United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
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JUL 30 2010

Mr. Joshua A. Bundick
Code 250.W
Goddard Space Flight Center's Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, Virginia 23337

Re: Programmatic Biological Opinion on the Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program

Dear Mr. Bundick:

This document transmits the U.S. Fish and Wildlife Service's (Service) programmatic biological opinion based on our review of National Aeronautics and Space Administration's (NASA) proposed Shoreline Restoration and Infrastructure Protection Program (SRIPP) at the Wallops Flight Facility (WFF) in Accomack County, Virginia, and its effects on the federally listed endangered green sea turtle (*Chelonia mydas*) and leatherback sea turtle (*Dermochelys coriacea*) and the threatened Atlantic population of the piping plover (*Charadrius melodius*), loggerhead sea turtle (*Caretta caretta*), and seabeach amaranth (*Amaranthus pumilus*) in accordance with section 7 of the Endangered Species Act (16 U.S.C. 1531-1544, 87 Stat. 884), as amended (ESA). On March 16, 2010 a proposed rule was published in the Federal Register to reclassify the loggerhead sea turtle through determination of the appropriate listing status for each of nine distinct populations of loggerhead sea turtle worldwide. Based on this proposed rule, the population affected by the proposed action is the north Atlantic population, and it is proposed for listing as endangered (72 FR 12598). Your February 12, 2010 request for formal consultation was received on February 18, 2010.

NASA has developed a draft Programmatic Environmental Impact Statement (PEIS) on the SRIPP. The purpose of the 50-year SRIPP is to reduce the potential for damage to or loss of infrastructure and assets critical to the missions of NASA, the U.S. Navy, and the Mid-Atlantic Regional Spaceport (MARS) on Wallops Island from wave impacts associated with storm events. Under this program, NASA plans to complete construction of a seawall along the entire shoreline at WFF and rebuild an eroded beach between the seawall and the Atlantic Ocean to aid in buffering the property from waves. Following completion of the seawall and beach, NASA plans subsequent beach renourishment cycles throughout the 50-year life of the SRIPP as needed to provide the necessary protection to infrastructure as determined by the proposed monitoring program. The location, magnitude, and extent of future renourishment and repair activities are

unknown and will vary due to the frequency and severity of storm activity and resulting shoreline erosion.

The U.S. Army Corps of Engineers (Corps) and the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE) have participated in the development of the PEIS as cooperating agencies, and both agencies are involved in the proposed action. NASA will require authorizations from both the Corps and the BOEMRE for the SRIPP. Under the Clean Water Act (33 U.S.C. 1251-1375, 86 Stat. 816)the Corps has jurisdiction over the disposal of dredged and fill material in waters of the U.S., and under Section 10 of the Rivers and Harbors Act of 1899, the Corps has jurisdiction over dredging conducted in navigable waters of the U.S. The Corps designed the SRIPP and will manage construction during project implementation, including hiring and overseeing contractors. BOEMRE has jurisdiction over mineral resources on the outer continental shelf (OCS), and has authority to convey, on a noncompetitive basis, the rights to OCS sand, gravel, or shell resources for shore protection, beach or wetlands restoration projects, or for use in construction projects funded or authorized by the Federal government. A memorandum of agreement will be negotiated between BOEMRE and NASA to allow dredging of sand from the OCS for the SRIPP. NASA is the lead federal agency for this consultation and the activities of the other two agencies that are included in the implementation of this program are incorporated into this consultation.

This biological opinion considers the effects of the entire program on listed species based on the extent and bounds of the proposed action discussed in the SRIPP draft PEIS to ensure that the implementation of the program will not jeopardize listed species. The proposed program only projects future beach renourishment activities based on average expected shoreline erosion rates, taking into account the effects of sea level rise, to the degree that it is appropriate to project. Because this projection is general and limited to current abilities to predict inherently unpredictable events, it is unlikely that the proposed action and scenario described in the draft PEIS will ever accurately reflect the actual implementation of this program beyond the initial fill. As a result, the assumptions used in conjunction with the description of the proposed program to conduct the jeopardy analysis are described herein, but this opinion does not provide for incidental take beyond the implementation of the initial beach and seawall construction and associated sand management and monitoring measures. Future renourishment events proposed under this program will require consultation under section 7 of the ESA.

This programmatic biological opinion is based on information provided in the February 2010 SRIPP draft PEIS (NASA 2010a), the February 2010 SRIPP biological assessment (BA) (NASA 2010b), the April 2009 draft environmental assessment (EA) for the expansion of WFF (NASA 2009), the January 2005 final site-wide EA (NASA 2005), telephone conversations, meetings, field investigations, and other sources of information. A complete administrative record of this consultation is on file in this office.

NASA determined in its BA that the proposed action "may affect, and is likely to adversely affect" the piping plover, Kemp's ridley sea turtle (*Lepidochelys kempi*), and loggerhead sea turtle. Effects of the proposed action on those species will be discussed in this biological

opinion. NASA determined in its BA that the proposed actions "may affect, but are not likely to adversely affect" red knot (*Calidris canutus rufa*), seabeach amaranth, leatherback sea turtle, Atlantic Green sea turtle, fin whale (*Balaeanoptera physalus*), right whale (*Eubalaena glacialis*), and humpback whale (*Megaptera novaeangliae*). The Service does not concur with the "not likely to adversely affect" determination for seabeach amaranth, leatherback sea turtle, and green sea turtle as presented in the BA and the effects of the proposed action on these species are included in this opinion. Because the Kemp's ridley sea turtle is not known to nest within Virginia, that species is not included in this biological opinion. The effects of the proposed action on the Kemp's ridley sea turtle, fin whale, right whale, and humpback whale and the effects to all sea turtles while at sea are addressed through NASA's section 7 consultation with National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS), and these species and effects are not discussed further in this biological opinion.

NASA did not make a determination on the federally listed threatened roseate tern (*Sterna dougalli*) in their BA. This species may occur in the vicinity of the proposed project during migration, but is considered a rare migrant along the east coast south of New Jersey (Nisbet 1984). Band recoveries suggest that roseate terns are a primarily trans-oceanic migrant. The effects of the proposed action on this species are expected to be limited to potential temporary disturbance to individuals during migration when terns may pass near or encounter vessels involved in dredging operations. Terns may alter their flight paths to avoid vessels and disturbance. These effects are expected to be insignificant and discountable and this species is not discussed further in this biological opinion.

The red knot, a candidate species, has not yet been proposed for listing and therefore will not be addressed further in this document. However, we appreciate NASA's consideration of this species and any conservation measures implemented to minimize or avoid threats to this species will contribute to its conservation. The Service would like to work with NASA to develop a candidate conservation agreement for the red knot.

CONSULTATION HISTORY

03-01-07	NASA transmitted a BA to the Service for the SRIPP.
04-24-07	The Service responded to NASA that the proposed SRIPP would not be likely to adversely affect listed species.
May 2007	NASA released a programmatic EA on a proposed SRIPP.
11-20-08	The Service participated in a stakeholder and regulatory agency meeting for the project which revised the proposed action identified in the previous EA. At this meeting, the Service recommended that NASA plan to conduct section 7 consultation on the project in conjunction with its planning process. NASA expressed their intent to develop a programmatic EIS.

04-01-09 The Service received a letter requesting comments related to NASA's Notice of Intent (NOI) to prepare an EIS and conduct public scoping.

05-11-09 The Service submitted a letter to NASA providing comments and recommendations related to the project during the public comment period in the NOI.

02-10-10 The Service received email notification of the release of NASA's SRIPP draft PEIS. The document included a BA.

04-12-10 The Department of Interior sent NASA comments on the SRIPP draft PEIS during the public comment period on behalf of the Service and other DOI agencies under the National Environmental Policy Act (NEPA) process.

03-30-10 The Service attended a meeting about the SRIPP with NASA and other regulatory agencies involved in reviewing the project. The Service again recommended that NASA rescind its request for formal consultation due to the lack of detailed information about project implementation and engage further in informal consultation to allow for accurate consideration of effects to listed species. NASA responded that they wanted to continue with their request for formal consultation despite lacking information due to scheduling necessities. NASA responded that the Service had all the information available about the project.

05-11-10 The Service notified NASA that we would provide the completed biological opinion by September 22, 2010, later than the prescribed 135 days as a result of workload and staffing limitations.

06-09-10 The Service notified NASA that the biological opinion would be expedited to help meet NASA's scheduling needs, as expressed by Congressional representatives, and would be delivered on July 16, 2010.

06-28-10 The Service received an email confirmation that the project description remained the same as that included in the EIS, but that work at night would occur. The Service responded to request additional details about the type and extent of work that would occur at night.

07-07-10 NASA provided via email a clarification that night work would include dredging, sand pumpout, and grading.

07-08-10 The Service received a telephone call from NASA providing notification that sand fence was added to the project design for the beach and dune. NASA requested any Service recommendations for sand fence placement to minimize potential impacts to listed species. NASA provided via email detailed design drawings and

cross-sections of the seawall, beach, and dune that showed sand fence on both the landward and seaward sides of the beach.

07-09-10 The Service provided two documents to NASA that included recommended sand fence construction and maintenance to minimize impacts to wildlife.

07-15-10 The Service received an email from NASA providing the description of the sand fence that was added to the proposed action and new information about the schedule for implementing the seawall and initial beach construction. The Service notified NASA that the opinion would be delayed slightly to incorporate the updated information.

07-19-10 The Service had a telephone conversation with NASA engineer Paul Bull to confirm the extent of seawall and beach/dune construction during initial project construction, seawall and beach design drawings and intended construction methods regarding placement of materials, excavation for seawall placement, and materials used for seawall construction.

07-21-10 The Service provided notification that the opinion would be delivered by July 30, 2010. Additional time was needed to incorporate new information about the project design and implementation.

BIOLOGICAL OPINION

DESCRIPTION OF PROPOSED ACTION

The purpose of the proposed action is to reduce the potential for damage to, or loss of, NASA, U.S. Navy, and MARS assets on Wallops Island from wave impacts associated with storm events. The proposed action is intended to use a multi-tiered approach to reduce damages to Wallops Island facilities from ongoing beach erosion and storm wave damage incurred during normal coastal storms including tropical systems and nor'easters. The goal of the proposed action is to move the zone of breaking waves away from vulnerable infrastructure and withstand storm surge that accompanies large coastal storms. This plan is not intended to protect against inundation flooding, wind damage, and other impacts during major hurricanes and exceptional nor'easters. Other NASA projects separate from this proposed action will address flood protection and other potential weather-related damage to infrastructure.

NASA has identified the project's design target performance of providing significant defense against a 100-year return interval storm with respect to storm surge and waves. The performance is provided by a combination of the reconstruction of a beach, berm, and dune which will help to absorb and dissipate wave energy before it nears NASA infrastructure, and a rock seawall embedded within the dune that will protect against the most severe energy.

A seawall composed of large rock is currently located along 15,900 feet (ft) of the Wallops Island shoreline. This seawall was built in 1992 and protects WFF infrastructure within the northern portion of the eroding shoreline from damage due to storms and large waves. The wall has prevented overwash and storm damage, but erosion of the shoreline seaward of the wall has continued, resulting in an increased risk of damage to the seawall. NASA's draft PEIS includes repairing the existing seawall and extending Wallops Island's existing rock seawall a maximum of 4,600 ft south of its southernmost point. Appendix 1 includes figures identifying the extent and location of proposed project features.

NASA proposes an initial beach reconstruction that would entail placement of 3.2 million cubic yards (yd^3) of sand seaward of the existing and new seawall along 4.2 miles of shoreline during the initial nourishment (Appendix 1). This effort would return a beach with a stable profile to the shoreline seaward of the seawall and add significantly to the storm buffering capability of the shoreline.

For these features to provide reliable protection for the project's design lifetime of 50 years, the beach must be maintained routinely throughout the project's lifetime. The shoreline on the southern end of Wallops Island has been retreating at a rate of approximately 10 ft per year as a result of erosion (Corps 2010). To maintain a beach and dune at a fixed location in a condition to effectively buffer wave energy, the beach will require routine renourishment over the 50-year project lifetime. Under the SRIPP, following reconstruction of the beach and dune, renourishment will occur approximately every 3-5 years for the life of the project. The timing and amount of the renourishment will be determined through monitoring for changes in the beach and dune that would reduce the project's effectiveness for storm protection.

The SRIPP proposed action also includes and incorporates the ongoing NASA operations and mission-related activities on Wallops Island and their interaction with the SRIPP. The Service's May 10, 2010 biological opinion describes and addressed the effects of NASA's operations on listed species on Wallops Island. This opinion includes by reference the NASA activities considered in the May biological opinion and considers additional effects to listed species that may result from construction of the SRIPP in conjunction with NASA activities.

Initial Shoreline Reconstruction

Seawall – The rock seawall extension would be the first feature built, and the draft PEIS described this component as extending up to 4,600 ft. In its July 15, 2010 email regarding the planned implementation of the project, NASA clarified that the initial project construction phase will extend the seawall 1,315 ft from the current southernmost terminus of the seawall, which would extend the seawall to just south of launch pad 0-B. Additional extension of the seawall may be included in future project modifications. The seawall extension would be placed approximately in line with and adjacent to the end of the existing seawall and would be installed in a straight line parallel to the shoreline. The location of the seawall would be primarily slightly seaward of the existing geotubes. In addition to the extension, the existing seawall may be

repaired or have sections replaced to ensure its functional integrity to the extent necessary to provide the intended protection.

For the seawall extension, the footprint will be excavated to a depth of approximately 2 ft below existing grade to build a stable base. Geotextile fabric will be placed on the sand bottom in the excavated area, an approximately 1 ft thick marine mattress will be placed above the geotextile fabric, and the area will be back-filled with stones ranging from approximately 2-6 inches. Larger stone will be placed on top of this base material. The seawall core will be composed of 600-1,600 pound stones, and the armor stone will be placed above the core material. The armor stone will be placed in a thickness of at least 9 ft above the core stone, but at both the landward and seaward toe of the structure, a single layer of armor stone will be placed directly on the marine mattress base to provide a stable configuration and prevent erosion and scour at the toe of the structure. The seawall will be faced with rocks weighing 5 to 7 tons each. Rocks would be piled to be approximately 12 to 13 ft above the existing beach, depending on the extent of existing shoreline retreat at the time of construction.

Rock will be delivered to the work site by truck and may be stockpiled in one of several potential stockpile areas near but landward of the existing seawall. NASA has already stockpiled enough armor stone in uplands adjacent to their facilities on Wallops Island for most of the planned construction, but some additional armor material may be needed. The core stone and the marine mattress fill material will be delivered to the site prior to construction using existing roads. Stabilized construction access roads will be built of stone underlain by geotextile fabric and will extend from existing paved access roads to the work area at regular intervals for the length of the project area. The construction access roads will be removed seaward of the seawall when construction is complete. Access points landward of the seawall may be left in place. Rock and materials will be delivered to the work area through these construction access roads. Heavy equipment, including tracked excavators, bulldozers, and similar equipment will excavate sand and prepare the base for the seawall construction. Excavators will be used to place the large stones for the seawall core and armor. Construction and site preparation will be conducted as much as possible during periods of low tide when the work area is not inundated to the extent practicable. However, it is likely that some of the construction activities will occur in the water. Silt fences will be deployed landward of the project area, but because of the wave action on the seaward side, no measures are expected to be deployed to prevent or control sediment suspension.

Repair of the existing seawall may occur within limited areas of the existing seawall. In these cases, the existing seawall will be removed and replaced with a seawall with design and specifications similar to the extension, including placement of geotextile and a marine mattress below the structure. The existing steel sheeting bulkhead that is within the existing seawall will be maintained, but may be reduced in height to conform to the current design and will be encased within the seawall. Ground base elevations in these repair sections will differ on either side of the bulkhead, but both sides will be excavated to provide a solid foundation, and the depth of stone fill will differ, with greater depth on the seaward side so that the final profile of the seawall will be consistent and similar to that of the seawall extension. Rock removed from repaired

sections of seawall will be recycled and used to face the landward surface of the seawall. Smaller repairs consisting of reconfiguring rocks or adding soil to fill voids may also occur.

When completed, both the seawall extension and repair areas will have relatively smooth faces on both landward and seaward faces. The slope of the seaward side will be 2:1 (run: rise) and the landward side will be slightly steeper with a slope of 1.5:1. Appendix 1 includes schematics of the proposed seawall, including example cross-sections of both the extension and repair sections.

Additional maintenance of the existing seawall may include operation of heavy equipment and placing or replacing dirt and/or rock in previously disturbed areas behind the seawall to maintain and augment the function of the existing seawall and the protection resulting from these features.

Beach Reconstruction – The initial beach nourishment/reconstruction would start approximately 1,500 ft north of the Wallops Island-Assawoman Island property boundary and extend north for approximately 3.7 miles, to the northern extent of the existing seawall. When completed, the beach will extend approximately 70 ft seaward from the seawall in a 6 ft high berm, and then slope underwater along the design equilibrium profile for an additional 170 ft seaward. The total distance of the fill profile from the current shoreline would be 240 ft. At the landward side of the berm, the fill profile would include a 14 ft high dune that would encase the seawall. As described above, the seawall may not extend the full length of the beach and dune reconstruction area. From approximately launch pad 0-B, where the seawall extension is planned to terminate, southward, the beach and dune will be constructed entirely of sand, with no stone core within the dune. NASA proposes to place a total of 3.2 million yd^3 of sand to build the berm, dune, and beach seaward of the seawall along 4.2 miles of shoreline during the initial nourishment. During storm events, the new beach would provide a surface to dissipate wave energy and provide additional sediment in the nearshore system. This initial fill volume includes an advance fill amount (or a sacrificial amount that is expected to erode away) and an additional amount to accommodate anticipated changes due to sea level rise while allowing the project to maintain its full shoreline protection function for an anticipated 8 years (dependent on weather).

Sand for the initial beach nourishment will be dredged from within an approximately 1,280 acre area located approximately 7 miles west of Wallops Island, referenced as unnamed shoal A (Appendix 1). The sand from this site matches closely with the target sand grain size of 0.29 millimeters (mm). This sand grain size was targeted because its relatively large size will help to reduce erosion losses over time. Smaller sand grain sizes may require additional sand overfill volume to achieve similar project performance (Corps 2010). Hopper dredges with a capacity of approximately 4,000 $yd^3$of sand are expected to be used to collect sand as a slurry from within the borrow area, and transport the sand along the 14-mile transit route from shoal A to a pumpout location approximately 2 miles offshore of Wallops Island at a depth of approximately 30 ft. Dredged material would then be pumped onto the beach through a pipe. A booster pump may be required to pump the sand the full distance from the pumpout location to the renourishment area, and the booster pump would be positioned either on the shore or on a barge or other vessel. The sand from the dredge will be pumped as slurry onto the shore. Based on the expected dredge

material and performance parameters, NASA estimates that 1,000 to 1,100 dredge round trips would be required to provide the target amount of sand for the initial beach reconstruction. Once the sand has been placed on the shore, it will be positioned and contoured using bulldozers and/or other heavy earth-moving equipment to meet the design specifications. Following the complete contouring of the beach and dune, American beachgrass (*Ammophila breviligulata)* would be planted on the crests and seaward and landward (where applicable) dunes sideslopes to aid in stabilizing the sand.

Sand Fence – In addition to planting beachgrass, sand fence will be placed near the interface between the dune and the berm to aid in reducing the loss of sand from winds and to aid in maintaining the dune profile. The sand fence will be installed to conform to recommended guidelines to minimize potential impacts to wildlife. Sand fence will be placed in 10 ft long sections, oriented at a 45 degree angle from the shoreline (sections oriented southeast to northwest). Fence sections are placed 7 ft apart. This orientation maintains the function of the sand fence while reducing the chance of interfering with wildlife movement and entrapment.

Construction Timing and Sequencing – The initial beach reconstruction, including the seawall extension, is expected to occur over 2 to 3 years and will be funded through three fiscal years. The seawall extension and repair will be the first component initiated. It is expected to be initiated and completed within an approximately 9 month period, including a margin of uncertainty. While the timing is contingent on several factors, this component is planned to be initiated in early spring, with completion in late fall/early winter. Placement of sand may be initiated within a month or less of the completion of the seawall, but there may be a delay of several months or more between construction of the seawall extension and the placement of sand.

The initiation of the beach/dune construction is dependent on the completion of the NEPA process and completion of the Memorandum of Agreement among BOEMRE, the Corps, and NASA for the use of OCS sand. The sand placement and beach/dune construction is planned to be funded through two fiscal years and under two separate contracts administered through the Corps. The construction activity is intended to be implemented seamlessly between the two contracts to prevent incurring the additional costs of mobilization/demobilization, but because the implementation is dependent on funding and contracting, the seamless implementation cannot be assured. If implemented seamlessly, the completion of the project is anticipated to take 8 months, with demobilization possibly requiring an additional 60 days. Any changes project implementation will require additional time for completion.

To meet the project timelines for construction completion and to ensure that contracts may be implemented seamlessly, construction activity for all phases of the project may occur during all hours of the day or night. Particularly during the sand placement, dredging and moving sand material on the beaches are expected to occur continuously.

Monitoring – As an integral part of the SRIPP, NASA is planning a shoreline monitoring program to record and document the changes in the shoreline characteristics over time as the

project is implemented and subjected to normal weathering and storm events. The monitoring effort will begin prior to initiating any construction of the seawall, beach, or dune to establish a baseline condition and record any changes that occur between design and implementation.

A monitoring survey of the shoreline in the vicinity of Wallops Island would be conducted twice a year. The first monitoring event would be conducted along the entire lengths of Wallops and Assawoman Islands, a distance of approximately 8.5 miles. The second of the two annual surveys would be limited to the length of shoreline from Chincoteague Inlet south to the former Assawoman Inlet, which defines the south end of Wallops Island. In the cross-shore direction, elevation data would be collected from behind the dune line to seaward of the depth of closure (the eastern edge of the underwater fill profile), estimated to be at approximately -15 to -20 ft below mean low water (MLW). Near Chincoteague Inlet the ebb shoal complex creates a large shallow offshore area; therefore, surveys in this area shall extend a maximum of 2 miles offshore if the depth of closure is not reached. The monitoring would preferably be conducted once at the end of summer (August to October) and once at the end of winter (March to May).

Cross-sections of the beach would be taken along new and/or previously established baselines on set stations every 500 ft from Chincoteague Inlet to Assawoman Inlet and every 1,000 ft from Assawoman Inlet to Gargathy Inlet. The beach survey would extend from the baseline to a depth of -4 ft below MLW offshore. An offshore hydrographic survey along the previously established baseline on set stations every 500 ft would be conducted. The offshore survey would extend from -3 ft below MLW to the depth of closure, anticipated to be between -15 to -20 ft below MLW. If possible (weather permitting), the hydrographic survey would be conducted within 2 weeks of the beach survey.

LIDAR data would be obtained for the monitoring area approximately once a year. Both horizontal and vertical survey datum would be obtained. The survey of the beach, surf zone, and offshore area, as described below, would document changes in the Wallops Island shoreline in addition to areas adjacent to Wallops Island.

The results of these monitoring efforts would be used to measure shoreline change to evaluate the performance of the project, potential impacts to resources, and to aid in planning renourishment when needed to ensure continued project function.

In conjunction with construction activities, qualified biologists will regularly survey the beaches in the vicinity of the project for use by sea turtles, piping plovers, and other species. If nesting activity of protected species is recorded, NASA will avoid work in the areas where the nesting occurs and/or implement other appropriate mitigation measures.

Renourishment and Long-Term Project Maintenance

Following the initial beach reconstruction, NASA plans subsequent beach renourishment cycles throughout the 50-year life of the SRIPP as determined by the proposed monitoring program. Because the renourishment and repair will be conducted as needed, the location, extent, and

magnitude of renourishment events may vary significantly as a result of the frequency and severity of storm activity and subsequent shoreline erosion. The availability of funding, logistical constraints, and other issues may also affect the implementation of renourishment over time.

Based on available modeling of project performance over time, the draft PEIS identifies an expected renourishment frequency of approximately every 5 years for the life of the project. Based on the general characterization of function, the draft PEIS estimates that each renourishment cycle would require approximately 806,000 yd^3 of sand placed on the beach in each of the 9 renourishment events, for a total expected renourishment volume of 7,254,000 yd^3 of sand over the life of the project, excluding the amount required for the initial beach and dune reconstruction.

The projected renourishment frequency and amounts are based on the modeled average rates of sand loss, with models that are based on the historic meteorological conditions recorded at and near the project area. If the project is affected by a particularly large storm, renourishment may be required at an interval much shorter than the planned 5 years. Similarly, if the frequency or intensity of storms is significantly greater than what was incorporated into modeled projections based on the period of record, more frequent renourishment will be required. Using similar assumptions, renourishment may be needed less frequently if there are fewer storms and storms of lower intensity, or if there are other changes in the processes affecting erosion and sand transport.

Renourishment may also occur less frequently based on NASA's availability of resources and assessment of need. Even if renourishment is needed based on the modeled project performance and intent, NASA may choose to forego or delay renourishment because the project will retain most of its intended and designed storm protection function even if renourishment is not implemented as envisioned in the draft PEIS.

Several other factors may also influence the future renourishment. If future renourishments use sand that is of smaller size or reduced quality, more frequent renourishment or larger volumes of sand may be required. If there are changes in the pattern of sand movement along the shoreline, such as reduced southerly transport over time, renourishment may be needed less frequently. In the draft PEIS, NASA considers the addition of breakwater or groin, and while not included in the current proposed action, addition of these features may result in reduced sand requirements.

The Wallops Island shoreline will experience the effects of future sea level rise, and this has been anticipated in planning the implementation of the project by providing an additional sediment volume during each renourishment event that would raise the level of the entire beach fill by an amount necessary to keep pace with the projected rise rate (Corps 2010). Applying the Corps' standard sea level rise equation based on local measurements to a 50 year project at Wallops Island yields sea level elevations that are between 0.84 ft and 2.53 ft above present levels. For project planning purposes, a target fill volume that was 85% of the upper estimates of the amount needed to match the 50-year projected sea level rise was selected, but the SRIPP

includes adding that volume in constant increments over time instead of in a pattern that would match anticipated increases. This would mean that in the early years of the project the amount of fill being added would exceed the amount necessary to match the expected amount with the cross over point being in the 28th year of the project (2038). This way, the sea level fill volume could be increased, if needed, during the later renourishment events. The Sea Level Rise Volume which is an additional amount that will be needed to be added during each renourishment event (assuming a 5-year interval between events) is 112,000 yd^3. Deviations from existing modeled or projected sea level rise scenarios may also change the amount of sand needed for renourishment.

The number of uncertainties included in the projections resulting from the modeling, model assumptions, limitations of the records of past meteorological and climatological measurements in the area, our understanding of meteorological and climatic patterns, and the future decisions of NASA and other agencies are all likely to result in deviations from the projected renourishment.

Sources of Sand for Renourishment – Three borrow sites have been identified as sources for potential future beach renourishment: the on-shore north Wallops Island borrow area, unnamed shoal A (the source of material for the initial beach/dune reconstruction), and unnamed shoal B (located east of shoal A). All of these sites have been determined to be consistent with the project purpose and suitable, but all have different costs and concerns associated with their use that must be evaluated prior to use in each proposed future renourishment.

The north Wallops Island borrow site is located on NASA property in the sand accretion zone on the northern end of Wallops Island. It is delineated for planning purposes as the seaward-most portion of the beach area where sand has accreted in recent years. The borrow area is approximately 150 acres in size. Excavation depth is expected to be limited to about 3.5 ft below the ground surface due to tidal fluctuations and the high permeability of the soil. Up to half of the projected fill volume for each renourishment cycle could be provided by the north Wallops Island borrow site. The remaining half of the expected needed volume, or the entire volume, would be obtained from one of the offshore borrow areas. The mean grain size (0.20 mm) at the north Wallops Island borrow area is the smallest of the three sites considered and is currently below the target grain size for renourishment (but is still within the suitable range). The average grain size in this borrow area is expected to increase following placement of material from shoal A in the initial beach and dune reconstruction as this larger material is transported to this accretion area.

Unnamed shoal A, the source of sand for the initial reconstruction, may also be used as the source for renourishment. The shoal covers an area of approximately 1,800 acres, and the total predicted volume of shoal A is approximately 40 million yd^3. The sand grain size (0.46 mm) is the largest of the three sources.

Unnamed shoal B is located offshore approximately 12 miles east of the southern portion of Assateague Island. This shoal covers an area of approximately 3,900 acres. The total predicted

sand volume of this shoal is approximately 70 million yd^3. The average sand grain size is 0.34 mm and the transit distance from the shoal to the pumpout location is approximately 19 miles.

Material from a combination of the sources may also be feasible for future renourishments, subject to the constraints of future funding, permitting, logistical constraints, and other considerations.

Sand Removal Methods – The proposed sand removal, transportation, and placement of sand from either of the two offshore sites for future renourishment is planned to be the same as that discussed for the initial beach reconstruction project.

Sand from north Wallops Island would be removed from the beach using a pan excavator or other heavy earth-moving equipment. Sand would be stockpiled, loaded onto trucks, trucked to the off-loading point on the beach, and spread by bulldozers. Off-road dump trucks would likely be used and would travel up and down the beach from the stockpile area to the fill site. However, road dump trucks could also be used in some circumstances. No constraints have been placed on the timing and methods of excavation at the north Wallops Island borrow area, but NASA has identified the intent to avoid excavation and disturbance near any piping plover nests, sea turtle nests, or occurrences of seabeach amaranth.

Seawall Extension – Additional extension of the seawall beyond the 1,315 ft proposed as part of the initial beach/dune reconstruction may be implemented in the lifetime of the project up to the maximum considered of 4,600 ft beyond the existing seawall. There are no available details about the timing, extent, or design of any such future seawall construction and the details will be provided in conjunction with detailed plans under this program. Effects of additional seawall extension will be considered in additional consultation following detailed design.

Addition of Related Features – The draft PEIS includes analysis and consideration of an offshore breakwater and a groin in conjunction with the SRIPP to aid in sand retention and reduce renourishment requirements. While not part of the proposed action, the draft PEIS does identify the intent to consider the need for sand retention structures through the monitoring and evaluation of project performance. Because there are no designs specified, any such feature would be considered through additional consultation on detailed design of such a feature.

Implementing Future Renourishment – NASA has identified the intent to prepare tiered NEPA documents, in conjunction with the Service and other stakeholders, that provide detailed analysis of future actions that will be implemented under this program. The uncertainty in the design, extent, magnitude, timing, and other characteristics of such future actions, in addition to the lack of identification of potential sand material preclude detailed analysis or description of future actions and their effects. The future tiered NEPA documents and the detailed plans for future actions under this program will serve as the basis for detailed analysis of potential effects to listed species. Because design details are not available, the effects of future renourishment projects under this program will be considered through future additional consultations when that design information is available.

Action Area

The action area is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action. The Service has determined that the action area for this project includes the entire land area of Wallops Island, the shoreline and beaches of Assawoman Island, which will be affected by littoral transport of sand placed on Wallops Island, the aquatic environment adjacent to these lands, and the three borrow sites including unnamed shoals A and B and north Wallops Island, and the waters through which dredges will transit from borrow sites to pumpout areas. The action area also includes the Hook and overwash segments of Assateague Island (see map below).

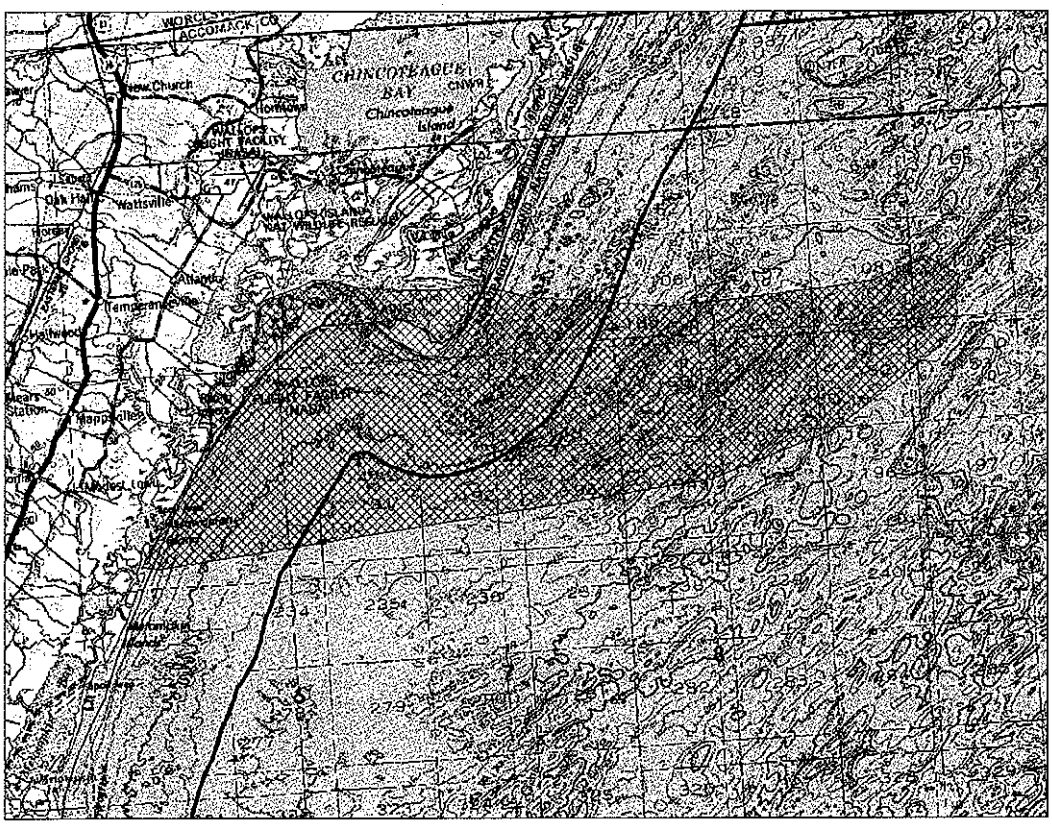

Figure 1. The cross-hatched area on the map delineates the project action area.

STATUS OF THE SPECIES AND CRITICAL HABITAT RANGEWIDE

PIPING PLOVER

On January 10, 1986, the piping plover was listed as endangered or threatened in various parts of its range pursuant to the ESA. Three separate breeding populations have been identified, each with its own recovery criteria: Atlantic Coast (threatened), Great Lakes (endangered), and Northern Great Plains (threatened). The Atlantic Coast population is the focus of this biological

opinion. No critical habitat has been proposed or designated for piping plovers in the Atlantic Coast breeding area.

The recovery plan for the Atlantic Coast population of the piping plover (Service 1996a) delineates four recovery units or geographic subpopulations within the population: Atlantic Canada, New England, New York-New Jersey, and Southern (Delaware, Maryland, Virginia, and North Carolina). Recovery criteria established within the recovery plan defined population and productivity goals for each recovery unit, as well as for the population as a whole. Attainment of these goals for each recovery unit is an integral part of a piping plover recovery strategy that seeks to reduce the probability of extinction for the entire population by: (1) contributing to the population total, (2) reducing vulnerability to environmental variation (including catastrophes, such as hurricanes, oil spills, or disease), (3) increasing likelihood of genetic interchange among subpopulations, and (4) promoting recolonization of any sites that experience declines or local extirpations due to low productivity or temporary habitat succession.

Species Description - Piping plovers are small, sand-colored shorebirds, approximately 17 centimeters (cm) (7 inches) long with a wingspread of about 38 cm (15 inches) (Palmer 1967). The Atlantic Coast population breeds on sandy, coastal beaches from Newfoundland to North Carolina, and winters along the Atlantic Coast from North Carolina south, along the Gulf Coast to Texas, and in the Caribbean (Service 1996a). Additional detailed information on the piping plover, its life history, and the population dynamics of the Atlantic population are provided in the species' recovery plan (Service 1996a).

Life History - Piping plovers generally begin returning to their Atlantic Coast nesting beaches in mid-March (Coutu et al. 1990, Cross 1990, Goldin 1990, MacIvor 1990, Hake 1993). Males establish and defend territories and court females (Cairns 1982). Piping plovers are monogamous, but usually shift mates between years (Wilcox 1959, Haig and Oring 1988, MacIvor 1990), and less frequently between nesting attempts in a given year (Haig and Oring 1988, MacIvor 1990, Strauss 1990). Plovers are known to begin breeding as early as one year of age (MacIvor 1990, Haig 1992); however, the percentage of birds that breed in their first adult year is unknown.

Piping plovers nest on the ground above the high tide line on coastal beaches, on sand flats at the ends of sand spits and barrier islands, on gently sloping foredunes, in blowout areas behind primary dunes, and in washover areas cut into or between dunes. In the central portions of their Atlantic Coast range, the birds may also nest on areas where suitable dredge material has been deposited. Nest sites are shallow, scraped depressions in substrates ranging from fine-grained sand to mixtures of sand and pebbles, shells or cobble (Bent 1929, Burger 1987, Cairns 1982, Patterson 1988, Flemming et al. 1988, MacIvor 1990, Strauss 1990). Nests are usually found in areas with little or no vegetation although, on occasion, piping plovers will nest under stands of American beachgrass or other vegetation (Patterson 1988, MacIvor 1990). Plover nests may be very difficult to detect, especially during the six to seven day egg-laying phase when the birds generally do not incubate the eggs within the nest cup (Goldin 1994).

Eggs may be present on the beach from early April through late July. Clutch size for an initial nest attempt is usually four eggs, one laid every other day. Eggs are pyriform in shape, and variable buff to greenish brown in color, marked with black or brown spots. The incubation period usually lasts 27-28 days. Full-time incubation usually begins with the completion of the clutch and is shared equally by both sexes (Wilcox 1959, Cairns 1977, MacIvor 1990). Eggs in a clutch usually hatch within four to eight hours of each other, although the hatching period of one or more eggs may be delayed by up to 48 hours (Cairns 1977, Wolcott and Wolcott 1999).

Piping plovers generally fledge only a single brood per season, but may renest several times if eggs are lost. Chicks are precocial, meaning they immediately can run from the nest cup upon hatching (Wilcox 1959, Cairns 1982). They may move with their parents hundreds of meters from the nest site during their first week of life (Service 1996a), and chicks may increase their foraging range up to 1,000 m before they fledge (are able to fly) (Loegering 1992). At CNWR, Daisey (2006) found that brood movements averaged 60.1 $\pm$ 28.0 m/day in 2004 and 68.8 m/day in 2005 (range = 5.4 – 120.8 m/day; 28.9 – 122.2 m/day, respectively). Chicks remain together with one or both parents until they fledge at 25 to 35 days of age. Depending on their date of hatching, flightless chicks may be present from mid-May until late August, although most fledge by the end of July (Patterson 1988, Goldin 1990, MacIvor 1990, Howard et al. 1993).

Cryptic coloration is a primary defense mechanism for this species; eggs, adults, and chicks all blend in with their typical beach surroundings. Chicks sometimes respond to vehicles and/or pedestrians by crouching and remaining motionless (Cairns 1977, Tull 1984, Goldin 1993, Hoopes 1993). Adult piping plovers respond to intruders (avian and mammalian) in their territories by displaying a variety of distraction behaviors, including squatting, false brooding, running, and injury feigning, in an effort to lure the predators away from the nest or chicks. Distraction displays may occur at any time during the breeding season but are most frequent and intense around the time of hatching (Cairns 1977).

Plovers feed on invertebrates such as marine worms, fly larvae, beetles, crustaceans, and mollusks (Bent 1929, Cairns 1977, Nicholls 1989). Important feeding areas include intertidal portions of ocean beaches, washover areas, mudflats, sand flats, wrack lines, sparse vegetation, and shorelines of coastal ponds, lagoons, or salt marshes (Gibbs 1986, Coutu et al. 1990, Hoopes et al. 1992, Loegering 1992, Goldin 1993, Elias-Gerken 1994). The relative importance of various feeding habitat types may vary by site (Gibbs 1986, Coutu, et al. 1990, McConnaughey et al. 1990, Loegering 1992, Goldin 1993, Hoopes 1993, Elias-Gerken 1994) and by stage in the breeding cycle (Cross 1990). Adults and chicks on a given site may use different feeding habitats in varying proportion (Goldin 1990). Feeding activities of chicks are particularly important to their survival. Most time budget studies reveal that chicks spend a high proportion of their time feeding. Cairns (1977) found that chicks typically tripled their weight during the first two weeks post-hatching; chicks that failed to achieve at least 60 percent of this weight gain by the twelfth day post-hatching were unlikely to survive.

During courtship, nesting, and brood rearing, feeding territories are generally contiguous to nesting territories (Cairns 1977), although instances where brood-rearing areas are widely

separated from nesting territories are not uncommon. Feeding activities of both adults and chicks may occur during all hours of the day and night (Burger 1993), and at all stages in the tidal cycle (Goldin 1993, Hoopes 1993).

Both spring and fall migration routes of Atlantic Coast breeders are believed to occur primarily within a narrow zone along the Atlantic Coast (Service 1996a). Relatively little is known about migration behavior or habitat use within the Atlantic Coast breeding range (Service 1996a), but the pattern of both fall and spring counts at migration sites along the southeastern Atlantic Coast demonstrates that many piping plovers make intermediate stopovers lasting from a few days up to one month during migration (National Park Service [NPS] 2003, Noel et al. 2005, Stucker and Cuthbert 2006).

A growing body of information shows that habitats on overwash beaches, accessible bayside flats, unstabilized and recently healed inlets, and moist sparsely vegetated barrier flats are especially important to piping plover productivity and carrying capacity in the New York-New Jersey and Southern recovery units.

In New Jersey, Burger (1994) studied piping plover foraging behavior and habitat use at three sites that offered the birds access to ocean, dune, and backbay habitats. The primary focus of the study was on the effect of human disturbance on habitat selection, and the author found that both habitat selection and foraging behavior correlated inversely with the number of people present. In the absence of people on an unstabilized beach, plovers fed in ocean and bayside habitats in preference to the dunes.

Loegering and Fraser (1995) found that chicks on Assateague Island, Maryland, that were able to reach bayside beaches and the island interior had significantly higher fledgling rates than those that foraged solely on the ocean beach. Higher foraging rates, percentage of time spent foraging, and abundance of terrestrial arthropods on the bay beach and interior island habitats supported their hypothesis that foraging resources in interior and bayside habitats are key to reproductive rates on that site. Their management recommendations stressed the importance of sparsely vegetated cross-island access routes maintained by overwash, and the need to restrict or mitigate human activities that reduce natural disturbance during storms.

Dramatic increases in plover productivity and breeding population on Assateague since the 1991-1992 advent of large overwash events corroborate Loegering and Fraser's (1995) conclusions. Piping plover productivity on Assateague, which had averaged 0.77 chicks per pair during the five years before the overwash events, averaged 1.67 chicks/pair in 1992-96. The nesting population on the northern five miles of the island also grew rapidly, doubling by 1995 and tripling by 1996, when 61 pairs nested there (MacIvor 1990). Habitat use is primarily on the interior and bayside of this island.

In Virginia, Watts et al. (1996) found that piping plovers nesting on 13 barrier islands between 1986 and 1988 were not evenly distributed along the islands. Beach segments used by plovers had wider and more heterogeneous beaches, fewer stable dunes, greater open access to bayside

foraging areas, and proximity to mudflats. They note that characteristics of beaches selected by plovers are maintained by frequent storm disturbance.

At Cape Lookout National Seashore in North Carolina, 13 to 45 pairs of plovers have nested on North and South Core Banks each year since 1992 (NPS 2007). While these unstabilized barrier islands total 44 miles long, nesting distribution is patchy, with all nests clustered on the dynamic ends of the barrier islands, recently closed and sparsely vegetated "old inlets," expansive barrier mudflats, or new ocean-to-bay overwashes. During a 1990 study, 96 percent of brood observations were on bay tidal flats, even though broods had access to both bay and ocean beach habitats (McConnaughey et al. 1990).

At Cape Hatteras National Seashore, North Carolina, distribution of nesting piping plovers is also "clumped," with nesting areas characterized by a wide beach, relatively flat intertidal zone, brackish ponds, and temporary pools formed by rainwater and overwash (Coutu et al. 1990).

Notwithstanding the importance of bayside flats, ephemeral pools, and sparsely vegetated barrier flats for piping plover nest site selection and chick foraging, ocean intertidal zones are used by adults and chicks of all ages. A three-year study of piping plover chick foraging activity at six sites on four Virginia barrier islands (Cross and Terwilliger 2000) documented chick use of the ocean intertidal zone at three of six study sites. Intensive observations at CNWR Overwash Zone in 2004, where chicks had unimpeded access to a large undisturbed bayside flat, documented occasional visits to the ocean intertidal zone by six of eleven broods ranging in age from one to 24 days (Hecht 2004 in litt.).

Population Dynamics/Status and Distribution - Historical population trends for the Atlantic Coast piping plover have been reconstructed from scattered, largely qualitative records. Nineteenth-century naturalists, such as Audubon and Wilson, described the piping plover as a common summer resident on Atlantic Coast beaches (Haig and Oring 1985). However, by the beginning of the 20th Century, egg collecting and uncontrolled hunting, primarily for the millinery trade, had greatly reduced the population, and, in some areas along the Atlantic Coast, the piping plover was close to extirpation. Following passage of the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §§ 7 03-712), and changes in the fashion industry that no longer exploited wild birds for feathers, piping plover numbers recovered to some extent (Haig and Oring 1985).

Available data suggest that the most recent population decline began in the late 1940s or early 1950s (Haig and Oring 1985). Starting in 1972, the National Audubon Society's "Blue List" of birds with deteriorating status included the piping plover (Tate 1981). Johnsgard (1981) described the piping plover as ". . . declining throughout its range and in rather serious trouble." The Canadian Committee on the Status of Endangered Wildlife in Canada designated the piping plover as "Threatened" in 1978 and elevated the species status to "Endangered" in 1985 (Canadian Wildlife Service 1989).

Reports of local or statewide declines between 1950 and 1985 are numerous and many are summarized by Haig and Oring (1985). While Wilcox (1939) estimated more than 500 pairs of piping plovers on Long Island, New York, the 1989 population estimate was 191 pairs (Service 2010). There was little focus on gathering quantitative data on piping plovers in Massachusetts through the late 1960s because the species was commonly observed and presumed to be secure. However, numbers of piping plover breeding pairs declined 50 to 100 percent at seven Massachusetts sites between the early 1970s and 1984 (Griffin and Melvin 1984). Recent experience of biologists surveying piping plovers has shown that counts of these cryptically colored birds sometimes go up with increased census effort, suggesting that some historic counts of piping plover numbers by one or a few observers, who often recorded occurrences of many avian species simultaneously, may have underestimated the piping plover population. Thus, the magnitude of the species' decline may have been more severe than available numbers imply.

Appendix 2 summarizes nesting pair counts for the Atlantic Coast piping plover population since listing in 1986 through 2009. Final range-wide numbers for the 2009 breeding season are not yet available, and 2009 data are considered preliminary at this time. The apparent increase in numbers of plover pairs between 1986 and 1989 is thought, at least partially, to reflect the effects of increased survey efforts following the proposed listing of the species in 1986.

The Atlantic Coast population has increased from 790 pairs since listing to over 1,800 pairs each year since 2007 (Service 2010). Population growth has been greatest in the New England and New York-New Jersey recovery units, with a more modest and recent increase in the Southern unit and a smaller increase in Atlantic Canada.

Productivity - Productivity needed to maintain a stable population for Atlantic Coast piping plovers is estimated at 1.24 fledged chicks per pair (Melvin and Gibbs 1994). Small populations may be highly vulnerable to extirpation due to variability in productivity and survival rates. The average productivity needed for a stable population may be insufficient to assure a high probability of species survival. To compensate for small populations, the recovery plan establishes productivity goals needed to assure a secure 2,000-pair population at 1.5 chicks per pair in each of the four recovery units, based on data from at least 90 percent of each recovery unit's population.

Appendix 2 provides a summary of piping plover productivity from 1987 to 2009. Both regional population trends and productivity rates have been uneven. The 10-year (1997-2009) average productivity for piping plovers on the U.S. Atlantic Coast is below the recovery target of 1.5 chicks per pair. Peak productivity in the U.S. occurred in 1994 when average productivity exceeded the recovery plan goal of 1.5 chicks per pair. In most years, average productivity across the Atlantic population remained below the target. While weather events were contributors to egg and chick losses in some years (Service 1998, 2002a), such periodic natural events are inevitable, and they underscore the need to reduce the species' vulnerability by increasing the breeding population and protecting the species against human caused factors that affect productivity.

Southern Recovery Unit Status and Distribution - The Southern Recovery Unit (a portion of the Atlantic Coast population) includes Delaware, Maryland, Virginia, and North Carolina. Some limited plover nesting has occurred in South Carolina. There were approximately 158 plover pairs in the Southern Recovery Unit in 1986 and approximately 302 pairs in 2009 (Appendix 2). The 2007 total (333) is the highest recorded within the Southern Recovery Unit to date. However, the Southern Recovery Unit, which includes CNWR, continues to fall short of its recovery goal of 400 pairs. During the period of monitoring, the population size has declined in some years, but has consistently rebounded following declines. The numbers have shown an increasing trend over the last 10 years, from 182 pairs in 1999 to 302 pairs in 2009 (Service 2010; Appendix 2).

In the Southern Recovery Unit, productivity has varied substantially over the past 10 years, with a low of 0.67 chicks per pair recorded in 2008 and a high of 1.96 in 2004 (Appendix 2). Overall, plover productivity has generally increased in Virginia and throughout the Southern Recovery Unit since 1999, despite declines in some years. High productivity in Virginia from 2000 to 2005 has contributed to population increases in Virginia and in the Southern Recovery Unit (Service 2010). Continued productivity at or above levels identified in the recovery plan are attainable with ongoing intensive management efforts, and are expected to result in additional increases in plover populations.

Factors Affecting the Species - Intensive management measures to protect piping plovers from disturbance by beach recreationists and their pets have been implemented for the Atlantic population at many nesting sites in recent years. In 2004, about 30 percent of the U.S. Atlantic Coast population of piping plovers nested on federally owned beaches where some protection is afforded under section 7 of the ESA (within the Southern Recovery unit, the majority of plovers occur on public or private conservation lands). The remaining 70 percent of the birds nested on state, town, or privately-owned beaches where plover managers are implementing protections in the face of increasing disturbance from recreation and development. Recreational activities and public use of some federally owned beaches have also increased. Pressure on Atlantic Coast beach habitat from development and human disturbance continues (Service 1996a). Piping plover protection is dependent on the efforts of Federal, State, and local government agencies, conservation organizations, and private landowners.

Recreational activities can be a source of both direct mortality and harassment of piping plovers. Pedestrians may flush incubating plovers from nests (Flemming et al. 1988, Cross 1990, Cross and Terwilliger 1993), exposing eggs to predators or excessive temperatures. Repeated exposure of shorebird eggs on hot days may cause overheating, killing the embryos (Bergstrom 1991); excessive cooling may kill embryos or retard their development, delaying hatching dates (Welty 1982). Pedestrians can also disturb unfledged chicks (Strauss 1990, Burger 1991, Loegering 1992, Hoopes 1993, Goldin 1993), forcing them out of preferred habitats, decreasing available foraging time, and causing expenditure of energy.

Concentrations of pedestrians may deter piping plovers from using otherwise suitable habitat. In Jones Beach Island, New York, Elias-Gerkin (1994) found less pedestrian disturbance in areas

selected by nesting piping plovers than areas unoccupied by plovers. Burger (1991, 1994) found that presence of people at several New Jersey sites caused plovers to shift their habitat use away from the ocean front to interior and bayside habitats, and that the time plovers devoted to foraging decreased and the time spent alert increased when more people were present. Burger (1991) also found that when plover chicks and adults were exposed to the same number of people, chicks spent less time foraging and more time crouching, running away from people, and being alert than did adult birds.

Fireworks are highly disturbing to piping plovers (Howard et al. 1993). Plovers are also intolerant of kites, particularly as compared to pedestrians, dogs, and vehicles. This may be because plovers perceive kites as potential avian predators, such as gulls, crows, or raptors (Hoopes 1993).

Motorized vehicle use on beaches is an extreme threat to piping plovers, as well as other shorebirds that nest on beaches and dunes. Vehicles can crush eggs, adults, and chicks (Wilcox 1959, Tull 1984, Burger 1987, Patterson et al. 1991). In Massachusetts and New York, 18 piping plover chicks and 2 adults were killed by off-road vehicles in 14 documented incidents (Melvin et al. 1994). Goldin (1993) compiled records of 34 chick mortalities (30 on the Atlantic Coast and 4 on the Northern Great Plains) due to vehicles. Biologists who monitor and manage piping plovers believe that vehicles kill many more chicks than are found and reported (Melvin et al. 1994).

Beaches used by recreational vehicles during nesting and brood-rearing periods generally have fewer breeding plovers than available nesting and feeding habitat can support. In contrast, plover abundance and productivity has increased on beaches where recreational vehicle restrictions during chick-rearing periods have been combined with protection of nests from predators (Goldin 1993).

Once hatched, piping plover broods are mobile and may not remain near the nesting area. Wire fencing placed around nests to deter predators (Rimmer and Deblinger 1990, Melvin et al. 1992) is ineffective in protecting chicks from vehicles because chicks typically leave the nest within a day after hatching and move extensively along the beach to feed. Typical behaviors of piping plover chicks increase their vulnerability to vehicles. Chicks frequently move between the upper berm or foredune and feeding habitat within the wrack line and intertidal zone. Chick use of the ocean intertidal zone is lower in the Southern recovery unit compared with more northerly portions of the breeding range. Data from Assateague Island Seashore in Maryland and from CNWR demonstrates that many broods make sporadic use of ocean intertidal zone habitat (Hecht 2004 in litt.). These movements along the beach and intertidal zone place chicks in the paths of vehicles. Chicks stand, walk, and run along tire ruts, and sometimes have difficulty crossing deep ruts or climbing out of them (Eddings et al. 1990, MacIvor 1990, Strauss 1990, Hoopes et al. 1992, Goldin 1993, Howard et al. 1993, Hoopes 1994). Chicks sometimes stand motionless or crouch as vehicles pass by or do not move quickly enough to get out of the way (Tull 1984, Hoopes et al. 1992, Goldin 1993).

Vehicles may also significantly degrade piping plover habitat or disrupt normal behavior patterns by crushing wrack into the sand and making it unavailable as cover or foraging substrate (Hoopes et al. 1992, Goldin 1993). Vehicles that are driven too close to the toe of the dune may destroy vegetation that may provide piping plover cover habitat (Elias-Gerken 1994).

Substantial evidence shows that human activities exacerbate natural predation on piping plovers, their eggs, and chicks (Service 1996a). Where Wilcox (1959) had observed 92 percent hatching success of nests observed between 1939-1958 on Long Island, New York, and loss of only 2 percent of nests to crows (*Corvus* sp.), Elias-Gerken (1994) documented loss of 21 percent of nests in her study area to crows in 1992-1993 as a result of increased human activity. Other important predators of plover eggs and chicks in the recovery unit include foxes (*Vulpes vulpes*), raccoons (*Procyon lotor*), Norway rats (*Rattus norvegicus*), herring gulls (*Larus argentatus*), great black-backed gulls (*Larus marinus*), domestic and feral dogs (*Canis familiaris*) and cats (*Felis catus*), and ghost crabs (*Ocypode quadrata*) (Riepe 1989, Jenkins and Nichols 1994, Jenkins et al. 1999, Canale 1997, Service 1996a).

Predators can be a major source of loss of eggs and juvenile plovers. For example, predators accounted for over half of all piping plover nest losses in New Jersey from 1995-1998 (Jenkins et al. 1999). A variety of techniques have been employed to reduce predation on plovers. Most notably, the use of predator exclosures (fences around nests) has demonstrated success to reduce predation on piping plover eggs (Melvin et al. 1992, Rimmer and Deblinger 1990) and has been credited with an important role in population increases in some parts of their range (Jenkins and Nichols 1994, Jenkins et al. 1999). However, these same devices have also been associated with serious problems including entanglements of birds in the exclosure netting, and attraction of "smart" predators that have learned there is potential prey inside. The downside risks may include not only predation or nest abandonment, sometimes at rates exceeding those that might occur without exclosures, but also induced mortality of adult birds. Exclosures provide no protection for mobile plover chicks, which generally leave the exclosure within a day of hatching and move extensively along the beach to feed.

Although exclosures are contributing to improved productivity and population increases in some portions of the Atlantic Coast range, problems have been noted in some localities. Loegering (1992) reported loss of six nests in exclosures without tops in Maryland in 1988, but nest loss stopped after string tops were added. Cross (1991) found that exclosed nests hatched significantly more often than unexclosed nests over three years on three sites at CNWR, but hatch rates were not significantly improved at all sites or in all years; furthermore, two instances of foxes depredating adult plovers occurred in the vicinity of exclosures. Due to the magnitude of predation threats to plovers and limitations associated with all currently available solutions, the piping plover recovery plan strongly recommends that on-site managers employ an integrated approach to predator management that considers a full range of management techniques (Service 1996a).

As effectiveness of exclosures has declined, managers have increased selective predator removal activities at many sites throughout the Atlantic Coast range (e.g., U.S. Department of Agriculture

[USDA] 2006, NPS 2007, Cohen et al. 2009). Most predator removal efforts have focused on mammalian predators, but gulls and crows have been targeted at some sites (e.g., Brady and Inglefinger 2008, USDA 2006). Boettcher et al. (2007) state that predator management is "one of the most important and expensive avian conservation measures being implemented on Virginia's barrier islands." Cohen et al. (2009) found that the number of chicks fledged per pair at Westhampton, New York increased with the annual number of cats and foxes trapped. Mean productivity at Maine sites where predator management was conducted was approximately double the productivity at sites without predator management in both 2007 and 2008 (USDA 2008). Productivity of piping plovers at Plymouth Beach, Massachusetts, averaged 1.67 fledged chicks per pair during three years when foxes were removed, compared with 0.86 chicks per pair during the preceding seven years (Service 2009a). Following selective crow removal at Crane Beach in Ipswich, Massachusetts, in 2008, piping plover productivity was the highest since 1999 and exceeded 1.25 fledglings per pair for first time since 2002 (Brady and Inglefinger 2008).

A detailed discussion of threats to Atlantic Coast piping plovers including contaminants, wind turbines, effects of climate change and sea level rise, and the reliability of effort and expenditures for conservation measures is found in the piping plover 5-year status review (Service 2009b).

SEABEACH AMARANTH

In 1993, seabeach amaranth was listed as a threatened species (58 FR 18035). The listing was based upon the elimination of seabeach amaranth from two-thirds of its historic range and continuing threats to the 55 populations that were known at the time (58 FR 18035).

Species Description - Seabeach amaranth is an annual plant and a member of the Amaranth family (*Amaranthaceae*). Upon germination, the plant initially forms a small, unbranched sprig, and soon begins to branch profusely, forming a low-growing mat. Seabeach amaranth's fleshy stems are prostrate at the base, erect or somewhat reclining at the tips, and pink, red, or reddish in color. The leaves are small, rounded, and fleshy, spinach-green in color, with a characteristic notch at the rounded tip. Leaves are approximately 1.3 to 2.5 cm in diameter, and clustered towards the tip of the stem (Weakley and Bucher 1992). The foliage turns deep red in the fall (Snyder 1996). Plants often grow to 30 cm in diameter, consisting of 5 to 20 branches, but occasionally reach 90 cm in diameter, with 100 or more branches. Flowers and fruits are inconspicuous, borne in clusters along the stems. Seeds are 2.5 mm in diameter, dark reddish-brown, and glossy, borne in low-density, fleshy, indehiscent utricles (bladder-like seed capsules or fruits), 4 to 6 mm long (Weakley and Bucher 1992). The seed does not fill the utricle, leaving an air-filled space (Service 1996b).

Habitat – Seabeach amaranth occupies a narrow beach zone that lies at elevations from 0.2 to 1.5 m above mean high tide, the lowest elevations at which vascular plants regularly occur. Seaward, the plant grows only above the high tide line, as it is intolerant of even occasional flooding during the growing season. Landward, seabeach amaranth does not occur more than approximately 1 m above the beach elevation on the foredune, or anywhere behind it, except in

overwash areas. The species is, therefore, dependent on a terrestrial, upper beach habitat that is not flooded during the growing season. This zone is generally absent on beaches experiencing high rates of erosion. Seabeach amaranth is not found on beaches where the foredune is scarped by undermining water at high or storm tides (Weakley and Bucher 1992).

The species' primary habitat consists of overwash flats at accreting ends of barrier islands, and lower foredunes and upper strands of non-eroding beaches. This species occasionally establishes small and temporary populations in secondary habitats including sound side beaches, blowouts in foredunes, and sand or shell dredge spoil or beach nourishment material (Weakley and Bucher 1992).

Seabeach amaranth usually occurs on a pure silica sand substrate, occasionally containing shell fragments. The Natural Resources Conservation Service classifies the habitat of seabeach amaranth as either Beach-Foredune Association or Beach (occasionally flooded). Seabeach amaranth habitat occurs within a wetland system classified by Cowardin et al. (1979) as Marine System, Intertidal Subsystem, Unconsolidated Shore Class (Weakley and Bucher 1992).

The habitat of seabeach amaranth is sparsely vegetated with annual herbs and, less commonly, perennial herbs (mostly grasses) and scattered shrubs. The number and type of vegetative associates vary with specific habitat type (i.e., overwash flat, accreting barrier island end, or lower foredune) (Chicone undated). The most constant associates of seabeach amaranth, with which the species almost always co-occurs, are sea rocket (*Cakile edentula*) and seabeach spurge (*Chamaesyce polygonifolia*) (Weakley and Bucher 1992).

Biogeography and Range - Seabeach amaranth is limited by its habitat requirements to a narrow strip of barrier islands and mainland oceanfront beach strands along the Atlantic coast. The original range of this species extended from Cape Cod in Massachusetts to central South Carolina, a stretch of coast approximately 1,600 km (994 miles) long. This stretch correlates with a geographic range of low tidal amplitude. Tidal amplitude and the relative importance of tidal versus wave energy in shaping coastal morphology are thought to limit the geographic range of seabeach amaranth, rather than availability of sandy beach substrates or sea water temperatures. The range of seabeach amaranth is characterized by islands developed by high wave energy, low tidal energy, frequent overwash, and frequent breaching by hurricanes with resulting formation of new inlets (Weakley and Bucher 1992). Some authors have observed that seabeach amaranth tends to occur on south or southeast facing coasts (Weakley and Bucher 1992, Snyder 1996), but a range-wide analysis of beach orientation has not been conducted.

Historic records of seabeach amaranth are known from nine states. Largely due to human activities, the species was eliminated from seven of these states by the 1980s, remaining only in North and South Carolina. Since 1990, the species has been rediscovered in four states from which it had previously been considered extirpated. Seabeach amaranth is still considered extirpated from two states: Massachusetts and Rhode Island. Table 1 gives the dates of rediscovery and the last previously known occurrence of the plant in each state.

Table 1. Rediscovery Dates of Seabeach Amaranth in Four States.

State	Date Rediscovered	Date of Last Previously Known Occurrence
New York	July 2000	1950 (Van Schoik and Antenen 1993)
Delaware	August 2000	1913 (Service 1996b)
Maryland	August 1998	1875 (McAvoy 2000)
Virginia	September 2001	1973 (Service 1996b)

To date, explanations for seabeach amaranth's rediscovery in the northern part of its range remain speculative. Sites in these five states may have been re-colonized by long-distance transport of seeds by wind or currents. At some sites, seeds may have been long buried in sediments used in beach nourishment projects. This hypothesis requires that seeds can remain viable after prolonged off-shore burial, an unknown factor. In Maryland's Assateague Island National Seashore, the NPS has allowed a previously stabilized foredune system to return to more natural conditions. This change in beach management and the possible existence of a persistent seed bank have been cited as factors in the species' return to the area (Ramsey et al. 2000).

The current range of naturally occurring seabeach amaranth is from Water Mill Beach on Long Island, New York, south to Dewees Island in South Carolina; a few reintroduction efforts south of Dewees Island have been unsuccessful (Young 2001; Hamilton 2000a; E. Eudaly, Service, Charleston, South Carolina , personal communication 2008).

Life History - Seabeach amaranth occupies a highly specific and restricted niche as a "fugitive" species in the narrow upper beach zones of newly formed, accreting barrier island ends and non-eroding beach strands. A dynamic, early successional pioneer species, seabeach amaranth is termed a "fugitive" because its populations are constantly shifting to newly disturbed areas. The plant is eliminated from existing habitats by competition and erosion, and colonizes newly formed habitats by dispersal and (probably) long-lived seed banks. A poor competitor, seabeach amaranth is eliminated from sites where perennials have become established, probably because of root competition for scarce water and nutrient supplies (Weakley and Bucher 1992). Seabeach amaranth acts as a capable sand binder (Weakley and Bucher 1992), which is typical of pioneer beach plants. The species is not likely to be a young or recently evolved species, considering its isolation within the genus (it has no apparently close relatives) and its possession of numerous adaptations to the peculiar environment in which it grows (Service 1996b).

Seabeach amaranth habitat exists in dynamic conditions. The same physical forces (e.g., storms, extreme high tides) that create the plant's specific and ephemeral coastal habitat also destroy it. Coastal storms are probably the single most important natural limitation on the abundance of seabeach amaranth. Existing habitat is eroded away, but new habitat is created by island overwash and breaching. Therefore, seabeach amaranth requires extensive areas of barrier island beaches and inlets, functioning in a relatively natural and dynamic manner. Such conditions

allow the species to move around in the landscape, occupying suitable habitat as it becomes available (Service 1996b).

Density and Distribution - Density of seabeach amaranth is extremely variable within and between populations. The species generally occurs in a sparse to very sparse distribution pattern, even in the most suitable habitats. A typical density is 100 plants per linear km of beach, though occasionally on accreting beaches, dense populations of 1,000 plants per km can be found. Island-end sand flats generally have higher densities than oceanfront beaches (Weakley and Bucher 1992). Comparing overwash flats, accreting barrier island ends, and lower foredunes, Chicone (undated) found that seabeach amaranth plants growing in foredune habitats tended to be larger, healthier, and have fewer associates. Seabeach amaranth has a strongly clumped distribution (Hancock 1995).

Within its primary habitats, seabeach amaranth tends to be concentrated in the line of wrack material deposited by high tides (Mangels 1991, Weakley and Bucher 1992, Hancock 1995, McAvoy 2000). Observations from New Jersey and Maryland suggest that plants within the wrack line tend to be larger (Service 2002b). Pauley et al. (1999), however, found that plots centered on seabeach amaranth had a lower percent area covered by litter material than random plots, suggesting that litter material may be an advantageous microhabitat for seabeach amaranth only when it contains higher levels of organic material and moisture than bare sand, as in the wrack line.

Life Cycle and Phenology - Individual plants live one season, with a single opportunity to produce seed. The species over-winters entirely as seeds. Germination of seedlings begins in April and continues at least through July. In the northern part of the range, germination occurs slightly later, typically late June through early August. Reproductive maturity is determined by size rather than age, and flowering begins as soon as plants have reached sufficient size. Flowering sometimes begins as early as June in the Carolinas, but more typically commences in July and continues until the death of the plant. Seed production begins in July or August and reaches a peak in most years in September. Seed production likewise continues until the plant dies. Senescence and death occur in late fall or early winter (Service 1996b).

Seabeach amaranth seems capable of essentially indeterminate growth (Weakley and Bucher 1992). However, predation and weather events, including rainfall, hurricanes, and temperature extremes, have significant effects on the length of the species' reproductive season. As a result of one or more of these influences, the flowering and fruiting period can be terminated as early as June or July (58 FR 18035).

Reproduction - As an annual, seabeach amaranth reproduces solely by sexual reproduction by seed, with no vegetative or clonal form of reproduction. The species is monoecious (male and female flowers on the same plant), and, based on morphology of the flower and inflorescence, most likely wind pollinated. Seabeach amaranth is capable of self fertilization, an advantageous adaptation for a pioneer species, allowing the founding of a new colony by a single propagule. Self fertilization likely plays a large, probably dominant, role in seed production (Weakley and

Bucher 1992). Once it reaches maturity, seabeach amaranth flowers and fruits continuously until death or senescence. Late season plants may continue flowering and fruiting with few or no leaves, sometimes producing an aberrant, dense, terminal inflorescence (Weakley and Bucher 1992). Even very small plants produce flowers under conditions of a short (12-hour) photoperiod (Jolls and Sellars 2000), likely an opportunistic adaptation to permit small, late germinating plants to reproduce at the end of the growing season.

Nearly all adult seabeach amaranth plants produce seeds, and fertility is assumed to be high (Weakley and Bucher 1992). Fruit production is correlated with plant weight (Hancock 1995), and large plants are estimated to produce several thousand fertile seeds over a fruiting season (Weakley and Bucher 1992). Within the genus *Amaranthus*, this is a low reproductive rate, but seabeach amaranth has apparently evolved a strategy of producing fewer, larger seeds than other members of its genus. Under favorable conditions, seabeach amaranth shows good reproductive success (Weakley and Bucher 1992).

Seed Dispersal - Seabeach amaranth seeds are dispersed by a variety of mechanisms. The fleshy tissues and air pocket of the utricle cause the fruit to have a lower density than the bare seed. Seeds retained in utricles are easily blown about, deposited in depressions, the lee behind plants, or in the surf. Naked seeds are also commonly encountered in the field, and are also dispersed by wind, but to a much lesser degree than seeds retained in utricles. Naked seeds tend to remain in the lee of the parent plant or get moved to nearby depressions (Weakley and Bucher 1992). Observations from South Carolina indicate that seabeach amaranth seeds are also dispersed in the guts of birds and deposited with their droppings (Hamilton 2000b).

Many utricles remain attached to the parent plant and are never dispersed, leading to *in situ* "planting." This phenomenon has also been observed in sea rocket and may be an adaptation to dynamic beach conditions. If conditions remain favorable at the site of the parent plant, the seed source for retention of that site is guaranteed. If conditions become unsuitable, other seeds have been dispersed to colonize new sites (Weakley and Bucher 1992).

Germination - Fresh seabeach amaranth seeds are physiologically dormant (Baskin and Baskin 1994, 1998). The tough seedcoat requires some physical modification before germination can occur. The primary mechanism(s) for breaking seed dormancy in the field is not known, but possible factors include abrasion, cold, imbibing water, and gradual breakdown over time (Weakley and Bucher 1992; Hancock 1995; Baskin and Baskin 1994, 1998; Hamilton 2000c; Jolls and Sellars 2000). Once dormancy is broken, light and high temperatures (25-35° C) are required for germination (Hancock 1995; Baskin and Baskin 1994, 1998). This high temperature requirement causes seabeach amaranth to germinate later in the season than other dune associates, and limits the time in which new seedlings can grow. Rainfall is also significant in promoting germination (Hancock 1995).

Initial studies have found that seabeach amaranth seedlings cannot emerge from a depth of more than 1 (Hancock 1995) or 2 cm (Service 2002b). Results of these studies, combined with the finding that light is required for germination, are strong evidence that deep burial may

completely prevent germination and seedling emergence (Jolls et al. 2001). Seabeach amaranth may have less opportunity to emerge and become established compared to other dune species such as sea rocket, as mean emergence of seedlings (growth rate of the newly sprouted seed) is less than predicted for the species' seed mass (Hancock 1995).

Natural Limiting Factors - Except where suitable habitat has persisted long enough for perennials to become established, the primary limiting factors of seabeach amaranth under natural conditions are abiotic. Abiotic limiting factors are expected for a fugitive species that occupies dynamic, early successional habitats. Weather is an important limiting factor, given the relatively narrow temperature and rainfall requirements for germination and seedling establishment. Flooding, drought, or unseasonable temperatures may impair survival and reproduction. Weather also limits abundance through wind, which may cause burial of seeds and plants by sand. In addition to decreasing germination and seedling establishment, burial may also impact reproduction by covering adult plants prior to seed set. This effect was observed in South Carolina (Hamilton 2000b) and may have occurred in Maryland (Service 2002b).

Under natural conditions interspecific competition for water and nutrients, especially with perennials, may be a significant biotic limiting factor of seabeach amaranth. Weakley and Bucher (1992) cite intraspecific competition as a possible factor in the mortality of young plants, but Hancock (1995) found no evidence of intraspecific density effects. If intraspecific competition limits seabeach amaranth abundance its effects are likely small compared to the effects of competition with perennial species, which possess superior abilities to extract water and nutrients from porous sand. Predators and disease are discussed below under threats.

Population Dynamics - Although the longevity of seabeach amaranth seeds is unknown, several lines of evidence suggest that seed banks may be an important factor in this species' life history (Weakley and Bucher 1992, Baskin and Baskin 1998). The relative roles of fresh and banked seeds are unknown (Service 1996b). In experimental plots in Maryland, a few late-season seedlings emerged from the current year's seed crop (Service 2002b); however the contribution of same-season seed to the current year's population and seed crop is likely small. For a sexually reproducing annual plant, natality is comprised of two components, the seed production rate (or fecundity) and the germination rate.

The viability rates of both fresh and banked seeds are uncertain; more is known about mortality of the plants. Substantial mortality of young plants occurs in some years, prior to reproduction. Hancock (1995) found seven percent survival of seedlings to 40 days of age, with mortality caused primarily by high tide flooding. Flooding resulted in almost 100 percent mortality of propagated plants at three of six experimental transplant sites in South Carolina in 1999. At a fourth site, drifting sand covered most of the transplants, with 10 of 196 plants (about 5 percent) surviving to produce seed (Hamilton 2000b). Burial by blowing sand may have also affected reproduction in New Jersey and Maryland in 2000 (Service 2002b). Unfavorable conditions early in the growing season, including drought, burial, and especially flooding and other storm damage, may reduce seed production by 90 (Weakley and Bucher 1992) to 98 percent (Hancock 1995).

Once past the stage of germination and early growth, mortality rates are generally lower. In the Carolinas, mortality of older plants tends to be caused primarily by webworm predation (Weakley and Bucher 1992). Larger plants may be able to withstand saltwater inundation better than smaller plants; however, prolonged salt water inundation kills almost all plants, regardless of size (Hancock 1995). Storms later in the growing season can effectively and abruptly curtail reproduction for the year (Weakley and Bucher 1992). Plants that have not died from other causes senesce and die in late fall or early winter.

Genetic Variability - Preliminary results from two initial genetic studies of seabeach amaranth suggest that the species' genetic variability is low. A study by Salisbury State University looked for genetic differences in nuclear DNA within and across three groups: propagated plants from Maryland, wild plants from Maryland, and wild plants from Delaware. Overall, genetic variability was low. Wild and propagated Maryland plants were similar, as might be expected, since the propagated plants were produced from wild plants taken from the same area (Service 2002b). Higher levels of genetic variability were found within the sample of plants from Delaware. A second study by Strand (2002) analyzed non-coding regions of nuclear and chloroplast DNA taken from seed and dry leaf samples from New York, New Jersey, North Carolina, and South Carolina. This study found no observable genetic variation among any of the samples. Although the results of these two studies are consistent, these results must be interpreted with caution. Lack of detection does not prove a lack of genetic variability, which might be present in other regions of the genome, or detectable through other techniques (Jolls and Sellars 2000, Strand 2002, Service 2002b).

Population Status and Distribution - As might be expected for a fugitive annual plant of dynamic barrier beach habitats, populations of seabeach amaranth at any given site are extremely variable (Weakley and Bucher 1992). Population size at a site often fluctuates by several orders of magnitude from year to year. The primary reasons for the natural variability of seabeach amaranth are the dynamic nature of its habitat, and the significant effects of stochastic factors such as weather and storms on mortality and reproductive rates. Although wide fluctuations in species populations tend to increase the risk of extinction, variable population sizes are a natural condition for seabeach amaranth, and the species is well adapted to its ecological niche.

Because variability in population size is so great among years, a single survey is a poor measure of a population's health. Assessing site-specific population trends is difficult even with several years of surveys. Weakley and Bucher (1992) suggest that a 5 to 10 year average is a more meaningful measure for assessing the vigor of a seabeach amaranth population. However long-term, consecutive, annual data are available for only a few sites in New York. Estimates of population sizes for seabeach amaranth across its range are imprecise, given available survey data. Early (pre-1987) survey data are limited. Rangewide surveys were conducted in 1987, 1988, and 1990 (excluding states where the species was considered extirpated at the time). Annual statewide surveys have been conducted subsequently in New York, but no comprehensive surveys in North or South Carolina have been carried out since 1990. Suitable areas in New Jersey, Delaware, and Maryland were thoroughly surveyed in 2000, but these efforts did not necessarily extend state-wide. Approximately 14 locations in Virginia were

surveyed in 2000, and no seabeach amaranth was found (Belden 2000). In 2001, seabeach amaranth was found on Assateague Island, Virginia, most likely the result of a restoration program in Assateague Island National Seashore in Maryland (Service 2002b).

Since 2000, the number of plants in each state has fluctuated greatly (Table 2). In Delaware numbers have always been low, with a high count for 2002 of 423 plants. New York has always produced the highest number of plants, with the 2000 numbers also being the highest count for the state (244,608 plants). In 2006, 1,551 plants were counted in Maryland and Virginia. Of these 1,551 plants, all but 13 were found on the Maryland side of Assateague Island. Numbers of plants within CNWR (see Virginia numbers in Table 2) have experienced major fluctuations since the species' rediscovery in 2001.

Factors Affecting the Species

Habitat Loss and Degradation - In the geologic past, seabeach amaranth has persisted through even relatively rapid episodes of sea level rise and barrier island retreat. A natural barrier island landscape, even a retreating one, contains localized accreting areas, especially in the vicinity of inlets (Service 1996b).

Erosion is accelerated in many areas by human-induced factors such as reduced sediment loads reaching coastal areas due to damming of rivers and beach stabilization structures. When the shoreline is "hardened" by artificial structures (e.g., seawalls, bulkheads) overwash and inlet formation is curbed. Erosion may also be increasing due to sea level rise and increased storm activity caused by global climate change (58 FR 18035).

Table 2. Seabeach amaranth numbers by year and state.

Year	New York	Delaware	New Jersey	Maryland	Virginia	North Carolina	South Carolina	Total
1987	0	0	0	0	0	3,395	1,341	4,736
1988	0	0	0	0	0	4,433	1,800	6,233
1989	0	0	0	0	0	0	0	0
1990	331	0	0	0	0	1,127	188	1,646
1991	2,251	0	0	0	0	1,170	0	3,421
1992	422	0	0	0	0	32,160	15	32,597
1993	195	0	0	0	0	22,214	0	22,409
1994	182	0	0	0	0	13,964	560	14,706
1995	599	0	0	0	0	33,514	6	34,119
1996	2,263	0	0	0	0	8,357	0	10,620
1997	11,918	0	0	0	0	1374	2	13,294
1998	10,699	0	0	2	0	11,490	141	22,332
1999	31,196	0	0	1	0	588	196	31,981
2000	244,608	32	1,039	4	0	103	2,312	248,098
2001	205,233	83	5,813	869	9	5037	231	217,275
2002	193,412	423	10,908	801	56	4440	0	210,040

2003	114,535	13	5,084	459	22	11,290	1,381	132,784
2004	30,942	4	6,820	531	2	11,213	2,110	51,622
2005	16,813	6	5,795	489	69	19,976	671	43,819
2006	32,553	40	6,522	1,538	13	3,190	721	44,577
2007	3,914	19	2,189	2176	3	872	60	9233
2008	4,416	40	1,139	1041	7	1,575	11,786	19974

Attempts to halt beach erosion through hard structures (i.e., sea walls, jetties, groins, bulkheads) appear invariably to destroy habitat for seabeach amaranth. In the Carolinas, seabeach amaranth is not found on shorelines where bulkheads, sea walls, or rip rap zones have been constructed. Such armoring generally occurs in the primary habitat of the plant, and water and wind erosion lower the profile of the beach seaward of the armoring. The upper beach habitat required by seabeach amaranth (above inundation by tidal action) ceases to exist as the beach is steadily eroded. Groins have mixed effects on seabeach amaranth. Immediately updrift from a groin, accretion sometimes provides or maintains, at least temporarily, habitat for seabeach amaranth; immediately downdrift, erosion usually destroys seabeach amaranth habitat. In the long term, groins (if they are successful) stabilize updrift beaches, allowing succession to perennials, and rendering even the updrift side only marginally suitable for seabeach amaranth. Widespread construction of sea walls, jetties, and other hard stabilization structures in New Jersey, New York, and other northern states is associated with the extirpation of seabeach amaranth from the northern part of its range (Service 1996b).

Even minor structures and non-structural beach stabilization techniques, such as sand fences and beachgrass planting, are generally detrimental to seabeach amaranth (58 FR 18035). Dune stabilization and vertical sand accretion caused by sand fences appear to be detrimental to seabeach amaranth. The effects of dune stabilization by planting vegetation are similar (Service 1996b). Seabeach amaranth very rarely occurs when sand fences and vegetative stabilization have taken place and, in these situations, is present only as rare, scattered individuals or short-lived populations (Weakley and Bucher 1992).

Beach nourishment can have positive site-specific impacts on seabeach amaranth. Although more study is needed before the long-term impacts can be accurately assessed, seabeach amaranth has colonized several nourished beaches and has thrived in some sites through subsequent re-applications of fill material (58 FR 18035). However, on the landscape level, beach nourishment is similar to other beach stabilization efforts in that it stabilizes the shoreline and curtails the natural geophysical processes of barrier islands. These effects are detrimental to the rangewide persistence of the species. In addition, beach nourishment may cause site-specific adverse effects by crushing or burying seeds or plants, or by altering the beach profile or upper beach micro-habitats in ways not conducive to colonization or survival. Deeply burying seeds during any season can have serious effects on populations; this also applies to the placement of dredge spoil (Service 1996b). Burial of the seed bank may be particularly detrimental to isolated populations, as no nearby seed sources are available to re-colonize the nourished site. Adverse effects of beach nourishment may be compounded if accompanied by artificial dune construction

and stabilization with sand fencing and/or beach grass, or if followed by high levels of erosion and scarping of the upper beach.

As a fugitive species dependent on a dynamic landscape and large-scale geophysical processes, seabeach amaranth is vulnerable to habitat fragmentation and isolation of small populations (58 FR 18035). Rendering 50 to 75 percent of a coastline permanently unsuitable may doom seabeach amaranth, because any given area will become unsuitable at some time due to natural forces. If a seed source is no longer available in the vicinity, seabeach amaranth will be unable to reestablish itself when the area once again provides suitable habitat. In this way, the species can be progressively eliminated even from generally favorable stretches of habitat surrounded by permanently unfavorable areas. Fragmentation of habitat in the northern part of the species range contributed to the regional extirpation during the last century. Areas of suitable habitat were separated from one another by distances too great to allow recolonization following natural catastrophes (Weakley and Bucher 1992).

Recreational Impacts - Intensive recreational use of beaches can threaten seabeach amaranth populations, both through direct damage and mortality of plants and by impacting habitat. Light pedestrian traffic, even during the growing season, usually has little effect on seabeach amaranth (58 FR 18035). Substantive impacts generally occur only on narrow beaches or beaches which receive heavy recreational use. In such areas, populations are sometimes eliminated or reduced by repeated trampling. While pedestrian traffic appears to be a minor problem in the Carolinas, the heavier traffic borne by northern beaches near major population centers may have been partially responsible for the past extirpation of seabeach amaranth in those regions (Service 1996b).

Vehicle use on the beach during the growing season can have detrimental effects on the species, as the fleshy stems of this plant are brittle and easily broken. Plants generally do not survive even a single pass by a truck tire (Weakley and Bucher 1992). Sites where vehicles are allowed drive on beaches often show severe population declines. Dormant season vehicle use has shown little evidence of significant detrimental effects, unless it results in massive physical erosion or degradation of the site, such as compacting or rutting of the upper beach. In some cases, winter vehicle traffic may actually provide some benefits for the species by setting back succession of perennial grasses and shrubs with which seabeach amaranth cannot compete successfully. However, extremely heavy vehicle use, even in winter, may have some negative impacts, including pulverization of seeds (Weakley and Bucher 1992).

Beach grooming, more common on northern beaches, may also have contributed to the previous extirpation of seabeach amaranth from that part of its range. Motorized beach rakes, which remove trash and vegetation from bathing beaches, do not allow seabeach amaranth to colonize long stretches of beach (Service 1996b). In New Jersey, plants were found along a nearly continuous length of beach, noticeably interrupted by stretches that are routinely raked.

Herbivory - Predation by webworms (caterpillars of small moths) is a major source of mortality and lowered fecundity in the Carolinas, often defoliating plants by early fall (58 FR 18035).

Defoliation at this season appears to result in premature senescence and mortality, reducing seed production, the most basic and critical parameter in the life cycle of an annual plant. Webworm predation may decrease seed production by more than 50 percent (Weakley and Bucher 1992). In the Carolinas, four species of webworm collected from seabeach amaranth have been identified: beet webworm (*Loxostege similialis*), garden webworm (*Achyra rantalis*), southern beet webworm (*Herpetogramma bipunctalis*), and Hawaiian beet webworm (*Spoladea recurvalis*). Webworm herbivory of seabeach amaranth has not been documented in Delaware or Maryland. Although the four webworms so far identified on seabeach amaranth are native species, their use of barrier islands has probably been altered by changes in the coastal plain landscape (i.e., extensive agricultural use), development of barrier islands, and introduction of weedy plants that can also serve as host plants. All four webworms are probably much more abundant now than in pre-Columbian times. For this reason, the level of predation that seabeach amaranth is experiencing is likely unnaturally high (Service 1996b). Webworm herbivory is probably a contributing, rather than a leading factor in the decline of seabeach amaranth. However, in combination with extensive habitat alteration, severe herbivory could threaten the existence of the species (Weakley and Bucher 1992).

Utilization and Collection - Seabeach amaranth is generally not threatened by over-utilization or collection, as it does not have showy flowers and is not a component of the commercial trade in native plants. However, because the species is easily recognizable and accessible, it is vulnerable to removal, vandalism, and incidental trampling by curiosity seekers. Seabeach amaranth is an attractive and colorful plant, with a prostrate growth habit that could lend itself to planting on beach front lots. The species' effectiveness as a sand binder could make it even more attractive for this purpose. In addition, seabeach amaranth is being investigated by the USDA and several universities and private institutes for its potential use in crop development and improvement. Over-collection and the development of genetically altered, domesticated varieties are potential, but currently unrealized, threats to the species (58 FR 18035).

New Threats - New threats have been documented since the species was listed in 1993. These factors are lesser threats than habitat modification, but may increase the risk of extinction by compounding the effects of other, more severe threats.

Several additional herbivores of seabeach amaranth have been observed including deer (*Odocoileus virginianus*), Sika deer/elk (*Cervus nippon*), eastern cottontail (*Sylvilagus floridanus*), and migratory song birds (Van Schoik and Antenen 1993), as well as feral horses in Maryland (Service 2002b). Hancock (1995) suggests that grasshoppers may feed on seabeach amaranth, but does not indicate whether this was actually observed. There is also strong circumstantial evidence for seabeach amaranth herbivory by grasshoppers (Service 2002b). Minor insect damage was noted on a few New Jersey plants in 2000, and larval insects were observed feeding on seabeach amaranth in 2001; to date, no species have been identified. In addition, a cluster of New Jersey plants appeared to have been damaged by a congregation of loafing gulls (*Larus* spp.), based upon feathers and droppings. As with webworms, the abundance of these newly documented predators on barrier islands is increased by human activities.

Asiatic sand sedge (*Carex kobomugi*) has been suggested as another potential threat. This sedge is strongly rhizomatous and dune-forming (NPS and Maryland Natural Heritage Program 2000). Asiatic sand sedge was introduced to the east coast (New Jersey to Virginia) from East Asia in the 1930s for erosion control and as a sand stabilizer. The species is known to crowd out native dune species (Virginia Department of Conservation and Recreation and Virginia Native Plant Society undated). Asiatic sand sedge may be detrimental to seabeach amaranth by direct competition, and by reducing habitat suitability through sand stabilization and dune building. Control programs have been implemented in managed natural areas where this species occurs.

The first known disease of seabeach amaranth was documented in South Carolina in 2000. During the 2000 growing season, a fungus (*Albugo* sp.) was observed on seabeach amaranth in several South Carolina sites (Strand and Hamilton 2000). This pathogen is a white rust or water mold. Lesions developed on the leaves during flowering, starting in July; leaves later fell off (Service 2002b). Effects on infected individuals were significant, resulting in death of the plants two to four weeks after lesions were first observed. Anecdotal observations suggest that isolated plants tended to avoid infection (Strand and Hamilton 2000).

Rangewide Trends - Total population trends can disguise important regional trends. Recent population increases have occurred almost entirely in the northern part of the species' range (Table 2). Seabeach amaranth has undergone a geographic expansion, reappearing in five states over 11 years, after decades of extirpation from the entire northern portion of its range. New York sites account for virtually all of the recent increases in total population size rangewide, offsetting lower numbers in the south. Although natural population variability and survey effort must be considered, the recent trend in North Carolina appears downward. The low 1999 and 2000 plant totals in that state are especially noteworthy given the relatively high survey effort in these years (approximately 75 percent of known sites visited). In South Carolina, the species experienced a 90 percent reduction in that state following 1988 storms, including Hurricane Hugo. However, survey efforts since 1998 suggest that populations may have recovered in some areas of South Carolina.

Despite the natural variability of seabeach amaranth's population size and distribution and inconsistent survey efforts, some trends can be discerned from the available data. The species has undergone a significant geographic expansion, both in terms of the number and distribution of occupied states and counties. Since the first intensive surveys in 1987, the species' extant range has increased approximately 650 km (404 miles) to the north, but contracted about 50 km (31 miles) to the south. Numerically, the population has seen a dramatic increase. Equally notable is the geographic shift of the species' stronghold (in terms of total numbers) from North Carolina to New York.

Despite the geographic expansion and booming New York populations, seabeach amaranth is still vulnerable to local and regional extirpation. The primary threat to seabeach amaranth, habitat alteration, has not significantly diminished since the species was listed and new threats have been subsequently discovered. Small population sizes in many locations increase the risk that seabeach amaranth will become locally extirpated. Almost 44 percent of sites documented

in 2000 contained fewer than 10 plants, including more than 60 percent of sites in North Carolina (Hamilton 2000a; Jolls and Sellars 2000; McAvoy 2000; NPS 2001a, 2001b; U.S. Army Corps of Engineers 2001; Young 2001).

One final trend of note is the propagation of seabeach amaranth in greenhouses and laboratories and the transplanting of propagated individuals or seed back into the wild. Such programs have been undertaken in Delaware, Maryland, North Carolina, and South Carolina (McAvoy 2000, NPS and Maryland Natural Heritage Program 2000, Jolls and Sellars 2000, Hamilton 2000b). These efforts have met with mixed results; thus a long term trend cannot be predicted.

LOGGERHEAD SEA TURTLE, GREEN SEA TURTLE, and LEATHERBACK SEA TURTLE

The loggerhead sea turtle was listed as threatened in the U.S. in 1978 (NMFS and Service 1991a), the green sea turtle was listed as endangered in 1978 (NMFS and Service 1991b), and the leatherback sea turtle was listed as endangered in 1970 (NMFS and Service 1992). In March 2010, the Service and NMFS published a proposed rule in the Federal Register to recognize nine distinct populations of loggerhead sea turtles worldwide. Under this proposed rule, the loggerhead sea turtle population that would be affected by the proposed actions is the north Atlantic population and it is proposed to be listed as endangered (72 FR 12598). There is designated critical habitat outside of Virginia for the green and leatherback sea turtles, but none has been designated for the loggerhead sea turtle.

This account emphasizes sea turtle nesting and breeding biology, which is the subject of this biological opinion. Additional information about the life history of these sea turtle species and their habitat use, behavior, and survival at sea can be found in other documents, including the recovery plans (NMFS and Service 1991a, 1991b, 1992), five-year statues reviews (NMFS and Service 2007a, 2007b, 2007c), and other sources (National Research Council 1990).

Species Description - The loggerhead is the smallest of the three turtles, with a mean carapace length of 92 cm and a mean mass of 133 kg (NMFS and Service 1991a), compared to 102 cm and 136 kg for the green sea turtle (National Research Council 1990). Green sea turtles nest primarily in the tropics and are rarer nesters at higher latitudes, while loggerheads have significant nesting populations outside the tropics (National Research Council 1990). Leatherback sea turtles are the largest turtle and the largest living reptile in the world. Mature males and females can be as long as 6.5 ft and weigh almost 2,000 pounds. The leatherback is the only sea turtle that lacks a hard, bony shell. The U.S. Caribbean, primarily Puerto Rico and the U.S. Virgin Islands, and southeast Florida support minor nesting colonies of the leatherback, but represent the most significant nesting activity within the U.S. (James et al. 2005).

Life History and Population Dynamics - Loggerhead females are believed to reach sexual maturity at a minimum age of 30 years (Snover 2002). At the start of the breeding season, they migrate from foraging areas on the continental shelf to mating areas in the waters near their nesting beaches (Schroeder et al. 2003). Reproductive females exhibit the desire to return to their birthplace to lay their eggs (Miller et al. 2003). Females may be inseminated by multiple

males (Bollmer et al. 1999). After mating, males return to their foraging areas while females remain in the waters near their natal beaches to emerge onto their nesting beaches to lay eggs. The following account of nesting biology is a synopsis of Miller et al. (2003).

Loggerhead females tend to nest on high wave energy, sandy ocean beaches. Gravid females emerge from the wash zone and crawl toward the dune line until they encounter a suitable nest site, typically on open sand at the seaward base of a dune, but sometimes in vegetation. The female clears away surface debris with the front flippers, creating a "body pit," then excavates a flask-shaped nest cavity with her hind flippers. Loggerheads lay an average of 112 eggs per nest. After laying, the female covers the nest with sand using all four flippers. Once the nest-covering phase is complete, she crawls back into the sea. Individual females may nest 1 to 6 times per nesting season, at intervals of 12-16 days, during the late spring to late summer. Intervals between nesting shorter than 10 days indicate that the previous nest attempt was likely aborted due to disturbance. Mature loggerheads nest every two to three years, on average (Schroeder et al. 2003). Nest incubation period (from laying to hatching) depends on temperature and ranges from 48 to 90 days at the extremes. Emergence of hatchlings from the nest cavity usually occurs within four days of hatch, but may take up to two weeks longer. Hatchling emergence from nests usually occurs at night when temperatures are lower and diurnal predators are inactive. Hatching success typically approaches 80 percent; after hatchlings leave the beaches, they typically fall prey to a variety of predators, including birds, fish, and sharks (National Research Council 1990).

Sex ratio of hatchlings depends on temperature during incubation. Below 84° Fahrenheit (29° Celsius), more males are produced than females and above that temperature more females are produced (Carthy et al. 2003). Furthermore, fluctuating incubation temperatures often produce more females than stable temperatures, and temperature, hydration, and gas exchange during incubation can determine hatchling size, early swimming behavior, growth rate, and hatchling robustness (Carthy et al. 2003). Newly emerged hatchlings immediately head for the sea, most likely orienting toward the water by moving toward the brightest horizon and away from dark silhouettes (Lohmann and Lohmann 2003). Sea turtles are most negatively sensitive to blue and green light and loggerheads in particular are averse to yellow light (Witherington and Martin 1996). Once in the sea, hatchling loggerheads swim into the waves and eventually enter the open ocean, where they will spend the first 6.5 to 11.5 years of their lives primarily at the top of the water column, until finally moving to foraging areas on the continental shelf (Bolten 2003).

Green sea turtles nest in two, three, or four year intervals, and may lay as many as nine clutches within a nesting season (NMFS and Service 1991b). Clutch size varies from 75-200 eggs, and incubation ranges from about 45-75 days (NMFS and Service 1991b).

Leatherback sea turtles nest in two to three year intervals, and average five to seven clutches per nesting season (NMFS and Service 1992). Leatherbacks average fewer eggs per clutch, 70-80 eggs, and incubation ranges from 55-75 days (NMFS and Service 1992).

Nesting habitat - Less is known about factors that cue nest site selection than about anthropogenic disturbances that discourage nesting (Miller et al. 2003). Typical nesting areas are sandy, wide, open beaches backed by low dunes, with a flat, sandy approach from the sea (Miller et al. 2003). Nesting is nonrandom along the shoreline, but studies of the physical characteristics associated with nests versus random or non-nesting sites on the beach have produced varying results. Some factors found to determine nest selection are beach slope (3 of 3 studies), temperature (2 of 3 studies), distance to ocean (1 of 3 studies), sand type (2 of 2 studies), and moisture (1 of 3 studies), although the results were occasionally contradictory (Miller et al. 2003). Data indicates that the leatherback sea turtle prefers beaches with proximity to deep water and generally rough seas (NMFS and Service 1992). Other factors examined but not found to be significant were sand compaction, erosion, pH, and salinity. Although the process of nest site selection is not well understood, a successful nest must be laid in a low salinity, high humidity, and well-ventilated substrate that is not prone to flooding or burying due to tides and storms and where temperature is optimal for development (Miller et al. 2003).

Status and Distribution – Approximately 58,000 loggerhead nests were estimated in the U.S. Atlantic in 1983 (NMFS and Service 1991a) and between 53,000 and 92,000 nests from 1989 to 1998 (Turtle Expert Working Group 2000). Within the northern subpopulation (north Florida to Virginia), studies in South Carolina and Georgia have documented a decline in number of nests (Ehrhart et al. 2003). Based on genetic evidence, male loggerheads disperse freely among sites within the U.S. Atlantic population, while females are faithful to their natal sites (Bowen et al. 2005). Because sex ratio is determined by temperature during incubation (Miller et al. 2003), the northern part of the U.S. Atlantic population, which includes Virginia, apparently provides a disproportionate number of males to the larger population (Mrosovsky et al. 1984, Hanson et al. 1998, Hawkes et al. 2007).

"Analyses of historic and recent abundance information by the Marine Turtle Specialist Group (MTSG) indicate that extensive population declines for the green sea turtle have occurred in all major ocean basins. The MTSG analyzed population trends at 32 index nesting sites around the world and found a 48-65percent decline in the number of mature females nesting annually over the past 100-150 years. The two largest nesting populations of green turtles are found at Tortuguero, on the Caribbean coast of Costa Rica, and Raine Island, on the Great Barrier Reef in Australia, where an annual average of 22,500 and 18,000 females nest per season, respectively. In the U.S., green turtles nest primarily along the central and southeast coast of Florida; present estimates range from 200 - 1,100 females nesting annually" (NMFS 2008). In the southeast U.S., the majority of green turtle nesting occurs in Florida. The green turtle nesting population of Florida appears to be increasing based on 19 years (1989-2007) of index nesting data from throughout the state (http://research.myfwc.com/features/view_article.asp?id=27537).

"Because adult female leatherbacks frequently nest on different beaches, nesting population estimates and trends are especially difficult to monitor. In the Pacific, the International Union for the Conservation of Nature (IUCN) notes that most leatherback nesting populations have declined more than 80. In other areas of the leatherback's range, observed declines in nesting populations are not as severe, and some population trends are increasing or stable. In the

Atlantic, available information indicates that the largest leatherback nesting population occurs in French Guyana, but the trends are unclear. Some Caribbean nesting populations appear to be increasing, but these populations are very small when compared to those that nested in the Pacific less than 10 years ago. Nesting trends on U.S. beaches have been increasing in recent years." (NMFS 2008). Similar to the green turtle, in the southeast U.S., the majority of leatherback nesting occurs in Florida. The leatherback nesting population of Florida appears to be increasing based on 19 years (1989-2007) of index nesting data from throughout the state (http://research.myfwc.com/features/view_article.asp?id=27537).

Factors Affecting the Species – Numerous factors affect sea turtle growth, survival, and behavior while at sea from when they leave natal beaches as hatchlings until they mature and return to beaches to breed. These factors are discussed in detail in the 5-year status reviews for the three turtle species (NMFS and Service 2007a, 2007b, 2007c). The discussion herein is limited to factors affecting turtle nesting. Threats to the loggerhead sea turtles on the nesting grounds are similar to those faced by the green and leatherback sea turtles. The following threats affect all three species, though there may be some differences in susceptibility among the three turtle species.

Weather and Tides - Storm events may erode beaches and destroy nests or cause nest failure due to flooding or piling of eroded sand on the nest site. Beach erosion due to wave action may also decrease the availability of suitable nesting habitat (Steinetz et al. 1998), leading to a decline in nesting rate on a particular beach. Sea level rise, often in combination with human development along beaches, is contributing to erosion, changes in beach characteristics, and more intensive management of many beaches

Predation - Predation of eggs and young by mammals, birds, and ghost crabs may eliminate up to 100 percent of the nests and any hatchlings that emerge on beaches where predation is not managed (National Research Council 1990). This is a natural phenomenon that has always affected sea turtle populations, but due to reduced turtle population sizes, reduced turtle habitat availability, and unnatural population increases of nest predators in some areas, predation is a significant threat to remaining breeding populations and is actively controlled through predator exclusion and predator control on most beaches where turtles nest.

Human Activities - Crowding of nesting beaches by pedestrians can disturb nesting females and prevent laying (NMFS and Service 1991a). Furthermore, the use of flashlights and campfires may interfere with sea-finding behavior by hatchlings. Beach driving, including pedestrian traffic, vehicle use, and beach cleaning pose a risk of injury to females and live stranded turtles, can leave ruts that trap hatchlings attempting to reach the ocean (Hosier et al. 1981, Cox et al. 1994), can disturb adult females and cause them to abort nesting attempts, and can interfere with sea-finding behavior if headlights are used at night (NMFS and Service 1991a). Driving directly over incubating egg clutches can cause sand compaction, which may decrease hatching and emergence success and directly kill pre-emergent hatchlings (NMFS and Service 2007a). Artificial lighting on human structures may affect turtle behavior in a similar manner (Witherington and Martin 1996). Beach cleaning can directly destroy nests. Poaching is a

problem in some countries and occurs at a low level in the U.S. (NMFS and Service 2007a). An increased human presence may also lead to an increase in the presence of domestic pets that can depredate nests and an increase in litter that may attract wild predators (National Research Council 1990).

The rate of habitat loss due to erosion and escarpment formation may be increased when humans attempt to stabilize the shoreline, either through renourishment (Dolan et al. 1973) or placement of hard structures such as sea walls or pilings (Bouchard et al. 1998). Vehicle traffic may alter the beach profile leading to steeper foredunes (Anders and Leatherman 1987), which may be unsuitable for nesting. Improperly placed erosion control structures such as drift fencing can act as a barrier to nesting females. Humans may also introduce exotic vegetation in conjunction with beach development, which can overrun nesting habitat, make the substrate unsuitable for digging nest cavities, invade nests and desiccate nests, or trap hatchlings.

Reduced nesting success on constructed/augmented beaches could result due to sand compaction, escarpment formation, and changes in the beach profile. Sand compaction has been shown to negatively impact sea turtles, particularly concerning beach nourishment projects. Research has shown that placement of very fine sand and/or the use of heavy machinery can cause sand compaction on nourished beaches (Nelson et al. 1987, Nelson and Dickerson 1988). Significant reductions in nesting success (i.e., false crawls occurred more frequently) have been documented on severely compacted nourished beaches (Nelson and Dickerson 1987, Nelson et al. 1987), and increased false crawls may result in increased physiological stress to nesting females. Sand compaction may also increase the length of time required to excavate nests and result in increased physiological stress (Nelson and Dickerson 1988).

ENVIRONMENTAL BASELINE

Status of the Species Within the Action Area

Piping Plover - Piping plovers use wide sandy beaches on Assawoman, Wallops, and Assateague Islands for courtship, nesting, and raising chicks. Suitable habitat has a variable distribution along the seaward edge of islands within the action area year to year due to the competing effects of erosion and vegetation succession. Annual piping plover production within the action area indicates that all islands possess some nesting habitat, with the greatest areas of suitable beach occurring on Assawoman Island and in the Hook and Overwash portions of Assateague Island. Little potential nesting habitat is available on the south end of Wallops Island, but the north end of Wallops Island has been rapidly accreting and appears to offer increasing quantities of wide sandy beach which is suitable for nesting.

CNWR, Virginia Department of Game and Inland Fisheries (VDGIF), The Nature Conservancy (TNC), and USDA Wildlife Services personnel conduct piping plover nest surveys on islands within the action area and observe fledgling production to determine fledgling production per nesting pair. Results of the 2005-2009 piping plover nest surveys within the action area are shown in Tables 3-6 below.

Table 3. Piping Plover Nesting Trends - Assateague (Overwash) Island (Service 2009c).				
Year	Nesting Pairs	Nest Attempts	Chicks Fledged	Fledglings/Pair
2005	8	12	16	2.00
2006	8	10	4	0.50
2007	6	8	6	1.00
2008	6	6	5	0.84
2009	3	5	3	1.00

Table 4. Piping Plover Nesting Trends - Assateague (Hook) Island (Service 2009c).				
Year	Nesting Pairs	Nest Attempts	Chicks Fledged	Fledglings/Pair
2005	32	39	58	1.81
2006	27	30	37	1.37
2007	22	30	24	1.09
2008	30	36	21	0.70
2009	23	33	12	0.52

Table 5. Piping Plover Nesting Trends - Wallops Island (Service 2009c).				
Year	Nesting Pairs	Nest Attempts	Chicks Fledged	Fledglings/Pair
2005	2	5	0	0.00
2006	1	1	0	0.00
2007	3	3	0	0.00
2008	0	0	0	0.00
2009	4	5	10	2.50

Table 6. Piping Plover Nesting Trends - Assawoman Island (Service 2009c).				
Year	Nesting Pairs	Nest Attempts	Chicks Fledged	Fledglings/Pair
2005	30	37	34	1.14
2006	23	25	28	1.22
2007	23	25	40	1.74
2008	26	35	30	1.15
2009	26	27	31	1.19

The 2010 piping plover season is underway while this opinion is being written. Piping plover breeding activity appears to be similar to past years at most sites. NASA has initiated a more formal monitoring program in 2010, and documented 4 plover nests to date on the northern end of Wallops Island (Figure 2). One of these nests fledged chicks successfully (4 chicks – J. Mitchell, NASA Wallops Environmental, personal communication 2010).

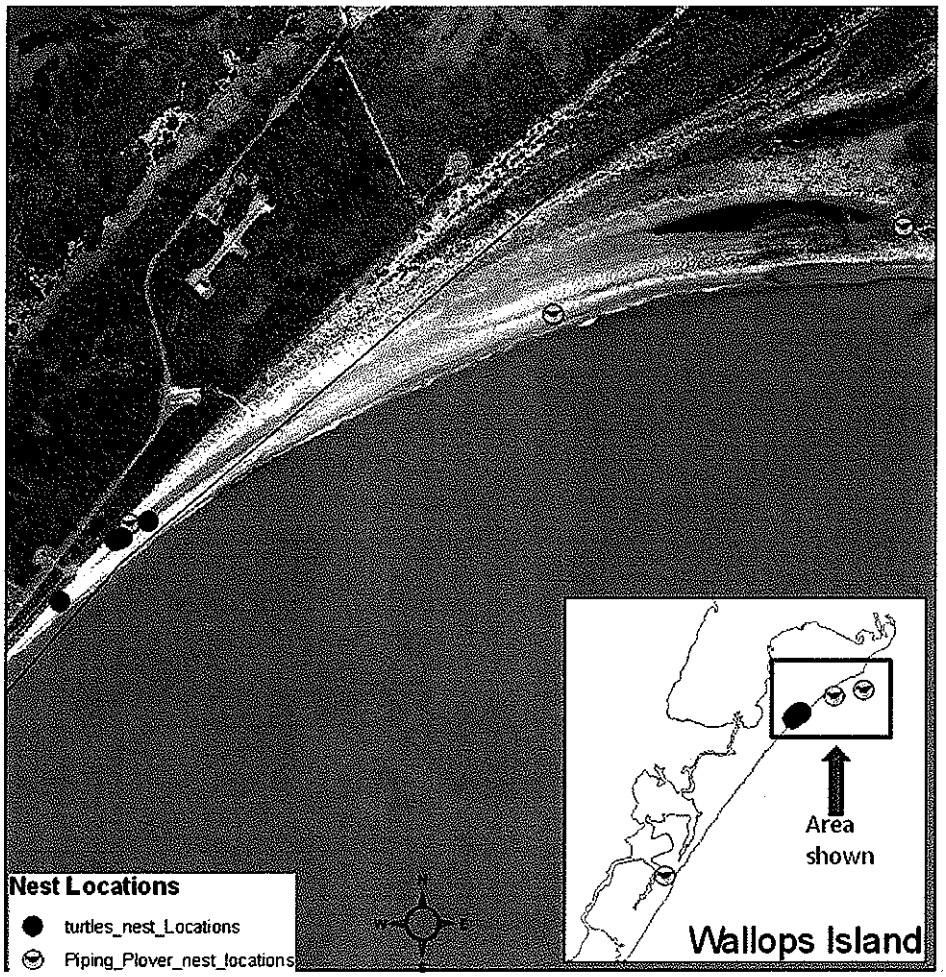

Figure 2. Sea turtle and plover nest locations on north Wallops Island in 2010.

During migration most of the plovers that nest farther north within the Atlantic population likely pass through the action area. This may involve birds passing through in flight, but many of these birds may stop and roost or feed on the beaches, tidal flats, and overwash areas within the action area. Little is known about the extent of use of the action area by migrating plovers beyond knowledge that they use the area.

Seabeach Amaranth - Seabeach amaranth surveys have been conducted on Assateague Island 12 times since 1966, with 9 of those surveys performed on an annual basis between 2001 and 2009. All surveys were negative except for a single plant discovered in the Hook in 2004. Assawoman and Metompkin Islands were surveyed for the first time in 2009 and no plants were found. No additional occurrences are known within the action area. Seabeach amaranth routinely occurs on the Wild Beach portion of Assateague Island just north of the action area. No surveys for this species have been conducted on Wallops Island to date, and the species has not been documented there despite the presence of suitable habitat.

Sea Turtles - Loggerhead sea turtles have occasionally nested within the action area. In mid-July 2008, a loggerhead nest was discovered by NASA personnel on north Wallops Island. Following flood inundation from several fall storms, CNWR personnel recovered approximately 170 eggs from the nest in October 2008. None were viable. In addition to this nest occurrence on WFF, a low level of loggerhead sea turtle nesting has become relatively common on CNWR.

Although green sea turtles and leatherback sea turtles are not known to have nested within the action area, the action area falls within the geographic range in which both species have shown nesting behavior. In 1996, a leatherback was seen displaying nesting behavior in daylight on the Maryland portion of Assateague Island National Seashore. Although a possible egg cavity was found on the beach, no eggs were discovered (Rabon et al. 2003). In 2006, a leatherback carcass was discovered on the southern tip of Assawoman Island at Gargatha Inlet.

A green sea turtle nest was recorded near Sandbridge, Virginia in 2005 outside of the action area (SeaTurtle.org 2006). Green sea turtles are present within the waters of the action area and there may be potential for nesting within the action area.

Nesting behavior is most often detected by the presence of crawl tracks turtles leave in the sand as they traverse the beach. CNWR staff document evidence of sea turtle nesting within the action area as tracks are discovered and conduct surveys for turtle nesting primarily in conjunction with plover monitoring. The following table presents recorded nesting behavior for sea turtles within the action area (Service 2009d).

Table 7. Sea Turtle Nest Activity 1974-2009 (Service 2009d).

Location	False Crawls	Nests	Unknown Crawl Type	Total Activity
Assawoman	1	0	0	1
Wallops	7	5	0	12
Hook	18	3	0	21
Overwash	6	4	0	10

To date in 2010, NASA personnel and contractors have reported four loggerhead sea turtle nests on north Wallops Island within NASA's recreational beach area (Figure 2). All of the nests have had the presence of eggs confirmed. In addition, NASA personnel documented a false crawl in the narrow beach in front of the seawall near the northern extent of the existing seawall. The turtle crawled ashore, but did not appear to nest. The tracks indicated that it encountered the seawall on at least three attempts to move farther landward before returning to sea.

Factors Affecting Species Environment Within the Action Area

A suite of existing actions affect listed species on Wallops Island; these involve flight operations and support operations associated with WFF. Of those, some are performed by NASA while others are performed by various military branches, MARS, and private contractors of these organizations. The activities include ongoing rocket launches and related training, testing, and

preparation; maintenance of existing buildings and infrastructure, including the existing shoreline stabilization structures; and operation of UAVs and aircraft overhead, primarily launched from Wallops Main Base. NASA and its contractors also conduct security patrols, surveys and monitoring for a variety of species and resources to support planning future actions, and other similar activities peripheral to NASA's primary mission also occur on Wallops Island. Many of these ongoing operations are considered in the Service's May 2010 biological opinion on NASA's Launch Range Expansion.

On Service lands, personnel actively manage invasive vegetation within action area. Phragmites (*Phragmites australis*) is found on the Hook and Overwash areas of Assateague Island. The Service, VDGIF, TNC, contractors, and universities conduct surveys for breeding birds, sea turtle nests, and seabeach amaranth throughout the action area each year. Predator control to benefit piping plovers and sea turtles during the nesting season affects both plover and sea turtle reproduction within the action area. Mammalian and avian predator control is conducted on Wallops Island.

Recreational use of the northern portion of Wallops Island (NASA personnel after-hours recreational area) occurs seasonally, with most activity occurring in spring and summer months. On CNWR, limited seasonal use of vehicles on the beach occurs. Other recreational use includes wildlife observation, sunbathing, and other typical beach recreation. CNWR staff posts signage and implement closures to aid in protecting sensitive resources and routinely patrol the beach and recreational use areas.

Storms and ocean currents contribute to erosion, accretion, and sand transport along the islands within the action area. Storms occur frequently, with widely varying effects on the shoreline and beach habitats. Both tropical storms and nor-easters (winter low pressure systems that tend to hug the Atlantic coast) can greatly alter the profile and amount of beach habitat among years, and these storms are what creates and maintains the overwash areas where most plovers nest. The existing seawall protects WFF from damage from storms and large waves. Little to no sandy beach exists on the seaward side of the wall and the shoreline seaward of the wall has been steepened by the presence of the seawall and the scour that results when waves encounter the seawall.

NASA reports an erosion rate of 3.3 m/year on southern Wallops Island, and there is little to no beach remaining seaward of the geotubes and seawall installed to protect sensitive infrastructure. In contrast, the beach on the north end of Wallops Island has been rapidly accreting. The beach and dune habitat found on the seaward side of the north end of Wallops Island is prone to natural beach stabilization and vegetation succession proceeding from sheltered areas toward areas more exposed to overwash and erosion during storms. This can render areas unsuitable for piping plover use and sea turtle nesting. The feature known as Fishing Point, the southernmost point of land on the Hook section of CNWR, has also been rapidly accreting. This mass movement of sand dictates where exposed sandy beach habitat will be available for piping plovers and sea turtles in any given year.

Sea level rise has affected the shoreline and beach habitats in the region. Combined with coastal storms, sea level rise has contributed to accelerated coastal erosion and shoreline change within the past few decades. The effects of sea level rise and climate change are difficult to distinguish from the natural coastal processes, but will continue to contribute to coastal change.

Wild bean (*Strophostyles holvola*) has been discovered on the southern end of Assawoman Island. The growth habit of this native plant may limit piping plover nesting habitat on the island in the future. Asiatic sand sedge has been found on the beach dune near the southern end of Wallops Island. This invasive exotic species has not spread significantly from where it was first observed, but it represents a potential threat because of its potential to spread and reduce the suitability of habitat for plovers, seabeach amaranth, and possibly sea turtles.

Recreational boating and fishing is common immediately offshore of all of the islands within the action area, and some boat landings and recreational use of the otherwise inaccessible beaches occurs, both permitted and illegally. The Chincoteague inlet is a maintained channel that provides boat passage from the ocean to Chincoteague Bay, and this well-used channel is located between CNWR and Wallops Island. These activities may result in disturbance to listed species on the beach, and boat traffic results in incremental increases in risk of contaminants (e.g., fuel and oil spills).

Navy and NASA facilities on Wallops Island are equipped with exterior lights at ground level, along catwalks, and at Federal Aviation Administration mandated heights for aircraft orienteering. Exterior lights can disorient hatchling sea turtles and may cause them to crawl toward the light rather than into the surf (NASA 2010a).

EFFECTS OF THE ACTION

The effects of the proposed action are discussed separately for the initial beach reconstruction, which includes the seawall extension and repair, placement of sand, and creation of a beach; expansion of WFF and ongoing operations; and the subsequent renourishment for the 50-year life of the project. To be conservative with respect to the species in this analysis when there is uncertainty in the range or type of effects that may result from the proposed action, we assess the effects that are most detrimental.

INITIAL BEACH RECONSTRUCTION

Seawall Extension and Repair - Construction of the seawall is expected to result in disturbance to any plovers and sea turtles that occur in the vicinity of the narrow beach where the construction activities will occur. During the period when plovers are nesting, they are not expected to occur in the area because of the limited amount of suitable nesting habitat. During migration and after nesting, plovers may occasionally forage along the beach or fly through the area while traveling among other foraging areas in the region. The construction activity, including noise, operation of vehicles, and presence of construction personnel may result in temporary disturbance. In

response, plovers are expected to fly away from the location where the activity is occurring or alter their flight path to avoid the activity.

During the period when sea turtles are nesting they are expected to occur in the area, but not in abundant numbers because of the limited amount of suitable nesting habitat. The noise and vibrations from heavy equipment may temporarily disturb sea turtles in the area. Any sea turtles in the vicinity are expected to move away from the immediate vicinity of construction activity. Because construction will occur in areas that may become shallowly inundated during high tides or periods of heavy wave action, the construction activity is expected to result in nearshore sediment suspension that will increase the turbidity and reduce visibility within the nearshore environment. Small quantities of fuel and oil (< 1 gallon) are also expected to enter the water as a result of equipment working in wetted areas. Any sea turtles in these areas or moving through these areas may experience temporary reductions in visibility resulting from the turbidity; less frequently, temporary reductions in visibility may occur from contaminants. Small quantities of fuel and oil may result in death or impairment of invertebrate prey of piping plovers within very limited areas. While toxicity to plovers is unlikely to occur, reduction in prey may reduce the suitability of habitat in affected areas.

These effects, if they occur, are expected primarily in spring, summer, and fall months when these species are expected to occur in the region. During the winter, these effects are not anticipated because the species are not expected to occur in the area.

If any seabeach amaranth plants occur within the construction area, they are likely to be killed, crushed, or uprooted by construction activity. Outside of the growing season, amaranth seeds may be buried or moved into unsuitable conditions as a result of construction activity. Because seabeach amaranth is not known to occur in the project area and the construction area does not include likely amaranth habitat, these potential effects are unlikely to occur.

Once completed, the presence of the seawall is expected to change local patterns of erosion and the characteristics of the shoreline and beach in the vicinity of the seawall. The increased scour in the immediate area is expected to result in loss of sediment near the seaward toe of the seawall and steepening of the shoreline in front of the seawall. At the southern terminus of the seawall extension, erosion is expected to increase due to the altered wave action and eddying that occurs when waves encounter an object. The Corps (2010) modeling indicated that the presence of the seawall will result in a loss of approximately 13.2 ft of beach within the first 3,000 ft south of the terminus of the seawall in their projections for a 1,500 foot extension which is most similar to the proposed design. This increased erosion is expected to extend approximately 5,000 ft southward, to just south of the Assawoman Inlet. The beach immediately south of the seawall extension is narrow and degraded due to erosion, and geotubes were placed in this area several years ago. The increased erosion is expected to further erode the shoreline seaward of the geotubes and reduce its already limited suitability for plovers and seabeach amaranth. No sea turtle nesting is expected in the vicinity.

Because the proposed action includes beach and dune renourishment following the seawall extension, the effects of the increased erosion are expected to be of relatively short duration. If the addition of sand is accomplished within one year of the seawall completion, it is unlikely that the accelerated erosion will result in the extent of beach loss predicted in the Corps (2010) document.

Dredging/Sand Placement - Because the operation of the dredge is limited to offshore areas and will not affect the shoreline beyond the delivery of sand, it will not affect the species considered in this opinion under the Service's jurisdiction; the effects to sea turtles at sea are addressed through NASA's section 7 consultation with NMFS.

The operation of heavy equipment on Wallops Island, the presence of personnel on the beach in conjunction with sand placement, the presence of surveyors, and associated support activities will result in disturbance to piping plovers using the area for foraging or passing through the area while moving among foraging areas in the vicinity. Any plovers using these areas are expected to temporarily cease normal foraging, roosting, or flight behavior and fly to adjacent suitable areas where there is not disturbance or alter their flight paths to avoid areas where activity is occurring. Similarly, sea turtles during nesting season may be temporarily disturbed by on-shore construction activities and move to other nearby areas where there is no disturbance. The suitability of the beach for plovers and sea turtles in the area where these activities will be occurring is low, and these effects are consequently expected to be small.

The placement of sand may bury any seabeach amaranth plants that occur on the beach. Because of the low likelihood of seabeach amaranth occurring within the construction area, this potential effect is unlikely. Seeds of seabeach amaranth may be similarly buried, preventing their germination or transport to other areas of more suitable habitat.

Pumping of sand slurry to the beach will result in increased turbidity in the nearshore waters as suspended fines return to sea leaving the heavier sand on the beach. Turbidity is expected to occur during sand pumpout, as well as a period after pumpout when the fine sediments left in or on the newly created beach following pumpout are resuspended by normal wave action or by storm-associated wave action. This increased turbidity may affect sea turtle behavior as they prepare to come ashore to nest, and may affect behavior and orienting of any hatchling sea turtles entering the nearshore waters. Depending on the location and extent of turbidity, sea turtles may also avoid adjacent beaches. Because nearshore sediment movement is northward along the northern section of Wallops Island, the turbidity may reduce the likelihood of turtles nesting on the north Wallops beach where nesting occurred in 2010, and may affect the survival of any hatchlings that result from nesting in that area.

The operation of heavy earthmoving equipment and other equipment involved in pumping and moving sand is expected to result in small amounts of fuel, oil, lubricants, and other contaminants entering the water. Small quantities of these substances may result in death or impairment of invertebrate prey of piping plovers within limited areas. While toxicity to plovers

is unlikely to occur, reduction in prey may reduce the suitability of habitat for plovers in affected areas.

The addition of sand dredged from the offshore shoal may result in a beach that is similar to a natural beach in appearance, but will be significantly different from a natural beach in sand density and compaction, grain size and assortment, and beach-associated fauna, including invertebrates, and the nutrients and chemical characteristics of the sand. A review of the effects of renourishment on beach fauna, including piping plover, sea turtles, and seabeach amaranth is provided within the Committee on Beach Nourishment and Protection, National Research Council (1995), and the discussion below describes many of the factors addressed in the book as they relate to this project.

The existing beach and associated plants and animals that occur within the area prior to beach reconstruction will be buried deeply during placement of sand, and many of them will only return to the beach through recolonization from adjacent areas. Some species are likely to recolonize the area within a few months, but other species, such as some of the flies, insects, and crustaceans may require much longer as a result of long life cycles. These species are prey for piping plovers and as a result of this difference in the beach habitat, suitability for plovers is expected to be significantly lower than at a natural beach of similar size and configuration. Over time, the faunal characteristics of a natural beach are expected to return as the created beach is recolonized by beach-associated fauna and plants, and as wave action, wind, rain, and other natural forces weather the beach. After recolonization of the beach by invertebrates, the beach may become higher quality foraging habitat for plovers than surrounding natural beaches because the beach will remain free from vegetation for a period of time (Melvin et al. 1991) and may be higher and wider than nearby eroding beaches.

The physical characteristics of the beach will affect the suitability for sea turtle nesting. Because of the relatively extensive beach following reconstruction and the relatively high elevation of the proposed berm compared to many natural beaches in the area, the newly created beach may be appealing as a nesting area to sea turtles in the area. In 2010, a false crawl and a nest occurred at the location where the beach will be placed, and some sea turtle nesting on the beach is expected.

Because the sand differs from other beaches in the area (sand grain size is almost twice that of the natural beach on north Wallops Island), the suitability for sea turtle nesting may differ from natural beaches. NASA stated in the draft PEIS that the sand placed on the beach would be similar to sand on the beaches in the area, but information on sand characteristics is not available with the exception of information on sand grain size which indicated that the sand to be used for initial beach reconstruction from shoal A was over twice the average diameter of sand on north Wallops Island.

Crain et al. (1995) conclude that the effects of a beach renourishment on sea turtle nesting is not predictable based on other renourishments, and potential effects should be considered on a case-by-case basis. The sand characteristics following beach and dune reconstruction are unlikely to be similar to those that occur on natural beaches in the area, especially shortly after deposition.

The characteristics that may be important to sea turtle nesting include gas exchange, moisture characteristics (drainage, desiccation, water potential), temperature, soil cohesion/shear characteristics, compaction, and others (Crain et al. 1995, Byrd 2004). The material that is placed will likely differ in some or all of these characteristics.

Based on the large grain size of the sand from shoal A, the relatively long distance from the water line to the berm/dune interface where turtles would be expected to nest, and that sand will be placed over and around the rock seawall for most of the project area, desiccation may be expected because the sand will likely drain quickly, the rock seawall will interfere with maintaining a natural moisture gradient, and the area may be infrequently affected by waves. The sand color is expected to be similar to that which occurs on the beaches of the area because the material that occurs in the offshore shoals is eventually transported to the beaches and likely originates from the same material as that which occurs on the beach. However, any differences in color, grain size, and moisture content may affect sand temperatures. Because the gender of sea turtles is determined by incubation temperatures, even relatively slight changes in sand temperature may alter the sex ratio of hatchlings. The large grain size is expected to maintain gas exchange that is appropriate for sea turtle egg development. The cohesiveness and shear characteristics of the sand are likely to differ from natural beaches in the area due to the relatively large grain size, and less cohesiveness and lower sheer strength are expected. This characteristic is not expected to interfere with adult females excavating an egg chamber, but it may reduce the ability of nestlings to emerge from the egg chamber under some conditions. Compaction of the sand is expected to occur as a result of the use of heavy equipment and pumping of heavy slurry during sand placement. The amount of equipment use and the associated degree of compaction is not known, but due to the need to place sand over the seawall and contour the beach to design specifications, compaction is expected to occur. This compaction can reduce the ability of females to excavate an egg chamber, and can also reduce gas exchange, drainage, and other sand characteristics.

Crain et al. (1995) and Byrd (2004) note that differences in turtle use and turtle nest success between nourished and natural beaches reduce over time. As wave action weathers the beach profile and re-sorts the sediments, the suitability for turtle nesting changes. Because the characteristics and the relative suitability of the beaches in the area for sea turtle nesting are not well known it is not possible to accurately predict the success of sea turtle nesting attempts that may occur within the area following beach and dune reconstruction. It is possible that the beach will be more suitable for sea turtle nesting than other beaches in the area due to its relatively high elevation and different sand characteristics, and nest attempts may be successful. However, nest failure and reduced rates of hatchling emergence are expected to occur on this beach due to one or more of the factors described above.

Following placement of the sand, beachgrass planting and sand fence installation will occur on the seaward side of the dune adjacent to the new beach. Depending on the timing of the installation, it may result in disturbance to piping plovers and sea turtles utilizing the beach shortly after construction. This disturbance is expected to cause plovers to flush and move to other areas and sea turtles nesting may result in false crawls and selection of other sites for

nesting. Planting and sand fence installation are expected to occur shortly after construction of the beach and dune. Consequently, these activities will occur before seabeach amaranth has a chance to become established, and no effects to seabeach amaranth are expected.

The presence of sand fence may affect sea turtles and plovers. The planned installation of the sand fence is expected to allow movement of adult sea turtles above the berm and into the dune area, and if turtles enter this area for nesting the sand fence design will not inhibit them from returning to sea. If nestling sea turtles hatch landward of the sand fence they will be able to move around sand fence sections to reach the sea, but because of their small size and relatively limited mobility on land, sand fence has the potential to entrap a small fraction of hatchling turtles, particularly if sand fence is not maintained or if other debris becomes entangled in the sand fence that prevents hatchling movements. The presence of sand fence may also deter plover nesting close to the sand fence and may increase the risk of plover depredation by providing cover for predators in close proximity to plover nests. Presence of sand fence may capture and retain seeds of seabeach amaranth, but may also collect sand at a rate that prevents seabeach amaranth from becoming well established.

Following the initial placement of sand on the beach and dune, some portion of this material will be transported onto the natural beaches adjacent to the project area. Because of the expected sand transport patterns, the sand is expected to move to the north and be deposited on north Wallops Island and portions of CNWR, and also to the south, where it will be deposited on Assawoman Island. The amount and degree of deposition on these islands is unknown and is dependent on the environmental conditions, storms, wave action, and other factors that may affect littoral sand transport. Over time, the deposition of the relatively large sand grains will affect the mean sand grain size and other physical characteristics of these beaches. These changes may either improve or reduce the suitability of beaches for plover nesting and foraging, seabeach amaranth establishment and survival, and sea turtle nesting and nest success. These changes will result in degradation of habitat, reducing the nesting success of plover and sea turtles and reducing use of the adjacent beaches by sea turtles, plovers, and seabeach amaranth.

EXPANSION OF WALLOPS FLIGHT FACILITY AND ONGOING OPERATIONS

The beach and dune reconstruction and renourishment as proposed will create foraging habitat for plovers or nesting habitat for plovers and sea turtles. This new and more suitable foraging and nesting habitat in the vicinity of the existing seawall is likely to result in increased use of this area by plovers and sea turtles, and an increased likelihood of seabeach amaranth occurring. The proximity of this new beach habitat to NASA activities and infrastructure increases the potential effects of NASA and Navy activities affecting these species. The Service's May 2010 biological opinion analyzed the effects of NASA's WFF Expansion and Infrastructure Improvements and ongoing operations on sea turtles, piping plovers, and seabeach amaranth. The types of effects discussed in that biological opinion will occur with greater intensity/severity and increased frequency as a result of the placement of potential habitat in close proximity to the activities considered in that biological opinion.

Through the 50 year life of the project, the amount and suitability habitat in close proximity to NASA's primary operations is expected to change. Erosion is expected to begin to reduce the amount of habitat adjacent to NASA facilities as soon as the initial beach reconstruction is completed, and over time, the beach is likely to become unsuitable for plover nesting and possibly sea turtle nesting as well. Following each beach renourishment event, the amount of habitat will increase such that it may again support plover and turtle nesting and conditions appropriate for establishment of seabeach amaranth. As these changes in habitat occur, the amount of effect is also expected to change as a result of changes in habitat use by the listed species. Because the use of the habitat is not readily predictable, we assume that an elevated level of effect occurs as long as a beach remains seaward of the seawall. The increased level of effects resulting from NASA's operations is discussed below. Additional description of the types of effects can be found in the May 10, 2010 biological opinion.

Noise - Ignition of rocket engines for orbital launches or static tests would produce instantaneous noise audible for a considerable distance from Launch Complex 0. In close proximity to the launch sites, within the area where the beach and dune reconstruction will occur, the noise generated will be high intensity across a broad range of frequencies. Sound intensity may exceed 160 dB on the beach and dune in close proximity to launch sites. The WFF Range Safety Office, using the NASA rocket size/noise equation (NASA 2009), estimated noise levels expected to occur during launches of envelope vehicles from each launch pad in the complex. An LMLV-3(8) rocket launched from pad 0-B will produce a noise level of 129 dB at 1.1 km, attenuating to 108 dB up to 12.6 km from pad 0-B. As many as 12 such launches could be performed per year at pad 0-B. Noise levels from Taurus 2 rockets launched from pad 0-A would reach 124 dB within a 1.55 km radius, attenuating to 108 dB at a distance of 9.6 km from pad 0-A. Static tests would produce noise levels identical to those of Taurus 2 launches from pad 0-A. As many as 6 launches and 2 static tests could be performed per year at pad 0-A. These noise levels are expected to be sustained for 30 to 60 seconds during a launch and for up to 52 seconds during a static test. Following the beach reconstruction, piping plovers and sea turtle nests may occur within 100 m of the launch sites, and when they occur between 100 m and 1.55 km of launches, they will be subjected to high intensity sound.

Deafening is not expected at the decibel levels predicted at 1.1 to 1.5 km from launches, but progressively closer to the rockets, the noise intensity may reach levels that could cause tissue damage. While not known in birds specifically, sound intensity of near 180 dB can result in nearly instantaneous tissue damage (McKinley Health Center 2007). Exposure to noises within these radii could deafen piping plovers present during ignition if exposed to high intensity noise. Deafness would significantly impair a piping plover's ability to breed, shelter, and behave normally. In addition to deafening, low frequency and high intensity sound that would be expected in very close proximity to the launch sites may be debilitating and cause disorientation or loss of balance, but these effects are not well established (Leventhall et al. 2003). Birds may be able to recover from sound-induced deafening over time (Adler et al. 1995), but some period of deafness may result from loud noises. Birds may recover from disorientation and other sound-induced effects, but the amount of time required is not known for piping plovers. While

debilitated, birds will be subject to increased vulnerability to predators and physiological stress resulting from inability to detect and avoid predators, feed, care for eggs/young, and seek shelter.

Burger (1981) demonstrated startle effects in birds exposed to anthropogenic sound pressure of 108 dB. Within the area of the beach and dune reconstruction, sound of much greater intensity is expected to occur frequently during launches of the several different types of rockets. Plovers that are not debilitated by high intensity noise are expected to be disturbed by launches. Plovers exposed to these levels of sound are expected to exhibit a startle response that interferes with normal behaviors, including breeding, feeding, and sheltering. This may include flushing from nests when incubating eggs, interruption of feeding or courtship, or similar responses. Because most of the noises are of short duration, plovers are expected to return to normal behavior within a few minutes of the noise. The combination of the sound with a visual stimulus such as a rocket in flight is expected to exacerbate the startle response of the plovers, particularly for those in close proximity to the launch sites for which the visual and auditory disturbance will be very close together, likely resulting in additive disturbance. Because of the intensity of sound and proximity to the launches, plovers that nest within the new beach area may permanently abandon nests, or they may flush from nests temporarily.

Atmospheric noise has been demonstrated to prevent sea turtles from entering an area. Considering the close proximity of potential sea turtle nesting habitat, high intensity noise that occurs during rocket launches is expected to prevent sea turtles from coming ashore to nest near the launch pads. The intensity of noise close to launch pads may be sufficient to impair the development of sea turtle eggs. Sand above the eggs is expected to attenuate the sound, but the degree of attenuation is not known. Noise is not expected to have an effect on seabeach amaranth.

Vibration - Some energy from rocket launches and static tests on Wallops Island will manifest as vibration in the ground near the launch pad. Vibration may be significant from rocket launches, engine tests, and open burns. Effects from vibrations are likely to be confined to an additive disturbance to adult piping plovers and nesting sea turtles that may cause birds and turtles to temporarily cease normal behaviors. The close proximity of potential habitat to launch sites may result in vibrations significant enough to affect egg viability for both sea turtles and plovers nesting within the new beach. Vibrations are not expected to have an effect on seabeach amaranth.

Rocket Exhaust - Rocket exhaust from Pad 0-B is directed out over the Atlantic Ocean by a vent located in the base of the gantry. Exhaust from launches and static tests at Pad 0-A will be directed out over the Atlantic Ocean through a flame trench in the launch pad. Wildlife within 200 to 300 m of the exhaust ports during engine ignition is expected to be injured or killed. Piping plovers or sea turtles exposed directly to the exhaust could be burned by hot gas or by caustic combustion products.

Combustion products in solid propellant rocket exhaust include aluminum oxide particles and hydrogen chloride. These contaminants have the potential to affect wildlife in areas subjected to

the highest concentrations of these contaminants. Because the flame trench will direct the exhaust directly over portions of the newly created beach, on the new beach near the launch pads combustion products may reach a concentration that is toxic to piping plovers, sea turtles, or seabeach amaranth (NASA 2005, 2009), potentially resulting in physiological stress, injury, impairment, or death.

Aluminum oxide particles in the atmosphere are efficient scavengers of water vapor and hydrogen chloride, and these particles produce hydrochloric acid. Hydrogen chloride vapor may exist in hazardous quantities in the immediate vicinity of launch pad 0-B at the completion of a launch. Piping plovers, sea turtles, and their nests, as well as seabeach amaranth that occurs on the new beach near launch pads may be adversely affected (NASA 2005, 2009). In high concentrations, hydrogen chloride may damage tissues causing impairment, injury, or death. Carbon monoxide concentrations may temporarily reach levels that could affect plovers and sea turtles, but the concentrations are expected to decrease rapidly to levels that will be unlikely to cause significant effects. However, carbon monoxide may have a small additive adverse effect resulting in temporary impairment.

Aircraft Operation - Most of the effects of aircraft noise to listed species are similar to the effects of rocket noise discussed above. Plovers may be additionally disturbed by the operation of aircraft maneuvering or overflying the area where nesting occurs. In a 2004 letter, the Service concurred that operation of UAVs would not be likely to adversely affect plovers if they avoided known nesting areas by at least 1,000 ft. However, operation of aircraft, including UAVs, has potential to affect plovers outside of nesting season, and during nesting season if nests are not detected and avoided. Plovers are thought to be susceptible to this type of disturbance because they perceive aircraft as potential avian predators. Balloons may have a similar effect on plovers. However, not all aircraft operation is likely to result in disturbance, and plovers are most likely to be disturbed by flights at low altitude down the beach or just offshore. Because the new beach will be located immediately adjacent to the existing UAV runway, UAV operation is expected to disturb plovers attempting to use the area. Effects to plovers may include flushing from nests when incubating eggs, interruption of feeding or courtship, or similar responses. Because most of the aircraft activity is of short duration, plovers are expected to return to normal behavior after aircraft depart the area. Aircraft operations may also disturb sea turtles that are attempting to nest on the new beach or near the UAV runway. Effects to sea turtles may include aborted nesting attempts, delayed nesting attempts, or similar responses. Aircraft operations are not expected to affect seabeach amaranth.

Rocket and Equipment Transportation and Construction - Support activities prior to a rocket launch may disturb sea turtles attempting to nest and nesting plovers on the sound end of Wallops Island. Construction noise will be confined to the vicinity of Pad 0-A and existing infrastructure within Wallops Island and is not expected to result in more than minor behavioral responses. These activities are expected to result in temporary increases in ambient noise, lighting, and human activity, but these activities are mostly distant from beaches and suitable habitat. Any effects to sea turtles and piping plovers that result from the construction of these facilities or transportation of rocket parts between them and the launch complex on the south end

of the island are expected to be insignificant and discountable. Because these activities do not occur on the beach, they are not expected to adversely affect the seabeach amaranth.

Lighting - Rockets staged at Launch Complex 0 are uplit with metal halide lighting for two days prior to and two days following a launch. Other structures within the launch complex use amber LEDs or low pressure sodium bulbs for exterior night lighting. The close proximity of several facilities to the newly created beach is likely to result in elevated levels of light. Anthropogenic light sources have had documented negative effects on sea turtles. Adult females looking for nesting beaches seek dark stretches of suitable shoreline. Unshielded lights can deter females from crawling onto a beach to nest. Bright full-spectrum or white lighting within view from the beach can cause female sea turtles to abandon nest attempts. At hatching, juveniles emerge and seek the nearest available light source, which on an undeveloped beach is the horizon over the ocean. Bright full-spectrum or white lighting shining in the vicinity of a nest can disorient emerging hatchlings, leading them away from the ocean and leaving them more vulnerable to predation, desiccation, or crushing by vehicles. Hatchlings that have reached the surf can also become disoriented by lighting and have been documented to leave the surf (NMFS and Service 2007a). Some of these behavioral effects on adult turtles and disorientation of young turtles are expected to occur. Lighting is not expected to have an effect on seabeach amaranth.

Monitoring, Maintenance, and Security Patrols - Monitoring activities, maintenance activities, and security patrols on the newly created beach have similar effects on listed species because they may involve operation of vehicles on the beach, in addition to people on foot in areas where plovers, seabeach amaranth, and sea turtles may occur. Security patrols have been ongoing at WFF for a number of years, and have likely presented some level of disturbance to piping plovers and nesting sea turtles, and perhaps seabeach amaranth. The presence of vehicles or humans on foot is known to disturb piping plovers and sea turtles.

Effects of human activity to nesting piping plovers can range from relatively minor disturbance that temporarily interferes with normal breeding, feeding, and sheltering behavior to injury or death of plover chicks or destruction of an entire plover nest, or sustained disturbance resulting in nest abandonment. The presence of people near plover nests can result in disturbance, and foot traffic and vehicle use on the beach could crush nests, eggs, or hatchlings. Vehicles can also create ruts capable of trapping hatchlings.

Closure of a plover nesting area will avoid these effects within that area to the extent that the closure is observed, but plovers are expected to nest outside of the established closure area in some cases. In these cases, monitoring, placing nest exclosures, and posting signage will minimize the potential effects, but not avoid them. After hatching, young plovers may move away from nesting areas, making them vulnerable to these effects throughout a much larger area. Even with surveys and monitoring conducted at a high frequency, there is potential to disturb nesting that is not detected and injure or kill young plovers. Outside of the nesting season, it is likely that there is some small impact to plovers that migrate along the barrier islands during fall migration to their wintering grounds. This impact would be from interference with foraging due to human activity and vehicle use on the beaches.

Similar effects are expected for nesting sea turtles. Personnel conducting monitoring and maintenance, as well as security patrols may inadvertently disturb nesting females, crush eggs within the egg cavity, or crush, entrap, or disturb hatchlings attempting to leave the nest. Vehicle use on the beaches may compact beach sand and/or injure, kill, or disturb female turtles attempting to nest. Monitoring for turtle activity followed by erecting exclosures to protect nests will avoid some adverse impacts, but is not sufficient to avoid all impacts.

Indirect effects to piping plovers and sea turtles could include an increased predation rate due to human activity. Human activity may result in trash on the ground, which could both attract predators and increase the carrying capacity of the predators due to increased food availability. The increased numbers of predators may increase risk of disturbance, nest loss, and adult mortality of plovers and increase losses of sea turtle eggs and nests. Plovers may expend more energy in predator surveillance and avoidance and that energy expenditure could decrease overall fitness.

Crushing of seabeach amaranth plants by maintenance and monitoring personnel, security patrols, or other vehicles may occur in some circumstances. Conducting surveys to identify and protect plants will help to minimize these effects, but are not sufficient to avoid the adverse effects.

Interaction of Effects - Frequent disturbance to plovers and sea turtles resulting from mission preparation and support may disturb the species to the extent that they avoid use of the area. If they avoid use of the area, listed species may not be subjected to the most intense and severe effects expected to occur during rocket launches. In addition, because the suitability of the newly created beaches is expected to be relatively low for a period following placement, use by plovers and sea turtles may be reduced and as a result some of the most severe effects resulting from launches may be reduced. However, because some migrant plovers and nesting sea turtles use the beach only for limited periods of time, frequent disturbance and/or low habitat suitability is not expected to completely prevent the most severe impacts from occurring. Because seabeach amaranth is not affected by noise or disturbance, the interactions of effects are limited to plovers and sea turtles.

Summary of Effects – Initial Beach Reconstruction and Expansion of Wallops Flight Facility and Ongoing Operations

Because there is little or no suitable habitat for listed species in the project area currently, the direct effects are likely to be minimal. However, the indirect effects that result from creating beach and dune habitat of unknown quality and quantity in close proximity to an area that will be subjected to frequent and occasionally severe impacts from NASA operations is likely to result in effects including injury and death of individual piping plovers and sea turtles, and possibly seabeach amaranth. The indirect effects to piping plovers and sea turtles are expected to include increased disturbance and interference with normal behavior resulting in reduced feeding, breeding, and sheltering activity, and destruction/loss of eggs and young or failure of nests. The indirect effects to seabeach amaranth are limited to changes in the suitability of potential habitat resulting from contaminants and disturbance. The lack of certainty in the suitability of these

habitats and the manner and extent of the interactions among the different effects that are likely to occur makes accurate prediction of the effects impossible.

As a result of the low likelihood that leatherback and green sea turtles will occur in the action area and be adversely affected by the on-going and proposed actions described above, we believe that effects described above are insignificant and discountable for these species.

FUTURE BEACH RENOURISHMENT

Most of the types of effects of future renourishment are similar to those discussed for the initial placement of material. The operation of equipment involved in sand pumpout and placement may disturb piping plover breeding, feeding, and sheltering; interfere with sea turtle nesting; and effect seabeach amaranth seed germination and transport. Because future beach renourishment will likely occur when a beach is present, the effects on species are likely to be greater than those that occur during the initial beach and dune reconstruction.

When renourishment is conducted, the beach and berm are expected to have eroded to the point where nesting by plovers is unlikely within the area identified to receive renourishment. Consequently, the effects of renourishment are expected to be limited to disturbance to migrant plovers that may be using the area for feeding and sheltering. Sea turtle nesting may still occur on the beaches when renourishment is planned, but NASA expects to avoid sand placement that may affect nests, and monitoring is expected to determine the locations of nests prior to placement. These nests may be subject to reduced hatch success as a result of changes in the moisture regime, gas exchange, and physical characteristics of the beach that result from adjacent sand placement and operation of heavy equipment in the general vicinity of the nests.

Seabeach amaranth may occur on the beaches where renourishment is planned. Because most of the plants would be expected to occur on the upper berm or dune, NASA intends to avoid placement of sand that would kill plants, and renourishment is not expected to directly affect plants, with the exception of any individuals that are not identified. However, renourishment is expected to affect seeds, and will likely result in burying or destruction of approximately half of the seeds that occur on the renourished beach.

Use of North Wallops Island Borrow Area - In future renourishment efforts, NASA may obtain up to half of the sand for renourishment from the north Wallops Island borrow area instead of from offshore shoals. Because the delineated borrow area either includes or is immediately adjacent to areas where piping plovers and sea turtles nest and to seabeach amaranth habitat, this borrow activity has the potential to directly and indirectly affect these species.

The operation of heavy equipment on the beach will result in disturbance of all plovers that use the area for foraging or nesting. Outside of the nesting season this disturbance is expected to result in frequent alteration of feeding and sheltering behavior for plovers, causing physiological stress and increased vulnerability to predators. If the activity is conducted during nesting season, it is expected to interfere with all aspects of breeding including territory establishment, courtship,

nesting, egg-laying, incubation, brooding, and feeding. This is expected to result in lack of nesting, failure of nests, or mortality of chicks.

Similarly, such activity is expected to deter sea turtle nesting through frequent disturbance or result in reduced hatch success and hatchling survival by increasing the chance of crushing nests, eggs, and hatchlings; compacting the sand in the nesting area; and trapping hatchling turtles in vehicle ruts. Equipment use on the beach at night may result in injury or death of female sea turtles attempting to nest and hatchling turtles on the beach.

Sand excavation and operation of heavy equipment on the beach may also uproot or crush seabeach amaranth and remove, bury, or destroy seeds that may be present.

Following completion of the sand excavation, the resulting changes in the beach profile will decrease its suitability for all listed species. Because the borrow area is the most seaward portion of the beach, the remaining beach will have a steeper initial profile, be more vegetated, and have different physical properties (e.g., sand grain characteristics, drainage) than a natural beach. These characteristics make it less suitable for use by sea turtles, plovers, and seabeach amaranth. As wave action and weathering affect the beach position and profile, vegetation is killed or uprooted by wave action, and the beach contour, sediment stratification, and other characteristics return, the new beach suitability and the amount of available potential habitat is expected to improve. The beach conditions are expected to be completely unsuitable for use by nesting plovers and sea turtles during the first year following sand excavation, with limited amounts of suitable habitat available one year following excavation, and returning to conditions similar to those that existed prior to excavation by three years following excavation.

Accretion of the beach in the borrow area, which has been occurring for several years, is expected to continue, resulting in gradual expansion of the beach following each sand excavation action. However, the use of the north Wallops Island borrow area is expected to prevent any expansion or increase in the availability, occupancy, or use of habitat on north Wallops Island by plovers, sea turtles, or seabeach amaranth.

Sand Transport and Renourishment - Movement of sand material from the borrow area to the renourishment area along the beach using heavy equipment will result in extensive sand compaction on the beaches of both north Wallops Island and in the renourished area. This compaction is expected to reduce the suitability for sea turtle nesting for a period of at least two years. Similar to the effects identified in the initial beach /dune reconstruction, the sand that is placed on the renourished beach will initially be unsuitable for use by the invertebrates and plants characteristic of natural beaches, and much of the fauna on the beach will be killed or adversely impacted by the renourishment. Use of the north Wallops Island borrow area may allow some faster recovery of flora and fauna if seeds or fauna in the sand survive transportation and placement, but because at least half of the renourishment material will originate from offshore shoals the difference is not expected to significantly improve the recovery time of beach-associated flora and fauna.

In NASA's BA and draft PEIS, they state that renourishment activities will avoid direct impacts to nesting plovers and sea turtles. The extensive amount of time that may be required to conduct renourishment may not always allow NASA to complete renourishment outside of periods when these species are nesting, but through NASA's monitoring program, nesting activity will be located prior to construction and areas where nesting is occurring will be avoided. Avoiding direct impacts to plover and sea turtle nesting activity and seabeach amaranth during the excavation of sand from the north Wallops Island borrow area and the placement of sand on the beach will reduce impacts, but the increased activity in the vicinity of the listed species may still result in reduced nesting success and survival.

For the purposes of the analysis, the effects of the future renourishment, including both excavation of sand from the north Wallops Island borrow area as described in the draft PEIS and the placement of the sand, is expected to result in loss of up to four piping plover nests (up to 16 eggs/chicks) in the first breeding season following each renourishment cycle. If borrow and renourishment is conducted during breeding season, that season is the one in which complete reproductive failure is expected. The action is also expected to result in loss of two plover nests (up to 8 eggs/chicks), through either nest failure or adults failing to nest, in the year following renourishment for each renourishment cycle.

Failure of up to two sea turtle nests, including all eggs, is expected to occur within the first year following each beach renourishment cycle, and one additional nest is expected to fail in the second year following each beach renourishment. In addition, injury or death of one adult sea turtle during beach renourishment and associated activities is expected to occur within each beach renourishment cycle.

Because detailed plans of future renourishment activities are not available, the actual effects that result may vary significantly. For example, if the north Wallops Island borrow area is not used and future renourishments are conducted using only material from offshore shoals, almost all of the direct adverse effects could be avoided. Additionally, because of the general nature of the consideration of future renourishment within the draft PEIS, it is foreseeable that the effects could exceed those anticipated in some or all of the future renourishment actions. As a result, the analysis of effects is limited to the general scenario described and considered within the draft PEIS, and it is not possible to consider the detailed effects that may result. Consequently, consultation will be required on all future proposed renourishment actions in conjunction with the detailed design of each project and the development and consideration of each NEPA evaluation that is tiered to the SRIPP PEIS.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. The Service is unaware of any cumulative effects to listed species within the action area.

CONCLUSION

After reviewing the status of the piping plover, green sea turtle, leatherback sea turtle, loggerhead sea turtle, seabeach amaranth, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program, as proposed, is not likely to jeopardize the continued existence of these species and is not likely to destroy or adversely modify designated critical habitat. Critical habitat has been designated for the piping plover and sea turtles, but no critical habitat occurs within the action area for these species.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns, which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are nondiscretionary, and must be undertaken by NASA for the exemption in section 7(o)(2) to apply. NASA has a continuing duty to regulate the activity covered by this incidental take statement. If NASA (1) fails to assume and implement the terms and conditions or (2) fails to require any applicant/contractor to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to any permit or grant document, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, NASA must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement.

Regarding the seabeach amaranth, sections 7(b)(4) and 7(o)(2) of the ESA generally do not apply to listed plants. However, limited protection of listed plants from take is provided to the extent that the ESA prohibits the removal and reduction to possession of federally listed endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on non-federal areas in violation of state law or regulations or in the course of any violation of a state criminal trespass law.

AMOUNT OR EXTENT OF TAKE ANTICIPATED

The Service anticipates incidental take of piping plovers and sea turtles will be difficult to determine for the following reasons: finding a dead or injured individual may be difficult to detect and take may be masked by seasonal fluctuations in numbers and other environmental factors. The amount of take anticipated is based on historic and recent use of the action area by these species and the effects that are expected to occur as a result of the proposed actions.

Incidental take is discussed below in three sections as analyzed and discussed in the "Effects of the Proposed Action" section above. The amount of take anticipated in each section is not interchangeable. Take will be considered exceeded if the effects in one section or effects of a particular activity in one section result in a greater amount of take than is anticipated for that section or specific type of activity, respectively.

The Service will not refer the incidental take of any migratory bird for prosecution under the Migratory Bird Treaty Act if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

INITIAL BEACH RECONSTRUCTION

Piping plover - No plover nesting is expected to occur within the construction area prior to construction, and consequently, no take of breeding plovers, nests, eggs, or young is anticipated to occur during initial beach reconstruction. Take in the form of harassment is anticipated when migrant plovers, which includes adults and young-of-the year, use the beach reconstruction area and adjacent areas for foraging and roosting after the end of the breeding season. Take in the form of harm is anticipated as habitat is lost due to increased erosion resulting from the seawall extension, the reduction in prey resulting from contaminants associated with construction activities, and the lack of prey in sand initially placed to create the beach/dune. Because of the low quality of habitat within and immediately adjacent to the construction area, the amount of incidental take is expected to be small. Therefore, take of up to one post-fledging plover per year for three years beginning when construction of the seawall is initiated may occur as a result of harassment and harm.

Sea turtles - The initial beach reconstruction is anticipated to result in take in the form of injury or death of one adult loggerhead sea turtle through crushing a female that has come up on the beach to nest. In addition, take of one loggerhead sea turtle nest is anticipated as a result of reconstruction activity on the beach encountering a nest that had not been identified through surveys and monitoring. This could occur as inadvertent excavation, operation of equipment over the nest resulting in compaction or crushing of the contents, burying to a depth that would prevent egg development or hatchling emergence, or placement of equipment and materials such as slurry pipes, sand stockpile embankments, or similar features.

Take in the form of harassment is anticipated during initial beach reconstruction through increased turbidity in nearshore waters that affect the likelihood adult loggerhead sea turtles will

come ashore to nest, and affect the ability of hatchling loggerhead sea turtles to orient in the nearshore waters once they depart the shore. The amount of take anticipated is one nest per year for three years beginning when construction of the seawall is initiated. The take can be manifest as the failure of one adult female loggerhead sea turtle to nest or as the loss of up to all hatchlings from one loggerhead sea turtle nest, or an equivalent number of hatchlings from several nests due to disorientation, increased susceptibility to predators, and similar effects. If take occurs as injury or death of hatchlings, the number of hatchlings equivalent to one nest is assumed to be 128.

Take in the form of harm is anticipated as a result of erosion occurring adjacent to the seawall extension prior to placing sand and following placement of sand on the beach and dune if the material is unsuitable to support all aspects of nesting. This includes loss of nests due to erosion of the beach as the beach profile adjusts to the local wave action and changes in physical and environmental characteristics resulting from construction. This includes incidental take resulting from females being unable to excavate an adequate egg chamber; characteristics of gas exchange, soil moisture, temperature, or other factors that prevent normal embryonic development; and soil characteristics that prevent hatchlings from digging out of the egg chamber to the sand surface. Take of four nests per year for the first three years following the initiation of sand placement is anticipated as a result of these factors.

No green sea turtle or leatherback sea turtle take or nest loss is expected to occur due to the low likelihood of nesting or occurrence of these species on Wallops Island, and no incidental take of these species is anticipated.

EXPANSION OF WALLOPS FLIGHT FACILITY AND ONGOING OPERATIONS

The Service's May 10, 2010 biological opinion, which addressed the Wallops Flight Facility Expansion and Infrastructure Improvement and ongoing NASA operations, anticipated incidental take. This opinion provides additional incidental take for the adverse effects that will result from the placement of suitable habitat in close proximity to NASA launch facilities, the UAV runway, and additional infrastructure. This incidental take begins when sand placement associated with the beach and dune reconstruction is initiated and ends either when renourishment of the reconstructed beach is initiated or10 years following the placement of sand, whichever occurs first. The incidental take does not extend beyond that period because after 10 years, the sand placed during initial beach and dune reconstruction is expected to have eroded sufficiently to preclude most use by plovers and sea turtles and consequently avoid the incidental take considered in this section. Future conditions beyond this period are sufficiently uncertain such that the amount of incidental take is not reasonably foreseeable due to anticipated changes in habitat conditions and characteristics.

Piping Plover - Incidental take in the form of injury or death of adult and post-fledging young plovers is anticipated from the effects of launch-related activities immediately adjacent to the beach, resulting from intense sound, exposure to rocket exhaust and contaminants, and similar launch activities. Take of two plovers per year is anticipated.

Take in the form of harassment is anticipated as a result of mission-related and maintenance activities in close proximity to the new beach and dune. Take of one adult or post-fledging young plover per year and three plover nests (or 12 plover chicks) per year is anticipated. This is expected to occur due to severe disturbance to plovers nesting near NASA facilities during rocket launches, UAV operations, and similar activities, and also due to disturbance to nesting plovers and their young and inadvertent crushing of chicks or nests that may occur as a result of proposed shoreline monitoring and maintenance of the SRIPP conducted in conjunction with this project.

Sea Turtles - Incidental take in the form of injury or death of two adult loggerhead sea turtles is anticipated, resulting from exposure to intense sound or exhaust gases and contaminants released during launch of rockets. Incidental take in the form of harassment, injury, or death of eggs or young, including hatchlings, of four loggerhead sea turtle nests is anticipated, resulting from the noise, vibration, and contaminants that may affect hatch success and survival. Incidental take in the form of harassment of two nests per year is anticipated as a result of adult female loggerhead sea turtles being disturbed by activity to the extent that they fail to nest, and disorientation of hatchling turtles resulting by mission-related lighting such as up-lighting of rockets prior to and following launches. The take can be manifest as the failure of two adult female loggerhead sea turtles to nest or as the loss of up to all hatchlings from two loggerhead sea turtle nests, or an equivalent number of hatchlings from several nests due to disorientation, increased susceptibility to predators, and similar effects. If take occurs as injury or death of hatchlings, the number of hatchlings equivalent to two nests is assumed to be 256.

No green sea turtle or leatherback sea turtle take or nest loss is expected to occur due to the low likelihood of nesting or occurrence of these species on Wallops Island, and no incidental take of these species is anticipated.

FUTURE BEACH RENOURISHMENT

No incidental take is anticipated in this biological opinion for the effects of future beach renourishment. The SRIPP draft PEIS provides the expectation that future renourishment, if and when it is conducted, will be designed based on the needs and conditions at the time and evaluated in tiered EAs. Incidental take will be anticipated, if appropriate, in future consultations on these projects based on their specific designs and characteristics. Any future incidental take resulting from the effects of mission-related activities on listed species that may use the renourished beaches will be addressed in future biological opinions.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat. The action area encompasses a relatively small portion of the rangewide habitat of each of the species addressed in this opinion and a small portion of each species' population. The proposed action includes a variety of protective measures that are intended to minimize

incidental take. For these reasons, the effect of the take anticipated in this biological opinion is not expected to significantly affect any of the species considered.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of listed species:

1. Conduct routine surveys and monitoring for the species addressed in this biological opinion and implement measures to avoid potential impacts whenever possible.

2. Conduct surveys and monitoring to determine the effects of the proposed action on listed species and their habitat.

3. Actively manage habitats and human activity on the beaches to avoid and minimize potential impacts to listed species.

TERMS AND CONDITIONS

To be exempt from the prohibitions of section 9 of the ESA, NASA must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are nondiscretionary.

1. Fully implement the activities related to listed species within chapter five of the SRIPP draft PEIS: Mitigation and Monitoring Plan, for seawall extension, offshore dredging, and sand placement activities. NASA must provide an annual report summarizing the survey and monitoring efforts, the location and status of all occurrences of protected species that are recorded, and any additional relevant information. Reports will be provided to the Service's Virginia Field Office in digital format, at the address, provided on the letterhead by December 31 of each year.

2. Develop a training and familiarization program for all personnel conducting construction activities and NASA operations in areas where listed species may occur. This training program shall include basic biological information about all listed species and be sufficient to allow personnel to tentatively identify the species and its likely habitat to allow them to incorporate appropriate avoidance and minimization measures into their activities.

3. Excavation of sand from the north Wallops Island borrow area for future renourishments must occur outside of plover and sea turtle nesting season (March 15 through November 30 or the last date of potential sea turtle hatchling emergence based on laying dates of all nests). Sand may be stockpiled outside of the north Wallops Island borrow area, and

outside of potential nesting habitat for plovers and sea turtles prior to placement for renourishment.

4. Following launches of rockets that produce an expected sound intensity > 150 dB seaward of the dune or seawall, surveys must be conducted for injured, dead, or impaired birds and wildlife. These surveys must be conducted as soon as possible following launches and within 2 hours of the launch or the first daylight following launch. If surveys cannot be conducted within this period, NASA shall place remotely operated video cameras on the beach to document and record the responses of plovers and similar birds and any sea turtles following launches. Cameras will be placed a maximum of 100 meters apart and extend to the limit of the projected area where sound intensity is expected to exceed 150 dB. Surveys for dead, injured, or impaired wildlife must still be conducted as soon as possible following a launch, in addition to the use of cameras. Reports/DVDs will be provided to the Service's Virginia Field Office in digital format, at the address provided on the letterhead, within 15 days of each launch event.

5. Concentrations of contaminants (hydrogen chloride, aluminum oxide, and other potentially toxic substances) predicted to occur within rocket exhaust gases must be measured on the beach in closest proximity to the flame trench following launches involving use of solid propellants. Measurements must be made daily until the levels reach background levels or conservative estimated non-toxic levels of these contaminants for birds, sea turtles, and other wildlife species. This information must be used to develop accurate expectations of exposure to contaminants on the beaches over time following a launch. Measurements must be made, analyzed, and submitted to the Service for at least the first five launches that occur following the placement of beach and dune adjacent to NASA infrastructure. Reports will be provided to the Service's Virginia Field Office in digital format, at the address provided on the letterhead, within 30 days of each launch event.

6. Report any evidence of potential nesting activity of green sea turtles or leatherback sea turtles on Wallops Island to the Service's Virginia Field Office, at the address provided on the letterhead, within one business day of observing the activity.

7. Care must be taken in handling any dead specimens of proposed or listed species that are found to preserve biological material in the best possible state. In conjunction with the preservation of any dead specimens, the finder has the responsibility to ensure that evidence intrinsic to determining the cause of death of the specimen is not unnecessarily disturbed. The finding of dead specimens does not imply enforcement proceedings pursuant to the ESA. The reporting of dead specimens is required to enable the Service to determine if take is reached or exceeded and to ensure that the terms and conditions are appropriate and effective. Upon locating a dead specimen, notify the Service's Virginia Law Enforcement Office at 804-771-2883, 7721 South Laburnum Avenue, Richmond, Virginia 23231, and the Service's Virginia Field Office at 804-693-6694 at the address provided on the letterhead above.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to further minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. The Service recommends that NASA work with the Service to develop a candidate conservation agreement for the red knot. The information provided in the BA and the NASA Protected Species Management Plan will provide a good foundation for such an agreement.

2. NASA should develop an integrated habitat conservation and management plan for Wallops Island. Due to the significance of the area for the conservation of migratory birds and other species, nearly all of the habitats that occur on WFF provide value to these species, and active efforts to manage them, including activities such as control of non-native invasive plants and similar activities may significantly improve the value of these areas as habitat.

3. NASA is encouraged to collect data on the characteristics of beaches and habitat where sea turtle nests and plover nests occur and share this information with the Service and VDGIF, or work with other interested parties to develop protocols for data collection and analysis throughout Virginia to improve our understanding of important habitat characteristics.

For the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in the request. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

If you have any questions, please contact Tylan Dean of this office at 804-693-6694, extension 166.

Sincerely,

Cindy Schulz
Supervisor
Virginia Field Office

Enclosures

cc: USACE, Norfolk VA (attn: Robert Cole, Craig Seltzer)
BOEMRE, Herndon, VA (attn: Dirk Herkhof)
FWS, Chincoteague NWR, Chincoteague, VA (attn: Lou Hinds)
VDGIF, Richmond, VA (attn: Ruth Boettcher, Ray Fernald)
VDACS, Richmond, VA (attn: Keith Tignor)
VDCR, Richmond, VA (attn: Rene Hypes)
TNC, Charlottesville, VA (attn: Gwynn Crichton)

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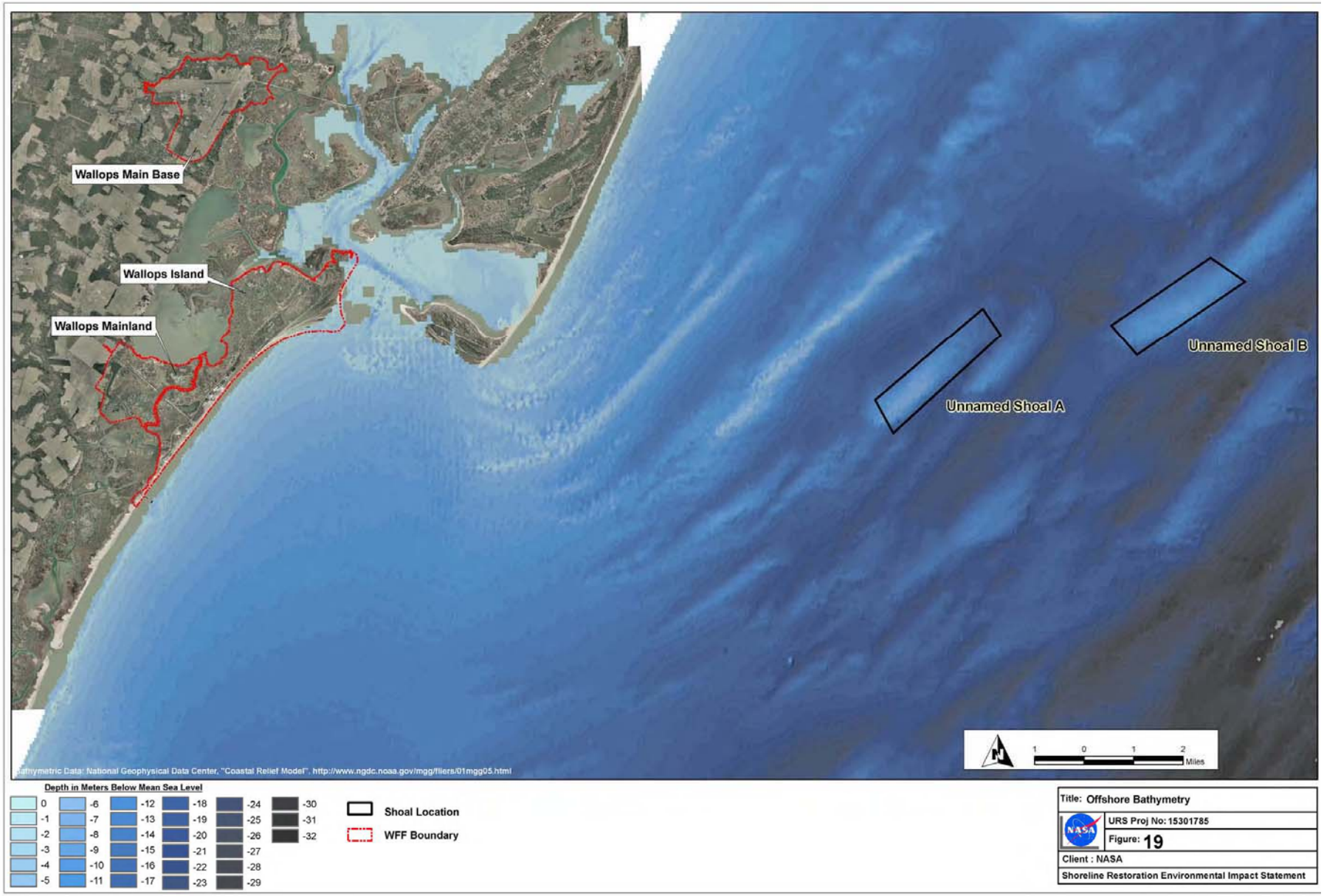
APPENDIX 1

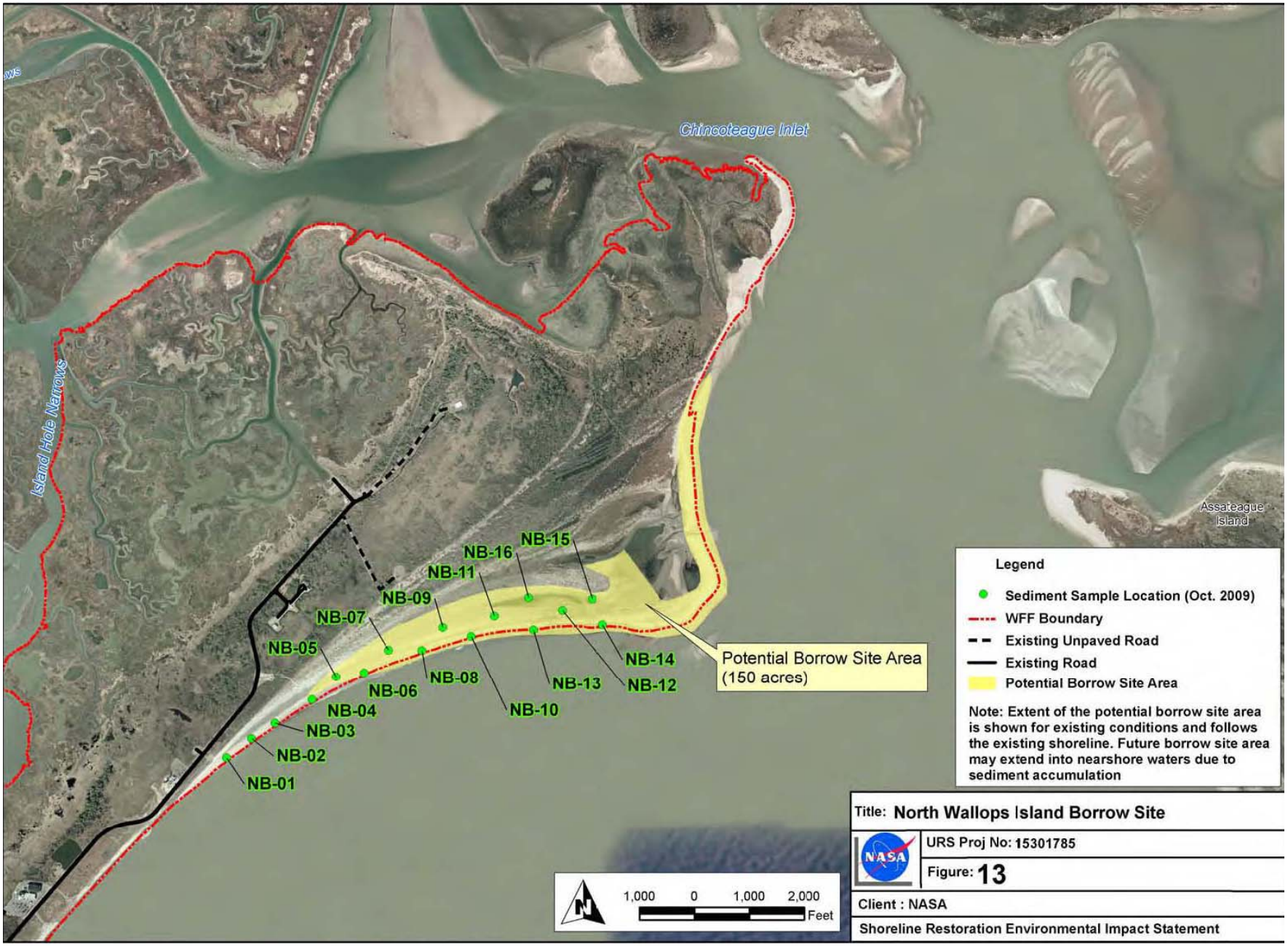
LOCATION, EXTENT, AND DESIGN OF SRIPP PROJECT FEATURES

LOCATION AND EXTENT OF PROPOSED SEAWALL AND BEACH RECONSTRUCTION

LOCATION OF PROPOSED OFFSHORE SAND BORROW AREAS



LOCATION AND EXTENT OF PROPOSED NORTH WALLOPS ISLAND BORROW AREA



SHORELINE DAMAGE REDUCTION PROJECT
SEAWALL REPAIR AND EXTENSION
NASA WALLOPS ISLAND
ACCOMACK COUNTY, VIRGINIA

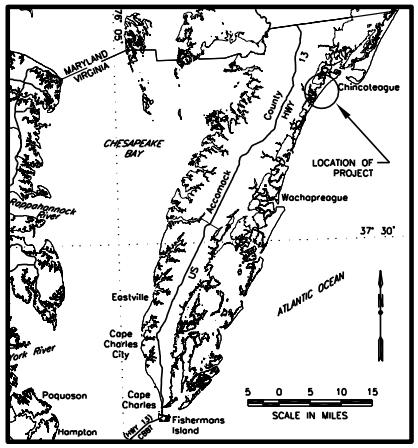
JUNE 2010

LEGEND

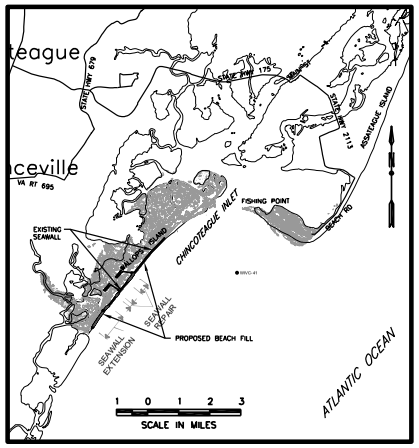
ITEM	EXISTING	PROPOSED
LIMIT OF DISTURBANCE	N/A	LOD
IMPERVIOUS SURFACED ROAD, DRIVE OR LOT		N/A
FENCE		x x x
DRAINAGE DITCH OR SWALE		N/A
EMBANKMENT SIDESLOPES (DOWN)		
CONTOUR	5	4.0
ELEVATION SPOT SHOT	x 6.50	5.00
BENCH MARK		N/A
PROPERTY LINE		N/A
CONSTRUCTION LINE	N/A	
TRAVERSE POINT & LINE		N/A
BUILDING OR STRUCTURE		N/A
SILT FENCE	N/A	SF
STABILIZED CONSTRUCTION ENTRANCE	N/A	SCE
STONE		
GRAVEL DRIVE		N/A

LIST OF ABBREVIATIONS

ADC	ALEXANDRIA DRAFTING COMPANY
AMA	ANDREWS, MILLER & ASSOCIATES
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
CD	CONSTRUCTION DOCUMENTS
DIA	DIAMETER
D.I.P	DUCTILE IRON PIPE
E	EAST
EIS	ENVIRONMENT IMPACT STATEMENT
ELEV	ELEVATION
H	HORIZONTAL
INV	INVERT
LB.	POUNDS
LOD	LIMIT OF DISTURBANCE
MEC	MUNITIONS & EXPLOSIVES OF CONCERN
MHW	MEAN HIGH WATER
MLW	MEAN LOW WATER
N	NORTH
NAVD	NORTH AMERICAN VERTICAL DATUM
NASA	NATIONAL AERONAUTICS & SPACE ADMINISTRATION
OCEW	ON CENTER EACH WAY
O.D.	OUTSIDE DIAMETER
RCP	REINFORCED CONCRETE PIPE
SCE	STABILIZED CONSTRUCTION ENTRANCE
SF	SILT FENCE
STA	STATION
TYP.	TYPICAL
USACE	UNITED STATES ARMY CORPS OF ENGINEERS
V	VERTICAL



VICINITY MAP



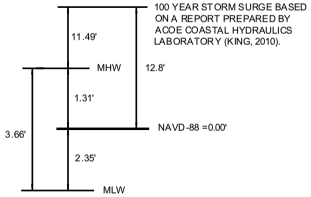
LOCATION MAP

GENERAL NOTES

1. THE EXISTING UTILITIES AND OBSTRUCTIONS SHOWN ARE FROM THE BEST AVAILABLE RECORDS AND SHALL BE VERIFIED BY THE CONTRACTOR TO HIS SATISFACTION PRIOR TO CONSTRUCTION.
2. NECESSARY PRECAUTIONS SHALL BE TAKEN BY THE CONTRACTOR TO PROTECT EXISTING SERVICES AND STRUCTURES. ANY DAMAGE TO THEM SHALL BE REPAIRED IMMEDIATELY AT HIS OWN EXPENSE.
3. IT SHALL BE DISTINCTLY UNDERSTOOD THAT FAILURE TO MENTION SPECIFICALLY ANY WORK WHICH WOULD NATURALLY BE REQUIRED TO COMPLETE THE PROJECT SHALL NOT RELIEVE THE CONTRACTOR OF HIS RESPONSIBILITY TO COMPLETE SUCH WORK.
4. PUBLISHED MEAN TIDAL RANGE IS 3.66 FEET.
5. TOPOGRAPHIC & BATHYMETRIC DATA WAS PROVIDED BY USACE AND IS BASED UPON NAVD 88. LIMITED SURVEYING LOCATED LANDWARD OF THE SEAWALL WAS PERFORMED BY AMA IN MAY 2010.
6. HORIZONTAL MERIDIAN IS BASED UPON NAD 83, VIRGINIA STATE PLANE, SOUTH
7. VERTICAL CONTROL IS BASED UPON NAVD 88.
8. PROPERTY LINES SHOWN ARE APPROXIMATE ONLY. THIS PLAN IS NOT INTENDED TO BE A PROPERTY LINE SURVEY.
9. DISTURBED AREAS WILL BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN FOUND. THIS INCLUDES THE TEMPORARY STAGING AND STONE STOCKPILE AREAS.
10. THE EXISTING BOTTOM AND SEAWALL PROFILES, BEACH CONTOUR AND/OR BANK ALIGNMENT SHOWN ON THE DRAWINGS WERE CORRECT WHEN SURVEYED. HOWEVER, BECAUSE OF THE INTERIM EROSION AND LITTORAL TRANSPORT, THE CONTRACTOR SHALL SATISFY HIMSELF AS TO ALL CONDITIONS AT THE TIME OF BIDDING THIS PROJECT AND INCLUDE IN HIS PROPOSAL ANY CHANGES THAT WOULD BE NECESSARY TO ACCOMPLISH A COMPLETE AND FUNCTIONAL PROJECT.

SCOPE OF WORK

BASE BID: SEAWALL EXTENSION (STA. 33+00A to STA. 46+15 = 1315 L.F.) LUMP SUM
OPTION 1: SEAWALL REPAIR (STA. 66+98 to STA. 73+48 = 650 L.F.) LUMP SUM
OPTION 2: SEAWALL REPAIR (STA. 97+08 to STA. 115+08 = 1800 L.F.) LUMP SUM
OPTION 3: SEAWALL EXTENSION (STA. 35+00 to STA. 0+15 = 3485 L.F.) LUMP SUM FOR EACH 100 L.F. CONTIGUOUS INCREMENT.



DATUM COMPARISON
NOT TO SCALE

INDEX TO DRAWINGS

SHEET NO.	TITLE	FILE NUMBER
C-1	COVER SHEET	
C-2	KEY SHEET	
C-3	PLAN VIEWS (3a,3b) : Sta. 0+15 to Sta. 19+47 (OPTION 3)	
C-4	PLAN VIEWS (4a,4b) : Sta. 19+47 to Sta. 42+00 (OPTION 3 / BASE BID)	
C-5	PLAN VIEWS (5a,5b) : Sta. 42+00 to Sta. 46+15 (BASE BID) ; Sta. 66+98 to Sta. 73+48 (OPTION 1)	
C-6	PLAN VIEWS (6a,6b) : Sta. 97+00 to Sta. 115+00 (OPTION 2)	
C-7	DETAILS	
C-8	SECTIONS (BASE BID / OPTION 3)	
C-9	SECTIONS (OPTION 1)	
C-10	SECTIONS (OPTION 2)	
C-11	SECTIONS (OPTION 2)	

SIGNATURES AFFIXED BELOW INDICATE OFFICIAL RECOMMENDATION AND APPROVAL OF ALL DRAWINGS IN THIS SET AS INDICATED ON INDEX OF DRAWINGS.

RECOMMENDED:

PROJECT MANAGER

APPROVED:

CHIEF, DESIGN BRANCH

APPROVED:

CHIEF, ENGINEERING DIVISION

APPROVED:

COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

APPROVED FOR:

DATE:

US Army Corps of Engineers
Norfolk District

SYM.	DATE	DESCRIPTION	BY	CHKD

DESIGNED E.T.F. | DRAWN G.O.W. | DATE 22 June 2010
CHECKED J.S.B. | SCALE 6/22/10 AS SHOWN
PROJECT NO. 00000 | NORFOLK DISTRICT FILE NO.
DRAWING NO. | SPECIFICATION NO.
LAST SAVED ON: | Plot Scale 1:1
FILE NAME: J:\ESDWG01\Boston\Plan.dwg

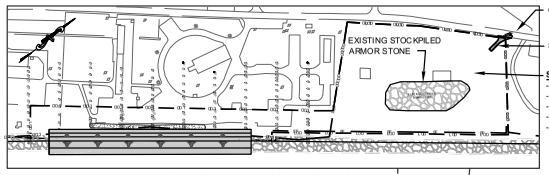
NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

COVER SHEET
NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
SEAWALL REPAIR AND EXTENSION
ACCOMACK COUNTY, VIRGINIA

C-1
SHEET 1 OF 11

PRE-FINAL SUBMITTAL

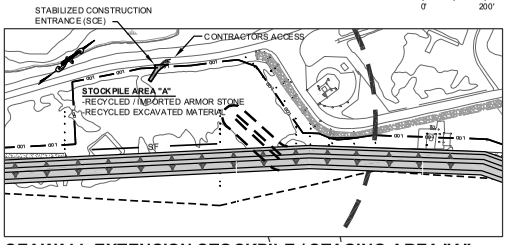


SEAWALL REPAIR STOCKPILE / STAGING AREA "B"

Scale: 1" = 200'

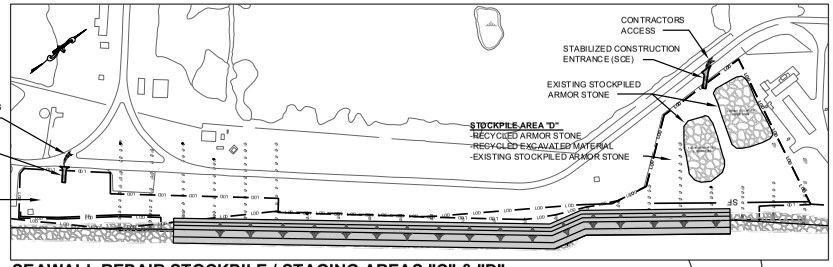
NOTES:

1. CONTRACTOR SHALL COORDINATE THE SPECIFIC LIMITS AND USAGE OF THE STOCKPILE AREAS WITH THE CONTRACTING OFFICER.
2. STOCKPILE SANDY MATERIAL EXCAVATED FOR THE NEW SEAWALL'S CONSTRUCTION FOR FUTURE USE AS BEACH FILL MATERIAL AT THE STOCKPILE AREAS SHOWN AND AS APPROVED BY THE CONTRACTING OFFICER. PLACE A SILT FENCE WITH WIRE SUPPORT AROUND THE PERIMETER OF THE STOCKPILED SANDY MATERIAL.
3. STOCKPILE ARMOR STONE REMOVED FROM DECONSTRUCTION OF THE EXISTING SEAWALL (FOR REUSE INTO THE NEW SEAWALL AS SPECIFIED IN "TYPICAL SEAWALL EXTENSION SECTION" AND "TYPICAL SEAWALL REPAIR SECTION"). PLACE A SILT FENCE WITH WIRE SUPPORT AROUND PERIMETER OF EXCESS ARMOR STONE THAT IS STOCKPILED AND NOT UTILIZED UNDER THIS CONTRACT.
4. AT THE CONCLUSION OF THE PROJECT, THE STOCKPILE AREAS AND DISTURBED AREAS SHALL BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN FOUND AT THE START OF CONSTRUCTION AS APPROVED BY THE CONTRACTING OFFICER.



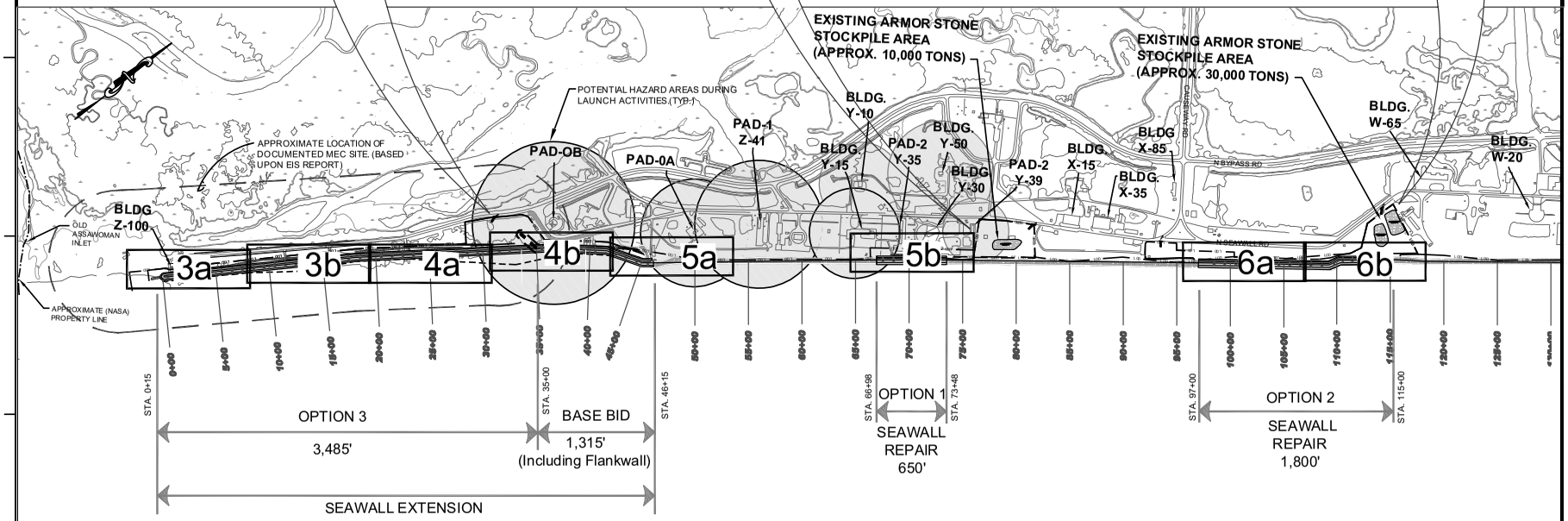
SEAWALL EXTENSION STOCKPILE / STAGING AREA "A"

Scale: 1" = 200'



SEAWALL REPAIR STOCKPILE / STAGING AREAS "C" & "D"

Scale: 1" = 200'



Scale: 1" = 500'

US Army Corps of Engineers
Norfolk District

SYM.	DATE	DESCRIPTION	BY	CHKD

DESIGNED E.T.F. | DRAWN J.S.B. | CHECKED C.O.W. | DATE 6/22/10 | DATE 22 June 2010 | SCALE As Shown

PROJECT NO. 00000 | DRAWING NO. | SPECIFICATION NO. | NORFOLK DISTRICT FILE NO.

File Name: /2010\00 - Revised Phasing | Plot Scale: 1:1

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

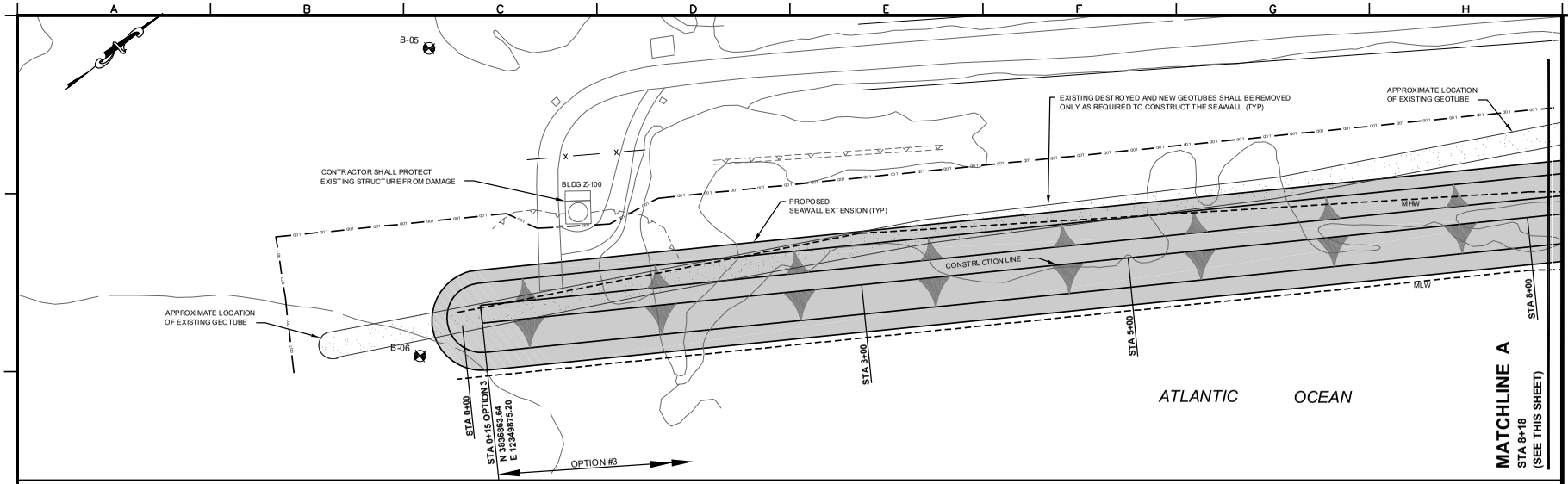
KEY SHEET

NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT SEAWALL REPAIR AND EXTENSION

ACCOMACK COUNTY, VIRGINIA

C-2
SHEET 2 OF 11

PRE-FINAL SUBMITTAL

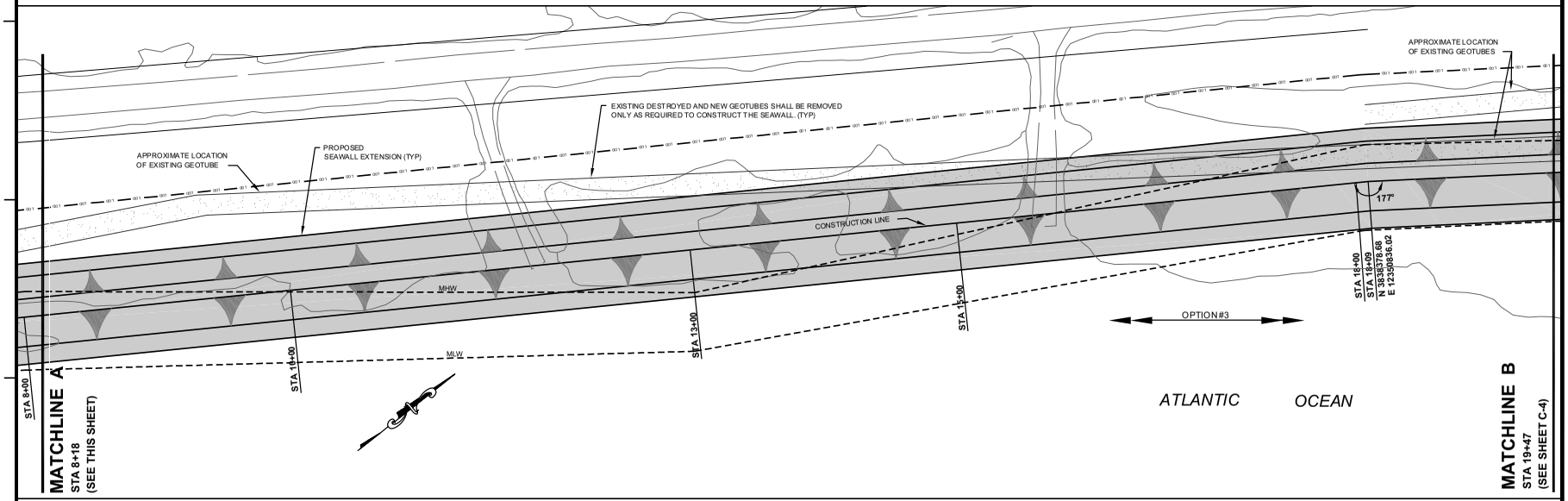


PLAN VIEW (3a) STA. 0+15 TO 8+18 (OPTION 3)

SCALE : 1" = 40'

0 20' 40'

NOTE: AT THE TIME OF AMA'S SURVEY, THE FACILITY WAS ACTIVELY PLACING NEW GEOTUBE ALONG THE SHORELINE. THE CONTRACTOR SHALL DETERMINE THE EXTENT OF NEW GEOTUBE PLACEMENT PRIOR TO SUBMITTING HIS BID.



PLAN VIEW (3b) STA. 8+18 TO 19+47 (OPTION 3)

SCALE : 1" = 40'

0 20' 40'

NOTE: AT THE TIME OF AMA'S SURVEY, THE FACILITY WAS ACTIVELY PLACING NEW GEOTUBE ALONG THE SHORELINE. THE CONTRACTOR SHALL DETERMINE THE EXTENT OF NEW GEOTUBE PLACEMENT PRIOR TO SUBMITTING HIS BID.

US Army Corps of Engineers
Norfolk District

SYM	DATE	DESCRIPTION	BY	CHKD

DESIGNED E.T.F. | DRAWN J.S.B. | CHECKED C.O.W. | DATE 6/22/10 | DATE 22 June 2010 | SCALE 1"=40' | PROJECT NO. 00000 | NORFOLK DISTRICT FILE NO. | DRAWING NO. | SPECIFICATION NO. | CAD SERVER DIR. | FILE NAME: /12200001-Bases/Plans.dwg | Plot Scale: 1:1

NORFOLK DISTRICT
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NORFOLK, VIRGINIA

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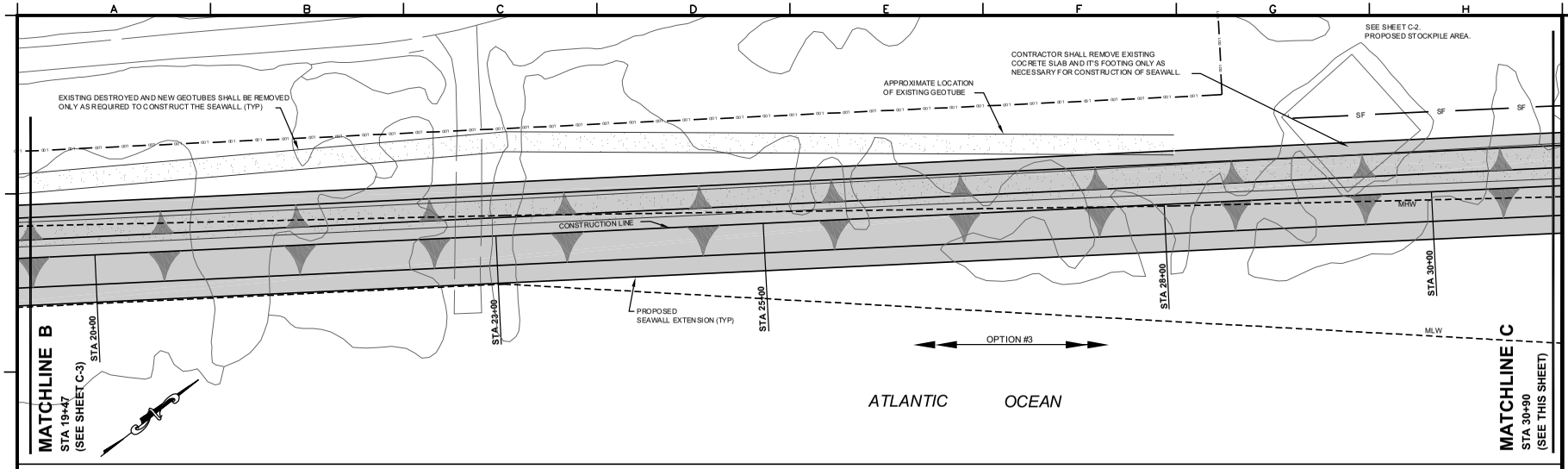
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

PLAN VIEWS : 3a & 3b STA 0+15 TO STA 19+47

NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
SEAWALL REPAIR AND EXTENSION
ACCOMACK COUNTY, VIRGINIA

C-3
SHEET 3 OF 11

PRE-FINAL SUBMITTAL

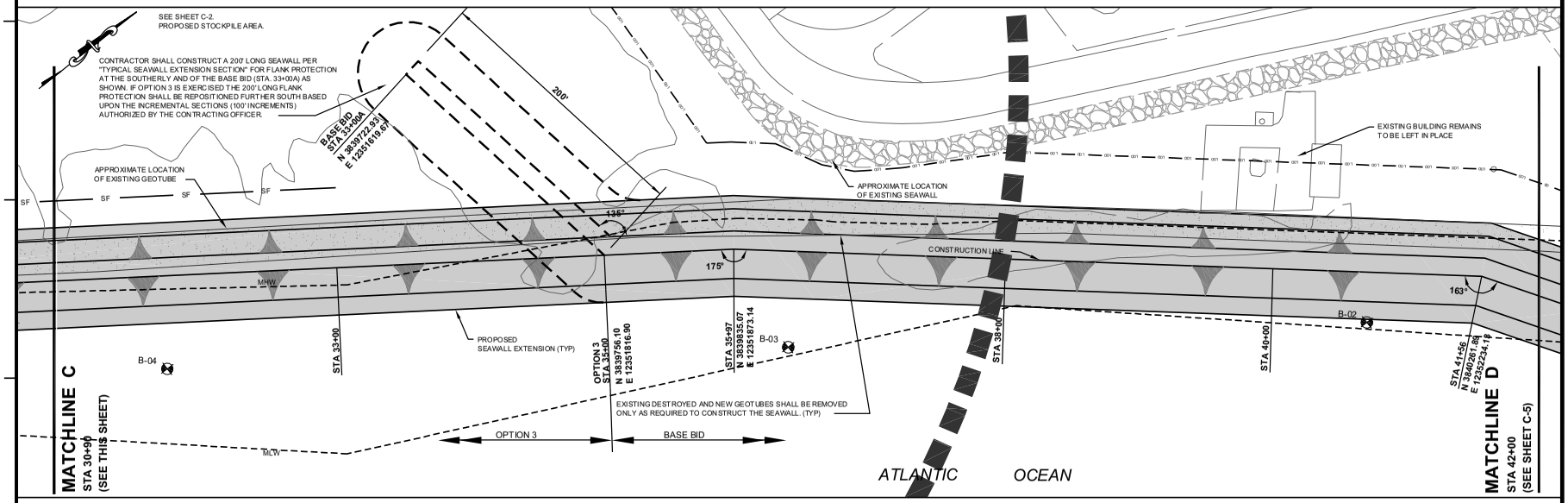


PLAN VIEW (4a) STA. 19+47 TO 30+90 (OPTION 3)

SCALE : 1" = 40'

0 20' 40'

NOTE: AT THE TIME OF AMA'S SURVEY, THE FACILITY WAS ACTIVELY PLACING NEW GEOTUBE ALONG THE SHORELINE. THE CONTRACTOR SHALL DETERMINE THE EXTENT OF NEW GEOTUBE PLACEMENT PRIOR TO SUBMITTING HIS BID.



PLAN VIEW (4b) STA. 30+90 TO 42+00 (OPTION 3 / BASE BID)

SCALE : 1" = 40'

0 20' 40'

NOTE: AT THE TIME OF AMA'S SURVEY, THE FACILITY WAS ACTIVELY PLACING NEW GEOTUBE ALONG THE SHORELINE. THE CONTRACTOR SHALL DETERMINE THE EXTENT OF NEW GEOTUBE PLACEMENT PRIOR TO SUBMITTING HIS BID.

US Army Corps of Engineers
Norfolk District

NO.	DATE	DESCRIPTION	BY	CHKD

DESIGNED E.T.F. | DRAWN J.S.B. | CHECKED C.O.W. | DATE 6/22/10 | DATE 22 June 2010 | SCALE 1"=40'

PROJECT NO. 00000 | DRAWING NO. | SPECIFICATION NO. | NORFOLK DISTRICT FILE NO.

CAD SERVER DIR. | FILE NAME: /2010\00001-Revised\Plan.dwg | Plot Scale: 1:1

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

PLAN VIEWS : 4a & 4b STA 19+47 TO STA 42+00

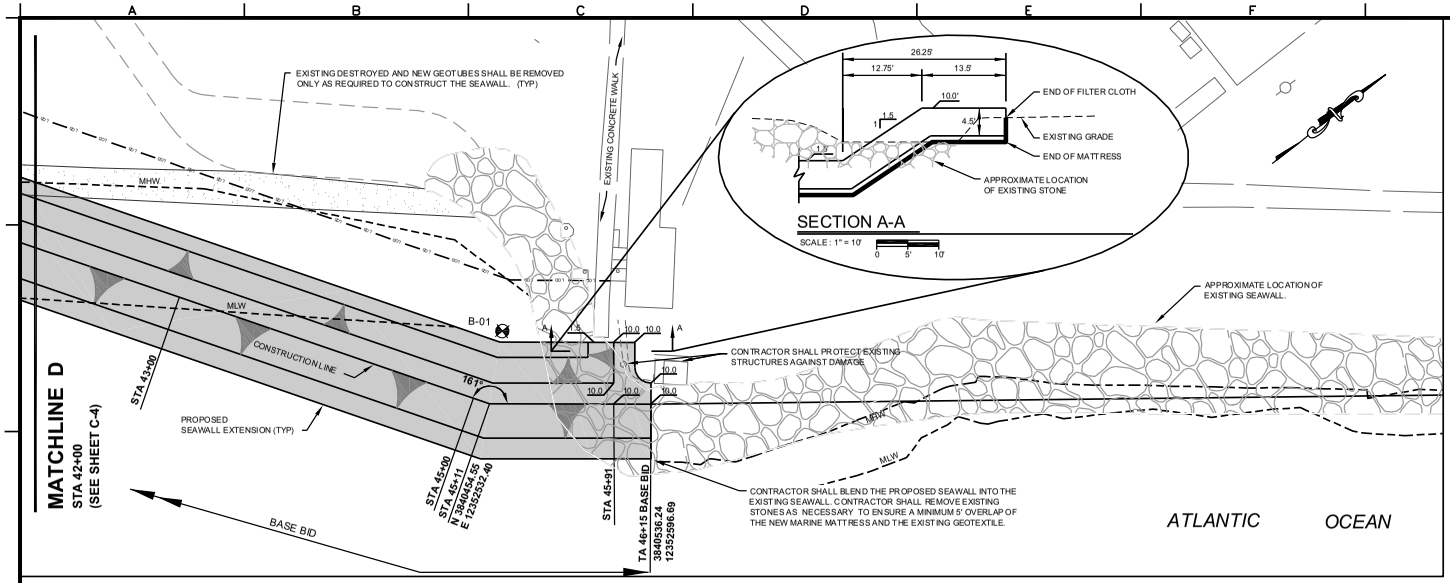
NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT SEAWALL REPAIR AND EXTENSION

ACCOMACK COUNTY, VIRGINIA

C-4

SHEET 4 OF 11

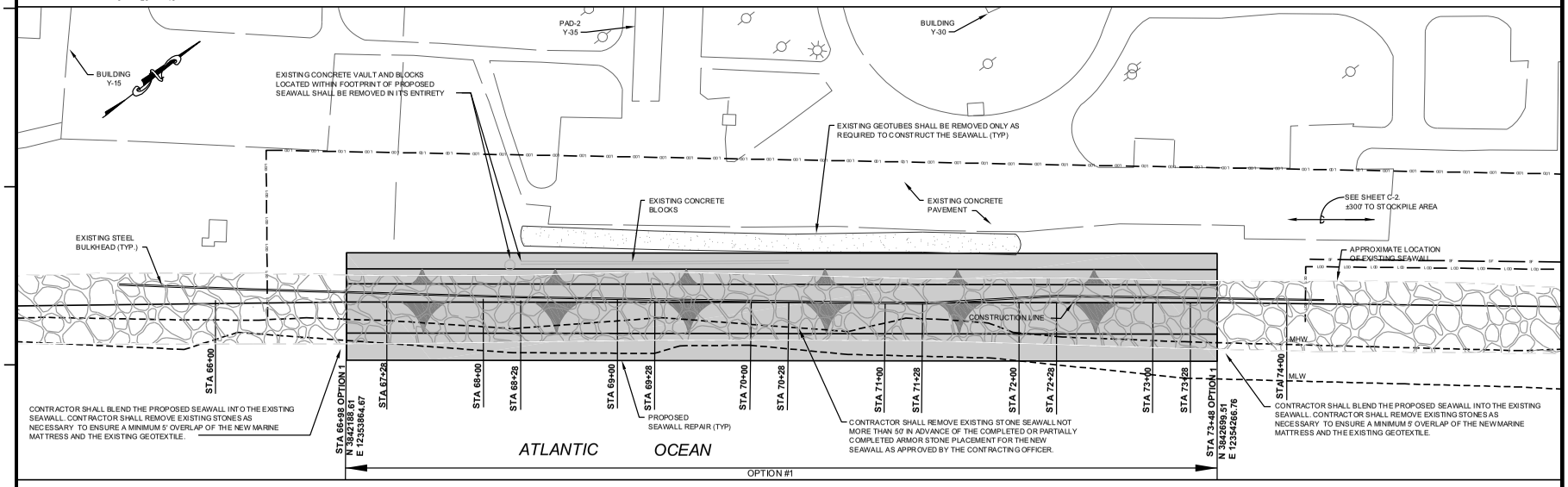
PRE-FINAL SUBMITTAL



PLAN VIEW (5a) STA. 42+00 TO 46+15 (BASE BID)

SCALE : 1" = 40'
0 20' 40'

NOTE: AT THE TIME OF AMA'S SURVEY, THE FACILITY WAS ACTIVELY PLACING NEW GEOTUBE ALONG THE SHORELINE. THE CONTRACTOR SHALL DETERMINE THE EXTENT OF NEW GEOTUBE PLACEMENT PRIOR TO SUBMITTING HIS BID.



PLAN VIEW (5b) STA. 66+98 TO 73+48 (OPTION 1)

SCALE : 1" = 40'
0 20' 40'

US Army Corps of Engineers
Norfolk District

SYM	DATE	DESCRIPTION	BY	CHKD

DESIGNED E.T.F. | DRAWN J.S.B. | CHECKED C.O.W. | DATE 6/22/10 | SCALE 1"=40' | DATE 22 June 2010

PROJECT NO. 00000 | NORFOLK DISTRICT FILE NO. | SPECIFICATION NO. | DRAWING NO.

LAST SAVED ON: Pre Save 11
FILE NAME: J:\2010\00 - Wallops\Plotting

NORFOLK DISTRICT
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NORFOLK, VIRGINIA

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401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

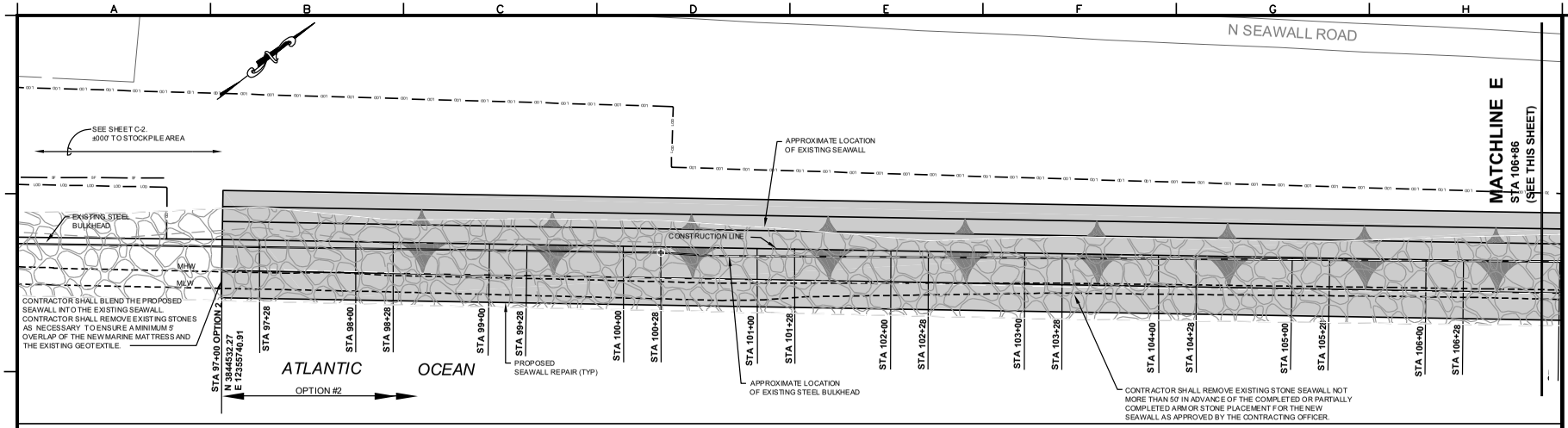
PLAN VIEWS : 5a STA 42+00 TO STA 46+15
5b STA 66+98 TO STA 73+48

NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT SEAWALL REPAIR AND EXTENSION

ACCOMACK COUNTY, VIRGINIA

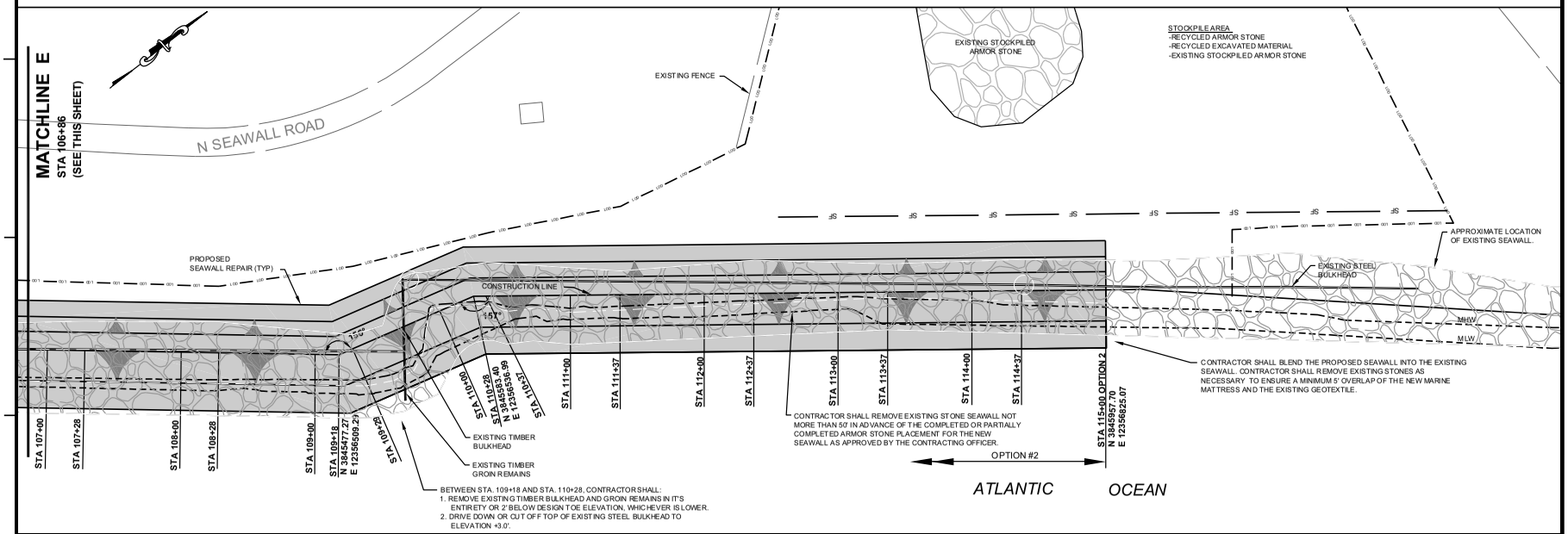
C-5
SHEET 5 OF 11

PRE-FINAL SUBMITTAL



PLAN VIEW (6a) STA. 97+00 TO 106+86 (OPTION 2)

SCALE : 1" = 40' 0 20' 40'



PLAN VIEW (6b) STA. 106+86 TO 115+00 (OPTION 2)

SCALE : 1" = 40' 0 20' 40'

US Army Corps of Engineers
Norfolk District

REV.	DATE	DESCRIPTION	BY	CHKD

DESIGNED E.T.F. | DRAWN J.S.B. | CHECKED C.G.W. | DATE 6/22/10 | DATE 22 June 2010 | SCALE 1"=40'

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

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CAMBRIDGE, MARYLAND 21613

PROJECT NO. 00000 | DRAWING NO. | NORFOLK DISTRICT FILE NO. | SPECIFICATION NO.

CAD SERVER PN: | FILE NAME: /2010/00001-Revised/Plan.dwg | Plot Scale: 1:1

PLAN VIEWS : 6a & 6b STA 97+00 TO STA 115+00

NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT SEAWALL REPAIR AND EXTENSION

ACCOMACK COUNTY, VIRGINIA

C-6

SHEET 6 OF 11

PRE-FINAL SUBMITTAL

STONE CONSTRUCTION ENTRANCE

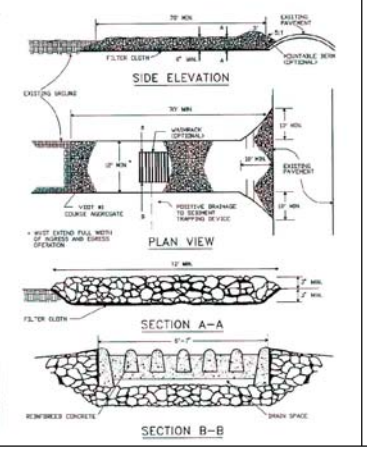


TABLE 3.02-A

CONSTRUCTION SPECIFICATIONS FOR FILTER CLOTH UNDERLINER

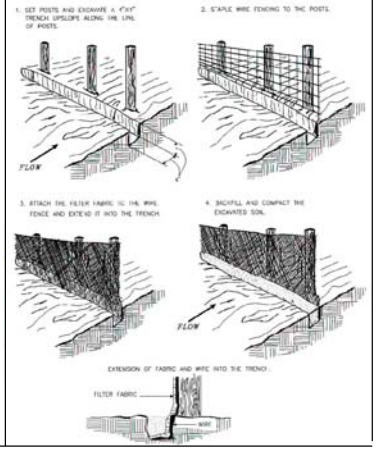
Fabric Properties[1]	Light-Duty Entrance[2] (Graded Subgrade)	Heavy-Duty Entrance[3] (Rough Graded)	Test Method
Grab Tensile Strength (lbs.)	200	220	ASTM D1682
Elongation at Failure (%)	50	220	ASTM D1682
Mullen Burst Strength (lbs.)	190	430	ASTM D3786
Puncture Strength (lbs.)	40	125	ASTM D751 (modified)
Equivalent Opening Size (mm)	40-80	40-80	U.S. Standard Sieve CW-02215

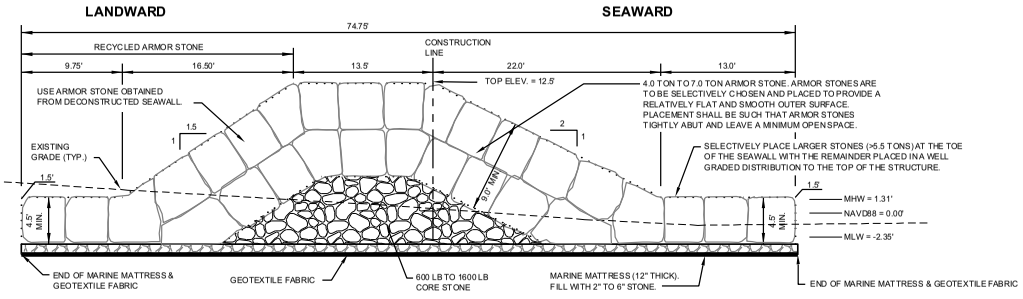
[1] Fabrics not meeting these specifications may be used only when design procedure and supporting documentation are supplied to determine aggregate depth and fabric strength.

[2] Light Duty Entrance: Sites that have been graded to subgrade and where most travel would be single axle vehicles and an occasional multi-axle truck. Examples of fabrics which can be used are: Trevira Spunbond 1115, Mirafi 100X, Typar 3401, or equivalent.

[3] Heavy Duty Entrance: Sites with only rough grading and where most travel would be multi-axle vehicles. Examples of fabrics which can be used are: Trevira Spunbond 1135, Mirafi 600X, or equivalent.

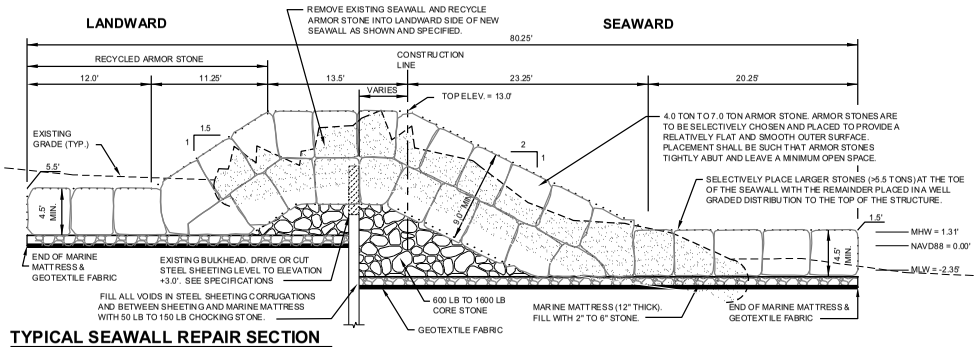
CONSTRUCTION OF A SILT FENCE (WITH WIRE SUPPORT)





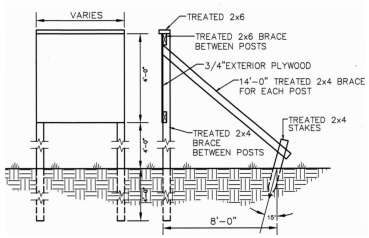
TYPICAL SEAWALL EXTENSION SECTION

Scale: 1" = 6'



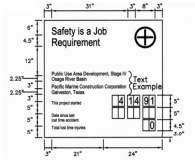
TYPICAL SEAWALL REPAIR SECTION

Scale: 1" = 6'



TYPICAL SIGN ERECTION DETAIL

Not To Scale



ALL TYPOGRAPHY IS FLUSH LEFT AND RAGGED RIGHT, UPPER AND LOWER CASE WITH WITH INITIAL CAPITALS ONLY AS SHOWN. LETTER AND WORD SPACING TO FOLLOW COPRS STANDARDS (EP 310–1–6a AND 6b).

LEGEND GROUP 1: STANDARD TWO–LINE TITLE "SAFETY IS A JOB REQUIREMENT" WITH (8" od.) SAFETY GREEN FIRST AID LOGO. TYPEFACE 3" HELVETIVA BOLD; COLOR: BLACK.

LEGEND GROUP 2: ONE TO TWO–LINE PROJECT TITLE LEGEND DESCRIBES THE WORK BEING DONE UNDER THIS PROJECT AND NAME OF HOST PROJECT. TYPEFACE: 1.5" HELVETIVA REGULAR; COLOR: BLACK; MAXIMUM LINE LENGTH: 42".

LEGEND GROUP 3: ONE TO TWO–LINE IDENTIFICATION: NAME OF PRIME CONTRACTOR AND CITY, STATE ADDRESS. TYPEFACE: 1.5" HELVETIVA REGULAR, COLOR: BLACK; MAXIMUM LINE LENGTH 42".

LEGEND GROUP 4: STANDARD SAFETY RECORD CAPTIONS AS SHOWN. TYPEFACE 1.25" HELVETIVA REGULAR; COLOR: BLACK.

REPLACEABLE NUMBERS TO MOUNTED ON WHITE 0.060 ALUMINUM PLATE AND SCREW–MOUNTED TO BACKDROP. TYPEFACE: 3" HELVETIVA REGULAR; COLOR: BLACK; PLATE SIZE: 2.5" X 4.5".

TYPICAL SAFETY SIGN

Not To Scale

US Army Corps of Engineers
Norfolk District

SYM.	DATE	DESCRIPTION	BY	CHKD

DESIGNED: E.T.F.
DRAWN: J.S.B.
CHECKED: G.O.W.
SUBMITTED: 6/22/10
DATE: June 2010
SCALE: AS SHOWN
PROJECT NO. 00000
NORFOLK DISTRICT FILE NO.
DRAWING NO.
SPECIFICATION NO.
File Name: 1:1
LAST REVISED ON:
File Name: J:\00000\01-Design\Plotting

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

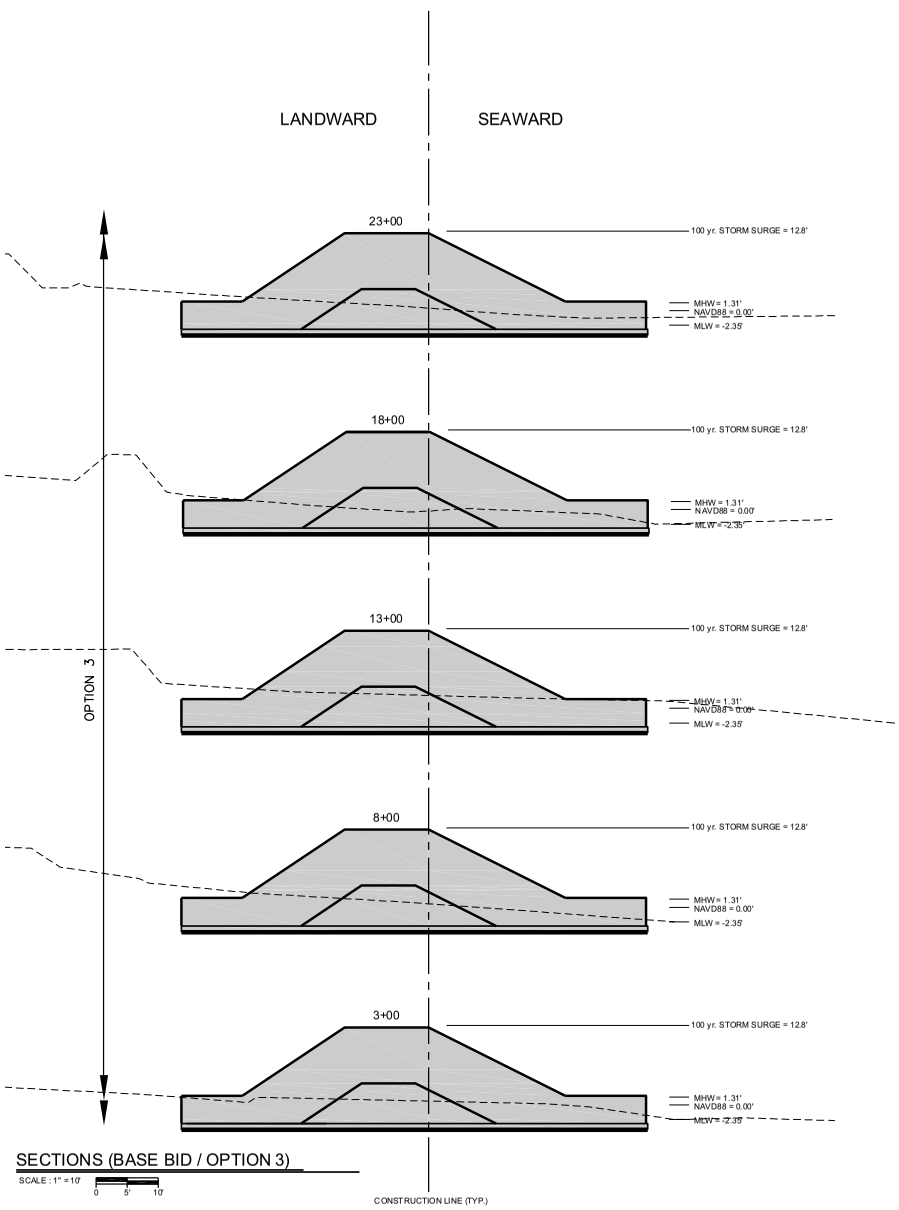
DETAILS

NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT SEAWALL REPAIR AND EXTENSION

ACCOMACK COUNTY, VIRGINIA

C-7
SHEET 7 OF 11

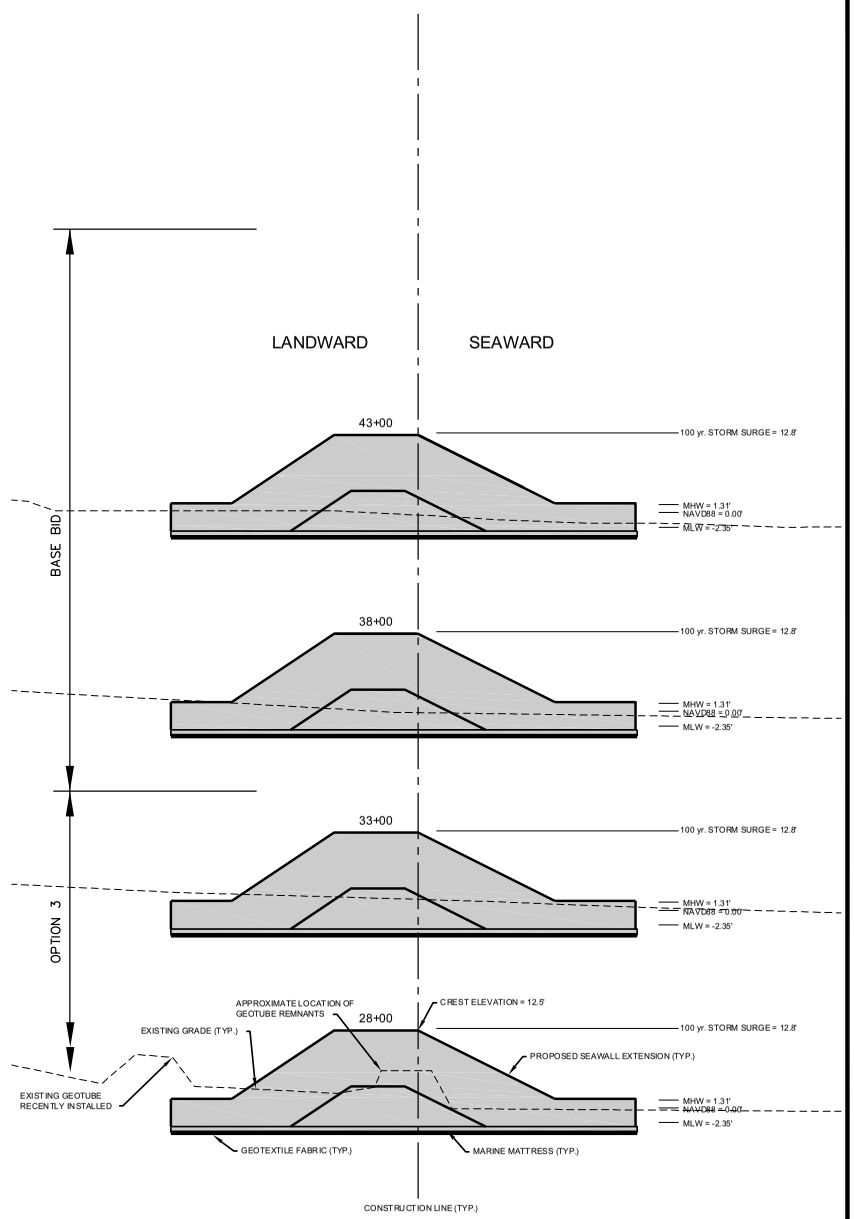
PRE–FINAL SUBMITTAL



SECTIONS (BASE BID / OPTION 3)

SCALE : 1" = 10'

0 5' 10'



US Army Corps of Engineers
Norfolk District

NO.	DATE	DESCRIPTION	BY	CHKD

DESIGNED: E.T.F. | CHECKED: G.O.W. | DATE: 22 June 2010
DRAWN: J.S.B. | SUBMITTED: 6/22/10 | SCALE: 1" = 10'
PROJECT NO. 00000 | NORFOLK DISTRICT FILE NO.
DRAWING NO. | SPECIFICATION NO.
CAD WORKS Dn | Plot Scale: 1:1
FILE NAME: J:\2007\0001-Seawall\Plots\

NORFOLK DISTRICT
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NORFOLK, VIRGINIA

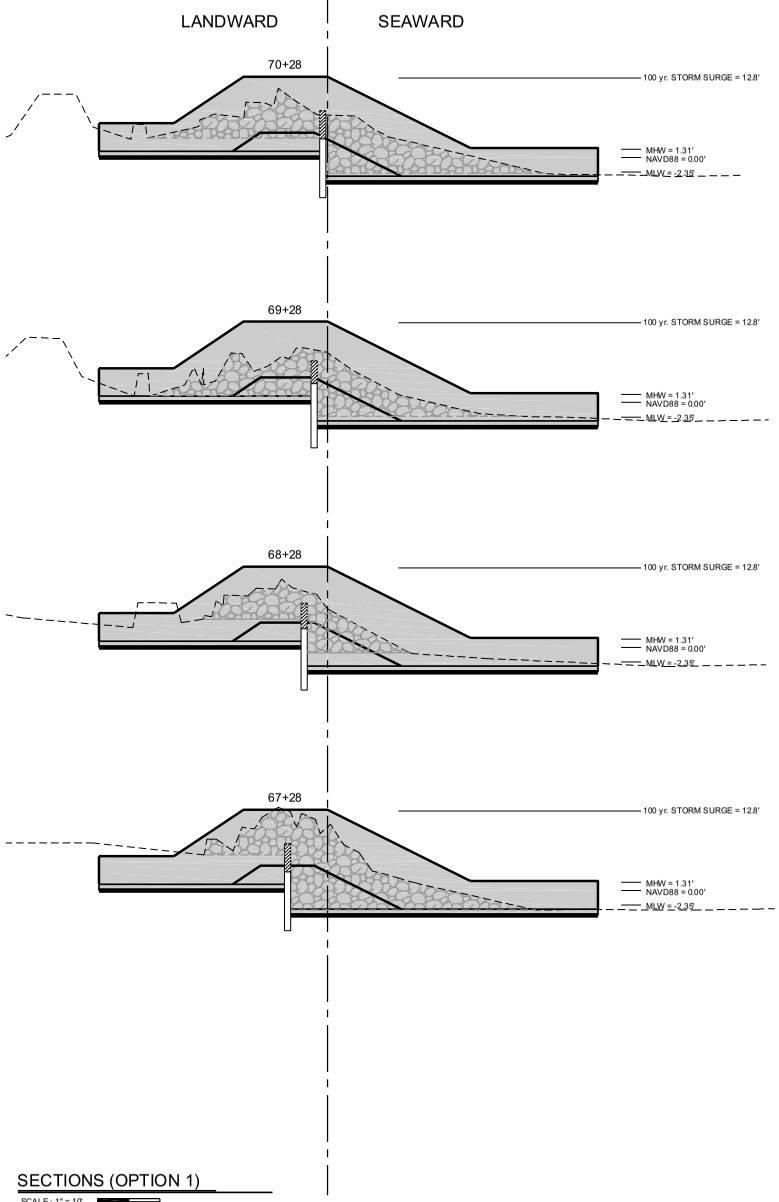
ANDREWS, MILLER & ASSOCIATES
4434 LAKEPOINTE CORPORATE, SUITE 1
CAMBRIDGE, MARYLAND 21613

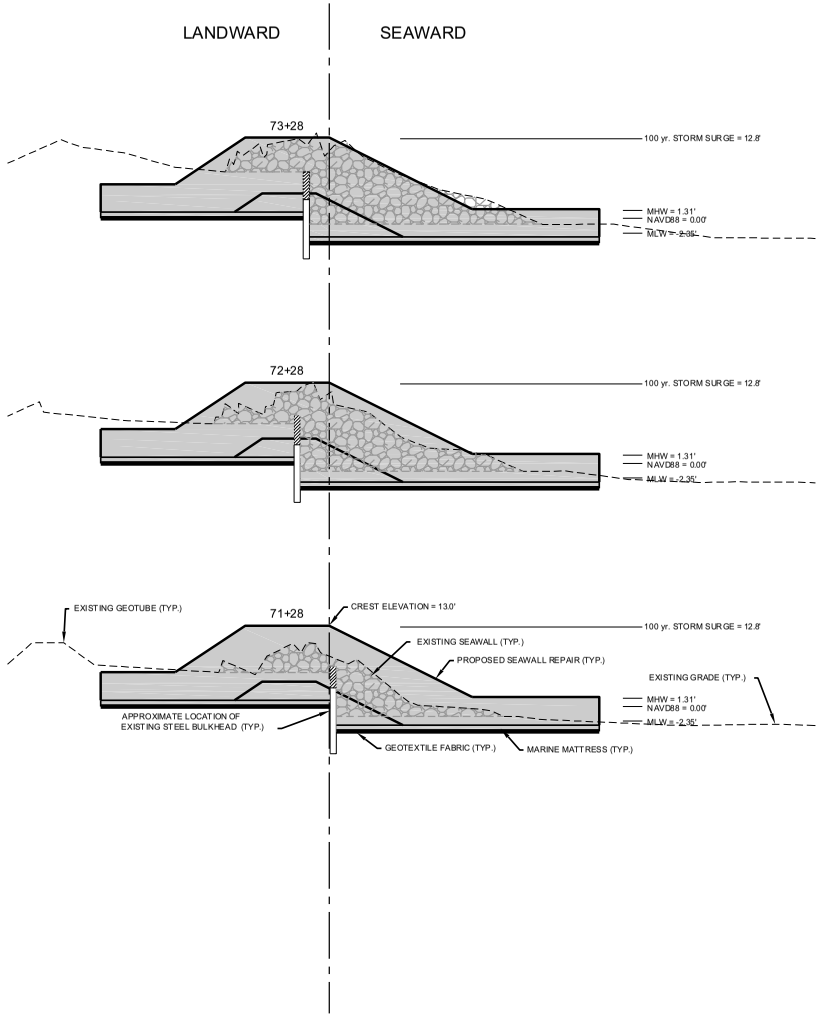
SEAWALL EXTENSION SECTIONS : BASE BID/OPTION 3

NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
SEAWALL REPAIR AND EXTENSION
ACCOMACK COUNTY, VIRGINIA

C-8
SHEET 8 OF 11

PRE-FINAL SUBMITTAL





SECTIONS (OPTION 1)

SCALE : 1" = 10'

0 5' 10'

US Army Corps of Engineers
Norfolk District

NO.	DATE	DESCRIPTION	BY	CHK'D

DESIGNED: E.T.F. | CHECKED: G.O.W. | DATE: 22 June 2010
DRAWN: J.S.B. | SUBMITTED: 6/22/10 | SCALE: 1"=10'
PROJECT NO. 00000 | NORFOLK DISTRICT FILE NO.
DRAWING NO. | SPECIFICATION NO.
CAD VERSION: Pro/ Engineer Wildfire 3.0
FILE NAME: /2007/0001-Seawall/Plans/Sections

NORFOLK DISTRICT
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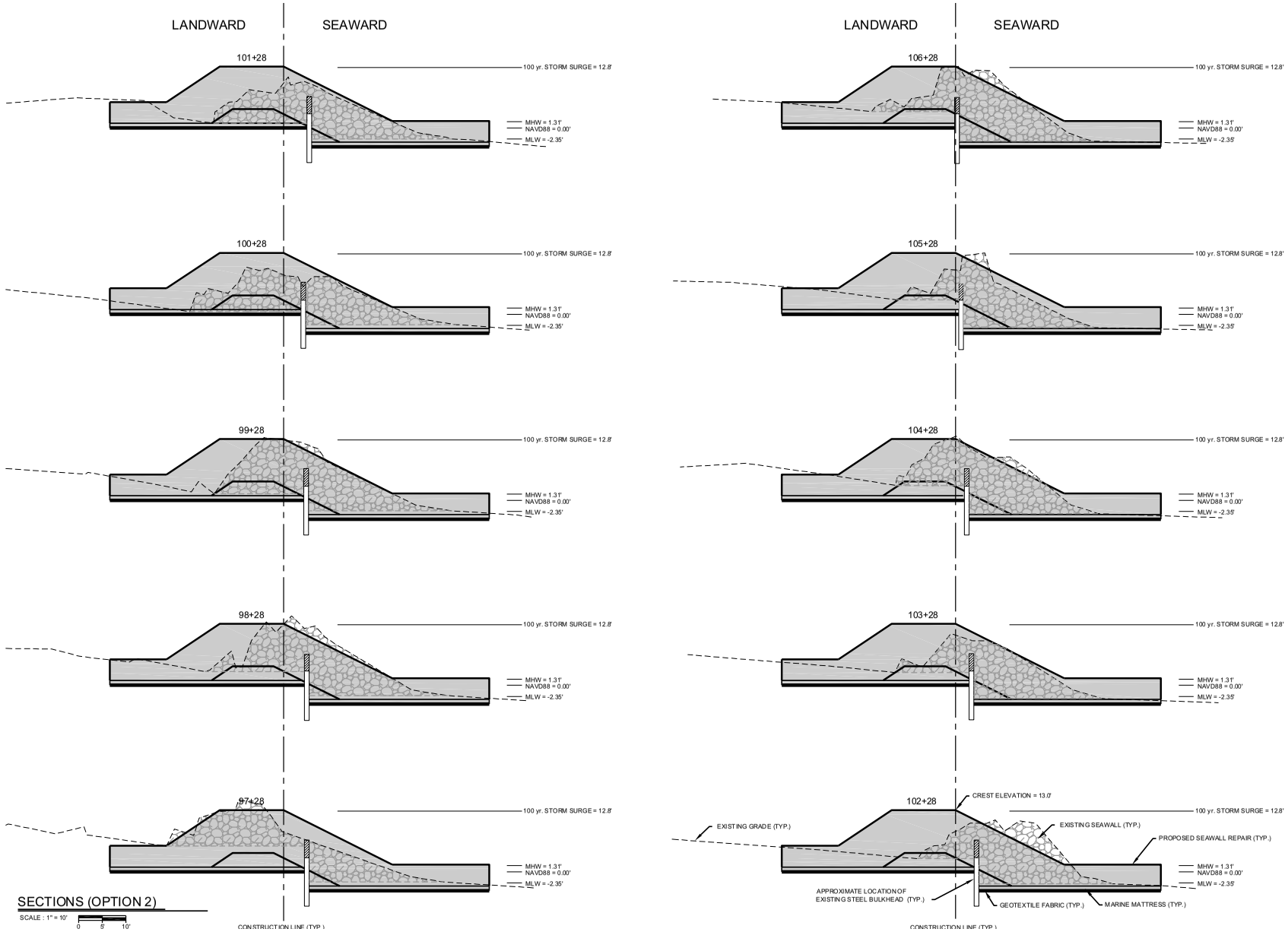
4400 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

SEAWALL REPAIR SECTIONS (OPTION 1)

NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
SEAWALL REPAIR AND EXTENSION
ACCOMACK COUNTY, VIRGINIA

C-9
SHEET 9 OF 11

PRE-FINAL SUBMITTAL



SECTIONS (OPTION 2)

SCALE : 1" = 10'

0 5' 10'

US Army Corps of Engineers
Norfolk District

NO.	DATE	DESCRIPTION	BY	CHKD

DESIGNED E.T.F. | CHECKED G.O.W. | DATE 6/22/10 | DATE 22 June 2010
DRAWN J.S.B. | SCALE 1" = 10'
PROJECT NO. 00000 | NORFOLK DISTRICT FILE NO.
DRAWING NO. | SPECIFICATION NO.
TOP WORKS Dn. | Pwf Scale "H"
FILE NAME: /2007001-Seawall/Pwf.dwg

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
4434 LANDER ROAD, SUITE 1
CAMBRIDGE, MARYLAND 21613

SEAWALL REPAIR SECTIONS (OPTION 2)

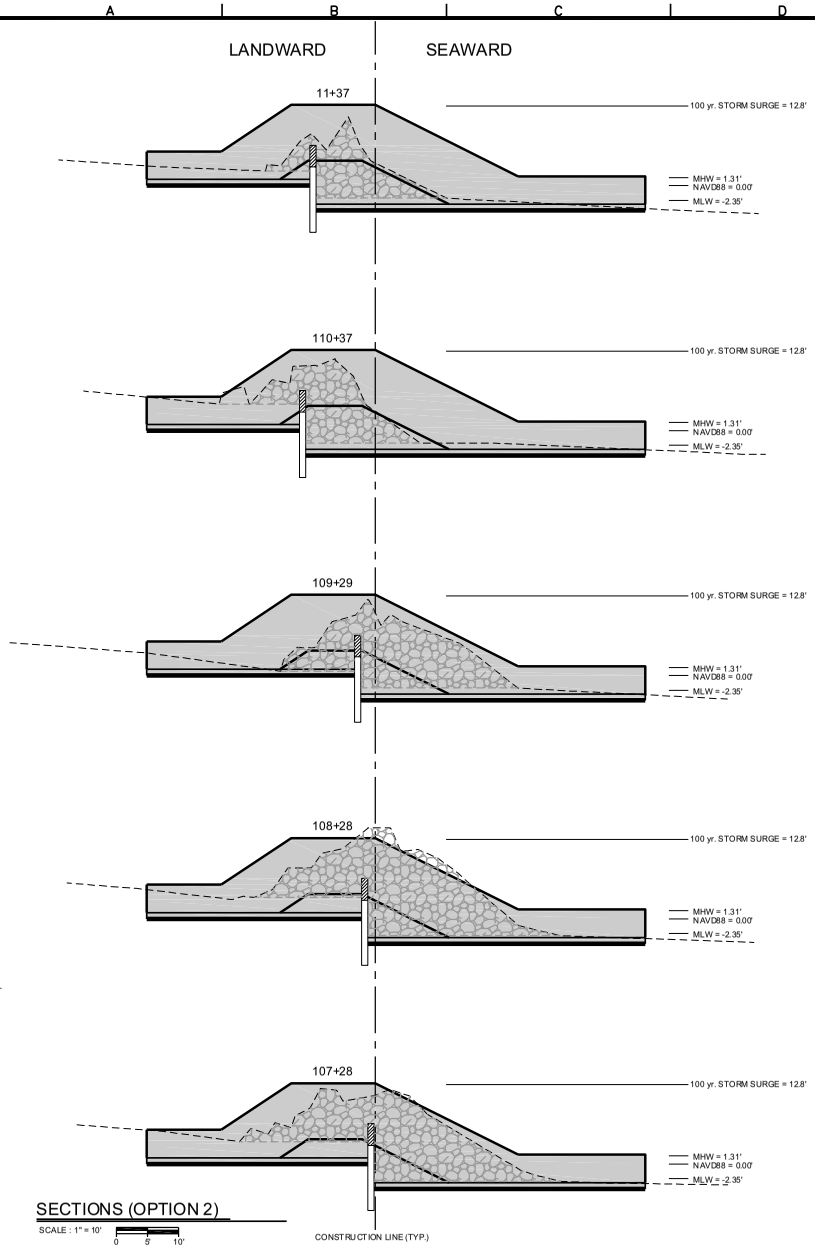
NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT SEAWALL REPAIR AND EXTENSION

ACCOMACK COUNTY, VIRGINIA

C-10

SHEET 10 OF 11

PRE-FINAL SUBMITTAL



SECTIONS (OPTION 2)

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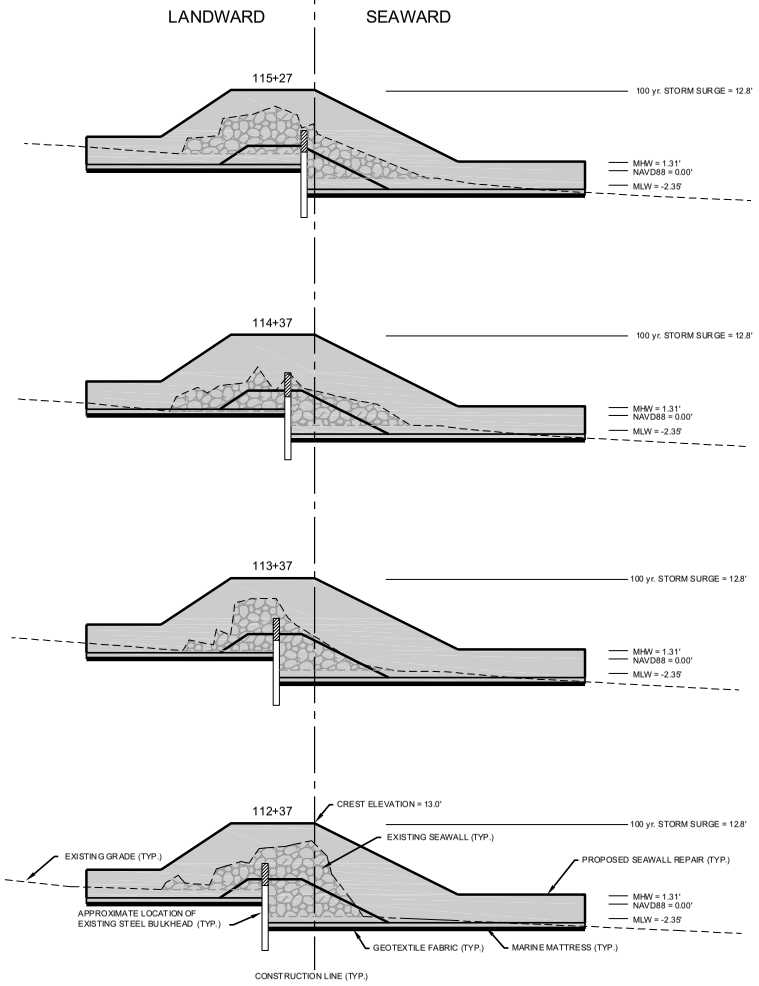


US Army Corps of Engineers
Norfolk District

NO.	DATE	DESCRIPTION	BY	CHKD

DESIGNED: E.T.F. | DRAWN: J.S.B. | CHECKED: G.O.W. | SUBMITTED: 6/22/10 | DATE: 22 June 2010 | SCALE: 1" = 10'

PROJECT NO. 00000 | NORFOLK DISTRICT FILE NO. | DRAWING NO. | SPECIFICATION NO.

CAD VERSION: 2k | Plot Scale: 1:1

FILE NAME: J:\2007\0001-Sandy\Plots\

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
4400 ACADEMY PARKWAY, SUITE 1
CAMBRIDGE, MARYLAND 21613

SEAWALL REPAIR SECTIONS (OPTION 2)

NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
SEAWALL REPAIR AND EXTENSION
ACCOMACK COUNTY, VIRGINIA

C-11
SHEET 11 OF 11

PRE-FINAL SUBMITTAL

SHORELINE DAMAGE REDUCTION PROJECT
BEACH FILL
NASA WALLOPS ISLAND
ACCOMACK COUNTY, VIRGINIA

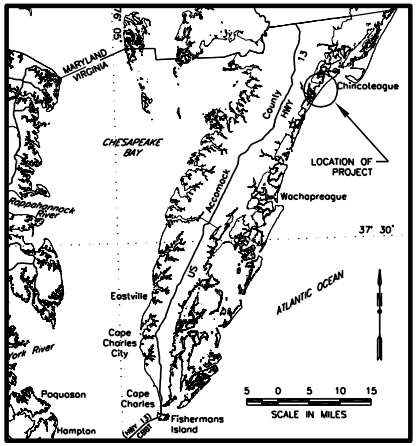
JUNE 2010

LEGEND

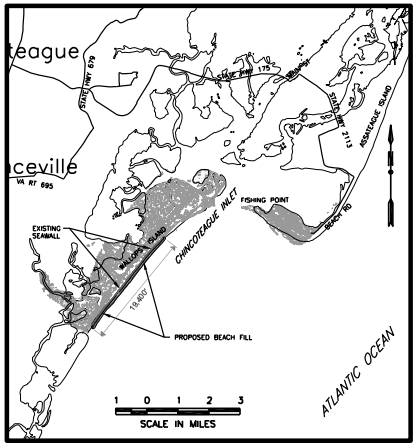
ITEM	EXISTING	PROPOSED
LIMIT OF DISTURBANCE	N/A	LOD
IMPERVIOUS SURFACED ROAD, DRIVE OR LOT		N/A
FENCE		
DRAINAGE DITCH OR SWALE		N/A
EMBANKMENT SIDESLOPES (DOWN)		
CONTOUR	5	4.0
ELEVATION SPOT SHOT	x 6.50	5.00
PROPERTY LINE		N/A
CONSTRUCTION LINE	N/A	
BUILDING OR STRUCTURE		N/A
SILT FENCE	N/A	SF
STABILIZED CONSTRUCTION ENTRANCE	N/A	SCE
STONE		N/A
BEACHGRASS PLANING	N/A	

LIST OF ABBREVIATIONS

ADC	ALEXANDRIA DRAFTING COMPANY
AMA	ANDREWS, MILLER & ASSOCIATES
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
CD	CONSTRUCTION DOCUMENTS
DIA	DIAMETER
D.I.P	DUCTILE IRON PIPE
E	EAST
EIS	ENVIRONMENT IMPACT STATEMENT
ELEV	ELEVATION
H	HORIZONTAL
INV	INVERT
LB.	POUNDS
LOD	LIMIT OF DISTURBANCE
MEC	MUNITIONS & EXPLOSIVES OF CONCERN
MHW	MEAN HIGH WATER
MLW	MEAN LOW WATER
N	NORTH
NAVD	NORTH AMERICAN VERTICAL DATUM
NASA	NATIONAL AERONAUTICS & SPACE ADMINISTRATION
OCEW	ON CENTER EACH WAY
O.D.	OUTSIDE DIAMETER
RCP	REINFORCED CONCRETE PIPE
SCE	STABILIZED CONSTRUCTION ENTRANCE
SF	SILT FENCE
STA	STATION
TYP.	TYPICAL
USACE	UNITED STATES ARMY CORPS OF ENGINEERS
V	VERTICAL



VICINITY MAP



LOCATION MAP

GENERAL NOTES

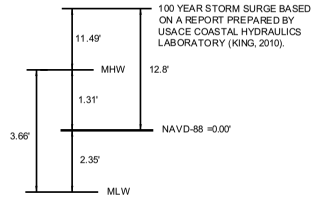
1. THE EXISTING UTILITIES AND OBSTRUCTIONS SHOWN ARE FROM THE BEST AVAILABLE RECORDS AND SHALL BE VERIFIED BY THE CONTRACTOR TO HIS SATISFACTION PRIOR TO CONSTRUCTION.
2. NECESSARY PRECAUTIONS SHALL BE TAKEN BY THE CONTRACTOR TO PROTECT EXISTING SERVICES AND STRUCTURES. ANY DAMAGE TO THEM SHALL BE REPAIRED IMMEDIATELY AT HIS OWN EXPENSE.
3. IT SHALL BE DISTINCTLY UNDERSTOOD THAT FAILURE TO MENTION SPECIFICALLY ANY WORK WHICH WOULD NATURALLY BE REQUIRED TO COMPLETE THE PROJECT SHALL NOT RELIEVE THE CONTRACTOR OF HIS RESPONSIBILITY TO COMPLETE SUCH WORK.
4. PUBLISHED MEAN TIDAL RANGE IS 3.66 FEET.
5. TOPOGRAPHIC & BATHYMETRIC DATA WAS PROVIDED BY USACE AND IS BASED UPON NAVD 88. LIMITED SURVEYING LOCATED LANDWARD OF THE SEAWALL WAS PERFORMED BY AMA IN MAY 2010.
6. HORIZONTAL MERIDIAN IS BASED UPON NAD 83, VIRGINIA STATE PLANE, SOUTH
7. VERTICAL CONTROL IS BASED UPON NAVD 88.
8. PROPERTY LINES SHOWN ARE APPROXIMATE ONLY. THIS PLAN IS NOT INTENDED TO BE A PROPERTY LINE SURVEY.
9. DISTURBED AREAS WILL BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN FOUND. THIS INCLUDES THE TEMPORARY STAGING AND STONE STOCKPILE AREAS.
10. THE EXISTING BOTTOM AND SEAWALL PROFILES, BEACH CONTOUR AND/OR BANK ALIGNMENT SHOWN ON THE DRAWINGS WERE CORRECT WHEN SURVEYED. HOWEVER, BECAUSE OF THE INTERIM EROSION AND LITTORAL TRANSPORT, THE CONTRACTOR, SHALL SATISFY HIMSELF AS TO ALL CONDITIONS AT THE TIME OF BIDDING THIS PROJECT AND INCLUDE IN HIS PROPOSAL ANY CHANGES THAT WOULD BE NECESSARY TO ACCOMPLISH A COMPLETE AND FUNCTIONAL PROJECT.

SCOPE OF WORK

BEACH FILL - 3.2 Million C.Y. (19,400 L.F.)
- DESIGN TEMPLATE: 1.8 Million C.Y.
- CONSTRUCTION TEMPLATE: 1.4 Million C.Y.

SAND FENCE - 39,600 L.F.

BEACH GRASS - 38 AC.



DATUM COMPARISON
NOT TO SCALE

INDEX TO DRAWINGS

SHEET NO.	TITLE	FILE NUMBER **
C-1	COVER SHEET	
C-2	KEY SHEET	
C-3	PLAN VIEW (BEACH FILL)	
*C-4	PLAN VIEW (BORROW AREA)	
*C-5	PLAN VIEW (BORROW AREA)	
*C-6	PLAN VIEW (BORROW AREA)	
C-7	DETAILS	
C-8	SECTIONS (STA. 3+00 – STA. 38+00)	
C-9	SECTIONS (STA. 43+00 – STA. 75+00)	
C-10	SECTIONS (STA. 80+00 – STA. 115+27)	
C-11	SECTIONS (STA. 120+00 – STA. 155+00)	
C-12	SECTIONS (STA. 160+00 – STA. 190+00)	

* TO BE INSERTED AT FINAL DESIGN LEVEL
** SURVEY DATA AND FILE NUMBERS TO BE PROVIDED BY USACE.

SIGNATURES AFFIXED BELOW INDICATE OFFICIAL RECOMMENDATION AND APPROVAL OF ALL DRAWINGS IN THIS SET AS INDICATED ON INDEX OF DRAWINGS.

RECOMMENDED:

PROJECT MANAGER

APPROVED:

CHIEF, DESIGN BRANCH

APPROVED:

CHIEF, ENGINEERING DIVISION

APPROVED:

COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

APPROVED FOR:

DATE:

US Army Corps of Engineers
Norfolk District

SYM	DATE	DESCRIPTION	BY	CHKD

DESIGNED E.T.F. | DRAWN J.S.B. | CHECKED G.O.W. | DATE 6/22/10 | SCALE AS SHOWN | DATE 22 June 2010
PROJECT NO. 00000 | NORFOLK DISTRICT FILE NO.
DRAWING NO. | SPECIFICATION NO.
USF SERIES DN. | File Name 11
FILE NAME: J:\ESTAGE1-Design\Plan.dwg

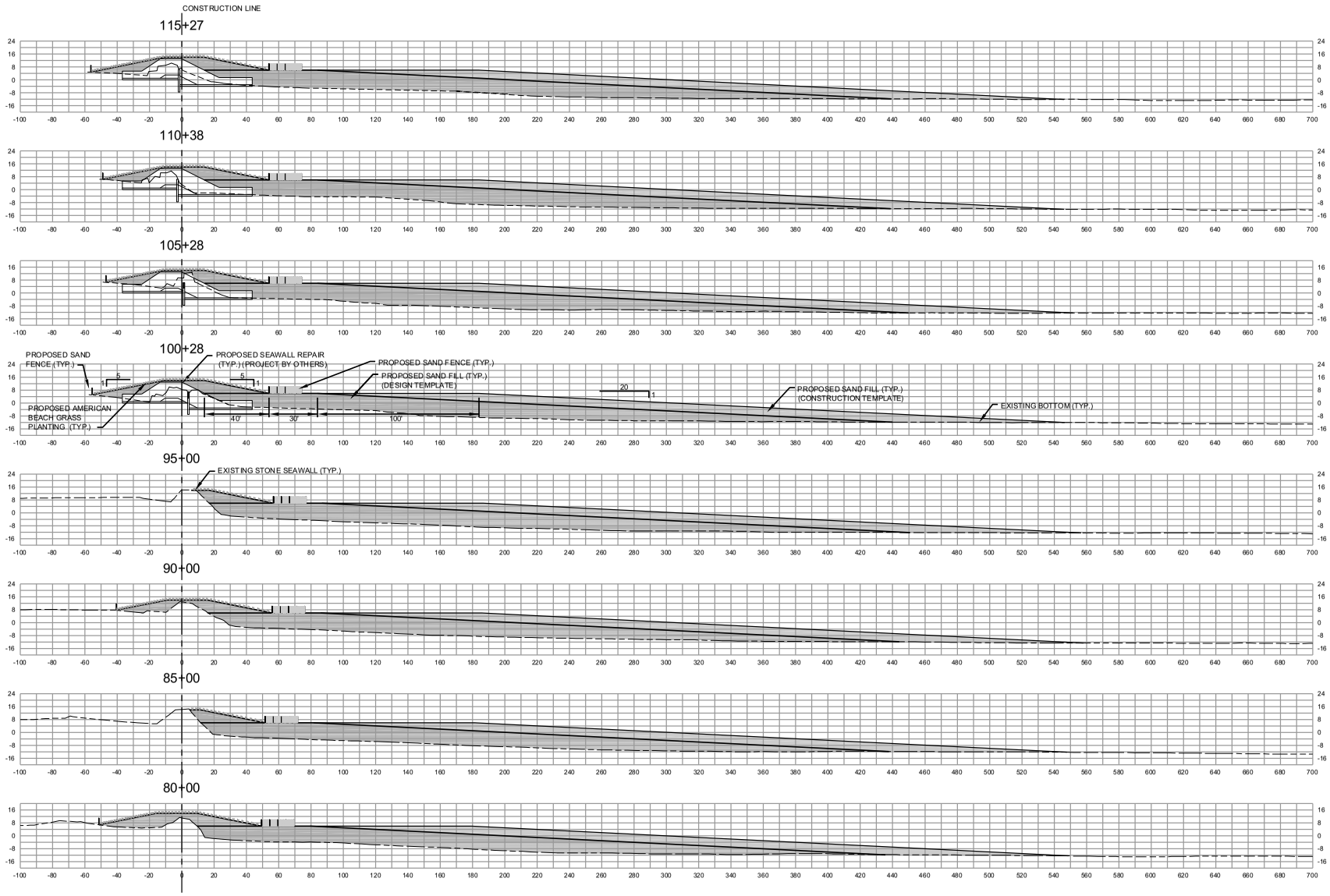
NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

COVER SHEET
NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
BEACH FILL
ACCOMACK COUNTY, VIRGINIA

C-1
SHEET 1 OF 12

PRE-FINAL SUBMITTAL



NOTE: DUE TO FUNDING LIMITATIONS CONSTRUCTION SCOPE OF THE STONE SEAWALL EXTENSION AND / OR STONE SEAWALL REPAIR MAY NOT EXTEND TO THE LIMITS SHOWN. SEAWALL EXTENSION AND REPAIR WORK IS A SEPARATE PROJECT TO BE PERFORMED BY OTHERS AND COMPLETED PRIOR TO PLACEMENT OF BEACH FILL.

SECTIONS

SCALE : 1" = 30' (0 15' 30')

US Army Corps of Engineers
Norfolk District

NO.	DATE	DESCRIPTION	BY

DESIGNED: E.T.F. | CHECKED: G.O.W. | DATE: 22 June 2010
DRAWN: J.S.B. | SUBMITTED: 6/22/10 | SCALE: 1" = 30'
PROJECT NO.: 00000 | NORFOLK DISTRICT FILE NO.:
DRAWING NO.: | SPECIFICATION NO.:
CAD WORKS ON: | Plot Scale: 1:1
FILE NAME: J:\2007\0001-Barnes\Plots\

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
4640 ADMIRALTY WAY, SUITE 1
CAMBRIDGE, MARYLAND 21613

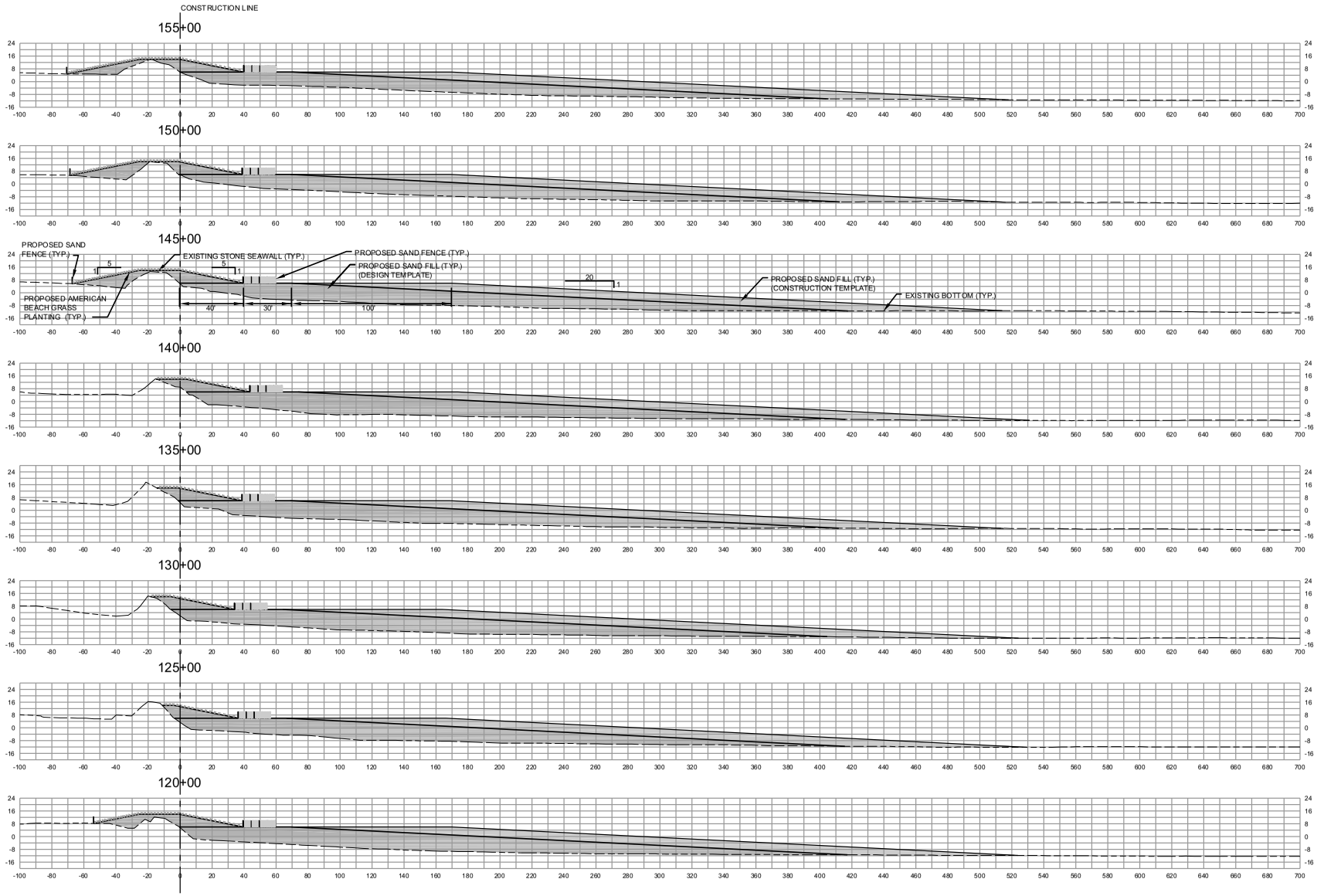
SECTIONS : (STA. 80+00 to STA. 115+27)

NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT BEACH FILL

ACCOMACK COUNTY, VIRGINIA

C-10
SHEET 10 OF 12

PRE-FINAL SUBMITTAL



US Army Corps of Engineers
Norfolk District

NO.	DATE	DESCRIPTION	BY

DESIGNED: E.T.F. | DRAWN: J.S.B. | CHECKED: G.O.W. | SUBMITTED: 6/22/10 | DATE: 22 June 2010 | SCALE: 1"=30'

PROJECT NO. 00000 | NORFOLK DISTRICT FILE NO. | DRAWING NO. | SPECIFICATION NO. | Pre Final 1st | CAD VERSION: | FILE NAME: J:\2007001-Sandy\Plans\

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
4640 ADMIRALTY WAY, SUITE 1
CAMBRIDGE, MARYLAND 21613

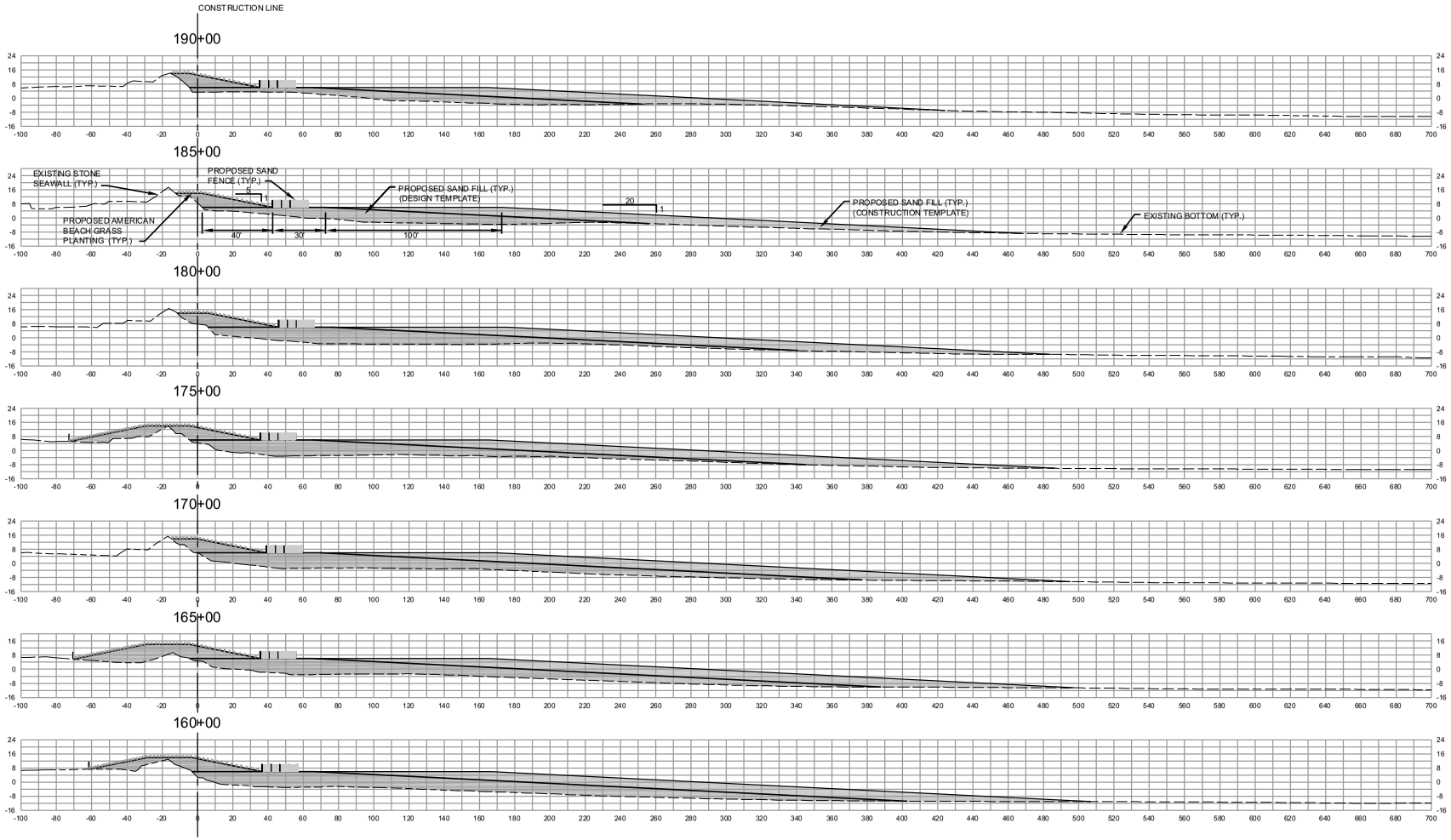
SECTIONS : (STA. 120+00 to STA. 155+00)

NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT BEACH FILL

ACCOMACK COUNTY, VIRGINIA

C-11
SHEET 11 OF 12

PRE-FINAL SUBMITTAL



SECTIONS

SCALE : 1" = 30'

0 15' 30'

US Army Corps of Engineers
Norfolk District

NO.	DATE	DESCRIPTION	BY

DESIGNED E.T.F. | CHECKED G.O.W. | DATE 22 June 2010
DRAWN J.S.B. | SUBMITTED 6/22/10 | SCALE 1"=30'
PROJECT NO. 00000 | NORFOLK DISTRICT FILE NO.
DRAWING NO. | SPECIFICATION NO.
CAD VERSION 24 | Pro Engineer 18
FILE NAME: /2007001-Design/Plans

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

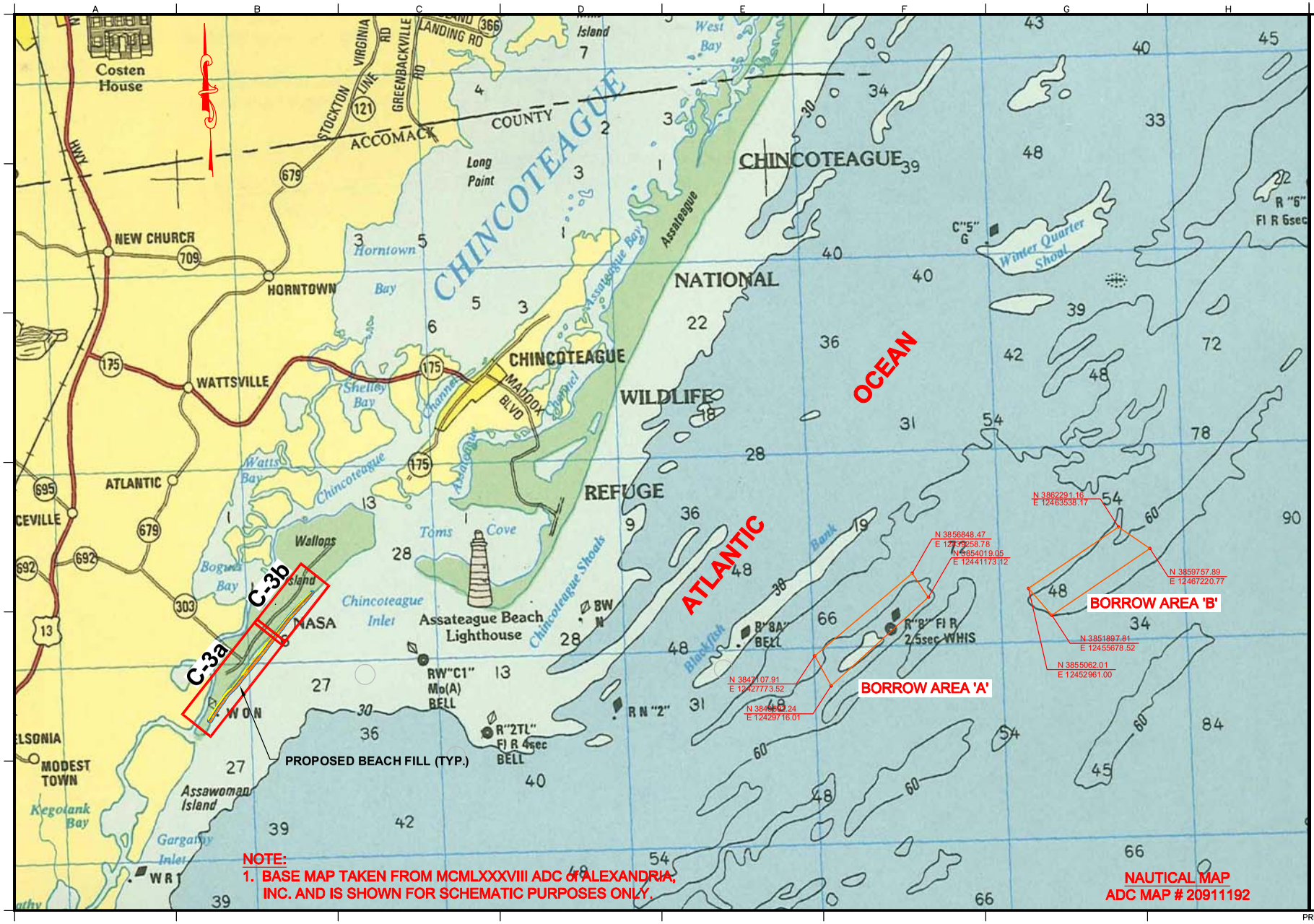
ANDREWS, MILLER & ASSOCIATES
4401 A MARTIN'S CROSSING, SUITE 1
CAMBRIDGE, MARYLAND 21613

SECTIONS : (STA. 160+00 to STA. 190+00)

NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
BEACH FILL
ACCOMACK COUNTY, VIRGINIA

C-12
SHEET 12 OF 12

PRE-FINAL SUBMITTAL



NOTE:
1. BASE MAP TAKEN FROM MCMLXXXVIII ADC of ALEXANDRIA, INC. AND IS SHOWN FOR SCHEMATIC PURPOSES ONLY.

US Army Corps of Engineers
Norfolk District

DEV.	DATE	DESCRIPTION	BY	APP.

DESIGNED: E.T.F. | DRAWN: J.S.B. | CHECKED: G.O.W. | DATE: 22 June 2010 | SCALE: 6/22/10 1"=1Mile | PROJECT NO. 00000 | NORFOLK DISTRICT FILE NO. | DRAWING NO. | SPECIFICATION NO. | LAST SAVED ON: | Plot Scale: 1:1 | FILE NAME: /2009\001-Wallops/Plot.dwg

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

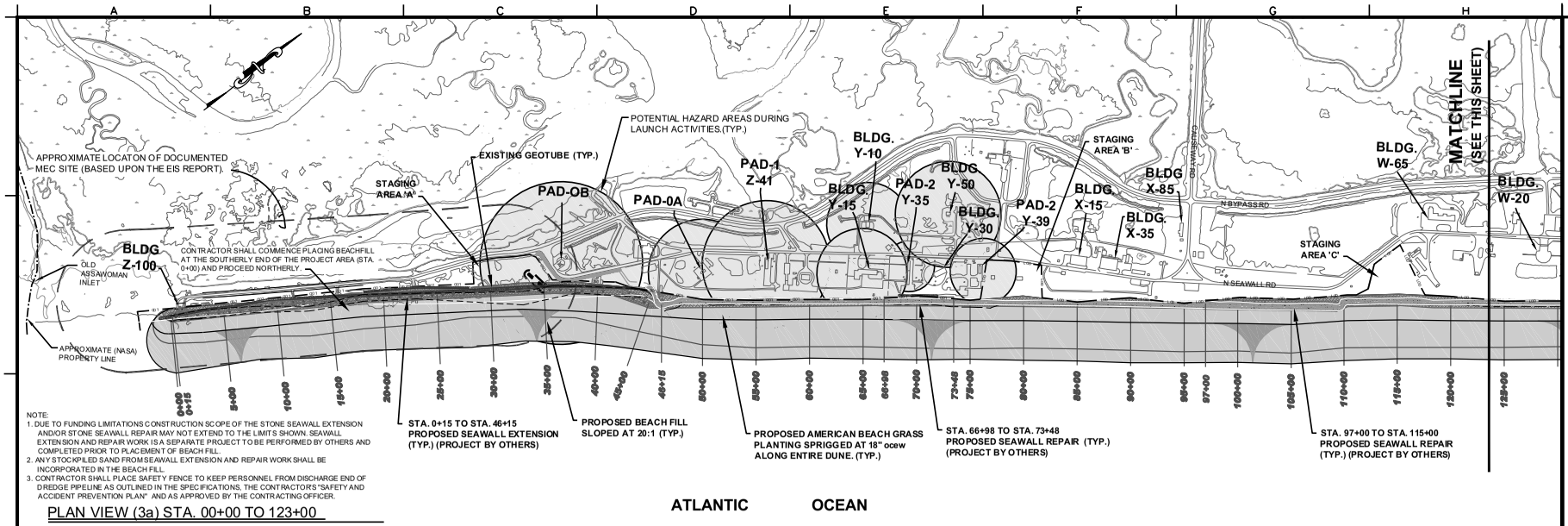
KEY SHEET

NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT

ACCOMACK COUNTY, VIRGINIA

C-2
SHEET 2 OF 12

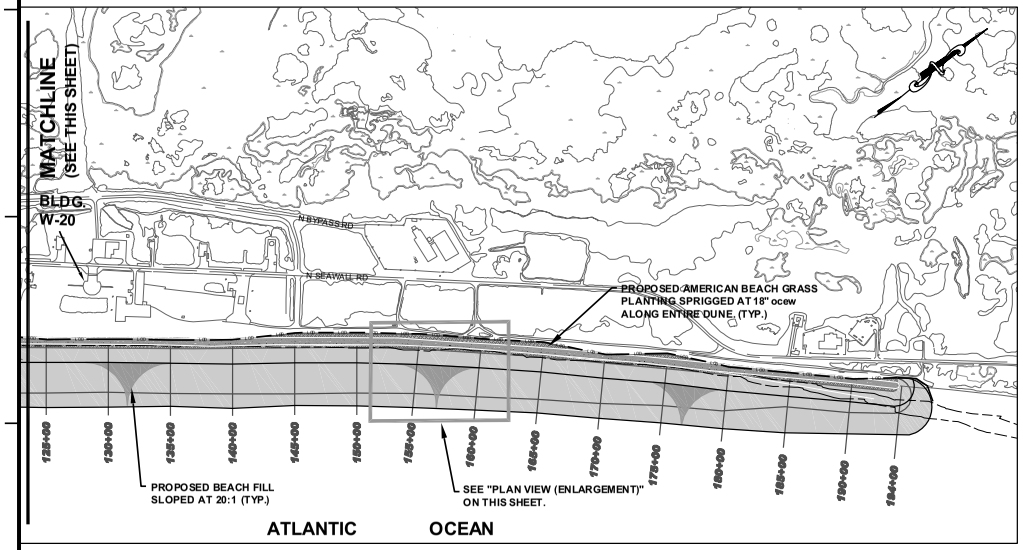
PRE-FINAL SUBMITTAL



NOTE:
1. DUE TO FUNDING LIMITATIONS CONSTRUCTION SCOPE OF THE STONE SEAWALL EXTENSION AND/OR STONE SEAWALL REPAIR MAY NOT EXTEND TO THE LIMITS SHOWN. SEAWALL EXTENSION AND REPAIR WORK IS A SEPARATE PROJECT TO BE PERFORMED BY OTHERS AND COMPLETED PRIOR TO PLACEMENT OF BEACH FILL.
2. ANY STOCKPILED SAND FROM SEAWALL EXTENSION AND REPAIR WORK SHALL BE INCORPORATED IN THE BEACH FILL.
3. CONTRACTOR SHALL PLACE SAFETY FENCE TO KEEP PERSONNEL FROM DISCHARGE END OF DREDGE PIPELINE AS OUTLINED IN THE SPECIFICATIONS, THE CONTRACTORS "SAFETY AND ACCIDENT PREVENTION PLAN" AND AS APPROVED BY THE CONTRACTING OFFICER.

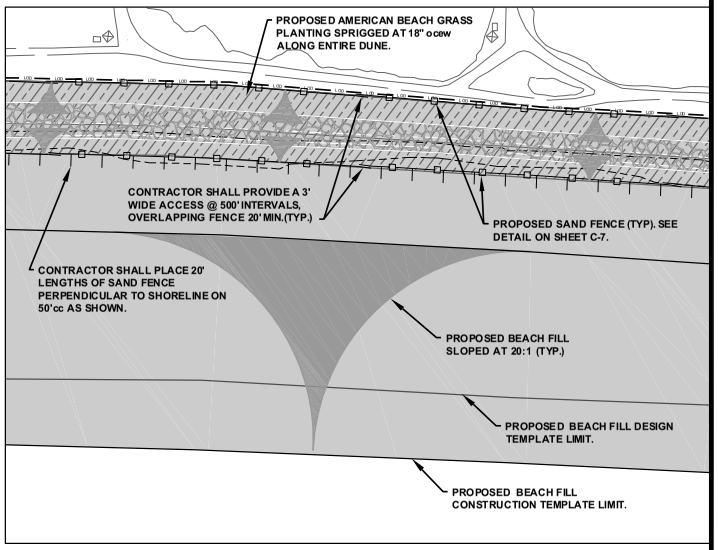
PLAN VIEW (3a) STA. 00+00 TO 123+00

SCALE : 1" = 500' 0 250' 500'



PLAN VIEW (3b) STA. 123+00 TO 194+00

SCALE : 1" = 500' 0 250' 500'



TYPICAL PLAN VIEW (ENLARGEMENT)

SCALE : 1" = 100' 0 50' 100'

US Army Corps of Engineers
Norfolk District

SYM	DATE	DESCRIPTION	BY	CHKD

DESIGNED E.T.F. | DRAWN J.S.B. | CHECKED C.O.W. | DATE 22 June 2010
SCALE As Shown | NORFOLK DISTRICT FILE NO. | PROJECT NO. 00000 | SPECIFICATION NO. | DRAWING NO.
CAD SERVER ON: Pw Serv 11
FILE NAME: /2010\001-Revised\Plan.dwg

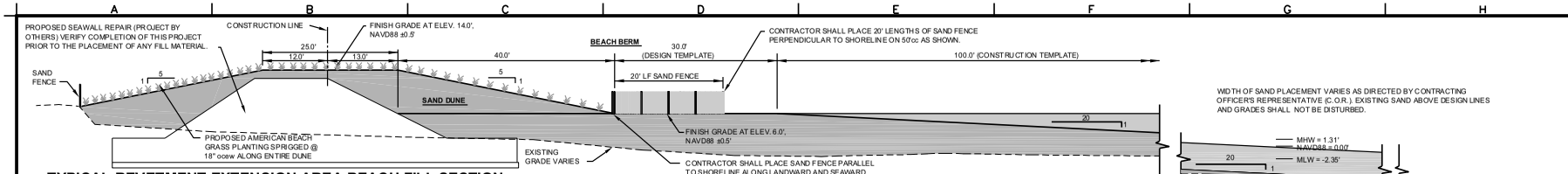
NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

PLAN VIEW (BEACH FILL)
NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT BEACH FILL
ACCOMACK COUNTY, VIRGINIA

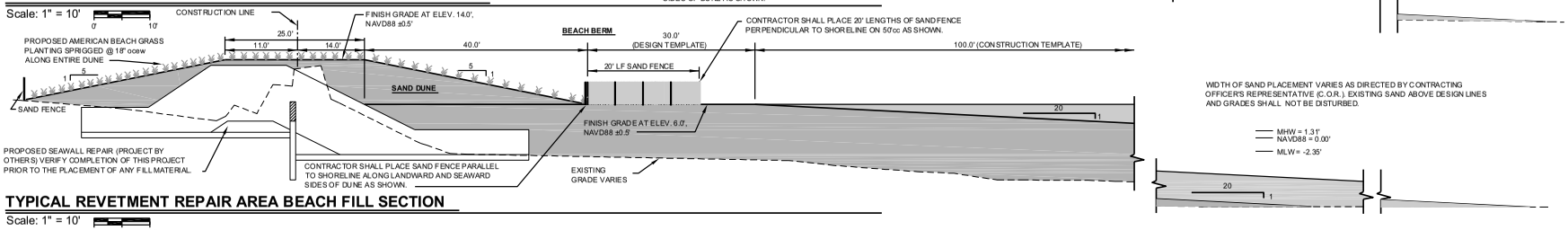
C-3
SHEET 3 OF 12

PRE-FINAL SUBMITTAL



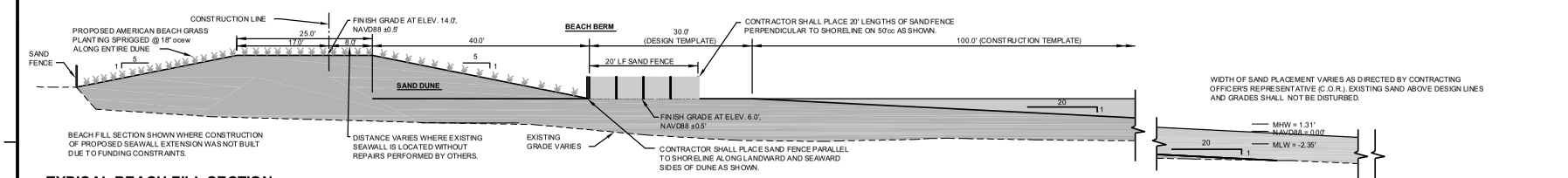
TYPICAL REVETMENT EXTENSION AREA BEACH FILL SECTION

Scale: 1" = 10'



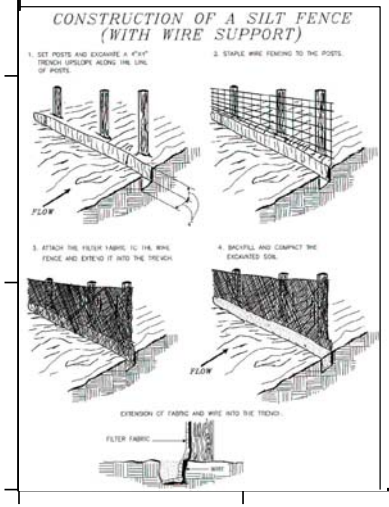
TYPICAL REVETMENT REPAIR AREA BEACH FILL SECTION

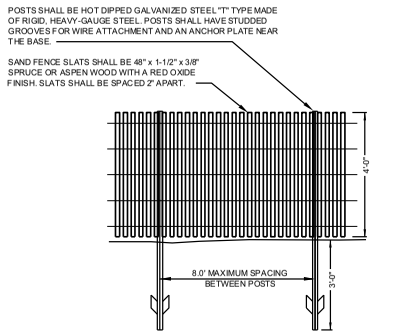
Scale: 1" = 10'



TYPICAL BEACH FILL SECTION

Scale: 1" = 10'

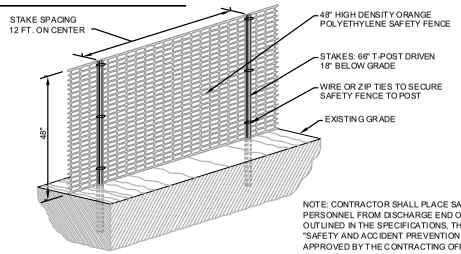




1. CONTRACTOR SHALL PLACE SAND FENCE PARALLEL TO SHORELINE ALONG LANDWARD AND WATERWARD SIDES OF DUNE AS SHOWN.
2. CONTRACTOR SHALL PLACE 20' LENGTHS OF SAND FENCE PERPENDICULAR TO SHORELINE ON 50'cc AS SHOWN.
3. CONTRACTOR SHALL PROVIDE A 3' WIDE ACCESS @ ±500' INTERVALS, OVERLAPPING FENCE 20' MIN. (TYP.)

TYPICAL SAND FENCE DETAIL

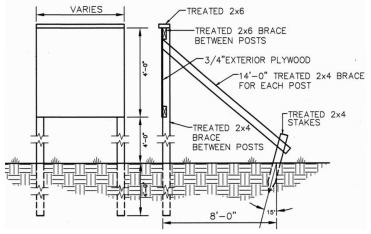
Scale: 1" = 2'



NOTE: CONTRACTOR SHALL PLACE SAFETY FENCE TO KEEP PERSONNEL FROM DISCHARGE END OF DREDGE PIPELINE AS OUTLINED IN THE SPECIFICATIONS. THE CONTRACTOR'S "SAFETY AND ACCIDENT PREVENTION PLAN" AND AS APPROVED BY THE CONTRACTING OFFICER.

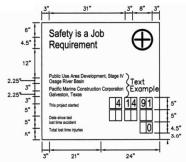
ORANGE SAFETY FENCE DETAIL

Not To Scale



TYPICAL SIGN ERECTION DETAIL

Not To Scale



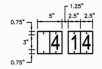
ALL TYPOGRAPHY IS FLUSH LEFT AND RAGGED RIGHT, UPPER AND LOWER CASE WITH WITH INITIAL CAPITALS ONLY AS SHOWN. LETTER AND WORD SPACING TO FOLLOW COPRS STANDARDS (EP 310-1-6a AND 6b).

LEGEND GROUP 1: STANDARD TWO-LINE TITLE "SAFETY IS A JOB REQUIREMENT" WITH (8" od.) SAFETY GREEN FIRST AID LOGO. TYPEFACE 3" HELVETIVA BOLD; COLOR: BLACK.

LEGEND GROUP 2: ONE TO TWO-LINE PROJECT TITLE LEGEND DESCRIBES THE WORK BEING DONE UNDER THIS PROJECT AND NAME OF HOST PROJECT. TYPEFACE: 1.5" HELVETIVA REGULAR; COLOR: BLACK; MAXIMUM LINE LENGTH: 42".

LEGEND GROUP 3: ONE TO TWO-LINE IDENTIFICATION: NAME OF PRIME CONTRACTOR AND CITY, STATE ADDRESS. TYPEFACE: 1.5" HELVETIVA REGULAR, COLOR: BLACK; MAXIMUM LINE LENGTH 42".

LEGEND GROUP 4: STANDARD SAFETY RECORD CAPTIONS AS SHOWN. TYPEFACE 1.25" HELVETIVA REGULAR; COLOR: BLACK.



REPLACEABLE NUMBERS TO MOUNTED ON WHITE 0.060 ALUMINUM PLATE AND SCREW-MOUNTED TO BACKDROP. TYPEFACE: 3" HELVETIVA REGULAR; COLOR: BLACK; PLATE SIZE: 2.5" X 4.5".

TYPICAL SAFETY SIGN

Not To Scale

US Army Corps of Engineers
Norfolk District

REV.	DATE	DESCRIPTION	BY

DESIGNED: T.F. | DRAWN: J.S.B. | CHECKED: S.O.W. | SUBMITTED: 6/22/10 | DATE: June 2010 | SCALE: AS SHOWN

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

PROJECT NO. 00000 | NORFOLK DISTRICT FILE NO. | SPECIFICATION NO. | DRAWING NO.

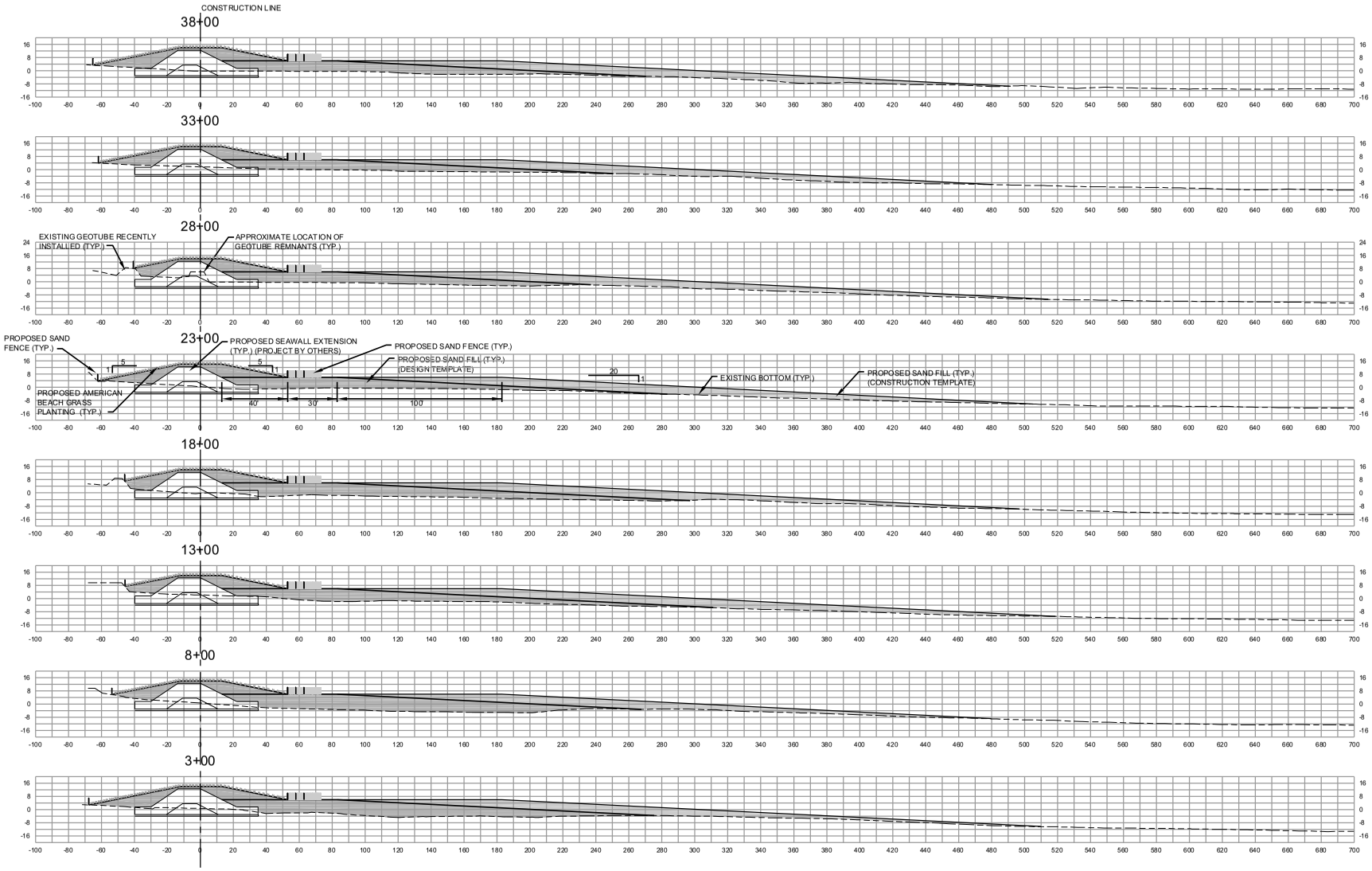
DETAILS

NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT BEACH FILL

ACCOMACK COUNTY, VIRGINIA

C-7
SHEET 7 OF 12

PRE-FINAL SUBMITTAL



NOTE: DUE TO FUNDING LIMITATIONS CONSTRUCTION SCOPE OF THE STONE SEAWALL EXTENSION AND / OR STONE SEAWALL REPAIR MAY NOT EXTEND TO THE LIMITS SHOWN. SEAWALL EXTENSION AND REPAIR WORK IS A SEPARATE PROJECT TO BE PERFORMED BY OTHERS AND COMPLETED PRIOR TO PLACEMENT OF BEACH FILL.

SECTIONS

SCALE : 1" = 30'

US Army Corps of Engineers
Norfolk District

NO.	DATE	DESCRIPTION	BY

DESIGNED: E.T.F. | CHECKED: G.O.W. | DATE: 22 June 2010
DRAWN: J.S.B. | SUBMITTED: 6/22/10 | SCALE: 1"=30'
PROJECT NO. 00000 | NORFOLK DISTRICT FILE NO.
DRAWING NO. | SPECIFICATION NO.
CAD VERSION: Pro/E Sizes "A1"
FILE NAME: /2010/2001-Seawall/Plots.dwg

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
4400 A MARTIN'S LANDING WAY, SUITE 1
CAMBRIDGE, MARYLAND 21613

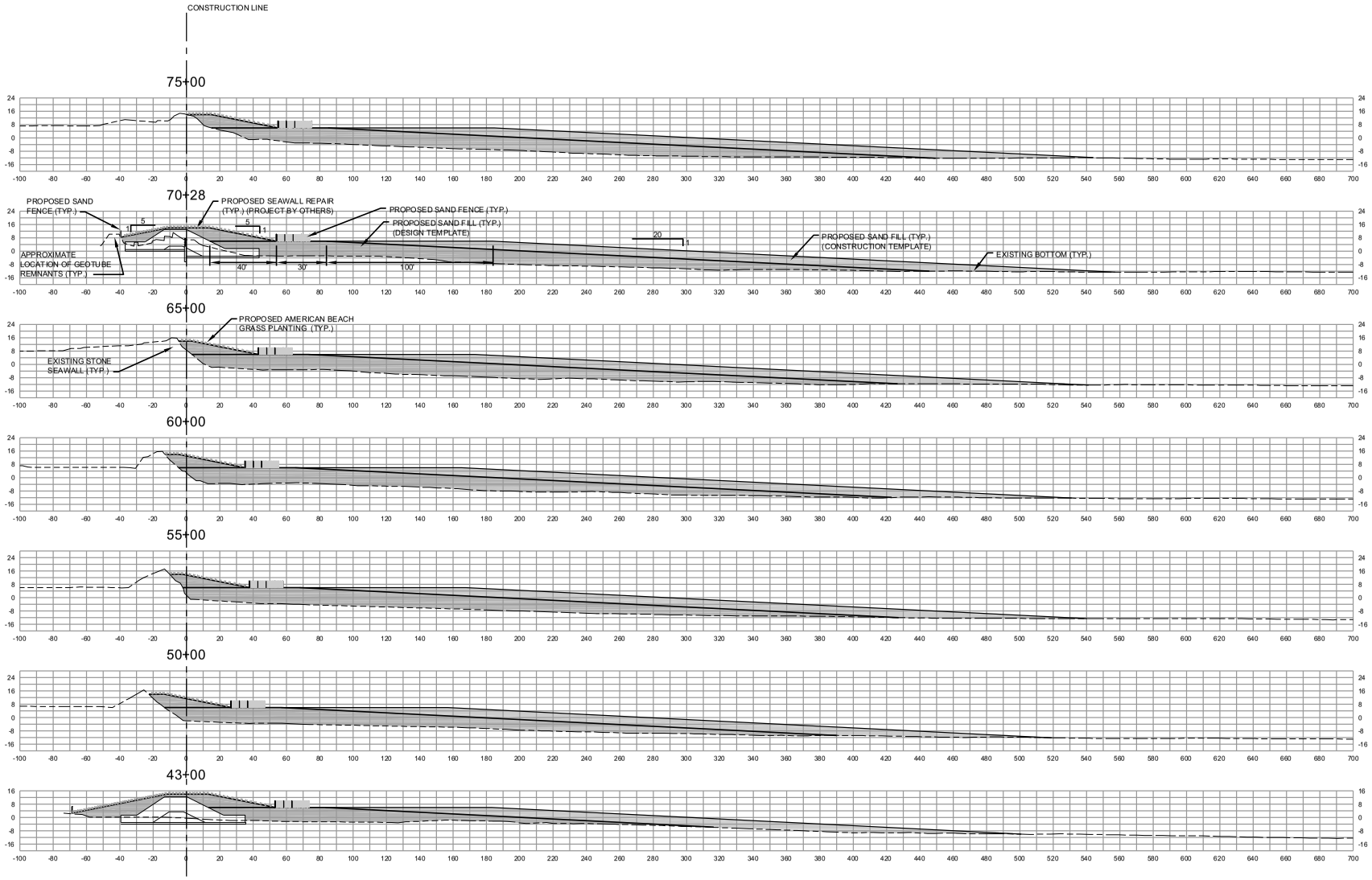
SECTIONS : (STA. 3+00 to STA. 38+00)

NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT BEACH FILL

ACCOMACK COUNTY, VIRGINIA

C-8
SHEET 8 OF 12

PRE-FINAL SUBMITTAL



SECTIONS

SCALE : 1" = 30' 0 15' 30'

US Army Corps of Engineers
Norfolk District

NO.	DATE	DESCRIPTION	BY	CHK'D

DESIGNED: E.T.F. | CHECKED: G.O.W. | DATE: 22 June 2010
DRAWN: J.S.B. | SUBMITTED: 6/22/10 | SCALE: 1"=30'
PROJECT NO. 00000 | NORFOLK DISTRICT FILE NO.
DRAWING NO. | SPECIFICATION NO.
UNIT WEIGHT lb/ft³ | Pay Scale '01
FILE NAME: /2007001-Sandy/Plots/

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
4400 A MARYLAND WAY, SUITE 1
CAMBRIDGE, MARYLAND 21613

SECTIONS : (STA. 43+00 to STA. 75+00)

NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT BEACH FILL

ACCOMACK COUNTY, VIRGINIA

C-9
SHEET 9 OF 12

PRE-FINAL SUBMITTAL

APPENDIX 2

ATLANTIC PIPING PLOVER POPULATION SIZE AND NESTING SUCCESS

APPENDIX 2

Estimated abundance of breeding pairs of Atlantic Coast piping plovers, 1986 – 2009 **PARENTHESES DENOTE PRELIMINARY ESTIMATES**

State/RECOVERY UNIT	Pairs																							
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Maine	15	12	20	16	17	18	24	32	35	40	60	47	60	56	50	55	66	61	55	49	40	35	24	27
New Hampshire												5	5	6	6	7	7	7	4	3	3	3	3	5
Massachusetts	139	126	134	137	140	160	213	289	352	441	454	483	495	501	496	495	538	511	488	467	482	558	566	(575)
Rhode Island	10	17	19	19	28	26	20	31	32	40	50	51	46	39	49	52	58	71	70	69	72	73	77	84
Connecticut	20	24	27	34	43	36	40	24	30	31	26	26	21	22	22	32	31	37	40	34	37	36	41	44
NEW ENGLAND	184	179	200	206	228	240	297	376	449	552	590	612	627	624	623	641	700	687	657	622	634	705	711	(735)
New York	106	135	172	191	197	191	187	193	209	249	256	256	245	243	289	309	369	386	384	374	422	457	443	(437)
New Jersey	102	93	105	128	126	126	134	127	124	132	127	115	93	107	112	122	138	144	135	111	116	129	111	105
NY-NJ	208	228	277	319	323	317	321	320	333	381	383	371	338	350	401	431	507	530	519	485	538	586	554	(542)
Delaware	8	7	3	3	6	5	2	2	4	5	6	4	6	4	3	6	6	6	7	8	9	9	10	10
Maryland	17	23	25	20	14	17	24	19	32	44	61	60	56	58	60	60	60	59	66	63	64	64	49	45
Virginia	100	100	103	121	125	131	97	106	96	118	87	88	95	89	96	119	120	114	152	192	202	199	208	193
North Carolina	30	30	40	55	55	40	49	53	54	50	35	52	46	31	24	23	23	24	20	37	46	61	64	54
South Carolina	3		0		1	1		1			0					0						0		
SOUTHERN	158	160	171	199	201	194	172	181	186	217	189	204	203	182	183	208	209	203	245	300	321	333	331	302
U.S. TOTAL	550	567	648	724	752	751	790	877	968	1150	1162	1187	1168	1156	1207	1280	1416	1420	1421	1407	1493	1624	1596	(1579)
EASTERN CANADA*	240	223	238	233	230	252	223	223	194	200	202	199	211	236	230	250	274	256	237	217	256	266	253	(252)
ATLANTIC COAST TOTAL	790	790	886	957	982	1003	1013	1100	1162	1350	1364	1386	1379	1392	1437	1530	1690	1676	1658	1624	1749	1890	1849	(1831)

* includes 1-5 pairs on the French Islands of St. Pierre and Miquelon, reported by CWS

Estimated productivity of Atlantic Coast piping plovers, 1987 – 2009 **PARENTHESES DENOTE PRELIMINARY ESTIMATES**

State/RECOVERY UNIT	Chicks fledged/pair																						
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Maine	1.75	0.75	2.38	1.53	2.50	2.00	2.38	2.00	2.38	1.63	1.98	1.47	1.63	1.60	1.98	1.39	1.28	1.45	0.55	1.35	1.06	1.75	1.70
New Hampshire											0.60	2.40	2.67	2.33	2.14	0.14	1.00	1.00	0.00	0.67	0.33	2.00	0.40
Massachusetts	1.10	1.29	1.59	1.38	1.72	2.03	1.92	1.81	1.62	1.35	1.33	1.50	1.60	1.09	1.49	1.14	1.26	1.38	1.14	1.33	1.25	1.41	(0.90)
Rhode Island	1.12	1.58	1.47	0.88	0.77	1.55	1.80	2.00	1.68	1.56	1.34	1.13	1.79	1.20	1.50	1.95	1.03	1.50	1.43	1.03	1.48	1.68	1.46
Connecticut	1.29	1.70	1.79	1.63	1.39	1.45	0.38	1.47	1.35	1.31	1.69	1.05	1.45	1.86	1.22	1.87	1.30	1.35	1.62	2.14	1.92	2.49	1.68
NEW ENGLAND	1.19	1.32	1.68	1.38	1.62	1.91	1.85	1.81	1.67	1.40	1.39	1.46	1.62	1.18	1.53	1.26	1.24	1.40	1.15	1.34	1.30	1.51	(1.04)
New York	0.90	1.24	1.02	0.80	1.09	0.98	1.24	1.34	0.97	1.14	1.36	1.09	1.35	1.11	1.27	1.62	1.15	1.46	1.44	1.55	1.15	1.21	(0.93)
New Jersey	0.85	0.94	1.12	0.93	0.98	1.07	0.93	1.16	0.98	1.00	0.39	1.09	1.34	1.40	1.29	1.17	0.92	0.61	0.77	0.84	0.67	0.64	1.05
NY-NJ	0.86	1.03	1.08	0.88	1.04	1.02	1.08	1.25	0.97	1.07	1.02	1.09	1.35	1.19	1.28	1.49	1.07	1.23	1.28	1.36	1.03	1.10	(0.96)
Delaware		0.00	2.33	2.00	1.60	1.00	0.50	2.50	2.00	0.50	1.00	0.83	1.50	1.67	1.50	1.17	2.33	1.14	1.50	1.44	1.33	0.30	1.30
Maryland	1.17	0.52	0.90	0.79	0.41	1.00	1.79	2.41	1.73	1.49	1.02	1.30	1.09	0.80	0.92	1.85	1.56	1.86	1.25	1.06	0.78	0.41	1.42
Virginia		1.02	1.16	0.65	0.88	0.59	1.45	1.66	1.00	1.54	0.71	1.01	1.21	1.42	1.52	1.19	1.90	2.23	1.52	1.19	1.16	0.87	1.19
North Carolina			0.59	0.43	0.07	0.41	0.74	0.36	0.45	0.86	0.23	0.61	0.48	0.54	0.50	0.17	0.46	0.65	0.92	0.87	0.26	0.30	0.70
SOUTHERN	1.17	0.85	0.88	0.72	0.68	0.62	1.18	1.37	1.05	1.34	0.68	0.99	1.04	1.09	1.22	1.27	1.63	1.95	1.38	1.12	0.92	0.67	1.14
U.S. (average)	1.04	1.11	1.28	1.06	1.22	1.35	1.47	1.56	1.35	1.30	1.16	1.27	1.45	1.17	1.40	1.34	1.24	1.43	1.24	1.30	1.13	1.19	(1.03)
EASTERN CANADA*		1.65	1.58	1.62	1.07	1.55	0.69	1.25	1.69	1.72	2.10	1.84	1.74	1.47	1.77	1.18	1.62	1.93	1.82	1.82	1.14	1.47	(1.22)

* includes St. Pierre and Miquelon, reported by CWS