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STUDY TITLE: Environmental Surveys of Potential Borrow Areas Offshore Northern New Jersey and Southern New York and the Environmental Implications of Sand Removal for Coastal and Beach Restoration

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FY 2004: $161,647; FY 2005: $ 77,778; Cumulative Costs: $499,999

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KEY WORDS: sand resources, New Jersey, New York, sediment transport, wave modeling, bathymetry change, dredging, benthic, pelagic, recolonization

BACKGROUND: Five potential sand borrow sites were defined for this study based on practical water depth extraction, environmental impact minimization, and suitable geologic characteristics provided by the New Jersey Geological Survey (NJGS) and the U.S. Geological Survey (USGS). All potential sand borrow sites exist on either shoreface-attached or offshore linear sand shoals immediately seaward of the Federal-State boundary. The main purpose of this study was to address potential environmental concerns associated with dredging sand from these Outer Continental Shelf (OCS) sites.

OBJECTIVES: Provide MMS environmental information to assess the potential impacts of offshore dredging activities for northeastern New Jersey and southwestern Long Island, and to identify ways in which dredging operations can be conducted to minimize or preclude long-term adverse physical and biological impacts to the environment.

DESCRIPTION: The inshore portion of the continental shelf, seaward of the Federal-State OCS boundary and within the New Jersey and New York Exclusive Economic Zone (EEZ), encompasses the project study area. The seaward limit of the study area is generally within about 10 to 15 km of the shoreline. Sand resource areas are located on the OCS between the 10- and 20-m depth contours. Large sections of the continental shelf surface within the Middle Atlantic Bight contain shoreface sand ridges oriented obliquely to the modern shoreline. South of Long Island, prominent ridge and swale morphology with a northwest-southeast orientation dominate, a distinct contrast to the northeast-southwest orientation of ridges west of the Hudson Channel. Ridges within the study area generally are spaced about 1 to 6 km apart, and their lengths range from about 2 to 7 km. Five potential sand borrow sites were defined for this study based on practical water depth extraction, environmental impact minimization, and suitable geologic characteristics (Figure 1). Most sand borrow sites are geologically similar (coarse-to-medium sand with maximum relief of about 3 to 5 m and resource volumes of at least 5 x 10^6 m^3) and exist on either shoreface-attached or offshore linear sand shoals immediately seaward of the Federal-State boundary. The lone exception to this trend is the westernmost borrow site offshore Long Island (Site 3) that contains very coarse sand and has relatively low relief (~2 m).

SIGNIFICANT CONCLUSIONS: Potentially rapid and significant changes in bathymetry due to sand extraction from the OCS may impact wave propagation on the continental shelf and at the shoreline. To determine potential physical impacts associated with dredging borrow sites offshore the northeastern coast of New Jersey and the southwestern coast of Long Island, New York, wave transformation

modeling and sediment transport potential calculations were performed for existing and post-dredging bathymetric conditions. A method based on historical wave climate variability, as well as local wave climate changes directly attributable to borrow site excavation, was applied to determine appropriate criteria for assessing impact significance.

Linear offshore sand ridges, oriented obliquely to the shoreline in a northwest-southeast direction, are the primary geomorphic features influencing wave propagation offshore southwestern Long Island beaches. For 1.3 m, 9.1 sec waves propagating from the east-southeast (predominant condition), shoals encompassed by Borrow Sites 3, 4W, and 4E had the greatest influence on waves in the modeled area; however, effects to waves were small because these shoals are located in approximately 17 to 20 m water depths. Post-dredging wave height changes at the borrow sites illustrated the impact of sand extraction at borrow sites, where seafloor topography within each site was lowered to a level not exceeding water depths at the base of the shoals (approximately -20 m). For the 1.3 m, 9.1 sec wave condition, borrow site dredging had no measurable influence on waves over a long section of coastline (>44 km), but changes on the order of 0.01 m did occur along 20 km of coast in the combined shadow of the three borrow sites.

Potential sand borrow sites offshore northeastern New Jersey are oriented obliquely to the shoreline in a northeast-southwest direction and have minimal influence on wave propagation to the shoreline. For 1.3 m, 9.1 sec waves propagating from the east (predominant condition), shoals encompassed by Borrow Sites H1 and H2 exhibited minimal wave focusing. The approximate minimum water depths at Sites H1 and H2 are 16 and 17 m, respectively. For the shoal at Site H1, maximum wave height increase was 0.13 m due to the focusing effect of the sand ridge. Post-dredging wave height changes at Sites H1 and H2 simulated the impact of sand extraction at borrow sites, where seafloor topography within each site was lowered to a level not exceeding water depths at the base of the shoals (approximately -20 m). Wave height differences resulting from numerically excavating Sites H1 and H2 are relatively small and diffuse, and wave height changes at the modeled shoreline are less than 0.01 m.

The controlling factors for bottom current velocities in the vicinity of proposed sand borrow sites were wind direction and intensity, and local bathymetric features controlled current direction. Bottom currents tended to flow parallel to contours causing currents to diverge around localized bathymetric highs and converge near bathymetric lows. In general, bottom flows at the borrow sites offshore southwestern Long Island flowed east-southeast or east and west with deviations caused by wind direction. Maximum bottom current speed was about 35 cm/s flowing east, with a mean speed of 8 cm/s (±5 cm/s) flowing southeast. Offshore northeastern New Jersey, bottom currents generally flow north and south along bathymetric contours. Maximum bottom current speed for this area was about 26 cm/s flowing north, with a mean velocity of 6 cm/sec (±4 cm/s) flowing north. Bottom current speeds at both sites primarily were controlled by wind speeds, and the direction of flow was controlled by local bathymetry.

Three independent sediment transport analyses were completed to evaluate impacts due to sand mining, including quantifying net sediment transport trends using historical bathymetric data sets; documenting sediment transport patterns at proposed offshore borrow sites using wave modeling results and existing current measurements; and predicting longshore sediment transport potential using wave modeling output. For the five modeled borrow sites, computed transport rates were extremely low, ranging from about 0 to approximately 580 m^3/yr. A number of factors contributed to the low transport rates, including 1) water depth (typically 20 m, which reduced the impact of wave-induced currents); 2) relatively short-period waves dominating the regional wave climate; 3) absence of significant storm events in the wave and current data sets that drive sediment transport in this area; 4) coarse grain size of in situ materials; and 5) relatively weak ambient shelf currents. Based on extremely low potential transport rates of in situ sediment and the geomorphic character of dredged deposits, it is unlikely that any of these borrow sites will re-form as shoal deposits in the near future. The dredging impact significance envelope for changes in longshore transport, relative to offshore borrow site dredging, increased along Jones Beach from ±20,000 m^3/yr at Fire Island Inlet to ±40,000 m^3/yr at Jones Inlet. The significance envelope for Long Beach had a similar range, with a maximum value midway between Jones Inlet and East Rockaway Inlet. The dredging impact significance envelope computed for changes in potential

longshore transport rates along northern New Jersey beaches landward of Sites H1 and H2 was generally constant at ±15,000 m^3/yr. For the entire study area, potential offshore dredging impacts to longshore transport rates are well within the transport significance envelope. Shoreline impacts are negligible due to the relatively deep water at potential borrow sites (19 to 20 m), their distance offshore, and wave climate (dominated by relatively short-period waves).

Results of field surveys for biological characterization agreed well with previous descriptions concerning benthic assemblages associated with shallow shelf habitats offshore northeastern New Jersey and southwestern Long Island. Numerically dominant infaunal groups included crustaceans, echinoderms, mollusks, and polychaetes, while epifaunal taxa consisted primarily of decapods, sand dollars, gastropods, and squids, all typical components of benthic assemblages in the study area. Demersal fishes collected in trawls within the borrow sites revealed that clearnose skate (*Raja eglanteria*), northern searobin (*Prionotus carolinus*), scup (*Stenotomus chrysops*), and summer flounder (*Paralichthys dentatus*) were numerical dominants during both surveys. Field surveys indicated that infaunal distribution and abundance was correlated broadly with sediment grain size. Temporal patterns of infaunal community indices did not meet expected patterns, possibly due to abnormally high temperatures in the region during the first half of 2002. Despite inherent spatial and temporal heterogeneity in the distribution and abundance of demersal taxa, results of the 2001-2002 surveys of the New Jersey and New York sand borrow sites generally are consistent with historical demersal survey results in the region.

Potential benthic effects from dredging will result from sediment removal, suspension/dispersion, and deposition. Effects are expected to be short-term and localized. Recovery time for any impacts to the benthic environment will vary depending on the organisms affected, seasonal timing of dredging, and type of excavation. Impacts to infauna will affect benthic feeding fishes and epifauna. Based on previous observations of infaunal reestablishment in dredged areas, the infaunal community in dredged sites within sand borrow sites most likely will become reestablished within 2 years, exhibiting levels of infaunal abundance, diversity, and composition comparable to nearby non-dredged areas. No cumulative effects to any groups are expected from multiple sand extractions offshore northeastern New Jersey and southwestern Long Island.

STUDY RESULTS: Data collected, analyses performed, and simulations conducted for this study indicate that proposed sand dredging at sites evaluated on the OCS offshore northeastern New Jersey and southwestern Long Island are expected to have minimal environmental impact on fluid and sediment dynamics, and biological communities. Minimal physical environmental impacts have been identified through wave and sediment transport simulations. The significance of changes to longshore transport along the modeled shoreline, resulting from dredging proposed borrow sites to their maximum design depths, was determined by comparing predicted change in transport potential between existing and post-dredging conditions to a transport significance envelope of one-half the standard deviation ($\pm 0.5\sigma$) of the variability in annual transport along the shoreline. Under representative wave conditions for each of the model grids, it was determined that no significant changes in longshore sediment transport potential would result from modeled borrow site configurations due to the relatively deep water at potential borrow sites (approximately -17 to -20 m), their distance offshore, and wave climate (dominated by relatively short-period waves). Short-term impacts to benthic communities are expected due to the physical removal of borrow material, but the potential for significant cumulative benthic impacts is remote. Additionally, no cumulative effects to any of the pelagic groups are expected from potential sand mining operations.

STUDY PRODUCTS: Byrnes, M.R., R.M. Hammer, S.W. Kelley, J.L. Baker, D.B. Snyder, T.D. Thibaut, S.A Zichichi, L.M. Lagera, Jr., S.T. Viada, B.A. Vittor, J.S. Ramsey, and J.D. Germano, 2004. Environmental Surveys of Potential Borrow Areas Offshore Northern New Jersey and Southern New York and the Environmental Implications of Sand Removal for Coastal and Beach Restoration. U.S. Department of the Interior, Minerals Management Service, Leasing Division, Marine Minerals Branch, Herndon, VA. OCS Report MMS 2004-044, Volume I: Main Text 264 pp. + Volume II: Appendices 194 pp.

[*]P.I.'s affiliation may be different than that listed for Project Manager.

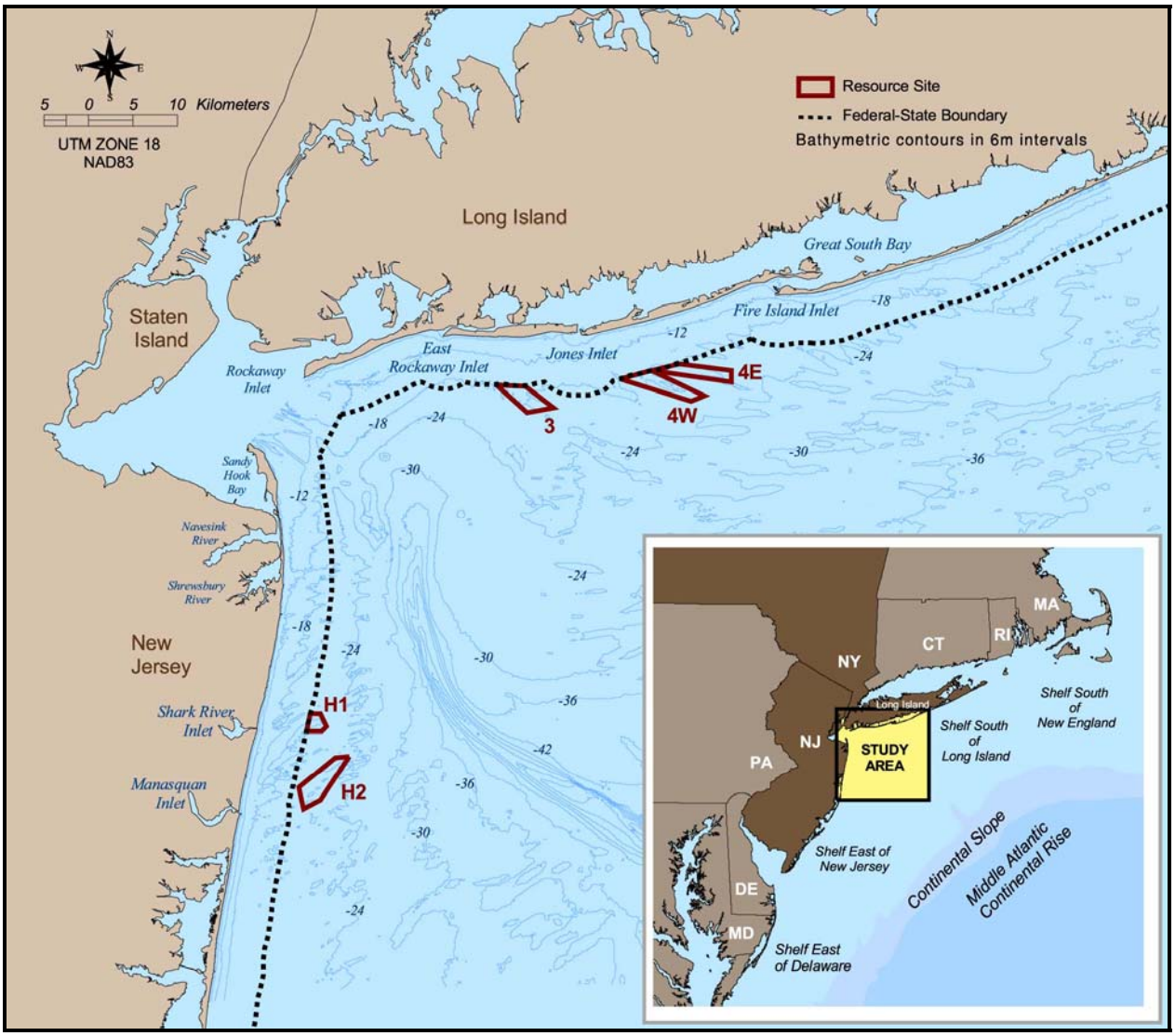

Figure 1. Identified sand borrow sites within the project study area relative to the Federal-State boundary.