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COASTAL REGIONAL SEDIMENT MANAGEMENT PLAN
FOR
SOUTHERN MONTEREY BAY

Prepared for

Association of Monterey Bay Area Governments

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Geographic and Historic Setting

Over the next 50 years, the coastal dunes of southern Monterey Bay between the Salinas River mouth and Wharf II in Monterey are predicted to erode at rates between 1.0 and 6.0 ft/year. Over this planning time frame, eight oceanfront facilities are at high risk due to this erosion, and will require mitigation measures to be implemented to prevent their loss. Six of these facilities; Sand City and Tioga Avenue west of Highway 1, Seaside Pump Station, Monterey Interceptor between Seaside Pump Station and Wharf II, Monterey Beach Resort, Ocean Harbor House condominiums, and Monterey La Playa town homes, are located along the shoreline of the Cities of Sand City, Seaside, and Monterey (the southern bight). The other two facilities are the Sanctuary Beach Resort and Marina Coast Water District buildings, located in Marina one mile south of the only remaining beach-sand mining operation on the west coast of the U.S.

Recognizing that the issue of coastal erosion could not be addressed on a city-by-city basis, the City of Monterey sought to form a regional consortium of local, state and federal agencies to determine what can be done to address this issue. Around the same time, as part of a process to update the Sanctuary's Management Plan, the Monterey Bay National Marine Sanctuary (MBNMS) developed an action plan to address the issues of coastal erosion and armoring along the Sanctuary's 276 miles of shoreline. This MBNMS action plan called for the development of a collaborative regional planning approach to address, along with other issues, coastal erosion in the southern Monterey Bay region. This led to the formation of the Southern Monterey Bay Coastal Erosion Workgroup (SMBCEW). The SMBCEW has developed an extensive list of ways to potentially address the issue of coastal erosion, and will be evaluating the applicability of those potential technologies to southern Monterey Bay erosion problems in the near future.

Regional Sediment Management

The California Coastal Sediment Management Workgroup (CSMW) is working with regional stakeholder groups such as the AMBAG and SMBCEW to develop Coastal Regional Sediment Management (RSM) Plans within specific regions of coastal California to help city, county, and coastal managers, and local and state-wide regulatory personnel identify and resolve issues of concern within that region. This Coastal RSM Plan examines a subset of the options to be explored by the SMBCEW, specifically those options that restore coastal habitat by removing or lessening disturbances to natural sedimentary processes that exacerbate coastal erosion. Within this subset, this Coastal RSM Plan recommends implementing the following four regional sediment management strategies for the southern Monterey Bay shoreline:

1. ***Investigate beach nourishment and other beach restoration strategies to ameliorate erosion in the stretch of shoreline within the Cities of Sand City, Seaside, and Monterey***. Here, the majority of high risk facilities are located, and healthy beaches are particularly important for recreation and tourism. Beach nourishment is feasible in the southern bight for a number of reasons. Low wave energy, low sand transport, and the location within a defined sub-cell (the southern bight is nearly self-contained in terms of sand transport) means that any placed sand would remain at the site for a longer period of time. This Coastal RSM Plan shows that there is clear economic justification for beach nourishment of the southern bight and it has the potential to deliver substantial benefits for the recreational value of the shoreline and for protection of its infrastructure assets. Beach nourishment may also reduce the need for 'hard' shore protection, and provide ecologic benefits associated with wider beaches.
2. ***Reduce or eliminate removal of sand from the beach at Marina***. The large extraction of beach sand permanently removes sediment that would otherwise feed beaches elsewhere along southern Monterey Bay. If this sand is released and subsequently transported alongshore, it could provide a significant additional buffer to dune erosion by waves. The effect would be more immediate at the Sanctuary Beach Resort and Marina Coast Water District buildings critical erosion sites, but would eventually benefit the shoreline further away as the sand migrates. The U.S. Army Corps of Engineers has reportedly issued a 'determination of non-jurisdiction' which allows the mining of beach sand at Marina to proceed without a permit from the Corps. The operation started prior to the passage of the California Coastal Act (1972) and therefore may be 'grandfathered' into legal non-conforming use. This Coastal RSM Plan recommends several potential routes that could be taken to reduce or eliminate removal of beach sand at Marina including:
   - Communication of the economic impacts of erosion associated with beach-sand mining on down coast communities
   - Revisit the U.S. Army Corps of Engineers determination of non-jurisdiction
   - Determine whether a change in operations post-1976 (i.e. the increased extraction with introduction of a new dredge sometime after 1979) requires a new permit from the City of Marina.
   - Communication of impacts that the beach-sand mining is having on endangered species
   - Examine the possibility of alternative mining operations.
3. ***Allow dune erosion to continue without human intervention north of Sand City to the Salinas River***. This erosion will continue to provide large quantities of sand to the beaches, maintaining their healthy condition and provide benefits for sensitive species and habitats, and recreation and tourism. Apart from the Sanctuary Beach Resort and Marina Coast Water District buildings, this area does not contain any facilities at high risk of erosion.

4. ***Use this Coastal RSM Plan as a baseline to build a regionally comprehensive erosion abatement approach through the ongoing efforts of the Southern Monterey Bay Coastal Erosion Workgroup (SMBCEW)***. The SMBCEW is preparing to evaluate additional erosion control methods, including retention structures such as offshore reefs, beach dewatering and pressure equalizing modules, and other technologies that could help reduce coastal erosion along the southern Monterey Bay shoreline. The information gathered for the RSM framework presented within this Coastal RSM Plan will provide the basis for evaluating the feasibility of potential erosion control technologies that will work locally and address regional sediment imbalances that are aggravating coastal erosion. Taken together, these two interconnected efforts should collectively provide valuable guidance and reference to city coastal managers, local and state-wide regulatory personnel, the AMBAGs Board of Directors, and state and federal funding entities, thereby setting the stage for specific projects to reduce coastal erosion.

RECOMMENDED MANAGEMENT AND POLICY CHANGES

Regional and local policies and management decisions affect the natural delivery of sand to and along the California coast. Historically, these policies and management decisions have not focused on protecting or preserving natural processes delivering sand to the coast, but rather, have been developed piece-meal and for the explicit purpose of protecting and/or managing terrestrial natural resources. Consequently, the application of these decisions has often hampered coastal restoration efforts. This Coastal RSM Plan recommends adopting the following seven management and policy changes for the southern Monterey Bay shoreline:

1. Formalize the governance structure for coastal RSM projects with staff from the AMBAG member agencies, including a dedicated staff member to assist the AMBAG Executive Director. In the recommended structure, the AMBAG as a Joint Powers Authority would be responsible for adopting and updating this Coastal RSM Plan, and implementing regional sediment management in southern Monterey Bay. Advice and guidance on RSM issues would come from the Southern Monterey Bay Coastal Erosion Workgroup (SMBCEW), a group of local stakeholders already set-up to address coastal erosion issues. A regular post-Plan program of outreach should be started by the AMBAG (meetings, workshops) to disseminate information and educate the public on coastal erosion issues and how this Coastal RSM Plan can help implement potential RSM activities within the southern Monterey Bay region.
2. Coordination with local cities, Monterey County, California Department of Parks and Recreation, California Coastal Commission and other relevant agencies will be essential to secure effective implementation of projects. The AMBAG should work with the County of Monterey and coastal cities to identify how this Coastal RSM Plan can be

recognized (referenced) in the county general plan and Local Coastal Programs (LCPs). In addition, steps should be explored on how to add the Coastal RSM Plan and its alternatives to address coastal erosion as items requiring answers on the CEQA checklist. Furthermore, the AMBAG should investigate whether RSM activities benefiting the entire region can be streamlined through a regional general permit from the California Coastal Commission.

3. Formalize coordination with the Monterey Bay National Marine Sanctuary (MBNMS) for joint shoreline management and coastal zone planning. The collaboration should work towards development of RSM strategies that would allow for the extraction and placement of beach-compatible sediment within the Sanctuary boundaries as a means to restore sands previously eroded from the beaches. This effort would require interpretation and discussion of the potential to modify the Sanctuary's Harbors and Dredge Disposal Action Plan in order to employ further beach nourishment sites in addition to those already approved by the Sanctuary (e.g. adjacent to Wharf II).
4. Adopt a consistent approach to planning for sea-level rise in RSM using the most recent predicted estimates. Currently, the recommended predictions of sea-level rise (by the California Resources Agency) for California are 16 inches (1.3 feet) by 2050 and 55 inches (4.6 feet) by 2100, and this Coastal RSM Plan uses these estimates as a basis for assessment of future shoreline erosion and the vulnerability of oceanfront properties. Management and policy regarding future set back distances also requires consideration of the erosion impacts of sea-level rise. It is recommended that Land Use Plans (LUPs) develop a strong set back ordinance for oceanfront development that puts high use facilities at an appropriate distance from the ocean. The set back distance should include the historical erosion rate plus a natural buffer (primary set back) plus erosion due to future sea-level rise (secondary set back). As part of this ordinance, consideration should be given to an extended planning horizon of 100 years for large cost or long-term projects.
5. The AMBAG should work with the Chambers of Commerce in Monterey, Sand City, Seaside, and Marina to develop a dedicated source of local funding in order to provide statutorily-required local matches to state and federal funding that would be required for any beach nourishment projects. For example, the Sanctuary Beach Resort charges a $15 per night fee to occupants to fund habitat restoration on its property. Other potential local sources of funding such as real estate transfer taxes, general sales taxes attributable to sporting goods, and parking and beach-user fees should all be explored. A dedicated source of local funding should enhance the southern Monterey Bay region's ability to compete for limited state and federal funding for erosion control projects that involve sediment management. Both the California Department of Boating and Waterways (CDBW) and the U.S. Army Corps of Engineers (major funding sources) are committed to RSM and may likely base future allocations of limited funding on whether a proposed project aligns with an approved Coastal RSM Plan.
6. Use the Sand Compatibility and Opportunistic Use Program Plan (SCOUP) process to obtain an opportunistic use program permit to facilitate beneficial reuse when local sand

sources become available. This SCOUP permit process will streamline the regulatory compliance process through establishment of a regional program providing for placement of opportunistic and compatible sand at pre-defined beach receiver sites with limited review from regulatory agencies. Having a program in place where appropriate sediment can be transported to the beach (or stockpile area) without lengthy and costly delays increases the chances that the opportunistic sands will be beneficially reused. Assessment of whether this process can facilitate a regional permit from the Coastal Commission should be investigated.

7. Secure and develop a sediment stockpiling and sorting facility at Fort Ord to aid in implementing the SCOUP opportunistic use program. Such a facility would help to facilitate the use of appropriately sized sand should any become available from future flood control, development, and other projects. Providing a location in advance where appropriate sediments can be transported relatively quickly eliminates lengthy and costly delays encountered if a permit is applied for at the time of the project, and would encourage beneficial reuse of sediment.

RECOMMENDED PROJECTS FOR FEASIBILITY ANALYSIS

Studies should be initiated to investigate the feasibility of large-scale beach nourishment using sand from offshore deposits. Sediment analyses should follow the protocols in the Sand Compatibility and Opportunistic Use Program Plan (SCOUP Tier II) to assess compatibility and include assessments of the technical feasibility of both subaerial-beach and nearshore placement in southern Monterey Bay. The projects are prioritized as follows.

1. ***Investigate other 'soft' erosion control technologies in southern Monterey Bay***. This study should assess erosion control approaches such as sand retention devices, beach dewatering techniques, and pressure equalizing modules, including an evaluation of regulatory requirements and potential constraints. These approaches are to be examined by an MBNMS-funded project, complementary to this Coastal RSM Plan, under the SMBCEW umbrella.
2. ***Technical and environmental feasibility of sand placement in the southern bight***. This study should investigate the feasibility of placing sand (both on the beach and nearshore) between Monterey Beach Resort and Ocean Harbor House condominiums as a beach nourishment solution. Important considerations in the study should include the specific placement location, volume of placed sand, cross-shore and longshore sediment transport processes, sand dispersal rates and distribution, and the impacts of placement on sensitive species and habitats.
3. ***Use of offshore shelf sand deposits***. This study should assess the feasibility of using sand from relict offshore deposits and the identification and feasibility of using active offshore

sand bodies. The sand offshore from a convergence of alongshore sediment transport at Sand City should be investigated as a potential nearby (and therefore economical) source for beach nourishment.

4. ***Use of sand deposits intercepted before they are lost to Monterey Submarine Canyon***. This study should include the feasibility of intercepting and extracting sand before it is lost to the Canyon. This effort would examine the results of the recent study supported by CSMW. The study should also address regulatory feasibility given that the proposed source area is part of the MBNMS.
5. ***Use of dune sand at Fort Ord***. This study should assess the feasibility of using dune sand at Fort Ord to nourish the southern bight beaches. Particular consideration should be given the particle size relationships of the source and receiver sites, and the regulatory requirements of removing sand from an inland dune source.
6. ***Reuse of sand from Monterey Harbor maintenance dredging***. This study requires investigation of the quantities of compatible sand (particle size and contamination) that could be made available for beach nourishment from dredging of Monterey Harbor.
7. ***Reuse of sand from Moss Landing Harbor entrance channel maintenance dredging***. This study should focus on the feasibility of using compatible sand from Moss Landing Harbor entrance channel. Attention should be given to the potential competition for the sand from sites that are currently being nourished using the sediment and the potential need for sediment for restoration of Elkhorn Slough.

SUMMARY OF SCIENTIFIC FINDINGS

The following scientific findings were compiled from existing sources and represent the latest research and information available on sediment, coastal erosion, economics, regulations, and species and habitat along the southern Monterey Bay shoreline. No new research was conducted in preparing this Coastal RSM Plan.

Sediment (Sand) Budget

1. Over 96% by length of the southern Monterey Bay littoral cell is undeveloped, comprising sand beaches backed by actively eroding dunes, which supply sediment to the littoral system. Less than 4% of the shoreline is armored with concrete seawalls and rock revetments.
2. Shoreline armoring and the impacts of placement loss and passive erosion are evident at Monterey Beach Resort and Ocean Harbor House condominiums. The removal of the riprap at Stilwell Hall in 2004 and the subsequent erosion of previously armored dunes to an equilibrium position parallel with adjacent shoreline segments shows the restoration

potential of the beach and shoreline, as well as the difficulties associated with armoring strategies.

3. Historically, the beaches and dunes of southern Monterey Bay were supplied with abundant sand from the Salinas River. This supply has been significantly reduced because of the shallowing of the river gradient due to sea-level rise, and the relatively low flow at which the river overflows its banks and deposits sediments in the flood plain.
4. The current average discharge rate of beach-size sand by the Salinas River to the littoral cell is estimated at approximately 65,000 yd^3/year. Only 10,000 yd^3/year is estimated to move south and 55,000 yd^3/year to move north.
5. The dominant supply of sand to the littoral cell is from erosion of low resistance unconsolidated coastal dunes south of the Salinas River. Rates of erosion are greatest at Fort Ord decreasing to the north and south, consistent with the general distribution of wave energy approaching the coast.
6. The constant supply of sand from dune erosion has meant that the beaches within the littoral cell have been sustainable over the long term. In areas with no shoreline armoring, the dune face has translated landward whilst the beaches have retained their width.
7. Average dune erosion rates during the years of drag line sand mining from the surf zone between 1940 and 1984 ranged from 1.0 to 6.5 ft/year, equating to a sand volume of approximately 350,000 yd^3/year from the dunes to the littoral system.
8. Up to 1990, large quantities of sand were mined from the surf/swash zone using drag lines at Sand City. Three operations mined a total average of approximately 111,000 yd^3/year. Up to 1986, two similar operations at Marina removed an average of approximately 33,000 yd^3/year. This sand mining was a predominant cause of coastal erosion in southern Monterey Bay prior to 1990.
9. Between 1985 and 2005, after closure of drag line sand mining operations, but continuation of hydraulic mining at Marina, the dune erosion rates ranged from 0.5 to 4.5 ft/year, equating to a sand volume of approximately 200,000 yd^3/year from the dunes to the littoral system.
10. In 1965, hydraulic mining of sand from a dredge pond was introduced at Marina. Between 1965 and 1990, this operation removed a further 105,000 yd^3/year of sand from the littoral system.
11. As other mines closed, the ongoing operation at Marina increased its extraction to 200,000 yd^3/year today. This is similar to the annual sand volume eroded from the dunes. Erosion rates at Marina increased after 1985, and are believed to be related to an increase in sand extraction at the Marina sand mine in the mid 1980s, 1990s, and 21st century.
12. Erosion rates at Sand City decreased after 1985, and are believed to be related to closure of drag-line mining at three sites at Sand City between 1970 and 1990.
13. Future dune erosion rates along the southern Monterey Bay shoreline will likely increase because of predicted sea-level rise.

Sediment (Sand) Transport

14. Net alongshore sediment transport rates are relatively low in southern Monterey Bay because the dominant wave crests approach near-parallel to the shoreline.
15. The net direction of alongshore sediment transport varies along the shoreline. North of the Salinas River the net transport is to the north into the head of Monterey Submarine Canyon and lost from the littoral system. South of the Salinas River to Sand City there is seasonal variability in transport direction with a net transport to the south. Sediment transport from Wharf II to Sand City is to the north resulting in a convergence of sediment transport near Sand City, and possible deposition of sand offshore from the convergence.
16. The total sand transport in all directions (also called gross transport to distinguish from net transport) is high owing to the exposure to north Pacific swells and storms. The gross transport is greatest in the center of southern Monterey Bay due to the refraction effects of Monterey Submarine Canyon on incident waves. The high gross transport results in rapid redistribution of perturbations such as beach-sand mining and local bluff erosion. Hence, mining of sand from the beach affects the entire area from the Salinas River mouth to Monterey Harbor.
17. Winter offshore transport of sediment may result in temporary loss from the beaches, which recover during the dominant onshore transport in summer. However, during large wave and storm events, sand may be transported offshore to water depths where summer waves cannot transport it back onshore. This means that there is potentially a net transport of sediment from the beaches to the offshore over the long-term, resulting in a loss from the beaches.

Beach Sediment Characteristics

18. There is a general trend of decreasing beach particle size (not including the shoreface) from north to south in southern Monterey Bay. Mean particle sizes are greater between the Salinas River and Fort Ord, where the wave energy is highest and smaller near Monterey Harbor where wave energy is lowest.
19. The composite particle size envelope of the beaches for two miles north of Wharf II is 0.2-0.4 mm; between this two-mile marker and Sand City the envelope is 0.4-0.8 mm, and north of Sand City the envelope increases to between 0.5 and 0.9 mm.
20. Approximately 50% of the sediment stored in the eroding dunes has particle sizes that are large enough to be retained on the beaches and shoreface. The smaller sand sizes are winnowed to the nearshore.

Critical Areas of Erosion

21. Critical areas of erosion were assessed using the following criteria:
    a. What is at risk?
    b. What is the probability that it will be impacted by coastal erosion over a management planning horizon of 50 years?
    c. What are the consequences of loss of the facility (economic, ecologic, recreational and public safety)?
22. The application of the above criteria identified eight segments of shoreline as high to moderate-risk, high-consequence critical areas of erosion. These are (from north to south) the Sanctuary Beach Resort and Marina Coast Water District buildings near Reservation Road, beach access and hazardous rubble in the vicinity of the seaward end of Tioga Avenue, Seaside Pump Station at Bay Avenue, Monterey Interceptor wastewater pipeline between Seaside Pump Station and Wharf II, Monterey Beach Resort, Ocean Harbor House condominiums, and Monterey La Playa town homes.
23. Six of the eight critical erosion areas (apart from the Sanctuary Beach Resort and Marina Coast Water District buildings) are located in the Cities of Sand City, Seaside, and Monterey (southern bight).
24. Extension to a longer planning horizon (100 years) would increase the number of critical erosion areas of concern to include portions of Highway 1 and other regional wastewater facilities as well as private development.

Critical Species and Habitat

25. The beaches and dunes of southern Monterey Bay provide habitat for numerous native animals including the threatened western snowy plover and numerous rare plants, including Yadon's wallflower. Sensitive subtidal habitat is located adjacent to Monterey Harbor and comprises rocky reef, kelp forest, and eelgrass meadow.
26. Beach nourishment has the potential to adversely impact sensitive species and habitat through disturbance or damage as a direct impact of placement or as an indirect impact through sediment transport away from the placement site. Of particular concern is the potential impact of sedimentation and turbidity on eelgrass and kelp/rocky reef in the southern bight. Beach nourishment also has potential to improve habitat for shorebirds, pinnepeds and other beach users and is generally considered preferable to coastal armoring.
27. Mitigation measures for construction should include buffer zones around kelp forest and eelgrass meadow, avoiding placement during nesting seasons for western snowy plovers and during grunion runs, and possibly implementing smaller-scale placements at several sites to maintain connectivity of the food chain.

Potential Receiver Site and Sediment (Sand) Sources

28. In order to mitigate for potential construction and post-construction impacts to sensitive species and habitat in the southern bight, a receiver site for both subaerial-beach and nearshore sand nourishment is recommended between the Monterey Beach Resort and the Ocean Harbor House condominiums. This location would allow dispersal of sand through gross alongshore sediment transport to feed critical areas of erosion to the north and south.
29. Four potential sand sources recommended for further investigation are in coastal and offshore locations. These are Moss Landing Harbor entrance channel, Monterey Harbor, north and south of the Monterey Submarine Canyon, and the offshore shelf (particularly near Sand City). The two harbors would provide limited volumes of sand for nourishment and it would be necessary to supplement with sand from other sources. In contrast, both Monterey Submarine Canyon and the offshore shelf could potentially provide large (millions of yd^3) repositories of sand.
30. These potential sources appear to be physically compatible with the potential receiver sites and relatively clean and free from pollutants, because they contain sediment that has been transported and reworked along and across the beaches, shoreface and offshore in southern Monterey Bay.
31. The coastal dune field of Fort Ord represents a fifth recommended source of sand for beach nourishment. The sand in these dunes was originally derived from the beach, and could provide large quantities of sand compatible with the beaches of the southern bight. The location of any dune sand extraction at Ford Ord would have to be carefully considered so as not to remove sediment that would otherwise supply the beaches through dune erosion over the next 50 years.
32. Although no upland sources of beach quality sand were identified, this Coastal RSM Plan recommends continued evaluation of any potential sources for smaller maintenance-style nourishment projects such as development projects at Fort Ord, river dredging, and CalTrans maintenance projects. If sand does become available from these potential sources, it could be stockpiled at a regional stockpile area (recommended at Fort Ord) until volumes become sufficient for a nourishment project. Sediment trapped behind dams is not considered a priority source at this time owing to the distance and trucking impacts, which do not compare favorably with offshore sand sources.

Economics of Beach Nourishment

33. Beach nourishment of the southern bight has a positive benefit-cost ratio and has the potential to deliver substantial benefits to its recreational value, through increase in beach width, and protection of the many valuable assets located along this shoreline.
34. Sand offshore from Sand City is the most cost-effective source due to it's proximity to the southern bight receiver site.

Regulatory Processes

35. Potential beach nourishment projects in southern Monterey Bay would need regulatory compliance at federal, state, and local levels.
36. The issuing of federal permits for beach nourishment is the responsibility of the U.S. Army Corps of Engineers and National Oceanic and Atmospheric Administration (because of the Monterey Bay National Marine Sanctuary), with input from resource agencies such as the U.S. Fish and Wildlife Service (endangered terrestrial species), National Marine Fisheries Service (endangered aquatic species), and the U.S. Minerals Management Service (public mineral resources).
37. State permits would need to be obtained from the California Coastal Commission, California State Lands Commission, and State Water Resources Control Board/Regional Water Quality Control Board, with input from resource agencies such as the California Department of Fish and Game and California Department of Parks and Recreation.
38. At a local level, the Cities of Marina and Sand City, and the County of Monterey have Local Coastal Programs (LCPs) certified by the Coastal Commission. The Cities of Seaside and Monterey have certified Land Use Plans (LUPs) but do not have approved LCPs. Beach nourishment projects along the shorelines with certified LCPs would require a Coastal Development Permit (CDP) issued by that jurisdiction. Projects in Seaside and Monterey would require a CDP from the Coastal Commission.

Recommended Projects to Fill Sediment Budget and Critical Species and Habitat Data Gaps

1. Undertake a regional particle size assessment to:
    a. determine the littoral cell cut-off diameter and envelope of particle sizes for each sub-cell to better judge beach nourishment needs and compatibility of source sediments
    b. investigate sediment particle sizes of potential source areas necessary for SCOUP Tier II protocols and permitting
    c. examine the relationship between the particle size distributions of the dunes, beaches and shoreface to provide a better appreciation of the sediment retention in the littoral zone.
2. Use divers to survey the present-day distribution of nearshore kelp forest and eelgrass meadow in the southern bight to assess potential impacts of beach nourishment. Investigation of beach and upland flora and fauna may also be needed although it appears there is sufficient data to evaluate these for environmental review, until more details are needed for the permit process for a particular beach nourishment activity (project).
3. Establish the extent of species and habitats in the potential offshore borrow areas to assess the impacts on these communities of sediment extraction. The investigations would include locating the limits of reef, eel grass, and kelp.

FUNDING CREDIT AND DISCLAIMERS

Funding for this project was provided to the AMBAG by a California Department of Boating and Waterways grant as part of CSMWs efforts related to implementation of their Coastal Sediment Master Plan. The AMBAG has utilized the funding to develop findings and recommendations that are in accord with local issues and needs, and CSMW has participated in an advisory role in order to help maintain consistency with similar projects elsewhere in coastal California.

Recommendations are presented in this report solely for consideration by government agencies, organizations, and committees involved in the management and protection of coastal resources in southern Monterey Bay. This document was prepared with significant input from CSMW members but does not necessarily represent the official position of any CSMW member agency.

This Coastal RSM Plan does not preclude the study and implementation of other erosion control alternatives such as perched beaches, groins, dynamic revetments, breakwaters, submerged breakwater, headland enhancement, etc. nor does the proposed Joint Powers Agreement Authority in Section 10 have any jurisdiction over these intervention measures.

1. INTRODUCTION

1.1 REGIONAL SEDIMENT MANAGEMENT

For social, recreational, economic, and environmental reasons, the coast of southern Monterey Bay is among the region's most prized natural resources. The sandy beaches and coastal dunes offer recreational activities and economic opportunities to Monterey Bay residents and visitors; they afford a natural barrier that protects the shoreline during storm events; they provide habitat for numerous shorebirds, including critical habitats for threatened or endangered species; and they are desirable places to live near, increasing property values and revenue for the community. Due to a persistent rise in sea level, changes in sand availability, and previous unsustainable public and private development practices, the southern Monterey Bay beaches and coastal dunes south of the Salinas River are eroding, on average, at the fastest rate in California (Hapke et al., 2006). Erosion compromises the ability of the beaches and dunes to buffer oceanfront development and infrastructure from storms and flooding, to provide vital natural habitat, and to successfully accommodate recreation and tourism.

Along the California coast, state, federal, and local agencies are now attempting to address sediment supply and coastal erosion problems caused by human modification through Regional Sediment Management (RSM). RSM focuses on restoring coastal habitat by eliminating or reducing disruptions to natural processes, which produce sediment imbalances and exacerbate coastal erosion. Hence, RSM solves sediment-related problems by designing solutions that recognize the regional nature of natural processes. RSM also recognizes that sediment is a resource integral to the economic and environmental vitality of coastal beaches, and that sustainability can be achieved through beneficial reuse of littoral, estuarine, and river sediments. RSM in California is being facilitated through the California Coastal Sediment Master Plan (Sediment Master Plan) developed by the California Coastal Sediment Management Workgroup (CSMW, 2006). Coastal RSM Plans are being prepared for specific regions of coastal California as a means to identify and target issues of concern within that region.

Regional Sediment Management is a collaborative effort between state, federal, and local agencies, and non-governmental organizations to evaluate California's coastal sediment management needs on a regional basis. More information is available on the CSMW web-site (http://www.dbw.ca.gov/CSMW)

1.2 SOUTHERN MONTEREY BAY COASTAL RSM PLAN

1.2.1 Development

The Association of Monterey Bay Area Governments (AMBAG) retained a team led by Philip Williams & Associates (PWA) to develop this Coastal RSM Plan for southern Monterey Bay. The objective of this Coastal RSM Plan is to provide consensus-driven management and policy recommendations on ways to reduce shoreline erosion and restore and maintain coastal beaches through implementation of regional sediment management and beneficial reuse of sediment.

The technical basis for this Coastal RSM Plan is an understanding of the local sedimentary and coastal processes, erosion rates, and sand budget. Using these data in combination with economic, environmental, and societal considerations, critical areas of erosion are identified, critical species and habitat are delineated, and recommendations are proposed for RSM. These recommendations are meant to inform the local decision-making process to help maintain the beaches and dunes of southern Monterey Bay and other critical areas of sediment deficit, in order to restore coastal sandy habitats, sustain recreation and tourism, enhance public safety and access, and reduce proliferation of protective shoreline structures. Other parts of this Coastal RSM Plan explore:

- economic benefits and costs of RSM in southern Monterey Bay
- permits required for planning and implementing RSM, and how to proceed through environmental review and regulatory compliance
- potential sources of funding for costs associated with managing sediment
- a recommended governance structure for implementation of this Coastal RSM Plan in southern Monterey Bay.

This Coastal RSM Plan has been produced within the framework of the Sediment Master Plan (CSMW, 2006). Funding was provided by the California Department of Boating and Waterways (CDBW) on behalf of CSMW. This Coastal RSM Plan was also developed in close collaboration with the Southern Monterey Bay Coastal Erosion Workgroup (SMBCEW). The SMBCEW was initiated in 2005 by the Monterey Bay National Marine Sanctuary (MBNMS), with the City of Monterey, state and other local partners, as part of a process to update the Sanctuary's Management Plan. The SMBCEW was established to address the issues of shoreline erosion and armoring in southern Monterey Bay and to develop a regional planning approach. The goals of the SMBCEW are:

- compile and analyze existing information on coastal erosion rates and threats to private and public facilities within southern Monterey Bay
- identify and assess the range of options available for responding to coastal erosion
- develop a regional shoreline preservation, restoration, and management plan for responding to coastal erosion that minimizes environmental and socioeconomic impacts.

Since its inception the SMBCEW has completed several projects that feed into the RSM process and are integrated into this Coastal RSM Plan. The projects include information on critical areas of erosion (SMBCEW, 2006c), regulatory and policy considerations (MBNMS, 2007b), and funding opportunities (MBNMS, 2007a). It is anticipated that the SMBCEW would serve as a technical advisory committee to the AMBAG in the proposed governance structure for implementation of this Plan (Section 10).

The SMBCEW is also evaluating potential solutions to coastal erosion in southern Monterey Bay that don't involve beneficial reuse of sediment (see below). The SMBCEW and Coastal RSM Plan efforts are intended to be individual, yet complementary, components of a larger integrated approach for addressing sediment management and coastal erosion in southern Monterey Bay. The MBNMS is in the process of funding, on behalf of SMBCEW, a technical evaluation of additional erosion control methods, including retention structures such as offshore reefs, beach dewatering, pressure equalizing modules, and other technologies that could help reduce erosion along the southern Monterey Bay shoreline. This project will also be carried out under the direction of the AMBAG and SMBCEW.

1.2.2 Purpose

The erosion of the southern Monterey Bay shoreline creates complex management problems; property owners want to protect their homes and businesses, municipalities want to protect their tax base and infrastructure, sand mine operators want to continue to remove sand from the beach and generate income, environmental groups want to preserve habitat and minimize damage to the beaches and dunes, and resource managers want to balance public access and habitat protection. This Coastal RSM Plan, which focuses primarily on sand management and mitigation of shoreline erosion, forms part of the solution to these broader shoreline management and coastal zone management challenges. Hence, the Plan could be considered a component of Land Use Plans, Local Coastal Programs, and the MBNMS Draft Management Plan, particularly the harbors and dredge disposal components (Sections 8 and 10).

In addition to the Plan's focus on how RSM can help address coastal erosion problems within the region, it should also enhance the southern Monterey Bay region's ability to compete for limited state and federal funding for erosion control projects that involve sediment management. The CDBW and U.S. Army Corps of Engineers (both members of CSMW) are major funding sources (Section 9) committed to RSM as a means to reduce coastal erosion. Both agencies have many requests for project funding, but only limited funds to disburse, and therefore look for benefits when making funding decisions. Hence, they may be likely to base future allocations of funding on whether a proposed project aligns with an approved Coastal RSM Plan.

This Coastal RSM Plan provides baseline information and a subset of regional recommendations for sediment management that address sediment imbalances aggravating coastal erosion. The information presented in this Coastal RSM Plan is important for evaluating the feasibility of potential erosion control technologies being undertaken by the SMBCEW (Section 1.2.1). Taken together, these two linked efforts will provide valuable guidance and reference to city and coastal managers, local and state-wide regulatory personnel, the AMBAGs Board of Directors, and state and federal funding entities, thereby setting the stage for specific projects to reduce coastal erosion.

This written Coastal RSM Plan is one of three main deliverables. The other two are a searchable database of references relevant to southern Monterey Bay, and a set of GIS data files to complement the information provided here. The database and GIS data files are accessible on the CSMW web-site (http://www.dbw.ca.gov/CSMW).

1.2.3 Implementation

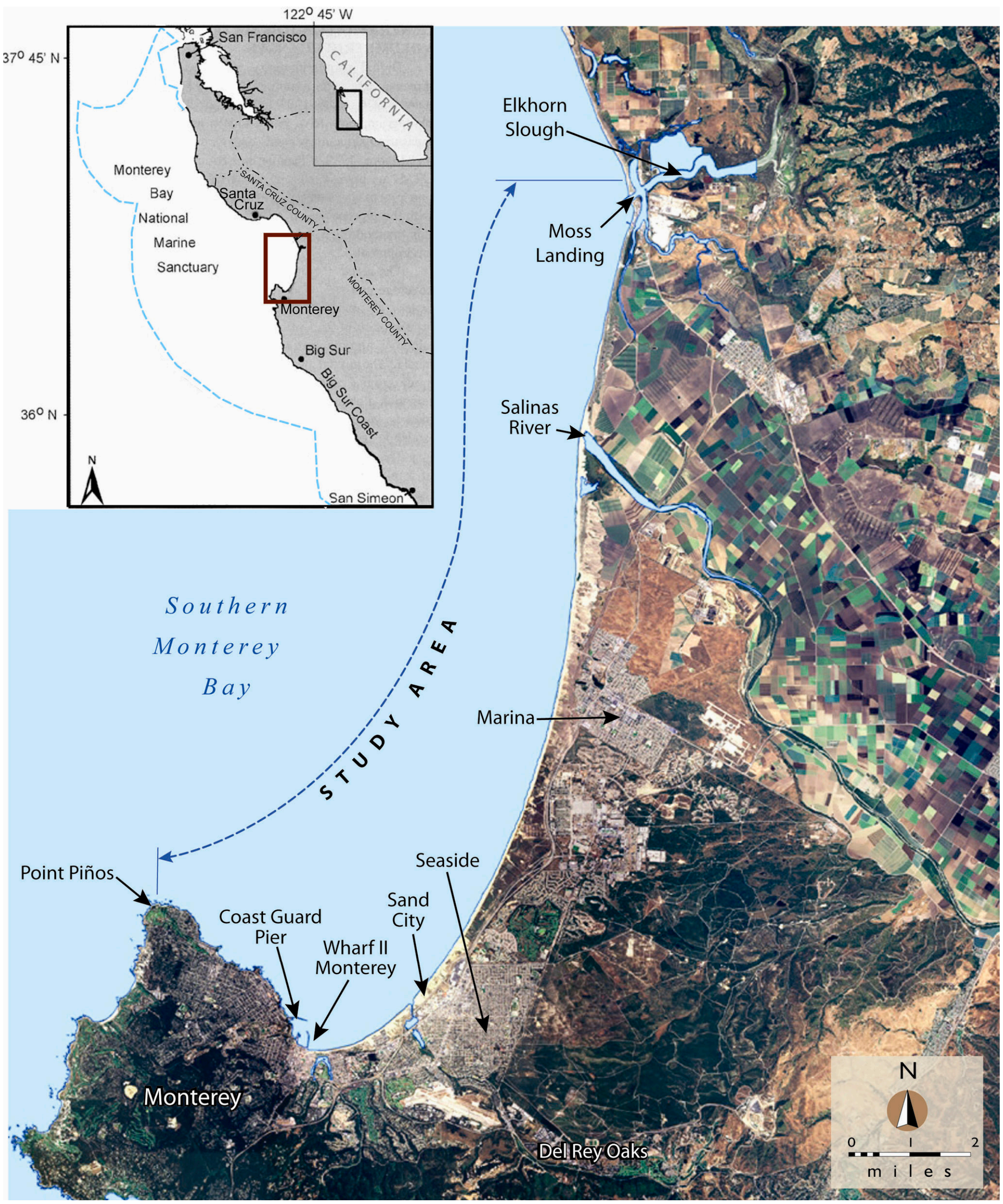
Implementation of this Coastal RSM Plan will require significant coordination with local cities, Monterey County, California Department of Parks and Recreation (CDPR), California Coastal Commission, and other relevant agencies. The AMBAG, as a Joint Powers Authority with a regional perspective, is best positioned for implementing RSM in southern Monterey Bay (Section 10). The AMBAG should work with the County of Monterey and coastal cities to identify how this Coastal RSM Plan can be recognized (referenced) in the county general plan and Local Coastal Programs (LCPs). Advice and guidance on RSM issues would be provided by the SMBCEW.

1.2.4 Jurisdictional Boundaries

Consistent with the California Coastal Act and the Coastal Zone Management Act, the coastal strip between Moss Landing and Wharf II (Figure 1) is divided into six coastal zone management planning areas. From Moss Landing to the northern boundary of the City of Marina (approximately one mile north of Marina sand mine), the shoreline falls within the jurisdiction of the Monterey County Local Coastal Program (LCP), more specifically the North County Land Use Plan (LUP). The City of Marina planning area is between the northern city limit and the northern boundary of Fort Ord. This approximately three-mile stretch of shoreline falls under the jurisdiction of the City of Marina LCP and is designated as habitat reserve and other open space in the City's LUP. Fort Ord is currently an uncertified coastal area and is within the jurisdiction of the Fort Ord Reuse Authority and is subject to the provisions of the Fort Ord Reuse Plan. However, the City of Marina LUP designates the northern half of Fort Ord as within its proposed 'sphere of influence' and hence also subject to the provisions of the LUP. South of Fort Ord is the City of Sand City planning area which extends to approximately 500 feet northeast of Monterey Beach Resort. The coastline for the remaining 500 feet to the northern boundary of Monterey Beach Resort is part of the City of Seaside LUP. The remaining stretch of coast southwest to

Wharf II is part of the City of Monterey planning area, which currently is an uncertified LCP. Any proposed amendments to permitted projects or additional coastal development project proposals in the City of Monterey planning area must go through the California Coastal Commission for approval. Details on the regulatory processes within each of these jurisdictions for implementation of beach nourishment projects are described in Section 8.

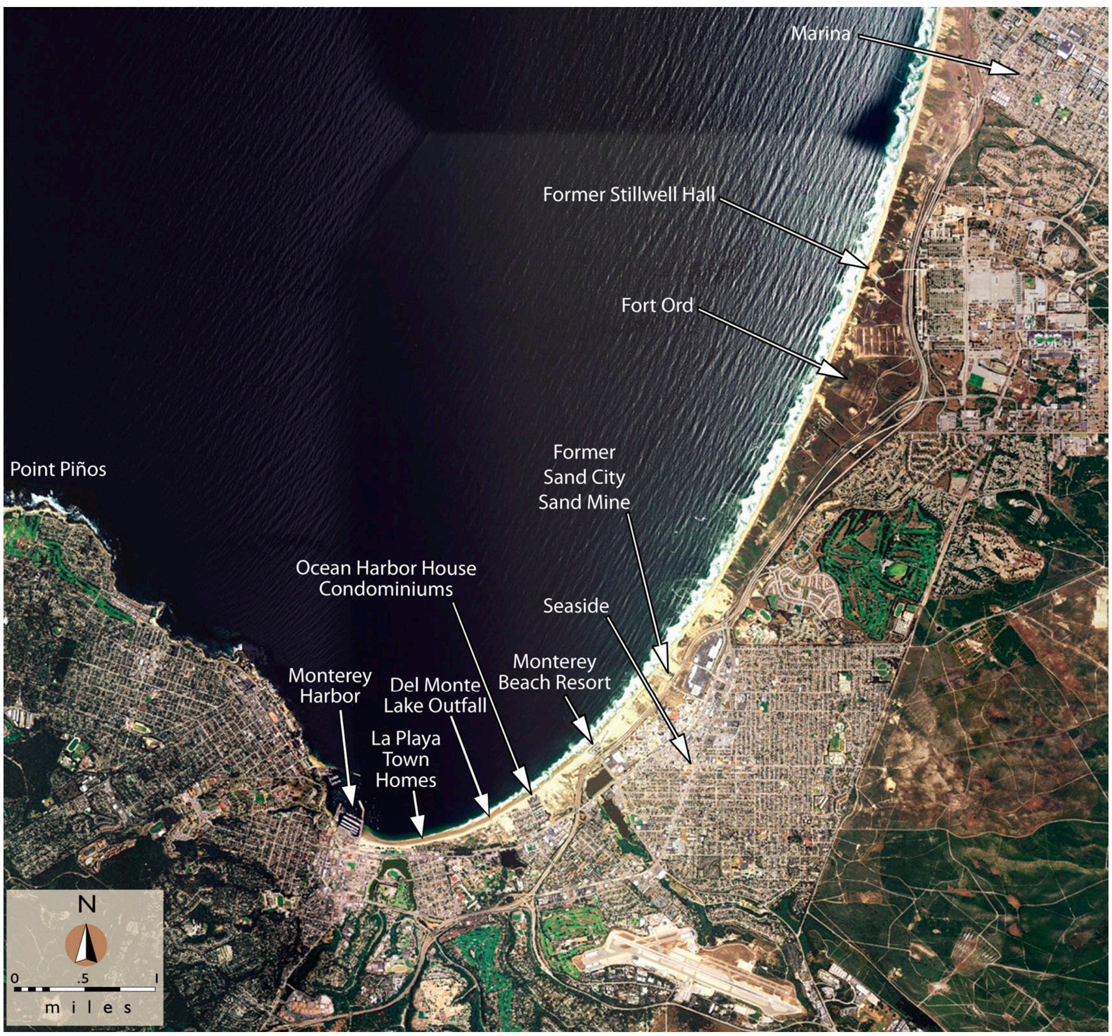
Figure 1. Location Map of Southern Monterey Bay



1.3 GEOMORPHOLOGY

Monterey Bay is a lowland coastal embayment, bounded by resistant rock headlands at its north (Santa Cruz) and south (Monterey) ends (Figures 1 and 2). The shoreline between the Salinas River mouth and Wharf II breakwater in Monterey is mostly composed of wide sandy beaches backed by relict (approximately 5,000 to 3,000 years old) sand dunes up to five miles wide and 150 feet high (Griggs and Patsch, 2005; Smith et al., 2005; Thornton et al., 2006). The sand dunes, referred to as the Flandrian and pre-Flandrian dunes, were deposited during the Quaternary.

Figure 2. Location Map of the Southern End of Southern Monterey Bay

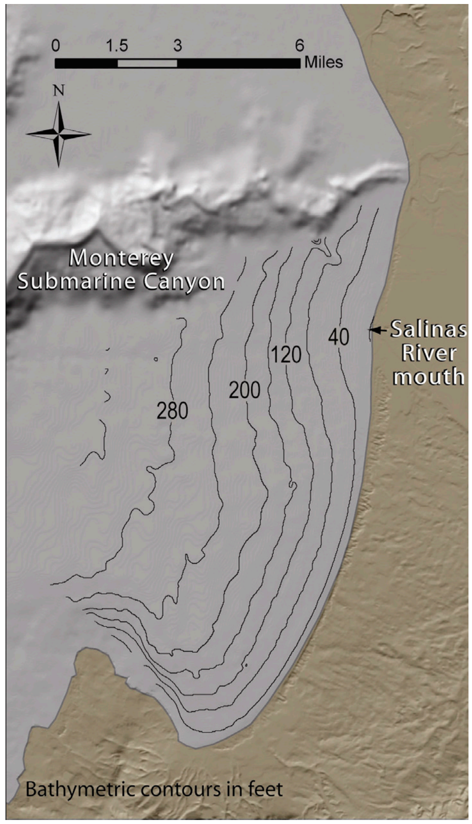


Approximately 18,000 years ago, at a lower stand of sea level, the dunes extended seven miles seaward of the present day shoreline (Chin et al., 1988). Historically, the beaches of southern Monterey Bay were supplied by large volumes of sand from the watershed of the Salinas River, when the river had a much steeper gradient and a larger transport capacity for sediments. The abundant sand in combination with dominant onshore winds created an extensive dune field in southern Monterey Bay. During the Flandrian (last 10,000 years) the shoreline eroded in response to sea-level rise, migrating landward to its present position at an average erosion rate of approximately 2.3 ft/year. This value is a rough measure of the historic average erosion rate due to natural causes such as sea-level rise and offshore losses. Since the present rate of sea-level rise is lower than the Flandrian rate, but erosion rates in general are higher than the historical mean value (Section 2.3.3), other processes have changed, such as a decrease in the amount of sand contributed by the Salinas River (Sections 2.3.1 and 2.3.2) and sand losses due to mining of the beach (Sections 1.4.4, 2.5.4, and 2.5.5).

The shoreline from Moss Landing to two miles south of the Salinas River mouth is occupied by low relief active (recent) dunes (i.e. dunes that are currently being supplied with wind-blown sand) backing wide sandy beaches. The beach-dune interface is less obvious north of the Salinas River and here the dunes are stable or accreting (Section 2.5.1) (Cooper, 1967; Hapke et al., 2006). Pockets of recent dunes are also present between Marina and Monterey (Section 2.5.2). Areas landward of the dunes are dominated by lowlands, and seaward the beaches are bounded by a continental shelf which descends into the Monterey Submarine Canyon (Figure 3) (Section 2.5.3). A second prominent offshore bathymetric feature is the ancient sediment lobe off the mouth of the Salinas River, which forms a bulge in the nearshore and offshore (Figure 3).

Historically, the Salinas River flowed north parallel to the shoreline behind the dune field and entered Monterey Bay north of present day Moss Landing Harbor. It may also have discharged near its present location, which is aligned with the ancient sediment lobe (Figure 3). In 1910, the river breached the dunes and was diked at its current location (Figure 1) to prevent northward flow into its old channel. In 1946, the U.S. Army Corps of Engineers (Corps) constructed two jetties and dredged an entrance channel at the present opening to Moss Landing Harbor. The historic opening of the Salinas River to the north eventually silted in as a result of the reduction in flow.

Figure 3. Bathymetry of Southern Monterey Bay



Source: Douglas Smith (CSUMB)

1.4 INFRASTRUCTURE AND THE EROSION PROBLEM

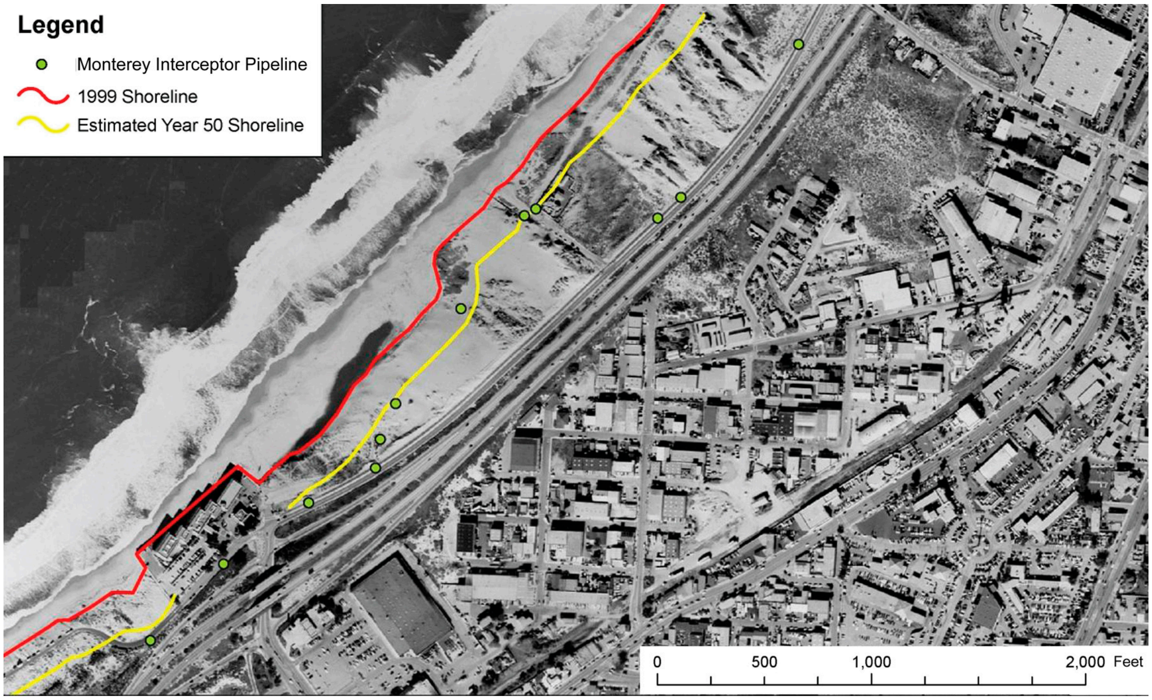
The southern Monterey Bay shoreline is highly susceptible to erosion given the unconsolidated nature of the sand beaches and dunes, and high degree of wave exposure (Section 1.5.2). The seaward face of the relict dunes that line the majority of the shoreline is an eroding bluff (Figure 4). PWA and Griggs (2004) predicted the position of the shoreline between Sand City and Monterey in 50 years time using a 1999 baseline and historic erosion rate data from Conforto Sesto (2004). They showed that over a 50-year timeframe, critical infrastructure including the Monterey Interceptor wastewater pipeline, which transports raw sewage from the Monterey Peninsula to the regional treatment plant in Marina, and other coastal developments would be undermined by erosion (Figure 5). This critical infrastructure is described in Sections 1.4.1 to 1.4.3.

Figure 4. Eroding Dune Bluffs at Fort Ord

Photo taken: September 19, 2007 (Justin Vandever, PWA)

Figure 5. Shoreline Projections in 50 Years using a 1999 Baseline

Sand City and Seaside



North Monterey

Source: PWA and Griggs (2004)

1.4.1 Coastal Armoring and Development

Apart from short lengths of riprap and seawall at Sand City, Monterey, and Moss Landing the majority of the southern Monterey Bay shoreline is unarmored (Stamski et al., 2005a, b). Approximately 0.6 miles at the southern end and 0.1 miles at the northern end of the 16-mile shoreline are currently armored (approximately 4%). Shoreline armoring in the south is focused at the privately-owned oceanfront Monterey Beach Resort and Ocean Harbor House condominiums (Figure 2). At these facilities the shoreline is fixed, and adjacent beaches and dunes continue to erode, causing armored areas to protrude seaward into the beach runup zones, and even the surf zone. The result is loss of beach width, and an adverse effect of blocking lateral beach access and recreation, posing a public safety hazard (Figure 6, left panel). The armoring consists of 600 feet of seawall to protect Monterey Beach Resort and 700 feet of emergency riprap to protect the Ocean Harbor House condominiums. The riprap in front of the Ocean Harbor House condominiums (Figure 6, right panel) is due to be replaced with a permanent seawall within the footprint of the condominiums. The seawall fronting the Monterey Beach Resort is due to be replaced with a new seawall abutting the front of the present structure.

Figure 6. Armoring at Monterey Beach Resort and Ocean Harbor House Condominiums

Monterey Beach Resort

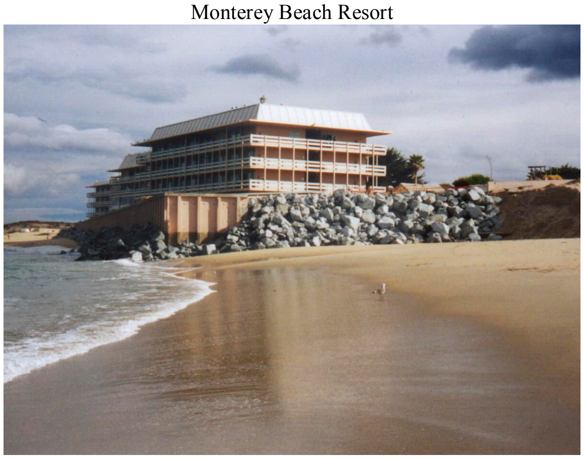


Photo taken: January 13, 2003 (Ed Thornton, NPS)

Ocean Harbor House condominiums

Photo taken: April 2006 (Gary Griggs, UCSC)

Shoreline armoring in the form of concrete and other debris is also present fronting the former sand mining complex at Sand City (Figure 2). Here, remnants of a cement mixing facility are located immediately north of Tioga Avenue. The facility is now used for temporary storage of construction equipment. Until at least 1990, concrete slurry was dumped here parallel to the shoreline to form an 800 foot-long concrete ridge that effectively acts as a seawall (Figure 7, right panel). In addition, at the seaward end of Tioga Avenue

there is a 750 foot-long collection of debris and riprap, composed predominantly of un-engineered cement and asphalt blocks, and the remains of a former road (Vista del Mar Street) where much of the asphalt has fallen over the bluff (Figure 7, left panel). A further 130 feet of riprap fronts the Del Monte Lake outfall (Figure 2) (inset). There is also a 470 foot-long concrete seawall in front of the main Monterey Bay Aquarium Research Institute (MBARI) building at Moss Landing (Figure 1).

Figure 7. Coastal Structures at Sand City

Collapsed former road at the end of Tioga Avenue | Concrete slurry 'wall'

Photo taken: September 19, 2007 (Justin Vandever, PWA) | Photo taken: September 19, 2007 (Justin Vandever, PWA)

1.4.2 <u>Utilities</u>

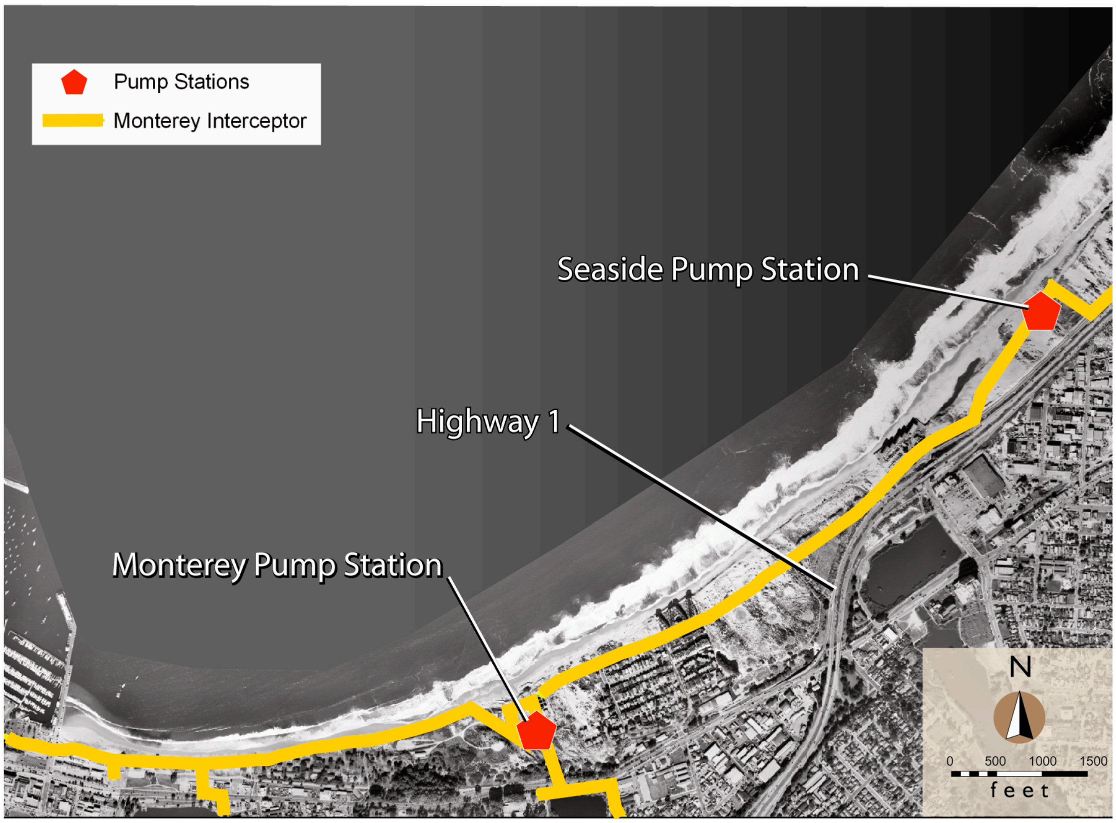
Monterey Regional Water Pollution Control Agency (MRWPCA) pump stations, pipelines, and outfalls extend along the southern Monterey Bay shoreline from Marina to Wharf II (PWA and Griggs, 2004). Pump stations are surface or sub-surface structures housing wastewater pumps and pipeline connections. At the shoreline, wastewater transport pipelines are typically buried in the dunes or beneath the beach. The MRWPCA oceanfront facilities include (Figure 8):

- Monterey Interceptor pipeline extending from Seaside Pump Station to Wharf II. This pipeline is buried in the dunes between Seaside and Monterey Pump Stations and beneath the beach between Monterey Pump Station and Wharf II
- Seaside Pump Station which is set back approximately 100 feet from the present dune edge
- Monterey Pump Station which is set back approximately 350 feet from the present dune edge.

The Monterey Interceptor pipeline was constructed between 1977 and 1981 to collect the raw wastewater from Pacific Grove, Monterey, Seaside, Sand City, and Fort Ord for regional secondary treatment at the Marina sewage treatment plant before discharge into Monterey Bay.

The pipe ranges in diameter from 3.0 to 3.5 feet, and there are manholes approximately 500 feet apart along the pipe and at each point of connection. The manholes, in accordance with California Coastal Commission permit requirements, were set so that their tops were approximately four feet below the lowest 'normal' sand level on the beach. Several of the manholes are now sometimes exposed, and are at risk of damage due to erosion (PWA and Griggs, 2004).

Figure 8. Monterey Regional Water Pollution Control Agency Facilities and Highway 1



Source: Location of pipeline provided by Jennifer Gonzalez (MRWPCA)

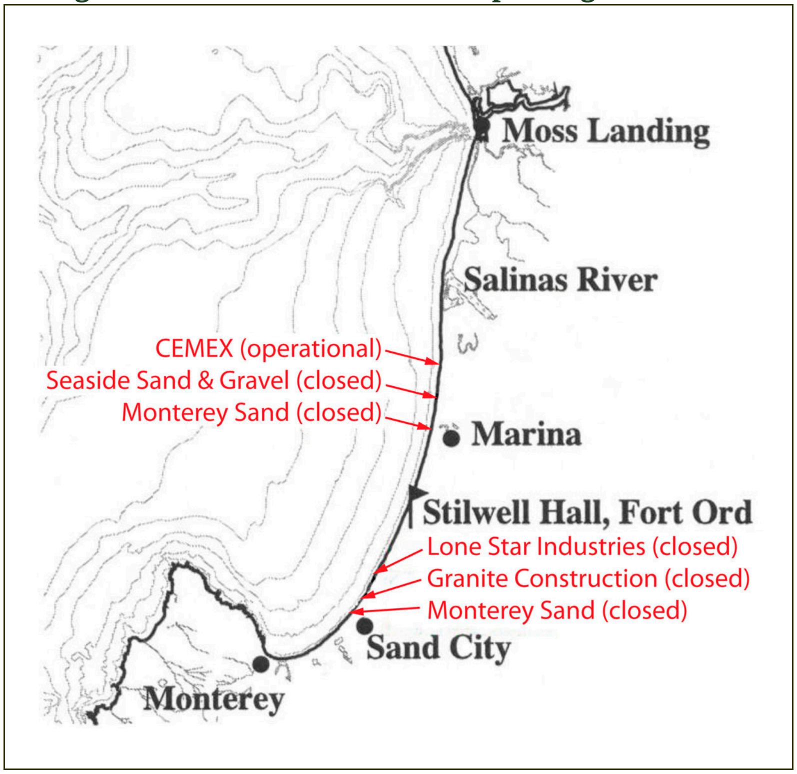
1.4.3 Highway 1

Portions of Highway 1 curve seaward at Sand City and in the vicinity of Monterey Beach Resort (Figures 2 and 8). These sections of the highway may be threatened by coastal erosion in the future.

1.4.4 Sand Mining

Southern Monterey Bay has been the most intensively mined shoreline in the U.S. Sand mining near the mouth of the Salinas River started in 1906, and expanded to six commercial sites; three at Marina and three at Sand City (Figure 9). Five of these operations used drag lines to mine coarse sand from the surf/swash zone (inset). In the summer months, when swell waves transported relatively fine sand back onshore, the operations were sometimes suspended. The sixth mine is located at Marina approximately two miles south of the Salinas River mouth, where the sand is hydraulically extracted just landward of the beach berm by a dredge floating on a self-made pond. Although all drag line sand mines were closed by 1990, the Marina operation (Pacific Lapis Plant) owned by CEMEX is ongoing (Section 2.5.4) (Figure 9).

Figure 9. Location of Former and Operating Sand Mines



The sand of southern Monterey Bay is economically valuable owing to high silica content, hardness, roundness, amber color, and is used for a variety of purposes including packing for water well casings, filtration, sandblasting, foundry and surface finishing (Combellick and Osborne, 1977). The time line of sand mining in southern Monterey Bay is:

- **1906** - Sand mining started near the Salinas River mouth
- **1940** – Start of intensive drag line sand mining directly from the surf/swash zone
- **1965** – Start of hydraulic sand mining of the pond at Marina
- **1980s** - Larger hydraulic dredge introduced to mine pond at Marina, continuing today
- **1986** - Sand mining by drag lines stopped at Marina
- **1990** - Sand mining by drag lines stopped at Sand City

1.5 PHYSICAL PROCESSES

1.5.1 Tidal Regime

The southern Monterey Bay coast experiences mixed semidiurnal tides, with two high and two low tides of unequal height each day. The mean tidal range (defined as mean low water minus mean high water) at Monterey Harbor (Station ID: 9413450) is 3.5 feet and the diurnal range (defined as mean higher high water minus mean lower low water) is 5.3 feet (Table 1). Tidal range determines the extent of beach exposure and inundation throughout the tidal cycle. Particularly important are the timing and height of high tides coincident with maximum wave heights and surge developed during storms.

Table 1. NOAA Tidal Datums for Monterey Harbor (Station ID: 9413450)

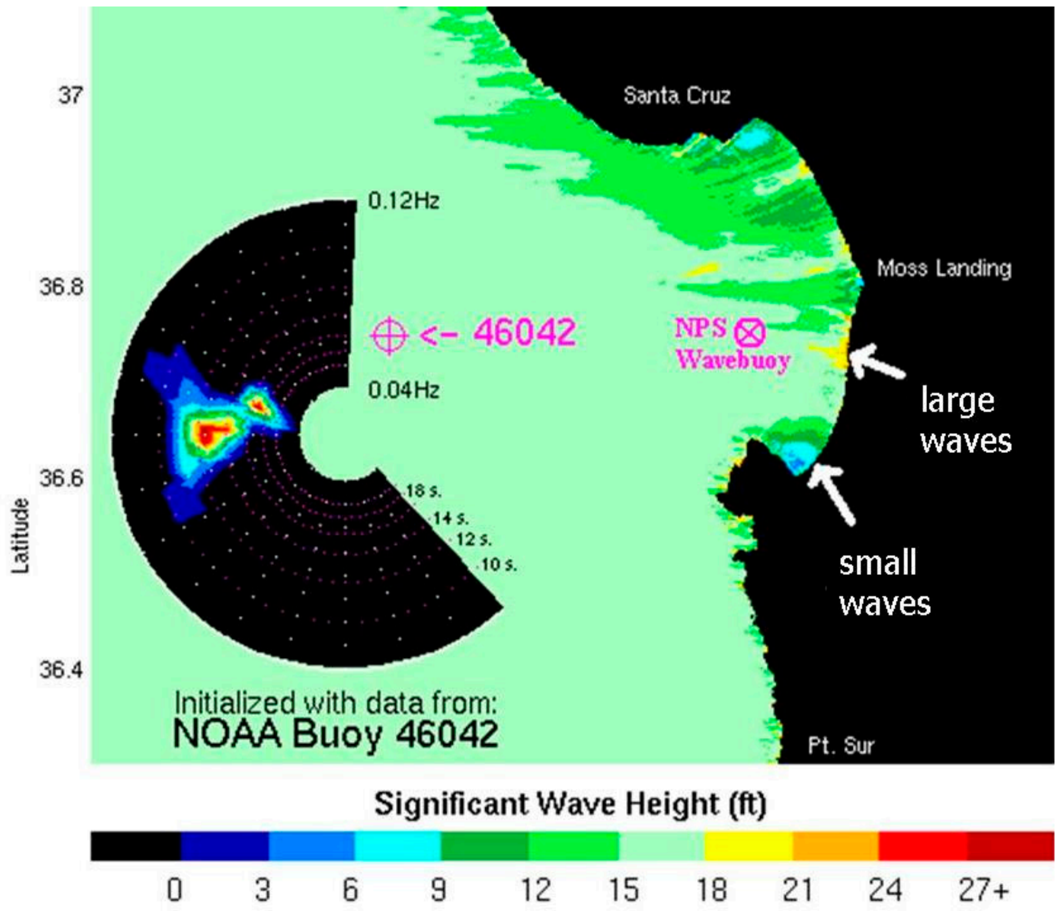
Tidal Datum	MLLW (feet)	NAVD 88 (feet)
Mean higher high water (MHHW)	5.34	5.48
Mean high water (MHW)	4.64	4.78
Mean tide level (MTL)	2.87	3.01
Mean sea level (MSL)	2.83	2.97
Mean low water (MLW)	1.10	1.24
Mean lower low water (MLLW)	0.0	0.14

1.5.2 Wave Climate

With respect to RSM, the wave climate of southern Monterey Bay is important for two reasons. First, differential wave energy alongshore causes variations in the magnitude of erosion due to wave impacts at the dune toe (Section 2.3.3). Second, the direction and magnitude of wave approach relative to the shoreline orientation, controls the direction and strength of alongshore sediment transport (Section 2.2).

The nearshore wave climate of southern Monterey Bay is impacted predominantly by waves from the northwest (Storlazzi and Wingfield, 2005). Xu (1999) reported a time series of wave height, period and energy data between 1990 and 1995 from a gauging station located 0.6 miles offshore from Marina. The time series showed that significant wave heights in winter are greater than in the summer and the highest waves arrive from the northwest in both seasons. Presently, the directional wave spectrum is measured every four hours at the National Oceanic and Atmospheric Administration (NOAA) wave directional buoy (Buoy ID: 46042) offshore of Monterey Bay (Figure 10) as part of the Coastal Data Information Program (CDIP). As a complement to this program, the wave height, direction, momentum flux, and sediment transport have been calculated every 200 m (600 feet) alongshore in Monterey Bay since October 2007 as part of the California Ocean Current Management Program (COCMP). Refraction occurs as the waves pass over Monterey Submarine Canyon focusing wave energy at Marina and Fort Ord (inset) and defocusing energy at Moss Landing. In addition, the shoreline at Monterey and Sand City is sheltered by Point Piños headland from waves from the south and west, resulting in reduced wave energy. The net result is a large alongshore energy gradient with relatively small wave heights at Monterey increasing to relatively large wave heights at Fort Ord and Marina (Figure 10) (Thornton et al., 2007).

Figure 10. Significant Wave Heights in Monterey Bay



Source: Coastal Data Information Program (http://cdip.ucsd.edu)

Longer term variations in wave climate are linked to large-scale atmospheric variations, particularly El Niño-Southern Oscillation and Pacific Decadal Oscillation (PDO) events. El Niño events are characterized by above average rainfall and large waves generated by Pacific storms, and generally last between six and eighteen months. The two most energetic El Niño's of the past 50 years along the California coastline occurred in 1982-83 and 1997-98. The PDO is a 20-25 year climate oscillation based on sea surface temperature phases, which have implications for ecosystems, physical processes, and beaches (Revell and Griggs, 2006; Adams et al., 2008). The PDO controls the jet stream and storm tracks in the north Pacific, which affects wave direction. During negative phases (relatively low water temperatures), La Niña conditions are more prevalent (dominated by waves from the northwest), while during positive phases (relatively high water temperatures), El Niño conditions are more dominant (more waves from the west). Higher intensity PDO and El Niño events were more common from 1910 to 1940, and after 1978, possibly continuing today, with the 1940 to 1978 period marked by a gentler climate.

The most destructive waves are most common during El Niño events (Storlazzi and Griggs, 2000; Dingler and Reiss, 2002; Storlazzi and Wingfield, 2005) when storms increase in frequency and intensity, producing waves of exceptional height and period at the shoreline. El Niño winter storm waves tend to approach the Monterey Bay shoreline from the west or west-southwest. Waves

from this direction diverge less due to refraction than those created by storms from the northwest, resulting in larger waves at the shoreline. Storlazzi and Griggs (2000) correlated El Niño events and the occurrence of large waves, higher than normal sea-surface elevations, and storms that caused significant erosion at the coast. A higher water surface together with the increased wave setup associated with the higher storm waves elevates the level of wave attack relative to the bluff toe (inset: photo taken by Steve Moore, CSUMB). The timing of El Niño storms also tends to be later in the winter season when the protective beach is already reduced (Section 2.3.3), further exposing the bluff toe to wave attack. The 1982-83 and 1997-98 El Niño winter storms caused severe beach and dune erosion along central California's coast including southern Monterey Bay (Storlazzi and Griggs, 2000; Thornton et al., 2006).

1.5.3 Base Flood Elevations

The Federal Emergency Management Agency (FEMA) coastal flood studies in southern Monterey Bay (FEMA, 2007) projected the maximum elevations of wave runup and overtopping during a 100-year flood event, denoted by the Base Flood Elevation (BFE) (Table 2). Structures at elevations below the BFE may be subject to damages from direct wave impacts or undermining by wave scour. The BFE estimates do not include a future sea-level rise component and may be low relative to potential future conditions.

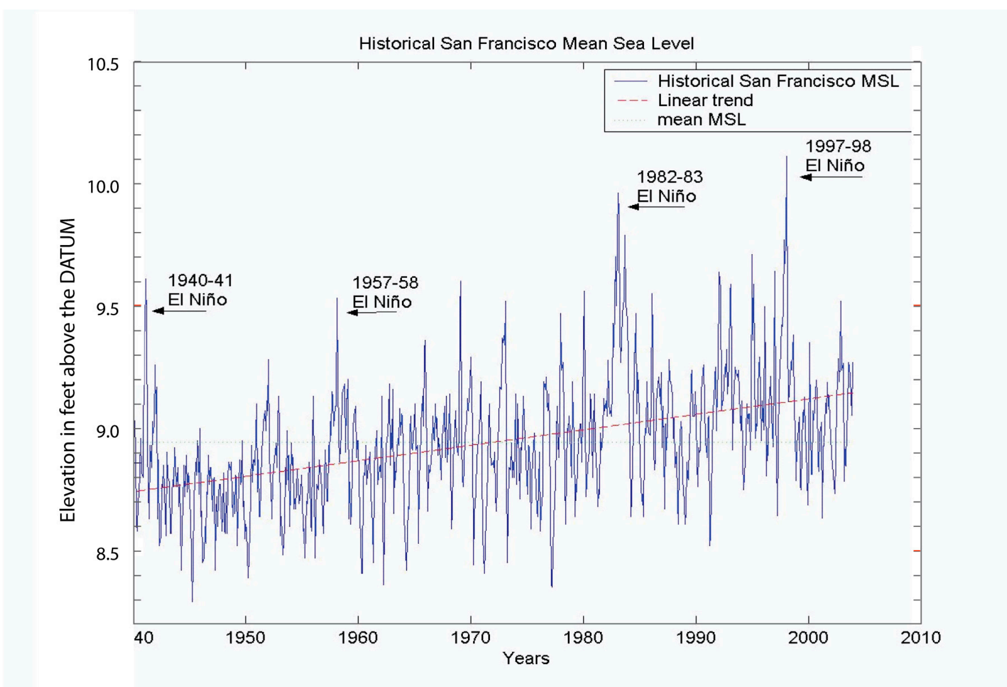
Table 2. FEMA (2007) Base Flood Elevations (BFE)

Location	BFE (feet NAVD)
North of the Salinas River mouth	23-24
Sand City (Tioga Avenue)	27
Seaside Pump Station	27
Monterey Beach Resort	24
North Del Monte Beach (Monterey)	26
Wharf II and South Del Monte Beach (Monterey)	22

1.5.4 Relative Sea-Level Rise

Measurements of monthly-averaged relative mean sea-level rise at Monterey started in 1973, providing a 35-year record for analysis. The Monterey record shows that relative sea-level has risen at a rate of 1.86 mm/year (0.31 ft/50 years) between 1973 and 1999. In order to determine if a longer record could be used to establish the relative sea-level rise rate in southern Monterey Bay before 1973, the Monterey tide gauge data was compared to San Francisco tide gauge data, which started in 1853 and is the longest continuous record in the U.S. The two time series have a high correlation coefficient (>0.9) (Conforto Sesto, 2004), indicating that the San Francisco record can be used to infer relative sea level at Monterey, since the regional land subsidence rates at these tide gauges is low (Battalio and Everts, 1989). The San Francisco record shows that relative sea level has risen at a rate of 2.13 mm/year (0.35 ft/50 years) since 1906. The record shows significant annual variations, and spikes in mean sea level correlate with El Niño events (Battalio and Everts, 1989; Ryan et al., 1999) (Figure 11).

Figure 11. Monthly Averaged Mean Sea Level at San Francisco (1940-2004)



Source: Adapted from Conforto Sesto (2004). Note: Mean sea level is relative to station datum.

Over the next century, the Intergovernmental Panel on Climate Change (IPCC, 2007) predicted a global rate of sea-level rise between approximately 0.6 and 1.8 feet, although considerable uncertainty surrounds these values. For example, Rahmstorf (2007) projected higher rates of global sea-level rise between 1.6 and 4.6 feet over the next century. The upper end of this range has been recommended for coastal planning in California (CRA, 2008). In this Coastal RSM Plan an average rise of 3.0 feet over the next century is used (one foot over the next 50 years, assuming an exponentially accelerating rise). This estimate is precautionary for long-term planning for sea-level rise and is in line with California Coastal Commission measures which require consideration of a three feet sea-level rise over the next century (Susan Craig, Coastal Commission, personal communication).

2. SEDIMENT BUDGET

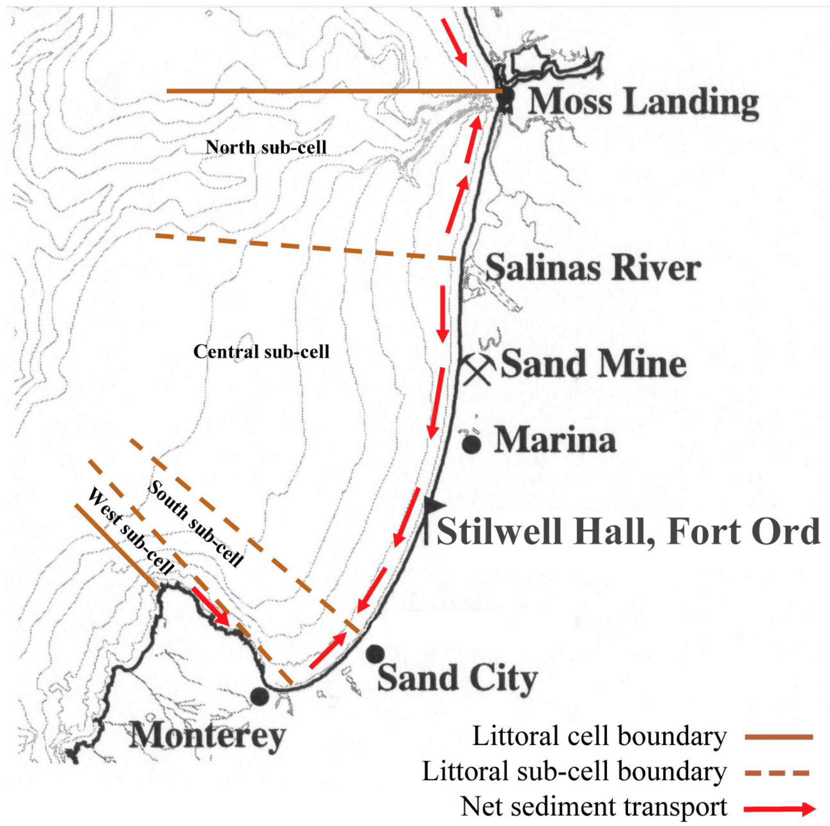
Sediment (sand) budgets are important tools in understanding regional sediment processes (Best and Griggs, 1991; Rosati, 2005) and quantifying the sediment sources (inputs) and sinks (outputs) from a littoral cell; a defined length of shoreline along which the cycle of sediment erosion, transportation, and deposition is essentially self-contained. Sediment enters a cell from one or more rivers (the Salinas River in southern Monterey Bay) draining the coastal watersheds and/or from erosion of coastal bluffs (coastal dunes in southern Monterey Bay). A littoral cell includes the beach above the highest tides, wind-blown sand, and any sediment within the surf/swash zone and out to the depth on the shoreface at which wave energy stops transporting sediment (so-called closure depth). Some of the sediment inputs and outputs are not well defined, such as those in cross-shore directions, and these components are often treated as an unknown and estimated by the residual in the budget.

2.1 DEFINITION OF THE SOUTHERN MONTEREY BAY LITTORAL CELL

Monterey Bay is currently divided into two primary littoral cells; Santa Cruz to the north and southern Monterey Bay to the south (Patsch and Griggs, 2007). The Santa Cruz littoral cell stretches from Point San Pedro to the head of Monterey Submarine Canyon close to the shoreline at Moss Landing. Sediment is transported south within this cell (Best and Griggs, 1991; Eittreim et al., 2002) until it is deflected offshore into Monterey Submarine Canyon by Moss Landing Harbor north jetty, and lost from the littoral system (Wolf, 1970).

The southern Monterey Bay littoral cell is considered in this Coastal RSM Plan to be comprised of four sub-cells (north, central, south, and west) between Monterey Submarine Canyon and the Point Piños headland, around which no sand enters the Bay (Figure 12). The boundary between the north and central sub-cells is located at the Salinas River mouth. Refraction of waves over Monterey Submarine Canyon (Section 1.5.2) and the relict Salinas River delta results in a net alongshore sediment divide, with a portion of the sand discharged from the Salinas River transported north towards Monterey Submarine Canyon, and a portion transported south towards Sand City (Figure 12) (Habel and Armstrong, 1978). Thornton et al. (2006) suggested seasonal variability in sand transport directions in the central sub-cell. During winter, waves approach from the west and sand is transported to the north, with transport to the south during the rest of the year (waves from the northwest), with an overall net southerly movement. The northerly transport during the winter coincides with the time of year when the Salinas River may be flowing into the Bay and providing sediment input (Section 2.3.1). This suggests that most of the river sediments are transported to the north, supporting the contention of Patsch and Griggs (2007) that most of the sediment from the Salinas River is driven north and potentially lost into Monterey Submarine Canyon at the northern boundary of the littoral cell.

Figure 12. Southern Monterey Bay Littoral Sub-Cells and Net Sediment Transport

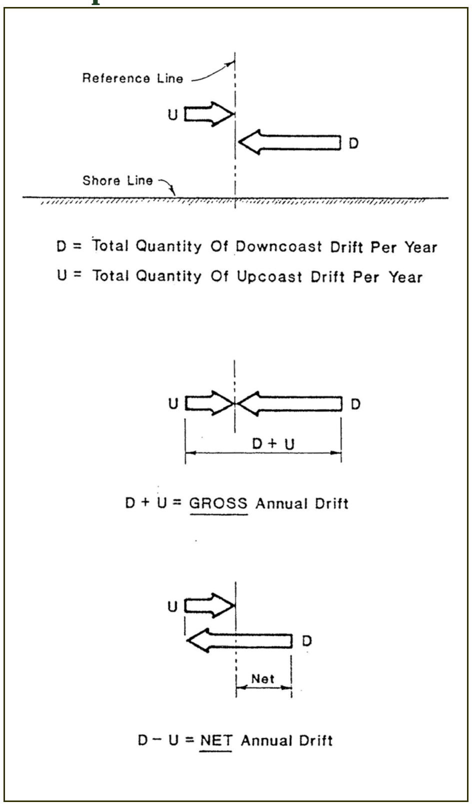


Note: Net is defined as southward minus northward transport and is smaller than the gross transport (defined as northward plus southward transport). Gross transport occurs across the net transport convergence at Sand City (across the central and south sub-cell boundary)

A third (south) sub-cell exists between Wharf II and near Sand City (Figure 12). Orzech et al. (2008) showed that the net sand transport at Sand City is to the north, resulting in a convergence with the net southerly transport at Fort Ord (Section 2.2). At the location of convergence, approximately 2.5 miles northeast of Wharf II (although seasonally variable in location), sand may migrate offshore, demarcating the boundary between the central and south sub-cells. Little sand has accumulated against the Wharf II breakwater since it was built in 1932, and the beach sand there appears to be derived primarily from runoff, suggesting little or no net southerly transport at this location.

The net sand transport is defined as the difference between transport to the south and transport to the north (Figure 13). The alongshore transport varies in magnitude and direction in response to incident wave conditions and the actual transport conditions can be different to the net transport shown in Figure 12. In southern Monterey Bay, the net sand transport is much smaller than the gross sand transport, which is defined as the sum of southward and northward transport, and can be greatly affected by sand supply and shoreline orientation changes (Battalio and Everts, 1989) (Section 2.2). This means that gross transport of sand can take place across the net transport boundary between the central and south sub-cells (i.e. large amounts of sand can move south through the boundary).

Figure 13. Concept of Gross and Net Sediment Transport



A fourth (west) sub-cell is defined between Point Piños and Monterey Harbor (Coast Guard Pier) where the alongshore sand transport is to the southeast (Patsch and Griggs, 2007). The shoreline of this sub-cell is comprised primarily of erosion-resistant granite, and hence, has probably not contributed a large amount of sand to the Bay. Monterey Harbor blocks most sand transport from the east with only a small amount passing the breakwater. After the Coast Guard Pier was built in 1959, the breakwater impounded sand such that San Carlos Beach adjacent to the west side of the pier increased in width to 80 feet by 1990 (Storlazzi and Field, 2000) and has since stabilized at about that width. This implies that the harbor is a barrier to sand transport to Del Monte Beach (Monterey) although the quantities and effects are small.

Monterey Harbor requires periodic dredging. Approximately 4,000 yd^3 was dredged in 2003 and it is estimated that approximately 75,000 yd^3 could be targeted for dredging in 2010-2011. The sand in the harbor appears to be derived locally based on mineralogy and sand size (Dingler et al., 1985). Sand enters the harbor past the east and west breakwaters, through three runoff outfalls within the harbor, and through an overflow runoff pipe just inside Wharf II.

Based on the potential for sand to be transported from the central sub-cell into the north sub-cell, it is recommended using Monterey Submarine Canyon as the northern boundary of the littoral cell (the littoral cell defined by Patsch and Griggs, 2007) (Figure 12). The 16 miles of shoreline between Monterey Submarine Canyon and Wharf II encapsulates all of the sediment that should be considered in RSM for southern Monterey Bay.

2.2 ALONGSHORE SEDIMENT TRANSPORT

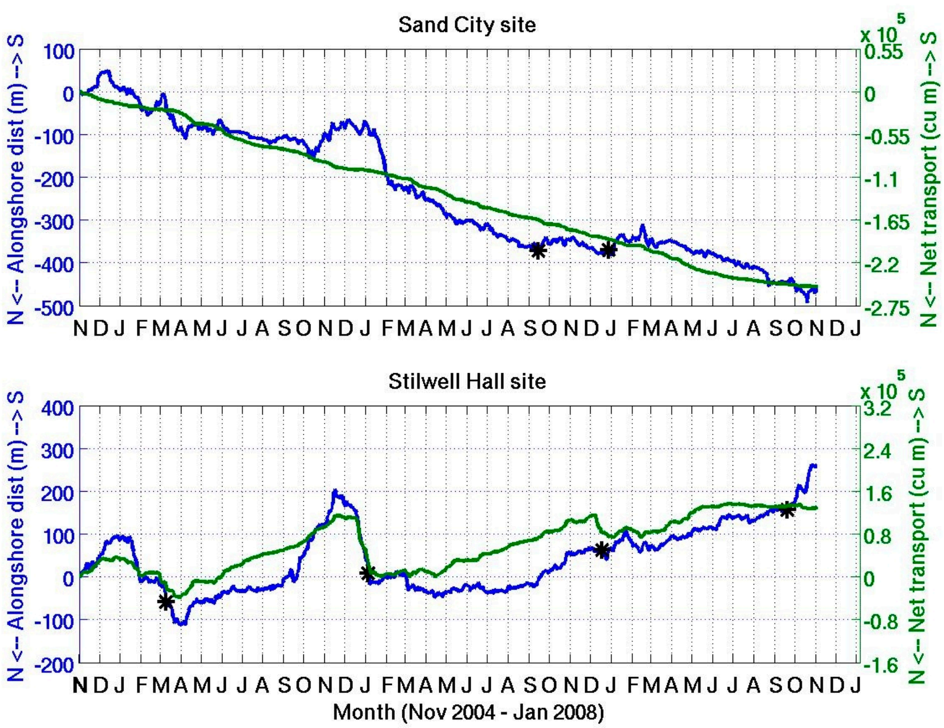
2.2.1 Impacts of Rip Currents

The near-normal incidence of waves approaching the southern Monterey Bay shoreline is conducive to rip current generation and maintenance (Thornton et al., 2007). Rip currents are generated when waves break sooner on nearshore bars (Section 2.3.5) than in the deeper rip channel. This results in greater setup over the bars than in the channel and creates pressure gradients towards the rip channel generating feeder currents from both up coast and down coast directions. The rip current flows offshore at the convergence of the feeder currents, creating a cross-shore component to the sediment transport. The feeder currents both retard and enhance the alongshore sediment transport, but the net affect is a reduction. The amount of reduction (R_c) is dependent on the rip channel width (W_c) compared to the spacing between rip channels (L_c) where $R_c = W_c/L_c$ (Fredsoe and Deigaard, 1992). The reduction to alongshore sediment transport (R_c) ranges from 0.5 at Monterey to 0.2 at Fort Ord and Marina.

2.2.2 Net Sand Transport

Orzech et al. (2008) measured the daily migration of rip current channels (Section 2.3.6) over a three-year period (2005-2008) using time-lapse video images taken at Sand City, Fort Ord and Marina, and hypothesized that the migration was due to alongshore sediment transport. They calculated daily net sediment transport rates over the same three years applying a modified version of the CERC formula (Corps, 1984) on wave spectra refracted from the offshore NOAA wave directional buoy (Buoy ID: 46042) (Figure 10). They found correlation values of 0.83-0.96 between daily migration distance and calculated net alongshore sediment transport giving confidence in the calculated directions (Figure 14). Sediment transport at Stilwell Hall (Fort Ord) and Marina (not shown in Figure 14 as it is similar to Fort Ord) is seasonally variable with transport to the north during the winter and to the south the rest of the year, with a calculated net rate to the south between 10,000 and 20,000 yd^3/year, which includes the reduction factor due to rip currents (Section 2.2.1).

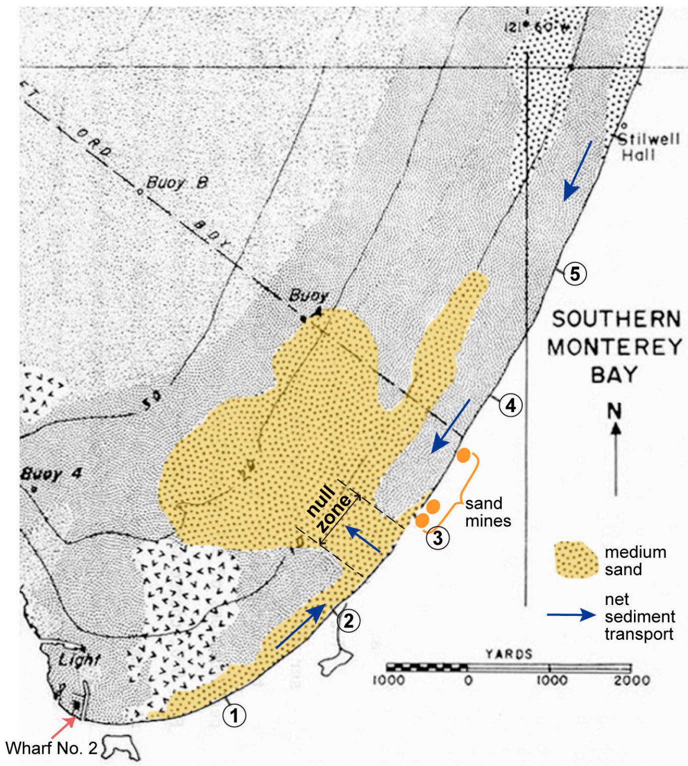
Figure 14. Calculated Sediment Transport and Net Transport of Rip Channel Morphology



Source: Adapted from Orzech et al. (2008). Sediment transport is green. Net transport of rip channel morphology is blue.

An important boundary in the net alongshore sediment transport regime is at Sand City where sand transported south from Fort Ord meets sand transported north from Monterey to form a zone of net convergence. Sediment transport at Sand City is complicated by its sheltered location in the shadow of the Point Piños headland. Wave directionality drives the transport consistently to the north. However, because of its sheltered location, there is also a transport component to the south. The alongshore gradient of wave energy in southern Monterey Bay (Section 1.5.2) creates a pressure gradient driving currents to the south that is seasonally variable and strongest in the winter when waves are largest. The resulting calculated net transport at Sand City, including the reduction in transport owing to rip currents, is to the north at 8,000 to 20,000 yd^3/year. These calculated values closely balance the net transport from the north, suggesting a null zone of small net transport at the convergence (Figure 15).

Figure 15. Distribution of Surface Medium Sand South of the Salinas River



Source: Adapted from Dorman (1968). Note: Net is defined as southward minus northward transport and is smaller than the gross transport (defined as northward plus southward transport). Gross transport occurs across the net transport 'null zone'. Miles from Wharf II shown.

Evidence supporting a net sediment convergence zone is found in Combellick and Osborne (1977) and Hunter et al. (1988). Combellick and Osborne (1977) combined the surface sediment data at the southern end of Monterey Bay of Dorman (1968) and Greene (1970), and found a zone of surface medium sand (particle size 0.25-0.5 mm) extending offshore from Sand City with mineralogy and physical characteristics consistent with the dune and beach sands (Figure 15). The location of the shore-connection of this offshore sand is consistent with the location of the net alongshore sediment transport convergence zone. Hunter et al. (1988) examined this area over a three-year period performing repeated side-scan sonar surveys, obtaining cores, and placing rods on the bottom to measure changes in the bed elevation. They found bands of coarse sand at water depths of 30-60 feet. The coarse sand (0.35-1.0 mm) was approximately three feet lower that the adjacent finer sands (0.12–0.35 mm). The cores (20–40 inches in length) recovered unconsolidated sand of recent age (150 years) containing iron and glass fragments, suggesting offshore transport.

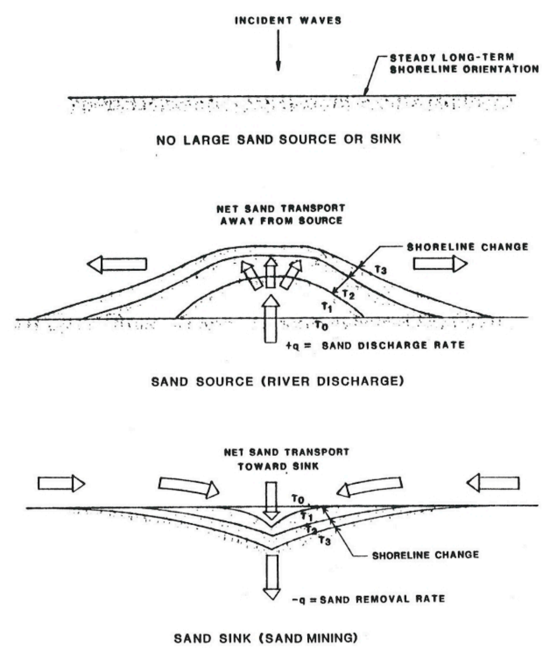
2.2.3 Gross Sand Transport

The net alongshore sediment transport rates within the southern Monterey Bay littoral cell are relatively low. This is because waves approach the shoreline at near-normal angles due to refraction across offshore bathymetric contours including Monterey Submarine Canyon, and the evolution of the shoreline in response to the wave climate. Southern Monterey Bay is essentially a hook-shaped bay (a near-equilibrium shape) between Point Piños and Monterey Submarine Canyon. These processes along with the shorelines exposure to the north Pacific, result in large total (gross) alongshore sand transport rates but small net transport rates (Section 2.2.2) over a given period. The gross transport rates are highest towards the center of the Bay (Fort Ord) due to the offshore wave refraction effects. High gross sand transport rates are important because they result in rapid redistribution along the Bay shoreline of perturbations such as beach-sand mining and local bluff erosion (Battalio and Everts, 1989). Hence, mining of sand from the beach in southern Monterey Bay affects sediment transport and supply along the entire shoreline from the Salinas River mouth to Monterey Harbor.

The net sediment transport rates estimated for the south and central sub-cells are expected to be an order of magnitude less than the gross sediment transport rates. Also, the null zone is not a barrier to sand transport, and sand does move through this zone (Section 2.1). The net rate is a calculation affected by sand sources and sinks as well as the change in shoreline orientation resulting from erosion. This implies that the northward net transport shown in Figures 12 and 15 may be a result of sand mining from the beach and coastal erosion. Also, the magnitude of net transport southward near the null zone would likely be effected by sand mining and shoreline response over time.

Mining of sand from the southern Monterey Bay beaches has increased erosion rates, and modified shoreline orientation and sand transport rates. A detailed review of historic shoreline positions and a sand budget indicated that beach-sand mining at Sand City and Marina had caused the shoreline to retreat in the vicinity of the mines, thereby increasing alongshore sand transport toward the mines (Battalio and Everts, 1989). The Fort Ord shoreline experienced the highest erosion rates due to its location between the Sand City and Marina beach-sand mining operations, and also due to greater wave exposure. Battalio and Everts (1989) used a conceptual model and a numerical model to evaluate these processes based on an equilibrium shoreline with small net transport, but large gross (total) transport, where perturbations like beach-sand mining and river discharge result in transport toward and away, respectively, from the perturbation (Figure 16). Therefore, the alongshore sand transport rate has varied over time in response to beach-sand mining, which continues today.

Figure 16. Conceptual Model of Beach-Sand Mining Impacts on Sediment Transport



Source: Battalio and Everts (1989)

Apart from the Moss Landing jetties, Wharf II breakwater and Coast Guard Pier at Monterey Harbor, southern Monterey Bay has no shore-normal structures that would act as barriers to alongshore sediment transport. There are also no shore-parallel offshore structures that would inhibit cross-shore transfer of sediment. However, mining of sand from the beach appears to be major barrier to sediment transport.

2.3 SEDIMENT SUPPLY

Sources of sand to the southern Monterey Bay littoral cell are from discharge of the Salinas River, erosion of the beaches and coastal dunes, and possibly transport of sand from offshore.

2.3.1 Salinas River

The quantity of sand that is contributed to the littoral cell by the Salinas River (inset) is a significant uncertainty in the sediment budget of southern Monterey Bay. The Salinas River has the third largest watershed in California (Willis and Griggs, 2003) and processes are characterized by large supply of fine sediments (McGrath, 1987). The sediments are generated from the natural dryness of the eastern portion of the watershed, from the expansion of agriculture, and from modification of the stream channel. Farnsworth and Milliman (2003) showed that sediment delivery to Monterey Bay from the Salinas River is episodic. During many years, the mouth of the Salinas River is blocked by a sand bar, which changes morphology with seasonal changes in wave climate and rainfall. During periods of low river discharge the bar grows through alongshore sediment transport and interrupts sediment supply from the Salinas River. Breaching of the bar may occur during periodic flood events in winter. Breaching also takes place annually by removal of part of the bar by the Monterey County Water Resources Agency (MCWRA) to prevent flood damage to the surrounding areas. Farnsworth and Milliman (2003) suggested that during major flood events, when the sand bar is breached, sediment concentrations are extremely high (Figure 17).

Figure 17. Salinas River during a Flood and Bar Breach

Source: Unknown

The majority of sediment delivered to the shoreline during flood events is very fine sand and mud that bypass the inner shelf as a plume (Figure 17). The Salinas River discharges on average nearly two million tons of fine sediment annually. After the sediment is introduced into coastal waters, it undergoes intervals of deposition, resuspension, and transport until it is ultimately deposited where it is no longer disturbed (Wright and Nittrouer, 1995). A distinct mid-shelf fine-sediment region is present in central Monterey Bay. This Salinas River mud lobe is a convex bulge in water depths of 30 to 300 feet covering an area of 28 square miles (Figure 3 (Chin et al., 1988). Due to the fine particle size of this sediment, it is not a source for beach nourishment.

Willis and Griggs (2003) studied river sediment discharge along the entire California coast, but focused on the Salinas River as a specific example, providing detailed information on this system. In their analysis, they determined suspended sediment concentrations by applying rating curves produced by an empirical power formula using daily measured suspended sediment concentrations and stream flow at Spreckels (11 miles upsteam from the river mouth) for water years 1967-1979 and 1986. They then applied the rating curves to the entire time series of measured discharge including the fraction of suspended load for sand particle sizes. However, the bedload was not measured and was assumed to be 20% of the total annual suspended flux, and sand size or coarser. The average annual sand and gravel flux at Speckels was calculated at 490,000 yd^3/yr. In this Coastal RSM Plan, this sediment discharge is judged an overestimate for several reasons:

- sand on the beaches of southern Monterey Bay contains little sand finer than 0.25 mm, which is the particle size of the majority of suspended sediments in the Salinas River
- the river is depositional between the measurement location at Spreckels and Monterey Bay
- the assumption that the bedload is equivalent to 20% of the suspended sediment is considered to be an overestimate.

McGrath (1987) argued that the Salinas River no longer contributes substantial beach-size sand to the littoral cell because the river gradient has greatly decreased with rise in sea level, reducing the flow rate. In addition, the dissipation of flood discharge in the channel (for example, during the February 1969 flood, which peaked at 117,000 cfs at Soledad, the flow was only 83,000 cfs at Spreckles further downstream) and the limited capacity of the active river channel provide evidence that the lower river is depositional. The river overflows at a relatively low flood stage (approximately 20,000 cfs) spilling the flow onto the adjacent wide floodplain where the sediment load is deposited and stored. Hence, the Salinas River deposits much of its beach-building sand before it can be carried to the southern Monterey Bay coast.

Further evidence that the Salinas River is depositional is provided by sediment studies. Combellick and Osborne (1977) found that the sediment size in the river decreased downstream towards the mouth suggesting that the coarse-sand fraction is deposited before reaching the Bay. They found that the sand in the river mouth is finer-grained and less well sorted than sand on the beaches, and they estimated that the quantity of medium and coarse sand near the mouth available for discharge into the Bay was less than 5%. Clark and Osborne (1982) performed textural and petrographic analyses to discriminate between the more angular river sands and the more rounded dune and beach sands, and found only a small influence of river sand on the beaches of Monterey Bay south of the Salinas River, even after the major flood of 1978. They concluded that the Salinas River is a minor local sand source to the beaches south of the river, even during periods of abnormal flooding. Sand contribution to the beaches to the south was limited to within 1.6 miles of the Salinas River mouth.

McGrath (1987) quantified the hydraulic behavior of the Salinas River, and then obtained relationships between stream flow and sediment discharge. He calculated rating curves based on the suspended sediment data for discharge flows greater than 1,000 cfs (similar to Willis and Griggs, 2003), but only included beach-size sand (>0.25 mm) in his rating curves. Rather than assuming bedload to be a percentage of the suspended load, he calculated the bedload transport using a variety of formulations. McGrath (1987) estimated that approximately 50,000 yd^3/year of the Salinas River sediment load has large enough particle size for the high-energy beaches of southern Monterey Bay. Since 28% of the suspended sediments are in the range 0.125 to 0.25 mm, the discharge would only increase to 64,000 yd^3/year if these particle sizes are included. The study was completed in 1987, so the estimates do not include the water years post-1986, during a time of positive PDO and increased rainfall (Section 1.5.2), which could increase the annual average sediment yield.

For the purposes of the budget used in this Coastal RSM Plan, a beach-size sand supply from the Salinas River to Monterey Bay of 65,000 yd^3/year is used (McGrath, 1987). Given the distance over which the Salinas River sands have been found south of the river mouth (1.6 miles) (Clark and Osborne, 1982) and given that sediment transport is generally to the north during the winter when the river is flowing into the Bay (Section 2.1), the budgetary contribution to the south is judged to be relatively small. For this sediment budget a value of 10,000 yd^3/year is estimated, leaving approximately 55,000 yd^3/year of sand transported north.

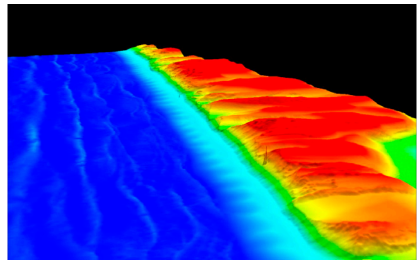
2.3.2 <u>Potential Barriers to River Sediment Transport</u>

Reductions in river sediment discharge to the ocean by coastal dams in California were examined by Slagel and Griggs (2006, 2008). Damming of these rivers impounded sediment behind the dams and lowered the sediment carrying capacity by reducing flow in the rivers, particularly during times of floods.

Three dams along the main tributaries of the Salinas River have changed the timing and amount of flow. The Salinas Dam (Lake Santa Margarita) was constructed in 1941 a few miles southeast of the town of Santa Margarita in San Luis Obispo County, close to the origin of the Salinas River. Nacimiento Dam (inset) in northern San Luis Obispo County is a 210-feet high earth-fill dam, built by the MCWRA on the Nacimiento River, which completed construction in 1961. Lake San Antonio in southern Monterey County is formed by an earth-fill dam on the San Antonio River. The dam is 202 feet high and was constructed in 1965. The lake and dam are owned by the MCWRA and are about 80 miles from the southern Monterey Bay shoreline. Slagel and Griggs (2006, 2008) calculated that at

Spreckles (11 miles upstream of the Salinas River mouth) the impact of these dams has been to reduce the total annual sediment flux by 31%.

2.3.3 Long-Term Dune Erosion



The largest input to the sand budget of the southern Monterey Bay littoral cell is from erosion of the coastal bluffs south of the Salinas River (inset), which are composed of relict dune sand with low cohesion. Erosion occurs during large winter wave events when wave setup and runup coincide with high tides to overtop the beach and undercut the base of the bluff causing the overlying sand to slump (http://hydro.csumb.edu/dunes_park/retreat/event_080104/index.html). This process causes aprons or cones of loose sand to accumulate at the top of the beach (Figure 4), from where the sediment is redistributed by wind or water, and replenished by further sloughing from the bluff face. The ability of the dunes to recover from erosion is limited. While onshore winds can re-build active dunes, such as those to the north of the Salinas River (Section 2.5.1), the heights and volumes of the relict dunes south of the Salinas River cannot be re-established at current sea levels. These relict dunes therefore form eroding sandy bluffs behind the beaches.

Long-term erosion of the dunes has been previously measured using a variety of techniques and references. The results of two recent studies undertaken by Thornton et al. (2006) and Hapke et al. (2006) are presented here. Dune erosion was measured by Thornton et al. (2006) using a combination of stereo-photogrammetry (1940 to 1984), LIDAR (1997, 1998) and GPS-walking surveys (2003). Since there was little to no dune erosion during the 2003-04 and 2004-05 winters, the date of the GPS survey was ascribed to 2005. The year 1984 approximately divides the 1940-2005 period into an earlier time when intense sand mining from the surf/swash zone was operational and a later time when it had ceased, except for the ongoing beach-sand mining operation at Marina (Sections 1.4.4 and 2.5.4). The comparative results are presented in Table 3. The dune erosion rates between 1940 and 1984 (1.0 to 6.4 ft/year) equate to an average sand volume of approximately 350,000 yd^3/year to the littoral cell (Thornton et al., 2006). Between 1985 and 2005 (0.4 to 4.7 ft/year) this volume decreased to 200,000 yd^3/year.

The particle size characteristics of the dune sand provide information on what volume of sediment eroded from the dunes is large enough to remain on the beaches and shoreface. Using the methods of Dean (1974) shows that approximately 25% of the dune sand has particle sizes equivalent to those that reside on the beach. However, according to Dingler et al. (1985), the eroded dune sand contains on average 76% medium-to-coarse sand (>0.25mm) that can remain within the beach and shoreface system. Using an average value of 50%, the retention of sand on the beach and shoreface is approximately 100,000 yd^3/year. Approximately 50% of the eroded dune sand (~100,000 yd^3/year) is lost offshore.

Table 3. Estimated Historic Long-term Average Erosion Rates (ft/year)

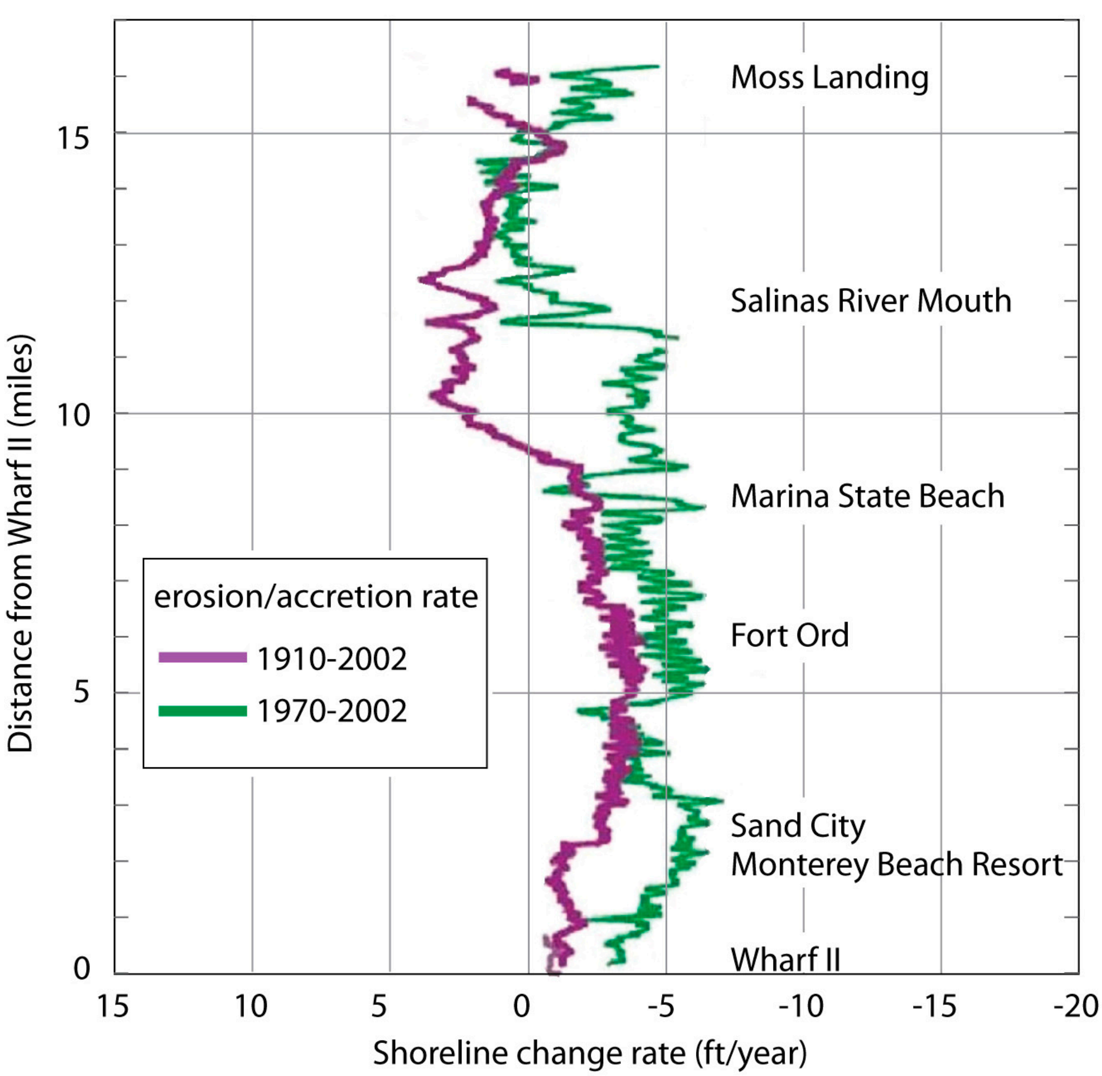
Location	Thornton et al. (2006)		Hapke et al. (2006)	
	1940-1984	1985-2005	1910-2002	1970-2002
Moss Landing			+1.2	-1.7
Salinas River			+3.7	0
Marina State Beach	-1.0	-4.7	-1.4 to -2.0	-3.1 to -5.2
Stilwell Hall (Fort Ord)	-5.2 to -6.2		-2.5 to -3.7	-3.7 to -6.6
Sand City	-3.9 to -6.4	-2.7	-1.4	-3.7 to -6.2
Monterey Beach Resort	-2.4	-0.9	-1.4	-3.0
Del Monte Beach	-2.0	-0.4		

Hapke et al. (2006) estimated dune erosion by measuring the movement of the mean high water (MHW) line along the entire California coastline. Average erosion rates were calculated between 1910 and 2002 and between 1970 and 2002. Hapke et al. (2006) calculated an average erosion rate from 1970 to 2002 of 4.0 ft/year for southern Monterey Bay between the Salinas River mouth and Monterey, which was the highest for all of California (and higher than the approximately 3.0 ft/year estimate of Thornton et al., 2006 for 1985 to 2005). Between 1910 and 2002, the shoreline for several miles south of the Salinas River was accretional (Figure 18) whereas from 1970 to 2002 the same stretch of shoreline eroded. This change may be related to the ongoing mining of sand from the beach that began at Marina in 1965 (Section 2.5.4).

A comparison of the 1970-2002 erosion rates using MHW calculated by Hapke et al. (2006) with the dune-top erosion rates calculated by Thornton et al. (2006) during the same time period shows that the results are broadly consistent. Both show that the highest erosion rates are at Fort Ord decreasing to the north and south (Table 3). This pattern is also consistent with the general distribution of wave energy approaching this coast, which is a maximum in the Fort Ord area (Figure 10).

Battalio and Everts (1989) used historic aerial photographs and the ‘wetted bound’ to estimate shoreline erosion rates for the period 1940-1988 that are similar to those of Thornton et al. (2006). The wetted bound is the limit of wet sand often visible in aerial photographs, approximately at the mean high water to mean higher high water elevation associated with beach ground water levels. Optical methods with specialized equipment were used to carefully adjust for photographic distortions.

Figure 18. Dune Erosion Rates in Southern Monterey Bay



Source: Adapted from Hapke et al. (2006)

2.3.4 Long-term Beach and Shoreface Erosion

Reid (2004) combined the 1930 T-sheet with five aerial photography surveys between 1956 and 2001 to assess 70-year beach width change throughout southern Monterey Bay. He found that while the dune bluff retreated landward, the beach itself maintained a constant width supplied by sand from erosion of the dunes.

Over the long-term the southern Monterey Bay shoreline has migrated landward through space as the dunes erode but the beaches maintained their width, except in locations of coastal armoring such as Monterey Beach Resort and Ocean Harbor House condominiums.

Although the beaches have maintained their width over the long term, there is still a volume loss of sand as the beaches translate landward. Sand is lost from the beach and shoreface, between the toe of the dune and the depth on the shoreface at which wave energy stops transporting sediment (the so-called depth of closure). This loss of sand was calculated as the volume difference between the initial shore profile and the eroded profile displaced landward by the recession rate over the 1940-1984 and 1985-2005 time periods using the height difference between the dune toe elevation and the depth of closure.

The shore recession rates used are the dune erosion rates reported by Thornton et al. (2006) (Table 3), assuming the dunes and beach retreat at the same rate (Reid, 2004). The elevation of the bluff toe was measured from cross-shore profiles every 75 feet using the 1997-1998 LIDAR surveys (Thornton et al., 2007). As a first approximation, the closure depth was estimated using the formula of Hallermeier (1978), where closure depth is a function of an extreme nearshore wave height (H_e) and period (T_e). The empirical formula is based on an offshore sand particle size of 0.2 mm, likely to be comparable to the fine sands in the nearshore of southern Monterey Bay (Section 2.7). Assuming a Rayleigh distribution for wave heights, the extreme nearshore wave height is approximated as $H_e = 2.03\ H_s$, where H_s is the average significant wave height. Average significant wave heights in 30 feet of water (Thornton et al., 2007) are used as input to the formulation. A value of T_e of 15 seconds is used, which corresponds to the design wave period for Monterey Bay (Wyland and Thornton, 1991). Owing to the uncertainty in the closure depth formula of Hallermeier (1978), a range of values are calculated based on a range of significant wave heights (established using recurrence values). The H_s, bluff toe elevations, range of closure depths, recession rates and range of beach/shoreface volume losses for locations along the southern Monterey Bay shoreline are shown in Table 4.

Table 4. Beach and Shoreface Change in Southern Monterey Bay

Distance from Wharf II (miles)	H_s (ft)	Bluff Toe Elevation (ft)	Closure Depth (ft)	Beach Recession (ft/year)		Cumulative Volume (yd^3/year x 1,000)	
				1940-84	1985-05	1940-84	1985-05
1.2	4.2-5.2	9.8	19-23	-2.2	-0.6	-10 to -13	-2 to -3
2.5	5.9-7.3	14.8	26-32	-3.9	-2.7	-32 to -48	-15 to -22
3.0	7.8-9.7	15.4	33-41	-6.4	-2.6	-61 to -91	-27 to -41
3.7	8.6-10.7	16.4	37-45	-6.3	-2.6	-93 to -139	-40 to -60
4.5	9.8-12.2	16.4	41-50	-3.1	-2.3	-134 to -200	-65 to -98
6.2	10.2-12.7	16.4	43-52	-5.7	-3.3	-188 to -282	-99 to -149
7.4	10.2-12.7	14.8	43-52	-5.2	-4.2	-248 to -374	-141 to -213
8.7	10.4-13.0	13.8	44-53	-1.0	-4.7	-273 to -411	-216 to -289
9.9	10.6-13.2	13.1	45-54	-3.9	-4.7	-313 to -473	-241 to -365
11.2	10.6-13.2	13.1	45-54	0	0	-350 to -529	-254 to -384
12.4	10.2-12.7	13.1	43-52	1.3	1.0	-335 to -505	-241 to -366
13.6	8.8-11.0	13.1	38-46	1.3	1.0	-322 to -486	-232 to -351
14.9	5.9-7.3	13.0	26-32	1.2	1.0	-312 to -471	-225 to -340
15.5	5.1-6.4	13.0	23-28	1.0	0.7	-309 to -466	-222 to -337

The closure depth and shoreface height can be estimated in different ways. A comparison of cross-shore elevation profiles is another method. Overlaying multiple profiles taken at different times at the same place will indicate the depth at which elevation changes are limited (where the multiple profiles ‘pinch-out’ to a narrow range of variability), and hence taken as the effective closure depth. This type of analysis was applied by Battalio and Everts (1989) using data from northern Del Monte Beach (northern Monterey). They found the closure depth to be 30 to 33 feet below mean lower low water (MLLW), and the upper beach to pinch out at 16 to 18 feet above MLLW, indicating a shoreface height of approximately 45 to 50 feet. An average shoreface height of 46 feet was used by Battalio and Everts (1989), which is generally consistent with the values shown in Table 4.

2.3.5 Short-term Dune Erosion and Beach Recovery

Erosion of the southern Monterey Bay shoreline is not a consistent process but occurs episodically. Large amounts of erosion have occurred during El Niño winters, followed by several 'regular' years producing less erosion, all of which can be summed to provide an average erosion trend (Figure 18). During the winter months, high-energy waves move sand offshore where it forms nearshore bars, and in the process steepening and narrowing the beach profile. Dingler and Reiss (2002) measured at least yearly changes to five portions of the shoreline in southern Monterey Bay between 1982-83 and 1997-98, using traditional survey methods. They showed that at Fort Ord most of the erosion occurred during the El Niño events of 1982-83 and 1997-98, with the beaches eroding then recovering later. Over the 15-year period, the total dune toe erosion was 70 feet, with 25 feet occurring between February and April 1983, and 30 feet over the 1997-98 El Niño winter, with only 15 feet over the remaining 14 years. They found that the beaches took approximately two years to recover both their width and volume after the severe erosion during the 1982-83 El Niño. Thornton et al. (2006) showed that during the 1997-98 El Niño winter storms the beaches lost 1.0 million yd^3 of sediment offshore. The 1997-98 El Niño also caused the most severe dune erosion along southern Monterey Bay where the volume of sand eroded was 2.4 million yd^3, a seven-fold increase compared to the average annual volume.

As high-energy wave conditions subside in late spring and early summer, the beaches recover as sand is moved onshore to rebuild the beach berm, which flattens and widens the beach profile. At the end of the summer and early fall when typically calm seas occur, the berm is well developed, reaching its peak width.

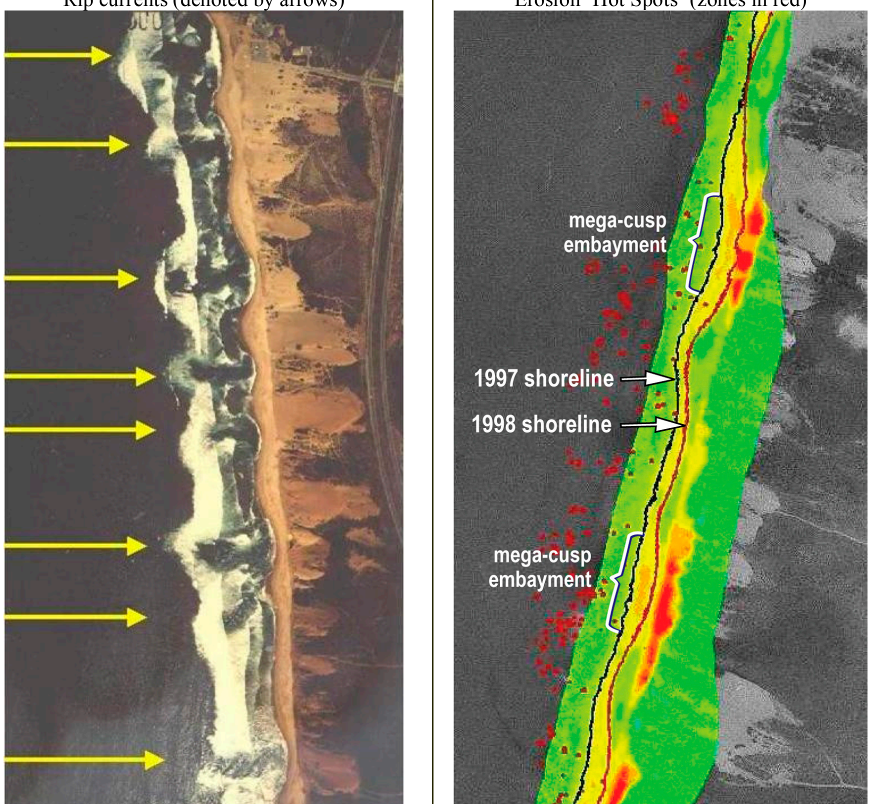
During coincident high water levels and extreme wave conditions, it is possible for sand to be transported offshore into water depths (beyond the shoreface) where summer waves cannot transport it back onshore. Hence, it is possible to have an imbalance in how much sand is transported back to the beaches in summer once winter storms have moved it offshore.

2.3.6 Enhanced Erosion due to Rip Currents

The mean erosion rate in southern Monterey Bay is the highest in California (Hapke et al., 2006). Thornton et al. (2007) hypothesized that erosion in southern Monterey Bay is enhanced by the presence of persistent rip currents and associated large-scale alongshore mega-cusps (order 650 feet alongshore between horns) throughout the year (Figure 19, left panel). Erosion of the dune face is enhanced at the center of the mega-cusp embayment where the beach is narrower and the swash of large waves at coincident high tide can more easily reach the dune toe. 'Hot spots' of dune erosion occur at the center of the embayments, as shown by the difference in LIDAR measurements of dune volumes over the 1997-98 El Niño winter. Figure 19 (right panel) shows volumetric change between October 1997 and April 1998. The rip current channels and mega-cusps migrate moving the hot spots along the shoreline, eroding the dune at an enhanced rate (Orzech et al., 2008). Rip current strength, the spacing between rip channels, and associated alongshore mega-cusp scale are a function of wave height. Therefore, this process of enhanced dune erosion is less effective along the protected shoreline between Monterey and Sand City, and more effective in the Fort Ord and Marina areas.

Figure 19. Rip Currents and Erosion 'Hot Spots'

Rip currents (denoted by arrows) | Erosion 'Hot Spots' (zones in red)



Source: Thornton et al. (2007) | Source: Thornton et al. (2007)

2.4 FUTURE EROSION RATES IN RESPONSE TO SEA-LEVEL RISE

One of the most important long-term concerns for RSM in southern Monterey Bay is the physical response of the shoreline to future sea-level rise. Predicting shoreline recession and bluff erosion rates is critical to planning a sediment management strategy, forecasting future problem areas, and assessing biological impacts due to habitat change or destruction. One solution is to assume that historic rates can be projected into the future. However, it is likely that the future recession rate of the shoreline and the erosion rate of the dunes will be affected by higher rates of sea-level rise than historically (Battalio and Everts, 1989). Higher baseline water levels would result in a greater occurrence of waves impacting the toes of the dune bluffs, increasing their susceptibility to erosion (Ruggiero et al., 2001). However, without proliferation of coastal armoring in southern Monterey Bay, beach widths will be maintained as the dunes erode, continuing to provide recreational, ecologic, and economic opportunities.

One approach for assessing the potential for future shoreline changes is the Coastal Vulnerability Index (CVI) (Thieler and Hammar-Klose, 2000). The CVI uses the physical characteristics of the coastal system (e.g. geology, coastal slope, wave energy, tidal range) to classify the potential effects of sea-level rise. Although this tool allows identification of portions of the shoreline at higher or lower risk relative to other parts of the shoreline, it is not a predictive tool. Southern Monterey Bay between Moss Landing and Wharf II is classified as having a 'very high' vulnerability (the highest designation) (Thieler and Hammar-Klose, 2000). This classification indicates that the combination of unstable geomorphology, high rates of historic shoreline change, high wave energy, and moderate tidal range make this area highly susceptible to the adverse effects of sea-level rise.

An approximate quantitative approach for predicting shoreline response to sea-level rise is to multiply the estimated amount of sea-level rise by the ratio of the shoreface width to shoreface height (Everts, 1985; Battalio and Everts, 1989).

$$R = \frac{Y}{X} S$$

where R = recession rate, Y = horizontal dimension of shoreface, and X = vertical dimension of shoreface, and S = sea-level rise.

This procedure is a derivative of the Bruun Rule, neglects possible three-dimensional effects of shoreline position change, and is based on numerous assumptions inherent in the Rule (Cooper and Pilkey, 2004 provide a critique of the Bruun Rule and its derivatives, including sediment budget analysis). It is important to note that the actual recession rate due to sea-level rise could be substantially greater than predicted by this simplified method.

The beach and shoreface between Sand City and the Salinas River slope at approximately 1:40. In general, lower-sloping shorelines should retreat faster than steeper shorelines. Using the recent historic relative sea-level rise rate of about 0.007 ft/year (Section 1.5.4) the above method yields an estimated shoreline erosion rate of approximately 0.3 ft/year. This is small compared to the observed erosion rates, indicating that relative sea-level rise has not been a large factor in shoreline erosion to date. However, sea-level rise is expected to accelerate in response to climate change (Section 1.5.4). Assuming a future relative sea-level rise of 0.5 to 1.5 feet in 50 years and 1.5 to 4.5 feet in 100 years, the corresponding estimates of shoreline recession would be 20 to 60 feet in 50 years and 60 to 180 feet in 100 years. The corresponding shoreline recession rates would be 0.4 to 1.2 ft/year averaged over 50 years and 0.6 to 1.8 ft/year averaged over 100 years. Given that relative sea-level rise and recession are expected to accelerate but rates and responses are uncertain, it may be more appropriate to distill these ranges to an approximate shoreline recession rate due to sea-level rise for each 50-year period; approximately 0.8 ft/year for the next 50 years and 1.6 ft/year for 50 to 100 years.

This analysis indicates that projected sea-level rise based on climate change forecasts will result in increased shoreline recession in southern Monterey Bay. Over the next 50 years, sea-level rise will increase erosion by about 40 feet (0.8 ft/year), an increase of approximately 20-25% over the historic erosion rates (approximately 3-4 ft/year). The rate increases in the 50 to 100 year time frame, amounting to an additional 80 feet (1.6 ft/year), an increase of 40-50% over historic erosion rates.

2.5 SEDIMENT SINKS

Potential sand sinks in the southern Monterey Bay littoral cell include active dunes, Monterey Submarine Canyon, beach-sand mining (currently only Marina), and offshore transport onto the continental shelf.

2.5.1 Dune and Beach Accretion North of the Salinas River

Hapke et al. (2006) showed that between 1970 and 2002 the shoreline from approximately one mile south of Moss Landing Harbor to the Salinas River slowly accreted (Figure 18). The four miles of beaches have accreted at an average rate of approximately 0.7 ft/year (Figure 18), which equates to a beach-sand gain (sink) of approximately 30,000 yd^3/year (Table 4). Active dunes at the Salinas River are about 800 feet wide, then gradually narrow and end against the Flandrian dunes two miles south of the river mouth. The dunes to the north of the river extend to Elkhorn Slough and vary in width from 300 to 600 feet with heights of approximately 20 feet above sea level. Using an average accretion rate of approximately 0.7 ft/year (Figure 18) and a length of four miles equates to a net accretion volume of approximately 10,000 yd^3/year of sand.

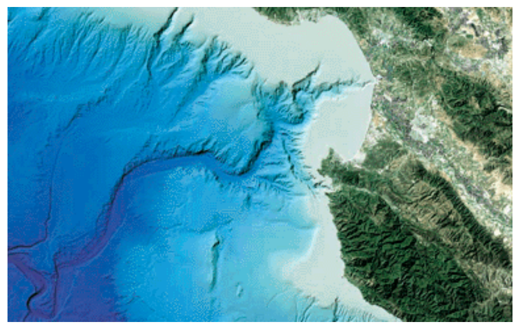
2.5.2 Dune and Beach Accretion South of the Salinas River

Blow-outs observed in the dunes and sand blowing over the coastal path on to Highway 1, provide evidence of onshore transport of wind-blown sand between the Salinas River and Monterey. Dorman (1968) calculated the transport based on eight years of hourly mean winds measured at Monterey Airport (approximately 1.5 miles inland). He applied the formula of Johnson and Kadib (1964), which estimates onshore transport volume as a function of wind speed and mean sediment particle size on the dune and at mean water level (Table 5). The transport between Monterey and Sand City is the largest because the particle size is smaller along this stretch of shoreline and more easily moved by wind. Dorman (1968) indicated that the calculated values are probably underestimates because the location of the measured onshore winds is sheltered by Point Piños, reducing the wind speeds compared to those on the open coast north of Sand City.

Table 5. Onshore Sand Transport by Wind South of the Salinas River (Dorman, 1968)

Distance from Wharf II (miles)	Wind Transport (yd^3/year)
0 – 3.7	14,000
3.7 – 5.7	3,000
5.7 – 7.5	5,000
7.5 – 9.3	6,000

2.5.3 Monterey Submarine Canyon



Monterey Submarine Canyon (inset) marks the boundary between the Santa Cruz littoral cell and the southern Monterey Bay littoral cell (Patsch and Griggs, 2007) (Section 2.1). Given its proximity to the shoreline (Figure 3), the head of Monterey Submarine Canyon is effective at capturing littoral sediments from the north and south that are diverted offshore by the Moss Landing harbor jetties. Smith et al. (2007) examined sequential multibeam sonar images sampled over 29 months and found substantial bedload sediment lost down the Canyon over that short period of time. Patsch and Griggs (2006) estimated that the Canyon captures approximately 300,000 yd^3 of sand per year. This Coastal RSM Plan estimates that up to approximately 15,000 yd^3/year of sand enters the Canyon from the south, transported alongshore from the discharge of the Salinas River. A potential sediment management alternative could be to capture the sand from both littoral cells before it is lost down the Canyon and beneficially reuse it for beach nourishment (Section 6.5.1).

2.5.4 Historic Sand Mining at Marina and Sand City Using Drag Lines

Sand mining in southern Monterey Bay was not regulated until 1960, when the California State Lands Commission (CSLC) asserted jurisdiction on extractions below MHW, which by law, belongs to the State of California, and began licensing the operations through issuance of leases and charging royalties. The CSLC interest promoted mining, so they imposed a royalty rate with a base minimum mining volume for each company ranging from 26,000 yd^3/year to 52,000 yd^3/year. In the 1960s, the sand mining companies obtained a court order, which made the volumes of sand mined at specific mines proprietary to each other and the public, ostensibly to prevent price fixing, and hence, the amount of sand mined was unknown. In 1974, the U.S. Army Corps of Engineers (Corps) also required leases under the Rivers and Harbors Act of 1899, which regulates activities below MHW. They, however, attached maximum mining volumes to their leases ranging from 100,000 yd^3/year to 150,000 yd^3/year to protect the environment. After the first ten-year lease expired, the Corps concluded that the beach-sand mining caused coastal erosion, and the permits were not renewed.

The actual quantities of sand mined from the beach as reported to the CSLC have now been obtained for this Coastal RSM Plan through a Freedom of Information Act request. A decadal breakdown of the volumes extracted from the beach at each mine is provided in Table 6 based on a yearly breakdown presented in Appendix A. The mines were located either in Sand City or Marina (Figure 9). The amounts reported were audited by the CSLC based on sales receipts and are deemed accurate. Some of the files were missing, which resulted in gaps in the records, which were filled using a ten-year moving average filter (Appendix A).

Table 6. Volume of Sand Mined from Beaches at Sand City and Marina (yd^3/year x 1000)

	Sand City				Marina				Total
	MSC[1]	GC[2]	PCA[3]	Sub-total	MSC[1]	SS[4]	PCA[5]	Sub-total	
Distance from Wharf II (miles)	3.0	3.1	3.5		9.1	9.5	9.8		
Years of Operation	1931 to 1990	1950 to 1969	1927 to 1986		1944 to 1986	1957 to 1970	1965 to now		
1940s	37	0	65	102	20	0	0	20	122
1950s	37	22	65	124	33	7	0	40	164
1960s	36	21	61	118	33	8	43	84	202
1970s	34	0	81	115	31	0	98	129	244
1980s	41	0	56	97	21	0	122	143	240
1990s	0	0	0	0	0	0	200	200	200
2000s	0	0	0	0	0	0	200	200	200

[1]The Monterey Sand Company (MSC) decreased the reported values by 3% to account for wash loss, and this has been added back into the volumes.
[2]GC = Granite Construction.
[3]PCA = Sand City Pacific Concrete and Aggregates was bought by Lone Star Industries
[4]SS = Seaside Sand and Gravel Company was bought by Floyd Bradley in 1970 and then sold to Standard Resources in 1974.
[5]PCA = Marina Pacific Concrete and Aggregates was bought by Lone Star Industries and then by CEMEX in 2005

2.5.5 Ongoing Hydraulic Beach-Sand Mining at Marina

The biggest change in the volume of sand mined from the beach in southern Monterey Bay was the introduction in 1965 of the dredging operation on the back beach at Marina (Table 6). The sand is mined by a floating dredge creating a large pond just landward of the beach berm (Figure 20, left panel). It is then pumped to a dewatering tower, kiln dried, screened and blended at a processing plant on the site. The height of the berm is at a similar elevation to the toe of the adjoining dunes. This beach-sand mining operation efficiently takes advantage of the cross-shore sorting of sediment where coarse sand is washed over the berm to fill the pond during times of high winter waves and high tide. The pond is continuously being filled with sand over time and this sand is continuously dredged. During the storms of January 2008, the pond was completely filled with sediment (Figure 20, right panel). After these storms the wrack line was landward of the pond perimeter indicating the maximum inland extent of the swash carrying sediments onto the beach. This is evidence that the sand being mined from the dredge pond is derived directly from the nearshore and constitutes a loss of sand from the littoral system.

Figure 20. Aerial Photographs of the Beach at Marina Sand Mine

Normal dredging operation showing extent of dredge pond (Photo taken: October 28, 2005; California Coastal Records project by Kenneth and Gabrielle Adelman)

Pond filled with sand by high waves at high tide carrying sand over the berm. (Photo taken: January 15, 2008 by Robert Wyland, NPS)

Between 1965 and 1970, Pacific Concrete and Aggregates (PCA) mined both the pond and the backing dunes, and when reporting the volumes extracted, differentiated the coarse fraction from the pond ('ocean sand') from the dune sand. The total volumes reported ranged from 68,000 yd^3/year to 98,000 yd^3/year. After 1970, the volumes of sand mined from the beach at Marina were not reported (Appendix A). The last reported value of 98,000 yd^3/year to CSLC was in 1970 and is conservatively used as the estimate for the amount dredged until the mid 1980s when the operation started using an improved larger dredge. It is assumed that the amount of sand extracted from the beach increased using the larger dredge, and that the mine further increased their

extraction after the other mines closed in 1990, to meet consumer demand. The total amount of sand sold annually over the last decade from the ongoing operation at Marina has been between 225,000 and 280,000 tons, or approximately 167,000-207,000 yd^3/year, based on an approximate density of 1.35 tons per cubic yard, as reported by CEMEX (the owners since March 2005). In this Coastal RSM Plan budget an extraction rate of 200,000 yd^3/year is used for the ongoing mining operation.

2.5.6 Offshore

It is likely that beach-size sand in southern Monterey Bay is transported both onshore and offshore. Swell wave action tends to move sand onshore because the magnitudes of wave-induced onshore velocities and accelerations generally exceed those in the offshore direction. Evidence of the onshore transport of sand during the summer is based on reports by sand miners that the sand in the summer was of smaller particle size at all sites along the shoreline (to the extent that they often ceased mining operations during the summer). Based on the textural characteristics of sand distributions in southern Monterey Bay, Dorman (1968) concluded that sand moved offshore at the convergence of alongshore sediment transport near Sand City (Figure 15). Assuming this zone of sand is three feet thick, the volume of medium sand offshore is approximately seven million yd^3, and potentially a large source for beach nourishment sand.

2.6 SAND BUDGET

2.6.1 Sand Inputs and Outputs

In order to understand the sedimentary processes operating in southern Monterey Bay, the sediment budget is broken down into spatial and temporal components. Table 7 presents a sand budget for the portion of the littoral cell between Moss Landing and the Salinas River mouth (north sub-cell). The sand is input by the Salinas River and transported north alongshore; an assumption is made that no sand is transported to the south from Moss Landing or onshore. The outputs are sand blown by wind onto the low accreting dunes backing the beach (Section 2.5.1), and sand lost down Monterey Submarine Canyon (or to the offshore). This length of shoreline has accreted over the last two decades (Table 4) resulting in an increase in the beach and shoreface volume (change in storage, Table 7).

Table 7. Sand Budget for the Littoral Cell between Moss Landing and the Salinas River

Budget Component		Volume (yd^3/year x 1,000)
(1) Inputs	Salinas River (net alongshore transport from the south)	55
	Dune erosion	0
	Net alongshore transport from the north	0
	Net onshore transport	?0
(2) Outputs	Dune accretion by wind	10
	Canyon (and offshore)	15
(3) Change in Storage	Beach and shoreface gain	30
Residual = (1)-(2)-(3)		0

Table 8 presents a sand budget for the portion of the littoral cell between Wharf II and the Salinas River mouth. Budgets are estimated for the 1940-1984 period when drag line beach-sand mining was operational and 1985-2005, during which time drag line mining ceased, but hydraulic mining at Marina increased. The location of sand losses due to beach-mining shifted to the north from Sand City to Marina during the 1985 to 2005 time period. The beach and shoreface loss was calculated using the erosion rate and closure depth information, and indicates that erosion was much greater during 1940-1984 than during 1985-2005 (Table 4). The sand budget indicates that there is a large loss (deficit) of sand from the littoral system to offshore and that the loss (deficit) has increased over the two time periods.

Table 8. Sand Budget for the Littoral Cell between the Salinas River Mouth and Wharf II

Budget Component		Volume (yd^3/year x 1,000)	
		1940-1984	1985-2005
(1) Inputs	Salinas River (net alongshore transport from the north)	10	10
	Dune erosion	350	200
	Net alongshore transport from the south	0	0
	Net onshore transport	?0	?0
(2) Outputs	Beach-sand mining (Sand City and Marina)	190	200
	Dune accretion by wind	28	28
	Offshore	208-358	268-398
(3) Change in Storage	Beach and shoreface loss	-350 to -500	-250 to -380
Residual = (1)-(2)-(3)		0	0

The impact of mining sand from the beach, either sand mined from the surf zone by drag line or from a pond dredged just over the berm, causes dune erosion to progress at a higher rate owing to what is referred to as an overfill ratio. The overfill ratio refers to the fact that the primary replacement for the sand mined from the beach is from sand eroded from the dunes. The dune sand has a smaller mean particle size than the mined beach sand; hence more dune sand is required to replace the mined beach sand. The larger and heavier sand particles remain in the energetic surf zone while the smaller sands are carried offshore where they can reside in less energetic wave conditions. The overfill ratio has been estimated to range from 25 to 75% based on the particle size distributions of the dune and beach sands (Section 2.3.3). As a result, mining sand from the beach has a greater impact than simply the amount of sand that is mined. Applying a mean overfill ratio of 0.5 would attribute the actual loss of sand due to mining the beach as effectively twice the volume mined.

The sand budget for the portion of the littoral cell covering the shoreline of the Cities of Sand City, Seaside, and Monterey (approximately the south sub-cell) is complicated because the historical sand mines were located adjacent to the boundary between the south and central sub-cells, at 3.0, 3.1 and 3.5 miles from Wharf II (Figures 9 and 15). This boundary coincides with the location of the medium sand stretching into the offshore and a null zone where the net alongshore transports from the north and south converge (Figure 15). The null zone appears to occur somewhere between 2.5 and 3.0 miles from Wharf II, which is close to the location of historic sand mining in Sand City.

It is important to note that sand transport crosses the null zone (Section 2.1) and that the gross transport in this area is much higher than the net transport that is used to define the null zone. Also, the historic and ongoing mining of beach sand has likely increased the northward transport of sand out of the south sub-cell. The sand supply from the eroding dunes, mostly at Fort Ord, has not mitigated this deficit, resulting in shoreline erosion.

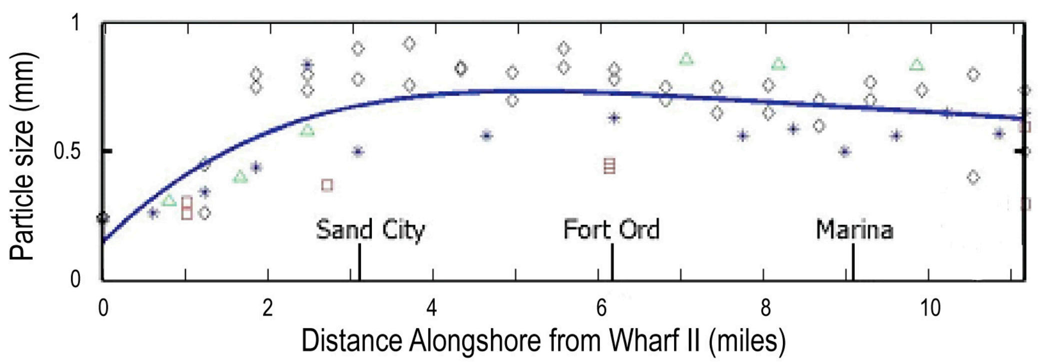
2.7 BEACH AND SHOREFACE SEDIMENT PARTICLE SIZE

The beaches and shoreface of southern Monterey Bay are potential receiver sites for beach nourishment and it is therefore important to characterize their particle size distribution. Discussion of the particle sizes of potential sediment sources, including offshore deposits, is provided in Section 6.

2.7.1 Beach Sand

Beach-sand particle size distributions have been measured in several previous studies (Sayles, 1966; Combellick and Osborne, 1977; Clark and Osborne, 1982; Dingler and Reiss, 2002). The mean particle sizes of the sand by distance from Wharf II are summarized in Figure 21, and Tables 9 and 10. This sand is already part of the active beach and is not a source of sand for nourishment. Clark and Osborne (1982) compared particle-size statistics from a year of low river discharge (February and June 1975) obtained by Combellick and Osborne (1977) to a year of high discharge (June 1978); samples were recovered approximately three feet above MHW. Dingler and Reiss (2002) sampled at mid-tide level during September 1988 and April 1989, and qualitatively related the mean particle size to beach slope and wave climate. Sayles (1966) also collected samples at mid-tide level.

Figure 21. Mean Particle Size of Beach Sand



Samples acquired by Sayles, 1965 (triangles), Combellick and Osborne, 1977 (diamonds), Clark and Osborne, 1982 (stars), and Dingler and Reiss, 2002 (squares). The solid line is a second order polynomial fit.

Table 9. Mean Particle Size of Beach Sand in Sand City, Seaside, and Monterey

Distance from Wharf II (miles)	Mean Particle Size (mm)	Source
0.0	0.23	Clark and Osborne (1982)
0.0	0.245[1] & 0.24[2]	Combellick and Osborne (1977)
0.6	0.26	Clark and Osborne (1982)
0.8	0.307	Sayles (1966)
1.0	0.255[3] & 0.305[4]	Dingler and Reiss (2002)
1.2	0.34	Clark and Osborne (1982)
1.2	0.45[1] & 0.26[2]	Combellick and Osborne (1977)
1.7	0.4	Sayles (1966)
1.9	0.44	Clark and Osborne (1982)
1.9	0.8[1] & 0.75[2]	Combellick and Osborne (1977)
2.5	0.58	Sayles (1966)
2.5	0.8[1] & 0.74[2]	Combellick and Osborne (1977)
2.5	0.84	Clark and Osborne (1982)
2.7	0.37[3] & 0.37[4]	Dingler and Reiss (2002)

[1]Sample taken February 1975 .[2]Sample taken June 1975. [3]Sample taken September 1988. [4]Sample taken April 1989.

Table 10. Mean Particle Size of Beach Sand North of Sand City

Distance from Wharf II (miles)	Mean Particle Size (mm)	Source
3.1	0.5	Clark and Osborne (1982)
3.1	0.78[1] & 0.9[2]	Combellick and Osborne (1977)
3.7	0.76[1] & 0.92[2]	Combellick and Osborne (1977)
4.3	0.82[1] & 0.83[2]	Combellick and Osborne (1977)
4.7	0.56	Clark and Osborne (1982)
5.0	0.81[1] & 0.7[2]	Combellick and Osborne (1977)
5.6	0.83[1] & 0.9[2]	Combellick and Osborne (1977)
6.2	0.455[3] & 0.435[4]	Dingler and Reiss (2002)
6.2	0.63	Clark and Osborne (1982)
6.2	0.78[1] & 0.82[2]	Combellick and Osborne (1977)
6.8	0.7[1] & 0.75[2]	Combellick and Osborne (1977)
7.1	0.86	Sayles (1966)
7.5	0.75[1] & 0.65[2]	Combellick and Osborne (1977)
7.8	0.56	Clark and Osborne (1982)
8.1	0.76[1] & 0.65[2]	Combellick and Osborne (1977)
8.2	0.84	Sayles (1966)
8.4	0.59	Clark and Osborne (1982)
8.7	0.6[1] & 0.7[2]	Combellick and Osborne (1977)
9.0	0.5	Clark and Osborne (1982)
9.3	0.7[1] &0.77[2]	Combellick and Osborne (1977)
9.6	0.56	Clark and Osborne (1982)
9.9	0.835	Sayles (1966)
9.9	0.74[1] & 0.74[2]	Combellick and Osborne (1977)
10.3	0.65	Clark and Osborne (1982)
10.6	0.4[1] & 0.8[2]	Combellick and Osborne (1977)
10.9	0.57	Clark and Osborne (1982)
11.2	0.5[1] & 0.74[2]	Combellick and Osborne (1977)
11.2	0.595[3] & 0.295[4]	Dingler and Reiss (2002)
11.2	0.65	Clark and Osborne (1982)

[1]Sample taken February 1975 .[2]Sample taken June 1975. [3]Sample taken September 1988. [4]Sample taken April 1989.

The smallest mean particle size of approximately 0.2 mm (fine sand) occurs near Monterey Harbor (Figure 21 and Table 9). The mean particle size then increases northwards to a maximum of approximately 0.7 mm (coarse sand) at Fort Ord, followed by a general decrease to 0.6 mm (coarse sand) further north towards the Salinas River mouth (Table 10). The mean particle size range south of Sand City is between 0.2 (fine) and 0.8 mm (coarse), but this range increases significantly approximately two miles north of Wharf II. South of this two-mile marker the range is approximately 0.2-0.4 mm (fine-medium), whereas from mile two to mile three the range is larger at 0.4-0.8 mm (medium-coarse). North of Sand City the particle size range is between 0.5 and 0.9 mm (coarse). The increasing particle size of the beaches from Wharf II to Marina is positively correlated with wave height (Thornton et al., 2007).

Alongshore variability in particle size between studies may be related to sampling at different times of year. Seasonal variations in beach particle size occur with coarser beach sands present during the more energetic winter months, and finer sands during summer months, when smaller particles are moved onshore by milder swell waves. Some of the variability may also be related to different sampling procedures. For example, the mean particle sizes reported by Dingler and Reiss (2002) are smaller than those of the other studies as they were acquired higher on the beach face.

2.7.2 Shoreface Sand

The shoreface is the part of the littoral cell between MLLW and the water depth where sediment is not disturbed by wave action during fair-weather conditions. The sand on the shoreface is likely to be constantly moving, either alongshore, onshore or offshore depending on seasonal wave conditions. Along most of the shoreline to the north of Sand City the sediment particle sizes of the shoreface are finer than on the beach. However, a large region of medium sand occurs on the outer shoreface and further offshore at Sand City (Figure 15), which is comparable in particle size to the beach sands to the south (Section 6.5.2). The sand offshore of the shoreface could be a potential source for nourishment for the southern Monterey Bay beaches at Sand City and Monterey.

3. CRITICAL AREAS OF EROSION

This section provides an analysis of critical areas of erosion within the southern Monterey Bay littoral cell. In order to delineate these areas, two criteria are adopted that are used to prioritize erosion responses over a planning horizon of 50 years; risk of erosion and consequences of erosion.

3.1 RISK AND CONSEQUENCES OF EROSION

The risk of erosion is based on the risk analysis developed by PWA and Griggs (2004). This method establishes our first level of risk assessment over a 50 year period:

- what facility is at risk?
- what is the probability that it will be impacted by erosion?

PWA and Griggs (2004) defined three risk categories to Monterey Regional Water Pollution Control Agency (MRWPCA) facilities between Marina and Wharf II. These risk categories were determined by assuming that current long-term historic erosion rates would continue over the next 50 years. For this Coastal RSM Plan assessment of critical areas of erosion, the historic erosion rate results of Thornton et al. (2006) are used (Table 3) with an increment of approximately 20% added to the erosion rate for potential increases due to future sea-level rise (Section 2.4). The risk categories are:

- **Low risk** - facilities with a low probability of being impacted by erosion over the next 50 years.
- **Moderate risk** - facilities not likely to be affected by chronic erosion over the next 50 years, but potentially susceptible to short-term storm event erosion within the planning horizon.
- **High risk** - facilities that are located seaward of the shoreline position anticipated in 50 years or presently vulnerable to short-term event-based erosion. A high risk designation also applies to facilities with shore protection (presently or approved), where erosion is impacting public safety and access, and reducing the shoreline recreational value.

Future erosion rates could be lower if beach-sand mining ceases (Section 2.5.5). In this case, moderate and high risk facilities would have a larger buffer zone of protection (Section 5.2.3), and management action could be delayed beyond the time lines recommended in this Coastal RSM Plan. Conversely, erosion rates may increase if future sea-level rise accelerates over the predicted estimates (Section 2.4), and management may need to be more immediate.

All the facilities identified as at high or moderate risk of erosion were then assessed as to their future value. This assessment is based on the SMBCEW (2006c) evaluation of the economic (potential loss of facility), environmental (potential loss of habitat), and safety and human health (potential loss of life) consequences of loss of the facility. The facilities are designated as high consequence, moderate consequence, or low consequence.

3.2 SITE SHORT-LIST

The locations of high to moderate risk, and high consequence critical areas of erosion are shown in Figure 22, summarized in Table 11, and described in detail in Section 3.3. They are also available as GIS data files in CSMWs GIS database.

Figure 22. Location of Critical Areas of Erosion

Source: Location of MRWPCA Interceptor provided by Jennifer Gonzalez (MRWPCA)

Table 11. Critical Areas of Erosion

Location	Summary of Facility	Erosion Rate (ft/year)	Risk of Erosion	Consequences of Erosion
Sanctuary Beach Resort near Reservation Road	Vacation complex approximately 120 feet from the bluff top	~5.5	High (compromised in approximately 20 years)	High economic
Marina Coast Water District buildings near Reservation Road	Office buildings approximately 70-90 feet from the bluff top	~5.5	High (compromised in approximately 15 years)	High economic (if buildings are converted to other uses)
Sand City and Tioga Avenue west of Highway 1	Bluff top road, storage facility, Highway 1, and proposed hotel developments, and desalination wells	~3.5	High (seaward end of Tioga Avenue eroding)	High environmental safety economic
Seaside Pump Station at Bay Avenue	Raw wastewater pump station approximately 100 feet from the bluff top	~3.0	High (compromised in approximately 30 years)	High economic environmental human health
Monterey Interceptor between Seaside Pump Station and Wharf II	Raw wastewater pipeline approximately 115 to 175 feet from the bluff top or buried mid-beach	~1.0-3.0	High to moderate (some dune portions compromised in approximately 40 years; beach sections exposed in winter)	High economic environmental human health
Monterey Beach Resort, Highway 1 and Resort Access Road	Hotel on Del Monte Beach, Highway 1, and hotel access road	~1.5	High (erosion compromising fronting seawall)	High economic safety
Ocean Harbor House Condominiums/Del Monte Beach Subdivision	Condominium complex and adjacent family homes on the bluff top	~1.0-1.5	High (erosion compromising fronting riprap and homes to the west)	High economic safety
Monterey La Playa Town Homes at La Playa Street	Homes, one of which is 30 feet from the bluff top	~1.0	High to moderate (some homes compromised in approximately 30-50 years)	High economic

3.3 HIGH TO MODERATE RISK AND HIGH CONSEQUENCE AREAS

3.3.1 Sanctuary Beach Resort near Reservation Road

Site

The Sanctuary Beach Resort is located on a 17-acre site between Dunes Road and the coastal bluff fronted by 550 feet of shoreline (Figure 23). The development includes 112 vacation units, a 72-unit hotel, a conference center, retail facilities, a large restaurant, a health club, a recreational building, two tennis courts, a pool, playground and nearly 500 parking spaces. The resort was constructed in the mid 1990s on land formerly owned by the Monterey Sand Company. Because the dunes had been mined for sand for about 45 years (Table 6), the site lies at a lower elevation than adjacent dunes to the north and south. The resort contains buildings and paving on 6.5 acres, landscaping on four acres, and restored dune habitat on 6.5 acres. A boardwalk provides beach access across the southern portion of the dunes. The seaward-facing wall and buildings of the Sanctuary Beach Resort complex are set back approximately 120 feet from the top of the bluff (Figure 23).

Figure 23. Sanctuary Beach Resort and Marina Coast Water District Buildings

Photo taken: Unknown

Risk

The bluff at this location has eroded approximately 4.5 ft/year over the past 20-30 years (Table 3) (Thornton et al., 2006), and with relative sea-level rise is estimated to erode at approximately 5.5 ft/year over the next 50 years. The erosion rate has increased over the past 20 years compared to pre-1985 (Table 3), which may be the result of increased extraction of beach sand from the mine located only one mile north of the resort (Section 5.2.2). Future dune erosion of 5.5 ft/year would mean that the Sanctuary Beach Resort would be compromised in approximately 20 years time and is therefore designated as a facility at high risk of erosion.

Consequences

The loss of this facility would have high economic consequences to the region as it is a popular tourist destination. The loss of the dunes on this site would also impact endangered western snowy plover, and the black legless lizard (Section 4.2).

The Sanctuary Beach Resort currently raises funds from a restoration fee (currently $15 per night) to protect endangered species and habitat on its property. The resort has already invested in mitigating threats by installing a 'lizard crossing' beneath the main entry road.

3.3.2 Marina Coast Water District Buildings near Reservation Road

Site

Figure 23 shows the location of a number of Marina Coast Water District (MCWD) buildings. The facilities include infrastructure and offices on a 12-acre site along 400 feet of shoreline. The seaward fence of the site is at the dune bluff edge in places, and buildings and infrastructure are set back 70-90 feet from the fence.

Risk

Using a future erosion rate of 5.5 ft/year the on-site facilities would be under threat of erosion in 10 to 15 years time. Hence, the MCWD site is at high risk of erosion. Indeed, wells on the beach at the end of Reservation Road that used to supply water to a small desalination plant were compromised by coastal erosion and are no longer operational.

Consequences

Although many of the utilities are no longer operational, the future of the office buildings is uncertain. They may be retained and converted into other uses or they may be abandoned and the whole facility removed over the next few years. Given the possibility of their continued future use, the MCWD buildings are, at this stage, designated as high consequence facilities.

3.3.3 Sand City and Tioga Avenue West of Highway 1

Site

From 1927 to around 1990 the parcel of dunes west of Highway 1 and for about 0.8 miles north of Tioga Avenue was the location of sand mining operations (Section 2.5.4), which left the site in an environmentally degraded condition. All the mines were closed by 1990, and currently, remnants of a cement mixing facility are located immediately north of Tioga Avenue in Sand City. The facility is now used for temporary storage of construction equipment (Figure 24). Un-engineered structures are holding the shoreline seaward of its natural position creating a peninsula effect (Figure 7) and in the process they block lateral public access (creating safety hazards), prevent natural shoreline recession, and beach area is lost both for recreation and as a habitat. Also, portions of Highway 1 curve seaward towards the dunes at Sand City. This section of the highway is approximately 400 feet from the dune edge and will ultimately be threatened by coastal erosion.

In order to boost the economy, Sand City has, since the 1970s, sought to provide for commercially viable resort and recreational development on designated portions of its shoreline. In the early 1980s, the certified Sand City Local Coastal Program (LCP) (Section 8.2.1) designated the former sand mine dune location for visitor-serving commercial uses, with a density not to exceed 650 units. In 1996, the City of Sand City entered into a Memorandum of Understanding with Regional and State Park agencies (the Coastal Commission was not party to the agreement) to permit visitor-serving and residential uses at two specific areas north of Tioga Avenue, which are still designated as such in the LCP.

Figure 24. Storage Facility at the end of Tioga Avenue, Sand City

Photo taken: September 19, 2007 (Justin Vandever, PWA)

Risk

The future erosion rate of the unprotected dunes adjacent to the Sand City site is estimated to be approximately 3.5 ft/year. Continued loss of beach in front of the structures at Sand City will lead to further undermining, erosion, and eventually total failure. The existing storage facility and part of Tioga Avenue which provides access to the facility and the beach would be lost. Continued loss of beach would also reduce public access, public safety, and the recreational value of the shoreline. The Tioga Avenue/Sand City complex west of Highway 1 is designated as a facility at high risk of erosion.

Consequences

The current land use has a relatively low economic consequence, but a future threat to Highway 1 (approximately 100 years) could have moderate levels of consequence over the 50 year planning horizon. However, there are several proposed development projects at the Sand City site, located along the west side of Highway 1, north of Tioga Avenue, which would increase the economic consequence of erosion. The Sterling Center is a proposed resort on eight acres immediately north of Tioga Avenue. This proposed development would consist of a 136-unit hotel with restaurant, conference and retail space, and parking garage. North of the Sterling Center is a plot of land owned by the Sand City Redevelopment Agency, on which they are pursuing development of a 39-acre resort complex comprising 495 mixed-use units known as the Monterey Bay Shores Resort.

In addition, the City of Sand City is implementing a water project along its coast to address water supply issues in Sand City. The Sand City desalination plant has a directionally drilled horizontal well for discharge of its byproduct water and intake wells between Bay Street and Tioga Avenue. Water is extracted from the shallow, brackish aquifer along the coast where seawater mixes with freshwater. As of October 2007, the City of Sand City completed and certified the Environmental Impact Report (EIR) on this project and achieved unanimous approval by the California Coastal Commission for its coastal development permit. Construction of the plant facilities should be completed by the spring of 2009.

As part of their condition compliance, the City of Sand City submitted an adaptive management plan to address the potential risk to the desalination components that could be subject to shoreline erosion. The plan includes surveying the bluff and shoreline edge at regular intervals to assess the risk to the wells and pipeline infrastructure, as well as monitoring the salinity level of the feed water. At the onset of a 'risk condition' (i.e. when the bluff recedes to within five feet or the salinity level exceeds an established threshold), measures would be taken to relocate the wells to an approved location in consultation with the Coastal Commission. Coastal armoring is not contemplated as a means of protecting the project components and would only be considered as a last resort.

Overall, the potential future consequence of erosion at Sand City and Tioga Avenue west of Highway 1 is high due to potential future environmental, safety, and economic factors.

3.3.4 Seaside Pump Station at Bay Avenue

Site

Seaside Pump Station (completed in 1983) is located at the junction of Bay Avenue and Vista del Mar Street. Seaside County Sanitation District's former wastewater treatment plant was originally located adjacent to Seaside Pump Station. That plant was decommissioned in 1990 when a Regional Treatment Plant was completed north of Marina, and all of the treatment plant tanks and structures were demolished. The bulk of the site was sold to the California Department of Parks and Recreation (CDPR), although MRWPCA retains ownership of the Seaside Pump Station site. The Seaside Pump Station is located approximately 100 feet from the edge of the low-lying dunes that front the facility (Figure 25).

Figure 25. Seaside Pump Station

Photo taken: October 28, 2005; California Coastal Records project by Kenneth and Gabrielle Adelman

Risk

The historic rate of erosion has been approximately 2.5 ft/year (Thornton et al., 2006), and the future rate is estimated at approximately 3.0 ft/year. The facility could be compromised by erosion in about 30 years. However, the site would be vulnerable to significant wave damage and flooding before that time due to the low elevation of the fronting dunes. The top of the dunes are at approximately 25 ft NAVD compared to the base flood elevation (BFE – maximum elevation of wave runup and overtopping during a 100-year flood event) at this location of 27 ft NAVD (FEMA, 2007) (Section 1.5.3). Seaside Pump Station is considered a high risk of erosion facility (PWA and Griggs, 2004).

Consequences

Seaside Pump Station pumps all of the raw (untreated) wastewater from the cities of Pacific Grove, Monterey, Del Rey Oaks, Seaside, and Sand City through the regional wastewater system to the MRWPCA Regional Treatment Plant. The pumps are a key component of the system and need to remain in full operation indefinitely, so erosion would have significant economic, environmental, and human health impacts. A breach of this facility would cause adverse environmental impacts to the dunes and beaches, and water quality impacts within the MBNMS. Seaside Pump Station is therefore designated as a high consequence facility.

3.3.5 Monterey Interceptor between Seaside Pump Station and Wharf II

The Monterey Interceptor pipeline is divided into three segments, each with a different set of erosion concerns; Seaside Pump Station to Monterey Beach Resort, Monterey Beach Resort to Tide Avenue, and Tide Avenue to Wharf II (Figure 8).

Site

The Monterey Interceptor between Seaside Pump Station and Monterey Beach Resort is buried in the dunes, approximately 100 to 175 feet from the dune bluff. Between Monterey Beach Resort and Tide Avenue the pipeline is not under imminent threat of erosion damage (PWA and Griggs, 2004). However, the pipeline could be vulnerable during a large storm event towards the end of the 50-year planning horizon. From Tide Avenue to Monterey Pump Station, the pipeline is located in the dunes a minimum of 115 feet from the shoreline. Between Monterey Pump Station and Wharf II, the Monterey Interceptor was originally buried beneath the back beach, but due to erosion is now at mid-beach.

Risk

Based on approximate future erosion rates of between 1.5 and 3.0 ft/year, the shoreline between Seaside Pump Station and Monterey Beach Resort would be expected to erode 75-150 feet over the next 50 years, and parts of the pipeline between these two locations may be compromised over the next 40 years. The erosion could uncover the pipe and/or manholes and make them vulnerable to damage. Hence, the Monterey Interceptor between Seaside Pump Station and Monterey Beach Resort is a facility at high risk of erosion (PWA and Griggs, 2004).

Between Monterey Beach Resort and Monterey Pump Station, the future erosion rate is estimated at approximately 1.5 ft/year, and therefore the pipeline would be at low risk of chronic erosion over the next 50 years. However, given the accuracy of the base map (+/- 16 feet) used to define the position of the pipeline in the dunes here (PWA and Griggs, 2004), it is designated as a moderate risk facility with the potential for storm damage towards the end of the 50-year planning horizon.

Between Monterey Pump Station and Wharf II the shoreline is estimated to erode at an average future rate of approximately 1.0 ft/year and the beach has been observed to scour during storms (Dingler and Reiss, 2002). Manhole covers are now sometimes exposed at low tide during the winter and are vulnerable to damage. At this location, the Monterey Interceptor pipeline is under imminent threat of erosion damage and is at high risk of erosion (PWA and Griggs, 2004).

Consequences

The Monterey Interceptor carries all of the raw (untreated) wastewater from the cities of Pacific Grove and Monterey. This flow is pumped through Monterey and Seaside Pump Stations to the MRWPCA Regional Treatment Plant. The pipeline is a vital facility that needs to remain fully operational indefinitely, and the consequences of erosion would be significant economic, environmental, and human health impacts. A breach to this facility would have adverse environmental impacts to the dunes and beaches, and water quality impacts within the MBNMS. The exposure of the pipeline would be a threat to marine resources if erosion caused a spill to occur. The Monterey Interceptor between Seaside Pump Station and Wharf II is therefore a high consequence facility.

3.3.6 Monterey Beach Resort, Highway 1, and Resort Access Road

Site

The 196-room Monterey Beach Resort hotel was constructed on north Del Monte Beach in 1968 and consists of five four-story buildings, a restaurant, meeting rooms, a pool, and parking structures (Figures 6 and 26). It was originally constructed with surrounding seawalls and a large beach area fronting the hotel. This part of Del Monte Beach was a major attraction of the hotel. Since the hotel was built, shoreline erosion has occurred up coast and down coast, and the hotel has become a headland.

Figure 26. Monterey Beach Resort

Photo taken: August 12, 2003; California Coastal Records project by Kenneth and Gabrielle Adelman

Risk

Future erosion rates at the Resort are estimated to be approximately 1.5 ft/year. When the existing seawall was built in 1968, beach elevations in front of the hotel were over three feet higher than today. Erosion has lowered the beach to the extent that during high tides there is now no beach access in front of the hotel. The existing seawall is not embedded deep enough into the sand to withstand further beach erosion. This structure was partially breached during the severe El Niño winter of 1983 when large waves coincident with very high tides surged through the stairwell opening in the wall, and broke through the joints in the wall causing loss of fill behind. In 2004, much of the south wing wall failed with collapse of the fill behind the wall. Emergency riprap was used to fill this void (Figures 6 and 26). Because of the erosion problem the hotel has received approval from the California Coastal Commission to build a new seawall. The seawall has not yet (September 2008) been constructed. It would comprise a 600-foot long sheet-pile metal seawall with a footprint of 1,000 square feet immediately adjacent to the existing seawall. The permitted project would also involve removal of the existing end walls and replacement with sheet-pile walls.

In addition to the Resort, the access road on Sand Dunes Drive and the access ramp from Highway 1 are within the 50-year erosion zone. The Monterey Beach Resort and the road infrastructure are designated as facilities at high risk of erosion.

Consequences

The hotel continues to be a popular tourist destination and loss of this facility would have high economic consequences. In addition, the presence of the seawall has led to loss of the fronting beach for recreational purposes and at high tide there is a public safety issue as lateral access along the beach is compromised. Monterey Beach Resort, access road, and Highway 1 access ramp are designated as high consequence facilities.

3.3.7 Ocean Harbor House Condominiums/Del Monte Beach Subdivision

Site

Beginning in 1968 the first eight buildings (Ocean House) of an apartment complex were constructed on the dunes at Surf Way in Monterey. An additional six buildings (Harbor House) were constructed further landward in 1974. At the time of construction, the City of Monterey allowed the front buildings to overhang the utility easement running parallel to the shoreline in return for all land seaward of the easement, which means the City owns all land up to the edge of the front buildings. Collectively, the 172 units, now converted to condominiums, are called Ocean Harbor House (Figures 6 and 27).

Figure 27. Ocean Harbor House Condominiums

Photo taken: October 11, 2004; California Coastal Records project by Kenneth and Gabrielle Adelman

Since its construction, Ocean Harbor House has had a history of erosion problems. Following the 1982-83 El Niño, erosion of the dunes had approached to within 14 feet of the shallow pilings supporting the complex (the bases of the pilings were ten feet above MLLW). Emergency riprap (600 feet of rock alongshore over 20 feet high) was placed on Del Monte Beach to provide protection to the buildings. It was subsequently removed, following completion of an Environmental Impact Report (EIR) in 1984, because of City of Monterey regulations regarding placement of materials on a public beach. The front pilings were later removed and 50-55 foot deep concrete caissons were then poured along with grade beams to support the front row of condominiums. Despite the deep caissons and grade beams, waves continued to erode the dune face landward beyond the two rows of caissons (Figure 6, right panel). Additional emergency riprap was required to protect the condominium units in 2002 and another EIR was completed to assess a number of longer-term alternatives. While the preferred alternative was to remove the front units, the owners of the condominiums preferred to build a seawall to protect their properties. The application was approved by the City of Monterey Planning Commission, the Monterey City Council, and the Coastal Commission, with substantial mitigation fees involving nourishment of the beach in front of the seawall. The seawall will be within the footprint of the existing building foundations, and will not encroach into the City of Monterey (Del Monte Beach) property.

There is no infrastructure to the east of the condominiums, whereas to the west, Tide Avenue with 15 homes runs parallel to the shoreline on the dune top. Tide Avenue is generally greater than 150 feet from the dune edge, although a short stretch appears to be within 50 feet. Landward of Tide Avenue is Del Monte Beach subdivision comprising several apartment buildings and 128 single-family homes, and associated infrastructure. The neighborhood has some problematic storm drain and sewer infrastructure that are targeted for improvements, including abandonment of a sewer main within the open space dune area and the consolidation of storm drain outfalls.

<u>Risk</u>

A new seawall fronting Ocean Harbor House is being engineered to withstand storm wave-attack and is considered a long-term (50-year planning) solution to erosion of the condominiums. However, it is likely that the new seawall would cause the fronting beach to lower in elevation because the armoring will provide a surface for wave reflection. The seawall will also enhance the peninsula effect at this location, with the dunes to the east and west continuing to erode. Because of the seaward position of Ocean Harbor House and the limited set back of the Tide Avenue community, the condominiums and the Del Monte Beach subdivision are designated as facilities at high risk of erosion.

<u>Consequences</u>

The condominiums and properties along Tide Avenue are privately owned and the consequences of their loss would be economically damaging and hazardous to safety, especially to individual owners. There is currently no lateral access along the beach in front of the condominiums at high tide and the frequency of access loss will increase in the future. A Coastal Commission condition of seawall approval is provision of lateral access around the back of the most seaward condominiums. Any loss of roads could also have impacts to public safety for the access of emergency services. Ocean Harbor House condominiums, Tide Avenue and Del Monte Beach subdivision are designated as high consequence facilities.

3.3.8 Monterey La Playa Town Homes at La Playa Street

Site

The La Playa town homes are located in the dunes at the end of La Playa Street in Monterey, and were originally constructed as apartments in 1964. The buildings were later converted to condominiums (Figure 28).

Figure 28. Monterey La Playa Town Homes

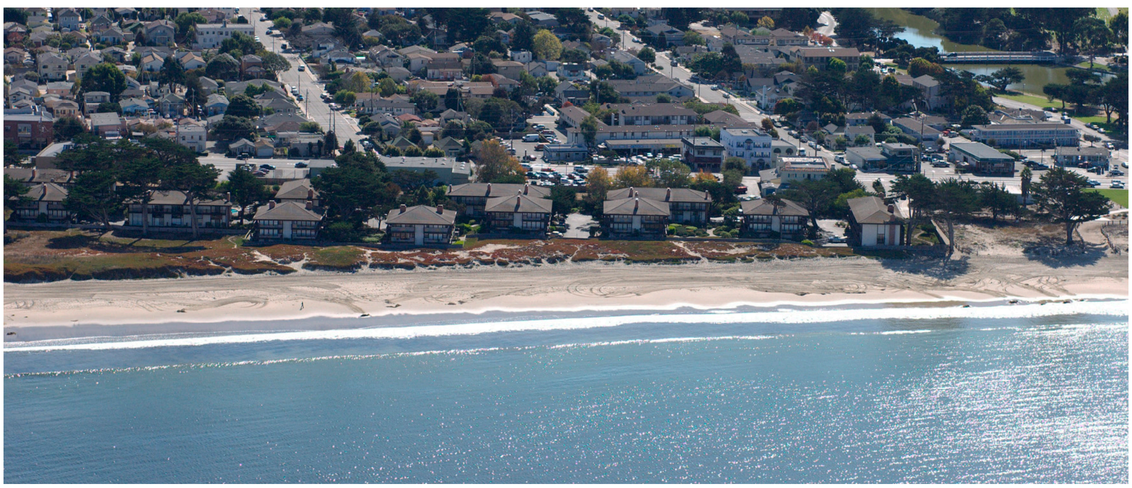


Photo taken: October 28, 2005; California Coastal Records project by Kenneth and Gabrielle Adelman

Risk

The westernmost condominium sits only 30 feet from the dune edge and is protected by a small pile of riprap, with most of the remaining complex over 50 feet from the shoreline. Long-term future erosion rates are estimated to be approximately 1.0 ft/year, and therefore structures towards the western end of the complex are at high risk of erosion over the next 50 years. In addition, the structures could be vulnerable to wave damage and flooding due to the low elevation of the fronting dunes, compared to the base flood elevation (BFE – maximum elevation of wave runup and overtopping during a 100-year flood event) at this location of 22-26 ft NAVD (FEMA, 2007) (Section 1.5.3).

Consequences

The town homes are privately owned and the consequences of their loss would be economically damaging to individual owners. Lateral access along the beach in front of the westernmost condominiums would potentially be lost and the beach would be hazardous at high tide. The La Playa town homes are considered to be high consequence facilities.

3.4 LOW RISK AND/OR LOW CONSEQUENCE AREAS

Numerous facilities along the southern Monterey Bay shoreline have either a low risk of erosion or a low consequence factor, and are not discussed further in this Coastal RSM Plan. Details of these facilities and the rationale for non-inclusion in the high risk-high consequence list are provided in Appendix B. It is recommended however that these facilities be considered for set back or relocation opportunistically as maintenance or other funds become available. These facilities are:

- Moss Landing spit community including the research facilities of MBARI
- Monterey Dunes Colony
- Ocean outfall pipeline near Marina sand mine
- Fort Ord storm water and sewer outfalls
- Fort Ord monitoring and injection wells
- Bay Avenue storm water outfall
- Roberts Lake/Laguna Grande outfall
- Sand Dunes Drive
- Monterey Pump Station
- Del Monte Lake outfall
- Lake El Estero Pump Station and outfall
- Catellus East property near Wharf II.

3.5 CRITICAL AREAS OF EROSION SHORT-LIST

In summary, the following lengths of shoreline are short-listed as high-risk and high-consequence critical areas of erosion, for three main reasons:

1. Areas where the facility is located on the dune top and is under threat over the next 50 years through continued erosion of the dune face. These critical erosion areas include:
   - Sanctuary Beach Resort near Reservation Road
   - Marina Coast Water District buildings near Reservation Road
   - Seaside Pump Station at Bay Avenue
   - Monterey Interceptor between Seaside Pump Station and Monterey Beach Resort
   - Del Monte Beach Subdivision
   - Monterey La Playa town homes at La Playa Street

2. Areas where the facility is located beneath the beach and is under threat over the next 50 years from exposure due to beach lowering as the shoreline profile migrates landward. These critical erosion areas include:
   - Monterey Interceptor between Monterey Pump Station and Wharf II.

3. Areas where armoring of the facility exists reducing the local supply of sand to the beach, causing passive erosion (Section 5.4.1) and increasing the potential for undermining the armoring once it is impacted by waves, as well as retreat of the beach on either side. These critical erosion areas include:
   - Sand City and Tioga Avenue west of Highway 1
   - Monterey Beach Resort
   - Ocean Harbor House condominiums.

In addition, the section of the Monterey Interceptor from Monterey Beach Resort to Monterey Pump Station is at moderate risk of erosion, with high consequences.

4. CRITICAL SPECIES AND HABITAT

One of the most important functions of the southern Monterey Bay coastal system is its role as a habitat for a unique flora and fauna. The beaches are habitat for numerous invertebrate species, which provide an important food source for shorebirds, seabirds, marine mammals, and fish. The beaches are also important to the endangered western snowy plover for foraging, nesting, and wintering. Subtidal areas contain kelp, eelgrass, and rocky reef, which provide habitat for marine mammals and fish. Dune areas provide habitat for many native plants and the endangered black legless lizard and Smith's blue butterfly. A key factor that needs to be considered as part of any beach nourishment project is the potential for smothering or temporary loss of marine life or habitats when placing the sand. The distribution and significance of critical species and habitat are discussed in this section and their locations are available as GIS data files in CSMWs GIS database. The impacts of beach nourishment on critical species and habitat are described in Section 5.1.1.

4.1 SENSITIVE HABITAT

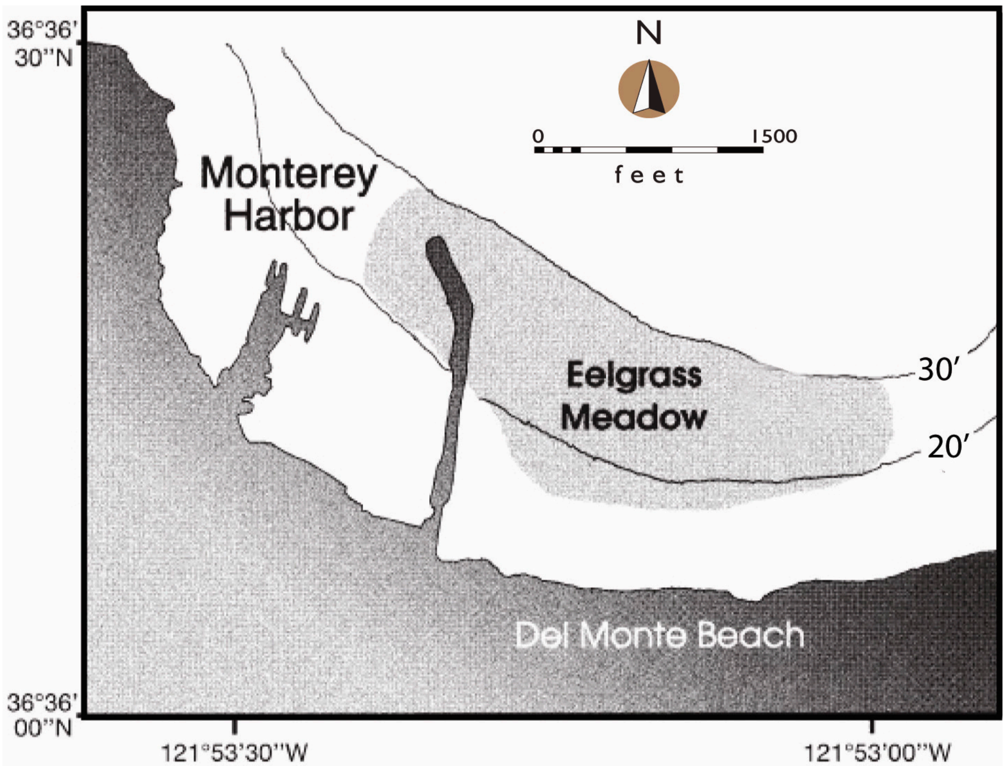
Sensitive habitat in southern Monterey Bay includes rocky reef, kelp forest, eelgrass meadow, sandy beaches, sandy subtidal, and coastal dunes.

4.1.1 Eelgrass Meadow

Eelgrass (*Zostera marina*) is considered important submerged aquatic vegetation of special interest in California, special aquatic sites (vegetated shallows) under the federal Clean Water Act (SAIC, 2008), and Essential Fish Habitat (NOAA Fisheries and federal and state agency designation). Cutting and disturbing eelgrass is prohibited by California fishing regulations. Eelgrass provides habitat for a variety of invertebrates and fish, including nursery habitat. The primary factors controlling eelgrass growth are light availability, substrate composition, temperature, salinity, nutrient availability, and wave/current energy. Light affects the depth distribution of eelgrass through its role in photosynthesis. The degree to which light is attenuated with depth in the water column is a strong determinant of the lower limit to which eelgrass can grow. Eelgrass can grow in a wide variety of substrates, but generally they flourish in medium to fine sands that contain relatively high levels of organic matter and nutrients.

Prior to 1993, the Del Monte eelgrass meadow covered a continuous 0.1 square miles of the seabed in water depths of 20-30 feet inshore and west of the rocky reef and kelp forest (Figure 29). Zimmerman et al. (2001) indicated that the meadow was fragmented and reduced to less than 50% of its total size following heavy grazing by a southern species of limpet that began in 1993. The prospects for recovery of the meadow to its former size were not considered favorable due to the limpet grazing. However, data after 2001 are limited and the status of this eelgrass meadow was not known as of 2005 (CDFG, 2005).

Figure 29. Eelgrass Meadow Adjacent to Monterey Harbor

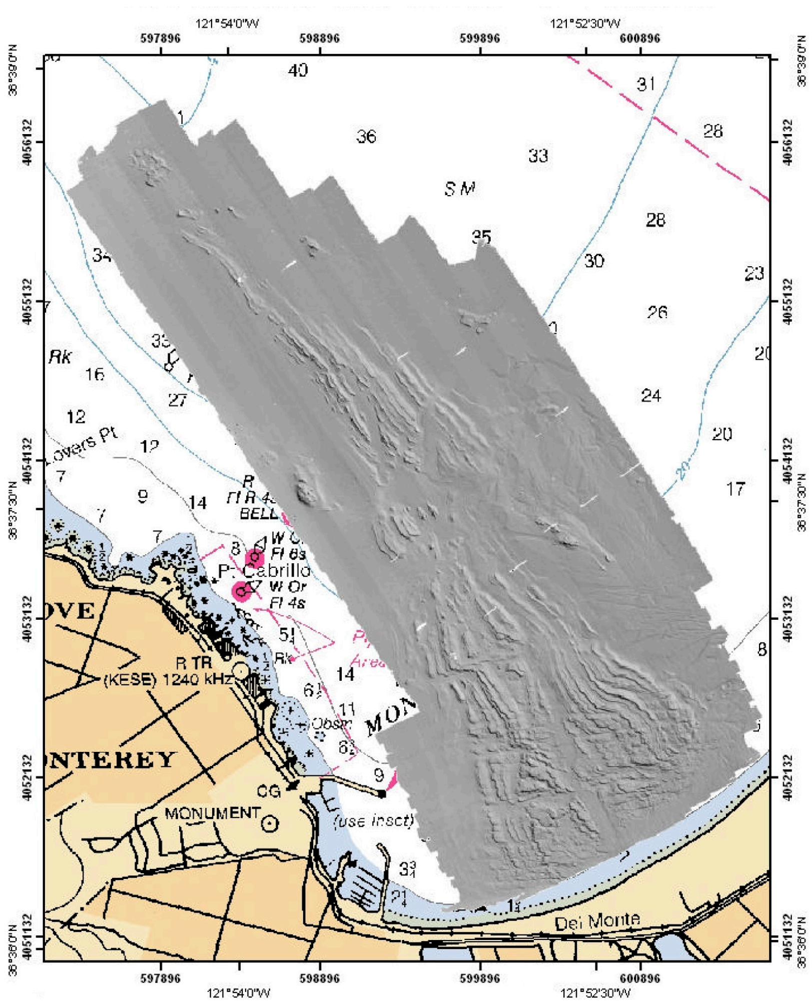


Source: Zimmerman et al. (2001)

4.1.2 Rocky Reef

A low relief rocky reef of shale known as Del Monte Shale Beds (or Tanker Reef) is situated offshore of the south end of Del Monte Beach (approximately 1.5 miles east of Wharf II and stretching almost to the Monterey Beach Resort), approximately 600 feet from the beach in 30-230 feet of water (Kvitek et al., 2004; Iampietro et al., 2005). The shale outcrop covers an area of over 3.5 square miles (stretching over three miles offshore, Figure 30) and is composed of Miocene Monterey Formation. The inner part of the reef supports a kelp forest and other submerged aquatic vegetation as well as species of fish and invertebrates. In 2005, the Natural Resources Defense Council (NRDC) submitted a proposal to the California Resources Agency which nominated this reef for Marine Protected Area (MPA) status as a marine park. The proposed MPA was not adopted by the CDFG as part of the central coast MPAs and therefore does not appear in the published 2007 MPA network. Since then, the NRDC has not further pursued designation of this reef.

Figure 30. Del Monte Shale Beds (Rocky Reef)



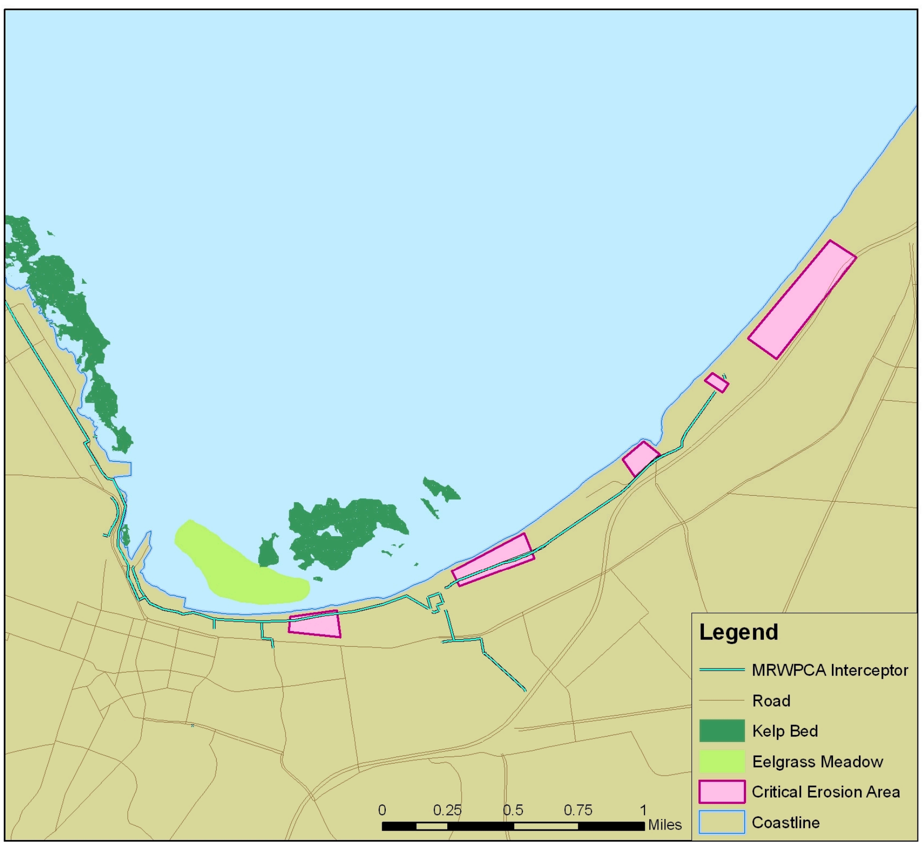
Source: Kvitek et al. (2004)

The reef is home to over 20 species of rockfish (*Sebastes* spp.), several of which have been identified by the National Marine Fisheries Service (NMFS) as over-fished. It provides juvenile fish habitat for deeply depleted species such as yelloweye and canary rockfish, and habitat for vermilion, and blue and copper rockfish adults and juveniles. All rocky subtidal areas are considered Essential Fish Habitat for managed fishery species. This reef is also known for worms and beds of boring clams that inhabit the soft shale substrate.

4.1.3 Kelp Forest

Attached to the inner part of the rocky reef is a kelp forest consisting of giant kelp (*Macrocystis pyrifera*) and bull kelp (*Nereocystis leutkeana*). Kelp favors nutrient-rich, cool clear water through which light penetrates easily, and generally occurs near the offshore limit of wave influence (Figure 31). The kelp forest in the southern bight may support thousands of invertebrate individuals, including polychaetes, amphipods, decapods, and ophiuroids, that are prey for birds and marine mammals, and support commercial fisheries. California sea lions, harbor seals, sea otters, and whales feed in the kelp or escape storms or predators in the shelter of the kelp, which helps to weaken currents and waves. Kelp forests are considered a submerged aquatic vegetation of special interest in California and Essential Fish Habitat. The distribution of this kelp forest likely varies seasonally and from year to year in the southern bight.

Figure 31. Relative Locations of the Kelp Forest and Eelgrass Meadow



Source: Location of eelgrass from Zimmerman et al. (2001). Location of kelp from CDFG. Location of pipeline provided by Jennifer Gonzalez (MRWPCA)

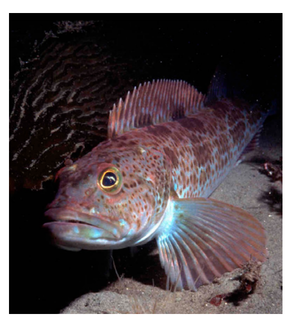
4.1.4 Sandy Beaches

Dune-backed sandy beaches exposed to surf are the most prevalent habitat in southern Monterey Bay. These beaches are primary habitat for a variety of invertebrate species including crustaceans, mollusks, polychaetes, and insects, as well as meiofauna that can reach high abundance and biomass. These species are prey resources for fish, seabirds, shorebirds and marine mammals. The beaches also provide roosting areas for shorebirds, pelicans, gulls, and other seabirds, and haul-out habitat for pinnipeds, such as harbor seals and sea lions. Western snowy plovers (a threatened shorebird species) nest and rear chicks on beaches in southern Monterey Bay, and California grunion are known to use these beaches for spawning.

4.1.5 Sandy Subtidal

Extensive sandy subtidal and surf zone habitats bound most of the southern Monterey Bay shoreline. This dynamic habitat can support a diversity of fish and invertebrate species including flatfish, surfperch, amphipods, isopods, mole crabs, Dungeness crabs, swimming crabs, Pismo clams, northern razor clams, sand dollars, sea pansies, sea stars and polychaetes, many of which are prey for seabirds and marine mammals.

Two sandy subtidal benthic infaunal communities are recognized along a gradient of wave activity in southern Monterey Bay. The crustacean zone is closest to shoreline and characterized by strong water motion and sandy sediments. This zone is occupied by small, mobile, deposit-feeding crustaceans, such as amphipods, which do not build permanent burrows. The polychaete zone is in deeper water (60 feet or more), and characterized by more stable fine sand with a significant amount of mud. The zone is dominated by polychaete worms living in relatively permanent tubes and burrows. Many other relatively sessile and suspension-feeding groups, including brittle stars, clams, tube anemones, sea pens, are also common here. The depth limits of these two benthic zones vary with wave activity with zones extending into deeper water with higher wave energy. In southern Monterey Bay, the transition between the two benthic zones is likely to be at a depth of approximately 40 feet.



Subtidal sands are primary foraging and reproductive habitat for a variety of invertebrates and demersal fish including lingcod (inset), white croaker, plainfin midshipman, staghorn sculpin, sand sole, English sole, speckled sand dab and curlfin sole. Marine mammals including otters, pinnipeds, and cetaceans forage on water column and benthic fish and invertebrates over sandy subtidal habitats. Subtidal sands are also important habitats supporting commercial and recreational fisheries for marine invertebrates (e.g. Dungeness crabs, sea cucumbers) and fish (e.g. California halibut, sanddabs).

4.1.6 Coastal Dunes

The coastal dune system of southern Monterey Bay is one of the most important in California. Native coastal strand and dune vegetation is designated as rare in California and much of the area of active sand dunes in southern Monterey Bay (mainly north of the Salinas River) with or without vegetative cover is designated as Ecologically Sensitive Habitat Area (ESHA) (California Coastal Commission designation). Most of the stable vegetated (relict) dunes south of the Salinas River also qualify as ESHA because of the presence of typical sand dune species, species and plants that are ESHA in their own right, and physical substrates that support or could support the above species. Coastal dunes are vulnerable to trampling, erosion, and invasion by exotic species. Dune restoration and conservation is actively ongoing in southern Monterey Bay, including the shorelines of Sand City, Seaside, and Monterey.

4.2 NATIVE ANIMALS

Several native animals inhabiting the dunes and beaches of southern Monterey Bay have special status, are already listed, or are on the candidate list for the federal register. A few other animal species of interest that are prey resources for endangered species or fishery species are also considered.

4.2.1 Western Snowy Plover

The western snowy plover (*Charadrius alexandrinus nivosus*) was listed as a threatened species in 1993 by the U.S. Fish and Wildlife Service (USFWS). In 2005, the USFWS published a final rule on western snowy plover critical habitat along the coast of California, which did not include any of the southern Monterey Bay shoreline. The final recovery plan for the species was published in 2007, in an attempt to remove the Pacific coast population from the list of endangered and threatened wildlife. Although excluded from the USFWS critical habitat designation, southern Monterey Bay provides suitable or potentially suitable habitat for snowy plover foraging and nesting.

Western snowy plovers (inset: photo by Morgan Ball) forage on the shoreline and nest on the beaches and dunes, and are present year-round. Southern Monterey Bay is an important nesting area for snowy plovers, with approximately 60 to 100 nesting birds each year. It is also an important wintering area, with up to 190 birds using this shoreline each winter. Chicks leave the nest to forage soon after hatching, and adults move chicks along the beach (possibly miles) to reach suitable foraging areas. Habitat features essential to the species include areas of sandy beach above and below the high tide line with surf-cast macrophyte wrack and other debris supporting small invertebrates (for nesting and foraging) and generally open barren to sparsely vegetated terrain (for foraging and predator avoidance). The distribution, including nesting sites, of snowy plover is expected to vary with beach conditions and the dynamics of the population.

At the Sanctuary Beach Resort, the dunes between the bluff edge and resort wall are being preserved to provide dune habitat for the western snowy plover. The dunes to the north of the Ocean Harbor House condominiums are also protected from human and canine disturbance to provide mating and nesting habitat.

4.2.2 Shorebirds

Many species (17) of shorebirds (inset) use the beaches of southern Monterey Bay during migration periods and over the winter months (Table 12). The average abundance of shorebirds is 192 birds per mile of shoreline with peak use occurring between August and March (Neuman et al., 2008). The rich and productive invertebrate prey resources of sandy beaches are important to the survival and success of breeding and non-breeding shorebirds in coastal ecosystems. Shorebirds have high metabolic rates and relatively high daily energy requirements (Kersten and Piersma, 1987) and are capable of consuming a large percentage (49-65%) of the annual production of invertebrate prey on beaches. The beaches of southern Monterey Bay provide important foraging and roosting habitat for shorebirds particularly when wetlands, such as Elkhorn Slough, are inundated during high tides. Many shorebird populations are declining in the U.S. and the maintenance of high quality foraging habitat is considered important to their conservation.

Table 12. Bird Counts in Monterey Bay (Neuman et al., 2008)

Common name	Scientific Name	Maximum	Density (birds km^{-1})	
			Low Tide Mean	High Tide Mean
Sanderling	*Calidris alba*	6,796	83.70 (37.4)	73.00 (31.8)
Willet	*Tringa semipalmata*	2,299	19.10 (16.3)	5.40 (6.6)
Marbled Godwit	*Limosa fedoa*	805	10.50 (5.5)	5.90 (4.4)
Black-bellied Plover	*Pluvialis squatarola*	497	3.20 (3.5)	1.70 (1.7)
Whimbrel	*Numenius phaeopus*	535	2.70 (4.2)	1.40 (1.9)
Snowy Plover	*Charadrius alexandrinus*	330	2.50 (1.7)	3.20 (2.2)
Western Sandpiper	*Calidris mauri*	1,175	0.78 (1.72)	4.80 (9.7)
Long-billed Curlew	*Numenius americanus*	94	0.50 (0.64)	0.19 (0.26)
Ruddy Turnstone	*Arenaria interpres*	42	0.17 (0.29)	0.22 (0.29)
Killdeer	*Charadrius vociferus*	85	0.17 (0.32)	0.34 (0.68)
Dunlin	*Calidris alpina*	61	0.14 (0.30)	0.21 (0.41)
Dowitcher spp.	*Limnodromus* spp.	43	0.14 (0.31)	0.03 (0.06)
Semipalmated Plover	*Charadrius semipalmatus*	60	0.03 (0.05)	0.30 (0.50)
Red Knot	*Calidris canutus*	9	0.03 (0.07)	0.01 (0.04)
American Avocet	*Recurvirostra americana*	14	0.03 (0.10)	0.01 (0.03)
Black Turnstone	*Arenaria melanocephala*	9	0.02 (0.05)	0.03 (0.06)
Least Sandpiper	*Calidris minutilla*	89	0.01 (0.02)	0.28 (0.67)
All Shorebirds		7,586	123.80 (44.5)	97.0 (37.6)

NB. Table shows maximum bay-wide count and low-tide and high-tide mean density (standard deviation in parentheses) of the 17 shorebird species observed between November 2002 and April 2003.

4.2.3 Black Legless Lizard

The black legless lizard (*Anniella pulchra nigra*) (inset) is considered a species of concern by the California Department of Fish and game (CDFG) because of its limited distribution. Much of the habitat for this lizard has been lost to agriculture and other development including recreation, especially in coastal dune areas, and by the introduction of non-native plants such as ice plant. It inhabits the Marina and Ford Ord dunes, although the exact distribution of these populations is not known. Kuhnz et al. (2005) suggested that standard survey methods may not be effective in establishing presence or absence of this species when densities are low. The Sanctuary Beach Resort has installed a 'lizard crossing' beneath the main entry road to allow the black legless lizard to safely traverse the eastern edge of the property.

4.2.4 Smith's Blue Butterfly

The tiny Smith's blue butterfly (*Euphilotes enoptes smithi*) (inset) is a species of concern and federally protected, and was listed as endangered by the USFWS in 1976 due to loss of dune habitat. At least 12 reserves for this butterfly have been established on Fort Ord. Coast buckwheat (*Eriogonum latifolium*) and dune buckwheat (*Eriogonum parvifolium*) are host plants for this butterfly. They grow in the coastal dunes and are needed by the butterfly for reproduction in their natural habitat. The distribution of coast buckwheat is limited and patchy in southern Monterey Bay and it has been or is planned to be planted in a number of restoration projects between the Salinas River and Sand City. The emergence of the butterfly is timed to coincide with the blooming of the host plants (approximately 4-6 weeks in late summer-early fall). Each adult butterfly lives about a week, mating and laying eggs on the host plant.

4.2.5 Globose Dune Beetle

The globose dune beetle (*Coelus globosus*) is a Category 2 species of concern for USFWS, meaning it is a potential candidate for listing, but there is insufficient information to support a proposed rule. This species of flightless beetle inhabits coastal dunes usually within 100 feet of the shoreline. They are primarily subterranean as adults and larvae, tunneling through sand underneath dune vegetation such as sand verbena, beach bursage and sea rocket. This species may be absent from southern Monterey Bay; however, the exact status of the population is not known.

4.2.6 Southern Sea Otter

The southern sea otter (*Enhydra lutris nereis*) (inset) inhabits southern Monterey Bay year round. This species is listed as federally threatened and is fully protected by both state and federal regulations. Sea otters require abundant benthic invertebrate prey of large body size including large crabs, sea urchins, abalone, snails, and clams. They feed in rocky and kelp forest habitats as well as low intertidal areas and surf zones of beaches in southern Monterey Bay. Kelp forests are important areas for resting, foraging, and as nursery sites. Hence, sea otters are considered a key factor in the dynamics of kelp forests. The highest density of sea otters occurs in the southern bight (location of kelp) and reproduction of otters as indicated by pup numbers is also relatively high in this area.

4.2.7 California Grunion

The California grunion (*Leuresthes tenuis*) is a beach nesting fish that breeds regularly on Monterey State Beach (Karen Martin, Pepperdine University, personal communication) and possibly on other beaches in southern Monterey Bay. This fish spawns in the upper intertidal zone between March and August, and occasionally in February and September. Peak spawning is late March to early June. Grunion leave the water for four consecutive nights starting the nights of the full and new moons. Spawning begins after high tide and continues for several hours. Eggs incubate in the sand for two or more weeks and during this period are vulnerable to burial and disturbance. Adult fish inhabit the shallow nearshore from the surf zone to a depth of approximately 60 feet. The most critical problem facing the grunion resource is the loss of spawning habitat caused by beach erosion. By the 1920s the fishery was showing definite signs of depletion and a regulation was passed in 1927 establishing a closed season of three months, April through June. The fishery improved and in 1947 the closure was shortened to April through May. This closure is still in effect to protect grunion during the peak spawning period.

4.2.8 Pismo Clam

The Pismo clam (*Tivela stultorum*) (inset) is a large heavy-shelled long-lived (>50 years) bivalve that inhabits low intertidal and shallow subtidal zones along open sandy coasts from Monterey Bay to Baja California. Southern Monterey Bay is close to the northern limit for this species. This clam can reach shell lengths of greater that six inches and can exhibit zonation by size, with juvenile clams located higher in the intertidal zone than adults.

Pismo clams formerly supported large commercial and recreational (sport) fisheries in the Monterey Bay area and other parts of the California coast until population numbers declined and the fishery collapsed. This clam is important prey for sea otters in southern Monterey Bay.

4.2.9 Beach Invertebrates

Beach invertebrates (inset) including spiny and common sand crabs, beachhoppers, razor clams, polychaete worms, insects, and a variety of small crustaceans can reach high abundance (>30,000 individuals per foot of shoreline) and biomass on the beaches of southern Monterey Bay. These invertebrates are an important prey resource for shorebirds, seabirds, fish, and marine mammals. Many of the invertebrate animals inhabiting the lower intertidal and swash zone can be dispersed relatively long distances as planktonic larvae. The upper shore invertebrates are associated with drift seaweed or wrack, avoiding direct contact with waves. These animals which include beach hoppers, isopods and a number of flightless insects develop directly on the beach and thus can be limited by dispersal and distance from source populations.

4.3 NATIVE PLANTS

Several native plants in southern Monterey Bay are either already listed or are on the candidate list for the federal register of endangered and threatened species. These include Yadon's wallflower (inset), Monterey spineflower, sand gilia, seaside bird's-beak, sandmat manzanita, Eastwood's ericameria, coast wallflower, and Monterey ceanothus. Of these species, Yadon's wallflower (*Erysimum menziesii ssp. yadonii*) occurs closest to the shoreline. This endangered species occurs on coastal strand close to high tide, in areas largely protected from wave action, but exposed to strong wind and salt spray. In southern Monterey Bay, this species is reported to be restricted to four occurrences in the vicinity of Marina dunes; two at Marina State Beach and two close to the Marina sand mine. Augmentation, through propagation and reintroduction, has been attempted for populations at Marina State Beach.

Critical habitat is designated by USFWS for the Monterey spineflower (*Chorizanthe pungens pungens*) a threatened annual dune plant that occurs in recent dunes and extends along almost the entire southern Monterey Bay shoreline. Sand gilia (*Gilia tenuiflora arenaria*) grows in the coastal dunes but generally in locations protected from waves, salt spray and strong winds. Sand gilia is both state-listed (threatened) and federal listed (endangered), and ranked by the California Native Plant Society as extremely rare. Seaside bird's-beak is protected under the California Plant Protection Act of 1977.

5. REGIONAL SEDIMENT MANAGEMENT APPROACHES

This section focuses on potential RSM approaches as solutions to coastal erosion problems in southern Monterey Bay. Based on the information outlined in Sections 2 to 4, three main approaches to RSM are considered appropriate. These are:

- beach restoration strategies particularly beach nourishment to slow erosion rates
- eliminate factors that exacerbate erosion
- allow the natural process of dune erosion to continue without intervention.

SMBCEW (2006a) carried out an initial investigation and ranking of a wide variety of erosion response alternatives (including but not exclusively RSM). The list created by SMBCEW (2006a) is presented in Table 13 and includes beach restoration alternatives such as beach dewatering and pressure equalizing modules, sand retention devices and other structures/alternatives, and set backs for any future developments. A full investigation of these methods is outside the scope of this Coastal RSM Plan, but the MBNMS is funding a study for the SMBCEW that further evaluates the higher ranking alternatives, and assesses their role within the RSM framework for southern Monterey Bay.

In addition, CSMW recently commissioned a project to investigate the biological impacts associated with sediment management activities along the California coastline (SAIC, 2008). The draft report is currently under review, and the final document will provide a valuable reference work and appraisal of the potential effects of sediment management on California's natural resources.

5.1 BEACH NOURISHMENT

At locations where it is not considered acceptable to allow natural processes to continue, because the beach resource is being lost and/or important facilities are at risk of erosion, human intervention to alter the shoreline is often considered. In general, there are two types of alteration strategies that are traditionally implemented; soft approaches (a variety of options including beach nourishment) and hard approaches (mainly armoring of different types).

Table 13. Potential Erosion Response Alternatives (SMBCEW, 2006a)

Alternative	Approach	Specific Method	Rank
Approaches to be used when addressing future developments	Prevent or discourage development in areas threatened by erosion	Transfer of Development Credit	20
		Conservation Easements	19
		Fee Simple Acquisition	18
		Present Use Tax	18
	Avoid threats from erosion permanently or for many years	Rolling Easements	19
		Structural or Habitat Adaptation	17
		Set backs for Bluff Top Development	17
		Set backs (Plus Elevation) for Beach Level Development	16
Regional approaches to be used for larger area-wide responses to slow beach erosion		Beach Nourishment - Nearshore Placement	15
		Beach Nourishment – Subaerial-Beach Placement	14
		Beach Nourishment - Dredge Sand from Deep or Offshore Deposits	14
		Dune Nourishment (adding both sand and vegetation)	14
		Pressure Equalizing Modules	14
		Beach Dewatering	12
		Submerged Breakwaters/Artificial Reefs	12
		Inter-littoral Cell Transfers	11
		Perched Beaches	11
		Groins	11
		Emergent Breakwaters	10
Site-specific approaches to be used for existing structures that are threatened by erosion	Move or remove structures away from erosive forces	Managed retreat	18
	Move erosive forces away from the threatened structure	Seawalls	8
		Revetments	8
Approaches that reduce factors that exacerbate erosion	Site-specific (often used in combination with other approaches)	Native Plants	12
		Sand Fencing/Dune Guard Fencing	11
		Controlling Surface Runoff	11
		Controlling Groundwater	11
		Berms/Beach Scraping	9/10
	Regional	Cessation of Mining Sand from the Beach	19

The California Beach Restoration Study (CDBW and SCC, 2002) defines beach nourishment as the introduction of sand on to a beach (inset) to supplement a diminished supply of natural sediment, for the purpose of beach restoration, enhancement, or maintenance. The southern Monterey Bay shoreline has no history of beach nourishment, because the majority of the shoreline is undeveloped and the beaches are healthy, being provided with significant amounts of sand from erosion of the relict dune bluffs (Section 5.3). However, SMBCEW (2006b) strongly recommended analysis of the feasibility of beach nourishment for sites at and south of Sand City to Wharf II, and this Coastal RSM Plan supports that recommendation. Six of the eight areas of critical erosion are located along the stretch of shoreline within the Cities of Sand City, Seaside, and Monterey (defined as the southern bight in this Coastal RSM Plan) where healthy beaches are especially important for recreation and tourism; hence this shoreline could potentially be a receptor for beach nourishment.

The shoreline within the Cities of Sand City, Seaside, and Monterey corresponds with the south sub-cell and the southern extreme of the central sub-cell (Section 2.1), which is the stretch of eroding shoreline impacted by relatively low wave energy and low net sediment transport rates. The clustering of most of the critical areas of erosion within the single relatively short south sub-cell impacted by relatively 'quiet' physical conditions provides potential benefits for implementation of beach nourishment strategies:

- The impacts of the nourishment would only be felt within the confines of the south sub-cell with little or no far-reaching impacts to the rest of southern Monterey Bay.
- The nourishment strategy could be implemented on a sub-cell scale and would benefit multiple facilities within the sub-cell region.
- Beach nourishment benefits are enhanced if critical areas of erosion are close together and not separated by large distances within a littoral cell.
- Low wave energy and low net alongshore sediment transport would mean that sand would remain at the receiver site for a longer period of time. This may lead to a reduced frequency of maintenance of the site through further nourishment, reducing costs.
- The location of an apparent alongshore sediment transport convergence close-by (at Sand City) and the associated potential accumulation of sand offshore that is suitable for nourishment would simplify implementation and reduce costs. The south sub-cell is also adjacent to Monterey Harbor providing a second easily accessible potential source of sand.
- The south sub-cell is the most accessible area of southern Monterey Bay for transportation of appropriate sand from inland sources if they become available in the future.

This Coastal RSM Plan recommends investigation of beach nourishment and other beach restoration strategies to ameliorate erosion along the stretch of shoreline within the Cities of Sand City, Seaside, and Monterey.

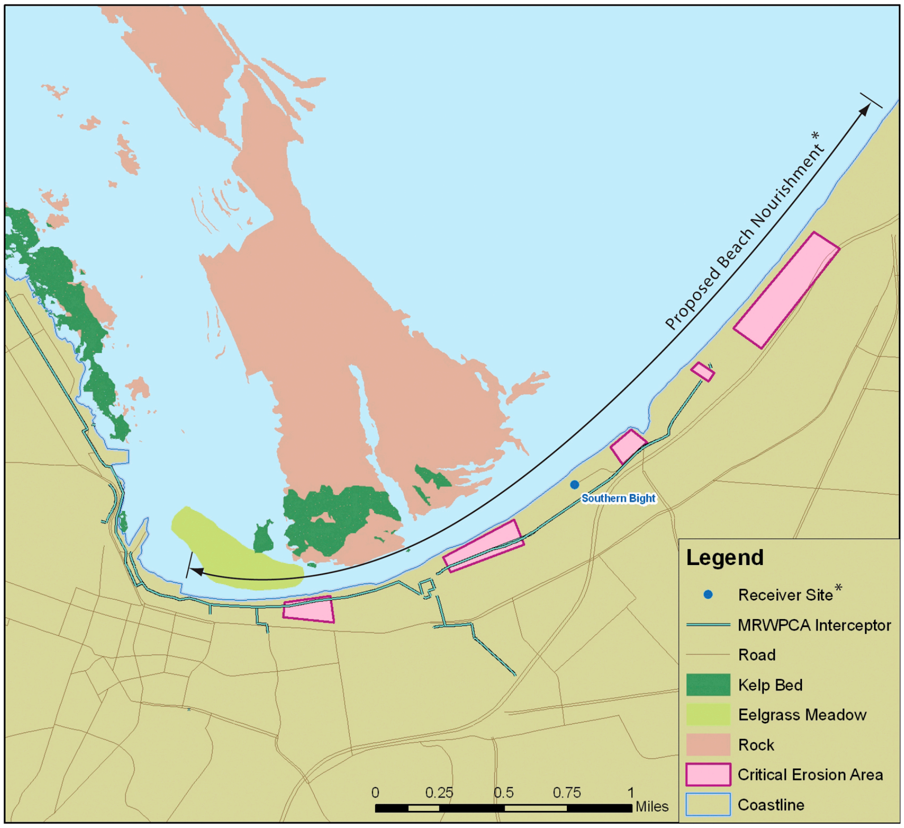
Two different beach nourishment approaches could be adopted; subaerial placement (on beach), and nearshore placement (in surf zone). Subaerial placement of sand is nourishment of the dry beach and near the water line (CDBW and SCC, 2002), which results in an immediate artificially wide beach. Waves then redistribute the sand across the entire beach and shoreface profile until equilibrium is reached. Through this process the dry beach narrows from its initial nourished width to accommodate the profile adjustment. Nearshore placement nourishes the part of the littoral cell immediately seaward of the surf zone (CDBW and SCC, 2002). The intent is that this sand will buffer waves and at the same time the waves will transport some of the sand onshore to increase the beach width. Nearshore placement of sand should result in a wider dry beach, but at a slower rate than if the same volume of sand is placed directly onto the beach.

The placement location and timing would be important considerations in southern Monterey Bay. Sand placement should occur away from sensitive resources (kelp, eelgrass, rocky reef, Section 4.1), should not take place during bird nesting (such as western snowy plover nesting season, March-September, Section 4.2.1), should not occur at times of high beach use (May to September), and should not be constructed so as to interrupt beach access. A strategy to mitigate placement impacts should be a key objective of the placement design (Section 5.1.2). The Sand Compatibility and Opportunistic Use Program (SCOUP) (Moffatt and Nichol Engineers, 2006) provides guidance and strategies for placement of sand in the nearshore.

5.1.1 Potential Environmental Impacts of Beach Nourishment

A number of sensitive habitats and species are present in southern Monterey Bay (Section 4). The stretch of shoreline where this Coastal RSM Plan supports potential beach nourishment (Cities of Sand City, Seaside, and Monterey), has rocky reef, kelp forest and eelgrass meadow in the nearshore (Figure 32), and may contain endangered birds, plants, and invertebrates as well as grunion spawning habitat in the dune and beach areas. The Corps requires a sensitive habitat survey for beach nourishment projects, which includes pre- and post-project monitoring and proposals for mitigation for any impacts to sensitive habitats adjacent to and down coast of the receiver site.

Figure 32. Beach Nourishment Considerations in the Southern Bight



*beach nourishment within the Cities of Sand City, Seaside, and Monterey.

Source: Location of eelgrass from Zimmerman et al. (2001). Location of kelp from CDFG. Location of rock from the Sanctuary Interactive Monitoring Network (SIMoN). Location of pipeline provided by Jennifer Gonzalez (MRWPCA)

Impacts of beach nourishment can occur at the site where the sand is placed; as a direct impact and as an indirect impact through dispersal of the sand by alongshore, cross-shore, or wind-driven transport. Impacts to biological resources can be classified into three major categories (Speybroeck et al., 2006):

- impacts directly related to the construction phases of a nourishment project
- impacts related to the characteristics of the sediments used
- impacts related to the quantity of sediment applied.

The magnitude of these impacts is strongly influenced by the place, time, and size of the project, and the strategy of the nourishment activity. Cumulative impacts are also important to consider with respect to the frequency and scale of activity, and for multiple sand management projects.

Impacts of beach nourishment construction activities (both subaerial-beach and nearshore placement) may include direct damage and disturbance, burial of habitat by sand placement at the site, and dispersal to down coast areas (the thickness of sand placed can influence the degree of impacts to biological resources), and water quality effects resulting from resuspension and settling of sediments. Disturbance to wildlife during construction can be both visual and auditory. The use of heavy equipment to transport and arrange sediments can destroy dune vegetation including threatened species, and compact beach sediments negatively affecting vascular plants and invertebrates, as well as affecting air quality.

Disturbance and/or burial associated with either subaerial-beach or nearshore sand placement may affect the mortality of the southern bight benthic community, its potential recovery, and the amount of prey available to higher trophic levels, birds, fish, and marine mammals. Recovery rates vary among species and depend on the scale and timing of the impacts. Periods of six months to greater than two years may be needed for recovery of shorter-lived species depending on the recruitment of planktonic larvae, their survival, subsequent growth, and resulting habitat changes. Recovery of longer-lived species, such as Pismo or razor clams, could take more than 5-10 years. Burial of grunion eggs by a layer of added sediment can prevent successful hatching, and changes in beach profile geometry could reduce spawning activity or potentially trap adult fish above high tide.

Increased turbidity resulting from nearshore and beach placement of sediments in the southern bight could negatively affect vegetation and animals living on the offshore rocky reefs, subtidal sand, eelgrass meadows, and kelp forests (Figure 32). Turbidity could adversely affect kelp recruitment and/or juvenile growth depending on the proximity of the operations, duration of the turbidity related to project size, sediment characteristics, and hydrodynamics. The eelgrass meadow could potentially be disturbed by construction activities, indirect sedimentation and turbidity as well as anchoring of support vessels and other activities. Recovery of kelp and eelgrass can be very slow (2-7 years) and transplantation of eelgrass has been needed in a number of areas where damage to benthic habitat has occurred (SAIC, 2008).

The characteristics of the placed sediment, such as the particle size distribution and proportion of shell fragments can affect habitat quality for burrowing animals and subsequent recovery of the biota and food chain support (Peterson et al., 2000, 2006; Speybroeck et al., 2006). Particle size can also affect beach morphology, compaction, and the subsequent biotic community. Sediments with a high proportion of shell fragments can potentially cement into a pavement, reducing wind-blown and hydrodynamic sand transport and creating a barrier to burrowing animals.

Post-construction transport of sand in the southern bight following placement (both subaerial-beach and nearshore) could negatively affect the adjacent kelp forest, rocky reef, and eelgrass meadow through indirect sedimentation of these habitats, with the magnitude of impact depending on project volume and proximity to the habitat. The Del Monte Shale Beds rocky reef is potentially vulnerable to sand inundation and scour. The kelp forest probably occurs seaward of the wave impacted seabed; however, inshore portions may extend into shallower waters during years lacking major storms. Sedimentation can adversely affect all life stages of the kelp due to scour and increased mortality of both adults and juveniles.

The beaches and coastal dunes of southern Monterey Bay provide important habitat and resources for the western snowy plover. Management to protect nests, chicks, and adults of this threatened bird is ongoing, particularly during the March to September breeding season. The importance of the area to western snowy plover is high and maintaining prey resources for foraging and chick rearing needs to be considered in beach nourishment activities. The entire southern Monterey Bay was originally proposed for designation as critical habitat for western snowy plover; however, it was removed from critical habitat designations in the final rule for this species (September 2005).

5.1.2 Mitigation Measures

Adverse impacts to the coastal habitats in the southern bight from beach nourishment activities could be reduced by implementing the following mitigation measures:

- match the particle size characteristics of sand used for nourishment with those at the receiver site as closely as possible
- select a placement location that avoids direct impacts to sensitive habitats and species and incorporates buffer distances from kelp forests, rocky reef and eelgrass meadow to minimize potential impacts from turbidity and sedimentation; recommended buffers range from 500 to 1,000 feet (SAIC, 2008)
- time project construction activities to avoid key biological periods; avoid nesting and spawning seasons for western snowy plover and grunion, respectively; avoid recruitment periods for key invertebrates with planktonic larvae, such as sand crabs and clams; avoid peak shorebird migration periods and wintering
- create refuges in project design to reduce impacts, maintain food chain support and facilitate biological recovery by nourishing small sections of beach (less than 2,000 feet) interspersed with undisturbed sections of habitat
- establish no work zones to avoid disturbance by vehicles, equipment, and other activities, and restrict vehicles and pipeline alignments to outside vegetated dune areas and sensitive habitats
- minimize the use of heavy equipment, with use of lighter equipment preferred to reduce mortality and habitat damage from compaction during construction
- implement monitoring and protective measures for sensitive species and habitats during construction (e.g. shorebird, sea otter, grunion)
- conduct pre- and post-project monitoring of ecological responses and recovery for a sufficient time period to inform design of future projects and adaptive management using a modified BACI (Before-After, Control-Impact) approach
- implement mitigation (e.g. restoration, transplantation) to offset any inadvertent and/or unavoidable habitat loss.

5.1.3 Potential Receiver Site in the Southern Bight

Given the location of the critical areas of erosion and the need to avoid adverse impacts to local sensitive habitat, this Coastal RSM Plan recommends a receiver site location for both subaerial-beach and nearshore sand placement between the Monterey Beach Resort and the Ocean Harbor House condominiums (Figure 32). This receiver site is considered suitable for three main reasons:

- The net alongshore sediment transport rate is low and to the north, but the gross transport rate is high in both northerly and southerly directions. This location is fairly central to the southern bight and would allow the sand to be transported most effectively along the whole shoreline (Figure 32). Sand placed at a location further to the north would be unlikely to disperse sufficiently to cover critical areas of erosion towards Monterey Harbor given the overall net transport to the north, and placement further to the south would be too close to the sensitive habitat located offshore.
- This location is far enough away from the sensitive kelp, eelgrass and rocky reef habitat so as not to cause disturbance through sedimentation or turbidity during construction and post-construction phases of the project.
- The location is relatively close to a potential stockpile area proposed at Fort Ord (Section 6.3.1) where inland sediments, if they become available, could be placed temporarily until a beach nourishment maintenance-style project could be developed. Road access to the location is available.

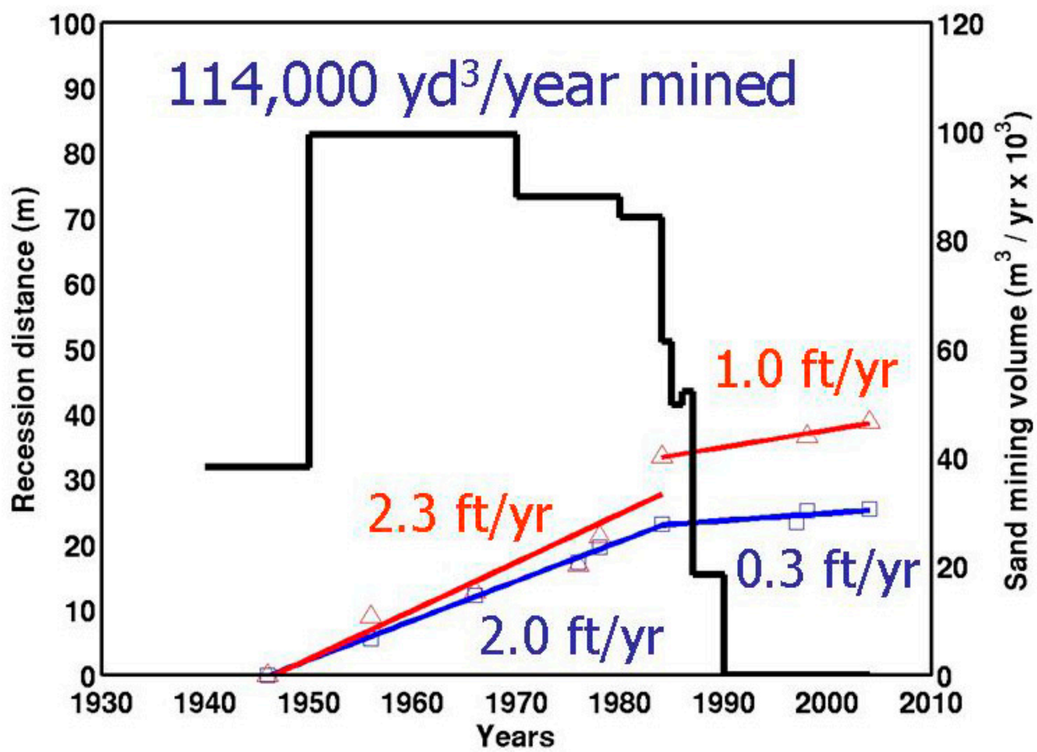
5.2 ELIMINATE FACTORS THAT EXACERBATE EROSION

The main human factor that affects the sediment budget, exacerbating shoreline erosion in southern Monterey Bay, is hydraulic sand mining from the beach. Cessation of mining beach sand would allow approximately 200,000 yd^3/year of sand (Table 8) to remain in the littoral budget, to supply both up coast and down coast beaches (beach replenishment). Battalio and Everts (1989) determined that the former beach-sand mining operations at Sand City acted as sediment sinks drawing in large quantities of sand from the surrounding littoral zone, and re-orienting the shoreline (Figure 16). They described a process whereby sediment from up coast and down coast moves towards the sink (created by the removal of beach sand by the mines) causing those portions of the shoreline to erode. Battalio and Everts (1989) showed reasonable agreement of their conceptual model with measured shoreline erosion rates (using aerial photograph comparisons) between 1949 and 1988. In this Coastal RSM Plan, the conceptual model is used to explain the impacts to shoreline erosion that mining sand from the beach has had historically and is having currently.

5.2.1 Impacts of Historic Beach-Sand Mining at Sand City

The 1985-2005 dune erosion rates at Sand City and south of Sand City (Monterey Beach Resort and Del Monte Beach) are lower than those during the beach-sand mining period between 1940 and 1984 (Table 3). The decrease in erosion rate is likely to be related to the complete cessation of beach-sand mining at Sand City in 1990 (Section 2.5.4). Figure 33 shows that extraction of beach sand at Sand City peaked at 114,000 yd^3/year and during this time erosion rates at Sand City were between 2.0 and 2.3 ft/year. As the amount of beach-sand mining was reduced during the 1980s and finally stopped in 1990, erosion rates at Sand City decreased to between 0.3 and 1.0 ft/year. After the 1980s, the mines ceased to be a sink for sediment from the surrounding littoral zone (Figure 16), the shoreline re-adjusted to the new condition, resulting in lower erosion rates.

Figure 33. Beach Sand Extraction at Sand City and Dune Erosion Rates at Monterey



Source: Adapted from Thornton et al. (2006). Blue line 0.6 miles from Wharf II. Red line 1.9 miles from Wharf II. Note axes are in SI units.

5.2.2 Impacts of Historic and Ongoing Beach-Sand Mining at Marina

After the Salinas River changed course in about 1910 (Section 1.3), there was significant accretion of the shoreline both north and south of the mouth as measured by the long term (1910-2002) shoreline change (Figure 18, Hapke et al., 2006). However, between 1970 and 2002 the shoreline from the Salinas River to Marina sand mine eroded. The switch from accretion to erosion is believed to correlate with the start-up and continuation of hydraulic mining of sand from the beach at Marina. The change from accretion to erosion only occurs south of the Salinas River mouth, whereas to the north of the mouth the shoreline continues to accrete (Figure 18). Assuming that the input of sediment from the river has remained constant, the recent losses to the south of the mouth are likely to be related to beach-sand mining, which acts as a sediment sink (Figure 16).

The estimates of Thornton et al. (2006) show that at Marina State Beach (south of the beach-sand mining) there has been a significant increase in erosion rates post-1984 (Table 3). This increase is believed to be related to the increase in extraction rate of beach sand at Marina in the mid-1980s, with further increases in extraction in the 1990s and 21st century (Table 14). The mining acts as a sink effectively drawing in sand resulting in a large loss from the littoral budget. The increase in extraction rate has resulted in less sand being available for transportation up coast and down coast, exacerbating the rate of erosion to the south and north. The erosion diminishes north of the Salinas River mouth, indicating that the offshore depth contours (ancient sediment lobe, Section 1.3) limit the net alongshore transport past this feature.

Table 14. Beach Sand Extraction and Dune Erosion Rates at Marina

Decade	Sand Mined from Beach (yd^3/year x 1000)	Average Erosion Rate at Marina State Beach (ft/year)
1940s	20	1.0
1950s	40	
1960s	84	
1970s	129	
1980s	143	
1990s	200	4.7
2000s	200	

An aerial photograph of the dredge pond at Marina taken after the storm of January 2008 (Figure 20, right panel) shows how effective the mined area on the beach is at trapping sediment from the littoral zone. Prior to the storm the pond was filled with water (Figure 20, left panel). During the storm, waves and surge overtopped the berm and broke loose the 80-ton dredge that was chained inside the pond. The overtopping waves transported large quantities of sand from the littoral zone, which was deposited in the pond. The photograph in Figure 20 (right panel) was taken on January 15, 2008 and shows the pond has been completely filled with sand. The wrack line is landward of the former pond indicating that swash entered the pond and then swept further inland.

5.2.3 Beneficial Impacts of Stopping Mining of Sand from the Beach

Stopping the mining of the beach would release approximately 200,000 yd^3/year of sand to replenish up coast and down coast beaches in southern Monterey Bay. This estimate of sand lost from the littoral cell is equivalent to the volume of sand supplied to the cell from erosion of the 12 miles of dunes between the Salinas River and Wharf II. Using Table 4 to calculate average beach recession rates from volume losses of beach and shoreface sand for the stretch of shoreline between the Salinas River and Wharf II, indicates that mining of 200,000 yd^3/year of beach sand is the equivalent of approximately two feet of beach every year. Loss of two feet of beach each year is approximately 50-75% of the ongoing erosion along southern Monterey Bay south of the Salinas River (Section 2.3.3). Hence, retention of the sand that would otherwise be lost from the budget through mining of the beach would have a major benefit for all of southern Monterey Bay.

The main impact of the cessation of beach-sand mining would be an expected increase in the amount of sand available to be transported to the south towards Sand City and Monterey. Thornton et al. (2006) showed that after the cessation of the drag line sand mines at Sand City and Marina the erosion rates significantly decreased in the southern bight. The erosion rates would therefore be expected to further decrease in the south sub-cell if mining of sand from the beach were to completely stop. In addition, gross alongshore sand transport is high throughout southern Monterey Bay enabling effective redistribution of beach-sand mining perturbations along the entire Bay shoreline. Hence, mining of sand from any beach location in southern Monterey Bay affects the entire shoreline from the Salinas River to Wharf II. The beach-sand mining selectively removes the coarser fraction which requires a greater amount of dune erosion to replace (Section 2.6.1). Consequently, the effect of mining sand from the beach, and the benefit of its cessation are likely greater than the beach-sand mining rates indicate.

The mining of sand from the beach disrupts sand transport, and ultimately results in enhanced beach erosion and loss of habitat needed by sensitive species (e.g. loss of western snowy plover breeding and wintering habitat) and other biological resources. Stopping beach-sand mining would result in increased beach widths, reduced erosion and enhanced beach and dune habitats for shorebirds and other sensitive species, as well as the biological resources that support them.

This Coastal RSM Plan recommends cessation of mining of sand from the beach because of its impact on the regional rates of shoreline erosion. Beach and shoreline erosion is particularly acute at the Sanctuary Beach Resort critical area of erosion. This resort is located approximately one mile south of the sand mine and the erosion rates of the dunes on which it is located are directly affected by the extraction of sand from the beach. Replenishment of the beach in front of the Sanctuary Beach Resort with sand that would otherwise be removed from the system would provide a larger and more effective buffer to waves in front of the dunes, reducing the erosion rate.

After confirming the Marina sand mine production rate, the SMBCEW should continue to explore the mining of sand from the beach and its impact on coastal erosion.

5.2.4 Potential Strategies for Reducing Impacts Associated with Mining Sand from the Beach

One of the primary conclusions of this Coastal RSM Plan is that ongoing mining of sand from the beach is contributing significantly to down coast beach erosion; this section of the report offers several options for addressing this issue, both regulatory and non-regulatory. Mining of sand from the beach is a controversial issue due on the one hand to its potential impacts on the environment, and on the other, its provision of jobs and tax revenue. In order to resolve these issues, options that are mutually acceptable to all stakeholders should be explored. This would include the full support of beach-sand mining property owners, and the general community, including business leaders, government officials, and entities concerned about impacts to endangered species and habitat.

In the first instance, the beach-sand mining property owners should be engaged in discussions as to potential futures for their land. For the wider community, the findings of this Coastal RSM Plan should be given wide distribution through official and media channels. A series of articles could be published in the Monterey Herald newspaper and other media outlets. The local communities and businesses that are particularly adversely impacted, such as the nearby Sanctuary Beach Resort and other tourist communities along the entire southern Monterey Bay shoreline, need to be aware of how the negative impacts of mining sand from the beach are directly affecting them.

In order to provide a context to the current mining of sand from the beach, the history of the current Marina sand mine should be investigated in three main areas.

- The sand mine was started in 1965 by Lone Star Industries, who originally reported to the California State Lands Commission (CSLC) under their general permit for mining. Reporting of the mining amounts from the dredging was stopped in 1967. A question to answer is did the CSLC have jurisdiction over this operation originally.
- In 1982, the City of Marina LCP was certified by the California Coastal Commission. The sand mining policy descriptions in the certified LCP should be examined (Section 8.2.1). The City of Marina annexed part of the plant property in 1986.
- In 1987, Lone Star Industries filed a mining restoration plan, which is available through Monterey County Public Works or the California Mining and Geology Board. This document should be reviewed.

Regulatory Options

U.S. Army Corps of Engineers. The Corps has determined that they do not have jurisdiction over the back-beach sand mining operation at Marina. A jurisdictional determination is conducted prior to the permit review process. In this case, the Corps found that the mining operations did not fall within its jurisdiction. Due to this ‘disclamation’ of jurisdiction, the Corps did not issue a public notice, since it is only required to do so once it is ascertained that a geographic area or activity falls within Corps jurisdiction and the subsequent permitting process. This Corps jurisdictional determination is available for public review upon request.

The Corps determination of non-jurisdiction for the back-beach sand mining may be demonstrably inconsistent with later determinations of jurisdiction the Corps has made (at other beach locations in the San Francisco Corps District) for beach grading and barrier beach breaching to regulate flooding (Peter Baye, personal communication). These determinations indicate that the geographic area in which beach grading and breaching occurs falls within Corps jurisdiction, and the activity of dredging sand from areas that intermittently fall within tidal influence (lagoons that breach) is also within Corps jurisdiction. The mined beach lagoon at Marina has a drift line delineating its edge evident in aerial photographs (Figure 20), and tides in winter capture the lagoon and make it at least temporarily subject to tidal flows. The industrial activity of beach-sand mining and the potential interstate sales of sand (or concrete) obtained from waters of the U.S. supports federal jurisdiction. Hence, the rationale used by the Corps in disclaiming jurisdiction of the beach-sand mining at Marina under Clean Water Act Section 404 and Rivers and Harbors Act Section 10 should be revisited.

California Coastal Commission. Examination of aerial photographs shows that a different dredge with a longer dredge head was introduced at the Marina sand mine sometime after 1979. This allowed deeper dredging and hence increased the dredging capacity significantly. Therefore, the new operation falls under the jurisdiction of the City of Marina, which did not review this significant change in dredging operation. The Marina LCP (Chapter 17.55.040, Section A.4, Permit Limitations) states that ‘no person who has obtained a legal vested right to conduct a surface mining operation prior to January 1, 1976 shall be required to secure a mining permit pursuant to the provision of this chapter so long as such vested right continues, provided that no substantial change is made in that operation except in accordance with the provisions of this chapter.’ This provision is interpreted to mean that a new permit may be required because there was a significant increase in the amount of sand mined from the beach after the introduction of the new dredge after 1979.

U.S. Fish and Wildlife Service. There are many endangered species in the area; for example western snowy plover, black legless lizard, and Yadon’s wallflower. Lone Star Industries did not obtain a take permit for endangered species, such as Yadon's wallflower, which is prevalent in proximity to the sand excavation area (Peter Baye, personal communication). The adverse impacts on endangered species of mining sand from the beach should be investigated under the Endangered Species Act.

Non-Regulatory Options

Alternative mining operation on the property. One alternative to mining sand from the beach could be to mine sand elsewhere on the property outside the littoral zone. It would need to be ascertained if there are sufficient placer sands of the same quality as the beach sands on the property to move the mining operation further landward so as not to ‘take’ sand from the littoral zone. This would be a more expensive mining operation, but would have less of an impact on erosion, and would continue to provide jobs and tax revenue locally.

Purchase the property and/or change the land-use designation. Dialogue with the beach-sand mining property owners could be started to discuss potential purchase and/or change of use. Purchasing the property outright would be expensive, although probably cost effective over the long term. The property could potentially be turned into conservation easement and/or public beaches. Funds would need to be generated for a buy-out. Discussions with land trust organizations (or possibly those entities being economically impacted by aggravated erosion) with a source of funding would need to be initiated if this alternative is to be pursued. The nearby Sanctuary Beach Resort and other affected properties along the southern Monterey Bay shoreline should be encouraged to invest monies in a potential acquisition. Opportunities should also be investigated to use Coastal Commission mitigation fees as another source of funding. For example, the Ocean Harbor House condominiums were required to pay several million dollars as mitigation for the approved seawall project. That money has been earmarked for Monterey Peninsula Regional Park District to purchase dune property.

Alternatives to removing sand from the beach could include development of the property for other uses that would allow the property owners to continue to generate income, jobs and tax revenue. In order to develop the property, the Marina LCP would have to be amended from the present zoned designation within the Coastal Conservation and Development/Coast Permit. One possibility that may be considered is purchase combined with allowing the current owners to retain the rights for development of some portion of the property. This should reduce the purchase price significantly.

5.3 ALLOW DUNE EROSION TO CONTINUE

This ‘no action’ approach allows the natural processes of dune erosion to continue without human intervention. Section 3 shows that within the portion of the littoral cell north of the City of Sand City, there are only two permanent structures or facilities (the Sanctuary Beach Resort and Marina Coast Water District buildings) known to be at risk either on the beach or on top of the dunes. The dunes are also sufficiently wide and high so there is no immediate threat of flooding to the low-lying areas behind the dunes. In addition, erosion of the dunes along this stretch of shoreline is providing large quantities of sand to the littoral system, maintaining the beaches in a healthy condition and providing benefits for sensitive species and habitats (Section 4).

This Coastal RSM Plan recommends that the dunes between Moss Landing and the northern boundary of the City of Sand City be allowed to erode without intervention.

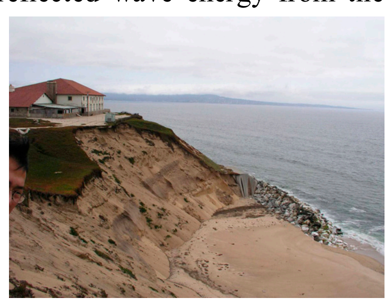
5.4 OTHER POTENTIAL EROSION RESPONSE ALTERNATIVES

5.4.1 Hard Structural Approaches

Hard structural approaches generally refer to armoring the shoreline to prevent erosion, and include seawalls, revetments, and riprap. As coastal development has grown in California, the use of coastal armoring to protect oceanfront property and infrastructure has become more common. For example, ten percent of the entire 1,100 mile coastline of California has now been armored, including 33% of the coastline of the four southern California counties (San Diego, Orange, Los Angeles and Ventura).

Shoreline armoring may lead to physical changes to the beach, ecological impacts, and beach access limitations. Physical impacts include the placement loss of usable beach caused by the footprint of the armoring structure. Armoring prevents erosion of sand from the bluffs that would normally nourish the beach, incrementally increasing erosion potential. Passive erosion is the drowning and narrowing of a beach in front of a structure while adjacent, unarmored shoreline segments continue to retreat (Griggs, 2005). Eventually, a peninsula effect can occur when the armor juts out into the water, impacting alongshore sediment transport, and lateral beach access. In addition, erosion rates tend to be increased at the flanks of the armoring, thus exacerbating erosion of adjacent stretches of shoreline. Armoring also fixes the back beach while the rest of the shoreface erodes. This can change wave energy dissipation and the adjacent shoreline geometry.

Ecological impacts occur primarily from the enhancement of reflected wave energy from the structure interacting with the incoming waves. This active erosion affects the entire sandy beach ecosystem by reducing the distribution and abundance of wrack, sandy beach invertebrates, and shorebirds (Dugan et al., 2008). From a recreational viewpoint, shoreline armoring reduces the usable beach width and over time, on an eroding shoreline, can significantly reduce lateral beach access. There is also the visual impact of most existing coastal protection structures.



One example of historic shoreline armoring in southern Monterey Bay shows the harm associated with this practice as well as the restoration potential when it is removed. Stilwell Hall (inset) was built in the 1940s as the Fort Ord soldier’s club between Sand City and Marina (Figure 1). In 1978, 650 feet of riprap and broken concrete was placed at the base of the bluff to protect Stilwell

Hall from bluff erosion, which was further augmented in 1985 (Figure 34, left panel). The riprap extended out onto the beach (placement loss), reducing the width of the beach in front of the armoring compared to the adjacent beaches. As dune erosion continued on the adjacent shoreline, the beach in front of the structure continued to narrow and disappear (passive erosion), while adjacent to the structure the shoreline and bluff continued to erode. Erosion on the flanks of the structure is increased owing to enhanced energy from waves reflected off the sidewalls of the structure (or bluffs in this case) exacerbating erosion to the shoreline (Figure 34, left panel). Continuing erosion along the adjacent shoreline created a riprap armored peninsula jutting out into the bay, which disrupted public access along the beach as well as reduced alongshore sediment transport. The riprap was eventually removed and Stilwell Hall was torn down in 2004. The now unprotected sandy bluff eroded rapidly during the winters of 2005 and 2006, and has reached a new equilibrium with restoration of the beach in front of the former structure (Figure 34, right panel).

Figure 34. Stilwell Hall Before and After Removal of Armoring

Photo taken: Unknown (pre-2004)	Photo taken: October 28, 2005; California Coastal Records project by Kenneth and Gabrielle Adelman

This Coastal RSM Plan recommends that, whenever possible, soft approaches should be adopted for RSM.

5.4.2 Dewatering

Dewatering is defined as the manipulation of groundwater within the beach to increase natural accretion processes. Beach dewatering works on the principle that if the beach face is dry when the wave runup swashes up the beach, then the water can infiltrate into the beach and deposit sediment. If the beach face is saturated, then the infiltration is limited and sediment is transported off the beach with the receding backwash. Dewatering is an effort to lower groundwater levels to enhance this natural infiltration process. Dewatering can either be active (with pumps and pipes), or passive (without pumps such as the pressure equalizing module - PEM). These dewatering technologies are relatively new to shoreline management and will be investigated as part of the complementary project funded by MBNMS and carried out under the SMBCEW process (Section 1.2.1).

5.4.3 Retention

Sand retention, while often covered under hard structures such as groins or jetties, can also be a soft approach through the use of geotextiles. Retention techniques enhance the ability of the beach to retain sand. They include artificial reefs which can serve dual purposes as habitat and recreation (surfing), and geotextiles placed in a cross–shore orientation acting as 'soft' groins, which can accumulate sand on their up coast side while still enabling sediment to overtop, thus avoiding some of the down coast impacts associated with harder groins and jetties. Retention techniques may be investigated as part of the associated MBNMS project (Section 1.2.1).

5.4.4 Bluff Top Development Set Back

Bluff top set back is a technique for locating new development so that it can be safe from erosion and slope failure for some identified time period. Normally the set back is established by determining where the facility can be placed at present, so that it will have an acceptable factor of safety (FS) against slope instability and add to that both the anticipated amount of erosion over the identified time period and a buffer. After the identified time period is over, the facility can be expected to be at risk from erosion and there will be the future question about whether the development should be removed or whether it should be protected. In order to secure the future of new development along southern Monterey Bay this Coastal RSM Plan recommends:

- consideration of an extended planning horizon of 100 years for large cost or long-term projects be incorporated into revised Local Coastal Programs. This planning horizon, however, is not recommended for narrow, urban beach areas adjacent to Highway 1 where a 100 year set back standard would be impractical. This pertains specifically to the coastal zone along the incorporated City of Sand City. Sand City's existing, certified LCP and related Memorandum of Understanding with the Park agencies establishes a 50-year erosion set back and also allows limited, visitor-serving and residential development.
- development of a strong set back ordinance in the Land Use Plans for oceanfront development that puts high use facilities at an appropriate distance from the ocean.

6. POTENTIAL SEDIMENT (SAND) SOURCES

The potential beach nourishment strategies outlined in Section 5.1 require sources of sand. This section investigates and characterizes potential sources of sediment for beach nourishment including:

- areas of excess sediment such as harbors and wetlands, where sand must be removed to restore function
- flood control projects such as dams and reservoirs where sand may become available as a result of dredging or excavation to restore capacity or close a dam
- inland commercial sand sources, which may become available during new development projects
- dunes at Fort Ord
- offshore sand.

Three main criteria are used as an initial basis for screening source locations; availability of large quantities of beach compatible sand, levels of contamination, and the location of the source relative to the potential southern Monterey Bay receiver site. Sediments with contamination are typically eliminated from further consideration for beach nourishment. Potential sources are then targeted, using the Tier I evaluation criteria of the Sand Compatibility and Opportunistic Use Program (SCOUP) Plan (Moffatt and Nichol Engineers, 2006), for more detailed compatibility studies.

The characteristics of the available source sediment are important in the design of beach nourishment strategies (CDBW and SCC, 2002). The source sediment should be similar in particle size (or larger) to the receiver site, so as to behave in a similar way to the natural beach sediment. Source sediments must be free of harmful chemical and biological contamination. Sediment is appropriate for placement on the subaerial beach if it is sand or possibly gravel, and is found in areas of high energy. Testing protocols for contamination are set out in the Inland Testing Manual (USEPA and Corps, 1998). Sediment that is placed on the beach should contain only a small mud fraction, whereas sediment with a higher percentage of fines or smaller sand particle sizes may be appropriate for placement in the nearshore.

To evaluate source-receiver site particle size compatibility, it is important to determine two parameters; the littoral cell cut-off diameter (LCD) of the receiver site (Limber et al., 2008), and the particle size distribution of the source sediment compared to the composite particle size envelope of the receiver site (Moffatt and Nichol Engineers, 2006).

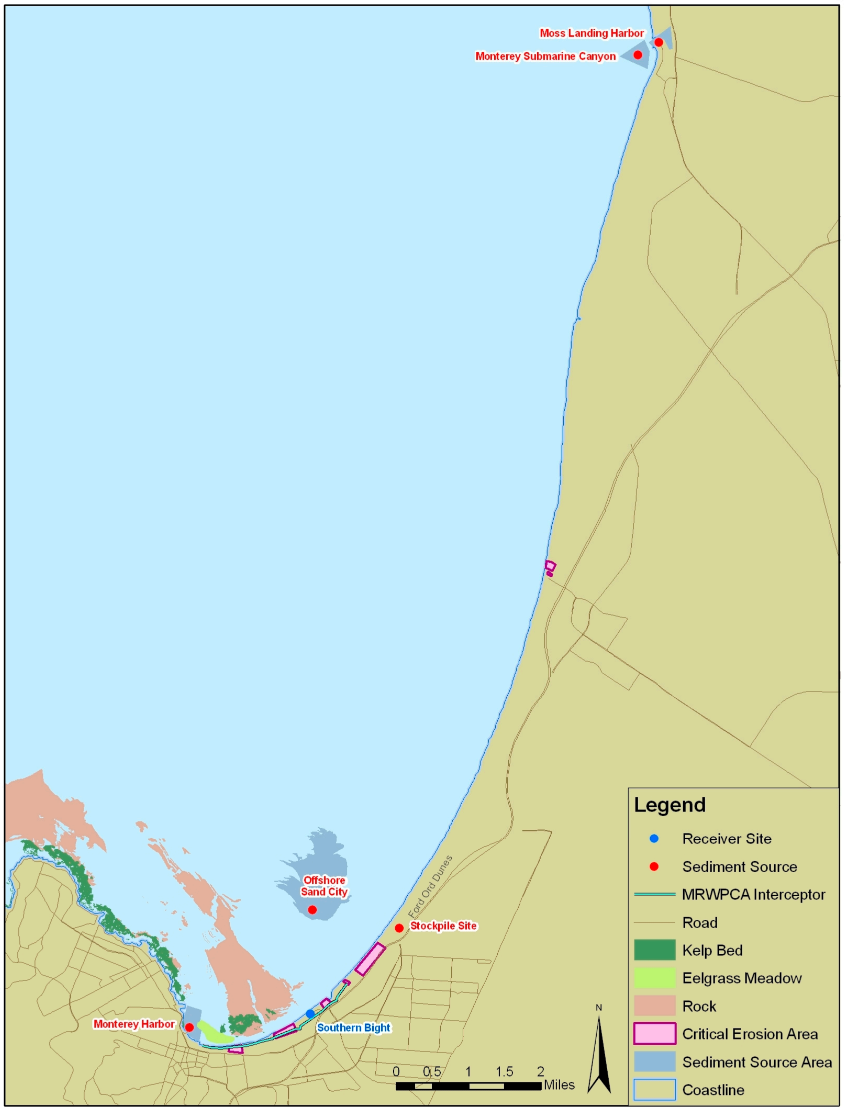
The LCD is the particle size diameter of the sediment below which it is generally removed from the beach to leave only the sediment with particle sizes greater than the cut-off diameter. The

LCD is strongly controlled by wave energy. Typically, fine-grained sand in the particle size range 0.063 to 0.125 mm does not remain on the exposed beaches of central California because they are high-energy wave environments. For potential beach nourishment projects the LCD is important because any sediment finer than the cut-off that is placed on the dry or subaerial beach would likely move offshore, driven by wave processes. However, finer sands could be placed in the nearshore, where they would support the overall receiver site profile.

Moffatt and Nichol Engineers (2006) recommended determination of a composite particle size envelope to characterize the surface sediment at the receiver site, bracketing the range of particle sizes, from the coarsest to finest fractions (LCD). They also recommended characterization of the wider littoral zone around the footprint of placement in order to understand how the sand may disperse once placed. If the sand gradation of the source falls within the receiver site composite particle size envelope, then the source and receiver sites are compatible with respect to particle size.

In this Coastal RSM Plan, available information was collated on the physical and chemical characteristics of the potential source sediments. The essential data include particle size, and chemical signatures (metals and other analytes). This is defined as a Tier I analysis in the SCOUP (Moffatt and Nichol Engineers, 2006). From these data, provisional recommendations are made regarding the suitability of the source sediments for placement at the potential receiver site, which should then be carried forward into a more detailed Tier II analysis. Tier II analysis requires sampling and testing for particle size distribution, chemistry, and physical properties, at each of the source sites and the potential receiver site providing a definitive statement regarding the suitability of the source sediments for placement at the receiver site. The Tier I analysis carried out for this Coastal RSM Plan targets five potential sources of sand for beach nourishment, which are described in Sections 6.1 to 6.5 (Figure 35). These locations are also available as GIS data files in CSMWs GIS database.

Figure 35. Location of Potential Sediment (Sand) Sources



Source: Location of eelgrass from Zimmerman et al. (2001). Location of kelp from CDFG. Location of rock of sediment source area from the Sanctuary Interactive Monitoring Network (SIMoN). Location of pipeline provided by Jennifer Gonzalez (MRWPCA)

6.1 HARBORS AND WETLANDS

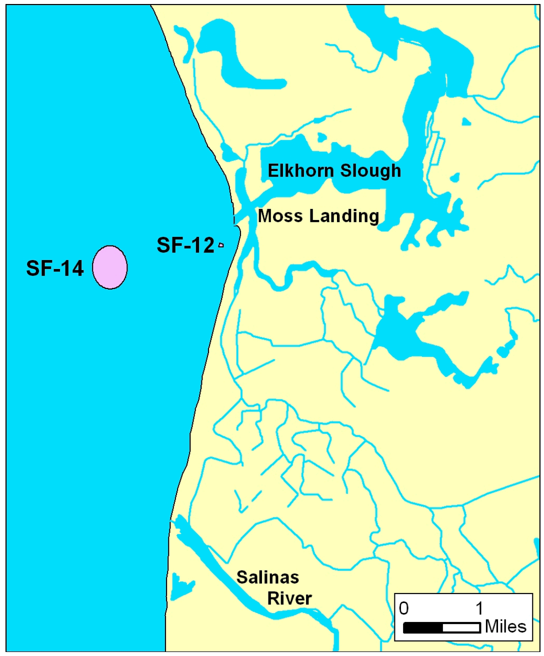
Three coastal harbors are situated in Monterey Bay: Santa Cruz, Moss Landing, and Monterey. Each harbor dredges sediment to keep their navigation channels and berths open for safe passage of commercial fishermen, recreational fishermen, and boaters. Moss Landing Harbor and Monterey Harbor are within the southern Monterey Bay littoral cell (Figure 35) and considered potential opportunistic sources of sand. Santa Cruz Harbor was not considered further because it is within another littoral cell and the vast majority of the sand is being used to successfully nourish beaches immediately down coast in the same cell. No surplus sand would be available for nourishment of southern Monterey Bay beaches without negatively impacting Santa Cruz beaches. No wetlands with compatible sand for beach nourishment are identified in this Coastal RSM Plan.

6.1.1 Moss Landing Harbor Entrance Channel

The U.S. Army Corps of Engineers and Moss Landing Harbor District have conducted maintenance dredging of Moss Landing Harbor (inset) since it opened in 1947. Sediment samples collected for the Environmental Assessment for maintenance dredging of the harbor in 2007 (Corps, 2007) showed that sediments in the entrance channel are greater than 90% (medium) sand and free of contaminants. Sediments further into the harbor are predominantly fine-grained (83-98% silt and clay), approximately 90% of which were contaminant-free in 2007. The primary sediment contamination issue at Moss Landing is chemicals from erosion of agricultural soils in the watershed. Soil loss from the surrounding land results in sediment deposition on roads, drainage channels, and ultimately into the harbor. In addition, Moss Landing Harbor provides haven to over 600 vessels year round, some of which may dispose wastewater into the harbor, or be subject to minor accidental oil spills during routine maintenance. However, chemical testing by Corps (2007) for metals, pesticides (including DDT), and PAHs, showed that the majority of the samples were below the threshold limit for aquatic disposal suitability.

Uncontaminated dredged finer-grained sediments (greater than 20% mud) from Moss Landing Harbor are disposed at two offshore unconfined discharge sites (SF-12 and SF-14) within the boundaries of the MBNMS (Figure 36). When the dredged sediment contains less than 20% fines, it may be placed at a beach disposal site adjacent to the south jetty. Moss Landing Harbor has typically dredged approximately 50,000 yd^3 of sediment every three years, although the present permit (California Coastal Commission Permit 3-01-049) allows up to 100,000 yd^3/year to be removed. Sand in Moss Landing Harbor is not abundant (Corps, 2007) and if used for beach nourishment purposes in the southern bight, would need to be supplemented with sand from other sources.

Figure 36. Moss Landing Harbor Dredge Disposal Sites within the MBNMS

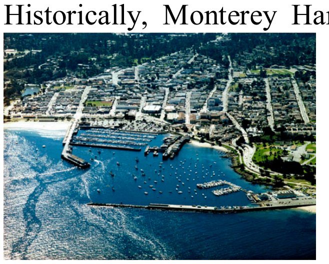


Source: MBNMS

Given that the Moss Landing Harbor entrance channel sediments meet the Tier I particle size and contamination requirements, the main constraint on their use to nourish southern Monterey Bay beaches is that the sand is already placed on the beach adjacent to the harbor. With additional transportation costs, this sand could be placed elsewhere in the southern Monterey Bay littoral cell. Therefore, Moss Landing Harbor entrance channel has the potential to be a source of sand and is recommended as a target for more detailed Tier II compatibility analysis. It should be noted that Elkhorn Slough (adjacent to Moss Landing Harbor, Figure 36) is rapidly eroding and therefore may also be targeted for receipt of dredged sediments. In addition, placement of sand from Moss Landing Harbor in the southern bight would require modification of the MBNMS Harbors and Dredge Disposal Action Plan for permitting purposes (Section 8.1.1).

6.1.2 Monterey Harbor

Historically, Monterey Harbor (inset) has been dredged approximately every 7-8 years with



removal of around 4,000-10,000 yd^3 of sediment from the main channels. Most of the sediment has been placed either in shallow water immediately adjacent to Wharf II or on the beach above MHW (Steve Scheiblauer, Monterey Harbormaster, personal communication). Approximately 2,000-3,000 yd^3 of the sediment was placed inland. In the future there is the possibility of a dredging operation to remove up to 75,000 yd^3 from the entire harbor basin. The intention would be a complete dredge of the berths and main channels to last for 40 years. Because of its complexity, particularly in obtaining permits to dispose of the sand, this dredging is unlikely to take place before 2010-2011.

Monterey Harbor is a potential source of sand for nourishment of the southern Monterey Bay beaches of Sand City, Seaside, and Monterey. The sediment infilling the harbor is locally derived from around the Coast Guard Pier breakwater, from three runoff outfalls within the harbor, and from an overflow runoff pipe just inside Wharf II. Little sand in the harbor appears to be derived from Del Monte Beach to the east. Monterey Harbor sediments may have potential for minor contamination including agricultural chemicals from runoff, and wastewater and oil discharge from vessel operations.

Sand from Monterey Harbor is not plentiful and would provide only a very small portion of the necessary volume to significantly nourish the southern bight, and would therefore need to be supplemented with sand from other sources. However, Monterey Harbor is recommended as a target for more detailed Tier II compatibility analysis. The AMBAG should coordinate with Monterey harbormaster about near-term dredging activities and the potential use of the sand for beach nourishment.

6.2 FLOOD CONTROL PROJECTS

6.2.1 Sediment Impounded by Dams

There are three dams along the main tributaries of the Salinas River that have sediment accumulated in the reservoirs behind them (Salinas, Nacimiento and San Antonio). Two more dams (San Clemente and Los Padres) are located along the nearby Carmel River but in a different watershed. None of the sediment bodies impounded behind these dams are considered potential sources of sand, for these reasons:

- the reservoirs on the Salinas River and behind Los Padres Dam contain sediment with a high percentage of mud, and so are unsuitable for beach nourishment purposes
- the Salinas Dam is approximately 120 miles from southern Monterey Bay, and the Nacimiento and San Antonio Dams are approximately 80 miles, so transportation of sand would be uneconomical
- although the particle size characteristics of the San Clemente Reservoir sediment may be compatible they are derived from granite rocks in a different watershed and would be unsuitable in terms of mineralogy and/or color (inset)
- although the San Clemente Dam is only 20 miles by road from southern Monterey Bay, it is remote, and access to the source sediment would be difficult, and transporting the sand by truck to southern Monterey Bay would be expensive (approximately \$20-\$30 per yd^3).

This cost is approximately two to three times higher per yd^3 than the most expensive offshore source (Section 7 provides results of economic analyses for offshore sources).

6.2.2 Salinas River Sand Bar Breaching

In order to prevent flood damage to the surrounding floodplain areas, Monterey County Water Resources Agency periodically removes part of the sand bar fronting the Salinas River mouth. A ten-foot wide notch is cut through the bar to allow water at high tide to pass over the bar and begin a process of scour which eventually creates a breach 150-200 feet wide. The notch is cut with an excavator which disposes the sediment adjacent to the notch. No sand is removed from the littoral cell during excavation and hence no new sand becomes available for nourishment purposes.

6.3 INLAND COMMERCIAL SITES

The SCOUP Plan (Moffatt and Nichol Engineers, 2006) provides a generic list of potential inland sources of beach quality sediment, including:

- road and railway construction
- landslides
- quarries
- commercial and residential development.

Currently there are no future major roads or railway construction projects identified in proximity to southern Monterey Bay, and in general most of the sediments yielded through these construction activities would not be suitable for beach nourishment purposes. However, routes that cut through coastal terrain comprised of marine sedimentary deposits may yield beach-compatible sand. In addition, landslides wouldn't likely provide beach-compatible sand or in quantities large enough to consider. However, slides in uplifted marine deposits in coastal regions may prove to be possible sources. Quarried sand and gravel may provide appropriate sediments. Development activities, if conducted in marine terrace or dune fields, could also yield beach compatible sand. These sources would only become available opportunistically and possibly not at a time suitable for immediate use. Hence, the sediment would require relatively rapid identification and characterization to determine compatibility with receiver sites, and then stockpiled for future nourishment needs.

6.3.1 Stockpiling

In order to temporarily store beach-compatible sand from opportunistic inland sources (and potentially from offshore if the nourishment is phased) requires a stockpile site. This Coastal RSM Plan suggests two potential stockpile sites:

- Fort Ord where there are many acres of unused land (recommended, Figure 35)

- a large pit, approximately 600 feet by 450 feet by 90 feet deep, at the north end of Sand City.

For the Fort Ord option, the AMBAG would need to approach the Fort Ord Reuse Authority (FORA) and the County of Monterey to receive permission. The Fort Ord site is large, accessible, and local to the southern bight (the southern end of Fort Ord is adjacent to Sand City), and hence transportation by truck of the stockpiled sand along established routes (Highway 1 and access roads) to the placement area would be relatively straightforward.

The alternative location in north Sand City is between Highway 1 and the shoreline and is a former sand mining pit. This site could accommodate approximately 1,000,000 yd^3 of sand.

Although no inland commercial sites with compatible sediments for beach nourishment are identified in this Coastal RSM Plan, it is recommended that the SCOUP process secures part of Fort Ord as a stockpile site where sediment can be stored and accumulated to the appropriate volumes for nourishment projects.

6.4 DUNES AT FORT ORD

There are over 40 square miles of sand dunes (inset) in southern Monterey Bay south of the Salinas River that extend inland as far as five miles at Fort Ord. The dunes north of the Salinas River are less extensive, narrower, and consist of several smaller complexes that total just under nine square miles. Thus, the total southern Monterey Bay dune area is about 50 square miles with 80% of this lying south of the Salinas River mouth (Cooper, 1967).

Although the particle size of the dunes is finer than the beach, the data suggest a potential 76% retention on the beach and shoreface of sediment eroded from the dune bluffs (Section 2.3.3). With over 40 square miles of sand dunes adjacent to the shoreline, derived originally from the beach, they are a large potential source of sand for nourishment of the southern Monterey Bay beaches (Figure 35). There are significant areas of dune sand within Fort Ord that have been disturbed, and do not contain endangered species, that would provide large quantities of compatible sand. Extraction of dune sand would need to be far enough inland of the dune edge so as not to remove sand that would otherwise supply the beaches through dune erosion over the next 50 years. The sand dunes within the Fort Ord complex are recommended as a target for more detailed Tier II compatibility analysis.

6.5 OFFSHORE LOCATIONS

Large volumes of sand exist offshore in southern Monterey Bay (Dorman, 1968; Combellick and Osborne, 1977; Reid et al., 2006; Smith et al., 2007). Offshore sand is a potential source that could be dredged and placed either on the beach or in the nearshore, where it can become part of the littoral cell. The main opportunities with offshore sources include relatively low cost, high placement rates on the receiver beach, and minimal disturbance onshore while the project is underway. One major constraint is that the offshore of southern Monterey Bay is part of the MBNMS, and dredging of the sand may be a complex issue due to a Sanctuary prohibition on alteration of the seabed. However, these activities can be permitted if it is determined that their impacts are neither significant nor long term (Section 8.1.1).

Textural analyses of the offshore surface sediments in southern Monterey Bay reveal major sandy environments based on particle size. The delineation of particle size variations in offshore zones is critical for identifying appropriate source sands for potential beach nourishment. The offshore sand environments of southern Monterey Bay that are potential sources include:

- Monterey Submarine Canyon
- a zone of sand offshore from Sand City
- a nearshore relict sand corridor

6.5.1 Monterey Submarine Canyon

The upper 2.5 miles of Monterey Submarine Canyon experiences both local deposition due to supply from adjacent littoral cells and erosion due to slope failure and landslides (Smith et al., 2007). Frequent episodes of sediment build-up and subsequent down-slope failure transport littoral sediments from the Canyon rim to deeper in the Canyon, where sediment is stored. Hence, the upper Canyon is a temporary storage site for sand.

A study is being undertaken by the U.S. Army Corps of Engineers to examine the feasibility of capturing littoral sediments adjacent to canyons (Moffatt and Nichol Engineers, 2008). Of all the canyons along the California coast, the two identified with the most potential were Monterey and Mugu Canyons. Monterey Submarine Canyon meets three important criteria used in the analysis:

- it meets the minimum critical capture rate of greater than 10,000 yd^3/year, determined to be economically worth pursuing
- the location of the sand to be captured is relatively near a critical coastal erosion area as identified by CSMW (southern Monterey Bay)
- there is an additional benefit that the nearby and eroding Elkhorn Slough, a federal reserve, is in need of sediment.

Several means to recover sediment from Monterey Submarine Canyon were considered in the feasibility study. First, the sand that has already been lost down the Canyon could be extracted. Second, it may be possible to intercept the sediment as it moves towards the Canyon head and redirect it back into the littoral system. Several interception alternatives were considered by Moffatt and Nichol Engineers (2008):

- use the Moss Landing north jetty to intercept sediments with an array of stationary jet pumps attached to the breakwater
- a jet pump on a moveable crane on the Moss Landing breakwater
- an offshore breakwater on the south side of the Canyon to impound sediments and provide shelter for a dredge
- use a hopper dredge to create an offshore pit south of the Canyon to serve as a sand trap for future extraction of sand.

The offshore pit approach was suggested to have the least environmental impact with the best benefit-cost ratio for providing sand that could be used for beach nourishment in the southern bight. Identifying an appropriate offshore pit location closer to the critical erosion areas, between the Salinas River Mouth and the Canyon head, could reduce transport costs.

Monterey Submarine Canyon is a large potential source of sand for nourishment of the southern Monterey Bay beaches. Given the proximity of the Canyon head to the nearshore zone (Figure 3), sediment in its vicinity should match the sediment characteristics of the adjacent littoral cell, and be a suitable source with respect to particle size and chemistry. The volumes available are probably sufficient to nourish all the critical erosion areas of Sand City, Seaside, and Monterey. The Monterey Submarine Canyon is recommended as a target for more detailed Tier II compatibility analysis.

6.5.2 Zone of Sand Offshore from Sand City

The possibility that sand is moving offshore from a probable alongshore convergence zone in the vicinity of Sand City (Section 2.2.3) should be investigated in more detail. This repository for sediment could be a potential zone for obtaining sand for beach nourishment purposes. Dorman (1968) and Combellick and Osborne (1977) showed the offshore zone to be comprised of medium sand (particle size 0.25-0.5 mm) (Figure 15). Reid et al. (2006) compiled particle size data for the Pacific coast including southern Monterey Bay. Their data offshore from the southern bight shows a grouping of surface samples in the 0.3 to 0.5 mm mean/median particle size range (medium sand) in a similar location to the medium sand zone of Dorman (1968) and Combellick and Osborne (1977). Particle size data from the offshore zone is presented in Table 15 (Reid et al., 2006).

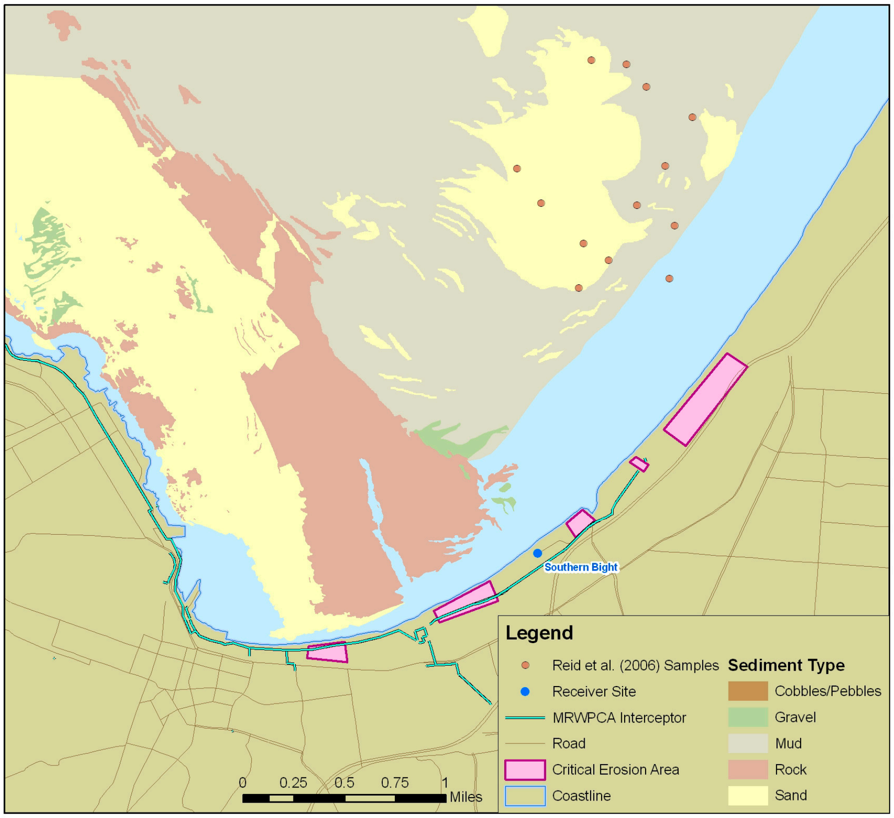
Table 15. Particle Size of Sand Offshore from Sand City (Reid et al., 2006)

Latitude[1]	Longitude[1]	% sand	Particle size[2] (mm)
36.64240	121.85500	100	0.38
36.64040	121.85080	100	0.31
36.63683	121.85300	100	0.27
36.63610	121.86610	99	0.31
36.63370	121.86380	100	0.35
36.62780	121.86010	100	0.31
36.63100	121.85990	100	0.33
36.64410	121.86000	99	0.50
36.64390	121.85690	100	0.33
36.63390	121.85530	100	0.47
36.63260	121.85190	100	0.47
36.62880	121.85210	100	0.33
36.62990	121.85760	100	0.33

[1]Location of samples is shown on Figure 37.
[2]Particle size reported as either mean or median.

Data compiled by the NOAAs National Coastal Data Development Center presented as part of the Sanctuary Interactive Monitoring Network (SIMoN) interactive map series also shows a large patch of sand in a similar location to the Combellick and Osborne (1977) and Reid et al. (2006) data sets (Figure 37). The locations of sediment samples taken by Reid et al. (2006) are also shown on Figure 37.

Figure 37. Offshore Sediment Types



Source: Location of sediment types from the Sanctuary Interactive Monitoring Network (SIMoN). Location of pipeline provided by Jennifer Gonzalez (MRWPCA)

The particle size of these offshore sands appears compatible with the southern Monterey Bay beach sands and therefore they are a potential source of sand for beach nourishment. The zone of sand offshore from Sand City is therefore recommended as a target for more detailed Tier II compatibility analysis.

6.5.3 Nearshore Relict Sand Corridor

Relict medium to coarse sand occurs on the inner shelf of southern Monterey Bay as irregularly shaped depressions, approximately three feet deep out to water depths of 200 feet. In shallower water depths of 30-60 feet, these medium-coarse sand trend parallel to the shoreline as bands 60-300 feet wide, alternating with bands of fine-medium sand that are of similar width (Hunter et al., 1988). The medium-coarse sands have a mean particle size of 0.35-1.0 mm, and the fine-medium sands have a mean particle size of 0.125-0.35 mm. Further offshore, patches of the medium-coarse sand are exposed through an overlying mud layer. The source of the sand may be a pre-Flandrian transgressive lag deposit underlying much of the shelf (Chin et al., 1988). It would appear that these coarse sands do not move onshore and contribute to the sand budget, so they may be a potential source of sand for beach nourishment.

6.6 SEDIMENT (SAND) SOURCE SHORT-LIST

The Tier I screening of potential sand sources for beach nourishment did not identify any suitable opportunistic inland sources. A regional stockpile area somewhere on Fort Ord close to the southern bight is recommended to allow accumulation of appropriate sediment of opportunity to a volume sufficient for a nourishment project, should it become available. The dunes at Fort Ord may themselves provide a suitable source. Of the three harbors in Monterey Bay, Moss Landing Harbor entrance channel and Monterey Harbor contain sand that could potentially be beneficially reused. Potential offshore sand sources include the area between the Salinas river mouth and head region of Monterey Submarine Canyon, and the shelf offshore of the transport convergence zone at Sand City.

In this Coastal RSM Plan, five potential sources of sand are recommended and prioritized for more detailed Tier II compatibility studies.

- **Shelf offshore from Sand City**
- **Sediment captured before entering Monterey Submarine Canyon**
- **Fort Ord dune field**
- **Monterey Harbor**
- **Moss Landing Harbor entrance channel**

All of the potential sand sources for nourishment of the beaches in southern Monterey Bay are in coastal and nearshore locations. It is anticipated that the feasibility of using sand sources from much further inland to nourish the southern Monterey Bay shoreline may change. Feasibility may increase due to increased value of sand for nourishment if future erosion is large enough. Consequently, the feasibility assessments in this Coastal RSM Plan should be updated, as appropriate, in the future.

6.7 ENVIRONMENTAL IMPACTS AT POTENTIAL SOURCE AREAS

Dredging in subtidal sandy habitats to obtain sand for beach nourishment disturbs and removes benthic habitat and results in elevated turbidity (NRC, 1995; Green, 2002) with potential impacts to invertebrates and fish in nearshore and offshore environments. Borrow site dredging removes sediment and associated benthic organisms and has the potential to entrain organisms as a result of near-bottom water being withdrawn by suction dredgers. Generally, complete mortality is assumed for dredge-removed and/or entrained organisms, although a small percentage may survive depending on discharge location (LaSalle et al., 1991).

Recovery of benthic communities following borrow site dredging varies depending on sediment infill rates, hydrodynamics, and dredging method, but can be protracted (SAIC, 2008). In Monterey Bay, Oliver and Slattery (1976) found that dredging in channel areas removed 60% of the benthic animals. Abundance remained low 1.5 years after dredging, but indices of species diversity and evenness were higher than before dredging. They suggested that the timing of dredging in relation to the reproductive cycles and distributive abilities of the benthic organisms in the area affects recovery.

6.7.1 Mitigation Measures

Recovery of benthos may be facilitated by shallow dredging over a larger area rather than creation of deep pits covering a limited area. Dredging shifting sands rather than more stable bottoms, retaining similar surface sediment type, and leaving undisturbed areas within the larger dredged area may also reduce disturbance (Thompson, 1973; Oliver and Slattery, 1976; Hurme and Pullen, 1988; Diaz et al., 2004).

7. ECONOMIC FEASIBILITY OF BEACH NOURISHMENT

7.1 POTENTIAL BEACH NOURISHMENT ALTERNATIVES

This Coastal RSM Plan describes two potential alternatives for nourishment of the southern bight beaches (Table 16):

- Alternative 1: small-scale nourishment using Monterey Harbor as a sand source
- Alternative 2: large-scale nourishment using offshore sand sources.

Alternative 1 considers the use of opportunistic sand sources from Monterey Harbor to nourish the shoreline of Sand City, Seaside, and Monterey. Approximately 75,000 yd^3 of sand may become available from dredging of the harbor for placement on the beach (Section 6.1.2). Sand would be placed at a location (or locations) away from the rocky reef, kelp forest and eelgrass meadow (if still present) and be allowed to spread along the shoreline through sediment transport processes (this Coastal RSM Plan recommends a receiver site between Monterey Beach Resort and Ocean Harbor House condominiums, Figure 32). For the purposes of estimating the economic benefits of the nourishment (using a volume of 1.7 yd^3 of sediment to nourish one square foot of beach), the increase in beach width along three miles of the southern bight would be approximately three feet.

Alternative 2 is a scenario in which large-scale extraction of sand from offshore sources (offshore Sand City or Monterey Submarine Canyon head) is placed in the southern bight, either as a nearshore or beach placement. Sand would be extracted and transported using a hopper dredge, and be placed at one or more locations (a recommended site is between Monterey Beach Resort and Ocean Harbor House condominiums) in the southern bight away from sensitive habitat. To increase the width of a three-mile equilibrium beach by 75 feet would require approximately two million yd^3 of sand.

Two methods of sand placement are considered for Alternative 2; subaerial placement (directly onto the beach); and nearshore placement (in the surf zone). Placement onto the beach creates a wider beach more quickly but is relatively expensive as additional equipment and time is required to move the sand onshore. Nearshore placement simply involves depositing the sand on the seabed as close to shore as feasible, which then takes longer to be worked onto the beach (by wave action). The relative merits of these approaches are further described in Section 5.1. Alternatives using Fort Ord sand dunes or the stockpile site as potential sources are not tested in this Coastal RSM Plan.

Table 16. Potential Beach Nourishment Alternatives for Southern Monterey Bay

Alternative		Receiver Site	Shore Length (miles)	Equilibrium Width (feet)	Required Volume (yd^3)	Source Site	Excavation / Dredge Method	Transport Method	Placement Method
1a	**Southern Bight Small**	South Sub-cell	3	3	75,000	Monterey Harbor Opportunistic	Hopper Dredge	Hopper	Hydraulic Discharge to Beach
b									Place in nearshore
2a	**Southern Bight Large**			75	2,000,000	Offshore Sand City			Hydraulic Discharge to Beach
b									Place in nearshore
c						Canyon Head			Hydraulic Discharge to Beach
d									Place in nearshore

7.2 APPROACH TO ECONOMIC ANALYSIS

At this regional scale of analysis the intention is not to determine exact costs and benefits for funding and approval purposes, but to determine the likely economic viability of proposed alternatives. If it can be determined that an alternative is likely to have a benefit to cost ratio robustly greater than 1 (i.e. benefits are greater than costs) then it can be considered viable and appropriate for further investigation and development, as part of the regional planning process.

Costs for the beach nourishment alternatives and recreational benefits of the nourishment have been calculated using a decision support tool developed for CSMW. Benefits associated with prevention of erosion, and hence protection of coastal assets, have been calculated using property values provided by the Monterey County Property Assessor and the Monterey Regional Water Pollution Control Agency (MRWPCA).

The analysis has been carried with the assumption that no future actions, such as constructing new or replacement seawalls or other structures, take place and, furthermore, that existing structures will become ineffective in the absence of additional sand nourishment to protect them beyond their design lives. The assessment of economic benefits is for beach nourishment alone and is not a full analysis of shore protection options. The U.S. Army Corps of Engineers may engage in a more rigorous benefit-cost analysis if/when they conduct a feasibility study for potential beach nourishment projects and will likely determine different benefit-cost ratios for potential projects as a result.

7.2.1 Application of the Coastal Sediment Benefits Analysis Tool

The benefit-cost analysis for beach nourishment in this Coastal RSM Plan uses the Coastal Sediment Benefits Analysis Tool (CSBAT) developed by CSMW (Corps, 2008). The tool is populated with data from southern Monterey Bay to investigate the economics of the small-scale and large-scale alternatives summarized Table 16.

CSBAT was originally developed for use in San Diego County, and the southern Monterey Bay application represents the first outside San Diego. The tool focuses principally on the value of recreational benefits arising from beach nourishment. Consequently, it uses a range of data on both the physical attributes of the source and receiver sites and the economic value of beach visitors.

Where possible, data specific to southern Monterey Bay has been obtained and used in the analysis; however there has been limited study of the economics of beach use in this area, so average and pro-rated values from the San Diego application have been used for many of the attributes. This application of analogous data (from another site within the state) in the absence of locally specific data is considered valid for a regional planning assessment such as this, where it is necessary to determine the likely viability of beach nourishment alternatives. Details of the input data used to run CSBAT and the full outputs are provided in Appendix C. The data provided in Appendix C only considers recreational benefits calculated by the CSBAT tool. The data does not include the benefits provided by beach nourishment to the protection of built assets.

The CSBAT tool allows the user to appraise various beach nourishment alternatives through different combinations of sediment source location, receiver site location, volume of sediment, and mode/s of transportation. Using background attribute data such as unit costs, beach visitor numbers, and other parameters, the tool produces reports containing information such as baseline data on the sites, estimated beach nourishment costs, change in recreational benefits, projected increases in spending and tax value, potential environmental impacts, estimated change in beach width, and cumulative cost/benefits using various transportation routes and scenarios.

The calculation of economic benefits within CSBAT is based on potential changes in the amenity/recreation value of the beach. These benefits are derived from increased visitor numbers due to increased capacity on the wider (post-nourishment) beach, the associated increased visitor spend, increased taxation on that spend, and increased recreational 'value' (economic equivalent of the recreational benefit) derived by visitors because of a wider beach. The increase in economic benefit caused by increase in visitor numbers is calculated using King (2001), where visitor surveys at a number of southern California beaches showed that in general respondents preferred wider beaches and would attend wider beaches more often. From the results of King (2001) and the analyses for the San Diego application of CSBAT, it was concluded that doubling beach width would increase attendance by 2.5% and recreational value (per visitor) by 18%. This is an underlying assumption in the CSBAT analysis.

The tool can calculate changes in beach width and hence visitor numbers and recreational benefits for up to a 20 year period from the original beach nourishment. Over time the placed sand spreads laterally along the shoreline, and this process combined with ongoing erosion gradually reduces the width of the beach and hence the additional recreational benefits provided by the nourishment. The tool considers that a 20-year period is a reasonable maximum duration of the positive affect of the nourishment on beach widths.

One of the most important benefit inputs for the CSBAT analysis is beach visitor numbers. Table 17 presents observed visitor numbers from 1995 to 2007 for Monterey State Beach in the southern bight. They show a large degree of fluctuation from year to year, with lower numbers in the early part of the record rising to peaks in excess of one million visitors (2002) before settling to a more consistent level in recent years. CSBAT uses an average annual attendance figure for benefit estimates, so in order to define a value relevant to current beach usage, an average from the last five years has been used. Using the 2002-2007 data avoids the large fluctuations in the earlier years, and is more representative of the present day beach use. The average visitor numbers used in the CSBAT analysis are 644,677 for Monterey State Beach.

Table 17. Annual Visitor Numbers for Monterey State Beach

Year	Number of Visitors
1995	107,946
1996	131,340
1997	251,994
1998	258,771
1999	919,104
2000	457,161
2001	493,170
2002	1,259,688
2003	841,461
2004	834,850
2005	598,204
2006	534,322
2007	414,548
Mean Last 5 Years	**644,677**

On the costs side of the analysis, generic cost rates defined for the San Diego application of CSBAT are used. It is recognized that the actual cost rates in southern Monterey Bay may be different from those in southern California; however it is considered appropriate to use these rates for this regional plan, as they are adequate to assess the overall economic viability of the nourishment alternatives.

7.2.2 Estimation of Protection Benefits

The CSBAT tool does not calculate the economic benefits arising from the protection of infrastructure and built assets. However, beach nourishment projects not only provide wider amenity beaches, but also slow the rate of beach/dune erosion. Nourishment projects prevent the loss of assets located within areas vulnerable to erosion and depending on the nature and location of coastal development and infrastructure, this can be a major contributor to the overall benefits.

Values for the majority of assets (facilities) at risk of erosion (Section 3) were obtained from the records of the Monterey County Property Assessor. The data provided locations of all property parcels together with value data for all taxable properties. GIS mapping of parcel locations is linked to a database with various property details, of which land value, improvement value (buildings/structures), and land use code, were used in this analysis.

The land and improvement values are summed to create a total asset value for the purposes of the erosion analysis. Where the land use code indicated that the asset was publicly owned no values were provided as they are not taxable uses. Several of the most important built assets are the Monterey Interceptor pipeline and the pump stations associated with the pipeline. Estimates of the replacement value of this infrastructure were obtained from MRWPCA. Approximately five years ago MRWPCA undertook an analysis of the Salinas Interceptor and concluded that a replacement cost of $600-700 per linear foot would be appropriate for that 36 inch-diameter pipeline. The Monterey Interceptor is 24 inches in diameter and in larger sections, and it was recommended that $600/foot be used for replacement, taking into account local ground conditions, access and property issues (Jennifer Gonzales, MRWPCA, personal communication). In addition, an estimated replacement cost of $75 million was recommended for Seaside Pump Station. The recreational benefits of increasing the width of the public beach under which the privately-owned pipeline is located are considered using the CSBAT tool (Sections 7.2.1 and 7.4.1).

Beach nourishment generally has a finite life and only acts to delay the erosion process. Consequently, the true value of the protection benefit is the value of the delay in loss of an asset. The process of evaluating this delay requires the definition of likely time scales for loss due to erosion with and without nourishment, then application of a discount rate to determine the present value of that benefit. The potential timescale until loss of facilities without any beach nourishment are provided in Section 3.3. It was then assumed that nourishment using 2,000,000 yd^3 of sand would delay the onset of erosion by 20 years (to be consistent with the time period considered in the recreation benefits analysis, Section 7.3.2). Discounted values for the loss of the asset (using a 5% discount rate) with and without nourishment were then calculated and the difference between those values is the benefit of the delay. A three-year delay was considered for the 75,000 yd^3 nourishment alternative. It was assumed that the delay in erosion would be the same regardless of whether sand was placed on the beach or in the nearshore (even though the dry beach area is less for nearshore placement). The discounting process is described in Appendix C.

7.3 COSTS

Tables 18 and 19 show the costs associated with the potential beach nourishment alternatives.

Table 18. Small-Scale Nourishment of the Southern Bight (Alternative 1)

Cost Component	1a. Beach	1b. Nearshore
Sand Volume (yd^3)	75,000	75,000
Transport Distance (miles)	2.53	2.53
Total Trips	28	28
Construction Period (days)	6	5
Total Transport Cost ($ x 1,000)	432	194
Mob/Demob. ($ x 1,000)	600	500
Cost per Yard ($ x 1,000)	14	9
Total Beach Nourishment Cost ($ x 1,000)	**1,032**	**694**

Table 19. Large-Scale Nourishment of the Southern Bight (Alternative 2)

Cost Component	2a. Sand City Beach	2b. Sand City Nearshore	2c. Canyon Head Beach	2d. Canyon Head Nearshore
Sand Volume (yd^3)	2,000,000	2,000,000	2,000,000	2,000,000
Transport Distance (miles)	1.81	1.81	15.33	15.33
Total Trips	741	741	741	741
Construction Period (days)	151	118	309	265
Total Transport Cost ($ x 10^6)	11.04	4.83	19.75	10.87
Mob/Demobilization ($ x 10^6)	0.6	0.5	0.6	0.5
Cost per Yard ($)	6	3	10	6

Cost Component	2a. Sand City Beach	2b. Sand City Nearshore	2c. Canyon Head Beach	2d. Canyon Head Nearshore
Total Nourishment Cost ($ x 10^6)	**11.64**	**5.33**	**20.35**	**11.37**

The results show that placing sand directly on the beach is substantially more expensive than placing sand in the nearshore. This is to be expected due to the significant increase in effort and equipment required to undertake the beach placement.

7.4 BENEFITS

7.4.1 Recreational Benefits

The benefits generated by CSBAT provide an estimate of the economic value of the improved recreational amenity of southern Monterey Bay beaches. Tables 20-23 present the benefits calculated by CSBAT for the two alternatives. For each alternative, the dollar value of the increase in recreational benefit is calculated in three parts, based on the increased beach width providing for increased visitor numbers and an increased recreational benefit value for all visitors. The parameters presented are:

- beach width increase: this varies dependant on the location of sand placement (subaerial-beach or nearshore) and is used to determine the increase in beach visitors
- increase in state and local spending: the increased spend resultant from more visitors
- increase in state and local taxes: income based on spending
- increase in recreational value: reflects the increased value derived by visitors from a wider beach, plus the increased visitor numbers
- total increase in recreational benefit: the discounted total of the three benefits increases over 20 years (note only the first ten years are presented in Tables 20 through 23).

Table 20. Recreational Benefits of Small-Scale Nourishment of the Southern Bight with Beach Placement (Alternative 1a)

Year	Increases in: Beach Width (ft)	State and Local Spending ($)	State and Local Taxes ($)	Recreational Value ($)
Year-1	3.75	11,243	1,293	38,329
Year-2	0.3	899	103	2,940
Year-3	0.0	0.0	0.0	0.0
Year-4	0.0	0.0	0.0	0.0
Year-5	0.0	0.0	0.0	0.0
Year-6	0.0	0.0	0.0	0.0
Year-7	0.0	0.0	0.0	0.0
Year-8	0.0	0.0	0.0	0.0
Year-9	0.0	0.0	0.0	0.0
Year-10	0.0	0.0	0.0	0.0
Total Increase in Recreational Benefit ($)		**54,995**		

Table 21. Recreational Benefits of Small-Scale Nourishment of the Southern Bight with Nearshore Placement (Alternative 1b)

Year	Increases in:			
	Beach Width (ft)	State and Local Spending ($)	State and Local Taxes ($)	Recreational Value ($)
Year-1	0.0	0.0	0.0	0.0
Year-2	0.6	1,799	207	5,877
Year-3	0.98	2,923	336	9,088
Year-4	1.09	3,261	375	9,652
Year-5	0.0	0.0	0.0	0.0
Year-6	0.0	0.0	0.0	0.0
Year-7	0.0	0.0	0.0	0.0
Year-8	0.0	0.0	0.0	0.0
Year-9	0.0	0.0	0.0	0.0
Year-10	0.0	0.0	0.0	0.0
Total Increase in Recreational Benefit ($)		**36,264**		

Table 22. Recreational Benefits of Large-Scale Nourishment of the Southern Bight with Beach Placement (Alternatives 2a and 2c)

Year	Increase in:			
	Beach Width (ft)	State and Local Spending ($)	State and Local Taxes ($)	Recreational Value ($)
Year-0	100.0	299,818	34,479	880,495
Year-1	77.76	233,136	26,811	671,330
Year-2	69.15	207,325	23,842	575,432
Year-3	62.84	188,413	21,668	502,571
Year-4	57.94	173,728	19,979	444,523
Year-5	54.01	161,928	18,622	396,936
Year-6	50.56	151,585	17,432	355,752
Year-7	47.11	141,241	16,243	317,382
Year-8	43.66	130,897	15,053	281,655
Year-9	40.21	120,553	13,864	248,411
Year-10	36.76	110,210	12,674	217,498
Total Increase in Recreational Benefit ($)		**8,067,127**		

Table 23. Recreational Benefits of Large-Scale Nourishment of the Southern Bight with Nearshore Placement (Alternatives 2b and 2d)

Year	Increase in:			
	Beach Width (ft)	State and Local Spending ($)	State and Local Taxes ($)	Recreational Value ($)
Year-0	0.0	0.0	0.0	0.0
Year-1	16.0	47,971	5,517	152,212
Year-2	26.0	77,953	8,965	231,435
Year-3	29.0	86,947	9,999	244,587
Year-4	15.0	44,973	5,172	123,493
Year-5	11.55	34,629	3,982	91,138
Year-6	8.1	24,285	2,793	61,267
Year-7	4.65	13,942	1,603	33,718
Year-8	1.2	3,599	414	8,343
Year-9	0.0	0.0	0.0	0.0
Year-10	0.0	0.0	0.0	0.0
Total Increase in Recreational Benefit ($)		**1,479,160**		

The increased recreational benefits where sand is placed directly on the beach (Table 22) are significantly greater than those for nearshore placement (Table 23). This is because the maximum beach width increase is realized in the first year, and, more importantly, because the overall beach width increase is much greater and lasts longer (as dispersion gradually reduces the beach width over time).

7.4.2 Property Protection Benefits

The protection of built assets from long-term erosion would be a tangible benefit of the beach nourishment proposals. Table 24 estimates the economic value of the assets at risk of erosion along the southern Monterey Bay shoreline (Figure 22) together with an estimate of when they would be lost to erosion without beach nourishment, and when the delayed loss would occur if nourishment was undertaken.

Table 24. Assets Protected by Beach Nourishment

Asset	Land Value ($M)	Buildings/Facility Value ($M)	Total Value ($M)	Approx. Year of Loss		Value of Delay in Erosion ($M)
				No Project	With 2M yd^3 Fill	
Monterey Interceptor (8,600 foot from Wharf II to Monterey Pump Station)	5.16			20	40	1.21
Monterey Interceptor (1,750 foot section south from Seaside Pump Station)	$76.05M (includes $75 million for replacement of Seaside Pump Station)			40	60	6.73
Monterey Beach Resort	5.06	13.00	18.04	50	70	4.24
Ocean Harbor House Condominiums	15.93	19.39	35.32	50	70	1.92
La Playa Town Homes	4.78	6.33	11.10	20 (ongoing)	40 (ongoing)	1.45

Note: M = million

Table 24 demonstrates the high value of the oceanfront facilities and properties in southern Monterey Bay, particularly in the southern bight. In addition to the value of the assets, their loss would have significant secondary impacts such as disruption to wastewater facilities for the cities of Pacific Grove and Monterey, as well as major environmental consequences, if the Monterey Interceptor was breached; and impacts to the local tourist economy if oceanfront resorts were lost.

In order to appropriately represent the likely nature of erosion losses at the facilities identified in Table 24, assumptions were made regarding the progression of loss:

- Given it's proximity to the shoreline, an 8,600 foot section of the Monterey Interceptor pipeline is considered to be at risk between Monterey Harbor and Monterey Pump Station. Elsewhere the pipeline is sufficiently set back from the shoreline, except near

Seaside Pump Station, where the Station itself and a 1,750 foot section of the pipeline are considered at long-term 50-year risk.

- The existing seawall at Monterey Beach Resort (constructed in 1968) is due to be replaced by a new seawall which has been approved for construction. It is assumed that this new seawall will have a 50-year life and completed in 2008, after which erosion of the property would begin.
- For Ocean Harbor House condominiums it is assumed that the seawall that is due to be constructed will have a 50-year life, after which erosion of the property would be immediate as the fronting beach would be lost and the property outflanked by erosion.
- Twenty six property parcels are identified as being at risk in the Monterey La Playa town homes development. It is assumed that the first losses occur in year 20, with 25% of the at-risk parcels lost every ten years thereafter.

Using the discounting process described in Appendix C the economic benefits of delaying erosion of these assets through beach nourishment with 75,000 yd^3 or two million yd^3 are calculated (Table 25). The table demonstrates that the erosion delay benefits of the proposed beach nourishment projects could be significant.

Table 25. Assets Protected Benefits

Asset	Land Value ($M)	Year of Loss			Discounted Value of Asset Loss ($M)			Benefit of Project ($M)	
		No Project	75,000 yd^3 Fill	2M yd^3 fill	No Project	75,000 yd^3 Fill	2M yd^3 fill	No Project	With 2M yd^3 fill
Monterey Interceptor (8,600 foot section)	5.16	20	23	40	1.94	1.68	0.73	0.26	1.21
Monterey Interceptor (1,750 foot section plus Seaside Pump Station)	76.05	40	43	60	10.80	9.33	4.07	1.47	6.73
Monterey Beach Resort	18.04	50	53	70	1.57	1.36	0.59	0.21	0.98
Ocean Harbor House Condominiums	35.32	50	53	70	3.08	2.66	1.16	0.42	1.92
La Playa Street Town Homes (assume 25% lost in ten year intervals)	2.78	20	23	40	1.05	0.90	0.39	0.14	0.65
	2.77	30	33	50	0.64	0.55	0.24	0.09	0.40
	2.78	40	43	60	0.39	0.34	0.15	0.05	0.25
	2.77	50	53	70	0.24	0.21	0.09	0.03	0.15
TOTALS	**145.67**				**19.73**	**17.04**	**7.43**	**2.69**	**12.29**

Note: M = million

7.4.3 Ecologic Protection Benefits

Reduction of beach widths associated with seawall construction may result in severe ecologic degradation (Dugan et al., 2008). If beach nourishment is not implemented it is possible that armoring would be installed to protect development. Therefore, beach nourishment would maintain ecology closer to existing conditions. This benefit has not been quantified in this Coastal RSM Plan.

7.5 ECONOMIC VIABILITY OF ALTERNATIVES

Sections 7.1 to 7.3 present the costs and benefits of beach nourishment alternatives in the southern bight of southern Monterey Bay. This section combines these aspects to review the economic viability of the alternatives.

7.5.1 Alternative 1: Small-Scale Nourishment of the Southern Bight

Table 26 presents a summary of the costs and benefits for Alternative 1, the placement of 75,000 yd^3 of sand from Monterey Harbor directly on to the beaches of the southern bight.

Table 26. Economic Summary of Alternative 1

Scenario	Total Cost ($M)	Increase in Recreational Benefits ($M)	Property Protection Benefits ($M)	Total Benefits ($M)	Net Benefits($M)	Benefit/Cost Ratio
Beach Placement	1.03	0.05	2.69	2.74	1.71	2.66
Nearshore Placement	0.69	0.04	2.69	2.72	2.03	3.93

Note: M = million

The data demonstrates that there is a clear economic justification to placing sand from Monterey Harbor on to the adjacent shoreline. It is notable that placing this relatively small volume of sand onto this frontage has little benefit in terms of increasing the beach for amenity purposes, and it is the benefits in delaying erosion that provide the justification.

7.5.2 Alternative 2: Large-Scale Nourishment of the Southern Bight

Table 27 presents a summary of the costs and benefits for Alternative 2, the nourishment of the southern bight with 2,000,000 yd^3 of sand from two potential offshore sources. Both subaerial-beach and nearshore placement are considered.

Table 27. Economic Summary of Alternative 2

Scenario	Total Cost ($M)	Increase in Recreational Benefits ($M)	Property Protection Benefits ($M)	Total Benefits ($M)	Net Benefits ($M)	Benefit/Cost Ratio
Offshore Sand City source to beach	11.64	8.07	12.29	20.36	8.71	1.75
Offshore Sand City source to nearshore	5.33	1.48	12.29	13.77	8.44	2.58
Canyon head source to beach	20.35	8.07	12.29	20.36	0.01	1.00
Canyon head source to nearshore	11.37	1.48	12.29	13.77	2.40	1.21

The economic summary for beach nourishment Alternative 2 demonstrates economic viability. All variants of this alternative have a positive benefit-cost ratio, with the Sand City offshore source proving most cost-effective due to it's proximity to the southern bight beaches.

Table 19 shows that the costs of placing sand on the beach are greater than placing in the nearshore; however beach placement also delivers a greater recreational benefit. Considering the benefit-cost ratios (Table 27), the nearshore placement option from offshore Sand City appears most attractive (ratio of 2.58). However, the incremental benefit of placing the sand directly on the beach is greater than one (i.e. the additional cost to place the sand on the beach is $6.2 million (Table 19) and the additional recreational benefits are $6.6 million, Table 27), suggesting the additional investment is economically worthwhile. This is supported by the Sand City source to beach placement alternative having the highest net benefit at $8.71 million.

The results of the economic analysis indicate that there is clear economic justification for undertaking beach nourishment in the southern bight of southern Monterey Bay. Although this analysis does not guarantee funding for these alternatives (Section 9), it has shown that beach nourishment in southern Monterey Bay would deliver net economic benefits to the region.

8. REGULATORY PROCESSES

The Beach Restoration Regulatory Guide (BRRG) (EIC, 2006) details federal and state regulatory processes for implementation of beach nourishment projects in California. The document describes the relevant regulatory requirements and the agencies responsible for administering permits, and should be consulted for California-wide federal and state regulatory processes that are relevant to southern Monterey Bay. However, several regulatory organizations administered by federal or state entities have jurisdiction that is specific to the Monterey Bay region and these are discussed in this Coastal RSM Plan. These organizations are:

- Monterey Bay National Marine Sanctuary (MBNMS)
- California Coastal Commission (Coastal Commission) (related to southern Monterey Bay Local Coastal Programs)
- California Department of Parks and Recreation (CDPR) (Salinas River, Marina, and Monterey State Parks).

This section provides an overview of the regulatory roles of these agencies and their policies regarding potential beach nourishment projects in the region. State and federal regulations other than MBNMS, Coastal Commission, and CDPR are tabulated from the BRRG but are not described in detail. Given the large number of local governmental organizations (coastal cities, counties) and the transitory nature of many of their regulations, the BRRG does not cover local regulatory processes. Hence, all relevant local regulations (principally those in Local Coastal Programs) are described in this Coastal RSM Plan.

8.1 FEDERAL REGULATIONS

Implementation of federal regulatory processes and the issuing of permits for beach nourishment in southern Monterey Bay are the responsibility of several organizations including the Corps, National Oceanic and Atmospheric Administration (NOAA), USFWS, and the U.S. Minerals Management Service (USMMS). Table 28 summarizes federal regulations potentially affecting beach restoration projects in California. Most of these regulations are described in the BRRG (EIC, 2006), and not all will necessarily apply to beach restoration in southern Monterey Bay.

Table 28. Relevant Federal Regulations Affecting Beach Restoration Projects

Policy/Regulation	Requirement	Responsible Agency
National Environmental Policy Act	Compliance	Lead Federal Agency
Coastal Zone Management Act	Coastal Consistency Determination	California Coastal Commission
Rivers and Harbors Act	Section 10 Permit	U.S. Army Corps of Engineers
Clean Air Act	Title V Operating Permit	California Air Resources Board
Clean Water Act	Section 401 Certification or Waiver (401 Permit)	Regional Water Quality Control Boards
Clean Water Act	Section 402 NPDES Permit (NPDES Permit)	Regional Water Quality Control Boards
Clean Water Act	Section 404 Permit (404 Permit)	U.S. Army Corps of Engineers
Endangered Species Act	Section 7 Consultation	U.S. Fish and Wildlife Service
National Marine Sanctuaries Act	Authorization	Monterey Bay National Marine Sanctuary
National Historic Preservation Act	Section 106 Approval	State Historic Preservation Officer
Fish and Wildlife Coordination Act	Coordination Act Report	U.S. Army Corps of Engineers
Magnuson-Stevens Fishery Conservation and Management Act	Assessment of Impacts to Essential Fish Habitat	National Marine Fisheries Service
Outer Continental Shelf Lands Act	Lease Agreement for Utilization of Outer Continental Shelf Sand	U.S. Minerals Management Service

8.1.1 Monterey Bay National Marine Sanctuary

The MBNMS is administered by NOAA, and spans over 5,300 square miles of coastal waters off central California including the waters of southern Monterey Bay. The Sanctuary's boundaries stretch from Marin County to Cambria, encompassing nearly 300 miles of shoreline and extending seaward from mean high water to an average distance of thirty miles offshore. The Sanctuary was designated in 1992, in response to potential offshore oil and gas development, for the purposes of resource protection, research, education, and public use. The MBNMS mission is to understand and protect the ecosystem and cultural resources of central California.

The MBNMS was designated in accordance with the National Marine Sanctuaries Act (NMSA) and their regulatory and enforcement powers are specified in the Act. The MBNMS enforces eleven federal regulatory prohibitions designed to preserve and protect the natural and cultural resources and qualities of the ocean and estuarine areas within its boundaries. Depending upon the nature of the project, three of these prohibitions may directly regulate beach nourishment in southern Monterey Bay:

- Drilling into, dredging or otherwise altering the seabed of the Sanctuary; or constructing, placing or abandoning any structure, material or other matter on the seabed of the Sanctuary.
- Discharging or depositing, from within the boundary of the Sanctuary, any material or other matter.
- Disposal of dredged material from harbors, outside of the existing sites authorized by the U.S. Environmental Protection Agency and U.S. Army Corps of Engineers.

Although some potential beach nourishment projects may be prohibited by MBNMS regulations, it is still possible for projects to be authorized through the Sanctuary's permitting program. Permits or authorizations may be issued by the MBNMS Superintendent under special circumstances for activities otherwise prohibited by Sanctuary regulations, when related to research to enhance scientific understanding of the Sanctuary environment or to improve management decision-making. Authorizations may also be issued under special circumstances for activities otherwise prohibited by Sanctuary regulations if an activity has been authorized by a valid lease, permit, license, approval or other authorization issued after the effective date of MBNMS designation by any federal, state, or local authority, and the Superintendent finds that the activity will not cause long-term or severe impacts to Sanctuary resources. In cases where projects require a Coastal Commission Coastal Development Permit, the MBNMS would review and potentially authorize that permit with special conditions.

MBNMS approval would be required for any beach nourishment project where sand is placed within Sanctuary boundaries, or where sediment is extracted from within Sanctuary boundaries. While it is possible to authorize some beach nourishment projects within the MBNMS, placement of dredged sediments from harbors, outside of those existing sites approved for dredge disposal, will require modifications to the Sanctuary's regulations. MBNMS currently recognizes four sites as approved for disposal of dredged sediment including SF-12, SF-14 (Section 6.1.1), and limited disposal sites at Monterey and Santa Cruz Harbors. However, the Sanctuary's Harbors and Dredge Disposal Action Plan states that if investigations indicate that employment of additional beach nourishment sites using clean dredged harbor sediment would be possible and appropriate, MBNMS may examine whether revision of its regulations may be warranted, or if a beneficial program might occur via MBNMS permit or authorization in concert with other agencies.

In order to obtain an MBNMS authorization, the applicant must submit a permit application to the MBNMS Permit Coordinator; guidelines for submitting applications can be found on the

Sanctuary website at: http://montereybay.noaa.gov/resourcepro/authorization.html. Authorization applications must be submitted at least 45 calendar days in advance of the requested effective date to allow sufficient time for evaluation and processing. In order to expedite processing, applicants are encouraged to contact the Sanctuary in advance of submitting a formal application to discuss any questions or issues they feel may complicate or delay the application process. Complete applications are reviewed by Sanctuary personnel, and, when deemed necessary, peer-reviewed by outside experts. Based on the reviews of the application, authorization will be approved or denied. If approved, the Sanctuary Superintendent will issue the authorization. If denied, applicants are notified of the reason(s) for denial and informed of the appeal process.

8.2 STATE REGULATIONS

The main state legislations regulating beach nourishment projects in southern Monterey Bay are the California Environmental Quality Act (CEQA) and the California Coastal Act (CCA). In addition, in 1978, the State of California adopted a Policy on Coastal Erosion ‘to prevent the loss of the state's beaches through coastal erosion and to preserve its coastal resources.’ The primary state agencies involved in regulatory processes and the issuing of permits for beach nourishment in California are the Coastal Commission, California State Lands Commission (CSLC), State Water Resources Control Board (SWRCB)/Regional Water Quality Control Board (RWQCB), California Department of Fish and Game (CDFG), and California Department of Parks and Recreation (CDPR). Table 29 summarizes state regulations affecting beach restoration projects in California. All these regulations are described in the BRRG (EIC, 2006). Details on the Coastal Commission and CDPR regulations specific to southern Monterey Bay are described in Sections 8.2.1 and 8.2.2.

Table 29. Relevant State Regulations Affecting Beach Restoration Projects

Policy/Regulation	Requirement	Responsible Agency
California Environmental Quality Act	Compliance	Lead CEQA Agency
California Coastal Act	Coastal Development Permit	California Coastal Commission
Porter-Cologne Water Quality Control Act	Compliance: Permits under CWA Sections 401, 402, and 404	State Water Resources Control Board Regional Water Quality Control Boards
California State Lands Public Resources Code	Lease Agreement for Utilization of Sovereign Lands	California State Lands Commission
California Public Resources Code Section 1600	Streambed Alteration Agreement	California Department of Fish and Game
California Endangered Species Act	Section 2081(b) Incidental Take Permit (State) Section 2081.1 Consistency Determination (State and Federal)	California Department of Fish and Game
Water Quality Control Plans California Ocean Plan	Consistency Compliance	Regional Water Quality Control Boards
Clean Air Act	Title V Operating Permit	Air Pollution Control Districts Air Quality Management Districts

8.2.1 California Coastal Commission and Local Coastal Programs

The Coastal Commission, in collaboration with local counties and cities, is the primary state agency responsible for planning and regulating the use of land and water within California's coastal zone, in accordance with the specific policies of the CCA. In addition to development within the coastal zone, the Coastal Commission also has jurisdiction over projects requiring federal permits or approval in federal waters. The Coastal Commission was also established to assist local governments in implementing local coastal planning and regulatory powers by adopting Local Coastal Programs.

Local Coastal Programs (LCPs) are basic planning tools prepared and used by local governments to guide development in the coastal zone, in partnership with the Coastal Commission. LCPs contain the ground rules for future development and short-term and long-term conservation and protection of coastal resources. Each approved LCP specifies appropriate locations, types, and scales of new or changed uses of land and water. Each LCP includes one or more Land Use Plans (LUPs) with goals and regulatory policies, and measures to implement the plan (such as zoning ordinances). While each LCP reflects the unique characteristics of individual local coastal communities, regional and statewide interests and concerns must also be addressed to conform to CCA goals and policies. Following adoption by a city council or county Board of Supervisors, an LCP is submitted to the Coastal Commission for review for consistency with CCA requirements.

After an LCP has been certified by the Coastal Commission, the Commission's coastal permitting authority is transferred to the local government, which applies the requirements of the LCP in reviewing proposed new developments. All project proposals located within the coastal zone will be reviewed for consistency with the LCP or the CCA (where no certified LCP exists) and will require a Coastal Development Permit. Any projects located on sovereign lands below mean high water remain within the Coastal Commission appeal jurisdiction (as are lands between the ocean and the first public road). Therefore, in some cases, two permits may be necessary; one from the local jurisdiction with a certified LCP and one from the Coastal Commission. The beach nourishment projects being evaluated for southern Monterey Bay would require Coastal Commission approval pursuant to Section 30106 of the CCA, which regulates coastal development. The definition of development includes beach nourishment, removal, dredging, mining, or extraction of sediments, and discharge or disposal of any dredged sediment.

Within southern Monterey Bay, the Cities of Marina and Sand City (north of Bay Avenue) and the County of Monterey have certified LCPs. The Cities of Seaside and Monterey have certified LUPs but do not have approved LCPs. Beach nourishment projects in the cities with certified LCPs would require a Coastal Development Permit issued by that city. The details of each LCP and the regulations and policies they contain pertaining to regional sediment management, particularly beach nourishment activities are provided below.

<u>County of Monterey</u>
The Monterey County LCP was certified by the Coastal Commission in 1988, whereby the County assumed permit-issuing authority. Most beach nourishment projects within the jurisdiction of the County of Monterey will require a Coastal Development Permit issued by the County's Planning Department. In addition a Grading Permit and an Erosion Control Permit may be required.

The LCP is composed of four LUPs, including the unincorporated section of southern Monterey Bay between the City of Marina northern boundary and Moss Landing, which is part of the North County LUP. Along this frontage, this Coastal RSM Plan does not identify any critical areas of erosion. The North County LUP (latest update, December 1999) designates the beaches and dunes (except the parking lots of the Salinas River State Beach) as Scenic and Natural Resource Recreation Areas to be maintained at a low level of development to protect dune habitats and preserve the natural character of the shoreline. The LUP recommends that the state acquire privately-owned dune areas that are offered for sale. The North County LUP does not designate set back requirements for new development like most other local LUPs. The policies from the North County LUP relating to RSM include the following:

- LUP Policy 2.3.2: With the exception of resource dependent uses, all development, including vegetation removal, excavation, grading, filling, and the construction of roads and structures, shall be prohibited in the following environmentally sensitive habitat areas: riparian corridors, wetlands, dunes, sites of known rare and endangered species of plants and animals, rookeries, major roosting and haul-out sites, and other wildlife breeding or nursery areas identified as environmentally sensitive. Resource dependent uses, including nature education and research hunting, fishing and aquaculture, where allowed by the plan, shall be allowed within environmentally sensitive habitats only if such uses will not cause significant disruption of habitat values.
- LUP 2.3.3: A dune stabilization and restoration program should be implemented by the California Department of Parks and Recreation. Damaged dune areas should be replanted with native vegetation. Dune areas of high sensitivity should be protected from disruptive uses and development. The dune area between the City of Marina and the Salinas River should be acquired by the U.S. Fish and Wildlife Service or the California Department of Fish and Game and managed as a wildlife reserve.
- LUP 2.4.2: 1. Further alteration of natural shoreline processes including drainage, erosion, water circulation, and sand transport, shall be limited to protection of public beaches, existing significant structures, coastal dependent development, and the public health and safety.
- LUP 2.4.2: 3. Dredging and spoils disposal should be planned and carried out to avoid significant disruption to marine, estuarine and wetland habitats, and the pattern and volume of water circulation. Dredged spoils suitable for beach replenishment shall be transported for such purposes to appropriate beach areas with suitable longshore current systems. Dredged spoils shall meet all state and federal standards for the protection of the marine biologic environment and shall be disposed of consistent with all current policies and sites.

The southern Monterey Bay shoreline south of the City of Marina northern boundary is under the jurisdiction of City LCPs, apart from Fort Ord, which is within the Monterey County coastal zone in an uncertified area. The Fort Ord Reuse Authority (FORA) has published a Fort Ord Reuse Plan (adopted June 1997) which outlines a set of recommended objectives and associated programs for appropriate land use including the beaches fronting the former base. The following objective and program relates to Monterey County/Fort Ord and RSM:

- Monterey County Objective E: Coordinate open space and recreation land use with other affected agencies at the former Fort Ord, such as the California Department of State Parks and Recreation and the Bureau of Land Management. Program E-1.1: The County of Monterey shall assist the CDPR to develop and implement a Master Plan for ensuring the management of the Fort Ord coastal dunes and beaches for the benefit of the public by restoring habitat, recreating the natural landscape, providing public access, and developing appropriate day use and overnight lodging facilities (limited to a capacity of 40 rooms).

Given the conversion from military to suburban land uses it is important that any future development on the dunes at Fort Ord be sited via set backs or transfer of development rights to avoid future erosion hazards, and that any generated spoils be beneficially reused (e.g. beach restoration).

City of Marina

The City of Marina LCP provides jurisdiction from the northern city limit of Marina to the northern boundary of Fort Ord. Within this length of coast, this Coastal RSM Plan identifies two critical areas of erosion; the Sanctuary Beach Resort and Marina Coast Water District buildings. Also, the LCP covers the sand mine at Marina. The City of Marina LCP was certified by the Coastal Commission in 1982, and the City assumed permit-issuing authority. Several amendments to the LCP have been made in the years up to 2001, with the effective LCP now dated 2002. Further amendments as appealed by the Coastal Commission went to the City Council meeting on November 20, 2007. The policies from the City of Marina LCP that are relevant to RSM include the following:

- LUP Policy 1: to insure access to and along the beach, consistent with recreational needs and environmental sensitivity of Marina coastal area.
- LUP 2: to provide beach access and recreational opportunities consistent with public safety and with the protection of the rights of the general public and of private property owners.
- LUP 8: to prohibit further degradation of the beach environment and conserve its unique qualities.
- LUP 19: to promote restoration and protection of native dune habitat and vegetation.
- LUP 23: to support continuation of the coastal dependent sand mining operations as long as they are economically feasible and their operations are managed with sensitivity to the adjacent dune environment.
- LUP 25: to protect the habitat of recognized rare and endangered species found in the coastal dune area.
- LUP 33: to protect scenic and visual qualities of the coastal area including protection of natural landforms, views to and along the ocean, and restoration and enhancement of visually-degraded areas.

More specific policy is provided in the LCP with respect to the sand mining operations at Marina:

- existing surf zone sand mining operations, as established coastal dependent uses, shall be permitted to continue at their existing locations in substantially the same manner as they are currently being conducted, and have been conducted in the past. All provisions of the LCP (including the Implementation Plan) relating to mining shall be construed and applied in a manner that supports such continuation of existing surf zone sand mining operations, so long as such existing surf zone sand mining operations are in accordance with the LCP.

- further, the City shall establish in its Implementation Plan a method of monitoring shoreline erosion along the Marina coast for the purpose of establishing a continuing project impact analysis. This analysis shall consist of the submission by sand mining operation on an annual basis, of an accurate cronaflex ortho-topographic map, meaningful information on shoreline retreat by way of a benchmark program or other equally effective measurement.
- the City shall not approve or renew a Mining Permit and/or Coastal Development Permit for new surf zone or beach sand mining, if it finds that such new sand mining, either individually or cumulatively, will have significant adverse impacts on shoreline erosion.
- such determination shall be made upon consideration of the results of the continuing project impact analysis, available evidence on the impact of beach and surf zone sand mining on coastal erosion and other relevant social, economic, environmental and technological factors.
- any Mining Permit and/or Coastal Development Permit shall be issued subject to the condition that will permit the City to require that new sand mining activity be reduced to previous levels (prior to the issuance of a Mining Permit and/or Coastal Development Permit) or terminated in the event of a new sand mining operation, if the continuing project impact analysis or other available evidence on the impact of beach and surf zone sand mining on shoreline erosion shows that such operations have a significant adverse impact on shoreline erosion.

The following objective and program from the Fort Ord Reuse Plan also relates to the City of Marina and RSM:

- City of Marina Objective A (also City of Seaside Objective A): Integrate the former Fort Ord's open spaces into the larger regional open space system, making them accessible as a regional resource for the entire Monterey Peninsula. Recreation Policy A-1: The City of Marina (Seaside) shall work with the California State Park System to coordinate the development of Fort Ord Beach State Park.

City of Sand City

Within the City of Sand City jurisdiction are the critical areas of erosion at Tioga Avenue, Seaside Pump Station, and the Monterey Interceptor. The City of Sand City LCP was certified by the Coastal Commission in 1986 with the exception of the part of the city south of Bay Avenue, which has been designated as an area for delayed certification. In 1990, the Coastal Commission issued a report to the City of Sand City (Coastal Commission, 1990) recommending major revisions to the LCP to reduce the amount of development allowed. This report was almost simultaneous with an LCP amendment recommended by the Monterey Peninsula Regional Park District (MPRPD) to make public parks and open space the preferred land use along Sand City's coast. In addition, MPRPD and CDPR sought to acquire coastal land within Sand City for park purposes. The City of Sand City resisted the efforts of MPRPD, because it wished to preserve certain coastal parcels for development to ensure a stable fiscal future for the city.

In 1996, the Sand City LCP was amended to allow public parks and open space over the vast majority of its coastal area. At the same time, MPRPD, CDPR and the City entered into a Memorandum of Understanding, outlining a few remaining 'development envelopes' on the coast where visitor-serving development (a priority use by the CCA) could be permitted. One of these envelopes is the area occupied by the former Sand City sand mining operation (Section 1.4.4). Now, MPRPD and CDPR would support reasonable development along the coast that does not block views of Monterey Bay, in exchange for acquisition of the majority of Sand City's coast for sensitive habitat reconstruction, public parks, and general open space.

8.2.2 California Department of Parks and Recreation

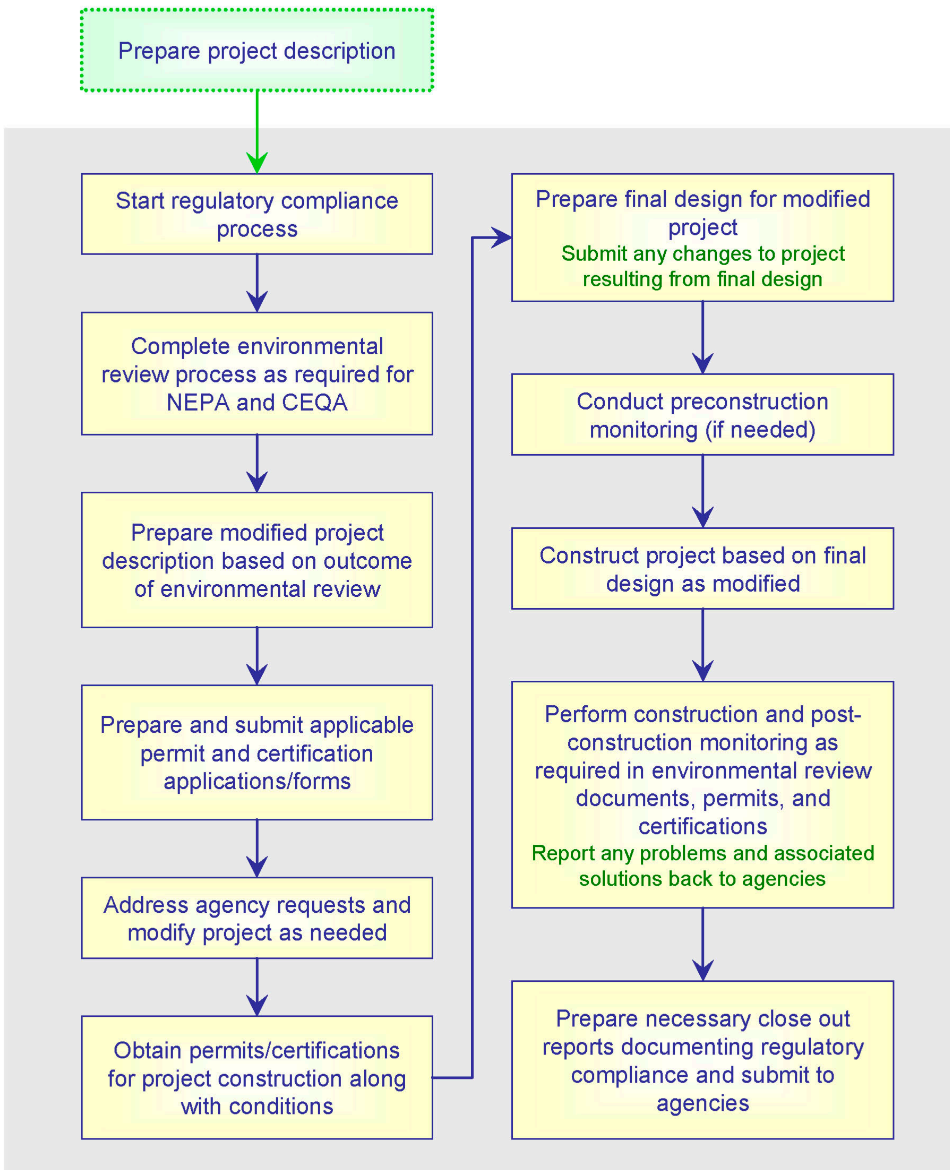
The CDPR is responsible for the management and protection of natural and cultural resources, and facilitating outdoor recreational opportunities within the State Parks. These include a number of sites in southern Monterey Bay including Monterey, Marina, and Salinas River State Beaches. Any project located on or affecting State Park land would require approval by CDPR in the form of an Encroachment Permit. The CDPR policy on coastal erosion is generally to allow coastal processes (such as wave erosion, beach deposition, dune formation, lagoon formation, and bluff retreat) to continue without interference. The CDPR will not construct permanent new structures and coastal facilities in areas subject to wave erosion and bluff retreat, or areas with unstable bluffs. Structural protection and re-protection of existing developments is appropriate only when the cost of protection over time is commensurate with the value of the development to be protected, and it can be shown that the protection will not negatively affect the beach or the nearshore environment. Where existing developments must be protected in the short term to achieve park management objectives, CDPR would use the most natural-appearing method feasible, while minimizing impacts outside the threatened area.

8.3 REGULATORY COMPLIANCE PROCESS

The regulatory compliance process for beach nourishment projects is described in the Beach Restoration Regulatory Guide (BRRG) (EIC, 2006). In southern Monterey Bay the process would comprise three phases (Figure 38):

- Environmental review
- Permitting
- Compliance review.

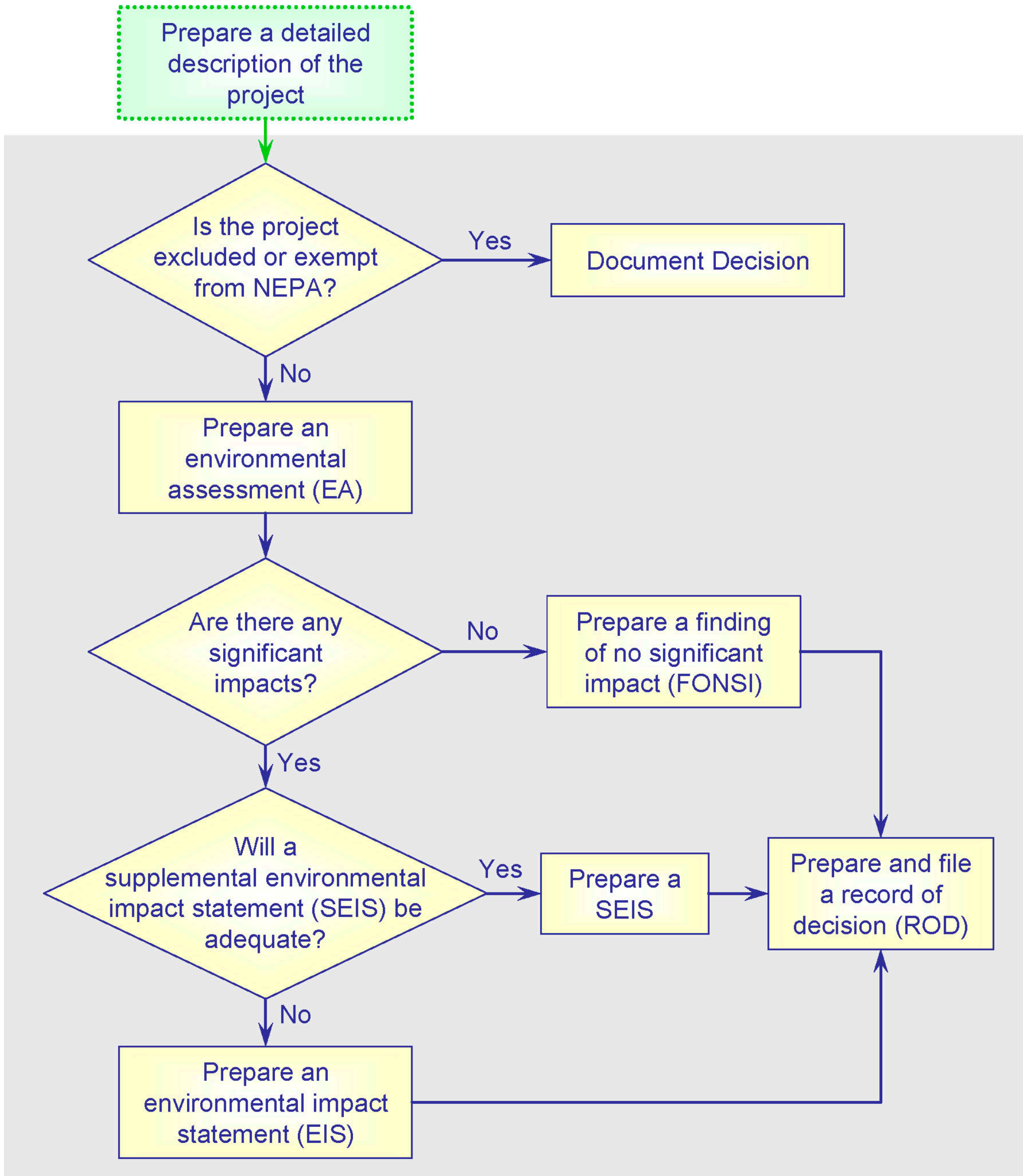
Figure 38. Regulatory Compliance Process



Source: Beach Restoration Regulatory Guide (EIC, 2006)

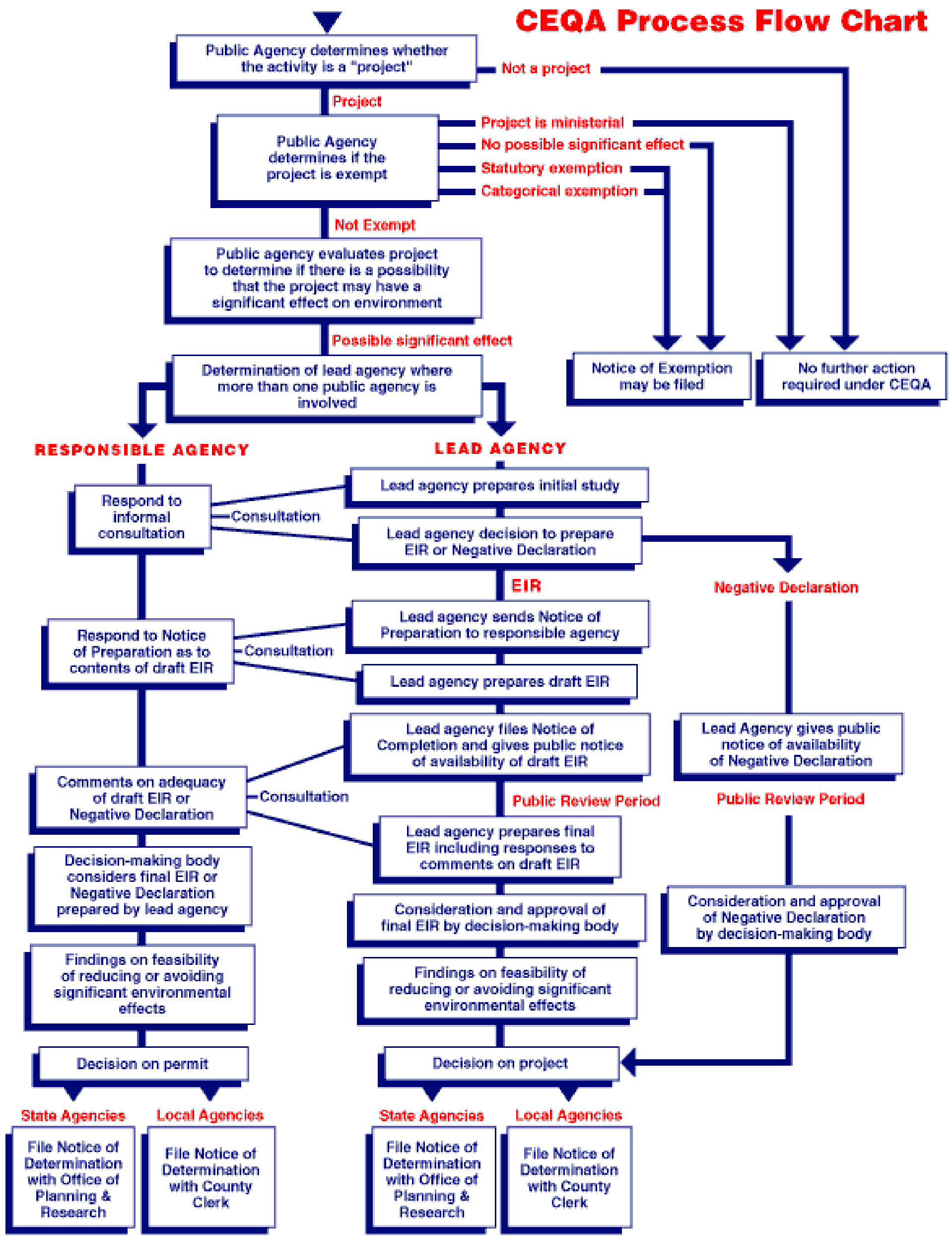
Environmental review consists of both National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) compliance, and is typically completed first. NEPA and CEQA documents should be prepared concurrently and are used as the basis upon which the regulatory and resource agencies process permits. The Corps typically serves as the lead agency under NEPA. For CEQA, several state agencies may be involved (such as the Coastal Commission, CDPR), details of which are described in the BRRG (EIC, 2006). However, Figures 39 and 40 provide flow charts of the NEPA and CEQA compliance processes.

Figure 39. NEPA Compliance Flow Chart



Source: Beach Restoration Regulatory Guide (EIC, 2006)

Figure 40. CEQA Compliance Flow Chart

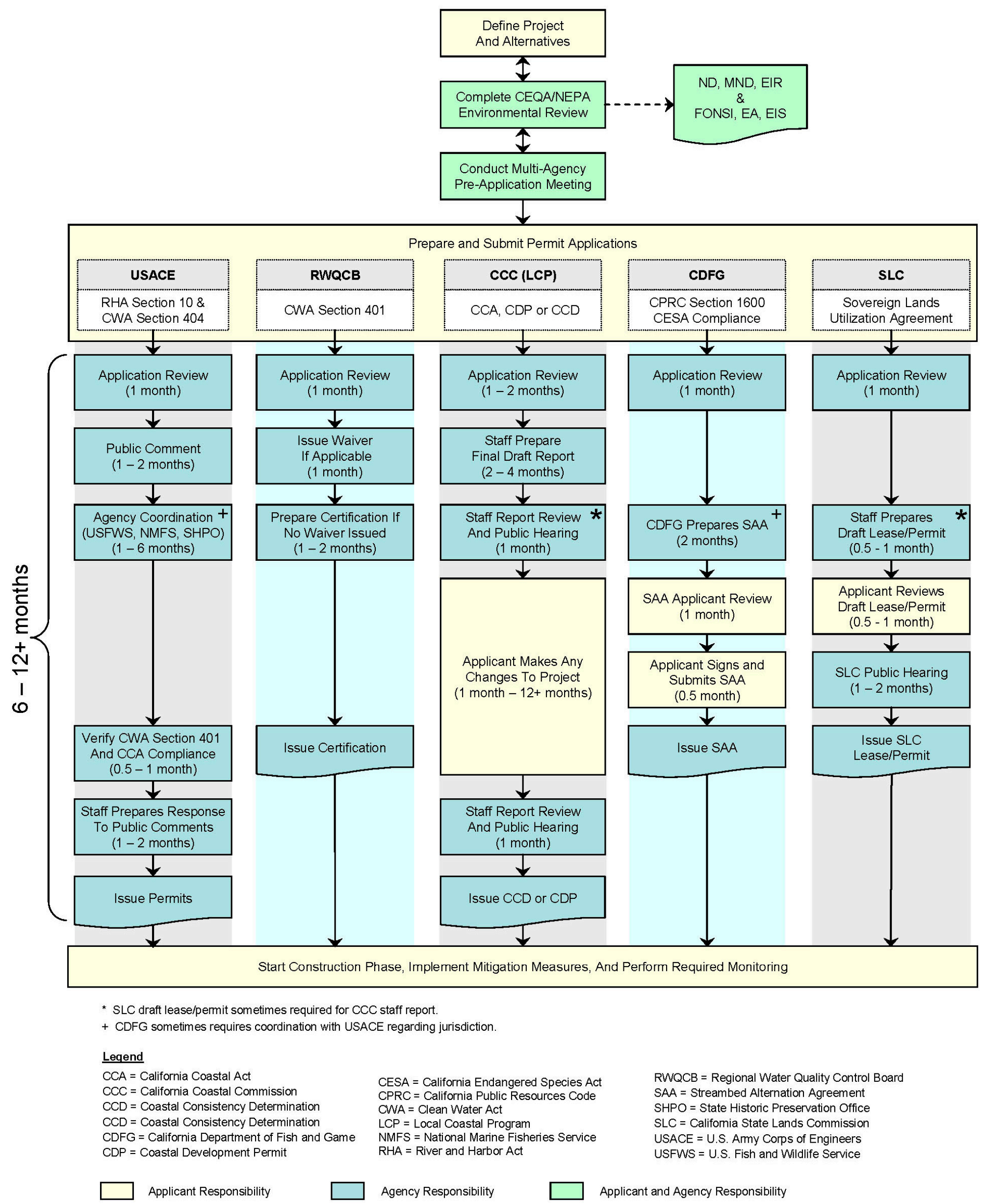


Source: http://ceres.ca.gov/images/CEQA_process_chart.gif

Once the environmental review is completed the permit process begins, and the applicant submits the necessary permit applications to the appropriate agencies. There are many routes that can be taken to receive the permits necessary for a beach nourishment project, depending on the implementing agency and the project applicant. Figure 41 illustrates the milestones for various permit applications for a typical beach nourishment project. In southern Monterey Bay, an additional permit would likely be required through the MBNMS; the process is described in

Section 8.1.1. Beach nourishment projects involve placement of sediment into waters of the U.S., which may result in significant environmental impacts, and hence they receive a high level of scrutiny during the environmental and permitting processes. In order to streamline and potentially shorten the regulatory compliance process, the AMBAG should consider acquisition of a SCOUP permit.

Figure 41. Permitting Process for a Typical Beach Nourishment Project



Source: Beach Restoration Regulatory Guide (EIC, 2006)

8.3.1 SCOUP Permitting Process

The intent of a SCOUP permit is to establish a process approved by regulatory agencies for environmentally-responsible use of opportunistic sediments to nourish pre-established receiver site(s) when sediment becomes available (Moffatt and Nichol Engineers, 2006). There are two types of SCOUP permit; a single opportunistic permit and an opportunistic use program. The single permit is for a project in which the source sediment is identified and the beach receiver site and method of delivery is permitted (Moffatt and Nichol Engineers, 2006). These are typically applied for by either the developer supplying the sand or the local jurisdiction receiving the sand. The opportunistic use program establishes a predefined program for placement of sediment at beach receiver sites. An approved SCOUP program permit streamlines the regulatory compliance process and enables opportunistically acquired sediments that meet certain criteria to be placed at pre-established receiver sites in various quantities and at times throughout the year with minimal review from the regulatory agencies. Generally, program permits are applied for by a local jurisdiction, county or regional association. This Coastal RSM Plan recommends that the AMBAG pursue a regional SCOUP program permit.

To receive a SCOUP program permit, several steps are required that are described in Moffatt and Nichol Engineers (2006). There are ten federal and state agencies, not including local jurisdictions, which need to be involved in the programmatic permitting; Federal – Corps, USEPA, USFWS; State – CDFG, Coastal Commission, CSLC, CDPR, SWRCB, and RWQCB. In summary, the steps include developing a sediment sampling and analysis plan, used to evaluate potential sources of sand and to identify appropriate receiver sites. For each potential receiver site, components include:

- a sediment budget analysis to establish the need for sand
- a summary of transport mechanisms and routes to identify potential impacts
- monitoring plans for each site including sensitive habitat surveys at established pre, post, and during construction intervals
- environmental review that must receive review and approval from all of the permitting agencies.

As complicated as the process sounds, SANDAG received a program permit on a Mitigated Negative Declaration (MND) which avoided significant environmental impacts by constraining the volume, % of fines, and timing of nourishment activities. In addition, this Coastal RSM Plan has generated much of the background information needed to streamline an application for a SCOUP program permit.

9. POTENTIAL FUNDING SOURCES

This section describes potential sources of federal and state funding and potential matching local funds to implement beach nourishment in southern Monterey Bay. MBNMS (2007a) provided an initial assessment of potential funding mechanisms for short- and long-term shoreline nourishment projects, which is used as a basis for this review.

9.1 FEDERAL FUNDING SOURCES

9.1.1 U.S. Army Corps of Engineers

The Corps is the primary federal agency funding shoreline restoration projects. Funds are available for a wide range of projects and are not limited to beach nourishment or large-scale structural alternatives; for example the Corps can participate in managed retreat projects. Funding mechanisms within the Corps consist of two major programs; the Continuing Authorities Program (CAP) and the General Investigations (GI) approach. For smaller projects, the Corps may act directly under CAP without authorization from Congress. CAP includes a number of standing authorities to study and construct certain specific projects. Projects that are larger in scope require congressional authorization and would fall under GI (i.e. a project larger than the CAP program funding limits). GI recommendations go before Congress for project (construction) authorization and then for funding. Requests for projects with the Corps can be made at any time; however for new starts under the GI program, and the CAP in recent years, the requests are always linked to the budget cycle. All projects funded by the Corps require reconnaissance and feasibility studies prior to implementation to determine whether a federal interest exists in the project, unless the Corps is directed by a member of Congress to move ahead with the project. In either case the Corps will conduct NEPA and/or CEQA environmental documentation prior to implementation.

Continuing Authorities Program

The CAP program is made up of nine individual programs that are categorized by the type of project being proposed. All projects are cost shared between the federal government and a non-federal sponsor. A non-federal partner is a legally constituted public body, such as a city, state, county, or conservancy district, that is capable of financing the project and providing for operation and maintenance of the project once completed. Sections 14, 103, 204, and 206 could potentially provide funding for beach nourishment projects in southern Monterey Bay:

- Section 14 Emergency stream bank and shoreline erosion: This program is authorized by Section 14 of the Flood Control Act and funds shoreline protection projects that protect public facilities including water and sewage treatment facilities, and roads that are in imminent danger of erosion. Private property is not eligible. Cost share requirements are 65% federal to 35% non-federal, and the maximum federal contribution is $1 million.

- Section 103 Hurricane and storm damage reduction (Beach erosion control): This program is authorized by Section 103 of the Rivers and Harbors Act and funds protection or restoration of public shorelines by the construction of revetments, groins, jetties, and sometimes beach nourishment. Design and construction cost share requirements are 65% federal to 35% non-federal, and the maximum federal contribution is $3 million.
- Section 204 Beneficial uses of dredged material: This program is authorized by Section 204 of the Water Resources Development Act and allows the use of dredged material from new or existing federal projects to restore, protect, or create aquatic and ecologically related habitats, including wetlands. The total project cost is shared 75% federal and 25% non-federal, and the maximum federal contribution for project development and construction is $5 million.
- Section 206 Aquatic ecosystem restoration: This program is authorized by Section 206 of the Water Resources Development Act and funds aquatic ecosystem restoration projects that will improve the environmental quality, are cost-effective, and are in the public interest. Although not directly related to beach nourishment, it may be possible to link with projects that restore species habitat such as that of western snowy plovers. The total project cost share requirement is 65% federal to 35% non-federal, and the maximum federal contribution is $5 million.

General Investigations

In addition to CAP funding, it is possible to get GI funding for larger projects that do not fit within the CAP program, or a collection of several smaller projects. This type of funding requires congressional authorization through either a Senate Resolution (Environment and Public Works Committee) or House Resolution (Transportation and Infrastructure Committee). Alternatively authorization could be accomplished with language in the Water Resources Development Act which, in theory, is passed by Congress and signed by the president every two years. The General Investigations process comprises four phases:

- Reconnaissance Phase: Duration 9-12 months. Corps covers full cost. This phase identifies the Project Study Plan and cost share details.
- Feasibility Phase: Duration 1-3 years. 50% to 50% cost share (up to 50%, either sponsor share or can be in-kind). Average cost $700,000 to $1.5 million or more.
- Pre Construction Engineering and Design Phase: Duration 1-2 years. Cost share varies depending on the type of project (typically 65% to 35%, federal/non-federal).
- Construction Phase: Time varies depending on the project. Cost share varies depending on the type of project (typically 65% to 35%, federal/non-federal).

The GI process may take six years to reach the construction phase, once the funds are authorized, and then appropriated. After the reconnaissance phase there is a significant (50%) matching requirement by the local sponsor.

9.1.2 U.S. Fish and Wildlife Service

The USFWS administers a variety of natural resource assistance grants to government, public and private organizations, groups and individuals. One potential source of funding assistance for projects that restore wildlife habitat is the Cooperative Conservation Initiative. This program provides funding for projects that restore natural resources and establish or expand wildlife habitat. A 50% match is required of the project sponsor. The Cooperative Endangered Species Conservation Fund also provides funding for implementation of conservation projects or acquisition of habitat that will benefit federally-listed threatened or endangered species. The required match for this program is a minimum 25% of the estimated project cost by the local sponsor.

9.1.3 Monterey Bay National Marine Sanctuary

The MBNMS occasionally receives settlement funds from Sanctuary violations involving disturbance of the seabed. These funds must be used to protect and restore Sanctuary habitats, and could potentially be used for evaluation, planning and implementation of projects related to retention of beach habitat. Provision of such funds would need to be complemented by funding from other sources.

9.2 STATE FUNDING SOURCES

9.2.1 California Department of Boating and Waterways

The CDBW is the California agency with responsibility for studying and reporting beach erosion issues in the state, and for developing measures to stabilize the shoreline pursuant to Article 2.5 of the Harbors and Navigation Code. Following the passage of the Public Beach Restoration Act (1999) the CDBW is also responsible for allocating funds for beach restoration projects (CDBW has no jurisdiction from a regulatory standpoint). The Public Beach Restoration Program (PBRP) developed as part of the Public Beach Restoration Act provides the funding vehicle for the legislature to support restoration, enhancement, and maintenance of California beaches (CDBW and SCC, 2002). The CDBW primarily funds promotion of boating activities, safety programs and boating access; beach erosion and restoration grants are the organizations only non-boating expenditures.

The PBRP funds beach nourishment projects, dune restoration, biological and sediment transport monitoring, and feasibility and research studies. In many cases, state money has been used to leverage federal Corps funding. The PBRP also allows for 100% funding of project construction costs for beach nourishment at state parks and state beaches, and a maximum (could be less depending on availability of funding) of up to 85% funding for projects at non-state beaches (the local sponsor provides a 15% match). CEQA documentation must be submitted with grant applications, and public beach access must be adequately addressed by the project.

Since the CDBW grant programs are limited fiscally, one possibility would be for various partners to approach state legislators and request funds be earmarked for a nourishment project. The southern Monterey Bay region has a potential advantage over locations in southern California since there is a 60% to 40% split between southern and northern California for funding not assigned to a specific project. While there is intense competition due to the large number of projects in the south, the only major project area competing for funding in the northern part of the state is Ocean Beach in San Francisco. However, funds deposited in the PBRP are often earmarked for specific projects. Regardless, a local source of funding is required to provide matching funds for any project.

9.2.2 California Coastal Conservancy

The California Coastal Conservancy (Conservancy) is a state agency that uses entrepreneurial techniques to purchase, protect, restore, and enhance coastal resources, and to provide access to the shoreline. The Conservancy works in partnership with local governments, other public agencies, non-profit organizations, and private landowners, and has carried out more than 1,000 projects along the California coastline and in San Francisco Bay. The Conservancy funds shoreline protection projects that are consistent with the goals of the CCA. Similar to CDBW grants, the availability of Conservancy grant money is entirely dependent upon availability of funds (mostly bond issues). The Conservancy can fund pre-project feasibility studies, property acquisition, planning (for large areas or specific sites), environmental review, construction, monitoring, and in limited cases, maintenance.

9.2.3 California Coastal Commission

A potential source of funding is fees collected by the Coastal Commission through the Coastal Development Permit (CDP) process, from special conditions on individual permits requiring mitigation fees. The Coastal Commission and SANDAG entered into a cooperative agreement through which a Public Recreation Beach Impact Mitigation Fund was established to make money available for projects that enhance public recreational access. The fund consists of fees collected by the Coastal Commission as mitigation for the adverse impacts on public recreational use of the region’s beaches. Monies from the fund will be used to implement projects that provide public recreational improvements, including but not limited to public beach access, bluff top access, viewing areas, public restrooms, public beach parking, and public trail amenities. The role of SANDAG is to collect funds mandated by the Coastal Commission and hold the money in an interest-bearing account. SANDAG staff will work with local jurisdictions to process requests for funds. The use of funds requires local jurisdiction, Coastal Commission, and SANDAG approval. A similar fund could potentially be established to help fund beach restoration projects in southern Monterey Bay, with contributions from various future CDP processes.

In southern Monterey Bay, mitigation fees for a seawall currently being constructed at Ocean Harbor House were allocated by the Coastal Commission to dune acquisition. In order to change the allocation, the recommendation would need to be revisited and approved by the Coastal Commission. Such a change would need to be supported by quantitative projections of the amount of sand estimated to be retained by the proposed project so that it could be compared to the estimated sand lost due to the seawall.

9.3 LOCAL/REGIONAL MATCHING FUNDS

If the southern Monterey Bay area is going to be successful in attracting state or federal funding, some form of revenue stream must be developed at the local/regional level in order to leverage the state and federal funds. The local sponsor is typically required to provide 50% (Corps) or a minimum of (and sometimes more) 15% (CDBW) of costs related to studies and construction. Revenue streams developed elsewhere to generate matching funds include a transient occupancy tax (TOT) levied on hotels (southern California and elsewhere), real estate transfer tax (RETT), tax levied on sporting goods (e.g. Texas), and parking or beach user fees. Other strategies that could potentially be implemented include cost-sharing among project beneficiaries and special assessment districts.

9.3.1 Transient Occupancy Tax

Transient occupancy taxes (TOTs) are hotel taxes levied on visitors. They are the primary source of local funding in several east coast states that have well established beach nourishment programs (e.g. Florida and New Jersey). In Florida, 55% of funding for beach nourishment projects is from local sources, mainly local TOTs. TOTs have recently been implemented by a few municipalities in southern California. The City of Carlsbad estimated that approximately $1 million could be raised annually by implementing a 1% increase in TOTs. In Solano Beach the City Council voted to increase the TOT by 3% (phased in over three years), of which two thirds will be used for sand replenishment/retention and coastal access projects (estimated to be $160,000 annually).

Encinitas has a similar program in place. In this case, the Encinitas TOT measure (Measure F) appeared on the city-wide ballot on June 3, 2008 where it was approved. The TOT imposes an 8% tax on short-term lodging rentals in Encinitas; short-term is defined as less than 30 days. There are approximately 130 short-term rentals in Encinitas, and if the tax on those rental units passes, it is expected to accrue about $250,000 per year for the City. Encinitas spends $40,000 a year to replenish the sand on its beaches. The ballot language reads ‘Shall an ordinance be approved to amend Section 3.12.030 of the Encinitas Municipal Code to require guests of short term rental units (for 30 days or less) to pay 8% of the rent charged as a transient occupancy tax effective January 1, 2009?’

The Sanctuary Beach Resort currently levies a $15 per night fee to occupants to fund restoration of habitat on its property.

9.3.2 Real Estate Transfer Tax

Real estate transfer taxes (RETTs) are assessed on real estate when a property changes hands. In California, the RETT is currently 0.11%. RETTs may be applied to residential sales or to other types of real estate transactions including commercial and industrial sales. Revenue raised from a RETT may be added to the jurisdiction's general fund or earmarked for specific uses, which could include beach nourishment.

9.3.3 Tax Levied on Sporting Goods

In 1993, the Texas State Legislature passed a bill for the revenue source for state and local parks to a draw from the general sales tax attributable to sporting goods. There is no separate state tax on sporting goods. Park funding comes from a portion of Texas general sales tax revenue that is 'attributed' to sporting goods. Sporting goods are defined as personal property designed and sold for use in a sport or sporting activity.

9.3.4 User Fees

Many local municipalities on the east coast and in southern California have implemented user fees as a source of funding for beach nourishment projects. This can include parking or beach-use fees, which are often levied on visitors, but not required of local residents. For example the City of Del Mar charges for parking in most areas near the beach.

9.3.5 Cost-Sharing Among Project Beneficiaries

In this strategy, the local share of the cost of a project would be distributed among the various entities that benefit from that project. The cost could be divided proportional to the total benefits attributed to each group (e.g. by the value of the property and the risk being averted). For example, for a project in southern Monterey Bay using this approach, the local costs may be borne by the City of Monterey, the City of Sand City, the private landowners (e.g. Ocean Harbor House homeowners, Monterey Beach Resort), and other potentially affected parties (e.g. MRWPCA, CDPR).

9.3.6 Special Assessments

In this strategy the local government places assessments on properties that would receive a higher proportion of the benefits derived from the project. For example, private property at high risk of erosion damage would be required to pay a special fee that would not be required of other properties that are not at risk and proportionally higher than those that are at moderate or low risk. In Florida, the state assesses a tax based upon the distance of the structure from the beach.

Geologic Hazard Abatement Districts have been developed in several parts of California, to create a local taxing authority in order to raise funds needed to address geologic hazards. Typically they have been used to address very large, deep-seated landslides and are currently being examined as a means to address flood control when developing on alluvial fans. This process could also be applied to address coastal erosion.

10. GOVERNANCE STRUCTURE

A governance structure provides a framework for the Coastal RSM Plan to be used, including interpretations, updates and implementation of particular actions. The Governance structure represents a coordinated implementation approach that provides a framework for input from citizens as well as federal, state, regional, and local entities. Several existing RSM entities were reviewed and are discussed in this section, along with the recommended governance structure for the southern Monterey Bay Coastal RSM Plan.

10.1 AMBAG AND JOINT POWERS AUTHORITY

A Joint Powers Agreement Authority (JPA) is an institution permitted under the laws of many states whereby two or more public authorities can operate collectively. They are permitted under Section 6500 of the State of California Government Code. JPAs may be used where an activity naturally transcends the boundaries of existing public authorities (such as southern Monterey Bay coastal erosion). It is distinct from the member authorities; the JPA has a separate operating Board of Directors, and the Board can be given any of the powers inherent in all of the participating agencies. In setting up a JPA, the constituent authorities must establish which of their powers the new authority will be allowed to exercise, and a term, membership and standing orders of the Board need to be specified. Also, the JPA can employ staff and establish policies independently of the constituent authorities. JPAs are flexible and can be tailored to meet specific needs, and there are many differences among individual JPAs.

The AMBAG is a JPA governed by a Board of Directors composed of locally elected officials appointed by their respective city council or Board of Supervisors. Each member city has one representative on the Board, while each member county has two. The AMBAG Board of Directors sets policy and oversees a small professional staff. The AMBAG's funding comes from various local sources, including the state and federal governments for mandated planning activities and grant projects. Funding comes from various local sources, including annual membership dues contributed by each member agency.

In order to define a governance structure and implementation for this Coastal RSM Plan using a JPA model we have investigated the governance models adopted by San Diego Association of Governments (SANDAG) and Beach Erosion Authority for Clean Oceans and Nourishment (BEACON).

10.1.1 San Diego Association of Governments

SANDAG comprises 18 cities and county governments and is a forum for decisions on a wide range of issues (not just coastal erosion). Similar to the AMBAG, the SANDAG is governed by a

Board of Directors composed of mayors, council members and county supervisors, as well as advisory members (non-voting) from Department of Defense, Caltrans, San Diego Port District, San Diego Water Authority, and others. In addition to the Board, SANDAG also have a staff of professional planners, engineers, and research specialists. SANDAG builds consensus, makes strategic plans, obtains and allocates resources, plans, engineers, and builds public transportation, and provides information on a wide variety of topics; they have a broader spectrum of responsibilities than the AMBAG. SANDAG also has the ability to issue bonds, as established in specific state legislation (SB 1703, Feb 12, 2002). SANDAG has a Shoreline Preservation Working Group with staff members and a Shoreline Preservation Strategy that was adopted by their Board in 1993. This strategy places a large emphasis on beach nourishment. The Working Group advises the Regional Planning Committee of SANDAG on issues related to the Shoreline Preservation Strategy.

10.1.2 Beach Erosion Authority for Clean Oceans and Nourishment

BEACON is a JPA with member agencies comprising the cities of Carpenteria, Goleta, Oxnard, Port Hueneme, Ventura, Santa Barbara, and the counties of Santa Barbara and Ventura. BEACON was established for the limited purposes of dealing with coastal erosion and beach problems in that coastal region. They have also recently expanded their purview to water quality issues and beach and ocean pollution. BEACON maintains technical staff to assist with coastal engineering issues inherent with beach nourishment.

10.1.3 Joint Powers Authority Options

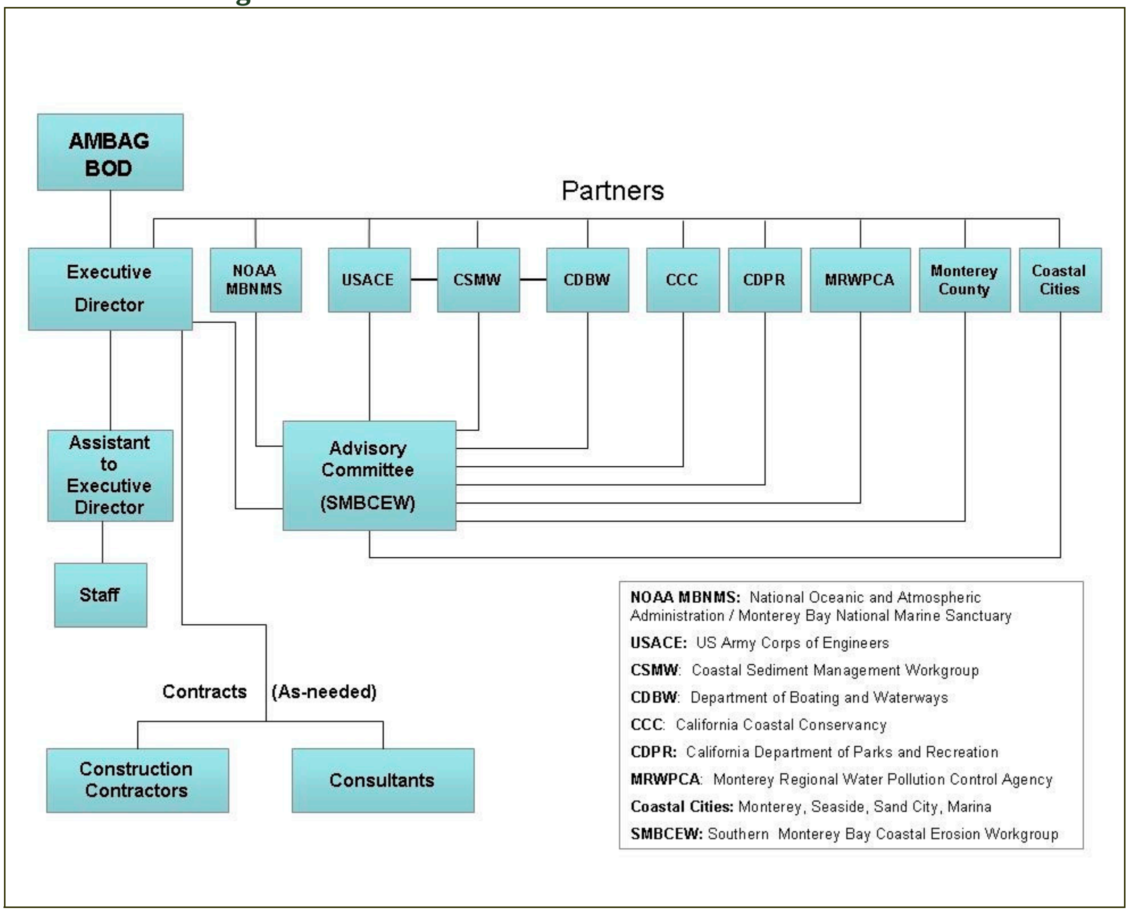
Adopting the SANDAG model, the governance structure would employ the AMBAG as an existing JPA and include a multi-stakeholder coastal erosion committee that advises the Executive Director and Board of Directors. This structure would negate the need to establish a new JPA, it could be extended to other geographic regions in the future (e.g. northern Monterey Bay, Santa Cruz), and the organization would already be set up to receive funding and implement projects. For this option to be adopted the AMBAG Board would need to expand their scope to take on this new coastal erosion/sediment management role.

Adopting the BEACON model would require formation of a new JPA that is only focused on erosion issues in the southern Monterey Bay area, rather than using the AMBAG as an existing JPA. The scope of the new JPA would be limited to erosion/sediment management issues and the geographic area would be limited to southern Monterey Bay, rather than the larger three-county AMBAG region.

10.2 RECOMMENDED GOVERNANCE STRUCTURE

This Coastal RSM Plan recommends a governance structure for implementation of RSM in southern Monterey Bay using the AMBAG as an existing JPA. The recommended governance structure for southern Monterey Bay is outlined in Figure 42.

Figure 42. Recommended AMBAG Governance Structure



In this structure the AMBAG acts as the lead planning and coordinating agency which adopts, seeks funds, administers grants and studies, assists with implementation activities as deemed necessary by the local implementing agencies, and maintains and updates the Coastal RSM Plan. The AMBAG would receive funds, complete environmental documentation, acquire regional permits as appropriate, and plan coastal projects, as appropriate. Local land use decision-making and implementation would remain with the local agencies.

AMBAG is defined as the lead-planning agency for sediment management issues only (i.e. this would not include such issues as seawalls or other interventions involving structural solutions).

As other erosion control measures are defined and proposed, the JPA may, with Board approval, consider expanding its ‘powers’ to govern these measures (perched beaches, groins, dynamic revetments, breakwaters, submerged breakwater, headland enhancement, etc).

This Coastal RSM Plan recommends that the AMBAG investigates hiring a dedicated staff member to assist the Executive Director to specifically manage sediment management issues and co-ordinate staff. This recommendation is conditional upon being able to fund the position. The Executive Director would be advised and guided on regional sediment management issues by a committee comprising representatives from local cities, academic institutions and industry. It is recommended to continue the Southern Monterey Bay Coastal Erosion Workgroup (SMBCEW) in this role. The Executive Director would then report to the Board of Directors.

It is important to note that this structure may be updated as experience is gained with sand management in southern Monterey Bay. The AMBAG may also find, like SANDAG and BEACON, that one or more technical staff may be desired to help local agencies to implement particular projects which require special capabilities in coastal engineering, construction contract administration, and/or monitoring, as needed.

10.2.1 Partners

Three main partners working closely with the advisory committee in the implementation of RSM in southern Monterey Bay are identified in this Coastal RSM Plan. The Coastal Sediment Management Workgroup (CSMW) provides the framework for Coastal RSM Plans throughout coastal California. The California Department of Boating and Waterways (CDBW) is the state department that funds many beach nourishment and erosion control projects, and is a member of CSMW. CDBW could cost share with any public agency that has a Board comprised of elected officials and that has the authority to enter into an agreement. The AMBAG has authority for planning and environmental aspects of beach nourishment. The U.S. Army Corps of Engineers (Corps) is a federal agency that funds many beach nourishment, erosion control, and ecosystem restoration projects, and is also a member of CSMW. The Corps could cost share with any non-Federal public agency, and generally if CDBW can partner with the AMBAG then so can the Corps. To partner with the Corps, the AMBAG would need to sign an agreement and demonstrate an ability to pay.

The AMBAG would enter into contracts for coastal processes studies, planning, environmental review, permitting and engineering as needed. The AMBAG also may enter into construction contracts for beach nourishment, if deemed necessary or desirable by local agencies.

10.2.2 Implementation

Implementation of this Coastal RSM Plan means activation of the AMBAG’s role to coordinate information and funding between the various levels of government and to solicit grant funding for various shoreline enhancement projects. In order for the Coastal RSM Plan to be considered when sediment management activities are being planned or implemented, the AMBAG should promote referencing of the Plan in individual Local Coastal Programs or Land Use Plans (cities of Monterey, Seaside, Sand City, Marina, and County of Monterey). The AMBAG could pursue implementation of the RSM plan by requesting that the local office of the Coastal Commission begin requiring all sediment management projects along the southern Monterey Bay shoreline be consistent with the Coastal RSM Plan by beneficially re-using surplus sediment for nourishment.

The AMBAG should coordinate with all local agencies (city and County-level) to pursue consistency with specific elements of the Coastal RSM Plan in their zoning ordinances and municipal codes in their General Plans. For example, any project component that requires a grading permit would be asked to show how that project could beneficially reuse surplus sediment (if it has the appropriate quality for nourishment purposes) within the coastal zone rather than for other purposes (such as construction materials or fill). Input from partner cities and the County of Monterey would be received by the SMBCEW, which would then make recommendations to the AMBAG Board of Directors.

The AMBAG should also work with MBNMS to find ways to implement RSM within the Sanctuary boundaries. This would specifically include ways to interpret or modify existing Sanctuary regulations to allow extraction and placement of sand for beach nourishment projects as part of the Harbors and Dredge Disposal Action Plan.

10.2.3 Outreach and Dissemination

In order for the AMBAG to coordinate with the local jurisdictions (County of Monterey, Cities of Monterey, Seaside, Sand City, Marina) and special districts to implement the Coastal RSM Plan, a post-Plan outreach program should be established. The AMBAG should develop existing resources including contact lists to provide a focused outreach campaign to encourage discussion amongst the southern Monterey Bay agencies and stakeholder groups. Public meetings should be also be convened as appropriate in which the AMBAG should seek public input and consensus to guide the implementation of the recommended actions in the Plan. This Coastal RSM Plan should also be supported through publication of brochures, fact sheets, and provision of information on the AMBAG, SMBCEW, and CSMW web pages.

11. DATA GAPS

11.1 SEDIMENT (SAND) BUDGET

Sections 1 and 2 outline the current knowledge about geomorphologic and sedimentary processes in southern Monterey Bay. However, in certain areas the knowledge is incomplete, and assumptions have been made. Two prioritized data gaps are summarized below, which should be filled in order to improve implementation of RSM initiatives.

Regional particle size characteristics and the littoral cell cut-off diameter: Data on regional sediment distribution and character are limited and is considered an important data gap in this Coastal RSM Plan. Filling this gap is important for several reasons:

- littoral cell cut-off diameters for each sub-cell need to be calculated to better assess beach nourishment needs and compatibility of source sediments.
- sediment particle size distributions of potential offshore source areas need to be established for compatibility with potential receiver sites. Side scan surveys to determine detailed bottom type, composition and depth are planned for Monterey Bay. These surveys would provide better information on offshore sand resources.
- the relationship between the particle size distributions of the dunes, beaches and shoreface should be examined to better quantify the amount of eroded sediment that remains in the littoral zone, and the impact of finer dune sand on beach slope and recession rate

Sediment transport calculations: Sediment transport will be calculated every 200 m as part of the COCMP and CDIP. An additional directional wave buoy was installed in southern Monterey Bay in 2007 to define the influence of sea breeze generated wind waves. This has improved the estimates of nearshore waves within southern Monterey Bay. The continually expanding information will provide better estimates on transport and definition of the south sub-cell between Wharf II and Sand City. This is important information for the design of a nourishment plan.

11.2 SENSITIVE SPECIES AND HABITAT

The current knowledge of the distribution of critical species and habitat in southern Monterey Bay is incomplete, and several areas need to be investigated further in order to understand the potential significance of sediment management activities. Two prioritized data gaps are summarized below, which should be filled in order to improve implementation of beach nourishment initiatives.

Distributions of kelp forest and eelgrass meadow: Knowledge regarding the general locations of kelp forest and eelgrass meadow in the southern bight is based on previous surveys undertaken several years ago. However, these areas could have changed significantly over periods of years and new up-to-date subsurface information on distribution of kelp and eelgrass is needed for use in beach nourishment planning. This Coastal RSM Plan recommends new diver field surveys for project planning and assessment of the sensitivity of these habitats to potential beach nourishment.

Species and habitat of potential offshore borrow sites: Synchronous with the investigation of regional particle size identified as a data gap, the extent and types of benthic communities associated with the potential sand sources (offshore Sand City, Monterey Submarine Canyon) and their relationships to specific substrates is an important data gap. Without these data it is difficult to assess the impacts on these communities of sediment recovery by dredging in the offshore.

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APPENDIX A - SAND MINED FROM THE BEACHES AT SAND CITY AND MARINA

Table A-1. Annual beach-sand mined along southern Monterey Bay (yd^3/year x 10^3)

Company	Monterey Sand Company[3]	Granite Construction	PCA[1]	Sub-total Sand City	Monterey Sand Company[3]	Seaside Sand[2]	PCA[1]	Sub-total Marina	Total
Location (miles from Wharf II)	3.0	3.1	3.5		9.1	9.5	9.8		
Year	1931-1990	1950-1969	1927-1986		1944-1986	1957-1970	1965-		
40's	37*	0	65*	102	20*	0	0	20	122
50's	37*	22*	65*	124	33*	7*	0	40	164
60	37*	8	14	59	33*	7	0	40	99
61	37*	40	52	129	33*	7	0	40	169
62	37*	33	44	114	33*	12	0	45	159
63	37*	33	41	111	33*	5	0	38	149
64	37*	31	39	107	33*	10	0	43	150
65	37*	31	39	107	33*	7	68	108	215
66	37*	0	78	115	33*	10	94	137	252
67	37*	14	108	159	33*	10	91	134	293
68	13	16	88	117	14	5	98	117	234
69	48	7	106	161	51	8	78	137	298
70	30	0	63	93	30	1	98*	129	222
71	85		59	144	34		98*	132	276
72	43		82*	125	44		98*	142	267
73	27*		82*	109	37*		98*	135	244
74	24		84	108	24		98*	122	230

Company	Monterey Sand Company[3]	Granite Construction	PCA[1]	Sub-total Sand City	Monterey Sand Company[3]	Seaside Sand[2]	PCA[1]	Sub-total Marina	Total
Location (miles from Wharf II)	3.0	3.1	3.5		9.1	9.5	9.8		
75	30		74	104	31		98*	129	233
76	29		95	124	29		98*	127	251
77	26		91	117	27		98*	125	242
78	26		95	121	27		98*	125	246
79	24*		82*	106	25*		98*	123	229
80	24*		82*	106	25*		98*	123	229
81	24*		123	147	25*		98*	123	270
82	24*		65	89	25*		98*	123	212
83	7		58	65	12		98*	110	175
84	30		60	90	33		131*	164	254
85	22		74	96	60		131*	191	287
86	24		91	115	33		131*	164	279
87	58		7	65	0		131*	131	196
88	135		0	135	0		131*	131	266
89	60		0	60	0		175*	175	235
90	0						200*	200	200
90's							200*	200	200
00's							200	200	200

[1]Pacific Concrete and Aggregates (PCA) was bought by Lone Star Industries and then by CEMEX in 2005

[2]Seaside Sand and Gravel Company was bought by Floyd Bradley in 1970 and then sold to Standard Resources in 1974.

[3]The Monterey Sand Company had mines at both Sand City and Marina and did not differentiate the total sand volumes reported, so the amount is evenly divided between the two mines.

[3]The Monterey Sand Company decreased the reported values by 3% to account for wash loss, and this has been added back into the volumes.

*Estimated values

APPENDIX B - LOW RISK AND / OR LOW CONSEQUENCE AREAS

Moss Landing spit communities

The Monterey Bay Aquarium Research Institute (MBARI) consists of a set of two main shoreline buildings connected by a catwalk, a warehouse that contains offices and Phil's Fish Market, and multiple structures to support research and development operations, including parking lots as well as docking facilities in the harbor. The original building was constructed in 1989, and major expansions occurred in 1995 and 2001. MBARI purchased an additional four square miles of land in the early 1990's, and is still in the process of developing plans for expansion and new facilities. The current property is located just south of the entrance to the Moss Landing Harbor, and includes land along the shoreline as well as the harbor. The current facilities span approximately 0.2 miles of shoreline beginning approximately 0.2 miles south of the entrance to Moss Landing Harbor. While the property is located on the beach, the area's erosion rates are strongly accretional in the long term and average to be moderately accretional in the short-term (Hapke et al., 2006). As such, the MBARI property and facilities are designated as low risk.

Monterey Dunes Colony

Monterey Dunes Colony comprises 120 vacation town homes stretched out over approximately 5,550 feet of shoreline. The most seaward units are within 100 feet of the dune edge. There is no information on the long-term movement of the dune face at this location. However, Hapke et al. (2006) showed that mean high water over the short term and long term has migrated seaward indicating beach accretion. The Monterey Dunes Colony is therefore designated as a facility at low risk of erosion.

Ocean outfall pipeline near Marina sand mine

The MRWPCA ocean outfall extends approximately three miles offshore from the beach near the Marina sand mine. The outfall pipeline is five feet in diameter and between the beach and 2,000 feet offshore is bounded on either side by sheet pile walls and capped by concrete. According to construction specifications, the outfall pipeline joins the onshore pipeline at a junction box with a top elevation of -23 feet NGVD. During the El Niño winter of 1998, back beach elevations were about +16 feet NGVD in the vicinity of the junction box. Given the depth of the pipeline at the junction box, it is unlikely that the outfall beneath the beach will be impacted significantly by erosion over the next 50 years. This assessment indicates that the ocean outfall pipeline is a low erosion risk facility (PWA and Griggs, 2004).

Fort Ord storm water and sewer outfalls

As part of the Fort Ord Reuse Plan of 1997, the Fort Ord Reuse Authority (FORA) is to eliminate all storm water discharges to Monterey Bay from Fort Ord. Prior to 2003, storm water from the Fort Ord site that is under FORA jurisdiction was discharged through three deteriorating outfalls.

In 2003, these outfalls were removed from the shoreline and replaced with two infiltration basins landward in the dunes. Although this project is temporary and expected to last about 20 years, a permanent solution is under preparation as part of a long-term drainage master plan and will include percolation galleries east of Highway 1. This project will improve water quality in the MBNMS, and reduce erosion at the former outfall sites, where small canyons have formed by undercutting and vertical failing of the buried pipes. Although remnants of the outfalls remain in the dunes, they are not functional. The land west of Highway 1 has been turned over to the California State Department of Parks and Recreation.

A fourth outfall structure towards the south end of Fort Ord was not removed, since it drains property that was not transferred to State Parks and is currently under Corps ownership. In 2003, the Corps constructed riprap, gabion, and grouted apron as a temporary fix to control erosion at this structure, but it failed during the first winter storm in December 2003. The watershed that drains to this outfall will be redeveloped as part of the Residential Communities Initiative (RCI). This effort was recently started (expected to be phased out over next 10 years), and will ultimately include on-site retention.

<u>Fort Ord monitoring and injection wells</u>

A suite of 13 monitoring wells in Fort Ord west of Highway 1 and north of the former Stillwell Hall exist to monitor the progress of a groundwater trichloroethene (TCE) plume that originated near 12th Street and is migrating seaward. These wells are part of a remediation program that also includes two injection wells into which treated water from the plume is pumped. Both the monitoring wells and injection wells are currently in use, and are owned and operated by the Corps. The wells are located at distance from the cliff edge and are not threatened by erosion.

<u>Bay Avenue storm water outfall</u>

The current 160-feet long concrete-lined Bay Avenue storm water outfall is exposed on the beach, causing aesthetic impacts and restricting public access along the beach. Several improvements to this outfall have been made, including: replacement with an 84 inch plastic pipe and new outlet headwall and overflow structure, with an overall length of 125-feet; removal of previously existing fencing, and installation of a diversion structure and pump station to divert dry-weather flows to the sanitary sewer system. These improvements reduced the length of the outfall on the beach by 35 feet, and improved local water quality by diverting dry-weather flows to a treatment facility. However, the storm drain outlet has not functioned as expected. The outlet is presently buried during normal conditions and has to be excavated before each expected rain so that the storm run-off does not cause floods in Sand City. As the outlet has not functioned as expected, the facility will probably have to be redesigned. The outfall crosses the beach and is therefore under imminent threat of erosion; a facility at high risk of erosion, but of low consequences economically.

Roberts Lake/Laguna Grande outfall

The Roberts Lake/Laguna Grande outfall, which was originally installed by Caltrans when Highway 1 was constructed, is located adjacent to the Monterey Beach Resort. The outfall drains the overflow from Roberts Lake and Laguna Grande, portions of Highway 1, the City of Del Rey Oaks, Fremont Boulevard, and approximately one third of the City of Seaside's storm water runoff. The outfall is located on the back beach at the landward point of the northern end wall of the hotel and is a facility at low risk of erosion.

It is possible that the drainage from this outfall is exacerbating coastal erosion locally by scour of the beach due to the high volume and velocity of water during high flows. A ponded area forms along the back beach in a trough created by erosion by the outfall water. This ponding compromises access to the beach and a temporary boardwalk is often constructed to allow crossing. This outfall has also presented water quality problems, as the urban runoff that flows to the ocean is not filtered, and can be contaminated.

Sand Dunes Drive

Sand Dunes Drive is located along the landward side of the Monterey Beach Resort. The road dead ends to vehicle traffic at the southwest extremity of the hotel where it joins a paved bike path/recreation trail. This section of road is used for access to the hotel and beach and is protected on the seaward side by the hotel. Sand Dunes Drive continues northeast running parallel to Highway 1, between the highway and the dunes, until it ends at Tioga Avenue. Immediately northeast of the Monterey Beach Resort the road is less than 250 feet from the edge of the dunes. Further to the north, the distance between the road and the shoreline becomes progressively greater. Given long-term future erosion rates of approximately 1.5 ft/year, the road would be compromised in 170 years, and is therefore at low risk of erosion.

Monterey Pump Station

Monterey Pump Station is located landward of a set of concrete structures that formed part of the former City of Monterey wastewater treatment plant decommissioned in 1990. The land surrounding the pump station is owned by the Navy, although MRWPCA continues to retain some of the underground tanks for possible emergency storage of peak flows that could occur during heavy rainfall. To date use of these tanks has not been necessary. Monterey Pump Station is set back about 350 feet from the present shoreline and at least part of the facility is protected on the seaward side by the concrete tanks. The facility is set back adequately to have a low risk of erosion over the next 50 years.

Del Monte Lake outfall

The Del Monte Lake outfall, located on the grounds of the Navy, provides drainage for Del Monte Lake overflow. The outfall is located at the dune-beach interface with water flows across the beach. A lateral access path was built over the outfall, which is protected to either side by riprap. The riprap also serves to protect the Monterey Interceptor, which is located halfway between the headwall and the abandoned sewage treatment plant. Damage to the riprap occurred following storms in December 2002, after which it was repaired and increased through an emergency permit. Currently, the riprap extends approximately 65 feet in each direction from the outfall. Concentrated flow from this outfall can exacerbate beach erosion in the immediate vicinity, and cut off lateral access along the beach. The outfall is directly on the beach and under imminent threat of erosion and so the facility is considered to be at high risk of erosion or being damaged. However, it is a low consequence facility because the cost of repair is small, there is adequate room to rebuild and move the outfall landward, and at high tide or during storms it is possible to bypass the outfall by walking along the back of the beach.

<u>Lake El Estero Pump Station and outfall</u>

Lake El Estero Pump Station and outfall was likely constructed during the early 1960s. Since its construction, there have not been any issues with coastal erosion. Indeed, the City of Monterey often has problems with the outfall pipe getting buried in the sand over the summer, probably due to local accretion of beach sand in the lee of Wharf II. The Lake El Estero Pump Station and outfall are categorized as facilities at low risk of erosion.

<u>Catellus East property near Wharf II</u>

The Catellus East property is located near Wharf II on the seaward side of the recreation trail in Monterey. The building was constructed between 1949 and 1958, originally as a headquarters for the Sea Scouts. It served as a Boy Scout lodge and has been leased by Adventures-by-the-Sea, a local company that uses the building to host catered parties and corporate team building activities. The property is not under any immediate or long-term threat from erosion since it is well protected by local build-up of sand adjacent to Wharf II. Run-up does reach the building during the winter when the City of Monterey builds a sand berm extending from Wharf II to the Catellus building to protect Del Monte Avenue from being flooded during high tides and large waves. Future plans for the Catellus East property by the City of Monterey is to have it removed within a ten year time frame to complete the ‘windows on the bay project’.

APPENDIX C - ECONOMIC ANALYSIS USING CSBAT

Introduction

This Appendix sets out details of the input data used in the economic analysis, along with full reporting of the results that are summarized in Section 7 of the Plan.

The analysis of costs for the various beach nourishment alternatives and the recreational benefit analysis were performed using the Coastal Sediment Benefits Analysis Tool (CSBAT) developed by the California Sediment Management Workgroup (CSMW). There is no attempt to reproduce the background documents and guidance for this tool as a number of reports already exist that explain the tool and it's analyses:

- The Coastal Sediment Benefits Analysis Tool (CSBAT – San Diego): *Technical Report*. Prepared by Everest, for U.S. Army Corps of Engineers (2008)
- Coastal Sediment Benefits Analysis Tool (CSBAT – San Diego): *How-To Users Guide*. Prepared by Everest, for U.S. Army Corps of Engineers (2007)
- The Coastal Sediment Benefits Analysis Tool (CSBAT – San Diego): *Technical Manual*. Prepared by Everest, for U.S. Army Corps of Engineers (2008)

These reports describe the analytical processes (e.g. cost and economic benefit functions) of the tool, together with guidance on its application. Details of the tool are also available from the CSMW website: http://dbw.ca.gov/csmw/default.aspx

Details of the input data and assumptions used in the CSBAT application are presented below. The data and methodology used to determine the 'property protection benefits' of the beach nourishment alternatives are also presented. The 'Scenario' and 'Alternative' reports produced by the tool are reproduced in full at the end of this appendix.

CSBAT assumptions and methodology

Table C.1 presents the input data used to run the CSBAT application for southern Monterey Bay. The values in white cells are inputs that were developed specifically to represent the local conditions in southern Monterey Bay. The grey cells represent those variables where no locally specific data was available so inputs were derived from review of the data used in previous (San Diego) applications of CSBAT.

Table C-1. Input Data for Southern Monterey Bay CSBAT Application

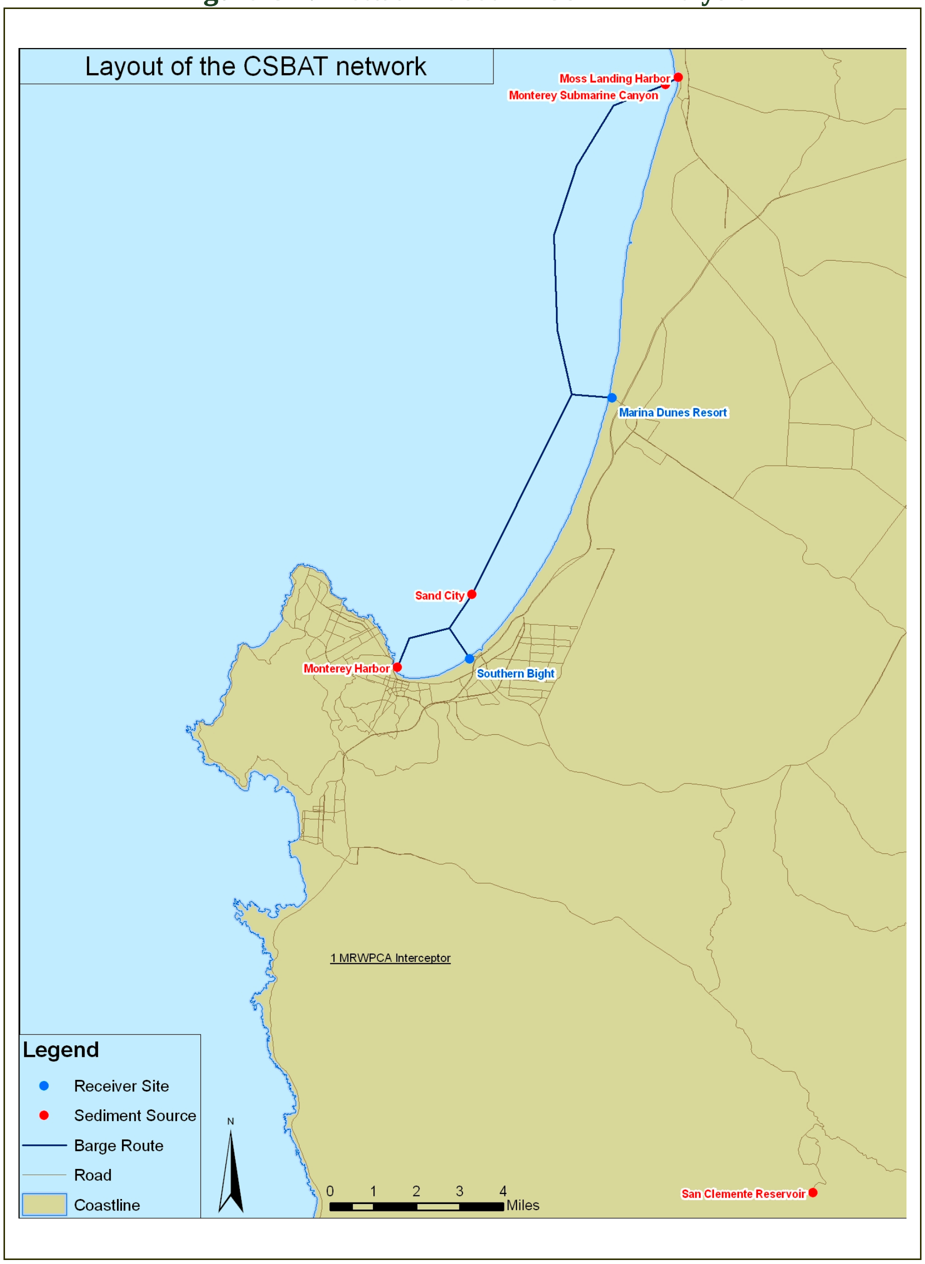
Parameter	Description	Southern Bight
s_d50	Particle diameter where there are 50 % finer [mm]	0.4 mm
s_fines	Clay and silts passing the #200 sieve (0.074 mm)	0%
existing_width	Existing width (ft) of the receiver beach before sediment application	150 ft
beach_length	Length (ft) of the beach that the source sediment could have been placed	15,000 ft (3 miles)
berm_height	Existing berm height (ft) of receiver beach	16 ft above MLLW
fill_length	Length (ft) of beach deposition of sediment from source site	15000 ft
depth_of_closure	Offshore depth (ft) beyond which there is little vertical change in the seabed with time	20 ft below MLLW
kelp	Whether kelp are present at the receiver site	yes
surfgrs	Whether surf grass beds are present at the receiver site	eel grass: yes; surf grass: unknown
grunion	Whether grunion are present at the receiver site	yes
gulltern	Whether gulls or terns are present at the receiver site	yes
divbirds	Whether diving birds are present at the receiver site	yes
shorebirds	Whether shorebirds are present at the receiver site	yes
fish	Whether fish of special status are present at the receiver site	yes
mammal	Whether reefs are present at the receiver site	yes
yearly_attendance	Number of yearly attendees	644,677
longshore_diffusivity	Coefficient corresponding to the tendency for wave action to spread out shoreline perturbation	0.261
state_spending	Amount of money spent in the state per year by visitors to the beach ($)	11,236,720
local_spending	Amount of money spent locally per year by visitors to the beach ($)	10,973,091
weather_value	The decimal percentage equivalent of the quality of weather at the beach	0.85
water_quality_value	The decimal percentage equivalent of the quality of water at the beach	0.84
beach_quality_value	The decimal percentage equivalent of the quality of beach at the beach	0.45
overcrowding value	The decimal percentage equivalent of the amount of space available at the beach	0.51

Parameter	Description	Southern Bight
facilities_value	The decimal percentage equivalent of the availability of facilities available at the beach	0.48
substitutes_value	The decimal percentage equivalent of the lack of available substitutes near the beach	0.44
weather_weight	Weight assigned to weather quality amenity value	0.2
water_quality_weight	Weight assigned to water quality amenity value	0.2
overcrowding_weight	Weight assigned to overcrowding amenity value	0.15
facilities_weight	Weight assigned to facilities amenity value	0.15
substitutes_weight	Weight assigned to substitutes amenity value	0.15
state_tax_rate	State tax rate	11.5
local_tax_rate	Local tax rate	2.5
discount_rate	The interest rate used in discounting future cash flows	0.05
attendance_increase_doubled	Increase in attendance when the beach width is doubled	0.025
max_daily_use_value	Maximum daily value derived per person attending the beach—$14 for all beaches	14
day_use_value	Current value of attendance per person per day at receiver beach	8.02
overnight_factor_state	% of non-California residents who spend the night	0.36
overnight_spending_state	Dollar amount/day spent by non-California residents who spend the night	20
daytripper_factor_state	% of non-California residents who do not spend the night	0.64
daytripper_spending_state	Dollar amount/day spent by non-California residents who do not spend the night	16
overnight_factor_local	% of California residents who spend the night	0.38
overnight_spending_local	Dollar amount/day spent by California residents who spend the night	16
daytripper_factor_local	% of California residents who do not spend the night	0.62

The state and local spending totals were specific to Monterey Bay; in so much as they were calculated based on the local visitor numbers. However, the 'spend per person' data used to build the dollar value was derived from the figures from the San Diego application (annual spend was divided by annual attendance for each San Diego beach and the mean of these values was used for Monterey). The San Diego mean was $17.43 and this value was multiplied by the Monterey visitor numbers to give the State and Local spending values.

The CSBAT tool uses a 'geometric network' within the project GIS to calculate transport routes, distances, etc in the cost calculations. Figure C.1 illustrates the network developed for southern Monterey Bay.

Figure C-1. Network Used in CSBAT Analysis



Outputs from CSBAT

The full 'Scenario' report outputs are at the end of this appendix. These scenarios provide a summary of the input data for each combination of source and receiver site, together with mapping to illustrate the location and environmental factors. The final page of each report presents the cost estimate, beach width increase and recreational benefit build-up.

The tool presents details for each individual scenario and then allows the user to combine a number of scenarios to create an 'Alternative'. This allows multiple source/receiver site combinations to be considered as a single alternative, in order to rationalize mobilization/de-mobilization costs etc. Note that no combinations of scenarios were considered for this study, hence the alternative outputs each relate to an individual scenario. Table C.2 presents the full set of all 'alternative' outputs from the CSBAT application.

Discounting Process

Discounting is the procedure used to sum economic benefits over the lifetime of the project using a discount rate to scale down future benefits and costs. The effect of using a discount rate is to reduce the value of projected future benefits to their values as seen from the present day. This process effectively reduces the present day value of benefits accrued in the future in order to give them an appropriate level of influence on present day decision making. Consequently, the sooner a benefit is realized the greater its relative value will be. In the context of this study, protection of assets at risk in the early years of the analysis has the greatest relative benefit.

For this study a discount rate of 5% has been used. This is consistent with the Federal Discount Rate for FY 2008 used by the U.S. Army Corps of Engineers. To illustrate this process; if a property worth $100,000 were anticipated to be lost this year the value of that loss would be $100,000. However, if the loss were to occur next year the present value would be approximately $95,000 (with the 5% reduction). With cumulative reductions over time, the later the loss, the lower its present value. Consequently the 'benefit' of delaying erosion is the reduction in the value of loss that is achieved through the delay.

Table C-2. 'Alternative' Outputs from the CSBAT Application

Option		Total Costs	Sub Total Costs	Mob/Demob Costs	Fill Volume	Increased Recreation	Benefit/Cost Ratio	Cost/Yard	Number of Environmental Factors
1a	75k from Monterey Harbor to Southern Bight via hopper beach	**$1,031,560**	$431,560	$600,000	75,000	$54,955	0.1	$14	9
1b	75k from Monterey Harbor to Southern Bight via hopper nearshore	**$693,503**	$193,503	$500,000	75,000	$36,264	0.1	$9	9
2a	2M from Sand City to Southern Bight via hopper beach	**$11,644,907**	$11,044,907	$600,000	2,000,000	$8,067,127	0.7	$6	9
2b	2M from Sand City to Southern Bight via hopper nearshore	**$5,332,452**	$4,832,452	$500,000	2,000,000	$1,479,160	0.3	$3	9
2c	2M from Monterey Sub to Southern Bight via hopper beach	**$20,347,048**	$19,747,048	$600,000	2,000,000	$8,067,127	0.4	$10	9
2d	2M from Monterey Sub to Southern Bight via hopper nearshore	**$11,373,016**	$10,873,016	$500,000	2,000,000	$1,479,160	0.1	$6	9

Scenario ID: 75000 Cy from Monterey Harbor to Southern Bight via hopper beach

Nearshore Placement of Sediment

Source Location		**Receiver Location**	
Source Site:	Monterey Harbor	Receiver Beach:	Southern Bight
County:	Monterey	County:	Monterey
Littoral Cell:	Monterey	Littoral Cell:	Monterey

Receiver Beach Information

Existing Beach Width*(ft):	150
Beach Fill Length(ft):	15,000
Berm Fill Volume(cy):	75,000
Increased Beach Width, Yr-0(ft):	3.75

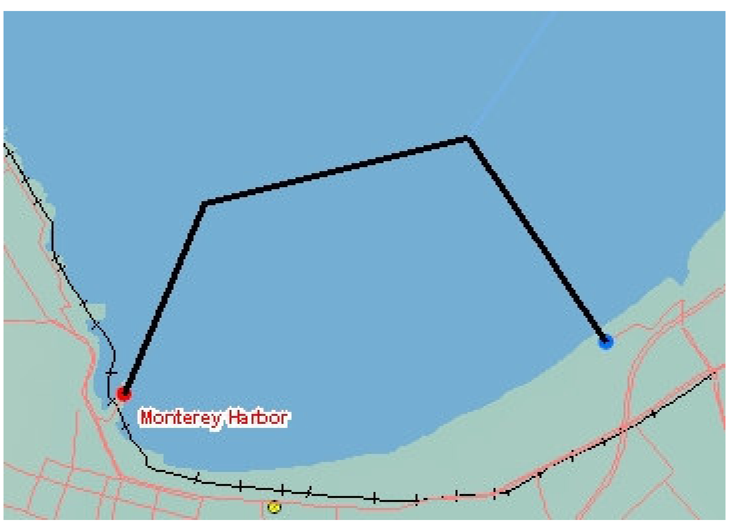
*Based on site observation in

Sediment Characteristics

Receiver D50 (mm):	0.4
Source D50 (mm):	0.3
Receiver % Fines:	0
Source % Fines:	5

Receiver Beach or Sediment Source: Environmental Considerations

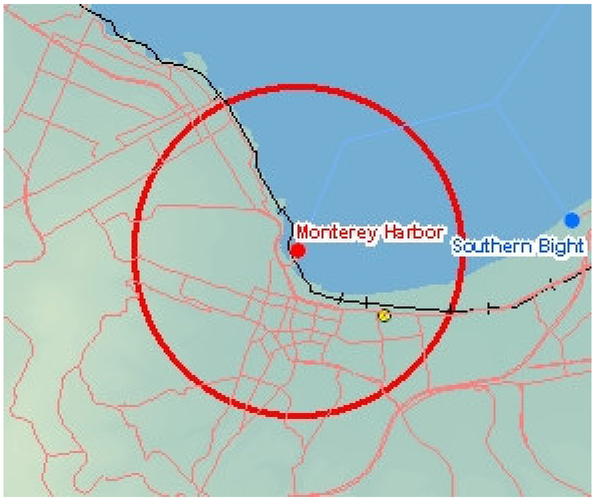
Reefs: No	Kelp Beds: Yes	Eelgrass/ Surfgrass: Yes	Grunion: Yes
Fish: Yes	Gulls/ Terns: Yes	Shorebirds: Yes	Diving Birds: Yes
Shellfish: No	Wading Birds: Yes	Marine Mammals: Yes	Transit Trips: **28**



Sediment Source: Environmental Considerations

Reefs: No	Kelp Beds: No	Eelgrass/ Surfgrass: No	Grunion: No
Fish: No	Gulls/ Terns: No	Shorebirds: No	Diving Birds: No
Shellfish: No	Wading Birds: No	Marine Mammals: No	

Kelp Persistence (1967-1999)



Oceanfloor Substrate

Receiver Beach: Environmental Considerations

Reefs: No	Kelp Beds: Yes	Eelgrass/ Surfgrass: Yes	Grunion: Yes
Fish: Yes	Gulls/ Terns: Yes	Shorebirds: Yes	Diving Birds: Yes
Shellfish: No	Wading Birds: Yes	Marine Mammals: Yes	

Kelp Persistence (1967-1999)

Oceanfloor Substrate

Receiver Beach Characteristics

Beach Width (ft):	150	Beach Fill Location:	
Beach Length (ft):	15,000	Beach Fill Length (ft):	15,000
Berm Height(ft):	16	Berm Volume (cy):	75,000
Historical Erosion Rate (ft/yr):	3.45	Depth of Closure (ft):	20
Longshore Diffusivity (sqft/sec):	0.261		

Increased Beach Width (ft) from Fill Placement:

Year-0:	Year-1:	Year-2:	Year-3:	Year-4:	Year-5:	Year-6:	Year-7:	Year-8:	Year-9:	Year-10:
3.75	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Scenario Costs

Miles Source to Receiver

Hopper Distance (mi):	2.53
Speed of Vessel (mph):	7
Hopper Capacity (cy):	2,700

Economic Variables

Amenity	**Weighted Value (%)**
Weather:	0.85
Water Quality:	0.84
Beach Width/Quality:	0.45

Hopper Down Time Percentage:	20%	Overcrowding:	0.51
Hopper Trips Per Day	4.6	Facilities/Services:	0.48
Total Hopper Trips:	28	Availability of Alternatives:	0.44
Construction Period (days)	6	Total Index Value:	0.59
Hopper Total Transport Cost	431,560	Day Use Value :	$5,358,353.30
		Annual Attendance:	644,677
		Existing Spending in CA :	$11,243,166.88
		Existing Local Spending :	$9,035,792.83
		Existing Taxes in CA :	$1,292,964.19
		Existing Local Taxes :	$225,894.82
Beach Nourishment Cost* :	**$431,560**	**Existing Recreational Benefit :**	**$5,170,310**

*Costs do not include mobilzation and demobilization of equipment. These costs are added in once a Scenario is added to an Alternative.

Scenario Benefits

Increased	**S/L Spending**	**S/L Taxes**	**Rec Value**
Year-0	$11,243.17	$1,292.96	$38,328.96
Year-1	$899.45	$103.44	$2,940.10
Year-2	$0.00	$0.00	$0.00
Year-3	$0.00	$0.00	$0.00
Year-4	$0.00	$0.00	$0.00
Year-5	$0.00	$0.00	$0.00
Year-6	$0.00	$0.00	$0.00
Year-7	$0.00	$0.00	$0.00
Year-8	$0.00	$0.00	$0.00
Year-9	$0.00	$0.00	$0.00
Year-10	$0.00	$0.00	$0.00
Total			$54,955

Increase in Recreational Benefit : $54,955

Scenario ID: 75000 Cy from Monterey Harbor to Southern Bight via hopper nearshore

Nearshore Placement of Sediment

Source Location		**Receiver Location**	
Source Site:	Monterey Harbor	Receiver Beach:	Southern Bight
County:	Monterey	County:	Monterey
Littoral Cell:	Monterey	Littoral Cell:	Monterey

Receiver Beach Information

Existing Beach Width*(ft):	150
Beach Fill Length(ft):	15,000
Berm Fill Volume(cy):	75,000
Increased Beach Width, Yr-0(ft):	0.00

*Based on site observation in

Sediment Characteristics

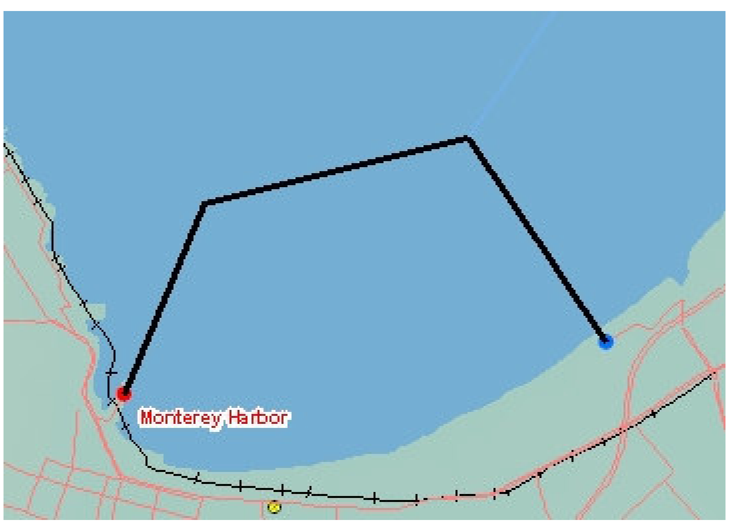
Receiver D50 (mm):	0.4
Source D50 (mm):	0.3
Receiver % Fines:	0
Source % Fines:	5

Receiver Beach or Sediment Source: Environmental Considerations

Reefs: No | Kelp Beds: Yes | Eelgrass/ Surfgrass: Yes | Grunion: Yes

Fish: Yes | Gulls/ Terns: Yes | Shorebirds: Yes | Diving Birds: Yes

Shellfish: No | Wading Birds: Yes | Marine Mammals: Yes | Transit Trips: **28**



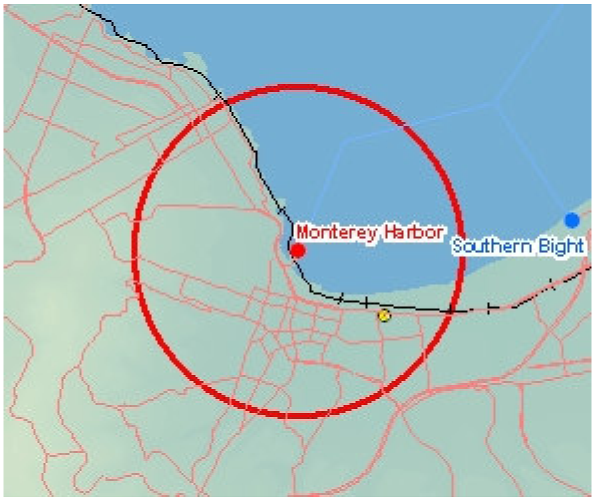
Sediment Source: Environmental Considerations

Reefs: No | Kelp Beds: No | Eelgrass/ Surfgrass: No | Grunion: No

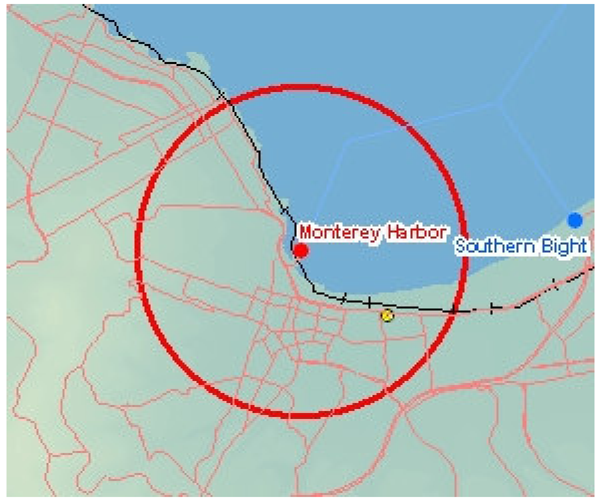
Fish: No | Gulls/ Terns: No | Shorebirds: No | Diving Birds: No

Shellfish: No | Wading Birds: No | Marine Mammals: No

Kelp Persistence (1967-1999)



Oceanfloor Substrate



Receiver Beach: Environmental Considerations

Reefs: No	Kelp Beds: Yes	Eelgrass/ Surfgrass: Yes	Grunion: Yes
Fish: Yes	Gulls/ Terns: Yes	Shorebirds: Yes	Diving Birds: Yes
Shellfish: No	Wading Birds: Yes	Marine Mammals: Yes	

Kelp Persistence (1967-1999)

Oceanfloor Substrate

Receiver Beach Characteristics

Beach Width (ft):	150	Beach Fill Location:	
Beach Length (ft):	15,000	Beach Fill Length (ft):	15,000
Berm Height(ft):	16	Berm Volume (cy):	75,000
Historical Erosion Rate (ft/yr):	3.45	Depth of Closure (ft):	20
Longshore Diffusivity (sqft/sec):	0.261		

Increased Beach Width (ft) from Fill Placement:

Year-0:	Year-1:	Year-2:	Year-3:	Year-4:	Year-5:	Year-6:	Year-7:	Year-8:	Year-9:	Year-10:
0.00	0.60	0.98	1.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Scenario Costs

Miles Source to Receiver	
Hopper Distance (mi):	2.53
Speed of Vessel (mph):	7
Hopper Capacity (cy):	2,700

Economic Variables

Amenity	Weighted Value (%)
Weather:	0.85
Water Quality:	0.84
Beach Width/Quality:	0.45

Hopper Cost (day):	$41,100	Overcrowding:	0.51
Hopper Down Time Percentage:	20%	Facilities/Services:	0.48
Hopper Trips Per Day	5.9	Availability of Alternatives:	0.44
Total Hopper Trips:	28	Total Index Value:	0.59
Construction Period (days)	5	Day Use Value :	$5,358,353.30
Hopper Total Transport Cost	193,503	Annual Attendance:	644,677
		Existing Spending in CA :	$11,243,166.88
		Existing Local Spending :	$9,035,792.83
		Existing Taxes in CA :	$1,292,964.19
		Existing Local Taxes :	$225,894.82
Beach Nourishment Cost* :	**$193,503**	**Existing Recreational Benefit :**	**$5,170,310**

*Costs do not include mobilzation and demobilization of equipment. These costs are added in once a Scenario is added to an Alternative.

Scenario Benefits

Increased	**S/L Spending**	**S/L Taxes**	**Rec Value**
Year-0	$0.00	$0.00	$0.00
Year-1	$1,798.91	$206.87	$5,876.71
Year-2	$2,923.22	$336.17	$9,088.18
Year-3	$3,260.52	$374.96	$9,651.97
Year-4	$0.00	$0.00	$0.00
Year-5	$0.00	$0.00	$0.00
Year-6	$0.00	$0.00	$0.00
Year-7	$0.00	$0.00	$0.00
Year-8	$0.00	$0.00	$0.00
Year-9	$0.00	$0.00	$0.00
Year-10	$0.00	$0.00	$0.00
Total			$36,264

Increase in Recreational Benefit : $36,264

Scenario ID: 2000000 Cy from Sand City to Southern Bight via hopper beach

Nearshore Placement of Sediment

Source Location		**Receiver Location**	
Source Site:	Sand City	Receiver Beach:	Southern Bight
County:	Monterey	County:	Monterey
Littoral Cell:	Monterey	Littoral Cell:	Monterey

Receiver Beach Information

Existing Beach Width*(ft):	150
Beach Fill Length(ft):	15,000
Berm Fill Volume(cy):	2,000,000
Increased Beach Width, Yr-0(ft):	100.00

*Based on site observation in

Sediment Characteristics

Receiver D50 (mm):	0.4
Source D50 (mm):	0.6
Receiver % Fines:	0
Source % Fines:	20

Receiver Beach or Sediment Source: Environmental Considerations

Reefs: No	Kelp Beds: Yes	Eelgrass/ Surfgrass: Yes	Grunion: Yes
Fish: Yes	Gulls/ Terns: Yes	Shorebirds: Yes	Diving Birds: Yes
Shellfish: No	Wading Birds: Yes	Marine Mammals: Yes	Transit Trips: **741**

Sediment Source: Environmental Considerations

Reefs: No	Kelp Beds: No	Eelgrass/ Surfgrass: No	Grunion: No
Fish: No	Gulls/ Terns: No	Shorebirds: No	Diving Birds: No
Shellfish: No	Wading Birds: No	Marine Mammals: No	

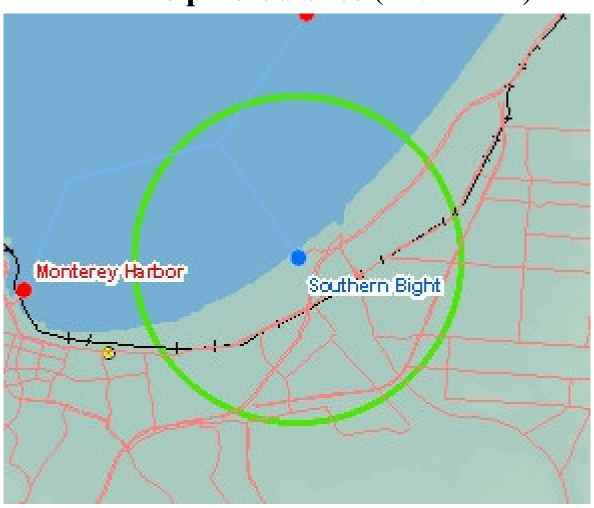
Kelp Persistence (1967-1999)

Oceanfloor Substrate

Receiver Beach: Environmental Considerations

Reefs: No	Kelp Beds: Yes	Eelgrass/ Surfgrass: Yes	Grunion: Yes
Fish: Yes	Gulls/ Terns: Yes	Shorebirds: Yes	Diving Birds: Yes
Shellfish: No	Wading Birds: Yes	Marine Mammals: Yes	

Kelp Persistence (1967-1999)



Oceanfloor Substrate

Receiver Beach Characteristics

Beach Width (ft):	150	Beach Fill Location:	
Beach Length (ft):	15,000	Beach Fill Length (ft):	15,000
Berm Height(ft):	16	Berm Volume (cy):	2,000,000
Historical Erosion Rate (ft/yr):	3.45	Depth of Closure (ft):	20
Longshore Diffusivity (sqft/sec):	0.261		

Increased Beach Width (ft) from Fill Placement:

Year-0:	Year-1:	Year-2:	Year-3:	Year-4:	Year-5:	Year-6:	Year-7:	Year-8:	Year-9:	Year-10:
100.00	77.76	69.15	62.84	57.94	54.01	50.56	47.11	43.66	40.21	36.76

Scenario Costs

Miles Source to Receiver	
Hopper Distance (mi):	1.81
Speed of Vessel (mph):	7
Hopper Capacity (cy):	2,700

Economic Variables

Amenity	Weighted Value (%)
Weather:	0.85
Water Quality:	0.84
Beach Width/Quality:	0.45

Hopper Down Time Percentage:	20%	Overcrowding:	0.51
Hopper Trips Per Day	4.9	Facilities/Services:	0.48
Total Hopper Trips:	741	Availability of Alternatives:	0.44
Construction Period (days)	151	Total Index Value:	0.59
Hopper Total Transport Cost	11,044,907	Day Use Value :	$5,358,353.30
		Annual Attendance:	644,677
		Existing Spending in CA :	$11,243,166.88
		Existing Local Spending :	$9,035,792.83
		Existing Taxes in CA :	$1,292,964.19
		Existing Local Taxes :	$225,894.82
Beach Nourishment Cost* :	**$11,044,907**	**Existing Recreational Benefit :**	**$5,170,310**

*Costs do not include mobilzation and demobilization of equipment. These costs are added in once a Scenario is added to an Alternative.

Scenario Benefits

Increased	S/L Spending	S/L Taxes	Rec Value
Year-0	$299,817.78	$34,479.05	$880,494.95
Year-1	$233,135.65	$26,810.60	$671,329.55
Year-2	$207,325.31	$23,842.41	$575,432.49
Year-3	$188,413.20	$21,667.52	$502,571.24
Year-4	$173,727.76	$19,978.69	$444,523.33
Year-5	$161,928.24	$18,621.75	$396,936.40
Year-6	$151,584.52	$17,432.22	$355,751.75
Year-7	$141,240.81	$16,242.69	$317,381.66
Year-8	$130,897.10	$15,053.17	$281,655.19
Year-9	$120,553.38	$13,863.64	$248,411.14
Year-10	$110,209.67	$12,674.11	$217,497.50
Total			$8,067,127

Increase in Recreational Benefit : $8,067,127

Scenario ID: 2000000 Cy from Sand City to Southern Bight via hopper nearshore

Nearshore Placement of Sediment

Source Location		**Receiver Location**	
Source Site:	Sand City	Receiver Beach:	Southern Bight
County:	Monterey	County:	Monterey
Littoral Cell:	Monterey	Littoral Cell:	Monterey

Receiver Beach Information

Existing Beach Width*(ft):	150
Beach Fill Length(ft):	15,000
Berm Fill Volume(cy):	2,000,000
Increased Beach Width, Yr-0(ft):	0.00

*Based on site observation in

Sediment Characteristics

Receiver D50 (mm):	0.4
Source D50 (mm):	0.6
Receiver % Fines:	0
Source % Fines:	20

Receiver Beach or Sediment Source: Environmental Considerations

Reefs: No	Kelp Beds: Yes	Eelgrass/ Surfgrass: Yes	Grunion: Yes
Fish: Yes	Gulls/ Terns: Yes	Shorebirds: Yes	Diving Birds: Yes
Shellfish: No	Wading Birds: Yes	Marine Mammals: Yes	Transit Trips: **741**

Sediment Source: Environmental Considerations

Reefs: No	Kelp Beds: No	Eelgrass/ Surfgrass: No	Grunion: No
Fish: No	Gulls/ Terns: No	Shorebirds: No	Diving Birds: No
Shellfish: No	Wading Birds: No	Marine Mammals: No	

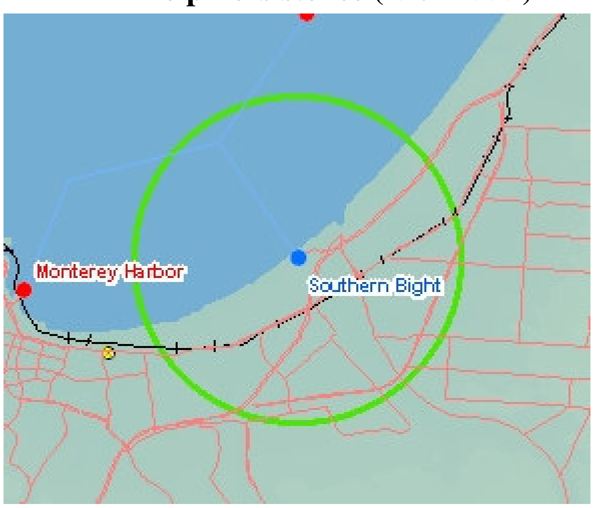
Kelp Persistence (1967-1999)

Oceanfloor Substrate

Receiver Beach: Environmental Considerations

Reefs: No	Kelp Beds: Yes	Eelgrass/ Surfgrass: Yes	Grunion: Yes
Fish: Yes	Gulls/ Terns: Yes	Shorebirds: Yes	Diving Birds: Yes
Shellfish: No	Wading Birds: Yes	Marine Mammals: Yes	

Kelp Persistence (1967-1999)



Oceanfloor Substrate

Receiver Beach Characteristics

Beach Width (ft):	150	Beach Fill Location:	
Beach Length (ft):	15,000	Beach Fill Length (ft):	15,000
Berm Height(ft):	16	Berm Volume (cy):	2,000,000
Historical Erosion Rate (ft/yr):	3.45	Depth of Closure (ft):	20
Longshore Diffusivity (sqft/sec):	0.261		

Increased Beach Width (ft) from Fill Placement:

Year-0:	Year-1:	Year-2:	Year-3:	Year-4:	Year-5:	Year-6:	Year-7:	Year-8:	Year-9:	Year-10:
0.00	16.00	26.00	29.00	15.00	11.55	8.10	4.65	1.20	0.00	0.00

Scenario Costs

Miles Source to Receiver

Hopper Distance (mi):	1.81
Speed of Vessel (mph):	7
Hopper Capacity (cy):	2,700

Economic Variables

Amenity	**Weighted Value (%)**
Weather:	0.85
Water Quality:	0.84
Beach Width/Quality:	0.45

Hopper Cost (day):	$41,100	Overcrowding:	0.51
Hopper Down Time Percentage:	20%	Facilities/Services:	0.48
Hopper Trips Per Day	6.3	Availability of Alternatives:	0.44
Total Hopper Trips:	741	Total Index Value:	0.59
Construction Period (days)	118	Day Use Value :	$5,358,353.30
Hopper Total Transport Cost	4,832,451	Annual Attendance:	644,677
		Existing Spending in CA :	$11,243,166.88
		Existing Local Spending :	$9,035,792.83
		Existing Taxes in CA :	$1,292,964.19
		Existing Local Taxes :	$225,894.82
Beach Nourishment Cost* :	**$4,832,451**	**Existing Recreational Benefit :**	**$5,170,310**

*Costs do not include mobilzation and demobilization of equipment. These costs are added in once a Scenario is added to an Alternative.

Scenario Benefits

Increased	S/L Spending	S/L Taxes	Rec Value
Year-0	$0.00	$0.00	$0.00
Year-1	$47,970.85	$5,516.65	$152,211.50
Year-2	$77,952.62	$8,964.55	$231,434.84
Year-3	$86,947.16	$9,998.92	$244,587.26
Year-4	$44,972.67	$5,171.86	$123,492.66
Year-5	$34,628.95	$3,982.33	$91,138.40
Year-6	$24,285.24	$2,792.80	$61,266.82
Year-7	$13,941.53	$1,603.28	$33,718.45
Year-8	$3,597.81	$413.75	$8,343.06
Year-9	$0.00	$0.00	$0.00
Year-10	$0.00	$0.00	$0.00
Total			$1,479,160
Increase in Recreational Benefit :			**$1,479,160**

Scenario ID: 2000000 Cy from Monterey Submarine Canyon to Southern Bight via hopper beach

Nearshore Placement of Sediment

Source Location		**Receiver Location**	
Source Site:	Monterey Submarine Canyon	Receiver Beach:	Southern Bight
County:	Monterey	County:	Monterey
Littoral Cell:	Monterey	Littoral Cell:	Monterey

Receiver Beach Information

Existing Beach Width*(ft):	150
Beach Fill Length(ft):	15,000
Berm Fill Volume(cy):	2,000,000
Increased Beach Width, Yr-0(ft):	100.00

*Based on site observation in

Sediment Characteristics

Receiver D50 (mm):	0.4
Source D50 (mm):	0.4
Receiver % Fines:	0
Source % Fines:	5

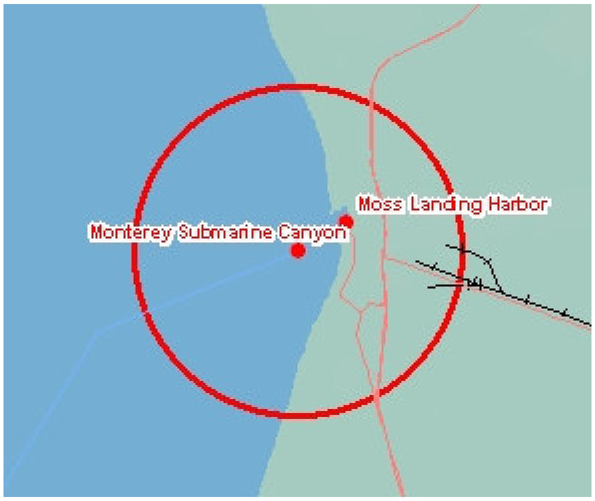
Receiver Beach or Sediment Source: Environmental Considerations

Reefs: No	Kelp Beds: Yes	Eelgrass/ Surfgrass: Yes	Grunion: Yes
Fish: Yes	Gulls/ Terns: Yes	Shorebirds: Yes	Diving Birds: Yes
Shellfish: No	Wading Birds: Yes	Marine Mammals: Yes	Transit Trips: **741**

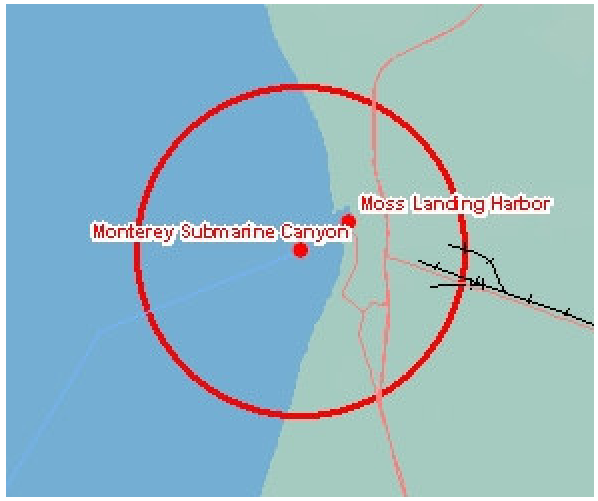
Sediment Source: Environmental Considerations

Reefs: No	Kelp Beds: No	Eelgrass/ Surfgrass: No	Grunion: No
Fish: No	Gulls/ Terns: No	Shorebirds: No	Diving Birds: No
Shellfish: No	Wading Birds: No	Marine Mammals: No	

Kelp Persistence (1967-1999)



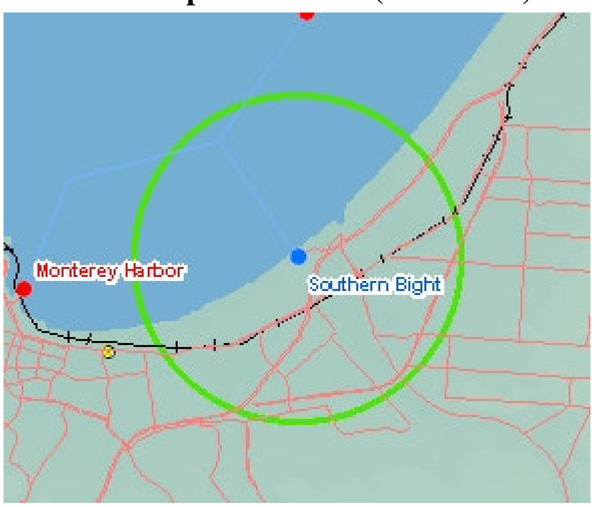
Oceanfloor Substrate



Receiver Beach: Environmental Considerations

Reefs: No	Kelp Beds: Yes	Eelgrass/ Surfgrass: Yes	Grunion: Yes
Fish: Yes	Gulls/ Terns: Yes	Shorebirds: Yes	Diving Birds: Yes
Shellfish: No	Wading Birds: Yes	Marine Mammals: Yes	

Kelp Persistence (1967-1999)



Oceanfloor Substrate

Receiver Beach Characteristics

Beach Width (ft):	150	Beach Fill Location:	
Beach Length (ft):	15,000	Beach Fill Length (ft):	15,000
Berm Height(ft):	16	Berm Volume (cy):	2,000,000
Historical Erosion Rate (ft/yr):	3.45	Depth of Closure (ft):	20
Longshore Diffusivity (sqft/sec):	0.261		

Increased Beach Width (ft) from Fill Placement:

Year-0:	Year-1:	Year-2:	Year-3:	Year-4:	Year-5:	Year-6:	Year-7:	Year-8:	Year-9:	Year-10:
100.00	77.76	69.15	62.84	57.94	54.01	50.56	47.11	43.66	40.21	36.76

Scenario Costs

Miles Source to Receiver

Hopper Distance (mi): 15.33

Economic Variables

Amenity	**Weighted Value (%)**
Weather:	0.85

Speed of Vessel (mph):	7
Hopper Capacity (cy):	2,700
Hopper Down Time Percentage:	20%
Hopper Trips Per Day	2.4
Total Hopper Trips:	741
Construction Period (days)	309
Hopper Total Transport Cost	19,747,047

Beach Nourishment Cost* : $19,747,047

*Costs do not include mobilzation and demobilization of equipment. These costs are added in once a Scenario is added to an Alternative.

Water Quality:	0.84
Beach Width/Quality:	0.45
Overcrowding:	0.51
Facilities/Services:	0.48
Availability of Alternatives:	0.44
Total Index Value:	0.59
Day Use Value :	$5,358,353.30
Annual Attendance:	644,677
Existing Spending in CA :	$11,243,166.88
Existing Local Spending :	$9,035,792.83
Existing Taxes in CA :	$1,292,964.19
Existing Local Taxes :	$225,894.82
Existing Recreational Benefit :	**$5,170,310**

Scenario Benefits

Increased	S/L Spending	S/L Taxes	Rec Value
Year-0	$299,817.78	$34,479.05	$880,494.95
Year-1	$233,135.65	$26,810.60	$671,329.55
Year-2	$207,325.31	$23,842.41	$575,432.49
Year-3	$188,413.20	$21,667.52	$502,571.24
Year-4	$173,727.76	$19,978.69	$444,523.33
Year-5	$161,928.24	$18,621.75	$396,936.40
Year-6	$151,584.52	$17,432.22	$355,751.75
Year-7	$141,240.81	$16,242.69	$317,381.66
Year-8	$130,897.10	$15,053.17	$281,655.19
Year-9	$120,553.38	$13,863.64	$248,411.14
Year-10	$110,209.67	$12,674.11	$217,497.50
Total			$8,067,127

Increase in Recreational Benefit : $8,067,127

Scenario ID: 2000000 Cy from Monterey Submarine Canyon to Southern Bight via hopper nearshore

Nearshore Placement of Sediment

Source Location		**Receiver Location**	
Source Site:	Monterey Submarine Canyon	Receiver Beach:	Southern Bight
County:	Monterey	County:	Monterey
Littoral Cell:	Monterey	Littoral Cell:	Monterey

Receiver Beach Information

Existing Beach Width*(ft):	150
Beach Fill Length(ft):	15,000
Berm Fill Volume(cy):	2,000,000
Increased Beach Width, Yr-0(ft):	0.00
*Based on site observation in	

Sediment Characteristics

Receiver D50 (mm):	0.4
Source D50 (mm):	0.4
Receiver % Fines:	0
Source % Fines:	5

Receiver Beach or Sediment Source: Environmental Considerations

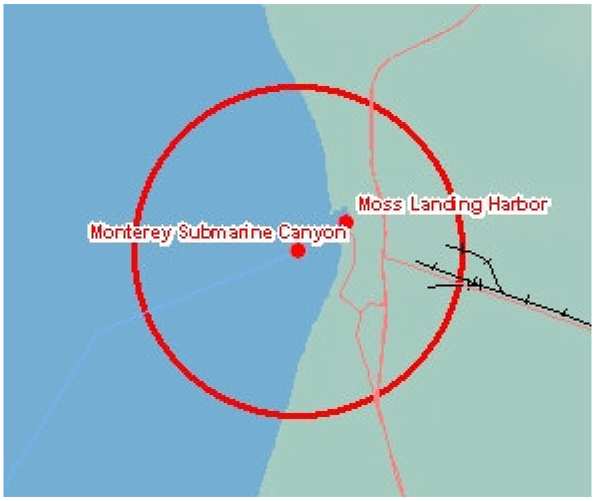
Reefs: No	Kelp Beds: Yes	Eelgrass/ Surfgrass: Yes	Grunion: Yes
Fish: Yes	Gulls/ Terns: Yes	Shorebirds: Yes	Diving Birds: Yes
Shellfish: No	Wading Birds: Yes	Marine Mammals: Yes	Transit Trips: **741**

Sediment Source: Environmental Considerations

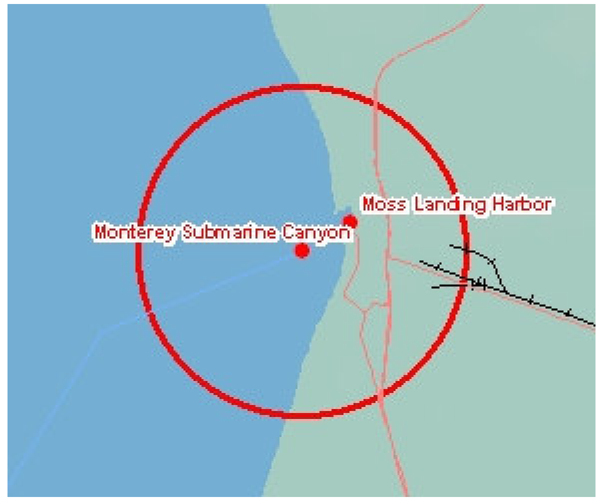
Reefs: No	Kelp Beds: No	Eelgrass/ Surfgrass: No	Grunion: No
Fish: No	Gulls/ Terns: No	Shorebirds: No	Diving Birds: No

Shellfish: No Wading Birds: No Marine Mammals: No

Kelp Persistence (1967-1999)



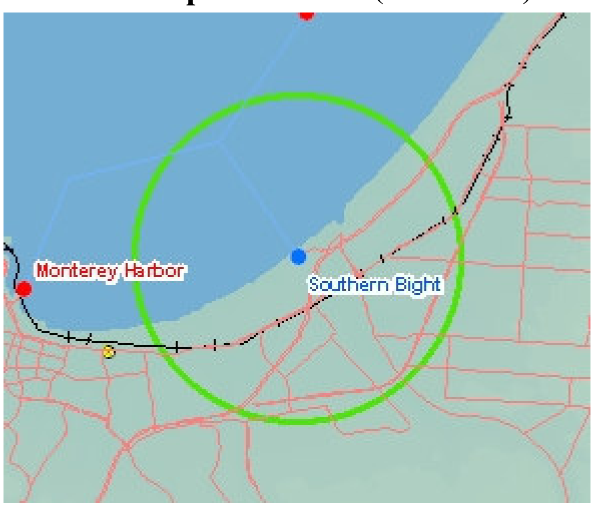
Oceanfloor Substrate



Receiver Beach: Environmental Considerations

Reefs: No
Kelp Beds: Yes
Eelgrass/ Surfgrass: Yes
Grunion: Yes
Fish: Yes
Gulls/ Terns: Yes
Shorebirds: Yes
Diving Birds: Yes
Shellfish: No
Wading Birds: Yes
Marine Mammals: Yes

Kelp Persistence (1967-1999)



Oceanfloor Substrate

Receiver Beach Characteristics

Beach Width (ft):	150	Beach Fill Location:	
Beach Length (ft):	15,000	Beach Fill Length (ft):	15,000
Berm Height(ft):	16	Berm Volume (cy):	2,000,000
Historical Erosion Rate (ft/yr):	3.45	Depth of Closure (ft):	20
Longshore Diffusivity (sqft/sec):	0.261		

Increased Beach Width (ft) from Fill Placement:

Year-0:	Year-1:	Year-2:	Year-3:	Year-4:	Year-5:	Year-6:	Year-7:	Year-8:	Year-9:	Year-10:
0.00	16.00	26.00	29.00	15.00	11.55	8.10	4.65	1.20	0.00	0.00

Scenario Costs

Miles Source to Receiver

Hopper Distance (mi): 15.33

Economic Variables

Amenity	Weighted Value (%)
Weather:	0.85

Speed of Vessel (mph):	7
Hopper Capacity (cy):	2,700
Hopper Cost (day):	$41,100
Hopper Down Time Percentage:	20%
Hopper Trips Per Day	2.8
Total Hopper Trips:	741
Construction Period (days)	265
Hopper Total Transport Cost	10,873,016

Beach Nourishment Cost* : $10,873,016

*Costs do not include mobilzation and demobilization of equipment. These costs are added in once a Scenario is added to an Alternative.

Water Quality:	0.84
Beach Width/Quality:	0.45
Overcrowding:	0.51
Facilities/Services:	0.48
Availability of Alternatives:	0.44
Total Index Value:	0.59
Day Use Value :	$5,358,353.30
Annual Attendance:	644,677
Existing Spending in CA :	$11,243,166.88
Existing Local Spending :	$9,035,792.83
Existing Taxes in CA :	$1,292,964.19
Existing Local Taxes :	$225,894.82

Existing Recreational Benefit : $5,170,310

Scenario Benefits

Increased	**S/L Spending**	**S/L Taxes**	**Rec Value**
Year-0	$0.00	$0.00	$0.00
Year-1	$47,970.85	$5,516.65	$152,211.50
Year-2	$77,952.62	$8,964.55	$231,434.84
Year-3	$86,947.16	$9,998.92	$244,587.26
Year-4	$44,972.67	$5,171.86	$123,492.66
Year-5	$34,628.95	$3,982.33	$91,138.40
Year-6	$24,285.24	$2,792.80	$61,266.82
Year-7	$13,941.53	$1,603.28	$33,718.45
Year-8	$3,597.81	$413.75	$8,343.06
Year-9	$0.00	$0.00	$0.00
Year-10	$0.00	$0.00	$0.00
Total			$1,479,160

Increase in Recreational Benefit : $1,479,160

APPENDIX D - LETTERS OF SUPPORT FOR THE COASTAL RSM PLAN

Division of Science & Environmental Policy
California State University Monterey Bay

100 Campus Center, Seaside CA 93955-8001 (831)582-4110; FAX:(831)582-4122

August 4, 2008

Mr. Nicholas Papadakis
AMBAG
445 Reservation Road, Suite G
P.O. Box 809
Marina, California 93933

Dear Nick,

As you know, continual coastal retreat in southern Monterey Bay is a fact that impacts the regional economies, natural resources, and aesthetics. When coastal retreat involves private or public infrastructure, there is typically an emergency response to armor the coastline. Coastal armoring is now well-recognized as a blight that benefits a few, but impacts the entire region. The Southern Monterey Bay Coastal Erosion Workgroup (SMBCEW) was conceived to address this issue several years ago at the urging of Sam Farr. Brad Damitz led the workgroup toward the goal of developing a broader vision of proactive, sustainable coastal management. Phillips Williams and Associates (PWA) has now developed a comprehensive guide to coastal management in southern Monterey Bay based upon the combination of the SMBCEW groundwork and the scientific work of Ed Thornton, Gary Griggs, and other local scientists.

I have read the scientific and technical parts of the report. While there is always room for more data to help improve our environmental decisions, the conclusions in this report are soundly based upon the best available data. **I encourage the AMBAG board to accept and endorse results of the PWA report.**

Many management options are considered, within the context of the specific regional sand budget and current dynamics of southern Monterey Bay. At the heart of the report are two conclusions.

1) Industrial sand extraction from the littoral zone is likely responsible for the sand deficit that fosters regional coastal erosion.
2) A combination of reduced sand extraction and well-orchestrated beach nourishment will reduce coastal retreat rates at several key places where infrastructure is now threatened.

While these conclusions are bound to be unpopular in some circles, they are, in my opinion, scientifically defensible.

Sincerely,

Douglas Smith

Associate Professor
Science & Environmental Policy, CSUMB

Douglas P. Smith, Ph.D., R.G. • Associate Professor • Division of Science & Environmental Policy • Bldg. 53, California State University Monterey Bay • 100 Campus Center • Seaside CA 93955-8001 • (831) 582-4696 • FAX (831) 582-4122 douglas_smith@csumb.edu

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Monterey Bay National Marine Sanctuary
299 Foam Street
Monterey, California 93940

AUG 2008

August 13, 2008

Association of Monterey Bay Area Governments, Board of Directors
Attn: Nick Papadakis, Executive Director
445 Reservation Road, Suite G
P.O. Box 809
Marina, California

RE: Southern Monterey Bay Regional Sediment Management Plan

Dear President Potelho and Board Members,

I am writing to express the Monterey Bay National Marine Sanctuary's (MBNMS) support of the recently completed *Draft Final Coastal Regional Sediment Management Plan for the Southern Monterey Bay* (Coastal RSM Plan), and to encourage the AMBAG Board of Directors' endorsement of this plan. As you know, the Southern Monterey Bay shoreline experiences the highest rates of coastal erosion in the State of California. Coastal erosion presents a significant set of policy issues that require the informed consideration of elected officials and resource managers in this region. The Coastal RSM Plan provides our region with a valuable technical resource and useful policy tool for addressing the multiple issues associated with coastal erosion in southern Monterey Bay.

The MBNMS has been involved in the issues of coastal erosion and armoring as part of the congressionally mandated update of the Sanctuary's Management Plan, as well as through our regular review and authorization process for permits that involve disturbance of the seabed. The updated management plan for MBNMS includes an Action Plan for addressing coastal erosion and armoring issues. This Action Plan emphasizes the intent of the Sanctuary to work closely with its partners in developing a more proactive and comprehensive regional approach that will help reduce the need for, and minimize the negative impacts of, coastal armoring throughout the Sanctuary.

Consistent with this collaborative regional approach and at the urging of Congressman Sam Farr, the Southern Monterey Bay Coastal Erosion Workgroup (SMBCEW) was jointly established in 2005 by the Monterey Bay National Marine Sanctuary and the city of Monterey. The Workgroup's membership includes scientists, federal and state agencies, and local government representatives, conservation interests and other local experts. The Workgroup's purpose is to develop a regional planning approach for addressing the issues of coastal erosion and armoring in the southern Monterey Bay region between Moss Landing and Wharf II in Monterey. In support of the SMBCEW's efforts, MBNMS has recently funded a comprehensive analysis of other potentially promising alternatives methods for addressing coastal. The SMBCEW project and the Coastal RSM Plan will be used together to inform the development of a proactive and comprehensive regional shoreline preservation, restoration, and management plan, with selected site-specific recommendations, as well as more general guidance for responding to coastal erosion issues in southern Monterey Bay.

Thank you for AMBAG's leadership in addressing this important issue for the Sanctuary and for southern Monterey Bay communities. If you have any questions or comments please contact Brad Damitz of my staff at (831) 647-4252.

Sincerely,

Paul Michel

Paul Michel
Superintendent, MBNMS

Surfrider Foundation

August 13, 2008

Association of Monterey Bay Area Governments, Board of Directors
Attn: Nick Papadakis, Executive Director
445 Reservation Road, Suite G
P.O. Box 809
Marina, California 9393345 Fremont Street, Suite 2000

Cc: Brad Damitz and Bob Battalio

RE: Southern Monterey Bay Regional Sediment Management Plan

Via electronic mail

Dear President Potelho and Board Members,

I am writing on behalf of Surfrider Foundation in regards to the Regional Sediment Management Plan (RSMP) that has been drafted for the southern portion of Monterey Bay. The Surfrider Foundation is an environmental organization dedicated to the protection and enjoyment of the world's oceans, waves and beach, for all people, through conservation, activism, research and education.

Coastal erosion is a natural process affecting the shoreline of Monterey Bay; unfortunately, many important man-made structures are being threatened by the receding shoreline and many beaches are being threatened by the hardened armoring of our coast. In an effort to protect the Monterey Bay and our communities, as well as promote economic vitality in the area, it is evident that a plan is needed to guide implementation of a regional coastal erosion response that will protect structures and preserve beaches. As opposed to piecemeal responses to coastal erosion on a case-by-case basis, a regional plan is advantageous in that it can take into consideration the disproportionate affects that coastal processes have on various sections of coast within the region—understanding that there are areas where erosion is having little effect and areas where erosion is occurring rapidly—and use this knowledge to develop a method of sediment management that efficiently and effectively manages sediment resources to protect both structures and beaches.

As a work product of the Southern Monterey Bay Coastal Erosion Workgroup—the membership of which includes representatives from local, state and federal agencies, local government staff, non-governmental organizations and members of the public—the RSMP is a result of many months of data analysis and workgroup meetings. With the professional analysis provided by Bob Battalio, David Brew and their team at PWA, the RSMP has taken shape to provide decision-makers with a scientifically sound policy tool that should guide decisions related to erosion response and future coastal development plans.

NATIONAL OFFICE • P.O. BOX 6010 • SAN CLEMENTE, CA 92674-6010
(949) 492-8170 • FAX (949) 492-8142 • www.surfrider.org • E-MAIL info@surfrider.org

Surfrider Foundation®

In our capacity as an environmental organization working to preserve beaches and protect waves for the enjoyment of all people, Surfrider Foundation has been an active participant in the Southern Monterey Bay Coastal Erosion Workgroup and a strong advocate within the group for coastal erosion responses that act to safeguard beaches. Surfrider is writing to the AMBAG Board of Directors to convey our support of the findings contained within the RSMP and to respectfully request that the Board adopt this plan based on its scientific merits and policy recommendations.

Sincerely,

Sarah Corbin

Sarah Corbin
Central California Regional Manager
Surfrider Foundation

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