 1 and 2 are expected to produce approximately $2.4 million and $3.0 million coastal storm damage reduction and recreation benefits, respectively, on average annually. Net benefits are approximately $250,000 and $1.4 million, respectively. Detailed costs estimates were only performed on the low sea-level rise scenario; thus, the high-sea level rise scenario is presented with benefits only. Under the high SLR scenario recreation benefits contribute the largest share to the overall growth in benefits while CSDR benefits increase modestly compared to the low SLR scenario in Segment 1. The contribution is more balanced in Segment 2. How detailed cost estimates were developed is explained in Section 6.4 and the Cost Engineering Appendix.

[84] California Coastal Commission findings on 15 August 2013

Table 6.3-1 LPP Plan Selection[85]

Low SLR	SEGMENT 1	SEGMENT 2
Type	Beach Fill	Beach Fill
Initial Added Width	50 ft	150 ft
Initial Volume Dredged	420,000 cy	860,000 cy
Nourishment Interval	5 yr	10 yr
Nourishment Volume Dredged	260,000 cy	350,000 cy
Coastal Storm Damage Reduction Benefits		
CSDR and Full Recreation – expected value	$2,395,000	$2,965,000
CSDR and Limited Recreation – expected value	$2,232,000	$2,822,000
CSDR only – expected value	$1,116,000	$1,411,000
Net Annual Benefits[86]		
CSDR and Full Recreation – expected value/ prob>0	$247,000 64%	$1,350,000 99%
CSDR and Limited Recreation – expected value/ prob>0	$84,000 51%	$1,206,000 82%
CSDR only – expected value/ prob>0	-$1,032,000 3%	-$204,000 38%
Standard Deviation	*531,000*	*683,000*
BCR		
CSDR and Full Recreation – expected value	1.11	1.84
CSDR and Limited Recreation – expected value	1.04	1.75
CSDR only – expected value	0.52	0.87
High SLR	**SEGMENT 1**	**SEGMENT 2**
Type	Beach Fill	Beach Fill
Initial Added Width	50 ft	150 ft
Initial Volume Dredged	470,000 cy	970,000 cy
Nourishment Interval	5 yr	10 yr
Nourishment Volume Dredged	330-400,000 cy	500-600,000 cy
Benefits		
CSDR and Full Recreation – expected value	$4,677,000	$3,651,000
CSDR and Limited Recreation – expected value	$3,197,000	$3,651,000
CSDR only – expected value	$1,598,000	$1,972,000
Net Annual Benefits – NOT AVAILBLE, NO DETAILED COST ESTIMATE		
BCR– NOT AVAILBLE, NO DETAILED COST ESTIMATE		

6.4 <u>Detailed Cost Estimate for the NED and Recommended Plans</u>

Cost engineering performed a formal risk analysis in compliance with *Engineer Regulation (ER) 1110-2-1302 Civil Works Cost Engineering* for the Recommended Plan and NED plan.

[85] Current price levels, detailed cost estimate, and current discount rate
[86] While benefits are calculated stochastically, costs are deterministic. This limits the accuracy when estimating the probability net benefits are greater than zero (prob>0). Probabilities should be used for comparison purposes only.

The purpose is to identify and measure cost and schedule impact of project uncertainties. This analysis determined construction cost risk is the main source of uncertainty and specifically sand volumes, fuel prices, mitigation, and bidding climate. More information about the project risk and schedule analysis is available in *Appendix F – Cost Engineering*.

The Recommended Plan, also referred to as the LPP, and NED Plan were selected using the low sea-level rise scenario but include adaptive management as part of planning. Since nourishments allow for adaption to changing conditions over time, construction can be adjusted to meet the sea-level rise conditions to some extent in the future should the study area experience higher sea lever rise than the low sea-level scenario projections. Thus, the detailed cost estimate performed for the Recommended Plans was developed according to projections for the low sea-level rise scenario but includes contingency that accounts for the possibly of other sea-level rise scenarios to ensure additional resources would be available for higher sea-level rise conditions although not necessarily the highest scenario.

For the purposes of the Economic Analysis the formal risk analysis and Total Project Cost Summary, also performed by Cost Engineering, provide detailed project costs and contingency costs for the recommended and NED plans. For the NED Plan the overall contingency value is $46 million, or 31% of most likely project costs. Most likely project costs are $148 million. Project cost plus contingency totals approximately $194 million—$124 million at Segment 1 (Encinitas) and $70 million at Segment 2 (Solana Beach). Overall, these costs are moderately higher than preliminary estimates used in plan formulation due to higher sand replenishment and overhead cost estimates. See the table below for the cost break-down.

Table 6.4-1 Detailed Cost Estimate for the NED Plans[87]

	Segment 1 (Encinitas)	Segment 2 (Solana Beach)	Total
Sand Replenishment	$83,521,000	$42,109,000	$125,630,000
Mitigation & Monitoring	$6,887,000	$7,856,000	$14,743,000
Lagoon Sedimentation	$4,225,000	$8,186,000	$12,411,000
Land Damages	$306,000	$121,000	$427,000
Pre-Engineering & Design/Construction Mgmt	$29,051,000	$11,889,000	$40,940,000
Total Before IDC	$123,990,000	$70,161,000	$194,151,000
Interest During Construction (current discount rate)	$103,000	$127,000	$230,000
Total	$124,093,000	$70,288,000	$194,381,000

These costs, which occur throughout the study period, were separated in to the year incurred and discounted at the current federal discount rate of 3.375% to calculate Net Present Value (NPV). Finally, the NPV was annualized (amortized) and presented in **Table 6.4-2** at the current discount rate and in **Table 6.4-3** at the 7% rate.

[87] Current price levels, undiscounted

Table 6.4-2 ER 1105-2-100 Appendix H - Economic Table for NED Plan, Current Discount Rate

Equivalent Annual Benefits and Costs Solana Beach-Encinitas Coastal Storm Damage Reduction Feasibility Study FY2015 Price Levels, 50-year Period of Analysis, 3.375% Discount Rate			
	Segment 1 (Encinitas)	Segment 2 (Solana Beach)	Total
Investment Costs			
Total Project Construction Costs	$123,990,000	$70,161,000	$194,151,000
Interest During Construction	$103,000	$127,000	$230,000
Total Investment Cost	$124,093,000	$70,288,000	$194,381,000
NPV of Investment Cost	$ 65,411,000	$ 42,872,000	$108,283,000
Average Annual Costs			
Interest and Amortization of Initial Investment	$2,726,000	$1,787,000	$4,513,000
OMRR&R	$0	$0	$0
Total Average Annual Costs	$2,726,000	$1,787,000	$4,513,000
Average Annual Benefits	$4,021,000	$3,562,000	$7,583,000
Net Average Annual Benefits	$1,295,000	$1,775,000	$3,070,000
Benefit-Cost Ratio	1.48	1.99	1.68

Table 6.4-3 ER 1105-2-100 Appendix H - Economic Table for NED Plan, 7% Discount Rate[88]

Equivalent Annual Benefits and Costs Solana Beach-Encinitas Coastal Storm Damage Reduction Feasibility Study FY2015 Price Levels, 50-year Period of Analysis, 7% Discount Rate			
	Segment 1 (Encinitas)	Segment 2 (Solana Beach)	Total
Investment Costs			
Total Project Construction Costs	$123,990,000	$70,161,000	$194,151,000
Interest During Construction	$214,000	$265,000	$479,000
Total Investment Cost	$124,255,000	$70,375,000	$194,630,000
NPV of Investment Cost	$ 42,023,000	$ 31,849,000	$73,872,000
Average Annual Costs			
Interest and Amortization of Initial Investment	$3,045,000	$2,308,000	$5,353,000
OMRR&R	$0	$0	$0
Total Average Annual Costs	$3,045,000	$2,308,000	$5,353,000
Average Annual Benefits	$4,285,000	$3,774,000	$8,059,000
Net Annual Benefits	$1,240,000	$1,466,000	$2,706,000
Benefit-Cost Ratio	1.41	1.64	1.51

[88] Per Executive Order 12893

The same procedure was repeated for the LPP, which is the Recommended Plan. The overall contingency value is $39 million, or 31% of most likely project costs. Most likely project costs are $126 million. Project cost plus contingency totals approximately $165 million—$100 million at Segment 1 (Encinitas) and $65 million at Segment 2 (Solana Beach).

Table 6.4-4 Detailed Cost Estimate for LPP (Recommended Plan)

	Segment 1 (Encinitas)	Segment 2 (Solana Beach)	Total
Sand Replenishment	$65,787,000	$39,039,000	$104,826,000
Mitigation & Monitoring	$6,647,000	$7,735,000	$14,382,000
Cultural Resources	$42,000	$0	$42,000
Lagoon Sedimentation	$1,872,000	$6,356,000	$8,228,000
Land Damages	$276,000	$121,000	$397,000
Pre-Engineering & Design/Construction Mgmt	$25,560,000	$11,457,000	$37,017,000
Total Before IDC	$100,184,000	$64,708,000	$164,892,000
Interest During Construction (current discount rate)	$72,000	$105,000	$177,000
Total	$100,256,000	$64,813,000	$165,069,000

These costs, which occur throughout the study period, were separated in to the year incurred and discounted at the current federal discount rate of 3.375% to calculate Net Present Value (NPV). Finally, the NPV was annualized (amortized) and presented in **Table 6.4-5** at the current rate and in **Table 6.4-6** at the 7% rate.

Table 6.4-5 ER 1105-2-100 Appendix H - Economic Table for LPP (Recommended Plan), Current Discount Rate

Equivalent Annual Benefits and Costs Solana Beach-Encinitas Coastal Storm Damage Reduction Feasibility Study FY2015 Price Levels, 50-year Period of Analysis, 3.375% Discount Rate			
	Segment 1 (Encinitas)	Segment 2 (Solana Beach)	Total
Investment Costs			
Total Project Construction Costs	$100,184,000	$64,708,000	$164,892,000
Interest During Construction	$72,000	$105,000	$177,000
Total Investment Cost	$100,256,000	$64,813,000	$165,069,000
NPV of Investment Cost	$51,550,000	$38,756,000	$90,306,000
Average Annual Costs			
Interest and Amortization of Initial Investment	$2,148,000	$1,615,000	$3,763,000
OMRR&R	$0	$0	$0
Total Average Annual Costs	$2,148,000	$1,615,000	$3,763,000
Average Annual Benefits	$2,395,000	$2,965,000	$5,360,000
Net Average Annual Benefits	$247,000	$1,350,000	$1,597,000
Benefit-Cost Ratio	1.11	1.84	1.42

Table 6.4-6 ER 1105-2-100 Appendix H - Economic Table for Recommended Plan (LPP), 7% Discount Rate[89]

Equivalent Annual Benefits and Costs Solana Beach-Encinitas Coastal Storm Damage Reduction Feasibility Study FY2015 Price Levels, 50-year Period of Analysis, 7% Discount Rate			
	Segment 1 (Encinitas)	Segment 2 (Solana Beach)	Total
Investment Costs			
Total Project Construction Costs	$100,184,000	$64,708,000	$164,892,000
Interest During Construction	$149,000	$218,000	$367,000
Total Investment Cost	$100,403,000	$64,856,000	$165,259,000
NPV of Investment Cost	$32,361,000	$28,284,000	$60,645,000
Average Annual Costs			
Interest and Amortization of Initial Investment	$2,345,000	$2,049,000	$4,394,000
OMRR&R	$0	$0	$0
Total Average Annual Costs	$2,345,000	$2,049,000	$4,394,000
Average Annual Benefits	$2,509,000	$3,124,000	$5,633,000
Net Annual Benefits	$164,000	$1,075,000	$1,239,000
Benefit-Cost Ratio	1.07	1.52	1.28

[89] Per Executive Order 12893

7 UNCERTAINTY AND RESIDUAL RISK

7.1 Major Sources & Analysis of Uncertainty

The *Planning Guidance Notebook* states, "Uncertainty and variability are inherent in water resource planning…Therefore, the consideration of risk and uncertainty is important in water resource planning."[90] To accomplish this objective the Economic modeling included Monte Carlo simulation techniques to ensure the damages from episodic erosion events were defined by probability distributions rather than deterministic values. In addition the coastal storm damage that could be theoretically prevented was compared to the damage we expect to be prevented by construction of the NED Plan and LPP (Recommended Plan).

To the extent possible economic modeling incorporated major sources of economic uncertainty including (1) variability in the cost of seawall construction, (2) sea-level rise, (3) the share of parcels that armor in time to prevent structure loss given the episodic nature of these bluff collapses, and (4) when nourishments at Segment 1 and 2 can be synchronized.[91]

1. Much of the uncertainty in fixed and variable costs of seawall construction has been modeled with probability distributions. To the extent that costs exceed this range or occur with greater probability than modeled at the upper range, project benefits would be overstated and vice versa. A parallel consideration that directly impacts fixed costs of seawall construction is whether groups of owners would collectively construct seawalls to reduce and share fixed costs (consulting, legal, permitting, etc.). If done in this manner the future fixed costs estimated for seawall construction would be moderately lower resulting in lower without project damages and project benefits.
2. Sea-level rise modeling shows that NED plan selection is generally not sensitive and projects at both segments would continue to be justified at the high scenario. Modeling has demonstrated that lower sea-level rise produces less without project damages and consequently fewer potential project benefits while higher sea-level rise increases without project damages and project benefits. Although the cost of nourishment increases as sea level rises, this is outweighed by additional project benefits, meaning there is additional economic justification to construct the Recommended Plans under the high sea-level rise scenario.
3. Many unknown factors impact when and if a parcel owner constructs a seawall in time to protect affected structures. Distance from the bluff edge is one important factor that has been modeled. Other factors such as personal finances, the ability to obtain permits in the future, personal beliefs/preferences, and the unexpected nature of episodic bluff collapse also impacts how many or few owners construct seawalls in a timely manner under without project conditions. These other factors were modeled indirectly by generating retreat and armoring scenarios for without project conditions and weighting these scenarios. The analysis shows that NED plan selection is not sensitive to the weighting assigned to these scenarios, which represent the relative share of owners that armor or allow uncontrolled bluff retreat to occur. While NED plan selection is not altered, net benefits increase when the project is expected to prevent more structure losses (managed retreat) and fewer seawalls (armoring).
4. Joint nourishment at Segment 1 and 2 throughout the study period would result in significant cost savings to mobilize construction equipment. If nourishments are synchronized consistently whenever possible then the cost savings would alter the

[90] The *Planning Guidance Notebook* ER-1105-2-100 section E-4
[91] See Section 8 for scenario and sensitivity analyses done for several important sources of uncertainty.

nourishment intervals for the NED Plan. For planning purposes the LPP nourishments overlap in Segment 1 and 2 four times in addition to the initial nourishment. A reasonable assumption is synchronization on the first two of those four occasions (year 2025 and 2035) and results have been presented with that assumption in Section 6. However, there is uncertainty in future erosion rates and federal and local funding that could push back these synchronized nourishments. A sensitivity analysis was performed with synchronized nourishments during the last two opportunities only (year 2045 and 2055).

In addition to modeling these sources of uncertainty other characteristics of the study area could impact the economic results and potentially alter the investment decision for this Feasibility study such as the variability in land and structure values, how intensively study area beaches will be utilized in the future, the economic value of recreation today and in the future, the impact to life-safety and its relationship to episodic bluff collapse, and the performance and longevity of sand nourishments. Many of these causes of uncertainty could increase or decrease the economic benefits or costs but be addressed potentially through adaptive management to ensure major project objectives like life-safety and coastal storm damage reduction continue to be met.

7.2 Major Sources & Analysis of Risk[92]

Risks from the LPP, also referred to as the Recommended Plan, include life-safety risk from collapsing bluff tops given the uncertainty around processes that cause and can halt episodic bluff collapse—the Recommended Plan has been formulated to reduce life-safety risk but does not purport to eliminate this completely. Risk also stems from the variability in the authorization, appropriation, and ultimate construction schedule for the project. The consequences of delay construction include unanticipated damages from structure loss/collapse as well as injury or death from falling debris. Finally, risk also includes coastal storm damages, which is a combination of the likelihood and consequence of continued land loss, potential structure loss, and seawall construction that the NED plan and LPP reduce but do not completely halt.

One important proxy for life-safety and coastal storm damage risk is how much preventable bluff erosion is decreased by the Recommended Plan. *Preventable bluff erosion damages* result from episodic bluff erosion occurring under without project conditions after being adjusted to remove damages due to sloughing at the bluff top edge, which would not be prevented by any of the alternatives formulated because that was determined to be outside the Federal interest of civil works projects.[93] *Preventable bluff erosion damages* are also referred to as the *maximum potential Coastal Storm Damage Reduction (CSDR) benefit,* since they are the theoretical limit in benefits an alternative could achieve. **Table 7.2-1** gives indicators of the residual risk and uncertainty for the NED Plans. The maximum potential CSDR benefit under the low sea-level rise scenario is $2.9 million in Segment 1 and $3.1 million in Segment 2 with standard deviation $290,000 and $504,000, respectively. The NED Plan achieves $1.97 million in reduced bluff erosion damages for Segment 1 and $1.70 million for Segment 2, which averages 68% and

[92] FY 2014 price levels and discount rates shown. Residual risk percentages, relative risk, and all conclusions about risk are unchanged by price level and discount rate.

[93] These sloughing damages are not preventable from the perspective of the US Army Corps of Engineers because they are outside the Federal interest for civil works projects. However, other individuals or entities could construct features on the bluff edge to prevent/reduce these sloughing damages.

55% of the maximum potential CSDR benefits, respectively. The LPP achieves $1.11 million and $1.37 million, respectively, which averages 38% and 44% of the maximum potential CSDR benefits. The maximum potential CSDR benefits under the high sea-level rise scenario are $3.35 million in Segment 1 and $3.99 million in Segment 2 with standard deviations of $417,000 and $525,000, respectively. Under the high sea-level rise scenario the NED Plan achieves $2.26 million in reduced in bluff erosion damages for Segment 1 and $2.76 million for Segment 2, which averages 68% and 69% of the maximum potential CSDR benefits, respectively. The LPP achieves $1.28 million and $1.76 million, respectively, which averages 38% and 44% of the maximum potential CSDR benefits. Importantly, results are conservative since analysis of risk and uncertainty are based on spring beach profiles when sand density near the base of the bluff is typically lowest. In other words, we expect the sand density to be measurably higher during other seasons each year, which could result in less residual risk than shown.[94]

Prevented bluff erosion damages are the NED Plan coastal storm damage reduction (CSDR) benefits. *Residual Preventable Damages* is the expected amount of damage that could occur with the NED plan or LPP implemented (see **Table 7.2-1**and **Table 7.2-2**, respectively). The *Residual Preventable Damage* as a share of the *Preventable Bluff Erosion Damages* is presented as the average across the study period and the minimum and maximum percentages attained within the nourishment interval. See the tables below for all results.

Table 7.2-1 Residual Risk Indicators & Uncertainty for the NED Plans[95]

	SEGMENT 1		SEGMENT 2	
	Low SLR	High SLR	Low SLR	High SLR
Plan Characteristics				
Duration of Nourishment Interval	5 yr	5 yr	13 yr	14 yr
Initial Added Beach Width	100 ft	100 ft	200 ft	300 ft
Preventable bluff erosion damages/max CSDR Benefits				
Expected Value	$2,910,000	$3,348,000	$3,118,000	$3,990,000
Standard Deviation	*290,000*	*417,000*	*504,000*	*525,000*
Prevented bluff erosion damages/CSDR Benefits				
Expected Value	$1,973,000	$2,262,000	$1,707,000	$2,764,000
Standard Deviation	*665,000*	*779,000*	*650,000*	*858,000*
Residual Preventable Damages, $				
Expected Value	$937,000	$1,086,000	$1,411,000	$1,226,000
Standard Deviation	*597,000*	*684,000*	*574,000*	*714,000*
Residual Preventable Damages, %				
Expected Value, study period	32%	32%	45%	31%
(“Level of Residual Risk”)	19%/36%	19%/36%	35%/52%	17%/40%
Expected Value, min/max				

[94] See Coastal Engineering Appendix for an explanation about why spring profiles were used to estimate project alternative Coastal Storm Damage risk reduction.
[95] FY2014 price level and discount rate applied. *Residual Preventable Damages %* and all conclusions about risk are unchanged by price level and discount rate.

Table 7.2-2 Residual Risk Indicator & Uncertainty for the LPP (Recommended Plan)[96]

	SEGMENT 1		SEGMENT 2	
	Low SLR	**High SLR**	**Low SLR**	**High SLR**
Plan Characteristics				
Duration of Nourishment Interval	5 yr	5 yr	10 yr	10 yr
Initial Added Beach Width	50 ft	50 ft	150 ft	150 ft
Preventable bluff erosion damages/max CSDR Benefits				
Expected Value	$2,910,000	$3,348,000	$3,118,000	$3,990,000
Standard Deviation	*290,000*	*417,000*	*504,000*	*525,000*
Prevented bluff erosion damages/CSDR Benefits				
Expected Value	$1,113,000	$1,277,000	$1,366,000	$1,755,000
Standard Deviation	*533,000*	*622,000*	*578,000*	*726,000*
Residual Preventable Damages, $				
Expected Value	$1,797,000	$2,071,000	$1,752,000	$2,235,000
Standard Deviation	*597,000*	*684,000*	*574,000*	*714,000*
Residual Preventable Damages, %				
Expected Value, overall	62%	62%	56%	56%
Expected Value, yearly min/max	48%/77%	48%/77%	50%/60%	50%/60%

An alternative that results in zero residual damages is unlikely to exist in practice; therefore, an acceptable level of residual preventable damages must exist but is subjective and likely to vary considerably depending on the viewpoint (beach visitors, affected homeowners, local government officials, the USACE-HQ, and so on). However, the relative effectiveness of alternatives is clearer. The NED plan is expected to reduce coastal storm damage risk further than the LPP. This could mean less potential structure loss, land loss, and seawall construction in the study area if the NED Plan is constructed. The LPP would still reduce coastal storm damage risk considerably compared to taking no action but not to the extent of the NED Plan or other more substantial alternatives, which could reduce residual risk further than even the NED Plan. In contrast the LPP may be nearly as effective at reducing life-safety risk. Presently, the shoreline available to recreate is narrow, particularly during high tide, through much of the study area. This encourages recreation closer to the bluff base. Since the LPP would increase the shoreline area compared to the No Action Plan, the public would have more opportunity to stay a safe distance from the bluff base/toe. That means even though the LPP has higher expected coastal storm damage risk than the NED Plan (i.e., is not as effective at preventing coastal storm damage), life-safety risk may be similarly managed by either plan because the public continues to have the opportunity to avoid close proximity to the base of the bluff where many of the deaths and injuries have occurred historically.

As **Figure 7.2-1** and **Figure 7.2-2** show, alternatives were analyzed that reduce preventable damages below 20% to above 90% on average. The NED Plan for Segment 2 falls toward the center of this range (the NED Plan under the high sea-level rise scenario falls toward lowest portion of this range). The NED Plan for Segment 1 falls toward the lower portion of this range. The LPP illustrates the tradeoff between a smaller environmental “footprint” and effective coastal storm damage risk reduction. It is higher up the chart for both segments than the NED Plan indicating greater coastal storm damage risk although not necessarily greater life-safety

[96] FY2014 price level and discount rate applied. *Residual Preventable Damages %* and all conclusions about risk are unchanged by price level and discount rate.

risk as explained above. These estimates are based on spring beach profiles when sand density near the base of the bluff is typically lowest so the residual risk indicators shown here may be toward the higher end of reasonable estimates. Nevertheless, the relative amount of residual damages each alternative is expected to allow can offer insight about the tradeoff between sand density (i.e., larger beach widths) and how alternatives could reduce coastal storm damage risk, particularly under lower sand density conditions in the spring time.

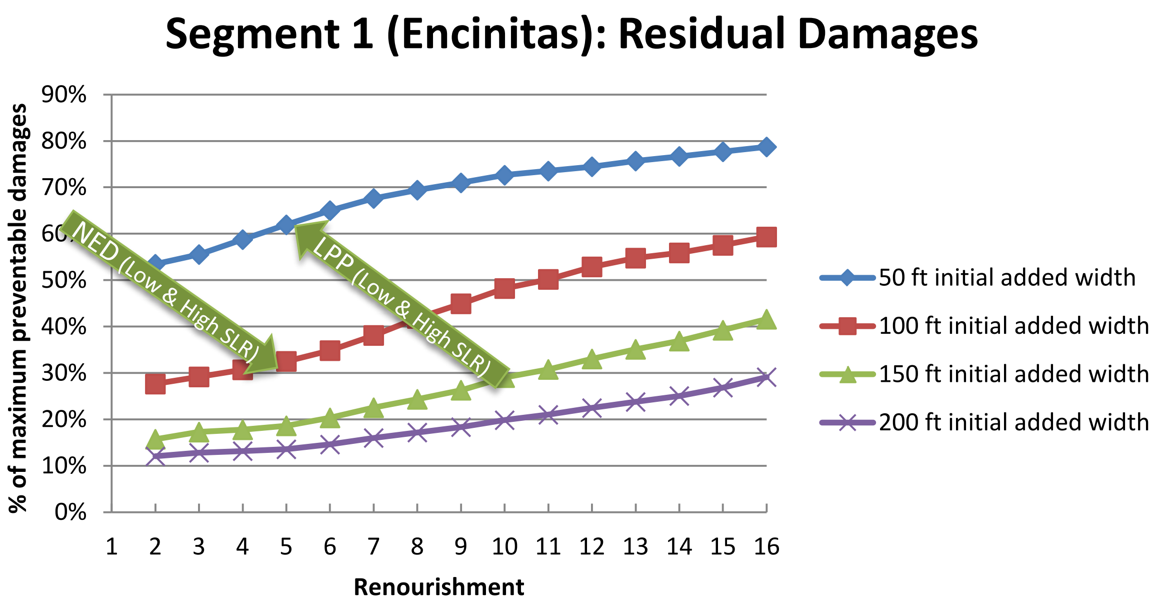

Figure 7.2-1 Residual Preventable Damages as a Share of Total Damages for Encinitas

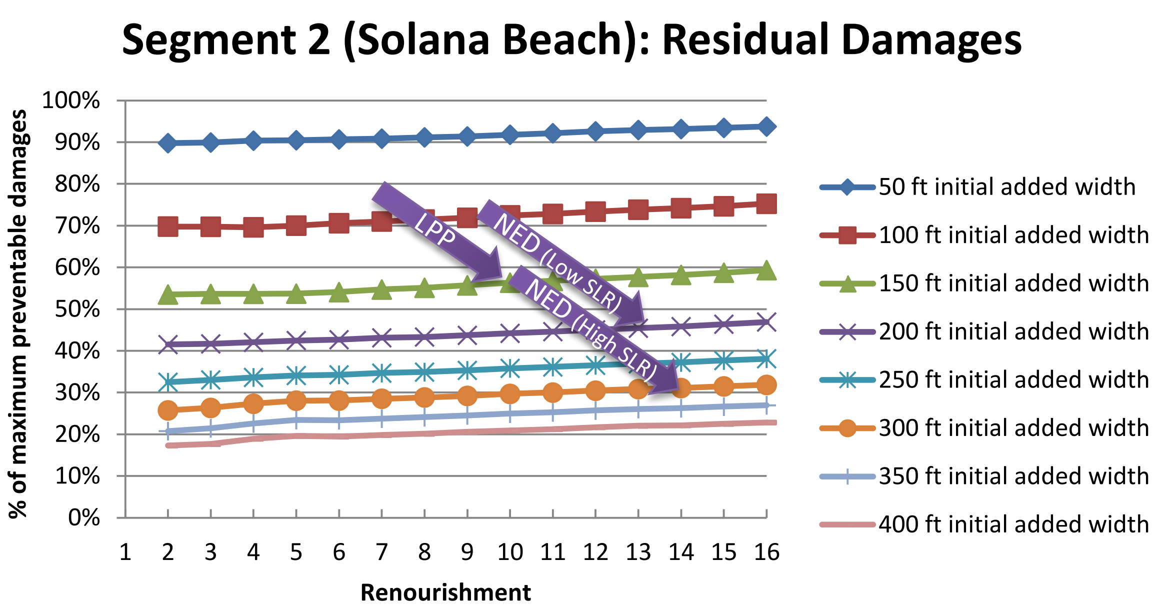

Figure 7.2-2 Residual Preventable Damages as a Share of Total Damages for Solana Beach

8 SCENARIO ANALYSES[97]

8.1 NED Plan Sensitivity to Synchronized Nourishments

8.1.1 Purpose

The purpose of the jointly-synchronized plan analysis is to augment plan selection criteria by determining the optimal set of project alternatives for Segment 1 or Segment 2 if the two segments are planned and constructed jointly to realize cost savings by sharing certain fixed costs through overlapping nourishment intervals. This analysis evaluates all nourishment intervals and added beach widths that can be applied in combination for Segment 1 and Segment 2 to determine the project alternative for Segment 1 and the project alternative for Segment 2 that yields the greatest combined net benefits when both projects can be executed jointly. This scenario relaxes a key assumption used to select the NED Plans—Segment 1 and 2 could not predictably synchronize nourishments to occur jointly due to uncertain future erosion rates and funding during the period of analysis. Instead this scenario relaxes those constraints and allows for synchronization to occur for every possible combination of beach width and nourishment cycle across both segments to determine the most economically beneficial plans that could be jointly constructed. This is an important scenario to analyze because if nourishment intervals overlap there would be substantial savings, primarily by sharing mobilization/demobilization costs.

8.1.2 Procedure

This analysis allows Segment 1 to vary across all possible combinations of added beach width and nourishment while Segment 2 is also allowed to vary across all possible combinations of initial added beach width and nourishment interval. Since both segments are evaluated for the pair of alternatives that generate the maximum combined net annual benefits, fixed construction costs have to be allocated to each segment. Each segment receives 50% of the combined construction equipment mobilization & demobilization costs plus 50% of all associated expenses (supervision & administration, interest during construction, contingency). The 50/50 split is a reasonable approximation of the actual cost allocation for the projects since much of the mobilization and demobilization costs stem from bringing the equipment long distances to the receiver site rather that shifting it a few miles between Encinitas to Solana Beach. Likewise, the duration the equipment would be used at each segment or the intensity of use (amount of dredged sand) has little impact to mobilization/demobilization costs.[98]

8.1.3 Results

Table 8.1-2 shows the combinations of nourishment intervals and initial added beach widths for both segments that yield the highest net annual benefits when we analyze the synchronized nourishment scenario. The ranking starts with the combination that yields the highest combined net benefits from both segments followed by the next nine highest combinations. Under the Synchronizing Scenario, results show the combined net benefits are greatest when the beach is initially extended 100 feet MSL and nourishments occur every 5 years in Segment 1 (the NED Plan) while Segment 2 is extended 200 feet every 10 years (250 feet under the high sea-level

[97] Results based on FY 2012 price levels and preliminary costs estimates unless otherwise indicated.
[98] When each segment is viewed as a stand-alone project, the mob/demob cost excluding contingency and overhead for Segment 1 is $2,586,052 while the cost for Segment 2 is $2,379,818, which also supports the 50/50 cost allocation when nourishments are synched.

rise scenario). To achieve these results both segments would be constructed jointly starting in the base year and then jointly nourished every 10 years later as shown in **Table 8.1-1**.

Table 8.1-1 Synchronizing Nourishments to Maximize Net Benefits

Low SLR		High SLR	
Segment 1	Segment 2	Segment 1	Segment 2
Yr 0	Yr 0	Yr 0	Yr 0
Yr 5		Yr 5	
Yr 10	Yr 10	Yr 10	Yr 10
Yr 15		Yr 15	
Yr 20	Yr 20	Yr 20	Yr 20
Yr 25		Yr 25	
Yr 30	Yr 30	Yr 30	Yr 30
Yr 35		Yr 35	
Yr 40	Yr 40	Yr 40	Yr 40

As noted previously, at this feasibility stage we are unable to determine if synchronizing would occur in practice. However, should nourishment cycles synchronize every 10 years, the commensurate savings from sharing mobilization/demobilization costs and related expenses would be $1.59 million for Segment 1 and $1.28 million for Segment 2 realized and the combined net annual benefits would be higher. Recall we formulated the NED Plans assuming construction at both segments cannot occur jointly except for the base year. In other words that cost savings was not factored in to select the NED Plans. However, when that savings is factored in to all overlapping nourishment cycles and net benefits compared, the NED Plans, which could never overlap during the 50-year study period, would produce the 10th highest net benefits (5th under high SLR) as shown in **Table 8.1-2**. This means that if synchronizing occurs in practice, then we expect constructing the NED Plans at both segments would produce moderately less combined net benefits than constructing the NED Plan at Segment 1 while extending the beach 200 feet at Segment 2 (250ft high SLR) and nourishing every 10 years. This would result in about $160k in increased net benefits compared to implementing the NED Plan at Segment 2. We have also demonstrated that identification of the NED Plan at Segment 1 is not affected by assuming synchronization can or cannot occur across all future nourishment cycles that overlap. In contrast, the NED Plan at Segment 2 would remain 200 feet of added beach width MSL but nourish every 10 years as opposed to every 13 years if synchronizing occurs. Overall the difference in expected net benefits between the NED plan with and without synchronization is modest.

Table 8.1-2 Synchronized Nourishment Analysis: Plans by Highest Combined Net Annual Benefits

Low SLR	Segment 1 (Encinitas)			Segment 2 (Solana Beach)			
RANK	Nourishment Interval	Added Width	Net Benefits	Nourishment Interval	Added Width	Net Benefits	Total NED net benefits
1	5yr	100ft	$1,333,445	10yr	200ft	$882,858	$2,216,303
2	5yr	100ft	$1,277,522	15yr	200ft	$900,790	$2,178,312
3	5yr	100ft	$1,277,522	15yr	250ft	$895,278	$2,172,800
4	5yr	100ft	$1,333,445	10yr	250ft	$835,411	$2,168,856
5	6yr	100ft	$1,242,417	12yr	200ft	$868,593	$2,111,010
6	5yr	100ft	$1,277,522	15yr	300ft	$817,779	$2,095,301
7	5yr	100ft	$1,277,522	15yr	350ft	$817,064	$2,094,586
8	5yr	100ft	$1,333,445	10yr	300ft	$750,358	$2,083,803
9	6yr	100ft	$1,242,417	12yr	250ft	$820,293	$2,062,710
NED Plans 10	5yr	100ft	$1,201,073	13yr	200ft	$859,291	$2,060,365
High SLR	**Segment 1 (Encinitas)**			**Segment 2 (Solana Beach)**			
RANK	Nourishment Interval	Added Width	Net Benefits	Nourishment Interval	Added Width	Net Benefits	Total NED net benefits
1	5yr	100ft	$1,833,038	10yr	250ft	$1,209,783	$3,042,821
2	5yr	100ft	$1,777,115	15yr	250ft	$1,217,779	$2,994,894
3	5yr	100ft	$1,833,038	10yr	300ft	$1,126,067	$2,959,105
4	5yr	100ft	$1,833,038	10yr	200ft	$1,116,853	$2,949,891
NED Plans 5	5yr	100ft	$1,700,416	14yr	300ft	$1,196,398	$2,896,814
6	5yr	100ft	$1,777,115	15yr	300ft	$1,118,795	$2,895,910
7	5yr	100ft	$1,777,115	15yr	300ft	$1,104,536	$2,881,651
8	5yr	100ft	$1,777,115	15yr	400ft	$1,102,333	$2,879,448
9	5yr	100ft	$1,700,416	13yr	300ft	$1,169,807	$2,870,223
10	5yr	100ft	$1,777,115	15yr	200ft	$1,076,167	$2,853,282

8.2 NED Plan Sensitivity to Unit Dredging Cost

Since a large volume of sand would be placed during the 50-year study period, slight changes in unit dredging costs would impact project costs and could potentially impact plan selection. To determine the potential impact to plan selection a sensitivity analysis was performed on a reasonable range of "worst-case" cost estimates per cubic yard of dredged material.

Plans were formulated using dredging costs of $7.62 per cubic yard at Segment 1 and $7.15 per cubic yard at Segment 2 for dredging activity at the primary borrow site closest to the study area. Since that borrow site can be exhausted during the study period, a secondary borrow site was identified considerably farther from the study area. When a beach-fill alternative exhausted the primary borrow site, dredging costs were increased 50% to $11.43 and $10.75, respectively, to account for the added costs of dredging at the secondary borrow site identified by geotechnical experts. This 50% increase in unit dredging costs is expected to cover cost increases from dredging at the secondary site; however, because of uncertainty when establishing that cost increase a sensitivity analysis was performed to determine how plan selection could be impacted by increased dredging costs. The cost increases examined were hypothetical but cover the plausible range unit dredging costs could increase under various worst-case scenarios.

To perform the sensitivity analysis unit dredging costs at the secondary borrow site were increased by 75%. This caused unit costs in Segment 1 to increase from $7.62 at the primary borrow site to $13.33 at the secondary site. In Segment 2 the increase was from $7.15 at the primary site to $12.51 at the secondary site. Next unit costs were increased 100% such that the secondary borrow site increased unit dredging costs in Segment 1 to $15.24 and $14.30 in Segment 2.

The impact from increasing unit dredging costs on plan selection is shown in **Table 8.2-1** below. Plan selection is not impacted by this increase from 50% to 75% of fill cost. The NED Plan for Segment 1 is also unaffected when unit dredging costs at the secondary site increase 100%; however, the NED Plan changes to 200 feet of added beach width MSL nourished every 13 years at Segment 2 under the high sea-level rise scenario only. Under the low sea-level rise scenario there is no impact to plan selection at either segment. Overall, the impact to net annual benefits is modest; typically a 25% point increase in unit dredging costs at the secondary borrow site reduces annualized net benefits $25-75,000. In all cases the expected net annual benefits continue to be strongly positive.

Table 8.2-1 NED Plan Sensitivity to Unit Dredging Costs

Low SLR	Segment 1			Segment 2		
Dredging cost increase	***Baseline/ 50%***	***75%***	***100%***	***Baseline/ 50%***	***75%***	***100%***
Net Annual Benefits	1,201,000	1,175,000	1,146,000	860,000	831,000	795,000
NED Plan Altered?	--	NO	NO	--	NO	NO
NED Plan	100ft/5yr	100ft/5yr	100ft/5yr	200ft/13yr	200ft/13yr	200ft/13yr
High SLR	**Segment 1**			**Segment 2**		
Dredging cost increase	***Baseline/ 50%***	***75%***	***100%***	***Baseline/ 50%***	***75%***	***100%***
Net Annual Benefits	1,700,000	1,621,000	1,538,000	1,196,000	1,129,000	1,071,000
NED Plan Altered?	--	NO	NO	--	NO	YES
NED Plan	100ft/5yr	100ft/5yr	100ft/5yr	300ft/14yr	300ft/14yr	200ft/13yr

8.3 NED Plan Sensitivity to Armoring & Retreat Scenario Weighting

Recall that without project damages were determined by weighting two scenarios. First, the *Armoring Scenario* assumes all owners threatened by structure failure/collapse are able to construct seawalls in time. Second, the *Retreat Scenario* assumes these same owners are unable to construct seawalls in time and the first row of structures collapse given enough bluff erosion. Since with Project Benefits are determined by the reduction in without project damages, the *Armoring* and *Retreat Scenario* damages have to be combined to determine the amount of preventable without project damages (i.e. the with-project maximum CSDR benefits). Therefore, these scenarios are weighted by the probability of occurrence to determine the expected value.

Weighting was determined by combining the probability of unpreventable structure loss due to bluff collapse with the probability of financial, political, and personal factors inhibiting seawall construction prior to structure loss.[99] Since both probabilities have inherent uncertainty, a sensitivity analysis with weightings above and below the baseline was performed. The baseline weighting used for plan selection is shown in the table below along with sensitivity analyses done by adding and subtracting 10 percentage points to that baseline weighting.

Table 8.3-1 Retreat Scenario Weighting Sensitivity

	Baseline		+10% Sensitivity		-10% Sensitivity	
	Low SLR	High SLR	High SLR	High SLR	High SLR	High SLR
Segment 1	18%	20%	28%	30%	8%	10%
Segment 2	22%	29%	32%	39%	12%	19%

The baseline *Retreat Scenario* weighting is 18-20% for Segment 1 and 22-29% for Segment 2 depending upon the sea-level rise scenario. Conversely, the *Armoring Scenario* weighting is 80-82% for Segment 1 and 71-78% for Segment 2 since its weighting is one minus *Retreat Scenarios* weighting. *Retreat Scenario* involves greater damages than *Armoring Scenario* because structures can be lost. As a result increasing the *Retreat Scenario* weighting increases the without project damages, which in turn increases the maximum Coastal Storm Damage Reduction (CSDR) benefits any given project alternative can achieve. Decreasing the *Retreat Scenario* weighting has the opposite effect—lower CSDR benefits. When the *Retreat Scenario* weighting is increased by 10 percentage points (+10% Sensitivity) then Segment 1 weighting increases to 28-30% and Segment 2 increases to 32-39% with a corresponding decrease in *Armoring Scenario* weighting. This increased weighting on *Retreat Scenario* could be explained by higher than expected constraints on constructing a seawall in time to prevent structure collapse. In contrast if constraints to building a seawall in time were much less than expected, the *Retreat Scenario* should be weighted lower such as shown in the "-10% Sensitivity" that sharply reduces the impact from the *Retreat Scenario* on plan selection.

The results of this sensitivity analysis show that plan selection is not affected by sizeable changes to the weighting assigned to the *Retreat Scenario*. In other words the optimal beach width and nourishment interval for Segment 1 and Segment 2 are unaffected while the net annual benefits increase moderately when the retreat scenario weighting is increased 10-percentage points and decreases moderately when the weighting is decreased 10-percentage points.

[99] See *Weighting Armoring & Retreat Scenarios* earlier in this document for further explanation.

Table 8.3-2 NED Plan Sensitivity Retreat Scenario Weighting

Low SLR	Segment 1			Segment 2		
Retreat Weighting	***Baseline***	***+10%***	***-10%***	***Baseline***	***+10%***	***-10%***
Net Annual Benefits	1,201,000	1,220,000	1,184,000	860,000	947,000	764,000
NED Plan Altered?	--	NO	NO	--	NO	NO
NED Plan	100ft/5yr	100ft/5yr	100ft/5yr	200ft/13yr	200ft/13yr	200ft/13yr
High SLR	**Segment 1**			**Segment 2**		
Retreat Weighting	***Baseline***	***+10%***	***-10%***	***Baseline***	***+10%***	***-10%***
Net Annual Benefits	1,701,000	1,805,000	1,594,000	1,196,000	1,334,000	1,032,000
NED Plan Altered?	--	NO	NO	--	NO	NO
NED Plan	100ft/5yr	100ft/5yr	100ft/5yr	300ft/14yr	300ft/14yr	300ft/14yr

8.4 LPP Results Sensitivity to Timing of Synchronized Nourishments[100]

The LPP nourishment cycle occurs every 5 years for Segment 1 and every 10 years for Segment 2. That allows nourishments to overlap four times during the study period plus once during the initial fill. Because of future uncertainty, the expectation is nourishments will synchronize during half of the future overlapping cycles plus the initial cycle resulting in savings from equipment mobilization and some overhead expenses. The results presented in Section 6 assume the synchronized nourishments occur in year 2025 and 2035 only. However, if nourishments do not occur in those years but instead occur during the last two overlapping cycles in 2045 and 2055 the net benefits remain greater than zero and benefit-cost ratios are above one as shown in **Table 8.4-1**. The results clearly demonstrate that the LPP is economically justified whether the two synchronized nourishments occur early or later in the study period. In addition, sensitivity analysis shows that if none of the future nourishments can be synchronized then Segment 1 is marginally unjustified but Segment 2 is justified.

[100] FY15 price levels and discount rate with FY2015 detailed cost estimates produced in October 2014—will not match FY15 price levels produced in March 2015. However, the detailed cost estimate produced March 2015 is slightly lower than the estimate produced in October 2014, which means net benefits and benefit-cost ratios shown would be marginally higher with March 2015 price levels. Conclusions drawn from the sensitivity analysis would remain unchanged.

Table 8.4-1 LPP Results and Timing of Synchronized Nourishments ($1,000s)

	Synch Year 2025 & 2035		Synch Year 2045 & 2055	
	Segment 1	Segment 2	Segment 1	Segment 2
Cost Total (undiscounted)	$100,898	$65,084	$100,898	$65,084
Cost Annualized - Current Rate	$2,164	$1,625	$2,203	$1,657
Cost Annualized - 7%	$2,362	$2,061	$2,424	$2,113
Benefits CSDR - Current Rate	$1,116	$1,405	$1,116	$1,405
Benefits CSDR - 7%	$1,440	$1,721	$1,440	$1,721
Benefits Recreation - Current Rate	$1,279	$1,555	$1,279	$1,555
Benefits Recreation - 7%	$1,069	$1,403	$1,069	$1,403
Benefits Annualized - Current Rate Limited Rec Ben	$2,232	$2,811	$2,232	$2,811
Benefits Annualized - 7% Limited Rec Ben	$2,509	$3,124	$2,509	$3,124
Benefits Annualized - Current Rate	$2,395	$2,960	$2,395	$2,960
Benefits Annualized - 7%	$2,509	$3,124	$2,509	$3,124
Net Benefits - Current Rate Limited Rec Benefits	$68	$1,186	$29	$1,153
Net Benefits - 7% Limited Rec Benefits	$147	$1,063	$85	$1,011
Net Benefits - Current Rate	$231	$1,335	$192	$1,303
Net Benefits - 7%	$147	$1,063	$85	$1,011
BCR - Current Rate Limited Recreation Benefits	1.03	1.73	1.01	1.70
BCR - 7% Limited Recreation Benefits	1.06	1.52	1.03	1.48
BCR - Current Rate	1.11	1.82	1.09	1.79
BCR - 7%	1.06	1.52	1.03	1.48

9 RED ANALYSIS[101]

9.1 Regional Economic Development from Project Expenditures

9.1.1 Purpose

"The regional economic development (RED) account registers changes in the distribution of regional economic activity that result from each alternative plan. Evaluations of regional effects are to be carried out using nationally consistent projections of income, employment, output and population."[102] The RED account displays information not analyzed in other accounts in the feasibility report that could have a "material bearing on the decision-making process."[103]

The RED account is born out of the difference in perspectives between the Federal government and local communities directly impacted by water resource planning. The Federal objective in water resource planning is contributing to national economic development and the Federal perspective is the nation as a whole. Local communities and regions directly impacted by water resource planning may consider impacts at the state, regional, or local level a more relevant measure. From the Federal perspective transferring employment opportunities and resources from one region of the nation to another to construct a water resource project does not in itself constitute national economic development and therefore regional economic impacts may not be fully captured in the national economic development (NED) account. However, from a regional or local perspective the transfer of employment opportunities and resources to construct a project in that region, as opposed to some other region of the United States, can be a significant benefit to the local economy in terms of more local employment, more local spending, and more local production. This is why the different perspectives between the Federal government and local communities impacted by water resource projects are addressed in different accounts. The Federal perspective is addressed principally in the NED account while the regional or local perspective is addressed principally in the RED account.

9.1.2 Process

To perform an economic analysis from the regional perspective (RED account), several different impacts from constructing the water resource project have to be analyzed. These impacts are termed direct, indirect, and induced effects.

i) *Direct effects* are "immediate effects associated with the change in total sales for a particular industry. In other words…the proportion of the expenditure in each industry that flows to material and service providers in that region."[104] Stated simply, these are the direct impacts to employment and income due to the demand for goods and services to complete construction (e.g. construction equipment and labor). The region is typically defined by political rather than economic or geographic

[101] Total project costs were updated twice in FY15—in October 2014 and March 2015. This section reflects updated costs from October 2014, which are slightly different than March 2015 costs presented earlier in this document. However, the difference in costs is minimal and the results presented in this section continue to be reasonable estimations. All conclusions drawn from those results remain valid.
[102] *Economic and Environmental Principles for Water and Related Land Resources Implementation Studies*, 1983
[103] Ibid
[104] *Regional Economic Development (RED) Procedures Handbook* 2011-RPT-01, March 2011

boundaries. Political boundaries are broken down to state and county or metropolitan area for analysis.

ii) *Indirect Effects* are changes in inter-industry purchases in response to new demand from the directly affected industries. In other words the supply of materials and services to meet the needs of the companies or individuals directly engaged in constructing the project (e.g. concrete suppliers).

iii) *Induced effects* are "changes in spending patterns [from] increases in income to directly and indirectly affected industries."[105] Stated simply, this is the increased spending on local goods and services such as restaurants, grocery stores, hotels, and gas stations due to the direct and indirect effects of the project.

The impact from spending to construct the project is shown in **Figure 9.1-1**. First the direct effects from hiring a construction firm to complete the project are experienced, then that firm purchases supplies and services from other firms to complete the project causing indirect effects.

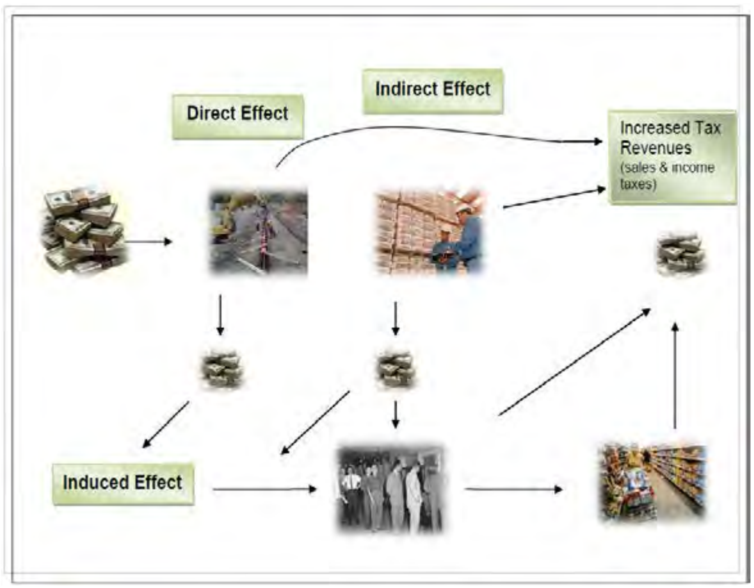

Figure 9.1-1 Process to Evaluate Regional Economic Development

Finally, both direct and indirect effects contribute to induced spending at local retailers, restaurants, convenience stores, etc. This leads local retailers, restaurants, convenience stores, and so on to purchase more goods and services and perhaps hire additional workers. At the same time all this cycling of dollars also leads to increased tax revenue. This cycle continues until the additional dollars are no longer in circulation in the regional economy due to leakages. Leakages occur when goods and services with value added outside of the region are purchased (e.g. purchased clothing that was manufactured in Asia or consulting services from a firm located and engaged in business activity primarily outside the region). The graphic below illustrates the concepts of direct, indirect, and induced effects.

The direct, indirect, and induced effects are estimated through multipliers, which can be thought of, figuratively, as money multiplying throughout the regional economy. A portion of the money spent on construction equipment and labor (direct effect) gets re-spent on construction supplies

[105] Ibid

(indirect effect) and a portion of the money from both is re-spent on local restaurants and gas stations (induced effect). Economists have used regression analysis on historical spending data to estimate how much spending and re-spending varies when there is an economic stimulus to the region through various construction projects. This produces the "multipliers" that are applied to the initial construction spending (i.e. cost of constructing the project) to estimate the direct, indirect, and induced effects of the project studied in this feasibility report.

In addition to the regional benefits from direct, indirect, and induced spending on constructing the project there are also benefits from increased recreation demand from non-locals and tax benefits to the local and state economy from preserving property tax receipts since episodic erosion events causing property loss would be markedly reduced once the project is constructed. These are called forward linkages since they link the construction project to the regional "consumers" of the outputs from this coastal storm damage reduction project, which are decreased land loss resulting in the preservation of property tax receipts as well as increased recreational opportunities resulting in more tourist spending. This contrasts with backward linkages from the construction firm to its suppliers captured in the "money multipliers" described earlier and analyzed in this section.

9.1.3 Analysis

The RECONS model was used to estimate the direct, indirect, and induced effects of the LPP and NED Plan for Segment 1 and 2 based on construction cost estimates. This model generates regional construction multipliers based on the USACE business lines (navigation, flood mitigation, water storage & supply, etc). Each business line is subdivided into numerous work activities, which improves the accuracy of the estimates for regional and national job creation, and retention and other economic measures such as income, value added, and sales. For this analysis the business line is *navigation* and the work activity is *hopper dredging*. Next the USACE construction expenditures including local sponsor cost share were adjusted to remove certain costs not associated with direct construction expenditure.[106] Based on this adjustment **Table 9.1-1** shows that the NED Plan direct expenditures are $122 million in Segment 1 and $69 million in Segment 2.[107] **Table 9.1-2** shows that the LPP direct expenditures are $98 million and $63 million, respectively. When discounted to the current period to account for the timing of those expenditures, this translates to $63 million and $42 million of construction expenditure for Encinitas and Solana Beach, respectively, with the NED plan while the LPP would generate $50 million and $38 million, respectively.

Table 9.1-1 NED Plan Construction Expenditure (constant FY2015 dollars)

	Segment 1 - Encinitas	Segment 2 – Solana Beach
Period of Expenditure	2018-2068	2018-2068
Cost (undiscounted)	$124,844,000	$70,561,000
NPV Total	**$65,860,000**	**$43,113,000**

[106] Interest During Construction, which accounts for the opportunity cost of capital used during construction.
[107] Construction expenditures are held at current price levels, not inflated. Actual expenditures in nominal amounts would be higher.

Table 9.1-2 LPP Plan Construction Expenditure (constant FY2015 dollars)

	Segment 1 - Encinitas	Segment 2 – Solana Beach
Period of Expenditure	2018-2068	2018-2068
Cost (undiscounted)	$ 100,898,000	$ 65,084,000
NPV Total	**$ 51,921,000**	**$ 38,980,000**

Since construction expenditures occur across a 50-year period and at different points throughout that study period depending on the Segment analyzed, discounted values were inputted in the RECONS model to account for the differences in the timing of expenditures. Consequently, results presented in section 9.1.4 estimate regional economic development in today's dollars.

9.1.4 Results

Figure 9.1-2 Regional Level of Analysis (San Diego County)

Results are presented for the region, state, and nation. The region consists of San Diego County shown in **Figure 9.1-2**, which includes the study area within Encinitas and Solana Beach. This means regional impacts that have been measured accrue within San Diego County but not specifically in the communities of Solana Beach and Encinitas. The state-level impacts shown in **Figure 9.1-3** are for California and the national impacts are for the contiguous United States. Since construction expenditures would occur over a 50-year period, discounting has been used to account for the differences in the timing of expenditures.

Direct impacts (effects) to employment and income due to the demand for goods and services to nourish the beach include fuels sales, equipment manufacturing and repair, transportation, retail/wholesale sales, and labor. These contribute to additional output, additional demand for jobs, and increased value-added to goods and services within San Diego County, the state of California, and the nation as shown in **Table 9.1-2** and **Table 9.1-3**.[108]

Figure 9.1-3 State Level of Analysis (California)

[108] All values discounted to current/today's dollars

Table 9.1-3 Overall Regional Economic Impacts from NED Plan Expenditure

Segment 1 (Encinitas)				
		Regional	State	National
Total Spending (Present Value)		$65,860,000	$65,860,000	$65,860,000
Direct Impact	Output	$6,964,000	$23,257,000	$61,757,000
	Jobs	66	82	674
	Labor Income	$3,361,000	$4,808,000	$32,133,000
	Value Added	$4,574,000	$8,249,000	$37,226,000
Total Impact	Output	$11,797,000	$39,131,000	$158,339,000
	Jobs	98	172	1229
	Labor Income	$5,004,000	$9,992,000	$63,260,000
	Value Added	$7,609,000	$17,423,000	$91,601,000
Segment 2 (Solana Beach)				
		Regional	State	National
Total Spending (Present Value)		$43,113,000	$43,113,000	$43,113,000
Direct Impact	Output	$4,559,000	$15,224,000	$40,427,000
	Jobs	43	54	441
	Labor Income	$2,200,000	$3,147,000	$21,035,000
	Value Added	$2,994,000	$5,400,000	$24,369,000
Total Impact	Output	$7,723,000	$25,616,000	$103,651,000
	Jobs	64	112	804
	Labor Income	$3,276,000	$6,541,000	$41,411,000
	Value Added	$4,981,000	$11,405,000	$59,963,000

Based on these estimated impacts we expect about 109 full-time equivalent (FTE) jobs to be created from direct employment constructing the NED Plan over the period of analysis within the region. Roughly 53 additional FTE jobs should be created by indirect and induced effects that support or compliment that construction effort. The regional capture rate, which is the region's direct output as a share of total spending, is around 11% and reflects the way hopper dredging is typically conducted—crews from outside the region travel with the hopper to the construction site. Since much of the labor and equipment comes from outside the region, we expect the capture rate to be lower as shown. However, from the perspective of the state of California the capture rate is over one-third suggesting that much more of the resources for construction would come from within the state as opposed to within San Diego County. Most of the remaining resources would come from other parts of the United States.

Overall, both projects should lead to $12.5 million in value-added goods and services to the region and about 162 additional job opportunities. Employment growth should be focused in those sectors specializing in maintenance and repair of construction equipment as well as food services, retail, and real estate/accommodations. The impact to the state would be of greater magnitude although less relative importance due to the large size of the California economy. Approximately $28.8 million in value-added goods and services and about 284 jobs would be created state-wide with similar business sectors impacted.

Table 9.1-4 Overall Regional Economic Impacts from LPP Expenditure

Segment 1 (Encinitas)				
		Regional	**State**	**National**
Total Spending (Present Value)		$51,921,000	$51,921,000	$51,921,000
Direct Impact	**Output**	$5,490,000	$18,335,000	$48,686,000
	Jobs[109]	52	65	532
	Labor Income	$2,650,000	$3,790,000	$25,332,000
	Value Added	$3,606,000	$6,503,000	$29,348,000
Total Impact	**Output**	$9,300,000	$30,849,000	$124,827,000
	Jobs	78	135	969
	Labor Income	$3,945,000	$7,878,000	$49,872,000
	Value Added	$5,999,000	$13,736,000	$72,214,000
Segment 2 (Solana Beach)				
		Regional	**State**	**National**
Total Spending (Present Value)		$38,980,000	$38,980,000	$38,980,000
Direct Impact	**Output**	$4,122,000	$13,765,000	$36,552,000
	Jobs	39	48	399
	Labor Income	$1,989,000	$2,846,000	$19,018,000
	Value Added	$2,707,000	$4,882,000	$22,033,000
Total Impact	**Output**	$6,982,000	$23,160,000	$93,715,000
	Jobs	58	102	727
	Labor Income	$2,962,000	$5,914,000	$37,441,000
	Value Added	$4,504,000	$10,312,000	$54,215,000

Based on these estimated impacts we expect about 91 full-time equivalent (FTE) jobs to be created from direct employment constructing the projects at both segments over the period of analysis in the region. Roughly 45 additional FTE jobs should be created by indirect and induced effects that support or compliment that construction effort. The regional capture rate, which is the region's direct output as a share of total spending, is around 11% like the NED Plan.

Overall, both projects should lead to $10.5 million in value-added goods and services to the region and nearly 136 additional job opportunities. Approximately $24 million in value-added goods and services and about 237 jobs would be created state-wide with similar business sectors impacted.

9.2 Regional Economic Development from Increased Recreation

9.2.1 Procedure & Methodology

The previous section focused on the temporary impact from project expenditures to the regional economy. These are called *backward linkages.* This recreation assessment focuses on the

[109] Full-time equivalent (FTE) jobs created during entire study period. Nominal construction expenditures were used to estimate FTEs rather than present value.

long-term impacts to the regional economy from the beach nourishment projects at Segment 1 and 2. These impacts are called *forward linkages* and result from increased spending in recreation and associated sectors of the regional economy. The direct, indirect, and induced effects for forward-linked impacts are identical to those examined for project expenditures (i.e., backward linkages) except the perspective has shifted from temporary construction impacts to longer-term recreation impacts.

i. *Direct effects* are changes in the industries associated directly with recreation and tourism spending, e.g., staying in a hotel.
ii. *Indirect effects are* changes resulting from the tourism industries made to other “backward-linked” industries in the region, e.g., hotel’s purchases of linen supply and utilities.
iii. *Induced effects are* changes resulting from household spending from income earned as a result of visitor spending either directly or indirectly. This could be apartment rentals or retail spending by hotel employees.

Table 9.2-1 Recreation Survey Spending Data

Recreation Survey Data[110]	Encinitas		Solana Beach	
	Share	Amount	Share	Amount
Nonlocal visitors	56.2%	--	64.2%	--
Visits, day trip	75.8%	--	70.8%	--
Visits, overnight	24.2%	--	29.2%	--
Spending per day (all visitors)[111]	--	$87.11	--	$71.78

Since assessing the economic impact from recreation on the region takes a longer-term view, the economic impacts are more sensitive to initial estimates. These estimates include total visitor spending, spending by various categories (motel, restaurants, fuel, retail, etc.), increased demand and spending attributable to the beach nourishment project, and visitor spending in the local area versus spending outside the local area. Recreation surveys done for the cities of Encinitas and Solana Beach revealed the average spending related to trips to the beach and the share spent within the cities versus outside the cities.[112] While useful, the reports from these surveys only show spending in aggregate rather than spending by category, which is needed to estimate impacts to employment, income, and regional output. Consequently, a generic spending pattern was selected for the modeling that was chosen in part to match the aggregate spending shown in these surveys. The economic impact from additional recreation/beach demand was estimated using the Recreation Economic Assessment System (REAS) developed jointly by the Engineer Research and Development Center within the US Army Corps of Engineers and the Department of Park, Recreation, and Tourism Resources at Michigan State University.

Several assumptions had to be made to estimate the economic impacts to the regional economy due to recreation. First we assumed that those living within Encinitas or Solana Beach would spend similar amounts of money locally with or without the project constructed. In other

[110] Ibid
[111] Inflated to current price levels
[112] *Economic Analysis of Beach Spending and the Recreation Benefits of Beaches in the City of Solana Beach* and *Economic Analysis of Beach Spending and the Recreation Benefits of Beaches in the City of Encinitas*, both by Phillip King, Ph.D.

words locals would shift spending from recreation to another sector of the local economy and the net impact of this shift is zero or minimal to the regional economy. As a result recreation by locals was excluded from the analysis and all spending done by these local visitors was not included in the estimated impacts from recreation in either Encinitas or Solana Beach. According to the surveys commissioned by both cities in 2001, the share of beach visits from those living outside of Encinitas was 56% while the share of nonlocal visitors to Solana Beach was 64%. Since this is the most recent, comprehensive survey taken, these percentages were used to adjust the additional demand expected with the beach nourishment project constructed. For instance from the recreation analysis outlined earlier in this document we expect nearly 24,000 additional visits to Segment 1 (Encinitas) in the base year because of the beach nourishment project. Yet of those visits only 56% are from those living outside of Encinitas, meaning only 14,000 additional visits are used for this economic assessment of recreation in the base year. This calculation was done for both cities across all 50 years of the study period to estimate the additional nonlocal visits.

We have assumed that additional demand for recreation at the beach is not materially different under high and low sea-level rise scenarios, which seems reasonable since sea-level rise should only affect recreation supply rather than demand. Another important assumption is that in the absence of recreating at the beach, nonlocal visitors would not engage in a substitute activity such as golf or shopping that also generates economic impacts. This is a necessary assumption given the data we have but does limit the accuracy of the estimates and likely means the economic impacts estimated in this section are at the high-end of reasonable estimates.

We also have assumed that additional beach visits can occur within the study area or transfer to one of several nearby beaches within the region when the combination of beach erosion and crowding deter further visits to the study area beaches. This requires the additional assumption that these transfers have the same spending profile as visitors to the study area. If both assumptions hold then transfers should have the same economic impact to the region as those beach visitors who remain in the study area. However, this does not mean the cities of Solana Beach and Encinitas would not be negatively impacted by transfers to other beaches—obviously both communities would be. Therefore the economic impact to these communities from recreation with the beach nourishment projects constructed should be substantial even though modeling is not precise enough to estimate the specific regional impacts to just those two communities. As a consequence estimates are presented for the region as a whole, which is defined by the REAS model as a 30-mile radius from the study area.

The REAS model requires inputting spending profiles by category (hotel, camping, restaurants, fuel, groceries, etc.) but spending profiles at this level of detail were not available for either city. Surveys only revealed this amount in aggregate across all spending categories, so the generic spending pattern was selected in the REAS model and then each spending category was inflated by the same percent to reach $87 in sales per visit, which is the amount in current price levels from the recreation survey done for Encinitas. The same method was applied to Solana Beach to reach $72 per visit. Multipliers were selected from the Los Angeles region due to the absence of any multipliers in San Diego County.

To determine the total impacts from additional demand for recreation to the regional economy, we compared the demand for beach visits that would occur during the study period without the project constructed and the demand that would occur with the project constructed.[113] The difference is the additional demand attributable to the beach nourishment projects. Next this added demand to recreate was separated using recent survey data in to demand originating locally and non-locally.

Only additional nonlocal demand is used to assess the regional economic impacts once the projects are constructed at Segment 1 and 2. These additional nonlocal visits (demand) are recorded for all 50 years of the study period. Last, the marginal impacts shown in the tables below (Marginal Impacts of Spending and Visits) were applied to those additional visits to determine the regional impacts.

9.2.2 Results

Based on recent survey data in Encinitas each beach visit generates $87 in sales on average. By modeling this in the Recreation Economic Assessment System (REAS) we can estimate how much of those $87 per visit remain or are captured within the region. This capture rate is direct sales divided by total visitor spending and accounts for how much visitor spending is captured by the local economy. For every dollar spent in Encinitas (Segment 1) approximately 90 cents is captured in the region, which means the local capture percentage is about 90%. Since sales are $87 per visit on average, $78 of this total spending is captured within the regional economy.[114] For this modeling the region is defined as a 30 mile radius and roughly approximates the area of San Diego County. This includes the San Diego metropolitan area and contributes to the high share of sales "captured" in the local region. By modeling this in the Recreation Economic Assessment System (REAS) we can estimate how much of those $72 per visit remain or are captured within the region in the same manner that was done for Encinitas. Since sales are $72 per visit on average, $65 of this total spending is captured within the regional economy.

[113] The estimates for beach demand came from the recreation analysis done under with and without project conditions. See *Recreation Analysis With/Without Project* sections earlier in this document for details. Offsite transfers are assumed to transfer to another beach within the region since there are nearby beaches.

[114] The reason 100% of sales are not captured by the regional economy is primarily due to leakages when goods not made in the local region are purchased by visitors. For those goods the retail margins are "captured" only.

Table 9.2-2 Regional Economic Impacts of NED Plans from Increased Recreation

Encinitas (Segment 1)		Annual Impacts
Direct	Personal income	$2,205,000
	Value added	$3,058,000
	Jobs[115]	74
Total	Personal income	$3,781,000
	Value added	$5,825,000
	Jobs	115
Solana Beach (Segment 2)		**Annual Impacts**
Direct	Personal income	$3,096,000
	Value added	$4,305,000
	Jobs	103
Total	Personal income	$5,285,000
	Value added	$8,148,000
	Jobs	161

Recreation analysis indicates demand to recreate at the study area beaches would grow moderately following construction of the NED Plan. Initially this would result in 35,000 added non-local visits in the base year and increase to 180,000 additional visits within the next four years before leveling off at around 230,000 additional visits, which is about a 10% increase above the current number of visitors. Solana Beach is expected to benefit relatively more from the constructed project because it is expected to receive a larger share of these increased visits.

Overall the NED project in Encinitas (Segment 1) should create approximately 115 FTE jobs on an annual basis cumulatively due to the increased spending from beach visitors while the project in Solana Beach should contribute around 161 FTEs to the region as shown in **Table 9.2-2**. **Table 9.2-2** reflects the expected boost to the local economy annually from $3.1 to $4.3 million in direct value added (gross regional product) each year per segment. Personal incomes would grow slightly less at $2-3 million annually per segment.

These increases to income and value-added would accrue across San Diego county but direct impacts (tourism, food & beverage services, and related sectors) would be concentrated to some degree in the cities of Encinitas and Solana Beach. However, these values represent the high end of reasonable estimates because we had to assume that none of this spending by non-local beach visitors would have occurred in the region without the projects constructed at both segments. In reality some spending would have occurred in other sectors of the regional economy adding jobs and increasing personal incomes that should not be attributed to the beach nourishment projects. Nevertheless, the positive impact these projects would have on job creation and overall regional economic development due to increased beach visitations would be unambiguously positive.

[115] Cumulative jobs created over the entire 50-year study period. Since we expect additional recreation demand primarily in the years immediately following initial construction in 2015, the majority of these jobs would be created during that same period.

Table 9.2-3 Regional Economic Impacts of LPP Plans from Increased Recreation

Encinitas (Segment 1)		Annual Impacts
Direct	**Personal income**	$1,447,000
	Value added	$2,007,000
	Jobs[116]	55
Total	**Personal income**	$2,482,000
	Value added	$3,824,000
	Jobs	86
Solana Beach (Segment 2)		**Annual Impacts**
Direct	**Personal income**	$2,640,000
	Value added	$3,670,000
	Jobs	88
Total	**Personal income**	$4,506,000
	Value added	$6,947,000
	Jobs	138

The LPP was similarly analyzed. Demand to recreate would grow moderately following construction of the LPP. Initially this would result in 30,000 added non-local visits in the base year and increase to 100,000 additional visits within the next four years before leveling off at around 190,000 additional visits, which is about an 8% increase above the current number of visitors. Solana Beach is expected to benefit relatively more from the constructed project because it is expected to receive a larger share of these increased visits.

Overall the LPP in Encinitas (Segment 1) should create approximately 86 FTE jobs cumulatively throughout the region due to the increased spending from beach visitors while the project in Solana Beach should contribute around 138 FTEs as shown in **Table 9.2-3**. **Table 9.2-3** reflects the expected boost to the local economy annually from $2.0 to $3.7 million in direct value added (gross regional product) each year per segment. Personal incomes would grow slightly less at $1.5-2.5 million annually per segment.

[116] Cumulative jobs created over the entire 50-year study period. Since we expect additional recreation demand primarily in the years immediately following initial construction in 2015, the majority of these jobs would be created during that same period.

10 OSE ANALYSIS

10.1 Purpose

Most water and land resource plans have beneficial and adverse effects on social well-being. These effects reflect a highly complex set of relationships and interactions between inputs and outputs of a plan and the social and cultural setting in which these are received and acted upon. These effects will be reported as appropriate in the system of accounts for each alternative plan. The OSE account is a means of displaying and integrating into water resource planning information on alternative plan effects from perspectives that are not reflected in the other three accounts.[117]

[New guidance] greatly increases the emphasis and potential application of the OSE account by stating all four accounts (NED, EQ, RED and OSE) will be considered in project analysis and decision making.[118]

The Other Social Effects (OSE) account analyzes the LPP, also referred to as the Recommended Plan, and NED Plan effects on social aspects of the communities of Solana Beach and Encinitas. This is contrasted with the effects from no action or without project plan. A number of indicators can be used to analyze Other Social Effects. For this study life-safety, social vulnerability & resiliency, emergency preparedness, displacement to population, and community cohesion & social connectedness were evaluated for impacts. After determining the extent of any impacts, life-safety, social vulnerability & resiliency, community cohesion were analyzed further due to the moderate to high probability the Recommended Plan and NED Plan alter these indicators compared to the No Action Plan.

10.2 Dimensions of Interest

10.2.1 Life-Safety

A basic human need is for personal and group safety. Conditions that are seen as unsafe or unhealthy create personal stress and dissatisfaction among those affected. The level of perceived risk associated with conditions or alternatives is also a factor in determining satisfaction.[119]

Both communities have been subject to repeated bluff collapse resulting in property damage, large debris falling on the beach, and even loss of life. According to the Coastal Engineering analysis, if no action is taken bluff failures will continue with increased frequency. At the same time over 2.8 million beach visits to the study area are expected in 2014 and slightly more in the coming years. Therefore continued bluff collapse constitutes a significant life-safety issue and is analyzed further.

10.2.2 Social Vulnerability/Resiliency

Social vulnerability refers to the capacity for being damaged or negatively affected by hazards or impacts. Resiliency is the capability to cope with and recover from a traumatic event. Studies

[117] ER 1105-2-100
[118] EC 1105-2-409 Planning in a Collaborative Environment (EC 409)
[119] Handbook on Applying Other Social Effects Factors in Corps Planning 09-R-4

show that social institutions such as families and public and private organizations play an important role in mediating the effects of disasters.[120]

Under the No Action Plan those living along the bluff edge would continue to be negatively impacted by episodic bluff collapse. In addition all beach visitors would experience increased social vulnerability over time as beaches erode and episodic bluff collapses increase in frequency. Social vulnerability and resiliency are analyzed further.

10.2.3 Emergency Preparedness

The capacity and capability to mitigate the risk of interruption in the flow of essential goods and services needed for special requirements of local, regional, and national security.[121]

Coast Highway 101, which runs along the coast and through both communities, is a designated tsunami evacuation corridor. Inundation maps prepared by the University of Southern California Tsunami Research Center show little to no potential tsunami inundation in the project area due to both cities locations atop high bluffs.[122] Minor inundation covering roughly two city blocks could occur at Fletcher Cove and Moonlight beaches. Major inundation could occur at Batiquitos, San Elijo, and San Dieguito Lagoons that would disrupt travel and evacuations on Coast Highway 101. However, these lagoons would not be impacted by the NED Plans in Segment 1 and 2 and consequently a tsunami's propensity to inundate these lagoons and cause travel and evacuations disruptions on Coast Highway 101 would not be impacted with or without the Recommended Plan or NED Plan. Therefore, the effects on emergency preparedness are *not* analyzed further.

10.2.4 Displacement to Population

[Displacement is] the act or process of being expelled or forced to flee from home or homeland. Displacement effects include the displacement of people, business, and farms.[123]

The Recommended and NED Plans offers protection that should significantly reduce the risk of structure failure due to episodic bluff collapse described in the coastal engineering appendix. Should no action occur instead, we expect most bluff-top parcel owners to armor in time to protect affected structures and prevent structure loss. However, some residences could be lost because of the episodic nature of bluff collapse in the study area as well as personal, financial, and regulatory constraints to armoring in time. This means the No Action Plan could compel displacement to a subset of residences situated on the bluff edge. Consequently, additional analysis has been performed on displacement to the population.

10.2.5 Community Cohesion & Social Connectedness

[Community cohesion & social connectedness are] the pattern of social networks within which individuals interact, which largely provides meaning and structure to life.[124]

[120] Ibid
[121] Modified from ER-1105-2-100 section D-40
[122] *San Diego County Tsunami Inundation Maps* http://www.conservation.ca.gov/cgs/geologic_hazards/Tsunami/Inundation_Maps/SanDiego/Pages/SanDiego.aspx accessed 17-AUG-2011
[123] Merriam-Webster dictionary and ER-1105-2-100 section D-40
[124] Ibid.

The NED, Recommended, and No Action Plans would impact the area of beach available for recreation within the study area differently thereby altering the manner and frequency residents' interaction while recreating and also reshaping perceived benefits of living within Solana Beach and Encinitas. Changes to community cohesion and social connectedness are analyzed further.

10.3 Analysis

10.3.1 Life-Safety: No Action Plan

Both communities have been subject to repeated bluff collapse resulting in property damage, large debris falling to the beach, and even loss of life. In the past decade numerous bluff failures have continued to occur and threaten public safety. Since the collapses are episodic, with little or no warning, city officials have tried to keep the public aware of the danger by displaying signs along the beach cautioning beach-goers to stay a safe distance from the base of the bluff at all times. After major bluff collapses that gather news media attention, city life guards often use the public attention to convey this same message: "Anybody that's walking anywhere on the North County beaches should be extremely aware of the danger and stay away from the cliffs."[125]

Both beaches are heavily utilized year-round—more than 2.8 million visits are expected in 2014.[126] Engineering analysis shows that most wave attacks to the toe of the bluff occur in the winter when sand volume is lowest. However, this is just a precursor to episodic bluff collapse, which can occur throughout the year and even during peak summer season when about 60% of all beach visits occur. To illustrate the danger to beach visitors and bluff-top residents, a list of major bluff failures is given in the following table. Note that these collapses cause significant safety issues because whenever recreation occurs near the base of the bluff, injury and death can and do occur.

Table 10.3-1 Major Bluff Failures since 2000

January 2000	A woman was killed in a bluff collapse while sitting on the beach in Leucadia (City of Encinitas).
January 2001	Four bluff-top homes in Leucadia (south of Beacon's Beach) were deemed unsafe by the City of Encinitas due to unstable and cracked bluffs. Large rocks were piled at the base of the bluffs to protect the cliffs from large surf and tides.
February 2001	A bluff collapse destroyed a portion of the trail at Beacon's beach off Neptune Avenue in Leucadia.
May 2001	In Solana Beach an adjoining bluff gave way as a neighbor was trying to reinforce it by driving steel pilings in to the bluff. A concrete slab from patio slid down toward the shore, taking with it a workman who had been standing on it. The bluff collapse also claimed part of an additional adjacent yard and rendered a portion of the house unsafe for occupancy. Owners of the three parcels obtained an emergency permit to build a 100-foot long, 35-foot high seawall.
July 2002	A man camping overnight in a small cave at South Carlsbad State Beach was killed when a portion of a bluff collapsed.

[125] Encinitas life guard captain quoted in North County Times http://www.nctimes.com/news/local/encinitas/article_fe7f01b6-2705-5071-8f59-6e09e0973cfb.html accessed 16-AUG-2011

[126] Based on recent attendance data provided by the cities of Encinitas and Solana Beach

July 2002	About 80 tons of sandstone, rocks, and boulders fell onto the beach as a 75-foot wide by 12-foot high section of bluff collapsed just south of Fletcher Cove Park, a major recreation area.
September 2002	Major bluff failure; Potential threat; Approx. 4 cu. yd. boulders, alluvium, and ice plant debris cascaded onto the beach
December 2002	Major bluff failure; Potential threat; 10 cu. yds of earthen debris and concrete; Posts, concrete footings, and other wooden retaining devices precarious; Continuation of already badly eroded area
February 2003	Major bluff failure; Potential threat; Approx. 3 cu yds, in and around existing sea cave plugs, large portion of bluff un-supported and in danger of collapse.
February 2003	Major bluff failure; 3rd Major failure 100 yards south of previously reported area; 3 cu. yd. of solid sandstone composition, debris and boulders.
November 2003	Major bluff failure; N. of cove, water flowing mid-bluff
March 2004	Major bluff failure; Upper and lower bluff failure over 2 cu. yds, dangling posts/rope
June 2004	Major, potential threat from overhang patio. Signs posted. Geosoils evaluating all.
July 2004	Major bluff failure; Directly S. of other failures, approx. 15' X 6' X 4'. Potential threat from overhang patio. Signs posted. On or about 6/30, contractor removed wall and concrete deck that had become undermined. On 7/6, "u-channel posts" and "Bluff Warning" signs were installed.
November 2004	Major bluff failure; Approx. 6' X 5' X 3', Initial failure was contained by protective shoring and fence system; subsequent bluff failure resulted in damage to shoring system.
November 2004	Major bluff failure; Potential threat; 2' X 8-10' portion of block wall separated from patio, large upper bluff failure, undermined a portion of concrete patio adjacent to rear of home. Overhanging portion to be removed and report to be updated.
November – December 2004	Major bluff failure; Approx. 22' X 5' X 3', bluff debris along with length of black pip, portion of fence dangling. Letter sent to owners 11/3.
November 2004	Major bluff failure; Upper bluff failure N. of Cove, area at top closed due to undermined fence along edge. Fence to be relocated and bench will be removed from outlook point, SW of Community center building.
April 2005	Major bluff failure. Although a large amount of material was deposited on the beach, it occurred from a localized area. Surrounding bluff does not appear in imminent danger of further failure.
June 2005	Major Upper bluff failure 2 cu yd or more witnessed by Encinitas lifeguard personnel.
August 2006	Major bluff failure; Potential threat; North of Seascape Sur access at reoccurring failure site;
February 2008	A landscaper was trapped and injured when a retaining wall atop beach bluffs in Encinitas collapsed.
May 2009	Major bluff failure; pre-existing failure site in Encinitas.
January 2010	Debris from private access staircase scattered across 1/2 mile of Beach - referred to Code Enforcement
March 2010	Major bluff failure, photos taken, caution tape placed. On 3/17/2010, the issue has been resolved to satisfaction of Engr. Dept.
April 2010	300-350 C yards detached from lower bluff, fell to beach.
August 2010	Lifeguards and firefighters rescued an injured man who was found on the beach at the bottom of a 30-foot cliff at the end of E Street. He suffered fractures to his legs. The victim probably rolled the first sloped 60 or 70 feet before the 30-foot vertical drop-off. Signs nearby warn visitors of the unstable cliffs.
December 2010	A bluff collapsed across two parcels damaging the existing seawall at the bluff base. An Encinitas lifeguard official subsequently warned, "Anybody that's walking anywhere on the North [San Diego] County beaches should be extremely aware of the danger and stay away from the cliffs."

January 2011	The southbound portion of San Elijo Avenue at Dublin Drive and Cornish Drive closed because of bluff collapses in mid-December leading to approximately 30 days of partial road closure.
January 2011	Major bluff failure (2 cubic yards or more). Lifeguards taped off area, photos taken.

As this list shows major bluff failures occur consistently and frequently throughout the study area. In response city officials continue to broadcast the dangers from unforeseen, episodic bluff failures to the public through signage and local media exposure. Those are the main tools local officials possess to discourage recreation near the base of bluffs and limit the chance of accidental injury or death since unstable bluffs can collapse without warning. This publicity tool probably has a positive impact on life-safety since news articles about major collapses tend to reveal local residents' concern and awareness that the bluffs are unstable and need to be avoided for this reason. However, local attention and exposure about the danger of bluff collapse only mitigates that danger rather than ensures the safety of beach visitors as three recent fatalities have shown.

Since the exposure is primarily through local media and government outlets, nonlocal visitors may be at increased risk to recreate too close to the base of these unstable bluffs. Nonlocal visits make up a sizeable share of all beach visits to the study area. The most recent and comprehensive survey of beach visitors in Encinitas revealed 35% or about 700,000 annually came from distances greater than 20 miles.[127] To highlight this danger several fatalities have occurred recently at or near the study area. Two tourists were killed when a beach bluff collapsed on them at Torrey Pines State Reserve, then in 2008 a Las Vegas resident was fatally struck in the head by rocks "the size of basketballs" when he sat down near a bluff to change shoes to play Frisbee.[128] One of the most tragic bluff collapses occurred in Encinitas in January 2000 when a woman was killed after an overhead bluff collapsed sending "tons of dirt and rocks down on her." According to the LA Times, "Horrified sunbathers tried desperately to dig through the moist red dirt that covered the woman while she was watching her husband surf near picturesque Moonlight Beach."[129] (Moonlight Beach is the most heavily visited beach in the study area. Counters placed by the city show that over 700,000 visits occur at this half-mile stretch of beach annually.) Another fatality occurred in July of 2002 at South Carlsbad beach when a portion of the bluff collapsed killing a man camping inside a cave. At the scene the chief lifeguard stated, "We constantly warn people to stay back [from the bluffs]."[130]

In addition to the large number of visitors to the study area, the area of beach available to recreate safely is expected to shrink over time if no action is taken. Data from 2009 showed that only three of nine reaches, about 1/3 of the length of all study area beaches, typically have dry beaches for recreation. The remaining six reaches or two-thirds of the study area beaches are chronically "wet" during the winter and spring because sand departs during winter storms and swells. Those six "wet" reaches currently host around 700,000 beach visits during the winter and spring season, typically have no dry beach area, and can leave only a narrow path that is a safe distance from bluffs and not saturated with ocean water for those beach goers to recreate. This limits the safe recreating area and may undermine beach visitors' ability to heed warnings

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[127] *Economic Analysis of Beach Spending and the Recreational Benefits of Beaches in the City of Encinitas* by Phillip King, PhD, 2001

[128] *Sign On San Diego* http://www.signonsandiego.com/uniontrib/20080222/news_1m22bluff.html accessed 16-AUG-2011 & LA Times http://articles.latimes.com/2008/aug/21/local/me-torreypines21 accessed 16-AUG-2011

[129] *LA Times* http://articles.latimes.com/2000/jan/16/news/mn-54646, accessed 16-AUG-2011

[130] North County Times http://www.nctimes.net/news/2002/20020718/55313.html, accessed 1-AUG-2011

by city officials to maintain a safe distance from bluffs. Figure 10.3-1, which is a photo taken from a public beach access point in Encinitas during a recent sunny winter day, illustrates this problem clearly. The trend is toward narrower beaches in the summer and particularly winter even under the low sea-level rise scenario as shown in **Table 10.3-2**. As sand continues to depart from these beaches during the study period these conditions are expected to worsen, namely, less area to safely recreate away from the bluffs and increasingly frequent episodic events earlier in the study period (before a majority of unprotected parcels have constructed seawalls).

Table 10.3-2 Winter Dry Beach Area with No Action Plan

Low SLR	Base Yr	Yr 5	Yr 15	Yr 25	Yr 35	Yr 45	Yr 50
Segment 1	156,631	135,034	94,350	78,684	65,918	53,152	48,045
Segment 2	23,374	8,452	-	-	-	-	-

Figure 10.3-1 Wave Inundation at beach in Encinitas

10.3.2 Life-Safety: LPP

The LPP at Segment 1 and 2 involves placing sand near the base of the bluff to protect the bluff toe from erosion. This erosion is directly responsible for the episodic bluff collapses identified in this study. By addressing this bluff collapse, the LPP offers two benefits for life-safety: reduced and less frequent episodic bluff collapse that is triggered by erosion to the bluff toe; and widened and maintained beaches to increase the “safe” recreating area away from the base of the bluff compared to the No Action Plan. The reduction in episodic bluff collapse, also known as coastal storm damage protection, begins immediately after construction in the base year. This compares with the gradual, “piece-meal” protection from seawalls constructed on the existing unprotected parcels under the No Action Plan. The immediate reduction in bluff collapse from LPP should result in less “close calls” where bluff collapses occur close in time and space to beach visitors without causing physical injury. It could also result in fewer or no injuries and deaths from direct exposure to falling debris. At the same time widened and maintained beaches provide larger dry beach areas extending outward from the base of the bluff. Since the base of the bluff is typically one of the highest points on the shoreline and therefore one of the last remaining dry beach areas when beach erosion occurs, the No Action Plan can create conditions that encourage recreation such as sunbathing, walking, and playing beach games close to the bluffs. The LPP would increase the dry beach areas substantially and maintain them as shown in **Table 10.3-3**, which should encourage recreation at a safer distance from the base of the bluff.

Table 10.3-3 Winter Dry Beach Area (Sqft) with LPP

Low SLR	Base Yr	Yr 5	Yr 15	Yr 25	Yr 35	Yr 45	Yr 50
Segment 1	383,000	383,000	383,000	383,000	383,000	383,000	87,000
Segment 2	803,000	710,000	710,000	710,000	710,000	710,000	589,000

Residual preventable damages would be reduced if the LPP is constructed compared to the No Action Plan although not as effectively as the NED Plan. Analysis presented in **Table 10.3-4** shows that coastal storm damage, which is the direct result of episodic bluff collapse, would be reduced about 38% in Segment 1 and 44% in Segment 2 on average across the study period and would be reduced nearly 52% and 50% immediately after fill is placed, respectively. Residual damages would average 62% and 56% with a commensurate reduction in episodic bluff collapses.

The LPP would reduce the severity and frequency of episodic bluff collapse while simultaneously widening safe areas on the beach for the public to recreate. These two factors should noticeably reduce life-safety risks at these popular recreation areas compared to the No Action Plan, which would allow continued wave attack to further erode the shoreline and compromise bluff stability. In contrast, constructing the LPP should lead to a significant improvement in public safety. While the NED Plan is more substantial than the LPP and has lower residual risk indicators, the overall benefit to public safety may be similar because the LPP offers the public a similar opportunity to recreate a safe distance from the base of the bluff where injuries and deaths have occurred historically.

Table 10.3-4 Residual Preventable Damages (Residual Risk Indicator) for the LPP

	SEGMENT 1		SEGMENT 2	
	Low SLR	High SLR	Low SLR	High SLR
Plan Characteristics				
Duration of Nourishment Interval	5 yr	5 yr	10yr	10 yr
Initial Added Beach Width	100 ft	100 ft	150 ft	150 ft
Residual Preventable Damages, %				
Expected Value, study period ("Level of Risk")	62%	62%	56%	56%
Expected Value, min/max	48%/77%	48%/77%	50%/60%	50%/60%

10.3.3 Life-Safety: NED Plans

The NED Plan at Segment 1 and 2 involves placing greater volumes of sand than the LPP near the base of the bluff to protect the bluff toe from erosion. This erosion is directly responsible for the episodic bluff collapses identified in this study. By addressing this bluff collapse, the NED Plans offer the same two benefits for life-safety: markedly reduced and less frequent episodic bluff collapse that is triggered by erosion to the bluff toe; and widened and maintained beaches to increase the "safe" recreating area away from the base of the bluff. The reduction in episodic bluff collapse compares with the gradual, "piece-meal" protection from seawalls constructed on the existing unprotected parcels under the No Action Plan and offers wider, more substantial shoreline protection than the LPP. As with the LPP, the NED Plan should result in an immediate reduction in bluff collapse and less "close calls" where bluff collapses occur close in time and space to beach visitors without causing physical injury. It could also result in fewer or no injuries and deaths from direct exposure to falling debris. At the same time widened and maintained beaches provide larger dry beach areas extending outward from the base of the bluff to encourage recreation as safer distance from the bluff base. The NED Plan would increase the dry beach areas substantially and maintain them as shown in **Table 10.3-3**, which should encourage recreation at a safer distance from the base of the bluff.

Table 10.3-5 Winter Dry Beach Area (Sqft) with NED Plans

Low SLR	Base Yr	Yr 5	Yr 15	Yr 25	Yr35	Yr45	Yr 50
Segment 1	880,000	880,000	880,000	880,000	880,000	880,000	521,000
Segment 2	1,131,000	1,010,000	1,041,000	1,131,000	1,063,000	1,041,000	1,131,000

In addition residual risk would be sharply lower if the NED Plan is constructed at both segments. Analysis on **Table 10.3-4** shows that coastal storm damages, which are the direct result of episodic bluff collapse, would be reduced 68% in Segment 1 and 55% in Segment 2 on average across the study period and would be reduced nearly 80% and 65% immediately after fill is placed, respectively. With the NED Plan constructed residual damages would average 32% and 45% with a commensurate reduction in episodic bluff collapses.

The NED Plans would also reduce the severity and frequency of episodic bluff collapse while simultaneously widening safe areas on the beach for the public to recreate. These two factors should noticeably reduce life-safety risks at these popular recreation areas compared to the No Action Plan, which would allow continued wave attack to further erode the shoreline and continue to compromise bluff stability. In contrast, constructing the NED Plan would lead to a significant improvement in public safety, which may be more than or commensurate with the LPP.

Table 10.3-6 Residual Preventable Damages (Residual Risk Indicator) for the NED Plans

	SEGMENT 1		SEGMENT 2	
	Low SLR	High SLR	Low SLR	High SLR
Plan Characteristics				
Duration of Nourishment Interval	5 yr	5 yr	13 yr	14 yr
Initial Added Beach Width	100 ft	100 ft	200 ft	300 ft
Residual Preventable Damages, %				
Expected Value, study period ("Level of Risk")	32%	32%	45%	31%
Expected Value, min/max	19%/36%	19%/36%	35%/52%	17%/40%

10.3.4 Social Vulnerability: No Action Plan

Social vulnerability refers to the capacity for being damaged or negatively affected by hazards or impacts. The group with the greatest capacity for being negatively affected is beach visitors since they would be subject to the most immediate danger when episodic bluff collapse occurs under the No Action Plan. Bluff-top parcel owners and residents also have social vulnerability but we expect most of these affected parcels to get seawalls under the No Action Plan before any structures can be compromised and residents injured (but not before significant bluff top collapses have occurred spurring the seawall construction). Therefore this section focuses on social vulnerability to beach visitors.

Two hundred ninety structures rest along the bluff edge in the study area. Sixty-one percent or 177 structures (condominiums, duplexes, apartments, and single-family residences) are currently unprotected by seawalls. Until unprotected parcels become armored with seawalls, the episodic bluff collapses coastal engineering has modeled will continue to occur and worsen over time due to beach erosion.[131] Each collapse represents potential peril to beach visitors recreating near the base of bluffs. A fatal bluff collapse in 2000 demonstrates the danger to beach visitors and trauma suffered by bystanders. "A woman sitting on the beach was killed Saturday when part of a bluff suddenly collapsed and sent tons of dirt and rocks tumbling down on her, officials said. Horrified sunbathers tried desperately to dig through the moist red dirt that covered the woman while she was watching her husband surf near picturesque Moonlight Beach."[132] Since bluff collapse would occur more frequently over time until seawalls are constructed on those 177 unprotect structures, social vulnerability for beach visitors is expected to initially increase/worsen over time under the No Action Plan. This is because we expect beach visitations to fall over time but the study area should continue to draw substantial visitors through the 2030s under the No Action Plan. At the same time bluff collapses should increase in frequency, which means the risk of injury or death to these visitors increases over time. In other words the social vulnerability to beach visitors should continue to increase until a large share of those 177 unprotected structures get seawalls halting most bluff collapses.

The increase in social vulnerability among beach visitors could manifest as increased "close calls" where bluff collapses occur close in time and space to beach visitors without causing physical injury or could manifest as injury or death from direct exposure to falling debris. In addition, beach visits could temporarily or permanently decline following news of major bluff collapses or injury and death occurring from bluff collapses. Local governments could decide to restrict access to sections of beach deemed too dangerous for recreation. All these responses

[131] See Coastal Engineering Appendix section 5-1 and 5-2
[132] LA Times http://articles.latimes.com/2000/jan/16/news/mn-54646, accessed 16-AUG-2011

to increased social vulnerability under the No Action Plan would tend to reduce social vulnerability over time to more acceptable levels while dramatically changing the manner and frequency the public interacts with the beach and ocean within Solana Beach and Encinitas.

10.3.5 Social Resiliency: No Action Plan

Social Resiliency is the capability to cope with and recover from a traumatic event. Both communities in the study area have high social resiliency by traditional socio-economic measures. The median household income is over $85,000 compared to about $62,000 across the state of California, more than a 40% premium. Similarly, per capita income is 59% higher in Encinitas than the California average (approximately $50,000 compared to $30,000). Vulnerable segments of the population such as children represent a smaller share of both cities population when compared to county and state data. Twenty-three percent of households have children in Solana Beach and 28% have children in Encinitas, but 31% of households have children in San Diego County and 33% in California. Minority populations (non-Caucasian) make up one quarter of residents. Sixty-three percent of Encinitas residences are owner-occupied and 60% of Solana Beach residences. In addition the average bluff-top structure value in Encinitas, which has primarily single-family residences along the bluff edge, is about $330,000 before accounting for land value suggesting households have wealth as well as high income to cope with and recover from a traumatic event. In other words both communities have high resiliency in terms of financial capacity to deal with bluff collapses. However, financial capacity cannot mitigate for all trauma.

Under the No Action Plan, seawalls would be constructed gradually to protect most parcels that are currently unprotected. While the financial impact of armoring is severe and financially untenable for some, typically $668,000 for a 50-foot parcel, in general we have assumed bluff top parcel owners have atypical resiliency to these traumatic events because of the socioeconomic data for Solana Beach and Encinitas. Therefore the focus is on the capacity to cope with and recover from episodic bluff collapse and potential structure loss not affected by financial position. Stated more directly the concern and uncertainty from repeated bluff top collapse under the No Action Plan cannot be mitigated with financial resources. For instance a family member of an affected bluff-top parcel owner stated recently, “The property is in peril. We’re just hoping for the best. We’re optimistic that we can get some help.”[133] Since all seawall construction must be approved by the California Coastal Commission, a state regulatory agency, unprotected parcel owners could be subject to uncertainty about whether seawall construction would be approved in time to secure their homes. Additional uncertainty occurs when neighboring parcels experience episodic collapses since adjoining parcels including those with seawall to protect against frontal wave attack, could become vulnerable to lateral wave attack from undermined neighboring bluffs that are not protected.

In addition beach visitors also have limited social resiliency to cope with “close calls,” injuries, and even fatalities from episodic bluff collapse expected under the No Action Plan. Recreation along the coastline is a primary identity for both communities. This could manifest in a manner similar to that outlined under *Social Vulnerability*, namely beach visits could temporarily or permanently decline following news of major bluff collapses or injury and death occurring from bluff collapses, and local governments could decide to restrict access to sections of beach deemed too dangerous for recreation. Without a project in place such events could reoccur until the remaining unprotected parcels become armored or shifted to a more stable repose. In this

[133] *North Coast Times* http://www.nctimes.com/news/local/encinitas/article_fe7f01b6-2705-5071-8f59-6e09e0973cfb.html accessed 17-AUG-2011

regard both communities, regardless of financial strength, would suffer from limited capability to cope and recover from episodic collapses (i.e., limited resiliency).

10.3.6 Social Vulnerability & Resiliency: LPP and NED Plan

The Recommended and NED Plans involve placing sand from offshore borrows on to Segment 1 (Encinitas) and Segment 2 (Solana Beach) and thereby protecting the bluff toe from erosion due to wave attacks. In turn episodic bluff collapse is reduced significantly from the base year. This contrasts with gradual, "piecemeal" protection afforded by individual parcel owners constructing seawalls one-by-one or in small groups over several decades. Therefore the Recommended and NED Plans reduce social vulnerability by immediately reducing episodic bluff collapse that threatens beach visitors across all of Segment 1 and Segment 2. The NED Plan would be more effective at reducing bluff collapse than the LPP but public safety risks could be similarly reduced from both plans because each creates a safer recreation space for the public (see Life-Safety for further details).This immediate reduction in danger to beach visitors should manifest as increased recreation visits due to larger beaches while simultaneously lowering the overall risk of injury or death from bluff collapse compared to the No Action Plan. We would expect far fewer "close calls" and major bluff collapses that could have depressed recreation demand and fewer instances where local governments need to restrict beach access for safety concerns. The end result should be to preserve the manner the public interacts with the beaches and oceans while increasing the frequency of that interaction within Encinitas and Solana Beach due to decreased social vulnerability and decreased need to cope with the traumatic consequences of bluff collapse (social resiliency) among beach visitors and bluff-top residents.

10.3.7 Displacement to Population: No Action Plan

Displacement is the act or process of being expelled or forced to flee from home or homeland. Under the No Action Plan approximately 193 unprotected residential structures remain at risk of being compromised from episodic bluff collapse. Some of these residential structures include condominiums with multiple households resulting in closer to 300 households at risk of displacement. However, we expect that the majority of these residences would secure emergency seawall permits and construct seawalls in time to save the structures. In contrast, a subset of these residences may not construct seawalls in time due to the episodic, unexpected nature of bluff collapse as well as personal, financial, and regulatory constraints. This subset of residents in the study area could be forced to evacuate from their homes under the No Action Plan and relocate inside or outside their community depending on each displaced household's financial and personal circumstances after losing their residence. Presently, the median single family residence inclusive of land is valued at $730,600 in Solana Beach and $597,200 in Encinitas making displacement to more affordable locations outside of these communities more likely.[134]

10.3.8 Displacement to Population: LPP and NED Plan

Under the Recommended and NED Plans narrowing areas of the beaches in Encinitas would be extended resulting in a significant reduction is bluff toe erosion that leads to episodic bluff collapse. Coastal storm damages that can be prevented by the NED Plans are expected to fall more than three-fifths across Segment 1 and Segment 2, the receiver sites for beach nourishment. They are expected to fall closer to half under the LPP. While coastal storm

[134] Zillow.com accessed May 22, 2012

damage would be sharply to moderately reduced but not completely eliminated, those 193 residential structures at risk from episodic bluff collapse under the No Action Plan should be protected largely from being undermined. In turn few if any residents would be displaced leading to a strong improvement to this dimension of interest.

10.3.9 Community Cohesion & Connectedness: No Action Plan, LPP, and NED Plan

Beaches have value to communities. Surveys done in 2001 by Dr. Phillip King estimated the economic value of the beaches at Encinitas and Solana Beach at $22 and $17 per beach visit, respectively. Currently that is over $60 million dollars in economic value annually and this value comes from the benefits these beaches provide.[135] This section of the OSE Account focuses on what these benefits are and how some of these benefits directly and indirectly impact community cohesion and social connectedness when the beach recedes (No Action Plan) and when the beach is maintained (Recommended and NED Plans).

Dr. Phillip King performed a more comprehensive survey on the economic value of beaches for Carlsbad, which is the beach community immediately north of Encinitas. Since this beach community is immediately north of the USACE study area and of similar demographics, in general the results and conclusions should be applicable to the USACE study area.[136] Those results and conclusions revealed that just over half of respondents cited physical activities that can be performed at the beach as the primary reason for visiting. These activities included swimming, playing in the sand, and surfing. Nearly all remaining respondents cited “hanging-out on the beach” as the primary reason for visiting the beach, which suggests these visitors benefit from the unique environment and social opportunities of the beach. This survey showed that 98% of respondents come to the beach to engage in activities that can only be enjoyed while at a beach. In addition beach visitors benefit from the unique recreation opportunities at the beach whether through active enjoyment (swimming, playing in the sand, and surfing) or passive enjoyment (“hanging out on the beach”). We believe this is also true within the USACE study area, which borders to the south.

These types of unique recreation opportunities at the beach attract visitors from outside the local beach community. Seventy-three percent of beach visitors live outside of the city of Carlsbad, where the survey was taken.[137] For those visitors the beach is a significant reason to plan a trip or vacation as shown in the survey. Seventy-five percent of respondents cited visiting the beach as an important reason for their trip or vacation and that results in important business and social relationships for affected beach community. While drawn to the beach, many beach visitors also engage in activities in the nearby communities. Spending in restaurants averages nearly $50 per day for a family of four. Those attending the beach also spend money on beer and spirits, and goods from stores. In other words beach visitors are actively engaging in business within the community in social settings such as restaurants and bars. Many also remain in the community overnight. Both businesses and friends and family are affected by the

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[135] Values are derived from the travel cost method described in *Economic Analysis of Beach Spending and the Recreational Benefits of Beaches in the City of Solana Beach/Encinitas Economic Analysis of Beach Spending and the Recreational Benefits of Beaches in the City of Solana Beach/Encinitas* by Dr. Phillip King 2001. $22 per visit times 2.7 million beach visits annually in Encinitas; $17 per visit times 130,000 visits annually in Solana Beach.

[136] See *The Economic and Fiscal Impact of Carlsbad’s Beach: a Survey and Estimate of Attendance*, by Dr. Phillip King 2005 for additional details.

[137] For comparison less comprehensive surveys by Dr. Phillip King done in Solana Beach and Encinitas revealed 64% and 57%, respectively, of visitors to those beaches came from outside the immediate community.

draw the beach has to visitors. Over one-third of all beach visitors (local and nonlocal) stay in hotels or campgrounds and nearly one-third stay with friends and family, and thereby engage in important business and social interactions with members of these beach communities.

In contrast when beaches disappear as under the No Action Plan beach attendance drops and the same business and social relationships that benefit from beach visitors become negatively impacted. The Carlsbad study also asked how a smaller beach would impact attendance. By shrinking the beach in half, a phenomenon that will occur in most of the study area beaches within two decades if no action is taken, attendance at Carlsbad beaches would drop 28%. Projecting a similar drop in attendance in the neighboring study area could result in over 700,000 less beach visits to the study area.[138] A significant portion of this projected loss in attendance could be averted by implementing the Recommend or NED Plans because this would maintain beach area across two large portions of the study area. Surveys conducted for Encinitas and Solana Beach revealed that each nonlocal visit that does not occur would result in a loss of spending of $70 and $84 on average per visit. Since nearly 60% of the drop in beach visits would be due to fewer nonlocal visits to the study area beaches, the result could be $30 million less spending in Solana Beach and Encinitas annually. Again, at least a portion of this could be retained by the communities if the LPP is implemented to prevent further beach erosion.

The fiscal consequences of significantly less spending on local restaurants, hotels, and bars in Encinitas and Solana Beach are not known but could include some business closures, fewer services, or shorter periods of operation. Less beach attendance could also mean fewer overnight stays at hotels and the residences of local friends and family members under the No Action Plan compared to the LPP. One third of beach visitors fall in to the latter category. Less visits by this group amounts to lost opportunities for friends and family to recreate together and enjoy the unique environment these beaches and beach communities can offer.

In conclusion under the No Action Plan the beaches would substantively erode away by the 2030s curtailing beach visits to Solana Beach and Encinitas while the both the LPP and NED Plan grow and then maintains these beaches leading to moderate increases in beach visits. The LPP ensures that these beaches continue to provide unique recreation and social opportunities that draw people to beach communities. Many beach visitors extend their trips overnight by staying with friends and family, camping, or staying at a hotel. When not at the beach many enjoy social activities in local restaurants and bars. Therefore the LPP benefit the individuals who use these beaches and the beach communities that host these visitors to a significantly greater extent that the No Action Plan.

[138] 2.8 million annual visits in 2010 times 28% equals 784,000 less visits annually

10.4 Dimensions of Interest Summary

Table 10.4-1 Other Social Effects Dimensions of Interest Summary

	No Action Plan	LPP (Recommended Plan)	National Economic Development Plan
Life-Safety	Strongly Adverse	Strongly to Moderately Beneficial	Strongly Beneficial
Social Vulnerability & Resiliency	Strongly to Moderately Adverse	Moderately Beneficial	Moderately Beneficial
Emergency Preparedness	No Impact	No Impact	No Impact
Displacement to Population	Moderately Adverse	Moderately Beneficial	Moderately Beneficial
Community Cohesion & Social Connectedness	Moderately Adverse	Moderately Beneficial	Moderately Beneficial

Encinitas-Solana Beach Coastal Storm Damage Reduction Feasibility Study

San Diego County, California

Attachment E1 – Economic Model

U.S. Army Corps of Engineers
Los Angeles District

April 2013

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1 Study Area Overview

The study area lies in the coastal zone from the northern boundary of Batiquitos Lagoon to the terminus of Solana Beach. The two coastal communities primarily impacted by the project alternatives are Encinitas and Solana Beach, California. Beach fill will be placed within a subset of this study area from 0.5 miles north of the intersection of Daphne Street & Neptune Avenue southward to Sea Cliff County Park. This area will be referred to as Segment 1 and covers roughly one-third of the coast line of Encinitas. Beach fill will also be placed from the northern to southern boundary of Solana Beach. This area will be referred to as Segment 2.

2 Purpose & Concepts to Model

The purpose of this model is to quantify the benefits and costs of alternatives formulated to reduce coastal storm damages. Specifically the project alternatives have been formulated to reduce shoreline retreat. Shoreline retreat is defined as the gradual landward movement of the sea/land boundary as defined by the location of some tidal datum such as MSL. In the study area, this retreat is generally caused by shoreline erosion caused by wave attack of the beach and bluffs. Retreat of the coast may occur gradually, at a relatively uniform rate, or episodically, in large increments, followed by long periods of little or no retreat. Gradual retreat is well represented by annualized retreat rates; however, annualized rates do not adequately describe the nearly instantaneous retreat of several feet or tens of feet that may occur episodically. Episodic retreat affects both the seacliff face and bluff top. The seacliff is affected by large wave events eroding sea caves at the bluff toe and triggering block topping and block fall, collapsing these “notch caves”. The sub aerial processes (rain, rilling, surficial overslope flow) acting on the bluff surface and crest generally produce a slower, more uniform erosion rate, but may also contribute to episodic failure over the longer term. In addition, deep-seated landslides can cut back into the coastal terrace upwards of 60 to 80 feet in a few hours or days. The figure below shows a typical bluff profile in the study area.

The project alternatives consist of varying amounts of initial beach fill followed by periodic beach renourishment for the duration of the study period. In addition one set of alternatives consists of a toe notch fill (see Notch in diagram above) in combination with initial and periodic beach fill. The reduction in coastal storm damages attributable to each project alternative is the with-project benefit and all associated construction, maintenance, mitigation, and monitoring expense is the with-project cost.

The observed, historical behavior of bluff-top parcel owners informed the modeling for the without project coastal storm damages and hence the model quantifies this concept. When episodic retreat and failure of the bluff tops occurs, termed an “episodic event”, land is lost and coastal structures are threatened. In response many but not all bluff-top property owners seek permission to construct seawalls to protect their property from further erosion and collapse. Others will not or cannot construct a seawall before an episodic event renders their structure unsafe for occupancy. These two distinct responses to the process of storm surge, toe notch erosion, and bluff-top collapse form the basis of the economic modeling done in this study.

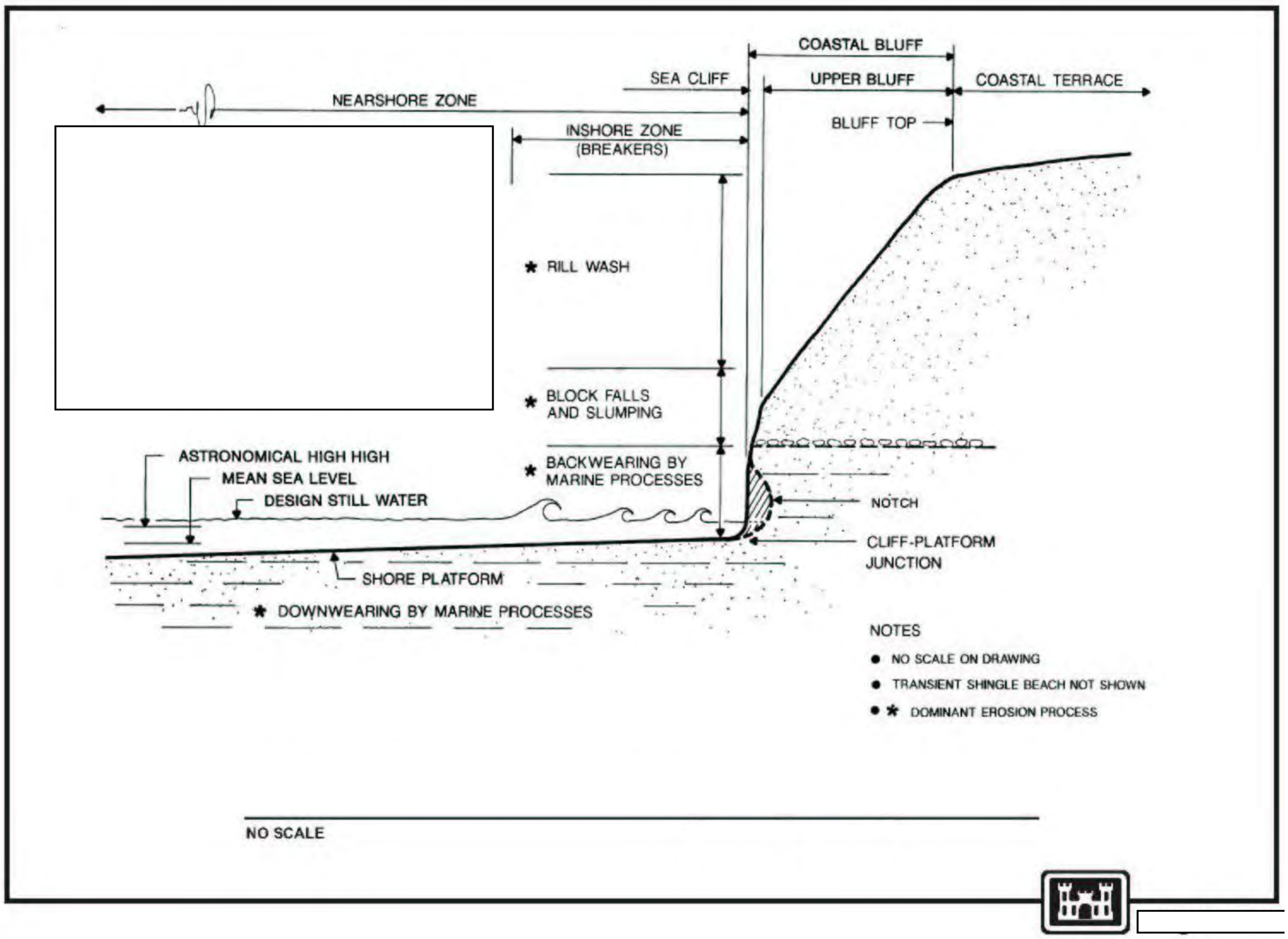


Figure 2.1-1 Typical Coastal Bluff Profile (Looking North up the Coast)

Recreation benefits of each project alternative also have been evaluated. Beach visitors can be impacted by long-term shoreline erosion, seasonal variations in the shoreline, and sea-level rise because these phenomena alter the area available for beach recreation. Visitations to these beaches steadily decline as the area that can be used to recreate gets smaller and can accommodate fewer visitors. Eventually this unmet demand results in potential visitors choosing to transfer to beaches outside the study area. The process of storm surge, sea-level rise, and beach erosion forms the basis for recreation modeling done in this study using the USACE Unit Day Value method.

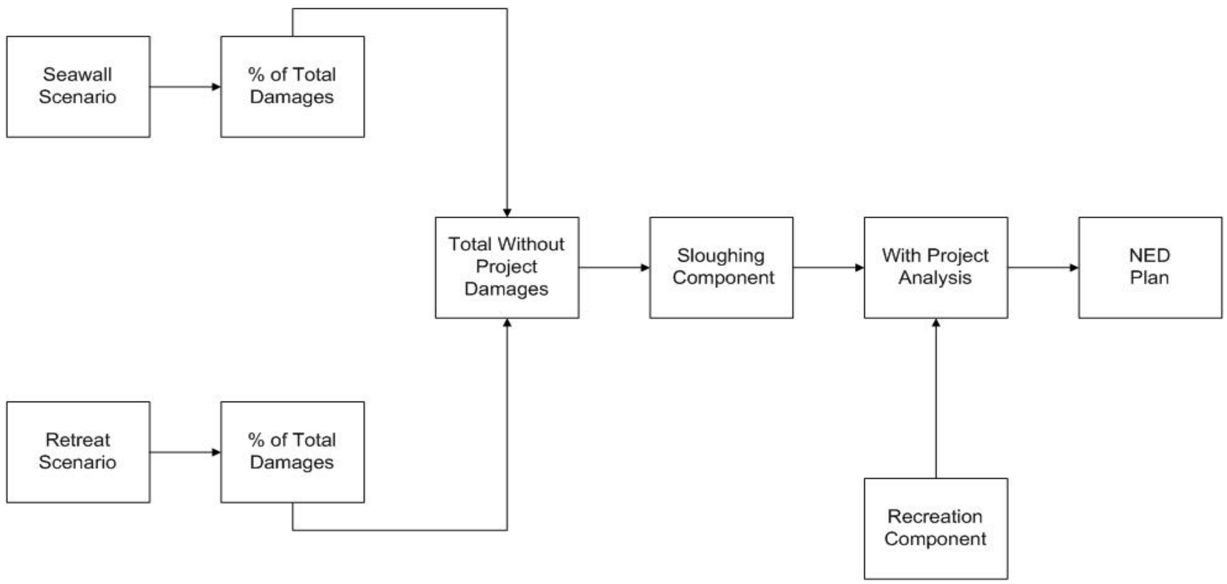


Figure 2.1-2 Flowchart of Coastal Damage Model

2.1 With-out Project Components

Under with-out project conditions the model is designed to capture the economic values associated with the behavior of property owners and beach visitors in the communities of Solana Beach and Encinitas in response to impending bluff-top collapse, loss of beach area for public recreation, and wave force damages to a major highway and nearby structures. Each of these concepts has a distinct component within the model. The components are:

Coastal Damages

- Armoring Scenario
- Retreat Scenario
- Wave Force Damage Analysis

Recreation Values

- Recreation Analysis Without Project

Under the *Armoring Scenario* all bluff-top property owners are 'proactive'—they can and do protect their property with seawalls before structure loss occurs. It has been designed to capture the damages from land and staircase loss after episodic events, and seawall construction and maintenance after the "triggering event". The triggering event is the bluff top setback distance when a homeowner decides to apply for permitting to construct a seawall. This triggering event is a probability distribution based on historical setback distances at the time an approved seawall application was submitted to the California Coastal Commission (CCC). All data was provided by the CCC and only included approved seawall permits within the study area and within the past decade. Seawalls analyzed in this study are approximately 35 feet tall and only designed to protect the lower portion of the bluff rather than the entire bluff face, which can be 100 feet or taller. Weathering at the bluff top edge, termed sloughing, can occur after a seawall has been constructed on the lower portion of the bluff and this phenomenon is addressed in the Sloughing Damages Analysis.[1]

Retreat Scenario captures the damages from land, structure, structure contents, and staircase loss after episodic events. Under this scenario all bluff-top property owners are 'passive'—they do not act early enough to protect their property and many vulnerable structures are rendered uninhabitable by repeated episodic events. Demolition costs are applied to these uninhabitable structures and the remaining parcel areas are considered lost. Even some interior (2nd row) parcels and city infrastructure could be damaged by episodic events without intervention. Since outside intervention is likely before city infrastructure is irreparably damaged, seawalls are assumed to be constructed before the second row of parcels can be damaged by episodic events.

Wave Force Analysis captures wave force damages in the low-lying area of Reach 7. This can cause partial or full closure of a stretch of Pacific Coast Highway connecting Encinitas and Solana Beach and flooding to nearby structures and contents. Travel delays and damage to structures and contents inside these structures can occur. [2]

Recreation Analysis captures the recreation values from the study area beaches under with and without-project conditions. Recreation values adjust with changes to the future shoreline (usable beach area). Beach visitors to the study area routinely recreate on the wet beach, which is above MSL but below the dry beach berm, where dry beach is not available. Both with and without project recreation values are calculated separately for wet and dry beach areas based on this observed pattern.

[1] See *With Project* section.
[2] Could not justify project for Reach 7 based on economic considerations because of limited without project damages.

Table 2.1-1 TABLE OF WITH-OUT PROJECT MODELING COMPONENTS

Modeling Component	Concept	Process
Armoring Scenario	Owners respond to toe notch erosion before episodic events damage structures; seawalls built and first row of structures preserved	1. Episodic event 2. Reduced set back distance from bluff 3. Seawall construction triggered and structure preserved
Retreat Scenario	Owners do not or cannot respond to toe notch erosion before episodic event damages structure; first row of structures lost, second row preserved by seawall	1. Episodic event 2. Reduced set back distance from bluff 3. Further episodic events 4. Structure collapse
Wave Force Damage Analysis[3]	Storm-induced flooding in low-lying area causes road closures and damage to structure contents (reach 7 only)	1. Storm-induced overtopping 2. Partial/full road closure & flooding of structures 3. Travel delays & structure content damages
Recreation Analysis	Sea-level rise, long-term erosion and beach renourishments change the shoreline (beach area); beach area impacts recreation experience and carrying capacity	1. Storm surge & sea-level rise (without project) 2. Reduced beach area 3. Reduced recreation value -- OR – 1. Beach Renourishment (with project) 2. Increased/maintained beach area 3. Increased/maintained recreation value

2.2 With Project Components

Valuing each project alternative involves capturing the reduced coastal storm damage to bluff-top property owners, increased recreational opportunities to beach visitors, and residual bluff-top erosion. Each of these concepts has a distinct component within the model. The components are:

Reduction in Coastal Damages

BC Analysis
Reduction in Armoring & Retreat Scenario Damages
Reduction in Wave Force Damages[4]

Recreation Values

Recreation Analysis With Project

Residual With Project Damages

Sloughing (Residual) Damages

BC Analysis calculates the net benefits of each project alternative. It weights without project damages established in *Armoring Scenario* and *Retreat Scenario* by estimated likelihood of occurrence to derive the expected without project damages, then applies the partial benefit capture curve to derive the reduction in coastal storm damages that correspond with each project alternative. Weighting for the mutually exclusive Armoring and Retreat Scenarios is

[3] Could not justify project for Reach 7 based on economic considerations because of limited without project damages
[4] Ibid.

derived from the intensity and frequency of bluff-top erosion events during the study period as well as historical parcel owner behavior.[5] Last the costs of each project alternative are calculated and the project alternative benefits and costs are presented along with net benefits and BC ratios.

The BC Analysis spreadsheet evaluates the costs and benefits of project alternatives that reduce coastal storm damages and wave force damages. These have been termed *Reduction in Armoring & Retreat Scenario Damages* and *Reduction in Wave Force Damages*.

Reduction in Armoring & Retreat Scenario Damages is the partial reduction in coastal storm damages each project alternative offers and is derived from *Armoring & Retreat Scenario*. First *Retreat Scenario* and *Armoring Scenario* damages are weighted by the expected probability of occurrence and combined to derive the weighted damages. Next *Sloughing (Residual) Damages* is subtracted from the weighted damages to derive the maximum preventable damages. Finally each project alternative is evaluated for its level of coastal storm damage protection using the Partial Benefits Capture Curve. The resulting "partial coastal storm damage reduction benefits" are derived and presented in *B-C Analysis*, BENEFITS SEG1/2 sheets.

Reduction in Wave Force Damages captures the reduction in wave force damages that would have occurred in the absence of a project alternative in the low-lying area of Reach 7. [Due to the limited number of affected structures and limited travel delays there is no project alternative that is economically viable and consequently the with-project analysis was not performed.]

Recreation Analysis with Project captures the recreation values from the study area beaches under with project conditions. Recreation values adjust with changes to the usable beach area and increased demand for beach visitations. The difference between with and without project recreation values are the recreation benefits used in the calculation of the each project alternative's benefits in *BC Analysis*.

Sloughing Damage Analysis evaluates the damages from weathering of the upper bluff and these damages are subtracted from the without project damages since the proposed project will not avoid these damages in the future.

2.3 Weighting Armoring & Retreat Scenarios[6]

In order to derive the expected without project damages, Armoring Scenario and Retreat Scenario were weighted. The Retreat Scenario weighting relies on a combination of objectivity and subjectivity to establish the probability that parcel owners do not or cannot act in time to episodic events from collapsing their structures. One minus this probability is the Armoring Scenario weighting. To derive the objective portion of the weighting, we recorded the relative number of episodic events that occurred in such a pattern that we would not expect even proactive, determined owners to be able to respond by building a seawall before their structures collapsed. This objective consideration provides the minimum possible weighting for *Retreat Scenario*. After establishing this minimum weighting, it was adjusted upward based on subjective considerations for owners that do not have the financial means or timely construction permits to build seawalls in time as well as those that do not construct seawalls in time for other personal reasons.

[5] Refer to *Weighting Armoring & Retreat Damages* section for further details.
[6] How the weighting was determined is detailed in the *With Project Conditions* section under the heading *Weighting Armoring & Retreat Scenarios*.

Table 2.3-1 COMPARISON OF WITH & WITHOUT PROJECT MODEL COMPONENTS

Without Project Component	With Project Component	With-Project Concept
Armoring Scenario	***Reduction in* Armoring Scenario Damages**	Each project alternative's partial reduction in coastal damages assuming all affected parcel owners build seawalls prior to structure failure under without project conditions; analysis done in BC Analysis spreadsheet.
Retreat Scenario	***Reduction in* Retreat Scenario Damages**	Each project alternative's partial reduction in coastal damages assuming no affected owners build seawalls prior to structure failure under w/o project conditions; analysis done in BC Analysis spreadsheet.
Wave Force Damage Analysis	***Reduction in* Wave Force Damages**	The maximum possible reduction in wave force damages in low-lying areas (reach 7)
Recreation Analysis without Project	**Recreation Analysis with Project**	Establish with project recreation values; difference in with and without project values are recreation benefits from each project alternative
N/A[7]	Sloughing Damage Analysis	Residual long-term erosion to the bluff top continuing to occur with project alternative implemented; subtracted from storm-damage benefits of *Armoring and Retreat Scenario*
N/A	BC Analysis	Apply maximum reduction in coastal damages (after accounting for residual sloughing damages) to "Partial Benefit Capture Curve" to derive actual/realized reduction in coastal damages (with project benefits) for each combination of fill alternative and renourishment cycle; calculate fill costs of each combination; determine net benefits

[7] Some sloughing damages would occur under without project conditions once property owners construct seawalls (Armoring Scenario). However factoring in this residual erosion would have minimal impact to the analysis.

2.4 Sea-Level Rise

Two scenarios for sea-level rise were included in the model: low and high. Based on the USACE guidance[8] the historic rate of sea level change should be used as the "low" rate. The "high" rate of local sea level change should be estimated using the modified Curve III from the 1987 NRC report.

Each model component is affected by sea-level rise. In *Armoring & Retreat Scenario* sea-level rise affects the frequency and intensity of episodic events, which changes the rate of property loss and seawall construction. In *Wave Force Damage Analysis* sea-level rise affects the frequency of flooding to structure contents and frequency and duration of road closures. In *Recreation Analysis* sea-level rise impacts the area available for recreation and produces lower recreation values under high-sea level rise compared to low. *Sloughing Damage Analysis*, which is erosion from weathering at the upper bluff, is not impacted by sea-level rise.

3 Without Project Conditions

SPREADSHEET

*Armoring Scenario**	*Erosion Rates*
*Retreat Scenario**	*Erosion Rates*
Wave Force Damage Analysis	
Recreation Analysis Without Project	*Recreation Analysis Without Project & With RSBP II Alt 1/2*
RSBP II Analysis	

*Excel Add-in @RISK must be running

The without-project damages are generated from land loss due to bluff-top collapse, beach erosion due to storm surge and sea-level rise, and flooding due to storm surge. The model assesses land loss and associated damages under two different scenarios: *Retreat Scenario* and *Armoring (Seawall) Scenario*. Each scenario models two possible outcomes depending on how each parcel owner and the regulatory agencies with jurisdiction over seawall construction behave. For financial, personal, regulatory, or other reasons some owners will not build seawalls before their structures are rendered uninhabitable from bluff-top collapses. This behavior is captured under the *Retreat Scenario*, where all owners do not build seawalls in time to protect their structures. On the other hand many owners will be able to build seawalls before their structures are rendered uninhabitable. In fact, approximately 39% of the study area parcels are already protected to some extent by seawalls. This behavior is captured in the *Armoring Scenario*, where all owners do build seawalls in time. Historically bluff-top structures threatened by imminent bluff-top collapse have been able to obtain permits and construct seawalls in time so more weight is given to the *Armoring Scenario* than the *Retreat Scenario*.

[8] EC 1165-2-209 and white paper *Approach to Incorporate Projected Future Sea Level Change into the Encinitas & Solana Beach Shoreline Protection Feasibility Study* and CEQA and NEPA Compliance Efforts.

Retreat Scenario assesses land loss from bluff-top collapse and any associated structure damages, stairway loss, seawall construction to preserve all infrastructure and land interior to the first row of bluff-top parcels but the first row of structures are not protected in time and are rendered uninhabitable The *Armoring Scenario* component also assesses land loss from bluff-top collapse but seawall construction is initiated prior to structure damage to the first row of bluff-top parcels rather than after structure damage.
Recreation Analysis assesses the recreation values generated by the beaches as they erode and become inundated due to long-term erosion and sea-level rise. The Travel Delay & Flooding component assesses travel delays costs due to the road closures and content damages inside flooded structures.

3.1 Armoring Scenario

SPREADSHEET[9]
Armoring Scenario *Erosion Rates*

3.1.1 Layout & Process

The *Armoring* (Seawall) *Scenario* assesses land loss from bluff-top collapse and any associated stairway loss and seawall construction to preserve the first row of structures on the bluff-top parcels. This component of the model applies a random erosion event to the initial bluff-top setback distance that is dependent on each parcel's initial toe notch depth and location within the study area. After the episodic event is applied a new setback distance is determined--land and staircase losses are calculated if applicable. The seawall trigger is applied to this new setback. If the seawall trigger is equal to or less than the setback distance, a permit is sought to construct a seawall and a delay of one to three years is applied before it can be constructed. When a seawall is constructed the cost of that seawall construction is applied and each subsequent year maintenance costs are assessed. No further damages from episodic events occur. If no seawall is constructed then another random erosion event occurs and the seawall trigger is applied to this new setback distance. This process is laid out in the diagram below.

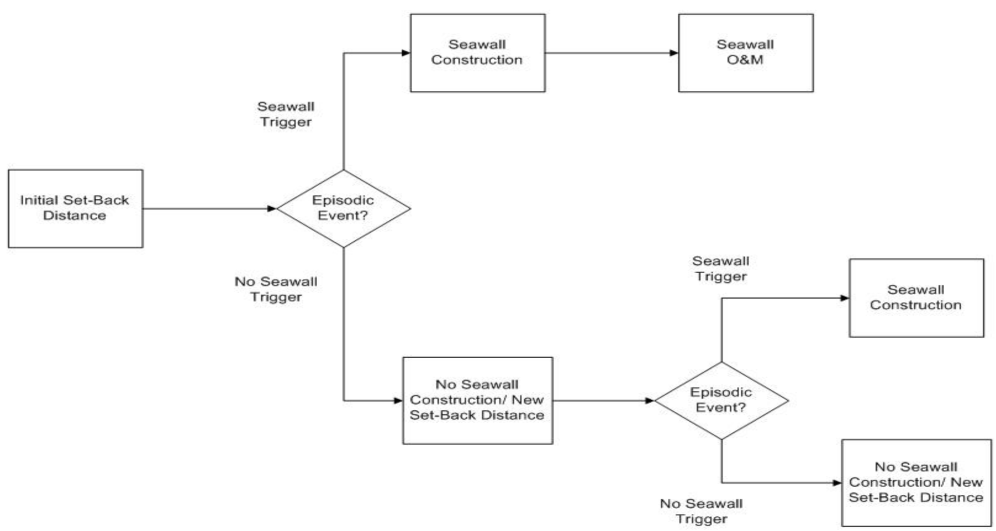


Figure 3.1-1 Seawall Armoring Component

[9] A table describes the layout and function of each sheet in the Armoring Scenario spreadsheet at the end of this section. Note Excel Add-in @Risk must be running when the spreadsheet is open.

3.1.2 Episodic events

Armoring Scenario draws erosion data from a simulation of episodic events in the separate Erosion Rates spreadsheet. The Erosion Rates spreadsheet consists of 50 years of episodic events separated by location (study area reach) and initial toe notch depth (0, 2, 4&6 feet). Each combination of location and toe notch depth has 1,000 simulated episodic events for each year of the study period. Each of these 1,000 rows has an equal probability of being drawn by the uniform probability function located in the VAR sheet within *Armoring Scenario*. Once drawn the episodic event (erosion rate) is applied to the Annual Erosion Rates sheet within *Armoring Scenario*. These episodic events form the basis for all damages. Loss of Staircase sheet calculates losses when staircases are damaged by episodic events. The Land Loss sheet calculates losses when land is damaged by episodic events. Armoring Construction and Armoring O&M sheets calculate costs after seawalls are constructed and subsequently maintained.

Armoring Scenario: seawall Application, Delay, & Construction

Historical seawall permit data in the study area was used to establish a probability distribution of bluff-top to structure setback distances immediately preceding application for a seawall permit, which must be done before a seawall can be legally constructed.[10] The triggering event (‘seawall trigger’) specified by the probability distribution =RiskExtvalueAlt(0.05,4,0.95,36,RiskTruncate(-5,40)) located in VAR sheet within *Armoring Scenario* establishes the setback distances from structure to bluff-top edge that causes the parcel owner to seek a seawall construction permit. Under the armoring scenario we have assumed that all parcel owners respond to the ‘seawall trigger’ by applying for a permit and all seawall permit applications are approved, although not in that same year. The model follows historical precedent: episodic events eventually threaten the structure; the affected parcel owner seeks a seawall permit; successful permit applications are typically approved in 1-3 years; and a seawall is constructed shortly thereafter. To model the delay we have added a seawall construction delay of one, two, or three years after the seawall permit application has been submitted (i.e. the ‘seawall trigger delay’). The ‘seawall trigger delay’ distribution is located in *Armoring Scenario* VAR sheet and is added to the year a seawall permit is applied for. In this way the Armored Permit sheet keeps track of if and when a parcel owner seeks a permit using the ‘seawall trigger’ and the ‘seawall trigger delay’ of 1-3 years is added to determine when the permit will be approved and the seawall can be constructed, which occurs in the Armored Parcel sheet. Seawall operation and maintenance costs follow the year after seawall construction until the end of the study period. Parcels with seawalls or properties labeled “exclude” in the Parcel Database do not incur damages.

Additional Damages: Staircases

Some parcels in the study area have staircases leading from the bluff top to the beach. Over time episodic events have caused several of these staircases to become unsafe or even collapse. Under without project conditions we expect more staircases to be lost. The replacement cost for a private staircase has been estimated at $42,000. Typically, after three feet of bluff-top erosion a staircase can fail. Therefore the “staircase trigger” occurs in the year there is three or more feet of cumulative erosion to the bluff top—in that year the staircase is

[10] Historic seawall construction data from the study area was provided by the California Coastal Commission. For further details see *Armoring Scenario* in the introduction.

lost. Since the number of staircases within Segment 1 & 2 is limited, the impact to without project damages is minimal. To see the 'staircase trigger' and how staircase damages are calculated refer to *Armoring Scenario* spreadsheet and VAR and Loss of Staircase sheets.

Table 3.1-1 ARMORING SCENARIO BY SHEET WITH DESCRIPTION, INPUTS, AND OUTPUTS

Sheet	Purpose/Description	Inputs	Outputs
VAR	Present key assumptions/inputs in one sheet	Staircase loss value, seawall construction & maintenance costs, land loss value, distribution of setback distances for seawall construction trigger, seawall trigger delay	n/a
Parcel Database	List all bluff-top parcels in Encinitas and Solana Beach with setback distance, parcel & structure area, structure value, toe depth	Area MFR&condos o condo & duplex area M&S o construction quality & condition valuations from Marshall & Swift	Structure depreciated replacement values
Area MFR&condos	Area of condos and duplexes by housing unit	n/a	n/a
M&S	Structure value per square foot by housing type, construction quality, and condition	Marshall & Swift Valuation Guide	n/a
Armored Permit	Determine if and when seawall permit application is submitted	VAR o seawall trigger delay Parcel Database o parcel type (land, structure, exclude), protected by seawall Parcel Erosion o current year setback distance after bluff-top collapse	Year when seawall application is submitted (year change from NO to YES occurs) present on parcel
Armored Parcel	Determine if and when seawall is constructed, which occurs 1-3 years after applying for seawall permit (see Armored Permit sheet). This delay is called the 'seawall trigger delay' and is a uniform probability distribution located in VAR sheet	VAR o seawall trigger Parcel Database o parcel type (land, structure, exclude), protected by seawall Parcel Erosion o current year setback distance after bluff-top collapse	Years when seawall is present on parcel (from year of seawall construction to end of period of analysis)
Year of Armoring	Determines year of seawall construction	Armored Parcel	Year seawall is constructed on parcel
Armored Constr.	Cost to construct seawall and year construction occurs	Armored Parcel o year of seawall construction VAR, Parcel Database o length of parcel/seawall and fixed & variable costs of seawall construction	Seawall construction costs
Armoring O&M	Annualized repair costs of seawall commencing the year following construction	Parcel Database, Armored Parcel o period seawall is present, length of parcel/seawall VAR o fixed & variable costs of seawall repair	Seawall repair costs (annualized)

Sheet	Purpose/Description	Inputs	Outputs
Land Loss	Land value lost to bluff-top collapse	Armored Parcel, Parcel Database o determine parcels to exclude and include Annual Erosion Rates, Parcel Database, VAR, Armored Parcel o determine area and value per sq foot of land loss to derive value of land lost	Value of bluff-top land lost to bluff-top collapse
Loss of Staircase	Staircase value lost to bluff-top collapse	Parcel Database o exclude parcels with seawalls and parcels coded "Exclude", include parcels with staircases Annual Erosion Rates o cumulative bluff-top land loss VAR o cumulative land loss before staircase is lost	Value of staircase lost to bluff-top erosion
Total Damages	Sum the damages from lost land, lost staircases, and seawall construction and maintenance	Armored Constr. Armoring O&M Land Loss Loss of Staircase	Sum of the values from *Armored Costr., Armoring O&M, Land Loss,* and *Loss of Staircase*
PV Losses	Calculate the present value of the damages	Armored Constr. Armoring O&M Land Loss Loss of Staircase	Present value of *Armored Costr., Armoring O&M, Land Loss,* and *Loss of Staircase* by reach
Summary of Losses	Summary presentation of total damages by reach from *PV Losses*	PV Losses	Present Value of total damages by reach
Annual Erosion Rates	Simulate bluff-top land loss based on initial toe notch depth	Erosion Rates (separate spreadsheet) o distribution of land erosion events dependent on toe notch depth Parcel Database o initial toe notch depth by parcel	Bluff-top land loss in linear feet
Parcel Erosion	Derive structure setback distance from bluff-top during current year	Parcel Database o initial structure setback distance from bluff-top Annual Erosion Rates o bluff-top land loss in linear feet	Structure setback distance from bluff-top during current year
Erosion Rates (separate spreadsheet)	Probably distribution of simulated bluff-top erosion events dependent on initial toe notch depth and location within study area	n/a	Annual Erosion Rates sheet, bluff-top erosion for current year

3.2 Retreat Scenario

SPREADSHEET[11]

Retreat Scenario[12] *Erosion Rates*

3.2.1 Layout & Process

Retreat Scenario assesses land loss from bluff-top collapse and any associated stairway loss, structure loss, structure demolition costs and seawall construction to protect structures and infrastructure beyond the first row of bluff-top parcels. This component of the model applies a random episodic event (bluff-top erosion) to the initial bluff-top setback distance that is dependent on initial toe notch depth and location within the study area. This determines the new setback distance and any land and staircase losses. After the episodic event is applied a new setback distance is determined--land and staircase losses are calculated if applicable. If a structure is lost then structure demolition costs are applied. If erosion leaves less than 15% of the original parcel in place, then a seawall is constructed to ensure interior infrastructure is protected. Each subsequent year after a seawall is constructed seawall maintenance costs are applied. No further damages from episodic events occur to land, structures, and infrastructure interior to the first row of bluff-top parcels. This process is laid out in the diagram below.

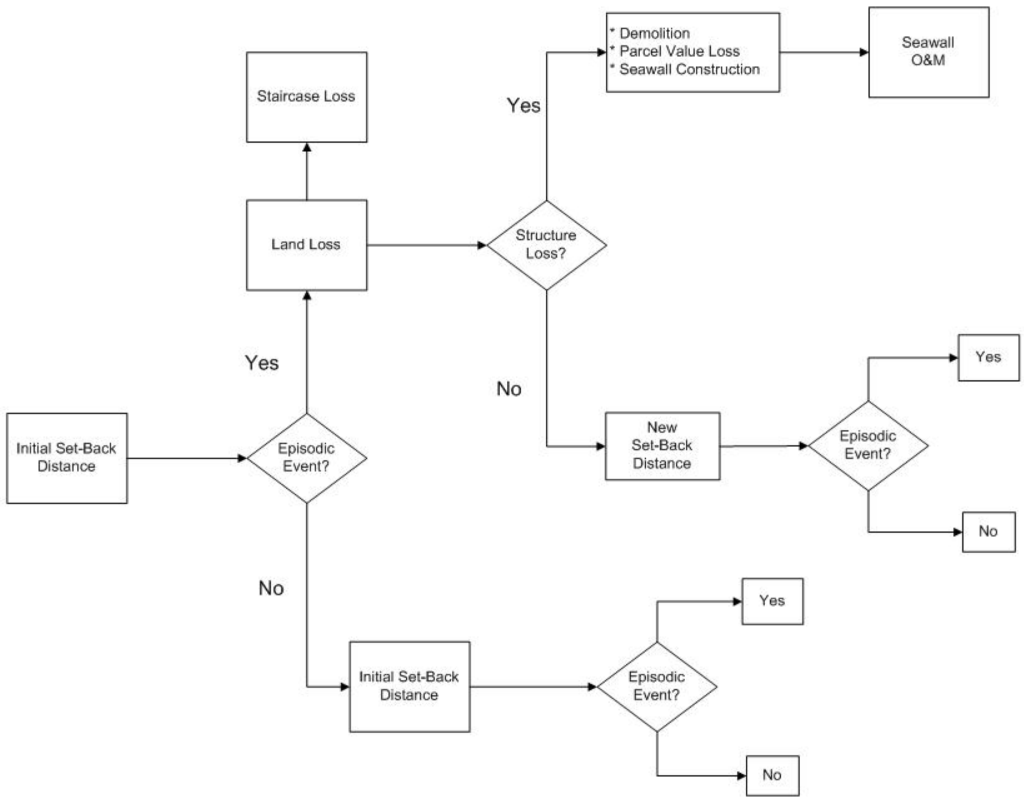


Figure 3.2-1 Retreat Component

[11] A table describes the layout and function of the Retreat Scenario spreadsheet at the end of this section.
[12] Excel Add-in @RISK must be running

3.2.2 Episodic events

Retreat Scenario draws erosion data from a simulation of episodic events in the separate Erosion Rates spreadsheet. The Erosion Rates spreadsheet consists of 50 years of episodic events separated by location (study area reach) and initial toe notch depth (0, 2, 4 & 6 feet). Each combination of location and initial toe notch depth has 1,000 simulated episodic events for each year of the study period. Each of these 1,000 rows has an equal probability of being drawn by the uniform probability function located in the VAR sheet within *Retreat Scenario*. Once drawn the episodic event (erosion rate) is applied to the Annual Erosion Rates sheet within *Retreat Scenario*. As in *Armoring Scenario* these episodic events form the basis for all damages. Loss of Staircase sheet calculates losses when staircases are damaged by episodic events. The Land Loss sheet calculates losses when land is damaged by episodic events. Armoring Construction and Armoring O&M sheets calculate costs when seawalls are constructed and subsequently maintained.

3.2.3 Seawall Trigger

Unlike *Armoring Scenario* the seawall trigger has been modified to occur after the structure has been rendered uninhabitable by episodic events and once only 15% of the original parcel area remains. If the parcel does not have a structure, a seawall is constructed once 15% of the original parcel area remains. Under the *Retreat Scenario* a seawall is constructed after the first row of parcels are lost because further erosion would undermine major public infrastructure such as roads, sewer lines, and power lines without this intervention. We have presumed that resources would be made available to construct seawalls and prevent this catastrophic scenario.

3.2.4 Additional Damages

Retreat Scenario and *Armoring Scenario* are laid out similarly (see table below). However since the first row of structures are lost under *Retreat Scenario*, their value along with content damages and demolition costs have been added to *Retreat Scenario* under Demolition and Structure Damages sheets. The Structure Damages sheet calculates losses at the depreciated structure value and a portion of the content value. Since structures subject to episodic erosion events generally become structurally unsound and uninhabitable rather than immediately falling off the cliff, only a randomly assigned percentage from 10% to 50% of the content value is considered lost. The total content value is a percentage of the depreciated structure value that varies by usage type (SFR and MFR).[13] The other sheets unique to the *Retreat Scenario* are Land Loss Bluff, Land Loss Non Bluff, Return Land Value, Structure Loss, Year of Structure Loss, Structure Damages, and Parcel Erosion.

- *Land Loss Bluff* calculates the value of bluff top land lost to episodic events with bluff top land defined as any land lost in periods prior to structure failure. In the year when the structure is lost any remaining land in the parcel is also considered lost and valued as non-bluff top.
-
- *Land Loss Non Bluff* calculates the value of non bluff top land lost to episodic events with non bluff top land defined as all land lost in the period of structure failure plus any remaining land on the parcel. When a structure is not present on the parcel, all land lost is valued as non bluff top.

[13] Refer to the Parcel Database sheet for content and structure value calculations.

- *Return Land Value* calculates the bluff-top premium (bluff top price minus non bluff-top price) for all bluff-top land lost up to the year of structure loss. This amount is subtracted out in the Total Land Loss sheet to reflect the transfer of bluff top premium to the adjacent interior parcel in the year the first-row structure is lost.

- *Structure Loss* calculates if and when a structure is lost due to episodic erosion events. This is indicated by the switching from “No” to “Yes” to indicate that a structure has failed and remains in that state for the remainder of the study period.

- *Year of Struct Loss* indicates only the year the structure failure occurs by switching from 0 to 1. This is pulled from the Structure Loss sheet

- *Structure Damages* uses the year the structure fails from the Year of Struct Loss sheet to assign structure damages and content damages in that year. The depreciated structure value and portion of contents that are damaged is calculated in the Parcel Database sheet.

- *Parcel Erosion* is similar to *Setback Erosion* because both apply the annual erosion rates to analyze cumulative erosion. The difference is that *Parcel Erosion* applies cumulative erosion to the length of the parcel to determine the remaining parcel length whereas *Setback Erosion* only applies erosion rates to the structure setback distance to determine the remaining setback distance.

If the parcel does not have a structure, all land loss occurs at the non bluff top value. Parcels with seawalls prior to the study period or properties labeled “exclude” in the Parcel Database sheet do not incur damages.

Table 3.2-1 RETREAT SCENARIO BY SHEET WITH DESCRIPTION, INPUTS, AND OUTPUTS

Sheet	Purpose/Description	Inputs	Outputs
VAR	Present key assumptions/inputs in one sheet	Staircase loss value, seawall construction and structure demolition costs, and land loss value	n/a
Parcel Database	List all bluff-top parcels in Encinitas and Solana Beach with setback distance, parcel & structure area, structure value, content value, and toe depth	Area MFR&condos o condo & duplex area M&S o construction quality & condition valuations from Marshall & Swift	Structure depreciated replacement values and content loss values applied if and when the structure fails
Area MFR&condos	Area of condos and duplexes by housing unit	n/a	n/a
M&S	Structure value per square foot by housing type, construction quality, and condition	Marshall & Swift Valuation Guide	n/a
Structure Loss*	Determine if and when structures are lost during period of analysis	VAR o Setback length causing structure failure Parcel Database o parcel type (land, structure, exclude), protected by seawall Setback Erosion o remaining setback length by year	Years when structure is lost and seawall is present on parcel (from year of structure loss to end of period of analysis)
Year of Struct* Loss	Determines year of structure failure/loss	Structure Loss	Year structure is lost

Sheet	Purpose/Description	Inputs	Outputs
Parcel Loss* (Armoring)	Determine if and when parcels are considered lost, which is the year of seawall construction. Parcel is considered lost when 15% or less of the original parcel remains.	VAR o Parcel length causing parcel loss and seawall construction ("Armoring trigger") Parcel Database o parcel type (land, structure, exclude), protected by seawall, seawall construction 'trigger' Parcel Erosion o remaining parcel length by year	Years when parcel is considered lost and seawall is present
Year of Parcel Loss*	Determine year parcel is considered lost, which is year of seawall construction (armoring).	Parcel Loss (Armoring)	Year parcel is considered lost and seawall constructed on parcel
Armored Constr.	Cost to construct seawall and year construction occurs	Year of Struct Failure o year of structure failure and seawall construction VAR, Parcel Database o length of parcel/seawall and fixed & variable costs of seawall construction	Seawall construction costs
Armoring O&M	Annualized repair costs of seawall commencing the year following construction	Parcel Database, Struct Failure or Parcel Loss o period seawall is present, length of parcel/seawall VAR o fixed & variable costs of seawall repair	Seawall repair costs (annualized)
Demolition*	Structure Demolition costs	Year of Struct Failure, Parcel Database o year of structure failure, area of structure VAR o demolition costs per sq foot	Structure demolition costs
Structure Damages*	Value of Structures lost	Year of Struct Failure o year structure failure occurs Parcel Database o depreciated replacement value of structure o value of portion of contents damages from structure failure	Value of structures and contents lost during structure failure
Staircase Loss	Staircase value lost to bluff-top collapse	Parcel Database o exclude parcels with seawalls and parcels coded "Exclude", include parcels with staircases Annual Erosion Rates o cumulative bluff-top land loss VAR o cumulative land loss before staircase is lost	Value of staircase lost to bluff-top erosion
Land Loss Bluff*	Value of land lost prior to structure collapse; valued as bluff-top	Parcel Database, Struct Failure or Parcel Loss o exclude parcels labeled "No-Value", "Exclude", and all parcels after structure failure Annual Erosion Rates, Parcel Database, VAR o linear feet of bluff-top land loss, parcel width, bluff-top land value per sq foot	Value of bluff-top land lost

Sheet	Purpose/Description	Inputs	Outputs
Land Loss non Bluff*	Land value lost if no structure is present or land value of remaining parcel during year of structure failure; valued as non bluff-top	Struct Failure of Parcel Loss, Parcel Database o determine parcels to exclude and include Annual Erosion Rates, Parcel Database, VAR, Year of Struct Failure o linear feet of land loss (or linear feet of remaining parcel length), parcel width, non bluff-top land value per sq foot	Value of non bluff-top land lost
Return Land Value*	Remove bluff-top land value premium: subtract bluff-top land value premium (difference between bluff-top and non bluff-top land value) for previous land lost on parcel at year of structure failure	Year of Struct Failure, Parcel Database o determine parcels to exclude and include Annual Erosion Rates, Parcel Database, VAR o cumulative linear feet of land erosion, parcel width, bluff-top premium per sq foot	Bluff-top premium for cumulative land area lost up to year of structure failure
Total Land Loss*	Calculates the total land value loss after adjusting for parcels that reverted from bluff-top value to non bluff-top value	Land loss bluff, land loss non bluff o value of land lost to bluff-top collapse (episodic events) Return Land Value o premium valuation of bluff-top land lost that has reverted to nonbluff top land lost	Total value of land lost after adjusting for parcels reverting from bluff top to non bluff top values
Total Damages	Sum the damages from lost land, lost staircases, and seawall construction and maintenance	Armored Constr. Armoring O&M Demolition Structure Damages Loss of Staircase Total Land Loss	Sum of the values from *Armoring Costr., Armoring O&M, Demolition, Structure Damages, Loss of Staircase, Total Land Loss*
PV Losses	Calculate the present value of the damages	Armored Constr. Armoring O&M Demolition Structure Damages Loss of Staircase Total Land Loss	Present value of *Armoring Costr., Armoring O&M, Demolition, Structure Damages, Loss of Staircase, Total Land Loss* by reach
Summary of Losses	Simplified presentation of total damages by reach from *PV Losses*	PV Losses	Present Value of total damages by reach
Annual Erosion Rates	Simulates bluff-top land loss based on initial toe notch depth	Erosion Rates (separate spreadsheet) o distribution of land erosion events dependent on toe notch depth Parcel Database o initial toe notch depth by parcel	Bluff-top land loss in linear feet
Setback Erosion	Derive structure setback distance from bluff-top during current year	Parcel Database o initial structure setback distance from bluff-top Annual Erosion Rates o bluff-top land loss in linear feet	Structure setback distance from bluff-top during current year
Parcel Erosion*	Derive remaining parcel length by year	Annual Erosion Rates	Parcel length remaining by year after erosion events

Sheet	Purpose/Description	Inputs	Outputs
Erosion Rates (separate spreadsheet)	Simulated probably distribution of bluff-top erosion dependent on initial toe notch depth and location within study area	n/a	Annual Erosion Rates sheet, bluff-top erosion for current year

**Sheets not present in Armoring Scenario*

3.3 Wave Force Damage Analysis

SPREADSHEET[14]
Wave Force Damage Analysis

3.3.1 Layout & Process

Wave Force Damage Analysis assesses the expected annual damages from return events (2-year to 100-year) given the probability of each return event occurring when tides are high enough to cause wave-overtopping. The two-year event is considered minor and causes partial road closures and minimal structure content damages. Five and ten-year events cause full road closures but minimal structure content damages. All other events are considered major and can cause full road closures and substantial structure and content damage.

In order for an event to cause wave force damages it must coincide with tidal conditions in the low-lying areas of Reach 7 only. All other reaches within the study area have bluff tops and are unaffected by wave force damages in the manner Reach 7 is impacted. The probability tidal conditions are suitable for a given return event to cause wave force damages is shown in the Prob Wave Exceedance sheet. These probabilities factor in the share of tidal conditions that meet or exceed the threshold for overtopping given each return event. As would be expected tidal conditions exceed this threshold more frequently under a 100-year event compared to a 2-year event and more frequently under the high sea-level rise scenario compared to the low. Damages from (1) travel delays and (2) structure damages & cleanup from each type of return event are shown in separate sheets. The EAD Wave Force Damages sheet combines the probability of wave exceedance, damages by return event, and probability of return event to determine the Expected Annual Damages. The stream of projected EAD values was discounted to a present value and annualized to derive an estimate of equivalent annual damages.

Table 3.3-1 Wave Force Damage Analysis Results (Low Sea-level Rise)

Return Event	Unadjusted Damages	Year	EAD
2	4,060	**2015**	17,203
5	13,461	**2025**	18,115
10	13,461	**2035**	19,030
25	838,679	**2040**	19,834
50	838,679	**2055**	20,762
100	838,679	**2064**	21,627

[14] A table describes the layout and function of Wave Force Damage Analysis at the end of this section.

For instance note the total damages for a 10-year event are $13,664 and $838,679 for a 25-year event. From the Prob Wave Exceedance sheet the probability of tidal conditions exceeding the height that would allow a 10-year return event to cause flooding is 22.05% in 2015 and under the low sea level scenario. This is multiplied by the total damages for a 10-year event, $13,664, to derive the calculation shown in cell E6 in the EAD Wave Force Damage sheet, $2,968. This process is repeated for the remaining return events (2, 5, 25, 50, and 100-year events). Next the average damages across return events are calculated by finding the difference between the probability of each pair of return event (e.g., the 10-year to 25-year pair is 10% - 4% = 6%) and multiplying this by the average damages between those same pairs of return events (e.g., $217,862/2 + $2,968/2 = $110,415). The sum of this set of calculations is the expected annual damages ($17,203 in 2015). These calculations are done for each return event for all 50 years of the study period, then summed and discounted to determine the net present value and annualized to estimate the equivalent annual damages for low and high sea-level rise scenarios shown in EAD Flooding and VAR sheets.

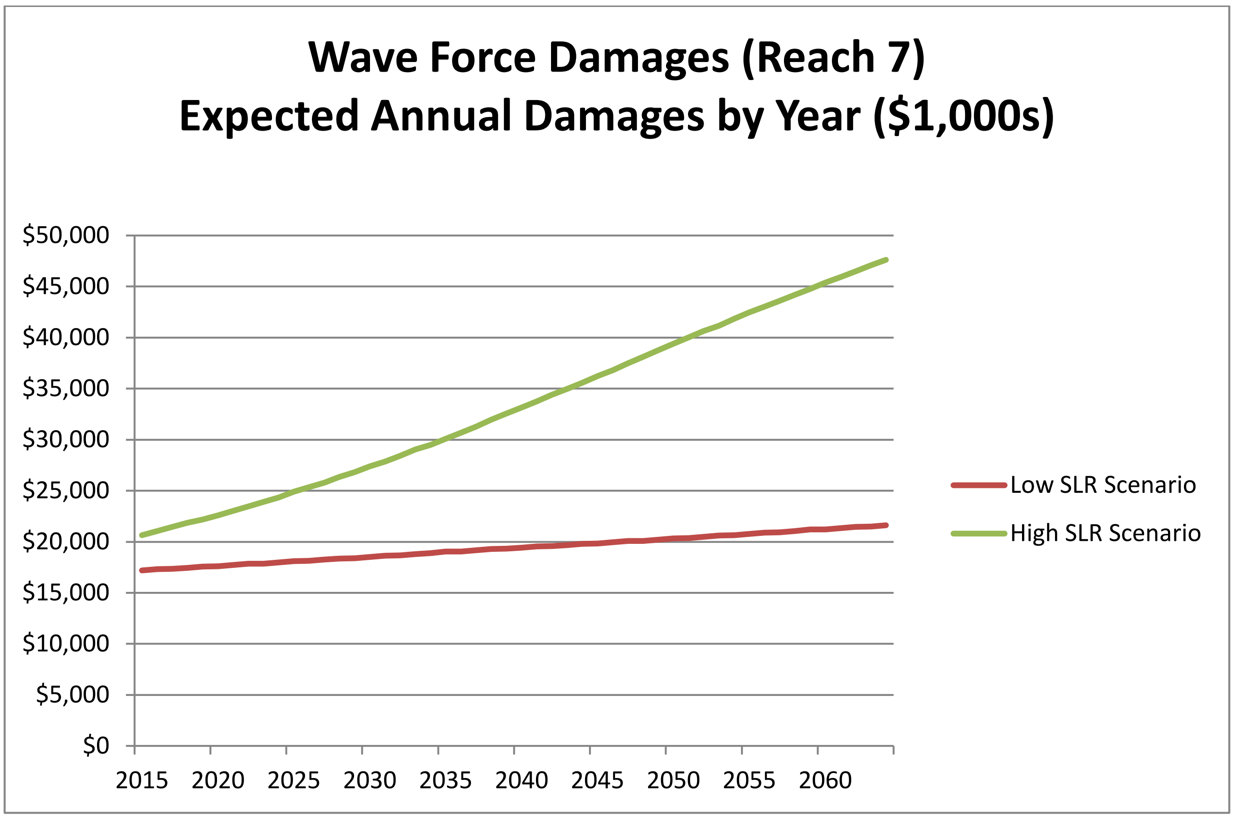


Figure 3.3-1 Wave Force Damages (Reach 7) - Expected Annual Damages by Year ($1,000s)

Table 3.3-2 WAVE FORCE DAMAGE ANALYSIS BY SHEET WITH DESCRIPTION, INPUTS, AND OUTPUTS

Sheet Name	Purpose/Description	Inputs	Outputs
VAR	Key assumptions used to derive damages due to travel delay & structure flooding	Median income, traffic volume, occupants per vehicle, trip purpose, rerouting distance, variable vehicle costs	n/a
Travel Delay	Compute value of additional travel time and travel distance for partial and full roadway closures	VAR o additional travel distance, time o share of vehicles by purpose o median hourly wage o value of time saved adjusted to percent of driver family income by trip purpose	Value of additional travel time; value of additional travel distance
Structure & Cleanup Damages	Damages to structure contents by category, roadway cleanup costs	Content values from 2005 draft report Roadway cleanup costs from 2005 draft report at 2010 price levels	Damages to structure contents and roadway cleanup costs for minor and major storm surge events
Damages	Average Damages from storm events and Expected Annual Damages before adjusting for wave-overtopping probabilities; EAD from return events	Structure & Cleanup Damages	Expected Annual Damages by return event before adjusting for wave-overtopping probabilities
Prob wave Exceedence	Probability of wave overtopping for return events over time and high and low sea-level rise scenarios	n/a	n/a
EAD Wave Force Damages	Expected Annual Damages after adjusting for wave overtopping probabilities; EAD from flooding	EAD Return Event Prob of wave exceedance	Expected Annual Damages from flooding

3.4 Recreation Analysis

SPREADSHEETS[15]

Recreation Analysis Without Project

Recreation Analysis Without Project & With RSBP II Alt 1

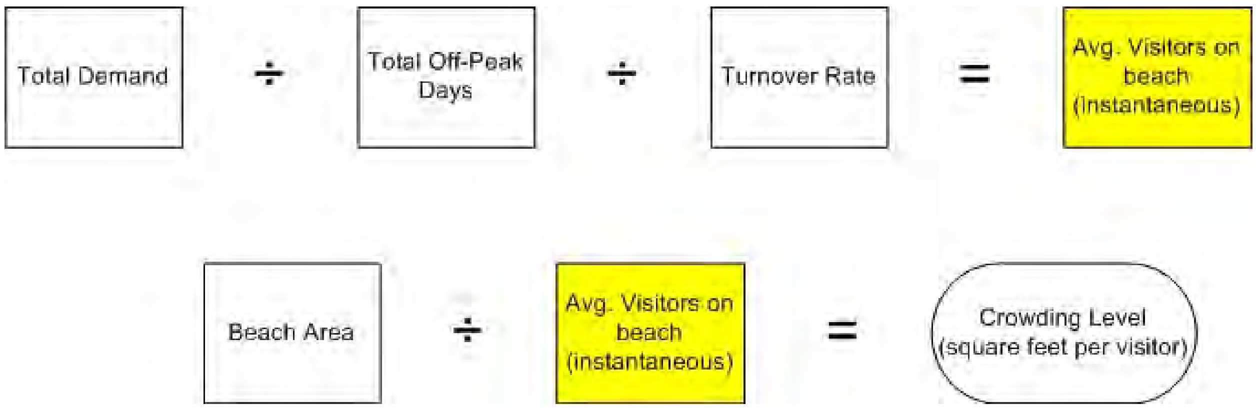
Recreation Analysis Without Project & With RSBP II Alt 2

3.4.1 Benefit Estimation Technique

Recreation Analysis assesses with and without project recreation benefits by using the Unit Day Value method as outlined by ER1105-2-100 and IWR Report 86-R-4. The Unit Day Value sheet in *Recreation Analysis* lists a range of values that consider the characteristics of the study area beaches and the level of crowding. Unit Day Values were assigned using the “Guidelines for Assigning Points for General Recreation” from EGM #11-03 and in consideration of expert opinion by two local lifeguards. These values are applied to all demand for beach recreation. First demand is met by visitations to the dry beach. These visitations are distributed among off peak days, peak weekdays, and peak weekends and assigned unit day values based on the average level of crowding (square feet per visitor). To derive the Crowding Level during the off-peak season, for instance, the total visitation demand during off-peak season is divided by the number of off-peak days to determine the average visitors per day. Then the average visitors

[15] A table describes the layout and function of the Recreation Analysis spreadsheet at the end of this section.

per day is divided by the turnover rate to determine the average number of visitors on the beach at any moment. Finally the beach area is divided by the average visitors on the beach at any moment to determine the level of crowding (square feet per visitor). The Crowding Level is not allowed to exceed 30 square feet per person on the dry beach (cell K2 in Rec Values – DRY BEACH sheet). When there is excess demand that would lead to crowding beyond this cut-off, it is transferred to the wet beach.



Example of how to calculate crowding level for 'off-peak' (winter) days. Calculating 'peak' demand days simply involves adding up the days and replacing *Total Off-Peak Days* with *Total Peak Days*. Once 'crowding level' is calculated the final step to value recreation involves applying the correct Unit Day Value and multiplying it by the number of beach visitors.

3.4.2 Wet Beach recreation

Visitors transfer to the wet beach rather than go to an off-site dry beach because historical attendance patterns show visitations have occurred on wet beaches, particularly during the winter when the beach area is smaller due to seasonal variations. The amount of dry to wet beach transfers are calculated on the DRY BEACH sheet but the recreation values from these wet beach transfers are derived in the WET BEACH sheet. The visitors that transfer from the dry to wet beach are located in rows 107 to 135 of Rec_Values – DRY BEACH sheet. These wet beach transfers carry over to the Rec_Values – WET BEACH sheet between rows 32 and 52, Winter and Summer Demand. Once visitors transfer to the wet beach, the same process used on the dry beach is used to determine the level of crowding on the wet beach. However, all wet beach attendees are given one fixed unit day value regardless of the level of crowding. That value, given in cell K1, is below the minimum dry beach unit day value. Another difference is tolerance for crowding on the wet beaches compared to dry beaches (see cell K2 of each respective sheet). When overcrowding occurs on the wet beach, potential visitors transfer to an off-site beach. The net gain from this transfer is assumed to be the lowest unit day value, $3.58, and is applied to all off-site transfers.

3.4.3 Sea-Level Rise and Beach Erosion

Sea-level rise reduces the available beach area to recreate throughout time. This impact is addressed in the Erosion Seg1 &2 sheets starting in column AT. Segments 1 & 2 have been broken down by their respective reaches since historical beach visitation has been compiled by reach. As expected the high sea-level rise scenario causes more rapid beach loss than the low sea-level rise. These losses impact the dry beach first if present. While the dry beach is eroding, the wet beach maintains its size. When the dry beach is gone, the wet beach area is reduced in the same manner as the dry beach. All else held constant beach erosion causes recreation to transfer from the high-value dry beach to low-value wet beach and off-site beach.

Table 3.4-1 RECREATION ANALYSIS BY SHEET WITH DESCRIPTION, INPUTS, AND OUTPUTS

Sheet Name	Purpose/Description	Inputs	Outputs
Rev_Values – DRY BEACH	Value recreation experience on dry beaches in study area; calculate number of transfers from dry beach to wet beach	*Given* o Daily visitor turnover o Weekday & weekend distribution of visitors o Peak week & weekend days, off peak days o Turn away/overcrowding point in square feet per visitor UDV o Range of values for dry beach recreation per visitation dependent on level of crowding EROSION SEG 1/2 o Reduction in dry beach area due to low and high SLR	Remaining dry beach area, recreation demand, capacity to meet demand, visitations, transfers to wet beach, square feet per visitor, UDV per visitor, annual recreation value by reach
Rec_Values – WET BEACH	Value recreation experience on wet beaches in study area; value recreation experience gain to off-site transfers	Rec_Values – DRY BEACH o Transfers from dry beach to wet beach, determine when dry beach begins to disappears due to low and high SLR UDV o Fixed value for wet beach recreation per visitation Area o Reduction in wet beach area due to low and high SLR and after dry beach disappears *Given* o Turn away/overcrowding point in square feet per visitor	Remaining wet beach area, recreation demand, capacity to meet demand, visitations, transfers to off-site beach, square feet per visitor, UDV per visitor, annual recreation value by reach
Erosion Seg 1	Change in beach width to Segment 1 (reaches 3-5)	Erosion rate of beach widths for Segment 1 (reaches 3-5) and sea-level rise scenario	n/a
Erosion Seg 2	Change in beach width to Segment 2 (reaches 3-5)	Erosion rate of beach widths for Segment 2 (reaches 3-5) and sea-level rise scenario	n/a
Demand	Apply forecasted recreation demand growth to historical attendance; growth mirrors projected San Diego county growth	Attend_Historical	Forecasted growth in recreation demand
UDV	Unit Day Value; range of points and corresponding unit day values for various levels of crowding at the study area beaches	Unit Day Value points	Unit Day Values by level of crowding on beach (available square feet per visitor)
Attend_Historical	Historical attendance data provided by local sponsors and used to forecast future attendance	n/a	n/a

3.5 RSBP II Impact

SPREADSHEET[16]

RSBP II Analysis

Recreations Analysis WITHOUT Project & WITH RSPB II, alt 1/2

3.5.1 Process & Layout

Regional Sand Beach Placement II (RSBP II) is a local, opportunistic sand nourishment project organized and funded by the San Diego Area Governments (SANDAG). RSBP II will occur in both study area communities in 2012, three years before the USACE project, and is assumed to be a one-time occurrence. RSPB II was analyzed because it is likely to occur and measurable per ER-1105-2-100 guidelines. In addition sand volume in the system under without project conditions does not provide storm damage reduction benefits unless sand volume from RSBP II is included in the evaluation. When RSBP II is considered part of the without project conditions then the sand volume in the system does provide modest coastal storm damage reduction benefits that overlaps with the initial portion of USACE study period.

RSBP II impacts Segment 1 and 2 differently. Segment 1 has one viable fill alternative and Segment 2 has two viable fill alternatives labeled “Alternative 1” and “Alternative 2”. The fill alternatives were given in sand volumes that have been translated to beach widths by USACE coastal engineers. Erosion rates by feet of beach width per year have also been provided by coastal engineers. These values can be found in the VAR sheet. From this information the average remaining beach width was calculated from the USACE base year until the end of the study period (2015-2064). Finally, after considering residual sand in the system with RSBP II in place, the remaining beach widths were analyzed for any storm damage reduction benefits. In a later step these will be subtracted from the storm damage reduction benefits from each USACE project alternative.[17]

The process to arrive at the partial storm damage reduction benefits under without project conditions (including RSBP II) mirrors the process applied to with project conditions. Essentially sand volume in the system offers partial protection from coastal damages. Sand volume is translated into beach width and the Partial Benefits Capture Curve shown in VAR sheet rows 58 to 127 shows the percent of storm damages that can be captured for a given beach width.[18] Cell D2 in the IMPACT SEG 1/2 sheet shows the storm damage reduction benefits (derived from weighting the *Armoring* and *Retreat Scenarios* just as in B-C Analysis) Next this amount is adjusted downward based on the partial benefits sand in the system can offer according to the Partial Benefits Capture Curve. The results are shown in IMPACT SEG 1/2 sheets, rows 16 to 17, under the heading “Partial Storm Damage Benefits.” In this manner the same Partial Benefits Capture Curve and method were applied to analyze with and without project conditions.

Recreation Analysis Without Project & With RSBP II is the without project conditions including the projected impacts of RSBP II. It is located in the Recreation Analysis folder and calculates the recreation values with RSBP II in place that occur during the USACE study period. Because this fill causes the without project beaches to become wider and maintain that width further into the study period than would otherwise occur, the recreation values are higher with RSBP II

[16] A table describes the layout and function of each sheet in RSBP II Analysis at the end of this section.

[17] See B-C Analysis in *With Project Conditions* section for an explanation of how the without project conditions from with project SDRB.

[18] See B-C Analysis in With Project Conditions section for an explanation of how the partial storm damage reduction benefits were derived.

included in the without project conditions. Therefore the recreation benefits that include the impacts of RSBP II have been calculated as well as the recreation benefits without considering the impacts of RSBP II. Later these benefits are deducted from the benefits under the USACE with project conditions to determine the additional recreation benefits of each USACE project alternative (see *With Project Conditions* section for more details.)

3.5.2 Reduced Initial Fill Costs

Offsetting this reduction in the USACE storm damage reduction benefits is savings from less initial sand fill volume for the USACE project alternative. This is because sand volume from RSBP II will remain in the system several years beyond 2015, the USACE base year. The exact amount of residual sand volume remaining in 2015 differs by segment and alternative. This extra sand volume in the base year means the USACE project alternative will need less sand volume for the initial fill in 2015. The amount of reduced sand fill volume is shown *RSBP II Analysis* spreadsheet, IMPACT SEG 1/2 sheets in cell E39. It is subtracted from the USACE project alternative initial fill in the *B-C Analysis* spreadsheet.

3.5.3 Impact to USACE Project Alternatives

The final step is to account for changes to without project conditions with the addition of RSBP II. This is done in the *BC Analysis* spreadsheet RECREATION sheet and the BC SUM SEG1/2 sheets by subtracting coastal storm damage benefits and initial fill cost savings attributable to RSBP II. In all other manners the benefits and costs for each project alternative are identical in calculation and presentation to the benefits and costs calculations done without consideration of the impact to RSBP II.

Table 3.5-1 RSBP II ANALYSIS BY SHEET WITH DESCRIPTION, INPUTS, AND OUTPUTS

Sheet	Purpose/Description	Inputs	Outputs
VAR	Present key assumptions/inputs in one sheet	n/a	n/a
IMPACT SEG 1	Calculate the partial coastal storm damage protection after considering the impact from RSBP II on Segment 1; calculate residual sand fill volume that occurs in the USACE base year	VAR o Beach width erosion rates based on low and high sea-level scenarios o Maximum potential storm damages protection o Partial benefits capture curve o Variable costs of beach fill	Without Project conditions for Segment 1 including impacts of RSBP II— modest coastal storm damage protection due to limited sand volume in system from USACE base year, 2015, until sand leaves system
IMPACT SEG 2 Alt 1	Calculate the partial coastal storm damage protection after considering the impact from RSBP II on Segment 2 and Alternative fill 1; calculate residual sand fill volume that occurs in the USACE base year	VAR o Maximum potential storm damages protection o Partial benefits capture curve o Variable costs of beach fill o Beach width erosion rates based on low and high sea-level scenarios	Without Project conditions for Segment 2 including impacts of RSBP II Alt 1— modest coastal storm damage protection due to limited sand volume in system from USACE base year, 2015, until sand leaves system
IMPACT SEG 2 Alt 2	Calculate the partial coastal storm damage protection after considering the impact from RSBP II on Segment 2 and Alternative fill 2; calculate residual sand fill volume that occurs in the USACE base year	VAR o Beach width erosion rates based on low and high sea-level scenarios o Maximum potential storm damages protection o Partial benefits capture curve o Variable costs of beach fill	Without Project conditions for Segment 2 including impacts of RSBP II Alt 2— modest coastal storm damage protection due to limited sand volume in system from USACE base year, 2015, until sand leaves system
Recreation Analysis without project & with/without RSBP II [separate spreadsheets]	Determine the to recreation values when considering from the impact from RSBP II	VAR o Beach width erosion rates based on low and high sea-level scenarios o Maximum potential storm damages protection o Partial benefits capture curve o Variable costs of beach fill	Recreation values without USACE project and with/without RSBP II

4 With Project Conditions

SPREADSHEETS

*B-C Analysis** *Sloughing Damage Analysis**

Recreation Analysis With Project (2/16 – year renourish interval)

*Excel Add-in @RISK must be running

4.1 Layout & Process

The with-project alternatives capture the benefits from the reduction in coastal damages modeled under without-project conditions—*Armoring & Retreat Scenarios* and *Wave Force Damage Analysis*—as well as increased recreation benefits from maintaining larger beaches—*Recreation Analysis with Project*. *Armoring* and *Retreat Scenario* are weighted according to the probability of each scenario occurring. This determines the expected damages and the maximum possible benefits under the with-project alternatives. The maximum benefits may or may not be achieved depending on the amount of coastal protection each alternative offers. *BC Analysis* calculates the partial coastal protection benefits of each project alternative. Similarly *Wave Force Damage Analysis* shows the maximum possible benefits under the with-project alternative and may not be achieved under all possible alternatives. *Recreation Analysis with Project* determines the recreation values under each project alternative. After *Recreation Analysis without Project* is deducted, the remainder is the recreation benefits from each project alternative.

4.2 Weighting Armoring & Retreat Scenario

Armoring and Retreat Scenario model two mutually exclusive behavior patterns of parcel owners that result in differing amounts of without project coastal storm damages. *Armoring Scenario* assumes all owners threatened by structure failure/collapse are able to construct seawalls in time. *Retreat Scenario* assumes these same owners are unable to construct seawalls in time and the first row of structures collapse. Since which owners will be able to respond in time to construct a seawall is not known, both scenarios have to be weighted. Weighting the Armoring and Retreat Scenario involves establishing the percentage of "unexpected" and "threatening" bluff-top collapses that can lead to structure failures. "Threatening events" are bluff top collapses that occur when the structure setback distance is between 25 and -5 feet, which is a range of distances that leave the structure vulnerable to the next episodic event. Parcels that experience threatening events may experience erosion events the following year that cause structure failure and these are called "unexpected events." Unexpected events happen when setback distances greater than 0 feet are followed immediately the next year by episodic events that cause the setback distance to be less than -5 feet, which is the minimum setback distance that causes structure failure. The percentage of "unexpected events" to "threatening" and "unexpected" events is the basis for the minimum possible weighting for *Retreat Scenario*. After establishing this minimum weighting, it was adjusted upward by 15% based on subjective considerations for owners that do not have the financial means or timely construction permits to build seawalls in time as well as those that do not construct seawalls in time for other personal reasons. Therefore the minimum weighting, which differs by segment and sea-level rise scenario, was increased by 15% based on subjective criteria to finally arrive at the adjusted weighting that is applied to *Retreat & Armoring*

Scenarios to calculate the expected without project damages.[19] The minimum and adjusted weighting results are shown in the table below.

	Minimum Weighting (objective consideration of "unexpected" episodic events only)		Adjusted Weighting (subjective consideration of financial, regulatory, and personal factors of owners)	
	Low SLR	**High SLR**	**Low SLR**	**High SLR**
Segment 1 (Encinitas)	2.9%	5.1%	18%	20%
Segment 2 (Solana Beach)	6.9%	14.1%	22%	29%

4.3 PROJECT BENEFITS: Realized/Partial Reduction to Coastal Damages[20]

Although the *Armoring and Retreat Scenarios* give the maximum possible reduction in coastal damages, the actual reduction depends on the amount of coastal protection each alternative provides. This protection is quantified in the "Partial Benefit Capture Curve," which defines the relationship between the mean sea level beach width and the percentage of potential benefits realized from protecting the toe of the bluff from coastal storm erosion. The Partial Benefit Capture Curve is found in the *BC Analysis* Component VAR sheet. A separate Benefits Capture Curve was derived for each of the two communities and covers reaches 3-5 and 8-9, respectively. Applying the percentage of potential benefits taken from the benefits capture curve to the maximum preventable damages, which is based on weighting the retreat and armoring scenarios and then accounting for residual sloughing damages, is the method to determine the realized benefits for each project alternative. Therefore the steps to determine the project alternative benefits are:

1) Determine without project damages for *Armoring & Retreat Scenarios*
2) Weight *Armoring & Retreat Scenarios*
3) Subtract Sloughing (Residual) With Project Damages
4) Establish Remaining Preventable Damages
5) Apply Benefit Capture Curve to determine percent of Remaining Preventable Damages each project alternative captures (i.e., project alternative benefits)

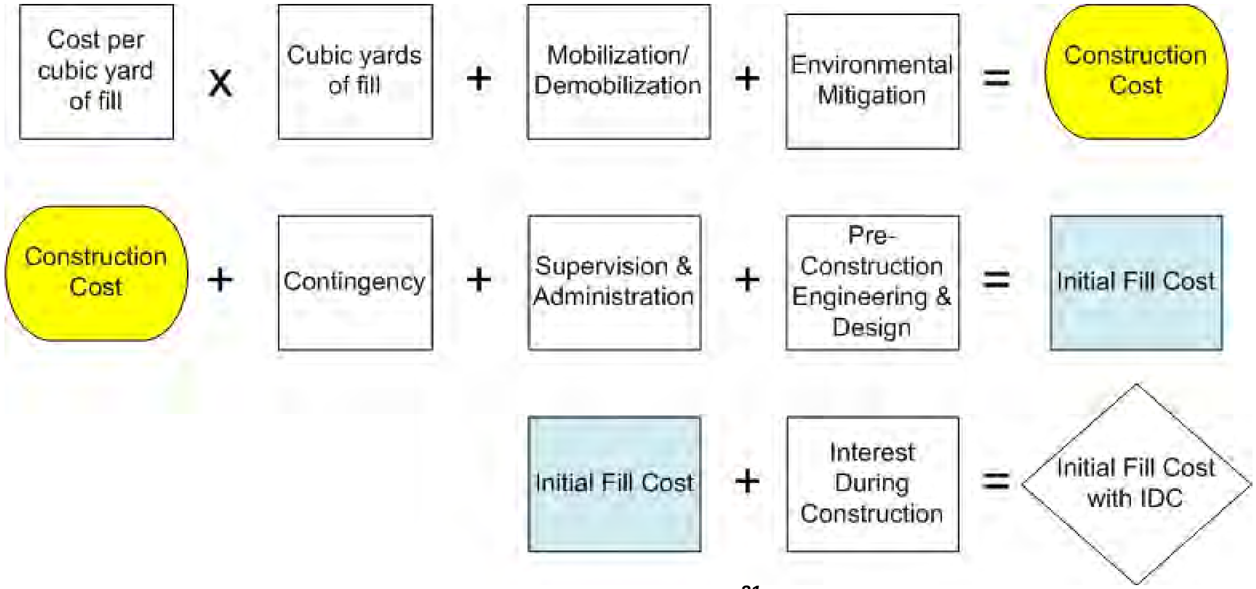
4.4 PROJECT COSTS: Initial & Renourishment Costs

The with-project costs for beach replenishment are found in *BC Analysis*, COST SEG1/2 sheets. The costs are mobilization and demobilization of equipment, pre-construction engineering & design, supervision & administration, operation & maintenance, monitoring, environmental mitigation, contingency, and cost per cubic yard of sand fill. The initial fill and subsequent renourishment cycles are calculated somewhat differently.

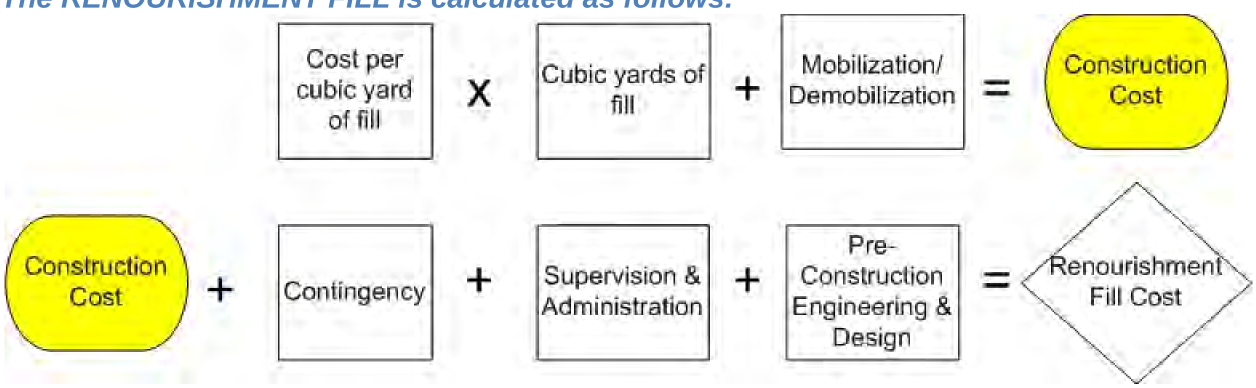
[19] *Sloughing (Residual) Damages* are subtracted after the expected without project damages have been calculated to arrive at the Remaining Preventable Damages. See the *Sloughing Damage Analysis* section for further details.

[20] With project benefits are estimated with a benefit capture curve. This curve defines the relationship between the mean sea level (MSL) beach width and the percentage of potential benefits realized from protecting the base of the bluff from coastal storm erosion. See *Encinitas and Solana Beach Benefit Curve Rationale* dated 8/1/2008 for further explanation.

The INITIAL FILL is calculated as follows:



The RENOURISHMENT FILL is calculated as follows: [21]



Once the initial fill cost and subsequent renourishment costs have been calculated by year the final step involves discounting all these costs, calculating the present value cost for monitoring and operation & maintenance, and adding each together to determine the net present value for each alternative fill and renourishment cycle combination. This gives the total costs during the study period for each project alternative and replenishment cycle as net present value. Construction costs are presented in the year they occur within the study period across all fifteen possible replenishment cycles. This creates a matrix of replenishment cycles from two years to sixteen years for each project alternative. For instance the 50-foot Project Alternative is presented in rows 8 to 70 of the COST SEG 1/2 sheets. Each replenishment cycles is a separate column with Total Initial Fill Cost appearing in row 16, the first year of the study period 2015, and subsequent renourishment fill costs appearing in later years. These costs are summed and discounted in row 67, NPV, then the net present value of monitoring and operation & maintenance are summed to arrive at the Total NPV Costs, row 70.

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[21] Note Renourishment Fill had to be calculated within a single excel formula. Contingency is a percentage of Construction Costs therefore the calculation to arrive at Construction Costs plus Contingency within a single spreadsheet cell is (1+Contingency %) x Construction Costs. Supervision & Administration is also a percentage of Construction Cost plus Contingency so, again, the formula within a single cell is (1+S&A %) x Construction plus Contingency Costs. PED is handled in the same manner. The result of these calculations is the same had Contingency, S&A, and PED been calculated on separate lines then added as shown in the formula visual above.

4.5 Recreation Analysis

SPREADSHEETS[22]

Recreation Analysis With Project (2-year renourish interval) … *Recreation Analysis With Project (16-year renourish interval)*

4.5.1 Layout & Process

Recreation Analysis with Project calculates recreation values using the same method as *Recreation Analysis without Project*. First demand and beach area are established to determine the maximum visitation capacity of each dry beach by peak and off-peak seasons. Demand that exceeds this dry beach capacity is transferred to the wet beaches at a lower, fixed unit day value. Finally any excess demand on the wet beaches transfers to an off-site beach and is given the lowest recreation value. For a more detailed explanation of this process see the earlier *Recreation Analysis without Project* description.

4.5.2 Growth in Demand

Recreation Analysis with Project incorporates increased recreation opportunities due to larger, maintained beach areas. To accommodate this three sheets not present in the without project component have been added, namely, *Demand Growth*, *Alternatives SEG 1*, and *Alternatives SEG 2*. The Demand Growth sheet projects the increased recreation demand from each of the project alternatives. Based on guidance from IWR Report 86-R-4[23], the Similar Project Method was used to estimate additional recreation demand created by the project alternatives. "The similar project method involves comparing certain characteristics of the proposed project with those of a bank of existing water resources projects for which use statistics and other information have been compiled. The most efficient and technically sound similar project techniques are those which provide for the development of per capita use curves from which use estimates are then indirectly derived." To this end use statistics for two nearby and similar beaches in Carlsbad and Oceanside were obtained.[24] Next per capita (beach) use curves were created by comparing use statistics (i.e. the share of beach visitors traveling various distances to get to the beach) to populations within each city, outside each city but within 20 miles, 20 to 60 miles, and more than 60 miles. Once the per capita beach visitors willing to travel these various distances is known for the similar project beaches, this result was adjusted per guidance before being applied to the study area beaches in Encinitas and Solana Beach. The adjustment is necessary due to (1) inherent dissimilarities between these similar-project beaches and the study area beaches despite close proximity, similar surrounding populations, and similar beach widths with a USACE project alternative in place and (2) insufficient data to develop a gravity model or use other methods of statistical control for dissimilar characteristics. This adjustment was made under the column heading "Adjusted Per Capita Day Use by Location" (column G in Demand Growth sheet). The range of project alternatives results in substantially different beach widths from 50 feet of additional beach width to 200 feet and the adjusted per capita use curve adjusts across this range of alternatives.

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[22] A table describing the layout and process of Recreation Analysis is located at the end of this section.

[23] IWR Report 86-R-4 *National Economic Development Procedures Manual - Recreation Volume I: Recreation Use and Benefit Estimation Techniques*.

[24] "Use Statistics" relevant to this analysis are beach attendance and the share of attendees traveling various distance to get to Carlsbad and Oceanside beaches. Use statistics were obtained for Carlsbad beaches from *The Economics and Fiscal Impact of Carlsbad Beaches* by Dr. Philip King (2005) and for Oceanside beaches from *US Army Corps of Engineers Beach Attendance Survey* (2005)

The statistics used and calculations performed to arrive at the with-project demand using the similar project approach are located on the Demand Growth sheet, rows 3 to 24. Among the project beaches Carlsbad was selected as the best analogue to Solana Beach and Oceanside as the best analogue to Encinitas. Use statistics from Carlsbad showed a majority of beach visitors came from within the city or up to 20 miles away. Use statistics from Solana Beach several years earlier showed a similar but even larger majority than in Carlsbad traveled no more than 20 miles to visit its beaches. As the beaches of Solana Beach exist now, they can be categorized a "localized" attraction to visitors of the community and nearby cities. Carlsbad also has a large share of "local" visitors but is more balanced by the larger share traveling 20 or more miles to visit. This makes Carlsbad a better analogue to Solana Beach. In contrast Encinitas has recently attracted about 3 million visitors to its beaches annually while its modest number of residents can only be a small share of those annual visits.[25] This makes Encinitas' beaches more comparable to Oceanside, which hosts twelve percent of visits from within the city and a large share, sixty percent, from distances of 20 miles or greater.

Again, while Carlsbad and Solana Beach as well as Oceanside and Encinitas showed many similarities including similar-sized communities, similar usage-distance patterns, close proximity, and similar with-project beach widths (approximately 190 feet in the similar project beaches chosen for this analysis), many uncontrolled factors/dissimilarities had to be accounted for through quantitative and qualitative adjustments to the per capita use curves before this could be applied to Solana Beach and Encinitas as specified in the guidance.

Once the projected recreation demand was estimated using the similar project method, it was separated by reach so that this demand could be incorporated in to the recreation values calculated in Rec_Values – DRY BEACH and Rec_Values – WET BEACH sheets. The steps used to separate demand by reach are shown in the Demand Growth sheet, rows 27 to 44. For Solana Beach the entire study area is within the placement of alternative beach renourishments. The projected demand was split according to historical attendance patterns by season and reach. For Encinitas reaches 3-5 overlap with the placement of beach renourishments and a reasonable amount of long shore sand movement so only these reaches experience the projected increase in demand (shown in blue text and italicized in Demand Growth sheet). Since sand fill is only placed within reaches 3-5 while the city of Encinitas extends from reach 1 to 7 that means about two-thirds of the study area is outside the placement of the alternative beach renourishments and roughly two-thirds of the visits occur outside those placement areas. To capture this only one-third of the projected increase in demand within Encinitas (roughly 200k of the 600k total projected increase in with-project demand) was used to calculate the increased recreation benefits as shown in Rec_Values – DRY BEACH and WET BEACH sheets.

The other additional sheets not present in the without project Recreation Benefits component are Alternatives SEG 1 and Alternatives SEG 2 sheets. Each sheet is laid out identically except that SEG 1 falls within reaches 3-5 in Encinitas and SEG 2 falls within reaches 8-9 in Solana Beach where the beach renourishments occur. Each sheet shows the averaged net beach width change from the project alternatives after placing 50 feet to 200 feet of initial fill down and allowing 1 to 16 years between renourishment cycles. For example row 14 of Alternatives SEG

[25] The exact share of attendance by distance from Encinitas is unknown because those statistics are not available.
However, we know the use statistics for nearby beach communities and can reasonably conclude that since Encinitas has about 64,000 residents no more than several hundred thousand of the 3 million annual beach visits can be attributed to its residents. The vast majority would have to come from areas outside Encinitas, which is comparable to Oceanside's use statistics.

1 sheet shows that five years after the 50-foot beach renourishment there is 19.7 feet of averaged remaining net beach. After eleven years there is only 1 foot remaining.

Table 4.5-1 RECREATION ANALYSIS WITH PROJECT BY SHEET WITH DESCRIPTION, INPUTS, AND OUTPUTS

Sheet Name	Purpose/Description	Inputs	Outputs
Rev_Values – DRY BEACH	Value recreation experience on dry beaches in study area; calculate number of transfers from dry beach to wet beach	*GIVEN* o Daily visitor turnover o Weekday & weekend distribution of visitors o Peak week & weekend days, off peak days o Turn away/overcrowding point in square feet per visitor UDV o Range of values for dry beach recreation per visitation dependent on level of crowding Area o Reduction in dry beach area due to low and high SLR	Remaining dry beach area, recreation demand, capacity to meet demand, visitations, transfers to wet beach, square feet per visitor, UDV per visitor, annual recreation value by reach
Rec_Values – WET BEACH	Value recreation experience on wet beaches in study area; value recreation experience gain to off-site transfers	*GIVEN* o Turn away/overcrowding point in square feet per visitor Rec_Values – DRY BEACH o Transfers from dry beach to wet beach, determine when dry beach begins to disappears due to low and high SLR UDV o Fixed value for wet beach recreation per visitation Area o Reduction in wet beach area due to low and high SLR and after dry beach disappears	Remaining wet beach area, recreation demand, capacity to meet demand, visitations, transfers to off-site beach, square feet per visitor, UDV per visitor, annual recreation value by reach
Area	Beach area for recreation lost to sea-level rise	Reduction in beach area under low and high sea-level rise scenarios by reach Initial mean-sea level (MSL) beach area and wet & dry beach area by reach	n/a
Demand	Apply forecasted recreation demand growth to historical attendance; growth mirrors projected San Diego county growth	Attend_Historical	Forecasted growth in recreation demand
Demand Growth	Apply Similar Project Method to estimate increased recreation demand with project alternatives in place	Travel distance by share of visitors Annual beach attendance at Carlsbad and Oceanside beaches Population by community in San Diego and Southern Orange & Riverside Counties	Estimated recreation demand by reach with project alternatives

Sheet Name	Purpose/Description	Inputs	Outputs
UDV	Unit Day Value; range of points and corresponding unit day values for various levels of crowding at the study area beaches; points assignment informed based by local expert assessment of five criteria	Unit Day Value points	Unit Day Values by level of crowding on beach
Alternative SEG 1	Provide averaged net beach width changes in Encinitas for each project alternative with zero to sixteen years between renourishment cycles	n/a	n/a
Alternative SEG 2	Provide averaged net beach width changes in Solana Beach for each project alternative with zero to sixteen years between renourishment cycles	n/a	n/a
Attend_Historical	Historical attendance data provided by local sponsors and used to forecast future attendance	n/a	n/a

4.6 Sloughing (Residual) Damage Analysis

SPREADSHEETS

Sloughing Damage Analysis[26]

Erosion Rates_sloughing

4.6.1 Layout & Process

With any of the alternatives in-place residual sloughing will occur in unstable areas until a stable angle of repose is achieved. Geotechnical analysis estimated the annual natural sloughing rates in unstable, unprotected areas of the study and this has been quantified in the *Erosion Rates_sloughing* spreadsheet. These annual sloughing rates are inputted in the Sloughing Damage Analysis spreadsheet, Annual Erosion Rates sheet to calculate annual land erosion rates due to sloughing. The Land Loss sheet takes these land erosion rates, which are in linear feet, and multiplies them by the affected parcel width to come up with land area lost. Finally this area is multiplied by the cost per square foot of bluff top land found in the VAR sheet. A summary of these losses are presented in the PV Losses and Summary of Losses sheets. An explanation of each sheet of the Sloughing Damage Analysis Component can be found in the table below.

[26] Excel Add-in @RISK must be running

Table 4.6-1 SLOUGHING DAMAGE ANALYSIS BY SHEET WITH DESCRIPTION, INPUTS, AND OUTPUTS

Sheet	Purpose/Description	Inputs	Outputs
VAR	Present key assumptions/inputs in one sheet	Bluff-top land loss value, iteration number to pull data from Erosion Rates sheet [separate spreadsheet]	n/a
Parcel Database	List all bluff-top parcels in Encinitas and Solana Beach with setback distance, parcel & structure area, structure value, toe depth	Area MFR&condos o condo & duplex area M&S o construction quality & condition valuations from Marshall & Swift	Structure depreciated replacement values
Area MFR&condos	Area of condos and duplexes by housing unit	n/a	n/a
M&S	Structure value per square foot by housing type, construction quality, and condition	Marshall & Swift Valuation Guide	n/a
Land Loss	Value of land lost prior to structure collapse; valued as bluff-top	Annual Erosion Rates, Parcel Database, VAR o linear feet of bluff-top land loss, parcel width, bluff-top land value per sq foot	Value of bluff-top land lost
PV Losses	Calculate the present value of the damages due to sloughing at bluff top	Total Land Loss	Present value *Total Land Loss* by reach
Summary of Losses	Simplified presentation of total damages by reach from *PV Losses*	PV Losses	Present Value of total damages by reach
Annual Erosion Rates	Simulates bluff-top land loss based on initial toe notch depth	Erosion Rates [separate spreadsheet] o distribution of land erosion events dependent on toe notch depth Parcel Database o initial toe notch depth by parcel	Bluff-top land loss in linear feet
Parcel Erosion	Derive structure setback distance from bluff-top during current year	Parcel Database o initial structure setback distance from bluff-top Annual Erosion Rates o bluff-top land loss in linear feet	Structure setback distance from bluff-top during current year
Toe Depths		Notch Erosion Rates [separate spreadsheet] Parcel Database o initial toe depths	Toe depth for current year
Erosion Rates_sloughing [separate spreadsheet]	Simulated probably distribution of bluff-top erosion dependent on initial toe notch depth and location within study area	n/a	Annual Erosion Rates sheet, bluff-top erosion for current year

4.7 Reduction in Storm Damage Benefits & Benefit Cost Analysis

SPREADSHEET[27]
B-C Analysis[28]

4.7.1 Layout & Process

B-C Analysis determines the net benefits of each project alternative by subtracting the costs from the benefits for each combination of fill alternative and replenishment/renourishment interval. The flow chart shown above outlines how to arrive at these cost and benefits. First without project damages from *Retreat* and *Armoring (Seawall) Scenario* are weighted and combined then *Sloughing Damages* are subtracted. Next the partial benefits curve is applied to arrive at the partial reduction in storm damages benefits of the project alternatives (Total With Project Benefits). Finally the project alternative costs are subtracted to arrive at the net benefits for each project alternative and the NED plan.

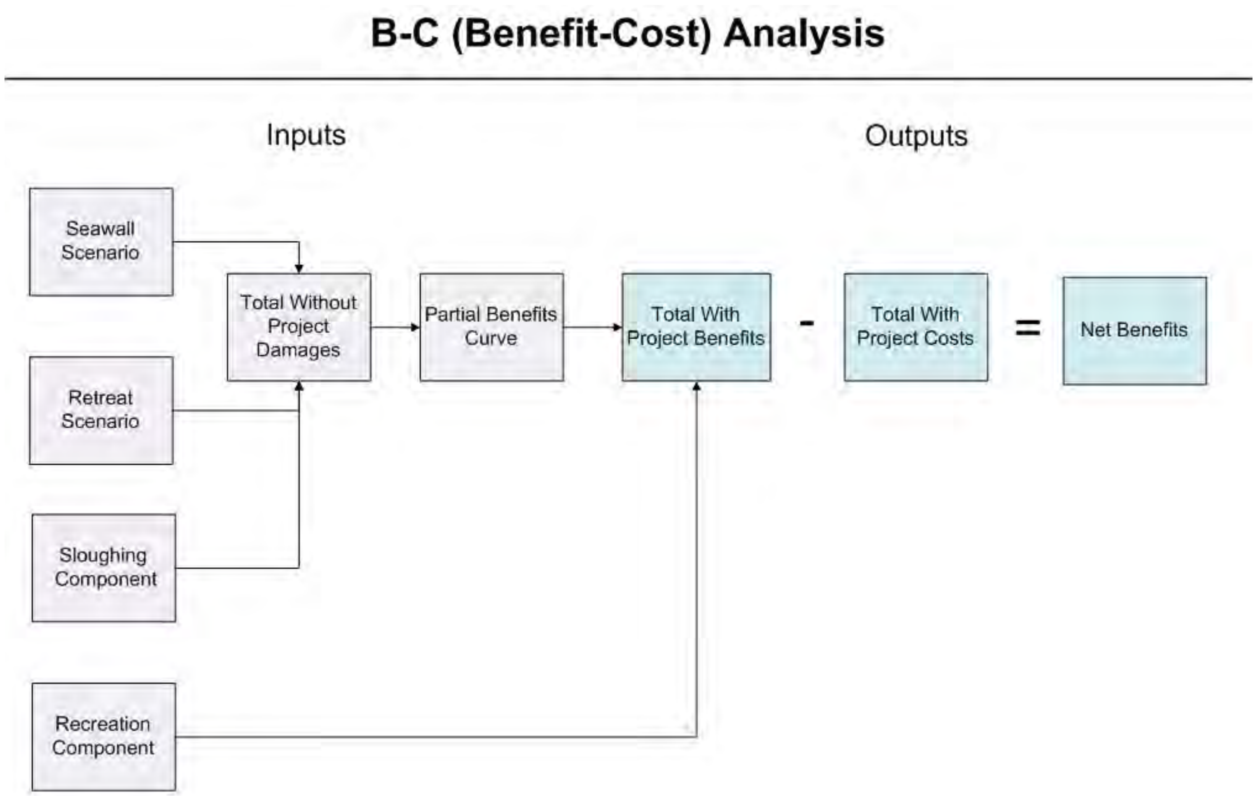

Figure 4.7-1 B-C (Benefit-Cost) Analysis

4.7.2 Deriving Realized/Partial Coastal Damage Benefits

To determine the realized coastal damage benefits, the maximum storm surge benefits are multiplied by the partial benefits curve percentage for each combination of renourishment interval and fill alternative. The steps to reach this calculation are found in BENEFIT SEG 1/2

[27] A table describes the layout and function of B-C Analysis at the end of this section.
[28] Excel Add-in @RISK must be running

sheets. The maximum possible storm protection benefits are given in cell D2. This is the weighted average of the annualized damages from the Retreat and Armoring Scenario Components derived in the VAR sheet rows 5 to 9.[29] The maximum storm protection benefit is used to derive the realized/actual storm damage benefits. The partial benefits curve is a range of beach widths with corresponding percentages of partial storm surge benefits that is displayed in VAR sheet rows 56 to 126. These partial benefits are weighted by the length of beach within seven ranges of widths shown in GENSESIS SEG 1/2 sheets, rows 53 to 99. The results are the weighted average percentage of storm damage benefits for all four fill alternatives across sixteen renourishment cycles shown in BENEFITS SEG 1, rows 31 to 37. This matrix of weighted average benefits is multiplied by the maximum potential storm surge benefits (cell D2) to derive the partial/realized storm surge benefits. Also included in this calculation are the recreation benefits, which are valued up to the partial storm surge benefits or the actual recreation benefits, whichever is less, in accordance with ER1105-2-100. The net present value and annualized benefits from this process are shown in BENEFIT SEG 1/2 from row 40 down.

Table 4.7-1 Selected Beach Widths and Corresponding Partial Benefits Curve Values (%)

feet	***90***	***100***	***110***	***120***	***……***	***170***	***180***	***190***	***200***	***210***
SEG 1	0%	0%	0%	6%	……	64%	72%	78%	83%	88%
SEG 2	0%	1%	6%	11%	……	33%	37%	41%	45%	49%

4.7.3 Beach Fill only & Hybrid Plan

A range of beach widths (50 to 200 additional feet) and renourishment cycles (2 to 16 years) are evaluated in *BC Analysis*. This is referred to as the 'Beach Fill Only' plan. In addition to the 'Beach Fill Only' plan, Coastal Engineers also evaluated placing semi-permanent fill inside the toe notches at the base of the bluff to augment each beach fill. This is referred to as the 'Hybrid' plan. These toe notch fills offers additional coastal storm surge damage reduction when minimal sand is present in the system to protect these coastal bluffs. To derive the protection factor, the toe notches for all parcels were set to zero feet in the *Armoring Scenario* spreadsheet. This approximates the initial conditions under the 'Hybrid' plan, which includes toe notch fills of similar density and durability as the surrounding sandstone. Next the excel add-in @RISK was used to run a simulation of erosion events (with *Erosion Rates* spreadsheet also open) on the parcels modeled in *Armoring Scenario.* The damages experienced by the unprotected parcels were compared to the damages experienced in a separate simulation in *Armoring Scenario* when the toe notches were not reset to zero feet (i.e. in their actual initial state). The percentage reduction is damages with the toe notches compared to unprotected properties with nonzero toe notches are the percent of additional coastal storm damage reduction benefits from the 'Hybrid' plan. These values are separated by segment and sea-level rise and stored in *BC Analysis, VAR* sheet for calculation in the *BENEFITS SEG 1/2* sheets.

[29] See B-C Analysis spreadsheet, VAR sheet at the top right. "Remaining Preventable Damages" is the result of weighting Armoring Damages and Retreat Damages then subtracting Sloughing Damages. See also "Weighting Armoring & Retreat Scenarios" earlier in this section.

Alternatives (net initial beach width change in feet)	Renourishment Cycles (years)	Sea-Level Rise Scenario
50	2 to 16	Low to High
100	2 to 16	Low to High
150	2 to 16	Low to High
200	2 to 16	Low to High

The additional costs of the toe notch fills in the 'Hybrid' plan are calculated in the *BC SUM SEG 1/2* sheets. These costs are added to each of the 'Beach Fill Only' alternatives calculated in the *COST SEG 1/2* sheets to determine the total costs for the 'Hybrid' plan as shown in *BC SUM SEG 1/2* sheets.

B-C Analysis retains the fill alternatives range from 50 feet to 200 feet of net increase to the initial shoreline width and the replenishment intervals range from two years to sixteen years. Each replenishment interval has a matrix that gives sand volume placements by each fill alternative and two sea-level rise scenarios. These matrices are found in Vol Lookup SEG 1/2 sheets. These volumes are used in the COST SEG 1/2 sheets to determine the variable cost to place a given amount of sand volume in the study area. The COST SEG 1/2 sheet combines the volume of sand placed with variable and fixed costs given in rows 2 to 6 to calculate the total costs in net present value of each renourishment interval and fill alternative across the study period. This information is laid out in matrices and the bottom of each matrix gives the net present value and annualized costs. A detailed description of how these costs are calculated is presented in the appendix under *With-Project Costs: Initial and Renourishment Fill*.

4.7.4 Presentation of Net Benefits

The benefits derived in BENEFIT SEG 1/2 and the costs derived in COST SEG 1/2 are summarized in the BC SUM SEG 1/2 sheet. The BC SUM SEG 1/2 sheet presents the benefit-cost ratio and the net benefits to arrive at the NED plan. It also calculates the additional cost to add toe notch fills to increase the storm surge protection of smaller beach width alternatives, which is labeled the "Hybrid Plan." The additional costs of the Hybrid Plan are shown in BC SUM 1 rows 93 to 116 and BC SUM 2 rows 137 to 168. The toe notch fill is placed during the initial year and continues to provide storm surge protection throughout the study period without maintenance costs. The additional benefits from the Hybrid Plan were derived by setting all toe notches to zero in the *Armoring and Retreat Scenario* to simulate the presence of toe notch fill. The partial benefits capture curve in VAR sheet rows 56 to 126 was adjusted by this percentage of added benefits, rows 57 to 61.

Table 4.7-2 B-C ANALYSIS BY SHEET WITH DESCRIPTION, INPUTS, AND OUTPUTS

Sheet[30]	Purpose/Description	Inputs	Outputs
VAR	Present key assumptions/inputs in one sheet, average annual without project damages (potential with-project benefits)	Armoring & Retreat Scenarios	n/a
REC BEN	Allow recreation benefits to be entered and evaluated with reduction to coastal storm damage benefits (BC SUM SEG 1/2 sheets)	Recreation Analysis With Project [separate spreadsheet] Recreation Analysis Without Project [separate spreadsheet]	n/a
SUM	Present Summary of Net Benefits and BC Ratios only	BS SUM SEG 1/2	n/a
GENESIS SEG 1	Segment 1 (Encinitas) Shoreline position across replenishment cycles for each project alternative; length of beach by width to determine full or partial storm surge protection benefits	Results from Genesis Model: changes to shoreline position, length of beach by width	n/a
BENEFIT SEG 1	Calculate partial benefits from storm surge provided by each combination of fill alternative and renourishment interval; determine annualized benefits for same	Benefits o weighted potential with-project benefits (from Armoring & Retreat Scenario) VAR o range of beach widths and corresponding partial benefits GENESIS SEG 1 o share of beach length of a given beach width	Partial benefits of storm surge protection by renourishment interval and fill alternative; annualized benefits
COST SEG 1	Calculate all associated sand replenishment costs; present annualized with-project costs.	VAR o fill cost per cubic yard, mo/demobilization, contingency, pre-construction engineering & design, SA, operation & maintenance, monitoring, environmental mitigation costs GENESIS SEG 1 o cubic yards of sand by fill alternative and renourishment interval	construction, monitoring, and operation & maintenance costs during the study period; average annualized costs
BC SUM SEG 1	Present annualized costs and benefits for each combination of alternative fill and replenishment cycle; calculate Net Benefits and BC Ratio; determine the NED Plan	COST SEG 1 o Annualized Costs BENEFIT SEG 1 o Annualized Benefits	Net Benefits, BC Ratio
Volume Lookup SEG 1	Provide volume of sand needed by fill alternative and replenishment cycle throughout study period	Results from Genesis Model: volumes of sand for each fill alternative and renourishment interval	n/a

[30] Sheets labeled GENESIS SEG 2, BENEFIT SEG 2, COST SEG 2, BC SUM SEG 2, and Volume Lookup SEG 2 refer to Segment 2 (Solana Beach) and are identical in layout and method of calculation to the sheets for Segment 1 shown in the table above.

Table 4.7-3 1 PROBABILITY DISTRIBUTIONS USED IN MODELING

Label	Distribution	Spreadsheet--Sheet	Description
Seawall Trigger	=RiskExtvalueAlt(0.05,4,0.95,36,RiskTruncate(-5,40))	Armoring Scenario --VAR	Minimum distance to bluff before armoring ("triggering event") derived from historical setback distances at time of seawall application
Seawall Trigger Delay	RiskUniform(1,2,3)		Delay in years between seeking seawall permit and receiving approval then constructing seawall; based on historical delay in within study area
Seawall Construction Costs	=RiskUniform(96000,150000,RiskStatic(180000))	Armoring/Retreat Scenario --VAR	Seawall Construction fixed costs including Permit, Design, Legal/Consulting derived from historical seawall construction in study area (most likely) with estimates of minimum and maximum
Seawall O&M Variable Costs	=RiskUniform(34,39)	Armoring/Retreat Scenario --VAR	Seawall O&M variable cost of repair (varies by linear feet of seawall) based on seawall engineer estimates
Seawall O&M Fixed Costs	=RiskUniform(2813,3214)	Armoring/Retreat Scenario --VAR	Seawall O&M fixed costs including permits, design, Legal/Consulting based on seawall engineer estimates
Erosion Rate Selection	=RiskIntUniform(1, 1000)	Armoring/Retreat Scenario & Sloughing Damage Analysis --VAR	Assigns uniform probability of choosing among 1000 simulated erosion rates for each year in the model. Note erosion rates are chosen from Erosion Rates spreadsheet

Label	Distribution	Spreadsheet--Sheet	Description
Demolition Costs	=RiskTriang(8.55,9.5,10.45,RiskStatic(9.5))	Retreat Scenario --VAR	Expert estimate of minimum, most likely, and maximum cost per square foot for demolition of structures
Percentage of Structure Content Damaged	=RiskTriang(10%,25%,50%,RiskStatic(25%))	Retreat Scenario --VAR	Percentage damage to structure contents when the structure fails from an episodic erosion event

Encinitas-Solana Beach Coastal Storm Damage Reduction Project (LPP)

San Diego County, California

Appendix F

Cost Estimate

U.S. Army Corps of Engineers
Los Angeles District

April 2015

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1 Overview

This paper discusses the cost assumptions and construction methodology utilized in the LPP for Encinitas and Solana Beach Shoreline Feasibility Study.

The Solana Beach-Encinitas shoreline study area is located along the Pacific Ocean in the Cities of Solana Beach and Encinitas, San Diego County, California. The City of Encinitas is approximately 10 miles (mi) south of Oceanside Harbor, and 17 mi north of Point La Jolla. The Encinitas shoreline is about 6 mi long. It is bounded on the north by Batiquitos Lagoon and on the south by San Elijo Lagoon. Immediately south of the City of Encinitas is the City of Solana Beach. Solana Beach is bounded by San Elijo Lagoon to the north and by the City of Del Mar on the south. It is approximately 17 mi south of Oceanside Harbor, and 10 mi north of Point La Jolla. Solana Beach's shoreline is about 2 mi long.

The project area consists of two segments. Segment 1 (Reaches 3, 4, and 5) exists within the City of Encinitas and is approximately 2.0 mi in length; Segment 2 (Reaches 8 and 9) exists within the City of Solana Beach and is approximately 1.4 mi in length.

The non-Federal sponsors are the City of Encinitas and the City of Solana Beach.

Project purpose is to reduce coastal storm damage and shoreline erosion at Encinitas and Solana Beach. The LPP recommended plan involves the use of a hopper dredge to excavate sand from offshore borrow sites and pumping it to Encinitas and Solana Beach.

The Cost Engineering Dredge Estimating Program (CEDEP) program was used to compute hopper dredging unit costs for Encinitas (Segment 1) and Solana Beach (Segment 2). The dredging unit costs were transferred to the Micro-Computer Aided Cost Engineering System, Second Generation (Mii) software program. Current Working Estimate (CWE) meets the Standard USACE Civil Works Work Breakdown Structure (WBS).

2 Direct Cost

Unit costs for mob/demob and hopper dredge operations were calculated using the Hopper Dredge CEDEP program. The CEDEP dredging units cost accounts for the dredging operation of a single event. Unit costs for the pump-out pipelines were calculated on a separate CEDEP run from a division of the Pipeline Dredge CEDEP program. Unit costs for the hopper dredge, pump-out pipeline, mob/demob and shore crews were integrated in MCACES (MII). There are a total of four MCACES (MII) estimates: one MII estimate for the initial event, a second MII estimate for subsequent synched Solana-Encinitas events, a third MII estimate for subsequent Solana Beach events and a fourth MII estimate for subsequent Encinitas Beach events.

The total project cost is broken down into three estimates. One estimate was prepared for the initial dredging event where the Solana and Encinitas segments are assumed to be awarded under contract. The initial combined Solana-Encinitas estimate includes associated mitigation and monitoring cost incurred within the first 5 years for the Encinitas reach and the first 10 years for the Solana reach. The other two estimates were prepared, individually, for Solana and Encinitas subsequent dredging events including associated mitigation and monitoring costs lapsing through the remaining years of the 50-yr project.

On years 2025 and 2035, the Encinitas re-nourishment events and Solana Beach re-nourishment events coincide. In other words they are synched and awarded under one contract, accordingly. Costs for these subsequent events (including mob and demob) are shared by the cities of Encinitas and Solana Beach. Therefore in the TPC, total costs for years 2025 and 2035 were apportioned between the Encinitas and Solana periodic beach nourishments; mobilization and demobilization were equally shared between the two cities.

Labor rates used to develop the estimate were provided from latest Davis-Bacon Wage Rates for San Diego County, Heavy and Dredging.

Equipment rates are based on the US Army Corps of Engineers EP 1110-1-8 "Construction Equipment Ownership and Expense Schedule", Region 7 and CEDEP.

Crews were developed for project specific application and are listed in the crew database.

3 Dredge Quantity and Material Analysis

In Encinitas (Segment 1), approximately 410,000 CY of beach quality sand will be initially dredged and placed along 1.5 mi of shoreline providing an additional nourishment width of 50 ft. In-place beach volume amounts to approximately 340,000 CY. The beach fill will then naturally slope seaward at a slope of 10:1. Beach replenishment of an additional dredged sand volume of 260,000 CY would occur, on average, every 5 years within the 50-year project life.

In Solana (Segment 2), approximately 860,000 CY of beach quality sand will be initially dredged and placed along 1.4 mi of the shoreline, providing an additional nourishment width of 150 ft. The beach fill will then naturally slope seaward at a slope of 10:1. Beach replenishment of an additional dredged sand volume of 350,000 CY would occur, on average, every 10 years within the 50-year project life.

Dredging area within the CEDEP program is based on the given volumes for each segment and a bank height of 3-feet.

Material classification assumed: 6% fines, 92% sand and 2% gravel. Material classification is directly linked to the excavating or pumping rate of the dredge.

4 Dredge Equipment Selection

Equipment selection and sizing were developed through construction cost estimator experience and consultation with the designer and study manager.

A medium-sized hopper dredge with pump-out capabilities is selected due to the long haul from the sand source to the receiver beach. Selected hopper maximum safe load capacity is 2,500 CY; however the effective capacity is 1,750 CY for sandy material. The hopper pump-out capabilities permit reverse pumping the dredge material via a pipeline.

The dredge and construction equipment are expected to operate on a 24/7 basis. Construction is planned to occur during a period of seasonably mild wave climate between April and September. And two (2) beach access/temporary staging areas will be required for the term of construction.

5 Fuel Adjustments

Of all the dredging equipment available, hopper dredges are the most sensitive to fuel price fluctuations. Out-in-the-ocean delivery marine diesel fuel cost was estimated from a quote from a local supplier.

6 Quantity Analysis

Quantities are based on dredged volumes instead of placement volumes. Dredge quantities assume 20% loss by volume. Placement quantities are based on shoreline modeling and erosion rates.

Take-off and hauling distances were provided by Noble Consultants (Chia Chi Lu, PE). Given volumes were used to run the CEDEP estimates and develop dredging unit costs.

7 Dredging Construction Methodology

Dredging operation mirrors the beach nourishment work that took place at San Diego, in 2001. The selected hopper is equipped with an installation at the bow of the ship, which makes it possible to connect to a moored floating/sunken pipeline in the open sea.

The first step in beginning the beach replenishment process involves transporting and installing the sunken/floating beach access pipeline. The dredge is attached to a floating section of the pipeline which is connected to the submerged pipeline section.

The hopper dredge is filled at the designated S0-6 borrow site for Encinitas and SO-5 borrow site for Solana Beach. Dredge material is hauled 2.5 miles to Encinitas (Segment 1) and 1.9 miles to Solana (Segment 2). At the receiver beach, the dredge is attached to a moored floating section of pipeline extending 2,640 feet to the shoreline. The material is re-suspended and discharged through its on-board pumping system to the receiver site.

Total pump-out pipeline length consists of 2,640 LF of submerged/floating pipeline, in addition to the shore pipeline. Shore pipeline length amounts to 1,500 lf for the Encinitas segment and 3,500 lf for the Solana segment.

For the Encinitas segment the mooring site where the hopper dredge connects to pump-out the slurry to the shore will be relocated 3 times.

The Solana segment allows for only one central pump out slurry location, therefore pump-out mooring site once established will not be relocated.

Remove submerged and shore pipeline upon completion.

The shore crew was broken down in two parts: morning crew and night (skeleton) crew. The morning crew consists of a loader (severe conditions), a dozer (severe conditions), fill placer, shoremen and a superintendent. The morning crew will build berms, contain the slurry, and build a gigantic hole for the night pumping. The beach is graded so that a basin is created by the morning crew to contain the slurry pumped at night. The shore night crew is for safety.

8 Dredge Mobilization and Demobilization

Includes hopper dredge and moored/sunken pipeline transfer, setup and dismantle. Since there is very little hopper dredge work on the west coast, a more likely scenario is that a hopper dredge would mob/demob from the Gulf of Mexico or from the east coast. The distance from New Orleans to Los Angeles is approximately 4,300 nautical miles (5,000 statute miles).

9 Dredging Schedule

Dredging operation is performed 24-hours a day, 7 days a week. Dredging shore crew operation is performed 12-hours a day, 7 days a week. Contract restrictions limit our operating time on the beach to meet noise ordinances. Dredging contracts limit heavy equipment operations on the beach between 7:00 am and 7:00 pm, but marine equipment is allowed to work 24-hours a day.

Estimated initial dredging (combined Encinitas and Solana Beach) duration amounts to 4 months, excluding mob/demob. Project duration per nourishment event is approximately 1 month for the Encinitas beach replenishment and an additional 1.1 months for the Solana beach replenishment, excluding mob/demob.

10 Mitigation and Monitoring Costs

Habitat mitigation costs consist of kelp establishment.

10.1 Kelp Reef Mitigation

The overall purpose is to create a reef kelp habitat to offset lost habitat. Costs are associated only with Solana Beach reef mitigation. Encinitas beach nourishment does not result into kelp habitat loss.

The profile of the reef consists of a single rock layer rising no more than 1.5 feet off the existing sand seafloor. Quarry boulders are the exclusive construction material used to build reefs, specifically quarter-ton rock. Assume quarry boulders are transported to the placement site utilizing tugboats towing either 1 or 2 flat deck barges. Boulders are mined from quarries at Santa Catalina Island. As a reference, the project by Southern California Edison on the Wheeler North Reef at San Clemente (2008) had a variation of boulder deposition ranging from 743 to 987 tons per acre with an average of 865 tons/acre. Based on the Wheeler North Reef at San Clemente assume an overall average tonnage per acre of 685 with a coverage of 42% to 66% (average of 54% coverage).

Initially a derrick barge is positioned by tugboat above the designated dumping area. Motorized winch anchor lines moor the derrick barge within the boundary. During boulder deposition, the derrick barge is guided into the designated position by winching in or out on anchor cables connected to their respective anchors. Each anchor is connected by a cable to a concrete anchor block and then cabled to the derrick-barge. The locations of the anchors are routinely monitored by an attending tugboat and by the derrick barge winch operator. After securely tethering the supply-barge to the derrick-barge, the derrick-barge winch operator maneuvers the edge of the flat deck barge to the required position. The derrick-barge winch operator assists in locating the edge of the supply barge at the exact line of deployment. The stone is pushed in a windrows by a track dozer over the edge of the supply barge. Assume stone is allowed to be placed during day light hours, only. No placement is done at night, except for hauling.

Assume contract allows lead time for the quarry to fabricate the stone ahead of time.

10.2 Shoreline Monitoring

Shoreline monitoring determines changes in beach and seabed morphology; and it triggers re-nourishment events. Physical monitoring involves measuring changes is elevation and volume through successive bathymetric surveys; taking sand samples; and measuring beach profiles. Physical monitoring is needed to quantify the benefits of the sand replenishment project. Monitoring is conducted along Encinitas; Solana Beach; geographical area between Encinitas and Solana Beach; Del Mar shores; and Peñasquitos Lagoon. Estimates account for two (2) surveys per year: spring and fall. Surveys occur annually and work will be contracted out.

10.3 Habitat Monitoring

Purpose is to map extent of reef habitat and submerged aquatic vegetation. Habitat Monitoring determines if there are project impacts. During the project the environmental monitoring is conducted to confirm that the management plan is having the desired effect. Continuation of monitoring after the project's completion guarantees no long-term negative impacts. Work consists on conducting off-shore surveys. Monitored area includes Encinitas, Solana Beach and the in-bounded segment between Encinitas and Solana Beach. Work will be contracted out.

10.4 Surfing Monitoring Plan

The monitored area includes the in-bounded segment between Encinitas and Solana Beach. Surfing monitoring costs consist of data acquisition from an established company that specializes in surfing observations and forecasting. A trained observer visually estimates the breaking wave climate at the shoreline twice daily. Oceanographic characteristics including the surf quality, wave height, wave period, wave direction, tide, sea surface condition, and video recordings. Cost estimates account for daily observations for the project life cycle.

10.5 Borrow Site Monitoring Plan

Work consists on monitoring seafloor morphology, water quality and benthic habitat quality. A total of six (6) off-shore surveys (monitoring) are forecasted for each dredging event.

10.6 Miscellaneous Monitoring Plans

Monitoring plans taking place during construction are included in the Mii estimates under field office overhead: water quality monitoring plan; California grunion monitoring and avoidance plan; noise monitoring plan; Snowy Plower monitoring; storm-water pollution prevention plan; oil spill prevention plan; and safety plan.

10.7 Lagoon Sedimentation

Lagoon sedimentation maintenance costs for San Dieguito, San Elijo, Batiquitos and Peñasquitos were provided by lagoon managers. Costs are based on on-going lagoon maintenance costs for their dredging cost maintenance.

11 Dredging Contractor Markups

The CWE is based on performing the work using the “Invitation for Bid” contract mechanism.

12 Planning, Engineering and Design (PED) and Construction Management

Planning, Engineering and Design (PED) and Construction Management estimates were based on labor-hour estimates provided by section chiefs. Associated burdened hourly rates were extracted from CEFMS.

13 Contingency

Contingency was derived from the Cost and Schedule Risk Analysis (CSRA). Please refer to the risk analysis study.

14 Escalation

Construction Escalation is based on the Civil Works Construction Cost Index System (CWCCIS) EM 1110-2-1304, dated 30 September 2013.

PED and Construction Management Escalation is based on EC 11-2-XXX Table 1, Class 1 (Government Personnel)

Real Estate escalation is based on the Construction Price Yearly Index (CPI)

Estimate was inflated to mid-point of construction for the initial and subsequent nourishment events.

Please refer to the Total Project Cost Summary (TPCS) for breakdown.

15 Dredging Alternatives

The hopper dredge method was used because it is the most likely method used for beach nourishment in this region. However, a combination of hopper/pipeline cutterhead was considered as an alternate procedure but conceptually it was determined to be less economical. The hopper hauls the material, disposes of it temporarily near the shore and a pipeline cutterhead pumps it ashore. The hopper and the hydraulic cutterhead would have worked independently, since production rates would have differed significantly. It should be noted an increase in quantity due to handling losses. Mob/demob of both plants will double.

Another alternative was to select the MB-1 borrow site as a source of borrow material instead of the SO-6 borrow site. The MB-1 borrow site is located farther than the SO-6 borrow site and its use would have significantly increased the cost.

During the PDT’s screening process the exclusive use of the hydraulic cutterhead and direct pipeline method was discarded due to project conditions or criteria. Dredging will take place in the open-ocean and hopper dredges work better in adverse sea conditions. Borrow site may or may not be available at the time dredging events are scheduled specially in the out years. The contract may require excavation at two or more different borrow sites during a single dredging event in which case relocating submerged pipelines out-in-the-ocean would be an inconvenience. Generally, hydraulic dredges are cost effective if within pumping distance of the disposal area, however, hopper dredges are more economical on longer hauls in case of modifications to current sole-source borrow site. Ultimately, the selected dredging method using the hopper dredge with pump-out capability mirrors the construction methodology utilized in 2001 by Great Lakes during construction of Torrey Pines.

WALLA WALLA COST ENGINEERING MANDATORY CENTER OF EXPERTISE

COST AGENCY TECHNICAL REVIEW

CERTIFICATION STATEMENT

SPL - PN 104716
Solana-Encinitas Coastal Storm Damage Reduction Project

The Solana-Encinitas Costal Storm Damage Reduction Project, as presented by the Los Angeles District, has undergone a successful Cost Agency Technical Review (Cost ATR) of remaining costs, performed by the Walla Walla District Cost Engineering Mandatory Center of Expertise (Cost MCX) team. The Cost ATR included study of the project scope, report, cost estimates, schedules, escalation, and risk-based contingencies. This certification signifies the cost products meet the quality standards as prescribed in ER 1110-2-1150 Engineering and Design for Civil Works Projects and ER 1110-2-1302 Civil Works Cost Engineering.

As of March 23, 2015, the Cost MCX certifies the estimated total project cost:

NED:

FY2015 First Costs:	$ 194,152,000
Fully Funded Costs:	$ 382,606,000

LPP:

FY2015 First Costs:	$ 164,892,000
Fully Funded Costs:	$ 330,008,000

Note: It remains the responsibility of the District to correctly reflect these cost values within the Final Report and to implement effective project management controls and implementation procedures including risk management throughout the life of the project.

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Kim C. Callan, PE, CCE, PM
Chief, Cost Engineering MCX
Walla Walla District

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: **Encinitas-Solana Beach Coastal Storm Damage Reduction -- NED PLAN**
PROJECT NO: P2 104716
LOCATION: San Diego County, CA

DISTRICT: Los Angeles District, SPL **PREPARED: 3/3/2015**
POC: CHIEF, COST ENGINEERING, Michael Newnam, P.E.

This Estimate reflects the scope and schedule in report; PDR based on Civil Works Review Board Comments

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROGRAM / BUDGET YEAR COST (Constant Dollar Basis)**						**TOTAL PROJECT COST (FULLY FUNDED)**			
						Program Year (Budget EC): 2015 Effective Price Level Date: 1 OCT 14									
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**	Spent Thru: **1-Oct-13** ($K)	**TOTAL COST** ($K)	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*K*	*L*	*M*	*N*	*O*
17	BEACH REPLENISHMENT (w/ Shoreline Monitoring)	$98,522	$32,512	$5	$131,034	1.5%	$99,953	$32,984	$132,937	$0	$132,937	67.0%	$166,962	$55,097	$222,059
06	FISH & WILDLIFE FACILITIES: REEF CONSTRUCTION	$2,023	$971	$0	$2,994	1.9%	$2,062	$990	$3,052	$0	$3,052	11.9%	$2,308	$1,108	$3,415
06	FISH & WILDLIFE FACILITIES MITIGATION: MONITORING AND LAGOON SEDIMENTATION	$11,103	$5,329	$4	$16,432	1.9%	$11,319	$5,433	$16,752	$0	$16,752	72.3%	$19,508	$9,364	$28,872
18	CULTURAL RESOURCE PRESERVATION	$34	$7	$0	$41	1.8%	$35	$7	$42	$0	$42	7.5%	$37	$8	$45
	CONSTRUCTION ESTIMATE TOTALS:	$111,682	$38,820	$10	$150,502	1.5%	$113,369	$39,415	$152,784	$0	$152,784	66.5%	$188,815	$65,577	$254,392
01	LANDS AND DAMAGES	$348	$66	$1	$414	3.3%	$360	$68	$428	$0	$428	56.9%	$564	$107	$671
30	PLANNING, ENGINEERING & DESIGN	$26,304	$4,998	$5	$31,302	2.2%	$26,872	$5,106	$31,978	$0	$31,978	221.9%	$86,505	$16,436	$102,941
31	CONSTRUCTION MANAGEMENT	$7,372	$1,401	$2	$8,773	2.2%	$7,531	$1,431	$8,962	$0	$8,962	174.5%	$20,673	$3,928	$24,601
	PROJECT COST TOTALS:	$145,706	$45,284	31.1%	$190,990		$148,132	$46,020	**$194,152**	$0	**$194,152**	97.1%	$296,558	$86,048	$382,606

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PROJECT MANAGER, Susie Ming, P.E.

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CHIEF, REAL ESTATE, Theresa Kaplan

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CHIEF, ENGINEERING, Richard J. Leifield, P.E.

ESTIMATED FEDERAL COST:	**52%**	**$197,431**
ESTIMATED NON-FEDERAL COST:	**48%**	**$185,175**
ESTIMATED TOTAL PROJECT COST:		**$382,606**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Encinitas-Solana Beach Coastal Storm Damage Reduction -- NED PLAN
LOCATION: San Diego County, CA
This Estimate reflects the scope and schedule in report; PDR based on Civil Works Review Board Comments

DISTRICT: Los Angeles District, SPL
POC: CHIEF, COST ENGINEERING, Michael Newnam, P.E.
PREPARED: 3/3/2015

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			5-Dec-13	Program Year (Budget EC):			2015					
		Effective Price Level:			1-Oct-13	Effective Price Level Date:			1 OCT 14					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	ENCINITAS & SONATA BEACH NOURISHMENT INITIAL EVENT													
17	Solana - Encinitas Initial Beach Nourishment (Yr 2018)	$19,470	$6,425	33%	$25,895	1.5%	$19,753	$6,518	$26,271	2018Q4	7.5%	$21,243	$7,010	$28,253
06	Solana - Reef Mitigation (Yr 2020)	$2,023	$971	48%	$2,994	1.9%	$2,062	$990	$3,052	2020Q4	11.9%	$2,308	$1,108	$3,415
17	Shoreline Monitoring (Yearly - Yr 2017 thru Yr 2022)	$440	$145	33%	$585	1.5%	$446	$147	$594	2020Q4	11.9%	$499	$165	$664
06	Habitat Monitoring Plan (Yearly - Yr 2017 thru Yr 2020)	$272	$131	48%	$403	1.9%	$277	$133	$410	2019Q4	9.7%	$304	$146	$450
06	Surfing Monitoring Plan (Yearly - Yr 2017 thru Yr 2022)	$90	$43	48%	$133	1.9%	$92	$44	$136	2020Q4	11.9%	$103	$49	$152
06	Borrow Site Monitoring Plan (Yearly - Yr 2017 thru Yr 2020)	$192	$92	48%	$284	1.9%	$196	$94	$290	2019Q4	9.7%	$215	$103	$318
06	Encinitas - Lagoon Sedimentation: San Elijo and Batiquitos - (Yearly - Yr 2018 thru Yr 2022)	$280	$134	48%	$414	1.9%	$285	$137	$422	2020Q4	11.9%	$319	$153	$473
06	Solana - Lagoon Sedimentation: San Dieguito, San Elijo, and Peñasquitos (Yearly - Yr 2018 thru Yr 2030)	$1,411	$677	48%	$2,088	1.9%	$1,438	$690	$2,129	2023Q4	18.7%	$1,708	$820	$2,528
18	Cultural Resources Plan (Yr 2018)	$34	$7	21%	$41	1.8%	$35	$7	$42	2018Q4	7.5%	$37	$8	$45
	CONSTRUCTION ESTIMATE TOTALS:	$24,212	$8,626	35.6%	**$32,838**		$24,585	$8,761	$33,346			$26,736	$9,562	$36,298
01	LANDS AND DAMAGES	48	$9	19.0%	$57	3.3%	$50	$9	$59	2017Q4	4.4%	$52	$10	$62
30	PLANNING, ENGINEERING & DESIGN													
0.0%	Project Management	$79	$15	19%	$94	2.2%	$81	$15	$96	2017Q4	10.6%	$89	$17	$106
0.0%	Planning & Environmental Compliance	$22	$4	19%	$26	2.2%	$22	$4	$27	2017Q4	10.6%	$25	$5	$30
0.0%	Engineering & Design	$1,289	$245	19%	$1,534	2.2%	$1,317	$250	$1,567	2017Q4	10.6%	$1,456	$277	$1,733
0.0%	Reviews, ATRs, IEPRs, VE	$350	$67	19%	$417	2.2%	$358	$68	$425	2017Q4	10.6%	$395	$75	$471
0.0%	Life Cycle Updates (cost, schedule, risks)	$29	$6	19%	$35	2.2%	$30	$6	$35	2017Q4	10.6%	$33	$6	$39
0.0%	Contracting & Reprographics	$40	$8	19%	$48	2.2%	$41	$8	$49	2017Q4	10.6%	$45	$9	$54
0.0%	Engineering During Construction	$532	$101	19%	$633	2.2%	$543	$103	$647	2018Q4	14.9%	$625	$119	$743
0.0%	Planning During Construction	$65	$12	19%	$77	2.2%	$66	$13	$79	2018Q4	14.9%	$76	$14	$91
0.0%	Project Operations	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
0.0%	Construction Management	$2,525	$480	19%	$3,005	2.2%	$2,580	$490	$3,070	2018Q4	14.9%	$2,964	$563	$3,528
0.0%	Project Operation:	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Project Management	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:	$29,191	$9,572		**$38,763**		$29,672	$9,728	$39,400			$32,497	$10,657	**$43,154**
COST SPLIT														
65%	**FEDERAL COST TOTALS:**				25,159				25,572					28,010
35%	**NON-FEDERAL COSTS TOTALS:**				13,604				13,828					15,144

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Encinitas-Solana Beach Coastal Storm Damage Reduction -- NED PLAN
LOCATION: San Diego County, CA
This Estimate reflects the scope and schedule in report; PDR based on Civil Works Review Board Comments

DISTRICT: Los Angeles District, SPL
POC: CHIEF, COST ENGINEERING, Michael Newnam, P.E.
PREPARED: 3/3/2015

Civil Works Work Breakdown Structure		ESTIMATED COST				PROGRAM / BUDGET YEAR COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 5-Dec-13 Effective Price Level: 1-Oct-13				Program Year (Budget EC): 2015 Effective Price Level Date: 1 OCT 14								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	ENCINITAS - 9 PERIODIC BEACH NOURISHMENTS ON 5-YR CYCLES (100-FT beach width)													
17	Encinitas - Subsequent Beach Nourishment (Yr 2023)	$5,940	$1,960	33%	$7,900	1.5%	$6,026	$1,989	$8,015	2023Q3	18.1%	$7,120	$2,350	$9,470
17	Encinitas - Subsequent Beach Nourishment (Yr 2028)	$5,940	$1,960	33%	$7,900	1.5%	$6,026	$1,989	$8,015	2028Q3	30.4%	$7,861	$2,594	$10,455
17	Encinitas - Subsequent Beach Nourishment (Yr 2033)	$5,940	$1,960	33%	$7,900	1.5%	$6,026	$1,989	$8,015	2033Q3	44.0%	$8,679	$2,864	$11,543
17	Encinitas - Subsequent Beach Nourishment (Yr 2038)	$5,940	$1,960	33%	$7,900	1%	$6,026	$1,989	$8,015	2038Q3	59.0%	$9,583	$3,162	$12,745
17	Encinitas - Subsequent Beach Nourishment (Yr 2043)	$5,940	$1,960	33%	$7,900	1%	$6,026	$1,989	$8,015	2043Q3	75.6%	$10,580	$3,491	$14,071
17	Encinitas - Subsequent Beach Nourishment (Yr 2048)	$5,940	$1,960	33%	$7,900	1%	$6,026	$1,989	$8,015	2048Q3	93.8%	$11,681	$3,855	$15,536
17	Encinitas - Subsequent Beach Nourishment (Yr 2053)	$5,940	$1,960	33%	$7,900	1.5%	$6,026	$1,989	$8,015	2053Q3	114.0%	$12,897	$4,256	$17,153
17	Encinitas - Subsequent Beach Nourishment (Yr 2058)	$5,940	$1,960	33%	$7,900	1.5%	$6,026	$1,989	$8,015	2058Q3	136.3%	$14,239	$4,699	$18,938
17	Encinitas - Subsequent Beach Nourishment (Yr 2063)	$5,940	$1,960	33%	$7,900	1.5%	$6,026	$1,989	$8,015	2063Q3	160.9%	$15,721	$5,188	$20,909
17	Shoreline and Surfing Monitoring (Yearly - Yr 2023 thru Yr 2067)	$2,585	$853	33%	$3,438	1.5%	$2,623	$865	$3,488	2047Q3	90.0%	$4,984	$1,645	$6,628
06	Borrow Site Monitoring (Yrs 2023, 2028, 2033, 2038, 2043, 2048, 2053, 2058, 2063)	$1,742	$836	48%	$2,578	1.9%	$1,776	$852	$2,628	2038Q3	59.0%	$2,824	$1,355	$4,179
06	Encinitas - Lagoon Sedimentation: San Elijo & Batiquitos (Yearly Yr 2023 thru Yr 2067)	$2,520	$1,210	48%	$3,730	1.9%	$2,569	$1,233	$3,802	2047Q3	90.0%	$4,882	$2,343	$7,226
	CONSTRUCTION ESTIMATE TOTALS:	$60,307	$20,541	34.1%	**$80,848**		$61,204	$20,849	$82,053			$111,051	$37,803	$148,853
01	LANDS AND DAMAGES	225	$43	19%	$268	3.3%	$233	$44	$277	2043Q3	64.7%	$383	$73	$456
30	PLANNING, ENGINEERING & DESIGN													
0.0%	Project Management	$549	$104	19%	$653	2.2%	$561	$107	$667	2042Q3	235.7%	$1,883	$358	$2,240
0.0%	Planning & Environmental Compliance	$198	$38	19%	$236	2.2%	$202	$38	$241	2042Q3	235.7%	$679	$129	$808
0.0%	Engineering & Design	$9,968	$1,894	19%	$11,862	2.2%	$10,183	$1,935	$12,118	2042Q3	235.7%	$34,180	$6,494	$40,675
0.0%	Reviews, ATRs, IEPRs, VE	$3,073	$584	19%	$3,657	2.2%	$3,139	$596	$3,736	2042Q3	235.7%	$10,537	$2,002	$12,539
0.0%	Life Cycle Updates (cost, schedule, risks)	$479	$91	19%	$570	2.2%	$489	$93	$582	2042Q3	235.7%	$1,642	$312	$1,955
0.0%	Contracting & Reprographics	$360	$68	19%	$428	2.2%	$368	$70	$438	2042Q3	235.7%	$1,234	$235	$1,469
0.0%	Engineering During Construction	$2,756	$524	19%	$3,280	2.2%	$2,816	$535	$3,350	2043Q3	252.7%	$9,930	$1,887	$11,817
0.0%	Planning During Construction	$540	$103	19%	$643	2.2%	$552	$105	$656	2043Q3	252.7%	$1,946	$370	$2,315
0.0%	Project Operations	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
0.0%	Construction Management	$3,508	$667	19%	$4,175	2.2%	$3,584	$681	$4,265	2043Q3	252.7%	$12,639	$2,401	$15,041
0.0%	Project Operation:	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Project Management	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:	$81,963	$24,655		**$106,618**		$83,330	$25,053	$108,383			$186,105	$52,063	**$238,168**
COST SPLIT														
50%	**FEDERAL COST TOTALS:**				53,175				54,053					118,856
50%	**NON-FEDERAL COSTS TOTALS:**				53,443				54,330					119,312

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Encinitas-Solana Beach Coastal Storm Damage Reduction -- NED PLAN
LOCATION: San Diego County, CA
This Estimate reflects the scope and schedule in report; PDR based on Civil Works Review Board Comments

DISTRICT: Los Angeles District, SPL PREPARED: 3/3/2015
POC: CHIEF, COST ENGINEERING, Michael Newnam, P.E.

Civil Works Work Breakdown Structure		ESTIMATED COST				PROGRAM / BUDGET YEAR COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			5-Dec-13	Program Year (Budget EC):			2015					
		Effective Price Level:			1-Oct-13	Effective Price Level Date:			1 OCT 14					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	SOLANA - 3 PERIODIC BEACH NOURISHMENTS ON 13-YR CYCLES (200-FT beach width)													
17	Solana - Subsequent Beach Nourishment (Yr 2031)	$6,742	$2,225	33%	$8,967	1.5%	$6,840	$2,257	$9,097	2031Q3	38.4%	$9,469	$3,125	$12,593
17	Solana - Subsequent Beach Nourishment (Yr 2044)	$6,742	$2,225	33%	$8,967	1.5%	$6,840	$2,257	$9,097	2044Q3	79.1%	$12,249	$4,042	$16,291
17	Solana - Subsequent Beach Nourishment (Yr 2057)	$6,691	$2,208	33%	$8,899	1.5%	$6,788	$2,240	$9,028	2057Q3	131.7%	$15,725	$5,189	$20,914
17	Shoreline and Surfing Monitoring (Yearly - Yr 2023 thru Yr 2067)	$2,392	$789	33%	$3,181	1%	$2,427	$801	$3,228	2045Q3	82.7%	$4,433	$1,463	$5,895
06	Borrow Site Monitoring (Yr 2031, Yr 2044 and Yr 2057)	$581	$279	48%	$860	1.9%	$592	$284	$877	2044Q3	79.1%	$1,061	$509	$1,570
06	Solana - Lagoon Sedimentation: San Dieguito, San Elijo and Peñasquitos (Yearly - Yr 2031 thru Yr 2067)	$4,015	$1,927	48%	$5,942	1.9%	$4,093	$1,965	$6,058	2049Q3	97.7%	$8,093	$3,884	$11,977
	CONSTRUCTION ESTIMATE TOTALS:	$27,163	$9,653	35.5%	**$36,816**		$27,580	$9,804	$37,384			$51,028	$18,212	$69,240
01	LANDS AND DAMAGES	75	$14	19%	$89	3.3%	$78	$15	$92	2044Q3	67.0%	$129	$25	$154
30	PLANNING, ENGINEERING & DESIGN													
0.0%	Project Management	$183	$35	19%	$218	2.2%	$187	$36	$222	2043Q3	252.7%	$659	$125	$785
0.0%	Planning & Environmental Compliance	$66	$13	19%	$79	2.2%	$67	$13	$80	2043Q3	252.7%	$238	$45	$283
0.0%	Engineering & Design	$3,323	$631	19%	$3,954	2.2%	$3,395	$645	$4,040	2043Q3	252.7%	$11,973	$2,275	$14,248
0.0%	Reviews, ATRs, IEPRs, VE	$1,024	$195	19%	$1,219	2.2%	$1,046	$199	$1,245	2043Q3	252.7%	$3,690	$701	$4,391
0.0%	Life Cycle Updates (cost, schedule, risks)	$160	$30	19%	$190	2.2%	$163	$31	$195	2043Q3	252.7%	$576	$110	$686
0.0%	Contracting & Reprographics	$120	$23	19%	$143	2.2%	$123	$23	$146	2043Q3	252.7%	$432	$82	$515
0.0%	Engineering During Construction	$919	$175	19%	$1,094	2.2%	$939	$178	$1,117	2044Q3	270.6%	$3,479	$661	$4,140
0.0%	Planning During Construction	$180	$34	19%	$214	2.2%	$184	$35	$219	2044Q3	270.6%	$681	$129	$811
0.0%	Project Operations	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
0.0%	Construction Management	$1,339	$254	19%	$1,593	2.2%	$1,368	$260	$1,628	2044Q3	270.6%	$5,069	$963	$6,032
0.0%	Project Operation:	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Project Management	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:	$34,552	$11,057		**$45,609**		$35,130	$11,239	$46,368			$77,956	$23,328	**$101,284**
COST SPLIT														
50%	**FEDERAL COST TOTALS:**				22,760				23,138					50,565
50%	**NON-FEDERAL COSTS TOTALS:**				22,849				23,230					50,719

Filename: Solana-Encinitas_TPCS_March 2015 -- NED.xlsx
TPCS

****** TOTAL PROJECT COST SUMMARY ******

PROJECT: **Encinitas-Solana Beach Coastal Storm Damage Reduction -- LPP PLAN**
PROJECT NO: P2 104716
LOCATION: San Diego County, CA

DISTRICT: Los Angeles District, SPL **PREPARED: 3/3/2015**
POC: CHIEF, COST ENGINEERING, Michael Newnam, P.E.

This Estimate reflects the scope and schedule in report; PDR based on Civil Works Review Board Comments

Program / Budget Year Cost: Program Year (Budget EC): 2015; Effective Price Level Date: 1 OCT 14

Civil Works Work Breakdown Structure		ESTIMATED COST				PROGRAM / BUDGET YEAR COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**	Spent Thru: **1-Oct-13** ($K)	**TOTAL COST** ($K)	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*		*K*	*L*	*M*	*N*	*O*
17	BEACH REPLENISHMENT (w/ Shoreline Monitoring)	$83,104	$27,424	$6	$110,528	1.5%	$84,311	$27,823	$112,134	$0	$112,134	70.5%	$143,782	$47,448	$191,230
06	FISH & WILDLIFE FACILITIES: REEF CONSTRUCTION	$1,851	$981	$1	$2,832	1.9%	$1,887	$1,000	$2,887	$0	$2,887	11.9%	$2,111	$1,119	$3,230
06	FISH & WILDLIFE FACILITIES MITIGATION: MONITORING AND LAGOON SEDIMENTATION	$7,959	$4,218	$5	$12,177	1.9%	$8,114	$4,300	$12,414	$0	$12,414	67.9%	$13,624	$7,221	$20,845
18	CULTURAL RESOURCE PRESERVATION	$34	$7	$0	$41	1.8%	$35	$7	$42	$0	$42	7.5%	$37	$8	$45
	CONSTRUCTION ESTIMATE TOTALS:	$92,948	$32,631	$11	$125,579	1.5%	$94,347	$33,130	$127,477	$0	$127,477	68.9%	$159,555	$55,796	$215,351
01	LANDS AND DAMAGES	$323	$61	$1	$384	3.3%	$334	$63	$397	$0	$397	50.4%	$502	$95	$597
30	PLANNING, ENGINEERING & DESIGN	$24,313	$4,619	$5	$28,932	2.2%	$24,838	$4,719	$29,557	$0	$29,557	220.5%	$79,615	$15,127	$94,741
31	CONSTRUCTION MANAGEMENT	$6,137	$1,166	$2	$7,303	2.2%	$6,270	$1,191	$7,461	$0	$7,461	158.9%	$16,234	$3,084	$19,319
	PROJECT COST TOTALS:	$123,721	$38,478	31.1%	$162,199		$125,788	$39,104	**$164,892**	$0	**$164,892**	100.1%	$255,905	$74,102	$330,008

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CHIEF, COST ENGINEERING, Michael Newnam, P.E

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PROJECT MANAGER, Susie Ming, P.E.

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CHIEF, REAL ESTATE, Theresa Kaplan

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CHIEF, ENGINEERING, Richard J. Leifield, P.E.

ESTIMATED FEDERAL COST:	**51%**	**$169,719**
ESTIMATED NON-FEDERAL COST:	**49%**	**$160,289**
ESTIMATED TOTAL PROJECT COST:		**$330,008**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Encinitas-Solana Beach Coastal Storm Damage Reduction -- LPP PLAN
LOCATION: San Diego County, CA
This Estimate reflects the scope and schedule in report; PDR based on Civil Works Review Board Comments

DISTRICT: Los Angeles District, SPL PREPARED: 3/3/2015
POC: CHIEF, COST ENGINEERING, Michael Newnam, P.E.

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 5-Dec-13 Effective Price Level: 1-Oct-13				Program Year (Budget EC): 2015 Effective Price Level Date: 1 OCT 14								
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	RISK BASED CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	ENCINITAS & SONATA BEACH NOURISHMENT INITIAL EVENT													
17	Solana - Encinitas Initial Beach Nourishment (Yr 2018)	$13,845	$4,569	33%	$18,414	1.5%	$14,046	$4,635	$18,681	2018Q4	7.5%	$15,106	$4,985	$20,091
06	Solana - Reef Mitigation (Yr 2020)	$1,851	$981	53%	$2,832	1.9%	$1,887	$1,000	$2,887	2020Q4	11.9%	$2,111	$1,119	$3,230
17	Shoreline Monitoring (Yearly - Yr 2017 thru Yr 2022)	$440	$145	33%	$585	1.5%	$446	$147	$594	2020Q4	11.9%	$499	$165	$664
06	Habitat Monitoring Plan (Yearly - Yr 2017 thru Yr 2020)	$272	$144	53%	$416	1.9%	$277	$147	$424	2019Q4	9.7%	$304	$161	$465
06	Surfing Monitoring Plan (Yearly - Yr 2017 thru Yr 2022)	$90	$48	53%	$138	1.9%	$92	$49	$140	2020Q4	11.9%	$103	$54	$157
06	Borrow Site Monitoring Plan (Yearly - Yr 2017 thru Yr 2020)	$192	$102	53%	$294	1.9%	$196	$104	$299	2019Q4	9.7%	$215	$114	$329
06	Encinitas - Lagoon Sedimentation: San Elijo and Batiquitos - (Yearly - Yr 2018 thru Yr 2022)	$120	$64	53%	$184	1.9%	$122	$65	$187	2020Q4	11.9%	$137	$73	$209
06	Solana - Lagoon Sedimentation: San Dieguito, San Elijo, and Peñasquitos (Yearly - Yr 2018 thru Yr 2027)	$815	$432	53%	$1,247	1.9%	$831	$440	$1,271	2022Q4	16.4%	$967	$513	$1,480
18	Cultural Resources Plan (Yr 2018)	$34	$7	21%	$41	1.8%	$35	$7	$42	2018Q4	7.5%	$37	$8	$45
	CONSTRUCTION ESTIMATE TOTALS:	$17,659	$6,491	36.8%	**$24,150**		$17,932	$6,594	$24,526			$19,480	$7,191	$26,671
01	LANDS AND DAMAGES	48	$9	19%	$57	3.3%	$50	$9	$59	2017Q4	4.4%	$52	$10	$62
30	PLANNING, ENGINEERING & DESIGN													
0.0%	Project Management	$79	$15	19%	$94	2.2%	$81	$15	$96	2017Q4	10.6%	$89	$17	$106
0.0%	Planning & Environmental Compliance	$22	$4	19%	$26	2.2%	$22	$4	$27	2017Q4	10.6%	$25	$5	$30
0.0%	Engineering & Design	$1,289	$245	19%	$1,534	2.2%	$1,317	$250	$1,567	2017Q4	10.6%	$1,456	$277	$1,733
0.0%	Reviews, ATRs, IEPRs, VE	$350	$67	19%	$417	2.2%	$358	$68	$425	2017Q4	10.6%	$395	$75	$471
0.0%	Life Cycle Updates (cost, schedule, risks)	$29	$6	19%	$35	2.2%	$30	$6	$35	2017Q4	10.6%	$33	$6	$39
0.0%	Contracting & Reprographics	$40	$8	19%	$48	2.2%	$41	$8	$49	2017Q4	10.6%	$45	$9	$54
0.0%	Engineering During Construction	$532	$101	19%	$633	2.2%	$543	$103	$647	2018Q4	14.9%	$625	$119	$743
0.0%	Planning During Construction	$65	$12	19%	$77	2.2%	$66	$13	$79	2018Q4	14.9%	$76	$14	$91
0.0%	Project Operations	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
0.0%	Construction Management	$2,495	$474	19%	$2,969	2.2%	$2,549	$484	$3,033	2018Q4	14.9%	$2,929	$557	$3,486
0.0%	Project Operation:	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Project Management	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:	$22,608	$7,432		**$30,040**		$22,989	$7,555	$30,544			$25,205	$8,279	**$33,484**
COST SPLIT														
65%	**FEDERAL COST TOTALS:**				19,489				19,815					21,725
35%	**NON-FEDERAL COSTS TOTALS:**				10,551				10,729					11,759

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Encinitas-Solana Beach Coastal Storm Damage Reduction -- LPP PLAN
LOCATION: San Diego County, CA
This Estimate reflects the scope and schedule in report; PDR based on Civil Works Review Board Comments

DISTRICT: Los Angeles District, SPL
POC: CHIEF, COST ENGINEERING, Michael Newnam, P.E.
PREPARED: 3/3/2015

Civil Works Work Breakdown Structure		ESTIMATED COST				PROGRAM / BUDGET YEAR COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			5-Dec-13	Program Year (Budget EC):			2015					
		Effective Price Level:			1-Oct-13	Effective Price Level Date:			1 OCT 14					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	ENCINITAS - 9 PERIODIC BEACH NOURISHMENTS ON 5-YR CYCLES 50-FT beach width)													
17	Encinitas - Subsequent Beach Nourishment (Yr 2023)	$5,106	$1,685	33%	$6,791	1.5%	$5,180	$1,709	$6,890	2023Q3	18.1%	$6,120	$2,020	$8,140
17	Encinitas - Subsequent Beach Nourishment (Yr 2028)	$3,915	$1,292	33%	$5,207	1.5%	$3,972	$1,311	$5,283	2028Q3	30.4%	$5,181	$1,710	$6,891
17	Encinitas - Subsequent Beach Nourishment (Yr 2033)	$5,106	$1,685	33%	$6,791	1.5%	$5,180	$1,709	$6,890	2033Q3	44.0%	$7,461	$2,462	$9,923
17	Encinitas - Subsequent Beach Nourishment (Yr 2038)	$3,915	$1,292	33%	$5,207	1%	$3,972	$1,311	$5,283	2038Q3	59.0%	$6,316	$2,084	$8,400
17	Encinitas - Subsequent Beach Nourishment (Yr 2043)	$5,106	$1,685	33%	$6,791	1%	$5,180	$1,709	$6,890	2043Q3	75.6%	$9,094	$3,001	$12,096
17	Encinitas - Subsequent Beach Nourishment (Yr 2048)	$5,106	$1,685	33%	$6,791	1%	$5,180	$1,709	$6,890	2048Q3	93.8%	$10,041	$3,314	$13,355
17	Encinitas - Subsequent Beach Nourishment (Yr 2053)	$5,106	$1,685	33%	$6,791	1.5%	$5,180	$1,709	$6,890	2053Q3	114.0%	$11,086	$3,658	$14,745
17	Encinitas - Subsequent Beach Nourishment (Yr 2058)	$5,106	$1,685	33%	$6,791	1.5%	$5,180	$1,709	$6,890	2058Q3	136.3%	$12,240	$4,039	$16,279
17	Encinitas - Subsequent Beach Nourishment (Yr 2063)	$5,106	$1,685	33%	$6,791	1.5%	$5,180	$1,709	$6,890	2063Q3	160.9%	$13,514	$4,460	$17,973
17	Shoreline and Surfing Monitoring (Yearly - Yr 2023 thru Yr 2067)	$2,585	$853	33%	$3,438	1.5%	$2,623	$865	$3,488	2047Q3	90.0%	$4,984	$1,645	$6,628
06	Borrow Site Monitoring (Yrs 2023, 2028, 2033, 2038, 2043, 2048, 2053, 2058, 2063)	$1,549	$821	53%	$2,370	1.9%	$1,579	$837	$2,416	2038Q3	59.0%	$2,511	$1,331	$3,842
06	Encinitas - Lagoon Sedimentation: San Elijo & Batiquitos (Yearly - Yr 2023 thru Yr 2067)	$1,080	$572	53%	$1,652	1.9%	$1,101	$584	$1,685	2047Q3	90.0%	$2,092	$1,109	$3,201
	CONSTRUCTION ESTIMATE TOTALS:	$48,786	$16,625	34.1%	**$65,411**		$49,508	$16,874	$66,381			$90,640	$30,832	$121,472
01	LANDS AND DAMAGES	200	$38	19%	$238	3.3%	$207	$39	$246	2043Q3	64.7%	$340	$65	$405
30	PLANNING, ENGINEERING & DESIGN													
0.0%	Project Management	$488	$93	19%	$581	2.2%	$499	$95	$593	2042Q3	235.7%	$1,673	$318	$1,991
0.0%	Planning & Environmental Compliance	$176	$33	19%	$209	2.2%	$180	$34	$214	2042Q3	235.7%	$604	$115	$718
0.0%	Engineering & Design	$8,861	$1,684	19%	$10,545	2.2%	$9,052	$1,720	$10,772	2042Q3	235.7%	$30,385	$5,773	$36,158
0.0%	Reviews, ATRs, IEPRs, VE	$2,731	$519	19%	$3,250	2.2%	$2,790	$530	$3,320	2042Q3	235.7%	$9,365	$1,779	$11,144
0.0%	Life Cycle Updates (cost, schedule, risks)	$426	$81	19%	$507	2.2%	$435	$83	$518	2042Q3	235.7%	$1,461	$278	$1,738
0.0%	Contracting & Reprographics	$320	$61	19%	$381	2.2%	$327	$62	$389	2042Q3	235.7%	$1,097	$208	$1,306
0.0%	Engineering During Construction	$2,450	$466	19%	$2,916	2.2%	$2,503	$476	$2,978	2043Q3	252.7%	$8,827	$1,677	$10,505
0.0%	Planning During Construction	$480	$91	19%	$571	2.2%	$490	$93	$584	2043Q3	252.7%	$1,729	$329	$2,058
0.0%	Project Operations	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
0.0%	Construction Management	$2,643	$502	19%	$3,145	2.2%	$2,700	$513	$3,213	2043Q3	252.7%	$9,523	$1,809	$11,332
0.0%	Project Operation:	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Project Management	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:	$67,561	$20,192		**$87,753**		$68,690	$20,518	$89,209			$155,644	$43,183	**$198,827**
COST SPLIT														
50%	**FEDERAL COST TOTALS:**				43,758				44,481					99,211
50%	**NON-FEDERAL COSTS TOTALS:**				43,996				44,727					99,616

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Encinitas-Solana Beach Coastal Storm Damage Reduction -- LPP PLAN
LOCATION: San Diego County, CA
This Estimate reflects the scope and schedule in report; PDR based on Civil Works Review Board Comments

DISTRICT: Los Angeles District, SPL
POC: CHIEF, COST ENGINEERING, Michael Newnam, P.E.
PREPARED: 3/3/2015

Estimated Cost — Estimate Prepared: **5-Dec-13**; Effective Price Level: 1-Oct-13
Program / Budget Year Cost (Constant Dollar Basis) — Program Year (Budget EC): 2015; Effective Price Level Date: 1 OCT 14

Civil Works Work Breakdown Structure		ESTIMATED COST				PROGRAM / BUDGET YEAR COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	SOLANA - 4 PERIODIC BEACH NOURISHMENTS ON 10-YR CYCLES (150-FT beach width)													
17	Solana - Subsequent Beach Nourishment (Yr 2028)	$4,568	$1,507	33%	$6,075	1.5%	$4,634	$1,529	$6,164	2028Q3	30.4%	$6,045	$1,995	$8,040
17	Solana - Subsequent Beach Nourishment (Yr 2038)	$4,568	$1,507	33%	$6,075	1.5%	$4,634	$1,529	$6,164	2038Q3	59.0%	$7,369	$2,432	$9,801
17	Solana - Subsequent Beach Nourishment (Yr 2048)	$5,567	$1,837	33%	$7,404	1.5%	$5,648	$1,864	$7,512	2048Q3	93.8%	$10,948	$3,613	$14,560
17	Solana - Subsequent Beach Nourishment (Yr 2058)	$5,567	$1,837	33%	$7,404	1.5%	$5,648	$1,864	$7,512	2058Q3	136.3%	$13,345	$4,404	$17,749
17	Shoreline and Surfing Monitoring (Yearly - Yr 2023 thru Yr 2067)	$2,392	$789	33%	$3,181	1%	$2,427	$801	$3,228	2045Q3	82.7%	$4,433	$1,463	$5,895
06	Borrow Site Monitoring (Yr 2028, Yr 2038, Yr 2048 and Yr 2058)	$581	$308	53%	$889	1.9%	$592	$314	$906	2033Q3	44.0%	$853	$452	$1,305
06	Solana - Lagoon Sedimentation: San Dieguito, San Elijo and Peñasquitos (Yearly - Yr 2028 thru Yr 2067)	$3,260	$1,728	53%	$4,988	1.9%	$3,323	$1,761	$5,085	2048Q3	93.8%	$6,442	$3,414	$9,856
	CONSTRUCTION ESTIMATE TOTALS:	$26,503	$9,514	35.9%	**$36,017**		$26,907	$9,662	$36,569			$49,435	$17,773	$67,207
01	LANDS AND DAMAGES	75	$14	19%	$89	3.3%	$78	$15	$92	2033Q3	41.5%	$110	$21	$131
30	PLANNING, ENGINEERING & DESIGN													
0.0%	Project Management	$183	$35	19%	$218	2.2%	$187	$36	$222	2043Q3	252.7%	$659	$125	$785
0.0%	Planning & Environmental Compliance	$66	$13	19%	$79	2.2%	$67	$13	$80	2043Q3	252.7%	$238	$45	$283
0.0%	Engineering & Design	$3,323	$631	19%	$3,954	2.2%	$3,395	$645	$4,040	2043Q3	252.7%	$11,973	$2,275	$14,248
0.0%	Reviews, ATRs, IEPRs, VE	$1,024	$195	19%	$1,219	2.2%	$1,046	$199	$1,245	2043Q3	252.7%	$3,690	$701	$4,391
0.0%	Life Cycle Updates (cost, schedule, risks)	$160	$30	19%	$190	2.2%	$163	$31	$195	2043Q3	252.7%	$576	$110	$686
0.0%	Contracting & Reprographics	$120	$23	19%	$143	2.2%	$123	$23	$146	2043Q3	252.7%	$432	$82	$515
0.0%	Engineering During Construction	$919	$175	19%	$1,094	2.2%	$939	$178	$1,117	2044Q3	270.6%	$3,479	$661	$4,140
0.0%	Planning During Construction	$180	$34	19%	$214	2.2%	$184	$35	$219	2044Q3	270.6%	$681	$129	$811
0.0%	Project Operations	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
0.0%	Construction Management	$999	$190	19%	$1,189	2.2%	$1,021	$194	$1,214	2044Q3	270.6%	$3,782	$719	$4,501
0.0%	Project Operation:	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Project Management	$0	$0	19%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:	$33,552	$10,854		**$44,406**		$34,109	$11,031	$45,140			$75,056	$22,640	**$97,696**
COST SPLIT														
50%	**FEDERAL COST TOTALS:**				22,158				22,524					48,783
50%	**NON-FEDERAL COSTS TOTALS:**				22,247				22,616					48,913

Encinitas and Solana Beach Fill (Initial) -- LPP Plan

Estimated by	Juan Dominguez, PE, CCE
Designed by	Art Shak, PE
Prepared by	Los Angeles District
Preparation Date	12/5/2013
Effective Date of Pricing	10/1/2013
Estimated Construction Time	Days

Description	Quantity	UOM	BareCost	DirectCost	CostToPrime	ProjectCost
Project Summary Report			**13,757,543**	**14,459,739**	**13,398,841**	**17,707,263**
1 Real Estate	**1.00**	**LS**	**48,000**	**48,000**	**0**	**48,000**
2 Solana-Encinitas Initial Beach Replenishment (awarded as one contract)	**1.00**	**LS**	**10,729,118**	**11,224,590**	**11,224,590**	**13,844,740**
2.1 Dredging - Mob/Demob (Initial) -- Assumed awarded as one contract	**1.00**	**LS**	**2,799,722**	**2,952,855**	**2,952,855**	**3,642,139**
2.2 Encinitas Beach Replenishment (One Cycle) - 50-ft Width, 5-Yr Cycles	**410,000.00**	**CY**	**2,612,486**	**2,725,444**	**2,725,444**	**3,361,643**
2.3 Solana Beach Replenishment (One Cycle) - 150-ft Width, 10-Yr Cycles	**860,000.00**	**CY**	**5,316,910**	**5,546,291**	**5,546,291**	**6,840,958**
4 Solana - Kelp Reef Construction (2:1 mitigation ratio for Solana 150-ft beach width)	**13.60**	**ACR**	**1,276,112**	**1,420,521**	**1,432,712**	**1,850,694**
4.1 Mob/Demob and Set-up	**1.00**	**LS**	**548,814**	**605,822**	**605,822**	**782,565**
4.2 Stone Placement in windrows on the sea floor	**12,000.00**	**TON**	**683,935**	**766,906**	**766,906**	**990,644**
4.3 Survey	**1.00**	**LS**	**43,362**	**47,793**	**59,984**	**77,484**
6 Shoreline Monitoring	**5.00**	**YR**	**326,712**	**348,396**	**348,396**	**440,274**
6.1 Shoreline Monitoring - Recover Monuments and Maintain Survey Controls	**5.00**	**EA**	**15,635**	**15,635**	**15,635**	**19,758**
6.2 Shoreline Monitoring - Encinitas and in-bounded Segment	**5.00**	**YR**	**98,755**	**110,469**	**110,469**	**139,602**
6.3 Shoreline Monitoring - Solana, Del Mar, Peñasquitos	**5.00**	**YR**	**83,437**	**93,406**	**93,406**	**118,039**
6.4 Shoreline Monitoring - Annual Report (for ALL segments)	**5.00**	**EA**	**128,885**	**128,885**	**128,885**	**162,874**
7 Habitat Monitoring Plan - Encinitas, Solana and in-bounded segment	**3.00**	**YR**	**193,981**	**215,120**	**215,120**	**271,851**
7.1 Encinitas Surveys (6 surveys)	**6.00**	**EA**	**64,660**	**71,707**	**71,707**	**90,617**
7.2 Solana Surveys (6 surveys)	**6.00**	**EA**	**64,660**	**71,707**	**71,707**	**90,617**
7.3 Segment b/s Encinitas and Solana Surveys (6 surveys)	**6.00**	**EA**	**64,660**	**71,707**	**71,707**	**90,617**
8 Surfing Monitoring Plan - Encinitas, Solana and in-bounded segment	**5.00**	**YR**	**90,000**	**90,000**	**0**	**90,000**
8.1 Surfing Monitoring	**5.00**	**YR**	**90,000**	**90,000**	**0**	**90,000**
9 Borrow Site Monitoring Plan (for one single initial event; hence UOM carries 1 EA)	**1.00**	**EA**	**133,963**	**152,249**	**152,249**	**192,400**
9.1 Off-shore Survey (4 day/survey x 6 surveys x 8 hr/day)	**192.00**	**HR**	**115,963**	**134,249**	**134,249**	**169,653**
9.2 Analyze Data / Prepare Reports (40 hr per visit x 6 visits)	**240.00**	**HR**	**18,000**	**18,000**	**18,000**	**22,747**
11 Encinitas - Lagoon Sedimentation - San Elijo & Batiquitos	**5.00**	**YR**	**120,000**	**120,000**	**0**	**120,000**
12 Solana - Lagoon Sedimentation - San Dieguito, San Elijo & Peñasquitos	**10.00**	**YR**	**815,090**	**815,090**	**0**	**815,090**

Description	Quantity	UOM	BareCost	DirectCost	CostToPrime	ProjectCost
14 Cultural Resources Plan	**1.00**	**LS**	**24,566**	**25,773**	**25,773**	**34,214**
14.1 Survey (assume a day)	**8.00**	**HR**	**1,365**	**1,480**	**1,480**	**1,965**
14.2 Trench and Backfill site west of seawall (assume a week)	**40.00**	**HR**	**14,202**	**15,293**	**15,293**	**20,302**
14.3 Prepare Record of Findings	**1.00**	**LS**	**9,000**	**9,000**	**9,000**	**11,947**

Encinitas and Solana Beach Fill (Synched) -- LPP Plan

Estimated by	Juan Dominguez, PE, CCE
Designed by	Art Shak, PE
Prepared by	Los Angeles District
Preparation Date	12/5/2013
Effective Date of Pricing	10/1/2013
Estimated Construction Time	Days

Description	Quantity	UOM	BareCost	DirectCost	CostToPrime	ProjectCost
Project Summary Report			**13,255,488**	**13,892,081**	**13,892,081**	**16,964,376**
1 Solana-Encinitas Beach Subsequent Replenishment (Synched Yr 2025)	**1.00**	**LS**	**6,627,744**	**6,946,040**	**6,946,040**	**8,482,188**
1.1 Dredging - Mob/Demob -- Assumed awarded as one contract	**1.00**	**LS**	**2,799,722**	**2,952,855**	**2,952,855**	**3,605,892**
1.1.1 Mob/Demob Hopper Dredge (CEDEP)	**1.00**	**LS**	**1,739,571**	**1,739,571**	**1,739,571**	**2,124,285**
1.1.2 Mob/Demob Pipeline to the jobsite	**14.00**	**DAY**	**161,105**	**161,105**	**161,105**	**196,734**
1.1.3 Mob/demob Pipeline within Encinitas (Segment 1)	**1.00**	**LS**	**527,913**	**618,031**	**618,031**	**754,711**
1.1.4 Mob/demob Pipeline within Solana (Segment 2)	**1.00**	**LS**	**371,133**	**434,148**	**434,148**	**530,162**
1.2 Encinitas Beach Replenishment - Segment 1 (Qty of one replenishment cycle)	**260,000.00**	**CY**	**1,657,727**	**1,729,336**	**1,729,336**	**2,111,787**
1.2.1 Encinitas Beach Replenishment - Segment 1 - Hopper Dredge (CEDEP)	**260,000.00**	**CY**	**1,276,600**	**1,276,600**	**1,276,600**	**1,558,926**
1.2.2 Pumpout Pipeline Cost	**4,140.00**	**LF**	**19,514**	**19,514**	**19,514**	**23,830**
1.2.3 Shore Crew	**260,000.00**	**CY**	**361,613**	**433,222**	**433,222**	**529,031**
1.3 Solana Beach Replenishment - Segment 2 (Qty of one replenishment cycle)	**350,000.00**	**CY**	**2,170,295**	**2,263,849**	**2,263,849**	**2,764,509**
1.3.1 Solana Beach Replenishment - Segment 2 - Hopper Dredge (CEDEP)	**350,000.00**	**CY**	**1,666,000**	**1,666,000**	**1,666,000**	**2,034,443**
1.3.2 Pumpout Pipeline Cost	**6,140.00**	**LF**	**31,865**	**31,865**	**31,865**	**38,912**
1.3.3 Shore Crew	**350,000.00**	**CY**	**472,430**	**565,984**	**565,984**	**691,153**
2 Solana-Encinitas Beach Subsequent Replenishment (Synched Yr 2035)	**1.00**	**LS**	**6,627,744**	**6,946,040**	**6,946,040**	**8,482,188**
2.1 Dredging - Mob/Demob -- Assumed awarded as one contract	**1.00**	**LS**	**2,799,722**	**2,952,855**	**2,952,855**	**3,605,892**
2.1.1 Mob/Demob Hopper Dredge (CEDEP)	**1.00**	**LS**	**1,739,571**	**1,739,571**	**1,739,571**	**2,124,285**
2.1.2 Mob/Demob Pipeline to the jobsite	**14.00**	**DAY**	**161,105**	**161,105**	**161,105**	**196,734**
2.1.3 Mob/demob Pipeline within Encinitas (Segment 1)	**1.00**	**LS**	**527,913**	**618,031**	**618,031**	**754,711**
2.1.4 Mob/demob Pipeline within Solana (Segment 2)	**1.00**	**LS**	**371,133**	**434,148**	**434,148**	**530,162**
2.2 Encinitas Beach Replenishment - Segment 1 (Qty of one replenishment cycle)	**260,000.00**	**CY**	**1,657,727**	**1,729,336**	**1,729,336**	**2,111,787**
2.2.1 Encinitas Beach Replenishment - Segment 1 - Hopper Dredge (CEDEP)	**260,000.00**	**CY**	**1,276,600**	**1,276,600**	**1,276,600**	**1,558,926**
2.2.2 Pumpout Pipeline Cost	**4,140.00**	**LF**	**19,514**	**19,514**	**19,514**	**23,830**
2.2.3 Shore Crew	**260,000.00**	**CY**	**361,613**	**433,222**	**433,222**	**529,031**
2.3 Solana Beach Replenishment - Segment 2 (Qty of one replenishment cycle)	**350,000.00**	**CY**	**2,170,295**	**2,263,849**	**2,263,849**	**2,764,509**

Description	Quantity	UOM	BareCost	DirectCost	CostToPrime	ProjectCost
2.3.1 Solana Beach Replenishment - Segment 2 - Hopper Dredge (CEDEP)	**350,000.00**	**CY**	**1,666,000**	**1,666,000**	**1,666,000**	**2,034,443**
2.3.2 Pumpout Pipeline Cost	**6,140.00**	**LF**	**31,865**	**31,865**	**31,865**	**38,912**
2.3.3 Shore Crew	**350,000.00**	**CY**	**472,430**	**565,984**	**565,984**	**691,153**

Encinitas Beach Fill (Nine (9) Subsequent replenishments on 5-yr Cycles) -- LPP

Estimated by	Juan Dominguez, PE, CCE
Designed by	Art Shak, PE
Prepared by	Los Angeles District
Preparation Date	12/5/2013
Effective Date of Pricing	10/1/2013
Estimated Construction Time	Days

Description	Quantity	UOM	BareCost	DirectCost	CostToPrime	ProjectCost
Project Summary Report			32,995,431	34,379,244	32,669,244	41,183,499
1 Real Estate (9 Cycles)	1.00	LS	225,000	225,000	0	225,000
1.1 Real Estate (9 events)	9.00	EA	225,000	225,000	0	225,000
2 Encinitas Beach Replenishment (Yr 2020)	1.00	LS	4,086,316	4,248,044	4,248,044	5,106,284
2.1 Dredging - Mob/Demob to Encinitas	1.00	LS	2,428,589	2,518,707	2,518,707	3,027,567
2.1.1 Mob/Demob Hopper Dredge (CEDEP)	1.00	LS	1,739,571	1,739,571	1,739,571	2,091,020
2.1.2 Mob/Demob Pipeline to the jobsite	14.00	DAY	161,105	161,105	161,105	193,653
2.1.3 Mob/demob Pipeline within Encinitas (Segment 1)	1.00	LS	527,913	618,031	618,031	742,893
2.2 Encinitas Beach Replenishment - Segment 1 (Qty of one replenishment cycle)	260,000.00	CY	1,657,727	1,729,336	1,729,336	2,078,718
2.2.1 Encinitas Beach Replenishment - Segment 1 - Hopper Dredge (CEDEP)	260,000.00	CY	1,276,600	1,276,600	1,276,600	1,534,514
2.2.2 Pumpout Pipeline Cost	4,140.00	LF	19,514	19,514	19,514	23,457
2.2.3 Shore Crew	260,000.00	CY	361,613	433,222	433,222	520,747
4 Encinitas Beach Replenishment (Yr 2030)	1.00	LS	4,086,316	4,248,044	4,248,044	5,106,284
4.1 Dredging - Mob/Demob to Encinitas	1.00	LS	2,428,589	2,518,707	2,518,707	3,027,567
4.1.1 Mob/Demob Hopper Dredge (CEDEP)	1.00	LS	1,739,571	1,739,571	1,739,571	2,091,020
4.1.2 Mob/Demob Pipeline to the jobsite	14.00	DAY	161,105	161,105	161,105	193,653
4.1.3 Mob/demob Pipeline within Encinitas (Segment 1)	1.00	LS	527,913	618,031	618,031	742,893
4.2 Encinitas Beach Replenishment - Segment 1	260,000.00	CY	1,657,727	1,729,336	1,729,336	2,078,718
4.2.1 Encinitas Beach Replenishment - Segment 1 - Hopper Dredge (CEDEP)	260,000.00	CY	1,276,600	1,276,600	1,276,600	1,534,514
4.2.2 Pumpout Pipeline Cost	4,140.00	LF	19,514	19,514	19,514	23,457
4.2.3 Shore Crew	260,000.00	CY	361,613	433,222	433,222	520,747
6 Encinitas Beach Replenishment (Yr 2040)	1.00	LS	4,086,316	4,248,044	4,248,044	5,106,284
6.1 Dredging - Mob/Demob to Encinitas	1.00	LS	2,428,589	2,518,707	2,518,707	3,027,567
6.1.1 Mob/Demob Hopper Dredge (CEDEP)	1.00	LS	1,739,571	1,739,571	1,739,571	2,091,020
6.1.2 Mob/Demob Pipeline to the jobsite	14.00	DAY	161,105	161,105	161,105	193,653
6.1.3 Mob/demob Pipeline within Encinitas (Segment 1)	1.00	LS	527,913	618,031	618,031	742,893

Description	Quantity	UOM	BareCost	DirectCost	CostToPrime	ProjectCost
6.2 Encinitas Beach Replenishment - Segment 1	**260,000.00**	**CY**	**1,657,727**	**1,729,336**	**1,729,336**	**2,078,718**
6.2.1 Encinitas Beach Replenishment - Segment 1 - Hopper Dredge (CEDEP)	**260,000.00**	**CY**	**1,276,600**	**1,276,600**	**1,276,600**	**1,534,514**
6.2.2 Pumpout Pipeline Cost	**4,140.00**	**LF**	**19,514**	**19,514**	**19,514**	**23,457**
6.2.3 Shore Crew	**260,000.00**	**CY**	**361,613**	**433,222**	**433,222**	**520,747**
7 Encinitas Beach Replenishment (Yr 2045)	**1.00**	**LS**	**4,086,316**	**4,248,044**	**4,248,044**	**5,106,284**
7.1 Dredging - Mob/Demob to Encinitas	**1.00**	**LS**	**2,428,589**	**2,518,707**	**2,518,707**	**3,027,567**
7.1.1 Mob/Demob Hopper Dredge (CEDEP)	**1.00**	**LS**	**1,739,571**	**1,739,571**	**1,739,571**	**2,091,020**
7.1.2 Mob/Demob Pipeline to the jobsite	**14.00**	**DAY**	**161,105**	**161,105**	**161,105**	**193,653**
7.1.3 Mob/demob Pipeline within Encinitas (Segment 1)	**1.00**	**LS**	**527,913**	**618,031**	**618,031**	**742,893**
7.2 Encinitas Beach Replenishment - Segment 1	**260,000.00**	**CY**	**1,657,727**	**1,729,336**	**1,729,336**	**2,078,718**
7.2.1 Encinitas Beach Replenishment - Segment 1 - Hopper Dredge (CEDEP)	**260,000.00**	**CY**	**1,276,600**	**1,276,600**	**1,276,600**	**1,534,514**
7.2.2 Pumpout Pipeline Cost	**4,140.00**	**LF**	**19,514**	**19,514**	**19,514**	**23,457**
7.2.3 Shore Crew	**260,000.00**	**CY**	**361,613**	**433,222**	**433,222**	**520,747**
8 Encinitas Beach Replenishment (Yr 2050)	**1.00**	**LS**	**4,086,316**	**4,248,044**	**4,248,044**	**5,106,284**
8.1 Dredging - Mob/Demob to Encinitas	**1.00**	**LS**	**2,428,589**	**2,518,707**	**2,518,707**	**3,027,567**
8.1.1 Mob/Demob Hopper Dredge (CEDEP)	**1.00**	**LS**	**1,739,571**	**1,739,571**	**1,739,571**	**2,091,020**
8.1.2 Mob/Demob Pipeline to the jobsite	**14.00**	**DAY**	**161,105**	**161,105**	**161,105**	**193,653**
8.1.3 Mob/demob Pipeline within Encinitas (Segment 1)	**1.00**	**LS**	**527,913**	**618,031**	**618,031**	**742,893**
8.2 Encinitas Beach Replenishment - Segment 1	**260,000.00**	**CY**	**1,657,727**	**1,729,336**	**1,729,336**	**2,078,718**
8.2.1 Encinitas Beach Replenishment - Segment 1 - Hopper Dredge (CEDEP)	**260,000.00**	**CY**	**1,276,600**	**1,276,600**	**1,276,600**	**1,534,514**
8.2.2 Pumpout Pipeline Cost	**4,140.00**	**LF**	**19,514**	**19,514**	**19,514**	**23,457**
8.2.3 Shore Crew	**260,000.00**	**CY**	**361,613**	**433,222**	**433,222**	**520,747**
9 Encinitas Beach Replenishment (Yr 2055)	**1.00**	**LS**	**4,086,316**	**4,248,044**	**4,248,044**	**5,106,284**
9.1 Dredging - Mob/Demob to Encinitas	**1.00**	**LS**	**2,428,589**	**2,518,707**	**2,518,707**	**3,027,567**
9.1.1 Mob/Demob Hopper Dredge (CEDEP)	**1.00**	**LS**	**1,739,571**	**1,739,571**	**1,739,571**	**2,091,020**
9.1.2 Mob/Demob Pipeline to the jobsite	**14.00**	**DAY**	**161,105**	**161,105**	**161,105**	**193,653**

Description	Quantity	UOM	BareCost	DirectCost	CostToPrime	ProjectCost
9.1.3 Mob/demob Pipeline within Encinitas (Segment 1)	1.00	LS	527,913	618,031	618,031	742,893
9.2 Encinitas Beach Replenishment - Segment 1	260,000.00	CY	1,657,727	1,729,336	1,729,336	2,078,718
9.2.1 Encinitas Beach Replenishment - Segment 1 - Hopper Dredge (CEDEP)	260,000.00	CY	1,276,600	1,276,600	1,276,600	1,534,514
9.2.2 Pumpout Pipeline Cost	4,140.00	LF	19,514	19,514	19,514	23,457
9.2.3 Shore Crew	260,000.00	CY	361,613	433,222	433,222	520,747
10 Encinitas Beach Replenishment (Yr 2060)	1.00	LS	4,086,316	4,248,044	4,248,044	5,106,284
10.1 Dredging - Mob/Demob to Encinitas	1.00	LS	2,428,589	2,518,707	2,518,707	3,027,567
10.1.1 Mob/Demob Hopper Dredge (CEDEP)	1.00	LS	1,739,571	1,739,571	1,739,571	2,091,020
10.1.2 Mob/Demob Pipeline to the jobsite	14.00	DAY	161,105	161,105	161,105	193,653
10.1.3 Mob/demob Pipeline within Encinitas (Segment 1)	1.00	LS	527,913	618,031	618,031	742,893
10.2 Encinitas Beach Replenishment - Segment 1	260,000.00	CY	1,657,727	1,729,336	1,729,336	2,078,718
10.2.1 Encinitas Beach Replenishment - Segment 1 - Hopper Dredge (CEDEP)	260,000.00	CY	1,276,600	1,276,600	1,276,600	1,534,514
10.2.2 Pumpout Pipeline Cost	4,140.00	LF	19,514	19,514	19,514	23,457
10.2.3 Shore Crew	260,000.00	CY	361,613	433,222	433,222	520,747
11 Shoreline and Surfing Monitoring - Encinitas and in-bounded Segment	45.00	YR	2,014,514	2,119,944	1,714,944	2,585,714
11.1 Shoreline Monitoring - Recover Monuments and Maintain Survey Controls	45.00	EA	140,715	140,715	140,715	178,932
11.2 Shoreline Monitoring - Encinitas and in-bounded Segment	45.00	YR	888,794	994,224	994,224	1,264,250
11.2.1 Number of Separate Surveys (12 transects/survey)	90.00	EA	888,794	994,224	994,224	1,264,250
11.3 Shoreline Monitoring - Annual Report (Encinitas and in-bound segments) -- Encinitas pays 50% of the cost and Solana pays the other 50%	45.00	EA	580,005	580,005	580,005	737,531
11.4 Surfing Monitoring	45.00	YR	405,000	405,000	0	405,000
12 Borrow Site Monitoring Plan (for 9 replenishment eventst; hence UOM carries 9 EA)	9.00	EA	1,071,706	1,217,995	1,217,995	1,548,795
12.1 Off-shore Survey	1,536.00	HR	927,706	1,073,995	1,073,995	1,365,686
12.1.1 Survey Boat	1,536.00	HR	203,144	215,248	215,248	273,708
12.1.2 Diving teams	1,536.00	HR	724,562	858,746	858,746	1,091,977
12.2 Analyze Data / Prepare Reports	1,920.00	HR	144,000	144,000	144,000	183,110
13 Lagoon Sedimentation - San Elijo and Batiquitos	45.00	YR	1,080,000	1,080,000	0	1,080,000

Description	Quantity	UOM	BareCost	DirectCost	CostToPrime	ProjectCost
13.1 Lagoon Sedimentation - San Elijo	**45.00**	**YR**	**45,000**	**45,000**	**0**	**45,000**
13.2 Lagoon Sedimentation - Batiquitos	**45.00**	**YR**	**1,035,000**	**1,035,000**	**0**	**1,035,000**

Solana Beach Fill (Four (4) Subsequent replenishments on 10-yr Cycles) -- LPP

Estimated by	Juan Dominguez, PE, CCE
Designed by	Art Shak, PE
Prepared by	Los Angeles District
Preparation Date	12/5/2013
Effective Date of Pricing	10/1/2013
Estimated Construction Time	Days

Description	Quantity	UOM	BareCost	DirectCost	CostToPrime	ProjectCost
Project Summary Report			14,523,728	14,981,445	11,216,085	17,467,883
1 Real Estate (4 cycles)	1.00	LS	100,000	100,000	0	100,000
1.1 Real Estate (4 events)	4.00	EA	100,000	100,000	0	100,000
4 Solana Beach Replenishment (Yr 2045) -- 350,000 CY	1.00	LS	4,442,411	4,598,980	4,598,980	5,566,882
4.1 Dredging - Mob/Demob to Solana	1.00	LS	2,272,116	2,335,131	2,335,131	2,826,583
4.1.1 Mob/Demob Hopper Dredge (CEDEP)	1.00	LS	1,739,571	1,739,571	1,739,571	2,105,682
4.1.2 Mob/Demob Pipeline to the jobsite	14.00	DAY	161,320	161,320	161,320	195,271
4.1.3 Mob/demob Pipeline within Solana Beach (Segment 2)	1.00	LS	371,225	434,240	434,240	525,630
4.2 Solana Beach Replenishment - Segment 2 (Qty of one replenishment cycle)	350,000.00	CY	2,170,295	2,263,849	2,263,849	2,740,299
4.2.1 Solana Beach Replenishment - Segment 2 - Hopper Dredge (CEDEP)	350,000.00	CY	1,666,000	1,666,000	1,666,000	2,016,627
4.2.2 Pumpout Pipeline Cost	6,140.00	LF	31,865	31,865	31,865	38,571
4.2.3 Shore Crew	350,000.00	CY	472,430	565,984	565,984	685,101
5 Solana Beach Replenishment (Yr 2055) -- 350,000 CY	1.00	LS	4,442,411	4,598,980	4,598,980	5,566,882
5.1 Dredging - Mob/Demob to Solana	1.00	LS	2,272,116	2,335,131	2,335,131	2,826,583
5.1.1 Mob/Demob Hopper Dredge (CEDEP)	1.00	LS	1,739,571	1,739,571	1,739,571	2,105,682
5.1.2 Mob/Demob Pipeline to the jobsite	14.00	DAY	161,320	161,320	161,320	195,271
5.1.3 Mob/demob Pipeline within Solana Beach (Segment 2)	1.00	LS	371,225	434,240	434,240	525,630
5.2 Solana Beach Replenishment - Segment 2 (Qty of one replenishment cycle)	350,000.00	CY	2,170,295	2,263,849	2,263,849	2,740,299
5.2.1 Solana Beach Replenishment - Segment 2 - Hopper Dredge (CEDEP)	350,000.00	CY	1,666,000	1,666,000	1,666,000	2,016,627
5.2.2 Pumpout Pipeline Cost	6,140.00	LF	31,865	31,865	31,865	38,571
5.2.3 Shore Crew	350,000.00	CY	472,430	565,984	565,984	685,101
6 Shoreline and Surfing Monitoring - Solana, Del Mar, Peñasquitos Lagoon	45.00	YR	1,876,656	1,966,377	1,561,377	2,392,390
6.1 Shoreline Monitoring - Recover Monuments and Maintain Survey Controls	45.00	EA	140,715	140,715	140,715	179,108
6.2 Shoreline Monitoring - Solana, Del Mar, Peñasquitos Lagoon	45.00	YR	750,936	840,657	840,657	1,070,026
6.2.1 Number of Separate Surveys (10 transects/survey)	90.00	EA	750,936	840,657	840,657	1,070,026
6.3 Shoreline Monitoring - Annual Report (Solana, Del Mar and Peñasquitos) -- Encinitas pays 50% of the cost and Solana pays the other 50%	45.00	EA	580,005	580,005	580,005	738,256

Description	Quantity	UOM	BareCost	DirectCost	CostToPrime	ProjectCost
6.4 Surfing Monitoring	**45.00**	**YR**	**405,000**	**405,000**	**0**	**405,000**
7 Borrow Site Monitoring Plan (for 4 replenishment eventst; hence UOM carries 4 EA))	**4.00**	**EA**	**401,890**	**456,748**	**456,748**	**581,369**
7.1 Off-shore Survey	**576.00**	**HR**	**347,890**	**402,748**	**402,748**	**512,635**
7.1.1 Survey Boat	**576.00**	**HR**	**76,179**	**80,718**	**80,718**	**102,742**
7.1.2 Diving teams	**576.00**	**HR**	**271,711**	**322,030**	**322,030**	**409,894**
7.2 Analyze Data / Prepare Reports	**720.00**	**HR**	**54,000**	**54,000**	**54,000**	**68,734**
8 Lagoon Sedimentation - San Dieguito, San Elijo and Peñasquitos	**40.00**	**YR**	**3,260,360**	**3,260,360**	**0**	**3,260,360**
8.1 Lagoon Sedimentation - San Dieguito	**40.00**	**YR**	**3,080,000**	**3,080,000**	**0**	**3,080,000**
8.2 Lagoon Sedimentation - San Elijo	**40.00**	**YR**	**40,000**	**40,000**	**0**	**40,000**
8.3 lagoon Sedimentation - Peñasquitos	**40.00**	**YR**	**140,360**	**140,360**	**0**	**140,360**

Description | **Page**

US Army Corps
of Engineers®

Solana-Encinitas Coastal Storm Damage Reduction Project

Feasibility Study – Public Draft Report (PDR)

Project Cost and Schedule Risk Analysis Report

LPP PLAN

Prepared for:

U.S. Army Corps of Engineers,
Los Angeles District

Prepared by:

Juan Dominguez, PE, CCE
U.S. Army Corps of Engineers
Cost Engineering

February 02, 2014

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EXECUTIVE SUMMARY

Under the auspices of the US Army Corps of Engineers (USACE), Los Angeles District, this report presents a recommendation for the total project cost and schedule contingencies for the Encinitas-Solana Beach Coastal Storm Damage Reduction Project. In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008, a formal risk analysis study was conducted for the development of contingency on the total project cost. The purpose of this risk analysis study was to establish project contingencies by identifying and measuring the cost and schedule impact of project uncertainties with respect to the estimated total project cost.

Specific to the Encinitas-Solana Beach Coastal Storm Damage Reduction Project (LPP Plan), the most likely total project cost (at price level) is estimated at approximately $124 Million. Based on the results of the analysis, the Cost Engineering Section (Los Angeles District) recommends a contingency value of $38 Million, or 31%.

Executive Summary on the Cost Risk.

Contingency includes $37.5 Million (97.5%) for cost growth potential due to risk analyzed in the base cost estimate. The key cost risk drivers are volume variations, impact of hopper size, fuel prices, mitigation functional replacement, reef mitigation success, bidding climate, and scope definition which together contribute approximately 75 percent of the statistical cost variance.

Executive Summary on the Schedule Risk.

Contingency includes $0.9 Million (2.5%) for cost growth potential due to risk analyzed in the baseline schedule. The key schedule risk drivers are impact of hopper size, small business set-aside, and funding stream which together contribute over 55 percent of the statistical schedule variance. Since the project consists of an initial construction event followed by eleven short subsequent construction events (two subsequent events are synched) within five and ten years intervals, the total project schedule (50 years) includes enough float time to absorb most of the schedule risk. Therefore, the total project risk unfolds mainly from the construction cost risk instead of the schedule risk.

Executive Summary on Risk Analysis procedure.

A separate contingency was calculated for each major project feature: beach nourishment; mitigation; cultural resources; real estate; planning, engineering and design; and construction management. Identified risks were distributed into three categories: risks associated with beach nourishment (dredging); risks directly connected with mitigation; and general project risks impacting all project items. General project risks encompass cited features; cultural resources; real estate; planning, engineering and design; and construction management.

The Los Angeles District performed the risk analysis using the *Monte Carlo* technique, producing the aforementioned LPP contingencies and identifying key risk drivers.

The following table ES-1 portrays the development of contingencies. Contingencies are based on an 80% confidence level, as per USACE Civil Works guidance.

Table ES-1 Contingency Analysis Tables

Most Likely Cost Estimate for Beach Nourishment	**$83,104,000**	
Confidence Level	**Value ($$)**	**Contingency (%)**
50%	$16,368,000	20%
80%	**$27,374,000**	**33%**
100%	$110,523,000	133%

Most Likely Cost Estimate for Mitigation	**$9,810,000**	
Confidence Level	**Value ($$)**	**Contingency (%)**
50%	$3,262,000	33%
80%	**$5,195,000**	**53%**
100%	$12,491,000	127%

Most Likely Cost Estimate for Real Estate	**$323,000**	
Confidence Level	**Value ($$)**	**Contingency (%)**
50%	$44,000	14%
80%	**$62,000**	**19%**
100%	$105,000	33%

Most Likely Cost Estimate for Cultural Resources	$34,000	
Confidence Level	**Value ($$)**	**Contingency (%)**
50%	$5,000	15%
80%	**$7,000**	**21%**
100%	$11,000	32%

Most Likely Cost Estimate for PED	$24,313,000	
Confidence Level	**Value ($$)**	**Contingency (%)**
50%	$3,314,000	14%
80%	**$4,652,000**	**19%**
100%	$7,919,000	33%

Most Likely Cost Estimate for Construction Management	$6,137,000	
Confidence Level	**Value ($$)**	**Contingency (%)**
50%	$837,000	14%
80%	**$1,174,000**	**19%**
100%	$1,999,000	33%

Notes:

1) Figures indicated in Table ES-1 are exact values from the Crystal Ball Analysis. These values were rounded for input into the Total Project Cost (TPC). Table ES-2 (below) show rounded values as calculated in the TPC. Rounding of contingency percent decimal point number may produce results that appear to be incorrect by very small amounts.

The following table ES-2 portrays the full costs of the recommended alternative based on the anticipated contracts. The costs are intended to address the congressional request of estimates to implement the project. The contingency is based on an 80% confidence level, as per accepted USACE Civil Works guidance.

Table ES-2. Cost Summary

Encinitas-Solana		COST ($1,000)	CNTG ($1,000)	TOTAL ($1,000)
01	LANDS AND DAMAGES	323	62	385
06	FISH AND WILDLIFE FACILITIES (MITIGATION)	9,810	5,195	15,005
17	BEACH NOURISHMENT	83,104	27,374	110,478
18	CULTURAL RESOURCES	34	7	41
30	PLANNING, ENGINEERING AND DESIGN	24,313	4,652	28,965
31	CONSTRUCTION MANAGEMENT	6,137	1,174	7,311
TOTAL PROJECT COST		**123,721**	**38,464**	**162,185**
Schedule Completion with Contingency		**1 Mar 2015**	**579 months**	**18 May 2063**

Notes:
1) All costs include recommended contingency..
2) Costs exclude O&M and Life Cycle Cost estimates.

KEY FINDINGS/OBSERVATIONS RECOMMENDATIONS

The key cost risk drivers identified through sensitivity analysis were volume variations (T-1), impact of hopper size (EST-1) fuel prices (EST-3), mitigation functional replacement (ENV-6), reef mitigation success (ENV-5), bidding climate (PR-3), and scope definition (PPM-2) which together contribute approximately 75 percent of the statistical cost variance. Volume variations (T-1) represent concern on dredging volumes, quantities are based on projected beach profiles and quantity changes are likely. Impact of hopper size (EST-1) represents concern on size of hopper dredges actually used could cause cost variance. Fuel prices (EST-3) represent concern that rising fuel prices will cause significant cost growth. Mitigation functional replacement (ENV-6) represents concern that estimated ratio, if differ from that assumed in the estimate, could cause variance in costs. Reef Mitigation Success (ENV-5) represents concern on achieving a level of functional equivalence to the existing reefs. Bidding climate (PR-3) represents concern that market conditions could impact project cost. Scope definition (PPM-2) represents concern that over the life of the project the scope may change.

The key schedule risk drivers identified through the sensitivity analysis were impact of hopper size (EST-1), small business set-aside (CA-2) and funding stream (PPM-1) which together contribute over 55 percent of the statistical schedule variance. Hopper size (EST-1) represents concern that size of hopper dredges actually used could cause schedule variance. Small business set-aside (CA-2) represents concern that biological monitoring could cause project delays since there are monitoring services in the overall implementation. Funding stream (PPM-1) represents concern that federal and/or non-federal appropriations delays may impact the project schedule.

Recommendations, as detailed within the main report, include the implementation of cost and schedule contingencies, further iterative study of risks throughout the project life-cycle, potential mitigation throughout the PED phase, and proactive monitoring and control of risk identified in this study.

MAIN REPORT

1.0 PURPOSE

Under the auspices of the US Army Corps of Engineers (USACE), Los Angeles District, this report presents a recommendation for the total project cost and schedule contingencies for the Solana-Encinitas Coastal Storm Damage Reduction Project.

2.0 BACKGROUND

Project purpose is to reduce coastal storm damage and shoreline erosion at Encinitas and Solana Beach. Recommended plan consists of beach replenishment activities. On-shore placement involves a trailing suction hopper dredge excavating sand from an off-shore borrow site, hauling and pumping it to the receiver beaches.

The initial dredging event combines the Encinitas and Solana Beaches under one contract award. Initial dredge volume equals 410,000 CY for Encinitas and 860,000 CY for Solana Beach totaling 1,270,000 CY. Each subsequent nourishment cycle quantity amounts to 260,000 CY for Encinitas and 350,000 CY for Solana Beach.

Encinitas (Segment 1) has a beach width addition of 50-feet in the initial nourishment and periodic replenishment intervals of 5-years. Solana Beach (Segment 2) has an beach width addition of 150-feet in the initial nourishment and periodic replenishment intervals of 10-years. Encinitas replenishment cycles amount to a total of nine (9) events and Solana Beach replenishment events amount to four (4) events. However, two (2) Encinitas replenishment events coincide (sync) with two (2) Solana Beach replenishment events, therefore instead of totaling thirteen (13) events, the subsequent sand nourishment events add up to eleven (11).

Costs are based on actual dredged volume in lieu of quantity placed on the receiver beach.

As a part of this effort, Los Angeles District requested that the USACE Cost Engineering Directory of Expertise for Civil Works (Cost Engineering Dx) provide an agency technical review (ATR) of the cost estimate, schedule and risk analysis for the Recommended Project Plan.

3.0 REPORT SCOPE

The scope of the risk analysis report is to calculate and present the cost and schedule contingencies at the 80 percent confidence level using the risk analysis processes, as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for cost risks for all project features. The study and presentation does not include consideration for life cycle costs.

3.1 Project Scope

The formal process included extensive involvement of the PDT for risk identification and the development of the risk register. The analysis process evaluated the most likely Micro Computer Aided Cost Estimating System (MCACES) cost estimate, schedule, and funding profiles using Crystal Ball software to conduct a *Monte Carlo* simulation and statistical sensitivity analysis, per the guidance in Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated September 30, 2008.

The project technical scope, estimates and schedules were developed and presented by the PDT. Consequently, these documents serve as the basis for the risk analysis.

The scope of this study addresses the identification of problems, needs, opportunities and potential solutions that are viable from an economic, environmental, and engineering viewpoint.

3.2 USACE Risk Analysis Process

The risk analysis process for this study follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering Dx. The risk analysis process reflected within this report uses probabilistic cost and schedule risk analysis methods within the framework of the Crystal Ball software. Furthermore, the scope of the report includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

Risk analysis results are also intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as the project progresses through planning and implementation. To fully recognize its benefits, cost and schedule risk analysis should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting and scheduling.

In addition to broadly defined risk analysis standards and recommended practices, this risk analysis was performed to meet the requirements and recommendations of the following documents and sources:

- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering Dx.

- Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008.

- Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated September 30, 2008.

4.0 METHODOLOGY / PROCESS

Cost Engineering, Los Angeles District, facilitated a risk identification and qualitative analysis meeting with the PDT on October 18, 2012 and again on December 5, 2013 to implement changes from the California Coastal Commission. The risk identification meeting also included qualitative analysis to produce a risk register that served as the framework for the risk analysis.

The initial cost and schedule risk models were completed and results reported on November 06, 2012. Revisions and iterations of the cost and schedule risk model took place between November 15, 2012 and November 27, 2012. Results were completed and reported on November 28, 2012. After the IEPR, minor revisions were made between April 5, 2013 and April 10, 2013. Revisions were completed and reported on April 11, 2013. Review from the California Coastal Commission (CCC) resulted in changes to the project cost and risk analysis. The final results were completed and reported for ATR on December 19, 2013. Revisions resulting from ATR and internal comments were completed on January 31, 2014.

In February, the PDT opted for combining (sync) the re-nourishment events of Solana Beach and Encinitas into one event. Two out of the four re-nourishment cycles for the Solana Beach segment will coincide with the re-nourishment for the Encinitas segment. On February 2, 2011, the MII, TPC, CSRA and Cost Appendix were revised and reported for ATR.

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve any desired level of cost confidence.

In simple terms, contingency is an amount added to an estimate to allow for items, conditions or events for which the occurrence or impact is uncertain and that experience will likely result in additional costs being incurred or additional time being required. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency should be applied in the project control plans. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

The Cost Dx guidance for cost and schedule risk analysis generally focuses on the 80-percent level of confidence (P80) for cost contingency calculation. It should be noted that use of P80 as a decision criteria is a risk averse approach (whereas the use of P50 would be a risk neutral approach, and use of levels less than 50 percent would be risk seeking). Thus, a P80 confidence level results in greater contingency as compared to a P50 confidence level. The selection of contingency at a particular confidence level is ultimately the decision and responsibility of the project's District and/or Division management.

The risk analysis process uses *Monte Carlo* techniques to determine probabilities and contingency. The *Monte Carlo* techniques are facilitated computationally by a commercially available risk analysis software package (Crystal Ball) that is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis purposes. The level of detail recreated in the Excel-format schedule is sufficient for risk analysis purposes that reflect the established risk register, but generally less than that of the native format.

The primary steps, in functional terms, of the risk analysis process are described in the following subsections. Risk analysis results are provided in Section 6.

4.1 Identify and Assess Risk Factors

Identifying the risk factors via the PDT is considered a qualitative process that results in establishing a risk register that serves as the document for the quantitative study using the Crystal Ball risk software. Risk factors are events and conditions that may influence or drive uncertainty in project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule.

Checklists or historical databases of common risk factors are sometimes used to facilitate risk factor identification. However, key risk factors are often unique to a project and not readily derivable from historical information. Therefore, input from the entire PDT was obtained using creative processes such as brainstorming or other facilitated risk assessment meetings.

Formal PDT meetings were held for the purposes of identifying and assessing risk factors. The meetings conducted on October 18, 2012 and December 5, 2013 included the following:

No.	Section	Title
1	CESPL-PM-N	Project Manager
2	CESPL-ED-DC	Coastal Engineering
3	CESPL-PD-RN	Environmental Specialist
4	CESPL-PD-WS	Planning
5	CESPL-PD-E	Economics
6	CESPD	Environmental
7	CESPL-ED-DD	Cost Engineering
8	CESPL-ED-GG	Geotechnical
9	CESPL-AM-A	Real Estate
10	CESPL-PD-WS	Heather Schlosser

The formal meeting focused primarily on risk factor identification using brainstorming techniques, but also included some discussions based on risk factors common to projects of similar scope and geographic location.

4.2 Quantify Risk Factor Impacts

The quantitative impacts of risk factors on project plans were analyzed using a combination of professional judgment, empirical data and analytical techniques. Risk factor impacts were quantified using probability distributions (density functions) because risk factors are entered into the Crystal Ball software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involved multiple project team disciplines and functions. This process used an iterative approach to estimate the following elements of each risk factor:

- Maximum possible value for the risk factor
- Minimum possible value for the risk factor
- Most likely value (the statistical mode), if applicable

- Nature of the probability density function used to approximate risk factor uncertainty
- Mathematical correlations between risk factors
- Affected cost estimate and schedule elements

The resulting product from the PDT discussions is captured within a risk register as presented in section 6 for both cost and schedule risk concerns. Note that the risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

4.3 Analyze Cost Estimate and Schedule Contingency

Contingency is analyzed using the Crystal Ball software, an add-in to the Microsoft Excel format of the cost estimate and schedule. *Monte Carlo* simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT. Contingencies are calculated by applying only the moderate and high level risks identified for each option (i.e., low-level risks are typically not considered, but remain within the risk register to serve historical purposes as well as support follow-on risk studies as the project and risks evolve).

For the cost estimate, the contingency is calculated as the difference between the P80 cost forecast and the baseline cost estimate. Each option-specific contingency is then allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by *Monte Carlo* simulation. Standard deviation is used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

5.0 PROJECT ASSUMPTIONS

The following data sources and assumptions were used in quantifying the costs associated with the project conditions at Encinitas and Solana Beach.

a. The MII MCACES (Micro-Computer Aided Cost Estimating Software) files "Encinitas and Solana Beach fill (Initial) -- LPP.mlp", "Encinitas Beach fill (Subsequent Cycles) -- LPP.mlp", "Encinitas and Solana Beach fill (Solana-Encinitas Synched) – LPP.mlp" and "Solana Beach fill (Subsequent Cycles) -- LPP.mlp"" as well as accompanying CEDEP (Corps of Engineers Dredge Estimating Program) files were the basis for the cost and schedule risk analyses.

b. The cost comparisons and risk analyses performed and reflected within this report are based on design scope and estimates that are at the feasibility level.

c. The schedule was analyzed for impact to the project cost in terms of both uncaptured escalation (variance from OMB factors and the local market) and monthly recurring costs (unavoidable fixed contract costs and/or languishing federal administration costs incurred throughout delay).

d. Per the CWCCIS Historical State Adjustment Factors in EM 1110-2-1304, State Adjustment Factor for California is 1.18, meaning that historical inflation is up to 18% higher than the national average.

e. Per the data in the estimate, the Job Office Overhead (JOOH) amount for the Contract Cost comprises approximately 3.82% to 5.88% (4.85% average) of the Project Cost at Baseline. However, the project includes fourteen individual nourishment activities occurring intermittently over nearly 50 years. Thus, the assumed monthly recurring rate for this project is half of the approximate JOOH rate average, or 2.43%. For the P80 schedule, this comprises less than 1% of the total contingency due to the accrual of residual fixed costs associated with delay.

f. The Cost Dx guidance generally focuses on the eighty-percent level of confidence (P80) for cost contingency calculation. For this risk analysis, the eighty-percent level of confidence (P80) was used. It should be noted that the use of P80 as a decision criteria is a moderately risk averse approach, generally resulting in higher cost contingencies. However, the P80 level of confidence also assumes a small degree of risk that the recommended contingencies may be inadequate to capture actual project costs.

g. Only high and moderate risk level impacts, as identified in the risk register, were considered for the purposes of calculating cost contingency. Low level risk impacts should be maintained in project management documentation, and reviewed at each project milestone to determine if they should be placed on the risk “watch list” for further monitoring and evaluation.

6.0 RESULTS

The cost and schedule risk analysis results are provided in the following sections. In addition to contingency calculation results, sensitivity analyses are presented to provide decision makers with an understanding of variability and the key contributors to the cause of this variability.

6.1 Risk Register

A risk register is a tool commonly used in project planning and risk analysis. The actual risk register is provided in Appendix A. The complete risk register includes low level risks, as well as additional information regarding the nature and impacts of each risk.

It is important to note that a risk register can be an effective tool for managing identified risks throughout the project life cycle. As such, it is generally recommended that risk registers be updated as the designs, cost estimates, and schedule are further refined, especially on large projects with extended schedules. Recommended uses of the risk register going forward include:

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact.
- Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of project controls.
- Communicating risk management issues.
- Providing a mechanism for eliciting feedback and project control input.
- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans.

6.2 Cost Contingency and Sensitivity Analysis

Identified risks were distributed into three major categories or among three major work features: risks associated with beach nourishment (dredging); risks directly connected with mitigation; and general project risks affecting all project civil work features, including cited risks, real estate, cultural resources, PED and construction management. In turn, a specific cost and schedule contingency was calculated for each category.

The baseline cost estimate was distributed by dollar weight: beach nourishment civil works features (WBS 17) represent 67% of the total project cost; mitigation features (WBS 06) represent 8% of the total project cost. Remaining civil work features such real estate (WBS 01), cultural resources (WBS 18); planning, engineering and design (WBS 30) and construction management (WBS 31) represent 25% of the total project cost. Calculated percent distribution of the total baseline estimate was used to distribute the general project cost risks by weight.

A dollar-weighted distribution of general project cost and schedule contingency amounts was apportioned over the beach nourishment and mitigation features. While general project features (i.e. real estate, cultural resources, PED and construction management) only carry the calculated general project contingency. Therefore, beach nourishment and mitigation contingencies result from the sum of their owned inherent risks and apportioned general risks from the total project. Shoreline monitoring comprises on-shore and off-shore surveys which state dredging volumes and therefore is was combined with beach nourishment features. Real estate, cultural resources, PED and construction management cost and schedule contingencies result from the general project forecast.

Table 1 provides the raw construction cost contingencies calculated for the P80 confidence level and rounded to the nearest thousand. The construction cost contingencies for the P50 and P100 confidence levels are also provided for illustrative purposes only.

The combined contingency was quantified at approximately $38 Million at the P80 confidence level (31% of the baseline cost estimate).

Table 1. Project Cost Contingencies Summary

LANDS AND DAMAGES CONTINGENCY SUMMARY (WBS 01)

Risk Analysis Forecast	Base Cost Estimate	Base Cost Estimate Contingency	Weighted Total Project Cost Estimate Contingency	Schedule Estimate Contingency	Weighted Total Project Schedule Estimate Contingency	Real Estate Contingency ($)	Real Estate Contingency (%)
50% Confidence Level							
Total Project Cost	$323,000	$42,636	--	$1,365	--	$44,000	14%
80% Confidence Level							
Total Project Cost	$323,000	$60,078	--	$1,924	--	$62,000	19%
100% Confidence Level							
Total Project Cost	$323,000	$101,744	--	$3,258	--	$105,000	33%

MITIGATION CONTINGENCY SUMMARY (WBS 06)

Risk Analysis Forecast	Base Cost Estimate	Base Cost Estimate Contingency	Weighted Total Project Cost Estimate Contingency	Schedule Estimate Contingency	Weighted Total Project Schedule Estimate Contingency	Mitigation Nourishment Contingency ($)	Mitigation Contingency (%)
50% Confidence Level							
Total Project Cost	$9,810,000	$1,887,242	$1,295,787	$37,505	$41,490	$3,262,000	33%
80% Confidence Level							
Total Project Cost	$9,810,000	$3,276,456	$1,831,269	$41,135	$45,836	$5,195,000	53%
100% Confidence Level							
Total Project Cost	$9,810,000	$9,243,351	$3,139,107	$52,673	$56,269	$12,491,000	127%

BEACH NOURISHMENT CONTINGENCY SUMMARY (WBS 17)

Risk Analysis Forecast	Base Cost Estimate	Base Cost Estimate Contingency	Weighted Total Project Cost Estimate Contingency	Schedule Estimate Contingency	Weighted Total Project Schedule Estimate Contingency	Total Beach Nourishment Contingency ($)	Beach Nourishment Contingency (%)
50% Confidence Level							
Total Project Cost	$83,104,000	$4,786,182	$10,977,070	$253,634	$351,474	$16,368,000	20%
80% Confidence Level							
Total Project Cost	$83,104,000	$11,187,837	$15,513,329	$284,607	$388,290	$27,374,000	33%
100% Confidence Level							
Total Project Cost	$83,104,000	$83,103,997	$26,592,488	$349,989	$476,675	$110,523,000	133%

CULTURAL RESOURCES CONTINGENCY SUMMARY (WBS 18)

Risk Analysis Forecast	Base Cost Estimate	Base Cost Estimate Contingency	Weighted Total Project Cost Estimate Contingency	Schedule Estimate Contingency	Weighted Total Project Schedule Estimate Contingency	Real Estate Contingency ($)	Real Estate Contingency (%)
50% Confidence Level							
Total Project Cost	$34,000	$4,845	--	$155	--	$5,000	15%
80% Confidence Level							
Total Project Cost	$34,000	$6,783	--	$217	--	$7,000	21%
100% Confidence Level							
Total Project Cost	$34,000	$10,659	--	$341	--	$11,000	32%

PLANNING, ENGINEERING AND DESIGN CONTINGENCY SUMMARY (WBS 30)

Risk Analysis Forecast	Base Cost Estimate	Base Cost Estimate Contingency	Weighted Total Project Cost Estimate Contingency	Schedule Estimate Contingency	Weighted Total Project Schedule Estimate Contingency	PED Contingency ($)	PED Contingency (%)
50% Confidence Level							
Total Project Cost	$24,313,000	$3,211,250	--	$102,821	--	$3,314,000	14%
80% Confidence Level							
Total Project Cost	$24,313,000	$4,507,765	--	$144,334	--	$4,652,000	19%
100% Confidence Level							
Total Project Cost	$24,313,000	$7,673,472	--	$245,696	--	$7,919,000	33%

CONSTRUCTION MANAGEMENT CONTINGENCY SUMMARY (WBS 31)

Risk Analysis Forecast	Base Cost Estimate	Base Cost Estimate Contingency	Weighted Total Project Cost Estimate Contingency	Schedule Estimate Contingency	Weighted Total Project Schedule Estimate Contingency	Construction Management Contingency ($)	Construction Management Contingency (%)
50% Confidence Level							
Total Project Cost	$6,137,000	$811,049	--	$25,969	--	$837,000	14%
80% Confidence Level							
Total Project Cost	$6,137,000	$1,137,600	--	$36,425	--	$1,174,000	19%
100% Confidence Level							
Total Project Cost	$6,137,000	$1,937,021	--	$62,021	--	$1,999,000	33%

Notes:
1) These figures combine uncertainty in the baseline cost estimates and schedule.
2) A P100 confidence level is an abstract concept for illustration only, as the nature of risk and uncertainty (specifically the presence of “unknown unknowns”) makes 100% confidence a theoretical impossibility.

6.2.1 Sensitivity Analysis

Sensitivity analysis generally ranks the relative impact of each risk/opportunity as a percentage of total cost uncertainty. The Crystal Ball software uses a statistical measure (contribution to variance) that approximates the impact of each risk/opportunity contributing to variability of cost outcomes during *Monte Carlo* simulation.

Key cost drivers identified in the sensitivity analysis can be used to support development of a risk management plan that will facilitate control of risk factors and their potential impacts throughout the project lifecycle. Together with the risk register, sensitivity analysis results can also be used to support development of strategies to eliminate, mitigate, accept or transfer key risks.

6.2.2 Sensitivity Analysis Results

The risks/opportunities considered as key or primary cost drivers are ranked in order of importance in contribution to variance bar charts. Opportunities that have a potential to reduce project cost and are shown with a negative sign; risks are shown with a positive sign to reflect the potential to increase project cost. A longer bar in the sensitivity analysis chart represents a greater potential impact to total project cost.

Figure 1 presents a sensitivity analysis for cost growth risk from the high level cost risks identified in the risk register. Likewise, Figure 2 presents a sensitivity analysis for schedule growth risk from the high level schedule risks identified in the risk register.

6.3 Schedule and Contingency Risk Analysis

Table 2 provides the general schedule duration contingencies calculated for the P80 confidence level. The schedule duration contingencies for the P50 and P100 confidence levels are also provided for illustrative purposes.

Schedule duration contingency was quantified as 35 months based on the P80 level of confidence. These contingencies were used to calculate the projected monthly recurring cost impact of project delays that are included in the Table 1 presentation of total cost contingency. The schedule contingencies were calculated by applying the high level schedule risks identified in the risk register for each option to the durations of critical path and near critical path tasks.

The schedule was not resource loaded and contained open-ended tasks and non-zero lags (gaps in the logic between tasks) that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the utility of the schedule contingency data presented. Schedule contingency impacts presented in this analysis are based solely on projected monthly recurring costs.

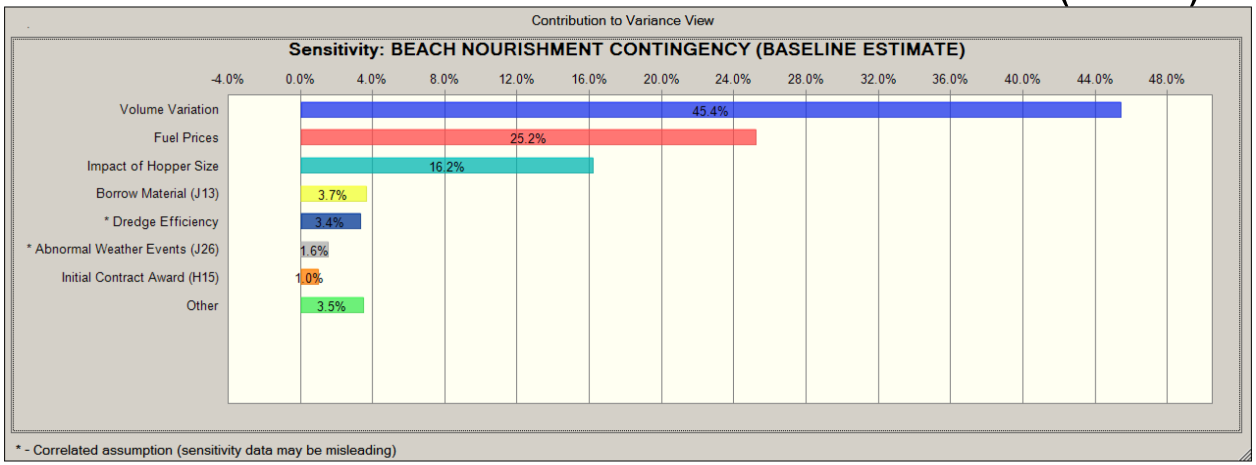
Table 2. Schedule Duration Contingency Summary (General Project)

Risk Analysis Forecast	Baseline Schedule Duration (months)	Contingency[1] (months)	Contingency (%)
50% Confidence Level			
Total Project Duration	543	27	5%
80% Confidence Level			
Total Project Duration	543	35	7%
100% Confidence Level			
Total Project Duration	543	57	10%

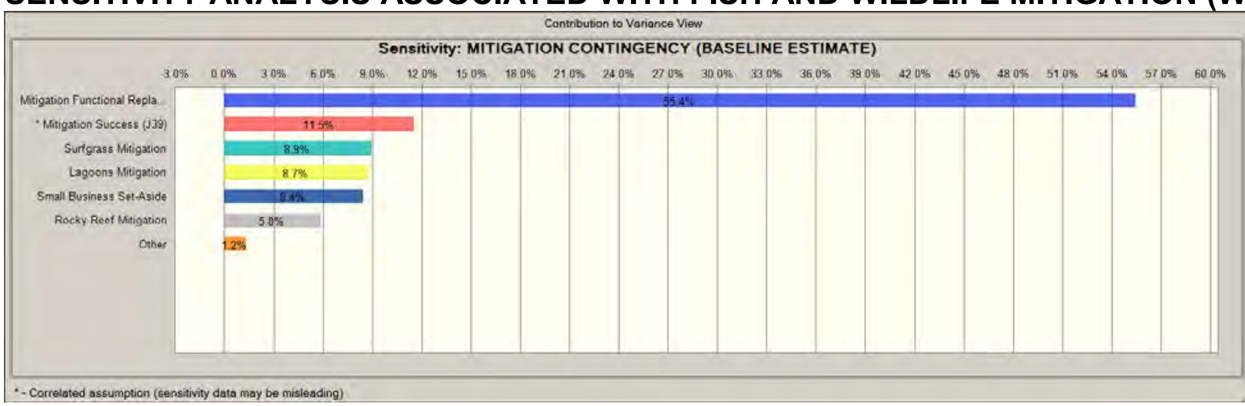
Notes:
1) The schedule was not resource loaded and contained open-ended tasks and non-zero lags (gaps in the logic between tasks) that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the utility of the schedule contingency data presented in Table 2.
2) A P100 confidence level is an abstract concept for illustration only, as the nature of risk and uncertainty (specifically the presence of “unknown unknowns”) makes 100% confidence a theoretical impossibility.

Figure 1. Cost Sensitivity Analyses

SENSITIVITY ANALYSIS ASSOCIATED WITH BEACH NOURISHMENT (WBS 17)



SENSITIVITY ANALYSIS ASSOCIATED WITH FISH AND WILDLIFE MITIGATION (WBS 06)



SENSITIVITY ANALYSIS ASSOCIATED WITH GENERAL RISKS (Impacting Beach Replenishment, Mitigation, Real Estate, PED and Construction Management Cost)

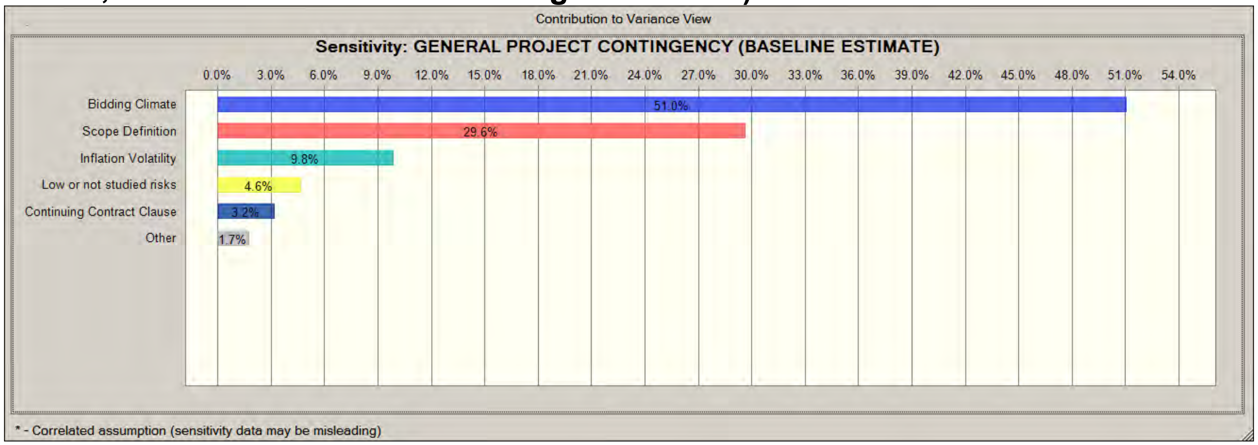
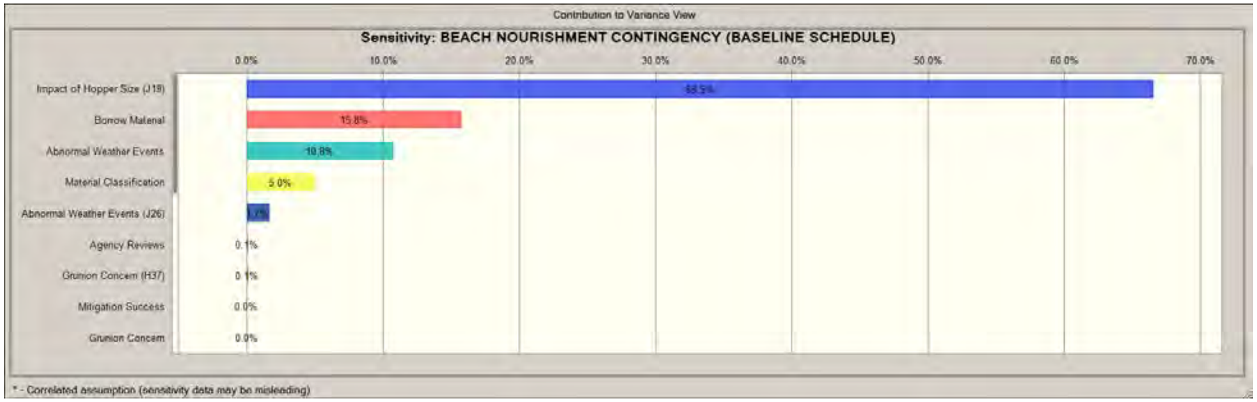
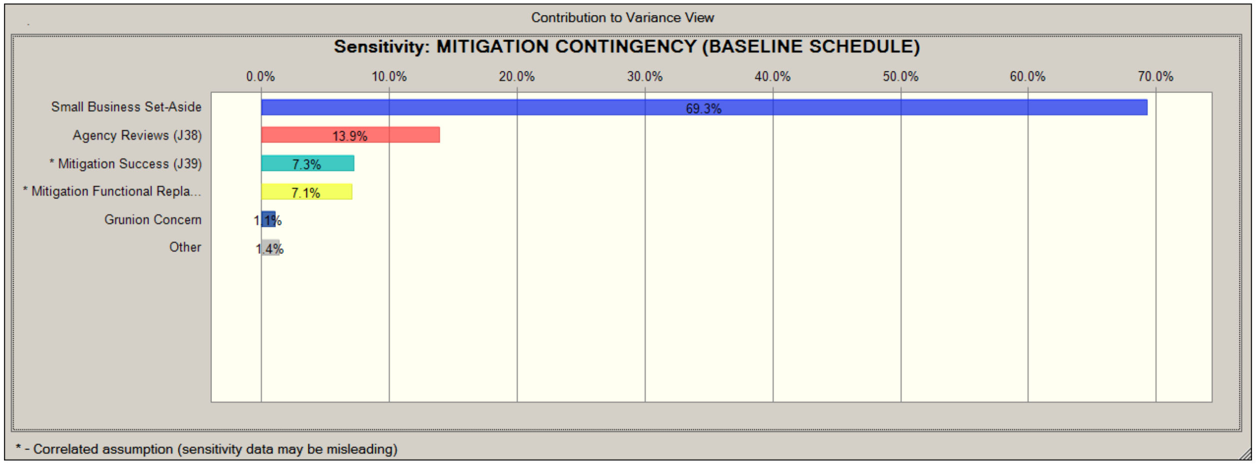


Figure 2. Schedule Sensitivity Analyses

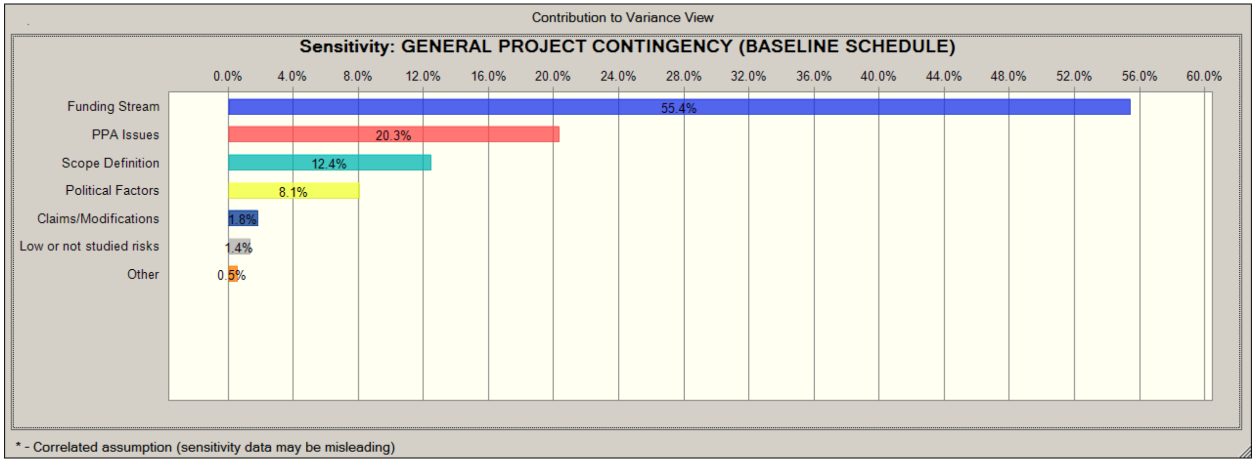
SENSITIVITY ANALYSIS ASSOCIATED WITH BEACH NOURISHMENT (WBS 17)



SENSITIVITY ANALYSIS ASSOCIATED WITH FISH AND WILDLIFE MITIGATION (WBS 06)



SENSITIVITY ANALYSIS ASSOCIATED WITH GENERAL RISKS (Impacting Beach Replenishment, Mitigation, Real Estate, PED and Construction Management Cost)



7.0 MAJOR FINDINGS/OBSERVATIONS/RECOMMENDATIONS

This section provides a summary of significant risk analysis results that are identified in the preceding sections of the report. Risk analysis results are intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as projects progress through planning and implementation. Because of the potential for use of risk analysis results for such diverse purposes, this section also reiterates and highlights important steps, logic, key assumptions, limitations, and decisions to help ensure that the risk analysis results are appropriately interpreted.

7.1 Major Findings/Observations

Total project cost comparison summaries are provided in Table 3. Additional major findings and observations of the risk analysis are listed below.

Major Findings / Observations associated with the Cost

1. The greatest key cost risk drivers are associated with the base cost estimate since they represent 97.5% ($37.5 million) potential cost growth. Therefore, the total project risk unfolds mainly from the construction cost risk instead of the schedule risk.

2. The key cost risk drivers identified through sensitivity analysis were volume variations (T-1), impact of hopper size (EST-3), fuel prices (EST-3), mitigation functional replacement (ENV-6), reef mitigation success (ENV-5), bidding climate (PR-3), and scope definition (PPM-2) which together contribute approximately 75 percent of the statistical cost variance.

Major Findings / Observations associated with the Schedule

1. Only, 2.5% ($0.9 million) cost growth potential is due to risk analyzed in the baseline schedule. Since the project consists of an initial construction event followed by thirteen (13) short subsequent construction events within 5-year (Encinitas) and 10-year (Solana Beach) intervals, the total project schedule (50 years) includes enough float time to absorb most of the schedule risk.

2. The key schedule risk drivers identified through sensitivity analysis were impact of hopper size (EST-1), small business set-aside (CA-2) and funding stream (PPM-1) which together contribute over 55 percent of the statistical schedule variance.

3. The schedule was not resource loaded and contains open-ended tasks, and non-zero lags (gaps in the logic between tasks) that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the

utility of the schedule contingency data presented. Schedule contingency impacts presented in this analysis are based solely on projected monthly recurring costs. Resource impacts related to potential schedule delays could not be evaluated.

Operation and maintenance activities were not included in the cost estimate or schedules. Therefore, a full lifecycle risk analysis could not be performed. Risk analysis results or conclusions could be significantly different if the necessary operation and maintenance activities were included.

Table 3. Project Cost Comparison Summary

REAL ESTATE COST SUMMARY

Confidence Level	Project Cost ($)	Contingency (%)
P0	301,881	-6.5%
P5	333,530	3.3%
P10	340,268	5.3%
P15	344,878	6.8%
P20	348,926	8.0%
P25	352,331	9.1%
P30	355,595	10.1%
P35	358,788	11.1%
P40	361,499	11.9%
P45	364,222	12.8%
P50	367,031	13.6%
P55	369,693	14.5%
P60	372,312	15.3%
P65	375,176	16.2%
P70	378,246	17.1%
P75	381,271	18.0%
P80	384,805	19.1%
P85	389,110	20.5%
P90	393,945	22.0%
P95	401,198	24.2%
P100	428,210	32.6%

BEACH NOURISHMENT COST SUMMARY

Confidence Level	Project Cost ($)	Contingency (%)
P0	51,389,727	-38.2%
P5	77,101,250	-7.2%
P10	81,964,178	-1.4%
P15	85,354,940	2.7%
P20	88,178,674	6.1%
P25	90,530,793	8.9%
P30	92,567,390	11.4%
P35	94,450,478	13.7%
P40	96,143,966	15.7%
P45	97,815,725	17.7%
P50	99,472,361	19.7%
P55	101,097,608	21.7%
P60	102,777,259	23.7%
P65	104,498,442	25.7%
P70	106,364,588	28.0%
P75	108,233,486	30.2%
P80	110,478,063	32.9%
P85	113,108,847	36.1%
P90	116,149,277	39.8%
P95	120,744,850	45.3%
P100	141,586,764	70.4%

MITIGATION PROJECT COST SUMMARY

Confidence Level	Project Cost ($)	Contingency (%)
P0	7,692,204	-21.0%
P5	10,456,473	6.7%
P10	10,956,067	11.7%
P15	11,310,045	15.3%
P20	11,615,300	18.4%
P25	11,882,925	21.1%
P30	12,132,205	23.7%
P35	12,374,623	26.2%
P40	12,599,075	28.4%
P45	12,830,576	30.8%
P50	13,070,773	33.3%
P55	13,325,686	35.9%
P60	13,576,152	38.4%
P65	13,860,620	41.3%
P70	14,176,778	44.5%
P75	14,552,661	48.4%
P80	15,003,200	53.0%
P85	15,685,123	59.9%
P90	16,746,344	70.7%
P95	17,944,265	82.9%
P100	22,286,393	127.3%

CULTURAL RESOURCES COST SUMMARY

Confidence Level	Project Cost ($)	Contingency (%)
P0	31,777	-6.5%
P5	35,108	3.3%
P10	35,818	5.3%
P15	36,303	6.8%
P20	36,729	8.0%
P25	37,087	9.1%
P30	37,431	10.1%
P35	37,767	11.1%
P40	38,053	11.9%
P45	38,339	12.8%
P50	38,635	13.6%
P55	38,915	14.5%
P60	39,191	15.3%
P65	39,492	16.2%
P70	39,815	17.1%
P75	40,134	18.0%
P80	40,506	19.1%
P85	40,959	20.5%
P90	41,468	22.0%
P95	42,231	24.2%
P100	45,075	32.6%

PLANNING, ENGINEERING AND DESIGN COST SUMMARY

Confidence Level	Project Cost ($)	Contingency (%)
P0	22,723,316	-6.5%
P5	25,105,650	3.3%
P10	25,612,811	5.3%
P15	25,959,824	6.8%
P20	26,264,541	8.0%
P25	26,520,817	9.1%
P30	26,766,542	10.1%
P35	27,006,855	11.1%
P40	27,210,915	11.9%
P45	27,415,897	12.8%
P50	27,627,292	13.6%
P55	27,827,673	14.5%
P60	28,024,817	15.3%
P65	28,240,449	16.2%
P70	28,471,506	17.1%
P75	28,699,217	18.0%
P80	28,965,196	19.1%
P85	29,289,240	20.5%
P90	29,653,178	22.0%
P95	30,199,171	24.2%
P100	32,232,385	32.6%

CONSTRUCTION MANAGEMENT COST SUMMARY

Confidence Level	Project Cost ($)	Contingency (%)
P0	5,735,738	-6.5%
P5	6,337,078	3.3%
P10	6,465,093	5.3%
P15	6,552,685	6.8%
P20	6,629,601	8.0%
P25	6,694,289	9.1%
P30	6,756,314	10.1%
P35	6,816,973	11.1%
P40	6,868,481	11.9%
P45	6,920,222	12.8%
P50	6,973,582	13.6%
P55	7,024,161	14.5%
P60	7,073,923	15.3%
P65	7,128,352	16.2%
P70	7,186,675	17.1%
P75	7,244,153	18.0%
P80	7,311,290	19.1%
P85	7,393,085	20.5%
P90	7,484,949	22.0%
P95	7,622,766	24.2%
P100	8,135,983	32.6%

TOTAL PROJECT COST SUMMARY

Confidence Level	Project Cost ($)	Contingency (%)
P0	87,900,000	-29%
P5	119,400,000	-3%
P10	125,400,000	1%
P15	129,600,000	5%
P20	133,100,000	8%
P25	136,000,000	10%
P30	138,600,000	12%
P35	141,000,000	14%
P40	143,200,000	16%
P45	145,400,000	18%
P50	147,500,000	19%
P55	149,700,000	21%
P60	151,900,000	23%
P65	154,100,000	25%
P70	156,600,000	27%
P75	159,200,000	29%
P80	162,200,000	31%
P85	165,900,000	34%
P90	170,500,000	38%
P95	177,000,000	43%
P100	204,700,000	65%

7.2 Recommendations

Risk Management is an all-encompassing, iterative, and life-cycle process of project management. The Project Management Institute's (PMI) *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, *4th edition*, states that "project risk management includes the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project." Risk identification and analysis are processes within the knowledge area of risk management. Its outputs pertinent to this effort include the risk register, risk quantification (risk analysis model), contingency report, and the sensitivity analysis.

The intended use of these outputs is implementation by the project leadership with respect to risk responses (such as mitigation) and risk monitoring and control. In short, the effectiveness of the project risk management effort requires that proactive management of risks does not conclude with the study completed in this report.

The Cost and Schedule Risk Analysis (CSRA) produced by the PDT identifies issues that require the development of subsequent risk response and mitigation plans. This section provides a list of recommendations for continued management of the risks identified and analyzed in this study. Note that this list is not all inclusive and should not substitute a formal risk management and response plan.

1. Key Cost Risk Drivers:

The key cost risk drivers identified through sensitivity analysis were volume variations (T-1), impact of hopper size (EST-1), fuel prices (EST-3), mitigation functional replacement (ENV-6), reef mitigation success (ENV-5), bidding climate (PR-3), and scope definition (PPM-2) which together contribute approximately 75 percent of the statistical cost variance.

a) Volume Variations: Project leadership should attempt to finalize dredging quantities to the maximum extent possible.

b) Impact of Hopper Size: Project leadership should ensure that the PDT conducts market research to determine the regional trends regarding the availability of equipment to meet the requirements in parallel to the general market research being conducted. Ultimately, this is an external risk, and its impacts must be communicated to management, and funds should be maintained in project reserve for treatment of this risk.

c) Fuel Prices: Project leadership should ensure proactive market research to identify trends and their effect on the project cost. Ultimately, this is an external risk, and its impacts must be communicated to management, and funds should be maintained in project reserve for treatment of this risk.

d) Mitigation Functional Replacement: With respect to mitigation, Cost Engineering recommends further research into the variables that support that support mitigation functional replacement values. Changes in mitigation values should be controlled and reported to management for expeditious cost recovery efforts.

e) Mitigation Success (Reef): Mitigation measures depend on monitoring data, appropriations and negotiations with state and federal resource agencies. Mitigation success progress reports should be reported to management for expeditious cost recovery efforts.

f) Bidding Climate: The PDT may consider changing the engineering requirements or methodologies to increase competition. Ultimately, this is an external risk, and its impacts must be communicated to management, and funds should be maintained in project reserve for treatment of this risk.

g) Scope Definition: Project leadership should attempt to capture and finalize the scope of the project to the maximum extent possible. It is imperative to identify all features of work and probable methodologies prior to project authorization, continuing to refine scoping details during the Pre-Construction Engineering and Design (PED Phase).

2. Key Schedule Risk Drivers: The key schedule risk drivers identified through sensitivity analysis were impact of hopper size (EST-1), small business set-aside (CA-2) and funding stream (PPM-1) which together contribute over 55 percent of the statistical schedule variance.

a) Impact of Hopper Size: Project leadership should ensure that the PDT conducts market research to determine the regional trends regarding the availability of equipment to meet the requirements in parallel to the general market research being conducted. Ultimately, this is an external risk, and its impacts must be communicated to management, and funds should be maintained in project reserve for treatment of this risk.

b) Small Business set-aside: Changes to anticipated timeline with respect to biological monitoring schedule should be controlled and reported to management for expeditious schedule recovery efforts.

c) Funding Stream: Project leadership should take proactive measures with respect to the schedule and the timeline for budget approval and disbursement of project funds. Impacts must be communicated to management.

3. Risk Management: Project leadership should use the outputs created during the risk analysis effort as tools in future risk management processes. The risk register should be updated at each major project milestone. The results of the sensitivity analysis may

also be used for response planning strategy and development. These tools should be used in conjunction with regular risk review meetings.

4. Risk Analysis Updates: Project leadership should review risk items identified in the original risk register and add others, as required, throughout the project life-cycle. Risks should be reviewed for status and re-evaluation (using qualitative measure, at a minimum) and placed on risk management watch lists if any risk's likelihood or impact significantly increases. Project leadership should also be mindful of the potential for secondary (new risks created specifically by the response to an original risk) and residual risks (risks that remain and have unintended impact following response).

APPENDIX A

Solana-Encinitas Coastal Storm Damage Reduction Project (LPP)

Risk Level

Likelihood of Occurrence					
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	High
	Negligible	Marginal	Significant	Critical	Crisis

Impact or Consequence of Occurrence

Overall Project Scope
The purpose is to address coastal storm water damage within coastal region of the Cities of Encinitas and Solana Beach Work involves beach fill with the use of a hopper dredge to excavate sand from an off-shore borrow site and place it on the beach. There will be an initial dredging cycle followed by subsequent dredging cycles spread over 50 years. Mitigation costs are also incurred.

Cost Impacts
For the Solana-Encinitas Beach Replenishment Project Project, any cost impact of $2 Million or higher should be considered at least "Significant." Anything over $1 Million should be considered at least "Marginal."

Schedule Impacts

For the Solana-Encinitas Beach Replenishment Project, any schedule impact of 6 months or greater should be considered at least "Significant." Anything over 3 months should be considered at least "Marginal."

				Project Cost				Project Schedule							
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)	Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
	Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)														
	PROJECT & PROGRAM MGMT														
PPM-1	Funding Stream	Schedule developed with the assumption that sufficient funding would be received on a timely basis.	Design and construction phases will be entirely dependent on appropriations which are uncertain. This issue can have an effect on the overall performance of planning and engineering, as far as schedule is concerned. The local sponsors may not have their non-federal share of project funding at the right time to move forward on the project. Funding stream delays could impact the project schedule.	Unlikely	Marginal	LOW		Likely	Critical	HIGH		Uniform	PPM-4	Project Manager	Project Schedule
PPM-2	Scope Definition	The PDT discussed the possibility that over the life of the project the scope may change. The storm damage reduction project could add sand retention features.	If the scope changes a Postauthorization Change (PAC) would need to be drafted, the cost would increase and the project would be delayed.	Unlikely	Significant	MODERATE		Unlikely	Critical	MODERATE		Uniform		Project Manager	Project Cost & Schedule
PPM-3	PPA Issues	The execution and finalization of the PPA may cause some delay. Show-stopping issues are not anticipated, but it could have an impact if the final agreements are delayed.	This could have an impact on the overall implementation schedule, as the Government cannot advertise until the PPA is signed.	Very Unlikely	Negligible	LOW		Very Likely	Significant	HIGH		Yes-No/Uniform		Project Manager	Projec Schedule
PPM-4	Continuing Contract Clause	If the initial construction is not fully funded, the Continuing Contract Clause will need to be exercised to make a subsequent cycle award.	Standard Continuing Contract Clause increases the risk of contractors increasing their prices.	Likely	Marginal	MODERATE		Very Unlikely	Marginal	LOW		Yes-No/Uniform	PPM-1	Project Manager	Project Cost
	TECHNICAL RISKS														
T-1	Volume Variation	Dredging volumes are calculated on projected beach profiles which will change from cycle to cycle.	Year-to-year variation of beach profile is high. Volume changes significantly affect dredging cost. Required quantities are also based on a 2015 construction start date. When this is delayed, additional quantities maybe required resulitng in higher cost for equivalent amount of storm damage risk reduction.	Likely	Significant	HIGH		Unlikely	Marginal	LOW		Yes-No/Triangular		Technical Lead	Contract Cost & Schedule

T-2	Dredging cycles	Dredging cycles (schedule) could change as a result of higher than average storm events during El-Niño-Southern Oscillation (ENSO) periods of the Pacific Ocean's decadel cycle.	There is a chance for the replenishment schedule to change. It may accelerate or slow down, resulting in one more or one less dredge event over the project life.	Likely	Marginal	MODERATE		Likely	Significant	HIGH		Uniform		Technical Lead	Contract Cost & Schedule
T-3	Borrow Material	Uncertainty with the yield of suitable material from the borrow site. There is uncertainty as to the actual limits and location of the borrow site(s), and of the quality of borrow material within those site(s). Competing projects may use the finite borrow materials at the identified site(s).	The identified borrow site will likely be available for the inital dredging cycle. However, the likelihood of the identified borrow site availability decreases for subsequent nourishment events. If another site must be identified and utilized, then it could change the sailing distance from approximately 6 miles to up to 25 miles. This would have a significant impact on the costs and the schedule.	Unlikely	Significant	MODERATE		Unlikely	Significant	MODERATE		Custom/Triangular		Technical Lead	Contract Cost & Schedule
	LANDS AND DAMAGES RISKS														
LD-1	State Land Permits	The sponsors has to obtain a State Land Permit for the borrow sites and the placement sites. The risk would be that State Lands may not want to give the permit to the sponsors.	This risk is seen as highly unlikely. The worst case scenario is that this would require that the PDT select a different borrow site. There is the possibility that some additional surveys may be required, as it pertains to habitat and wildlife issues.	Very Unlikely	Significant	LOW		Very Unlikely	Marginal	LOW		Yes-No/Uniform		Real Estate	
	ACQUISITION STRATEGY														
CA-1	Initial Contract Award	The estimate is build under the assumption that the initial dredging event for the Solana Beach Replenishment and the Encinitas Beach replenishment will be awarded together under one contract.	If the initial dredging event is broken down into two contracts, mob/demob might double, but the life of the project is unlikely to be altered.	Unlikely	Significant	MODERATE		Unlikely	Negligible	LOW		Yes-No/Triangular		Contracting	Contract Cost
CA-2	Small Business Set-Aside	Small Business Set-Aside for Biological Monitoring Services.	There are biological monitoring services in the overall implementation. These could be set aside for small business or 8(a). The District has experienced several challenges with small business contracts in the past for these services. This issue would ca+D30use a cost impact, but it could also cause schedule delays, if qualified offerors are unavailable.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE		Uniform		Contracting	Contract Cost & Schedule
	ENVIRONMENTAL														
ENV-1	Rocky Reef Mitigation	Currently, the extent of the mitigation is undefined. Mitigation size will result from actual impacts.	The details of the mitigation reef and it's extents are not defined. The PDT's currently assumes no mitigation costs associated with the Encinitas segment. Mitigation costs could significantly increase or decrease. Overall schedule should not be affected.	Likely	Critical	HIGH		Likely	Negligible	LOW		Yes-No/Triangular		Environmental	Project Cost
ENV-2	Surfgrass Mitigation	Surfgrass mitigation is not predicted, may have to be built if it occurs.	Surfgrass mitigation is not proposed or included in estimated costs and schedule. If monitoring shows impacts, mitigation will have to be negotiated, designed, built, and monitored resulting in increased costs.	Unlikely	Significant	MODERATE	~$2M	Unlikely	Negligible	LOW		Yes-No/Triangular		Environmental	Project Cost

ENV-3	Grunion Concern	If the constructed protective beach becomes a spawning site for the California grunion (fish), the replenishment cycles schedule would be affected.	Schedule could be altered so that dredging cycles occur outside the grunion season. Pushes project into the rough season. Initial dredging cycle is unlikely to be affected, but the subsequent cycles are more likely to be affected. If grunion are on the fill beaches (most likely only for the renourishment events) we are required to avoid as much as possible. We are not required to avoid entirely and it is unlikely we would re-schedule solely due to potential grunion impacts. Also, very low levels of grunion spawning activity do not require protection.	Very Unlikely	Marginal	LOW		Likely	Marginal	MODERATE	~4 months	Yes-No/Triangular		Environmental	Projec Schedule
ENV-4	Agency Reviews	Mitigation policy could be elevated to headquearter level by the Fish and Wildlife Services (FWS) and the National Marine Fishery Services (NMFS).	Review process from the draft to final report could affect the mitigation scope. This is a large and expensive project that could be elevated to headquarters for further review. Additional review processes could result into additional project restrictions and significant costs and schedule delays.	Likely	Significant	HIGH		Likely	Marginal	MODERATE		Yes-No/Uniform		Environmental	Project Cost & Schedule
ENV-5	Mitigation Success	This assumes that the mitigation will achieve a level of functional equivalence to the existing reefs.	If the reef does not achieve full functionality, additional work may be needed to achieve full functionality in coordination with state and federal resource agencies. Additional work translates into higher costs and extended schedule.	Likely	Significant	HIGH		Likely	Marginal	MODERATE		Yes-No/Uniform	ENV-6	Environmental	Project Cost & Schedule
ENV-6	Mitigation Functional Replacement	Mitigation quantities are based on a a 2:1 functional replacement, the ratio could go as high as 4:1.	There is some disagreement about what ratio to use in the baseline estimate. If other agencies approach headquarters, the variables that support the mitigation functional replacement may increase resulting in higher mitigation costs and delaying the schedule. With the completion of the Consistency Determination there are no likely challenges to the 2:1 ratio remaining. So, it is very unlikely that this ratio will be changed during the remainder of the study.	Very Unlikely	Crisis	HIGH		Very Unlikely	Crisis	HIGH		Yes-No/Custom	ENV-5	Environmental	Project Cost & Schedule
ENV-7	Lagoons Mitigation	Mitigation Value to Lagoon managers will based on monitoring. Lagoon Managers will try to extract as much funds from a federal project as they can, whether or not there is an incremental increase in maintenance as a result of the project. If appropriations are erratic, high quality monitoring data will be compromised.	There are four coastal lagoons that have on-going maintenance at their tidal inlets to keep them clear of littoral drift. This requirement varies from year to year. Mitigation expense to offset increase in shoaling will be based on physical monitoring and comparative analysis to historical practice. Increasing or decreasing Lagoons maintenance efforts will not likely affect the schedule .	Likely	Significant	HIGH		Very Unlikely	Marginal	LOW		Uniform		Environmental	Contract Cost
	CONSTRUCTION														
CON-1	Inefficient Contractor	There is a possibility that a new dredging contractor obtains one of the contracts and is unable to perform the work.	The nature of this type of work makes this unlikely. Capable remaining dredging contractors in the area are experienced and the work is not complex.	Very Unlikely	Significant	LOW		Very Unlikely	Significant	LOW		Yes-No/Triangular		Contracting	

CON-2	Misplacement Risk	If contractor misplaces the material (pipe leaks, misdumps, etc) it would result into additional mitigation costs.	Misplaced dredged material would create additional mitigation requirements, however the PDT team feels this event is very unlikely to happen, but the impact would be significant.	Very Unlikely	Significant	LOW		Very Unlikely	Significant	LOW		Yes-No/Triangular		Construction	
CON-3	Claims/Modifications	This item captures the risk that post-award construction modifications or claims may cause a variance to project cost and schedule.	Possible claims and modifications may rise affecting the cost and/or causing schedule delays.	Likely	Marginal	MODERATE		Likely	Significant	HIGH		Triangular		Construction	Contract Cost & Schedule
	ESTIMATE AND SCHEDULE														
EST-1	Impact of Hopper Size	Baseline estimate considered a medium size hopper, however, there is the possibility of a large or small hopper dredge bidding the job.	The use of a large size hopper will result in a lower dredging unit cost. The use of a small size hopper will result in a higher dredging unit cost.	Very Likely	Marginal	MODERATE		Very Likely	Marginal	MODERATE		Yes-No/Uniform		Cost Engineering	Contract Cost & Schedule
EST-2	Dredge Availability	Availability of hopper dredges on West Coast is scarse, however baseline estimate considered mob/demob from the East Coast.	The baseline estimate assumes mob/demob from the East Coast which is the worst case but highly likely scenario. It is unlikely that dredging equipment will mob/demob from a farther location.	Very Unlikely	Critical	LOW		Unlikely	Marginal	LOW		Yes-No/Uniform		Cost Engineering	Contract Cost
EST-3	Fuel Prices	Fuel prices are volatile.	Fluctuations in fuel prices affect the dredging unit cost.	Very Likely	Marginal	MODERATE		Unlikely	Marginal	LOW		BetaPERT		Cost Engineering	Contract Cost
EST-4	Dredge Efficiency	Unusual wave action and downtime related to dredge Effective Working Time (EWT).	Baseline estimate assumes a 90% effective working time. Efficiency could range from 70% to 90% affecting the dredging unit cost.	Likely	Marginal	MODERATE		Unlikely	Marginal	LOW		Triangular	PR-1	Cost Engineering	Contract Cost
EST-5	Material Classification	Dredging productivity may vary based on material classification.	Fine components range from 6% mud, 92% sand and 2% gravel. Current material classification resulted from average of 9 test holes in the area. However, sediment classification changes with time, currents, etc. Variation in gradations could affect the unit costs of dredging and the dredging time and the placement costs.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE		Triangular		Cost Engineering	Contract Cost & Schedule
EST-6	Dredge Haul Distance	This relates to longer or shorter hauls for the dredge within the identified borrow site.	Most likely haul distance from borrow site to receiver beach is estimated at 2.5 miles for Encinitas and 1.9 miles for Solana. Worst case scenario would be 3.0 miles. Best case scenario would be 1.8 miles.	Unlikely	Significant	MODERATE		Unlikely	Marginal	LOW		Yes-No/Triangular		Cost Engineering	Contract Cost
EST-7	Confidence on Est. and Sch.	Estimated costs are detailed and the schedule has gone through an extensive review process.	Confidence level in the current working estimate (CWE) and schedule are high.	Very Unlikely	Significant	LOW		Unlikely	Marginal	LOW		Triangular		Cost Engineering	
	REGULATORY AND ENVIRONMENTAL RISKS														
RE-1	Regulatory Agencies	Fish and Wildlife Services (FWS) and National Marine Fisheries Service (NMFS) reviews may cause changes to the current plan.	Regulatory agencies could impose additional studies, environmental windows or areas to be avoided. Additional restriction will impact the cost and significantly delay the project. We have received and coordinated initial responses with the resource agencies. It is considered unlikely that additional comments will be received from the resource agencies in the future that will result in design modifications.	Unlikely	Significant	MODERATE		Unlikely	Significant	MODERATE	~ 1 Yr	Uniform		Project Manager	Contract Cost & Schedule

RE-2	State Regulation Changes	Coastal policy changes	Policy changes could alter the B/C ratio and the 902 limit . There is a chance that the project would not provide enough protection and the benefit value is insufficient. The PDT feels this risk is unilikely.	Very Unlikely	Significant	LOW		Very Unlikely	Significant	LOW		Uniform		Project Manager	
	CONSIDERATION FOR INTERNAL RISKS IDENTIFIED AS LOW OR NOT STUDIED ("UNKNOWN, UNKNOWNs")														
INT-1	Low or not studied risks	This item captures the risk that low or unknown internal risks may cause a variance to project cost and schedule.	Risk based on standard items not included in the formal cost and schedule risk analyses, such as sufficient studies.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE		Triangular		Project Manager	Contract Cost & Schedule
	Programmatic Risks	(External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)													
PR-1	Abnormal Weather Events	Abnormally excessive waves due to weather events could slow productivity of the hopper dredging.	The issue is that the contractor would not be able to complete in the dredging window, meaning that they would have to be remobilized the following year (additional mob and demob costs). This has happened before on previous jobs. The wave issue arises about every 15 years or so.	Likely	Marginal	MODERATE		Unlikely	Significant	MODERATE		Hypergeometric/Custom	EST-4	N/A	Contract Cost & Schedule
PR-2	Political Factors	There are local SIGs (i.e. Surf Rider Foundation) that are opposed to the nourishment activities. They could potentially attempt to file a suit against the project. There are also other groups that oppose nourishment activities.	There remains the possibility that political opposition could stop the project or any individual event. It could also create a delay in the activities as well.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE		Yes-No/Uniform		Project Manager	Projec Schedule
PR-3	Bidding Climate	Large dredging projects requiring hopper dredges has always being handled by a limited pool contractors.	Lack of competition may have a high impact on the construction cost.	Likely	Significant	HIGH		Unlikely	Marginal	LOW		Uniform		N/A	Contract Cost
PR-4	Inflation Volatility	Extreme volatility and inflation on (WBS 17) Beach Replenishment projects is not captured by CWICCIS tables.	CWCCIS tables show 3.76% per year on average (years 2000 thru 2011). Costs may increase higher than the inflation factors captured in the CWCCIS tables.	Likely	Significant	HIGH		Unlikely	Marginal	LOW		Uniform		N/A	Contract Cost

1. Risk/Opportunity identified with reference to the Risk Identification Checklist and through deliberation and study of the PDT.
2. Discussions and Concerns elaborates on Risk/Opportunity Events and includes any assumptions or findings (should contain information pertinent to eventual study and analysis of event's impact to project).
3. Likelihood is a measure of the probability of the event occurring -- **Very Unlikely**, **Unlikely**, **Moderately Likely**, **Likely**, **Very Likely.** The likelihood of the event will be the same for both Cost and Schedule, regardless of impact.
4. Impact is a measure of the event's effect on project objectives with relation to scope, cost, and/or schedule -- **Negligible**, **Marginal**, **Significant**, **Critical**, or **Crisis.** Impacts on Project Cost may vary in severity from impacts on Project Schedule.
5. Risk Level is the resultant of Likelihood and Impact **Low**, **Moderate**, or **High**. Refer to the matrix located at top of page.
6. Variance Distribution refers to the behavior of the individual risk item with respect to its potential effects on Project Cost and Schedule. For example, an item with clearly defined parameters and a solid most likely scenario would probably follow a triangular or normal distribution. A risk item for which the PDT has little data or probability of modeling with respect to effects on cost or schedule (i.e. "anyone's guess") would probably follow a uniform or discrete uniform distribution.
7. The responsibility or POC is the entity responsible as the Subject Matter Expert (SME) for action, monitoring, or information on the PDT for the identified risk or opportunity.
8. Correlation recognizes those risk events that may be related to one another. Care should be given to ensure the risks are handled correctly without a "double counting."
9. Affected Project Component identifies the specific item of the project to which the risk directly or strongly correlates.
10. Project Implications identifies whether or not the risk item affects project cost, project schedule, or both. The PDT is responsible for conducting studies for both Project Cost and for Project Schedule.
11. Results of the risk identification process are studied and further developed by the Cost Engineer, then analyzed through the Monte Carlo Analysis Method for Cost (Contingency) and Schedule (Escalation) Growth.

Encinitas-Solana Beach Coastal Storm Damage Reduction Project

San Diego County, California

Appendix G

Real Estate

U.S. Army Corps of Engineers
Los Angeles District

April 2015

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Table of Contents

Contents

Exhibits

1 The Real Estate Plan

1.1 Statement of Purpose

This REP is prepared in accordance with the Real Estate Handbook, ER 405-1-12, and is for planning purposes in support of the feasibility study for the Encinitas-Solana Beach Coastal Storm Damage Reduction Project. It is anticipated that project construction authorization will come under a future Water Resources Development Act (WRDA) as a specifically authorized water resources project for the USACE. The REP is intended to support the decision to authorize the project under a future WRDA.

The purpose of the REP is to provide data on lands, easements, relocations, rights-of-way and disposal site (LERRD) requirements necessary to support the feasibility study for the solution to the existing beach and bluff erosion problem along the shoreline in the City of Encinitas and the City of Solana Beach in San Diego County, California, that reduces coastal storm-related damages and complies with local, state, and federal environmental laws and regulations. This REP addresses the Recommended Plan, the Locally Preferred Plan (LPP) plan. The recommended plan consists of sand replenishment on the beach.

This Real Estate Plan (REP) is tentative in nature and is to be used for planning purposes only. There may be modifications to the plans that occur during Preconstruction, Engineering and Design (PED) phase, thus changing the final acquisition area(s) and/or administrative and land cost. This REP is written to the same level of detail as the Integrated Feasibility Study it supports.

1.2 Study Authority

The Encinitas-Solana Beach feasibility study was authorized by 2 resolutions.

The 13 May 1993 Resolution of the House Public Works and Transportation Committee provides as follows:

> ***Resolved by the Committee on Public Works and Transportation of the United States House of Representatives, That, in accordance with Section 110 of the River and Harbor Act of 1962, the Secretary of the Army, acting through the Chief of Engineers, is directed to make a survey to investigate the feasibility of providing shore protection improvements in and adjacent to the City of Encinitas, California, in the interest of storm damage reduction, beach erosion control, and related purposes.***

The 22 April 1999 Resolution of the House Committee on Transportation and Infrastructure provides:

> ***Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army, in accordance with Section 110 of the River and Harbor Act of 1962, is hereby requested to conduct a study of the shoreline along the City of Solana Beach, San Diego County, California, with a view to determining whether shore protection improvements for storm damages reduction, environmental restoration and protection, and other related purposes are advisable at the present time.***

1.3 Project Location

The Encinitas-Solana Beach coastal storm damage reduction study area is located along the Pacific Ocean in the Cities of Encinitas and Solana Beach, San Diego County, California. The City of Encinitas is approximately 10 miles (mi) south of Oceanside Harbor, and 17 mi north of Point La Jolla. The Encinitas shoreline is about 6 mi long. It is bounded on the north by Batiquitos Lagoon and on the south by San Elijo Lagoon. Immediately south of the City of Encinitas is the City of Solana Beach. Solana Beach is bounded by San Elijo Lagoon to the north and by the City of Del Mar on the south. It is approximately 17 mi south of Oceanside Harbor, and 10 mi north of Point La Jolla. Solana Beach's shoreline is about 2 mi long.

Area/Length of Project: The project area consists of two segments. Segment 1 (also identified as Reaches 3, 4, and 5 of the study area) is located within the City of Encinitas and extends from the 700 Block of Neptune Avenue to Swami's Reef and is approximately 1.5 mi in length; Segment 2 is located within the City of Solana Beach and stretches from Table Tops Reefs to the southern limit of Solana Beach (Reaches 8 and 9) and is approximately 1.4 mi in length. **Exhibits C-1 and C-2** shows the locations of the project segments in the study area.

The non-Federal Sponsors (NFS) are the City of Encinitas and the City of Solana Beach.

1.4 Project Description

The Recommended Plan, which is the Locally Preferred Plan (LPP), includes two Segments described below:

In Segment 1 (Encinitas), approximately 340,000 CY of beach quality sand would be initially placed along 1.5 mi of shoreline providing a nourishment width of 50 ft at Mean Sea Level (MSL). The beach fill would then naturally slope seaward at a slope of 10:1 (horizontal distance: vertical distance). Beach replenishment of an additional sand volume of 220,000 CY would occur on average every 5 years within the 50-year period of federal participation. Total placement over the 50-year period will be approximately 2,320,000 CY.

In Segment 2 (Solana Beach), approximately 700,000 CY of beach quality sand would be initially placed along 1.4 mi of the shoreline, providing a nourishment width of 150 ft at MSL. The beach fill would then naturally slope seaward at a slope of 10:1 (horizontal distance: vertical distance). Beach replenishment of an additional sand volume of 290,000 CY would occur on average every 10 years within the 50-year period of federal participation. Total placement over the 50 year period will be approximately 1,860,000 CY.

Prior Real Estate Plans: A prior REP on the combined "San Elijo Lagoon and Solana Encinitas Shoreline Protection Project" was prepared in November 2003. In late July 2005, a decision was made to separate the project into two projects and reformulate solutions for the Encinitas Solana Beach coastal storm damage reduction study. The current study does not address San Elijo Lagoon.

2 Real Estate Requirements – Description of Lands, Easements, and Rights of Way Required for the Project

2.1 Background

This section addresses the amount and type of real estate required for the Project, including the indicated minimum interest and the ownership of project LERRD. Recommended standard estates and recommended non-standard estates are addressed in Section 3. A Table is included in Section 4 and shows the acreage required.

The Project has a 50-year period of federal participation consisting of replenishment for beach areas within the Cities of Encinitas and Solana Beach. Within the 50-yr period of federal participation, replenishment would occur in Segment 1, which is located in the City of Encinitas, on average, every 5 years, and in Segment 2, which is located in the City of Solana Beach, on average every 10 years. Borrow sites located in the Pacific Ocean will be used for obtaining the sand for the replenishments. In addition, staging areas are required. It is the policy of the Corps of Engineers to require the non-Federal sponsor(s) to provide the minimum interest in real property necessary to support a project, and the property interests described in this section represent those minimum interests.

The real estate required for the project is as follows:

2.2 Borrow sites (Exhibits C3, C4, C5)

The Project proposes to use 3 established offshore borrow sites previously used by other projects (Borrow Sites SO-5, SO-6 and MB-1) to obtain the sand required for replenishment. The borrowing of sand from the offshore sites will occur periodically during the 50-year period of federal participation, and in short duration, approximately six to eight months at a time. ER 1165-2-130, paragraph 7.e. (page 15) states that periodic nourishment by placement of suitable material on a beach at appropriate intervals of time is considered “construction” for cost sharing purposes when such periodic nourishment is accomplished as an alternative to structural measures. ER 405-1-12 states that while fee interest is required for borrow areas required for future maintenance, a temporary easement is the appropriate interest for the borrowing of materials necessary for construction. On this basis, the indicated minimum interest for the borrow sites would be temporary easement.

2.3 Beach Nourishment sites (Exhibits C-1 and C-2)

The project has identified two nourishment sites, Segment 1 in the City of Encinitas and Segment 2 in the City of Solana Beach. The placement of sand on the beaches will occur periodically during the 50-year period of federal participation, and in short duration, approximately six to eight months at a time. The indicated minimum interest for beach nourishment sites is perpetual easement; however, for reasons discussed in Section 3, less than perpetual rights are anticipated to be sufficient for this project.

2.4 Staging Areas (Exhibits C-1 and C-2)

The project will require two staging areas, one in the City of Encinitas and one in the City of Solana Beach. In Segment 1 (Encinitas), beach access and staging will be at the parking area at Moonlight Beach. In Segment 2 (Solana Beach), beach access and staging will be at the parking area at Fletcher Cove. A temporary fence may be erected around both staging areas for safety and security reasons. These staging areas will be used periodically during the 50-year period of federal participation, as material is borrowed from the offshore sites and deposited at the beach nourishment sites. The dredge and construction equipment are expected to operate on a 24/7 basis, and construction may occur at any time throughout the year. Should equipment need to be temporarily moved off the beach, it will be stored at the staging area.

The use of these parking lots for staging is not anticipated to interfere with public access and parking. There is sufficient public parking available to the public free of charge. Public access to the beach is available via access points which are generally less than 1/2 mile apart. In the event that additional space is needed for contractor mobilization, an alternative/expansion staging area has been identified at Seaside Parking Lot at Cardiff State Beach.

The indicated minimum interest for staging areas is temporary easement.

2.5 Mitigation (Exhibit C-6)

Currently, offshore mitigation in the form of reef habitat is projected to be needed to address indirect impacts to reefs from sand placement within the Solana Beach segment of the project. The modeling conducted identifies anticipated indirect impacts of 6.8 acres after accounting for natural variation in sand movement. The mitigation projected to be required is 13.6 acres based on functional equivalence as described in the Mitigation Strategy (Appendix M) and Mitigation Plan (Appendix H). However, exact impacts, and resulting required mitigation, will be calculated based on monitoring results.

The indicated minimum interest for mitigation is fee simple.

2.6 Ownership of LERRD Required For the Project

NOTE: The California Coastal Commission has regulatory jurisdiction over effects to the coastal zone, which includes both the borrow activities located in the Pacific Ocean as well as the replenishment activities under the Coastal Zone Management Act (CZMA). This regulatory jurisdiction should not be confused with property rights and real estate interests required for project purposes. A consistency determination per the CZMA has been made by the Corps, and the Coastal Commission has concurred with the consistency determination.

Offshore borrow sites SO-5 and SO-6 are owned by the State of California and are under the jurisdiction of the California State Lands Commission (CSLC). Jurisdiction of the CSLC includes the State's sovereign lands along the coastline and offshore islands from the mean high tide line (MHTL) to three nautical miles offshore. **Offshore borrow site MB-1** is, based on a review of available documents, part of lands granted by CSLC to the City of San Diego pursuant to Chapter 688, Statutes of 1933.[1] The required interest will need to be obtained from the City of San Diego. Furthermore, the borrow sites are currently used by SANDAG (the San Diego Association of Governments) for another beach renourishment project, for which CSLC has granted non-exclusive leases to use SO-5 and SO-6 through 2016 (leases may be renewed prior to the end of the lease term). As part of its standard review of applications for use of

[1] Coordination with CSLC has confirmed that MB-1 is within the lands granted to the City of San Diego, with no reservation of mineral rights. No non-standard estate for MB-1 is currently understood to be needed. If further coordination identifies that the City of San Diego cannot grant the standard estate, a separate request for a non-standard estate for MB-1 will be submitted to HQUSACE.

sovereign lands, CSLC confers with current lessees to ensure that proposed grants of interests to new users do not conflict with existing leases. No conflict is anticipated.

Offshore mitigation lands are also owned by the State of California and are under the jurisdiction of the CSLC.

The CSLC also has jurisdiction over **beach nourishment sites** located **below the mean high tide line (MHTL)**.

Beach nourishment sites above the MHTL in Segment 1 (City of Encinitas) are partially owned by the City of Encinitas (non-Federal sponsor) and partially under the jurisdiction of California State Parks. **Beach nourishment sites above the MHTL in Segment 2** (City of Solana Beach) are owned by the City of Solana Beach (non-Federal sponsor).

Staging area for Segment 1 (City of Encinitas) is owned by the City of Encinitas (non-Federal sponsor). **Staging area for Segment 2 (**City of Solana Beach) is owned by the City of Solana Beach (non-Federal sponsor).

The **alternate/expansion staging area at Seaside Parking Lot at Cardiff State Beach (if needed)** is owned by California State Parks.

3 Proposed Estates

3.1 Standard Estates

The standard estate for offshore borrow areas for construction is Standard Estate #15, Temporary Work Area Easement.

The standard estate for beach nourishment areas is Standard Estate #26, Perpetual Beach Storm Damage Reduction Easement.

The standard estate for staging areas is Standard Estate #15, Temporary Work Area Easement.

The standard estate for mitigation is fee simple.

We are recommending the standard estate for (a) Borrow Site MB-1, (b) the portion of the beach nourishment sites owned in fee by the non-Federal sponsors, and (c) the staging areas owned in fee by the non-Federal sponsors:

(a) As stated above, borrow site MB-1 is owned by the City of San Diego; we are recommending standard estate (#15, Temporary Work Area Easement).
(b) The non-Federal sponsors own in fee portions of the replenishment sites above the mean high tide line. It will not be necessary to acquire any interest in those areas, and the sponsors will provide the requisite authorizations for entry.
(c) Because the non-Federal sponsors own the two main staging areas, no acquisition will be necessary and the sponsors will provide the appropriate authorization for entry.

Offshore borrow sites SO-5 and SO-6, offshore mitigation, and the portion of beach nourishment sites not owned by the non-Federal sponsors will require the use of non-standard estates as discussed below. In addition, the alternative/expansion staging area owned by California State Parks may require the use of a non-standard estate, as coordination with California State Parks indicates its general practice for staging areas is to grant a non-recorded entry permit with similar rights to those in our standard temporary work area easement.

3.2 Non-standard Estates

We are proposing non-standard estates with regard to two entities: CSLC and California State Parks.

As discussed above, two of the offshore borrow sites, offshore mitigation acreage, and the beach nourishment sites below the MHTL are sovereign lands of the State of California and are under the jurisdiction of CSLC. California State Parks has jurisdiction over a portion of the beach nourishment site in the City of Encinitas and has jurisdiction over the alternative/expansion staging area at Seaside Parking Lot at Cardiff State Beach. The non-Federal sponsors (City of Encinitas and City of Solana Beach) are responsible for acquiring project lands, easements, and rights-of-way pursuant to state law and procedure.

With respect to CSLC managed lands, we propose to acquire a lease for borrow and placement, which are interrelated and ongoing activities that would be appropriately included in a single instrument from the granting entity. The standard estate for borrow sites is a temporary work area easement and perpetual easement for placement/nourishment sites. Inconsistent term lengths for borrow and placement and separate instruments for this project would not meet the need for this project given that the necessity to use a borrow site arises at the same time as the need for placement. Additionally, acquisition of a permanent easement is not feasible without condemnation. CSLC procedure for granting use of offshore borrow sites and beach nourishment sites under its jurisdiction is to issue a “CALIFORNIA BORROW AND PLACEMENT LEASE.”

We also propose to include mitigation as an additional purpose in the lease described in the preceding paragraph. CSLC procedure for granting use of offshore lands for mitigation or restoration is to issue a lease for mitigation rather than the Corps’ standard fee estate. Acquisition of fee simple title from the State is unlikely and not necessary for the proposed mitigation activities. Here, the underlying fee owner, the State acting by and through CSLC, would have an ongoing and continuing interest in preserving the mitigation area reducing the potential for risk or damage to the mitigation site. For resource and negotiation purposes, CSLC and the Corps agree that a multi-purpose lease would be the most efficient means of outgranting State lands under CSLC control for borrow, mitigation, and placement activities in support of this project. Under California Public Resources Code Section 6501, the term "lease" includes a permit, right-of-way, easement, license, compensatory agreement, or other entitlement of use. (2 CCR § 1900).

CSLC has advised that it does not release “blank” or template documents; however, we have located a standard CSLC lease issued for a similar project and have included the lease as Exhibit E. The sample lease is between CSLC and SANDAG (the San Diego Association of Governments. SANDAG is a public agency composed of the 18 cities and the county government. The Cities of Encinitas and Solana Beach are both members of SANDAG, and the project for which the sample lease was issued will benefit beaches in both cities). The lease issued for the Encinitas-Solana Beach Project is anticipated to be substantially the same as this example, with additional language to address mitigation lands (a multi-purpose lease to address borrow, placement, and mitigation).

The CSLC typically issues multi-purpose leases for terms of 5 years and is prohibited from granting any lease for longer than 49 years. The Los Angeles District's experience is that the CSLC routinely extends and/or renews these leases and/or issues subsequent borrow and placement leases for total terms adequate for the anticipated duration of the project. Online research indicates this to be the common practice of the CSLC. The non-Federal sponsors will need to re-submit a new lease application prior to the expiration of the current lease for each cycle. Before the CSLC renews the instrument, it will do a review to make sure the non-Federal sponsors are in compliance with the conditions of the lease, and that environmental conditions are substantially unchanged from those contemplated in the NEPA/CEQA documentation at the time the lease was originally executed. As long as the project is implemented in accordance with the Feasibility Report, there is a very low risk that the CSLC will not renew. The project includes monitoring and other conditions that will ensure it is implemented appropriately.

The Los Angeles District's "Surfside Sunset Beach Replenishment Project, San Pedro Bay, Orange County" employed this non-standard estate, and the District's "San Clemente Shoreline, Orange County California" feasibility report, which was the subject of a 2012 Chief's Report, also contemplates use of this non-standard estate, as is the State practice in California. In the case of the Surfside Sunset project, the CSLC lease was authorized in 1970 and was amended on four successive occasions (1989, 1997, 2001 and 2008) as required for project purposes.

In assessing the adequacy for project purposes of the proposed non-standard estate, we note the granting entity is a State entity established pursuant to the California Public Resources Code, entrusted with the jurisdiction and management of public lands for the benefit of the people of the State and subject to the Public Trust for water related commerce, navigation, fisheries, recreation, open space and other recognized Public Trust uses. The proposed Lease will serve project purposes and will not increase the costs or potential liability of the United States.

The second non-standard estate is an easement proposed for beach nourishment areas under the jurisdiction of California State Parks. Discussion with California State Parks is ongoing; however, it is anticipated that State Parks would not grant a perpetual easement, the required estate for beach nourishment areas. California State Parks has indicated that for instances where there is a reccurring need greater than 5-10 years, the State has issued long-term easements. An easement for less than a perpetual term would be pursued for this project. The anticipated non-standard estate is not available for review at this time. As required by ER 405-1-12, the proposed easement will be submitted to Headquarters for approval separately, at such time as it is available.

The third non-standard estate may be needed if the alternative/expansion staging area at Seaside Parking Lot at Cardiff State Beach is necessary for contractor mobilization and staging. California State Parks has indicated that, for staging area, it generally issues an entry permit rather than a temporary easement, with substantially the same rights as the standard temporary work area easement; however, it would not be recorded. A copy of California State Parks' standard Right-of-Entry Permit template is provided in Exhibit G and submitted for approval as a non-standard estate.

4 Table of LERRD Required for the Project

Feature	Ownership	Interest to be acquired/provided	Acres
Segment #1 City of Encinitas Periodic Beach Nourishment sites			17 acres
Area from mean high tide line seaward	CSLC	Lease (non-standard)	
Area from mean high tide line landward to base of bluff (see Exhibit F, jurisdictional map)	(1) California State Parks	Less-than-Perpetual Easement (non-standard)	
	(2) City of Encinitas	Perpetual Storm Damage Reduction Easement – however since NFS owns in Fee no interest needs to be acquired	
Staging Area	City of Encinitas	Temporary Work Area Easement - however since NFS owns in fee, no interest needs to be acquired	.80 acre
Segment #2, City of Solana Beach, Periodic Beach Nourishment sites			24.27 acres
Area from mean high tide line seaward	CSLC	Lease (non-standard)	
Area above mean high tide line	City of Solana Beach	Perpetual Storm Damage Reduction Easement – however since NFS owns in fee, no interest needs to be acquired	
Staging Area	City of Solana Beach	Temporary Work Area Easement - however since NFS owns in Fee no interest needs to be acquired	.50 acre
Optional Staging Area at Cardiff State Beach (IF REQUIRED)	California State Parks	Right-of-Entry Permit (non-standard)	
Mitigation (offshore)	CSLC	Lease (non-standard)	13.6 acres (est.)Ŧ
Segments 1 & 2, Offshore Borrow Sites			
Segment 1 & 2 Borrow site SO-6	CSLC	Lease (non-standard)	N/A*
Segment 1 & 2 Borrow site SO-5	CSLC	Lease (non-standard)	N/A*
Segment 1 & 2 Borrow site MB-1	City of San Diego	Temporary Work Area Easement	N/A*

ŦExact acreage to be determined based on monitoring results
*Use of offshore borrow sites is stated in terms of cubic yards of material, not in terms of acreage

5 Existing Federal Projects That Lie Within LER Required For the Project

There are no existing Federal projects that are fully or partially within the LER required for this project.

6 Existing Federal Land Required For the Project

There are no federally owned lands included within the LER required for this project.

7 Navigational Servitude

The navigational servitude is not being invoked for this project.

8 Maps

The Real Estate Project Maps are attached as Exhibit C1, C2, C3, C4, C5, C6 and Exhibit F of this Appendix.

9 Potential Flooding Induced by Construction, Operation, or Maintenance of Project

This is a shoreline protection project involving dredging operations and placement of dredged material on the beach. It will not entail any construction-induced flooding.

10 Baseline Cost Estimate for Real Estate

The following cost estimates are based on the assumption that no privately owned lands are required for the construction, operation, and/or maintenance of this project:

ENCINITAS & SOLANA BEACH NOURISHMENT - INITIAL EVENT				
Federal Costs				
Item:	**Federal**	**Local**	**Subtotal**	**Total**
Administration	$43,000	$0	$43,000	$43,000
Payments for Real Estate	$0	$0	$0	$0
Relocations	$0	$0	$0	$0
TOTAL FEDERAL COSTS:				$43,000
Non-Federal Costs				
Item:	**Federal**	**Local**	**Subtotal**	**Total**
Temp Work Area Easement	$0	$20,000	$20,000	$20,000
Administration	$0	$5,000	$5,000	$5,000
Incidental Costs	$0	$23,000	$23,000	$23,000
TOTAL NON- FEDERAL COSTS:				$48,000
Sub-Total Federal and Non-Federal Costs:				**$91,000**
Contingency (19%)				$17,290
Total:				**$108,290**

ENCINITAS - 9 PERIODIC BEACH NOURISHMENTS ON 5-YR CYCLES				
Federal Costs				
Item:	**Federal**	**Local**	**Subtotal**	**Total**
Administration	$90,000	$0	$90,000	$90,000
Payments for Real Estate	$0	$0	$0	$0
Relocations	$0	$0	$0	$0
TOTAL FEDERAL COSTS:				$90,000
Non-Federal Costs				
Item:	**Federal**	**Local**	**Subtotal**	**Total**
Temp Work Area Easement	$0	$160,000	$160,000	$160,000
Administration	$0	$40,000	$40,000	$40,000
Incidental Costs	$0	$0	$0	$0
TOTAL NON- FEDERAL COSTS:				$200,000
Sub-Total Federal and Non-Federal Costs:				**$315,000**
Contingency (19%)				$59,850
Total:				**$374,850**
SOLANA BEACH - 4 PERIODIC BEACH NOURISHMENTS ON 10-YR CYCLES				
Federal Costs				
Item:	**Federal**	**Local**	**Subtotal**	**Total**
Administration	$30,000	$0	$30,000	$30,000
Payments for Real Estate	$0	$0	$0	$0
Relocations	$0	$0	$0	$0
TOTAL FEDERAL COSTS:				$30,000
Non-Federal Costs				
Item:	**Federal**	**Local**	**Subtotal**	**Total**
Temp Work Area Easement	$0	$60,000	$60,000	$60,000
Administration	$0	$15,000	$15,000	$15,000
Incidental Costs	$0	$0	$0	$0
TOTAL NON- FEDERAL COSTS:				$75,000
Sub-Total Federal and Non-Federal Costs:				**$105,000**
Contingency (19%)				$19,950
Total:				**$124,950**

The contingency was added to account for future escalation of real estate costs over the next three years. After the PPA is signed, the non-Federal sponsors will begin acquisition based on a design memorandum depicting the project boundaries.

The above table is an estimate of costs derived from consultations with the District appraisal staff, the non-Federal sponsors, the CSLC and research using publicly available data. Pursuant to Policy Guidance Letter No. 31, because total real estate costs will constitute less than 10% of the Total Project Cost, a gross appraisal is not required. The cost information in the Table was derived with full consideration of offsetting benefits.

In accordance with Supreme Court decision (United States v. River Rouge Co. (1926) 269 U.S. 411) and applicable guidance (EC 405-1-04, paragraph b (2)), shore protection projects are to be treated in a manner as to not allow credit for LERRD when the project provides direct (off-setting) benefits to those lands subject to shore erosion, that are required for the project; and no credit is allowed for the value of LERRD areas below the mean high tide line for oceanic and tidal waters (33 CFR §329.12).

The staging areas to be provided by the non-Federal sponsors are located on the bluff above the beach areas and therefore are not themselves directly subject to shore erosion. These areas will not be directly benefitted by the project. The Baseline Cost Estimate for Real Estate was developed with full consideration of the rules applicable to offsetting benefits. The estimate includes: (1) only the incidental costs of providing the lands that will directly benefit from the project (beach nourishment sites); (2) the incidental costs of providing borrow areas and mitigation areas (under multi-purpose lease); (3) the estimated value of the staging areas as well as the incidental costs of providing such staging areas.

11 Relocation Assistance Benefits Anticipated being required in accordance with P.L. 91-646

The project does not propose any acquisition of private lands and would not include any displacement of persons or businesses.

12 Mineral/Timber Activity

There is no known mineral activity currently occurring inside the selected project area, with the exception of use by others of the designated borrow sites for dredging sands (discussed in Section 2.6 above), which would not conflict with the use proposed by this project. There is no known timber harvesting within the project boundary that would affect the project.

13 Non-Federal Sponsors' Legal and Professional Capability and Experience to Acquire and Provide LERRD

A capability checklist from each non-Federal sponsor is included at Exhibit A.

The non-Federal sponsors have the legal authority, the human resource capabilities, and the financial resources to sponsor this project. The sponsors do not have condemnation authority for State lands under the jurisdiction of CSLC and California State Parks.

According to the capability checklists attached to this report, the non-Federal sponsors have both indicated that they will require training to become familiar with the real estate requirements of Federal projects as related to Public Law (P.L.) 91-646. The District will ensure that training in the overall application of P.L. 91-646 is provided to both sponsors prior to acquisition.

14 Application or Enactment of Zoning Ordinances

Application or enactment of zoning ordinances is NOT proposed in lieu of, or to facilitate, acquisition in connection with this project.

15 Schedule of all Land Acquisitions

PPA Signed	October 2017
Final Plans and Specifications	December 2017
Obtain Land Survey	February 2018
Obtain Title Evidence	April 2018
Notice to Proceed with Acquisition	June 2018
Completion of Acquisition	November 2018

16 Facility and/or Utility Relocations

There are no known utilities or facilities within the project area that would interfere with the project and require relocations. No relocations are planned.

ANY CONCLUSION OR CATEGORIZATION CONTAINED IN THIS REPORT THAT AN ITEM IS A UTILITY OR FACILITY RELOCATION TO BE PERFORMED BY THE NON-FEDERAL SPONSOR AS PART OF ITS LERRD RESPONSIBILITIES IS PRELIMINARY ONLY. THE GOVERNMENT WILL MAKE A FINAL DETERMINATION OF THE RELOCATIONS NECESSARY FOR THE CONSTRUCTION, OPERATION, OR MAINTENANCE OF THE PROJECT AFTER FURTHER ANALYSIS AND COMPLETION AND APPROVAL OF FINAL ATTORNEY'S OPINIONS OF COMPENSABILTY FOR EACH OF THE IMPACTED UTTILITIES AND FACILITIES.

17 Impact on Real Estate Acquisition Due to Suspected or Known Contaminants

The non-Federal sponsors fully understand their responsibilities for assessing the properties for any potential or presence of hazardous waste materials as defined and regulated under CERCLA. There are no known "Superfund" sites or sites presently under CERCLA remediation or response orders identified in the project area. There is no known presence of any substances in the project area that are regulated under CERCLA or other environmental statutes or regulations. The LERRD estimate is predicated on the assumption that all lands and properties are clean and require no remediation. The model Project Partnership Agreement (PPA) conditions shall be followed in assigning responsibility and cost allocation for such matters.

18 Known or Anticipated Support or Opposition to Project

Public participation has taken place throughout the feasibility study phase. Several public workshops were held throughout the study process. Two final public meetings were held February 6 & 7, 2013, following the Public Release of the Integrated Report. General issues raised during public review included concerns over potential impacts to near shore habitats and recreation activities such as surfing. USACE and the sponsors have addressed these concerns by proposing a smaller Locally Preferred Plan rather than the NED Plan, and by including monitoring for surfing. There is no known opposition to the project that would impact the acquisition process.

19 Notification of Sponsors as to Pre-PPA Risks

The non-Federal sponsors have been notified in writing about the risks associated with acquiring lands prior to the execution of a PPA and the Government's formal notice to proceed with acquisition. See attached Exhibit B.

EXHIBIT A

ASSESMENT OF NON-FEDERAL SPONSOR'S
REAL ESTATE ACQUISITION CAPABILITY
SOLANA BEACH & ENCINITAS SHORELINE PROTECTION PROJECT

CITY OF SOLANA BEACH
August 17, 2011

I. Legal Authority:

a) Does the sponsor have legal authority to acquire and hold title to real property for project purposes? **Yes.**
b) Does the sponsor have the power of eminent domain for this project? **For private property yes. For State lands, no.**
c) Does the sponsor have a "quick-take" authority for this project? **No, but this is not expected to be needed for this project.**
d) Are any of the lands/interests in land required for the project located outside the sponsor's political boundary? **Yes. The California State Lands Commission owns the land seaward of the mean high tide line and the California Coastal Commission has regulatory permit jurisdiction.**
e) Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? **Yes, State lands.**

II. Human Resource Requirements:

a) Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including P.L. 91-646, as amended? **Yes, if required.**
b) If the answer to II a is yes, has a reasonable plan been developed to provide such training? **Not yet, but not likely needed either. If a plan is needed, one will be developed.**
c) Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? **Yes, as required by the project.**
d) Is the sponsor's projected in-house staffing level sufficient considering its other work load if any, and the project schedule? **Yes.**
e) Can the sponsor obtain contractor support, if required, in a timely fashion? **Yes.**
f) Will the sponsor likely request USACE assistance in acquiring real estate? **No. Not needed.**

III. Other Project Variables:

a) Will the sponsor's staff be located within reasonable proximity to the project site? **Yes.**
b) Has the sponsor approved the project/real estate schedule/milestones? **Yes.**

IV. Overall Assessment:

a) Has the sponsor performed satisfactorily on other USACE projects? **Yes.**
b) With regard to this project, the sponsor is anticipated to be **highly capable.**

V. Coordination:

a) Has this assessment been coordinated with the sponsor? Yes.
b) Does the sponsor concur with this assessment? Yes.

CITY OF SOLANA BEACH

David Ott, City Manager

Reviewed and approved by:

KAPLAN.THERES A.M.1241411547 Digitally signed by KAPLAN.THERESA.M.1241411547 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=KAPLAN.THERESA.M.1241411547 Date: 2013.04.30 14:28:10 -07'00'

Theresa M. Kaplan
Chief of LA Asset Management Division

ASSESMENT OF NON-FEDERAL SPONSOR'S
REAL ESTATE ACQUISITION CAPABILITY
SOLANA BEACH & ENCINITAS SHORELINE PROTECTION PROJECT

CITY OF ENCINITAS
August 17, 2011

I. Legal Authority:

a) Does the sponsor have legal authority to acquire and hold title to real property for project purposes? **Yes**
b) Does the sponsor have the power of eminent domain for this project? **No, the project involves placing sand on lands owned by the State. The City does not have eminent domain power over the State.**
c) Does the sponsor have a "quick-take" authority for this project? **No, but not needed for this project.**
d) Are any of the lands/interests in land required for the project located outside the sponsor's political boundary? **Yes. The California State Lands Commission owns the land seaward of the mean high tide line. State Parks Department has jurisdictional ownership over the majority of Encinitas beaches.**
e) Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? **Yes, State lands & State Parks.**

II. Human Resource Requirements:

a) Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including P.L. 91-646, as amended? **Yes.**
b) If the answer to II (a) is yes, has a reasonable plan been developed to provide such training? **Not yet. If a plan is needed, one will be developed.**
c) Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? **Yes, as required by the project.**
d) Is the sponsor's projected in-house staffing level sufficient considering its other work load if any, and the project schedule? **Yes.**
e) Can the sponsor obtain contractor support, if required, in a timely fashion? **Yes.**
f) Will the sponsor likely request USACE assistance in acquiring real estate? **No. Not needed.**

III. Other Project Variables:

a) Will the sponsor's staff be located within reasonable proximity to the project site? **Yes.**
b) Has the sponsor approved the project/real estate schedule/milestones? **Yes.**

IV. Overall Assessment:

a) Has the sponsor performed satisfactorily on other USACE projects? **Yes.**
b) With regard to this project, the sponsor is anticipated to be highly **capable.**

V. Coordination:

a) Has this assessment been coordinated with the sponsor? **Yes.**
b) Does the sponsor concur with this assessment? **Yes.**

CITY OF ENCINITAS

Katherine Weldon, Project Manager

Reviewed and approved by:

KAPLAN.THERESA.M.124 1411547

Digitally signed by KAPLAN.THERESA.M.1241411547
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=KAPLAN.THERESA.M.1241411547
Date: 2013.04.30 14:18:58 -07'00'

Theresa M. Kaplan

Chief of LA Asset Management Division

EXHIBIT B

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
ARIZONA ASSET MANAGEMENT OFFICE
3636 N CENTRAL AVE, SUITE 900
PHOENIX, ARIZONA 85012-1939

REPLY TO
ATTENTION OF:

November 21, 2011

CESPL-AM-AZ-A

David Ott
City of Solana Beach
635 South Highway 101
Solana Beach, CA, 92075

Dear Mr.Ott:

During the planning and feasibility phase of civil projects, the U. S. Army Corps of Engineers identifies the estimated need and extent of real estate interests required for the proposed project. My staff and I have been working on the Solana Beach/ Encinitas Shoreline real estate requirements and have come up with some initial estimates.

When real estate requirements are determined, Government regulations require us to send a letter advising the sponsor of the risks involved in acquiring necessary real estate interests prior to execution of the Project Partnership Agreement ("PPA").

This letter constitutes official notice of the risks involved with acquiring property rights for the proposed protection and re-nourishment of the Solana Beach/ Encinitas Shoreline located in the Cities of Solana Beach and Encinitas, CA, prior to the signing of the PPA. As the non-Federal sponsor, the city of Solana Beach assumes full and sole responsibility for any and all costs, responsibility, or liability arising out of the acquisition effort. Generally, these risks include, but are not limited to, the following:

1. Congress may not appropriate funds to construct the proposed project;
2. The proposed project may otherwise not be funded or approved for construction.;
3. A PPA, mutually agreeable to the non-Federal sponsor and the Government, may not executed and implemented;
4. The non-Federal sponsor may incur liability and expense by virtue of its ownership of contaminated lands, or interests therein, whether such liability should arise out of local, state, or Federal laws or regulations including liability arising out of CERCLA as mentioned;
5. The non-Federal sponsor may acquire interests or estate that are later determined by the Government to be inappropriate, insufficient, or otherwise not required for the project;
6. The non-Federal sponsor may incur costs or expenses in connection with its decision to acquire or perform LERRD (lands, easements, rights-of-way, relocations, disposal areas) activities in advance of the executed PPA and the Government's notice to proceed which might not be creditable under the provisions of Public Law 99-662 or the PPA; and

The non-Federal sponsor may initially acquire insufficient or excessive real property acreage which may result in additional negotiations and/or benefit payments under P.L. 91-646 as well as the payment of additional fair market value to affected landowners which could have been avoided by delaying acquisition until after PPA execution and the Government's notice to commence acquisition and performance of LERRD.

If you have any questions please contact Joseph Gatti at 602-230-6966 or joseph.m.gatti@uasce.army.mil or feel free to contact me at 602-230-6960 or ann.p.volz@usace.army.mil.

Sincerely,

Ann P. Volz
Chief, Arizona/ Nevada
Asset Management Office

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
ARIZONA ASSET MANAGEMENT OFFICE
3636 N CENTRAL AVE, SUITE 900
PHOENIX, ARIZONA 85012-1939

REPLY TO
ATTENTION OF:

November 22, 2011

CESPL-AM-AZ-A

Larry Watt
Director of Public Works
505 Vulcan Avenue
Encinitas, CA 92024

Dear Mr. Watt:

During the planning and feasibility phase of civil projects, the U. S. Army Corps of Engineers identifies the estimated need and extent of real estate interests required for the proposed project. My staff and I have been working on the Solana Beach/ Encinitas Shoreline real estate requirements and have come up with some initial estimates.

When real estate requirements are determined, Government regulations require us to send a letter advising the sponsor of the risks involved in acquiring necessary real estate interests prior to execution of the Project Partnership Agreement ("PPA").

This letter constitutes official notice of the risks involved with acquiring property rights for the proposed protection and re-nourishment of the Solana Beach/ Encinitas Shoreline located in the Cities of Encinitas and Solana Beach, CA, prior to the signing of the PPA. As the non-Federal sponsor, the city of Encinitas assumes full and sole responsibility for any and all costs, responsibility, or liability arising out of the acquisition effort. Generally, these risks include, but are not limited to, the following:

1. Congress may not appropriate funds to construct the proposed project;
2. The proposed project may otherwise not be funded or approved for construction.;
3. A PPA, mutually agreeable to the non-Federal sponsor and the Government, may not executed and implemented;
4. The non-Federal sponsor may incur liability and expense by virtue of its ownership of contaminated lands, or interests therein, whether such liability should arise out of local, state, or Federal laws or regulations including liability arising out of CERCLA as mentioned;
5. The non-Federal sponsor may acquire interests or estate that are later determined by the Government to be inappropriate, insufficient, or otherwise not required for the project;
6. The non-Federal sponsor may incur costs or expenses in connection with its decision to acquire or perform LERRD (lands, easements, rights-of-way, relocations, disposal areas) activities in advance of the executed PPA and the Government's notice to proceed which might not be creditable under the provisions of Public Law 99-662 or the PPA; and

The non-Federal sponsor may initially acquire insufficient or excessive real property acreage which may result in additional negotiations and/or benefit payments under P.L. 91-646 as well as the payment of additional fair market value to affected landowners which could have been avoided by delaying acquisition until after PPA execution and the Government's notice to commence acquisition and performance of LERRD.

If you have any questions please contact Joseph Gatti at 602-230-6966 or joseph.m.gatti@uasce.army.mil or feel free to contact me at 602-230-6960 or ann.p.volz@usace.army.mil.

Sincerely,

Ann P. Volz
Chief, Arizona/ Nevada
Asset Management Office

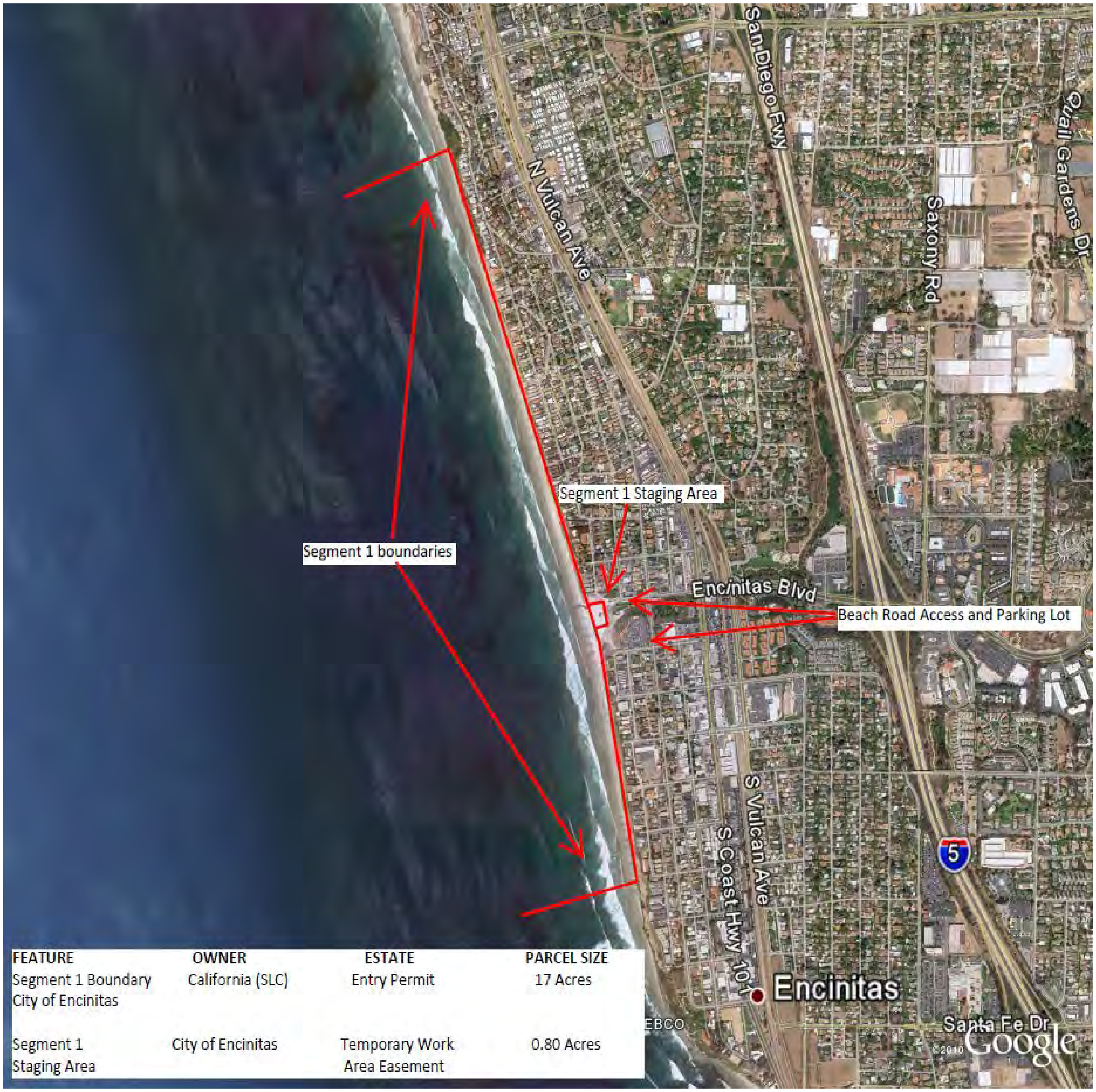
Segment 1 Staging Area
Segment 1 boundaries
Beach Road Access and Parking Lot
N Vulcan Ave
San Diego Fwy
Saxony Rd
Quail Gardens Dr
Encinitas Blvd
S Vulcan Ave
S Coast Hwy 101
Encinitas
Santa Fe Dr
5
FEATURE | OWNER | ESTATE | PARCEL SIZE
Segment 1 Boundary City of Encinitas | California (SLC) | Entry Permit | 17 Acres
Segment 1 Staging Area | City of Encinitas | Temporary Work Area Easement | 0.80 Acres
©2010 Google

EXHIBIT C1

FEATURE	OWNER	ESTATE	PARCEL SIZE
Segment 2 Boundary City of Encinitas	California (SLC)	Entry Permit	24.27 Acres
Segment 2 Staging Area	City of Solana Beach	Easement Temporary Work Area Easement	0.50 Acres

EXHIBIT C2

Borrow Sites

North Solana Beach Off-Shore Borrow Site

EXHIBIT C3

South Solana Beach Off-Shore Borrow Site

EXHIBIT C4

San Diego Off-Shore Borrow Site

EXHIBIT C5

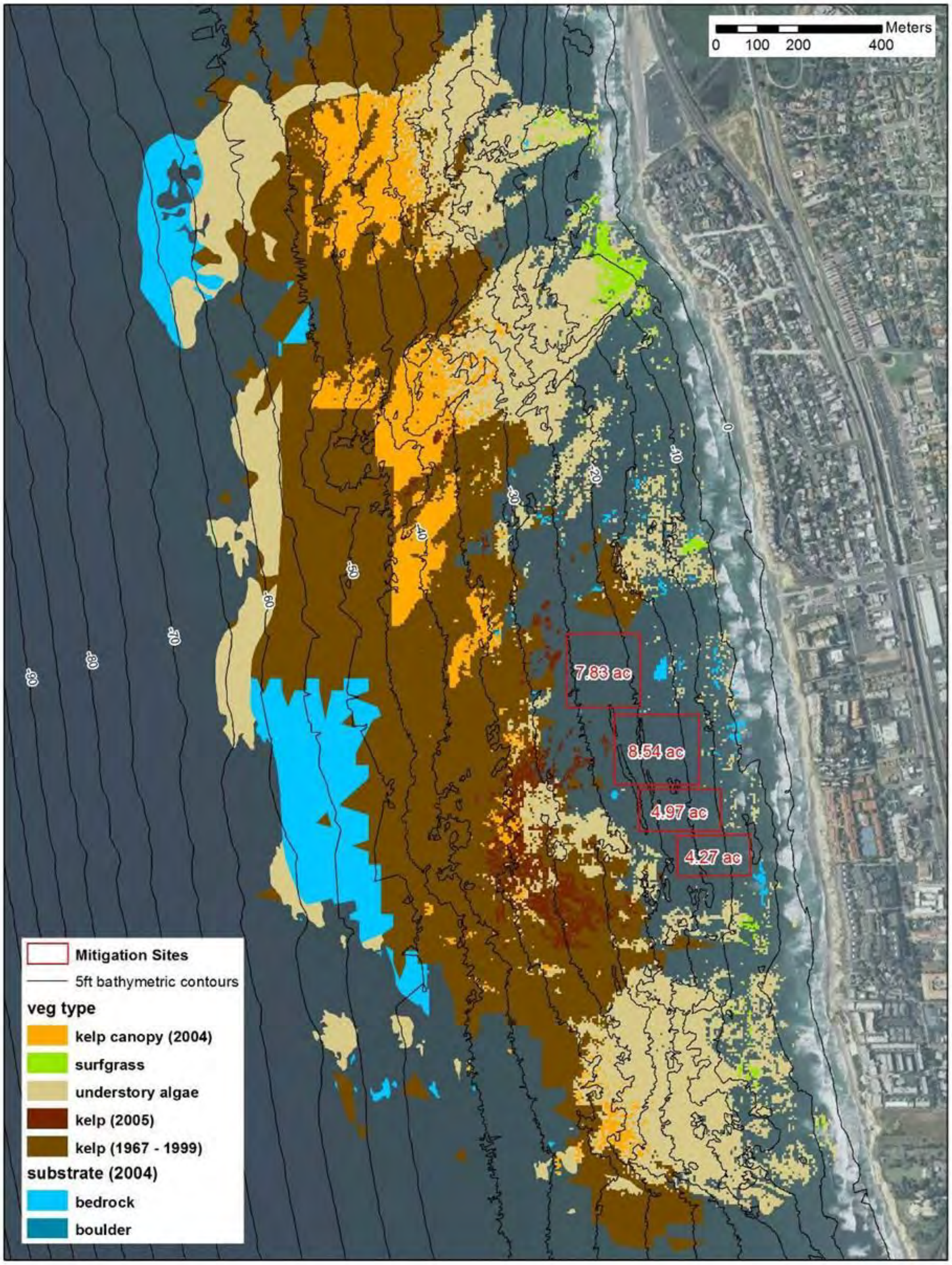
Meters
0
100
200
400
7.83 ac
8.54 ac
4.97 ac
4.27 ac
Mitigation Sites
5ft bathymetric contours
veg type
kelp canopy (2004)
surfgrass
understory algae
kelp (2005)
kelp (1967 - 1999)
substrate (2004)
bedrock
boulder

EXHIBIT C6

EXHIBIT D
(SAMPLE) Non Standard Estate:
California Borrow and Placement Lease

RECORDED AT THE REQUEST OF
AND WHEN RECORDED MAIL TO:
STATE OF CALIFORNIA
California State Lands Commission
Attn: Title Unit
100 Howe Avenue, Suite 100-South
Sacramento, CA 95825-8202

STATE OF CALIFORNIA
OFFICIAL BUSINESS
Document entitled to free recordation
pursuant to Government Code Section 27383

SPACE ABOVE THIS LINE FOR RECORDER'S USE

County: Santa Barbara, Ventura

LEASE PRC 8228.9

This Lease consists of this summary and the following attached and incorporated parts:

Section 1	Basic Provisions
Section 2	Special Provisions Amending or Supplementing Section 1 or 4
Section 3	Lease Area Description
Section 4	General Provisions
Exhibit A	Location Map

SECTION 1

BASIC PROVISIONS

THE STATE OF CALIFORNIA, hereinafter referred to as Lessor acting by and through the **CALIFORNIA STATE LANDS COMMISSION** (100 Howe Avenue, Suite 100-South, Sacramento, California 95825-8202), pursuant to Division 6 of the Public Resources Code and Title 2, Division 3 of the California Code of Regulations, and for consideration specified in this Lease, does hereby lease, demise and let to the **San Diego Association of Governments (SANDAG)**, hereinafter referred to as Lessee, those certain lands described in Section 3 subject to the reservations, terms, covenants and conditions of this Lease.

MAILING ADDRESS: 401 B Street, Suite 800
San Diego, CA 92101

LEASE TYPE: General Lease - Public Agency Use

LAND TYPE: Tide and Submerged Sovereign Land

LOCATION: In the Pacific Ocean, at seven beach receiver sites and two offshore borrow sites as shown on Exhibit A – Location Map, and as described in Section 3 – Land Description:

Receiver sites:
- North Carlsbad
- South Carlsbad North
- Batiquitos
- Leucadia
- Moonlight
- Cardiff
- Solana Beach

Borrow sites:
- Two offshore sites identified as SO-5 and SO-6

LAND USE OR PURPOSE: Implementation of the SANDAG Regional Beach Sand Project II (RBSP II) involving the dredging of up to 1,635,000 cubic yards of sand from two offshore borrow sites for placement at multiple beach receiver sites as identified and described in Paragraph 3 of Section 2 – Special Provisions.

TERM: Five years, beginning September 1, 2011; ending August 30, 2016 unless sooner terminated as provided under this Lease.

CONSIDERATION: The public use and benefit with the State reserving the right at any time to set a monetary rent if the Commission finds such action to be in the State's best interest; subject to modification by Lessor as specified in Paragraph 2(b) of Section 4 - General Provisions.

LIABILITY INSURANCE: N/A

SURETY BOND OR OTHER SECURITY: N/A

SECTION 2
SPECIAL PROVISIONS

BEFORE THE EXECUTION OF THIS LEASE, ITS PROVISIONS ARE AMENDED, REVISED OR SUPPLEMENTED AS FOLLOWS:

1. At least 30 days prior to the start of the initial beach replenishment activity performed at any of the seven un-granted sovereign lands receiver sites described in Lease Section 3, Lessee shall submit a mean high tide line survey for Lessor's review and approval. The following is required:

   a. The survey must be based on the California Coordinate System 1983 and must include a control scheme showing found monuments and coordinates referencing the epoch date.
   b. The survey must locate a minimum of two property monuments shown on an official record map.
   c. The vertical datum must be shown on the map with the benchmark location and elevation.
   d. The mean high tide elevation and tidal epoch must be noted on the survey and Lessor's staff must approve the elevation prior to the fieldwork.
   e. Stations used to locate the mean high tide line must be at intervals of 50'±.
   f. The survey must be performed by or under the supervision of a Licensed Land Surveyor.
   g. Lessee will provide Lessor with a hardcopy map and Autocad drawing file within 30 days of completion of survey fieldwork.

2. Lessee will undertake the Regional Beach Sand Program II (RBSP II) pursuant to: 1) the Mitigation Monitoring Program contained in Final Environmental Impact Report (FEIR) SCH# 2010051063 prepared and adopted by Lessee on May 27, 2011; 2) the RBSP II Coastal Development Permit as authorized by the California Coastal Commission; and, 3) the requirements of all other agencies having approval authority over the RBSP II.

3. Lessee is authorized during the lease term to dredge up to a combined maximum of 1,635,000 cubic yards of sand from two offshore borrow sites identified in Exhibit A as SO-5 and SO-6 and as described in Lease Section 3, for placement at the following beach receiver sites up to the quantities indicated:

   a. Oceanside- 420,000 cy;
   b. North Carlsbad- 225,000 cy;
   c. South Carlsbad North- 158,000 cy;
   d. Batiquitos- 118,000 cy;
   e. Leucadia- 117,000 cy;
   f. Moonlight- 105,000 cy;
   g. Cardiff- 101,000 cy;
   h. Solana Beach- 146,000 cy; and
   i. Torrey Pines- 245,000 cy.

4. Lessor acknowledges that the receiver sites identified variously in Paragraph 3 of this Section and in Exhibit A as Oceanside, Torrey Pines, and Imperial Beach are contained within lands granted respectively to the city of Oceanside pursuant to Chapter 846, Statutes of 1979 with minerals rights reserved; within lands granted to the city of San Diego pursuant to Chapter 688, Statutes of 1933 and as amended with no mineral rights reserved; and within lands originally granted to the city of Imperial Beach pursuant to Chapter 330, Statutes of 1961 with mineral rights reserved, and subsequently transferred to the San Diego Unified Port District pursuant to Chapter 168, Statutes of 1990 with mineral rights reserved, and are not included in the Lease Premises subject to this Lease.

5. Lessor acknowledges that the borrow site identified in Exhibit A as site MB-1 is contained within lands granted to the city of San Diego pursuant to Chapter 688, Statutes of 1933 and as amended with no mineral rights reserved and is not included in the Lease Premises subject to this Lease.

6. At least 30 days prior to the start of beach replenishment activities as described herein, Lessee shall provide Lessor with:

   a. Copies of all final permits and approvals from all other agencies with jurisdiction over the RBSP II;
   b. The name and telephone number of the Lessee's representative responsible for maintaining the beach replenishment database for all sites within the Lease Premises;
   c. Written notification to Lessor, and all other regulatory agencies having approval authority for the RBSP II; and
   d. All copies of public notification that are issued prior to the commencement of beach replenishment activities.

7. Prior to the start of beach replenishment activities as described herein, Lessee shall provide Lessor with the name, address, telephone number and contractor's license number of the contractor(s) selected to implement the beach replenishment program. Should Lessee change contractors, Lessee shall provide Lessor with all pertinent information, as described above.

8. Lessee shall provide any subsequent pre-project biological survey information not included in the FEIR for each beach replenishment site prior to commencement of beach replenishment activities within the Lease Premises. Lessee shall provide to Lessor copies of all mitigation monitoring compliance reports for replenishment activities within the Lease Premises.

9. Lessee agrees that printed material, such as handouts and signs or other types of printed notices installed to provide notification of the public use and benefit of the project as set forth herein shall contain and reasonably display a statement acknowledging the California State Lands Commission as having contributed lands for the project. The statement may read as follows: "A portion of the land required for the Regional Beach Sand Program II was contributed by the California State Lands Commission."

10. Lessee acknowledges and agrees:

   a. The sites may be subject to hazards from natural geophysical phenomena including, but not limited to, waves, storm waves, tsunamis, earthquakes, flooding and erosion.
   b. To assume the risks of injury and damage to Lessee, its agents, employees, contractors, permittees, invitees and guests and the Leased Lands from such hazards in connection with the development and use of the Leased Lands subject to any Coastal Development Permit.
   c. To unconditionally waive any claim or damage or liability against the State of California, its agencies, officers, agents, and employees for injury and/or damage from such hazards to Lessee, its agents, employees, contractors, permittees, invitees and guests.
   d. To indemnify, hold harmless and, at the option of Lessor, defend the State of California, its agencies, officers, agents, and employees, against and for any and all liability, claims, demands, damages, injuries, or costs of any kind and from any cause (including costs and fees incurred in defense of such claims), expenses, and amounts paid in settlement arising from any alleged or actual injury, damage or claim due to site hazards or connected in any

way with respect to the approval of any Coastal Development Permit involving the Leased Lands, except for any such liability, claims, damage or injury solely caused by the negligence of Lessor, its officers, agents and employees.

11. Any vehicles, equipment, or machinery to be used on the Lease Premises are limited to those which are directly required to perform the authorized use and shall not include any vehicles, equipment, or machinery that may cause damage to the Lease Premises or lands subject to Lessor's jurisdiction.

12. All vehicles, equipment, machinery, tools or other property taken onto or placed within the Lease Premises or lands subject to Lessor's jurisdiction shall remain the property of the Lessee and/or its authorized contractors (collectively, Lessee). Such property shall be promptly and properly removed by Lessee, at its sole risk and expense.

13. Lessor does not accept any responsibility for any damages to any property, including any vehicles, equipment, machinery, or tools within the Lease Premises or lands subject to Lessor's jurisdiction.

14. No vehicle or equipment refueling, maintenance, or repairs will be permitted within the Lease Premises or lands subject to Lessor's jurisdiction.

15. All waste material and debris created by Lessee shall be entirely removed from the Lease Premises and lands subject to Lessor's jurisdiction.

16. The State of California's sovereign ownership claim of the lands underlying the Pacific Ocean extends to the ordinary high water mark. The description in Section 3 contained herein is not to be deemed an admission by Lessor or Lessee as to the boundary between private, City-owned and State-owned lands.

17. Lease Section 4, Paragraph 4(a) LAND USE - General, is modified as follows: 'Lessee shall use the Lease Premises only for the purpose or purposes stated in this Lease and only for the operation and maintenance of the improvements expressly authorized in this Lease.' The remainder of Paragraph 4(a) is deleted in its entirety.

In the event of any conflict between the provisions of Section 2 and Section 4 of this Lease, the provisions of Section 2 shall prevail.

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SECTION 3

WP 8228

LAND DESCRIPTION

Nine (9) parcels of tide and submerged lands lying in the bed of the Pacific Ocean, San Diego County, State of California, being more particularly described as follows:

Parcel 1 (Solana Beach North Borrow Site)

BEGINNING at a point have coordinates CCS83 (Zone 6) N(y)=1947283.6 feet, E(x)=6241714.7 feet (Latitude=N 33°00'20.34", Longitude=W 117°17'37.13") thence in a clockwise direction through the following three (3) points:

(1) N(y)=1947689.1 feet, E(x)=6243778.4 feet;
(2) N(y)=1947345.0 feet, E(x)=6243858.0 feet;
(3) N(y)=1945892.0 feet, E(x)=6242048.1 feet;

thence continuing to the POINT OF BEGINNING.

Parcel 2 (Solana Beach South Borrow Site)

BEGINNING at a point have coordinates CCS83 (Zone 6) N(y)=1936384.3 feet, E(x)=6244600.2 feet (Latitude=N 32°58'32.77", Longitude=W 117°17'01.98") thence in a clockwise direction through the following three (3) points:

(1) N(y)=1936605.4 feet, E(x)=6245958.6 feet;
(2) N(y)=1932664.2 feet, E(x)=6246719.2 feet;
(3) N(y)=1932481.2 feet, E(x)=6245418.8 feet;

thence continuing to the POINT OF BEGINNING.

Parcel 3 (North Carlsbad Receiver Site)

BEGINNING at a point have coordinates CCS83 (Zone 6) N(y)=2005260.7 feet, E(x)=6222393.7 feet (Latitude=N 33°09'51.97", Longitude=W 117°21'31.24") thence in a clockwise direction through the following three (3) points:

(1) N(y)=2002278.2 feet, E(x)=6224282.6 feet;
(2) N(y)=2002357.2 feet, E(x)=6223927.4 feet;
(3) N(y)=2004941.6 feet, E(x)=6222286.3 feet;

thence continuing to the POINT OF BEGINNING.

Parcel 4 (South Carlsbad North Receiver Site)

BEGINNING at a point have coordinates CCS83 (Zone 6) N(y)=1990842.0 feet, E(x)=6230872.5 feet (Latitude=N 33°07'30.20", Longitude=W 117°19'49.74") thence in a clockwise direction through the following five (5) points:

(1) N(y)=1989668.9 feet, E(x)=6231555.5 feet;
(2) N(y)=1987738.9 feet, E(x)=6232359.9 feet;
(3) N(y)=1987806.6 feet, E(x)=6232015.5 feet;
(4) N(y)=1989546.3 feet, E(x)=6231281.4 feet;
(5) N(y)=1990539.7 feet, E(x)=6230696.4 feet;

thence continuing to the POINT OF BEGINNING.

Parcel 5 (Batiquitos Receiver Site)

BEGINNING at a point have coordinates CCS83 (Zone 6) N(y)=1976298.1 feet, E(x)=6236242.9 feet (Latitude=N 33°05'06.85", Longitude=W 117°18'44.86") thence in a clockwise direction through the following three (3) points:

(1) N(y)=1974105.4 feet, E(x)=6236643.3 feet;
(2) N(y)=1974346.2 feet, E(x)=6236308.2 feet;
(3) N(y)=1975976.3 feet, E(x)=6236019.8 feet;

thence continuing to the POINT OF BEGINNING.

Parcel 6 (Leucadia Receiver Site)

BEGINNING at a point have coordinates CCS83 (Zone 6) N(y)=1971855.0 feet, E(x)=6237303.0 feet (Latitude=N 33°04'23.00", Longitude=W 117°18'31.87") thence in a clockwise direction through the following three (3) points:

(1) N(y)=1969265.8 feet, E(x)=6238182.5 feet;
(2) N(y)=1969393.0 feet, E(x)=6237885.8 feet;
(3) N(y)=1971621.8 feet, E(x)=6237134.7 feet;

thence continuing to the POINT OF BEGINNING.

Parcel 7 (Moonlight Receiver Site)

BEGINNING at a point have coordinates CCS83 (Zone 6) N(y)=1963036.8 feet, E(x)=6240296.7 feet (Latitude=N 33°02'56.05", Longitude=W 117°17'55.64) thence in a clockwise direction through the following three (3) points:

(1) N(y)=1962080.9 feet, E(x)=6240580.8 feet;
(2) N(y)=1962211.1 feet, E(x)=6240243.5 feet;
(3) N(y)=1962767.1 feet, E(x)=6240083.8 feet;

thence continuing to the POINT OF BEGINNING.

Parcel 8 (Cardiff Receiver Site)

BEGINNING at a point have coordinates CCS83 (Zone 6) N(y)=1949803.2 feet, E(x)=6245856.3 feet (Latitude=N 33°00'45.67", Longitude=W 117°16'48.80") thence in a clockwise direction through the following four (4) points:

(1) N(y)=1949545.8 feet, E(x)=6245959.3 feet;
(2) N(y)=1948664.4 feet, E(x)=6246155.3 feet;
(3) N(y)=1948770.8 feet, E(x)=6245767.1 feet;
(4) N(y)=1949533.0 feet, E(x)=6245568.2 feet;

thence continuing to the POINT OF BEGINNING.

Parcel 9 (Solana Beach Receiver Site)

BEGINNING at a point have coordinates CCS83 (Zone 6) N(y)=1943184.7 feet, E(x)=6247270.5 feet (Latitude=N 32°59'40.33", Longitude=W 117°16'31.42") thence in a clockwise direction through the following three (3) points:

(1) N(y)=1938062.2 feet, E(x)=6248111.2 feet;
(2) N(y)=1938191.1 feet, E(x)=6247891.9 feet;
(3) N(y)=1942890.2 feet, E(x)=6247118.7 feet;

thence continuing to the POINT OF BEGINNING.

EXCEPTING THEREFROM any lands lying landward of the Ordinary High Water Mark of said ocean.

END OF DESCRIPTION

PREPARED 5/24/11 BY THE CALIFORNIA STATE LANDS COMMISSION BOUNDARY UNIT

LICENSED LAND SURVEYOR
STEVE C. LEHMAN
Exp. 12/31/11
No. 7377
STATE OF CALIFORNIA

SECTION 4

GENERAL PROVISIONS

1. **GENERAL**
These provisions are applicable to all leases, permits, rights-of-way, easements, or licenses or other interests in real property conveyed by the State Lands Commission.

2. **CONSIDERATION**
(a) **Categories**
(1) **Rental**
Lessee shall pay the annual rental as stated in this Lease to Lessor without deduction, delay, or offset, on or before the beginning date of this Lease and on or before each anniversary of its beginning date during each year of the Lease term.

(2) **Non-Monetary Consideration**
If the consideration to Lessor for this Lease is the public use, benefit, health, or safety, Lessor shall have the right to review such consideration at any time and set a monetary rental if the State Lands Commission, at its sole discretion, determines that such action is in the best interest of the State.

(b) **Modification**
Lessor may modify the method, amount, or rate of consideration effective on each fifth anniversary of the beginning date of this Lease. Should Lessor fail to exercise such right effective on any fifth anniversary it may do so effective on any one (1) of the next four (4) anniversaries following such fifth anniversary, without prejudice to its right to effect such modification on the next or any succeeding fifth anniversary. No such modification shall become effective unless Lessee is given at least thirty (30) days notice prior to the effective date.

(c) **Penalty and Interest**
Any installments of rental accruing under this Lease not paid when due shall be subject to a penalty and shall bear interest as specified in Public Resources Code Section 6224 and the Lessor's then existing administrative regulations governing penalty and interest.

3. **BOUNDARIES**
This Lease is not intended to establish the State's boundaries and is made without prejudice to either party regarding any boundary claims which may be asserted presently or in the future.

4. **LAND USE**
(a) **General**
Lessee shall use the Lease Premises only for the purpose or purposes stated in this Lease and only for the operation and maintenance of the improvements expressly authorized in this Lease. Lessee shall commence use of the Lease Premises within ninety (90) days of the beginning date of this Lease or within ninety (90) days of the date set for construction to commence as set forth in this Lease, whichever is later. Lessee shall notify Lessor within ten (10) days after commencing the construction of authorized improvements and within sixty (60) days after completing them. Lessee's discontinuance of such use for a period of ninety (90) days shall be conclusively presumed to be an abandonment.

(b) **Continuous Use**
Lessee's use of the Lease Premises shall be continuous from commencement of the Lease until its expiration.

(c) **Repairs and Maintenance**
Lessee shall, at its own expense, keep and maintain the Lease Premises and all improvements in good order and repair and in safe condition. Lessor shall have no obligation for such repair and maintenance.

(d) **Additions, Alterations, and Removal**
(1) Additions - No improvements other than those expressly authorized in this Lease shall be constructed by the Lessee on the Lease Premises without the prior written consent of Lessor.

(2) Alteration or Removal - Except as provided under this Lease, no alteration or removal of improvements on or natural features of the Lease Premises shall be undertaken without the prior written consent of Lessor.

(e) **Conservation**
Lessee shall practice conservation of water, energy, and other natural resources and shall prevent pollution and harm to the environment. Lessee shall not violate any law or regulation whose purpose is to conserve resources or to protect the environment. Violation of this section shall constitute grounds for termination of the Lease. Lessor, by its executive officer, shall notify Lessee, when in his or her opinion, Lessee has violated the provisions of this section and Lessee shall respond and discontinue the conduct or remedy the condition within 30 days.

(f) **Toxics**
Lessee shall not manufacture or generate hazardous wastes on the Lease Premises unless specifically authorized under other terms of this Lease. Lessee shall be fully responsible for any hazardous wastes, substances or materials as defined under federal, state or local law, regulation, or ordinance that are manufactured, generated, used, placed, disposed, stored, or transported on the Lease Premises during the Lease term and shall comply with and be bound by all applicable provisions of such federal, state or local law, regulation or ordinance dealing with such wastes, substances or materials. Lessee shall notify Lessor and the appropriate governmental emergency response agency(ies) immediately in the event of any release or threatened release of any such wastes, substances, or materials.

(g) **Enjoyment**
Subject to the provisions of paragraph 5 (a) (2) below, nothing in this Lease shall preclude Lessee from excluding persons from the Lease Premises when their presence or activity constitutes a material interference with Lessee's use

and enjoyment of the Lease Premises as provided under this Lease.

(h) **Discrimination**

Lessee in its use of the Lease Premises shall not discriminate against any person or class of persons on the basis of race, color, creed, religion, national origin, sex, age, or handicap.

(i) **Residential Use**

No portion of the Lease Premises shall be used as a location for a residence or for the purpose of mooring a structure which is used as a residence. For purposes of this Lease, a residence or floating residence includes but is not limited to boats, barges, houseboats, trailers, cabins, or combinations of such facilities or other such structures which provide overnight accommodations to the Lessee or others.

5. **RESERVATIONS, ENCUMBRANCES, AND RIGHTS-OF-WAY**

(a) **Reservations**

(1) Lessor expressly reserves all natural resources in or on the Lease Premises, including but not limited to timber and minerals as defined under Public Resources Code Sections 6401 and 6407, as well as the right to grant leases in and over the Lease Premises for the extraction of such natural resources; however, such leasing shall be neither inconsistent nor incompatible with the rights or privileges of Lessee under this Lease.

(2) Lessor expressly reserves a right to go on the Lease Premises and all improvements for any purpose associated with this Lease or for carrying out any function required by law, or the rules, regulations or management policies of the State Lands Commission. Lessor shall have a right of reasonable access to the Lease Premises across Lessee owned or occupied lands adjacent to the Lease Premises for any purpose associated with this Lease.

(3) Lessor expressly reserves to the public an easement for convenient access across the Lease Premises to other State-owned lands located near or adjacent to the Lease Premises and a right of reasonable passage across and along any right-of-way granted by this Lease; however, such easement or right- of-way shall be neither inconsistent nor incompatible with the rights or privileges of Lessee under this Lease.

(4) Lessor expressly reserves the right to lease, convey, or encumber the Lease Premises, in whole or in part, during the Lease term for any purpose not inconsistent or incompatible with the rights or privileges of Lessee under this Lease.

(b) **Encumbrances**

This Lease may be subject to pre-existing contracts, leases, licenses, easements, encumbrances, and claims and is made without warranty by Lessor of title, condition, or fitness of the land for the stated or intended purpose.

6. **RULES, REGULATIONS, AND TAXES**

(a) Lessee shall comply with and be bound by all presently existing or subsequently enacted rules, regulations, statutes or ordinances of the State Lands Commission or any other governmental agency or entity having lawful authority and jurisdiction.

(b) Lessee understands and agrees that a necessary condition for the granting and continued existence of this Lease is that Lessee obtains and maintains all permits or other entitlements.

(c) Lessee accepts responsibility for and agrees to pay any and all possessory interest taxes, assessments, user fees or service charges imposed on or associated with the leasehold interest, improvements or the Lease Premises, and such payment shall not reduce rental due Lessor under this Lease and Lessor shall have no liability for such payment.

7. **INDEMNITY**

(a) Lessor shall not be liable and Lessee shall indemnify, hold harmless and, at the option of Lessor, defend Lessor, its officers, agents, and employees against and for any and all liability, claims, damages or injuries of any kind and from any cause, arising out of or connected in any way with the issuance, enjoyment or breach of this Lease or Lessee's use of the Lease Premises except for any such liability, claims, damage or injury solely caused by the negligence of Lessor, its officers, agents and employees.

(b) Lessee shall notify Lessor immediately in case of any accident, injury, or casualty on the Lease Premises.

8. **INSURANCE**

(a) Lessee shall obtain and maintain in full force and effect during the term of this Lease comprehensive general liability insurance and property damage insurance, with such coverage and limits as may be reasonably requested by Lessor from time to time, but in no event for less than the sum(s) specified, insuring Lessee and Lessor against any and all claims or liability arising out of the ownership, use, occupancy, condition or maintenance of the Lease Premises and all improvements.

(b) The insurance policy or policies shall name the State of California, its officers, employees and volunteers as insureds as to the Lease Premises and shall identify the Lease by its assigned number. Lessee shall provide Lessor with a certificate of such insurance and shall keep such certificate current. The policy (or endorsement) must provide that the insurer will not cancel the insured's coverage without thirty (30) days prior written notice to Lessor. Lessor will not be responsible for any premiums or other assessments on the policy. The coverage provided by the insured (Lessee) shall be primary and non-contributing.

(c) The insurance coverage specified in this Lease shall be in effect at all times during the Lease term and subsequently until all of the Lease Premises have been either accepted as improved, by Lessor, or restored by Lessee as provided elsewhere in this Lease.

9. **SURETY BOND**

(a) Lessee shall provide a surety bond or other security device acceptable to Lessor, for the specified amount, and naming the State of California as the assured, to guarantee to Lessor the faithful observance and performance by Lessee of all of the terms, covenants, and conditions of this Lease.

(b) Lessor may require an increase in the amount of the surety bond or other security device to cover any additionally authorized improvements, alterations or purposes and any modification of consideration.

(c) The surety bond or other security device shall be maintained in full force and effect at all times during the Lease term and subsequently until all of the Lease Premises have been either accepted as improved, by Lessor, or restored by Lessee as provided elsewhere in this Lease.

10. **ASSIGNMENT, ENCUMBRANCING OR SUBLETTING**

(a) Lessee shall not either voluntarily or by operation of law, assign, transfer, mortgage, pledge, hypothecate or encumber this Lease and shall not sublet the Lease Premises, in whole or in part, or allow any person other than the Lessee's employees, agents, servants and invitees to occupy or use all or any portion of the Lease Premises without the prior written consent of Lessor, which consent shall not be unreasonably withheld.

(b) The following shall be deemed to be an assignment or transfer within the meaning of this Lease:

(1) If Lessee is a corporation, any dissolution, merger, consolidation or other reorganization of Lessee or sale or other transfer of a percentage of capital stock of Lessee which results in a change of controlling persons, or the sale or other transfer of substantially all the assets of Lessee;

(2) If Lessee is a partnership, a transfer of any interest of a general partner, a withdrawal of any general partner from the partnership, or the dissolution of the partnership.

(c) If this Lease is for sovereign lands, it shall be appurtenant to adjoining littoral or riparian land and Lessee shall not transfer or assign its ownership interest or use rights in such adjoining lands separately from the leasehold rights granted herein without the prior written consent of Lessor.

(d) If Lessee desires to assign, sublet, encumber or otherwise transfer all or any portion of the Lease Premises, Lessee shall do all of the following:

(1) Give prior written notice to Lessor;

(2) Provide the name and complete business organization and operational structure of the proposed assignee, sublessee, secured third party, or other transferee; and the nature of the use of and interest in the Lease Premises proposed by the assignee, sublessee, secured third party or other transferee. If the proposed assignee, sublessee, or secured third party is a general or limited partnership, or a joint venture, provide a copy of the partnership agreement or joint venture agreement, as applicable;

(3) Provide the terms and conditions of the proposed assignment, sublease, or encumbrance or other transfer;

(4) Provide audited financial statements for the two most recently completed fiscal years of the proposed assignee, sublessee, secured party or other transferee; and provide pro forma financial statements showing the projected income, expense and financial condition resulting from use of the Lease Premises; and

(5) Provide such additional or supplemental information as Lessor may reasonably request concerning the proposed assignee, sublessee, secured party or other transferee.

Lessor will evaluate proposed assignees, sublessees, secured third parties and other transferees and grant approval or disapproval according to standards of commercial reasonableness considering the following factors within the context of the proposed use: the proposed party's financial strength and reliability, their business experience and expertise, their personal and business reputation, their managerial and operational skills, their proposed use and projected rental, as well as other relevant factors.

(e) Lessor shall have a reasonable period of time from the receipt of all documents and other information required under this provision to grant or deny its approval of the proposed party.

(f) Lessee's mortgage or hypothecation of this Lease, if approved by Lessor, shall be subject to terms and conditions found in a separately drafted standard form (Agreement and Consent to Encumbrancing of Lease) available from Lessor upon request.

(g) Upon the express written assumption of all obligations and duties under this Lease by an assignee approved by Lessor, the Lessee may be released from all liability under this Lease arising after the effective date of assignment and not associated with Lessee's use, possession or occupation of or activities on the Lease Premises; except as to any hazardous wastes, substances or materials as defined under federal, state or local law, regulation or ordinance manufactured, generated, used, placed, disposed, stored or transported on the Lease Premises.

(h) If the Lessee files a petition or an order for relief is entered against Lessee, under Chapters 7,9,11 or 13 of the Bankruptcy Code (11 USC Sect. 101, et seq.) then the trustee or debtor-in-possession must elect to assume or reject this Lease within sixty (60) days after filing of the petition or appointment of the trustee, or the Lease shall be deemed to have been rejected, and Lessor shall be entitled to immediate possession of the Lease Premises. No assumption or assignment of this Lease shall be effective unless it is in writing and unless the trustee or debtor-in-possession has cured all defaults under this Lease (monetary and non-monetary) or has provided Lessor with adequate assurances (1) that within ten (10) days from the date of such assumption or assignment, all monetary defaults under this Lease will be cured; and (2) that within thirty (30) days from the date of such assumption, all non-monetary defaults under this Lease will be cured; and (3) that all provisions of this Lease will be satisfactorily performed in the future.

11. **DEFAULT AND REMEDIES**

(a) **Default**

The occurrence of any one or more of the following events shall immediately and without further notice constitute a default or breach of the Lease by Lessee:

(1) Lessee's failure to make any payment of rental, royalty, or other consideration as required under this Lease;

(2) Lessee's failure to obtain or maintain liability insurance or a surety bond or other security device as required under this Lease;

(3) Lessee's vacation or abandonment of the Lease Premises (including the covenant for continuous use as provided for in paragraph 4) during the Lease term;

(4) Lessee's failure to obtain and maintain all necessary governmental permits or other entitlements;

(5) Lessee's failure to comply with all applicable provisions of federal, state or local law, regulation or ordinance dealing with hazardous waste, substances or materials as defined under such law;

(6) Lessee's Failure to commence to construct and to complete construction of the improvements authorized by this Lease within the time limits specified in this Lease; and/or

(7) Lessee's failure to comply with applicable provisions of federal, state or local laws or ordinances relating to issues of Health and Safety, or whose purpose is to conserve resources or to protect the environment.

(b) Lessee's failure to observe or perform any other term, covenant or condition of this Lease to be observed or performed by the Lessee when such failure shall continue for a period of thirty (30) days after Lessor's giving written notice; however, if the nature of Lessee's default or breach under this paragraph is such that more than thirty (30) days are reasonably required for its cure, then Lessee shall not be deemed to be in default or breach if Lessee commences such cure within such thirty (30) day period and diligently proceeds with such cure to completion.

(c) **Remedies**

In the event of a default or breach by Lessee and Lessee's failure to cure such default or breach, Lessor may at any time and with or without notice do any one or more of the following:

(1) Re-enter the Lease Premises, remove all persons and property, and repossess and enjoy such premises;

(2) Terminate this Lease and Lessee's right of possession of the Lease Premises. Such termination shall be effective upon Lessor's giving written notice and upon receipt of such notice, Lessee shall immediately surrender possession of the Lease Premises to Lessor;

(3) Maintain this Lease in full force and effect and recover any rental, royalty, or other consideration as it becomes due without terminating Lessee's right of possession regardless of whether Lessee shall have abandoned the Lease Premises; and/or

(4) Exercise any other right or remedy which Lessor may have at law or equity.

12. **RESTORATION OF LEASE PREMISES**

(a) Upon expiration or sooner termination of this Lease, Lessor upon written notice may take title to any or all improvements, including fills, or Lessor may require Lessee to remove all or any such improvements at its sole expense and risk; or Lessor may itself remove or have removed all or any portion of such improvements at Lessee's sole expense. Lessee shall deliver to Lessor such documentation as may be necessary to convey title to such improvements to Lessor free and clear of any liens, mortgages, loans or any other encumbrances.

(b) In removing any such improvements Lessee shall restore the Lease Premises as nearly as possible to the conditions existing prior to their installation or construction.

(c) All plans for and subsequent removal and restoration shall be to the satisfaction of Lessor and shall be completed within ninety (90) days after the expiration or sooner termination of this Lease or after compliance with paragraph 12(d), whichever is the lesser.

(d) In removing any or all the improvements Lessee shall be required to obtain any permits or other governmental approvals as may then be required by lawful authority.

(e) Lessor may at any time during the Lease term require Lessee to conduct at its own expense and by a contractor approved by Lessor an independent environmental site assessment or inspection for the presence or suspected presence of hazardous wastes, substances or materials as defined under federal, state or local law, regulation or ordinance manufactured, generated, used, placed, disposed, stored or transported on the Lease Premises during the term of the Lease. Lessee shall provide the results of the assessment or inspection to Lessor and the appropriate governmental response agency(ies) and shall further be responsible for removing or taking other appropriate remedial action regarding such wastes, substances or materials in accordance with applicable federal, state or local law regulation or ordinance.

13. **QUITCLAIM**

Lessee shall, within ninety (90) days of the expiration or sooner termination of this Lease, execute and deliver to Lessor in a form provided by Lessor a good and sufficient release of all rights under this Lease. Should Lessee fail or refuse to deliver such a release, a written notice by Lessor reciting such failure or refusal shall, from the date of its recordation, be conclusive evidence against Lessee of the termination of this Lease and all other claimants.

14. **HOLDING-OVER**

Any holding-over by Lessee after the expiration of the Lease term, with or without the express or implied consent of Lessor, shall constitute a tenancy from month to month and not an extension of the Lease term and shall be on the terms, covenants, and conditions of this Lease, except that the annual rental then in effect shall be increased by twenty-five percent (25%).

15. **ADDITIONAL PROVISIONS**

(a) **Waiver**

(1) No term, covenant, or condition of this Lease and no default or breach of any such term, covenant or condition shall be deemed to have been waived, by Lessor's acceptance of a late or nonconforming performance or otherwise, unless such a waiver is expressly acknowledged by Lessor in writing.

(2) Any such waiver shall not be deemed to be a waiver of any other term, covenant or condition of any other default or breach of any term, covenant or condition of this Lease.

(b) **Time**

Time is of the essence of this Lease and each and all of its terms, covenants or conditions in which performance is a factor.

(c) **Notice**

All notices required to be given under this Lease shall be given in writing, sent by U.S. Mail with postage prepaid, to Lessor at the offices of the State Lands Commission and the Lessee at the address specified in this Lease. Lessee shall give Lessor notice of any change in its name or address.

(d) **Consent**

Where Lessor's consent is required under this Lease its consent for one transaction or event shall not be deemed to be a consent to any subsequent occurrence of the same or any other transaction or event.

(e) **Changes**

This Lease may be terminated and its term, covenants and conditions amended, revised or supplemented only by mutual written agreement of the parties.

(f) **Successors**

The terms, covenants and conditions of this Lease shall extend to and be binding upon and inure to the benefit of the heirs, successors, and assigns of the respective parties.

(g) **Joint and Several Obligation**

If more than one Lessee is a party to this Lease, the obligations of the Lessees shall be joint and several.

(h) **Captions**

The captions of this Lease are not controlling and shall have no effect upon its construction or interpretation.

(i) **Severability**

If any term, covenant or condition of this Lease is determined by a court of competent jurisdiction to be invalid, it shall be considered deleted and shall not invalidate any of the remaining terms, covenants and conditions.

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STATE OF CALIFORNIA - STATE LANDS COMMISSION

LEASE NO. PRC 8228.9

This Lease shall become effective only when approved by and executed on behalf of the State Lands Commission of the State of California and a duly executed copy has been delivered to Lessee. The submission of this Lease by Lessor, its agent or representative for examination by Lessee does not constitute an option or offer to lease the Lease Premises upon the terms and conditions contained herein, or a reservation of the Lease Premises in favor of Lessee. Lessee's submission of an executed copy of this Lease to Lessor shall constitute an offer to Lessor to lease the Lease Premises on the terms and conditions set forth herein.

IN WITNESS WHEREOF, the parties hereto have executed this Lease as of the date hereafter affixed.

LESSEE:

SAN DIEGO ASSOCIATION OF GOVERNMENTS

Gary L. Gallegos

EXECUTIVE DIRECTOR

8-22-2011

LESSOR:

STATE OF CALIFORNIA STATE LANDS COMMISSION

By: ______________________

Title: ______________________

Date: ______________________

ACKNOWLEDGMENT(S)

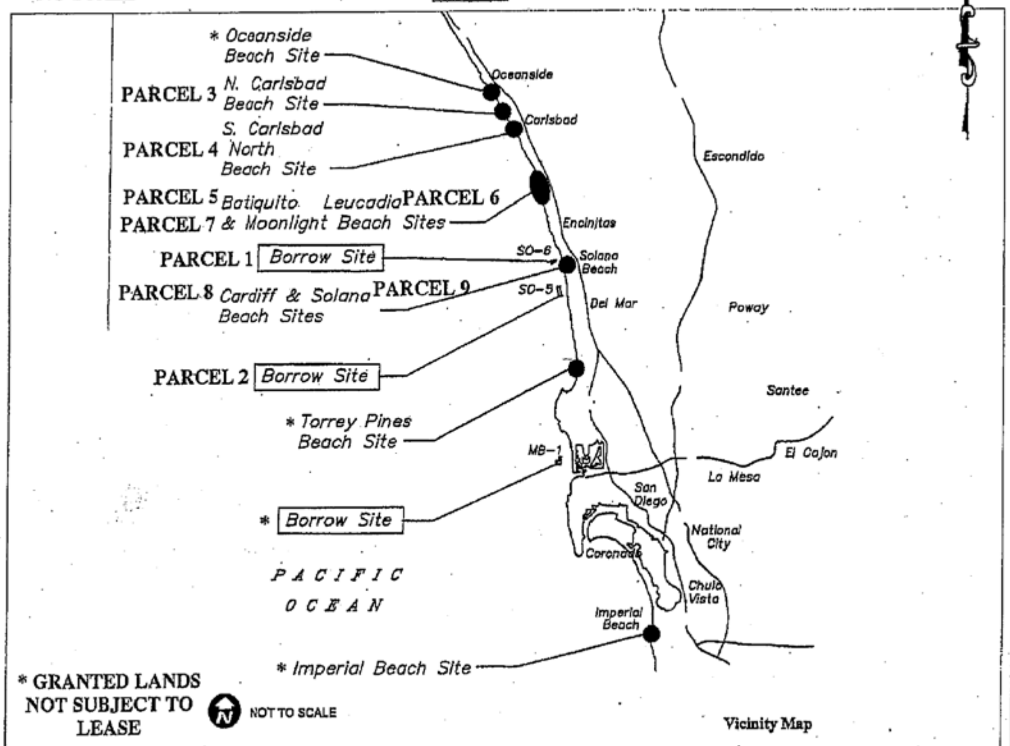
This Lease was authorized by the California State Lands Commission on

____

(Month Day Year)

NO SCALE

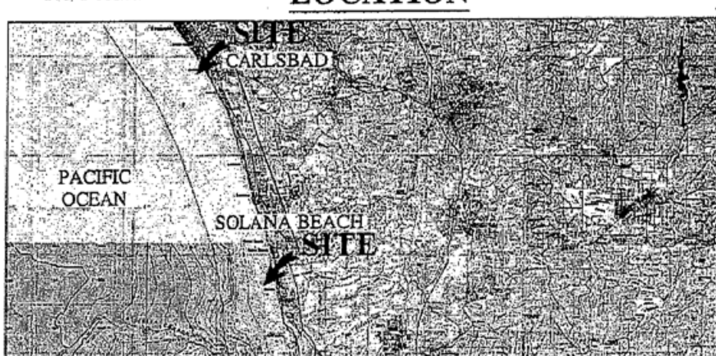
SITE



2 Borrow and 7 Receiver Sites from Carlsbad to Solana Beach

NO SCALE

LOCATION



MAP SOURCE: USGS QUAD

This Exhibit is solely for purposes of generally defining the lease premises, is based on unverified information provided by the Lessee or other parties and is not intended to be, nor shall it be construed as, a waiver or limitation of any State interest in the subject or any other property.

Exhibit A

WP 8228.9
SANDAG
GENERAL LEASE -
PUBLIC AGENCY USE
SAN DIEGO COUNTY

MJF 6/2/11

EXHIBIT E

Standard Estate #15

TEMPORARY WORK AREA EASEMENT

A temporary easement and right-of-way in, on, over and across the land described in Exhibit C for a period not to exceed ______ years, beginning with the date possession and use of the land is granted to ___________________{Name of Non-Federal Sponsor} for the use of this Grantee, its representatives, agents, and contractors as a work area including the right of access, ingress and egress, and including the right to borrow and deposit fill, spoil and waste material thereon, move store and remove equipment and supplies and erect and remove any temporary structures placed on the land; and to perform any other work necessary and incidental to the Encinitas-Solana Beach Coastal Storm Damage Reduction Project; reserving however to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

EXHIBIT F

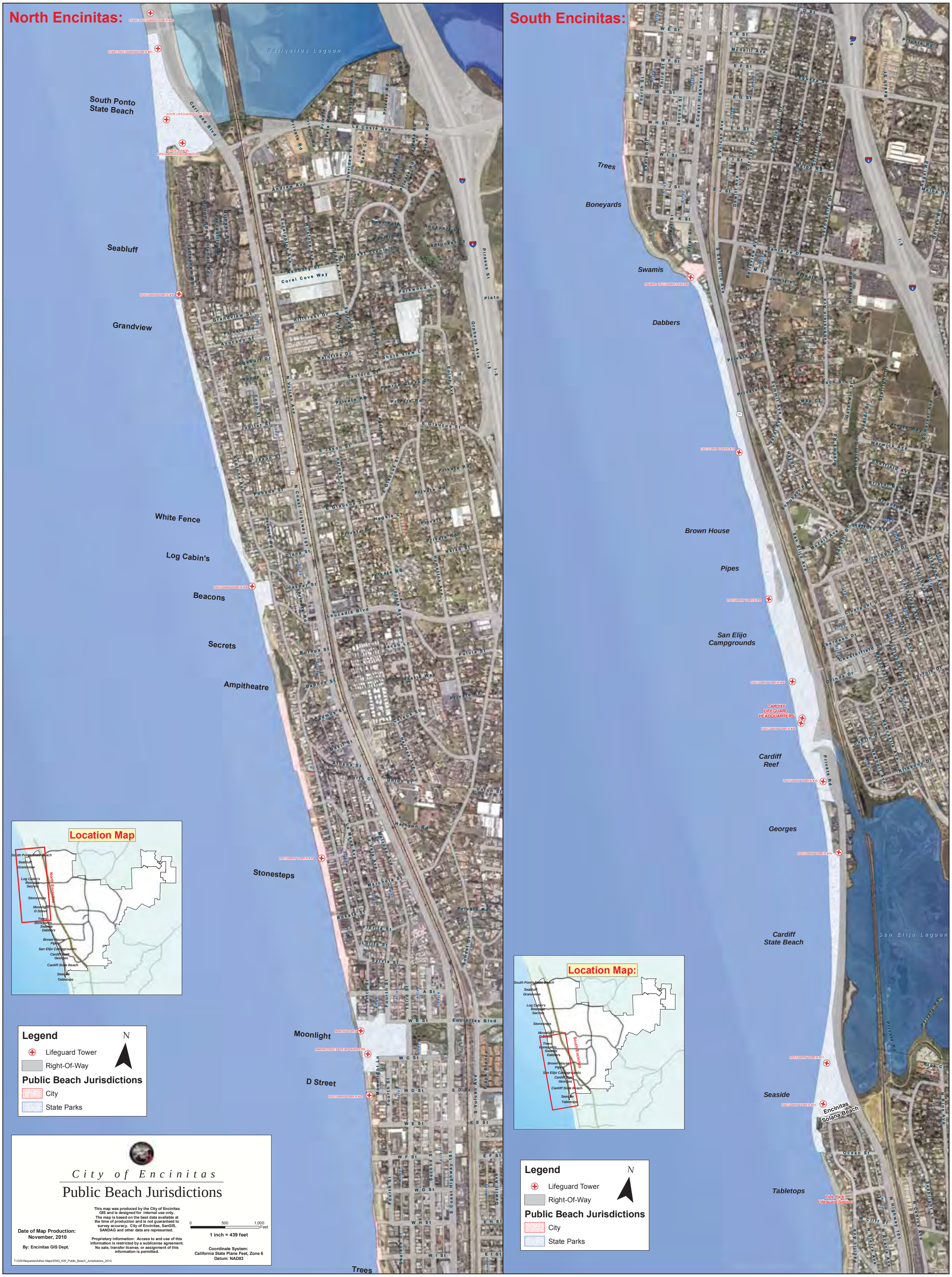

North Encinitas:
South Encinitas:
South Ponto State Beach
Seabluff
Grandview
White Fence
Log Cabin's
Beacons
Secrets
Ampitheatre
Stonesteps
Moonlight
D Street
Trees
Boneyards
Swamis
Dabbers
Brown House
Pipes
San Elijo Campgrounds
Cardiff Reef
Georges
Cardiff State Beach
Seaside
Tabletops
Encinitas
Solana Beach
CARDIFF LIFEGUARD HEADQUARTERS
Location Map
Location Map:
Legend
Lifeguard Tower
Right-Of-Way
Public Beach Jurisdictions
City
State Parks
N
City of Encinitas
Public Beach Jurisdictions
Date of Map Production: November, 2010
By: Encinitas GIS Dept.
1 inch = 439 feet
Coordinate System: California State Plane Feet, Zone 6
Datum: NAD83

EXHIBIT G
(SAMPLE) Non-Standard Estate:
Temporary Staging Area

RIGHT OF ENTRY PERMIT	Agency: Department of Parks and Recreation Project:

This Right of Entry Permit (Permit) is made and entered into this ___. day of ______ between the State of California, acting by and through its Department of Parks and Recreation, hereinafter called State, and , pick one: an indiviual, a non-profit public benefit corporation, LLC, sole proprietorship, a corporation, etc. hereinafter called Permittee; State and Permittee may hereinafter be referred to as a Party, or collectively the Parties.

RECITALS

- **Whereas**, the State owns, operates and maintains the State Park known as **Error! Bookmark not defined.**, in the County of **Error! Bookmark not defined.**, State of California; and
- **Whereas**, Permittee has applied to State for permission to access **Error! Bookmark not defined.** for purposes of carrying out Permittee's**Error! Bookmark not defined.** project (the Project); and
- **Whereas**, the State desires to accommodate Permittee's application for permission to enter **Error! Bookmark not defined.** for purposes of the Project, as provided herein and as, and to the extent, such Project may be ultimately described, permitted, approved and conditioned by Permittee's environmental document entitled **Error! Bookmark not defined.** and dated the Environmental Document **Error! Bookmark not defined.**, attached hereto as Exhibit "A" and herein incorporated by reference, and as may be conditioned by any other regulatory agency having jurisdiction, if applicable.

TERMS AND CONDITIONS

Now therefore, the State by this Permit hereby grants to the Permittee permission to enter upon State's property, conditioned upon the agreement of the Parties that this Permit does not create or vest in Permittee any interest in the real property herein described or depicted, that the Permit is revocable and non-transferable, and that the Permit is further subject to the following terms and conditions:

1. **Project Description:** By this Permit, the State hereby grants to the Permittee permission to enter onto those lands depicted **Error! Bookmark not defined.** and/or described on Exhibit "B" (the Property), attached hereto and herein incorporated by this reference, solely for the purpose of **Error! Bookmark not defined.**, . the limits of which are described in the Environmental Document.

2. **Permit Subject to Laws and Regulatory Agency Permits:** This Permit is expressly conditioned upon Permittee's obtaining any and all regulatory permits or approvals required by the relevant regulatory agencies for the Project and Permittee's use of the Property, and upon Permittee's compliance with all applicable municipal, state and federal laws, rules and regulations, including all State Park regulations. Permittee shall, at Permittee's sole cost and expense, comply with the Project Description, and requirements and mitigations contained in the Environmental Document.

   Prior to commencement of any work, Permittee shall obtain all such legally required permits or approvals and submit to the State full and complete copies of all permits and approvals, including documentation related to or referenced in such permits and approvals, along with the corresponding agency contact and telephone numbers, and related California Environmental Quality Act (CEQA) and/or National Environmental Policy Act (NEPA) documentation as applicable.

3. **Term of Permit:** This Permit shall only be for the period beginning on **Error! Bookmark not defined.**, and ending on 1/22/2015, or as may be reasonably extended by written mutual agreement of the Parties.

4. **Consideration:** Permittee agrees to pay State the sum of **Error! Bookmark not defined.** and No/100 Dollars ($) as consideration for the rights granted by this Permit. Payment is due upon execution of this Permit.

5. **Permit Subject to Existing Claims:** This Permit is subject to existing contracts, permits, licenses, encumbrances and claims which may affect the Property.

6. **Waiver of Claims and Indemnity:** Permittee waives all claims against State, its officers, agents and/or employees, for loss, injury, death or damage caused by, arising out of, or in any way connected with the condition or use of the Property, the issuance, exercise, use or implementation of this Permit, and/or the rights herein granted. Permittee further agrees to protect, save, hold harmless, indemnify and defend State, its officers, agents and/or employees from any and all loss, damage, claims, demands, costs and liability which may be suffered or incurred by State, its officers, agents and/or employees from any cause whatsoever, arising out of, or in any way connected with this Permit, exercise by Permittee of the rights herein granted, Permittee's use of the Property and/or the Project for which this Permit is granted, except those arising out of the sole active negligence or willful misconduct of State. Permittee will further cause such indemnification and waiver of claims in favor of State to be inserted in each contract that Permittee executes for the provision of services in connection with the Project for which this Permit is granted.

7. **Contractors:** Permittee shall incorporate the terms, conditions and requirements contained herein when contracting out all or any portion of the work permitted hereunder. Permittee shall be responsible for ensuring contractor/subcontractor compliance with the terms and conditions contained herein. Failure of Permittee's contractors to abide by State's terms and conditions shall constitute default by Permittee (see DEFAULT paragraph below) allowing State to terminate this Permit and seek all legal remedies.

8. **Insurance Requirements:** As a condition of this Permit and in connection with Permittee's indemnification and waiver of claims contained herein, Permittee shall maintain, and cause its contractors to maintain, a policy or policies of insurance as follows:

A. Commercial Permittees

Permittee shall maintain motor vehicle liability with limits of not less than $1,000,000 per accident. Such insurance shall cover liability arising out of a motor vehicle, including all owned, hired, and non-owned motor vehicles.

Permittee shall maintain statutory Workers' Compensation and employer's liability insurance coverage in the amount of $1,000,000/employee/disease/each accident, for all its employees who will be engaged in the performance of work on the Property, including special extensions where applicable. Said policy shall include a waiver of subrogation in favor of State. If the permittee has no employees and/or the owner(s) have elected not to be covered by workers' compensation, Permittee shall provide State with a written confirmation that Permittee is not required to be, and/or has elected not to be, covered by Workers' Compensation.

Permittee shall procure commercial general liability insurance at least as broad as the most commonly available ISO policy form CG 0001 covering premises operations, products/completed operations, personal/advertising injury and contractual liability with limits not less than $1,000,000 per occurrence and $2,000,000 general aggregate. Said policy shall apply separately to each insured against whom any claim is made or suit is brought subject to the Permittee limits of liability

B. Private Party Permittees

Permittee shall maintain personal auto insurance with limits of not less than $100,000 bodily injury per person, $300,000 bodily injury per accident, and $50,000 property damage per accident.

Permittee shall maintain comprehensive personal liability with limits of not less than $300,000 each occurrence.

Each policy of insurance required by this provision shall: (a) be in a form, and written by an insurer, reasonably acceptable to State and (b) be maintained at Permittee's sole expense.

Permittee shall provide to the State within five (5) business days following receipt by contractor a copy of any cancellation or non-renewal of insurance required by this Permit.

Insurance companies issuing such policies shall have a rating classification of "A-" or better and financial size category ratings of "VII" or better according to the latest edition of the A.M. Best Key Rating Guide. All Insurance companies issuing such policies shall be licensed admitted insurers or eligible surplus lines insurers authorized to do business in the State of California.

Said motor vehicle liability and commercial general liability policies shall contain an endorsement naming the STATE OF CALIFORNIA and the CALIFORNIA DEPARTMENT OF PARKS AND RECREATION as an additional insured at no cost to State. The endorsements shall be provided and not substituted by referring to such coverage on the certificate of insurance.

Permittee shall provide to State evidence that the insurance required to be carried by this Permit, including the endorsements affecting the additional insured status and waiver of subrogation, is in full force and effect and that premiums therefore have been paid. Such evidence shall, at State's discretion, be in the form of a Certificate of Insurance **or** DPR Form 169A, Certificate of Insurance for Concession Contracts/Special Events, **or** a certified copy of the original policy, including all endorsements.

Permittee is responsible for any deductible or self-insured retention contained within the insurance program.

Should Permittee fail to keep the specified insurance in effect at all times, Permittee shall be considered to be in default of this Permit, and State may, in addition to any other remedies it has, terminate this Permit.

Permittee shall require and ensure that all contractors and subcontractors have adequate insurance meeting the coverage requirements in this provision.

Any insurance required to be carried shall be primary and not excess to any other insurance carried by State.

Coverage shall be in force for the complete term of this Permit, including any extension thereof, and for all work being done for which this Permit is required.

9. **Reservation of Rights:** State reserves the right to use the Property in any manner, provided such use does not unreasonably interfere with Permittee's rights herein.

10. **Access Limits and Conditions:** Access to the Property shall be limited to the access designated by State .

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11. **Notice of Work:** Any required notices to State shall be sent to the State authorities in charge of **Error! Bookmark not defined.** State Park named below. At least **Error! Bookmark not defined.** forty-eight (48) hours prior to any entry upon the Property for any of the purposes hereinabove set forth, Permittee shall provide the State contact[s] named below with written notice of Permittee’s intent to enter the Property. Permittee shall also notify the State contact[s] listed below in writing at least **Error! Bookmark not defined.** forty-eight (48) hours prior to any change in the Project schedule or cessation or completion of work. Should State personnel need to contact Permittee, State shall notify Permittee’s contact person listed below:

STATE:	**PERMITTEE’S CONTACT:**
Contact:, District Superintendent	Contact:
District: **Error! Bookmark not defined.**	
Address:	Address:
Telephone:	Telephone:
Fax:	Fax:

12. **Limits of Work:** In no event shall this Permit authorize work in excess or contrary to the terms and conditions of any regulatory agency permit or approval. Under no circumstances, whether or not authorized by any regulatory agency, other permit or any person or entity other than State, shall work exceed that which is authorized by this Permit.

13. **Public Safety:** Permittee shall erect orange plastic temporary construction fencing and appropriate signage prior to commencement of work to prevent public access to the construction zone. Permittee shall remove such fencing within two (2) days after the completion of work. Permittee shall take, and shall cause its contractors or subcontractors to take, any and all necessary and reasonable steps to protect the public from harm in connection with the Project or implementation of this Permit.

14. **Compliance with Project Requirements, Monitoring and Mitigation Measures (if applicable):** Resource monitoring and mitigation measures identified by **Error! Bookmark not defined.** shall be completed in accordance with and to the satisfaction of the District Superintendent or designee. Permittee’s activities conducted under this Permit shall comply with all State and Federal environmental laws, including, but not limited to, the Endangered Species Act, CEQA, and Section 5024 of the Public Resources Code.
Any of Permittee’s archaeological consultants working within the boundaries of the Property shall obtain a permit from the California State Parks Archaeology, History & Museums Division prior to commencing any archaeological or cultural investigations of the Property.

Permittee shall immediately advise State's contact person if any new site conditions are found during the course of permitted work. State will advise Permittee if any new historical resources (including archaeological sites), special status species, threatened/endangered species protocols, or other resource issues are identified within the Project site. Permittee shall abide by District Superintendent or designee's instructions to protect the resource(s) during the permitted work or risk revocation of the Permit.

Permittee shall make all excavation activities on the Property available to the State Archaeologist for observation and monitoring. During excavation, the State archaeological monitor may observe and report to the State on all excavation activities. State archaeological monitor shall be empowered to stop any construction activities as necessary to protect significant cultural resources from being disturbed.

In the event that previously unknown cultural resources, including, but not limited to, dark soil containing shell, bone, flaked stone, groundstone, or deposits of historic trash are encountered during Project construction by anyone, work will be suspended at that specific location, and the Permittee's work will be redirected to other tasks, until after a State-qualified archaeologist has evaluated the find and implemented appropriate treatment measures and disposition of artifacts, as appropriate, in compliance with all applicable laws and department resource directives.

If human remains are discovered during the Project, work will be immediately suspended at that specific location and the District Superintendent or designee shall be notified by Permittee. The specific protocol, guidelines and channels of communication outlined by the California Native American Heritage Commission (NAHC), and/or contained in Health and Safety Code Section 7050.5 and Public Resources Code Sections 5097.9 et seq., will be followed. Those statutes will guide the potential Native American involvement in the event of discovery of human remains.

Permittee shall provide a written work schedule to State so that the State archaeological monitor can arrange to be on site on the necessary days. Permittee shall provide reasonable advance notice of and invite the District Superintendent or designee to any preconstruction meetings with the prime contractor or subcontractors.

15. **Restoration of Property:** Permittee shall complete the restoration, repair, and revegetation of the Property in consultation with, and to the satisfaction of, the State Environmental Scientist within one (1) year after completion of the Project or the expiration or termination of this Permit, whichever comes first. This obligation shall survive the expiration or termination of this Permit.

Error! Bookmark not defined.

16. **Performance Bond:** If required by State in order to ensure that Permittee performs and completes its obligations in accordance with the terms of the Permit, Permittee shall obtain a Performance Bond in the amount of from a surety duly licensed in the State of California. Permittee shall provide State with a copy of such insurance bond.

17. **Right to Halt Work:** The State reserves the right to halt work and demand mitigation measures at any time, with or without prior notice to Permittee, in the event the State determines that any provision contained herein has been violated, or in the event that cessation of work is necessary to prevent, avoid, mitigate or remediate any threat to the health and safety of the public or state park personnel, or to the natural or cultural resources of the state park.

18. **Use Restrictions:** The use of the Property by Permittee, including its guests, invitees, employees, contractors and agents, shall be restricted to the daytime hours between sunrise and sunset on a day-by-day basis, unless otherwise approved in advance in writing by State. No person shall use or occupy the Property overnight.

Activities on the Property shall be conducted only in a manner which will not interfere with the orderly operation of the state park. Permittee shall not engage in any disorderly conduct and shall not maintain, possess, store or allow any contraband on the Property. Contraband includes, but is not limited to: any illegal alcoholic beverages, drugs, firearms, explosives and weapons.

Roads and trails where motorized vehicles are normally prohibited may be used for vehicle access by Permittee, its employees, agents or contractors for patrol, maintenance or repair purposes only, and only to the extent specified by State, and shall be otherwise subject to all other conditions and/or restrictions of this Permit and any applicable laws, state park regulations and state park policies.

Permittee shall not use or allow the Property to be used, either in whole or in part, for any purpose other than as set forth in this Permit, without the prior written consent of the State.

19. **State's Right to Enter:** At all times during the term of this Permit and any extension thereof, there shall be and is hereby expressly reserved to State and to any of its agencies, contractors, agents, employees, representatives, invitees or licensees, the right at any and all times, and any and all places, to temporarily enter upon said Property to survey, inspect, or perform any other lawful State purposes.

Permittee shall not interfere with State's right to enter.

20. **Protection of Property:** Permittee shall protect the Property, including all improvements and all natural and cultural features thereon, at all times at Permittee's sole cost and expense, and Permittee shall strictly adhere to the following restrictions:

    (a) Permittee shall not place or dump garbage, trash or refuse anywhere upon or within the Property, except in self-contained trash receptacles that are maintained to State's satisfaction by Permittee.

    (b) Permittee shall not commit or create, or suffer to be committed or created, any waste, hazardous condition or nuisance in, on, under, above or adjacent to the Property.

    (c) Permittee shall not cut, prune or remove any vegetation upon the Property, except as identified in the Project description and herein permitted or subsequently approved in writing by the District Superintendent.

    (d) Permittee shall not disturb, move or remove any rocks or boulders upon the Property, except as identified in the Project description and herein permitted or subsequently approved in writing by the District Superintendent.

    (e) Permittee shall not grade or regrade, or alter in any way, the ground surface of the Property, except as herein permitted, or subsequently approved in writing by the District Superintendent.

    (f) Permittee shall not bait, poison, trap, hunt, pursue, catch, kill or engage in any other activity which results in the taking, maiming or injury of wildlife upon the Property, except as identified in the Project description and herein permitted or subsequently approved in writing by the District Superintendent.

    (g) Permittee shall not use, create, store, possess or dispose of hazardous substances (as defined in the California Hazardous Substances Act) on the Property except as herein permitted, or subsequently approved in writing by the District Superintendent.

    (h) Permittee shall exercise due diligence to protect the Property against damage or destruction by fire, vandalism and any other causes.

21. **Default:** In the event of a default or breach by Permittee of any of the terms or conditions set forth in this Permit, State may at any time thereafter, without limiting State in the exercise of any right of remedy at law or in equity which State may have by reason of such default or breach:

    (a) Maintain this Permit in full force and effect and recover the consideration, if any, and other monetary charges as they become due, without terminating Permittee's right to use of the Property, regardless of whether Permittee has abandoned the Property; or

    (b) Immediately terminate this Permit upon giving written notice to Permittee, whereupon Permittee shall immediately surrender possession of the Property to State and remove all of Permittee's equipment and other personal property from the Property. In such event, State shall be entitled to recover from Permittee all damages incurred or suffered by State by reason of Permittee's default, including, but not limited to, the following:

        (i) any amount necessary to compensate State for all the detriment proximately caused by Permittee's failure to perform its obligations under this Permit, including, but not limited to, compensation for the cost of restoration, repair and revegetation of the Property, which shall be done at State's sole discretion and compensation for the detriment which in the ordinary course of events would be likely to result from the default; plus

        (ii) at State's election, such other amounts in addition to or in lieu of the foregoing as may be permitted from time to time by applicable law.

22. **State's Right to Cure Permittee's Default:** At any time after Permittee is in default or in material breach of this Permit, State may, but shall not be required to, cure such default or breach at

Permittee's cost. If State at any time, by reason of such default or breach, pays any sum or does any act that requires the payment of any sum, the sum paid by State shall be due immediately from Permittee to State at the time the sum is paid. The sum due from Permittee to State shall bear the maximum interest allowed by California law from the date the sum was paid by State until the date on which Permittee reimburses State.

23. **Revocation of Permit:** The State shall have the absolute right to revoke this Permit for any reason upon ten (10) days written notice to Permittee. Written notice to Permittee may be accomplished by electronic or facsimile transmission, and the notice period set forth in this paragraph shall begin on the date of the electronic or facsimile transmission, or, if sent by mail, on the date of delivery. If Permittee is in breach of the Permit or owes money to the State pursuant to this Permit, any prepaid monies paid by Permittee to State shall be held and applied by the State as an offset toward damages and/or amounts owed. Nothing stated herein shall limit the State's exercise of its legal and equitable remedies.

24. **Recovery of Legal Fees:** In any action brought to enforce or interpret any provisions of this Permit or to restrain the breach of any agreement contained herein, or for the recovery of possession of the Property, or to protect any rights given to the State against Permittee, and in any actions or proceedings under Title 11 of the United States Code, if the State shall prevail in such action on trial or appeal, the Permittee shall pay to the State such amount in attorney's fees in said action as the court shall determine to be reasonable, which shall be fixed by the court as part of the costs of said action.

25. **Voluntary Execution and Independence of Counsel:** By their respective signatures below, each Party hereto affirms that they have read and understood this Permit and have received independent counsel and advice from their attorneys with respect to the advisability of executing this Permit.

26. **Reliance on Investigations:** Permittee declares that it has made such investigation of the facts pertaining to this Permit, the Property and all the matters pertaining thereto as it deems necessary, and on that basis accepts the terms and conditions contained in this Permit. Permittee acknowledges that State has made, and makes, no representations or warranties as to the condition of the Property, and Permittee expressly agrees to accept the Property in its as-is condition for use as herein permitted.

27. **Entire Agreement:** The Parties further declare and represent that no inducement, promise or agreement not herein expressed has been made to them and this Permit contains the entire agreement of the Parties, and that the terms of this agreement are contractual and not a mere recital.

28. **Warranty of Authority:** The undersigned represents that they have the authority to, and do, bind the person or entity on whose behalf and for whom they are signing this Permit and the attendant documents provided for herein, and this Permit and said additional documents are, accordingly, binding on said person or entity.

29. **Assignment:** This Permit shall not be assigned, mortgaged, hypothecated, or transferred by Permittee, whether voluntarily or involuntarily or by operation of law, nor shall Permittee let, sublet or grant any license or permit with respect to the use and occupancy of the Property or any portion thereof, without the prior written consent of State.

30. **Choice of Law:** This Permit will be governed and construed by the laws of the State of California.

STATE OF CALIFORNIA
Department of Parks and Recreation

By: ______________________________
Name:
Title: District Superintendent
Error! Bookmark not defined.

ERROR! BOOKMARK NOT DEFINED.

By: ________________________________
Name:
Title:
Address:
Phone: ; Fax:

Encinitas-Solana Beach Coastal Storm Damage Reduction Project

San Diego County, California

Appendix H

Potential Impacts to Nearshore Resources and Mitigation and Monitoring Plan

U.S. Army Corps of Engineers
Los Angeles District

April 2015

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1 INTRODUCTION

The Encinitas-Solana Beach Coastal Storm Damage Reduction Project was developed by the United States Army Corps of Engineers, Los Angeles District (USACE) in coordination with the local sponsors (City of Encinitas and City of Solana Beach) to address shoreline erosion problems along 9 miles (mi) of coastline of both cities. A primary environmental concern for the project is the potential to impact nearshore reefs that support sensitive aquatic vegetation and represent special aquatic site. Specific concerns are the potential for sand elevation changes associated with beach nourishment to: 1) indirectly bury reefs and 2) degrade reef habitat from increased scour and/or sedimentation. Kelp beds, which occur in relatively deeper nearshore waters, are highly diverse habitats supporting many fish and invertebrate species. In addition, nearshore reefs with surfgrass support a variety of species and serve as nursery areas for juvenile lobster. Impacts to surfgrass are of additional concern since that habitat is slow to recover if substantially impacted and is currently infeasible to restore on a large scale if mitigation is required (Reed and Holbrook. 2003).

Approximately 480 acres of reef habitat occurs in the nearshore zone of the study area. The distribution of reef habitat is non-continuous and patchy, varying in size and relative quality that is influenced by the local geology and natural sand movement (MEC 2000, SAIC 2007, San Diego Nearshore Program http://nearshore.ucsd.edu/). Nearshore reefs are naturally exposed to changes in sand depth associated with seasonal on and offshore movement of sand within the littoral zone. The littoral zone is bounded by the backshore and offshore "depth of closure", which ranges between approximately -13 and -30 feet (ft) Mean Lower Low Water (MLLW) off the cities of Encinitas and Solana Beach (Coastal Frontiers 2004).

Estimating impacts from beach nourishment projects is complex and includes inherent uncertainties. Sediment transport models (e.g., GENESIS) have been developed to predict the long shore fate and transport of sand in sandy beach areas, although local physical conditions and model assumptions may influence model performance. In addition, available models do not include assumptions for geologic characteristics (e.g., reefs, rock outcrops), and the influences of nearshore reefs on local sand movement are also poorly understood and likely complex because of reef geometry and orientation (e.g., channels between reefs may facilitate sand movement [AMEC 2005] and reef structure may retain sand [SAIC 2007]).

Despite these uncertainties, sediment transport modeling has been implemented within the region (e.g., Regional Beach Sand Project [RBSP] I and II). For the RBSP I and II, modeling was used to predict sedimentation in the nearshore region and identify areas of substantial deposition on nearshore reefs associated with the project. No irreversible, long-term impacts to sensitive marine resources were predicted based on modeling results, and all short-term impacts were considered within the range that would occur naturally, and post-construction physical and biological monitoring conducted in support of the RBSP I generally confirmed that modeling (working with conservative assumptions) was a useful tool for predicting potential impacts to nearshore reefs.

For this Project, sediment transport modeling was used to estimate potential impacts to nearshore resources. Additional data on nearshore reefs have been collected since the time of the RBSP I, and a more extensive record of beach profile data was available for inclusion into the USACE model. The beach profile monitoring stations provide an empirical record of seasonal sand elevation changes in the cross-shore direction from the backshore to approximate "depth of closure."

2 PHYSICAL SETTING

The Cities of Encinitas and Solana Beach are located along the central coast of San Diego County, as shown in **Integrated Report Figure 1.5-1**. San Elijo Lagoon is the dividing feature separating Encinitas to the north from Solana Beach to the south. Encinitas is approximately 10 mi south of Oceanside Harbor and 17 mi north of Point La Jolla. Encinitas' shoreline is approximately 6 mi long and is bounded by Batiquitos Lagoon in the City of Carlsbad to the north and the City of Solana Beach to the south. The major portion of the shoreline within Encinitas can be characterized as consisting of narrow sand and cobble beaches backed by seacliffs. The southernmost segment at Cardiff, which is approximately 4,920 ft long, is a low-lying tidal spit that fronts the San Elijo Lagoon. The City of Solana Beach is approximately 20 mi north of San Diego and is bordered by the San Elijo Lagoon in the City of Encinitas to the north and the City of Del Mar to the south. Solana Beach's shoreline, which is approximately 2 mi in length, is comprised almost solely of narrow sand and cobble beaches fronting coastal bluffs.

2.1 Reach Discretization

To better characterize the coastal bluff and shoreline morphology, as well as, oceanographic conditions, the entire study area was divided into nine reaches as illustrated in **Integrated Report Figure 1.5-1**. The distinction between reaches is based on differences in seacliff geology, topography, coastal development, and beach conditions, and is described in detail in Chapter 1 of the Integrated Report.

3 BIOLOGICAL SETTING

3.1 Data Sources

Several data sources were used to characterize nearshore reef dimensions, physical characteristics, and biological resources, and include:

- 2009 and 2010 reef dives and intertidal surfgrass mapping within the study area were used to provide representative information on reef heights and habitat quality indicators (San Diego Association of Governments [SANDAG] 2011).
- 2006 reef dives and intertidal surfgrass mapping within the study area were used to provide representative information on reef heights and habitat quality indicators (SAIC 2007).
- 2004 light detection and ranging imagery (LiDAR) data were used to provide bathymetric information for portions of the study area.
- 2002 California State Conservancy and SANDAG San Diego Nearshore Program GIS layers of bathymetry, hard substrate, and aquatic vegetation mapping served as the basis for reef and sensitive resource acreage calculations.
    - Substrate GIS data enabled calculation of reef dimensions and acreage.
    - Vegetation GIS data enabled calculation of acreage by dominant and sensitive resource categories (i.e., surfgrass, giant kelp, understory algae).
- 2000 reef dives and intertidal surfgrass mapping produced for the 2001 RBSP were used to provide additional representative information on reef heights and habitat quality indicators.

3.2 Reef and Vegetation Footprints

The 2002 SANDAG seafloor map provides the best available data of nearshore habitat in the study area (**Figure 3.2-1**). Similarly, the 2002 SANDAG vegetation map provides the best available quantitative estimates of the vegetative indicator species (**Figure 3.2-2**). Those data include acreage estimates for various habitat types: surfgrass, giant kelp (kelp canopy), and understory algae. The understory category includes several species, including feather boa kelp and sea palm indicators. Indicator species were selected in coordination with resource agencies to be consistent with previous reef characterization surveys and monitoring conducted in the study area (USDN 1997a, b; MEC 2000, AMEC 2005). The indicators represent dominant species that are sensitive to varying degrees of sand scour and sedimentation, as follows:

- Persistent indicator species considered relatively sensitive to sand scour and sedimentation (sea fans, giant kelp).
- Persistent indicator species considered relatively tolerant of some sand influence (surfgrass, sea palm).
- Opportunistic indicator species considered relatively sand tolerant (feather boa kelp).

The USACE model area, which extends from the shoreline to approximately 1,600 ft offshore, includes approximately 480 acres of reef offshore Encinitas and Solana Beach. The combined total acreage of the vegetative categories is similar to that of bedrock on the substrate map (**Table 3.2-1**). While the amount of exposed reef may vary depending on time of year and environmental conditions (e.g., El Nino oceanographic events), the 2002 substrate and vegetation acreage estimates are considered representative for the impact analysis, and are further supported by subsequent sampling and monitoring from 2003 to 2010 (SANDAG 2011).

Table 3.2-1 Summary of Nearshore Resources within each Reach (in acres)

Reach #	Total bedrock substrate	Bedrock with surfgrass	Bedrock w/other indicators
1	99.3	24.2	71.8
2	23.1	6.1	16.3
3	31.5	3.6	26.5
4	28.1	1.8	25.0
5	65.8	13.0	50.5
6	128.1	27.5	95.5
7	36.8	2.1	33.9
8	31.9	3.7	26.2
9	30.1	0.7	27.0
TOTAL	**474.7**	**82.7**	**372.7**

Source: SANDAG 2002

Figure 3.2-1 Seafloor Substrate off Encinitas and Solana Beach.

Source: SANDAG 2002

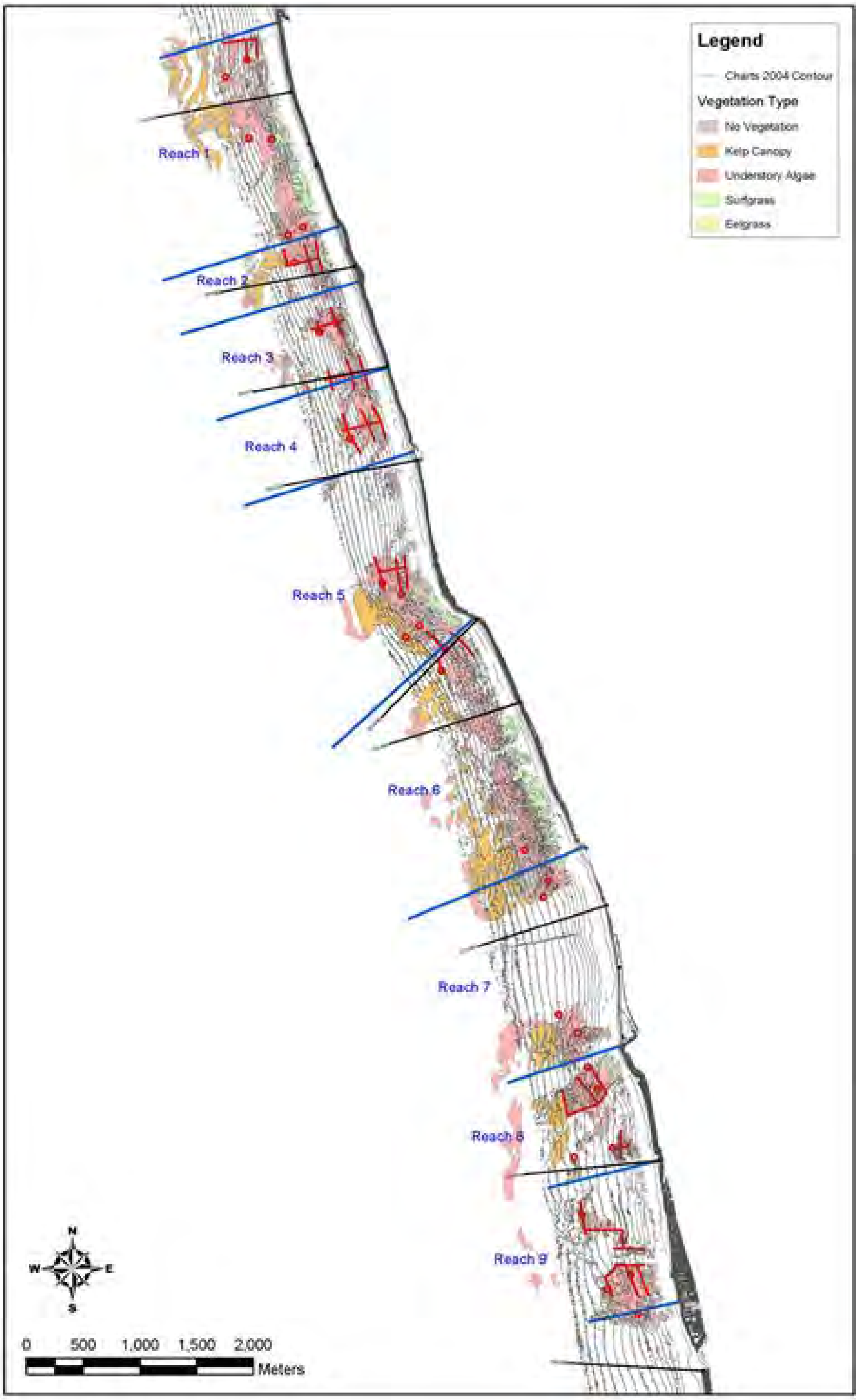

Figure 3.2-2 Marine Vegetation off Encinitas and Solana Beach.

Source: SANDAG 2002

Reef quality or the ability to support indicator species is directly correlated with reef elevation (i.e., height of the reef), as higher-relief reefs are more resistant to sedimentation and scour, and therefore, allows perennial species to persist. Reef heights in relatively higher quality areas include a greater percentage of heights >1 ft compared to relatively lower quality areas. Seventy percent of the 2006 survey transects had substrate heights that were predominantly <1 ft in relatively lower quality reef areas (SAIC 2007). In some cases, low-relief reefs may also support perennial indicator species, if other factors contribute to minimize the effects of sedimentation and scour. An example includes the presence of sand channels which allow sand to migrate on and off shore between low-relief reefs. A summary of reef elevation within the project area is provided in **Table 3.2-2**, with a further breakdown by surfgrass in **Table 3.2-3** and other indicator species in **Table 3.2-4**.

Table 3.2-2 Summary of Bedrock by Reef Elevation within each Reach (in acres).

	Reef Elevation (ft)			
Reach #	**(0 - 1)**	**(1 - 2)**	**(2 - 3)**	**(> 3)**
1	53.6	20.6	14.0	11.1
2	16.6	4.6	1.7	0.2
3	20.0	4.9	2.9	3.7
4	16.8	3.4	3.6	4.3
5	25.1	6.2	4.7	29.8
6	74.3	27.9	15.0	10.9
7	13.0	6.2	5.6	12.0
8	12.2	2.6	1.5	15.6
9	13.5	3.0	3.3	10.3
TOTAL	**245.1**	**79.4**	**52.3**	**97.9**

Source: SANDAG 2002

Table 3.2-3 Summary of Bedrock with Surfgrass by Reef Elevation within each Reach (in acres).

	Reef Elevation (ft)			
Reach #	**(0 - 1)**	**(1 - 2)**	**(2 - 3)**	**(> 3)**
1	9.5		4.3	4.0
2	4.9	1.0	0.2	0.0
3	2.1	0.8	0.3	0.4
4	1.4	0.2	0.2	0.0
5	3.8	2.1	1.6	5.5
6	13.6	5.6	4.4	3.9
7	0.7	0.3	0.3	0.8
8	0.0	0.0	0.0	3.7
9	0.0	0.0	0.0	0.7
TOTAL	**36.0**	**16.4**	**11.3**	**19.0**

Source: SANDAG 2002

Table 3.2-4 Summary of Bedrock with other Indicator Species by Reef Elevation within each Reach (in acres)

	Reef Elevation (ft)			
Reach #	**(0 - 1)**	**(1 - 2)**	**(2 - 3)**	**(> 3)**
1	41.6	13.7	9.5	7.0
2	11.0	3.6	1.5	0.2
3	16.6	4.0	2.6	3.3
4	14.3	3.1	3.3	4.3
5	19.9	3.9	2.9	23.8
6	56.9	21.3	10.4	6.9
7	11.8	5.8	5.2	11.1
8	10.7	2.4	1.4	11.7
9	11.5	2.9	3.2	9.4
TOTAL	**194.3**	**60.7**	**40.0**	**77.7**

Source: SANDAG 2002

The SAIC 2007 study also noted relationships between indicator species occurrence, reef heights, and depth distribution. Several examples include:

- Surfgrass, which primarily occurred at water depths ≤ 15 ft, was uncommon on reef heights < 1 ft and had denser cover on substrate heights ≥ 2 ft than on 1 ft heights.
- Giant kelp primarily occurred at water depths > 15 ft on reef heights ≥ 1 ft. Giant kelp had sparse occurrence on nearshore reefs. Primary giant kelp canopies occur offshore beyond the beach depth of closure (MEC 2000).
- Sea palm and feather boa understory algae mainly occurred at water depths < 26 ft, with greater number between 15 and 26 ft. Both species had greater cover on reef heights > 1 ft.
- Sea fan occurrence increased with depth, with most records at depths > 26 ft. Although sea fans mainly occurred on ≥ 1 ft substrate, there were more records on reefs < 1 ft in height than observed for other indicator species, most likely related to less sand influence with increasing depth.
- Hard substrate with opportunistic turf algae, sparse occurrence of opportunistic feather boa kelp, and/or lacking vegetation have been used to distinguish substantially sand influenced (scoured) reef (MEC 2000, SAIC 2007).

Figure 3.2-3 and **Figure 3.2-4** illustrate nearshore resources based on the 2002 SANDAG data for Encinitas and Solana Beach, respectively.

Photos of typical resources are shown in **Photo 3.2-1** to **Photo 3.2-4**.

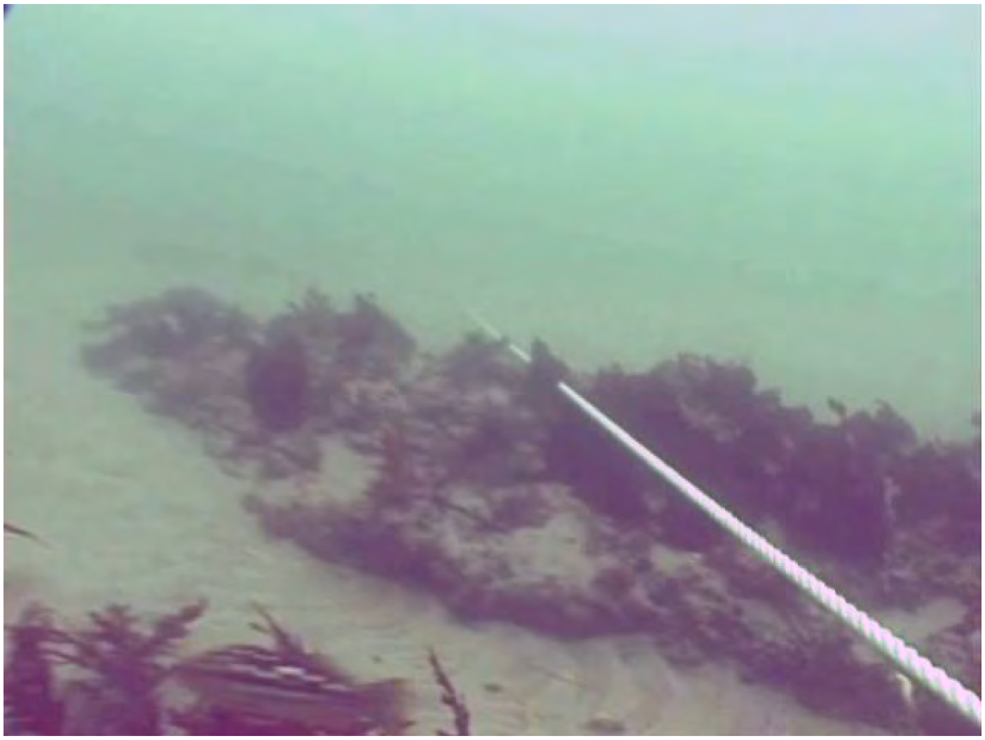

Photo 3.2-1 Low Relief Reef with Sand Scour

Source: SAIC, 2007

Photo 3.2-2 Low Relief Reef with Sand Scour at Leucadia

Source: SAIC, 2010

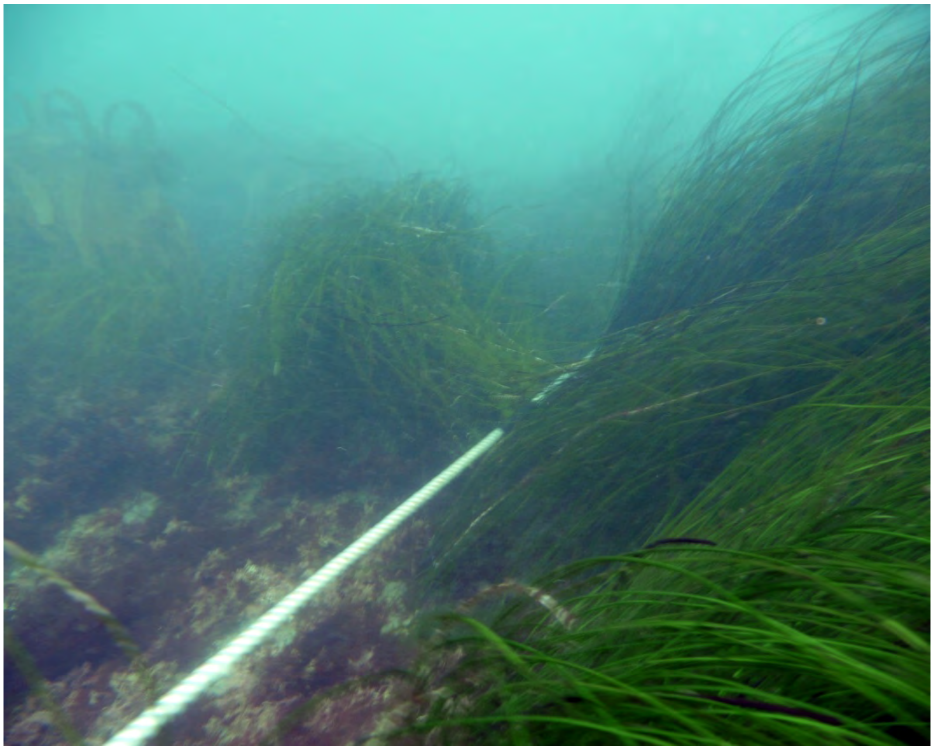

Photo 3.2-3 Subtidal Surfgrass

Source: SAIC, 2009

Photo 3.2-4 Surfgrass in Reach 8

Source: SAIC, 2006

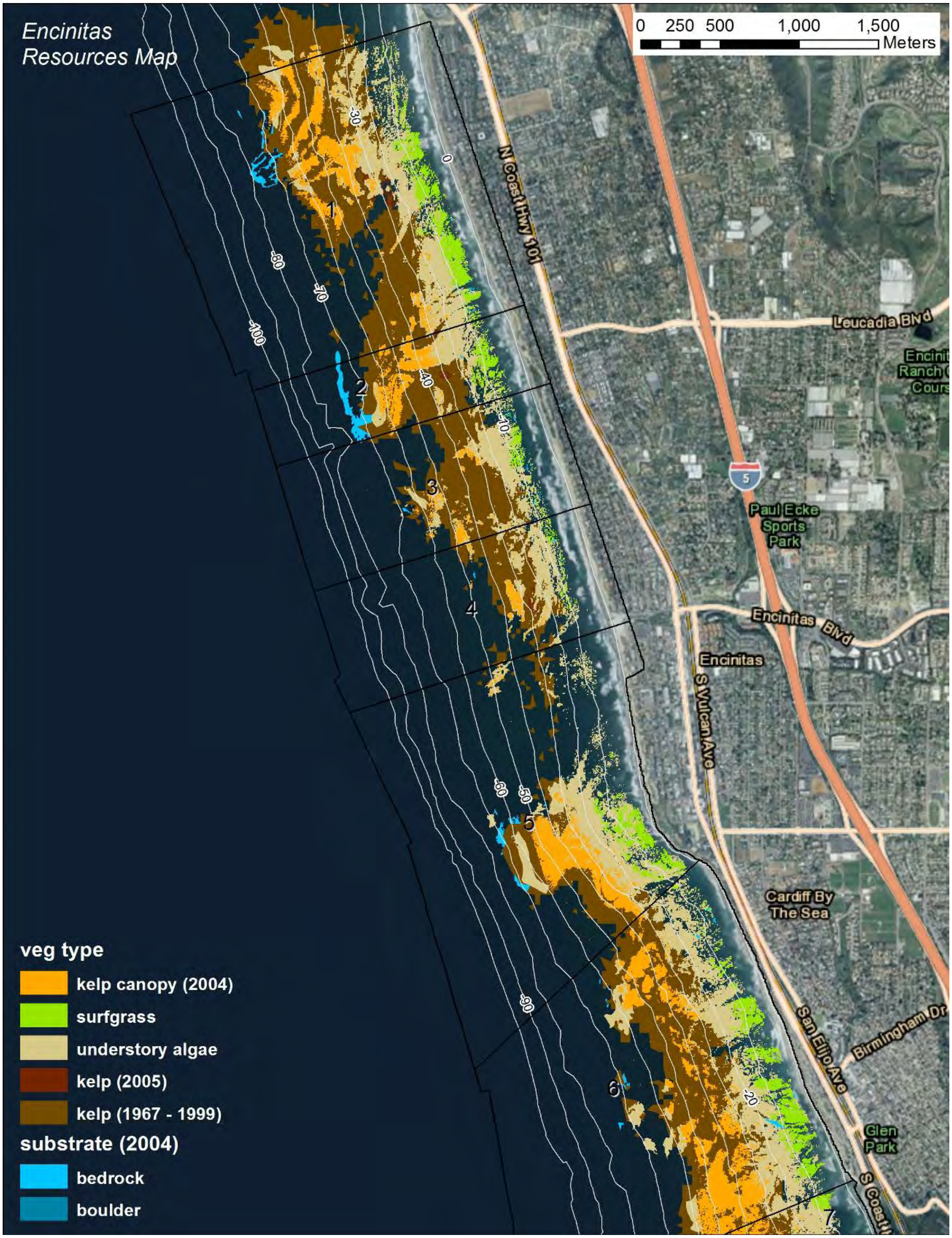

Figure 3.2-3 Nearshore Resources off Encinitas.

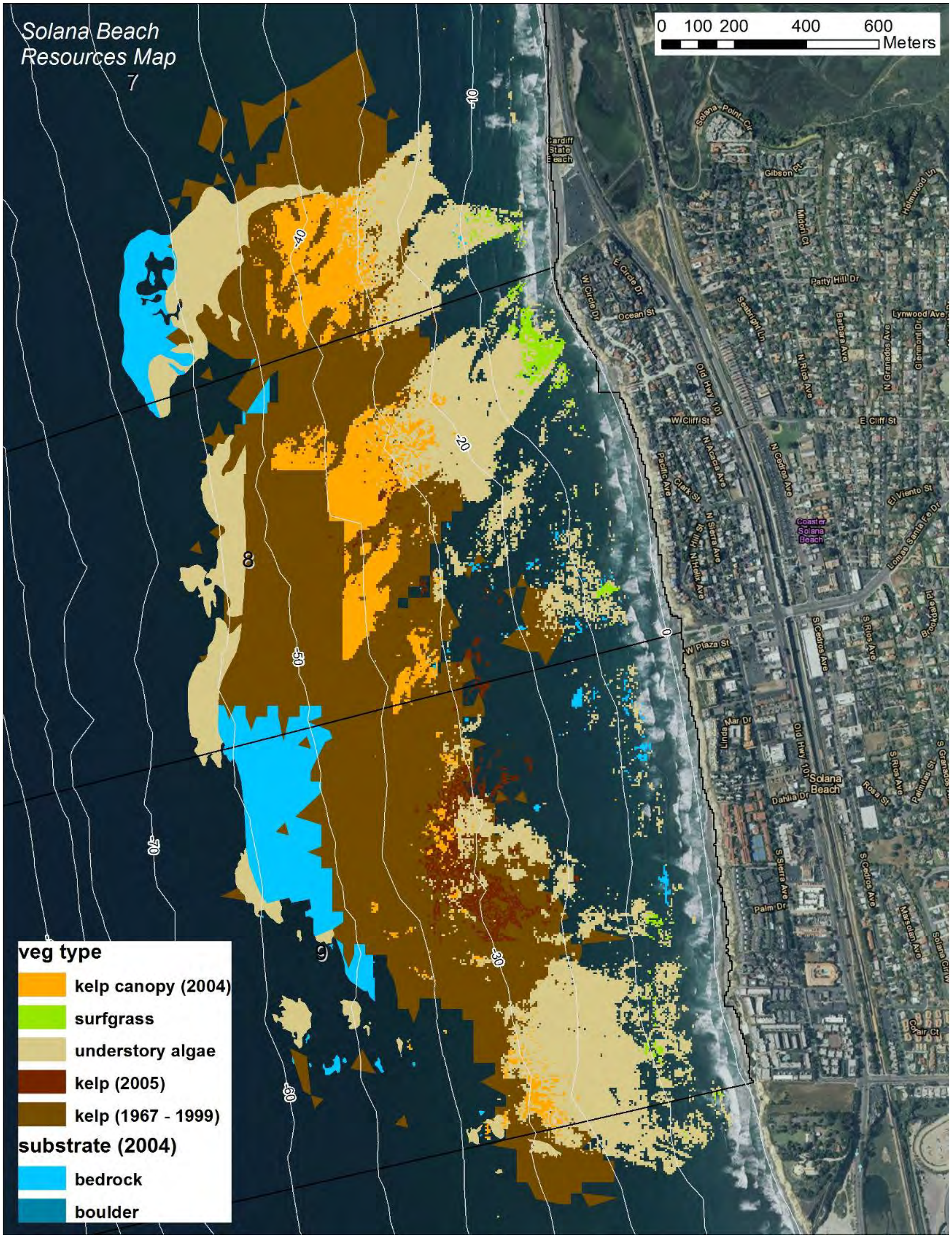

Figure 3.2-4 Nearshore Resources off Solana Beach.

4 METHODS

4.1 Sediment Transport Modeling

To support the cost-benefit analyses and to assist in selection of the NED Plan, beach fill plans were formulated to extend the mean sea level (MSL) seaward from the without project position in increments of 50-ft, with varying replenishment intervals and quantity to reestablish initial MSL position. Projected loss rates of the beach fill were estimated with the GENESIS shoreline modeling and consideration of the performance of prior beach fills in the project area.

Shoreline modeling positions were output at each model cell within the GENESIS model domain. For each profile, the average shoreline position was calculated including data from half the distance to the next downcoast profile through half the distance to the next upcoast profile. These averages were calculated for the spring and fall of year 2 for each profile in the study area, and each beach nourishment option including the without project condition. Profiles from DM-590 through SD-700 were utilized (**Figure 4.1-1**).

Net differences between each beach nourishment option and the without project condition were calculated. These net shoreline differences at each profile location were then converted into sand volumes using v/s ratios. These sand volumes were distributed across the profiles using the cross shore sand thickness distributions. Sand thicknesses were interpolated between the profiles where data were non-existent. In addition to sand thickness from beach nourishment, sand thickness was also added to each segment to keep pace with the low and high sea level rise scenarios as calculated with the Bruun Rule and described in Section 7.8.2 of the **Appendix B**.

Table 4.1-1 depicts the beach width options and sea level rise scenarios that were analyzed for potential nearshore habitat impacts. Any potential impact to nearshore resources were based on Year 2 estimated deposition per USACE direction and negotiations with resource and regulatory agencies. A detailed description of the modeling is provided in the **Appendix B** and model outputs for all the beach width options (50 ft, 100 ft, 150 ft, 200 ft, and 300 ft for both low and high sea level rise scenarios) are provided in **Appendix A of this document**.

Table 4.1-1 Summary of Beach Width Options and Sea Level Scenarios Analyzed

Sea Level Rise Scenario	Beach Width Option (ft)	
	Encinitas	Solana Beach
Low	50	50
	100	100
	150	150
	200	200
	N/A	250
	N/A	300
High	50	50
	100	100
	150	150
	200	200
	N/A	250
	N/A	300

Figure 4.1-1 Locations of 2001 SANDAG RBSP receiver sites and beach profile monitoring stations.

4.2 GIS-Based Approach to Nearshore Habitat Impact Methodology

A GIS-based methodology was developed to automate what was done for previous efforts (i.e., SANDAG RBSP and the Encinitas-Solana Beach Shoreline Feasibility Study from 2005 through 2007), and was developed in coordination with three resource agencies (California Department of Fish and Wildlife, National Marine Fisheries Service, and United States Fish and Wildlife Service), USACE, and the local sponsors. For the Encinitas-Solana Beach Shoreline Feasibility Study, the 2004 LiDAR data was used as base bathymetry upon which changes in sand thickness was added. It is conceded that data were collected at a snapshot in time, and it may be similar to a spring or fall profile, thereby not representing any long-term or average bathymetry.

The key assumptions on which this methodology relied include:

- Bathymetry baseline model year is 2004 for the lifetime of the project. This baseline is more precise and accurate than any other data set available, and is considered to be more representative of existing conditions than generating a new baseline based on erosion and accretion independent of the project without a firm knowledge of the underlying nearshore conditions.

- Substrate and vegetation data from the 2002 SANDAG Nearshore Habitat Inventory Survey is representative of existing conditions, and is supported with data collected in 2006, 2008, 2009, and 2010.

- The potential sensitive resources in the study area are similar to those analyzed for the previous studies (e.g., 2005 Encinitas-Solana Beach Shoreline Feasibility Study, RBSP I and II), and consist of Bedrock with Surfgrass and Bedrock with Other Indicator Species (i.e., kelps). Another unique resource of interest for Solana Beach, also included in the analysis was Tabletops Reef, which is a sand-influenced rocky intertidal platform located at the northern portion of the city.

The approach utilizes the same baseline data that was used for previous analyses regarding substrate, resources, etc.; however, the approach uses a 4-dimensional, GIS-based approach. The key steps to applying the GIS-based approach included:

1. Create a base bathymetric surface (i.e., 2004 LiDAR and 2002 Nearshore Inventory Surveys). This provides the baseline depth from which any increase in sedimentation can be measured (**Figure 4.4-1** and **Figure 4.4-2**).

2. Create a theoretical sand surface based on existing data (i.e., 2004 LiDAR and 2002 Nearshore Inventory Surveys). This surface ties in and is overlaid on the bathymetric surface to create a reference from which any increase in sedimentation can be measured. Therefore, the difference between the bathymetric surface and the sand surface denotes a change in elevation (presumably reef), and therefore provides reef elevations (**Figure 4.4-3**).

3. Overlay resource layers (e.g., substrate type and vegetation type) based on existing data (i.e., 2004 LiDAR and 2002 Nearshore Inventory Surveys). This layer provides a spatial representation (areal coverage) of the resources, a mosaic of habitat types (e.g.,

sandy areas, rocky reef) and resources (e.g., surfgrass, kelp) that also includes reef elevation (**Figure 4.4-4** and **Figure 4.4-5**).

4. Overlay cross-shore modeling results by creating a sand isopach. This isopach is a sand layer that denotes the model-based predictions of offshore sedimentation (**Figure 4.4-6**). When this layer is added to the baseline layers above, the areal coverage of any resource of interest can be calculated. The difference between this and the baseline data denotes potential burial or loss of the resource. Seasonal modeling results were provided for spring and fall seasons.

5. Establish burial criteria. For this project, a burial criteria of ≥ 12 inches (in) was used for several reasons:

   a. Similar criteria were used to assess impacts on biological resources for previous beach nourishment projects (e.g., RBSP I and II).

   b. Given the dynamic nature of the environment and natural seasonal sediment transport, rocky habitat less than 12 in (0.3m) typically supports ephemeral species due to sediment scour. Therefore, project-related impacts above and beyond this level were considered to have potential impacts on perennial/indicator species and habitat.

   c. Although this approach could use any numeric criteria, it should be noted that the high degree of natural variation, the level of resolution, and the margin of error of the baseline data, as well as the modeling results, brings into question the accuracy of fine-tuning a sediment criteria (i.e., any small incremental change in the criteria is overshadowed by the margin of error in baseline resolution, modeling results and natural variation).

6. Calculate acreage for potential impact areas that exceeds criteria for attribute(s) of interest (e.g., bedrock with surfgrass, bedrock with other indicators species, intertidal reef platform) (**Figure 4.4-7**).

7. To estimate sedimentation and impacts to resources based on "Natural Variation," a sand layer was created from empirical data provided from the 1996 to 2008 coastal profile dataset (**Figure 4.4-8**). Due to the high degree of variation of the coastal profile data (most likely a sampling artifact), the standard deviation of the sand layer depth was used instead of the maximum values. This sand layer was overlaid onto the baseline layer similar to the modeled sedimentation results, and the same ≥ 12 in criteria was applied, and area impacted calculated.

8. Seasonal impacts were determined based on Year 2 results, and averaged to determine the Most Probable Impact. The potential Project-Related Impact was estimated by subtracting the Most Probable Impact from Natural Variation.

4.3 Mitigation Cost Estimate

To support the cost-benefit analyses and to assist in selection of the NED Plan and other project alternatives, costs to mitigate potential impacts were estimated. Numerous assumptions were used to estimate potential mitigation costs and include:

- No mitigation if no long-term impacts are discernible
- In-kind mitigation, except for intertidal reef platform (for Solana Beach only)
- Mitigation functional equivalent of 2:1 based on the assumption that the mitigation reef would be constructed as a mid-depth reef (refer to **Appendix M**).
- Reef mitigation cost based on Southern California Edison (SCE) San Onofre Mitigation Reef costs plus escalation and other costs ($500,000 per acre)
- Rounded to nearest $5,000
- Transplanting adult kelp plants and sporophytes
- Surfgrass mitigation includes both habitat creation and transplant
- Surfgrass transplant based on $250,000 per acre
- Surfgrass habitat creation cost based on Everest Consultant's estimate for high-relief reef ($2,000,000 per acre)

4.4 Construction Monitoring

While the Integrated Report relies on predicted impacts, actual impacts would be assessed by implementation of a construction monitoring program. If mitigation is implemented, mitigation monitoring would also be conducted. Section 6 provides information regarding the mitigation and monitoring for the project.

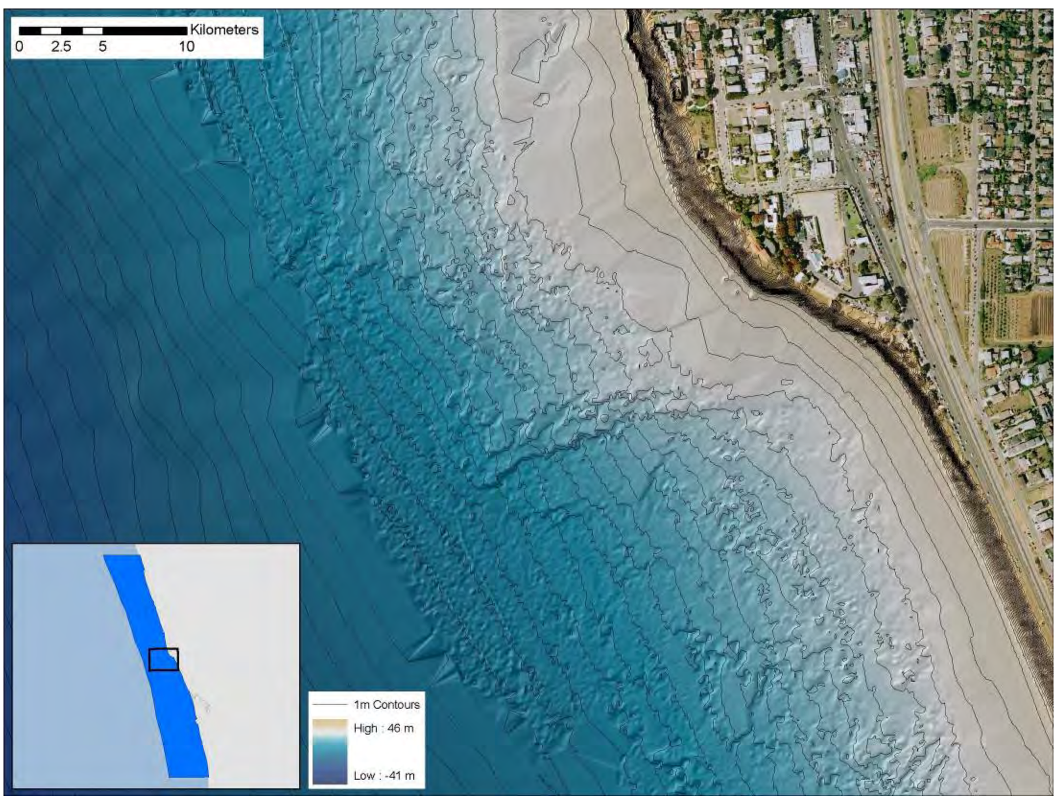

Figure 4.4-1 Close-up view of bathymetric contours.

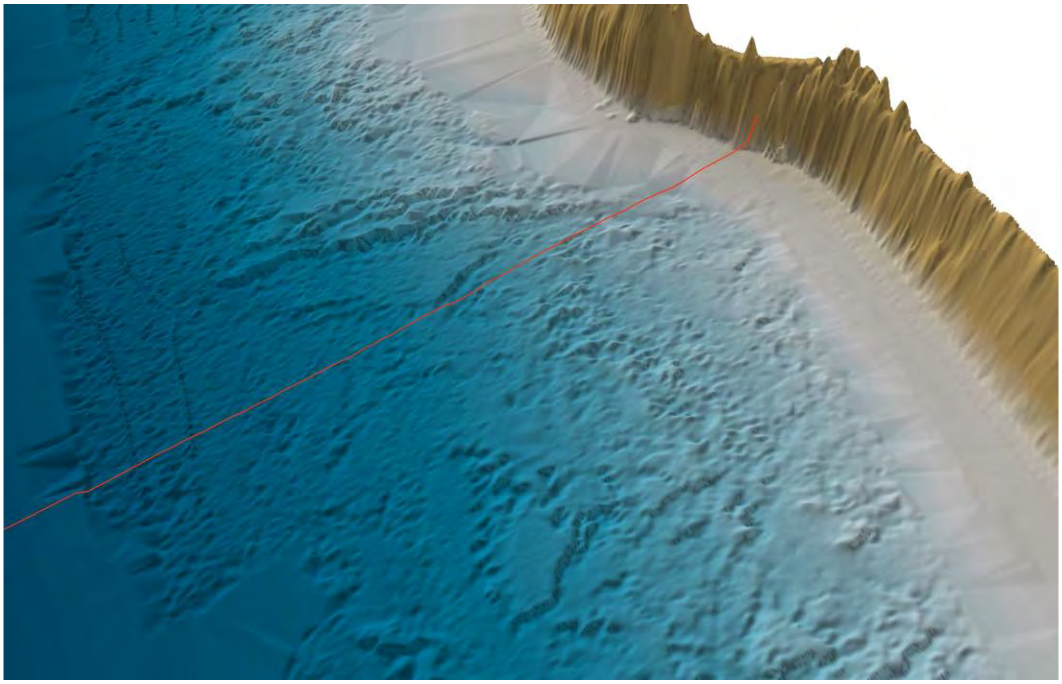

Figure 4.4-2 Oblique view of bathymetry with vertical exaggeration to enhance the reef habitat.

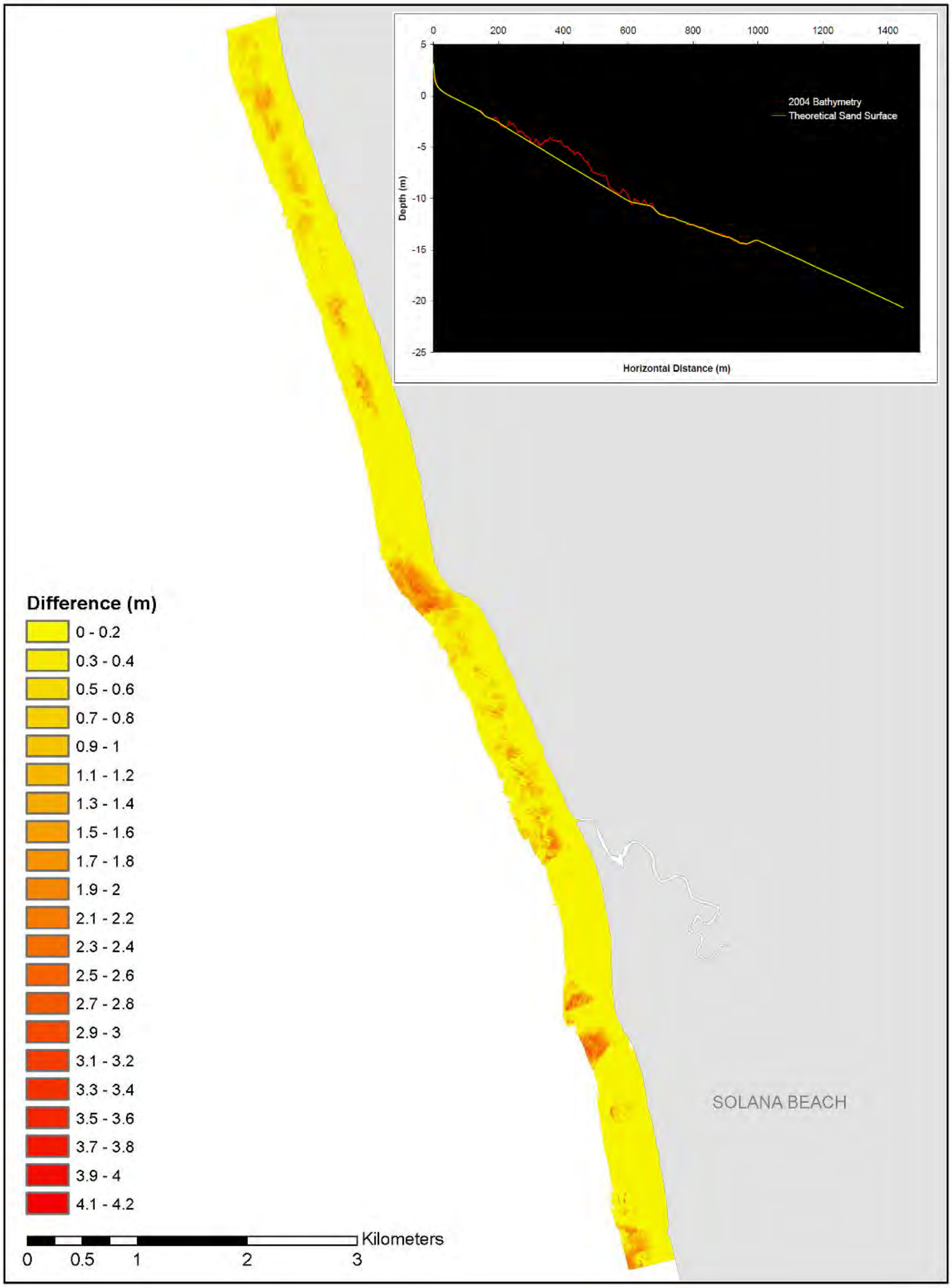

Figure 4.4-3 Theoretical sand surface subtracted from bathymetric surface. This difference denotes reef elevation.

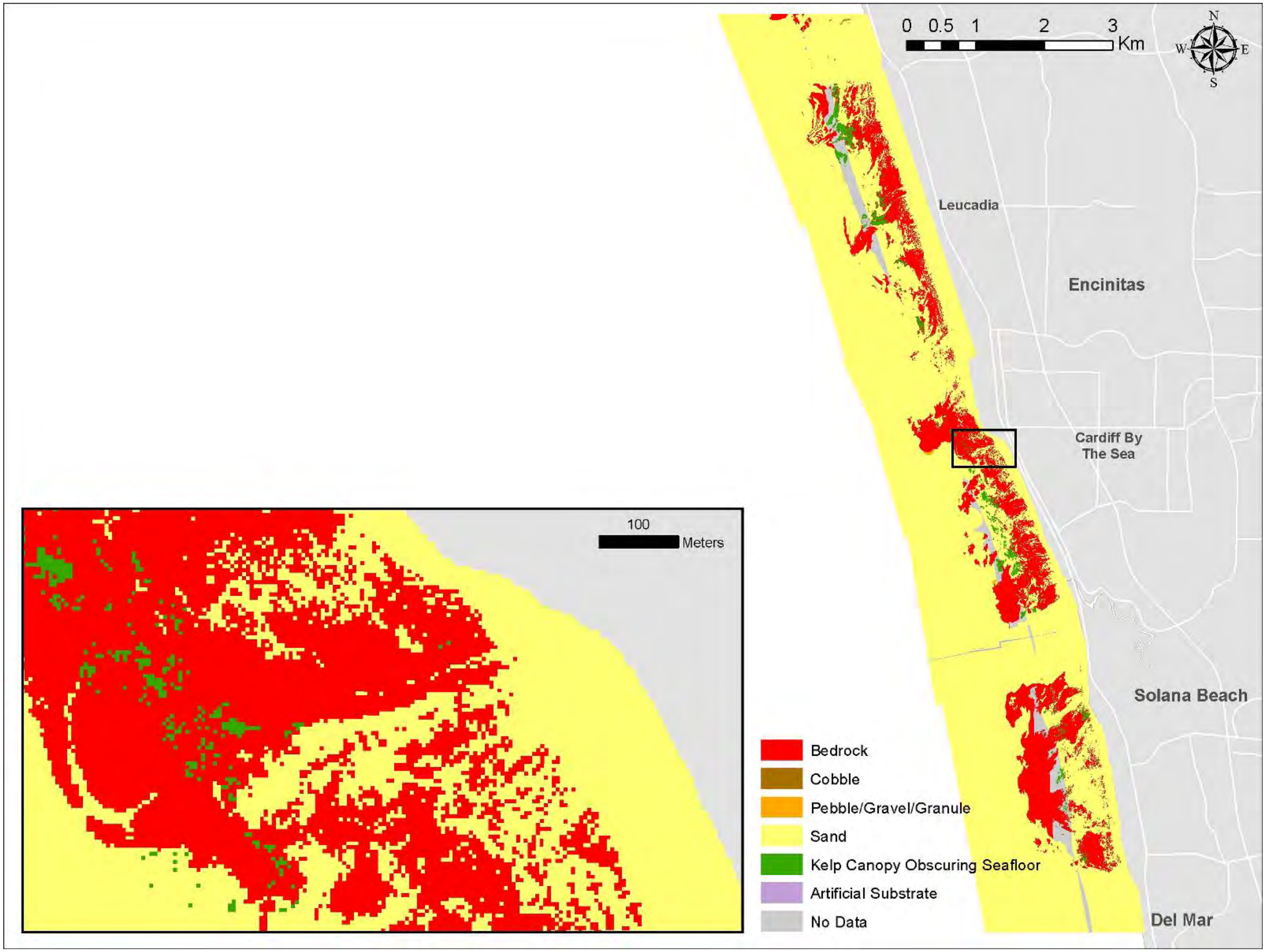

Figure 4.4-4 Substrate coverage in study area based on 2004 LiDAR and 2002 vegetation surveys.

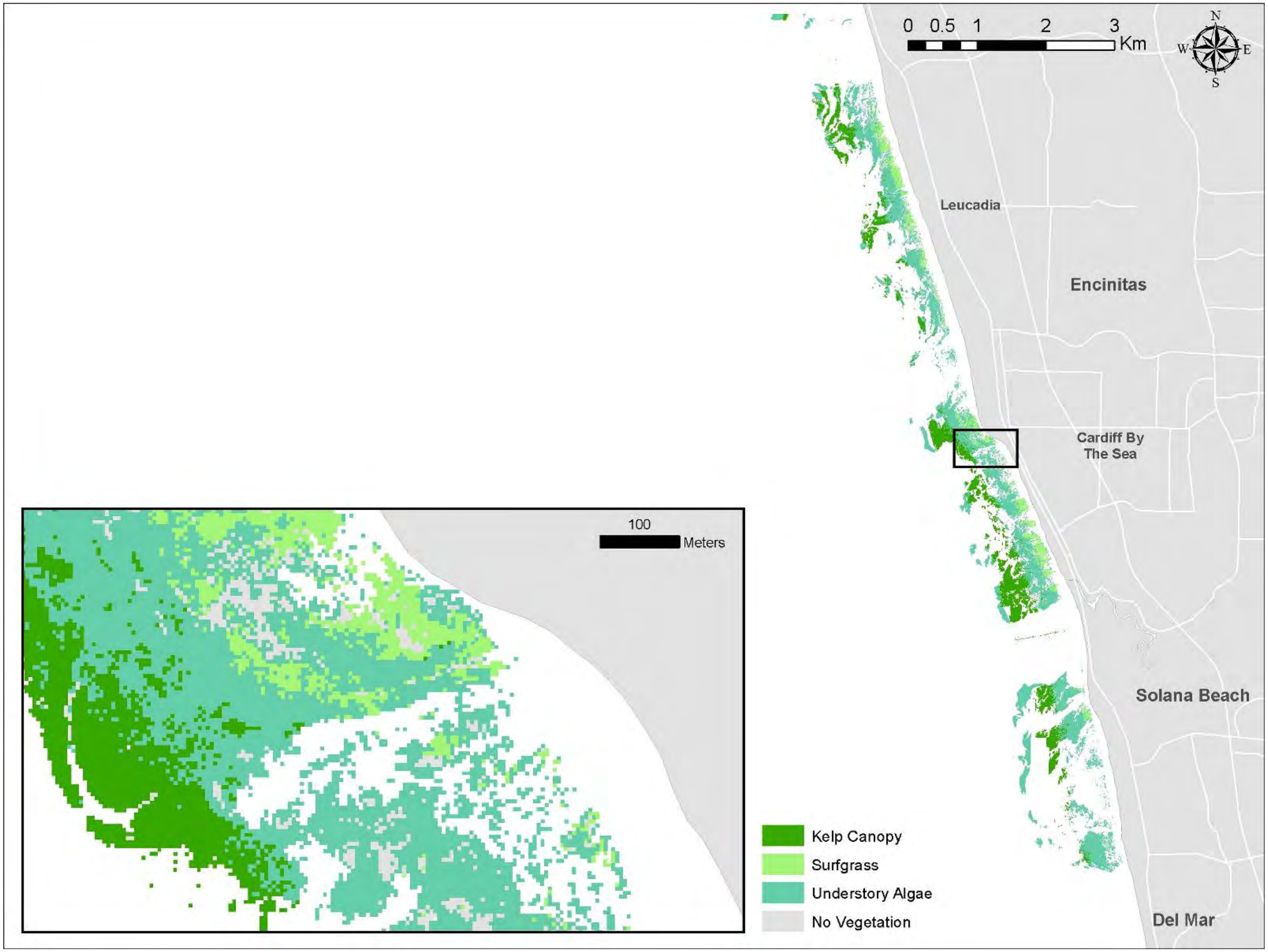

Figure 4.4-5 Vegetation coverage in study area based on 2002 vegetation survey.

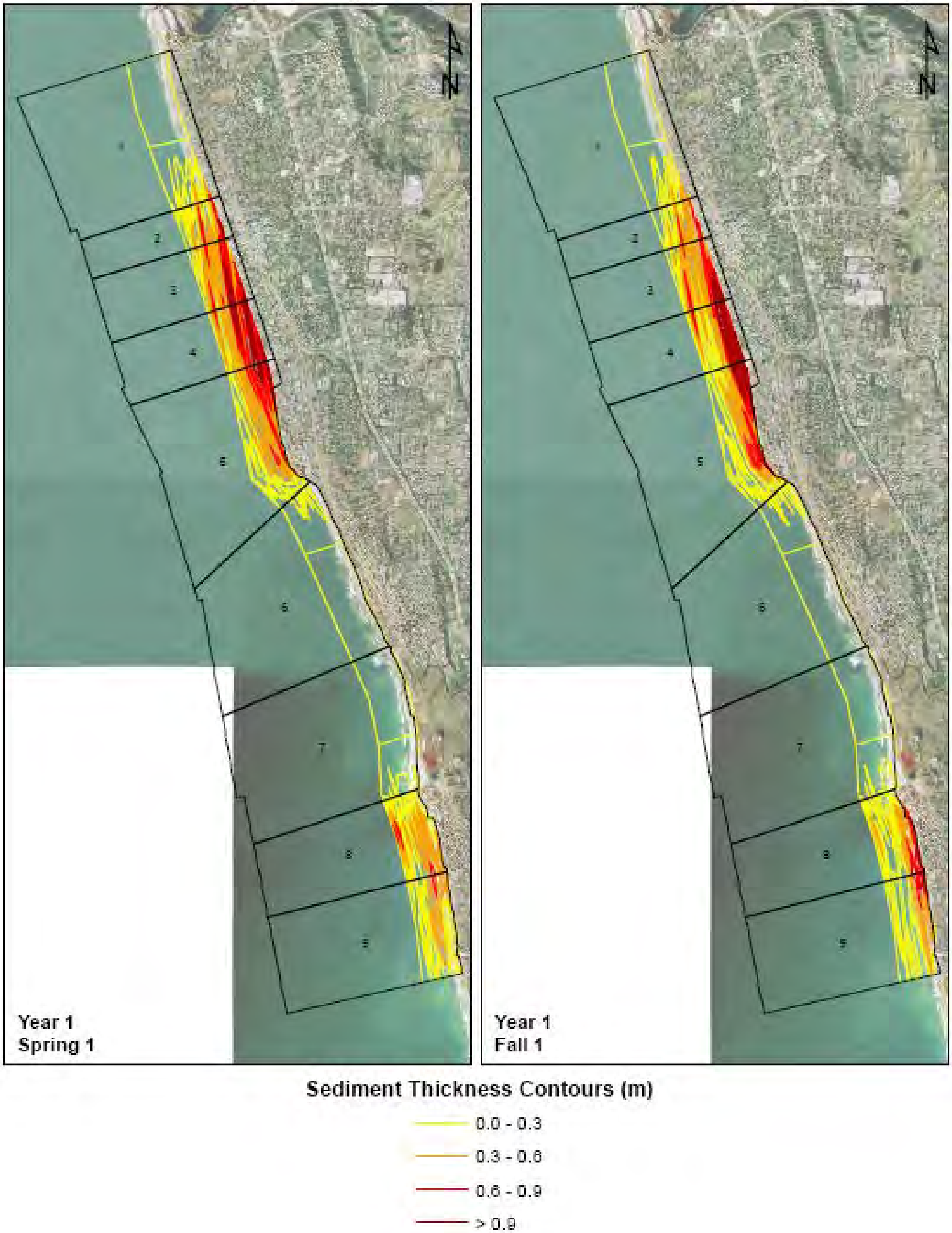

Figure 4.4-6 Example of estimated cross-shore sediment deposition.

Figure 4.4-7 Areas depicting sediment thickness on bedrock with surfgrass based on Fall-Year 1 model results.

Figure 4.4-8 "Natural Variation" sediment thickness based empirical coastal profile data collected from 1996 to 2008.

5 RESULTS

5.1 Estimated Impacts to Nearshore Resources

Estimated impacts by study reach for all beach width options and sea level rise scenarios are provided in **Appendix B of this document**. The impacts do not account for natural variation, which is a key step in assessing potential project-related impacts. **Table 5.1-1** through **Table 5.1-4** incorporate natural variation and summarize the potential impacts to nearshore reefs for all the beach width options and sea level rise scenarios, and **Figure 5.1-1** and **Figure 5.1-2** illustrate examples of year 2, high sea level, spring, modeled sedimentation results for Encinitas (100 ft beach width) and Solana Beach (300 ft beach width), respectively. The detailed methodology for these tables is in Section 4.2 and the data used to calculate the Most Probable Impact (Spring and Fall for Year 2) is in **Appendix B of this Appendix**.

For Encinitas, modeling estimates indicate no project-related impact (i.e., no impacts greater than Natural Variation) to nearshore resources at beach widths up to 100 ft for both low and high sea level rise scenarios (**Table 5.1-1** and **Table 5.1-2**). Impacts to nearshore resources were predicted for beach widths at 150 ft or greater for both low and high sea level rise scenarios (**Table 5.1-1** and **Table 5.1-2**). This included predicted impacts to both reefs supporting surfgrass (ranging from 2.0 acres for the 150 ft beach width at low sea level rise scenario, up to 4.6 acres for the 200 ft beach width at the high sea level rise scenario) and other indicator species (ranging from 9.5 acres for the 150 ft beach width at low sea level rise scenario, up to 23.2 acres for the 200 ft beach width at the high sea level rise scenario).

For Solana Beach, modeling estimates indicate no project-related impact to nearshore resources at beach widths up to 50 ft for both low and high sea level rise scenarios (**Table 5.1-3** and **Table 5.1-4**). Impacts to nearshore resources were predicted for beach widths at 100 ft or greater for both low and high sea level rise scenarios, but only impacts to reefs supporting other indicator species and intertidal reef platform (i.e., Tabletops Reef) were predicted (**Table 5.1-1** and **Table 5.1-2**). No impacts to reefs supporting surfgrass were predicted possibly due to high natural variation and the occurrence of high-relief reefs that support surfgrass which would not be affected by increased sedimentation.

Table 5.1-1 Estimated year 2 impact to surfgrass and other indicator species (0.3 m criteria) incorporating natural variation (in acres) by beach width option for Encinitas for the low sea level rise scenario

Low Sea Level Rise	Most Probable Impact*	Impact Associated with Natural Variation (NV)**	Project-Related Impact***
50 ft Beach Width			
Reefs with Surfgrass	0.4	2.1	(-1.7)
Reefs with Other Indicators	1.0	8.2	(-7.2)
100 ft Beach Width			
Reefs with Surfgrass	1.8	2.1	(-0.3)
Reefs with Other Indicators	6.7	8.2	(-1.5)
150 ft Beach Width			
Reefs with Surfgrass	4.1	2.1	**2.0**
Reefs with Other Indicators	17.7	8.2	**9.5**
200 ft Beach Width			
Reefs with Surfgrass	5.5	2.1	**3.4**
Reefs with Other Indicators	30.7	8.2	**22.5**

Table 5.1-2 Estimated year 2 impact to surfgrass and other indicator species (0.3 m criteria) incorporating natural variation (in acres) by beach width option for Encinitas for the high sea level rise scenario.

High Sea Level Rise	Most Probable Impact*	Impact Associated with Natural Variation (NV)**	Project-Related Impact***
50 ft Beach Width			
Reefs with Surfgrass	0.4	2.1	(-1.7)
Reefs with Other Indicators	1.1	8.2	(-7.1)
100 ft Beach Width			
Reefs with Surfgrass	1.9	2.1	(-0.2)
Reefs with Other Indicators	7.4	8.2	(-0.8)
150 ft Beach Width			
Reefs with Surfgrass	4.2	2.1	**2.1**
Reefs with Other Indicators	18.8	8.2	**10.6**
200 ft Beach Width			
Reefs with Surfgrass	6.7	2.1	**4.6**
Reefs with Other Indicators	31.4	8.2	**23.2**

Notes for Table 5.1-1 and Table 5.1-2:
*Most Probable Impact based on averaged Year 2 results.
**"Natural Variation" was determined using the standard deviation of empirical coastal profile data collected by Coastal Frontiers from 1996 to 2008.
***Project-related impact equals Most Probable Impact minus Natural Variation. Negative number denotes estimated impact less than "Natural Variation".

Table 5.1-3 Estimated year 2 impact to intertidal reef platform, surfgrass, and other indicator species (0.3 m criteria) incorporating natural variation (in acres) by beach width option for Solana Beach for the low sea level rise scenario.

Low Sea Level Rise	Most Probable Impact*	Impact Associated with Natural Variation (NV)**	Project-Related Impact***
50 ft Beach Width			
Intertidal Reef Platform	0.0	0.0	0.0
Reefs with Surfgrass	0.0	0.4	(-0.4)
Reefs with Other Indicators	0.7	4.0	(-3.3)
100 ft Beach Width			
Intertidal Reef Platform	0.1	0.0	**0.1**
Reefs with Surfgrass	0.0	0.4	(-0.4)
Reefs with Other Indicators	5.6	4.1	**1.5**
150 ft Beach Width			
Intertidal Reef Platform	0.3	0.0	**0.3**
Reefs with Surfgrass	0.0	0.4	(-0.4)
Reefs with Other Indicators	10.6	4.1	**6.5**
200 ft Beach Width			
Intertidal Reef Platform	0.4	0.0	**0.4**
Reefs with Surfgrass	0.0	0.4	(-0.4)
Reefs with Other Indicators	12.1	4.1	**8.0**
250 ft Beach Width			
Intertidal Reef Platform	0.4	0.0	**0.4**
Reefs with Surfgrass	0.0	0.4	(-0.4)
Reefs with Other Indicators	14.7	4.1	**10.6**
300 ft Beach Width			
Intertidal Reef Platform	0.4	0.0	**0.4**
Reefs with Surfgrass	0.0	0.4	(-0.4)
Reefs with Other Indicators	16.9	4.1	**12.8**

Table 5.1-4 Estimated year 2 impact to intertidal reef platform, surfgrass, and other indicator species (0.3 m criteria) incorporating natural variation (in acres) by beach width option for Solana Beach for the high sea level rise scenario.

High Sea Level Rise	Most Probable Impact*	Impact Associated with Natural Variation (NV)**	Project-Related Impact***
50 ft Beach Width			
Intertidal Reef Platform	0.0	0.0	0.0
Reefs with Surfgrass	0.0	0.4	(-0.4)
Reefs with Other Indicators	0.9	4.1	(-3.2)
100 ft Beach Width			
Intertidal Reef Platform	0.1	0.0	**0.1**
Reefs with Surfgrass	0.0	0.4	(-0.4)
Reefs with Other Indicators	6.0	4.1	**1.9**
150 ft Beach Width			
Intertidal Reef Platform	0.3	0.0	**0.3**
Reefs with Surfgrass	0.0	0.4	(-0.4)
Reefs with Other Indicators	11.0	4.1	**6.9**
200 ft Beach Width			
Intertidal Reef Platform	0.4	0.0	**0.4**
Reefs with Surfgrass	0.0	0.4	(-0.4)
Reefs with Other Indicators	13.1	4.1	**9.0**
250 ft Beach Width			
Intertidal Reef Platform	0.4	0.0	**0.4**
Reefs with Surfgrass	0.0	0.4	(-0.4)
Reefs with Other Indicators	14.9	4.1	**10.8**
300 ft Beach Width			
Intertidal Reef Platform	0.4	0.0	**0.4**
Reefs with Surfgrass	0.0	0.4	(-0.4)
Reefs with Other Indicators	17.1	4.1	**13.0**

Notes:
*Most Probable Impact based on averaged Year 2 results.
**Natural Variation was determined using the standard deviation of empirical coastal profile data collected by Coastal Frontiers from 1996 to 2008.
***Project-related impact equals Most Probable Impact minus Natural Variation. Negative number denotes estimated impact less than “Natural Variation”.

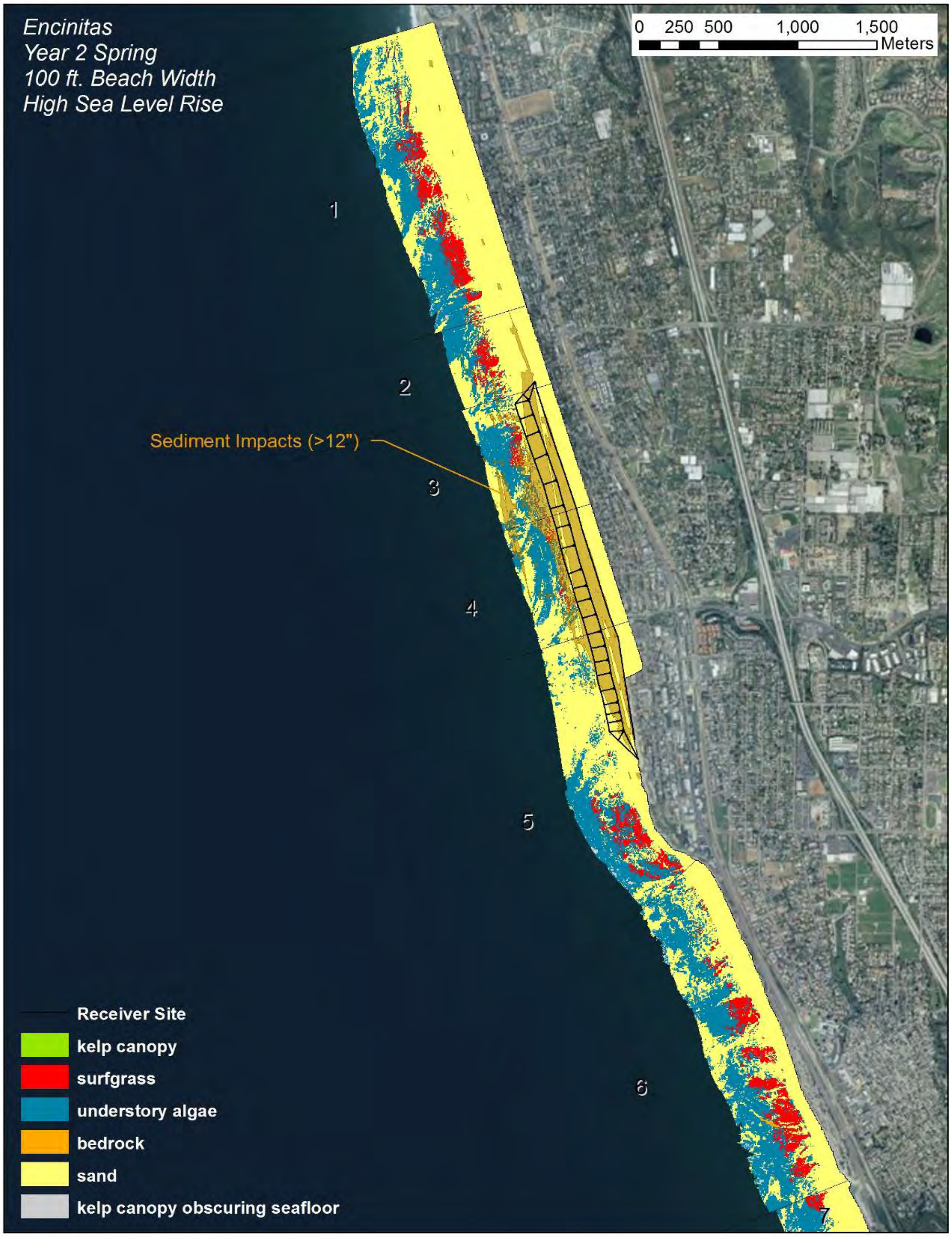

Figure 5.1-1 Example of year 2 (spring) modeled sedimentation results for Encinitas (100 ft beach width and high sea level rise).

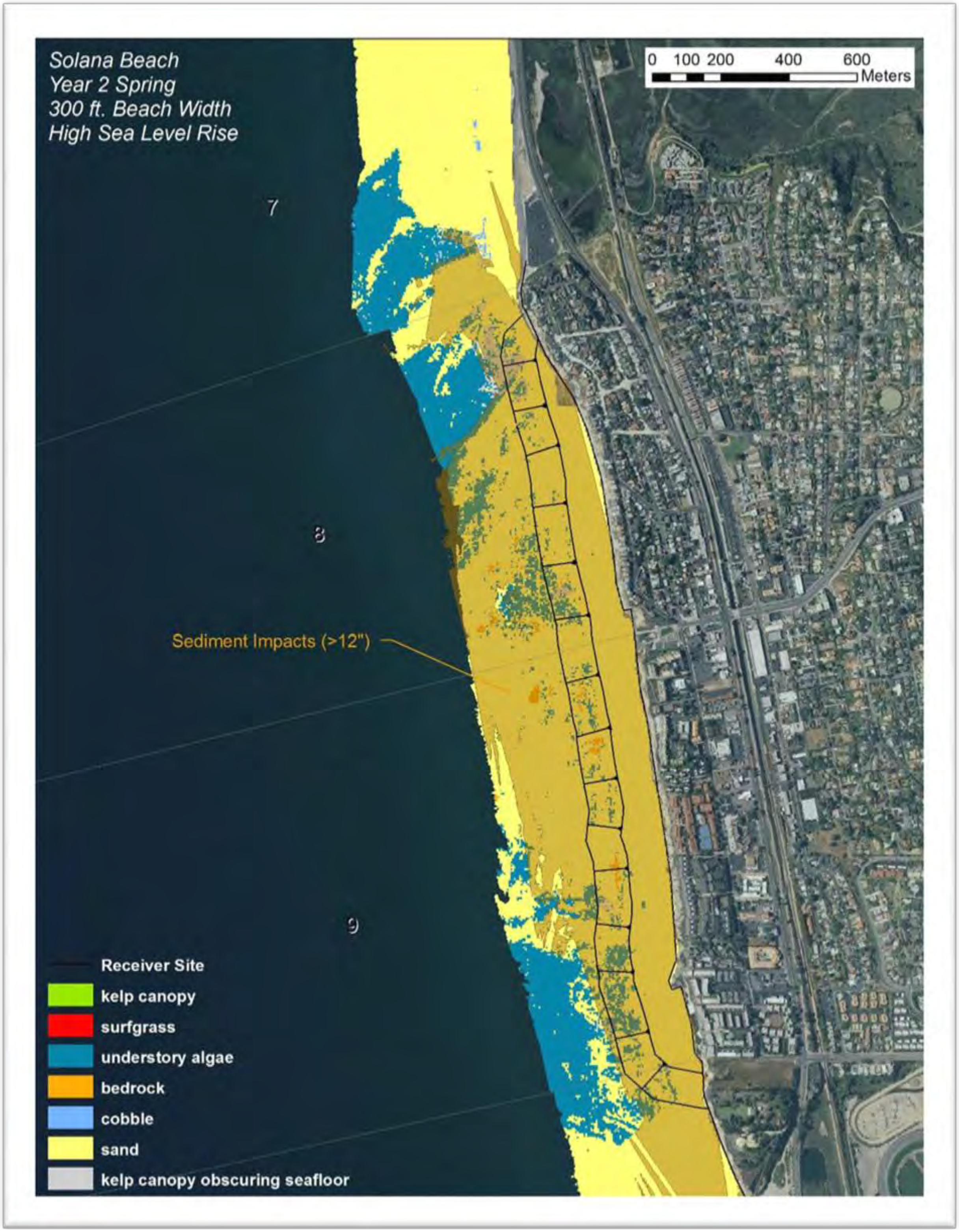

Figure 5.1-2 Example of year 2 (spring) modeled sedimentation results for Solana Beach (300 ft beach width and high sea level rise).

6 MITIGATION AND MONITORING

To assist in the cost-benefit analyses and in the selection of the NED Plan and other potential project alternatives, potential impacts to nearshore reefs and indicator species were assessed based on USACE model predictions for a variety of beach width options and sea level rise scenarios. To accommodate the need to conduct multiple model runs, a GIS-based approach was developed to utilize the existing spatial data available (e.g., LiDAR, multibeam bathymetry, and multi-spectral aerial imagery). To assess specifically potential project-related impacts, natural sediment variation was incorporated into the model based on 12 years of empirical coastal profile data.

The model predicted no project-related impact to nearshore reefs supporting surfgrass or other indicator species at Encinitas for both high and low sea level rise scenarios with beach widths of 100 ft or less; however, impacts to these resources were predicted for beach widths of 150 ft or greater. At Solana Beach, no project-related impacts to nearshore reefs supporting surfgrass were predicted for all beach width options and sea level rise scenarios. However, impacts to nearshore reefs supporting other indicator species (kelps) were predicted for beach widths greater than 50 ft for both low and high sea level rise scenarios. Costs to mitigate potential impacts and conduct monitoring were estimated based on recent similar mitigation projects (i.e., Wheeler North Kelp Reef). These costs were one metric used in the cost-benefit analysis to determine the NED Plan and other potential project alternatives.

Regarding potential impacts associated with renourishment, the need for renourishment was based on the equilibrium beach width that will be implemented (e.g., if a 100 ft beach width is proposed for the initial placement, renourishment volume will be based on maintaining a 100 ft beach width).

Therefore, no additional impacts are anticipated from renourishment, as any impact to nearshore resources would be expected during the initial beach fill. Renourishment events require substantially less sand to maintain beach widths than the initial fill volume. Impacts from those reduced volumes are expected to be less than those from the initial fill. Impacts from the initial fill will be mitigated as needed by the construction reef habitat features. Any impacts associated with renourishment would have been mitigated for following the initial fill. In addition, an adaptive monitoring program is proposed for the project to also account for potential cumulative impacts associated other beach nourishment activities (e.g., opportunistic programs, lagoon maintenance).

Due to inherent uncertainties associated with estimating impacts based on model predictions, a monitoring program would be implemented to assess actual impacts during the two years following construction. Delaying the identification of mitigation requirements for two years allows sand to migrate and to reach steady state conditions. Waiting for two years allows time for temporary impacts to end thus preventing the project from mitigating for short-term impacts that do not warrant mitigation. Reef features are naturally exposed to periodic burial, so that short-term burial resulting from the project is not a loss. Monitoring of the near shore resources will begin prior to construction to establish baseline conditions and resume immediately following construction. Mitigation would be triggered only if certain conditions occur during, and persist through, the two year post-construction monitoring period. Temporal loss for impacted resources due to the two-year waiting period are considered when establishing the mitigation functional equivalent described in **Appendix M**. The impact assessment methodology discussed in this appendix, the mitigation functional equivalent discussed in **Appendix M**, and the two-year waiting period to measure long-term impacts were established in conjunction with federal and state resource agencies, including the NMFS, CDFW, Coastal Commission, and USFWS. If mitigation is implemented, mitigation monitoring would also be conducted. This section provides information regarding mitigation and monitoring for nearshore biological resources regardless of which project alternative is selected, and includes:

1. A pre- and post-construction monitoring program for rocky reef/surfgrass habitat in the project area[1] to determine if project mitigation would be necessary;

2. A mitigation plan, if mitigation is determined to be necessary; and

3. A mitigation monitoring plan, if mitigation is determined to be necessary.

The mitigation and monitoring plans will be refined during the pre-construction engineering design (PED) phase of the project in consultation with knowledgeable, experienced, and qualified marine ecologists. The monitoring will be performed by knowledgeable, experienced, and qualified marine biologists. **Table 6.1-1** shows a summary of the project monitoring and potential mitigation by phase of construction. The total estimated cost of the monitoring and mitigation plans is $22,652,000 (FY2015 price level). These knowledgeable, experienced, and qualified marine ecologists may come from a variety of agencies, organizations, institutions, or community centers of practice and expertise, such as – the University of California, USACE Engineer Research and Development Center (ERDC), NOAA National Marine Fisheries Service (NMFS) Southwest Fisheries Sciences Center, U.S. Geological Survey (USGS) Western Ecological Research Center, other Federal and state agencies, as well as, consulting marine ecologists. California Department of Fish and Wildlife (CDFW), U.S. Fish and Wildlife Service (USFWS), and NMFS staff will also be involved with the review process.

[1] For purposes of this monitoring program, the project area is defined to include the areas offshore of each of the two beach fill segments plus the offshore area between the two segments.

Table 6.1-1 Summary of Project Monitoring and Potential Mitigation

	Purpose	Pre-Initial-Event Construction	Initial Event Construction	Post-Initial-Event Construction	Renourishment Event?	Costs (FY15) Initial/ Renourishment
Water Quality Monitoring Plan	Monitoring at receiver and borrow sites for salinity, pH, temperature, dissolved oxygen, and light transmissivity (turbidity).	One week prior.	Weekly.	One week post.	Same as construction.	Included with Construction Costs
Habitat Monitoring Plan	Map extent of reef habitat and submerged aquatic vegetation. Used to determine if there are project impacts and will include control sites.	1 year pre-construction (spring and fall).		Repeat pre-construction surveys at years 1 and 2 post-construction (spring and fall).	None for renourishment events	$424,000
Biological Mitigation and Monitoring Plan	Monitoring for success of mitigation project, if needed.			1, 3, 6 and 12 months post-construction of mitigation reef; spring and fall for years 2-5 post-construction		$2,887,000 Includes mitigation costs
Cultural Resources Plan Monitoring	Avoid impacts to previously undiscovered cultural resources.	Survey conducted of borrow site(s); survey of mitigation site, if necessary.	Periodic spot-checking of dredged materials from low- and moderate-sensitivity contexts and continuous monitoring from high-sensitivity contexts.		Same as construction	$42,000 (initial)
California Grunion Monitoring and Avoidance Plan	Avoid/minimize impacts to spawning grunion	Receiver sites and access/staging areas surveyed for suitable habitat	Seasonal monitoring may be required if suitable habitat is identified in project area.		Same as construction.	Included with Construction Costs

	Purpose	Pre-Initial-Event Construction	Initial Event Construction	Post-Initial-Event Construction	Renourishment Event?	Costs (FY15) Initial/ Renourishment
Shoreline Monitoring Plan	Determine changes in beach and seabed morphology. Trigger renourishment events.	Profile data from back beach to wading depth; 1 yr prior to construction in the spring and fall		Annually for 2 years post construction in the spring and fall	Annually throughout the life of the project.	$594,000 (initial) $5,634,000 (total for all renourishment events)
Lagoon Monitoring	Monitoring will indicate if the beach fills result in increases in dredge quantities and/or inlet closure rates.			Annually for 2 years post construction in the spring and fall	Same as construction	Costs are included with the Shoreline Monitoring Plan
Lagoon Sedimentation Mitigation	Dredging for additional lagoon sedimentation will be conducted should the project result in closure or restrictions to lagoon entrances.		Potential for increased sedimentation during initial construction		Potential for increased sedimentation during renourishment events	$1,458,000 (initial) $6,770,000 (total for all renourishment events)
Noise Monitoring Plan	Verify noise levels remain below significant levels.		Performed during all beach construction activities.		Performed during all beach construction activities.	Included with Construction Costs
Surfing Monitoring Plan	Monitor surfing conditions to confirm if impacts occur.	Monitor one year prior to construction.		Repeat pre-construction surveys at years 1 and 2 post-construction.	Same as construction	$140,000 (initial) $1,082,000 (total for all renourishment events)
Snowy plovers	Screen, for presence, monitor effectiveness of avoidance measures, if present.	Propose avoidance measures if Seaside parking lot is used for staging	Monitor avoidance measures if Seaside parking lot is used for staging		Survey all beach fill and access and staging areas for presence. Avoid/monitor if present	Included with Construction Costs

	Purpose	Pre-Initial-Event Construction	Initial Event Construction	Post-Initial-Event Construction	Renourishment Event?	Costs (FY15) Initial/ Renourishment
Stormwater Pollution Prevention Plan (SWPPP)	Control runoff of construction-related contaminants into the sea.	Construction contractor prepares SWPPP.	Construction contractor implements SWPPP.	Construction contractor reports on SWPPP.	Same as construction.	Included with Construction Costs
Oil Spill Prevention and Response Plan (OSPRP)	Details spill prevention measures and cleanup plans.	Construction contractor prepares OSPRP.	Construction contractor implements OSPRP.	Construction contractor reports on OSPRP.	Same as construction.	Included with Construction Costs
Borrow Site Monitoring Plan	Monitor seafloor morphology, water quality, and benthic habitat quality.	1 year pre-construction (spring and fall).		Repeat pre-construction surveys at years 1 and 2 post-construction (spring and fall).	Same as construction.	$299,000 $3,322,000 (renourishment events)
Safety Plan	Detail safety procedures, including OSHA and safety for recreational beach users.	Construction contractor prepares Safety Plan.	Construction contractor implements Safety Plan.	Construction contractor reports on Safety Plan.	Same as construction.	Included with Construction Costs

	Purpose	Pre-Initial-Event Construction	Initial Event Construction	Post-Initial-Event Construction	Renourishment Event?	Costs (FY15) Initial/ Renourishment
Staging Plan	Details on location of staging areas, precautions for maintenance and fueling of construction equipment, precautions for storing equipment on the beach, minimizing space requirements, safety precautions for equipment operations and fueling to avoid public beaches and public beach parking lots to the maximum extent feasible, utilize minimal number of public parking spaces when not avoidable.	Construction contractor prepares Staging Plan.	Construction contractor implements Staging Plan.	Construction contractor reports on Staging Plan.	Same as construction.	Included with Construction Costs

6.1 Monitoring Plans

6.1.1 Habitat Monitoring Plan

The project has been designed to avoid or minimize impacts to sensitive biological resources to the maximum extent practicable. This was done by selecting fill alternatives that limit fill volume while achieving project objectives. Encinitas, for example, was able to select a beach width that avoids losses of rocky and surf grass habitats while still achieving shoreline protection objectives. Solana Beach selected an alternative that resulted in no impacts to surf grass resources while impacting minimal reef resources. Fill footprints for both cities avoid any direct impacts to sensitive resources; all estimated impacts are the result of indirect burial. However, for several alternatives, potential project impacts have been identified using a conservative coastal engineering model. Prior to the implementation of construction of the project, the extent of reef habitat and vegetation throughout and adjacent to the entire predicted equilibrium footprint will be mapped using remote sensing techniques such as multi-spectral aerial photography and/or interferometric side scan sonar. Multi-spectral aerial photography utilizes an airplane to capture multispectral reflectance characteristics that allow the identification and separation of various bottom substrates and vegetation, while interferometric side scan sonar is a type of technology used to interpret seabed features, material, and textures from acoustic backscatter response intensity, as well as, bathymetry. When the techniques are combined, data sets include bathymetry, bottom substrate type, and vegetation type information. Results from similar methodologies were used for this study to provide the baseline data (i.e., SANDAG 2002), and the proposed mapping provides the most cost-effective approach for surveying the large study area. This pre-construction monitoring is to establish baseline conditions to compare post-construction conditions against. All data would be geo-rectified, and habitat types digitized as a theme over an aerial image to calculate the coverage of various habitat types and show its distribution. Diver surveys would also be conducted to ground truth or verify remote sensing data. The diver surveys would be at a level appropriate to effectively ensure that data were representative (e.g., 20 random locations for each substrate or habitat type). The proposed mapping would be repeated during years one and two post-construction to determine what long-term impacts result from the project that require mitigation. Based on the data collected, a decision will be made as to whether, and to what extent, mitigation is necessary.

Pre- and post-construction monitoring of the nearshore environment will be conducted to allow for identification of project-related impacts for purposes of delineating mitigation requirements. Given the high degree of sediment transport that occurs in the nearshore zone, sampling at control sites would provide some level of natural variability. By sampling control sites, any change in the sediment cover could be put into a regional/local perspective, and natural variation taken into account. If this was not measured, any increase in sediment cover in the project area would have to be considered project related. This is especially helpful if there is a reduction in surf grass at the project site that may be the result of a natural decline (measured at the reference area) and not a project impact.

Any detectable loss, or burial at year 2 beyond natural variation as established at reference stations, of nearshore rocky reef or surf grass habitat based on Year 2 monitoring results would require mitigation.

The general approach for assessing impacts would be similar to that used to identify potential project-related impacts to eelgrass as per the Southern California Eelgrass Mitigation Policy (SCEMP; NMFS 2005). The project area and control site(s) will be surveyed prior to construction, and annually for two years following construction. Only rocky reef habitat and surf grass will be considered as potential losses requiring mitigation. Each monitoring report will be evaluated to determine areas of habitat burial, date of initial burial, duration of burial, and gain or reduction in habitat compared to the comparable pre-construction survey (e.g. spring post-construction results will be compared to spring pre-construction results and fall to fall). Habitats identified as undergoing long-term burial (identified as being buried for one year or longer) that are still buried at the time of the later Year 2 survey (timing of which survey is conducted later, spring or fall, will depend on when the initial fill is completed relative to the monitoring effort) will be identified as a long-term loss for the project area and control site(s). If the long-term loss for the control site(s) is equal to or greater than the project area, no mitigation would be required. If the long-term loss for the control site(s) is less than the project area, than a proportional area lost at the control sites would be deducted from the project area, the remainder would be identified as the mitigation requirement. For example, if 25% of the control site(s) is lost and 40% of the project area is lost, then 15% of the project area loss will be considered project impacts thus requiring mitigation. Project area losses will be determined separately for the Encinitas and Solana Beach segments.

Seasonal monitoring may be required for grunion (if suitable habitat is identified in any of the sand placement areas). The season for grunion is identified as March 15 to September 1. A cultural resource survey of the mitigation sites would be needed prior to mitigation construction. A cultural resource survey of the borrow site would also be performed prior to construction. Water quality monitoring will be performed during construction on a weekly basis. Pre- and post-construction monitoring of the nearshore environmental will be conducted to allow for identification of project-related impacts for purposes of delineating mitigation requirements.

Given the relatively high natural variation of sediment transport that occurs in the nearshore zone, multiple control sites were mapped to provide a level of natural variability. Potential control areas, chosen for their similarity to potential impact sites, in the general project area include North Carlsbad (in the vicinity of Tamarack Boulevard) and South Carlsbad (north of Palomar Airport Road). By sampling control sites, changes in the sediment cover would be put into a regional perspective and natural variation taken into account. If this was not measured, any increase in sediment cover in the project area would be considered project related. This is similar to the eelgrass mapping/impact assessments, whereby changes at the project site are compared with reference areas. This is necessary if there is a reduction in eelgrass at the project site that may be the result of a natural decline measured relative to the reference area. Pre-construction (baseline) areal coverage will be compared to Year 2 (post-construction) areal coverage, taking into account any natural variation at control areas to identify potential project-related impacts.

The City of Encinitas and the City of Solana Beach have been performing annual fall and spring beach profile surveys to monitor shoreline changes. The survey included transects historically monitored by the Cities. Data would be obtained from the back beach seaward, offshore of the presumed depth of closure. Beach profile data would be acquired to wading depth along transects located within or adjacent to the nourishment site.

The expected monitoring schedule includes:

Pre-construction baseline monitoring (year prior to construction):

- Spring Survey
- Fall Survey

Post-construction (annually for two years following construction):

- Spring Survey
- Fall Survey

Two years of annual post-construction monitoring were determined to be sufficient to determine long-term burial impacts resulting from the project. Monitoring at year two will be used, as described above, to determine the areal extent of long-term burial of rocky reef and/or surf grass habitats. Post-construction monitoring one year after construction is also proposed to allow USACE to determine which habitats buried at year 2 were long-term burial, as opposed to short-term. Long-term burial at year 2 requires mitigation. It would not be possible to determine which burial is long-term at year 2 without monitoring during year 1. Additionally, there can be large natural annual fluxuations of the areal extent of rocky reef and surf grass habitats. Conducting annual post-construction habitat surveys are needed to capture a time series to best define long-term impacts to habitat within the project sites.

6.1.2 Borrow Site Monitoring

Pre-and post-construction monitoring of the borrow sites was added as a condition of the Coastal Consistency Determination concurrence by the California Coastal Commission. Monitoring includes bathymetric surveys of the borrow site, water quality sampling of the overlying sediment, and determination of benthic habitat quality. Bathymetric surveys will be used to monitor changes to the bathymetry resulting from borrow site dredging. Water quality sampling will monitor to see if borrow site dredging creates dead spots with reduced water quality due to dredging creating a low spot with reduced circulation. Water sampling will be performed by an instrumentation packager to measure dissolved oxygen, water temperature, pH, and salinity through the water column at random points over the borrow site. Benthic habitat quality will be determined by taking random samples of bottom sediment, sieving for and identifying benthic organisms, and analyzing using statistical tools to determine a habitat quality index. The purpose of the borrow site monitoring is to monitor physical and biological impacts to, and recovery of, the borrow sites resulting from dredging.

If monitoring shows that the borrow site dredging results in the creation of dead spots with reduced circulation, as shown by reduced dissolved oxygen levels in bottom waters, future dredging will be conducted to shallower dredge cuts resulting in a larger area of impact, but avoiding the creation of deep water in the borrow sites adjacent to shallower waters. If monitoring shows that benthic habitat recovery is slower than expected, future dredging would be moved to other areas within the borrow site to allow full recovery of impacted areas and dredging would be reduced in area by dredging deeper, smaller areas within the borrow site. If both impacts occur, moving into an unused portion of the borrow site(s) or one of the other borrow sites identified for this project should be considered using shallower cuts. Specific measures would be established following consultation with federal and state resource agencies.

If monitoring shows no reduced water quality and if benthic habitat recovers as expected following the initial placement, coordination will be conducted with federal and state resource agencies, the California Coastal Commission in particular, with an eye to reducing or eliminating borrow site monitoring for future renourishment events.

6.1.3 Shoreline Monitoring

The beach monitoring plan will include semi-annual beach profile surveys along 19 shore perpendicular transects and oblique photos at each of the receiver sites. The beach profile data will be obtained in the Spring and Fall, corresponding to the transitions between the winter and summer wave seasons, commencing prior to construction and continuing until two years post construction. The oblique aerial photos will be obtained semi-annually in the Spring and Fall during the first two years post construction. The transect locations will begin at SD-710 in the north and end at DM-0560 in Del Mar at the southern end.

Post construction monitoring will include data collection of the lagoon entrances to evaluate potential impacts. Lagoon entrance monitoring will be confined to those lagoon entrances immediately adjacent and/or within the project limits: Batiquitos Lagoon, San Elijo Lagoon, San Dieguito Lagoon and Los Penasquitos. Monitoring methods will consist of oblique aerial photography, physical inspections, and an assessment of lagoon closure and maintenance dredging records. Each lagoon is currently operated/maintained by separate jurisdictional authorities (e.g. San Elijo Lagoon Conservancy) and they maintain records for inlet maintenance dredging volumetric requirements and open/closure data. The data collection program will be compared against existing available monitoring records. Monitoring will indicate if the beach fills result in increases in dredge quantities and/or inlet closure rates. Based on USACE assessment, should the monitoring results indicate significant closure/restrictions to lagoon entrances and significant increases in dredging requirements, mitigation measures (dredging) to offset lagoon sedimentation may be implemented.

6.1.4 Surfing Monitoring

Surfing and high quality surfable waves are an increasingly valuable resource. Working with local stakeholders and the California Coastal Commission, which included a Surfing Monitoring requirement as a condition of their concurrence with our consistency determination, an innovative method pioneered by the Los Angeles District has been developed to quantify surf quality (surfability). Surfing impacts shall be based on a quantifiable downward change in the measured surfability index that can be clearly and directly attributed to the beach fill. The downward change in surfability index shall be measurable and sustained across input oceanographic conditions (height, period, direction, tide), and also sustained across a reasonably long time period to rule out transitory impacts from other external factors. The actual amount of downward change in surfability index necessary to trigger an adaptive management measure shall be carefully determined by the USACE on a case-by-case basis. If impacts to surfing occur, adaptive management measures could be employed in the next nourishment to minimize the impacts. These measures may consist of construction template adjustments such as: adjustment of the longshore fill distribution which can minimize (and sometimes enhance) surfing effects; adjustment of the foreshore slope which can eliminate wave reflections which are often dangerous to swimmers; and adjust the fill technique to profile nourishment which creates a more immediate natural profile in lieu of on-the-beach nourishment. Monitoring will occur throughout the initial construction as well as renourishment events. Continuous life cycle monitoring of a beach fill is necessary to accurately characterize the surfability as it changes through time. It is anticipated that as a beach fill erodes, surfability will change in response to the changing beach fill condition. Continuous monitoring will accurately characterize this changing surfability throughout the life cycle. Long-term background oceanographic conditions, such as storm intensity, longshore and cross shore sediment transport dynamics, and sea level rise, are expected to change over the project life cycle in response to long-term climatic changes. Continuous long-term monitoring between fills will ensure that long-term cumulative impacts to surfability can be quantitatively evaluated. If/when the monitoring indicates that there is no change to the surfability index over the second or subsequent fill life cycles, USACE shall begin coordination with the applicable Resource agencies to discontinue the monitoring requirement. The Surfing Monitoring Plan will include the following features:

a. A trained observer visually estimates the breaking wave climate at the shoreline twice daily, typically at first light and at 1300 (times are approximate). Oceanographic characteristics including the surf quality (surfability), wave height, wave period, wave direction, tide, and sea surface condition are simultaneously recorded for cross-comparisons. Visual observations are supplemented with video recordings.
b. Quantitative analysis of the measured data will focus on single and multi-parameter histograms of surfability versus the various oceanographic characteristics.
c. In order to capture seasonal variability inherent in surf quality characteristics, data collection will include one full year of pre-construction monitoring and one full year of post-construction monitoring.
d. Supplemental measured parameters include a usage scale, or number of surfers in the water. This measurement has been shown to be a valuable resource in evaluating project impacts.
e. Local interest surfing groups shall be closely involved in Identification of locations to be monitored and identifying surf quality within the project region. Local interest groups, having detailed familiarity with the project area, are best able to identify target surf locations which would assist in developing the most meaningful and representative monitoring program. Local interest group experience and expertise will aid in identifying if surf quality changes are occurring on a larger, regional scale which may potentially influence the targeted surf quality monitoring program. A separate location within the region may also be chosen to act as a control site to help determine if there are changes within the region to surfing conditions that could be attributable to factors other than project implementation.
f. Establishing mechanisms for informing the local community about the project, and encouraging public comments on surfing quality (or other recreational concerns), including but not limited to: (i) a web site, (ii) pre-construction notifications to the public; and (iii) signs.

6.2 Mitigation

If mitigation for rocky reef and/or surfgrass were required based on results of the second annual post-construction monitoring, rocky reef and surfgrass mitigation shall each be conducted at an equivalent functional value to the impacted area. Because it will take at least two years to identify impacts, some temporal loss of habitat, if impacts were to occur, is unavoidable. Delaying the identification of mitigation requirements for two years allows sand to migrate and to reach steady state conditions. Waiting for two years allows time for temporary impacts to end thus preventing the project from mitigating for short-term impacts that do not warrant mitigation. Recovery of impacted habitats may also occur as sand is redistributed within the littoral cell; some observed burial of reef or surfgrass habitat would be temporary because sand would be expected to move out of the project area. Additionally, if impacts are substantially different than predicted were to occur, future beach fills would be modified as part of the adaptive management plan for this project. The decision point for determination of mitigation is after the second annual post-construction monitoring. Any loss of nearshore habitat relative to the reference sites would require mitigation. Temporal loss of habitat are mitigated by using a mitigation functional equivalent that includes this temporal loss as one of the factors used in the calculation (see **Appendix M**). A functional equivalent of 2:1 is proposed for rocky reef resources. As discussed above, impacts to nearshore resources shall be fully mitigated through compensatory mitigation subsequent to the intiial construction event, and no additional mitigation for subsequent events is required.

Mitigation would be implemented in the project area at sites to be determined by the USACE and the two cities in consultation with the various resource and regulatory agencies noted previously (NMFS, USFWS, Coastal Commission, CDFW). Since potential impacts were identified for Solana Beach for the project alternatives carried forward, potential mitigation areas offshore of Solana Beach were identified (approximately 26 acres) and includes areas that consist primarily of sandy bottom habitat (**Figure 6.2-1**). No estimated project-related impacts were predicted for Encinitas under the alternatives that were carried forward, and therefore no potential mitigation areas were identified offshore of Encinitas. However, it should be noted that if mitigation is required for impacts that occur at Encinitas, there are options including the nearshore resources and the Swami's State Marine Conservation Area.

Reef habitat mitigation shall consist of shallow-water, mid-water, or deep-water reef at a functional equivalent dependent on the nature of the mitigation reef to be constructed. Shallow-water reef would be the type of mitigation reef constructed for any surfgrass mitigation, mid-water mitigation reef would be located inshore of the existing kelp beds, and deep-water mitigation reef would be located offshore of the existing kelp beds. The mid-water reef would be the first priority chosen for use for mitigation as it is most like the reef being impacted and is thus closer to an in-kind mitigation. However, deep-water reef mitigation may be required if insufficient area in the mid-water depth is available for all required mitigation.

Mid-water reef would be constructed on the offshore/outer edge of the existing reef; mid-water reef would be constructed at approximately -30 ft Mean Lower Low Water (MLLW); and deep water reef would be constructed at approximately -40 ft MLLW along the outside edge of the existing reefs. Shallow-water reef shall be constructed with a final top elevation of -10 to -14 ft MLLW. Construction of a reef that is shallower than -10 to -14 ft MLLW is not proposed because construction methods would not be practical (e.g., a barge with the reef construction materials would not be able to operate in this shallow of water). Although the surfgrass mitigation reef would be deeper than the impacted area, if surfgrass transplants are successful, the slightly deeper reef would replace the lost surfgrass resource. If surf grass transplants are not successful, the shallow-water reefs will be vegetated with kelp to serve as out of kind mitigation for surf grass losses, if any. No surf grass losses are predicted for either city.

Mid-water reef is the preferred reef mitigation as it is closest to in-kind replacement in terms of water depth and expected habitat. Mid-water reef also has some sand-retention value for adjacent beaches, similar to natural reefs. Mid- and deep-water reef shall be constructed in a fashion similar to the SCE Wheeler North Reef, which was constructed as mitigation for the impacts of the San Onofre Nuclear Generating Station. For example, if the monitoring shows 1 acre of reef impact and 1 acre of surfgrass impact, 2.5 acres of shallow-water reef would be constructed and 2 acres of mid- or 1.5 acres of deep-water reef would be constructed.

Although several studies currently are being conducted to determine how to successfully transplant surfgrass, and may show success, success rates to date have not been consistent (Reed and Holbrook 2003, Reed et al. 1999). Due to the absence of an established, successful method for mitigation of surfgrass loss, proposed mitigation currently is focused upon restoration of the rocky reef that surfgrass currently uses as habitat and an experimental transplant that allows for one attempt to transplant surf grass followed by out of kind kelp transplant, which does have a history of success. However, if it is determined that surfgrass has been affected by the project, and not due to natural variation, an experimental surfgrass transplant shall be implemented in addition to the construction of a shallow-water rocky reef.

Currently, surfgrass transplant success is much higher for subtidal than for intertidal conditions and, therefore, surfgrass mitigation efforts for this project will focus on subtidal transplants only. The methodology for the surfgrass transplant shall be the transplant of sprigs from a donor bed to the new reef using the method developed by Bull et al. (2004). To harvest sprigs, an unbranched terminal end of an actively growing rhizome is carefully removed from the perimeter of a bed with a knife. The rhizome of each sprig should contain several lateral shoots and a terminal shoot. Sprigs are then transplanted by attaching the cut end of the rhizome to the reef using marine epoxy. An alternative transplant method could be proposed, if evidence can be presented that the alternative method has as great or greater chance of success as the sprig transplant method. To avoid harvesting effects to the subject surfgrass bed, donor material will be taken from a larger area of surfgrass in the vicinity of the study area.

A portion of the shallow-water reef shall be test planted with surfgrass. The transplant will be conducted in the late summer/early fall, the time of year when most surfgrass seeds are released and germinate in southern California. A test area equal to approximately 25 percent of the surfgrass impact area (not to exceed 0.1 acre) will be test planted. Success of the transplant shall be determined after six months based on survivorship, percentage change in the number of leaves and the amount of areal coverage. The experimental transplant will be considered successful if the sprigs survive and there is a net increase in number of leaves and areal coverage. If the transplants survive, surfgrass grows. If the test transplant is successful, the remainder of the surfgrass impact area will be planted on the shallow-water reef with surfgrass. If the surfgrass transplant is not successful, an equal acreage of shallow-water kelp (e.g., *Egregia menziesii* and *Eisenia arborea*) will be transplanted on the shallow-water reef built during the project mitigation.

6.2.1 Surf grass Mitigation Monitoring Plan

This section describes monitoring requirements if surf grass impacts require mitigation and mitigation is performed by transplanting surf grass onto a shallow water reef. Surf grass mitigation will be monitored for five years after the mitigation is completed or until success criteria are met. This would be a part of the post-construction monitoring program to be performed for the project. Permanent transects shall be established on the mitigation reef containing the surf grass bed (if the experimental surf grass transplant is successful) and at a reference site (control area) of similar depth. The same number of transects would be established in the control area as in the mitigation area, and transects will be at similar depths. Transects should be monitored at the following intervals, if successful:

Post-mitigation implementation*:
Year One

- within one month after completion
- 3 months after completion
- 6 months after completion
- 1 year after completion

Years Two through Five

- Spring survey
- Fall survey

*This time line follows full mitigation, which occurs only if the experimental transplant is successful. This is not after the experimental transplant, which is only monitored once, six months after transplant.

Success Criteria

The mitigation functional equivalent established in Appendix M results in the creation of mitigation surf grass reefs that are functionally equivalent to the surf grass reef habitats permanently lost. This includes temporal loss of habitat value during the two-year monitoring period and design and construction time for the mitigation features. Success criteria would include determining if measured parameters are significantly different than the control transects. Success criteria for the mitigation reef itself would include no complete permanent burial of the reef. On each surf grass transect, the following parameters will be monitored at a minimum: areal coverage of surf grass; additional parameters including 1) surf grass density (i.e., number of shoots per square meter), 2) percent cover of surf grass, sand, and rock, and 3) sand depth. In addition, 4) identification and quantity of flora and fauna, should be able to be recorded by the monitor during transect monitoring at no additional cost and as a qualitative measure of reef health. The line intercept method is recommended for measuring percent cover and sand depth. With this method, a tape measure is deployed and at pre-determined or random numbers, data are collected. Monitoring will determine the extent of reef habitat by mapping using remote sensing techniques such as multi-spectral aerial photography and/or interferometric side scan sonar. Monitoring will be used to determine if mitigation reef becomes buried and thus lost. Modifications to general Specific success criteria below may be refined during the PED phase. General success criteria will consist of the following:

1. Approximately 50% - 60% of surfgrass survival at the mitigation site two years post-mitigation implementation.
2. Approximately 90% of the constructed reef remains unburied at the mitigation site two years post-mitigation.

Success criteria for surf grass transplants is based solely on survival of the transplants. Past surf grass transplant efforts were initially successful and then grew or failed. There were no incidents where surf grass grew initially then failed. If plants are still growing at year 2, then the transplant will be considered a success.

An estimated cost to implement the mitigation and mitigation monitoring is provided in Table 6.2-1 through Table 6.2-4 and is dependent on the estimated level of impact. Key assumptions are also provided Section 4.4.

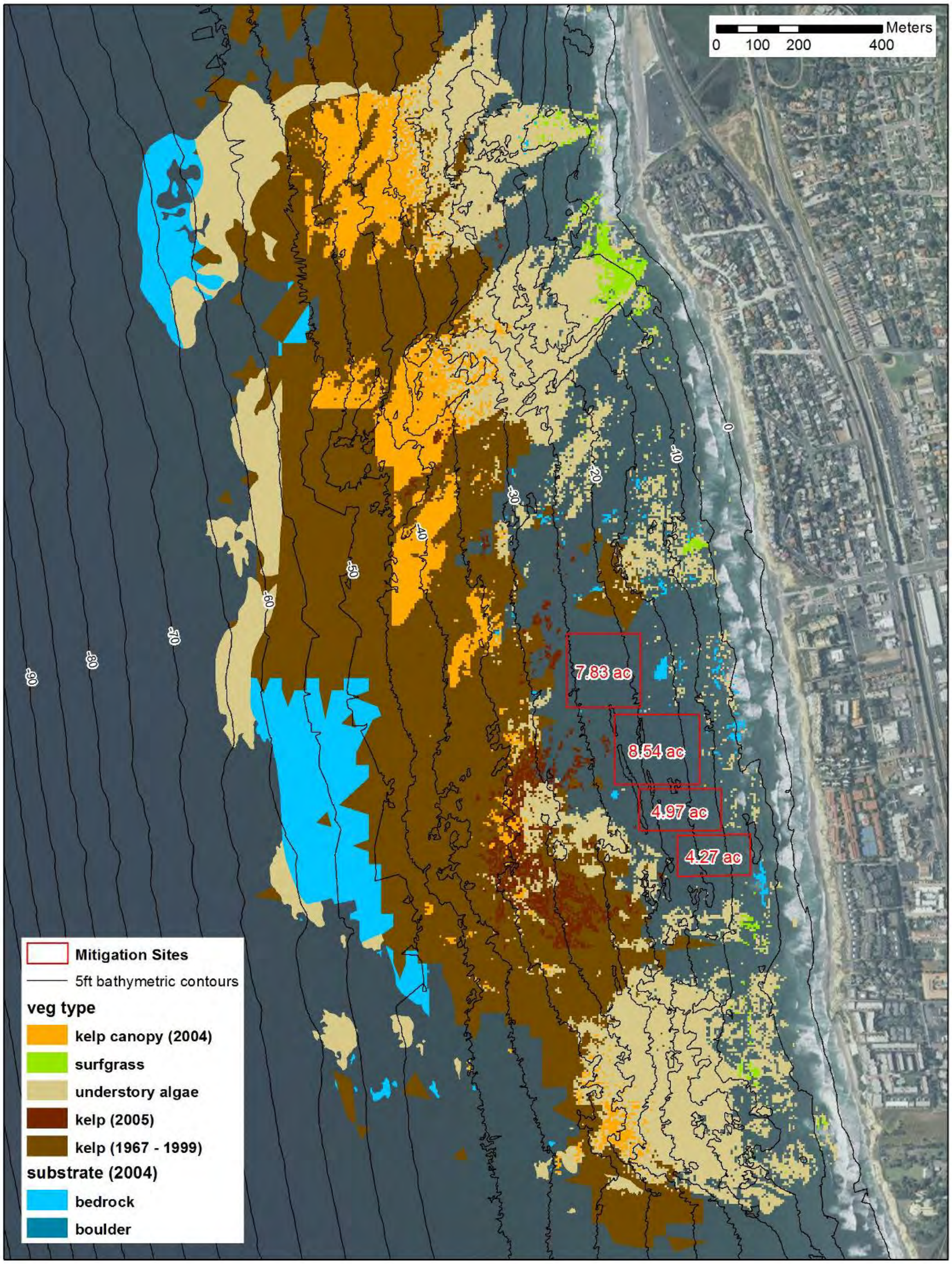

Figure 6.2-1 Potential mitigation areas off Solana Beach.

Table 6.2-1 Mitigation estimate for Encinitas for the low sea level rise scenario.

Beach Width Option (ft)	Resource	Project-Related Impact (Acres)	Mitigation Required ?	Estimated Construction Monitoring Cost*	Surfgrass Transplant Cost*	Reef Mitigation*	Estimated Kelp Transplant Cost*	Estimated Mitigation Monitoring Cost*	Sub-Total Mitigation Cost*	Total Mitigation Cost**
50	Reefs with Surfgrass	(-1.7)	No	$75,000	N/A	N/A	N/A	N/A	N/A	$150,000
	Reefs with Other Indicators	(-7.2)	No		N/A	N/A	N/A	N/A	N/A	
100	Reefs with Surfgrass	(-0.3)	No	$75,000	N/A	N/A	N/A	N/A	N/A	$150,000
	Reefs with Other Indicators	(-1.5)	No		N/A	N/A	N/A	N/A	N/A	
150	Reefs with Surfgrass	**2.0**	**Yes**	$75,000	$500,000	$4,000,000	N/A	$75,000	$4,500,000	$18,870,000
	Reefs with Other Indicators	**9.5**	**Yes**		N/A	4,750,000	$35,000		$4,785,000	
200	Reefs with Surfgrass	**3.4**	**Yes**	$75,000	$850,000	$6,800,000	N/A	$75,000	$7,650,000	$38,190,000
	Reefs with Other Indicators	**22.5**	**Yes**		N/A	$11,250,000	$45,000		$11,295,000	

*Assumes 1:1 mitigation functional equivalent (used for cost-estimation purposes)
**Assumes 2:1 mitigation functional equivalent

Table 6.2-2 Mitigation estimate for Encinitas for the high sea level rise scenario.

Beach Width Option (ft)	Resource	Project-Related Impact (Acres)	Mitigation Required?	Estimated Construction Monitoring Cost*	Surfgrass Transplant Cost*	Reef Mitigation*	Estimated Kelp Transplant Cost*	Estimated Mitigation Monitoring Cost*	Sub-Total Mitigation Cost*	Total Mitigation Cost**
50	Reefs with Surfgrass	(-1.7)	No	$75,000	N/A	N/A	N/A	N/A	N/A	$150,000
	Reefs with Other Indicators	(-7.1)	No		N/A	N/A	N/A	N/A	N/A	
100	Reefs with Surfgrass	(-0.2)	No	$75,000	N/A	N/A	N/A	N/A	N/A	$150,000
	Reefs with Other Indicators	(-0.8)	No		N/A	N/A	N/A	N/A	N/A	
150	Reefs with Surfgrass	**2.1**	**Yes**	$75,000	$525,000	$4,200,000	N/A	$75,000	$4,725,000	$20,430,000
	Reefs with Other Indicators	**10.6**	**Yes**		N/A	$5,300,000	$40,000		$5,340,000	
200	Reefs with Surfgrass	**4.6**	**Yes**	$75,000	$1,150,000	$9,200,000	N/A	$75,000	$10,350,000	$44,300,000
	Reefs with Other Indicators	**23.2**	**Yes**		N/A	$11,600,000	$50,000		$11,650,000	

*Assumes 1:1 mitigation functional equivalent (used for cost-estimation purposes)
**Assumes 2:1 mitigation functional equivalent

Table 6.2-3 Mitigation estimate for Solana Beach for the low sea level rise scenario.

Beach Width Option (ft)	Resource	Project-Related Impact (Acres)	Mitigation Required?	Estimated Construction Monitoring Cost**	Reef Mitigation**	Estimated Kelp Transplant Cost**	Estimated Mitigation Monitoring Cost**	Total Mitigation Cost***
50	Intertidal Reef Platform	0.0	No	$75,000	N/A	N/A	N/A	$150,000
	Reefs with Surfgrass	(-0.4)	No		N/A	N/A	N/A	
	Reefs with Other Indicators	-3.3	No		N/A	N/A	N/A	
100	Intertidal Reef Platform	**0.1**	**Yes**	$75,000	$50,000*	N/A	$75,000	$1,920,000
	Reefs with Surfgrass	(-0.4)	No		N/A	N/A		
	Reefs with Other Indicators	**1.5**	**Yes**		$750,000	$10,000		
150	Intertidal Reef Platform	**0.3**	**Yes**	$75,000	$150,000*	N/A	$75,000	$7,270,000
	Reefs with Surfgrass	(-0.4)	No		N/A	N/A		
	Reefs with Other Indicators	**6.5**	**Yes**		$3,300,000	$35,000		
200	Intertidal Reef Platform	**0.4**	**Yes**	$75,000	$200,000*	N/A	$75,000	$8,800,000
	Reefs with Surfgrass	(-0.4)	No		N/A	N/A		
	Reefs with Other Indicators	**8.0**	**Yes**		$4,000,000	$50,000		
250	Intertidal Reef Platform	**0.4**	**Yes**	$75,000	$200,000*	N/A	$75,000	$11,630,000
	Reefs with Surfgrass	(-0.4)	No		N/A	N/A		
	Reefs with Other Indicators	**10.6**	**Yes**		$5,400,000	$65,000		
300	Intertidal Reef Platform	**0.4**	**Yes**	$75,000	$200,000*	N/A	$75,000	$13,650,000
	Reefs with Surfgrass	(-0.4)	No		N/A	N/A		
	Reefs with Other Indicators	**12.8**	**Yes**		$6,400,000	$75,000		

*Based on out-of-kind mitigation cost
**Assumes 1:1 mitigation functional equivalent (used for cost-estimation purposes)
***Assumes 2:1 mitigation functional equivalent

Table 6.2-4 Mitigation estimate for Solana Beach for the high sea level rise scenario.

Beach Width Option (ft)	Resource	Project-Related Impact (Acres)	Mitigation Required?	Estimated Construction Monitoring Cost**	Reef Mitigation**	Estimated Kelp Transplanting Cost**	Estimated Mitigation Monitoring Cost**	Total Mitigation Cost***
50	Intertidal Reef Platform	0.0	No	$75,000	N/A	N/A	N/A	$150,000
	Reefs with Surfgrass	(-0.4)	No		N/A	N/A	N/A	
	Reefs with Other Indicators	(-3.2)	No		N/A	N/A	N/A	
100	Intertidal Reef Platform	**0.1**	**Yes**	$75,000	$50,000*	N/A	$75,000	$2,320,000
	Reefs with Surfgrass	(-0.4)	No		N/A	N/A		
	Reefs with Other Indicators	**1.9**	**Yes**		$950,000	$10,000		
150	Intertidal Reef Platform	**0.3**	**Yes**	$75,000	$150,000*	N/A	$75,000	$7,670,000
	Reefs with Surfgrass	(-0.4)	No		N/A	N/A		
	Reefs with Other Indicators	**6.9**	**Yes**		$3,500,000	$35,000		
200	Intertidal Reef Platform	**0.4**	**Yes**	$75,000	$200,000*	N/A	$75,000	$9,810,000
	Reefs with Surfgrass	(-0.4)	No		N/A	N/A		
	Reefs with Other Indicators	**9.0**	**Yes**		$4,500,000	$55,000		
250	Intertidal Reef Platform	**0.4**	**Yes**	$75,000	$200,000*	N/A	$75,000	$11,630,000
	Reefs with Surfgrass	(-0.4)	No		N/A	N/A		
	Reefs with Other Indicators	**10.8**	**Yes**		$5,400,000	$65,000		
300	Intertidal Reef Platform	**0.4**	**Yes**	$75,000	$200,000*	N/A	$75,000	$13,860,000
	Reefs with Surfgrass	(-0.4)	No		N/A	N/A		
	Reefs with Other Indicators	**13.0**	**Yes**		$6,500,000	$80,000		

*Based on out-of-kind mitigation cost
**Assumes 1:1 mitigation functional equivalent (used for cost-estimation purposes)
***Assumes 2:1 mitigation functional equivalent

6.2.2 Compensatory Shallow-Water Mitigation Monitoring Plan-Kelp

This section describes monitoring requirements if surf grass impacts require mitigation and mitigation performed by transplanting surf grass onto a shallow water reef has failed requiring out of kind mitigation by creating a kelp reef. An equal acreage of shallow-water kelp (e.g., *Egregia menziesii* and *Eisenia arborea*) will be transplanted on the shallow-water reef built during the project mitigation. Mitigation will be monitored for five years after the mitigation is completed or until success criteria are met. Similar to the Surf grass Mitigation Monitoring Plan, permanent transects shall be established in the rocky reef area containing the kelp on the mitigation reef and at a reference site (control area) of similar depth. The same number of transects would be established in the control area as in the mitigation areas and transects would be at similar depths. On each kelp transect, the following parameters would be monitored at a minimum: 1) kelp density (number of kelp plants per square meter) of each age class, 2) holdfast diameter of each adult kelp plant on the transect, 3) number of stipes of each adult kelp plant on the transect, and 4) identification and quantity of associated flora and fauna. Transects should be monitored at the following intervals:

Post-compensatory mitigation implementation:
Year One

- within one month after completion
- 3 months after completion
- 6 months after completion
- 1 year after completion

Years Two through Five

- Spring survey
- Fall survey

<u>Success Criteria</u>

Success criteria of kelp would include determining if the measured parameters are significantly different than the reference transects. Success criteria for the mitigation reef itself (if it is not planted with kelp) would include no complete permanent burial of the reef. Because of the predominantly sandy bottom environment in the project area, placement of the deep water rocky reef would be considered successful if a characteristic invertebrate and fish community were to become established. On each kelp transect, the following parameters should be monitored and evaluated at a minimum: 1) kelp density (number of kelp plants per square meter) of each age class and 2) identification and quantity of associated flora and fauna. In addition, 3) holdfast diameter of each adult kelp plant on the transect, 4) number of stipes of each adult kelp plant on the transect should be able to be recorded by the monitor during transect monitoring at no additional cost and as a qualitative measure of reef health. Monitoring will determine the extent of reef habitat by mapping using remote sensing techniques such as multi-spectral aerial photography and/or interferometric side scan sonar. Monitoring will be used to determine if mitigation reef becomes buried and thus lost. Specific success criteria below may be refined during the PED phase. General success criteria will consist of the following:

1. Approximately 50% - 60% of the number of fish, invertebrates, and algae species found at the reference site occur at the mitigation site two years post-mitigation.
2. Approximately 50% - 60% of kelp survival at the mitigation site two years post-mitigation implementation, relative to the reference site.
3. Approximately 90% of the constructed reef remains unburied at the mitigation site two years post-mitigation.

Key assumptions are also provided in Section 4.4. For areas not meeting the success criteria, additional reef would be constructed.

6.2.3 Compensatory, Mid-Water, or Deep-Water Reef Mitigation Monitoring Plan-Rocky Reef

This section describes monitoring requirements if rocky reef mitigation is required. There are two possible types of mitigation: a mid-water reef is constructed or a deep-water reef is constructed. The mid-water reef is considered to be closer in depth and type to the reef lost and is considered to be in-kind mitigation. The deep-water reef is considered to be out of kind mitigation. Mid-water reef is constructed, but not planted. This type of reef would be built in close proximity to existing rocky reef habitat and it is expected to colonize rapidly on its own from nearby rock reef habitat. Deep-water reef would be planted by a mix of algal species as it would not be close enough to existing reef to colonize on its own. Monitoring and success criteria are thus different for the two types of reefs. Mitigation will be monitored for five years after the mitigation is completed or until success criteria are met.

Mid-Water Reef

This monitoring is meant to represent mitigation for long term burial of rocky reef habitat. In that case, mitigation is establishment of a rocky reef habitat. Monitoring will be used to determine if constructed rock reef is lost due to burial or subsidence. Mid-water rocky reefs should be monitored at the following intervals:

Post-compensatory mitigation implementation:
Year One

- within one month after completion
- 3 months after completion
- 6 months after completion
- 1 year after completion

Years Two through Five

- Spring survey
- Fall survey

<u>Success Criteria</u>

Success criteria for the mitigation reef itself would include no complete permanent burial of the reef. This is the sole success criteria for mid-depth reef. Monitoring will determine the extent of reef habitat throughout and adjacent to the entire mitigation site[s] by mapping using remote sensing techniques such as multi-spectral aerial photography and/or interferometric side scan sonar. Monitoring will be used to determine if mitigation reef becomes buried and thus lost. General success criteria below may be refined during the PED phase. General success criteria will consist of the following:

1. Approximately 90% of the constructed reef remains unburied at the mitigation site two years post-mitigation.

Deep-Water Reef

This monitoring is meant to represent mitigation for long term burial of rocky reef habitat. In that case, mitigation is establishment of a rocky reef habitat planted with kelp. Similar to the Surf grass Mitigation Monitoring Plan, permanent transects shall be established in the rocky reef area containing the kelp on the mitigation reef and at a reference site (control area) of similar depth. The same number of transects would be established in the control area as in the mitigation areas and transects should be at similar depths. On each kelp transect, the following parameters would be monitored at a minimum: 1) kelp density (number of kelp plants per square meter) of each age class, and 2) identification and quantity of associated flora and fauna. In addition, 3) holdfast diameter of each adult kelp plant on the transect and 4) number of stipes of each adult kelp plant on the transect should be able to be recorded by the monitor during transect monitoring at no additional cost and as a qualitative measure of reef health. Monitoring will also determine the extent of reef habitat throughout and adjacent to the entire mitigation site[s] by mapping using remote sensing techniques such as multi-spectral aerial photography and/or interferometric side scan sonar. Monitoring will be used to determine if mitigation reef becomes buried and thus lost. Deep-water rocky reefs should be monitored at the following intervals:

Post-compensatory mitigation implementation:
Year One

- within one month after completion
- 3 months after completion
- 6 months after completion
- 1 year after completion

Years Two through Five

- Spring survey
- Fall survey

<u>Success Criteria</u>

Success criteria for the mitigation reef itself would include no complete permanent burial of the reef. This is the sole success criteria for mid-depth reef. Because of the predominantly sandy bottom environment in the project area, placement of the deep water rocky reef would be considered successful if a characteristic invertebrate and fish community were to become established. Monitoring will determine the extent of reef habitat and vegetation throughout and adjacent to the entire mitigation site[s] by mapping using remote sensing techniques such as multi-spectral aerial photography and/or interferometric side scan sonar. Monitoring will be used to determine if mitigation reef becomes buried and thus lost and the extent of vegetation (for deep-water mitigation reefs). Specific success criteria below may be refined during the PED phase. General success criteria will consist of the following:

1. Approximately 90% of the constructed reef remains unburied at the mitigation site two years post-mitigation.
2. Approximately 50% - 60% of coverage reef by algae and/or submerged aquatic vegetation at the mitigation site two years post-mitigation implementation, relative to the reference site.

Key assumptions are also provided in Section 4.4. For areas not meeting the success criteria, additional reef would be constructed.

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Appendix A
Year 2 Sediment Transport Model Predictions

Year 2 Sand Thickness (feet)
Beach Width = 50'

Distance Offshore (m)	DM565		DM560		DM580		DM590		SD595		SD600		SD610		SD620		SD625		SD630		SD650		SD660		SD670		SD675		SD680		SD690		SD695		SD700		SD710	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
0	0.0	0.0	0.0	0.0	0.03	0.01	0.01	0.01	0.01	0.03	1.29	1.88	0.67	2.25	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.012	0.005	0.74	0.65	0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00
10	0.0	0.0	0.0	0.0	0.02	0.02	0.19	0.12	0.07	0.22	0.43	1.09	0.73	2.04	0.08	0.08	0.01	0.02	0.04	0.04	0.00	0.00	0.00	0.01	0.766	0.873	1.78	1.65	0.68	0.52	0.05	0.04	0.04	0.04	0.00	0.00	0.02	0.02
20	0.0	0.0	0.0	0.0	0.02	0.04	0.18	0.12	0.15	0.30	1.02	1.67	0.71	1.63	0.13	0.16	0.01	0.03	0.04	0.05	0.00	0.00	0.00	0.01	0.504	0.821	1.11	1.20	**0.55**	0.45	0.03	0.02	0.03	0.03	0.00	0.00	0.02	0.03
30	0.0	0.0	0.0	0.0	0.01	0.04	0.16	0.12	0.13	0.34	0.79	1.35	0.61	1.36	0.16	0.22	0.03	0.05	0.04	0.05	0.00	0.00	0.00	0.01	0.828	1.234	0.97	1.29	0.43	0.42	0.01	0.01	0.02	0.02	0.00	0.00	0.02	0.03
40	0.0	0.0	0.0	0.0	0.02	0.04	0.16	0.13	0.16	0.38	0.97	1.53	0.50	1.24	0.11	0.16	0.02	0.04	0.04	0.06	0.00	0.00	0.00	0.01	0.572	0.976	1.38	1.97	0.33	0.36	0.01	0.01	0.02	0.02	0.00	0.00	0.02	0.04
50	0.0	0.0	0.0	0.0	0.02	0.04	0.13	0.12	0.17	0.35	0.99	1.57	0.48	1.17	0.06	0.13	0.02	0.03	0.04	0.05	0.00	0.00	0.00	0.01	0.462	0.824	1.36	2.22	0.31	0.34	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.03
60	0.0	0.0	0.0	0.0	0.02	0.04	0.08	0.09	0.20	0.37	0.89	1.47	0.41	0.98	0.05	0.12	0.02	0.02	0.03	0.04	0.00	0.00	0.00	0.01	0.406	0.735	0.88	1.91	0.32	0.35	0.01	0.02	0.01	0.02	0.00	0.00	0.01	0.02
70	0.0	0.0	0.0	0.0	0.03	0.04	0.07	0.10	0.22	0.36	0.73	1.33	0.47	0.91	0.05	0.12	0.02	0.02	0.03	0.04	0.00	0.00	0.00	0.00	0.375	0.613	0.91	1.87	0.27	0.33	0.01	0.02	0.02	0.03	0.00	0.00	0.00	0.01
80	0.0	0.0	0.0	0.0	0.03	0.04	0.08	0.11	0.21	0.33	0.68	1.28	0.69	1.04	0.07	0.13	0.01	0.02	0.03	0.04	0.00	0.00	0.01	0.01	0.574	0.766	0.99	1.91	0.20	0.29	0.02	0.03	0.02	0.03	0.00	0.00	0.00	0.01
90	0.0	0.0	0.0	0.0	0.03	0.04	0.12	0.16	0.17	0.28	1.01	1.58	1.07	1.24	0.08	0.14	0.01	0.02	0.03	0.03	0.00	0.00	0.01	0.01	0.627	0.781	1.06	2.00	0.22	0.32	0.01	0.02	0.01	0.02	0.00	0.00	0.01	0.02
100	0.0	0.0	0.0	0.0	0.02	0.03	0.19	0.22	0.15	0.30	1.23	1.70	1.14	1.17	0.09	0.15	0.01	0.02	0.02	0.03	0.00	0.00	0.01	0.01	0.670	0.798	1.01	1.96	0.13	0.26	0.02	0.03	0.01	0.01	0.00	0.00	0.01	0.02
110	0.0	0.0	0.0	0.0	0.01	0.03	0.24	0.27	0.10	0.30	1.05	1.46	1.10	0.96	0.09	0.16	0.01	0.03	0.03	0.04	0.00	0.00	0.01	0.01	0.572	0.724	0.44	1.31	0.09	0.22	0.03	0.03	0.02	0.01	0.00	0.00	0.02	0.04
120	0.0	0.0	0.0	0.0	0.02	0.04	0.17	0.23	0.18	0.46	1.01	1.42	1.68	1.34	0.10	0.18	0.01	0.03	0.03	0.04	0.00	0.00	0.01	0.00	0.656	0.836	0.43	1.11	0.16	0.30	0.02	0.02	0.03	0.01	0.00	0.00	0.02	0.04
130	0.0	0.0	0.0	0.0	0.02	0.04	0.13	0.22	0.21	0.55	1.02	1.39	0.78	0.62	0.12	0.19	0.01	0.02	0.03	0.04	0.00	0.00	0.01	0.00	0.748	0.946	0.51	0.92	0.22	0.36	0.02	0.01	0.02	0.01	0.00	0.00	0.02	0.04
140	0.0	0.0	0.0	0.0	0.03	0.04	0.12	0.22	0.19	0.54	1.12	1.36	1.27	1.20	0.13	0.17	0.02	0.02	0.04	0.04	0.00	0.00	0.01	0.00	0.642	0.840	0.85	0.93	0.20	0.33	0.01	0.01	0.02	0.01	0.00	0.00	0.02	0.04
150	0.0	0.0	0.0	0.0	0.04	0.05	0.13	0.22	0.14	0.48	1.28	1.27	1.04	0.85	0.13	0.16	0.03	0.03	0.04	0.05	0.00	0.00	0.01	0.00	0.658	0.814	1.38	1.03	0.19	0.30	0.01	0.01	0.01	0.01	0.00	0.00	0.02	0.03
160	0.0	0.0	0.0	0.0	0.04	0.04	0.19	0.26	0.16	0.40	1.42	1.17	0.81	0.41	0.13	0.14	0.04	0.03	0.04	0.04	0.00	0.00	0.00	0.00	0.637	0.722	1.68	0.90	0.22	0.22	0.01	0.01	0.01	0.01	0.00	0.00	0.02	0.03
170	0.0	0.0	0.0	0.0	0.03	0.04	0.22	0.27	0.27	0.36	1.42	0.94	0.66	0.37	0.13	0.12	0.04	0.03	0.03	0.04	0.00	0.00	0.01	0.01	0.618	0.618	1.78	0.65	0.23	0.21	0.01	0.01	0.01	0.01	0.01	0.00	0.02	0.02
180	0.0	0.0	0.0	0.0	0.03	0.03	0.15	0.22	0.32	0.30	1.38	0.80	0.89	0.45	0.13	0.10	0.04	0.02	0.04	0.03	0.00	0.00	0.00	0.00	0.568	0.477	2.24	0.78	0.20	0.18	0.01	0.01	0.01	0.01	0.01	0.00	0.02	0.01
190	0.0	0.0	0.0	0.0	0.04	0.03	0.11	0.18	0.39	0.22	1.20	0.61	1.21	0.75	0.13	0.07	0.03	0.02	0.04	0.03	0.00	0.00	0.00	0.00	0.550	0.383	1.85	0.60	0.18	0.20	0.01	0.01	0.01	0.01	0.00	0.00	0.02	0.01
200	0.0	0.0	0.0	0.0	0.04	0.03	0.08	0.14	0.46	0.18	1.09	0.48	0.83	0.43	0.14	0.08	0.03	0.02	0.03	0.03	0.00	0.00	0.01	0.01	0.536	0.323	1.44	0.62	0.18	0.21	0.02	0.01	0.01	0.01	0.00	0.00	0.01	0.01
210	0.0	0.0	0.0	0.0	0.04	0.02	0.13	0.14	0.54	0.22	1.00	0.36	1.30	0.85	0.15	0.08	0.03	0.01	0.03	0.02	0.00	0.00	0.01	0.00	0.527	0.299	1.15	0.54	0.17	0.26	0.02	0.02	0.02	0.01	0.00	0.00	0.01	0.01
220	0.0	0.0	0.0	0.0	0.04	0.02	0.14	0.10	0.53	0.16	0.88	0.23	1.09	0.75	0.14	0.08	0.03	0.01	0.03	0.02	0.00	0.00	0.01	0.00	0.406	0.159	0.83	0.39	0.24	0.14	0.02	0.02	0.01	0.01	0.00	0.00	0.03	0.01
230	0.0	0.0	0.0	0.0	0.03	0.01	0.15	0.08	0.50	0.14	0.81	0.20	0.90	0.59	0.13	0.08	0.03	0.01	0.03	0.02	0.00	0.00	0.00	0.00	0.448	0.184	0.76	0.52	0.13	0.08	0.03	0.04	0.02	0.01	0.00	0.00	0.03	0.01
240	0.0	0.0	0.0	0.0	0.03	0.01	0.10	0.06	0.45	0.14	0.80	0.30	0.62	0.42	0.13	0.08	0.02	0.01	0.03	0.02	0.00	0.00	0.01	0.01	0.343	0.124	0.72	0.43	0.20	0.23	0.03	0.02	0.02	0.01	0.00	0.00	0.02	0.00
250	0.0	0.0	0.0	0.0	0.03	0.01	0.12	0.07	0.50	0.17	0.73	0.29	0.60	0.50	0.14	0.08	0.02	0.01	0.02	0.01	0.00	0.00	0.01	0.00	0.325	0.126	0.53	0.25	0.55	0.46	0.03	0.02	0.02	0.01	0.00	0.00	0.03	0.01
260	0.0	0.0	0.0	0.0	0.03	0.01	0.14	0.08	0.43	0.17	0.66	0.27	0.72	0.62	0.12	0.08	0.02	0.01	0.02	0.01	0.00	0.00	0.01	0.00	0.296	0.114	0.57	0.18	0.34	0.29	0.02	0.03	0.01	0.01	0.00	0.00	0.03	0.01
270	0.0	0.0	0.0	0.0	0.02	0.01	0.13	0.07	0.36	0.10	0.68	0.34	1.18	1.06	0.11	0.06	0.02	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.473	0.318	0.53	0.20	0.26	0.21	0.02	0.02	0.01	0.01	0.00	0.00	0.02	0.01
280	0.0	0.0	0.0	0.0	0.02	0.01	0.07	0.05	0.33	0.08	0.58	0.25	1.08	0.71	0.11	0.05	0.02	0.01	0.02	0.01	0.00	0.00	0.01	0.01	0.241	0.111	0.84	0.45	0.18	0.15	0.01	0.02	0.01	0.01	0.00	0.00	0.02	0.01
290	0.0	0.0	0.0	0.0	0.02	0.01	0.04	0.04	0.40	0.17	0.65	0.39	1.03	0.77	0.10	0.04	0.02	0.01	0.02	0.01	0.00	0.00	0.01	0.01	0.246	0.159	0.91	0.80	0.11	0.13	0.01	0.01	0.02	0.03	0.00	0.00	0.02	0.01
300	0.0	0.0	0.0	0.0	0.02	0.01	0.06	0.06	0.38	0.17	0.65	0.41	0.64	0.54	0.10	0.03	0.01	0.01	0.02	0.01	0.00	0.00	0.01	0.01	0.215	0.120	0.47	0.63	0.21	0.17	0.01	0.02	0.02	0.02	0.00	0.00	0.02	0.01
310	0.0	0.0	0.0	0.0	0.02	0.01	0.06	0.05	0.31	0.16	0.52	0.36	0.71	0.66	0.06	0.05	0.01	0.01	0.02	0.01	0.00	0.00	0.01	0.01	0.231	0.111	0.64	0.60	0.13	0.11	0.01	0.01	0.01	0.00	0.00	0.00	0.02	0.01
320	0.0	0.0	0.0	0.0	0.02	0.01	0.09	0.07	0.15	0.09	0.64	0.55	0.86	0.63	0.19	0.22	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.326	0.169	0.78	0.51	0.13	0.06	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01
330	0.0	0.0	0.0	0.0	0.02	0.01	0.07	0.06	0.18	0.10	0.61	0.56	0.82	0.60	0.10	0.14	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.251	0.146	0.63	0.38	0.14	0.11	0.03	0.02	0.02	0.02	0.00	0.00	0.02	0.01
340	0.0	0.0	0.0	0.0	0.01	0.01	0.08	0.04	0.12	0.09	0.60	0.50	0.58	0.31	0.04	0.03	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.261	0.130	0.30	0.27	0.12	0.08	0.01	0.02	0.02	0.02	0.00	0.00	0.01	0.01
350	0.0	0.0	0.0	0.0	0.01	0.01	0.07	0.04	0.19	0.25	0.61	0.50	0.87	0.40	0.07	0.05	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.200	0.101	0.31	0.24	0.12	0.12	0.01	0.01	0.02	0.01	0.00	0.00	0.02	0.01
360	0.0	0.0	0.0	0.0	0.01	0.01	0.05	0.02	0.20	0.23	0.63	0.57	1.17	0.67	0.04	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.285	0.167	0.33	0.37	0.24	0.12	0.01	0.01	0.02	0.01	0.00	0.00	0.01	0.01
370	0.0	0.0	0.0	0.0	0.01	0.01	0.03	0.01	0.35	0.30	0.62	0.57	0.76	0.48	0.04	0.04	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.230	0.209	0.40	0.49	0.17	0.19	0.02	0.01	0.01	0.01	0.00	0.00	0.01	0.01
380	0.0	0.0	0.0	0.0	0.01	0.01	0.03	0.01	0.22	0.19	0.56	0.54	0.49	0.45	0.07	0.06	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.151	0.133	0.40	0.45	0.24	0.24	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01
390	0.0	0.0	0.0	0.0	0.01	0.00	0.05	0.03	0.26	0.23	0.50	0.46	0.68	0.45	0.11	0.13	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.123	0.086	0.43	0.48	0.17	0.15	0.01	0.02	0.02	0.03	0.00	0.00	0.01	0.01
400	0.0	0.0	0.0	0.0	0.01	0.01	0.02	0.02	0.19	0.20	0.40	0.35	0.33	0.32	0.06	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.134	0.080	0.70	0.80	0.16	0.14	0.01	0.01	0.01	0.02	0.00	0.00	0.01	0.00
410	0.0	0.0	0.0	0.0	0.01	0.00	0.03	0.02	0.25	0.23	0.36	0.33	0.62	0.58	0.06	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.221	0.134	1.06	1.29	0.10	0.09	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00
420	0.0	0.0	0.0	0.0	0.00	0.00	0.03	0.02	0.23	0.20	0.32	0.32	0.40	0.45	0.07	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.119	0.080	0.82	1.01	0.15	0.11	0.01	0.01	0.01	0.02	0.00	0.00	0.01	0.00
430	0.0	0.0	0.0	0.0	0.00	0.01	0.03	0.02	0.16	0.14	0.31	0.29	0.36	0.38	0.06	0.06	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.131	0.090	0.49	0.62	0.13	0.09	0.01	0.01	0.01	0.02	0.00	0.00	0.00	0.00
440	0.0	0.0	0.0	0.0	0.01	0.01	0.03	0.02	0.07	0.04	0.56	0.53	0.30	0.31	0.09	0.06	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.142	0.087	0.62	0.69	0.08	0.05	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01
450	0.0	0.0	0.0	0.0	0.00	0.01	0.04	0.04	0.04	0.08	0.41	0.37	0.24	0.25	0.06	0.03	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.131	0.076	0.65	0.65	0.05	0.03	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
460	0.0	0.0	0.0	0.0	0.00	0.00	0.04	0.03	0.03	0.06	0.30	0.25	0.18	0.18	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.094	0.036	0.51	0.52	0.06	0.03	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
470	0.0	0.0	0.0	0.0	0.00	0.00	0.04	0.03	0.02	0.05	0.38	0.37	0.12	0.11	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.092	0.036	0.35	0.27	0.09	0.04	0.02	0.02	0.00	0.01	0.00	0.00	0.00	0.00
480	0.0	0.0	0.0	0.0	0.00	0.00	0.02	0.02	0.01	0.04	0.40	0.41	0.06	0.04	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.064	0.032	0.31	0.29	0.07	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
490	0.0	0.0	0.0	0.0	0.00	0.00	0.03	0.02	0.00	0.03	0.30	0.30	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.048	0.016	0.32	0.40	0.06	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Year 2 Sand Thickness (feet)

Beach Width = 100'

Distance Offshore (m)	DM565		DM560		DM580		DM590		SD595		SD600		SD610		SD620		SD625		SD630		SD650		SD660		SD670		SD675		SD680		SD690		SD695		SD700		SD710	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
0	0.00	0.00	0.00	0.00	0.12	0.03	0.02	0.02	0.03	0.05	2.47	3.60	1.28	4.30	0.01	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.03	0.01	1.47	1.28	0.00	0.00	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.08	0.11	0.48	0.30	0.15	0.47	0.82	2.09	1.39	3.90	0.16	0.16	0.02	0.03	0.06	0.06	0.00	0.00	0.01	0.02	1.72	1.96	3.53	3.27	1.79	1.38	0.08	0.07	0.06	0.07	0.00	0.01	0.03	0.03
20	0.00	0.00	0.00	0.00	0.08	0.17	0.44	0.30	0.31	0.64	1.94	3.19	1.35	3.12	0.26	0.34	0.01	0.04	0.06	0.07	0.00	0.00	0.01	0.03	1.13	1.84	2.21	2.38	1.44	1.19	0.04	0.04	0.05	0.05	0.00	0.00	0.03	0.05
30	0.00	0.00	0.00	0.00	0.07	0.19	0.39	0.29	0.28	0.71	1.51	2.57	1.17	2.60	0.34	0.46	0.04	0.07	0.05	0.08	0.00	0.00	0.01	0.02	1.86	2.77	1.92	2.56	1.14	1.11	0.02	0.02	0.04	0.04	0.00	0.00	0.02	0.05
40	0.00	0.00	0.00	0.00	0.08	0.19	0.40	0.31	0.35	0.81	1.85	2.93	0.96	2.37	0.23	0.32	0.03	0.05	0.06	0.09	0.00	0.00	0.01	0.02	1.28	2.19	2.75	3.91	0.86	0.96	0.01	0.02	0.03	0.03	0.00	0.00	0.03	0.05
50	0.00	0.00	0.00	0.00	0.10	0.18	0.33	0.29	0.36	0.74	1.89	3.00	0.91	2.23	0.13	0.28	0.02	0.04	0.05	0.07	0.00	0.00	0.01	0.02	1.04	1.85	2.70	4.40	0.82	0.91	0.02	0.02	0.02	0.02	0.00	0.00	0.01	0.04
60	0.00	0.00	0.00	0.00	0.10	0.17	0.19	0.23	0.42	0.79	1.69	2.81	0.79	1.87	0.10	0.25	0.02	0.03	0.04	0.06	0.00	0.00	0.01	0.01	0.91	1.65	1.75	3.78	0.85	0.93	0.02	0.03	0.02	0.04	0.00	0.00	0.01	0.03
70	0.00	0.00	0.00	0.00	0.12	0.17	0.17	0.24	0.46	0.77	1.39	2.54	0.90	1.75	0.10	0.25	0.02	0.03	0.05	0.06	0.00	0.00	0.01	0.01	0.84	1.37	1.81	3.71	0.72	0.86	0.02	0.03	0.03	0.05	0.00	0.00	0.01	0.02
80	0.00	0.00	0.00	0.00	0.14	0.18	0.20	0.28	0.45	0.71	1.31	2.45	1.33	1.98	0.14	0.26	0.02	0.03	0.05	0.06	0.00	0.00	0.01	0.01	1.29	1.72	1.97	3.78	0.53	0.77	0.03	0.04	0.03	0.04	0.00	0.00	0.01	0.02
90	0.00	0.00	0.00	0.00	0.12	0.17	0.30	0.39	0.35	0.60	1.94	3.01	2.04	2.38	0.17	0.30	0.01	0.03	0.04	0.05	0.00	0.00	0.03	0.03	1.41	1.75	2.11	3.97	0.57	0.85	0.01	0.03	0.02	0.03	0.00	0.00	0.01	0.02
100	0.00	0.00	0.00	0.00	0.07	0.14	0.47	0.53	0.32	0.64	2.34	3.25	2.18	2.24	0.19	0.32	0.01	0.03	0.03	0.05	0.00	0.00	0.03	0.02	1.50	1.79	2.01	3.90	0.35	0.68	0.03	0.04	0.02	0.02	0.00	0.00	0.01	0.04
110	0.00	0.00	0.00	0.00	0.03	0.12	0.59	0.66	0.21	0.63	2.00	2.79	2.11	1.84	0.19	0.33	0.02	0.04	0.04	0.05	0.00	0.00	0.02	0.02	1.28	1.62	0.87	2.59	0.25	0.59	0.04	0.04	0.03	0.01	0.00	0.01	0.03	0.05
120	0.00	0.00	0.00	0.00	0.07	0.16	0.41	0.57	0.38	0.96	1.93	2.72	3.21	2.56	0.20	0.36	0.02	0.04	0.04	0.05	0.00	0.00	0.02	0.01	1.47	1.87	0.85	2.21	0.43	0.79	0.04	0.02	0.05	0.01	0.01	0.01	0.03	0.06
130	0.00	0.00	0.00	0.00	0.08	0.17	0.31	0.54	0.45	1.17	1.94	2.66	1.48	1.18	0.25	0.38	0.02	0.03	0.05	0.06	0.00	0.00	0.02	0.01	1.68	2.12	1.01	1.82	0.59	0.96	0.03	0.02	0.04	0.02	0.01	0.01	0.03	0.06
140	0.00	0.00	0.00	0.00	0.13	0.20	0.30	0.54	0.40	1.15	2.13	2.60	2.43	2.29	0.27	0.36	0.03	0.03	0.05	0.06	0.00	0.00	0.01	0.01	1.44	1.88	1.70	1.85	0.52	0.88	0.02	0.01	0.03	0.01	0.01	0.01	0.03	0.05
150	0.00	0.00	0.00	0.00	0.17	0.23	0.32	0.54	0.29	1.02	2.44	2.43	2.00	1.63	0.27	0.32	0.04	0.04	0.05	0.06	0.00	0.00	0.01	0.01	1.48	1.82	2.75	2.04	0.50	0.78	0.02	0.01	0.01	0.01	0.01	0.00	0.03	0.05
160	0.00	0.00	0.00	0.00	0.16	0.20	0.47	0.64	0.33	0.84	2.71	2.23	1.55	0.78	0.27	0.28	0.05	0.04	0.05	0.06	0.00	0.00	0.00	0.01	1.43	1.62	3.34	1.79	0.58	0.58	0.02	0.02	0.01	0.01	0.01	0.00	0.03	0.04
170	0.00	0.00	0.00	0.00	0.15	0.17	0.55	0.67	0.57	0.76	2.71	1.80	1.27	0.72	0.28	0.25	0.05	0.04	0.05	0.05	0.00	0.00	0.02	0.02	1.39	1.39	3.53	1.30	0.62	0.55	0.01	0.02	0.02	0.01	0.01	0.00	0.03	0.02
180	0.00	0.00	0.00	0.00	0.14	0.12	0.38	0.54	0.68	0.63	2.65	1.53	1.71	0.85	0.28	0.20	0.05	0.03	0.05	0.05	0.00	0.00	0.01	0.01	1.27	1.07	4.44	1.54	0.54	0.47	0.01	0.02	0.01	0.02	0.01	0.01	0.03	0.01
190	0.00	0.00	0.00	0.00	0.17	0.11	0.28	0.44	0.82	0.46	2.30	1.16	2.31	1.44	0.27	0.15	0.05	0.03	0.05	0.04	0.00	0.00	0.01	0.01	1.23	0.86	3.67	1.19	0.46	0.52	0.02	0.02	0.02	0.02	0.01	0.00	0.03	0.01
200	0.00	0.00	0.00	0.00	0.19	0.12	0.20	0.34	0.97	0.38	2.09	0.92	1.59	0.82	0.29	0.16	0.05	0.03	0.05	0.04	0.00	0.00	0.01	0.01	1.20	0.72	2.87	1.23	0.47	0.55	0.02	0.02	0.02	0.02	0.00	0.00	0.02	0.01
210	0.00	0.00	0.00	0.00	0.19	0.10	0.31	0.35	1.14	0.46	1.91	0.68	2.48	1.62	0.30	0.17	0.04	0.02	0.04	0.03	0.00	0.00	0.01	0.01	1.18	0.67	2.28	1.07	0.45	0.68	0.02	0.03	0.03	0.02	0.00	0.00	0.02	0.01
220	0.00	0.00	0.00	0.00	0.17	0.09	0.35	0.26	1.11	0.33	1.68	0.44	2.08	1.44	0.29	0.16	0.04	0.02	0.04	0.03	0.00	0.00	0.01	0.01	0.91	0.36	1.64	0.78	0.64	0.37	0.03	0.04	0.03	0.01	0.00	0.00	0.04	0.01
230	0.00	0.00	0.00	0.00	0.15	0.06	0.36	0.21	1.06	0.30	1.55	0.39	1.72	1.13	0.27	0.16	0.04	0.02	0.04	0.02	0.00	0.00	0.01	0.01	1.01	0.41	1.51	1.03	0.35	0.21	0.05	0.06	0.03	0.02	0.00	0.00	0.04	0.01
240	0.00	0.00	0.00	0.00	0.14	0.05	0.26	0.15	0.96	0.31	1.54	0.56	1.19	0.79	0.27	0.16	0.03	0.02	0.04	0.02	0.00	0.00	0.02	0.01	0.77	0.28	1.44	0.86	0.53	0.60	0.05	0.03	0.03	0.01	0.00	0.00	0.03	0.01
250	0.00	0.00	0.00	0.00	0.13	0.05	0.29	0.17	1.06	0.36	1.39	0.56	1.15	0.95	0.28	0.17	0.03	0.02	0.03	0.02	0.00	0.00	0.02	0.01	0.73	0.28	1.04	0.49	1.45	1.21	0.04	0.03	0.04	0.02	0.00	0.00	0.04	0.01
260	0.00	0.00	0.00	0.00	0.12	0.05	0.35	0.20	0.90	0.36	1.27	0.51	1.38	1.19	0.26	0.16	0.03	0.02	0.03	0.02	0.00	0.00	0.01	0.00	0.66	0.26	1.14	0.36	0.90	0.76	0.04	0.05	0.01	0.01	0.00	0.00	0.04	0.02
270	0.00	0.00	0.00	0.00	0.11	0.04	0.32	0.16	0.76	0.22	1.30	0.65	2.26	2.03	0.23	0.12	0.03	0.02	0.03	0.02	0.00	0.00	0.01	0.00	1.06	0.71	1.05	0.40	0.68	0.55	0.02	0.03	0.01	0.02	0.00	0.00	0.03	0.02
280	0.00	0.00	0.00	0.00	0.10	0.04	0.17	0.12	0.69	0.16	1.12	0.47	2.07	1.36	0.22	0.09	0.02	0.02	0.03	0.02	0.00	0.00	0.02	0.02	0.54	0.25	1.67	0.90	0.47	0.40	0.02	0.03	0.02	0.02	0.00	0.00	0.03	0.01
290	0.00	0.00	0.00	0.00	0.09	0.04	0.09	0.09	0.85	0.36	1.25	0.74	1.97	1.48	0.22	0.08	0.02	0.02	0.03	0.02	0.00	0.00	0.02	0.01	0.55	0.36	1.80	1.58	0.30	0.35	0.02	0.02	0.04	0.05	0.00	0.01	0.03	0.01
300	0.00	0.00	0.00	0.00	0.09	0.05	0.15	0.14	0.80	0.37	1.24	0.79	1.23	1.04	0.20	0.07	0.02	0.01	0.02	0.02	0.00	0.00	0.02	0.02	0.48	0.27	0.93	1.25	0.55	0.45	0.02	0.02	0.04	0.03	0.00	0.01	0.03	0.01
310	0.00	0.00	0.00	0.00	0.09	0.06	0.16	0.13	0.66	0.33	0.99	0.68	1.36	1.26	0.12	0.10	0.01	0.01	0.02	0.01	0.00	0.00	0.01	0.01	0.52	0.25	1.27	1.19	0.35	0.30	0.01	0.01	0.02	0.00	0.00	0.00	0.03	0.01
320	0.00	0.00	0.00	0.00	0.08	0.05	0.22	0.17	0.32	0.20	1.22	1.05	1.65	1.21	0.40	0.45	0.01	0.01	0.02	0.01	0.00	0.00	0.02	0.02	0.73	0.38	1.55	1.00	0.33	0.17	0.02	0.02	0.03	0.02	0.00	0.00	0.02	0.01
330	0.00	0.00	0.00	0.00	0.07	0.05	0.18	0.14	0.38	0.20	1.17	1.08	1.58	1.14	0.21	0.28	0.01	0.01	0.02	0.01	0.00	0.00	0.02	0.01	0.56	0.33	1.25	0.75	0.37	0.28	0.04	0.03	0.04	0.03	0.00	0.00	0.02	0.01
340	0.00	0.00	0.00	0.00	0.07	0.04	0.20	0.10	0.26	0.18	1.14	0.95	1.10	0.60	0.08	0.07	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.59	0.29	0.60	0.53	0.32	0.20	0.01	0.03	0.04	0.04	0.00	0.00	0.02	0.01
350	0.00	0.00	0.00	0.00	0.06	0.03	0.17	0.09	0.40	0.53	1.16	0.96	1.66	0.77	0.14	0.10	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.45	0.23	0.61	0.48	0.33	0.32	0.02	0.02	0.03	0.02	0.00	0.00	0.02	0.01
360	0.00	0.00	0.00	0.00	0.05	0.03	0.11	0.05	0.42	0.49	1.20	1.09	2.23	1.27	0.08	0.05	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.64	0.37	0.65	0.74	0.64	0.33	0.02	0.01	0.03	0.01	0.00	0.00	0.02	0.01
370	0.00	0.00	0.00	0.00	0.04	0.03	0.07	0.02	0.73	0.64	1.19	1.09	1.44	0.92	0.09	0.08	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.51	0.47	0.80	0.97	0.44	0.49	0.03	0.01	0.01	0.01	0.00	0.00	0.02	0.01
380	0.00	0.00	0.00	0.00	0.03	0.03	0.08	0.03	0.45	0.40	1.07	1.03	0.94	0.85	0.14	0.12	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.34	0.30	0.80	0.90	0.62	0.64	0.01	0.02	0.01	0.02	0.00	0.00	0.01	0.01
390	0.00	0.00	0.00	0.00	0.02	0.02	0.12	0.08	0.55	0.49	0.96	0.88	1.30	0.87	0.23	0.26	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.28	0.19	0.85	0.95	0.46	0.39	0.02	0.02	0.03	0.04	0.00	0.00	0.01	0.01
400	0.00	0.00	0.00	0.00	0.03	0.03	0.06	0.04	0.39	0.41	0.76	0.67	0.63	0.61	0.11	0.05	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.30	0.18	1.39	1.59	0.43	0.38	0.01	0.02	0.01	0.03	0.00	0.00	0.01	0.01
410	0.00	0.00	0.00	0.00	0.03	0.02	0.06	0.05	0.53	0.49	0.68	0.63	1.18	1.10	0.12	0.07	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.50	0.30	2.10	2.56	0.27	0.24	0.01	0.01	0.01	0.02	0.00	0.00	0.01	0.00
420	0.00	0.00	0.00	0.00	0.02	0.02	0.07	0.06	0.49	0.43	0.62	0.62	0.76	0.86	0.15	0.11	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.27	0.18	1.63	2.00	0.39	0.29	0.02	0.01	0.01	0.04	0.00	0.00	0.01	0.01
430	0.00	0.00	0.00	0.00	0.02	0.02	0.08	0.06	0.34	0.29	0.60	0.55	0.69	0.73	0.12	0.12	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.29	0.20	0.98	1.23	0.35	0.23	0.01	0.01	0.02	0.03	0.00	0.00	0.00	0.00
440	0.00	0.00	0.00	0.00	0.03	0.03	0.06	0.05	0.15	0.09	1.08	1.01	0.58	0.60	0.18	0.12	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.32	0.20	1.24	1.38	0.22	0.13	0.01	0.01	0.01	0.02	0.00	0.00	0.01	0.01
450	0.00	0.00	0.00	0.00	0.02	0.03	0.11	0.09	0.09	0.16	0.79	0.70	0.46	0.47	0.13	0.06	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.29	0.17	1.29	1.29	0.14	0.08	0.01	0.01	0.01	0.02	0.00	0.00	0.01	0.01
460	0.00	0.00	0.00	0.00	0.01	0.02	0.09	0.07	0.07	0.13	0.58	0.48	0.34	0.34	0.05	0.06	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.21	0.08	1.02	1.03	0.16	0.07	0.02	0.02	0.01	0.02	0.00	0.00	0.00	0.01
470	0.00	0.00	0.00	0.00	0.01	0.01	0.09	0.07	0.04	0.11	0.73	0.70	0.23	0.21	0.04	0.04	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.21	0.08	0.69	0.53	0.23	0.12	0.03	0.03	0.01	0.01	0.00	0.00	0.00	0.00
480	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.04	0.02	0.08	0.76	0.79	0.11	0.09	0.02	0.03	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.14	0.07	0.62	0.58	0.20	0.08	0.03	0.02	0.00	0.01	0.00	0.00	0.00	0.00
490	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.06	-0.01	0.06	0.58	0.57	-0.01	0.00	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.11	0.04	0.64	0.79	0.16	0.08	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00

Year 2 Sand Thickness (feet)
Beach Width = 150'

Distance Offshore (m)	DM565		DM560		DM580		DM590		SD595		SD600		SD610		SD620		SD625		SD630		SD650		SD660		SD670		SD675		SD680		SD690		SD695		SD700		SD710	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
0	0.00	0.00	0.00	0.00	0.20	0.05	0.04	0.03	0.05	0.09	3.51	5.11	1.82	6.08	0.02	0.00	0.00	0.00	0.03	0.02	0.00	0.00	0.00	0.00	0.05	0.02	2.04	1.79	0.01	0.00	0.14	0.14	0.00	0.00	0.01	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.12	0.17	0.84	0.52	0.25	0.78	1.17	2.96	1.97	5.51	0.29	0.28	0.02	0.03	0.10	0.09	0.00	0.00	0.02	0.05	2.85	3.25	4.91	4.56	3.03	2.34	0.13	0.11	0.10	0.11	0.01	0.01	0.03	0.04
20	0.00	0.00	0.00	0.00	0.13	0.27	0.78	0.53	0.51	1.05	2.76	4.53	1.92	4.41	0.46	0.59	0.02	0.05	0.09	0.11	0.00	0.00	0.02	0.06	1.88	3.05	3.08	3.31	2.44	2.01	0.08	0.06	0.08	0.08	0.00	0.00	0.03	0.06
30	0.00	0.00	0.00	0.00	0.11	0.31	0.69	0.51	0.46	1.18	2.14	3.66	1.65	3.68	0.59	0.79	0.05	0.09	0.08	0.12	0.00	0.00	0.02	0.06	3.08	4.59	2.67	3.56	1.92	1.88	0.03	0.03	0.06	0.06	0.00	0.00	0.03	0.06
40	0.00	0.00	0.00	0.00	0.12	0.31	0.70	0.55	0.57	1.33	2.62	4.16	1.35	3.35	0.40	0.56	0.04	0.07	0.10	0.14	0.00	0.00	0.02	0.05	2.13	3.63	3.83	5.45	1.46	1.62	0.02	0.03	0.05	0.05	0.00	0.00	0.03	0.07
50	0.00	0.00	0.00	0.00	0.16	0.30	0.58	0.52	0.59	1.23	2.69	4.27	1.29	3.15	0.23	0.48	0.03	0.05	0.09	0.12	0.00	0.00	0.02	0.04	1.72	3.06	3.76	6.14	1.38	1.54	0.03	0.04	0.03	0.04	0.00	0.00	0.02	0.05
60	0.00	0.00	0.00	0.00	0.17	0.27	0.34	0.41	0.69	1.30	2.41	3.99	1.12	2.65	0.18	0.44	0.03	0.05	0.07	0.10	0.00	0.00	0.02	0.03	1.51	2.73	2.44	5.27	1.44	1.58	0.03	0.04	0.04	0.06	0.00	0.00	0.01	0.04
70	0.00	0.00	0.00	0.00	0.19	0.27	0.29	0.43	0.76	1.26	1.98	3.60	1.28	2.47	0.18	0.43	0.03	0.04	0.08	0.10	0.00	0.00	0.02	0.02	1.39	2.28	2.53	5.16	1.21	1.46	0.03	0.05	0.05	0.08	0.00	0.00	0.01	0.03
80	0.00	0.00	0.00	0.00	0.22	0.29	0.36	0.50	0.74	1.16	1.86	3.48	1.88	2.80	0.25	0.46	0.03	0.04	0.07	0.09	0.00	0.00	0.03	0.04	2.13	2.85	2.74	5.27	0.90	1.29	0.05	0.07	0.05	0.07	0.00	0.00	0.01	0.02
90	0.00	0.00	0.00	0.00	0.19	0.27	0.54	0.68	0.58	0.99	2.75	4.28	2.89	3.36	0.30	0.52	0.02	0.04	0.06	0.08	0.00	0.00	0.07	0.06	2.33	2.91	2.94	5.54	0.97	1.44	0.02	0.05	0.04	0.05	0.00	0.00	0.01	0.03
100	0.00	0.00	0.00	0.00	0.11	0.23	0.83	0.94	0.53	1.06	3.33	4.61	3.09	3.17	0.33	0.55	0.02	0.04	0.05	0.07	0.00	0.00	0.06	0.04	2.49	2.97	2.80	5.43	0.59	1.15	0.05	0.07	0.04	0.03	0.00	0.00	0.02	0.04
110	0.00	0.00	0.00	0.00	0.06	0.19	1.05	1.17	0.35	1.04	2.84	3.97	2.98	2.61	0.34	0.58	0.03	0.05	0.06	0.08	0.00	0.00	0.06	0.04	2.13	2.69	1.21	3.62	0.42	1.00	0.07	0.07	0.05	0.02	0.01	0.01	0.04	0.07
120	0.00	0.00	0.00	0.00	0.11	0.26	0.72	1.01	0.63	1.58	2.75	3.87	4.54	3.62	0.35	0.63	0.02	0.05	0.07	0.08	0.00	0.00	0.06	0.03	2.44	3.11	1.18	3.08	0.73	1.34	0.06	0.04	0.07	0.02	0.01	0.01	0.03	0.07
130	0.00	0.00	0.00	0.00	0.13	0.27	0.55	0.95	0.74	1.92	2.76	3.77	2.10	1.67	0.44	0.67	0.02	0.04	0.07	0.09	0.00	0.00	0.05	0.02	2.78	3.52	1.41	2.54	0.99	1.63	0.05	0.03	0.06	0.03	0.01	0.01	0.03	0.07
140	0.00	0.00	0.00	0.00	0.21	0.33	0.53	0.96	0.66	1.89	3.03	3.69	3.45	3.24	0.47	0.63	0.04	0.04	0.08	0.10	0.00	0.00	0.03	0.02	2.39	3.12	2.36	2.58	0.88	1.48	0.03	0.02	0.04	0.02	0.01	0.01	0.04	0.06
150	0.00	0.00	0.00	0.00	0.28	0.37	0.57	0.96	0.48	1.68	3.46	3.46	2.82	2.31	0.47	0.56	0.06	0.06	0.08	0.10	0.00	0.00	0.03	0.02	2.45	3.03	3.83	2.84	0.84	1.33	0.03	0.02	0.02	0.01	0.01	0.01	0.04	0.06
160	0.00	0.00	0.00	0.00	0.26	0.33	0.82	1.12	0.55	1.39	3.86	3.17	2.19	1.10	0.48	0.49	0.07	0.06	0.08	0.10	0.00	0.00	0.01	0.03	2.37	2.69	4.66	2.49	0.98	0.98	0.03	0.03	0.02	0.02	0.01	0.00	0.04	0.05
170	0.00	0.00	0.00	0.00	0.25	0.27	0.96	1.19	0.93	1.25	3.85	2.56	1.79	1.01	0.48	0.43	0.07	0.05	0.08	0.08	0.00	0.00	0.04	0.05	2.30	2.30	4.91	1.81	1.05	0.94	0.03	0.03	0.03	0.02	0.01	0.01	0.04	0.03
180	0.00	0.00	0.00	0.00	0.23	0.19	0.67	0.96	1.12	1.03	3.76	2.17	2.42	1.21	0.48	0.35	0.07	0.04	0.08	0.07	0.00	0.00	0.02	0.01	2.11	1.78	6.19	2.15	0.91	0.80	0.02	0.03	0.02	0.03	0.01	0.01	0.03	0.01
190	0.00	0.00	0.00	0.00	0.28	0.18	0.49	0.78	1.35	0.75	3.26	1.65	3.27	2.04	0.48	0.27	0.07	0.04	0.08	0.07	0.00	0.00	0.02	0.02	2.05	1.43	5.12	1.66	0.78	0.89	0.03	0.03	0.03	0.03	0.01	0.01	0.04	0.02
200	0.00	0.00	0.00	0.00	0.31	0.19	0.36	0.60	1.60	0.63	2.97	1.30	2.25	1.16	0.51	0.28	0.06	0.04	0.07	0.06	0.00	0.00	0.03	0.03	1.99	1.20	4.00	1.71	0.79	0.94	0.04	0.04	0.04	0.03	0.01	0.01	0.03	0.01
210	0.00	0.00	0.00	0.00	0.31	0.17	0.55	0.62	1.87	0.76	2.72	0.97	3.51	2.29	0.53	0.29	0.06	0.03	0.07	0.05	0.00	0.00	0.03	0.02	1.96	1.11	3.18	1.49	0.77	1.15	0.04	0.06	0.05	0.04	0.00	0.00	0.02	0.01
220	0.00	0.00	0.00	0.00	0.28	0.14	0.61	0.45	1.84	0.55	2.38	0.63	2.95	2.03	0.51	0.29	0.05	0.02	0.06	0.04	0.00	0.00	0.03	0.02	1.51	0.59	2.28	1.08	1.08	0.63	0.05	0.06	0.04	0.02	0.00	0.00	0.05	0.02
230	0.00	0.00	0.00	0.00	0.25	0.10	0.64	0.37	1.74	0.49	2.21	0.55	2.43	1.60	0.48	0.28	0.05	0.02	0.06	0.04	0.00	0.00	0.02	0.01	1.67	0.68	2.11	1.43	0.59	0.36	0.08	0.10	0.04	0.04	0.00	0.00	0.05	0.02
240	0.00	0.00	0.00	0.00	0.22	0.08	0.45	0.27	1.58	0.50	2.18	0.80	1.68	1.12	0.48	0.27	0.05	0.02	0.06	0.03	0.00	0.00	0.04	0.03	1.28	0.46	2.00	1.20	0.90	1.02	0.08	0.06	0.05	0.02	0.00	0.00	0.03	0.01
250	0.00	0.00	0.00	0.00	0.20	0.07	0.51	0.30	1.75	0.60	1.98	0.80	1.63	1.34	0.49	0.30	0.04	0.02	0.05	0.03	0.00	0.00	0.04	0.02	1.21	0.47	1.45	0.68	2.45	2.05	0.07	0.06	0.06	0.04	0.00	0.01	0.05	0.01
260	0.00	0.00	0.00	0.00	0.19	0.08	0.63	0.35	1.49	0.59	1.80	0.72	1.95	1.69	0.45	0.28	0.04	0.02	0.05	0.03	0.00	0.00	0.03	0.01	1.10	0.42	1.58	0.50	1.51	1.29	0.06	0.08	0.02	0.02	0.00	0.00	0.05	0.02
270	0.00	0.00	0.00	0.00	0.18	0.07	0.56	0.29	1.25	0.36	1.85	0.92	3.20	2.87	0.40	0.22	0.03	0.02	0.05	0.03	0.00	0.00	0.02	0.01	1.76	1.18	1.47	0.55	1.16	0.93	0.04	0.05	0.02	0.03	0.00	0.00	0.04	0.02
280	0.00	0.00	0.00	0.00	0.17	0.06	0.29	0.22	1.15	0.27	1.59	0.67	2.93	1.93	0.38	0.17	0.03	0.02	0.05	0.03	0.00	0.00	0.05	0.04	0.90	0.41	2.32	1.25	0.80	0.68	0.03	0.04	0.04	0.03	0.00	0.00	0.03	0.01
290	0.00	0.00	0.00	0.00	0.15	0.07	0.16	0.16	1.41	0.59	1.78	1.05	2.79	2.09	0.38	0.14	0.03	0.02	0.04	0.03	0.00	0.00	0.04	0.03	0.91	0.59	2.50	2.20	0.50	0.59	0.04	0.03	0.06	0.09	0.00	0.01	0.03	0.01
300	0.00	0.00	0.00	0.00	0.15	0.08	0.27	0.24	1.32	0.61	1.76	1.12	1.74	1.47	0.36	0.12	0.03	0.02	0.04	0.03	0.00	0.00	0.04	0.06	0.80	0.45	1.30	1.74	0.94	0.77	0.04	0.04	0.06	0.06	0.00	0.01	0.04	0.02
310	0.00	0.00	0.00	0.00	0.14	0.09	0.28	0.23	1.09	0.55	1.41	0.96	1.92	1.78	0.22	0.17	0.02	0.02	0.04	0.02	0.00	0.00	0.03	0.03	0.86	0.41	1.77	1.66	0.58	0.50	0.02	0.02	0.03	0.01	0.00	0.00	0.03	0.02
320	0.00	0.00	0.00	0.00	0.13	0.08	0.38	0.29	0.53	0.33	1.74	1.50	2.34	1.71	0.70	0.79	0.02	0.02	0.03	0.02	0.00	0.00	0.04	0.05	1.21	0.63	2.16	1.40	0.57	0.29	0.04	0.03	0.04	0.04	0.00	0.00	0.03	0.02
330	0.00	0.00	0.00	0.00	0.12	0.08	0.33	0.25	0.63	0.33	1.66	1.53	2.23	1.61	0.36	0.49	0.01	0.02	0.03	0.02	0.00	0.00	0.04	0.02	0.94	0.54	1.74	1.04	0.63	0.47	0.07	0.05	0.06	0.05	0.00	0.00	0.03	0.02
340	0.00	0.00	0.00	0.00	0.11	0.06	0.35	0.17	0.43	0.30	1.62	1.35	1.56	0.84	0.15	0.12	0.01	0.01	0.02	0.02	0.00	0.00	0.02	0.02	0.97	0.48	0.83	0.74	0.55	0.34	0.02	0.05	0.06	0.07	0.00	0.00	0.02	0.01
350	0.00	0.00	0.00	0.00	0.10	0.06	0.31	0.16	0.66	0.88	1.65	1.36	2.35	1.08	0.24	0.18	0.01	0.01	0.02	0.01	0.00	0.00	0.03	0.03	0.75	0.37	0.86	0.67	0.56	0.54	0.03	0.03	0.06	0.03	0.00	0.00	0.03	0.02
360	0.00	0.00	0.00	0.00	0.07	0.04	0.20	0.09	0.69	0.80	1.71	1.55	3.16	1.80	0.14	0.08	0.01	0.01	0.02	0.01	0.00	0.00	0.01	0.01	1.06	0.62	0.91	1.03	1.08	0.55	0.03	0.02	0.04	0.02	0.00	0.00	0.02	0.01
370	0.00	0.00	0.00	0.00	0.06	0.05	0.12	0.03	1.21	1.05	1.69	1.55	2.04	1.30	0.16	0.13	0.01	0.01	0.01	0.01	0.00	0.00	0.03	0.03	0.85	0.78	1.12	1.36	0.75	0.83	0.05	0.02	0.02	0.02	0.00	0.00	0.02	0.02
380	0.00	0.00	0.00	0.00	0.05	0.04	0.13	0.05	0.75	0.66	1.53	1.47	1.33	1.21	0.25	0.22	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.02	0.56	0.50	1.11	1.25	1.05	1.08	0.02	0.03	0.02	0.03	0.00	0.00	0.02	0.01
390	0.00	0.00	0.00	0.00	0.04	0.03	0.22	0.15	0.90	0.81	1.36	1.25	1.84	1.23	0.40	0.46	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.46	0.32	1.18	1.32	0.77	0.66	0.03	0.04	0.04	0.07	0.00	0.00	0.01	0.01
400	0.00	0.00	0.00	0.00	0.05	0.04	0.10	0.07	0.65	0.68	1.08	0.95	0.89	0.86	0.20	0.08	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.02	0.50	0.30	1.94	2.22	0.74	0.64	0.02	0.03	0.02	0.04	0.00	0.00	0.01	0.01
410	0.00	0.00	0.00	0.00	0.04	0.03	0.11	0.09	0.87	0.81	0.97	0.90	1.67	1.56	0.21	0.12	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.82	0.50	2.93	3.56	0.45	0.40	0.02	0.02	0.01	0.04	0.00	0.00	0.01	0.01
420	0.00	0.00	0.00	0.00	0.03	0.03	0.13	0.10	0.81	0.70	0.88	0.88	1.07	1.22	0.27	0.19	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.02	0.44	0.30	2.27	2.79	0.66	0.49	0.03	0.02	0.02	0.06	0.00	0.00	0.01	0.01
430	0.00	0.00	0.00	0.00	0.04	0.04	0.14	0.10	0.57	0.47	0.85	0.79	0.98	1.03	0.20	0.20	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.49	0.33	1.36	1.71	0.59	0.39	0.02	0.02	0.03	0.05	0.00	0.00	0.01	0.01
440	0.00	0.00	0.00	0.00	0.05	0.05	0.11	0.08	0.24	0.15	1.53	1.44	0.81	0.85	0.31	0.22	0.01	0.01	0.01	0.01	0.00	0.00	0.02	0.02	0.53	0.32	1.72	1.92	0.38	0.23	0.02	0.02	0.02	0.03	0.00	0.00	0.01	0.01
450	0.00	0.00	0.00	0.00	0.03	0.04	0.19	0.16	0.16	0.26	1.12	0.99	0.65	0.67	0.23	0.11	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.49	0.28	1.79	1.79	0.23	0.14	0.02	0.02	0.02	0.03	0.00	0.00	0.01	0.01
460	0.00	0.00	0.00	0.00	0.02	0.03	0.16	0.13	0.11	0.22	0.82	0.68	0.48	0.49	0.08	0.09	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.02	0.35	0.13	1.42	1.44	0.27	0.12	0.04	0.03	0.02	0.03	0.00	0.00	0.00	0.01
470	0.00	0.00	0.00	0.00	0.01	0.02	0.16	0.12	0.07	0.18	1.04	1.00	0.32	0.30	0.06	0.07	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.02	0.34	0.13	0.96	0.73	0.39	0.20	0.06	0.04	0.01	0.02	0.00	0.00	0.00	0.01
480	0.00	0.00	0.00	0.00	0.01	0.01	0.09	0.07	0.03	0.14	1.08	1.12	0.15	0.12	0.04	0.05	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.24	0.12	0.86	0.80	0.33	0.14	0.05	0.04	0.01	0.01	0.00	0.00	0.00	0.00
490	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.10	-0.01	0.10	0.82	0.81	-0.01	0.00	0.01	0.03	0.01	0.01	0.01	0.01	0.00	0.00	0.02	0.01	0.18	0.06	0.90	1.10	0.27	0.14	0.04	0.03	0.01	0.01	0.00	0.00	0.00	0.00

Year 2 Sand Thickness (feet)
Beach Width = 200'

Distance Offshore (m)	DM565		DM560		DM580		DM590		SD595		SD600		SD610		SD620		SD625		SD630		SD650		SD660		SD670		SD675		SD680		SD690		SD695		SD700		SD710	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
0	0.00	0.00	0.00	0.00	0.24	0.06	0.06	0.04	0.07	0.13	4.46	6.50	2.33	7.79	0.02	0.01	0.00	0.00	0.04	0.04	0.00	0.00	0.00	0.00	0.06	0.02	2.57	2.25	0.01	0.01	0.24	0.24	0.00	0.00	0.01	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.15	0.21	1.23	0.77	0.37	1.13	1.49	3.77	2.53	7.06	0.44	0.43	0.03	0.05	0.15	0.14	0.00	0.01	0.05	0.09	4.00	4.56	6.17	5.73	4.33	3.35	0.24	0.20	0.13	0.14	0.01	0.01	0.04	0.05
20	0.00	0.00	0.00	0.00	0.16	0.33	1.14	0.77	0.73	1.52	3.51	5.76	2.45	5.66	0.70	0.90	0.03	0.07	0.14	0.17	0.00	0.01	0.05	0.12	2.63	4.29	3.87	4.16	3.49	2.87	0.14	0.12	0.12	0.11	0.00	0.01	0.04	0.07
30	0.00	0.00	0.00	0.00	0.13	0.38	1.02	0.74	0.66	1.70	2.72	4.65	2.12	4.72	0.90	1.22	0.07	0.13	0.13	0.19	0.00	0.00	0.05	0.11	4.33	6.44	3.36	4.48	2.74	2.69	0.06	0.06	0.09	0.08	0.00	0.00	0.03	0.07
40	0.00	0.00	0.00	0.00	0.15	0.37	1.03	0.81	0.82	1.92	3.34	5.29	1.73	4.30	0.61	0.86	0.05	0.10	0.15	0.21	0.00	0.00	0.04	0.10	2.99	5.10	4.81	6.84	2.09	2.31	0.04	0.05	0.06	0.07	0.00	0.00	0.04	0.08
50	0.00	0.00	0.00	0.00	0.19	0.36	0.85	0.76	0.85	1.77	3.42	5.42	1.65	4.04	0.35	0.74	0.04	0.07	0.13	0.18	0.00	0.00	0.04	0.08	2.41	4.30	4.72	7.71	1.98	2.20	0.05	0.07	0.04	0.05	0.00	0.00	0.02	0.06
60	0.00	0.00	0.00	0.00	0.20	0.32	0.50	0.60	1.00	1.87	3.06	5.07	1.43	3.40	0.27	0.67	0.04	0.06	0.11	0.15	0.00	0.00	0.04	0.05	2.12	3.84	3.07	6.62	2.05	2.26	0.05	0.08	0.05	0.08	0.00	0.00	0.02	0.05
70	0.00	0.00	0.00	0.00	0.23	0.32	0.43	0.63	1.09	1.83	2.51	4.58	1.64	3.17	0.28	0.66	0.04	0.06	0.12	0.15	0.00	0.00	0.04	0.04	1.96	3.20	3.17	6.49	1.73	2.09	0.05	0.10	0.07	0.10	0.00	0.00	0.01	0.03
80	0.00	0.00	0.00	0.00	0.27	0.35	0.53	0.73	1.07	1.68	2.36	4.42	2.40	3.59	0.38	0.71	0.03	0.06	0.11	0.14	0.00	0.00	0.07	0.07	3.00	4.00	3.45	6.62	1.29	1.85	0.08	0.13	0.06	0.10	0.00	0.00	0.01	0.03
90	0.00	0.00	0.00	0.00	0.23	0.33	0.79	1.00	0.84	1.43	3.50	5.44	3.70	4.31	0.46	0.79	0.02	0.05	0.09	0.12	0.00	0.00	0.14	0.12	3.28	4.08	3.69	6.96	1.39	2.06	0.04	0.09	0.05	0.07	0.00	0.00	0.01	0.03
100	0.00	0.00	0.00	0.00	0.14	0.27	1.22	1.38	0.76	1.53	4.23	5.87	3.95	4.06	0.51	0.84	0.02	0.05	0.08	0.11	0.01	0.00	0.13	0.08	3.50	4.17	3.52	6.83	0.84	1.64	0.09	0.12	0.05	0.04	0.00	0.01	0.02	0.05
110	0.00	0.00	0.00	0.00	0.07	0.23	1.54	1.71	0.51	1.50	3.61	5.04	3.82	3.34	0.52	0.89	0.04	0.07	0.09	0.12	0.01	0.00	0.12	0.07	2.99	3.78	1.53	4.54	0.59	1.44	0.12	0.12	0.07	0.03	0.01	0.01	0.04	0.08
120	0.00	0.00	0.00	0.00	0.14	0.32	1.05	1.48	0.91	2.29	3.50	4.92	5.82	4.64	0.53	0.96	0.03	0.07	0.10	0.13	0.01	0.00	0.12	0.05	3.43	4.37	1.48	3.86	1.05	1.92	0.11	0.08	0.10	0.03	0.01	0.01	0.04	0.08
130	0.00	0.00	0.00	0.00	0.16	0.33	0.81	1.40	1.07	2.78	3.51	4.80	2.69	2.14	0.68	1.02	0.03	0.06	0.11	0.14	0.01	0.00	0.09	0.04	3.91	4.94	1.77	3.19	1.41	2.33	0.09	0.05	0.09	0.03	0.01	0.01	0.04	0.08
140	0.00	0.00	0.00	0.00	0.25	0.39	0.78	1.40	0.95	2.74	3.85	4.69	4.41	4.16	0.72	0.96	0.05	0.06	0.12	0.15	0.01	0.00	0.07	0.04	3.35	4.39	2.97	3.25	1.25	2.12	0.06	0.03	0.06	0.02	0.01	0.01	0.05	0.08
150	0.00	0.00	0.00	0.00	0.33	0.44	0.84	1.41	0.69	2.43	4.40	4.39	3.62	2.96	0.72	0.86	0.08	0.08	0.13	0.16	0.00	0.00	0.06	0.05	3.44	4.25	4.81	3.57	1.20	1.89	0.06	0.04	0.03	0.02	0.01	0.01	0.05	0.07
160	0.00	0.00	0.00	0.00	0.32	0.39	1.21	1.65	0.79	2.01	4.90	4.03	2.81	1.41	0.73	0.75	0.10	0.08	0.13	0.15	0.00	0.00	0.02	0.05	3.33	3.77	5.85	3.13	1.40	1.40	0.05	0.05	0.03	0.02	0.01	0.01	0.04	0.05
170	0.00	0.00	0.00	0.00	0.30	0.32	1.42	1.75	1.35	1.81	4.90	3.26	2.30	1.30	0.74	0.66	0.10	0.07	0.12	0.12	0.00	0.00	0.08	0.09	3.23	3.23	6.17	2.28	1.50	1.34	0.05	0.05	0.04	0.03	0.01	0.01	0.04	0.04
180	0.00	0.00	0.00	0.00	0.28	0.23	0.99	1.40	1.61	1.49	4.78	2.76	3.10	1.54	0.74	0.53	0.09	0.06	0.12	0.11	0.00	0.00	0.04	0.03	2.97	2.49	7.77	2.70	1.30	1.14	0.04	0.05	0.03	0.05	0.01	0.01	0.04	0.02
190	0.00	0.00	0.00	0.00	0.34	0.22	0.72	1.14	1.95	1.09	4.15	2.09	4.19	2.61	0.73	0.41	0.09	0.05	0.12	0.10	0.00	0.00	0.04	0.04	2.88	2.00	6.43	2.08	1.12	1.27	0.06	0.06	0.04	0.04	0.01	0.01	0.04	0.02
200	0.00	0.00	0.00	0.00	0.37	0.23	0.52	0.88	2.31	0.91	3.78	1.66	2.88	1.48	0.78	0.43	0.09	0.05	0.11	0.09	0.00	0.00	0.06	0.06	2.80	1.69	5.02	2.15	1.13	1.34	0.07	0.07	0.05	0.05	0.01	0.01	0.03	0.01
210	0.00	0.00	0.00	0.00	0.38	0.20	0.81	0.92	2.71	1.09	3.46	1.23	4.50	2.94	0.81	0.44	0.08	0.04	0.11	0.07	0.00	0.00	0.07	0.03	2.76	1.56	4.00	1.87	1.10	1.65	0.07	0.10	0.07	0.05	0.01	0.00	0.03	0.01
220	0.00	0.00	0.00	0.00	0.34	0.17	0.90	0.66	2.66	0.79	3.03	0.80	3.78	2.60	0.79	0.44	0.07	0.03	0.10	0.06	0.00	0.00	0.06	0.03	2.12	0.83	2.87	1.36	1.55	0.90	0.09	0.12	0.06	0.03	0.01	0.00	0.06	0.02
230	0.00	0.00	0.00	0.00	0.30	0.12	0.94	0.54	2.52	0.71	2.81	0.70	3.11	2.05	0.73	0.42	0.07	0.03	0.09	0.06	0.01	0.01	0.05	0.03	2.34	0.96	2.65	1.80	0.85	0.52	0.15	0.18	0.06	0.05	0.01	0.00	0.06	0.02
240	0.00	0.00	0.00	0.00	0.27	0.10	0.66	0.40	2.29	0.73	2.78	1.02	2.15	1.44	0.73	0.42	0.06	0.03	0.09	0.05	0.01	0.01	0.07	0.06	1.79	0.65	2.52	1.50	1.29	1.46	0.14	0.11	0.07	0.03	0.01	0.00	0.04	0.01
250	0.00	0.00	0.00	0.00	0.25	0.09	0.74	0.45	2.52	0.86	2.52	1.02	2.09	1.72	0.76	0.46	0.06	0.03	0.08	0.05	0.01	0.01	0.07	0.05	1.70	0.66	1.83	0.85	3.51	2.93	0.13	0.10	0.08	0.05	0.01	0.01	0.06	0.02
260	0.00	0.00	0.00	0.00	0.23	0.09	0.92	0.52	2.15	0.86	2.29	0.92	2.50	2.17	0.68	0.42	0.05	0.03	0.08	0.05	0.00	0.01	0.06	0.02	1.55	0.60	1.99	0.63	2.16	1.84	0.11	0.14	0.03	0.03	0.00	0.01	0.06	0.02
270	0.00	0.00	0.00	0.00	0.22	0.08	0.82	0.42	1.81	0.52	2.35	1.17	4.10	3.68	0.61	0.33	0.05	0.03	0.08	0.05	0.00	0.00	0.04	0.02	2.47	1.66	1.84	0.69	1.65	1.33	0.08	0.10	0.03	0.05	0.00	0.01	0.05	0.03
280	0.00	0.00	0.00	0.00	0.20	0.07	0.43	0.32	1.65	0.39	2.02	0.86	3.75	2.47	0.58	0.25	0.05	0.03	0.08	0.05	0.00	0.00	0.09	0.07	1.26	0.58	2.92	1.57	1.14	0.98	0.05	0.08	0.05	0.05	0.00	0.01	0.04	0.02
290	0.00	0.00	0.00	0.00	0.19	0.08	0.24	0.23	2.03	0.85	2.26	1.33	3.58	2.68	0.58	0.21	0.04	0.03	0.07	0.04	0.00	0.00	0.08	0.05	1.28	0.83	3.14	2.76	0.71	0.85	0.07	0.05	0.08	0.12	0.01	0.01	0.04	0.01
300	0.00	0.00	0.00	0.00	0.18	0.10	0.40	0.35	1.91	0.88	2.24	1.43	2.23	1.88	0.54	0.18	0.03	0.03	0.06	0.04	0.01	0.01	0.08	0.11	1.12	0.63	1.63	2.19	1.34	1.10	0.06	0.07	0.08	0.08	0.01	0.01	0.04	0.02
310	0.00	0.00	0.00	0.00	0.17	0.11	0.41	0.33	1.58	0.79	1.80	1.23	2.46	2.29	0.33	0.26	0.03	0.03	0.06	0.03	0.01	0.00	0.06	0.05	1.21	0.58	2.22	2.09	0.84	0.72	0.04	0.04	0.04	0.01	0.00	0.01	0.04	0.02
320	0.00	0.00	0.00	0.00	0.15	0.10	0.56	0.43	0.76	0.47	2.21	1.90	3.00	2.19	1.07	1.21	0.02	0.02	0.05	0.03	0.01	0.01	0.08	0.10	1.70	0.88	2.71	1.75	0.81	0.41	0.07	0.05	0.05	0.05	0.00	0.00	0.03	0.02
330	0.00	0.00	0.00	0.00	0.14	0.09	0.48	0.36	0.91	0.48	2.11	1.95	2.86	2.07	0.56	0.74	0.02	0.02	0.04	0.02	0.00	0.00	0.08	0.05	1.31	0.76	2.19	1.31	0.90	0.68	0.13	0.09	0.08	0.07	0.00	0.00	0.03	0.02
340	0.00	0.00	0.00	0.00	0.13	0.07	0.51	0.26	0.62	0.43	2.06	1.72	2.00	1.08	0.22	0.19	0.02	0.02	0.04	0.02	0.00	0.00	0.03	0.03	1.36	0.68	1.05	0.93	0.79	0.49	0.04	0.08	0.08	0.09	0.00	0.00	0.03	0.01
350	0.00	0.00	0.00	0.00	0.12	0.07	0.45	0.24	0.95	1.27	2.10	1.73	3.01	1.39	0.37	0.28	0.02	0.02	0.03	0.02	0.00	0.00	0.05	0.05	1.05	0.53	1.07	0.85	0.80	0.78	0.05	0.06	0.07	0.03	0.00	0.00	0.03	0.02
360	0.00	0.00	0.00	0.00	0.09	0.05	0.30	0.14	1.00	1.16	2.17	1.97	4.04	2.31	0.21	0.12	0.02	0.02	0.03	0.01	0.00	0.00	0.02	0.02	1.49	0.87	1.14	1.30	1.55	0.79	0.06	0.03	0.06	0.03	0.00	0.00	0.03	0.02
370	0.00	0.00	0.00	0.00	0.07	0.06	0.18	0.05	1.75	1.52	2.14	1.97	2.62	1.66	0.24	0.20	0.02	0.02	0.02	0.01	0.00	0.00	0.05	0.06	1.20	1.09	1.40	1.71	1.07	1.18	0.08	0.04	0.03	0.03	0.00	0.00	0.03	0.02
380	0.00	0.00	0.00	0.00	0.06	0.05	0.20	0.08	1.08	0.96	1.94	1.87	1.70	1.55	0.39	0.33	0.02	0.01	0.02	0.02	0.00	0.00	0.03	0.04	0.79	0.70	1.40	1.57	1.50	1.54	0.03	0.05	0.03	0.05	0.00	0.00	0.02	0.01
390	0.00	0.00	0.00	0.00	0.05	0.04	0.32	0.21	1.31	1.17	1.73	1.59	2.36	1.57	0.60	0.70	0.01	0.01	0.02	0.02	0.00	0.00	0.01	0.03	0.64	0.45	1.48	1.65	1.10	0.94	0.05	0.07	0.06	0.10	0.00	0.00	0.01	0.01
400	0.00	0.00	0.00	0.00	0.06	0.05	0.15	0.11	0.93	0.98	1.37	1.21	1.14	1.10	0.31	0.13	0.01	0.01	0.02	0.01	0.00	0.00	0.03	0.05	0.70	0.42	2.44	2.79	1.05	0.92	0.04	0.05	0.02	0.06	0.00	0.00	0.01	0.01
410	0.00	0.00	0.00	0.00	0.05	0.04	0.17	0.14	1.25	1.17	1.23	1.14	2.14	2.00	0.32	0.19	0.01	0.01	0.02	0.01	0.00	0.00	0.01	0.02	1.15	0.70	3.68	4.47	0.65	0.58	0.04	0.03	0.02	0.05	0.00	0.00	0.01	0.01
420	0.00	0.00	0.00	0.00	0.04	0.04	0.19	0.15	1.18	1.02	1.12	1.11	1.37	1.56	0.41	0.30	0.01	0.01	0.01	0.01	0.00	0.00	0.03	0.04	0.62	0.42	2.86	3.51	0.94	0.70	0.05	0.04	0.03	0.08	0.00	0.00	0.01	0.01
430	0.00	0.00	0.00	0.00	0.04	0.05	0.20	0.15	0.82	0.69	1.08	1.00	1.25	1.32	0.31	0.31	0.01	0.01	0.02	0.02	0.00	0.00	0.01	0.02	0.69	0.47	1.71	2.15	0.85	0.56	0.04	0.04	0.04	0.07	0.00	0.00	0.01	0.01
440	0.00	0.00	0.00	0.00	0.06	0.07	0.16	0.12	0.35	0.21	1.94	1.83	1.04	1.09	0.48	0.33	0.01	0.02	0.02	0.01	0.00	0.00	0.04	0.03	0.74	0.46	2.16	2.41	0.54	0.32	0.04	0.04	0.03	0.05	0.00	0.00	0.02	0.02
450	0.00	0.00	0.00	0.00	0.04	0.05	0.29	0.23	0.23	0.38	1.42	1.26	0.83	0.86	0.35	0.17	0.01	0.01	0.02	0.01	0.00	0.00	0.02	0.03	0.68	0.40	2.25	2.25	0.33	0.19	0.04	0.04	0.03	0.05	0.00	0.00	0.01	0.01
460	0.00	0.00	0.00	0.00	0.03	0.04	0.24	0.19	0.17	0.32	1.05	0.87	0.62	0.62	0.11	0.13	0.01	0.01	0.01	0.01	0.00	0.00	0.02	0.04	0.49	0.19	1.78	1.81	0.38	0.17	0.07	0.06	0.02	0.04	0.00	0.00	0.01	0.01
470	0.00	0.00	0.00	0.00	0.02	0.02	0.24	0.18	0.11	0.26	1.32	1.27	0.41	0.39	0.08	0.10	0.01	0.01	0.01	0.01	0.00	0.00	0.02	0.04	0.48	0.19	1.20	0.92	0.56	0.29	0.10	0.08	0.01	0.03	0.00	0.00	0.00	0.01
480	0.00	0.00	0.00	0.00	0.01	0.01	0.13	0.10	0.05	0.20	1.38	1.42	0.20	0.15	0.05	0.07	0.02	0.01	0.01	0.01	0.00	0.00	0.02	0.03	0.33	0.17	1.08	1.01	0.48	0.21	0.10	0.07	0.01	0.02	0.00	0.00	0.00	0.01
490	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.15	-0.01	0.14	1.04	1.03	-0.01	0.00	0.02	0.04	0.01	0.02	0.01	0.01	0.00	0.00	0.03	0.02	0.25	0.08	1.13	1.39	0.39	0.20	0.08	0.06	0.01	0.01	0.00	0.00	0.00	0.00

Year 2 Sand Thickness (feet)																																						
Beach Width = 250'																																						
Distance Offshore	DM565		DM560		DM580		DM590		SD595		SD600		SD610		SD620		SD625		SD630		SD650		SD660		SD670		SD675		SD680		SD690		SD695		SD700		SD710	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
0	0.00	0.00	0.00	0.00	0.27	0.07	0.08	0.05	0.09	0.16	5.27	7.67	2.75	9.20	0.03	0.01	0.00	0.00	0.06	0.05	0.00	0.00	0.00	0.00	0.08	0.03	3.06	2.68	0.01	0.01	0.43	0.43	0.00	0.00	0.01	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.17	0.24	1.60	1.00	0.46	1.41	1.75	4.45	2.98	8.34	0.62	0.60	0.04	0.06	0.21	0.20	0.01	0.01	0.08	0.14	5.15	5.87	7.37	6.84	5.61	4.34	0.42	0.35	0.18	0.19	0.01	0.01	0.05	0.06
20	0.00	0.00	0.00	0.00	0.18	0.37	1.48	1.00	0.92	1.90	4.14	6.80	2.90	6.68	0.98	1.26	0.03	0.09	0.19	0.24	0.01	0.01	0.07	0.19	3.39	5.53	4.62	4.97	4.53	3.72	0.24	0.20	0.15	0.14	0.01	0.01	0.05	0.09
30	0.00	0.00	0.00	0.00	0.15	0.43	1.33	0.97	0.83	2.13	3.22	5.49	2.50	5.57	1.26	1.71	0.09	0.16	0.18	0.26	0.01	0.01	0.07	0.18	5.57	8.30	4.01	5.34	3.56	3.49	0.11	0.11	0.11	0.11	0.00	0.01	0.04	0.09
40	0.00	0.00	0.00	0.00	0.17	0.42	1.34	1.05	1.03	2.41	3.94	6.24	2.05	5.08	0.85	1.20	0.07	0.12	0.21	0.30	0.00	0.00	0.07	0.15	3.85	6.57	5.74	8.17	2.71	3.00	0.07	0.09	0.09	0.09	0.00	0.00	0.05	0.10
50	0.00	0.00	0.00	0.00	0.21	0.41	1.10	0.99	1.07	2.22	4.03	6.40	1.95	4.77	0.49	1.03	0.05	0.09	0.19	0.25	0.00	0.00	0.07	0.13	3.11	5.54	5.63	9.21	2.56	2.85	0.09	0.12	0.05	0.07	0.00	0.00	0.02	0.07
60	0.00	0.00	0.00	0.00	0.23	0.37	0.65	0.79	1.25	2.35	3.61	5.99	1.69	4.01	0.38	0.94	0.05	0.08	0.15	0.21	0.00	0.00	0.06	0.09	2.73	4.95	3.67	7.91	2.66	2.93	0.09	0.14	0.07	0.11	0.00	0.00	0.02	0.06
70	0.00	0.00	0.00	0.00	0.26	0.37	0.56	0.82	1.37	2.29	2.97	5.41	1.93	3.74	0.39	0.92	0.05	0.07	0.17	0.21	0.01	0.01	0.06	0.07	2.52	4.12	3.79	7.75	2.25	2.71	0.09	0.17	0.09	0.14	0.00	0.00	0.01	0.04
80	0.00	0.00	0.00	0.00	0.30	0.40	0.69	0.95	1.34	2.11	2.79	5.22	2.84	4.24	0.53	0.99	0.04	0.07	0.16	0.19	0.01	0.01	0.11	0.11	3.86	5.15	4.11	7.91	1.67	2.40	0.14	0.22	0.09	0.13	0.00	0.00	0.01	0.03
90	0.00	0.00	0.00	0.00	0.27	0.37	1.03	1.30	1.05	1.79	4.13	6.42	4.37	5.09	0.64	1.11	0.03	0.07	0.13	0.16	0.01	0.01	0.22	0.19	4.22	5.26	4.40	8.31	1.80	2.68	0.08	0.15	0.07	0.09	0.00	0.00	0.01	0.04
100	0.00	0.00	0.00	0.00	0.16	0.31	1.59	1.80	0.95	1.91	4.99	6.92	4.67	4.80	0.71	1.18	0.03	0.06	0.12	0.16	0.01	0.01	0.20	0.12	4.51	5.37	4.20	8.15	1.09	2.13	0.16	0.22	0.07	0.05	0.00	0.01	0.03	0.06
110	0.00	0.00	0.00	0.00	0.08	0.26	1.99	2.23	0.63	1.88	4.26	5.95	4.51	3.95	0.72	1.25	0.05	0.09	0.13	0.18	0.01	0.01	0.18	0.12	3.85	4.87	1.82	5.42	0.77	1.86	0.22	0.22	0.09	0.04	0.01	0.01	0.05	0.10
120	0.00	0.00	0.00	0.00	0.16	0.36	1.37	1.93	1.14	2.86	4.13	5.80	6.88	5.48	0.74	1.35	0.04	0.09	0.15	0.19	0.01	0.01	0.18	0.08	4.42	5.63	1.77	4.61	1.36	2.49	0.19	0.13	0.13	0.04	0.01	0.01	0.05	0.11
130	0.00	0.00	0.00	0.00	0.18	0.37	1.05	1.81	1.34	3.48	4.14	5.66	3.18	2.52	0.95	1.43	0.04	0.07	0.16	0.19	0.01	0.00	0.14	0.06	5.03	6.37	2.12	3.81	1.83	3.02	0.16	0.08	0.12	0.05	0.01	0.01	0.05	0.10
140	0.00	0.00	0.00	0.00	0.29	0.45	1.01	1.82	1.19	3.43	4.55	5.54	5.21	4.91	1.01	1.34	0.06	0.08	0.18	0.21	0.01	0.00	0.10	0.07	4.32	5.65	3.55	3.88	1.63	2.74	0.11	0.05	0.08	0.03	0.01	0.01	0.06	0.10
150	0.00	0.00	0.00	0.00	0.38	0.50	1.09	1.83	0.87	3.05	5.20	5.18	4.27	3.50	1.00	1.20	0.10	0.10	0.19	0.22	0.01	0.00	0.09	0.07	4.43	5.48	5.75	4.27	1.56	2.46	0.10	0.08	0.04	0.03	0.01	0.01	0.06	0.08
160	0.00	0.00	0.00	0.00	0.36	0.45	1.57	2.15	0.99	2.51	5.79	4.76	3.32	1.66	1.02	1.05	0.12	0.10	0.19	0.21	0.01	0.01	0.02	0.08	4.29	4.86	6.99	3.74	1.81	1.81	0.09	0.09	0.04	0.03	0.01	0.01	0.06	0.07
170	0.00	0.00	0.00	0.00	0.34	0.37	1.84	2.27	1.69	2.27	5.78	3.85	2.71	1.53	1.03	0.92	0.12	0.09	0.17	0.18	0.01	0.01	0.13	0.14	4.16	4.16	7.37	2.72	1.94	1.74	0.08	0.09	0.05	0.04	0.01	0.01	0.05	0.04
180	0.00	0.00	0.00	0.00	0.32	0.26	1.28	1.82	2.02	1.86	5.64	3.26	3.66	1.82	1.03	0.75	0.12	0.07	0.17	0.16	0.00	0.00	0.06	0.04	3.83	3.21	9.28	3.22	1.69	1.47	0.08	0.08	0.04	0.06	0.01	0.01	0.05	0.02
190	0.00	0.00	0.00	0.00	0.38	0.25	0.94	1.48	2.44	1.36	4.90	2.47	4.95	3.08	1.02	0.57	0.11	0.07	0.17	0.14	0.01	0.01	0.06	0.06	3.71	2.58	7.68	2.48	1.45	1.64	0.10	0.10	0.05	0.05	0.01	0.01	0.06	0.03
200	0.00	0.00	0.00	0.00	0.43	0.26	0.68	1.14	2.90	1.14	4.46	1.95	3.40	1.75	1.10	0.61	0.11	0.06	0.16	0.13	0.01	0.01	0.09	0.10	3.61	2.17	5.99	2.57	1.46	1.74	0.13	0.12	0.07	0.06	0.01	0.01	0.04	0.02
210	0.00	0.00	0.00	0.00	0.43	0.23	1.05	1.19	3.39	1.37	4.08	1.45	5.31	3.47	1.13	0.62	0.10	0.05	0.15	0.10	0.01	0.01	0.10	0.05	3.55	2.01	4.78	2.23	1.42	2.14	0.12	0.18	0.10	0.07	0.01	0.01	0.03	0.01
220	0.00	0.00	0.00	0.00	0.39	0.19	1.17	0.86	3.33	0.99	3.57	0.94	4.46	3.07	1.10	0.61	0.09	0.04	0.14	0.09	0.01	0.01	0.09	0.05	2.73	1.07	3.42	1.62	2.01	1.17	0.16	0.20	0.07	0.04	0.01	0.00	0.07	0.03
230	0.00	0.00	0.00	0.00	0.34	0.14	1.22	0.70	3.15	0.88	3.31	0.82	3.68	2.42	1.02	0.59	0.09	0.04	0.13	0.08	0.01	0.01	0.07	0.04	3.02	1.24	3.16	2.15	1.10	0.67	0.26	0.31	0.08	0.07	0.01	0.00	0.08	0.03
240	0.00	0.00	0.00	0.00	0.31	0.12	0.86	0.52	2.86	0.91	3.28	1.20	2.54	1.70	1.03	0.59	0.08	0.04	0.13	0.08	0.01	0.01	0.11	0.10	2.31	0.84	3.01	1.80	1.67	1.89	0.25	0.18	0.09	0.03	0.01	0.01	0.05	0.01
250	0.00	0.00	0.00	0.00	0.28	0.10	0.97	0.58	3.16	1.08	2.97	1.20	2.47	2.04	1.06	0.64	0.07	0.04	0.12	0.07	0.01	0.01	0.12	0.08	2.19	0.85	2.18	1.02	4.55	3.80	0.23	0.18	0.11	0.07	0.01	0.01	0.08	0.02
260	0.00	0.00	0.00	0.00	0.26	0.10	1.20	0.67	2.69	1.08	2.70	1.08	2.96	2.56	0.96	0.60	0.06	0.04	0.11	0.07	0.01	0.01	0.09	0.03	1.99	0.77	2.37	0.76	2.81	2.39	0.19	0.25	0.04	0.04	0.01	0.01	0.07	0.03
270	0.00	0.00	0.00	0.00	0.25	0.09	1.07	0.55	2.26	0.66	2.77	1.38	4.84	4.35	0.86	0.46	0.06	0.04	0.11	0.07	0.01	0.01	0.06	0.04	3.18	2.14	2.20	0.83	2.14	1.72	0.13	0.17	0.04	0.06	0.00	0.01	0.06	0.04
280	0.00	0.00	0.00	0.00	0.23	0.08	0.56	0.42	2.07	0.49	2.38	1.01	4.43	2.92	0.82	0.35	0.06	0.04	0.11	0.07	0.01	0.01	0.15	0.12	1.63	0.75	3.49	1.87	1.48	1.27	0.10	0.14	0.07	0.06	0.01	0.01	0.05	0.02
290	0.00	0.00	0.00	0.00	0.21	0.09	0.31	0.30	2.55	1.06	2.67	1.57	4.22	3.16	0.81	0.30	0.05	0.04	0.09	0.06	0.00	0.00	0.13	0.09	1.65	1.07	3.75	3.30	0.93	1.10	0.11	0.08	0.11	0.16	0.01	0.01	0.05	0.01
300	0.00	0.00	0.00	0.00	0.21	0.11	0.52	0.46	2.39	1.10	2.65	1.68	2.64	2.22	0.76	0.25	0.04	0.03	0.09	0.06	0.01	0.01	0.13	0.18	1.45	0.81	1.95	2.61	1.74	1.43	0.11	0.13	0.11	0.10	0.01	0.01	0.05	0.02
310	0.00	0.00	0.00	0.00	0.20	0.13	0.53	0.43	1.98	0.99	2.12	1.45	2.91	2.70	0.46	0.37	0.03	0.03	0.08	0.05	0.01	0.01	0.10	0.08	1.55	0.75	2.65	2.50	1.08	0.93	0.08	0.06	0.05	0.01	0.00	0.01	0.05	0.02
320	0.00	0.00	0.00	0.00	0.17	0.12	0.72	0.56	0.95	0.59	2.61	2.25	3.54	2.59	1.50	1.70	0.03	0.03	0.07	0.04	0.01	0.01	0.13	0.15	2.20	1.14	3.24	2.10	1.05	0.53	0.12	0.08	0.07	0.07	0.00	0.00	0.04	0.02
330	0.00	0.00	0.00	0.00	0.16	0.11	0.62	0.47	1.13	0.60	2.49	2.30	3.38	2.44	0.78	1.04	0.02	0.03	0.06	0.03	0.01	0.01	0.13	0.08	1.69	0.98	2.61	1.57	1.16	0.88	0.23	0.16	0.11	0.10	0.00	0.00	0.04	0.02
340	0.00	0.00	0.00	0.00	0.15	0.08	0.66	0.33	0.78	0.54	2.44	2.03	2.36	1.28	0.32	0.27	0.02	0.02	0.05	0.03	0.01	0.01	0.05	0.05	1.76	0.87	1.25	1.11	1.02	0.64	0.08	0.15	0.11	0.12	0.01	0.01	0.03	0.02
350	0.00	0.00	0.00	0.00	0.13	0.08	0.58	0.31	1.19	1.59	2.48	2.05	3.56	1.64	0.52	0.39	0.02	0.02	0.04	0.03	0.00	0.01	0.08	0.08	1.35	0.68	1.28	1.01	1.03	1.01	0.09	0.10	0.10	0.05	0.00	0.00	0.04	0.03
360	0.00	0.00	0.00	0.00	0.10	0.06	0.38	0.18	1.25	1.46	2.56	2.33	4.78	2.73	0.30	0.17	0.02	0.02	0.04	0.02	0.00	0.00	0.03	0.04	1.92	1.12	1.37	1.55	2.01	1.02	0.10	0.05	0.08	0.04	0.00	0.00	0.03	0.02
370	0.00	0.00	0.00	0.00	0.08	0.06	0.23	0.06	2.19	1.90	2.53	2.33	3.09	1.97	0.34	0.29	0.02	0.02	0.03	0.02	0.00	0.00	0.08	0.09	1.54	1.40	1.67	2.04	1.39	1.53	0.15	0.07	0.04	0.03	0.00	0.00	0.03	0.02
380	0.00	0.00	0.00	0.00	0.07	0.06	0.25	0.10	1.35	1.20	2.29	2.21	2.01	1.83	0.54	0.46	0.02	0.02	0.03	0.02	0.00	0.01	0.04	0.06	1.02	0.90	1.67	1.87	1.95	2.00	0.05	0.08	0.04	0.06	0.00	0.00	0.02	0.02
390	0.00	0.00	0.00	0.00	0.06	0.04	0.42	0.28	1.64	1.46	2.04	1.88	2.79	1.85	0.85	0.99	0.02	0.01	0.02	0.02	0.00	0.01	0.02	0.04	0.83	0.58	1.77	1.98	1.43	1.21	0.09	0.13	0.08	0.13	0.00	0.00	0.02	0.01
400	0.00	0.00	0.00	0.00	0.07	0.06	0.19	0.14	1.17	1.23	1.61	1.43	1.35	1.30	0.43	0.18	0.02	0.01	0.02	0.02	0.00	0.00	0.04	0.07	0.90	0.54	2.92	3.33	1.36	1.19	0.08	0.10	0.03	0.08	0.00	0.00	0.01	0.01
410	0.00	0.00	0.00	0.00	0.06	0.05	0.22	0.18	1.57	1.46	1.45	1.34	2.53	2.36	0.45	0.26	0.02	0.01	0.02	0.02	0.00	0.00	0.02	0.04	1.49	0.90	4.39	5.34	0.84	0.75	0.07	0.06	0.02	0.07	0.00	0.00	0.01	0.01
420	0.00	0.00	0.00	0.00	0.05	0.04	0.25	0.20	1.47	1.27	1.32	1.31	1.62	1.84	0.57	0.42	0.02	0.01	0.02	0.01	0.00	0.00	0.05	0.07	0.80	0.54	3.41	4.19	1.22	0.90	0.08	0.07	0.04	0.10	0.00	0.00	0.01	0.01
430	0.00	0.00	0.00	0.00	0.05	0.05	0.27	0.20	1.03	0.86	1.27	1.18	1.48	1.56	0.44	0.43	0.01	0.01	0.03	0.02	0.00	0.00	0.02	0.03	0.88	0.60	2.04	2.57	1.10	0.73	0.07	0.07	0.05	0.10	0.00	0.00	0.01	0.01
440	0.00	0.00	0.00	0.00	0.07	0.08	0.21	0.16	0.43	0.27	2.30	2.16	1.23	1.29	0.67	0.47	0.02	0.02	0.02	0.02	0.00	0.00	0.06	0.05	0.96	0.59	2.58	2.87	0.70	0.42	0.07	0.08	0.04	0.06	0.00	0.00	0.02	0.02
450	0.00	0.00	0.00	0.00	0.04	0.06	0.37	0.30	0.28	0.48	1.68	1.49	0.98	1.01	0.49	0.23	0.01	0.02	0.03	0.02	0.00	0.00	0.03	0.04	0.88	0.51	2.69	2.69	0.43	0.25	0.07	0.07	0.04	0.06	0.00	0.00	0.01	0.01
460	0.00	0.00	0.00	0.00	0.03	0.04	0.31	0.24	0.21	0.40	1.24	1.02	0.73	0.73	0.15	0.18	0.02	0.01	0.01	0.01	0.01	0.00	0.03	0.06	0.63	0.24	2.13	2.16	0.49	0.22	0.11	0.11	0.03	0.05	0.00	0.00	0.01	0.01
470	0.00	0.00	0.00	0.00	0.02	0.03	0.31	0.23	0.13	0.33	1.56	1.50	0.48	0.46	0.11	0.14	0.02	0.01	0.01	0.02	0.01	0.00	0.04	0.07	0.62	0.24	1.43	1.10	0.72	0.37	0.18	0.13	0.02	0.04	0.00	0.00	0.01	0.01
480	0.00	0.00	0.00	0.00	0.01	0.01	0.17	0.12	0.06	0.25	1.63	1.68	0.23	0.18	0.07	0.10	0.02	0.02	0.02	0.02	0.00	0.00	0.03	0.04	0.43	0.21	1.29	1.20	0.62	0.27	0.17	0.12	0.01	0.02	0.00	0.00	0.01	0.01
490	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.19	-0.02	0.18	1.23	1.21	-0.02	0.00	0.03	0.06	0.02	0.02	0.01	0.01	0.00	0.00	0.05	0.03	0.32	0.11	1.34	1.65	0.51	0.26	0.13	0.10	0.02	0.02	0.00	0.00	0.00	0.00

Year 2 Sand Thickness (feet)
Beach Width = 300'

Distance Offshore	DM565		DM560		DM580		DM590		SD595		SD600		SD610		SD620		SD625		SD630		SD650		SD660		SD670		SD675		SD680		SD690		SD695		SD700		SD710	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
0	0.00	0.00	0.00	0.00	0.30	0.08	0.10	0.07	0.12	0.20	6.21	9.04	3.25	10.86	0.04	0.01	0.00	0.00	0.08	0.07	0.00	0.00	0.01	0.01	0.10	0.04	3.56	3.11	0.02	0.01	0.68	0.68	0.00	0.00	0.01	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.19	0.26	1.96	1.22	0.58	1.78	2.07	5.24	3.52	9.85	0.80	0.78	0.04	0.07	0.28	0.27	0.01	0.01	0.11	0.21	6.29	7.17	8.56	7.94	6.86	5.31	0.68	0.56	0.23	0.25	0.01	0.01	0.06	0.08
20	0.00	0.00	0.00	0.00	0.20	0.41	1.82	1.23	1.16	2.39	4.88	8.02	3.42	7.89	1.27	1.63	0.04	0.11	0.25	0.32	0.01	0.01	0.10	0.28	4.14	6.75	5.36	5.77	5.54	4.56	0.38	0.32	0.20	0.19	0.01	0.01	0.06	0.11
30	0.00	0.00	0.00	0.00	0.16	0.48	1.62	1.18	1.05	2.68	3.79	6.47	2.95	6.58	1.63	2.20	0.10	0.19	0.24	0.35	0.01	0.01	0.11	0.26	6.80	10.13	4.65	6.20	4.35	4.27	0.17	0.17	0.15	0.14	0.00	0.01	0.05	0.11
40	0.00	0.00	0.00	0.00	0.19	0.47	1.65	1.29	1.30	3.04	4.64	7.36	2.42	5.99	1.10	1.55	0.08	0.14	0.28	0.39	0.01	0.01	0.10	0.23	4.70	8.02	6.66	9.48	3.31	3.67	0.11	0.14	0.11	0.11	0.00	0.00	0.06	0.12
50	0.00	0.00	0.00	0.00	0.24	0.45	1.35	1.21	1.35	2.80	4.76	7.54	2.31	5.64	0.64	1.33	0.06	0.11	0.25	0.33	0.00	0.01	0.10	0.19	3.80	6.77	6.54	10.68	3.14	3.49	0.15	0.19	0.07	0.09	0.00	0.00	0.03	0.09
60	0.00	0.00	0.00	0.00	0.26	0.41	0.79	0.96	1.58	2.96	4.26	7.06	2.00	4.74	0.49	1.21	0.06	0.09	0.20	0.28	0.00	0.01	0.08	0.13	3.33	6.04	4.26	9.18	3.25	3.58	0.15	0.23	0.08	0.14	0.00	0.00	0.03	0.07
70	0.00	0.00	0.00	0.00	0.29	0.41	0.68	1.00	1.72	2.88	3.50	6.37	2.28	4.42	0.51	1.19	0.06	0.09	0.22	0.28	0.01	0.01	0.08	0.10	3.08	5.03	4.40	8.99	2.75	3.31	0.15	0.27	0.12	0.18	0.00	0.00	0.01	0.05
80	0.00	0.00	0.00	0.00	0.34	0.44	0.84	1.16	1.69	2.65	3.28	6.16	3.35	5.01	0.68	1.28	0.05	0.09	0.21	0.25	0.01	0.01	0.16	0.16	4.71	6.29	4.77	9.18	2.04	2.94	0.23	0.36	0.11	0.17	0.00	0.00	0.01	0.04
90	0.00	0.00	0.00	0.00	0.29	0.42	1.26	1.60	1.32	2.26	4.87	7.57	5.15	6.00	0.83	1.43	0.04	0.08	0.17	0.22	0.01	0.01	0.32	0.28	5.15	6.42	5.11	9.64	2.20	3.28	0.12	0.24	0.09	0.12	0.00	0.00	0.02	0.05
100	0.00	0.00	0.00	0.00	0.17	0.34	1.94	2.20	1.20	2.41	5.89	8.16	5.51	5.66	0.92	1.53	0.04	0.07	0.16	0.21	0.01	0.01	0.29	0.18	5.50	6.56	4.88	9.46	1.33	2.61	0.26	0.35	0.08	0.07	0.01	0.01	0.03	0.08
110	0.00	0.00	0.00	0.00	0.09	0.29	2.44	2.73	0.80	2.36	5.03	7.02	5.33	4.66	0.93	1.61	0.06	0.10	0.18	0.23	0.02	0.01	0.27	0.17	4.70	5.95	2.11	6.29	0.94	2.28	0.34	0.35	0.12	0.05	0.01	0.01	0.07	0.13
120	0.00	0.00	0.00	0.00	0.18	0.40	1.68	2.36	1.44	3.61	4.86	6.84	8.12	6.47	0.96	1.74	0.05	0.10	0.19	0.24	0.01	0.01	0.27	0.12	5.39	6.87	2.05	5.35	1.67	3.05	0.31	0.21	0.17	0.05	0.01	0.01	0.06	0.13
130	0.00	0.00	0.00	0.00	0.20	0.42	1.29	2.22	1.69	4.38	4.89	6.68	3.75	2.98	1.22	1.84	0.05	0.09	0.21	0.26	0.01	0.01	0.21	0.09	6.14	7.78	2.46	4.42	2.24	3.70	0.25	0.13	0.15	0.06	0.01	0.01	0.06	0.13
140	0.00	0.00	0.00	0.00	0.32	0.50	1.24	2.24	1.50	4.32	5.36	6.53	6.15	5.80	1.31	1.73	0.07	0.09	0.23	0.28	0.02	0.01	0.15	0.10	5.27	6.90	4.12	4.50	1.99	3.36	0.17	0.08	0.10	0.04	0.01	0.01	0.07	0.12
150	0.00	0.00	0.00	0.00	0.42	0.56	1.34	2.24	1.09	3.84	6.13	6.11	5.05	4.13	1.30	1.55	0.12	0.12	0.24	0.29	0.01	0.00	0.14	0.11	5.41	6.69	6.67	4.95	1.91	3.01	0.16	0.12	0.05	0.03	0.01	0.01	0.07	0.10
160	0.00	0.00	0.00	0.00	0.40	0.50	1.93	2.63	1.25	3.17	6.83	5.61	3.92	1.96	1.32	1.35	0.15	0.12	0.25	0.28	0.01	0.01	0.03	0.11	5.24	5.93	8.11	4.34	2.22	2.22	0.14	0.14	0.05	0.04	0.01	0.01	0.07	0.08
170	0.00	0.00	0.00	0.00	0.38	0.41	2.25	2.78	2.13	2.86	6.82	4.54	3.20	1.81	1.33	1.19	0.15	0.10	0.22	0.23	0.01	0.01	0.18	0.21	5.08	5.08	8.56	3.15	2.38	2.13	0.13	0.15	0.06	0.05	0.01	0.01	0.07	0.06
180	0.00	0.00	0.00	0.00	0.35	0.29	1.57	2.23	2.55	2.35	6.65	3.84	4.32	2.15	1.33	0.97	0.14	0.09	0.23	0.21	0.00	0.00	0.09	0.06	4.67	3.92	10.77	3.74	2.06	1.80	0.12	0.13	0.06	0.08	0.02	0.01	0.06	0.03
190	0.00	0.00	0.00	0.00	0.43	0.28	1.15	1.82	3.07	1.72	5.77	2.91	5.85	3.64	1.32	0.74	0.13	0.08	0.23	0.19	0.01	0.01	0.09	0.09	4.52	3.15	8.91	2.88	1.78	2.01	0.16	0.17	0.07	0.07	0.01	0.01	0.07	0.03
200	0.00	0.00	0.00	0.00	0.47	0.29	0.83	1.40	3.65	1.44	5.26	2.30	4.01	2.07	1.41	0.79	0.13	0.08	0.21	0.17	0.01	0.01	0.13	0.14	4.40	2.65	6.96	2.99	1.79	2.13	0.21	0.19	0.09	0.08	0.01	0.01	0.05	0.02
210	0.00	0.00	0.00	0.00	0.48	0.26	1.29	1.46	4.27	1.72	4.81	1.71	6.27	4.10	1.46	0.81	0.12	0.06	0.20	0.14	0.01	0.01	0.15	0.08	4.33	2.46	5.54	2.59	1.74	2.61	0.20	0.28	0.12	0.09	0.01	0.01	0.04	0.02
220	0.00	0.00	0.00	0.00	0.43	0.22	1.43	1.05	4.19	1.25	4.21	1.11	5.27	3.63	1.42	0.79	0.11	0.05	0.18	0.12	0.01	0.01	0.13	0.08	3.33	1.30	3.97	1.88	2.46	1.43	0.26	0.33	0.10	0.06	0.01	0.01	0.09	0.03
230	0.00	0.00	0.00	0.00	0.38	0.15	1.50	0.86	3.97	1.11	3.91	0.97	4.34	2.85	1.32	0.76	0.10	0.04	0.18	0.10	0.01	0.01	0.11	0.06	3.68	1.51	3.67	2.50	1.35	0.82	0.41	0.49	0.10	0.09	0.01	0.00	0.10	0.03
240	0.00	0.00	0.00	0.00	0.34	0.13	1.06	0.64	3.61	1.15	3.86	1.42	3.00	2.01	1.32	0.76	0.09	0.04	0.17	0.10	0.01	0.02	0.17	0.15	2.82	1.02	3.49	2.08	2.04	2.32	0.39	0.29	0.12	0.04	0.01	0.01	0.06	0.02
250	0.00	0.00	0.00	0.00	0.31	0.11	1.18	0.71	3.98	1.36	3.51	1.42	2.91	2.40	1.37	0.83	0.09	0.05	0.16	0.09	0.01	0.02	0.17	0.11	2.67	1.04	2.53	1.18	5.56	4.65	0.37	0.28	0.15	0.09	0.01	0.01	0.10	0.03
260	0.00	0.00	0.00	0.00	0.29	0.12	1.47	0.82	3.39	1.35	3.18	1.28	3.49	3.02	1.24	0.77	0.08	0.05	0.14	0.09	0.01	0.02	0.14	0.04	2.43	0.94	2.75	0.88	3.43	2.93	0.31	0.40	0.05	0.06	0.01	0.01	0.09	0.04
270	0.00	0.00	0.00	0.00	0.27	0.10	1.31	0.67	2.85	0.83	3.27	1.62	5.72	5.13	1.11	0.60	0.07	0.04	0.15	0.09	0.01	0.01	0.08	0.05	3.89	2.61	2.55	0.96	2.62	2.11	0.21	0.27	0.05	0.08	0.01	0.01	0.08	0.04
280	0.00	0.00	0.00	0.00	0.25	0.09	0.68	0.51	2.61	0.61	2.81	1.19	5.23	3.45	1.06	0.46	0.07	0.04	0.14	0.09	0.01	0.01	0.22	0.17	1.98	0.91	4.05	2.18	1.81	1.55	0.15	0.22	0.09	0.08	0.01	0.01	0.06	0.03
290	0.00	0.00	0.00	0.00	0.23	0.10	0.38	0.37	3.21	1.34	3.14	1.86	4.99	3.73	1.04	0.38	0.06	0.04	0.12	0.08	0.01	0.00	0.19	0.13	2.02	1.31	4.36	3.83	1.13	1.35	0.18	0.13	0.14	0.20	0.01	0.01	0.06	0.02
300	0.00	0.00	0.00	0.00	0.23	0.12	0.64	0.56	3.02	1.39	3.12	1.98	3.11	2.62	0.98	0.32	0.05	0.04	0.11	0.07	0.01	0.02	0.19	0.26	1.77	0.99	2.26	3.03	2.13	1.75	0.18	0.20	0.14	0.13	0.01	0.01	0.07	0.03
310	0.00	0.00	0.00	0.00	0.22	0.14	0.65	0.53	2.49	1.25	2.50	1.71	3.43	3.19	0.60	0.47	0.04	0.04	0.10	0.06	0.02	0.01	0.15	0.12	1.90	0.91	3.08	2.90	1.33	1.14	0.12	0.10	0.07	0.02	0.00	0.01	0.06	0.03
320	0.00	0.00	0.00	0.00	0.19	0.13	0.89	0.68	1.20	0.75	3.07	2.65	4.18	3.06	1.93	2.20	0.03	0.04	0.09	0.06	0.02	0.02	0.19	0.22	2.68	1.39	3.76	2.43	1.28	0.65	0.19	0.13	0.09	0.09	0.00	0.00	0.05	0.03
330	0.00	0.00	0.00	0.00	0.18	0.12	0.76	0.58	1.43	0.76	2.94	2.71	3.99	2.88	1.01	1.35	0.03	0.03	0.08	0.05	0.01	0.01	0.18	0.11	2.06	1.20	3.03	1.82	1.42	1.07	0.36	0.26	0.14	0.12	0.00	0.00	0.05	0.03
340	0.00	0.00	0.00	0.00	0.16	0.09	0.81	0.41	0.98	0.68	2.87	2.39	2.78	1.51	0.41	0.35	0.03	0.03	0.07	0.04	0.01	0.01	0.07	0.08	2.15	1.07	1.45	1.29	1.25	0.78	0.12	0.23	0.14	0.16	0.01	0.01	0.04	0.02
350	0.00	0.00	0.00	0.00	0.15	0.08	0.72	0.39	1.50	2.01	2.92	2.41	4.20	1.94	0.66	0.50	0.02	0.02	0.06	0.04	0.00	0.01	0.12	0.12	1.65	0.83	1.49	1.17	1.26	1.24	0.14	0.16	0.13	0.06	0.00	0.00	0.05	0.03
360	0.00	0.00	0.00	0.00	0.11	0.07	0.47	0.22	1.57	1.83	3.02	2.74	5.64	3.22	0.38	0.22	0.02	0.03	0.05	0.03	0.00	0.01	0.04	0.05	2.34	1.37	1.59	1.80	2.46	1.25	0.16	0.09	0.10	0.05	0.00	0.00	0.04	0.02
370	0.00	0.00	0.00	0.00	0.09	0.07	0.29	0.07	2.76	2.40	2.98	2.75	3.65	2.32	0.44	0.37	0.03	0.02	0.04	0.03	0.00	0.01	0.12	0.14	1.89	1.71	1.94	2.36	1.70	1.88	0.24	0.11	0.05	0.04	0.00	0.00	0.04	0.03
380	0.00	0.00	0.00	0.00	0.08	0.06	0.31	0.13	1.71	1.51	2.70	2.60	2.37	2.16	0.70	0.60	0.02	0.02	0.04	0.03	0.01	0.01	0.07	0.08	1.24	1.10	1.94	2.17	2.39	2.44	0.09	0.13	0.05	0.08	0.00	0.00	0.03	0.02
390	0.00	0.00	0.00	0.00	0.06	0.05	0.52	0.34	2.06	1.85	2.40	2.21	3.29	2.19	1.09	1.27	0.02	0.02	0.03	0.03	0.01	0.01	0.03	0.06	1.01	0.71	2.06	2.29	1.75	1.49	0.14	0.21	0.10	0.17	0.00	0.00	0.02	0.02
400	0.00	0.00	0.00	0.00	0.07	0.07	0.24	0.17	1.47	1.55	1.90	1.69	1.59	1.54	0.55	0.23	0.02	0.02	0.03	0.02	0.01	0.01	0.06	0.10	1.10	0.65	3.38	3.87	1.67	1.46	0.12	0.15	0.04	0.10	0.00	0.00	0.02	0.01
410	0.00	0.00	0.00	0.00	0.06	0.05	0.27	0.22	1.98	1.85	1.71	1.58	2.99	2.78	0.58	0.34	0.02	0.02	0.03	0.02	0.00	0.00	0.03	0.05	1.81	1.10	5.09	6.20	1.03	0.92	0.11	0.09	0.03	0.09	0.00	0.00	0.02	0.01
420	0.00	0.00	0.00	0.00	0.05	0.05	0.31	0.24	1.85	1.60	1.56	1.55	1.91	2.17	0.74	0.54	0.02	0.02	0.03	0.02	0.00	0.00	0.07	0.10	0.98	0.66	3.96	4.86	1.50	1.11	0.13	0.10	0.05	0.13	0.00	0.00	0.02	0.01
430	0.00	0.00	0.00	0.00	0.05	0.06	0.33	0.24	1.29	1.08	1.50	1.39	1.75	1.85	0.57	0.56	0.02	0.02	0.04	0.03	0.00	0.00	0.03	0.05	1.08	0.74	2.37	2.98	1.35	0.89	0.11	0.11	0.07	0.13	0.00	0.00	0.01	0.01
440	0.00	0.00	0.00	0.00	0.08	0.08	0.26	0.19	0.55	0.34	2.71	2.55	1.45	1.52	0.86	0.60	0.02	0.02	0.03	0.03	0.00	0.01	0.08	0.08	1.17	0.72	3.00	3.34	0.86	0.52	0.11	0.12	0.06	0.08	0.00	0.00	0.03	0.03
450	0.00	0.00	0.00	0.00	0.05	0.06	0.46	0.37	0.36	0.60	1.98	1.76	1.16	1.19	0.63	0.30	0.02	0.02	0.03	0.03	0.01	0.01	0.05	0.06	1.08	0.62	3.12	3.12	0.52	0.31	0.11	0.12	0.05	0.08	0.00	0.00	0.02	0.02
460	0.00	0.00	0.00	0.00	0.04	0.05	0.38	0.30	0.26	0.51	1.46	1.20	0.87	0.87	0.19	0.23	0.02	0.02	0.02	0.02	0.01	0.01	0.05	0.09	0.77	0.29	2.47	2.51	0.61	0.27	0.18	0.17	0.04	0.06	0.00	0.00	0.01	0.01
470	0.00	0.00	0.00	0.00	0.02	0.03	0.38	0.28	0.17	0.41	1.84	1.76	0.57	0.54	0.14	0.18	0.02	0.02	0.02	0.02	0.01	0.01	0.05	0.10	0.75	0.29	1.66	1.28	0.88	0.46	0.28	0.22	0.02	0.05	0.00	0.00	0.01	0.01
480	0.00	0.00	0.00	0.00	0.01	0.01	0.21	0.15	0.07	0.32	1.92	1.97	0.28	0.22	0.09	0.12	0.02	0.02	0.02	0.02	0.00	0.00	0.04	0.06	0.52	0.26	1.49	1.40	0.76	0.33	0.27	0.18	0.02	0.03	0.00	0.00	0.01	0.01
490	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.23	-0.02	0.22	1.45	1.43	-0.02	0.00	0.04	0.07	0.02	0.02	0.02	0.02	0.00	0.00	0.07	0.04	0.39	0.13	1.56	1.92	0.62	0.32	0.21	0.17	0.02	0.02	0.00	0.00	0.01	0.01

Appendix B
Year 2 Impacts (Spring and Fall) to Surfgrass, Other Indicator Species, and Intertidal Reef Platform Using 0.3 m Sedimentation Criteria For Each Reach, Beach Width Option, and Sea Level Rise Scenario

LOW SEA LEVEL RISE SCENARIO

	50FT BEACH WIDTH			
	Bedrock w/ Surfgrass Area (acres)		Bedrock w/ Other Indicators Area (acres)	
	Spring 2	Fall 2	Spring 2	Fall 2
Reach 1	0.0	0.0	0.0	0.0
Reach 2	0.0	0.0	0.0	0.0
Reach 3	0.2	0.0	0.7	0.4
Reach 4	0.8	0.0	1.4	0.2
Reach 5	0.0	0.0	0.0	0.0
Reach 6	0.0	0.0	0.1	0.1
Reach 7	0.0	0.0	0.0	0.0
Reach 8	0.0	0.0	2.3	0.7
Reach 9	0.0	0.0	0.5	0.3

	100FT BEACH WIDTH			
	Bedrock w/ Surfgrass Area (acres)		Bedrock w/ Other Indicators Area (acres)	
	Spring 2	Fall 2	Spring 2	Fall 2
Reach 1	0.0	0.0	0.0	0.0
Reach 2	0.2	0.1	0.2	0.1
Reach 3	0.9	0.3	4.2	2.7
Reach 4	1.4	0.7	3.9	1.9
Reach 5	0.0	0.0	0.1	0.0
Reach 6	0.0	0.0	0.1	0.1
Reach 7	0.0	0.0	0.0	0.0
Reach 8	0.0	0.0	7.3	3.5
Reach 9	0.0	0.0	1.5	0.9

	150FT BEACH WIDTH			
	Bedrock w/ Surfgrass Area (acres)		Bedrock w/ Other Indicators Area (acres)	
	Spring 2	Fall 2	Spring 2	Fall 2
Reach 1	0.1	0.0	0.1	0.1
Reach 2	1.0	0.8	1.2	1.1
Reach 3	1.7	1.2	8.6	7.3
Reach 4	1.6	1.2	8.3	4.5
Reach 5	0.2	0.4	2.4	1.9
Reach 6	0.0	0.0	0.1	0.1
Reach 7	0.0	0.0	0.0	0.0
Reach 8	0.0	0.0	10.2	7.5
Reach 9	0.0	0.0	2.3	1.5

	200FT BEACH WIDTH			
	Bedrock w/ Surfgrass Area (acres)		Bedrock w/ Other Indicators Area (acres)	
	Spring 2	Fall 2	Spring 2	Fall 2
Reach 1	0.2	0.1	0.2	0.8
Reach 2	2.6	2.0	3.8	2.9
Reach 3	2.0	1.8	13.6	11.6
Reach 4	1.7	1.4	11.7	6.9
Reach 5	0.7	0.9	6.3	4.5
Reach 6	0.0	0.0	0.1	0.1
Reach 7	0.0	0.0	0.1	0.0
Reach 8	0.0	0.0	12.1	9.2
Reach 9	0.0	0.0	2.50	1.9

	250FT BEACH WIDTH			
	Bedrock w/ Surfgrass Area (acres)		Bedrock w/ Other Indicators Area (acres)	
	Spring 2	Fall 2	Spring 2	Fall 2
Reach 1	NA	NA	NA	NA
Reach 2	NA	NA	NA	NA
Reach 3	NA	NA	NA	NA
Reach 4	NA	NA	NA	NA
Reach 5	NA	NA	NA	NA
Reach 6	NA	NA	NA	NA
Reach 7	0.0	0.0	0.2	0.3
Reach 8	0.0	0.0	13.1	10.3
Reach 9	0.0	0.0	2.9	2.7

	300FT BEACH WIDTH			
	Bedrock w/ Surfgrass Area (acres)		Bedrock w/ Other Indicators Area (acres)	
	Spring 2	Fall 2	Spring 2	Fall 2
Reach 1	NA	NA	NA	NA
Reach 2	NA	NA	NA	NA
Reach 3	NA	NA	NA	NA
Reach 4	NA	NA	NA	NA
Reach 5	NA	NA	NA	NA
Reach 6	NA	NA	NA	NA
Reach 7	0.0	0.00	0.90	0.6
Reach 8	0.0	0.0	13.8	11.3
Reach 9	0.0	0.0	3.4	3.8

HIGH SEA LEVEL RISE SCENARIO

	50FT BEACH WIDTH			
	Bedrock w/ Surfgrass Area (acres)		Bedrock w/ Other Indicators Area (acres)	
	Spring 2	Fall 2	Spring 2	Fall 2
Reach 1	0.0	0.0	0.0	0.0
Reach 2	0.0	0.0	0.0	0.0
Reach 3	0.4	0.1	2.3	1.3
Reach 4	1.1	0.3	2.3	0.9
Reach 5	0.0	0.0	0.0	0.0
Reach 6	0.0	0.0	0.1	0.1
Reach 7	0.0	0.0	0.0	0.0
Reach 8	0.0	0.0	5.0	1.8
Reach 9	0.0	0.0	1.09	0.6

	100FT BEACH WIDTH			
	Bedrock w/ Surfgrass Area (acres)		Bedrock w/ Other Indicators Area (acres)	
	Spring 2	Fall 2	Spring 2	Fall 2
Reach 1	0.0	0.0	0.0	0.0
Reach 2	0.2	0.1	0.2	0.2
Reach 3	1.0	0.4	4.5	3.1
Reach 4	1.4	0.8	4.3	2.3
Reach 5	0.0	0.0	0.1	0.1
Reach 6	0.0	0.0	0.1	0.1
Reach 7	0.0	0.0	0.0	0.0
Reach 8	0.0	0.0	7.5	4.0
Reach 9	0.0	0.0	1.5	1.0

	150FT BEACH WIDTH			
	Bedrock w/ Surfgrass Area (acres)		Bedrock w/ Other Indicators Area (acres)	
	Spring 2	Fall 2	Spring 2	Fall 2
Reach 1	0.1	0.0	0.1	0.1
Reach 2	1.0	0.8	1.2	1.1
Reach 3	1.7	1.3	9.2	7.8
Reach 4	1.7	1.2	8.7	4.8
Reach 5	0.2	0.40	2.5	2.0
Reach 6	0.0	0.0	0.1	0.1
Reach 7	0.0	0.0	0.0	0.0
Reach 8	0.0	0.0	10.5	7.8
Reach 9	0.0	0.0	2.3	1.6

	200FT BEACH WIDTH			
	Bedrock w/ Surfgrass Area (acres)		Bedrock w/ Other Indicators Area (acres)	
	Spring 2	Fall 2	Spring 2	Fall 2
Reach 1	0.2	0.0	0.2	0.1
Reach 2	2.6	0.8	3.8	1.1
Reach 3	2.1	1.3	14.1	7.8
Reach 4	1.8	1.2	12.1	4.8
Reach 5	0.7	0.4	6.4	2.0
Reach 6	0.0	0.0	0.1	0.0
Reach 7	0.0	0.0	0.1	0.0
Reach 8	0.0	0.0	12.2	9.4
Reach 9	0.0	0.0	2.5	2.0

	250FT BEACH WIDTH			
	Bedrock w/ Surfgrass Area (acres)		Bedrock w/ Other Indicators Area (acres)	
	Spring 2	Fall 2	Spring 2	Fall 2
Reach 1	NA	NA	NA	NA
Reach 2	NA	NA	NA	NA
Reach 3	NA	NA	NA	NA
Reach 4	NA	NA	NA	NA
Reach 5	NA	NA	NA	NA
Reach 6	NA	NA	NA	NA
Reach 7	0.00	0.00	0.2	0.3
Reach 8	0.0	0.0	13.2	10.4
Reach 9	0.0	0.0	2.9	2.9

	300FT BEACH WIDTH			
	Bedrock w/ Surfgrass Area (acres)		Bedrock w/ Other Indicators Area (acres)	
	Spring 2	Fall 2	Spring 2	Fall 2
Reach 1	NA	NA	NA	NA
Reach 2	NA	NA	NA	NA
Reach 3	NA	NA	NA	NA
Reach 4	NA	NA	NA	NA
Reach 5	NA	NA	NA	NA
Reach 6	NA	NA	NA	NA
Reach 7	0.0	0.0	0.9	0.6
Reach 8	0.0	0.0	13.8	11.5
Reach 9	0.0	0.0	3.5	4.1

Rocky Reef Platform in Acres (for Tabletops Reef in Solana Beach)

Beach Width	Season	Sea Level Rise Scenario	
		Low	High
50 ft	Spring	0.0	0.0
	Fall	0.0	0.0
100 ft	Spring	0.1	0.1
	Fall	0.1	0.1
150 ft	Spring	0.3	0.3
	Fall	0.3	0.3
200 ft	Spring	0.4	0.4
	Fall	0.4	0.4
250 ft	Spring	0.4	0.4
	Fall	0.4	0.4
300 ft	Spring	0.4	0.4
	Fall	0.4	0.4