DRAFT

BROAD BEACH RESTORATION PROJECT
ANALYSIS OF PROJECT IMPACTS ON COASTAL PROCESSES

by

Coastal Environments

Submitted to

AMEC Environment & Infrastructure, Inc.
104 West Anapamu Street, Suite 204A
Santa Barbara, CA 92037

Submitted by

Coastal Environments
2166 Avenida de la Playa, Suite E
La Jolla, CA 92037

6 August 2012
CE Reference No. 12-22

TABLE OF CONTENTS

1.0 INTRODUCTION 1
2.0 DESCRIPTION OF WESTERN, CENTRAL AND EASTERN AREAS 9
2.1 REACH A 9
2.2 REACH B 9
2.3 REACH C 10
3.0 NUMERICAL MODELING AND RELATED IMPACT RESULTS 15
3.1 GENESIS NUMERICAL MODEL 15
3.2 DEPTH OF SAND COVER 16
4.0 IMPACTS ON COASTAL PROCESSES 25
4.1 APPROACH TO ANALYSIS 25
4.2 WAVES 26
4.3 TIDES 26
4.4 CURRENTS 27
4.5 SEDIMENT TRANSPORT 27
4.6 SURF CONDITIONS 28
4.7 WATER QUALITY 29
4.7.1 Turbidity 29
4.7.2 Bacteria 30
4.8 WAVE RUN-UP 31
4.9 SEALEVEL RISE 31
5.0 IMPACTS OF THE PROJECT ON TRANCAS CREEK 34
5.1 LONGSHORE SAND TRANSPORT IMPACTS 34
5.2 MITIGATION 36
5.2.1 Maintain the Hydrology of Trancas Creek Lagoon and the Zuma Wetlands 36
6.0 IMPACTS OF THE PROJECT ON PUBLIC ACCESS 38
6.1 EXISTING PUBLIC LANDS AND ACCESS RIGHTS 38
6.2 SHORT AND MEDIUM-TERM EFFECTS ON RECREATIONAL USE 40
6.3 LONG-TERM EFFECTS ON RECREATIONAL USE 42
7.0 IMPACTS ON SAND SOURCE SITES 48
7.1 DOCKWEILER BORROW SITE 48
7.1.1 Loss of Dredged Sand as a Resource for Other Beaches 48
7.2 CENTRAL TRANCAS BORROW SITE 49
8.0 CONSTRUCTION METHOD AND ASSOCIATED IMPACTS 57
8.1 CONSTRUCTION 57
8.2 POSSIBLE IMPACTS 57
9.0 BACKPASSING OPERATION AND ITS IMPACTS 61
9.1 BACKPASSING AND CONSTRUCTION ACTIVITIES 61
9.2 BACKPASSING IMPACTS 61
10.0 ANALYSIS OF PROJECT ALTERNATIVES 63
10.1 ALTERNATIVE 1: NO PROJECT 63
10.2 ALTERNATIVE 2: RETENTION OF MODIFIED REVETMENT AT CURRENT LOCATION WITH BEACH NOURISHMENT AND DUNE RESTORATION 63

10.3 ALTERNATIVE 3: LANDWARD RELOCATION OF MODIFIED REVETMENT AT CURRENT LOCATION WITH BEACH NOURISHMENT AND DUNE RESTORATION ... 64
10.4 ALTERNATIVE 4: REPLACEMENT OF REVETMENT WITH LANDWARD-LOCATED SEAWALL WITH BEACH NOURISHMENT AND DUNE RESTORATION ... 64
10.5 ALTERNATIVE 5: REDUCED PROJECT WITH LOWER LEVELS OF SAND IMPORTATION ... 64
10.6 ALTERNATIVE 6: BEACH NOURISHMENT AND DUNE RESTORATION WITH ELIMINATION OF REVETMENT ... 65
11.0 SUMMARY OF POTENTIAL IMPACTS OF PROPOSED PROJECT ... 70
12.0 CUMULATIVE IMPACTS ... 72
13.0 CONCLUSIONS ... 74
14.0 REFERENCES ... 76

LIST OF FIGURES

Figure 1-1. Plan view of initial beach nourishment project. From M&N (2012) ... 4
Figure 1-2. Profile of Reach A with proposed initial beach nourishment project. From M&N (2012) ... 5
Figure 1-3. Profile of Reach B with proposed initial beach nourishment project. From M&N (2012) ... 6
Figure 1-4. Profile of Reach C with proposed initial beach nourishment project. From M&N (2012) ... 7
Figure 2-1. Westernmost (rocky intertidal) portion of Broad Beach, Reach A ... 12
Figure 2-2. Coastal protection structures at the eastern end of Reach A ... 12
Figure 2-3. Middle portion of Reach B, showing various residential protective structures ... 13
Figure 2-4. Revetment at the east end of Reach B. Notice large rock size. ... 13
Figure 2-5. Central portion of Broad Beach and emergency revetment installed in February 2010, Reach B ... 14
Figure 2-6. Easternmost (widest) portion of Broad Beach, Reach C ... 14
Figure 3-1. GENESIS model results, beach nourishment with existing revetment ... 18
Figure 3-2. GENESIS model results, initial backpass two years after beach nourishment ... 19
Figure 3-3. GENESIS model results, third backpass four years after beach nourishment ... 20
Figure 3-4. Locations of Transects 408 and 411 ... 21
Figure 3-5. Predicted depth of cover at Transect 408 ... 22
Figure 3-6. Predicted depth of cover at Transect 411 ... 23
Figure 5-1. Location of Trancas Creek and Trancas Creek Lagoon ... 37
Figure 6-1. East central Broad Beach, location of access and recreational easements/offers to dedicate ... 46
Figure 6-2. Central Broad Beach, project relationship to public trust lands/applicant-proposed access plan ... 47
Figure 7-1. Dockweiler borrow site and wave analysis reach ... 51

Figure 7-2. Effect on wave height (upper) and direction (lower) from the Dockweiler borrow site for southwest swell 52
Figure 7-3. Effects on wave height (upper) and direction (lower) from the Dockweiler borrow site for northwest swell....53
Figure 7-4. Central Trancas borrow site and wave analysis reach 54
Figure 7-5. Effects on wave height (upper) and direction (lower) from the Central Trancas borrow site for southwest swell....55
Figure 7-6. Effects on wave height (upper) and direction (lower) from the Central Trancas borrow site for northwest swell....56
Figure 8-1. Dredge discharge line to beach....59
Figure 8-2. Placement of dredged sand on the beach showing training dike 60
Figure 9-1. Backpassing operation in Long Beach, CA 62

LIST OF TABLES

Table 1-1. Designed dimensions of sand deposition and slope of beach face. 8
Table 3-1. GENESIS model predicted beach widths post-nourishment. From M&N (2012)....24
Table 4-1. Beach recession due to sealevel rise predicted by Bruun's rule. From M&N (2012) 33
Table 6-1. AREs for parcels in primary project area 44
Table 6-2. Location of existing revetment relative to public land and AREs....45
Table 10-1. Pros and cons of alternatives suggested for full evaluation of Broad Beach....66
Table 11-1. Summary of study results of impacts for the proposed project alternatives....71

BROAD BEACH RESTORATION PROJECT
ANALYSIS OF PROJECT IMPACTS ON COASTAL PROCESSES

1.0 INTRODUCTION

The purpose of this report is to present the impact analysis for the Broad Beach Restoration Project (Project), which includes the placement of imported sand along 6,000 feet (ft) of shoreline to create a wide beach backed by a dune system, along with the permanent validation of an existing emergency revetment.

The nourishment sand will be dredged and transported from one or more of the following locations: 1) offshore of Dockweiler Beach in Los Angeles County, 2) the sand trap at the mouth of Ventura Harbor, or 3) offshore of Trancas Beach in the City of Malibu. Sand for dune construction may be dredged from a deposit offshore of Broad Beach near the Trancas Creek mouth (100,000-150,000 cubic yards [cyd]). After placing the sand on the beach, the project also includes a maintenance component (annually or biannually), which involves the backpassing of 20,000-25,000 cyd of sand from the eastern reach to the western reach in order to maintain the nourished sand and prolong its residence time. The second nourishment event of 450,000 cyd of sand would occur when erosion leads to substantial narrowing of the newly created beach, estimated to occur 5-10 (or more) years after the initial nourishment. The proposed project does not involve further beach nourishment after the second event.

Impacts to and from coastal processes on Broad Beach, Zuma Beach, and Trancas Creek are herein considered for the proposed project and various alternatives. In addition, this report considers the effects on coastal processes of removing more than 1,000,000 cyd of sand from offshore deposits at Dockweiler Beach in the City of Los Angeles and/or from a sand trap at Ventura Harbor. In addition to the proposed project, the alternatives that were reviewed in this study are:

1. No project.
2. Retention of modified revetment in its current location with beach nourishment and dune restoration.

3. Landward relocation of modified revetment with beach nourishment and dune restoration.
4. Replacement of revetment with landward-located seawall with beach nourishment and dune restoration.
5. Reduced project with lower levels of sand importation.
6. Beach nourishment and dune restoration with elimination of revetment.

The purpose of the analysis is to determine: 1) the beneficial impacts of the beach fill; 2) the fate (physical movement) of the dredged sand placed at the beach fill sites; 3) any adverse impacts of the beach fill in the context of naturally-occurring beach processes; 4) any adverse effects on other littoral cells or subcells as a result of removing sediment from those areas; and 5) the effects of coastal processes on the proposed project, including the restored beach, dunes, and emergency revetment.

Beneficial impacts include provision of increased dry sandy beach for recreation, improved lateral beach access, short- to mid-term shoreline and property protection, and erosion control. Potential adverse impacts include sand migration outside of the fill placement site and/or into sensitive marine habitats and/or impacts to Trancas Creek.

The post-placement sand movement from the project site is difficult to accurately forecast. The methodology for the analysis of beach fill response is as follows: 1) study historic beach fill in southern California to determine fill response (Coastal Environments 2012b; Moffatt & Nichol [M&N], 2012); 2) utilize five theoretical models to estimate the longevity of the sand on the beach (Coastal Environments, 2012b; M&N 2010); and 3) estimate beach width and beach profile changes after the fill using the numerical model GENESIS.

Sand grain size compatibility is one of the single most important factors in determining the beneficial impacts of the proposed beach fill. For a given wave climate, coarser beach fill will have a greater probability of staying on the beach in the vicinity of Mean Sea Level (MSL) for a longer period of time than material with a finer composite grain size. Although the berm of the fill beach will erode above MSL over time, a high percentage of the sediments will be retained within the littoral zone and contribute to long-term nourishment of the beach.

Sand placement along Broad Beach would increase beach width and protect the shoreline and private property from erosion over the life of the proposed project's two beach nourishment efforts as extended by backpassing, which may extend over 10 to 20+ years. The project area is delimited by Lechuza Point to the west and Trancas Creek to the east (Figure 1-1). In this study, Broad Beach is divided into three reaches: A, B and C.

The project will deposit 450,000 cyd of sand on the beach and 150,000 cyd on the dunes. The distribution of sand is designed to minimize the impact on the hard substrate area at the western portion of the site. Representative profiles and cross-sections showing the initial sand nourishment on the various reaches of the beach are shown in Figures 1-2 through 1-4 (M&N, 2012). The designed slope of the beach face for the two western areas of the project (Reaches A and B) is 1:3, while the profile for the central and eastern portion (Reach C) has a gradual slope of 1:10 (Table 1-1). The natural slope of Broad Beach is 1:6. These designed profiles will change naturally shortly after sand placement is completed.

Impacts to or from coastal processes would be considered substantial if the proposed project were to result in:

1. Measurable differences in wave climate (e.g., wave frequency, heights, or locations of wave breaks).
2. Disruption of existing surface and subsurface currents and sand transport.
3. Change in wave energy and run-up on beaches in the primary or secondary project areas.
4. Change in rate of accretion on beaches or loss of beach sand in the primary or secondary project areas.
5. Any long-term impacts related to the adequacy of project-created protection of coastal properties, homes, and septic systems from coastal processes.

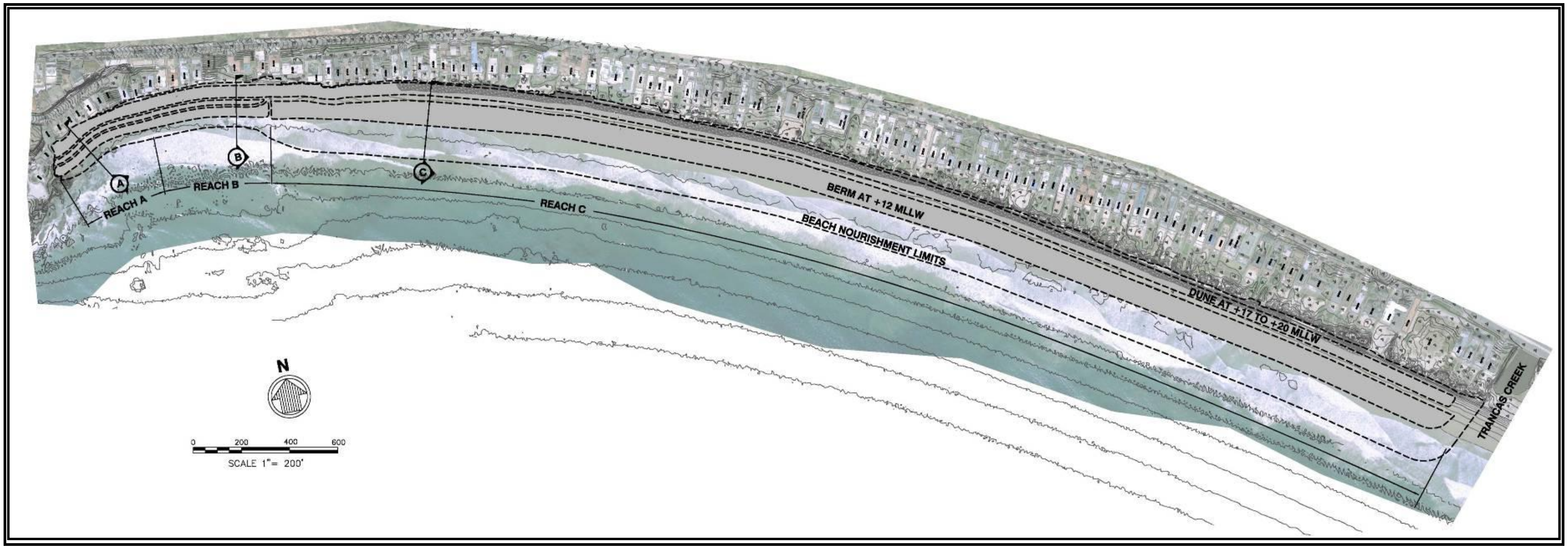


Figure 1-1. Plan view of initial beach nourishment project. From M&N (2012).

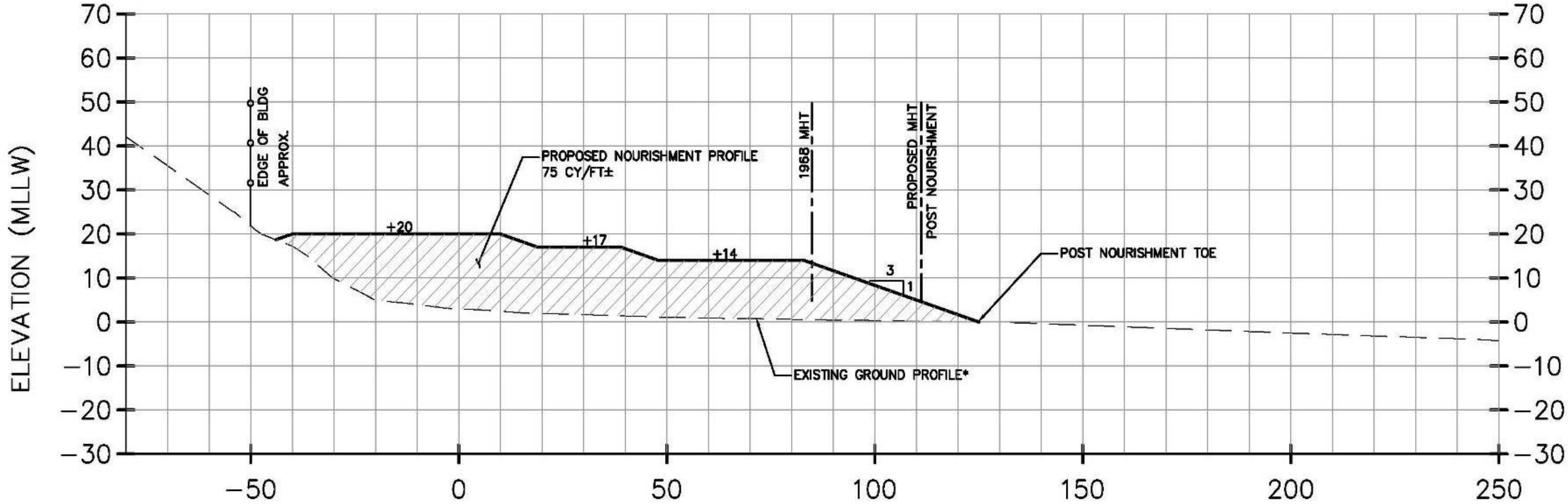


Figure 1-2. Profile of Reach A with proposed initial beach nourishment project. From M&N (2012).

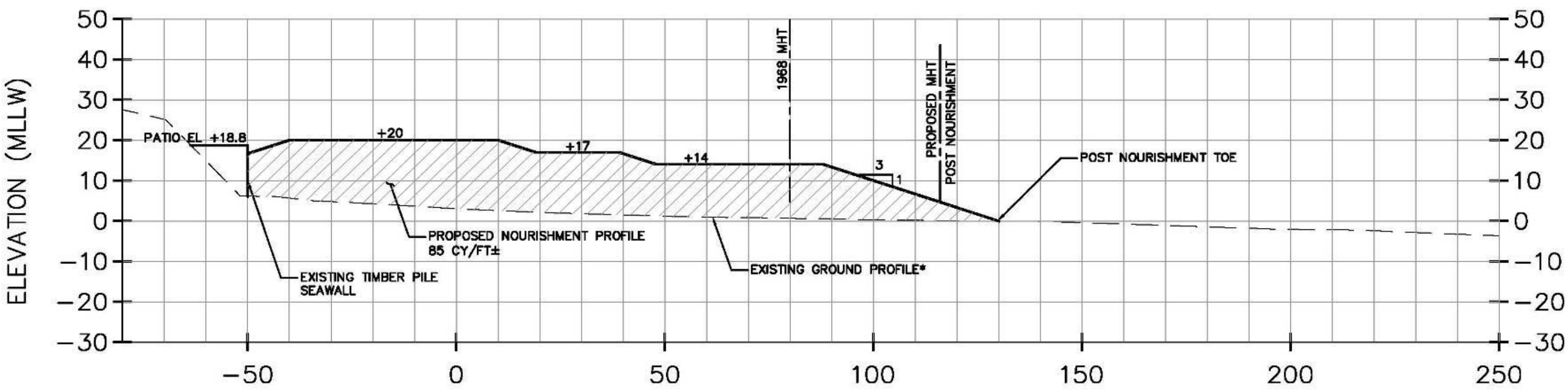


Figure 1-3. Profile of Reach B with proposed initial beach nourishment project. From M&N (2012).

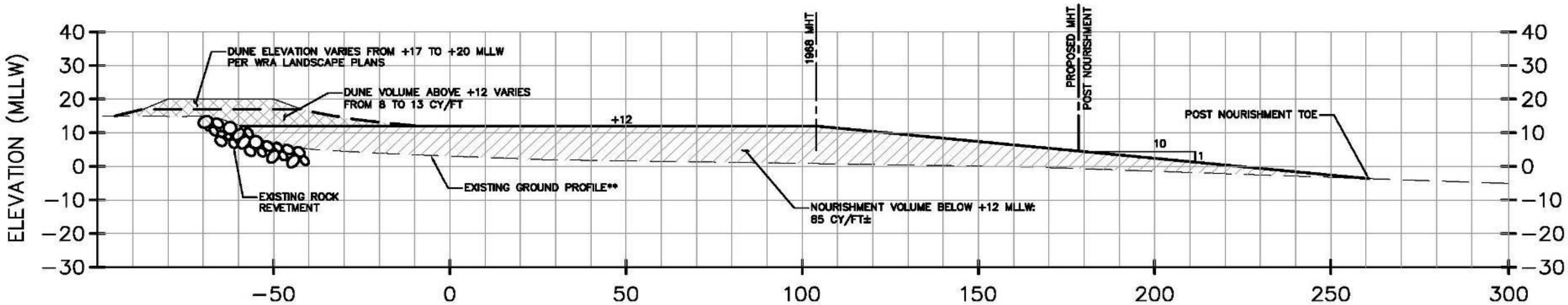


Figure 1-4. Profile of Reach C with proposed initial beach nourishment project. From M&N (2012).

Table 1-1. Designed dimensions of sand deposition and slope of beach face.

Profile	Beach Berm Width (ft)	Width of Nourished Sand Start to End (ft)	Slope
A	126	168	1:3
B	137	180	1:3
C	164	280	1:10

Note: Natural slope of Broad Beach is 1:6.

2.0 DESCRIPTION OF WESTERN, CENTRAL AND EASTERN AREAS

2.1 REACH A

Reach A covers the west end of Broad Beach and extends 400 ft from Lechuza Point (Figure 1-1). It consists of a rocky intertidal zone with a thin sandy beach in small portions of the high tide area (Figure 2-1). This rocky intertidal zone is composed of the same type of rock as Lechuza Point, which borders this area to the west and provides a variety of intertidal marine habitat, including rocky outcrops, offshore reef, and associated surf grass and kelp habitat.

Reach A does not have any portion of the large emergency rock revetment in front of it. The most westerly five houses in this reach have been built upon the rocky bluff that extends above the beach in this area. These westerly homes appear to have individual concrete support foundations tied into the bedrock. The bedrock is the same as that of Lechuza Point and is comprised of metamorphic blueschist conglomerate-breccia of the Trancas Formation. This is a rock type that is not easily eroded by waves, evidenced by the continued existence of Lechuza Point. Some of the residences have non-engineered deteriorated rock revetments as protection, both for the homes and for the stairway down to the beach. These revetments consist of rocks that weigh approximately 0.5 – 2 tons. Other residences in the eastern part of Reach A have either wood or concrete-wrapped steel pilings to raise the base of the home for protection from wave attack (Figure 2-2).

The beach nourishment program calls for sand to be placed offshore of Reach A for approximately 168 ft. Sand placement will be between 10 and 15 ft thick at the beach berm, decreasing as the profile extends offshore (Figure 1-2). It will likely cover up to 168-250 ft of intertidal zone habitat in the western part of Broad Beach.

2.2 REACH B

Reach B extends about 500 ft (Figure 1-1) east of Reach A and includes the transition between the environmentally sensitive rocky habitat areas and the less constrained sandy beach and intertidal areas (Figure 2-3). Most of the homes along Reach B have their own protective structures, which were installed in the 10 years after the destructive El Niño winter of 1997-1998. These structures include concrete-wrapped steel pilings, concrete seawalls, wooden seawalls, and at least one small rock revetment.

The easternmost approximately 150 ft of Reach B are backed by the more robust portion of the emergency rock revetment (Figure 2-4). The portion of the revetment between 31302 and 31346 Broad Beach Road was designed to be more robust by incorporating larger boulders (up to 4 tons per rock). The majority of the revetment is comprised of rocks weighing between 0.5 and 2 tons.

This area will also be covered by sand placement, which will be 10-15 ft thick at the beach berm and thinner as the profile extends offshore (Figure 1-3).

2.3 REACH C

Reach C (Figure 1-1) includes the other parts of the project area and extends approximately 5,000 ft. It extends to just upcoast of Trancas Creek and supports less sensitive sandy beach intertidal habitats (Figure 2-5). The offshore portions of the beach profiles are covered by sand.

Reach C of Broad Beach is by far the longest section. The entire reach is backed by the emergency rock revetment, except for the easternmost 600 ft, which are backed by large deteriorating sand bags. The easternmost portion of this reach has the widest sandy beach on Broad Beach (Figure 2-6).

The existing emergency rock revetment is 4,100 ft long, extending from 30760 Broad Beach Road, which is approximately 600 ft west of Trancas Creek, to 31346 Broad Beach Road, which is just west of the western public access point for Broad Beach. A total of approximately 36,000 tons of rock was used to create the revetment in February 2010. The revetment is 27 to 41 ft wide at its base and 13 to 17 ft high, with the overall height averaging around 15 ft. Individual boulders for the majority of the revetment are between ½ and 2 tons in weight, although many smaller rocks were used during construction.

The majority of the existing revetment rests on private land. However, portions of the seaward side, which total approximately 0.85 acres, rest on public trust lands below the mean high tide line. An additional 0.71 acres overlay the Access Restricted Easements (AREs) that were granted to the public.

A geologic reconnaissance of the revetment was conducted on June 13, 2012. The boulders comprising the revetment were observed to range between 1 and 7 ft, as measured along the long axis. The bulk of revetment rock is reported to range from ½ to 2 tons per rock; however, a considerable portion consists of rocks as small as 1 foot in the maximum dimension. These smaller rocks act as filler between and amongst the larger boulders. The resistance of these smaller rocks to coastal erosion is entirely dependent on the stability of the larger boulders resting along the seaward edge of the revetment.

The petrology of the revetment boulders consists primarily of a dark, fine-grained gabbro. Additional petrologies observed included diorite, granodiorite, gneiss and marble. All of the boulders exhibited fresh, hard faces with little or no chemical weathering. Some of the smaller rocks may represent fragments of larger boulders broken off by mechanical weathering from wave action, abrasion from settlement and adjustment, or perhaps abrasion from the initial placement of the boulders. All of the boulders exhibited angular shapes conducive to interlocking reinforcement. The boulders were placed on top of a filter fabric to support them and to help resist vertical settlement of the rock into the beach sand (Moffatt & Nichol 2011, 2012). Stability of the existing revetment is, therefore, dependent on the stability of the sand layer underlying the boulders of the revetment.

The profile of Reach C of the proposed initial beach nourishment project is shown in Figure 1-4.

Figure 2-1. Westernmost (rocky intertidal) portion of Broad Beach, Reach A.

Figure 2-2. Coastal protection structures at the eastern end of Reach A.

Figure 2-3. Middle portion of Reach B showing various residential protective structures.

Figure 2-4. Revetment at the east end of Reach B. Notice large rock size.

Figure 2-5. Central portion of Broad Beach and emergency revetment installed in February 2010, Reach C.

Figure 2-6. Easternmost (widest) portion of Broad Beach, Reach C.

3.0 NUMERICAL MODELING AND RELATED IMPACT RESULTS

3.1 GENESIS NUMERICAL MODEL

M&N (2012) presented a study simulating changes in the shoreline resulting from placing 600,000 cyd of sand at Broad Beach to create a wide, sandy beach backed by a system of sand dunes using the GENESIS (USACOE, 1989) numerical model. M&N recognized that the accuracy of numerical modeling for the shoreline is limited because of the complexity of coastal processes. However, the GENESIS program has been utilized in many artificial beach nourishment projects and provides some useful results. The limitations of GENESIS are discussed below.

GENESIS is a one-line model that accounts only for longshore sand transport. However, sand moves along the coast by waves alongshore (parallel to the shoreline) and also across-shore (perpendicular to the shoreline). This model's results depend to a large extent on the input data for the program, including: 1) wave data (height, period and direction), 2) bathymetry data for the study area, and 3) shoreline orientation, as well as 4) selecting the proper values for the program parameters. Longshore sand transport equations are sensitive to breaking wave angles and shoreline orientations, such that small errors in estimating these angles can result in inaccurate results. The GENESIS model can predict approximate shoreline changes over long time periods, but not on a short-term basis or for specific dates in the future. The limitations of the GENESIS model were discussed in detail in Coastal Environments (2012b).

M&N (2012) has carried out several attempts to calibrate and validate the numerical model, and they have found that: 1) the model can predict the shoreline reasonably well for Broad Beach, but not at the area downcoast of it; 2) the model results should not be used to define a specific shoreline position at a specific date; and 3) the purpose of the model is to predict general long-term shoreline trends. Figure 3-1 presents the GENESIS-predicted shoreline changes after beach nourishment for a period of 10 years. The rate of beach loss is greatest at the west end of Broad Beach, indicating that the nourished beach may last for only 3-4 years near Lechuza Point. The model results suggest that beach nourishment may last up to 7 or 8 years at the east end of Broad Beach.

From Figure 3-1, M&N (2012) concluded that beach width at the west end of Broad Beach would be less than 50 ft two years after the initial nourishment. At this stage, M&N recommended moving the sand annually from the east end to the west end (backpassing) to widen the western portion. The backpassing is planned to begin the year after initial project completion and proceed on an annual or bi-annual basis depending on site conditions. Figures 3-2 and 3-3 show the shoreline changes resulting from the backpassing of sand from east to west on Broad Beach after two and four years, respectively.

Coastal Environments (CE) has reviewed the GENESIS model and its outputs. In general, CE finds that in spite of its limitations and the difficulty of calibrating it, it provides qualitative information about shoreline modeling and sand longevity. The GENESIS model results predicting the longevity of the imported sand were lower than those predicted by the available theoretical equations. CE also agrees with the GENESIS results suggesting that backpassing the sand to the west of Broad Beach would increase beach width at the west end and would likely prolong the residence time of the beach nourishment sand in general. The backpassing of nourished sand from one location to another has been carried out successfully in the past at several locations, including Long Beach and Newport Beach.

3.2 DEPTH OF SAND COVER

In order to estimate the biological impacts of the sand fill, it is necessary to have estimates of sand cover for the present substrate (hard or sand) on the beach and offshore after the project. M&N (2012) predicted the shape of the equilibrium profile with a method developed for other beach nourishments in the past, including the San Diego Regional Beach Sand Project prepared by M&N. Once the equilibrium beach profile is determined, it is translated landward to match the beach width predicted by the GENESIS model at each location at the closure depth. This method was applied to two transects, 408 and 411, which are shown in Figure 3-4. These two transects were selected as representative sections for east and west Broad Beach, respectively. The GENESIS model results are used to represent the post-project shoreline after 1, 3 and 5 years. The results of predicted beach width post-nourishment are presented in Table 3-1.

Figures 3-5 and 3-6 show the predicted beach profiles at Transect 408 after 1, 3 and 5 years, and at Transect 411 after 1, 2, 3 and 5 years.

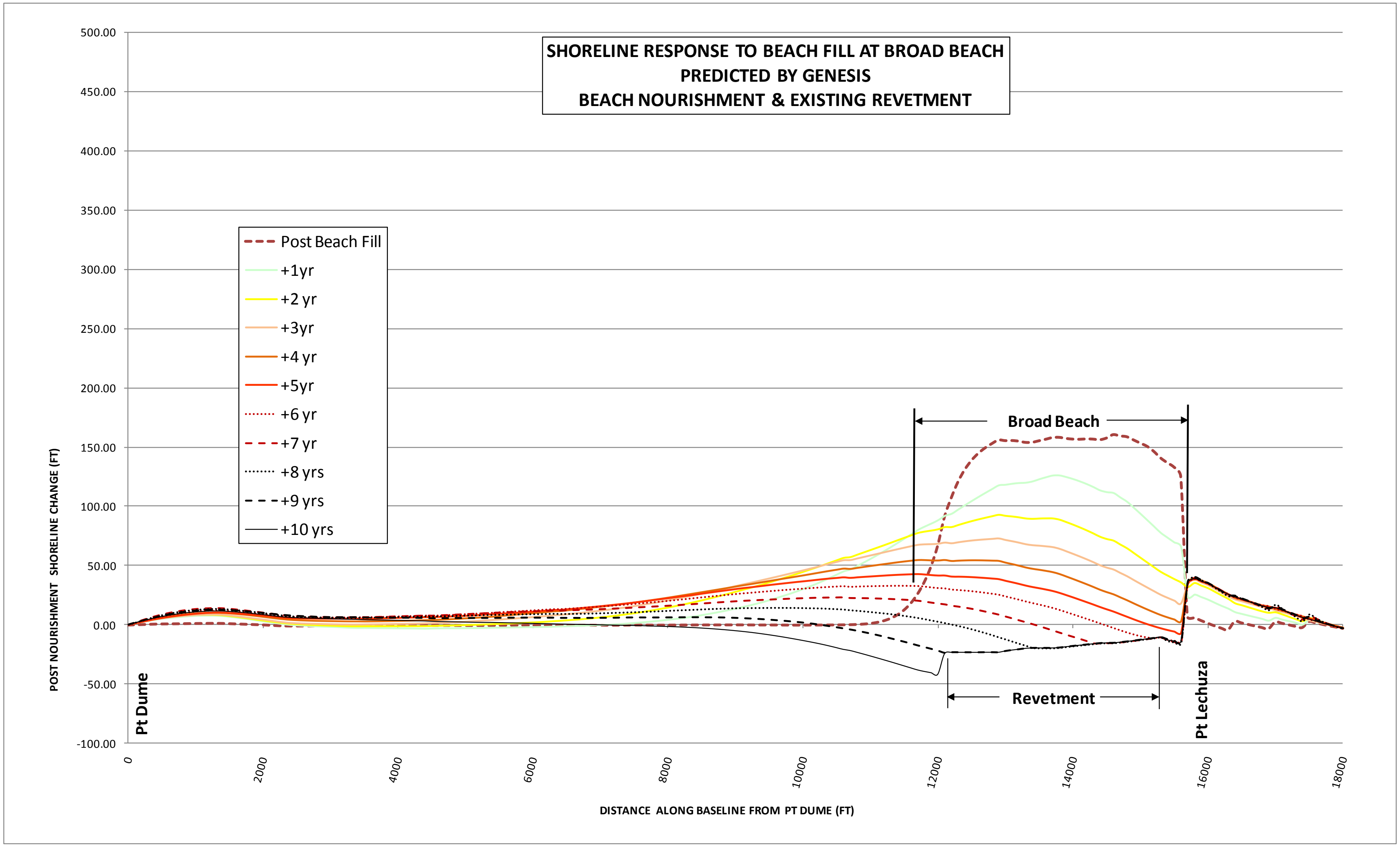


Figure 3-1. GENESIS model results, beach nourishment with existing revetment.

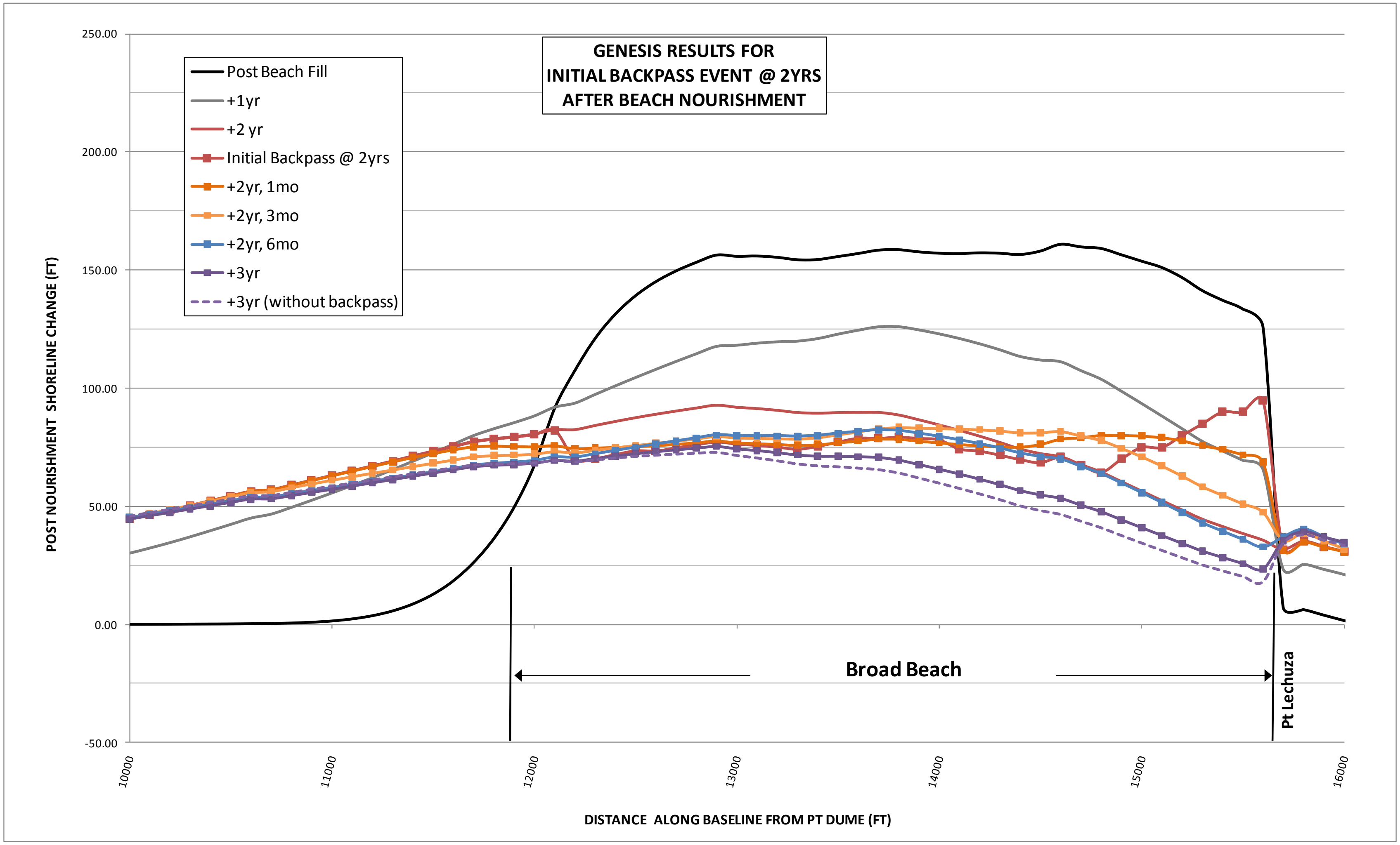


Figure 3-2. GENESIS model results, initial backpass two years after beach nourishment.

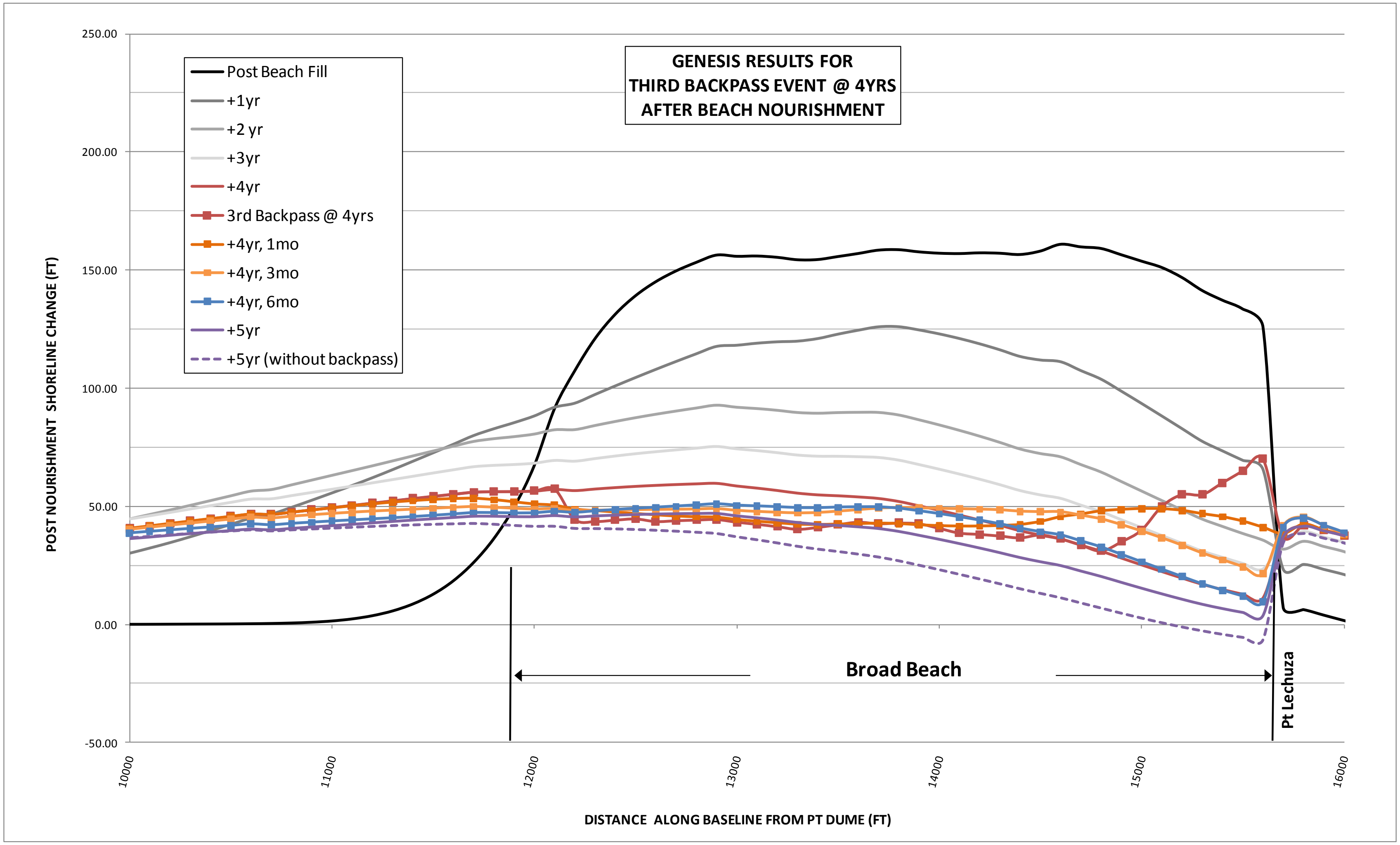


Figure 3-3. GENESIS model results, third backpass four years after beach nourishment.

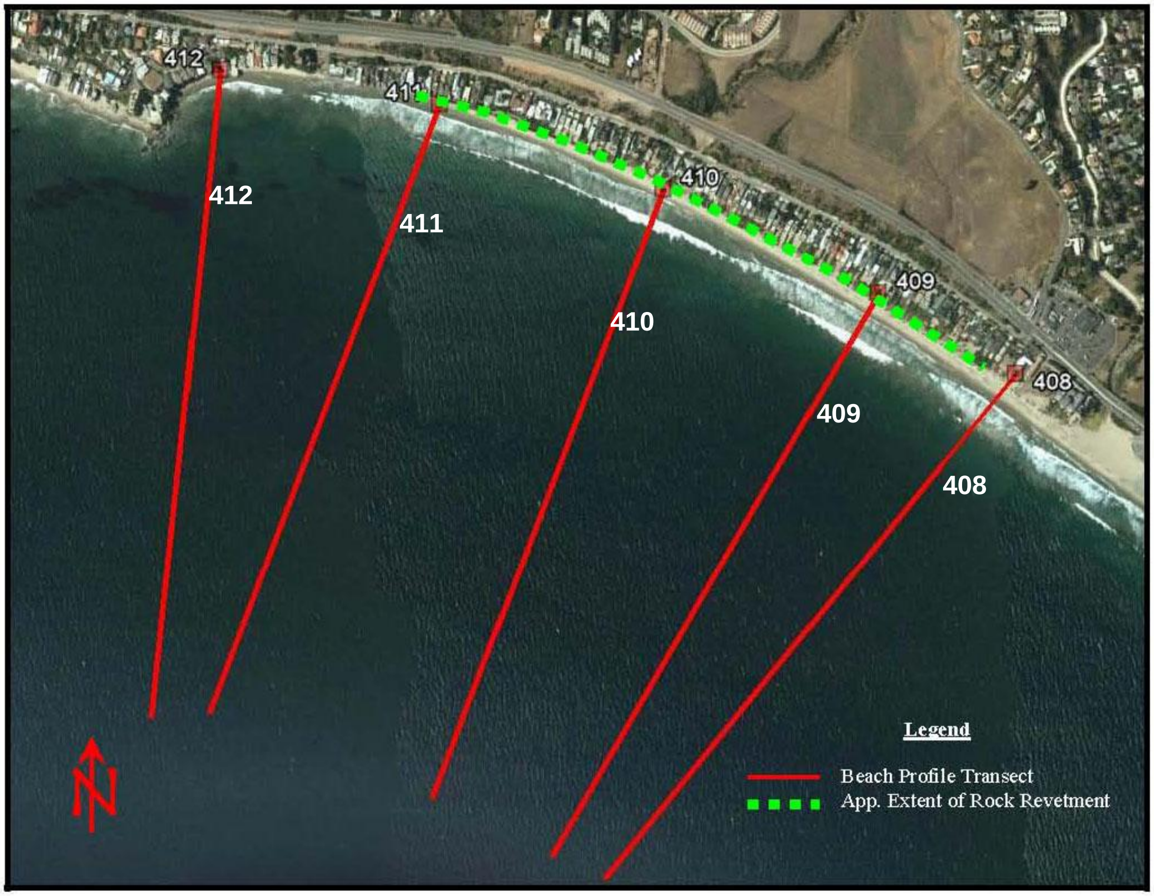


Figure 3-4. Locations of transects 408 and 411.

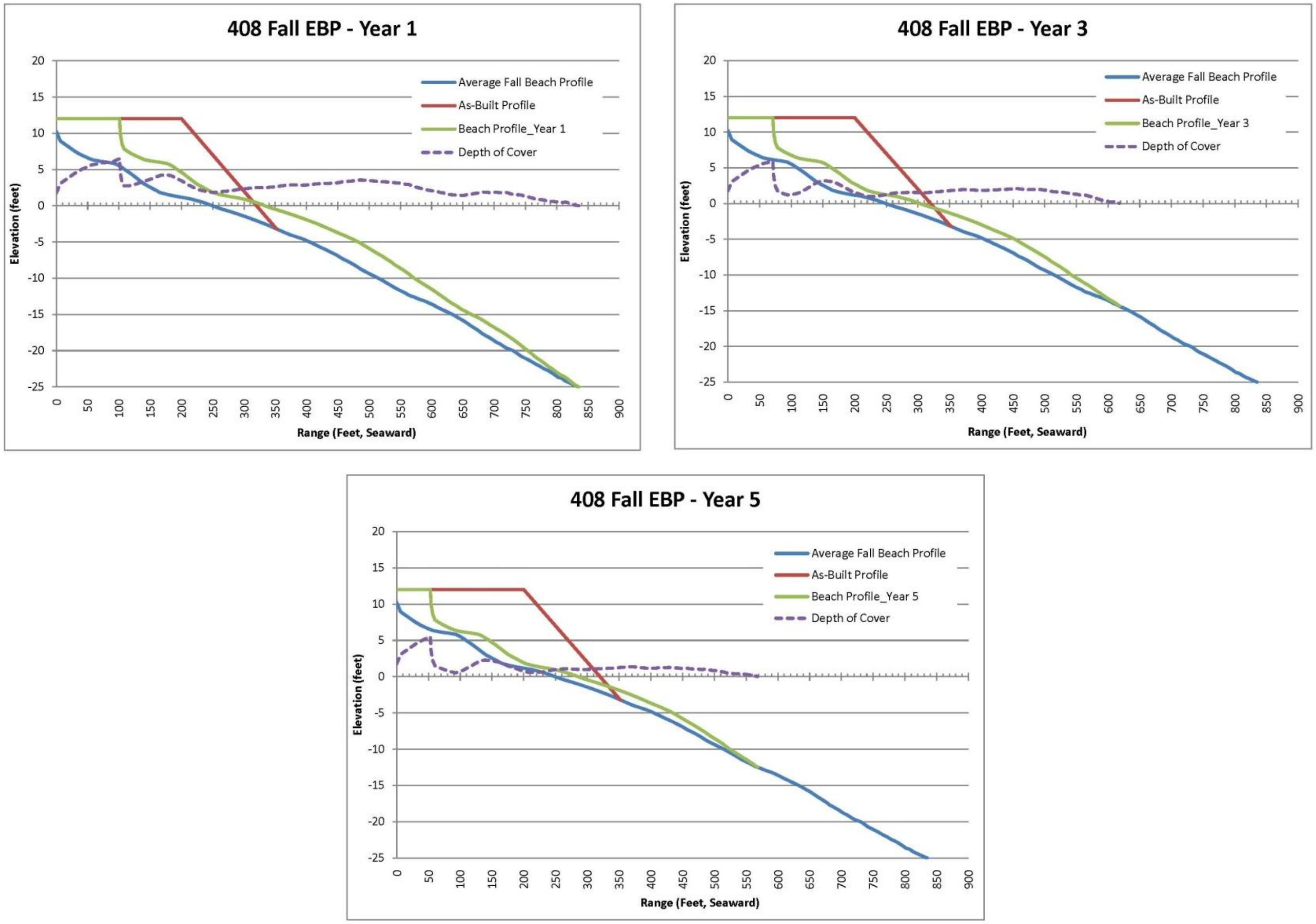


Figure 3-5. Predicted depth of cover at Transect 408.

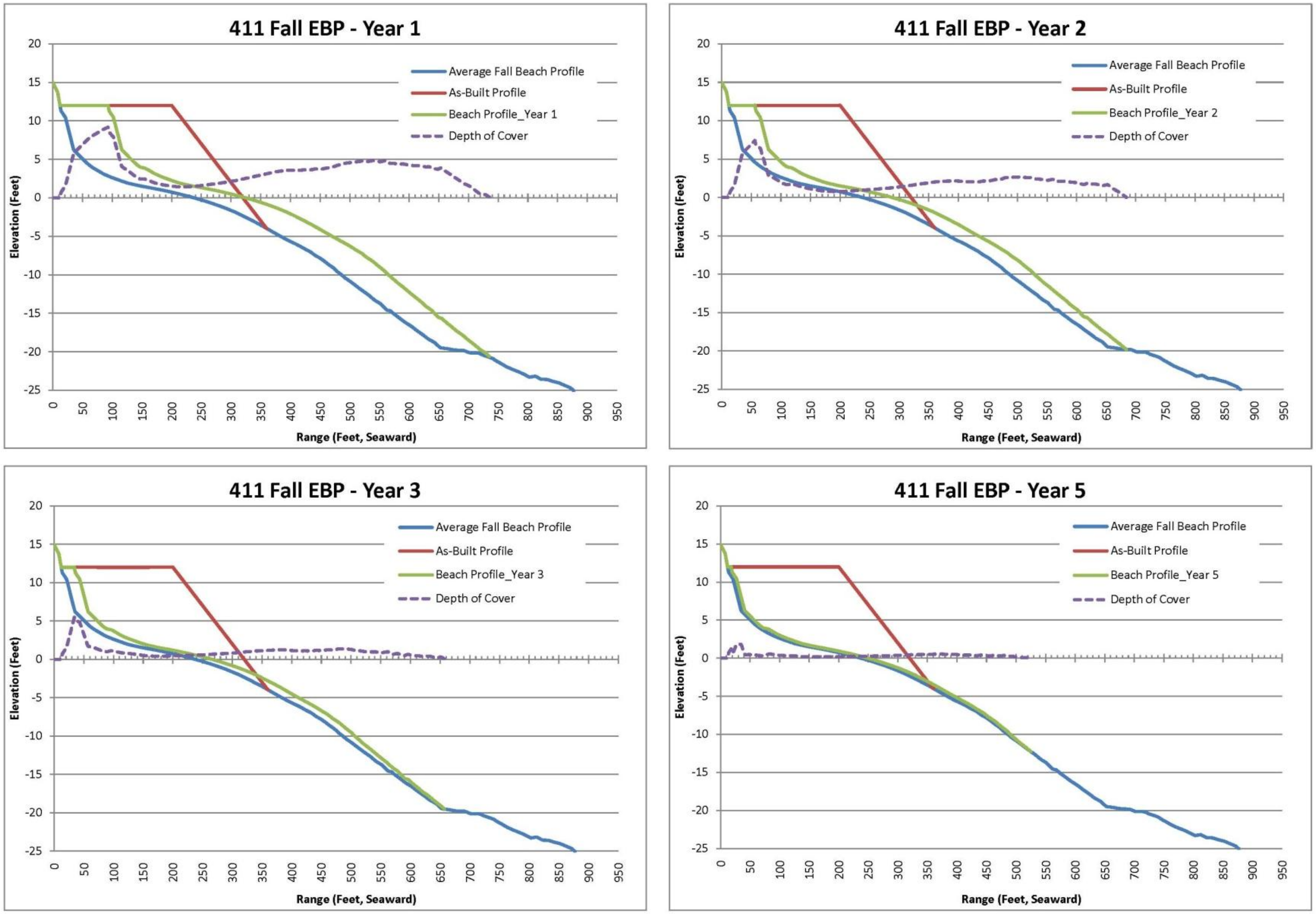


Figure 3-6. Predicted depth of cover at Transect 411.

Table 3-1. GENESIS model predicted beach widths post-nourishment. From M&N (2012).

Year[a]	Transect Number				
	408	**409**	**410**	**411**	**412**
1	101	119	119	93	66
2	86	91	80	56	36
3	71	69	55	34	18
4	54	50	34	15	3
5	53	48	30	5	-16
6	29	21	5	-9	-16
7	17	9	-7	-21	-25
8	6	-2	-17	-30	-34
9	-4	-13	-28	-39	-40
10	-13	-22	-36	-46	-45

[a] Years post-nourishment.

Note: Negative numbers indicate erosion from pre-nourishment beach width.

4.0 IMPACTS ON COASTAL PROCESSES

4.1 APPROACH TO ANALYSIS

The protection of unique geologic coastal features and the minimization of erosion are considerations when evaluating the potential impacts of a proposed action. For this analysis, an impact to geologic resources would be significant if it would result in:

1. Measurable differences in wave climate (e.g., wave frequency, heights or locations of wave breaks).
2. Disruption of existing surface and subsurface currents and sand transport.
3. Change in wave energy and run-up on beaches in the primary or secondary project areas.
4. Change in rate of accretion on beaches or loss of beach sand in the primary or secondary project areas.
5. Any long-term impacts related to the adequacy of project-created protection of coastal properties, homes and septic systems from coastal processes.

Beach replenishment using dredged sediment is generally considered a beneficial use in areas where beach erosion is a problem, as fill can be utilized to create a sand berm that protects the shoreline. Over a period of a few years, the sand would move and be redistributed from the placement location alongshore through natural littoral transport. The shoreline would temporarily widen at locations upcoast and downcoast of the beach fill site, until natural littoral transport redistributed the sand along the coast.

The use of a rock revetment to protect a shoreline is more complex and sometimes controversial. While well-designed rock revetments are often effective in protecting shoreline development from erosion, such revetments may also obstruct beach access, affect longshore processes and rates of beach erosion, and deprive the littoral cell of sediment sources, such as dunes or cliffs, in effect incrementally depriving downcoast beaches of nourishment.

Use of sediment from offshore sites for beach nourishment can also be beneficial, as these deposits are removed from the littoral cell and often contain relatively low densities of marine life that can relatively quickly recover from dredging. However, the use of sand from a different littoral cell or subcell for beach nourishment can raise concerns regarding coastal erosion in those areas or the loss of a potential beach nourishment source for the affected area.

The following analysis of coastal and littoral processes related to beach replenishment is based on the summary of oceanographic conditions and coastal processes at the site that was presented by M&N (2012) and Coastal Environments (2012b).

4.2 WAVES

Waves are random in nature. Their characteristics vary seasonally and inter-annually in terms of intensity and direction, depending on the weather conditions occurring locally and throughout the Pacific Ocean region.

Placing sand on Broad Beach will not change the general wave climate in the area. Waves are generated a distance away from Broad Beach in deep water and propagate to the coast. After the beach fill is completed, the waves will be breaking farther away from the beach (at present, the waves are breaking at the toe of the revetments). Theoretically, waves will break when the ratio of wave height to water depth equals 0.78, and then they will propagate as a bore. After the fill is completed, the wave breaker height will be less than the height of waves approaching the revetment at present due to the gentler slope of the placed sand. There will be no noticeable changes in the wave characteristics (height, periods and direction) offshore of the surfzone.

4.3 TIDES

Broad Beach has a mixed semidiurnal (daily) tide with two high tides and two low tides of different magnitudes every 24 hours and 50 minutes. The range between mean high and low water is approximately 3.7 ft (1.1 m), and the diurnal range is approximately 5.4 ft (1.6 m).

Tidal characteristics in the vicinity of Broad Beach range from a lowest observed tide of -2.7 ft Mean Lower Low Water (MLLW) to a highest observed tide of 7.8 ft, MLLW.

The proposed project would not have an impact on tidal elevations, and after the fill project is completed, the beach is expected to be wider than at present, since the ocean water would be farther seaward. This will provide the public with more opportunities for recreational activities.

4.4 CURRENTS

Coastal currents have two components: alongshore and cross-shore. These currents are present outside of the surf zone (offshore of wave breaking points) and are controlled by large weather systems, winds, and tides; therefore, the proposed project will not have impacts on the magnitude or direction of these currents.

Longshore currents are generated by energy dissipation in the breaking waves inside of the surf zone. These currents flow parallel to the shore. The flow is caused by the oblique angle of the wave (angle between wave approach and shoreline normal), and an alongshore variation in wave height. Longshore currents are responsible for transporting the sand up and down the coast. Their magnitude is sensitive to any changes in the angle between wave approach and shoreline direction. Longshore currents are also randomly variable, and there are changes in their magnitude and direction seasonally, annually and inter-annually. The proposed fill will result in changes to the magnitude and direction of the longshore currents; however, these changes will be within the natural variability of their values (Coastal Environments 2012b).

4.5 SEDIMENT TRANSPORT

Sand placed at Broad Beach would be distributed along the coast by the longshore currents induced by waves. Net transport in the area of the receiver beach is estimated to move downcoast with the capacity to move approximately 35,000 cyd/yr to 40,000 cyd/yr. This downcoast movement is the net result of both upcoast and downcoast movements that occur depending on the angle of wave approach.

The average sand volume change at Broad Beach between 1946 and 2007 was approximately 21,000 cyd/yr, and the estimated volume change in the beach after the beach fill is completed will be from 35,000 cyd/yr to 40,000 cyd/yr. Therefore, there will be an increase in the rate of sand gain from west to east of approximately 14,000 cyd/yr to 19,000 cyd/yr, which would have positive impacts on Zuma Beach, Westward Beach and Point Dume State Beach, with decreasing positive effects farther downcoast.

4.6 SURF CONDITIONS

A suitable surfing environment can be impacted and improved by beach fill efforts when a beach is nourished with fill materials with characteristics similar to those of the pre-existing beach. Most beach breaks in Southern California are made of sandbars, which become altered and sometimes improved when nourishments increase sand volumes. The dynamics of sandbars, which include increased sand volumes of similar grain size, more steeply sloped beaches, and wider beach widths, contribute to a more tidally dependent surf zone. This creates multiple variations in the nearshore bathymetry and improves the sandbars and wave shape quality for surfers. Broad Beach fill will likely improve surfing conditions at Broad Beach and Zuma Beach because of the increased size of the sand bars at both beaches due to the import of up to 500,000 cyd of sand. Surf breaks at or west of Lechuza Point will not be affected since the predominant longshore transport is to the east.

During construction, the public can lose portions of access to its favorite surfing and beach-going locations. And, just as the beach gains width above the shoreline for multiple recreational purposes, the shoreline also moves seaward into the existing swim zone and may cause the slope of the beach to drop off sharply, resulting in waves breaking dramatically as the shore breaks. These beach replenishment characteristics and the plunging breakers during higher tides are likely to be temporary, but they may still present hazards to swimmers until the newly designed slope and sandbars settle at an equilibrium level.

4.7 WATER QUALITY

4.7.1 Turbidity

Turbidity refers to the total amount of suspended sediments in the water column and is caused by the presence of fine sediments (e.g., silts and clays). Increases of turbidity can affect fish growth, propagation, feeding and respiration. It reduces the transparency of seawater and therefore reduces the amount of light available for kelp, seagrass, phytoplankton and photosynthesis. Larger particles (>63 microns) will settle out rapidly and do not cause a significant increase in turbidity. Visibility is significantly reduced in the surf zone due to sediment disturbance from wave action. Therefore, the intertidal waters of the receiver beaches are naturally turbid due to high energy activity in the nearshore environment.

Turbidity impacts to water will likely occur at both the dredge sites (Dockweiler and Central Trancas) and the dredge pipe discharge sites at Broad Beach. A Regional Water Quality Control Board (RWQCB) 401 Certification of Waste Discharge Requirements permit will be required for these dredge operations, and this permit will require turbidity monitoring at both the dredge and disposal sites. The 401 permit will establish turbidity parameters for water quality and require sampling both at the dredge and disposal sites and at certain distances and directions from both the dredge and disposal sites. The 401 permit will establish the frequency and duration of turbidity monitoring and any other water quality monitoring required by the RWQCB, as well as lay out the required steps should the turbidity surpass the established parameters.

Turbidity impacts are directly related to the amount of fine sediment (silts and clays) in the dredge slurry. For the Central Trancas area, which is just offshore from Broad Beach and where the dune sand will likely originate, the percentage of fines was found to be between 3.2 and 6.8 percent in the test borings conducted by M&N (2012). This percentage is low, and with training dikes in place, turbidity should not have a major impact at the beach disposal site. The Central Trancas dredge site could create a sizable turbidity plume at the dredge location, which will be monitored according to the RWQCB 401 permit.

The percentage of fines at the Dockweiler site is reported to be less than 1 percent by M&N (2012). With this very low fines percentage, turbidity should not be a major impact at either the dredge or disposal sites.

4.7.2 Bacteria

Bacteria can be harmful to swimmers and surfers using Broad Beach for recreation. Bacterial levels at Broad Beach were more or less similar to those at the Trancas Beach entrance between 1995 and 2000 (Coastal Environments, 2012a). There is a noticeable increase in the number of days when bacteria levels exceeded standards from 2005 to 2012 at Broad Beach at the Trancas Creek mouth (Coastal Environments, 2012a). This may be due to the change in the location of the measurements from the Broad Beach and Trancas Beach entrance from 1995 through 2000 to the mouth of Trancas Creek, beginning in 2005 and continuing to date (Coastal Environments, 2012a).

There are 114 parcels located along Broad Beach, and 78 residences have septic systems according to M&N (Project 10937-000-460 Summary Table). In response to severe and continued erosion at Broad Beach, the owners hired Topanga Underground (2011, 2012a, 2012b) to determine the existing location of the onsite wastewater treatment systems and the possibility of relocating the septic systems from the dunes on the south side of the residences to the landward (north) side of the property structures, farther away from the beach. Topanga Underground (2012c) determined that 32 systems were already located on the north side of the properties, and therefore were not a danger to public health. They determined that 15 additional systems could be relocated at a cost of $2,570,000, but the remaining 31 septic systems were impractical to relocate, primarily due to insufficient space to construct new landward systems.

If the beach replenishment project were not to happen or the current rock revetment were to be removed, the chances of one or more of the septic systems (located south of the residences) being damaged during a large storm or wave event would increase dramatically. Septic system damage could cause a major deleterious impact to Broad Beach and nearby coastal waters.

4.8 WAVE RUN-UP

Wave run-up is defined as the rush of water up a beach or coastal structure caused by or associated with wave-breaking. The run-up elevation is the maximum vertical height above 0 ft, MLLW that the run-up will reach. If the run-up elevation is higher than the beach berm, the excess represents overtopping. Run-up depends on the incident wave characteristics, the slope and porosity of the beach, and if a structure is present, that structure's shape, slope roughness, permeability and water depth at the toe.

M&N (2012) estimated the run-up and overtopping for existing conditions at Broad Beach for a 25-year return wave period. They considered two cases: 1) wave height equal to 9 ft and wave period equal to 16 seconds; and 2) wave height equal to 9 ft and period equal to 20 seconds. They estimated wave run-up to be 22.7 and 24.7 ft, MLLW respectively. Since there is no beach in the existing condition, waves break at the toe of the revetment.

After the beach fill, the wave run-up values will be lower than those values presented by M&N for the same wave conditions, because: 1) waves will break farther away from the shoreline; and 2) as the broken wave propagates along the beach slope, waves will lose a considerable part of their energy.

4.9 SEALEVEL RISE

The rate of change of sealevel rise in the short term (5 to 10 years) ranges from 1.2 to 1.7 mm/year. Predictions of sealevel rise over longer time periods are given in Table 4-1. According to Table 4-1, by 2040 sealevel rise will be 0.78 ft. This value is small in relation to the daily tidal range changes. Therefore, the impact of sealevel rise on the project is considered insignificant during the life of the proposed project.

M&N (2012) used the Bruun Rule (Bruun, 1962) to estimate the recession of the beach at Broad Beach due to sealevel rise. M&N estimated sealevel changes based on the high end of sealevel rise projections, and their results suggest that coastal recession attributed to sealevel rise will be about 0.6 ft/yr from 2025 to 2040. This is a relatively small change in beach width compared to the long-term rate of erosion along Broad Beach. M&N’s results for sea level rise and beach recession are presented in Table 4-1.

Table 4-1. Beach recession due to sealevel rise predicted by Bruun's rule. From M&N (2012).

Year	Years After Construction	Sealevel Rise[a] (ft)	Beach Recession (ft)
2025	10	0.26	5
2030	15	0.41	8
2035	20	0.59	12
2040	25	0.78	15

[a] Estimates based on high rate of sealevel rise (USACOE, 2011).

5.0 IMPACTS OF THE PROJECT ON TRANCAS CREEK

5.1 LONGSHORE SAND TRANSPORT IMPACTS

Trancas Creek forms the eastern boundary of the project area. Trancas Creek is a predominantly ephemeral stream that, in addition to rainfall runoff, receives a small volume of residential irrigation runoff along its lower reach, as well as seawater during periods of tidal interchange or from over-wash during higher tides. Figure 5-1 shows the locations of Trancas Creek and Trancas Creek Lagoon.

Trancas Creek drains a watershed of 6,233 acres, most of which are located north of the City of Malibu, California. There is a small (approximately 2 acres) impaired lagoon at the mouth of Trancas Creek. This lagoon mouth is usually blocked from regular tidal interchange by a wide sand berm. The creek habitats are characterized as predominantly brackish and freshwater (M&N, 2012).

The primary potential impact to Trancas Creek will be the increased amount of sand in front of the creek/lagoon mouth. The proposed beach nourishment plan calls for the deposit of sand to taper off at the eastern end of Broad Beach and to be placed at a distance from Trancas Creek. Over the estimated 5- to 10-year life of the initial nourishment project, up to 450,000 cyd of sand would move downcoast, adding to the width of the sand berm currently in place in front of the mouth of Trancas Creek.

According to aerial photographs from 1946 to the present, Trancas Creek is usually closed off from the Pacific Ocean by a large sand berm, except during the heaviest winter rainfall events. Also, due to the small size of the lagoon and the ephemeral nature of the creek, it is likely that the lagoon entrance will remain closed most of the year, even if no future restoration projects are completed. Due to the small volume of this lagoon (2 acres), it will be subject to closure after the mouth of the creek is opened by large rain events. By adding significant amounts of sand to updrift beaches, the proposed Project would incrementally affect both the frequency and duration of the opening of the Trancas Creek lagoon mouth. However, it is impossible to quantify the extent of these effects on the number of times the lagoon is open annually or on the duration of each opening. Lagoon habitats and wildlife are adapted to periods of prolonged closure, and the anticipated minor changes in the hydrology of the lagoon mouth are not anticipated to be significant.

The proposed nourishment of Broad Beach would likely result in increased longshore sand transport from Broad Beach downcoast, potentially impacting Zuma Beach and the Zuma wetlands. Adverse impacts on the secondary study areas include potential changes in the hydrology of the Trancas Creek lagoon as well as the Zuma wetlands due to increased sand berm width interfering with lagoon mouth opening and tidal interchange. Both of these freshwater habitats, which are considered Environmentally Sensitive Habitat Areas (ESHAs) under the Malibu LCP, are periodically open to the marine environment (City of Malibu 1995), and have been identified by the NPS as potential habitat for southern steelhead. As mentioned above, increases in longshore sand transport, as a result of the proposed beach nourishment, would likely result in the deposition of sand in the vicinity of Trancas Creek lagoon and the Zuma wetlands, potentially reducing the overall amount of time that these lagoons are open to the ocean. This may have negative implications for the restoration efforts aimed at restoring southern steelhead or tidewater goby habitat. Further, as longshore sand transport may reduce the period of time that these lagoons are open to the marine environment, the proposed Project may indirectly decrease the function value of these ESHAs. This potential adverse impact would be long-term; however, proposed backpassing would somewhat reduce these impacts by retaining sand on Broad Beach.

Additionally, longshore sand transport resulting in a wider beach profile at Zuma Beach may increase habitat for sensitive species that require sandy beach habitat, such as the western snowy plover. This may constitute a beneficial impact, resulting in local population increases for a number of sensitive species, including the California least tern and the western snowy plover.

Longshore sand transport is not likely to affect the sites downcoast of Point Dume, as these areas are outside of the primary Project area’s littoral cell. Therefore, as impacts to these areas would be negligible, they are not described in further detail.

5.2 MITIGATION

5.2.1 Maintain the Hydrology of Trancas Creek Lagoon and the Zuma Wetlands

Before initiating sand deposition activities in the primary Project area, the Applicant shall prepare a Trancas Creek Lagoon and Zuma Wetlands Beach Berm Management Plan. This Plan shall be submitted to the California Department of Fish and Game (CDFG) and the Los Angeles County Parks and Recreation Department (LACPRD) for review and approval. The proposed Beach Berm Management Plan shall identify the anticipated rate of sand deposition in front of the mouths of these water bodies and include measures to maintain the connection between these wetlands and the marine environment, as determined appropriate by CDFG and LACPRD.

Implementation of the above would reduce the long-term impacts to onshore freshwater aquatic habitat by providing for the maintenance of the connection between Trancas Creek Lagoon and the Zuma Wetlands to the Pacific Ocean. Through the maintenance of this connection, these water bodies will continue to be good candidates for restoration efforts focused on the recovery of southern steelhead populations.

After the implementation of mitigation measures, the impacts of the project to terrestrial biological resources from longshore sand transport would be less than substantial.

Figure 5-1. Locations of Trancas Creek and Trancas Creek Lagoon.

6.0 IMPACTS OF THE PROJECT ON PUBLIC ACCESS

Public access to Broad Beach is available via lateral access from Zuma Beach County Park and two vertical access points from Broad Beach Road. At present, there is no dry beach along most of Broad Beach, even during moderate tides. On many parts of the beach, especially the western and central parts, waves break at the toe of the existing revetment. The eroded beach and temporary revetment restrict lateral access along most of Broad Beach, except at low tides.

One of the objectives of this project is to improve public benefits from the beach. All currently existing lateral access easements will be suspended in the future.

6.1 EXISTING PUBLIC LANDS AND ACCESS RIGHTS

The public currently has the legal right of access to and along intertidal public trust lands as well as to multiple public easements at Broad Beach. In general, the area below the MHTL (Mean High Tide Line) is considered a public beach under the California Constitution and the Public Trust Doctrine, and it is thus open for public use and enjoyment. Further, over the course of the last 30 years, the public has acquired multiple easements to permit public lateral access along Broad Beach. However, the ambulatory nature of the MHTL, coastal erosion and the resulting loss of beach area, new and expanded development, and the installation of emergency geotextile and rock revetments along Broad Beach have all resulted in a shifting public-private boundary, with boundaries that are difficult for the public to ascertain within the primary Project area.

Generally speaking, all beach areas seaward of the toe of the existing emergency revetment and other coastal protection structures at Broad Beach are public trust lands and open to public use and enjoyment. Thus, access along the existing low tide beach occurs on public land. However, as discussed below, this matter is further complicated as portions of the existing revetment overlie public lands located below the MHTL and existing access easements held by the State, with many such easements also located landward of the revetment.

Broad Beach currently supports approximately 27 acres of intertidal public trust land that are generally available for public use and enjoyment at lower tides, with the vast majority of these lands located seaward of the existing revetment. These lands are located south of the MHTL, which is located along the toe of or beneath the existing revetment. Approximately 0.85 acres of public land currently lie beneath the existing revetment, blocking access to these lands[1]. The accessible seaward edge of this land is defined by the MLLW, with these lower lying areas generally accessible only during minus tide conditions. The vast majority of these public intertidal lands consist of low tide wet sandy beach, although limited areas of dry beach berm do accrue during summer months. Several acres of rocky intertidal area also exist on these public lands toward the west end of Broad Beach.

Landward of the MHTL, public lateral access is legally available only on those properties which have deeded such access within AREs.[2] Approximately 52 of the 114 private parcels along Broad Beach have granted easements, deed restrictions, or other legal documents providing the public with the right to lateral coastal access across the seaward edge of these private properties.[3] Collectively, these easements and deed restrictions are referred to as AREs. The status of the current AREs in the primary Project area is provided in Table 6-1.

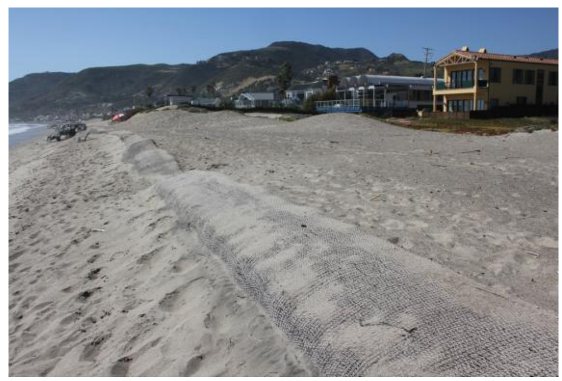
These AREs vary in terms, but they typically extend 25 ft inland from the “daily high water line” or the MHTL; in some cases, AREs are restricted by buffers against the residential structures. Most of these AREs are currently covered, either partially or entirely, by the emergency revetment, and they frequently extend landward of the revetment (Table 6-2; Figure 6-1). In total, more than 94 percent (1.1 acres) of these public lateral access easements lie beneath or landward of the revetment.

---

[1] CSLC staff completed a survey of the MHTL in January of 2010 that is the basis for this estimate. Moffatt and Nichol, the agent for the GHAD, also completed an MHTL survey, which showed lesser intrusion on public land (refer to Section 2.0, *Project Description*).
[2] Also known as Offers to Dedicate (OTDs); however, OTDs are only offers of easements. The interest belongs to the property owner until the offer is accepted by a government agency or a nonprofit organization. Once the OTD is accepted, the accepting entity obtains title to the easement and the easement remains in the public domain in perpetuity. AREs are accepted OTDs and have been dedicated by former or current owners of land within the GHAD and held by various agencies including the CSLC.
[3] An additional 23 easements have been offered, but have not yet been accepted.

The existing revetment covers or cuts off access to a total of approximately 2.01 acres of existing public land and existing lateral access easements. Since legal public lateral access is limited to public lands below the MHTL and to the AREs, the revetment substantially limits public lateral access along the shoreline at Broad Beach. Under current conditions, coastal erosion, combined with the installation of the existing revetment, has materially diminished the area of beach available for recreation and public use.

6.2 SHORT AND MEDIUM-TERM EFFECTS ON RECREATIONAL USE



Implementation of the project would result in a dry sand beach berm, such as those currently found in the eastern Project area, covering 12 acres and expanding the recreational opportunities available on Broad Beach, as well as increasing the time the public would be able to access and use the beach.

A substantial beneficial effect on recreation would occur during the life of the Project, with these benefits anticipated to last for 10-20 years, or possibly longer, depending on the rate of coastal erosion. Current conditions limit beach access primarily to low tides, during which the beach is estimated to provide approximately 25 acres for public recreational uses compatible with a low-tide beach (e.g., walking, jogging, swimming, body surfing). However, this beach is often submerged during medium and high tides, and during these tides, lateral access is largely blocked by the revetment, limiting the amount of time that the public can use and enjoy these public trust lands. The proposed Project would include burying the revetment beneath the new sand dune system and restoring a historically wide, dry, sandy beach berm, allowing public recreation and lateral access during medium and high tides on public lands that are currently submerged during such tides. Thus, over the short- to mid-term, the proposed Project would substantially expand the amount of time that Broad Beach could be accessed by the public and would increase the types of recreational activities that could be accommodated to include those that typically occur on dry sand beaches (e.g., sunbathing, picnicking). The post-construction restored dune and beach would range in width from 92 ft in the western portions near Lechuza Point to 180 ft along the majority of the beach (Figure 6-2). This would result in a net increase of approximately 12.15 acres of dry sand beach. This substantial increase would occur initially after construction and renourishment; however, it is anticipated that the constructed beach would immediately undergo erosion by waves and tides that would distribute the sand both offshore and alongshore until the beach profile reaches an equilibration shape. This equilibration erosion is anticipated to reduce the total area by approximately 25-30 percent after the first year to a total dry beach area of approximately 8.5 acres. Of this total beach area, a privacy buffer would prohibit public access on 3.49 acres (41 percent) of the new beach, which, it should be noted, overlies public trust land. The portion of public lands that the privacy buffer would occupy would increase as the beach width declined.

In addition to the privacy buffer, the dune system would not be open to public recreation and access in order to protect ESHA. The dune system and privacy buffer would preclude public use over approximately 15 acres, overlying substantial areas of public trust lands and AREs. However, over the short- to mid-term, the Project would result in a substantial increase of dry sandy public beach that would increase both the range of recreational activities that could occur on Broad Beach and the amount of time that Broad Beach would be accessible to the public. The Project would therefore result in a substantially enhanced and expanded public recreation area backed by a scenic dune system, as compared to current conditions. However, while these benefits would be substantial, they would also be ephemeral. It is anticipated that erosion of the beach area would continue despite backpassing. These benefits may potentially remain for 10-20 years or even longer; however, worst-case-scenario modeling projects a potential for a return to near-existing conditions within 5 years of the initial nourishment, particularly at the beach's west end. This could result in coastal erosion eliminating the entire dry sandy beach and substantial loss of new sand dunes with potential for exposure of the revetment and the associated adverse effects of blocking public access to public trust lands.

Because of this potential for erosion, the timing of renourishment is critical for extending these beneficial effects. The Project Applicant currently proposes that renourishment be triggered when the nourished beach is in deficit (i.e., the point in time when the western beach width has been 50 ft or less for 12 consecutive months and the eastern beach width has been less than 25 ft wider over the same period, or *vice versa*), provided 10 years have passed. Given the potential for the beach to return to near-existing conditions within 5 years, the public benefit provided by the Project could be eliminated prior to the 10 years stipulated to pass prior to re-nourishment, eliminating this benefit.

The erosion of sand from project nourishment and re-nourishment would result in direct benefits to beaches downcoast, including Zuma Beach and Point Dume, which are anticipated to benefit from the influx of sand to the immediate littoral cell, contributing to incrementally wider beaches with the associated coastal access and recreational benefits.

6.3 LONG-TERM EFFECTS ON RECREATIONAL USE

A substantial beneficial effect on recreation would occur during the projected 10-20 year life of the Project due to the creation of a wide sandy beach. However, after both the initial and the second proposed nourishment event, these benefits would begin to diminish, as coastal processes cause the beach to retreat back to current conditions, eroding portions of the dune system and eventually re-exposing the revetment, which would block public access to public trust lands and AREs.

Permitting the revetment as a permanent structure overlying or cutting off access to almost two acres of public trust lands and access easements would result in substantial long-term adverse impacts to recreation and access after the cessation of beach re-nourishment activities.

The Applicant has proposed the option, at the Applicant's discretion, of providing additional nourishment events; however, because the Applicant has not committed to such future nourishment, this analysis assumes that no additional re-nourishment events would occur. If no future renourishment were to occur after implementation of the second renourishment, it is anticipated that natural processes would erode the Project beach and the restored dune system within 20 years – and potentially as quickly as within 10 years – resulting in a substantial loss of recreational benefits and dune ESHA.

The erosion of the beach and dune would eventually result in exposure of the revetment, which would substantially inhibit public lateral beach access. The revetment would be permitted as a permanent structure under the proposed Project. Since the revetment overlays or is seaward of 2.01 acres of AREs and public trust lands, the permitting of the revetment would permanently prohibit public use of these access easements. Additionally, public lateral access would again be impeded by the revetment, as it is under existing conditions. The long-term loss of public access to 2.01 acres of public trust land and AREs would be an adverse effect.

Additionally, the long-term effects of sea level rise on the proposed Project would potentially be adverse. The California State Lands Commission (CSLC) *Report on Sea Level Rise Preparedness* notes that sea level rise, in combination with increased storm intensity, may lead to the loss of sandy beaches in some areas, which, coupled with the potential increase in shoreline protective devices, could reduce or eliminate public access along the coastline (CSLC 2009). This guidance document recommends: "*Where appropriate, staff should recommend project modifications that would eliminate or reduce potentially adverse impacts from sea level rise, including adverse impacts on public access*." The proposed Project would result in the permitting of a permanent revetment in a location that would result in the impediment of public access to public trust lands, particularly over the long-term, as the shoreline and MHTL shift landwards. This would be potentially inconsistent with the recommendations of the State of California and CSLC guidance related to sea level rise. However, the Project is only proposed as a 20-year measure, over which time the effects of sea level rise are not anticipated to substantially affect Project implementation or public access.

Table 6-1. AREs for parcels in the primary project area.

Type of AREs	**Total #**
Accepted AREs	52
Deed Restriction Recorded	18
Document Recorded	2
Dedication Recorded	4
Offer Not Accepted	1
Total AREs	*77*
(Parcels without an ARE)	37

Table 6-2. Location of existing revetment relative to public land and AREs.

Public Lands and AREs	Acreage	Percent (%)
Public Land Under the Revetment	0.85 ac	variable
AREs Under the Revetment	0.71 ac	57.7
AREs Inland of the Revetment	0.45 ac	36.6
AREs Seaward of the Revetment	(0.07 ac)	5.7
Total Public Land / AREs Affected by the Revetment	*2.01 ac*	--

Note: Total public land under the revetment was calculated based upon the MHTL as determined by the CSLC in relation to the location of the existing revetment.

Figure 6-1. East central Broad Beach, location of access and recreational easements / offers to dedicate.

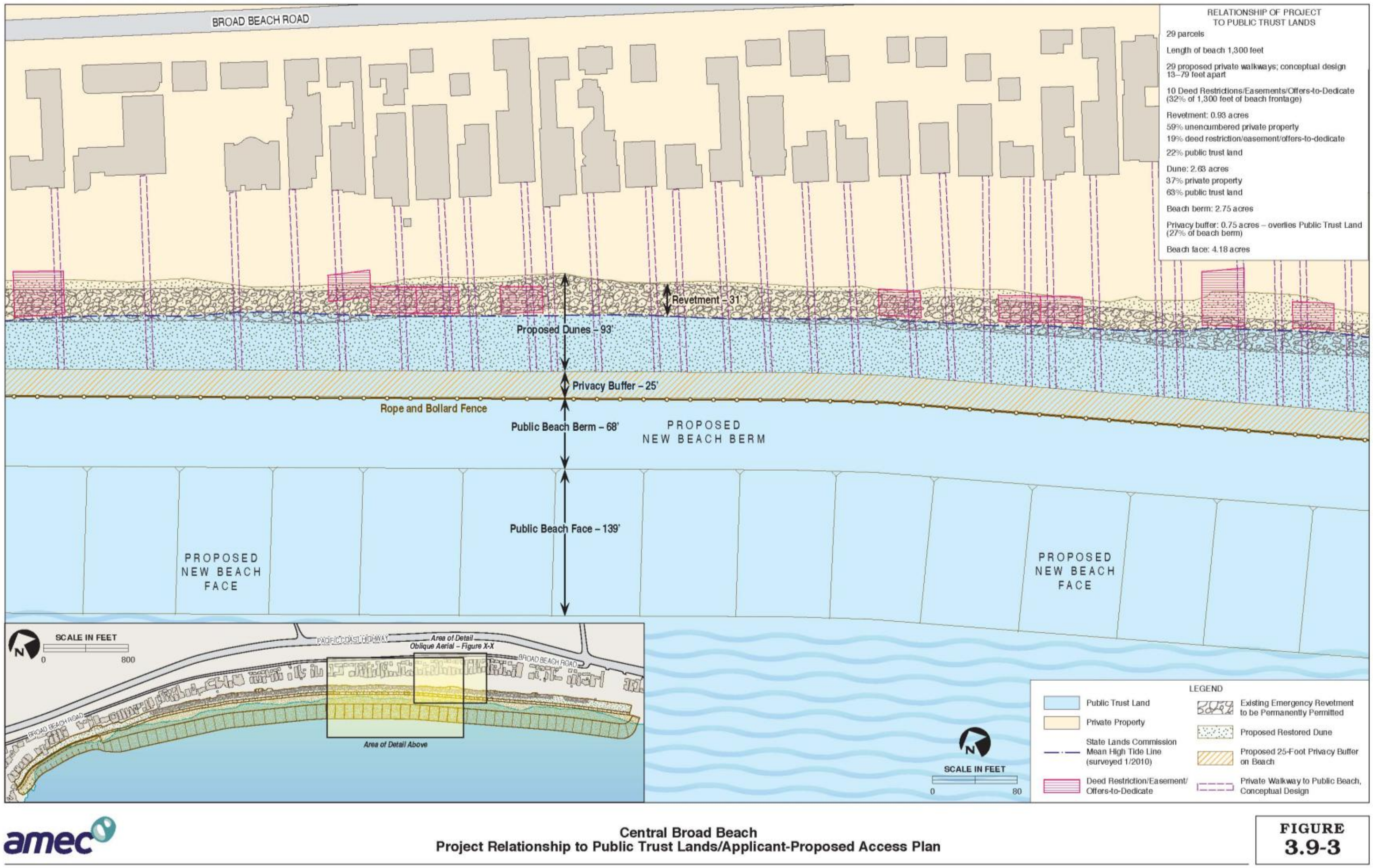


Figure 6-2. Central Broad Beach, project relationship to public trust lands/applicant-proposed access plan.

7.0 IMPACTS ON SAND SOURCE SITES

Sand will be taken from two borrow sites located offshore of Dockweiler Beach and Trancas Canyon. The impacts on these two sites are discussed below.

7.1 DOCKWEILER BORROW SITE

The sand borrow site offshore of Dockweiler Beach was positioned outside of the closure depth in order to reduce any impacts on the beach. The closure depth at Dockweiler Beach is about 28 ft, MLLW (Noble Consultants, 2009). Closure depth is defined as the water depth below which no sand movement occurs, either offshore or onshore. The location of the Dockweiler borrow site is shown in Figure 7-1. M&N (2012) used numerical modeling (Mike 21) to determine changes to the wave climate off Dockweiler Beach. Modeling included scenarios of high waves from the southwest and northwest. The results of M&N's numerical modeling are shown in Figures 7-2 and 7-3. These figures show the existing incident wave height, period, and direction and the changes in wave parameters (height or direction) with the borrow site.

The change in wave height was negligible; the change in wave direction was about 2^{o} to 3^{o}. While change in wave direction is important because longshore sediment transport is sensitive to any change in the wave-approaching angle, this small change is within the accuracy of the numerical model. Therefore, the oceanographic impacts of taking sand from the Dockweiler borrow site are considered insignificant.

7.1.1 Loss of Dredged Sand as a Resource for Other Beaches

Initial project nourishment would remove an estimated 450,000 cyd, either from the Ventura Harbor sand trap or from the Dockweiler sand deposit. The quantity of sand entering the Ventura Harbor sand trap is approximately 600,000 cyd per year (Griggs and Patsch, 2002). Historically, when funding has been available, this sand has been dredged from the sand trap and placed on downcoast beaches, which helps maintain wide, scenic beaches in Ventura County downcoast from the harbor. Thus, the initial nourishment Project would withdraw more than 80 percent of the annual deposit from the sand trap and make it unavailable for local beach nourishment. The second nourishment event could withdraw 450,000 cyd or 75 percent of the annual deposit of sand. Therefore, over the proposed Project's 10-20 year life, dredging for two nourishment events could remove from 8 percent (over 20 years) to 16 percent (over 10 years) of the available sand supply in the sand trap. Because the sand would be placed downcoast from Ventura County, littoral drift would not carry any of the sand placed on Broad Beach back to Ventura County beaches.

The loss of sand as a resource that could be used to restore another beach could be a substantial impact if there were plans or intentions to use the same sand resources in the reasonably foreseeable future. The dredged sand would no longer be available for extraction and nourishment projects at other beaches.

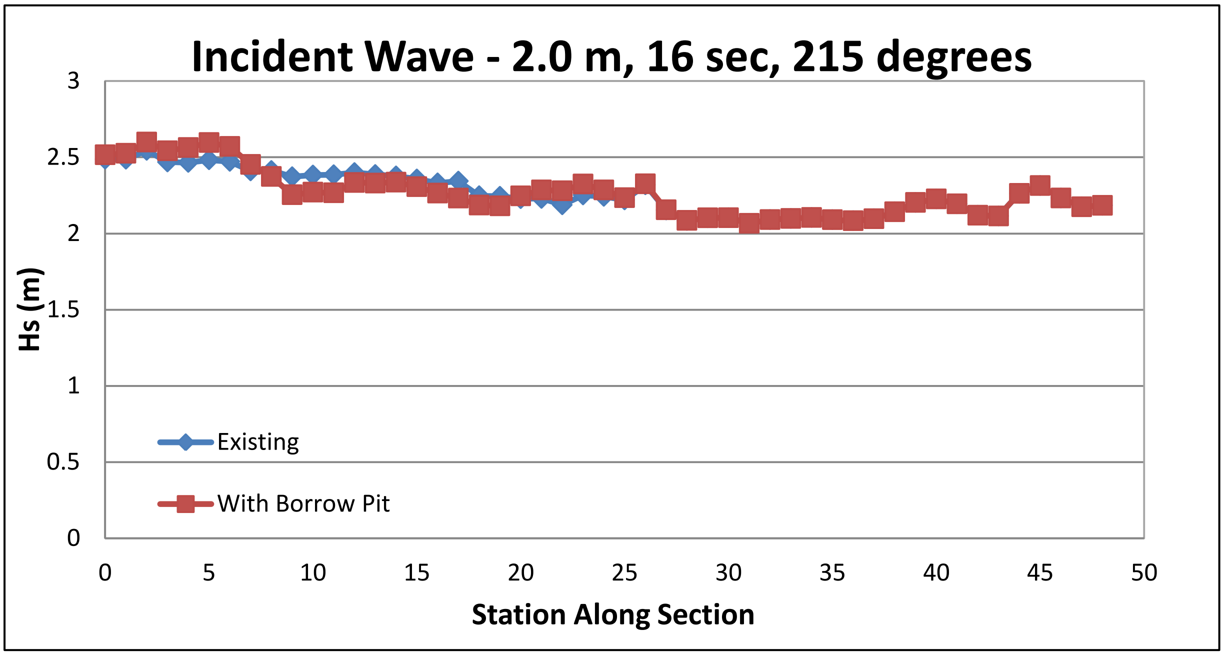
Sand offshore of Dockweiler is under the jurisdiction of the City of Los Angeles and would require approval to be used for the proposed Project. The amount of sand that would potentially be used from this source would be 500,000 cyd during the initial nourishment and 450,000 cyd during the second nourishment event. The total supply at this sand source is estimated at 3.3 million cyd. Thus, up to 15 percent of the sand source would be utilized during the initial nourishment event and 14 percent of the sand source would be utilized throughout the life of the Project. It is unknown at what rate the sand in the Dockweiler deposit is replenished. As with the Ventura Harbor sand, the loss of sand as a resource that could be used to restore another beach could be a substantial impact if there were plans or intentions to use the same sand resources in the reasonably foreseeable future. The dredged sand would no longer be available for extraction and nourishment projects at other beaches.

7.2 CENTRAL TRANCAS BORROW SITE

The Central Trancas borrow site is located offshore of Broad Beach (Figure 7-4) at water depths of between -40 ft and -60 ft, MLLW. This depth is greater than the closure depth of Broad Beach, which is 28 ft, MLLW. The methods described in Section 7.1 were used to determine the impacts of this borrow site on wave characteristics at Broad Beach. Modeling results are shown in Figures 7-5 and 7-6. The changes in wave height and direction were very small. Therefore the oceanographic impacts of taking the sand from the Central Trancas borrow site are considered insignificant.

Because the Central Trancas sand is fine-grained, it is planned to be used for dune restoration and to cover the existing revetment. This will be a beneficial aesthetic impact for the public.

Figure 7-1. Dockweiler borrow site and wave analysis reach.



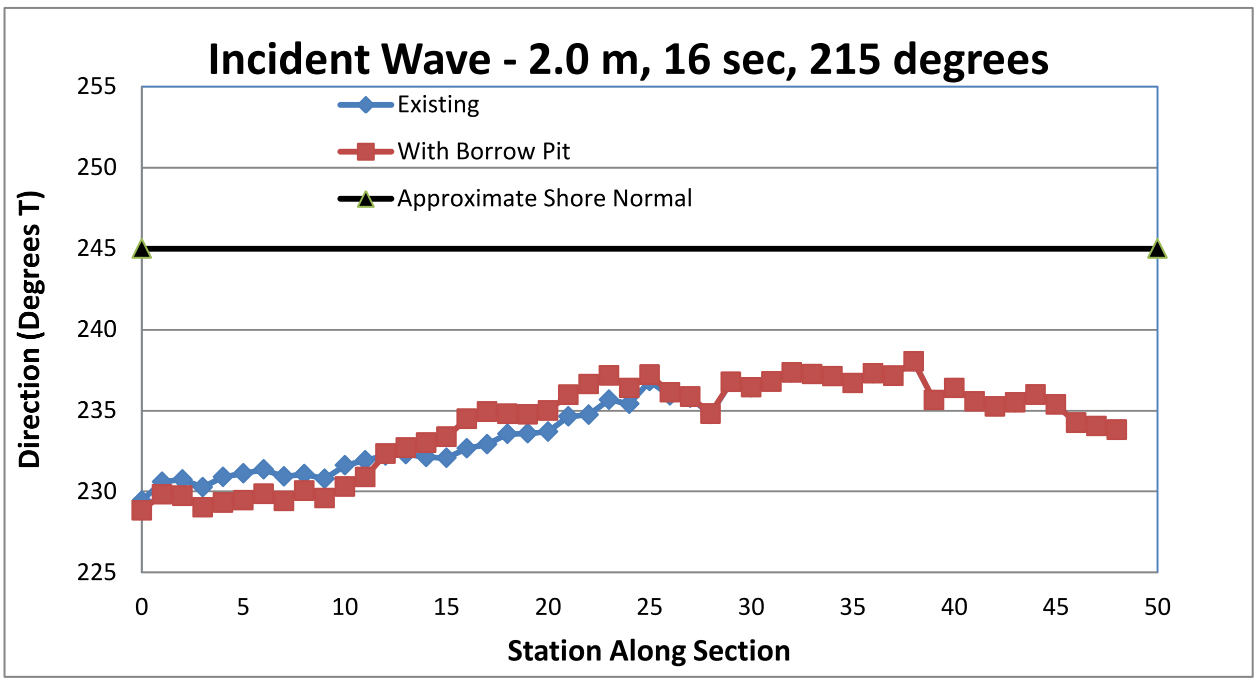
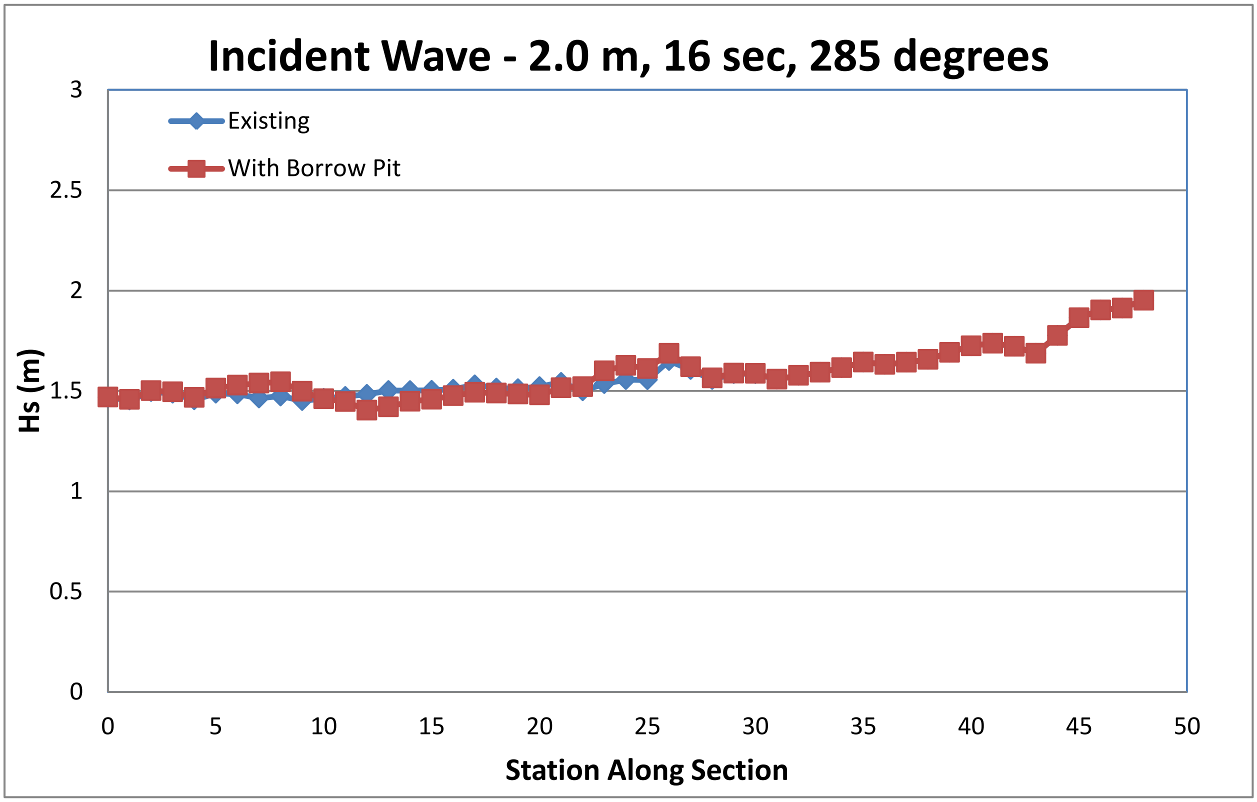


Figure 7-2. Effects on wave height (upper) and direction (lower) from the Dockweiler borrow site for southwest swell.



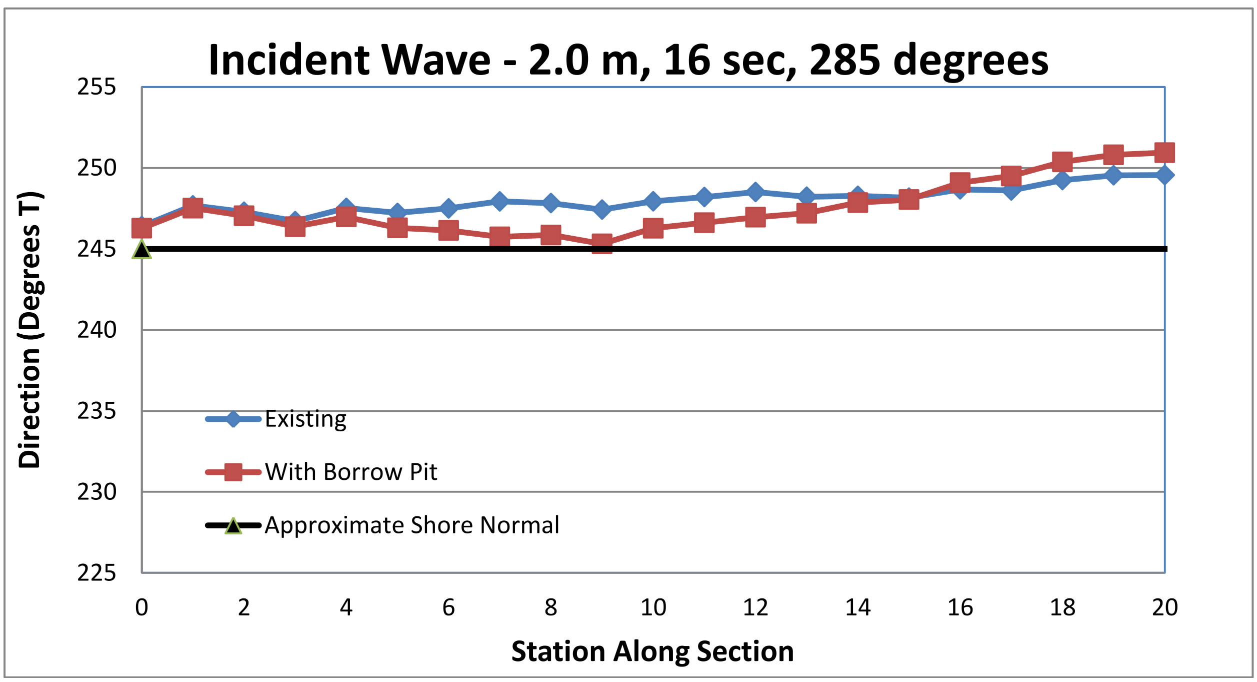


Figure 7-3. Effects on wave height (upper) and direction (lower) from the Dockweiler borrow site for northwest swell.

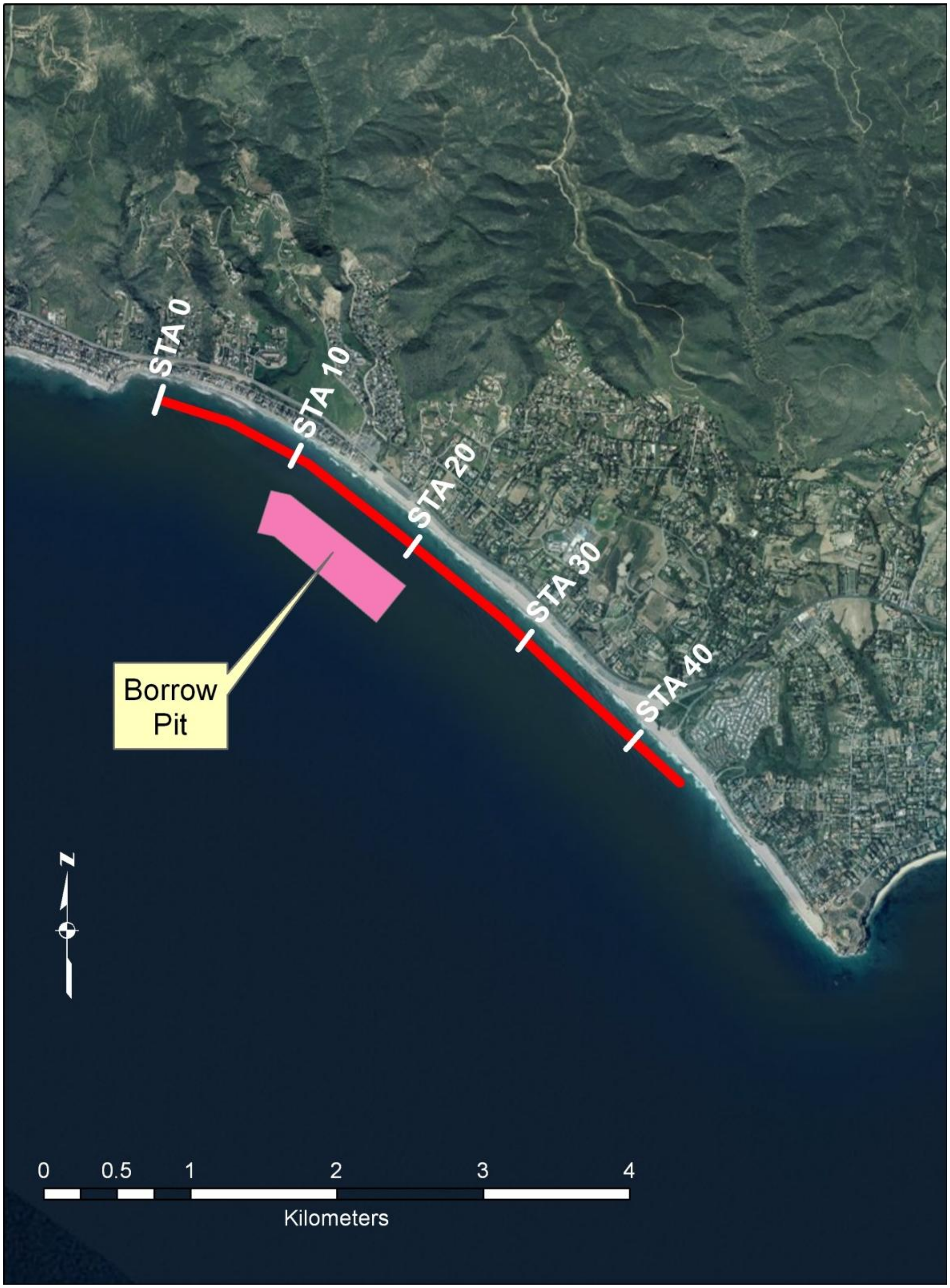
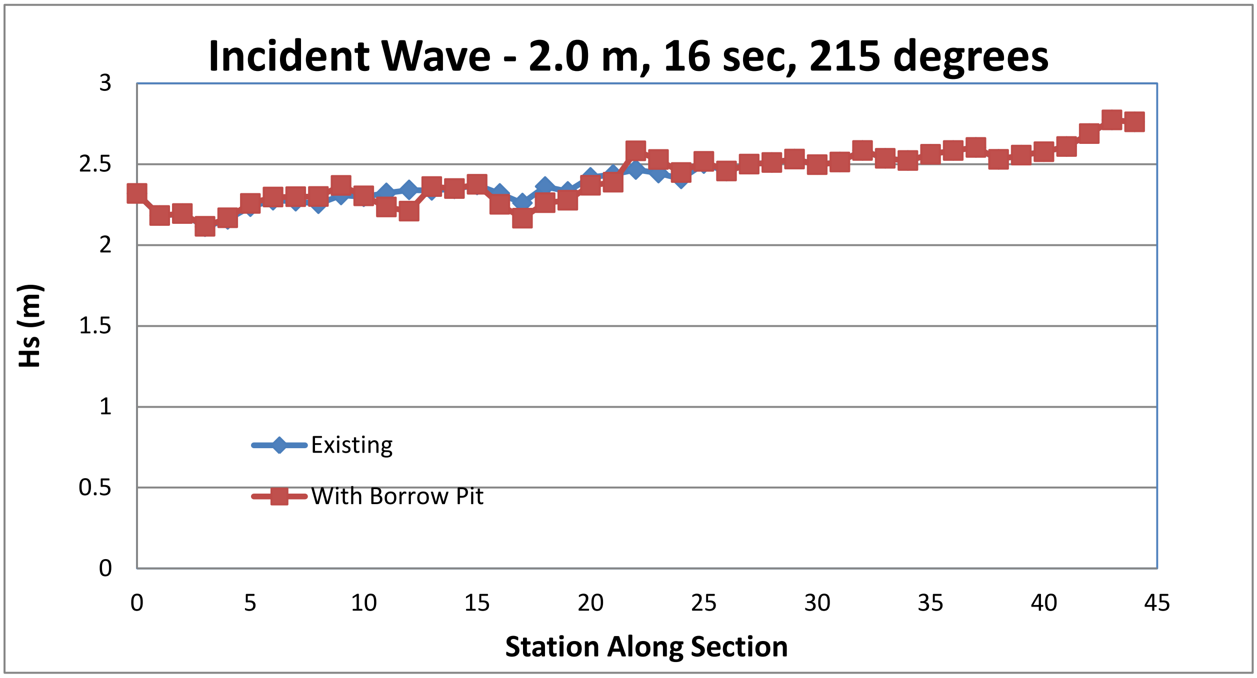


Figure 7-4. Central Trancas borrow site and wave analysis reach.



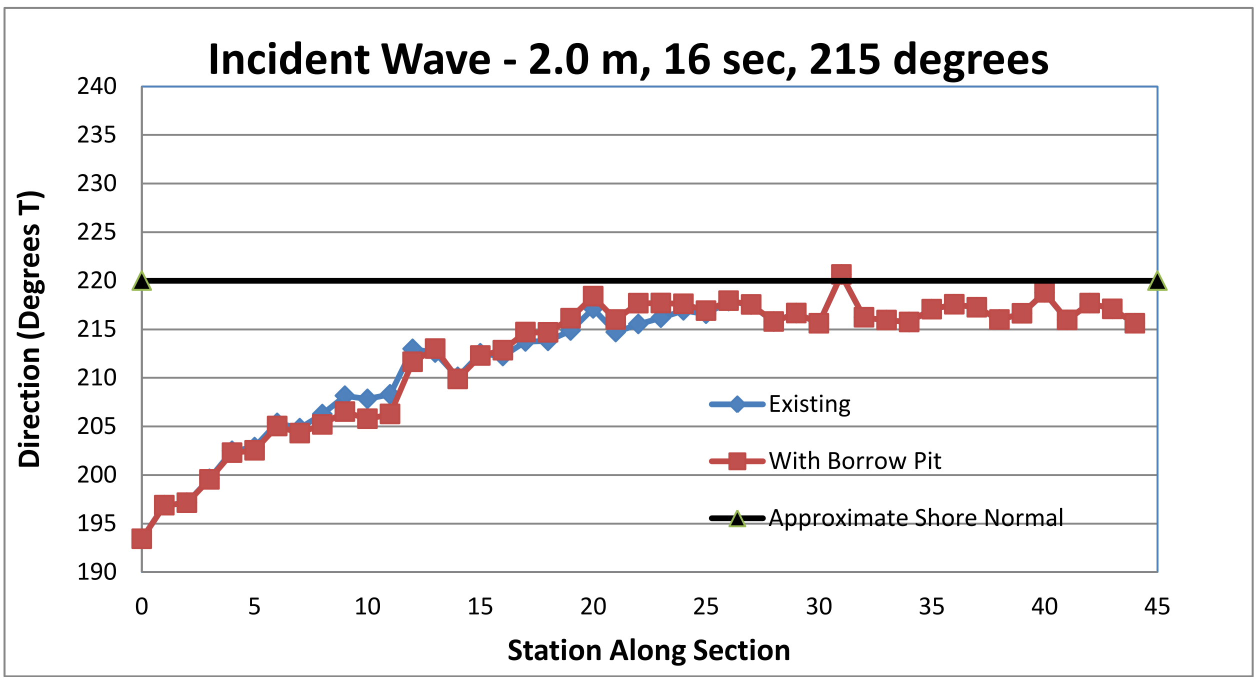
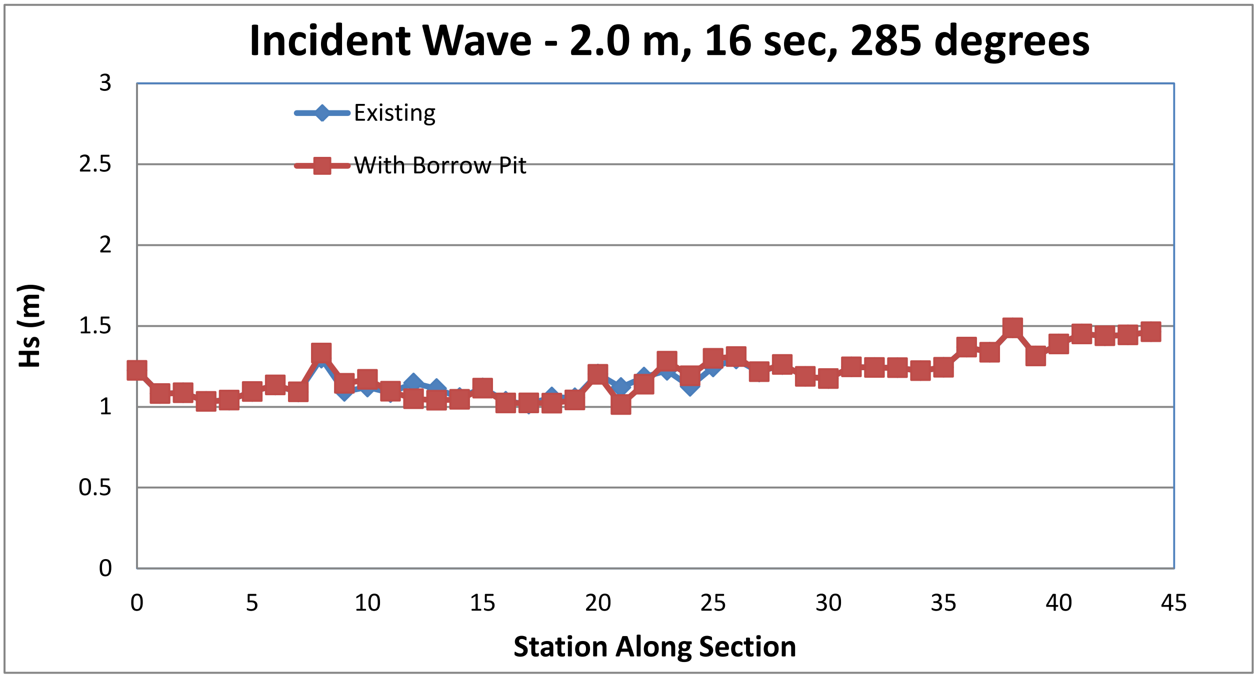


Figure 7-5. Effects on wave height (upper) and direction (lower) from the Central Trancas borrow site for southwest swell.



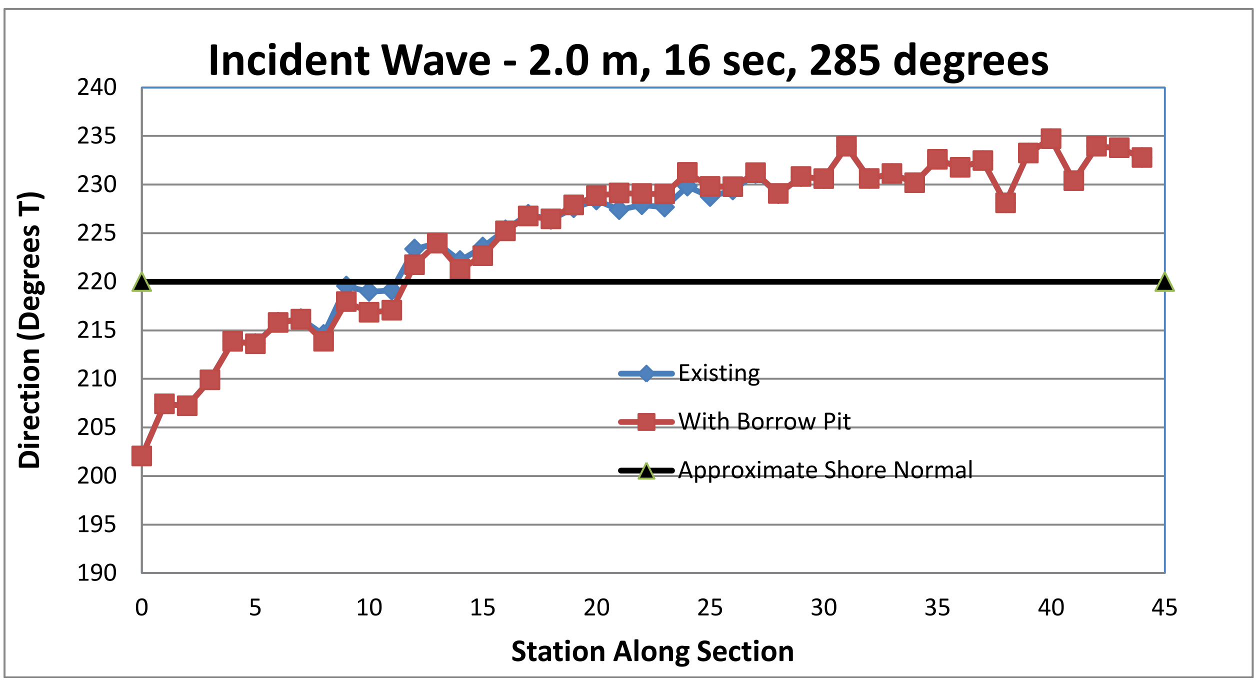


Figure 7-6. Effects on wave height (upper) and direction (lower) from the Central Trancas borrow site for northwest swell.

8.0 CONSTRUCTION METHOD AND ASSOCIATED IMPACTS

8.1 CONSTRUCTION

This Project will hydraulically and mechanically dredge the borrow sites at either the Dockweiler Beach site (Dockweiler site) or the Ventura Harbor site and offshore of Broad Beach (Central Trancas site). The volume of sand to be dredged from the Dockweiler or Ventura harbor site is about 500,000 cyd; from the Central Trancas site, it is about 100,000 cyd. The dredging of the offshore borrow sites will be carried out by either a clamshell dredge, hopper dredge, or cutterhead suction dredge, depending on equipment and dredge availability (M&N, 2012). A dredge is the preferred and most economical method for removing sediment from the borrow sites.

Both the beach nourishment and dune re-building parts of the project will involve pumping sand to Broad Beach from an offshore scow, hopper dredge, or cutterhead suction dredge via floating or submerged pipeline connected to a single-point mooring buoy (Figure 8-1). The dredge slurry is generally composed of 20-30 percent sand by weight and the rest is water. This creates a very turbid outflow from the dredge pipe onto the beach. To keep this turbid dredge slurry from flowing back into the ocean, training dikes of sand are constructed parallel to shore to hold the slurry on the beach and allow the turbidity to dissipate before the water is allowed to return to the ocean (Figure 8-2). Bulldozers will then be used to place the sand in the specific areas required by the design.

8.2 POSSIBLE IMPACTS

Sand placement will result in direct burial and death of non-mobile epibenthic invertebrates; however, this would be a short-term impact as recolonization of the area would occur rapidly. Mobile invertebrates, such as crustaceans, would be expected to move into the area within days of cessation of sand placement, and other organisms would be expected to recolonize within 6 to 12 months (Butler Roach, 1995). Because the effect would be temporary and would not directly impact any sensitive species, impacts to intertidal invertebrates would be considered insignificant.

Non-mobile invertebrates in the sub-tidal area would also be buried by sediment that is washed offshore from implementation of the proposed Project. Since this a natural process, most sub-tidal invertebrates are adapted to shallow burial by sediment. As mobile invertebrates would move vertically within the sandy substrate or horizontally to deeper waters to avoid burial, this impact would be considered insignificant.

Sensitive marine resources near the western end of Broad Beach would be impacted and buried by 10 to 12 ft of sand; these include vegetated sub-tidal reefs and nearshore reefs with surfgrass, sea fans and other biological resources. The impact of burial of these biological resources is discussed in detail in the biological report.

Estimated sand cover for various beach profiles is presented in Figures 3-5 and 3-6 for 1, 2, 3, and 5 years. Sand movement offshore after the initial losses of sand would be mimicking the existing natural processes. Sand on the beaches naturally undergoes a seasonal cycle. It moves offshore in winter and then back onto the beach in summer. Other impacts such as noise, public inconvenience, traffic, air emissions, and so forth will be discussed in the main environmental document.

Figure 8-1. Dredge discharge line to beach.

Figure 8-2. Placement of dredged sand on the beach showing the training dike.

9.0 BACKPASSING OPERATION AND ITS IMPACTS

9.1 BACKPASSING AND CONSTRUCTION ACTIVITIES

A part of the proposed Project is backpassing sand from the eastern part of Broad Beach to the central and western parts of the beach. The trigger for backpassing (M&N 2012) will be: 1) when any one reach of the beach becomes narrower than required for public access, shore protection, and recreation; 2) when the western average width is 50 ft or less of dry sand for 6 consecutive months, and the eastern average width is a minimum of 25 ft wider over the same time frame; and 3) when the east end has an average beach width of 50 ft or less for 6 consecutive months, and the western average width is a minimum of 25 ft wider over the same time period. Since the net direction of sand movement is to the east, it is likely that backpassing operations will be from east to west.

Backpassing would involve using conventional mechanical equipment such as bulldozers to excavate the sand from areas of deposition to the eroding reach of Broad Beach. Backpassing is proposed to extend the lifetime of the fill. Backpassing has been used on other beaches, as shown in Figure 9-1, which shows a backpassing operation in Long Beach, California.

9.2 BACKPASSING IMPACTS

Backpassing impacts will be similar to those of the initial fill (Section 8.2), but because less sand will be placed, negative impacts will also be less.

Figure 9-1. Backpassing operation in Long Beach, CA.

10.0 ANALYSIS OF PROJECT ALTERNATIVES

In this chapter, we will discuss the six proposed project alternatives. These alternatives are:

1. No project.
2. Retention of modified revetment in its current location with beach nourishment and dune restoration.
3. Landward relocation of modified revetment with beach nourishment and dune restoration.
4. Replacement of revetment with landward-located seawall with beach nourishment and dune restoration.
5. Reduced project with lower levels of sand importation.
6. Beach nourishment and dune restoration with elimination of revetment.

10.1 ALTERNATIVE 1: NO PROJECT

The no-project option would include removing the temporary revetment constructed in 2010 by 2013, and no beach fill activities would occur. While this is the least expensive option, damages to existing properties and septic systems are almost certain to occur due to continued erosion of the beach. Damages to the septic systems would have a significant environmental impact. In the near future, it may be necessary to use sandbags or the owners may be forced to re-apply for a new emergency revetment in place of the one that will be removed. Public access to the beach will be minimal or diminished.

10.2 ALTERNATIVE 2: RETENTION OF MODIFIED REVETMENT AT CURRENT LOCATION WITH BEACH NOURISHMENT AND DUNE RESTORATION

In this alternative, the existing revetment would remain in the current location, but will be augmented with outer layers of large armor stone (3 to 5 tons), and the foundation of the existing revetment would be improved by constructing a deeper toe. Since the intent of the proposed Project is to maintain sand on the beach to protect the properties and to increase public access for at least 20 years (further sand fills likely would be required), it may be not be necessary to augment the existing revetment or improve the foundation by constructing a deeper toe since the revetment would be covered by the fill and the fill will be maintained. This alternative would have significant impacts on existing habitat located along the existing revetment.

10.3 ALTERNATIVE 3: LANDWARD RELOCATION OF MODIFIED REVETMENT AT CURRENT LOCATION WITH BEACH NOURISHMENT AND DUNE RESTORATION

This alternative would require moving the existing revetment landward and augmenting the revetment as described in Section 10.2. Removing the revetment and augmenting it would result in: 1) unnecessary inconvenience to the public, and 2) additional costs in order to achieve the goals of the alternative. Meanwhile, no benefit would result from these two actions since the revetment would be covered by sand.

10.4 ALTERNATIVE 4: REPLACEMENT OF REVETMENT WITH LANDWARD-LOCATED SEAWALL WITH BEACH NOURISHMENT AND DUNE RESTORATION

This alternative would be expensive to adapt and has some engineering complexities. These complexities are: 1) it would inhibit the function of the leach fields along Broad Beach, which would consequently have a negative impact on the ocean water quality; 2) the close proximity of bedrock to surface prevents keying the seawall to the ground and would impact the stability of any seawall; 3) it is not possible to tie back the seawall to the dunes; and 4) any water from rain or irrigation behind the seawall would impact its stability and function. The impacts of a newly constructed seawall would result in damage to and reduction of existing degraded dune habitat and small patches of mixed remnant dune. The high costs associated with seawall construction compared to its benefits make this alternative less favorable.

10.5 ALTERNATIVE 5: REDUCED PROJECT WITH LOWER LEVELS OF SAND IMPORTATION

Several methods were used to estimate the longevity of beach fill volume of 600,000 cyd at Broad Beach. These studies concluded that longevity of the sand on the beach ranges from 5 to 8 years, depending on the wave climate and assuming that backpassing will be allowed every 2 years or less. Placing a lesser quantity of sand at Broad Beach would likely reduce the residence time of fill to 2-3 years. This will require follow-up nourishment events and more frequent backpassing.

While this alternative reduces impacts associated with sand placement activities on Broad Beach and reduces impacts to nearshore marine habitats associated with the nourishment volume, it would be inconvenient to the public and impact public access to the beach. Also the longer duration between the larger initial nourishment event and subsequent backpassing and re-nourishment may provide better opportunities for marine habitat to reestablish itself.

10.6 ALTERNATIVE 6: BEACH NOURISHMENT AND DUNE RESTORATION WITH ELIMINATION OF REVETMENT

The existing revetment is not an engineered one. Removing the revetment would increase the available beach to the public. However, if the sand placed on the beach erodes before a second re-nourishment project is in place, or there is a change in wave climate that would shorten the residence time of sand on the beach, the residences would face situations similar to those during the winter of 2009-2010, which required implementation of the emergency revetment. Leaving the existing revetment in place will eliminate this concern. The impact of leaving the existing revetment in place is not significant as long as it is covered by sand.

Table 10-1 presents a summary of the pros and cons of the alternatives suggested for full evaluation of Broad Beach project alternatives.

Table 10-1. Pros and cons of alternatives suggested for full evaluation of Broad Beach.

PROS	CONS
Alternative 1: No project (includes removing temporary emergency revetment installed in 2010).	
1. Least expensive alternative.	1. Since no beach replenishment would occur and the emergency revetment would be removed, the trend of erosion would be expected to continue and even accelerate.
2. Requires least amount of permitting.	2. Existing septic systems and portions of the most seaward homes would continue to be at risk for damage or loss during a single large storm event (and will likely be impacted even by normal waves and tides).
3. No impacts on rocky intertidal area around Lechuza Point.	3. The threat of significant environmental impact from direct wave attack on existing septic systems/leach fields will be of serious concern for water quality.
	4. Public beach access will continue to be a problem as no beach nourishment would occur.
	5. No dune restoration would occur.
	6. Emergency protection of homes, septic systems, and public beach access will be required in the near future.
Alternative 2: Retention of modified revetment at current location with beach nourishment and dune restoration.	
1. Long-term engineered revetment design will be less susceptible to armor stone displacement than current emergency revetment.	1. Adding armor stone rocks may increase the size of the revetment and result in further encroachment on public trust lands.
2. The revetment would provide a last line of defense should the beach experience excessive sand loss during large storms.	2. Deep foundation for the existing revetment may require re-design of the revetment to prevent further encroachment on public trust lands.
3. The revetment would provide a last line of defense should the beach experience extensive erosion.	3. Additional costs and substantial increases in construction activities and the time required to complete the project.

PROS	CONS
4. This alternative would meet the basic project alternatives, including restoring a wide sandy beach, protecting the properties and septic tanks, restoring the dune system, and enhancing public and private access along Broad Beach.	4. Benefit is limited, taking into consideration that the revetment would be covered by sand for the duration of the project and that re-nourishment will be necessary if the beach erodes substantially.
	5. Emergency protection of homes, septic systems, and public beach access will be required in the near future.
Alternative 3: Landward re-location of modified revetment with beach nourishment and dune restoration.	
1. Replaces temporary emergency revetment with a more stable “permanent” revetment by covering smaller revetment stone with larger (3-5 ton) armor stone.	1. Re-locating part of the current revetment landward and adding armor stone would be much more expensive and time-consuming, leaving less money for sand nourishment and dune restoration.
2. Long-term engineered revetment design will be less susceptible to armor stone displacement than current emergency revetment.	2. Revetment relocation and re-engineering would result in greater impacts to the currently degraded dune habitat.
3. New revetment would be completely landward of agreed-upon MHTL	3. Some of the homes’ septic systems would likely have to be decommissioned or relocated, resulting in more expense and permitting.
4. The revetment would provide a last line of defense should the beach experience excessive sand loss during large storms or series of storms.	4. This alternative may create somewhat more severe impacts to public access and aesthetics. This could result from an increased revetment footprint on public land and interference with lateral access when coastal erosion has caused the revetment to become exposed.
5. This alternative would meet the basic project objectives of protecting the homes and septic systems, restoring a wide sandy beach backed by a restored dune system, and enhancing public and private access along Broad Beach.	5. Construction-related impacts would increase as well as potential aesthetic impacts due to a larger and taller revetment.

Alternative 4: Replacement of revetment with landward-located seawall with beach nourishment and dune restoration.	
1. Vertical seawalls are currently preferred over rock revetments by resource agencies because of the reduced footprint.	1. The high cost of removing the emergency revetment and constructing a seawall would most likely result in the need to reduce the beach nourishment and dune reconstruction volumes, thereby significantly reducing the public and environmental benefits.
2. This alternative would meet the basic project objectives of protecting the homes and septic systems, restoring a wide sandy beach backed by a restored dune system, and enhancing public and private access along Broad Beach.	2. In contrast to stone revetments, vertical seawalls are inflexible structures, and failures can be catastrophic and difficult (as well as expensive) to repair.
3. Vertical seawall would be completely landward of agreed-upon MHTL.	3. Construction of a vertical seawall would inhibit the function of the leach fields along Broad Beach.
	4. Vertical seawalls reflect wave energy and tend to scour beach sand at the structure toe without proper toe protection and/or foundation design, which is quite expensive.
	5. Septic system effluent would likely pond behind the wall, producing large hydrostatic pressure forces, potentially leading to failure of the seawall.
Alternative 5: Reduced project with lower levels of sand importation.	
1. Would reduce impacts associated with sand placement activities and possibly reduce impacts to nearshore marine habitats, especially east of Lechuza Point.	1. Benefits associated with reduced environmental impacts may be offset by the need for more frequent backpassing and follow-up nourishment events, which may result in frequent disturbance that makes it difficult for habitat to become established.
2. Would take less time and cost less money (at least initially).	2. A reduced nourishment volume compromises the project objective of providing long-term shoreline protection, and would be more susceptible to greater shoreline damage during especially large wave events.

3. This alternative would meet the basic project objectives of protecting the homes and septic systems, restoring a wide sandy beach backed by a restored dune system, and enhancing public and private access along Broad Beach.	3. This alternative would require a more intensive monitoring program to quantify sand loss and plan for follow-up nourishments. These follow-up nourishments would increase the frequency of construction impacts.
4. This alternative would reduce the footprint of the initial sand nourishment and be less likely to erode substantially based on the smaller footprint.	4. This plan would also likely require placement of sand upcoast from Broad Beach, which would be less effective in providing a wide, longer-lasting, sandy beach along Broad Beach.
Alternative 6: Beach nourishment and dune restoration with elimination of revetment.	
1. This Alternative would meet some of the basic project objectives, including restoring a wide sandy beach, restoring the dune system, and enhancing public and private access along Broad Beach.	1. All of the homes and septic systems behind the emergency revetment would lack the “last line of defense” that is currently provided by the revetment and could become exposed to coastal erosion hazards from larger storms or a series of storms that could erode the beach and dune system.
2. This alternative would not require a permanent structure, and would thus not protrude over the agreed upon MHTL.	2. Despite provisions that include a backpassing program to preserve a minimum average beach width and provide a buffer against seasonal coastal erosion, a severe winter season could result in greater than expected beach loss and require emergency protection measures.
3. This alternative would be the most aesthetically pleasing and easiest to permit.	3. Backpassing operations would likely be larger and more frequent if the revetment did not exist in order to protect the properties.
4. This alternative would provide some protection to the homes and septic systems along Broad Beach.	4. Removal of the revetment would increase short-term construction costs when compared to the proposed Project.

11.0 SUMMARY OF POTENTIAL IMPACTS OF PROPOSED PROJECT

Table 11-1 summarizes the potential impacts on Broad Beach of the proposed project alternatives. No significant adverse impacts are expected at the beach fill site, except at the western end of Broad Beach, extending eastward from Lechuza Point, due to the presence of rocky intertidal and hard-bottom habitat in the area. Offshore habitat along Broad Beach could be impacted by sand migration.

Monitoring of the beach fill material should be carried out for the life of the Project to track the movement of sand and provide data for an improved design for future beach fill projects. The physical monitoring program should consist of pre- and post-fill placement surveys, which are required during construction of the fill. Planned monitoring of the beach should include quarterly beach surveys and photography. At a minimum, the beach profile surveys to closure depth should be carried out at the end of the winter and summer seasons, and computations of changes on profile volumes and beach width should be made.

Table 11-1. Summary of study results of impacts for the proposed project alternatives.

ITEM	IMPACT	COMMENTS
Recreation	+	Increased recreational value will result from a wider sand beach area.
Beach Access	+	At present, there is no beach except at low tide. Longitudinal access at mid and high tides will be increased. Potential for a small scarp (on order of 3-4 ft) to form at the shoreline. Broad Beach is a steep beach with slope 8^o-9^o.
Residence Time of Nourished Sand	+	Likely 5 to 8 years with backpassing per beach fill.
Erosion Control	+	Wider beach will temporarily postpone shoreline recession.
Shoreline Protection	+	Higher and wider berm will provide limited and temporary increase in shoreline protection.
Waves	+	Temporal sand bar should enhance surf conditions. Beach profile changes could modify wave break type and location.
Wave Run-up	+	Reduction in the elevation of the wave run-up on the beach due to the project.
Water Quality	+	Expected to improve.
Impacts to Zuma Beach	+	Immediately after placing the sand, a small part of Zuma Beach adjacent to the fill may erode, but the long term-impact on the whole of Zuma Beach is very positive.
Requirement for Future Nourishment	-	The beach will need to be nourished after 5-8 years.
Structures and Utilities	None	No impact on structures and utilities is anticipated.
Construction Impacts	Temporary	Noise, limited access to beach, increase of water turbidity.
Rocky Habitat	TBD[a]	Habitat east of Lechuza Point will be buried by 10-12 ft of sand.
Offshore Habitat	TBD[a]	Fines released from the beach fill should not exceed existing conditions.

[a] To be determined.

12.0 CUMULATIVE IMPACTS

Environmental assessment of the Project requires an analysis of the incremental effects of an action that are considered cumulatively when viewed in connection with closely-related present, planned, or reasonably foreseeable future actions. Cumulative projects consist of other beach replenishment or beach nourishment projects that are going on or are planned to occur nearby Broad Beach. The future projects known to date are: 1) the restoration of Trancas Creek; and 2) the requirement to replenish the beach after 5 to 8 years.

Should the Santa Monica Bay Restoration Project for Trancas Creek become a reality, it is likely more sand would have to be excavated from the mouth of the creek as a result of this beach nourishment project. However, due to the small size of the lagoon and the ephemeral nature of the creek, it is likely that the lagoon entrance will remain closed most of the year even with the proposed restoration. Small Southern California lagoons suffer from this fate, and due to the particularly small volume of this lagoon (2 acres), it will be particularly subject to closure. With or without the additional nourishment sand on the beach, this lagoon will be closed to tidal flow for most of the year. Therefore, the impacts of the Broad Beach Project on lagoon restoration will be potentially negative but minimal.

The cumulative impacts for replenishment of Broad Beach after 5-8 years are:

1. Cumulative impacts to surfing would not be expected to vary from those discussed earlier for individual beach fills.
2. Cumulative impacts to existing habitat would expect to be beyond those discussed for individual beach fills, since this habitat would be difficult to establish, taking into consideration frequent bypassing, future nourishment, and the desire to maintain beach in this area.
3. Cumulative impacts to Trancas Creek would not be expected beyond those discussed for individual beach fills.
4. Cumulative impacts to turbidity would not be expected beyond those discussed for individual beach fills.

5. Cumulative impacts to noise would not be expected beyond those discussed for individual beach fills.
6. Recreation and shoreline protection would be significantly improved at Broad Beach.

13.0 CONCLUSIONS

This study presents the anticipated impacts of the proposed Project on coastal processes. The objective of the proposed action is to provide protection for existing homes and septic systems, reduce erosion potential, and increase recreational opportunities at Broad Beach.

Beneficial impacts of artificial beach fills include enhanced recreation areas, improved surf breaks, shoreline protection and erosion control. These benefits are significant due to the lack of a recreational beach area at Broad Beach and the risk of erosion to shoreline properties. Possible adverse impacts include impacts on biological resources, especially in the rocky intertidal area located within 400 ft of Lechuza Point.

The projected impacts of the proposed Project on waves, current, tide and surf conditions are minimal or insignificant. Shoreline protection, public access, wave run-up and water quality (bacteria concentration) will significantly improve.

The Project will have a long-term positive impact on Zuma Beach. It is expected that about 35,000 cyd will migrate from Broad Beach to Zuma Beach each year. Sea level impacts on the Project are insignificant in the short term (5-8 years) or longer term (20 years). There will be temporary impacts during construction (inconvenience, noise, and increased water turbidity). The Project may have impacts on the present habitat in the western part of Broad Beach. These biological impacts would need to be mitigated since the proposed Project will be repeated in the future.

Backpassing operations and its triggers and impacts are discussed in Chapter 9. The object of the backpassing is to extend the residence time of fill sand on the beach. It may be worthwhile for the applicant to consider obtaining sand from a land source and placing 40,000 cyd on a yearly basis (or whenever necessary) on Broad Beach instead of carrying out a future large nourishment project after 5-8 years. The yearly cost of replacing 40,000 cyd of sand on the beach is about $800,000 per year ($20 per cyd). This option may be worth considering if access to Broad Beach is available for dump trucks, and it may be less expensive in the long run than renourishing the beach. It will provide a wider beach for the length of the Project and may reduce possible environmental impacts from future large fill projects.

Five other alternatives were considered in Chapter 10. While these alternatives have value, they can only be implemented at a high cost and the benefits would be minimal. It might be better if the permit conditions would allow the revetment to remain as it is, with the requirement of being consistently covered by sand, with only temporary natural uncovering under unforeseen circumstances (unexpectedly large wave storms). The beach fill would need to be monitored by quarterly beach surveys up to the closure depth. These data would be the basis for the design of future beach replenishment projects at Broad Beach.

14.0 REFERENCES

Bruun, P., 1962. Sea-level Rise as a Cause of Shore Erosion. *Proceedings of the ASCE Journal of Waterways & Harbors Division* 88:117-130.

Butler Roach Group, 1995. Evaluation of Potential Impacts to Marine Biota from the Beach Replenishment Component of the Proposed Lomas Santa Fe Drive Grade Separation Project. Prepared by MEC Analytical Systems, Inc., April 1995.

California State Lands Commission (CSLC), 2009. Sea Level Rise Preparedness. Staff report to CSLC commission, Sacramento, CA, December 2009. 62 pp.

City of Malibu, 1995. Trancas Canyon Park Final EIR. City of Malibu, 23825 Stuart Ranch Road, Malibu, CA 90265. http://www.malibucity.org

Coastal Environments, 2012a. Broad Beach Restoration Project, Water Quality and Bacteria Surveys, 1995-2012. Report submitted to AMEC Earth & Environmental, Inc., 104 West Anapamu, Santa Barbara, CA, CE Ref # 12-20. 10 pp. and 3 appendices.

Coastal Environments, 2012b. Broad Beach Restoration Project, Coastal Processes. Report submitted to AMEC Earth & Environmental, Inc., 104 West Anapamu, Santa Barbara, CA, CE Ref # 12-21. 45 pp. and 4 appendices.

Griggs, G., and K. Patsch, 2002. Littoral Cells and Sand Budgets Along the Coast of California. Proposal submitted to California Department of Boating and Waterways. 7 pp.

Moffatt & Nichol, 2012. Broad Beach Restoration Project, Public Trust Resource Environmental Impact Analysis, Coastal Engineering Appendix. Prepared for Broad Beach Geologic Hazard Abatement District, June 2012.

Noble Consultants, Inc., 2009. Coast of California Storm and Tidal Waves Study Los Angeles Region, Draft Report. Report submitted to USACOE, Los Angeles District, May 2009.

Topanga Underground, 2011. Onsite Wastewater Treatment System Location Investigation Report for Broad Beach Project. Submitted to Moffatt & Nichol, 3780 Kilroy Airport Way, Suite 600, Long Beach, CA 90806, on December 13, 2011. 6 pp.

Topanga Underground, 2012a. Onsite Wastewater Treatment System Location Investigation Report for Broad Beach Project. Submitted to Moffatt & Nichol, 3780 Kilroy Airport Way, Suite 600, Long Beach, CA 90806, on January 15, 2012. 17 pp.

Topanga Underground, 2012b. Onsite Wastewater Treatment System Location Investigation Report for Broad Beach Project. Submitted to Moffatt & Nichol, 3780 Kilroy Airport Way, Suite 600, Long Beach, CA 90806, on February 27, 2012. 12 pp.

Topanga Underground, 2012c. Cost Summary for Broad Beach Project No. 10937-000-460. Submitted to Moffatt & Nichol, 3780 Kilroy Airport Way, Suite 600, Long Beach, CA 90806, on March 5, 2012. 3 pp.

USACOE, 1989. Technical Report CERC-89-19 GENESIS: Generalized Model for Simulating Shoreline Change, Report 1: Technical Reference, and Report 2: Workbook and System User's Manual.

USACOE, 2011. Sea-Level Change Considerations for Civil Works Programs, Engineering Circular (EC) No. 1165-2-212, October 2011.