OVERVIEW OF ASSIGNMENT

INTRODUCTION

In 2004, the California Coastal Sediment Management Workgroup (CSMW) requested that the California Geological Survey (CGS) conduct research and prepare brief summaries of literature on various topics and geographic locations related to physical properties of sediment management along the coast of California. The CSMW, a consortium of state and federal agencies, is charged with preparing the Coastal Sediment Management Master Plan, a dynamic document that will guide the future coordination of local, regional, state, and federal approaches to coastal sediment management in California. The goal of the plan is to manage regionally, from a natural-systems approach, rather than locally, from a site-specific approach.

As prepared and prioritized by Clif Davenport, the state's project manager for the CSMW, this research was divided into seven tasks, which are listed below. The tasks were distributed among three staff geologists of the CGS. Because of the interest of the CSMW in completing this research quickly so that other phases of the Master Plan could move forward, the assignment was limited to a few months for research and preparation of results. Correspondingly, the research on the seven tasks was neither intensive nor comprehensive. Nonetheless, the results of the research should provide foundations for follow-up detailed research and direction for the CSMW Master Plan.

The results of this literature search are symptomatic of what the CSMW Master Plan will attempt to resolve, namely, that the studies and reports related to coastal activities have historically been done largely from a local, project-by-project approach. There is abundant information and documentation, but much of it has been accomplished and presented in piecemeal, isolated (rather than integrated) fashion.

There are many hundreds of published and unpublished technical reports and documents pertinent to the topics addressed in the seven tasks of this assignment. Many of those listed in the attached bibliographies were not reviewed. Nonetheless, they are presented here as examples of the literature as well as what we interpreted to be potentially the most important sources of information on the respective topics. We have not attempted to cull all pertinent data and information from these many reports. Rather, the bibliographies are presented as starting points for future detailed research on each of the topics as needed.

We researched literature and information for this project from the following sources:

- Standard hard-copy reports and maps
- Visits to libraries
- On-line search engines (e.g., GEOREF, ASCE, USACE, NTIS, AGU, Google)
- Web sites (e.g., NOAA, USGS, CERES)
- Personal interviews and correspondence

At the end of this overview are lists of selected Web sites for information on marine and coastal topics. We used some of these regularly to aid our research. Regarding search engines, we found many instances where journal articles were missed by on-line searches.

Within the main body of this report, we have broken each task into two sections: results and bibliography. For some of the tasks, we have included recommendations for continued related work to assist the Master Plan. For the tasks that are geographically oriented, we have divided the bibliographies into two sections. The first lists general references that the reader may want to use for related background or further education. The second lists references that apply directly to the coast of California. Several of the tasks include accompanying tables (Tables 1-5), which are included here as separate Excel spreadsheet files. Some of the tables have blank columns for latitude and longitude, which will allow the data in the tables to be georeferenced in GIS format. Values for latitude and longitude were not determined during this assignment.

Finally, we greatly appreciate the information and assistance provided by many individuals, particularly those at the California Coastal Commission, California Geological Survey Library, California Department of Boating and Waterways, California State Lands Commission, Orange County Public Facilities and Resources Department, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Geological Survey, U.S. Minerals Management Service, and several academic institutions. We especially thank Melanie Coyne for sharing insights on her table of beach-nourishment projects in California.

SUMMARIES BY TASK

The following sections list the seven tasks and briefly summarize findings for each of them:

Task 1 - Compile available and known beach nourishment needs along the entire California coast (locations, reasons, severity of need, and consequences); identify critical beaches that would benefit most from beach nourishment and compile a list of known erosion hot spots.

Erosion along the coast of California manifests itself through two types of processes: natural and man-induced. The former is expected because of the dynamic geology of the state. The latter has resulted from many coastal and inland modifications that have disrupted or exacerbated the natural processes. Coastal erosion in the state affects beaches, cliffs/bluffs, and steep mountain slopes adjacent to the ocean; overall, the first two are of most concern.

The severity of erosion can be viewed from a purely geologic perspective or a cultural perspective. From a cultural perspective, many factors affect the need for intervention to reduce or halt erosion. They fall into the categories of public safety and economic/recreation. These are largely driven in California by the disparate distribution of population and associated development along the coast. The two segments of the coastline with the greatest need for intervention to protect the public from erosion are from the Santa Barbara area to the border with Mexico and from the San Francisco Bay region to the Monterey area.

There appears to be no consistent definition of the term “erosion hot spot.” Although the National Research Council has defined it in one of its technical publications, how the term is used can depend on context and need.

Literature on coastal erosion in California covers from statewide to the local site-specific level. Some reports are published and widely available; others are more obscure and require more effort to locate and obtain. The documentation of locations and features of erosion are probably greater for cliffs and bluffs than for beaches.

An up-to-date, systematic, detailed inventory of rates and locations of erosion along the entire coast is warranted. A database for cliff/bluff erosion is in preparation, but one for beach erosion remains to be developed.

Task 2 - Gather studies that investigate the transport and depositional fate of fine-grained materials associated with natural and anthropogenic turbidity plumes; focus on what’s currently known about the densities and duration of “natural” turbidity plumes, and similar information on plumes associated with beach nourishment or other sediment management activities.

“Turbidity” as related to marine/coastal environments falls into two main categories, natural and anthropogenic. If the subcategory of turbidity currents is excluded from the natural category, then the volume of research and literature for the anthropogenic category by far exceeds that for the natural category.

Natural turbidity plumes in the marine environment generally fall into one of three categories: 1) classical turbidity currents, which transport sediment from the shelf slope to the deep abyssal environment, 2) hypopycnal (surface) and hyperpycnal (bottom-flowing) turbidity plumes at river mouths, and 3) storm-related turbidity plumes.

The primary sources of anthropogenic, open-water turbidity are channel-maintenance dredging, disposal of dredged material, beach replenishment, mining of aggregate by dredge, and coastal construction activities. Many studies have been conducted by the U.S. Army Corps of Engineers (USACE) on maintenance dredging and disposal activities in enclosed waters such as estuaries and embayments, locations where the presence of a high fine-sediment fraction is conducive to elevated turbidity. Studies have demonstrated that most dredge-induced turbidity plumes are localized, spreading less than a thousand meters from their source; the plumes are short-lived, dissipating to ambient water quality within several hours after dredging is completed. In many cases, suspended-sediment concentrations are less than those generated by commercial shipping operations or during severe storms. In some infrequent cases involving high fine-sediment content and strong tidal or riverine currents, surface plumes can be visible for distances of many kilometers.

Considerably less research has been conducted in unprotected marine waters where most of the literature has focused on the effect of turbidity on specific marine species and biosystems or on the transport dynamics of coarse sand, rather than on the temporal or spatial characteristics of re-suspension of fine sediment.

Few attempts have been made to quantify turbidity conditions during beach-nourishment activities. Nonetheless, it is generally agreed that turbidity that results from placement of sand on the beach face is even more localized and transitory than that during offshore or enclosed-water operations. In some studies, elevated turbidity was rarely observed outside the surf zone and was not discernable from normal turbidity caused by waves in the surf zone. In another study, elevated turbidity was limited to a narrow swath in the swash zone in the immediate vicinity of the operation. These results are largely attributable to the use of nourishment material that is low in clay and silt and resembles as closely as possible the indigenous beach sand.

Recent efforts have concentrated on modeling to predict suspended-sediment behavior. Most notable of these are the USACE PLUme MEasurement System (PLUMES) model, which documents the movement of sediment plumes using sediment concentrations and three-dimensional fluid velocity data; the Short-Term FATE (STFATE) model which evaluates the short-term behavior of surface discharges in open water; the Long Term FATE (LTFATE) model designed to assess the long-term fate of seabed accumulations of disposed material; and more recently, the Suspended Sediment FATE (SSFATE) numerical modeling system, which allows the running of multiple simulations to determine those scenarios with the least potential for adverse environmental impact.

Task 3 - Compile known and available information on: the types and grain size distribution of sands that have been used for nourishment projects along the important California beaches; observed end results of nourishment projects; the basis for limitation placed on the percentage of allowable finer grained materials in nourishment projects. Include any information gathered on existing grain size distributions at those important beaches.

Beach nourishment began in the early 1900s in California and has since encompassed hundreds of episodes at dozens of beaches along the coast. Most of the projects have been in southern California from Santa Barbara County to the Mexico border.

Data and information on the physical character of sediment (fill and native materials) involved in these projects range from sparse to well documented. This range results

largely from the purpose and time period of the individual projects; those designed as purely nourishment (rather than disposal) projects and that are relatively recent tend to have more data and information. Sources of data include academic studies as well as site-specific reports prepared by government agencies and private consultants.
To date, the overall results of beach nourishment in California have been mixed. Regarding documentation of results, it appears that early projects were either not monitored or monitoring was more qualitative in nature; documentation of results in the literature has been spotty. Rigorous quantitative monitoring (e.g., beach profiling, fill-volume measurements) of fill performance has become more routine in the last 10-20 years.

Various parameters can affect the performance of beach fills. There is some question as to the importance of the continued use of grain-size comparisons between fill and native materials as measures of beach performance.

Task 4 - Compile available information which identifies the presence of fine-grained "mud belts", potential sand source areas, and sandy and rocky bottom habitats in the offshore vicinity of potential beach nourishment locations.

Because of its diverse and dynamic setting along an active plate margin, the seafloor off California is underlain by a complex distribution of geologic materials. Areas of mud, sand, and bedrock are interspersed, with sand prevalent along most of the coast at shallow depths.

The available data and information on the locations and character of these materials ranges from very sparse to highly detailed. There are a few statewide compilations of offshore geology. These were prepared from many historic observations, geophysical surveys, and samples collected by numerous institutions, both public and private. At the regional and local level along the coast, many academic and government groups have conducted studies of seafloor materials. The density and scale of coverage of these studies vary from place to place depending on funding and purpose. The most-detailed studies have been done in the San Francisco-Monterey Bay region and along the Southern California Bight from Santa Barbara County to the Mexico border.

Volumes of sand deposits using hypothetical thicknesses have been estimated for sand deposits along the entire coast of the state. Many sand deposits have been studied locally along the coast of southern California through direct sampling and vibracoring. Such deposits have served and could continue to serve as sources of sand for beach-nourishment projects nearby.

Task 5 - Research any studies assessing the 80/20 coarse-to-fines "rule-of-thumb" ratio used by various regulatory agencies to determine whether potential source sands are compatible with a given beach. Identify the origin of the rule-of-

thumb and nourishment projects where variances from the rule of thumb were allowed, including the basis for each variance.

There is a common misperception that beach-nourishment operations must conform to an 80/20 coarse-to-fines ratio, which prohibits the use of material containing more than 20% fines (silt and clay). This arises from the U.S. Corps of Engineers' (USACE) and U.S. Environmental Protection Agency's (EPA) use of this arbitrary cut-off for applying testing exclusions to marine disposal projects regulated under the Marine Protection, Research, and Sanctuaries Act (MPRSA). Beach nourishment is considered a fill activity and thus jointly regulated by the USACE and EPA under the under Section 404 of the Clean Water Act (CWA), which imposes no specific limits on sediment grain size. Instead, the 404(b)(1) guidelines require site-specific determinations that dredged material be demonstrably compatible with the receiving beach. Compatibility of dredged material is determined through a tiered testing protocol outlined in the Inland Testing Manual of the USACE and EPA.

It is necessary to proceed through the tiers only until enough information is obtained to make factual determinations. Tier-one testing evaluates the compatibility of grain-size distribution. If there is a reason to believe that the dredged material might contain contaminants, which are commonly adsorbed to the fine-clay fraction, then a second, and possibly third, tier of testing is required to identify potential adverse chemical and biological impacts. In California, to preclude second- and third-tier chemical and biologic testing, the USACE generally requires that the overall percentage of silt and clay in the dredged material be no more than 10% higher than that of the finest beach sample. Sediments containing more than this can be approved for beach nourishment provided that the additional testing demonstrates they pose no adverse environmental or health effects.

In recent years, there have been some beach nourishment projects in California that have been approved to use dredged material with greater than 20% fines, but only after complying with the 404(b)(1) guidelines and Inland Testing Manual protocols.

We were unable to determine why the values of 80% and 20% were originally selected.

Task 6 - Compile known information on debris-basin locations, contacts, volumes, and cleanout frequencies. Focus efforts outside of Ventura and Los Angeles Counties, since debris basins in those counties are already included within the SMP GIS.

We contacted officials in San Diego, Orange, San Luis Obispo, and Monterey counties to collect information on debris basins. Of these, only Orange County has debris basins, which are classified by local officials as retarding basins to trap fines and slow runoff during storms.

We did not collect information from Santa Barbara, Ventura, Los Angeles, San Bernardino, and Riverside counties because these were documented in detail in a study published in 2002.

Task 7 - Document known information (i.e., case studies, etc.) regarding the natural seasonal movement of sand from the beach to nearshore and back.

Numerous morphological studies of beach profiles and the hydrologic and hydraulic conditions that form them have demonstrated the phenomenon of seasonal cross-shore (onshore-offshore) transport of beach sediments on wave-dominated beaches. Seasonal beach erosion and accretion are natural mechanisms that allow the beach profile to adjust itself to the prevailing wave forces in order to effectively dissipate wave energy.

In winter, California's beaches are subjected to pounding by tall, high-energy short-wavelength "storm waves" generated by local storms. Beaches respond by reducing their overall slope through erosion of the beach face and berm and the transport and redeposition of the sand in an offshore bar. This shifts the breaker zone farther offshore and produces a "winter" beach profile. At this point, the surf zone is at its widest and the breaker heights greatest. In summer, low, long-wavelength "swell waves", generated by distant storms, reverse this process by eroding and redelivering the sand stored in the offshore bar to the beach face and berm (summer profile). Decreasing wave energy also causes beaches to narrow and steepen. The critical wave conditions that govern the shift between summer and winter profiles are largely a function of critical wave steepness (ratio of wave height to wavelength). Storm waves have high steepness values, while long swell waves have low steepness values. Up until the late 1990s, it appeared that no study had yet identified critical wave-steepness values that would dictate when a summer profile would revert to a winter profile and vice versa.

While the complete cycle between fully developed seasonal profiles is uncommon, southern California beaches are examples that generally experience the full sequence.

SELECTED WEB SITES FOR INFORMATION ON MARINE AND COASTAL TOPICS

Presented here are lists of Web sites that contain pertinent information and avenues for additional research on the seven tasks.

Web sites for marine and coastal data:

http://www.ngdc.noaa.gov/mgg/mggd.html (repository for marine geophysical and geologic data – NOAA National Geophysical Data Center – free)

http://www.nodc.noaa.gov/ (site for ocean data – NOAA National Oceanographic Data Center – free)

http://ceres.ca.gov/ocean/ (site for ocean and coastal data and information – California Environmental Resources Evaluation System – free)

http://www.netlobby.com/beachapprops05_table.htm (proposed 2005 funding for beach nourishment projects in California)

http://www.ngdc.noaa.gov/mgg/geology/mmdb.html (database for marine minerals - NOAA National Geophysical Data Center – free)

http://geopubs.wr.usgs.gov/dds, IN REVIEW (a Web-based GIS project that covers the central California coast from Cape Mendocino to Point Conception – U.S. Geological Survey: contact Mimi D'Iorio at mmdiorio@usgs.gov)

Web sites for bibliographic references for marine and coastal studies:

http://webspirs.silverplatter.com/cgi-bin/login.cgi (GEOREF database - highlights geologic studies - American Geological Institute – subscription service for CGS, not free)

http://www.spn.usace.army.mil/library.html (listing of holdings for technical library - U.S. Army Corps of Engineers – free)

http://www.lib.noaa.gov/ (list of library holdings and NOAA publications – NOAA Central Library – free)

http://www.csc.noaa.gov/ (list of library holdings and publications of Coastal Services Center – NOAA Coastal Services Center – free)

http://www.ntis.gov/search/index.asp?loc=3-0-0 (list of miscellaneous publications since 1990 – National Technical Information Service – free search, but charge for download of document) http://grc.ntis.gov/daypass.htm (list of miscellaneous publications since 1964 – National Technical Information Service - $15 per day charge plus download costs)

http://www.pubs.asce.org/chrhome2.html (list of journal articles since 1970 – American Society of Civil Engineers – free)

http://www.mms.gov/library/ (list of publications – U.S. Minerals Management Service – free – many publications on-line, but appear to be limited to fairly recent) plus http://www.mms.gov/itd/pacpubs.htm

http://scilib.ucsd.edu/sio/ (information and services – Scripps Institution of Oceanography Library – free and cost?)

http://www.coastalconservancy.ca.gov/Publications/pubs.htm (list of agency publications some of which are about California beaches and wetlands) Also on CCC Web site are two pages for "Southern California Wetlands Recovery Project" and "Southern California Wetlands information Station"

http://gis.ca.gov/catalog/BrowseRecord.epl?id=1532 (catalog of publications held by CDBW related to coastal hazards – California Department of Boating and Waterways – free)

Miscellaneous Papers on Beach Erosion, Nourishment, and Performance

http://www.coastal.ca.gov/pgd/pgd-mon.html (main text)

http://www.coastal.ca.gov/web/pgd/pgd-mon2.html (appendix)

http://resources.ca.gov/ocean/html/chapt_5c.html

http://bigfoot.wes.army.mil/6720.html (Orange County 1998)

http://ceres.ca.gov/ceres/calweb/coastal/beaches.html (General discussion of California beaches)

http://cdip.ucsd.edu/SCBPS/Torrey/homepage.shtml#top (Torrey Pines Beach nourishment project)

http://www.eurekalert.org/pub_releases/2000-12/UoCS-Hrrl-1612100.php (UCSC studies on coastal erosion related to storms)

http://www4.nationalacademies.org/onpi/oped.nsf/0/25D22ABB0CCB005F852566750073B95C?OpenDocument (General on eroding beaches) http://www.beacon.dst.ca.us/goleta_beach_restoration.htm (Goleta Beach restoration project)