# Preliminary Annotated Bibliography for Sand Needs and Resources Offshore New York

Prepared for

BOEM-NYS DOS Cooperative Agreement M14AC00001

Prepared by

Henry Bokuniewicz and Justin Lashley, School of Marine and Atmospheric Sciences
Stony Brook University
Stony Brook, NY 11794-5000

And

Wilhelmina Innes, Office of Planning and Development, New York Department of State
Albany, NY 12231

**2016**

## Stony Brook University's COAST Institute

The Coastal Ocean Action Strategies (COAST) Institute was created in 1989 within the School of Marine and Atmospheric Sciences to assist in coastal zone management and coastal marine policy analysis. We do this by exploring future scenarios for Long Island's coastline and coastal environment and by working with policy makers and environmental managers in identifying and analyzing strategies that will conserve and, when necessary, rehabilitate the coastal ocean; by ensuring that not only is the best technical information included in developing the strategies, but economic and other critical information as well; and by forming effective linkages among environmental groups, the scientific community, lawmakers, regulators, and managers to tackle coastal environmental issues.

COAST has been called upon to assist in resolving coastal problems at home on Long Island, throughout the U.S. and in many parts of the world. COAST also provides a real world, action-learning laboratory for graduate students at MSRC. Each year students who are interested in coastal management and policy take part in gathering and analyzing data, in transforming data into information, and in synthesizing information-all targeted at identifying and evaluating management alternatives to attack the problems that COAST is helping to solve.

# Preliminary Annotated Bibliography for Sand Needs

# and Resources Offshore New York.

Henry Bokuniewicz and Justin Lashley School of Marine and Atmospheric Sciences
Stony Brook University
Stony Brook, NY 11794-5000
and
Wilhelmina Innes, Office of Planning and Development, New York Department of State
Albany, NY 12231

May 2016

## INTRODUCTION

This annotated bibliography represents available literature relevant to the initial phase of an assessment of sand needs and resources along New York's ocean shoreline (Cooperative Agreement: M14AC00001 between the U.S. Bureau of Ocean Energy Management and the New York State Department of State/Stony Brook University). This assessment is intended to help in planning for future sand use and potential projects using offshore sand resources that may be desired to recover from beach erosion or needs driven by severe storms and sea level rise. Such information is needed to contribute towards coastal communities' resiliency planning, and to consider potential effects of this activity on coastal habitats and ecosystems.

The bibliography is arranged in five parts:

1. BOEM-NY Cooperative Agreement Project deliverables
2. Study-Area data publications
3. Associated regional publications
4. Methodologies
5. Geophysical survey data.

While this collection is not exhaustive, these entries represent some of the primary sources used for this initial stage of the assessment.

### PART 1. OTHER BOEM-NY COOPERATIVE AGREEMENT TECHNICAL REPORTS

These entries represent the synthesis reports and interpretations developed in the initial phase of the assessment. They were prepared, in large part, using the publications listed in the other four parts of this bibliography. Except for the report on physical modeling, all were accompanied by ARCGIS geodatabases and compilations of supporting data.

**Bokuniewicz, H.J. and H. Huang, 2016. Preliminary Assessment of New York's Sand Needs. School of Marine and Atmospheric Sciences, Stony Brook University, Unpublished Report.**

The average demand for sand is about 1.5 million cubic yards per year but approximately two-thirds of that comes from routine maintenance dredging of inlets. With new and pending commitments to long-term maintenance of large projects, the routine demand will increase. Extraordinary demands could push that up, perhaps to as much as six million cubic yards per year. A preliminary screening indicated that approximately 30% of offshore sand cover is suitable for beach nourishment.

**Bokuniewicz, H., and H. Huang, 2016. Inventory of New York's Sand Borrow Sites Along New York's Ocean Shoreline & Their Sustainable Management. School of Marine and Atmospheric Sciences. Stony Brook University. Unpublished Report to NYS DOS: 34 pp.**

The offshore area of sand resources in both State and Federal waters covers about 1080 square miles. The historical and existing borrow areas are all in State waters. Combined, they contain approximately 50 to 75 million cubic yards of sand which could fulfill demand for approximately 8-150 years depending on level of demand and future conditions. Borrow areas seem to refill with sand on the order of decades of time. However, we don't know enough about rates and routes of sand transport on the shelf to predict replenishment rates.

**Flood, R., Bokuniewicz, H., and Lashley, J. 2016. Synthesis of existing geological and geophysical surveys with suggestions for areas for future research, School of Marine and Atmospheric Sciences, Stony Brook University, Unpublished Report.**

Geophysical and geological data is compiled and reassessed to support identification, characterization, and delineation of sand resources for potential use in future coastal restoration, beach nourishment, and/or wetland restoration efforts. The South Shore of Long Island includes, in part, the Fire Island National Seashore. Holocene sand ridges extend at an oblique angle to the cross shore in the seaward direction. Borrow pits among the sand ridges that have been excavated were apparent in the most recent surveys and it appears that natural replenishment of offshore borrow areas has been occurring although the rates will need to be determined in order to assess their sustainability. Extension of this assessment will include data analysis from a recent survey sponsored by the Bureau of Ocean Energy Management that resulted in approximately 700 km of geophysical survey lines located between 3 and 9 nautical miles offshore, and 46 geotechnical samples, comprised of a combination of grab samples and vibracores.

**Wilson, R., A. Ilia, H. Bokuniewicz and C. Hinrichs. 2016. Technical report on physical wave modeling. School of Marine and Atmospheric Sciences, Stony Brook University, Unpublished Report.**

Physical wave modeling is intended to asses of the effects of hypothetical sediment borrow areas on nearshore wave climate and longshore sediment transport rate. This would lead to the identification of those borrow area locations that might have minimal effect, and those locations which might have a more detrimental effect on wave climate and longshore transport. The offshore wave climatology has been defined by analyzing long-term records from NOAA/NDBC wave buoys 44025 and 44017. Wave scenarios expected to most influence coastal wave climate longshore sand transport were identified in terms of significant wave height, wave direction, wave period and wave length. Waves with significant wave heights greater than four meters come from a markedly more easterly more shore parallel direction than smaller waves. The larger waves also have a longer period. Average wave period is much longer for waves over four meters high. Wave climatologies derived from offshore wave buoys are used to define forcing for the wave model SWAN for existing bathymetry and selected bathymetries modified to represent borrow areas.

It should be emphasized that these are very limited model simulations; to estimate the net effect of the offshore wave field on the shoreline over the course of a year, a full suite of realized waves would need to be taken into account.

## PART 2. STUDY-AREA DATA PUBLICATIONS

These publications provided some of the site-specific data used in the interpretation and assessment.

**Armstrong, B.N., Warner, J.C., List, J.H., Martini, M.A., Montgomery, E.T., Voulgaris, George, and Traykovski, P.A., 2014, Coastal Change Processes Project data report for observations near Fire Island, New York, January to April 2012: U.S. Geological Survey Open-File Report 2014–1159, http://dx.doi.org/10.3133/ofr20141159.**

Abstract: An oceanographic field study during January through April 2012 investigated processes that control the sediment-transport dynamics near Fire Island, New York. This report describes the project background, field program, instrumentation configuration, and locations of the sensors deployed. The data collected and supporting meteorological observations are presented as time series plots for data visualization. Additionally, individual, links to the database containing digital data files are available as part of this report.

**Batten, B.K. 2003. Morphologic typologies and sediment budget for the ocean shoreline of Long Island, NY. Ph.D. dissertation, State University of New York at Stony Brook, Stony Brook, NY.**

Abstract: The Atlantic Coast of New York Monitoring Program (ACNYMP) collected approximately 3,136 beach profiles and seasonal aerial photography along the south shore of Long Island between 1995 and 2002. Data analysis for each profile consisted of identification or measurement of up to 44 parameters, which generated approximately 137,984 entries. Data were organized with a relational database to enable data access and analysis by geographic units, or individual to multiple stations. Analysis of these parameters showed several trends related to regional geomorphology. The slope of the glacial outwash plain in combination with increasing wave energy to the eastern end of the island influenced depth/distance to closure, beach width and volume and dune toe elevations. Volumetric beach profile change was calculated to the 7.3 m (24 ft) depth contour, representing volume change from landward of the primary dune to below the depth of closure for the region between Jones Inlet and Montauk Point. Volume change was extrapolated alongshore between available stations with seasonal and end-member calculations performed. Residual volumes indicated a net gain in sand volume between 1995 and 2001. Artificial nourishment inputs into the system were removed from the calculations, therefore, it must be assumed that the gain represents an onshore flux of material at a minimum rate of 586,000 $m^3$/yr (766,000 $yd^3$/yr). A combination of 44 profile properties was used to delineate areas of vulnerability to storm events or persistent erosion. It is often difficult to incorporate such a large number of parameters in an analysis; however, recent environmental studies into coastal typologies have demonstrated the value of clustering analysis techniques for dealing with large datasets of multiple parameters. Supervised clustering analysis was applied for the first time to a coastal data set, ACNYMP beach profiles were classified into one of three groups: a high risk profile, moderate risk profile and low risk profile. Thirteen areas of consistent high vulnerability were identified. Areas along Fire Island and Westhampton were similar to areas previously identified with vulnerability to breaching events by the U.S. Army Corps of Engineers.

**Bliss, J.D., Williams, S.J., and Bolm, K.S., 2009. Modeling cape and ridge-associated marine sand deposits: a focus on the U.S. Atlantic Shelf , chapter M in Bliss, J.D., Moyle, P.R., and Long, K.R., eds., Contributions to Industrial-Minerals Research: U.S. Geological Survey Bulletin 2209-M, 22 p.**

Abstract: Cape- and ridge-associated marine sand deposits, which accumulate on storm-dominated continental shelves that are undergoing Holocene marine transgression, are particularly notable in a segment of the U.S. Atlantic Continental Shelf that extends southward from the east tip of Long Island, N.Y., and eastward from Cape May at the south end of the New Jersey shoreline. These sand deposits commonly contain sand suitable for shore protection in the form of beach nourishment. Increasing demand for marine sand raises questions about both short- and long-term potential supply and the sustainability of beach nourishment with the prospects of accelerating sea-level rise and increasing storm activity. To address these important issues, quantitative assessments of the volume of marine sand resources are needed. Currently, the U.S. Geological Survey is undertaking these assessments through its national Marine Aggregates and Resources Program (URL http://woodshole.er.usgs.gov/project-pages/aggregates/).

[The paper] presents a hypothetical example of a quantitative assessment of cape-and ridge-associated marine sand deposits in the study area, using proven tools of mineral-resource assessment. Applying these tools requires new models that summarize essential data on the quantity and quality of these deposits. Two representative types of model are descriptive models, which consist of a narrative that allows for a consistent recognition of cape-and ridge-associated marine sand deposits, and quantitative models, which consist of empirical statistical distributions that describe significant deposit characteristics, such as volume and grain-size distribution. Variables of the marine sand deposits considered for quantitative modeling in this study include area, thickness, mean grain size, grain sorting, volume, proportion of sand-dominated facies, and spatial density, of which spatial density is particularly helpful in estimating the number of undiscovered deposits within an assessment area. A Monte Carlo simulation that combines the volume of sand-dominated-facies models with estimates of the hypothetical probable number of undiscovered deposits provides a probabilistic approach to estimating marine sand resources within parts of the U.S. Atlantic Continental Shelf and other comparable marine shelves worldwide.

**Bliss, J.D., S.J. Williams, and M.A. Arsenault, 2009. Mineral resource assessment of marine sand resources in cape- and ridge-associated deposits in three tracts, New York and New Jersey, United States Atlantic continental shelf, chap. N in Bliss, J.D., Moyle, P.R., and Long, K.R., eds., Contributions to Industrial-Minerals Research: U.S. Geological Survey Bulletin 2209–N, 6 p.**

Abstract : Demand is growing in the United States and worldwide for information about the geology of offshore continental shelf regions, the character of the seafloor, and sediments comprising the seafloor and subbottom. Interest in locating sand bodies or high quality deposits that have potential as sources for beach nourishment and ecosystem restoration is especially great in some regions of the country. The Atlantic coast, particularly New York and New Jersey, has been the focus of these studies for the past 40 years with widely varying results. This study is the first attempt at applying probability statistics to modeling Holocene-age cape-and ridge-associated sand deposits and thus focuses on distinct sand body morphology. This modeling technique may have application for other continental shelf regions that have similar geologic character and late Quaternary sea-level transgression history.

An estimated volume of 3.9 billion $m^3$ of marine sand resources is predicted in the cape-and ridge-associated marine sand deposits in three representative regions or tracts on the continental shelf offshore of New York and New Jersey. These estimates are taken from probabilistic distributions of sand resources and are produced using deposit models and Monte Carlo Simulation (MCS) techniques. The estimated sand resources presented here are for only three tracts as described below and for Holocene age sand resources contained in cape-and ridge-associated marine sand deposit types within this area. Other areas may qualify as tracts for this deposit type and other deposit types and geologic ages (for example, paleo-stream channels, blanket and outwash deposits, ebb-tide shoals, and lower sea level-stand deltas), which are present on the New Jersey and New York continental shelf area but are not delineated and modeled in this initial evaluation.

Admittedly, only a portion of these probable sand resources will ultimately be available and suitable for production, dependent largely on geographic, economic, preemptive use, environmental, geologic and political factors. In addition, offshore sand resources should only be considered if the area is seaward of the active zone of significant nearshore sediment transport, about 10 to 12 m in depth, and in sufficiently shallow water so that sand can be extracted within U.S. dredging equipment limits, currently about 40 m in depth. If the material is to be used for beach nourishment, material must be of an appropriate sediment texture and character (grain size, sorting, shape, and color) to match the native beach and have mineralogical properties important to its use. Extraction of sand can disturb or alter the benthic habitat and seafloor ecology, so these factors and other site-specific effects will need to be evaluated for any intended use. These and other factors are not considered in this report but can be expected to reduce the total net volume of sand resources available for production. The purpose of this report is to describe and present results from a probabilistic mineral modeling technique previously applied to onshore mineral resources. This modeling and assessment procedure is being used for the first time to assess and estimate offshore aggregate resources; this study is part of the U.S. Geological Survey (USGS) Marine Aggregates Resources and Processes Project (http://woodshole.er.usgs.gov/project-pages/aggregates/).

**Bocomazo, L., H.J. Bokuniewiz, and J.J. Tanski, 2011. Sand Resources offshore of Long Island (NY) Proceedings of the Coastal Sediments 2011(Volume 2): 1021-1033.**

Abstract: Sand for beach nourishment has been found in State and federal waters on the shelf south of Long Island, New York, both in submerged ridges and in a widely distributed, Pleistocene/glacial blanket. Ridges appear to be actively maintained by hydrodynamic processes in the coastal ocean, although relative importance of various processes has not been quantified. Estimates of the volume of beach-compatible sand found, in waters less than 40-meters deep, range from about 1.0 to 5.6 billion cubic meters; the projected volume of sand required for federal beach nourishment projects corresponds to between 0.8 to 4.2 percent of this beach-compatible sand. There is geologic evidence that sand is being transported to the beach from beyond the surf zone, although both the volumes and mechanisms are uncertain. The published estimates of onshore transport range from 0% to 63% of the longshore transport estimates.

**Butman, B., Danforth, W.W., Schwab, W.C. and Buchholtz ten Brink, M.R., 1998. Multibeam bathymetric and backscatter maps of the Upper Hudson Shelf Valley and adjacent shelf, offshore of New York: U.S. Geological Survey Open-File Report 98-616, 4 sheets, scale 1:125,000. http://pubs.usgs.gov/of/1998/of98-616/**

Introduction: "The objective of the U.S. Geological Survey mapping project is to map the surficial geology and subsurface stratigraphy of the Hudson Shelf Valley and adjacent shelf from its head in the Christiansen Basin at about 40° 25' N and 73° 48' W to where it crosses the outer shelf at about 39° 40' N and 72° 50' W…The multibeam survey data present here [1996], along with the companion sidescan and high-resolution geophysical surveys of the surrounding area …provide a detailed view of the sedimentary features of the area offshore of the New York - New Jersey metropolitan region. The high-resolution maps of bathymetry and backscatter intensity show that the sea floor is impacted by extensive disposal of material, modern sedimentary processes, and the underlying geologic framework. The observations suggest that dumping of material has affected a large area of the sea floor outside designated disposal sites and altered the rates and scales of sedimentary processes and benthic habitats.

**Coastal Planning and Engineering of New York, PC, Inc. 2009. Coastal Protection Study, City of Long Beach, NY, Oceanside Shore Protection Plan. Unpublished report to the City of Long Beach: 60 pp.**

This is an independent analysis of the Corps LRR or a Locally Preferred Plan (LPP) for the City of Long Beach. It concludes that "..current conditions are such that the beach is wide, but low in elevation, which demonstrates the need for a storm protection project. While the groins have been effective in stabilizing the shoreline, the low elevation of the beach allows for overtopping during moderate storm events. Dry beach fill placed as a berm cap would avoid sand placement in the water and increase the elevation of the existing beach to help address overtopping. Additional protection in the form of a sand barrier or floodwall is needed under the boardwalk to prevent flooding from major storms. If the storm protection project is implemented, the beach template would then be authorized for nourishment as needed, such as after a major storm event".

**Hill, J., Thieler, E., Foster, D., Swift, B., and O'Brien, T., 2000, Archive of Datasonics SIS-1000 chirp subbottom data collected during USGS Cruise DIAN 97032, Long Island, New York inner shelf--Fire Island, New York, 24 September - 19 October, 1997: U.S. Geological Survey Open-File Report 00-152, 11 CD-ROMs.**

"The goal of this project is to survey the offshore area, the harbor, and the southern shore of Long Island, providing a regional synthesis to support a wide range of management decisions and a basis for further process-oriented investigations".

**Hill, J., Thieler, E., Foster, D., Swift, B., and O'Brien, T., 2000, Archive of boomer and sparker subbottom data collected during USGS Cruise DIAN 97032, Long Island, New York inner shelf--Fire Island, New York, 24 September - 19 October, 1997: U.S. Geological Survey Open-File Report 00-142, 15 CD-ROMs.**

"The goal of this project is to survey the offshore area, the harbor, and the southern shore of Long Island, providing a regional synthesis to support a wide range of management decisions and a basis for further process-oriented investigations. …This CD-ROM contains digital high resolution seismic reflection data collected during the USGS Diane G 97032 cruise. The coverage is the nearshore of Long Island, NY in the vicinity of Fire Island".

**Kana, T.W., 1995. A mesoscale sediment budget for Long Island, New York, Marine Geology 126: 87-110.**

Abstract: A sediment budget encompassing the shoreline from Montauk Point to Fire Island Inlet, New York, derived longshore transport rates for 25 coastal cells using comparative surveys. The study area along the south shore of Long Island, a generally straight coast of mainland and barrier island beaches, includes the eroding headland at Montauk Point, three jettied inlets, two groin fields, and three barrier beaches. Bridging between small-scale (quantitative) surveys and large-scale regional geology, the sediment budget provides a mesoscale view and quantitative estimates of key coastal processes in the area. Results integrate changes between the foredunes and lower foreshore to the estimated depth of closure (-9 to - 12 m below mean sea level) for a 24-year period (1955-1979). Beach fills and losses to washovers and breach channels are incorporated in the analysis. The results confirm net westerly transport and provide the first evidence that shoaling in Fire Island Inlet (long estimated to be -400,000 $m^3$/yr) is due primarily to cannibalization of the immediate updrift compartments, particularly erosion of the foreshore below mean low water. This lowers estimates of longshore transport rates along most of the study area compared with previous estimates. The offshore source attributed by others to account for Fire Island's stability appears to be trailing ebb shoals lagging behind inlet migration. Jettied inlets in the central study area intercept some longshore transport but since stabilization (circa 1955) have been ebb dominant, preserving the littoral budget seaward of the strandline; littoral losses to the lagoons by inlets or washovers were insignificant over the period. However, breach channels, if not closed soon after storms, were found to offset years of ebb dominance in jettied inlets by depositing major flood deltas. Beach fills had measurable and positive effect on the sediment budget along the western half of the study area through the early 1970s. The volume of beach fills since1975 has diminished to about 10% of the earlier rate. A field of 15 groins in the central study area is shown to trap100% of the longshore transport and produce a local drift reversal. Rates of accretion within the groin cells and erosion along the downdrift compartment dwarf the average rates of change for the majority of littoral compartments in the study area.

**Reid J.M., J. A. Reid, C. J. Jenkins, M. E. Hastings, S. Jeffress Williams, and L. J. Poppe, 2005. usSEABED: Atlantic Coast Offshore Surficial Sediment Data Release, 2005, Version 1.0, U.S. Geological Survey Data Series 118.**

"The report contains a compilation of published and unpublished sediment texture and other geologic data about the seafloor from diverse sources. usSEABED is an innovative database system developed to bring assorted data together in a unified database. …Examples of maps displaying attributes such as grain size and sediment color are included".

**Schwab, W.C., Baldwin, W.E., and Denny, J.F., 2014, Maps showing the change in modern sediment thickness on the Inner Continental Shelf Offshore of Fire Island, New York, between 1996–97 and 2011: U.S. Geological Survey Open-File Report 2014–1238, http://dx.doi.org/10.3133/ofr20141238.**

Abstract: The U.S. Geological Survey mapped approximately 336 square kilometers of the lower shoreface and inner continental shelf offshore of Fire Island, New York, in 1996 and 1997, using high-resolution sidescan-sonar and seismic-reflection systems, and again in 2011, using interferometric sonar and high-resolution chirp seismic-reflection systems. This report presents a comparison of sediment thickness and distribution as mapped during these two investigations. These spatial data support research on the Quaternary evolution of the Fire Island coastal system and provide baseline information for research on coastal processes along southern Long Island.

**Schwab, W.C., Denny, J.F., and Baldwin, W.E., 2014, Maps showing bathymetry and modern sediment thickness on the inner continental shelf offshore of Fire Island, New York, pre-Hurricane Sandy: U.S. Geological Survey Open-File Report 2014–1203, http://dx.doi.org/10.3133/ofr20141203.**

Abstract: The U.S. Geological Survey mapped approximately 336 square kilometers of the lower shoreface and inner continental shelf offshore of Fire Island, New York, in 2011 by using interferometric sonar and high-resolution chirp seismic-reflection systems. This report presents maps of bathymetry, acoustic backscatter, the coastal plain unconformity, the Holocene marine transgressive surface, and modern sediment thickness. These spatial data support research on the Quaternary evolution of the Fire Island coastal system and provide baseline information for research on coastal processes along southern Long Island.

**Schwab, W.C., Denny, J.F., Butman, B., Danforth, W.W., Foster, D.S., Swift, B.A., Lotto, L.L., Allison, M.A. and Thieler, E.R., 2000, Sea-floor characterization offshore of the New York-New Jersey metropolitan area using sidescan sonar: U.S. Geological Survey Open-File Report 00-295. http://pubs.usgs.gov/of/2000/of00-295/**

Introduction: "…In 1995, the USGS, in cooperation with the U.S. Army Corps of Engineers (USACOE), New York District, began a program designed to generate reconnaissance maps of the sea floor offshore of the New York - New Jersey metropolitan area (Schwab and others, 1997b), one of the most populated coastal regions within the United States (Fig. 1). This mapping effort differs from previous studies of this area (e.g.,Williams, 1976; Freeland and Swift, 1978) by obtaining digital, sidescan-sonar images that cover nearly 100 percent of the sea floor (Figs. 2 and 3). The sidescan-sonar data were digitally mosaicked and incorporated into a geographic information system (GIS) of the New York Bight region. Preliminary interpretations of data collected in 1995 and 1996 were presented in Schwab and others (1997a, 1997b) and Lotto (1999). Preliminary interpretations of multibeam swath bathymetry data collected over the Hudson Shelf Valley area were presented in Butman and others (1998). In this report, we expand on these earlier reports and present a composite sidescan-sonar image of the sea floor collected during surveys conducted between 1995 to 1998, along with further interpretations"..

**Strong, B.B. 1997. Shoreline trends from 1950-1995 on Jones Beach, Long Island. M.S. Dissertation, State University of New York at Stony Brook: 180 pp.**

Abstract: The condition of Jones Beach, located on the south shore of Long Island, has been influenced not only by erosive storms, but also by the presence of Fire Island inlet to the east, jetty construction and dredging and beach nourishment projects. Beach response has been variable, as evidenced by many years of monitoring. Approximately one hundred and twenty five surveys encompassed in each of fifteen profiles from 1950-1953, 1962-1974, 1994 and 1995 were studied in order to assess mean high water (MHW) shoreline trends along Jones Beach. Individual storms cause short term changes in MHW intercept width while sediment supplied from nourishment projects contributes to longer term trends. Accretionary trends as large as 36 feet per year were found at the eastern and western ends of the beach. This is explained in both areas by sediment being impounded behind jetty structures. MHW shoreline recession on the order of three to four feet per year is the dominant long term trend in the middle section of the beach. In addition to the impact of storms and anthropogenic alterations, the beach has been responding to general erosive conditions along the coast. Consistent monitoring of the beach profile evolution is the key to understanding what trends, if any are taking place.

**Tsien H., 1986. Differential transport of sand on the south shore of Long Island. M.S. Dissertation, State University of New York at Stony Brook: 119pp.**

Abstract: As outwash sediments are incorporated into the net westerly drift of the littoral system of the south shore of Long Island, various grain-size classes are transported differently. Thirty-four cross-shore transects were sampled at nine locations from the dune to a depth of ten meters in order to determine the longshore and cross-shore distribution of sediments. Coarser grain sizers are concentrated at the intertidal beach, which indicates a tendency for coarser sand to move onshore, whereas finer sediments showed a peak abundance on the outer part of the surfzone indicating a net movement offshore. Sands of intermediate grain size have peak abundance in the surfzone. Alongshore, the percentage of fine-grained sediments increases towards the west at the outer edge of the surfzone whereas the coarser grained sediments show no alongshore trend. There is a distinct coarsening of sediments in the vicinity of tidal inlets due to strong tidal currents winnowing out the finer sediments. Here, the westerly movement can only be recognized at the outer part of the surfzone. The results of the study provide the basis for understanding the net dispersion patterns of sand on the upper shoreface, the maintenance of the barrier island sand budget and the morphodynamics of Long Island's south shore in general.

**USACE. 1996. Fire Island to Montauk Point Long Island, New York breach contingency plan. U.S. Army Corps of Engineers, New York District, 44 pp. + appendices.**

Abstract: Under the proposed Breach Contingency Plan, breach closure would be initiated within 72 hours of termination of the storm event, in which the State of New York formally requests action, that occurs along barrier island chain from Fire Island Inlet to Southampton, excluding the Federal Wilderness Area within the Fire Island National Seashore Boundary. The Wilderness Area would be monitored for indication of natural breach closure. If this does not occur in the Wilderness Area, or if there is an increase in tidal ranges within the Great South Bay that can potentially flood development on the south shore of Long Island or Fire Island, the breach would then be closed under the provisions of this plan.

Fill placement to close a breach will match existing shoreline profiles of the corresponding bays (Great South Bay, Moriches Bay and Shinnecock Bay) to the north and the Atlantic Ocean to the south. A minimum berm width of 150 feet would be created at a maximum elevation of 9 feet National Geodetic Vertical Datum (NGVD) between the back-bay and the Atlantic Ocean. The fill areas would blend into existing topography west and east of the breach fill areas. Placement fill grain size shall be compatible if possible, with the grain size of the existing beach at the breach site.

Fill will be obtained from several possible sources including, NEPA-approved upland sand sources, Federally-created stockpiles, SEQRA or locally approved stockpiles created by the State or local municipalities throughout the barrier island system, and/or hydraulically dredged from one of the following locations.

1. U.S. Army Corps of Engineers' Atlantic Ocean Borrow Areas.
2. The Federally authorized Intracoastal Waterway.
3. The Federally authorized channels of Fire Island, Moriches and Shinnecock Inlets.
4. Existing channels maintained by Suffolk County.
5. Harbor or channel area maintained by local municipalities.

The dredging and nourishment required in this emergency project will produce three general classes of environmental impacts: the dredging of the borrow area, an increase in turbidity levels, and the placements of suitable material on the beach or in open water to restore a breached area to pre-emergency conditions.

Analysis of the impacts of placing material on the beach is based on the abundance and kind of organisms present, the quantity and quality of material placed, the method used for placement, and time of year of placement. No significant adverse impact is anticipated in the filling of the breached areas to pre-emergency conditions.

Due to the sandy substrate and the locations of the site, any plume at the placement site will be restricted in size and duration, and it is not anticipated that there will be a release of pollutants or a significant lowering of dissolved oxygen levels resulting from the project, either at the dredge location of placement site.

Biological recovery of the disturbed area will occur reasonable quickly, when organism relocate from outlying undisturbed areas. The recovery process is optimized when the placement material matches the beach material and beach profiles are the same. There are some unavoidable adverse impacts in direct deposit and direct loss of benthos at the borrow area, but they are minor and of

**USACE, 2014. Fire Island inlet to Moriches inlet stabilization project hurricane Sandy limited reevaluation report. Evaluation of a Stabilization Plan for Coastal Storm Risk Management In Response to Hurricane Sandy & Public Law 113-2 Main Report: Appendix B Physical conditions: 32 pp.**

"A general description of the coastal processes that characterize the study area and provide the basis for design and evaluation of storm protection measures…describes the shorefront and back bay conditions in greater detail to more effectively characterize the relative risk to storm damages that have been accounted for in the project modeling… provides an overview of the specific hydrodynamics of the study area. To orient the reader, the following paragraphs summarize the modeling efforts undertaken for this study, including an overview of the hydrodynamic modeling and the estimation of frequency relationships".

**USACE, 2014. Fire Island inlet to Moriches Inlet stabilization project technical support document, Evaluation of a stabilization plan for coastal storm risk management. Borrow Area Appendix: 31pp.**

"The primary objective of the borrow area investigation was to identify and delineate sources of sand borrow material in the offshore waters of Long Island for use as design fill and beach nourishment material for the Fire Island Interim project, which proposes fill intermittently from Robert Moses State Park to Smith Point County Park, fronting approximately 12 miles of shoreline. The fill is primarily focused on the inhabited communities of Fire Island. Sediments were sought which were of suitable grain size, and present in sufficient volume, within a reasonable distance from the project shoreline".

## PART 3. ASSOCIATED REGIONAL PUBLICATIONS

These entries represent important publications helpful to the interpretation. For example they are published summaries of the regional framework, examinations of nearby areas and discussions of some of the relevant processes.

**Beardsley, R.C., 1976. Physical Oceanography of the Middle Atlantic Bight. American Society of Limnology and Oceanography Special Symposium, v. 2: 20-34.**

Abstract: Historical information in combination with recent physical observations provide a first-order knowledge of circulation patterns and hydrographic structure in the Middle Atlantic Bight. Preliminary results from the National Oceanic and Atmospheric Administration MESA program, the National Science Foundation sponsored shelf programs, and other investigations reveal details of the mean longshore water motion and the distribution of mean transport along and across the shelf. The physical mechanisms which govern the lower frequency (subtidal) variability of water motion have been identified and estimates can now be made of their contribution to the longshore mass transport. Recent work has also shed light on the exchange processes between the shelf and the slope water, which are difficult to observe properly because of their small spatial scales and their time dependency.

Modern techniques of direct current measurement and temperature and salinity sensing have allowed longer time-series records and greater spatial coverage and resolution. Physical oceanographers are now able to pursue their interests in the local, smaller scale processes. One specific interest in the nearshore region is the control that estuaries exert on the nearby shelf waters. Another is the topographic influences on local circulation in the New York Bight apex and in the Hudson shelf valley. In the offshore region, interests focus on the shelf break region where the transition between the shelf water and the slope water usually occurs as a sharp front. Both extrusions ("bubbles") of shelf water off the shelf and intrusions of slope water have been observed and are likely to constitute a major part of the shelf-slope exchange. Attention has been focused also on the dynamics of the front itself – its movements, velocity shears and mixing processes.

**Bokuniewicz H.J. and M. Wolff, 1994. Planning Long Island's response to rising sea level. Chapter 21 in "The Environment": J.E. Hickey and L.A. Longmire, editors Greenwood Press Westport, CT: 247-260.**

Abstract: Increases in the abundance of the atmospheric greenhouse gases is indisputable. A prediction that sea level will rise at an accelerated rate is based on this fact, but the conclusion is reached only at the end of a long chain of arguments. Forecasts of the global temperature change, of the shifts in precipitation, of expansion of ocean surfaces, and of the responses of the ice cap are all links in this chain. Each link carries some uncertainty with it so that the ultimate conclusion concerning the rate and timing of future seal level rise is plagued with some doubts. To make matters worse, there is no direct evidence as yet that the rate of relative sea level rise is accelerating, although this level along New York's shoreline does continue to increase gradually.

Faced with choosing an appropriate response to shore erosion due to a rise in sea level, the uncertainty is debilitating, yet the potential risks are so high, the costs of an effective response so great, and the time required to implement a coordinated effort so long that the problem deserves attention even while work continues to establish confidence in long-range predictions. This chapter discusses a possible strategy for a section of New York's coast. The proposed strategy is not currently a management alternative, but it does not require any great departure from existing policy; it can be done on a local basis, and it does not demand an irreversible commitment at this time.

Action can be begun now that is proportionate to the great uncertainty in the prediction of future sea level rise and the shoreline response. The commitment is a gradual one, and the level of effort is fairly predictable for very long periods**.**

**Bumpus, D.F., 1973. A description of the circulation on the continental shelf of the east coast of the United States. Progressive Oceanography 6: 111-157.**

Abstract: The circulation on the continental shelf of the east coast of the United States is discussed, including the historical development of the concepts, and the surface and bottom circulation based on drift-bottle data and sea-bed drifter data. Suggestions for future research to further our understanding of the circulation problem are offered.

**Buonaiuto, F.S. Jr, M. Slattery and H. J. Bokuniewicz, 2011. Wave Modeling of Long Island Coastal Waters, Journal of Coastal Research 27; 470-477 doi: 10.2112/08-1014.**

Abstract: Simulating waves nearshore (SWAN) and steady state wave (STWAVE) nearshore wave transformation models were applied to Long Island, New York, coastal waters to investigate regions of wave focusing and their relationship to offshore shelf and shoal zone morphology. Model simulations extended from 1 February 1999 through 28 February 1999, and encompassed five wave events in which measured significant wave heights exceeded 1.5 m. For many of the storm events, wave energy along the coast was concentrated at Montauk, Westhampton, central Fire Island, Jones Island, and Long Beach. The focusing and structure of wave energy at Westhampton appears to be related to infragravity wave influenced morphology between Shinnecock and Moriches inlets. Wave energy concentration along central Fire Island was the result of shoaling and refraction around a submerged terrace offshore of Watch Hill. In addition the investigation illustrates the benefit of using multiple models to compute wave transformation processes.

**Butman, B., Gutierrez, B.T., Buchholtz ten Brink, M.R., Schwab, W.C., Blackwood, D.S., and Middleton, T.J., 2003, Photographs of the sea floor offshore of New York and New Jersey: U.S. Geological Survey Open-File-Report 01-470, DVD-ROM.**

Abstract: This DVD-ROM contains photographs of the sea floor and sediment texture data collected as part of studies carried out by the U.S. Geological Survey (USGS) in the New York Bight (PDF format)). The studies were designed to map the sea floor (Butman, 1998, URL: http://pubs.usgs.gov/fs/fs133-98/) and to develop an understanding of the transport and long-term fate of sediments and associated contaminants in the region (Mecray and others, 1999, URL: http://pubs.usgs.gov/fs/fs114-99/). The data were collected on four research cruises carried out between 1996 and 2000 (Appendix I). The images and texture data were collected to provide direct observations of the sea floor geology and to aid in the interpretation of backscatter intensity data obtained from sidescan sonar and multibeam surveys of the sea floor. …This DVD-ROM contains digital images of bottom still photographs, images digitized from videos, sediment grain-size analysis results, and short QuickTime movies from video transects.

**Butman, B., Middleton, T.J., Thieler, E.R., and Schwab, W.C.,2003, Topography, shaded relief, and backscatter intensity of the Hudson Shelf Valley, offshore of New York : U.S. Geological Survey Open-File-Report 03-372, DVD-ROM.**

Abstract: This report presents maps of the sea floor topography, shaded relief, and backscatter intensity of the Hudson Shelf Valley at a scale of 1:150,000 based on multibeam echo-sounder data.

The multibeam surveys were conducted aboard the vessel Frederick G. Creed in fall 1996, 1998, and spring 2000. The maps are presented on two sheets in PDF format.

**Butman, B., W.W. Danforth, B. May, S.C. Knowles, and L. Serrett, 2002. Sea floor topography and backscatter intensity of the historic remediation site (HARS), offshore of New York, based on multibeam surveys conducted in 1996, 1998, and 2000. U.S. Geological Survey Open File Report 00-503.**

Abstract: This data set includes topography and backscatter intensity of the sea floor of the Historic Area Remediation Site (HARS), located offshore of New York and New Jersey. The data were collected with a multibeam sea floor mapping system on surveys conducted November 23 - December 3, 1996, October 26 - November 11, 1998, and April 6 - 30, 2000. The surveys were conducted using a Simrad EM 1000 multibeam echo sounder mounted aboard the Canadian Hydrographic Service vessel Frederick G. Creed. This multibeam system utilizes 60 electronically aimed receive beams spaced at intervals of 2.5 degrees that insonify a strip of sea floor up to 7.5 times the water depth (swath width of 100 to 200 m within the survey area). The horizontal resolution of the beam on the sea floor is approximately 10% of the water depth (3-5 meters in the survey region). Vertical resolution is approximately 1 percent of the water depth, or 0.3 m. Maps derived from the mulitbeam observations show sea floor topography, shaded relief, and backscatter intensity (a measure of sea floor texture and roughness) at a spatial resolution of 3 m/pixel.

**Danforth, W.W., Thieler, E.R., and Butman, B., 2003, High-resolution quaternary seismic stratigraphy of the New York Bight Continental Shelf: U.S. Geological Survey Open-File Report 02-152, DVD-ROM. Online at http://pubs.usgs.gov/of/2002/of02-152/**

**"**This report presents a synthesis of results obtained from systematic high-resolution mapping of the sea floor of the New York Bight, principally by means of 100%-coverage sidescan sonar and seismic-reflection methods. The resulting maps offer detailed views of the sea floor, and provide a new framework for understanding the sedimentary evolution of the inner continental shelf. This new framework is essential for understanding the regional sediment-transport system of the New York Bight. Our interpretation of the subbottom data shows that: (1) a regional unconformity truncates the Late Cretaceous to early Tertiary coastal-plain strata and the topographic relief of this unconformity has controlled the accommodation space for subsequent deposition of Pleistocene sediment; (2) the Pleistocene sedimentary deposit is relatively thin, with the exception of areas where sediment-filled paleofluvial channels cut into the underlying Late Cretaceous to early Tertiary coastal-plain strata; (3) the Holocene sedimentary deposit is extremely thin and composed of sediment reworked from Pleistocene and Late Cretaceous to early Tertiary coastal-plain deposits during the last marine transgression, and; (4) Pleistocene and Late Cretaceous to early Tertiary strata crop out on the continental shelf and continue to be reworked by oceanographic processes. The sidescan-sonar images of the New York Bight provide an acoustic view of the formation, or active modification, of a ravinement surface formed by Holocene transgression".

**Foster, D S, Swift, B A, Schwab, W C, 2000, Stratigraphic framework maps of the nearshore area of southern Long Island from Fire Island to Montauk Point, New York: U.S. Geological Survey Open-File Report 99-559, 2 sheets, scale 1:250,000.**
**http://pubs.usgs.gov/of/1999/of99-559/**

Abstract: The maps presented in this report (depth to Coastal Plain unconformity, Quaternary sediment thickness, paleochannel thickness, and modern sand thickness) are helpful for determining sand-resource availability for beach nourishment programs and understanding the influence that the inner-shelf framework of southern Long Island has on coastal processes and evolution. The maps showing structure of the Coastal Plain unconformity and thickness of overlying Quaternary sediment delineate the framework of the coastal region. The map showing the distribution and thickness of paleochannel fill indicates areas not suitable as sources for beach nourishment, assuming the channels contain muddy estuarine deposits. The areas between channels are Pleistocene glacial deposits and probably consist of coarse sediment that may be suitable for beach nourishment. These coarser-grained glacial deposits are the source for modern sand deposits. The modern sands have been reworked primarily from glacial deposits and a Cretaceous outcrop off Watch Hill. These reworked deposits provide well-sorted clean sand that have and will provide nourishment for southern Long Island beaches.

**Goff, J.A., R. D. Flood, J. A. Austin, W. C. Schwab, B. Christensen, C. M. Browne, J. F. Denny, and W. E. Baldwin, 2015. The impact of Hurricane Sandy on the shoreface and inner shelf of Fire Island, New York: Large bedform migration but limited erosion, Continental Shelf Research 98:13–25.**

Abstract: We investigate the impact of superstorm Sandy on the lower shore face and inner shelf offshore the barrier island system of Fire Island, NY using before-and-after surveys involving swath bathymetry, backscatter and CHIRP acoustic reflection data. As sea level rises over the long term, the shore face and inner shelf are eroded as barrier islands migrate landward; large storms like Sandy are thought to be a primary driver of this largely evolutionary process. The "before" data were collected in 2011 by the U.S. Geological Survey as part of a long-term investigation of the Fire Island barrier system. The "after" data were collected in January, 2013 two months after the storm. Surprisingly, now widespread erosional event was observed. Rather, the primary impact of Sandy on the shore face and inner shelf was to force migration of major bed forms (sand ridges and sorted bed forms)10's of meters WSW alongshore, decreasing in migration distance with increasing water depth. Although greater in rate, this migratory behavior is no different than observations made over the15-year span prior to the 2011survey. Stratigraphic observations of buried, offshore-thinning fluvial channels indicate that long-term erosion of older sediments is focused in water depths ranging from the base of the shore face(13–16m) to 21 m on the inner shelf, which is coincident with the range of depth over which sand ridges and sorted bedforms migrated in response to Sandy. We hypothesize that bed form migration regulates erosion over these water depths and controls the formation of a widely observed transgressive ravinement; focusing erosion of older material occurs at the base of the stoss (up-current) flank of the bedforms. Secondary storm impacts include the formation of ephemeral hummocky bedforms and the deposition of a mud event layer.

**Harris, C.K. and R.P. Signell, 1999. Circulation and sediment transport in the vicinity of the Hudson Shelf Valley. In: Spaulding, M.A. (Ed.), Proceedings of the Sixth Conference of Estuarine and Coastal Modeling, American Society of Civil Engineers, New York, pp. 380-394.**

Abstract: Sediment transport in the Hudson Shelf Valley and on the adjacent Long Island Shelf are evaluated using available data along with a three-dimensional wind-driven circulation model and a one-dimensional sediment transport model. Winds from the northwest drive currents up the Hudson Shelf Valley, while winds from the east produce weaker currents directed down the valley. Consistent with previous studies, sediment transport on the Long Island Shelf is dominated by resuspension during energetic wave events that are correlated with strong winds from the northeast,

and net sediment flux is predicted to be towards the southwest along bathymetric contours. Transport of muddy sediments in the Hudson Shelf Valley, however, does not appear to be wave-dominated. These sediments are most likely to be resuspended by energetic currents driven by strong winds from the northwest that are not associated with energetic waves. The strong up-valley flows associated with these winds implies that net sediment flux along the Hudson Shelf Valley is up-valley.

**Harris, C.K., Butman, B., and Traykovski, P., 2003, Winter-time circulation and sediment transport in the Hudson Shelf Valley: Continental Shelf Research, v. 23, no. 8.**

Abstract: The Hudson Shelf Valley is a bathymetric low that extends across the continental shelf offshore of New York and New Jersey. From December 1999 to April 2000 a field experiment was carried out to investigate the transport of sediment in the shelf and valley system. Near-bed tripods and water-column moorings were deployed at water depths from 38 to 75 m in the axis of the shelf valley and at about 26 m on the adjacent shelves offshore of New Jersey and Long Island, New York. These measured suspended sediment concentrations, current velocities, waves, and water column properties. This paper analyzes observations made during December 1999 and January 2000, and presents the first direct near-bed measurements of suspended sediment concentration and sediment flux from the region. Sediment transport within the Hudson Shelf Valley was coherent over tens of kilometers, and usually aligned with the axis of the shelf valley. Down-valley (off-shore) transport was associated with energetic waves, winds from the east, moderate current velocities (5-10 cm/s), and sea level setup at Sandy Hook, NJ. Up-valley (shoreward) transport occurred frequently, and was associated with winds from the west, low wave energy, high current velocities (20-40 cm/s), and sea level set-down at the coast. Within the shelf valley, net sediment flux (the product of near-bed concentration and velocity) was directed shoreward, up the axis of the valley. Current velocities and suspended sediment fluxes on the New York and New Jersey continental shelves were lower than within the shelf valley, and exhibited greater variability in alignment. Longer term meteorological data indicate that wind, setup, and wave conditions during the study period were more conducive to up-valley transport than seasonal data suggest as average. To relate the observed up-valley sediment flux to observed accumulation of contaminants within the Hudson Shelf Valley requires consideration of transport over longer timescales than those observed here, and methods that account for the region's complex bathymetry, sediment distribution, and circulation.

**Hill, J., Schwab, W., and Danforth, W., 2001, Archive of sidescan-sonar data and DGPS navigation data collected during USGS Cruise SEAX 96004, New York Bight, 1 May - 9 June, 1996: U.S. Geological Survey Open-File Report 01-95, 12 DVD-ROMs.**

"This DVD-ROM contains copies of the navigation and field sidescan-sonar data collected aboard the R/V Seaward Explorer. USGS Cruise SEAX 96004 was conducted along New York Bight from 1 May - 9 June, 1996".

**Hill, J., Schwab, W., and Foster, D., 2000, Archive of boomer and sparker data collected during USGS Cruise DIAN 97011, Long Island, New York inner shelf--Fire Island, 5-26 May, 1997: U.S. Geological Survey Open-File Report 00-241, 17 CD-ROMs.**

"This CD-ROM contains digital high resolution seismic reflection data collected during the USGS DIAN 97011 cruise. The coverage is the nearshore of Long Island, NY in the vicinity of Fire Island

**Hill, J., Schwab, W., and Foster, D., 2000, Archive of Datasonics SIS-1000 chirp subbottom data collected during USGS Cruise DIAN 97011, Long Island, New York Inner Shelf--Fire Island, New York, 5-26 May, 1997: U.S. Geological Survey Open-File Report 00-242, 3 CD-ROMs.**

The program was "designed to map the seafloor offshore of the New York-New Jersey metropolitan area; the most heavily populated, and one of the most impacted coastal regions of the United States. The ultimate goal of this program is to provide an overall synthesis of the sea floor environment, including surficial sediment texture, subsurface geometry, and anthropogenic impact (e.g. ocean dumping, trawling, channel dredging), through the use and analysis of sidescan-sonar and subbottom mapping techniques".

**Hill, J., Schwab, W., and Foster, D., 2001, Archive of Datasonics SIS-1000 chirp subbottom data collected during USGS Cruise SEAX 96004, New York Bight, 1 May - 9 June, 1996: U.S. Geological Survey Open-File Report 01-96, 3 DVD-ROMs.**

"The goal of this mapping program is to provide a regional synthesis of the sea-floor environment, including a description of sedimentary environments, sediment texture, seafloor morphology, and geologic history to aid in understanding the impacts of anthropogenic activities, such as ocean dumping. This mapping effort differs from previous studies of this area by obtaining digital, sidescan sonar images that cover 100 percent of the sea floor. This investigation was motivated by the need to develop an environmentally acceptable solution for the disposal of dredged material from the New York - New Jersey Port, by the need to identify potential sources of sand for renourishment of the southern shore of Long island, and by the opportunity to develop a better understanding of the transport and long-term fate of contaminants by investigations of the present distribution of materials discharged into the New York Bight over the last 100+ years (Schwab and others, 1997)".

**Hill, J., Schwab, W., and Foster, D., 2001, Archive of datasonics SIS-1000 CHIRP subbottom data, collected during USGS Cruise SEAX 95007, New York Bight, 7-25 May, 1995: U.S. Geological Survey Open-File Report 2001-97, 2 DVD-ROMs.**

The program was intended "to provide a regional synthesis of the sea-floor environment, including a description of sedimentary environments, sediment texture, seafloor morphology, and geologic history to aid in understanding the impacts of anthropogenic activities, such as ocean dumping. This mapping effort differs from previous studies of this area by obtaining digital, sidescan sonar images that cover 100 percent of the sea floor".

**Hill, J., Schwab, W., and Foster, D., 2001, Archive of water gun subbottom data collected during USGS Cruise SEAX 95007, New York Bight, 7-25 May, 1995: U.S. Geological Survey Open-File Report 2001-157, DVD-ROM.**

"The goal of this mapping program is to provide a regional synthesis of the sea-floor environment, including a description of sedimentary environments, sediment texture, seafloor morphology, and geologic history to aid in understanding the impacts of anthropogenic activities, such as ocean dumping. This mapping effort differs from previous studies of this area by obtaining digital, sidescan sonar images that cover 100 percent of the sea floor. This investigation was motivated by the need to develop an environmentally acceptable solution for the disposal of dredged material from the New York - New Jersey Port, by the need to identify potential sources of sand for renourishment of the southern shore of Long island, and by the opportunity to develop a better understanding of the transport and long-term fate of contaminants…"

**Mecray, E.L., Reid, J.M., Hastings, M.E., and Buchholtz ten Brink, M.R., 2003. Contaminated Sediments Database for Long Island Sound and the New York Bight : U.S. Geological Survey Open-File Report 03-241.**

"The Contaminated Sediments Database for Long Island Sound and the New York Bight provides a compilation of published and unpublished sediment texture and contaminant data. This report provides maps of several of the contaminants in the database as well as references and a section on using the data to assess the environmental status of these coastal areas. The database contains information collected between 1956-1997; providing an historical foundation for future contaminant studies in the region".

**Schwab, W.C., Thieler, E.R., Allen, J.R., Foster, D.S., Swift, B.A., and Denny, J.F., 2000, Influence of inner-continental shelf geologic framework on the evolution and behavior of the barrier-island system between Fire Island Inlet and Shinnecock Inlet, Long Island, New York: Journal of Coastal Research, v. 16, p. 408–422.**

Abstract: High-resolution, sea-floor mapping techniques, including sidescan-sonar and subbottom profiling, were used to investigate how the geologic framework of the inner-continental shelf influenced the Holocene evolution and modern behavior of the Fire Island barrier-island system, Long Island, New York. The inner-continental shelf off Long Island is divided into two physiographic provinces by a broad outcrop of Cretaceous coastal-plain strata offshore of Watch Hill; this outcrop was part of a subaerial headland during the Holocene marine transgression. Erosion of the headland during transgression furnished sediment to the inner-continental shelf downdrift to the west. The sediment was, in turn, reworked by oceanographic processes into a series of shoreface-attached sand ridges. The oldest (~1200 yr BP) and most stable part of the barrier-island system is immediately landward of the outcropping coastal-plain strata and thickest sand ridges. East of Watch Hill, Pleistocene sediment either is exposed on the inner-continental shelf or is buried by a veneer of modern reworked sediment. Here the barrier-island system has migrated landward at a faster rate than the segment west of Watch Hill and has been breached by numerous historic inlets Because the Pleistocene sedimentary deposit is generally of uniform thickness throughout the study area and unconformably overlies the Cretaceous coastal-plain strata, both the Holocene and historical evolution of the Fire Island barrier-island system are controlled by the physiography of this regional unconformity. In particular, the shoreface-connected sand ridges appear to be a significant source of sediment to the western portion of Fire Island. Previous attempts to develop a sediment budget for this coastal system have failed to explain volumetric discrepancies, primarily because poor assumptions were made about the nature of sediment transport in the system. A more realistic sediment budget must include a significantly larger spatial scale, including sediment input from the inner-continental shelf.

**Schwab, W., Thieler, E., Denny, J., and Danforth, W., 2000, Seafloor sediment distribution off southern Long Island, New York: U.S. Geological Survey Open-File Report 00-243. http://pubs.usgs.gov/of/2000/of00-243/default.htm**

"In 1996, the U.S. Geological Survey, in cooperation with the U.S. Army Corps of Engineers, began a program to produce geologic maps of the sea floor along the south shore of Long Island using high-resolution sidescan-sonar, subbottom profiling, and sediment sampling techniques. The study area extends from the 8-m isobath to about 10 km offshore. The goals of the investigation are to determine regional-scale sand-resource availability for planned beach-nourishment programs and to investigate the role that inner-shelf morphology and geologic framework play in the evolution of this coastal region…In this report, we present the sidescan-sonar imagery and interpretation based on the stratigraphic framework presented in Foster and others (1999) and on the textural analysis of bottom sediment samples.

**Schwab, W.C., Denny, J.F., Foster, D.S., Lotto, L.L., Allison, A.L., Uchupi, E., Swift, B.A., Sheridan, R.E., Ashley, G.M., Miller, K.G., Waldner, J.S., Hall, D.W., and Uptegrove, J., 2000, Offshore-onshore correlation of upper Pleistocene strata, New Jersey Coastal Plain to continental shelf and slope: Sedimentary Geology, v. 134, no. 1-2, p. 197-207.**

Abstract: High-resolution seismic reflection profiles (~1–5 m resolution), including Geopulse™, Uniboom™, minisparker, small air gun, and water gun sources, are used to trace the δ18O stage 5 portion of the outcropping Cape May Formation across the shelf to the continental slope. The δ18O stage 5/6 boundary identified at Ocean Drilling Project (ODP) Site 903 on the continental slope anchors the onshore-offshore seismic correlations. Above the δ18O stage 5 sequence, there are distinguishable lowstand systems tracts (LST), transgressive systems tracts (TST) and highstand systems tracts (HST) that correlate with δ18O stages 4 through 1. Atlantic Margin Coring Project (AMCOR) holes 6009, 6010, 6011, 6020, and 6021C provide age and paleoenvironmental indicators that agree with these correlations. The sub-arctic paleoenvironmental indicators in sequences of δ18O stage 3 agree with the cooler temperatures and lower sea-level highstands of that time. Thicker δ18O stage 3 and 4 sequences are preserved in the Paleo-Hudson River incised valley across the shelf. The expanded ice sheets during stage δ18O 3 compared to δ18O stages 1 and 5 probably increased sediment discharge in the Hudson River drainage system.

**Schwab, W.C., W. E. Baldwin, C. J. Hapke, E. E. Lentz, P. T. Gayes, J. F. Denny, J. H. List, and J. C. Warner, 2013. Geologic Evidence for Onshore Sediment Transport from the Inner Continental Shelf: Fire Island, New York, Journal of Coastal Research 29: 526–544.**

Abstract: Sediment budget analyses along the south shore of Fire Island, New York, have been conducted and debated in the scientific and coastal engineering literature for decades. It is well documented that a primary component of sediment transport in this system is directed alongshore from E to W, but discrepancies in volumetric sediment budget calculations remain. An additional quantity of sand, averaging about 200,000 $m^3/y$ is required to explain the growth of the western segment of the barrier island, a prograding spit. Littoral sediment derived from updrift erosion of the coast, addition of beach nourishment fill, and onshore transport of inner continental shelf, shoreface sediments, or both have all been proposed as potential sources of the additional sediment needed to balance the sediment budget deficit. Analysis of high resolution seafloor mapping data collected in 2011, including seismic reflection profiles and inteferometric sonar acoustic backscatter and swath bathymetry; comparison with seafloor mapping data collected in 1996–1997; and shoreline change analysis from 1933 to 2011 support previous suggestions that the inner-shelf Holocene sedimentary deposit is a likely source to resolve this sediment budget discrepancy.

**Swift, D.J.P., G.L. Freeland, and R.A. Young, 1979. Time and space distribution of megaripples and associated bedforms, Middle Atlantic Bight, North American Atlantic Shelf. Sedimentology 26: 389-406.**

Abstract: Three genetically distinct size classes of lower regime transverse bedforms have long been known from laboratory studies, and from studies of the intertidal zone; ripples, megaripples, and sand waves. These features are also present on the subtidal shelf surface of the Middle Atlantic Bight, and their distribution in time and space allows us to draw inferences concerning the time and space pattern of sediment transport. Transverse bedforms in the Middle Atlantic Bight occur in response to tidal flows at estuary and inlet mouths and on tide-dominated banks; on the shelf surface, however, they are primarily responses to wind-driven flows. Ripples are the most widespread of the three classes. They are current-formed during peak storm flows, but are probably remade as oscillatory wave ripples as the flow wanes. Megaripples are found primarily on the inner shelf, also as responses to peak storm flows. Sand waves of several metres amplitude occur on the inner shelf in the vicinity of topographic highs; low amplitude sand waves (< 2m), solitary or in trains, are widespread on the inner shelf. They survive through many seasons of storm flows. Megaripples are especially interesting as records of specific flow events. They are widespread on the inner shelf during the winter, occurring in fields up to several kilometres in diameter. On a portion of the Long Island inner shelf during December 1976, megaripple fields covered approximately 15% of the shelf surface. They tend to be erased during the succeeding summer months. Both megaripples (short-term response elements) and sand waves (long-term response elements) indicate that sand transport in the Middle Atlantic Bight is directed to the southeast, parallel with the regional trend of the isobaths.

**Thieler, E., Hill, J., Brooks, R., Gutierrez, B., Irwin, B., and Nichols, D., 2001. Archive of Boomer subbottom data collected during USGS Cruise MGNM 99023, southern Long Island, NY inner shelf and Hudson Shelf Valley, 26-31 July, 1999: U.S. Geological Survey Open-File Report 00-274, 6 CD-ROMs.**

Abstract: As outwash sediments are incorporated into the net westerly drift of the littoral system of south shore of Long Island, various grain-size classes are transported differentially. Thirty-four cross-shore transects were sampled at nine locations from the dune to a depth of ten meters in order to determine the alongshore and cross-shore distribution of sediments. Coarser grain-sizes are concentrated at the intertidal beach, which indicates a tendency for coarser sands to move onshore, whereas finer sediments showed a peak abundance on the outer part of the surfzone indicating a net movement offshore. Sands of intermediate grain-size have peak abundance in the surfzone. Alongshore, the percentage of fine-grained sediments increases toward the west at the outer edge of the surfzone, whereas the coarser grained sediments show no alongshore trend. There is a distinct coarsening of sediments in the vicinity of tidal inlets due to strong tidal currents winnowing out the finer sediments. Here, the westerly movement can only be recognized at the outer part of the surfzone. The results of the study provide the basis for understanding the net dispersion patterns of sand on the upper shoreface, the maintenance of the barrier island sand budget and the morphodynamics of Long Island south shore in general.

**Williams, S.J., 1976. Geomorphology, Shallow Subbottom Structure, and Sediments of the Atlantic Inner Continental Shelf off Long Island, New York: US Army Corps of Engineers, Coastal Engineering Research Center Technical Paper No. 76-2: 125 pp.**

Abstract: About 800 square miles of the Atlantic Inner Continental Shelf off Long Island, New York, were studied by CERC to obtain information on the sea floor morphology, sediment distribution, and shallow sub-bottom stratigraphy and structure. This information is used for delineating sand and gravel resources and deciphering shelf geologic history. Basic survey data by CERC consists of 735 miles of high-resolution continuous seismic profiles and 70 vibratory cores;

additional data were available from 82 sediment cores and 225 miles of seismic records. Data coverage extends from Atlantic Beach east to Montauk and in Gardiners Bay; and from the shoreface seaward about 10 miles to water depths of 105 feet. Three primary acoustic horizons are evident on the seismic profiles and have been identified by correlation with .cores, land borings, and surface exposures of the reflectors. Granitic bedrock is the oldest and deepest horizon underlying Long Island, but its recognition on the seismic records due to limited subbottom penetration, is confined to northern Gardiners Bay. TI1e bedrock surface slopes southeast and exhibits considerable relief where glacial ice has enlarged pre-Pleistocene drainage channels. Upper Cretaceous and Tertiary semi consolidated clastic sediments overlie the bedrock and dip and thicken to the southeast. The surfaces of these strata, which are present throughout the study area and project north under Long Island, are the second major horizon. The third seismic horizon is a Pleistocene erosion surface cut by fluvial and glacial agents into the older rock units. Depth of this surface varies from -50 to -300 feet MSL off the western and eastern Long Island shelf to sea floor outcropping in parts of the central Long Island dinner shelf. Pleistocene detritus consists primarily of blanket like deposits of outwash sand and gravel; however, radiocarbon dates show that Holocene-age barrier-lagoonal sequences and estuarine sediments cover parts of the Long Island shelf. Surficial sediments on the inner shelf are primarily fine to medium quartz sand with secondary occurrences of coarse sand and pea gravel on the Atlantic shelf and silt-clay mixtures in the Gardiners Bay region. The granular facies are relict outwash detritus, carried onto the shelf by ancient rivers and washed and sorted by marine processes since the Holocene rise of sea level. Fine-grained sediments on the shelf originated in early Holocene back-barrier or lacustrine environments; however, those in Gardiners Bay are estuarine or lacustrine deposits from Pleistocene lakes which occupied that region. Glauconitic sands, restricted to a zone off Fire Island Inlet, appear to be residual from the underlying Monmouth Group which, along with other Cretaceous strata, form a cuesta where strata are truncated by the sea floor.

Numerous major buried ancestral drainage channels transect Long Island mainland in a north-south orientation and continue south across the shelf. Thalweg depths of the channels range from -100 to -550 feet MSL and channel widths are often several miles. Many channels on the north shore of Long Island underlie reentrant bays and most were significantly enlarged by Pleistocene glacial ice and later filled with sediment. Much of the surficial sand on the inner shelf is suitable as fill for beach restoration, except for that of the shoreface region (0 to -30 feet MSL) which contains fine sand and that of major parts of Gardiners Bay which contain organic-rich silt and clay. Topographic highs on the sea floor in the form of linear shoals, and broad delta like platforms in eastern Long Island appear most suitable for sand recovery. The sea floor or in most potential borrow areas is flat and sand occurs as blanket deposits. Potential sand reserves within about 12 feet of the sea floor in the region are estimated to be more than 8 billion cubic yards.

**Williams, S.J. and Duane, D.B., 1974. Geomorphology and sediments of the inner New York Bight continental Shelf. CERC Technical Memorandum No. 45, U.S. Army Corps of Engineers Coastal Engineering Research Center.**

Abstract: Approximately 445 miles of continuous seismic reflection proflles and 61 vibrating cores were obtained from the Inner New York Bight which encompasses about 250 square miles of the offshore from northern New Jersey and western Long Island. The major physiographic features include Sandy Hook and Rockaway Beach, both prograding barrier islands, Shrewsbury Rocks and the Hudson (submarine) Channel. Shrewsbury Rocks mark the demarcation between two distinct geomorphic provinces. The area north of Shrewsbury Rocks is underlain ·by Coastal Plain strata

which have been deeply eroded by Pleistocene glacial processes and covered by· sand and gravel outwash. South of Shrewsbury Rocks Coastal Plain strata have been evenly truncated and covered by a veneer of residual material. Three primary types of bedding have been observed on the seismic records. Coastal Plain strata exhibit a monoclinal regional southeast dip; steeply, inclined crossbeds are restricted to an elongate basin east of Sandy Hook, considered to be of fluvial origin. The third type is Pleistocene-Holocene stratified fluvial sands and gravels which are regionally discontinuous and exhibit gentle seaward dip. Cores reveal that fine to· medium sand is the predominant sediment type on the inner shelf. Isolated patches of coarse sand and rounded pea gravels are present off Long Island where fluvial materials are exposed. Coarse sediment off New Jersey is judged to be residual from sea floor outcrops of Coastal Plain strata. Very fine sand, silt and muds comprise the sea floor at the head of the Hudson Channel and along the body. Sand suitable for beach nourishment projects is found in abundance throughout the shallow shelf parts of the Inn.er New York Bight. Sea floor topography is fairly flat and sand occurs as blanket deposits. It is estimated that over 2 billion cubic yards of clean sand is available for retrieval by present dredging techniques. Comparison of bathymetric maps made from 1845 to 1970 has confirmed that significant parts of the natural Hudson Channel have been filled from ocean disposal of up to 1 billion cubic yards of assorted anthropogenic materials, resulting from early construction in New York City and channel dredging within the estuaries and bays.

## PART 4. METHODOLOGIES

While not containing site specific data, these publications provide useful calculation methods and interpretative guidelines.

**Bodge, K.R., 2006. Alternative computation of Dean's overfill ratio. American Society of Civil Engineers. Journal of Waterways, Port, Coastal and Ocean Engineering March/April, Technical Note: 133-138.**

Abstract: An alternative graphical expression is presented for the computation of overfill ratio using the Dean method. The expression yields the same numeric results as the original Dean curves, but allows simple computation of the overfill ratio from a single curve for an unlimited range of sediment cases. The physical significance of results yielded from the Dean method is contrasted with those from the James-Krumbein method. A convenient numeric means to directly translate between phi and millimeter grain sizes is additionally noted.

**Booij, N, R.C. Ris, L.H. Hothuijsen. 1999. A third-generation wave model for coastal regions 1. Model description and validation. Journal of Geophysical Research. 104(C4): 7649-7666.**

Abstract: The processes of wind generation, whitecapping, quadruplet wave-wave interactions, and bottom dissipation are represented explicitly. In SWAN, triad wave-wave interactions and depth-induced wave breaking are added. In contrast to other third-generation wave models, the numerical propagation scheme is implicit, which implies that the computations are more economic in shallow water. The model results agree well with analytical solutions, laboratory observations, and (generalized) field observations.

**Byrnes, M.R., R. M. Hammer, T.D. Thibaut, and D.B.Snyder, 2004. Effects of Sand Mining on Physical Processes and Biological Communities Offshore New Jersey, U.S.A. Journal of Coastal Research 20: 25-43.**

Introduction: The primary purpose of the study was to address environmental concerns raised by the potential for dredging OCS sand offshore northeastern New Jersey and southwestern Long Island, and to document the findings in a technical report. Environmental information was collected and compiled to assist the MMS in making future decisions relative to negotiated agreements (non-competitive leases), NEPA documents (Environmental Assessments and Environmental Impact Statements), and other regulatory requirements concerning Federal sand deposits offshore New Jersey and Long Island.

- Wave Modifications: Evaluate potential modifications to waves and currents in the study region due to offshore dredging within potential sand resource areas.
- Sediment Transport Patterns: Evaluate impacts of dredging in Federal waters and beach nourishment in terms of potential alterations in sediment transport patterns and sedimentary environments, and impacts to local shoreline processes.
- Benthic Ecological Conditions: Characterize benthic ecological conditions in and around potential sand resource areas identified by the MMS, NJGS, and USACE-NY District.
- Benthic Infaunal Evaluation: Evaluate benthic infauna resident in potential sand resource areas and assess potential effects of offshore dredging activity on these organisms, including an analysis of recolonization periods and success following cessation of dredging activities.
- Project Scheduling Considerations: Evaluate times for dredging in the sand resource areas relative to transitory pelagic species.

**Csanady, G.T., 1982. Circulation in the coastal ocean. Reidel, Dordrecht, The Netherlands: 279 pp.**

"This text presents the first synthesis of a new subfield of dynamical oceanography, the dynamics of coastal 'circulation', i.e. of motion on time scales much longer than the period of tides. The coastal ocean may consist of … continental shelf seas, which are not much deeper than 1 00 m and have typical widths measured in tens or hundreds of kilometres. Earth rotation effects on the motion in such seas are prominent…"

**Dalyander, P.S., Mickey, R.C., Long, J.W., and Flocks, James, 2015. Effects of proposed sediment borrow pits on nearshore wave climate and longshore sediment transport rate along Breton Island, Louisiana: U.S. Geological Survey Open-File Report 2015–1055, 41 p., http://dx.doi.org/10.3133/ofr20151055.**

Abstract: As part of a plan to preserve bird habitat on Breton Island, the southernmost extent of the Chandeleur Islands and part of the Breton National Wildlife Refuge in Louisiana, the U.S. Fish and Wildlife Service plans to increase island elevation with sand supplied from offshore resources. Proposed sand extraction sites include areas offshore where the seafloor morphology suggests suitable quantities of sediment may be found. Two proposed locations east and south of the island, between 5.5–9 kilometers from the island in 3–6 meters of water, have been identified. Borrow pits are perturbations to shallow-water bathymetry and thus can affect the wave field in a variety of ways, including alterations in sediment transport and new erosional or accretional patterns along the beach. A scenario-based numerical modeling strategy was used to assess the effects of the proposed offshore borrow pits on the nearshore wave field. Effects were assessed over a range of wave conditions and were gaged by changes in significant wave height and wave direction inshore of the borrow sites, as well as by changes in the calculated longshore sediment transport rate. The change in magnitude of the calculated sediment transport rate with the addition of the two borrow pits was an order of magnitude less than the calculated baseline transport rate.

**Dean, R. G. 2000. "Beach Nourishment Design: Consideration of Sediment Characteristics," UFL/COEL-2000/002, Department of Civil and Coastal Engineering, University of Florida, Gainesville, FL.**

Abstract: Two issues relevant to beach nourishment design are addressed in this report. The first is a rational approach to characterize the composite sand characteristics of the prenourished (native) beach. Given the mean and sorting (standard deviation) of each of several samples across the active native profile, a method is presented for calculating the mean and sorting of the composite of the samples. These characteristics provide a rational basis for comparison against candidate nourishment sediments. The second issue relates to the equilibrated beach profile resulting from a nourishment sediment characterized by a mean and sorting. Previous methods have considered the nourishment material to be characterized by a single size (usually the median) which is equivalent to a sorting value of zero. These previous methods provide reasonable results for the cases in which the nourishment sediments are of the approximate same size or coarser than the native. However, if the nourishment sediments are substantially smaller than the native and have reasonable sorting values (> 0.5), these results underpredict substantially the additional dry beach width. The explanation is that some of the sediments in the distribution will be as coarse as and coarser than the native and will thus contribute to a steeper profile which yields a greater additional dry beach width than for a single sized nourishment sediment with the same mean. For nourishment sediments with mean sizes greater than the native, non-zero sorting of the nourishment sediments reduces the additional dry beach width relative to nourishment sediments with a single size. The variation with time of dry beach plan area is investigated for various nourishment sand size characteristics. Plan areas within and outside the nourishment area are quantified for typical project characteristics. It is shown that for nourishment sands coarser and finer than the native, the total dry beach plan areas increase and decrease with time, respectively.

**Dean, R. G. 2002. Beach nourishment theory and practice, Advanced series on ocean engineering, Volume 18, World Scientific, Singapore.**

"The improvement of project performance through proper design and the predictability of performance are emphasized. The overall longevity of a project is addressed as are local erosional areas. The roles which wave height, project length and sediment quality play in project performance are addressed quantitatively. The results are illustrated through reference to a number of monitored nourishment projects. Biological and economic aspects of beach nourishment are addressed".

**James, W. R. 1974. "Beach fill stability and borrow material texture." Proc., 14th Int. Conf. on Coastal Engineering, ASCE, Reston, Va., 1334–1344.**

Abstract: The dependence of beach fill stability on the textural properties of borrow material requires development of quantitative methods for use in selection of borrow areas and in prediction of possible maintenance costs associated with periodic renourishment. If a shore segment is viewed as a sediment mass transfer system, where grains of different size have different transport rates, then termination of natural sediment input to the shore segment will cause the beach to retreat and the materials in the active zone will become coarser. The ratio of retreat rates associated with a given borrow material texture to that associated with native material can be used in optimizing economic factors involved in selection among potential borrow zones. With certain simplifying assumptions the relative retreat rate associated with a given borrow material texture can be predicted from observations of the modifications in textural properties of native material which occur during the eroding condition following termination of the natural supply of sediment. Further simplifying assumptions result in an analytical expression for relative retreat rates which may not require observations of the natural beach in the eroding condition. The proposed method is in substantial agreement with qualitative guidelines provided in the Shore Protection Manual

**James, W. R. 1975. "Techniques in evaluating suitability of borrow material for beach nourishment." Technical Memo (TM)-60, Coastal Engineering Research Center, U.S. Army Waterways Experiment Station, Vicksburg, Mississippi.**

Abstract: Selection of borrow material for use in beach restoration and periodic nourishment requires analysis of the textural differences between the potential borrow and native beach materials. Three quantitative techniques proposed for such analysis are reviewed and compared, and guidelines are suggested for use in planning and designing projects requiring beach nourishment. The techniques are of two types. One is based on the assumption that sorting processes will selectively remove borrow material from the various size classes until a 'stable grain-size distribution' (gsd) is obtained and the placed fill stabilized. The gsd of the native material is used to predict the character of the stable gsd. Methods of this type lead to calculation of a 'fill factor,' an estimate of volume of borrow material required to produce a unit volume of stable beach material. Examination of the conceptual basis for each method suggests that the SPM method may overestimate fill factors whereas Dean's method may underestimate them. A modification in the assumptions underlying the SPM method results in an approach which appears to represent a satisfactory compromise between these alternatives. Another type of technique was proposed by James (1974). It is based on the assumption that no material is absolutely stable, but that erosion rates depend in part on the gsd of the material exposed to existing coastal processes. Prediction of erosion rates associated with a given borrow material is based on observation of erosion rates and textural properties associated with native materials.

**Jin, Kang-Ren, Zhen-Gang Ji. 2001. Calibration and verification of the spectral wind-wave model for Lake Okeechobee. Ocean Engineering. 28: 571-584.**

Abstract: A spectral wind wave model SWAN (Simulation WAves Nearshore) that represents the generation, propagation and dissipation of waves was applied to Lake Okeechobee. This model includes the effects of refraction, shoaling, and blocking in wave propagation. It accounts for wave dissipation by white-capping, bottom friction, and depth-induced wave breaking. The wave–wave interaction effect also is included in this model. Measurements of wind and wave heights were made at different stations and different time periods in Lake Okeechobee. Significant wave height values were computed from the recorded data. The correlation between wind stress and significant wave height also was analyzed. A 6-day simulation using 1989 data was conducted for model calibration. Another 6-day simulation using 1996 data was conducted for model verification. The simulated significant wave heights were found to agree reasonably well with measured significant wave heights for calibration and verification periods. Agreement between observed and simulated values was based on graphical comparisons, mean, absolute and root mean square errors, and correlation coefficient. Comparisons showed that the model reproduced both general observed trends and short term fluctuations.

**Kraus, N.C. , M.R. Larson, M. R. Wise, 1999. Depths of closure in beach fill design. Proceedings of the 12th National Conference of Beach Preservation Technology. Florida. Shore and Beach Preservation Association: 271-286.**

Abstract: This Technical Note presents guidance on use of the depth of closure for beach fills placed on the open coast. An operational definition of the depth of closure and the associated conceptual background are presented. Procedures for estimating the depth of closure are given and illustrated with calculation examples. The depth of closure (DoC) affects numerous coastal engineering operations such as beach-fill design, planning of beach-profile surveys, siting and functioning of structures (including jetties, groins, breakwaters, pipelines, and wastewater outfalls), sediment-budget analysis, sand borrow-site identification, dredged-material placement in the offshore, and deployment of marine instrumentation. This note concerns the DoC for beach-fill design. It is assumed that the engineer or planner is involved in developing the design of a sand beach fill for the open coast. The fill project will have an expected number of years between renourishments, such as 3 to 10 years, or have a certain lifetime without renourishment, as might be the situation in a Section-933 project (one-time placement of fill as a beneficial use of dredged material to achieve a specified level of protection). Some of the fill placed on the beach berm and inshore in a construction cross section will gradually move offshore to the DoC as the nourished profile adjusts to changes in water level and to wave action by shifting seaward to form the design cross section. Therefore, an accurate estimate of the DoC helps form an accurate estimate of the required fill volume.

**Krumbein, W. C., and James, W. R. 1965. "Spatial and temporal variations in geometric and material properties of a natural beach." Technical Rep. No. 44, Coastal Engineering Research Center, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.**

Modified author abstract: Contour maps of beach foreshore properties, such as mean grain size and beach slope, give spatial continuity to beach observations, and repetitive sampling endows the areal patterns with continuity in time. Rapid measurement methods and data reduction by portable computer terminal yield nearly real-time data for analyzing beach phenomena in theoretical and applied geological and coastal engineering studies while the field party is on the site. Maps were made at intervals over a 3-year period on the same stretch of beach located upcoast from Point Mugu, California. These maps included open unimpeded segments and segments immediately upbeach and downbeach of an impermeable steel sheet piling groin built for experimental purposes by CERC. A rectangular foreshore grid, 100 by 125 feet on edge, with rows parallel to the waterline was used as a convenient mapping cell. Aggregate properties of the beach, such as bulk density, shear resistance, water content, and conventional textural and geometric attributes, were mapped from samples collected at the grid points.

**Lentz, E., Hapke, C., Stockdon, H., and Hehre, R., 2013. Improving Understanding of Long-Term Barrier Island Evolution through Multi-Decadal Assessment of Morphologic Change: Marine Geology, v. 337, no. 1:,65–67 p.**

Abstract: Observed morphodynamic changes over multiple decades were coupled with storm-driven run-up characteristics at Fire Island, New York, to explore the influence of wave processes relative to the impacts of other coastal change drivers on the near-term evolution of the barrier island. Historical topography was generated from digital stereo-photogrammetry and compared with more recent lidar surveys to quantify near-term (decadal) morphodynamic changes to the beach and primary dune system between the years 1969, 1999, and 2009. Notably increased profile volumes were observed along the entirety of the island in 1999, and likely provide the eolian source for the steady dune crest progradation observed over the relatively quiescent decade that followed. Persistent patterns of erosion and accretion over 10-, 30-, and 40-year intervals are attributable to variations in island morphology, human activity, and variations in offshore bathymetry and island orientation that influence the wave energy reaching the coast. Areas of documented long-term historical inlet formation and extensive bayside marsh development show substantial landward translation of the dune–beach profile over the near-term period of this study. Correlations among areas predicted to overwash, observed elevation changes of the dune crestline, and observed instances of overwash in undeveloped segments of the barrier island verify that overwash locations can be accurately predicted in undeveloped segments of coast. In fact, an assessment of 2012 aerial imagery collected after Hurricane Sandy confirms that overwash occurred at the majority of near-term locations persistently predicted to overwash. In addition to the storm wave climate, factors related to variations within the geologic framework which in turn influence island orientation, offshore slope, and sediment supply impact island behavior on near-term timescales.

**Long, J.W., N.G. Plant, P.S. Dalyander, and D.M. Thompson, 2014. A probabilistic method for constructing wave time-series at inshore locations using model scenarios, Coastal Engineering 89: 53–62 doi:10.1016/j.coastaleng.2014.03.008.**

Abstract: Continuous time-series of wave characteristics (height, period, and direction) are constructed using a base set of model scenarios and simple probabilistic methods. This approach utilizes an archive of computationally intensive, highly spatially resolved numerical wave model output to develop time-series of historical or future wave conditions without performing additional, continuous numerical simulations. The archive of model output contains wave simulations from a set of model scenarios derived from an offshore wave climatology. Time-series of wave height, period, direction, and associated uncertainties are constructed at locations included in the numerical model domain. The confidence limits are derived using statistical variability of oceanographic parameters contained in the wave model scenarios. The method was applied to a region in the northern Gulf of Mexico and assessed using wave observations at 12 m and 30 m water depths. Prediction skill for significant wave height is 0.58 and 0.67 at the 12 m and 30 m locations, respectively, with similar performance for wave period and direction. The skill of this simplified, probabilistic time-series construction method is comparable to existing large-scale, high-fidelity operational wave models but provides higher spatial resolution output at low computational expense. The constructed time-series can be developed to support a variety of applications including climate studies and other situations where a comprehensive survey of wave impacts on the coastal area is of interest.

**Palmsten, M.L. 2001. Application of the SWAN wave model to a high-energy continental shelf. MA thesis University of South Florida.**

Abstract: This thesis initiated an investigation of wave shoaling over the southwest Washington inner continental shelf. To better understand wave characteristics along the southwest Washington coast, the SWAN (Simulating WAves Nearshore) model will be implemented for this narrow high-energy shelf and sensitivity to changes in model formulation will be investigated. Pressure and velocity data collected at five stations near Grays Harbor, Washington between October and December 1999 will be used to calibrate and validate the model. The study was conducted in fall because of the variable wave climate in the Pacific Northwest. The data were deglitched and processed to produce estimates of significant wave height, peak direction, and peak period. Wave heights ranged between approximately 1 m and 8 m during the experiment. Wave direction was generally from the northwest during low wave conditions and the southwest during storm events. Peak period ranged from approximately 10 s to 20 s during the study. Processed data and results of the sensitivity study are used to calibrate and validate the SWAN model. Modeled wave characteristics were most like field measurements when the Madsen formulation for bottom friction was used with KN = 0.05 m, and the Janssen formulation for wind input/whitecapping was used with Cds1 = 4 .5. The SWAN model reproduced wave shoaling over model domain well. The greatest difficulty in using the SWAN model on the southwest Washington inner continental shelf is inadequate input at the model boundary. An application of validated model results, along-isobath energy flux was interpreted at the Grays Harbor ebb tidal delta. Using along-isobath energy flux as a proxy for a component of sediment transport, the stability of the ebb tidal delta was examined. Along-isobath energy flux appears to contribute to the northward component of ebb tidal delta movement.

**Ris, R.C., L.H. Holthuijsen, N. Booij. 1999. A third-generation wave model for coastal regions 2. Verification. Journal of Geophysical Research. 104(C4: 7667-7681.**

Abstract: A third-generation numerical wave model to compute random, short-crested waves in coastal regions with shallow water and ambient currents (Simulating Waves Nearshore (SWAN)) has been developed, implemented, and validated. The model is based on an Eulerian formulation of the discrete spectral balance of action density that accounts for refractive propagation over arbitrary bathymetry and current fields. It is driven by boundary conditions and local winds. As in other third-generation wave models, the processes of wind generation, whitecapping, quadruplet wave-wave interactions, and bottom dissipation are represented explicitly. In SWAN, triad wave-wave interactions and depth-induced wave breaking are added. In contrast to other third-generation wave models, the numerical propagation scheme is implicit, which implies that the computations are more economic in shallow water. The model results agree well with analytical solutions, laboratory observations, and (generalized) field observations.

**Rogers, W.E., J.M. Kaihatu, H.A.H. Petit, N. Booij, L.H. Holthuijsen. 2002. Diffusion reduction in an arbitrary scale third generation wind wave model. Ocean Engineering. 29: 1357-1390.**

Abstract:  The numerical schemes for the geographic propagation of random, short-crested, wind-generated waves in third-generation wave models are either unconditionally stable or only conditionally stable. Having an unconditionally stable scheme gives greater freedom in choosing the time step (for given space steps). The third-generation wave model SWAN ("Simulated WAves Nearshore", Booij et al., 1999) has been implemented with this type of scheme. This model uses a first order, upwind, implicit numerical scheme for geographic propagation. The scheme can be employed for both stationary (typically small scale) and nonstationary (i.e. time-stepping) computations. Though robust, this first order scheme is very diffusive. This degrades the accuracy of the model in a number of situations, including most model applications at larger scales. The authors reduce the diffusiveness of the model by replacing the existing numerical scheme with two alternative higher order schemes, a scheme that is intended for stationary, small-scale computations, and a scheme that is most appropriate for nonstationary computations. Examples representative of both large-scale and small-scale applications are presented. The alternative schemes are shown to be much less diffusive than the original scheme while retaining the implicit character of the particular SWAN set-up. The additional computational burden of the stationary alternative scheme is negligible, and the expense of the nonstationary alternative scheme is comparable to those used by other third generation wave models. To further accommodate large-scale applications of SWAN, the model is reformulated in terms of spherical coordinates rather than the original Cartesian coordinates. Thus the modified model can calculate wave energy propagation accurately and efficiently at any scale varying from laboratory dimensions (spatial scale O (10 m) with resolution O(0.1 m)), to near-shore coastal dimension (spatial scale O(10 km) with resolution O(100 m)) to oceanic dimensions (spatial scale O(10 000 km) with resolution O(100 km).

**Rogers, W.E., P.A. Hwang, D.W. Wang. 2003. Investigation of wave growth and decay in the SWAN model: three regional-scale applications. Journal of Physical Oceanography. 33: 366-389**

Abstract: Wave growth and decay characteristics in a typical wave action model [Simulating Waves Nearshore (SWAN)] are investigated in this paper. This study is motivated by generally poor agreement between model results and measurements for a regional-scale model of a two-day period during the SandyDuck '97 experiment, wherein there is consistent underprediction of lower-frequency (0.05–0.19 Hz) energy. Two separate methods are presented for improving predictions of low-frequency energy: 1) by altering the weighting of the relative wavenumber term that exists in the whitecapping formulation and 2) by disallowing the breaking of swell. The SandyDuck '97 simulation is repeated with the proposed modifications. Using the first modification, a slight improvement is seen, and with the second modification an apparent problem with nonphysical dissipation of swell by the model is corrected. The modifications are then applied to two other test cases, one in Lake Michigan and the other in the Mississippi Bight. Both cases are of similar scale to the SandyDuck '97 experiment but are freer of uncertainties related to forcing. In both cases, the underprediction of low-frequency energy is observed using the original model, and in both cases agreement with observations is improved via the first of these two proposed modifications. During the course of this investigation, it becomes apparent that, though the model's dissipation term can be improved by these modifications, fundamental problems with the form of the term severely limit the level of improvement that can be achieved.

**USACE. 1984. Shore protection manual, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi**

"The Coastal Engineering Manual (CEM) assembles in a single source the current state-of-the-art in coastal engineering to provide appropriate guidance for application of techniques and methods to the solution of most coastal engineering problems. The CEM provides a standard for the formulation, design, and expected performance of a broad variety of coastal projects. These projects are undertaken to provide or improve navigation at commercial harbors, harbor works for commercial fish handling and service facilities, and recreational boating facilities. As an adjunct to navigation improvements, shore protection projects are often required to mitigate the impacts of navigation projects. Beach erosion control and hurricane or coastal storm protection projects provide wave damage reduction and flood protection to valuable coastal commercial, urban, and tourist communities. Environmental restoration projects provide a rational layout and proven approach to restoring the coastal and tidal environs where such action may be justified, or required as mitigation to a coastal project's impacts, or as mitigation for the impact of some previous coastal activity, incident, or neglect. As the much expanded replacement document for the Shore Protection Manual (1984) and several other U.S. Army Corps of Engineers (USACE) manuals, the CEM provides a much broader field of guidance and is designed for frequent updates"

**Warner, J.C., C.R. Sherwood, R.P. Signell, C.K. Harris, and H.G. Arango, 2008. Development of a three-dimensional, regional, coupled wave, current, and sediment-transport model: Computers and Geosciences 34: 1284-1306.**

Abstract: We are developing a three-dimensional numerical model that implements algorithms for sediment transport and evolution of bottom morphology in the coastal-circulation model Regional Ocean Modeling System (ROMS v3.0), and provides a two-way link between ROMS and the wave model Simulating Waves in the Nearshore (SWAN) via the Model-Coupling Toolkit. The coupled model is applicable for fluvial, estuarine, shelf, and nearshore (surfzone) environments. Three-dimensional radiation-stress terms have been included in the momentum equations, along with effects of a surface wave roller model. The sediment-transport algorithms are implemented for an unlimited number of user-defined non-cohesive sediment classes. Each class has attributes of grain diameter, density, settling velocity, critical stress threshold for erosion, and erodibility constant. Suspended-sediment transport in the water column is computed with the same advection–diffusion algorithm used for all passive tracers and an additional algorithm for vertical settling that is not limited by the CFL criterion. Erosion and deposition are based on flux formulations. A multi-level bed framework tracks the distribution of every size class in each layer and stores bulk properties including layer thickness, porosity, and mass, allowing computation of bed morphology and stratigraphy. Also tracked are bed-surface properties including active-layer thickness, ripple geometry, and bed roughness. Bedload transport is calculated for mobile sediment classes in the top layer. Bottom-boundary layer submodels parameterize wave–current interactions that enhance bottom stresses and thereby facilitate sediment transport and increase bottom drag, creating a feedback to the circulation. The model is demonstrated in a series of simple test cases and a realistic application in Massachusetts Bay.

## PART 5. GEOPHYSICAL SURVEY DATA

A data archive of historical geophysical data was created as a deliverable under the cooperative agreement. The tables below describe the data that has been acquired and archived up to the date of this report. The first table describes historical data sets indexed by research cruise identification numbers. This includes data that includes coverage of the New York Bight in part or in whole. The second set of tables describes specific seismic data that falls within the project planning area. These datasets are indexed by cruise identification number, dates and times within the planning area and further by instrument type. The profiles are primarily SEG-Y format that were digitized from scanned microfilm records and have not yet been reinterpreted. Together this information describes records of scientific interest for the Bight, and more specifically records that may play a role in sand resource identification in the planning area.

These tables were compiled for this project from scanned microfilm data available from NOAA's National Geophysical Data Center. The data have been constrained to segments of the individual cruises that fall within the 40 meter depth planning area for the BOEM project.

Entrance and exit times are the respective date and time that the vessel entered and exited the planning area. Data are separated by instrument type resulting in duplicate date and time entries for different instruments.

The directory structure is based on the Geophysical Data Archive deliverable that is maintained on an external storage device. The NGDC File entry is the original directory name as found in NGDC deliverables. File names are referenced within this directory structure and care should be taken to ensure the correct directory is accessed, especially when dealing with E/S 3.5 kHz instrument data as two scanned microfilm reels of these data were often supplied and a similarly named directory created for each reel.

SEG-Y file creation uses Chesapeake Technology's Image to SEGY software to digitize the microfilm image into the SEG-Y format.

Cruise:

Atlantis II – 89 Leg 1 (A2089L01)

| Instrument | Entrance Time | Exit Time | Directory | NGDC Directory | Microfilm File | SEG-Y FIle | Notes |
|---|---|---|---|---|---|---|---|
| Airgun CSP Master | 4/18/75 10:20 | 4/18/75 11:50 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\AirgunCSP | A2089l01_R660_NS3 | 00000028.tif | AIIL1028A | |
| | 4/18/75 18:45 | 4/18/75 20:05 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\AirgunCSP | A2089l01_R660_NS3 | 00000028.tif | AIIL1028B | |
| | 4/18/75 21:25 | 4/18/75 0:00 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\AirgunCSP | A2089l01_R660_NS3 | 00000028.tif | None | No Data: Shut Down for Minisparker Test |
| | 4/19/75 0:01 | 4/19/75 7:50 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\AirgunCSP | A2089l01_R660_NS3 | 00000028.tif | AIIL1028C | Only 0630-0750 Available |
| | | | | | | | |
| Airgun CSP Slave | 4/18/75 10:20 | 4/18/75 11:50 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\AirgunCSP | A2089l01_R660_NS3 | 00000035.tif | AIIL1035A | |
| | 4/18/75 18:45 | 4/18/75 20:05 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\AirgunCSP | A2089l01_R660_NS3 | 00000035.tif | AIIL1035B | |
| | 4/18/75 21:25 | 4/18/75 0:00 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\AirgunCSP | A2089l01_R660_NS3 | 00000035.tif | None | No Data: Shut Down for Minisparker Test |
| | 4/19/75 0:01 | 4/19/75 7:50 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\AirgunCSP | A2089l01_R660_NS3 | 00000035.tif | None | Data is Patch and Poor Quality |
| | | | | | | | |
| Minisparker | 4/18/75 10:20 | 4/18/75 11:50 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\Minisparker | A2089l01_R663_NS3 | 00000009.tif | None | No Data Available: Minisparker Test |
| | 4/18/75 18:45 | 4/18/75 20:05 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\Minisparker | A2089l01_R663_NS3 | 00000009.tif | None | No Data Available: Minisparker Test |
| | 4/18/75 21:25 | 4/18/75 0:00 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\Minisparker | A2089l01_R663_NS3 | 00000028.tif | AIIL1028C | Only 2345-MN Available |

| Instrument | Entrance Time | Exit Time | Directory | NGDC Directory | Microfilm File | SEG-Y FIle | Notes |
|---|---|---|---|---|---|---|---|
| | 4/19/75 0:01 | 4/19/75 7:50 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\Minisparker | A2089l01_R663_NS3 | 00000011.tif | AIIL1011A | |
| | | | | | | | |
| Uniboom | 4/18/75 10:20 | 4/18/75 11:50 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\Uniboom | A2089l01_R659_NS3 | None | None | No Data Available: No Record Present |
| | 4/18/75 18:45 | 4/18/75 20:05 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\Uniboom | A2089l01_R659_NS3 | None | None | No Data Available: No Record Present |
| | 4/18/75 21:25 | 4/18/75 0:00 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\Uniboom | A2089l01_R659_NS3 | None | None | No Data Available: No Record Present |
| | 4/19/75 0:01 | 4/19/75 7:50 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\Uniboom | A2089l01_R659_NS3 | None | None | No Data Available: No Record Present |
| | | | | | | | |
| E/S 3.5 kHz | 4/18/75 10:20 | 4/18/75 11:50 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\ES3point5khz | A2089l01_R661_NS3 | 00000012.tif | AIIL1012A | |
| | 4/18/75 18:45 | 4/18/75 20:05 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\ES3point5khz | A2089l01_R661_NS3 | 00000012.tif | AIIL1012B | |
| | 4/18/75 21:25 | 4/18/75 0:00 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\ES3point5khz | A2089l01_R661_NS3 | 00000012.tif | AIIL1012C | |
| | 4/19/75 0:01 | 4/19/75 7:50 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\ES3point5khz | A2089l01_R661_NS3 | 00000012.tif | AIIL1012D | |

## Cruise:

## Atlantis II – 89 Leg 2 (A2089L02)

| Instrument | Entrance Time | Exit Time | Directory | NGDC Directory | Files | SEG-Y File | Notes |
|---|---|---|---|---|---|---|---|
| Airgun CSP Master | 5/5/75 7:35 | 5/5/75 15:10 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\AirgunCSP | A2089l02_R660_NS | 00000055.tif | AIIL2055A | |
| | 5/8/75 9:35 | 5/8/75 12:25 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\AirgunCSP | A2089l02_R660_NS | 00000057.tif | AIIL2057A | |
| | 5/8/75 13:15 | 5/8/75 13:35 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\AirgunCSP | A2089l02_R660_NS | 00000057.tif | AIIL2057B | |
| | 5/8/75 20:00 | 5/8/75 23:59 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\AirgunCSP | A2089l02_R660_NS | 00000057.tif | AIIL2057C | |
| | 5/9/75 0:01 | 5/9/75 1:05 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\AirgunCSP | A2089l02_R660_NS | 00000057.tif | AIIL2057D | |
| | | | | | | | |
| Airgun CSP Slave | 5/5/75 7:35 | 5/5/75 15:10 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\AirgunCSP | A2089l02_R660_NS | 00000082.tif | AIIL2082A | |
| | 5/8/75 9:35 | 5/8/75 12:25 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\AirgunCSP | A2089l02_R660_NS | 00000086.tif | AIIL2086A | |

| Instrument | Entrance Time | Exit Time | Directory | NGDC Directory | Files | SEG-Y File | Notes |
|---|---|---|---|---|---|---|---|
| | 5/8/75 13:15 | 5/8/75 13:35 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\AirgunCSP | A2089l02_R660_NS | 00000086.tif | AIIL2086B | |
| | 5/8/75 20:00 | 5/8/75 23:59 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\AirgunCSP | A2089l02_R660_NS | 00000086.tif | AIIL2086C | |
| | 5/9/75 0:01 | 5/9/75 1:05 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\AirgunCSP | A2089l02_R660_NS | 00000086.tif | AIIL2086D | |
| | | | | | | | |
| Minisparker | 5/5/75 7:35 | 5/5/75 15:10 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\Minisparker | A2089l02_R663_NS | None | None | No Data Available: No Record Present |
| | 5/8/75 9:35 | 5/8/75 12:25 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\Minisparker | A2089l02_R663_NS | None | None | No Data Available: No Record Present |
| | 5/8/75 13:15 | 5/8/75 13:35 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\Minisparker | A2089l02_R663_NS | None | None | No Data Available: No Record Present |
| | 5/8/75 20:00 | 5/8/75 23:59 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\Minisparker | A2089l02_R663_NS | None | None | No Data Available: No Record Present |
| | 5/9/75 0:01 | 5/9/75 1:05 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\Minisparker | A2089l02_R663_NS | None | None | No Data Available: No Record Present |
| | | | | | | | |
| Uniboom | 5/5/75 7:35 | 5/5/75 15:10 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\Uniboom | A2089l02_R659_NS | None | None | No Data Available: Uniboom Out of Water |
| | 5/8/75 9:35 | 5/8/75 12:25 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\Uniboom | A2089l02_R659_NS | 00000049.tif | AIIL2049A | |
| | 5/8/75 13:15 | 5/8/75 13:35 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\Uniboom | A2089l02_R659_NS | 00000049.tif | AIIL2049B | |
| | 5/8/75 20:00 | 5/8/75 23:59 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\Uniboom | A2089l02_R659_NS | 00000051.tif | AIIL2051A | |
| | 5/9/75 0:01 | 5/9/75 1:05 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\Uniboom | A2089l02_R659_NS | 00000051.tif | AIIL2051B | |
| | | | | | | | |
| E/S 3.5 kHz | 5/5/75 7:35 | 5/5/75 15:10 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\ES3point5khz | A2089l02_R661_NS | 00000037.tif | AIIL2037A | |
| | 5/8/75 9:35 | 5/8/75 12:25 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\ES3point5khz | A2089l02_R661_NS | 00000045.tif | AIIL2045A | |
| | 5/8/75 13:15 | 5/8/75 13:35 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\ES3point5khz | A2089l02_R661_NS | 00000045.tif | AIIL2045B | |
| | 5/8/75 20:00 | 5/8/75 23:59 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\ES3point5khz | A2089l02_R661_NS | 00000047.tif | AIIL2047A | |
| | 5/9/75 0:01 | 5/9/75 1:05 | .\BOEMProjectDataArchive\Cruise_Data\A2089L02\ScannedMicrofilm\ES3point5khz | A2089l02_R661_NS | 00000047.tif | AIIL2047B | |

Cruise:

Atlantis II – 89 Leg 3 (A2089L03)

| Instrument | Entrance Time | Exit Time | Directory | NGDC Directory | Files | SEG-Y File | Notes |
|---|---|---|---|---|---|---|---|
| Airgun CSP Master | 5/21/75 7:05 | 5/21/75 10:05 | .\BOEMProjectDataArchive\Cruise_Data\A2089L03\ScannedMicrofilm\AirgunCSP | A2089L03_R660_NS | 00000100.tif | AIIL30100A | |
| | 5/22/75 5:50 | 5/22/75 10:25 | .\BOEMProjectDataArchive\Cruise_Data\A2089L03\ScannedMicrofilm\AirgunCSP | A2089L03_R660_NS | None | None | No Data Available: No Record Present |
| | 5/22/75 16:55 | 5/22/75 23:00 | .\BOEMProjectDataArchive\Cruise_Data\A2089L03\ScannedMicrofilm\AirgunCSP | A2089L03_R660_NS | 00000104.tif | AIIL30104A | Only 2000-2300 Available |
| | | | | | | | |
| Airgun CSP Slave | 5/21/75 7:05 | 5/21/75 10:05 | .\BOEMProjectDataArchive\Cruise_Data\A2089L03\ScannedMicrofilm\AirgunCSP | A2089L03_R660_NS | None | None | No Data Available: No Record Present |
| | 5/22/75 5:50 | 5/22/75 10:25 | .\BOEMProjectDataArchive\Cruise_Data\A2089L03\ScannedMicrofilm\AirgunCSP | A2089L03_R660_NS | None | None | No Data Available: No Record Present |
| | 5/22/75 16:55 | 5/22/75 23:00 | .\BOEMProjectDataArchive\Cruise_Data\A2089L03\ScannedMicrofilm\AirgunCSP | A2089L03_R660_NS | None | None | No Data Available: No Record Present |
| | | | | | | | |
| Minisparker | 5/21/75 7:05 | 5/21/75 10:05 | .\BOEMProjectDataArchive\Cruise_Data\A2089L03\ScannedMicrofilm\Minisparker | A2089L03_R663_NS | 00000037.tif | AIIL3037A | |
| | 5/22/75 5:50 | 5/22/75 10:25 | .\BOEMProjectDataArchive\Cruise_Data\A2089L03\ScannedMicrofilm\Minisparker | A2089L03_R663_NS | None | None | No Data Available: No Record Present |
| | 5/22/75 16:55 | 5/22/75 23:00 | .\BOEMProjectDataArchive\Cruise_Data\A2089L03\ScannedMicrofilm\Minisparker | A2089L03_R663_NS | 00000039.tif | AIIL3039A | Only 2230-2300 Available |
| | | | | | | | |
| Uniboom | 5/21/75 7:05 | 5/21/75 10:05 | .\BOEMProjectDataArchive\Cruise_Data\A2089L03\ScannedMicrofilm\Uniboom | A2089L03_R659_NS | None | None | No Data Available: No Record Present |
| | 5/22/75 5:50 | 5/22/75 10:25 | .\BOEMProjectDataArchive\Cruise_Data\A2089L03\ScannedMicrofilm\Uniboom | A2089L03_R659_NS | 00000025.tif | AIIL3025A | Only 1400-1706 Available |
| | 5/22/75 16:55 | 5/22/75 23:00 | .\BOEMProjectDataArchive\Cruise_Data\A2089L03\ScannedMicrofilm\Uniboom | A2089L03_R659_NS | None | None | No Data Available: No Record Present |
| | | | | | | | |
| E/S 3.5 kHz | 5/21/75 7:05 | 5/21/75 10:05 | .\BOEMProjectDataArchive\Cruise_Data\A2089L03\ScannedMicrofilm\ES3point5khz2 | A2089L03_R662_NS | 00000020.tif | AIIL3020A | Ensure Correct Directory Name |
| | 5/22/75 5:50 | 5/22/75 10:25 | .\BOEMProjectDataArchive\Cruise_Data\A2089L03\ScannedMicrofilm\ES3point5khz2 | A2089L03_R662_NS | 00000022.tif | AIIL3022A | Ensure Correct Directory Name, Only 0705-0745 Available |
| | 5/22/75 16:55 | 5/22/75 23:00 | .\BOEMProjectDataArchive\Cruise_Data\A2089L03\ScannedMicrofilm\ES3point5khz2 | A2089L03_R662_NS | 00000024.tif | AIIL3024A | Ensure Correct Directory Name, Only 1833-1927 Available, See file 000000.26.tif |
| | 5/22/75 16:55 | 5/22/75 23:00 | .\BOEMProjectDataArchive\Cruise_Data\A2089L03\ScannedMicrofilm\ES3point5khz2 | A2089L03_R662_NS | 00000026.tif | AIIL3026A | Ensure Correct Directory Name, Starts at 1945, See file 00000024.tif |

Cruise:

Atlantis II – 96 Leg 1 (A2096L01)

| Instrument | Entrance Time | Exit Time | Directory | NGDC Directory | Files | SEG-Y File | Notes |
|---|---|---|---|---|---|---|---|
| Airgun CSP Master | 9/15/77 1:50 | 9/15/77 3:20 | .\BOEMProjectDataArchive\Cruise_Data\A2096L01\ScannedMicrofilm\AirgunCSP | A2096l01_R839_NS | None | None | No Data Available: No Record Present |
| | 9/15/77 4:30 | 9/15/77 11:10 | .\BOEMProjectDataArchive\Cruise_Data\A2096L01\ScannedMicrofilm\AirgunCSP | A2096l01_R839_NS | None | None | No Data Available: No Record Present |
| | 9/15/77 20:45 | 9/15/77 23:15 | .\BOEMProjectDataArchive\Cruise_Data\A2096L01\ScannedMicrofilm\AirgunCSP | A2096l01_R839_NS | None | None | No Data Available: No Record Present |
| | | | | | | | |
| Airgun CSP Slave | 9/15/77 1:50 | 9/15/77 3:20 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\AirgunCSP | A2096l01_R839_NS | None | None | No Data Available: No Record Present |
| | 9/15/77 4:30 | 9/15/77 11:10 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\AirgunCSP | A2096l01_R839_NS | None | None | No Data Available: No Record Present |
| | 9/15/77 20:45 | 9/15/77 23:15 | .\BOEMProjectDataArchive\Cruise_Data\A2089L01\ScannedMicrofilm\AirgunCSP | A2096l01_R839_NS | None | None | No Data Available: No Record Present |

Cruise:

Trident Sunrise II (TR027)

| Instrument | Entrance Time | Exit Time | Directory | NGDC Directory | Files | SEG-Y File | Notes |
|---|---|---|---|---|---|---|---|
| Airgun CSP Master | 8/20/65 1:45 | 8/20/65 4:15 | .\BOEMProjectDataArchive\Cruise_Data\TR027\ScannedMicrofilm\AirgunAndMag | Tr027_R617_NBMS | 00000028.tif | TR027II028A | |
| | 8/23/65 7:15 | 8/23/65 8:30 | .\BOEMProjectDataArchive\Cruise_Data\TR027\ScannedMicrofilm\AirgunAndMag | Tr027_R617_NBMS | None | None | No Data Available: No Record Present |
| | 8/23/65 14:25 | 8/23/65 15:00 | .\BOEMProjectDataArchive\Cruise_Data\TR027\ScannedMicrofilm\AirgunAndMag | Tr027_R617_NBMS | None | None | No Data Available: No Record Present |
| | 8/28/65 7:10 | 8/28/65 2:20 | .\BOEMProjectDataArchive\Cruise_Data\TR027\ScannedMicrofilm\AirgunAndMag | Tr027_R617_NBMS | None | None | No Data Available: No Record Present |
| | 8/29/65 20:00 | 8/29/65 21:25 | .\BOEMProjectDataArchive\Cruise_Data\TR027\ScannedMicrofilm\AirgunAndMag | Tr027_R617_NBMS | None | None | No Data Available: No Record Present |
| | | | | | | | |
| E/S 3.5 kHz | 8/20/65 1:45 | 8/20/65 4:15 | .\BOEMProjectDataArchive\Cruise_Data\TR027\ScannedMicrofilm\AirgunAndMag | Tr027_R617_NBMS | 00000013.tif | TR027II013A | SEGY DATE INCORRECT |
| | 8/23/65 7:15 | 8/23/65 8:30 | .\BOEMProjectDataArchive\Cruise_Data\TR027\ScannedMicrofilm\AirgunAndMag | Tr027_R617_NBMS | 00000016.tif | TR027II016A | SEGY DATE INCORRECT |
| | 8/23/65 14:25 | 8/23/65 15:00 | .\BOEMProjectDataArchive\Cruise_Data\TR027\ScannedMicrofilm\AirgunAndMag | Tr027_R617_NBMS | None | None | No Data Available: No Record Present |
| | 8/29/65 20:00 | 8/29/65 21:25 | .\BOEMProjectDataArchive\Cruise_Data\TR027\ScannedMicrofilm\AirgunAndMag | Tr027_R617_NBMS | None | None | No Data Available: No Record Present |

| Survey | Cruise | Data Type | Data Description | Archive | Archive Link |
|---|---|---|---|---|---|

| Date | | | | | |
|---|---|---|---|---|---|
| 1975 | Atlantis II | Scanned Microfilm | Navigation and Subbottom Profile | NOAA National Geophysical Data Center | http://www.ngdc.noaa.gov |
| 1977 | Atlantis II | Scanned Microfilm | Navigation and Single Channel Seismics | NOAA National Geophysical Data Center | http://www.ngdc.noaa.gov |
| 1966 | TR034 | Scaned Microfilm | Navigation, Echosounder and Single Channel Seismics | NOAA National Geophysical Data Center | http://www.ngdc.noaa.gov |
| 1966 | V2301 | Scanned Microfilm and Analog Seismics | Navigation, Echosounder and Seismics | NOAA National Geophysical Data Center | http://www.ngdc.noaa.gov |
| 1975 | A2089L02 | Scanned Microfilm | Navigation and Single Channel Seismics | NOAA National Geophysical Data Center | http://www.ngdc.noaa.gov |
| 1974 | V3202 | Analog Seismics | Seismics | NOAA National Geophysical Data Center | http://www.ngdc.noaa.gov |
| 1966 | V2201 | Scanned Microfilm and Analog Seismics | Seismics | NOAA National Geophysical Data Center | http://www.ngdc.noaa.gov |
| 1977 | A2096L01 | Scanned Microfilm | Navigation, Echosounder and Single Channel Seismics | NOAA National Geophysical Data Center | http://www.ngdc.noaa.gov |
| 1965 | TR027 | Scanned Microfilm | Navigation, Bathymetry, Mag + SC Seismics | NOAA National Geophysical Data Center | http://www.ngdc.noaa.gov |
| 1968 | TR051 | Scanned Microfilm | Navigation and Single Channel Seismics | NOAA National Geophysical Data Center | http://www.ngdc.noaa.gov |
| 1973 | SUMP3,SUMP5,SUMP6 | Scanned Microfilm | Navigaton and Sidescan Sonar | NOAA National Geophysical Data Center | http://www.ngdc.noaa.gov |
| 1973 | SUMP2 | Scanned Microfilm | Navigation and Sidescan Sonar | NOAA National Geophysical Data Center | http://www.ngdc.noaa.gov |
| 1975 | ECST9-10 | Scanned Microfilm, Analog + Digital Seismics | Velocity Profile, Single and Multi Channel Seismics | NOAA National Geophysical Data Center | http://www.ngdc.noaa.gov |
| 1978 | ECT18-38 | Scanned Microfilm and Digital Seismics | Multi Channel Seismics | NOAA National Geophysical Data Center | http://www.ngdc.noaa.gov |
| 1977 | ECT14-17 | Scanned Microfilm, Analog + Digital Seismics | Multi Channel Seismics | NOAA National Geophysical Data Center | http://www.ngdc.noaa.gov |
| 1993 | 1993-009-FA | Scanned Microfilm and Digital GPS | CHiRP, Sidescan, Gravity Core and GPS | USGS Coastal and Marine Geology InfoBank | http://walrus.wr.usgs.gov/infobank/ |
| 1995 | 1995-007-FA | SEG-Y, Data and Images | Navigation, Sidescan, GRAB sample, CHiRP and Boomer Seismics | USGS Coastal and Marine Geology InfoBank | http://walrus.wr.usgs.gov/infobank/ |
| 1996 | 1996-004-FA | SEG-Y, Data and Images | Navigation, Sidescan, GRAB sample, CHiRP and Boomer Seismics | USGS Coastal and Marine Geology InfoBank | http://walrus.wr.usgs.gov/infobank/ |
| 1997 | 1997-011-FA | SEG-Y, Data and Images | Navigation, CHiRP, Boomer and Sparker Seismics | USGS Coastal and Marine Geology InfoBank | http://walrus.wr.usgs.gov/infobank/ |
| 1998 | 1998-013-FA | SEG-Y, Data and Images | Navigation, Boomer Sidescan, CHiRP, Water Gun and Sparker Seismics | USGS Coastal and Marine Geology InfoBank | http://walrus.wr.usgs.gov/infobank/ |
| 2002 | EN370 | SEG-Y | GPS and Airgun Seismics | Lamont-Doherty Marine Geoscience Data System | http://www.marine-geo.org/index.php |

| Survey Date | Cruise | Track Length (km) | Data Type | Data Description | Archive Link |
|---|---|---|---|---|---|
| 1993 | 1993-009-FA | Unprocessed | Navigation Lines | GPS, Photography Log and Cruise Report | http://cmgds.marine.usgs.gov/fan_info.php?fa=1993-009-FA |
| 1995 | 1995-007-FA | 2016 | SEG-Y and Navigation | Navigation, Cruise Report, CHiRP and Water Gun Seismics | http://cmgds.marine.usgs.gov/fan_info.php?fa=1995-007-FA |
| 1996 | 1996-004-FA | 910 | SEG-Y and Navigation | Navigation Cruise Report, CHiRP, Boomer and Water Gun Seismics | http://cmgds.marine.usgs.gov/fan_info.php?fa=1996-004-FA |
| 1996 | 1996-040-FA | 988 | SEG-Y | Boomer Seismics | http://cmgds.marine.usgs.gov/fan_info.php?fa=1996-040-FA |
| 1997 | 1997-011-FA | 555 | SEG-Y and Navigation | Navigation, Boomer and Sparker Seismics | http://cmgds.marine.usgs.gov/fan_info.php?fa=1997-011-FA |
| 1998 | 1998-013-FA | 1386 | SEG-Y and Navigation | Navigation, Boomer Sidescan, CHiRP, Water Gun and Sparker Seismics | http://cmgds.marine.usgs.gov/fan_info.php?fan=1998-013-FA |
| 1975 | A2089L01 | 620 | MGD77 and netCDF Files | Gravity and Navigation | http://www.geomapapp.org |
| 1975 | A2089L02 | 1318 | Scanned Microfilm | Navigation and Single Channel Seismics | http://www.ngdc.noaa.gov/trackline/request/?surveyTypes=All%20Parameters&surveyIds=A2089L02 |
| 1975 | A2089L03 | 1130 | Scanned Microfilm | Navigation and Single Channel Seismics | http://www.ngdc.noaa.gov/trackline/request/?surveyTypes=All%20Parameters&surveyIds=A2089L03 |
| 1977 | A2096L01 | 476 | Scanned Microfilm | Navigation, Echosounder and Single Channel Seismics | http://www.ngdc.noaa.gov/trackline/request/?surveyTypes=All%20Parameters&surveyIds=A2096L01 |
| 1975 | ECST9-10 | 251 | Scanned Microfilm, Analog + Digital Seismics | Velocity Profile, Single and Multi Channel Seismics | http://www.ngdc.noaa.gov/trackline/request/?surveyTypes=All%20Parameters&surveyIds=ECST9-10 |

| | | | | | |
|---|---|---|---|---|---|
| 1977 | ECT14-17 | 338 | Scanned Microfilm, Analog + Digital Seismics | Multi Channel Seismics | http://www.ngdc.noaa.gov/trackline/request/?surveyTypes=All%20Parameters&surveyIds=ECT14-17 |
| 1978 | ECT18-38 | 936 | Scanned Microfilm and Digital Seismics | Multi Channel Seismics | http://www.ngdc.noaa.gov/trackline/request/?surveyTypes=All%20Parameters&surveyIds=ECT18-38 |
| 2002 | EN370 | 1297 | SEG-Y | GPS and Unprocessed Airgun Seismics | http://www.marine-geo.org/tools/search/entry.php?id=EN370 |
| 2014 | EX1402 L1 | 27 | SEG-Y, Backscatter and Swath | Multibeam Sonar and Unprocessed CHiRP | http://www.marine-geo.org/tools/search/entry.php?id=EX1402L1 |
| 1969 | KEA 10-69 | Unprocessed | MGD77 and netCDF Files | Gravity (Free air correction) and Navigation | http://www.geomapapp.org |
| 1973 | SUMP2 | Unprocessed | Scanned Microfilm | Navigation and Sidescan Sonar | http://www.ngdc.noaa.gov/trackline/request/?surveyTypes=All%20Parameters&surveyIds=SUMP2 |
| 1973 | SUMP3 | Unprocessed | Scanned Microfilm | Navigation and Sidescan Sonar | http://www.ngdc.noaa.gov/trackline/request/?surveyTypes=All%20Parameters&surveyIds=SUMP3 |
| 1973 | SUMP5 | Unprocessed | Scanned Microfilm | Navigation and Sidescan Sonar | http://www.ngdc.noaa.gov/trackline/request/?surveyTypes=All%20Parameters&surveyIds=SUMP5 |
| 1973 | SUMP6 | Unprocessed | Scanned Microfilm | Navigation and Sidescan Sonar | http://www.ngdc.noaa.gov/trackline/request/?surveyTypes=All%20Parameters&surveyIds=SUMP6 |
| 1965 | TR027 | 1250 | Scanned Microfilm and SEG-Y | Navigation, Bathymetry, Mag + SC Seismics | http://www.ngdc.noaa.gov/trackline/request/?surveyTypes=All%20Parameters&surveyIds=TR027 |
| 1966 | TR034 | Unprocessed | Scanned Microfilm | Navigation, Echosounder and Single Channel Seismics | http://www.ngdc.noaa.gov/trackline/request/?surveyTypes=All%20Parameters&surveyIds=TR034 |
| 1968 | TR051 | Unprocessed | Scanned Microfilm | Navigation and Single Channel Seismics | http://www.ngdc.noaa.gov/trackline/request/?surveyTypes=All%20Parameters&surveyIds=TR051 |
| 1966 | V2201 | 281 | Scanned Microfilm and Analog Seismics | Seismics | http://www.ngdc.noaa.gov/trackline/request/?surveyTypes=All%20Parameters&surveyIds=V2201 |
| 1966 | V2301 | 258 | Scanned Microfilm and Analog | Navigation, Echosounder and | http://www.ngdc.noaa.gov/trackline/request/?surveyTypes=All%20Parameters&surveyIds=V2301 |

| | | | | | |
|---|---|---|---|---|---|
| | | | Seismics | Seismics | |
| 1974 | V3202 | 495 | Analog Seismics | Seismics | http://www.ngdc.noaa.gov/trackline/request/?surveyTypes=All%20Parameters&surveyIds=V3202 |
| Total Track Length: 14,532 Km | | | | | |